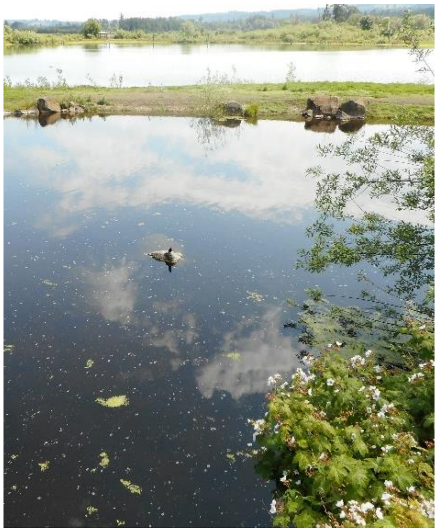
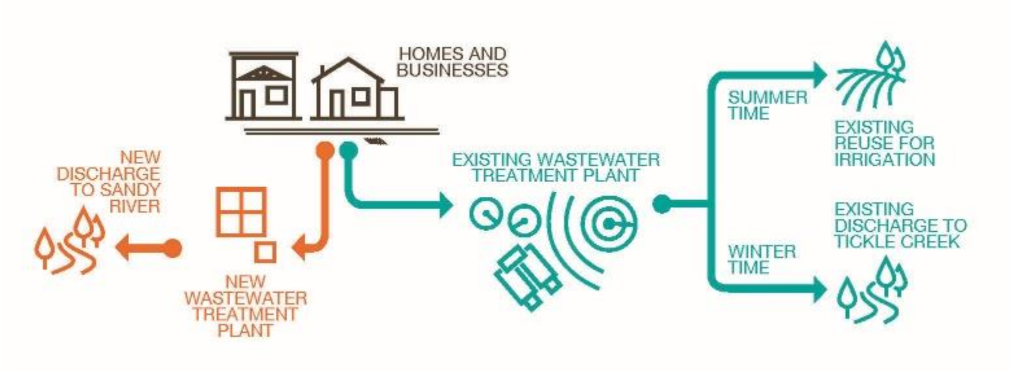


Photo provided by Wolf Water Resources



CITY OF SANDY

Detailed Discharge Alternatives Evaluation Final Report

June 2021

This project was funded in part by the Oregon State Lottery and administered by the Oregon Business Development Department.

Detailed Discharge Alternatives Evaluation Final Report

City of Sandy

June 2021

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This project was funded in part by the Oregon State Lottery and administered by the Oregon Business Development Department.

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Executive Summary

Introduction

The City of Sandy (City) is a growing community and has an aging existing WWTP and collection system. Based on growth and deterioration of the existing sanitary sewer system, the City's existing wastewater treatment plant (WWTP) does not have adequate capacity to continue to serve the City. Additionally, DEQ regulations such as the Three Basin Rule mandate that the discharge into Tickle Creek, which is part of the Clackamas River Basin, may not be increased. To address these issues and to prepare for future growth, the recent Wastewater System Facilities Plan (WSFP) and continuing analysis associated with this plan recommend that the only feasible long term solution is to construct a new satellite treatment facility and a new year-round outfall to the Sandy River. This new facility will work in concert with the existing WWTP, which will be upgraded to meet wastewater effluent quality requirements for Tickle Creek. The WSFP also includes rehabilitation to the existing sewer collection network.

The City of Sandy Detailed Discharge Alternatives Evaluation (DDAE) Study provides an evaluation of discharge alternatives building on the adopted Recommended Plan contained in the WSFP. The goal of the DDAE is to identify and evaluate discharge options in lieu of or in combination with a direct year-round discharge to the Sandy as proposed in the WSFP Recommended Plan.

Summary of the Scope

This document is associated with Task 9.1 of the project scope of work, which involves consolidating the information, including evaluations, findings, and recommendations from each of the memoranda into a single report identified in the scope-of-work. This memorandum is divided into sections based on the technical memoranda provided under the scope of work followed by summary conclusions for the DDAE.

Analysis Summary

TM-3: Alternative Wastewater System Connection

Technical Memorandum 3 (TM-3) contains a summary of information regarding pumping raw wastewater from the City to either the Clackamas County Water Environment Services (WES) Tri-City Water Pollution Control Plant (WPCP) or the City of Gresham WWTP (Gresham WWTP). Alignments, capital costs, and lifecycle costs for each option were developed. It was assumed that the cost was a planning estimate to be used solely for the purpose of a detailed discharge alternatives evaluation for the City.

The purpose of documenting these alternatives was to verify the results of previous planning efforts presented in the City's WSFP, prepared in 2018. In the WSFP, it was documented that the discharge alternatives to WES and Gresham represented greater costs than the alternatives outlined for a new discharge to the Sandy River, which totaled approximately $60M. The evaluation relative to the WES and Gresham alternatives was completed at a planning level effort based several assumptions. The evaluation presented with the memorandum represents additional details relative to pipe routing and pump stations, additional cost analysis and additional information provided through discussions with staff from WES and the Gresham WWTP. The estimated costs for the WES and Gresham alternatives were $116M and $130M, respectively.

The costs outlined within TM-3 are significantly higher than the Sandy River Discharge Alternative. Based on that, as well as the uncertainty associated with exporting flows and the associated, potentially higher operational costs, these alternatives are not recommended for this project.

TM-4: Basis of Design Report

The purpose of this technical memorandum is to summarize the activities of Task 3: Sandy Wastewater Treatment Facilities Basis of Design. Specifically, the report provides greater clarification of the design criteria for the existing City of Sandy WWTP (Sandy WWTP) and the Eastside MBR Facility, as recommended in the WSFP.

As part of the WSFP, the 20-year flow and load projections for the entire system were developed as shown on **Table ES-1** through **Table ES-3**.

A summary of the projected flows from 2017 to 2040 to the existing Sandy WWTP based on proposed staging of the Eastside MBR Facility is shown in **Table ES-4**, and the revised wastewater loads to the Sandy WWTP are show in **Table ES-5** and **Table ES-6.**

For the Eastside MBR Facility, a summary of the projected flows is shown in **Table ES-7**, and the projected wastewater loads are show in **Table ES-8** and **Table ES-9.**

Table ES-1 | Summary of Existing and Projected Flow

Flow	Existing Flow, MGD	2040 Flow, MGD
Annual Average Flow (AAF)	1.4	2.39
Average Dry Weather Flow (ADWF)	1.0	2.0
Average Wet Weather Flow (AWWF)	1.78	3.05
Maximum Month Dry Weather Flow (MMDWF)	1.5	2.4
Maximum Month Wet Weather Flow (MMWWF)	2.6	4.1
Peak Week Flow (PWF)	4.0	6.6
Peak Day Flow (PDF)	8.9	12.1
Peak Instantaneous Flow (PIF)	10.3	14.0

Table ES-2 | Current BOD_5 and TSS Loads

2017 Population	Parameter	Monthly Average			Maximum Month		
		Concentration (mg/L)	Load (ppd)	Load Factor (ppcd)	Concentration (mg/L)	Load (ppd)	Load Factor (ppcd)
Summer Season (May 1 through October 31)							
11,800	BOD_5	286	2,500	0.209	455	3,600	0.305
11,800	TSS	280	2,400	0.201	456	3,500	0.294
Winter Season (November 1 through April 30)							
11,800	BOD_5	192	2,400	0.203	297	3,500	0.294
11,800	TSS	190	2,400	0.202	342	3,900	0.333

Notes:

1. ppd= pounds per day
2. ppcd = pounds per capita per day

Table ES-3 | 2040 BOD_5 and TSS Loading Projections

2040 Population	Parameter	Monthly Average		Maximum Month	
		Load Factor (ppcd)	Load (ppd)	Load Factor (ppcd)	Load (ppd)
Summer Season (May 1 through October 31)					
22,400	BOD_5	0.209	4,700	0.305	6,800
22,400	TSS	0.201	4,500	0.294	6,600
Winter Season (November 1 through April 30)					
22,400	BOD_5	0.203	4,600	0.294	6,600
22,400	TSS	0.202	4,500	0.333	7,500

Notes:

1. ppd= pounds per day
2. ppcd = pounds per capita per day

Table ES-4 | Summary of Current and Projected Flow (MGD) to Existing Sandy WWTP

Flow Event	2017	2020	2025	2026[1]	2030	2035	2036[2]	2040
AAF	1.4	1.45	**1.53**	0.93	1.14	**1.35**	0.76	1.20
ADWF	1.08	1.12	**1.18**	0.72	0.88	**1.05**	0.59	0.93
AWWF	1.78	1.85	**1.95**	1.19	1.45	**1.73**	0.97	1.53
MMDWF	1.41	1.46	**1.54**	0.94	1.15	**1.37**	0.77	1.21
MMWWF	2.66	2.76	**2.91**	1.8	2.17	**2.58**	1.44	2.27
PWF	5.01	5.19	**5.48**	3.34	4.08	**4.85**	2.71	4.28
PDF	5.87	6.08	**6.42**	3.91	4.77	**5.68**	3.18	5.02
PIF	9.05	9.38	**9.9**	6.40	7.73	**9.13**	5.63	7.00

Notes:

1. First stage of Eastside MBR Facility begins operation in 2026
2. Second stage of Eastside MBR Facility begins operation in 2036

Table ES-5 | Sandy WWTP Average Day BOD_5 and TSS Loading Projections

Year	Average Dry Weather			Average Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS,ppd
2020	1.12	2,700	2,600	1.85	2,600	2,600
2025	1.18	3,100	3,000	1.95	3,000	3,000
2026[1]	0.718	1,900	1,800	1.19	1,800	1,800
2030	0.878	2,300	2,200	1.45	2,300	2,200
2035	1.05	2,800	2,700	1.73	2,700	2,700
2036[2]	0.585	1,600	1,500	0.97	1,500	1,500
2040	0.925	2,300	2,200	1.53	2,300	2,300

Notes:
1. First stage of Eastside MBR Facility begins operation in 2026
2. Second stage of Eastside MBR Facility begins operation in 2036

Table ES-6 | Sandy WWTP Maximum Month BOD_5 and TSS Loading Projections

Year	Maximum Month Dry Weather			Maximum Month Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS, ppd
2020	1.46	3,900	3,800	2.76	3,800	4,300
2025	1.54	4,500	4,300	2.91	4,300	4,900
2026[1]	0.9375	2,700	2,600	1.78	2,700	3,000
2030	1.1475	3,400	3,300	2.17	3,300	3,700
2035	1.37	4,100	4,000	2.58	4,000	4,500
2036[2]	0.765	2,300	2,200	1.44	2,200	2,500
2040	1.205	3,400	3,300	2.27	3,300	3,700

Notes:
1. First stage of Eastside MBR Facility begins operation in 2026
2. Second stage of Eastside MBR Facility begins operation in 2036

Table ES-7 | Summary of Projected Flow for Eastside MBR Facility in MGD

Flow Event	2026[1]	2030	2035	2036[2]	2040
AAF	0.60	0.60	0.60	1.20	1.20
ADWF	0.46	0.46	0.46	0.93	0.93
AWWF	0.76	0.76	0.76	1.53	1.53
MMDWF	0.60	0.60	0.60	1.21	1.21
MMWWF	1.14	1.14	1.14	2.27	2.27
PWF	2.14	2.14	2.14	4.28	4.28
PDF	2.51	2.51	2.51	5.02	5.02
PIF	3.50	3.50	3.50	7.00	7.00

Notes:
1. First stage of Eastside MBR Facility begins operation in 2026
2. Second stage of Eastside MBR Facility begins operation in 2036

Table ES-8 | Eastside MBR Facility Average Day BOD_5 and TSS Loading Projections

Year	Average Dry Weather			Average Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS, ppd
2026	0.46	1,211	1,164	0.76	1,173	1,167
2040	0.93	2,337	2,248	1.53	2,270	2,259

Table ES-9 | Eastside MBR Facility Maximum Month BOD_5 and TSS Loading Projections

Year	Maximum Month Dry Weather			Maximum Month Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS,ppd
2026	0.60	1,764	1,700	1.14	1,695	1,920
2040	1.21	3,411	3,288	2.27	3,288	3,724

The report further evaluated and determined that flows at the Diversion Pump Station were sufficient to consistently send the required flow to the Eastside MBR Facility.

The Biowin biological process model of the existing Sandy WWTP, developed as part of the WSFP, was evaluated at key points in the phased implementation plan outlined in the WSFP to confirm performance of the Sandy WWTP. The results of the biological process analysis showed that the planned improvements at the Sandy WWTP along with the staged construction of the Eastside MBR Facility will result in the facility meeting its permit through 2040, assuming all equipment operates as designed. The upcoming immediate needs improvements project will improve performance of key unit processes, including the aeration basins and the secondary clarifiers that had resulted in permit exceedances. In addition, increased capacity of the sodium hydroxide feed system was found to be key for meeting the ammonia permit limit. The phasing of the improvements to the Sandy WWTP outlined in Phase 2 of the WSFP should be implemented based on the observation of growth in the community that results in increased flow and load to the WWTP.

As noted in the WSFP, the Eastside MBR Facility will be constructed under two stages. TM-4 provides a basis of design for the unit processes to be constructed including identifying design criteria and redundant equipment requirements. The Eastside MBR Facility will consist of headwork, membrane bioreactor, UV disinfection, and post-aeration. The headworks facility will consist of the three fine screens after Stage 2 construction, each with a rated capacity of 3.5 MGD with openings less than 2 mm. A single vortex grit removal system with a rated capacity of 7.0 MGD will be installed in Stage 1. The MBR will consist of a total of four trains; two trains will be installed during Stage 1 construction, and the remaining two trains will be installed under Stage 2. Four in-pipe UV disinfection systems will be installed to disinfect the secondary treated wastewater to discharge to the Sandy River or to meet either Class A Recycle Water standards for irrigation or discharge to Roslyn Lake. Finally, a post-aeration system will be installed to increase the dissolved oxygen to 6 mg/L to meet the discharge effluent requirements that were identified in the preliminary anti-degradation analysis (TM-11). A summary of the design criteria can be found on Table 5-2 in TM-4. A preliminary layout of the Eastside MBR Facility is shown on **Figure ES-1**.

TM-5: Sandy River Temperature Evaluation

Technical Memorandum 5 (TM-5) is a deliverable under Task 4.2 of the DDAE program. This memo includes a review of potential impacts to temperature on the Sandy River due to effluent discharges from the proposed, new membrane bioreactor facility.

Part of the WSFP Continuing Planning Services project, TM-5 is an update to the memo prepared on May 22, 2019. This update provides the opportunity to review this topic with additional temperature data collected on the Sandy River, and updated estimates of river flows, effluent flows, and effluent temperatures.

The project team used new and updated data to review potential temperature impacts to the Sandy River from the proposed new Eastside MBR Facility. Results from this new review are consistent with those from 2019: the planned effluent discharge into the Sandy River will need thoughtful temperature design and management to meet regulatory temperature thresholds, especially as the community grows. Furthermore, this updated temperature review results in the following conclusions.

- Temperature will be one of the more challenging issues to address during the final design and National Pollutant Discharge Elimination System (NPDES) permitting process for the Eastside MBR Facility and Sandy River discharge.
- With population growth at the City and climate change, temperatures and heat load will increase, resulting in greater need for temperature management and likely more stringent regulatory controls.
- As summarized in TM-5, summer and fall discharges to the Sandy River (especially in the future) could result in violations of current regulatory temperature thresholds if temperature is not managed appropriately. Preliminary analysis indicates that these thresholds could be exceeded before 2030.
- The City will want to continue to work closely with the Oregon Department of Environmental Quality (DEQ) to better understand which regulatory thresholds will govern final design and permitting. There are currently several thresholds listed in the total maximum daily load (TMDL) study and in the Antidegradation Internal Management Direct (IMD).
- Likewise, the City will want to coordinate closely with DEQ on methodology for temperature reviews. For planning purposes, it was assumed that 1/4 of the Sandy 7Q10 River flows would mix with effluent (consistent with DEQ's point source temperature

reviews in the Sandy River TMDL). Other methodology could assume 100 percent of 7Q10 river flows for mixing and different temperature thresholds.

- Final NPDES permitting reviews of temperature will require outfall design, dilution modeling, and related mixing zone studies to better estimate mixing and dilution of effluent when it enters the Sandy River. The regulatory temperature thresholds would need to be met after the effluent mixes and travels to the defined regulatory mixing zone boundary.
- The DDAE planning study identified and recommended the Roslyn Lake site for discharging portions of the effluent (into constructed wetlands) during summer and fall periods to help eliminate/minimize temperature impacts to the Sandy River now and into the future.

TM-6: Sandy River Water Quality Sampling and Testing Program Summary

Technical Memorandum 6 (TM-6) contains a summary of 2019-2020 Sandy River water quality data collected in proximity to alternatives for the outfall location of the proposed Eastside MBR Facility. The City and DEQ hope to determine compliance with anti-degradation laws set forth in the Oregon Administrative Rules (OAR) regulated by the DEQ in the NPDES permitting process.

Murraysmith collected grab samples and Alexin Analytical Laboratories, Inc in Tigard, Oregon analyzed the samples in accordance with the Sampling and Testing Plan prepared August 7, 2019. Waterways Consulting, Inc installed temperature probes which recorded measurements on a 15-minute interval from July through October in 2019 and 2020. River discharge was estimated using instantaneous data from USGS Gages. TM-6 summarizes the findings for the following parameters: pH, bacteria, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Kjeldahl Nitrogen (TKN), ammonia, nitrate, nitrite, phosphorus, Total Organic Carbon (TOC), hardness, chromium, iron, temperature, and flow.

This ambient water quality data was used to inform design proposals such as outfall site selection as described in Technical Memorandum 7.1 (TM-7.1). The data will be used as the project moves forward to better understand the water quality characteristics of the Sandy River. In this memorandum, Murraysmith recommends continued water quality sampling on a quarterly basis to provide a robust dataset for these evaluations.

TM-7.1: Sandy River Outfall Siting Study

This technical memorandum is a summary of Task 5: The Sandy River Outfall Siting Study. The purpose of Task 5 is to review alternative discharge locations on the Sandy River for placing the outfall from the proposed Eastside MBR Facility.

The reviewers conducted desktop and field studies to evaluate key river characteristics that would make for a good outfall site including:

- River depth and velocity, to provide good water quality mixing conditions
- Channel geologic/geomorphic stability, so that the channel would not migrate away from the outfall over time
- Fish use for spawning/rearing/migration, to minimize fisheries impacts/concerns
- Distance from the new treatment plant, for pipe economy
- Outfall accessibility, for construction and operation and maintenance
- Related characteristics

Based on the results of Task 5 (The Sandy River Outfall Siting Study), the Ten Eyck Road and Revenue Bridge site is the recommended location for the new outfall. This site has several advantages over other alternatives.

- This river reach is dominated by bedrock, so the channel does not migrate in this area, providing for greater geomorphic stability and consistent outfall operating conditions.
- This reach of the river is deep and has reasonable velocity (providing greater dilution and dispersion) and good water quality mixing characteristics.
- The area has less public accessibility than river reaches near the park and less potential for vandalism (although that possibility needs to be considered during final design).
- This location is upstream from the Cedar Creek fish hatchery; therefore, there would be less potential for impacts to hatchery fish.
- This reach is used for anadromous fish migration, not spawning or rearing, so anadromous fish would just be passing through.
- This site seems to have the greatest agency support based on preliminary meetings.
- Revenue Bridge provides a good river crossing location for the effluent pipeline that would carry effluent to the Roslyn Lake area, where it could be reused for creating wetlands, as described in Technical Memorandum 9-10.

TM-7.2: Pipe Routing

Technical Memorandum 7.2 (TM-7.2) summarizes the evaluation and findings associated with routing the effluent pipeline from the proposed Eastside MBR Facility to potential discharge locations identified on the Sandy River, and a recommended pipeline route from the river up to Roslyn Lake. The memorandum includes a summary of route selection criteria and a summary of potential alternatives. The preliminary cost estimates presented in TM-7.2 are planning estimates to be used solely for the purpose of a detailed discharge alternatives evaluation for the City. The memorandum also outlines, on a preliminary basis, pipeline routing considerations and conceptual design elements for the recommended route for the pipeline.

The purpose of the study is to determine a practical route for the effluent pipe relative to the selected outfall locations and assist with developing conceptual level costs estimates. The purpose of documenting the alternatives and the preferred route is to evaluate the feasibility of routing the pipeline along various alignments and identify the challenges and required engineering to develop a final pipeline route. Other key considerations to develop final alignment recommendations and final routing concepts include permitting, easement and property acquisition needs, geotechnical considerations, pipe material selection, detailed hydraulic analysis, and final designs associated with the effluent pipe. It is anticipated that these elements will be further evaluated in subsequent permitting and preliminary design phases of the project. An overview map of the pipeline routing alternatives is shown in **Figure ES-2**.

The team reviewed three options for routing the pipeline between the plant and the river (Segment 1) and three options between the river and the Roslyn Lake site (Segment 2). The alternatives were assessed relative to several criteria outlined above including construction at highway and bridge crossings, maintenance accessibility, system control, geological stability, opportunity projects, and the cost factors associated with each criterion. Based on the evaluation, the preferred route is Segment 1 Option 1.B and Segment 2 Option 2.B, as shown in **Figure ES-2**. This selected route extends through City right-of-way, through the City's Sandy River Park and across ODFW and private property to the Sandy River. Between the Sandy River and the Roslyn Lake site, it extends along County right-of-way. The estimated cost for this proposed pipeline is approximately $12.8 M.

Additional data collection and analysis is recommended to verify the concepts presented in TM-7.2. Further evaluations should include geotechnical investigations, outreach to private property owners regarding easements, discussions with ODFW, ODOT, and the County to confirm routing, opportunity projects, and permit requirements.

TM-8 Water Recycling Market Assessment

Technical Memorandum 8 (TM-8) contains a summary of information collected during the Water Recycling Program Customer Outreach study as part of the City's Detail Discharge Alternatives Evaluation. The initial Water Recycling Program Customer Outreach conducted by Barney & Worth, Inc. (B&W) evaluated several sites to determine if a property or properties near the City or along the proposed effluent pipe route had the irrigation demands to take all or most of the effluent from the City's proposed Eastside MBR Facility. The goal was to find an irrigator or irrigators which could take effluent during the summer and shoulder seasons (late spring and early fall) to help minimize the flows to the Sandy River during these times of year. TM-8 provides an analysis which evaluates the options for providing recycled water to potential customers including the pumping requirements, pipeline alignments, and capital and lifecycle costs. Eight options were initially considered relative to large irrigators and five options are considered for small use irrigators.

The purpose of TM-8 is to document the evaluation of potential options and opportunities to expand the City's successful water recycling program based on effluent from the Eastside MBR Facility.

Based on the analysis of cost and potential discharge rates, the large-scale irrigator sites did not show real market demand for the recycled water and required larger capital investments because of the longer pipeline lengths required between the main effluent piping routed to the Sandy River and the potential irrigation sites. The small-scale irrigator sites showed greater current irrigation utilization rates and required a much smaller capital investment due to the shorter pipeline lengths from the preferred pipeline alignments.

It is recommended to pursue a recycled water program for irrigators close to the preferred pipeline alignment. In TM-8, Murraysmith recommends the City establish a fair basis to extend recycled water to interested users based on the length of pipe required for service and the total supply of recycled water requested. Some of these potential users of the recycled water will require little capital investment to connect to the main pipeline and will benefit from the availability of recycled water. Additionally, irrigation use of the recycled water will help reduce discharges to the Sandy River during the critical dry months of the year.

TM-9 & 10 Indirect Discharge and Roslyn Lake Alternatives Site Review

This technical memorandum summarizes Task 7 of the Detailed Discharge Alternatives Evaluation: Indirect Discharge and Roslyn Lake Alternatives. The regulations surrounding indirect discharge (Technical Memorandum 9) and site reviews and analysis of indirect discharge (Technical Memorandum 10) are related. Thus, both aspects are summarized in this one document, Technical Memorandum 9 and 10 (TM-9 & 10).

Based on this review, it is anticipated that DEQ will regulate the proposed discharge to the Sandy River and the Roslyn Lake constructed wetlands through a single NDPES permit. DEQ currently regulates the City's discharge to Tickle Creek and the container nursery that way. It is not clear if DEQ will modify the existing Tickle Creek permit by adding the Sandy River and Roslyn Lake discharges, or if they will issue a new permit for the Sandy River and Roslyn Lake discharges.

The City has the opportunity to construct wetlands to beneficially recycle/reuse the high-quality effluent from the proposed Eastside MBR Facility. The Roslyn Lake site seems well suited for this approach and Trackers Earth (the property owner) is interested in partnering with the City on this type of a project. The project team will need to conduct further reviews of soils/infiltration and of existing wetlands and waterways on the Roslyn Lake property as the project moves into final design to better understand associated opportunities and constraints.

Based on these planning level reviews, the City would need to construct approximately 30 to 60 acres of wetlands and the construction cost would be approximately $3 million to $6 million dollars. See **Figures ES-3** and **ES-4** for a plan and profile view of the proposed wetlands concept.

TM-11 Anti-degradation Report

Technical Memorandum 11 (TM-11) describes the proposed Eastside MBR Facility and the proposed discharge into the Sandy River. The discharge into the Sandy River would constitute a new, permitted effluent discharge. Therefore, the proposed project is subject to a water quality antidegradation review (OAR-340-041-0026). Furthermore, since the proposed discharge would be to a water quality limited waterbody, the antidegradation review would follow the approach outlined for these waterbodies in the IMD for antidegradation reviews (ODEQ, 2001).

The purpose of TM-11 is to describe the proposed project and summarize the antidegradation review and findings. The following conclusions are based on the results of that review.

- The new Eastside MBR Facility would discharge into the Sandy River using a new pipeline and outfall. The final pipe alignment and outfall location are currently being determined.
- The Eastside MBR Facility would generate high-quality effluent using modern technology.
- The project engineers have evaluated the potential impacts from the proposed discharge using DEQ's methodology for evaluating discharges into the Sandy River from the Sandy River Basin TMDL (assuming 25 percent of the 7Q10 river flows mix with effluent).
- The antidegradation thresholds under review include: (1) no greater than 0.25 °F temperature increase, and (2) no greater than 0.1 mg/L decrease in dissolved oxygen, after mixing at the end of an assumed mixing zone.
- With estimated effluent flows from the Eastside MBR Facility for existing (2020) conditions, the discharge would not exceed the antidegradation thresholds for temperature or dissolved oxygen.
- With estimated flows from the Eastside MBR Facility for future (2040) conditions (as the community grows), the discharge would start to exceed the antidegradation thresholds for temperature and dissolved oxygen during the summer and fall months.
- The City proposes a temperature management plan where they would land apply a portion of the high-quality effluent during summer and fall to prevent possible thermal impacts to the river.
- The exact months and amount of effluent to be land applied will be determined during final design and through the NPDES permitting process.
- To prevent possible impacts to dissolved oxygen, the City proposes a DO management plan where they would land apply a portion of the effluent during the summer and fall, and also oxygenate the effluent as needed.

- The exact months and amount of effluent to be land applied will be determined during final design and through the NPDES permitting process.
- The review of other water quality parameters will occur, as needed, during the NPDES permitting process once a new outfall location has been identified and when mixing zone boundaries and estimated dilution are better known.
- Other environmental reviews for the project under local, state, and federal regulations will progress as the project moves from the planning to design phases.

DDAE Program Summary

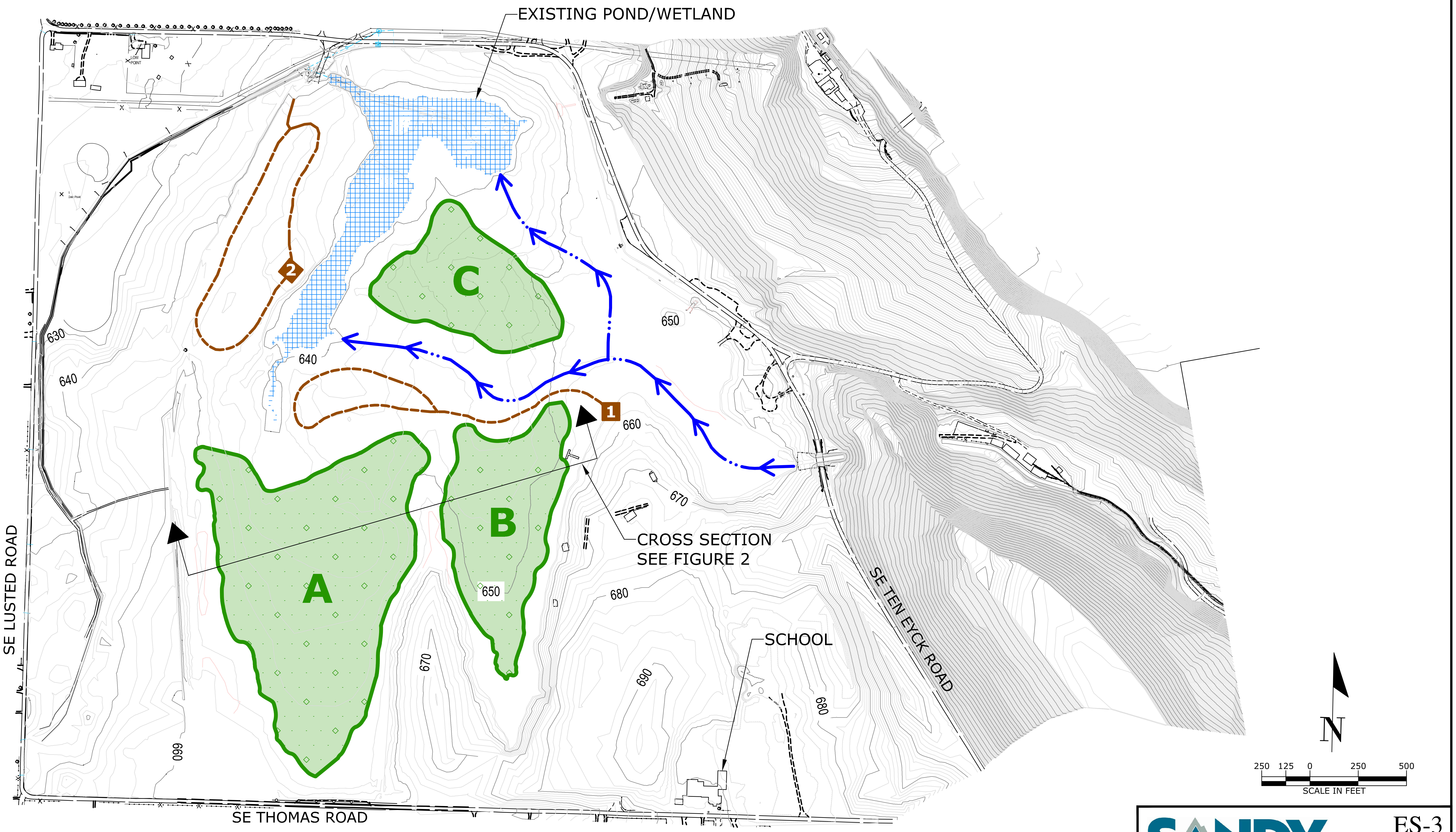
The City's DDAE Study provides an evaluation of discharge alternatives to the Sandy River for the proposed Eastside MBR Facility. It also included reviewing alternatives to the discharge to the Sandy River including irrigation potential and the potential to conveying raw sewage to WES and the City of Gresham WWTP which were found to be less cost effective.

The DDAE included development of concepts for the diversion pump station and the Eastside MBR Facility, furthering concepts for effluent pipeline routing and development of concepts for improvements at the Roslyn Lake site.

Based on analyses in the DDAES, it was found that, as the community grows, discharges to the Sandy River will start to exceed the temperature impacts threshold during the summer months. To address this, the DDAE assessed concepts for discharging to Roslyn Lake and reviewed these with the property owner of the former lake. The concepts involve constructed wetlands sized to accept the flows without discharge to downstream water bodies. The DDAE also reviewed 3 alternatives for effluent pipeline routing. The selected route extends through City right-of-way, through the City’s Sandy River Park and across ODFW and private property to the Sandy River. Between the Sandy River and the Roslyn Lake site, it extends along County right-of-way.

The goal of the DDAE Study was to build on previous planning work to select an outfall location, assess the feasibility of discharging to the Sandy River relative to temperature and other impacts and evaluate the feasibility of discharging to the former Roslyn Lake site if there were limitations identified relative to discharges to the River. Following preliminary concept development and analyses, the City and the engineering team met with regulatory agencies to review the feasibility relative to the agencies perspective an identify potential issues relative to permitting. The agencies were in favor of the proposed outfall location and leveraging the Roslyn Lake site to minimize temperature impacts to the River. The team also reviewed the feasibility of discharging to the Roslyn Lake site with the property owner. There were several site visits and meetings with the property owner to outline preliminary concepts. The concepts of constructed wetlands and trail system were acceptable to the property owner. Additionally, the feasibility of routing the effluent pipeline through ODFW property and private properties was assessed. Based on discussions with ODFW and property owners, the proposed route appears to be feasible on a preliminary basis.

The DDAE Study evaluated alternatives and assessed the feasibility of preliminary concepts relative to the satellite facility, the outfall location and pipeline routing. The City has a program that includes acquiring permits, developing final design and eventually construction of the wastewater system improvements. The next steps following the DDAE Study include further assessments and analysis to further establish concepts outlined in the DDAE Study. These include further investigations at the Roslyn Lake site, the satellite facility, and diversion pump station sites and additional assessment of the pipeline routing to confirm routing and property owners' willingness to provide easements. There is significant permitting work to completed prior to final designs including acquiring an NPDES permit for the outfall, permitting associated with the Roslyn Lake site and permits associated with the effluent pipeline.



LEGEND

TRAILS ---------
WETLANDS ▬
VIEWING PLATFORM LOCATION ■
NATURAL WATERS ←··—··—

SANDY
WHERE INNOVATION MEETS ELEVATION

ES-3

Detailed Discharge
Alternatives Evaluation

WETLAND CONCEPT PLAN

NOVEMBER 2020
20-2276

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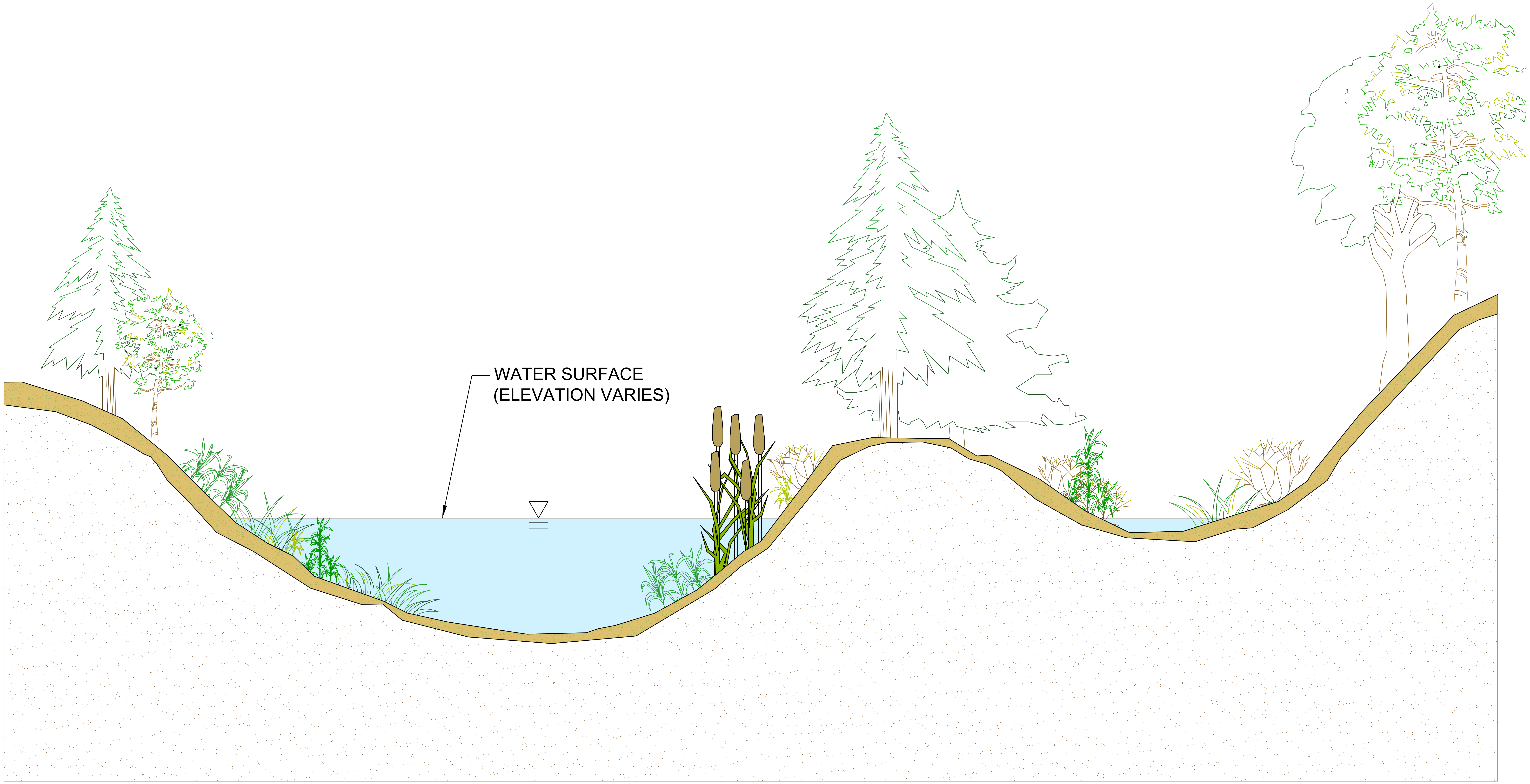


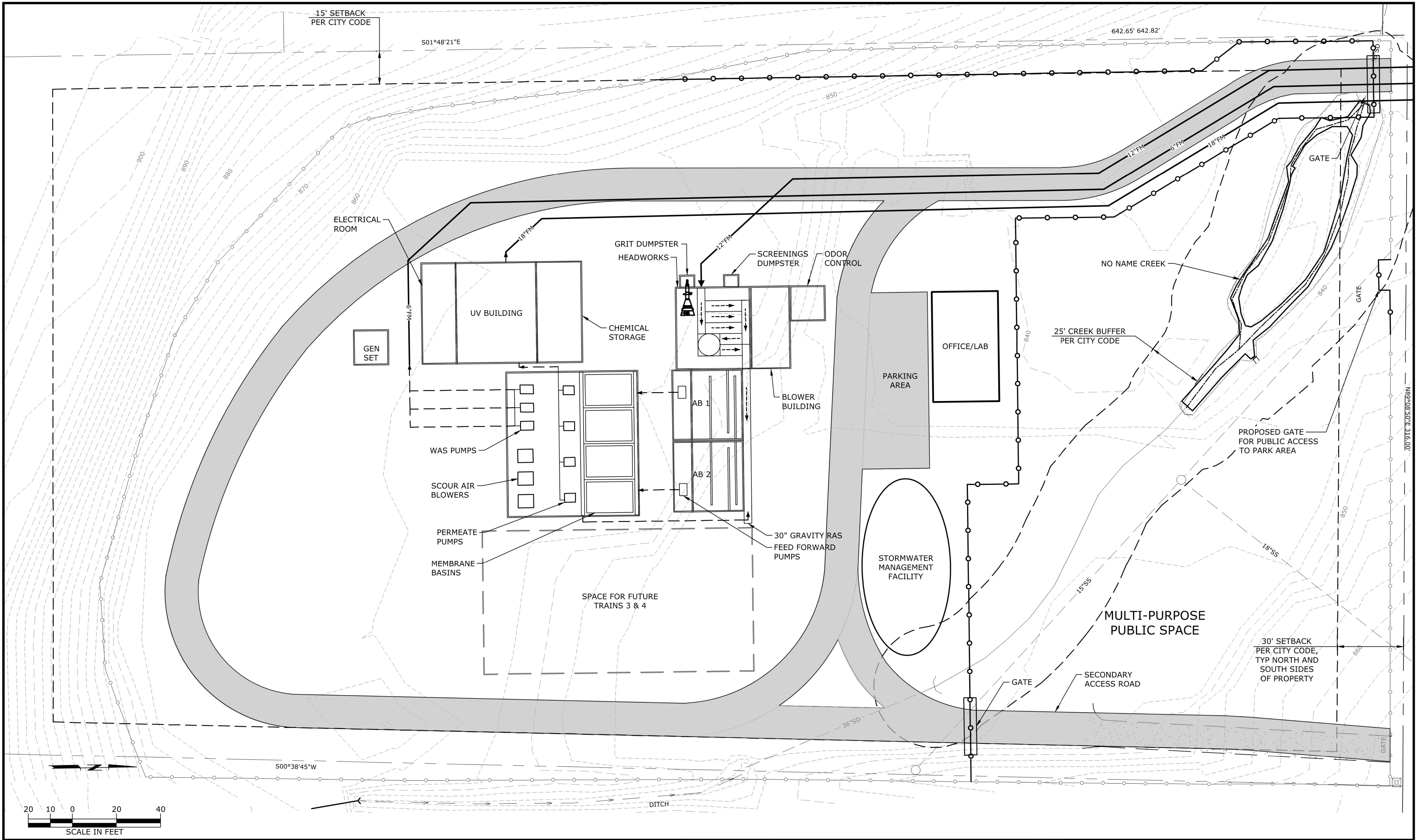
SANDY
WHERE INNOVATION MEETS ELEVATION

ES-4

Detailed Discharge Alternatives Evaluation

WETLAND CONCEPT SECTION

NOVEMBER 2020
20-2276



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NO.	DATE	BY	REVISION

NOTICE
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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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PRELIMINARY ONLY
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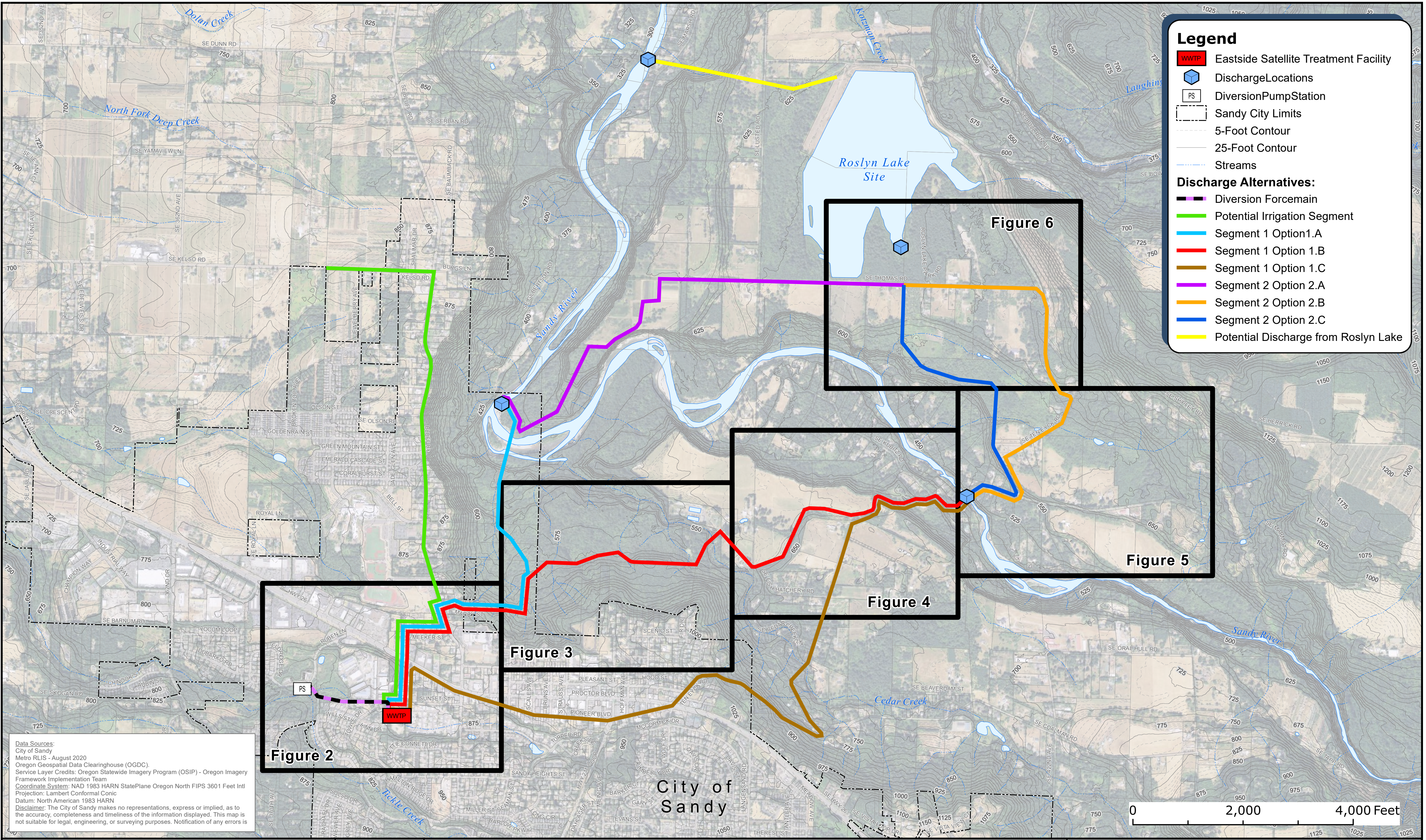
SANDY
WHERE INNOVATION MEETS ELEVATION

EASTSIDE SATELLITE TREATMENT FACILITY BASIS OF DESIGN

PRELIMINARY CONCEPTUAL EASTSIDE SATELLITE TREATMENT FACILLITY SITE PLAN

PROJECT NO.: 20-2776 SCALE: AS SHOWN DATE: NOVEMBER 2020

SHEET
ES-1



Data Sources:
City of Sandy
Metro RLIS - August 2020
Oregon Geospatial Data Clearinghouse (OGDC).
Service Layer Credits: Oregon Statewide Imagery Program (OSIP) - Oregon Imagery Framework Implementation Team
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
Disclaimer: The City of Sandy makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is

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SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Wastewater System Facility Plan

ES-2
PIPELINE ALTERNATIVES

February 2021

20-2776

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Technical Memorandum 3

Date: September 24, 2020

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler,
Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Matt Hickey, PE
Jessica Cawley, PE
Murraysmith

Re: Alternate Wastewater System Connection Options TM-3

Introduction

This memo contains a summary of information regarding pumping raw wastewater from the City of Sandy (City) to either the Clackamas County Water Environment Services (WES) Tri-City Water Pollution Control Plant (WPCP) or the City of Gresham Wastewater Treatment Plant (WWTP). Alignments, capital costs, and lifecycle costs for each option have been developed. It is assumed that the cost is a planning estimate to be used solely for the purpose of a detailed discharge alternatives evaluation for the City of Sandy.

Purpose

The purpose of documenting these alternatives is to verify the results of previous planning efforts presented in the City of Sandy Wastewater System Facility Plan prepared in 2018. In the Facility Plan, it was documented the discharge alternatives to WES and Gresham represented greater costs than the alternatives outlined for a new discharge to the Sandy River which totaled approximately $60M. The evaluation relative to the WES and Gresham alternatives was completed at a planning level effort which included limited detail. The evaluation presented with the memorandum, represents additional details relative to pipe routing and pump stations, additional cost analysis and additional information provided through discussions with staff from the WES and the Gresham WWTP's. An overview map of the connection alternatives is shown in **Figure 1**.

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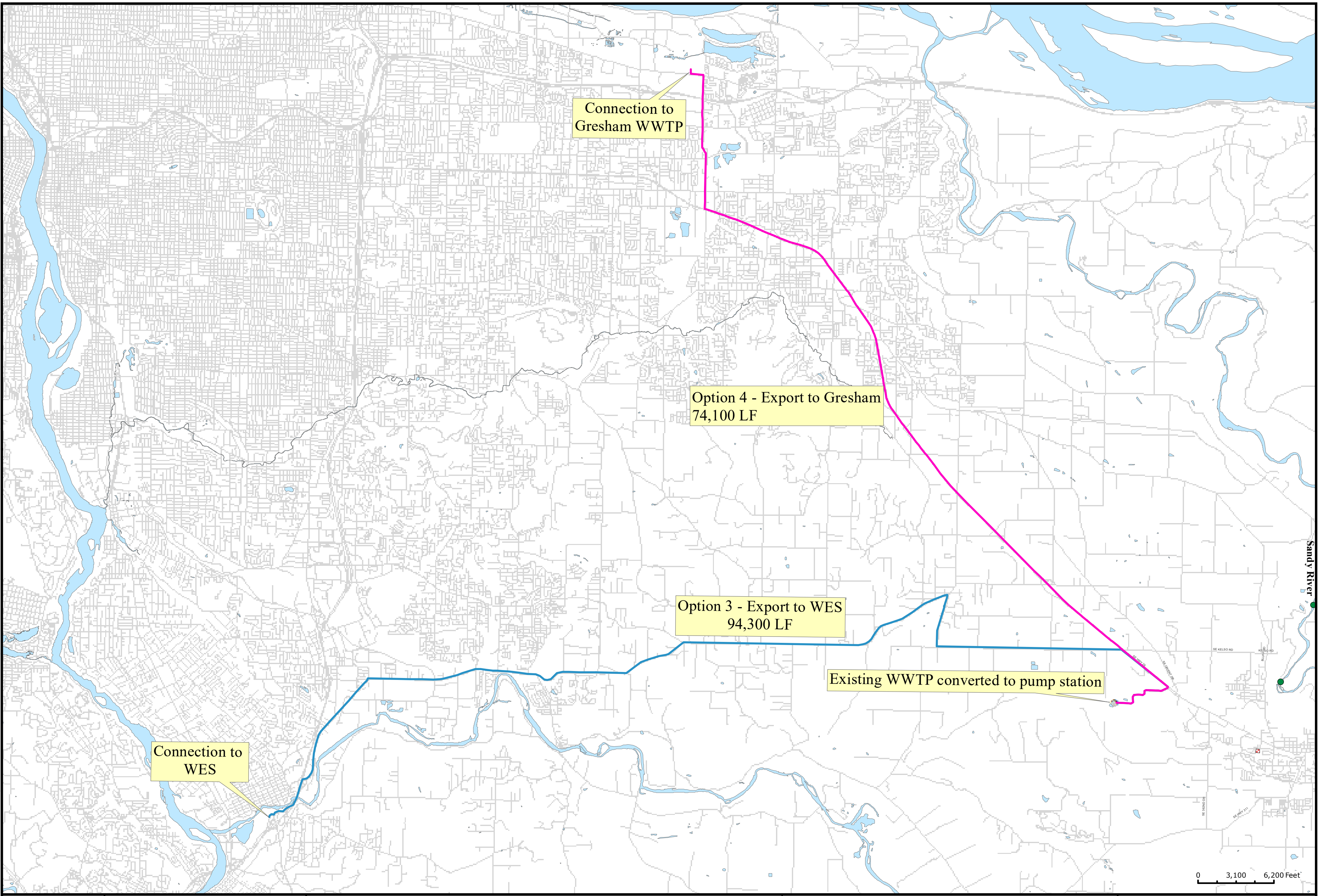

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SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Detailed Discharge Alternatives Evaluation

Legend

Discharge Alternatives

▬	Option 3
▬	Option 4

Figure 1
Overview Map
Alternative Wastewater System Connection Options

August 2020 20-2776

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Scope

The following items are included in the scope of this memo:

1. Meet with representatives from Clackamas County WES and the City of Gresham to discuss the ability of capacity and potential capitalization costs associated with accepting, treating and discharging the City's raw wastewater.
2. Develop alternatives, including preliminary pipeline alignment and costs, for pumping and transmission of raw wastewater from the City of Sandy to either WES or Gresham
3. Capital and 20-year lifecycle costs for each alternative
4. Figure of pipeline alignments

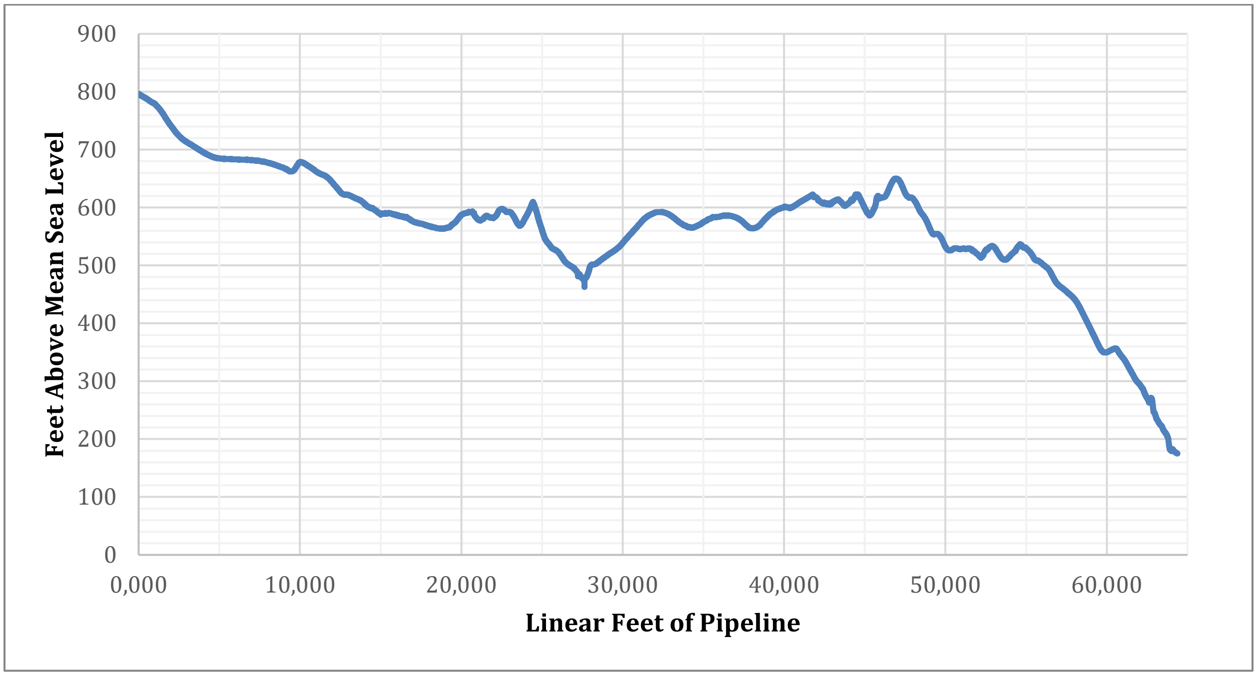
Connection Alternatives

The two options considered for this evaluation are the WES and Gresham facilities. Exporting raw wastewater to WES is identified as *Option 3* and exporting raw wastewater to the Gresham facility as *Option 4*. The proposed pipeline routes were selected following major roads, minimized pipeline distances, and avoided major stream crossings.

Connection Point to the Clackamas WES Collection System

A preliminary evaluation was conducted for connecting to the WES collection system to be treated at the Tri-City WPCP. This pipeline route follows Highway 26, Kelso Road, Richey Road, and Highway 212. The connection point is assumed to be the existing WWTP. The connection point will likely be further out in the collection system, but for the high-level analysis, it was assumed the capacity upgrades to the collection system needed to accommodate the City's flows would be equal to or less than the cost to pipe directly to the WPCP. The profile for the potential force main route is shown in **Figure 2**.

Figure 2 | Profile of Sewer Alignment from Sandy to WES



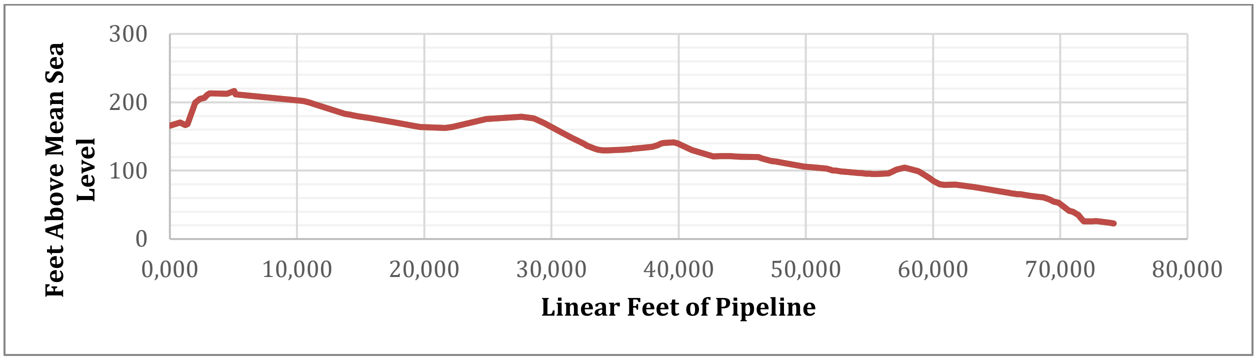
WES is currently upgrading their collection system capacity and it is assumed that a fee would be apportioned as a capital cost for the proportional capacity improvements necessitated by the connection to both the collection system and the Tri-City WPCP. The costs are based on a 24" force main (FM) to be installed less than 20 feet deep and include trenching, excavation, manhole installations, resurfacing costs of a main arterial, and contingency costs. The potential conveyance system will also include two pump stations.

Connection Point to the Gresham WWTP

An evaluation to determine appropriate trunk lines to connect to within the Gresham system were simplified by assuming the cost of capacity improvements to the collection system would be approximately equal to the cost of piping directly to the Gresham WWTP.

It is assumed that a fee would be apportioned as a capital cost for the proportional capacity improvements required for the WWTP to accept flows from the City of Sandy. **Table 2** lists the capitol costs associated with connecting to the Gresham WWTP. The costs are based on a 14 MGD lift station to be installed at the existing wastewater treatment plant and then to flow by gravity to the Gresham WWTP. The profile for the potential force main alignment is shown in Figure 3 below.

Figure 3 | Profile of Sewer Alignment from Sandy to Gresham WWTP



One pump station is required for this alternative, and the remainder of the pipeline can be conveyed via gravity. The gravity pipe meets minimum slope requirements and would have an average depth of 12 feet below ground surface. Figure 3 shows the profile of the alignment to the Gresham WWTP. The maximum depth below ground surface is approximately 35 feet.

Capital Cost Evaluation

Capital costs for exporting wastewater to WES or Gresham include pipeline materials and installation, pump station costs, and a connection fee to the system. Not included in these costs are the annual pumping costs, collection system maintenance fees and treatment fees per gallon of wastewater. A description of each the capital costs is described in the following sections.

Pipeline Costs

Pipeline costs assume an average of 20 feet of depth based on the analysis of the profiles and preliminary pump station locations. These costs include trenching, excavation, manhole installations, resurfacing costs of a main arterial, and contingency costs. Costs are differentiated between gravity lines and force mains in the cost estimate. Manholes are assumed every 400 feet. Force mains and gravity lines are sized to satisfy City hydraulic design criteria utilizing flow rates established for 2040 with pipe degradation and respective RDII reduction.

Pump Station Costs

Pump station installation costs will include excavation and installation of a wet well, pumps, and associated mechanical and electrical improvements. It does not include odor control.

Connection Fees

Capital costs to connect to the system were discussed with personnel from WES and the City of Gresham. However, without conducting a detailed study on the capacity improvements required for the collection system and treatment systems to accommodate flows from the City of Sandy, an estimate of the connect fee was not provided by City representatives. Meeting were not conducted in person. A copy of correspondence is found in **Attachment 1, 2, 3, and 4**. In lieu of an agreed upon cost, average construction costs provided by RS Means for wastewater treatment facilities per gallon were used to estimate approximate connection fees for the treatment facilities. This is based on either buy-in to the existing WWTP's if capacity is available or contributing to the cost of plant upgrades to accommodate additional flows from Sandy. The estimate of the collection system portion of the connection fee required to accommodate the additional flow from Sandy was excluded from the connection fee and instead approximated by including the cost of piping directly to the WWTPs instead of the more likely situation of finding an appropriate location in the collection system to discharge to and paying associated fees to help the upgrade the collection system to accommodate the increase in flow volume.

Summary of Costs

Export to Clackamas County – WES

The total conceptual level opinion of probable project cost to export the raw wastewater from the existing City of Sandy WWTP to the Clackamas County – WES Tri-City WPCP are listed below in **Table 1**. Gravity piping costs assume a depth between 25 and 30 feet and sized so that minimum slopes allow for 2 feet per second scour velocity when flowing full.

Table 1 | Conceptual Level Cost Estimate for Conveyance from Sandy to WES WWTP

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
36-inch Gravity main	39,900	LF	$ 1,300	$ 51,870,000
16-inch Force main	24,500	LF	$ 700	$ 17,150,000
Pump Station	2	EA	$ 10,780,000	$ 21,560,000
Connection Fee	4,540,000	GPD	$ 5.59	$ 25,380,000
			Total Project Cost[1]	**$ 115,960,000**
		Construction Contingency	30%	Included
		Design:	20%	Included
		Construction Management:	15%	Included
		Public Involvement/Permitting:	3%	Included
		Contractor Overhead/Profit:	20%	Included

Note:

1 Cost estimates represent a Class 5 budget estimate in 2020 dollars, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +50 to +100 percent on the high end, meaning the actual cost should fall in the range of 50 percent below the estimate to 100 percent above the estimate.

Export to Gresham

The total conceptual level opinion of probable project cost to export the raw wastewater from the existing City of Sandy WWTP to the Gresham WWTP are listed below in **Table 2**. Gravity piping costs assume a depth between 25 and 30 feet and sized so that minimum slopes allow for 2 feet per second scour velocity when flowing full.

Table 2 | Conceptual Level Cost Estimate for Conveyance from Sandy to Gresham WWTP

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL COST
36-inch Gravity main	69,000	LF	$ 1,300	$ 89,700,000
16-inch Force main	5,200	LF	$ 700	$ 3,640,000
Pump Station	1	EA	$ 10,780,000	$ 10,780,000
Connection Fee	4,540,000	GPD	$ 5.59	$ 25,380,000
			Total Project Cost[1]	**$ 129,500 ,000**
		Construction Contingency	30%	Included
		Design:	20%	Included
		Construction Management:	15%	Included
		Public Involvement/Permitting:	3%	Included
		Contractor Overhead/Profit:	20%	Included

Note:

1 Cost estimates represent a Class 5 budget estimate in 2020 dollars, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +50 to +100 percent on the high end, meaning the actual cost should fall in the range of 50 percent below the estimate to 100 percent above the estimate.

Life Cycle Costs

As presented above, the capital costs are substantially higher for the WES and Gresham alternatives than the recommended option for discharging to the Sandy River. Since these options do not appear to be viable when compared to the recommended Sandy discharge, the additional effort to provide life cycle cost estimates for the two alternatives were not developed for this memorandum. Additionally, it is anticipated the operational needs and associated costs will be similar to or greater than the operational costs for the recommended Sandy River alternative. This is based on potentially similar costs for treatment and substantially more cost to maintain and operate significantly more infrastructure (longer pipelines and more pump stations) needed for the WES and Gresham alternatives.

Conclusion and Summary

The alternatives outlined in this memorandum involve an evaluation of exporting flows to existing treatment facilities outside of the City. The purpose of the analysis is to compare these to the recommended alternative to discharge to the Sandy River. Based on the costs outlined above being significantly higher than the Sandy River Discharge Alternative, as well as the uncertainty associated with exporting flows and associated potentially higher operational costs, these alternatives are not recommended for this project. This comparison further verifies the Sandy River alternative appears to be the preferred option for long term wastewater discharge for the City.

Cc: Matt Hickey, Murraysmith

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City of Sandy

Sandy Wastewater Treatment Facilities Basis of Design Report

March 2021 | Project # 20-2776

Sandy Wastewater Treatment Facilities Basis of Design Report

City of Sandy

March 2021

Murraysmith

888 SW 5th Avenue
Suite 1170
Portland, OR 97204

Table of Contents

1. Introduction

2. Planning and Design Criteria

3. Existing Sandy WWTP Biological Process Analysis

4. Proposed Eastside Satellite Treatment Facility Basis of Design

5. Conclusion

Figures

Tables

Appendix

Section 1

Section 1

Introduction

1.1 Purpose

The purpose of this basis of design report is to document the further evaluation of the recommendations made in the Wastewater System Facilities Plan (Facilities Plan). Specifically, this basis of design report will provide greater clarification of the design criteria for the existing City of Sandy Wastewater Treatment Plant (WWTP) and the Eastside Satellite Treatment Facility as recommended in the Facilities Plan.

1.2 Background

The City owns and operates the City of Sandy WWTP to serve the residents and businesses of Sandy, Oregon. For nearly 20 years the City has used contract operators to operate the plant. The plant is currently operated by Veolia North America.

The treatment system, shown in **Figure 1-1**, was first constructed around 1971 and included screenings, contact stabilization process, effluent polishing pond, and disinfection using a chlorine contact tank before discharging into Tickle Creek. The last major treatment plant update occurred in 1997 when the entire plant was updated to include new screening, grit removal, activated sludge secondary treatment process, disk cloth filtration, and UV disinfection. During the summer months from May through October, treated WWTP effluent is utilized for irrigation by a local container plant nursery. During the winter months from November through April, when no irrigation water is needed at the nursery, water is discharged to Tickle Creek.

Recently, the treatment plant has exceeded its National Pollutant Discharge Elimination System (NPDES) permit effluent levels for total suspended solids (TSS), biochemical oxygen demand (BOD_5), ammonia, *E. coli* bacteria, chlorine, and stream discharge dilution requirements.

In 2017, the City retained Murraysmith to develop a Facilities Plan to develop improvements to handle growth for the next 20 years. The facilities plan completed in 2019 evaluated both improvements required for the collection and the existing treatment system. The facilities plan recommended immediate improvements and long-term improvements at the existing Sandy WWTP. It also recommended a new Eastside Satellite Treatment Facility that will be constructed in two stages in 2026 and approximately 2036 to progressively treat half of the flow from the collection system. Below is a summary of the phased treatment improvements identified in the Facilities plan.

1.1.1 Phase 1 (2021 through 2026):

Phase 1 improvement include immediate needs improvements for the existing Sandy WWTP as well as construction of a new Eastside Satellite Treatment Facility as outlined as follows:

- Existing Sandy WWTP Improvement*s*
    - Replace the existing mechanical screen
    - Replace the grit removal system mechanical components.
    - Improve equalization basin flow control
    - Replace existing aeration basin blowers to provide better air control.
    - Repair existing secondary clarifier mechanism and releveling the clarifier effluent weir.
    - Replace the existing UV disinfection system.
- Stage 1 Eastside Satellite Treatment Facility Construction
    - Construct new 3.5 million gallons per day (MGD) Satellite Treatment Plant with:
        - Headworks (Fine Screen and Grit Removal)
        - Two Membrane Bioreactor (MBR) Trains
        - UV Disinfection System
        - Effluent Aeration System

1.1.2 Phase 2 (2025 through 2032)

Phase 2 improvement include process and capacity improvements to the Existing Sandy WWTP as outlined as follows:

- Existing Sandy WWTP Improvements
    - Upgrade Headworks Facility
    - Install Two Primary clarifiers.
    - Conversion to anaerobic digestion.
    - Upgrade the solids handling system including new sludge dewatering and dryer equipment.

1.1.3 Phase 3 (2033 through 2040)

Phase 3 improvement include expansion of the Eastside Satellite Treatment Facility as outlined as follows:

- Stage 2 Eastside Satellite Treatment Facility Construction
    - Expand the MBR to treat 7.0 MGD peak flow.

1.3 Overview

The preliminary basis of design report is divided into four sections including Introduction, Planning and Design Criteria, Existing Sandy WWTP Biological Process Analysis, and Proposed Eastside Satellite Treatment Facility Basis of Design, and Conclusion.

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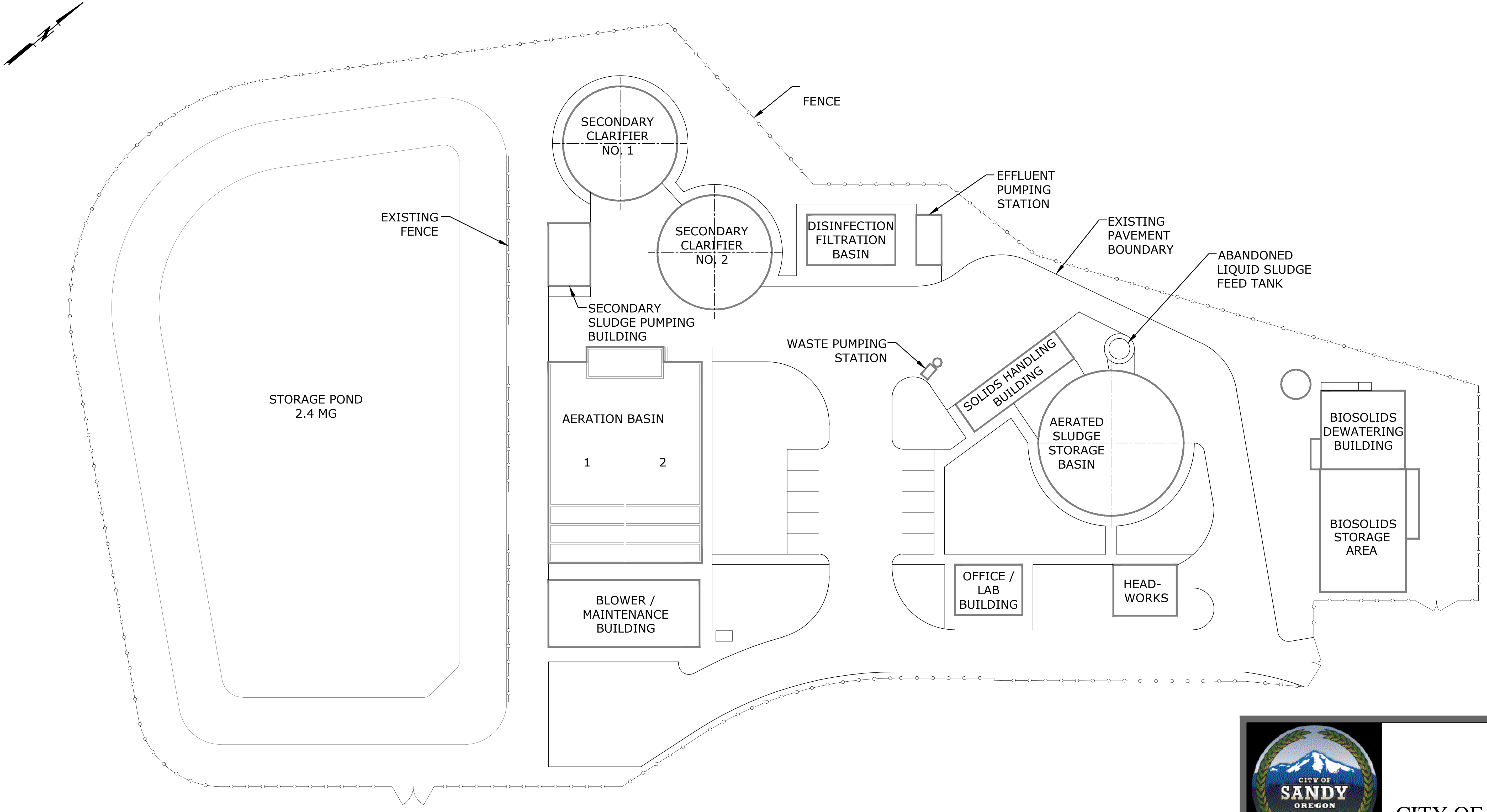

SITE PLAN
SCALE: 1/4" = 1'-0"

CITY OF SANDY
WWTP

EXISTING
SITE PLAN

December 2020

FIGURE 1-1

murraysmith

Project # - 19-2445

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Section 2

Section 2

Planning and Design Criteria

2.1 Regulatory Considerations

2.1.1 Existing Sandy WWTP

City of Sandy NPDES Permit #102492 was renewed on January 23, 2010, allowing the discharge of treated effluent to Tickle Creek about one mile downstream of the plant (Outfall 001) during the Winter NPDES Permit Season from November 1st to April 30th, and to a local container plant nursery for recycled water irrigation during the Summer NPDES Permit Season from May 1st to October 31st (Outfall 002). A copy of the City's NPDES Permit is included in **Appendix A**. The NPDES permit expired on November 30, 2013. The permit was submitted for renewal in March 2013, but the permit has not been renewed to date.

Table 2-1 is a summary of waste discharge limitations for the Sandy WWTP Outfall 001 to Tickle Creek as contained in Schedule A of the City's NPDES Permit.

Table 2-1
Outfall 001 NPDES Waste Discharge Limits[a]

	Monthly Average Concentration (mg/L)	Weekly Average Concentration (mg/L)	Daily Maximum Concentration (mg/L)	Monthly Average Load[b] (ppd)	Weekly Average Load[b] (ppd)	Daily Maximum Load[b,c] (ppd)
Winter Season (November 1 through April 30)						
BOD_5	10	15	NA	125	187	250
TSS	10	15	NA	125	187	250
Ammonia	3.7	NA	10.9	NA	NA	NA

Notes:
a) From current Sandy WWTP NPDES Permit #102492 for File Number 78615.
b) Mass load limits are based upon WWTP average dry weather design flow of 2.5 MGD.
c) The daily mass load limit is suspended on any day in which the flow to the treatment facility exceeds 2.5 MGD.
Abbreviations:
mg/L = Milligrams per liter.
ppd = Pounds per day.

During the allowed Winter NPDES Permit Season discharge to Tickle Creek from November 1st to April 30th, the current permit limits discharge to Tickle Creek when the available stream dilution is less than 10 based on the following equation:

$$Dilution = \frac{(Q_e + Q_s)}{Q_e}$$

Where: Q_e = WWTP Discharge Flow in MGD
Q_s = Tickle Creek Flow measured at a gauging station 1 mile upstream from Outfall 002 in MGD

The NPDES does allow for emergency overflow discharge to Tickle Creek at the plant site (Outfall 003) when flows exceed 4.0 MGD.

2.1.2 Future Eastside Satellite Treatment Facility

Since the Eastside Satellite Treatment Facility has not yet been issued an NPDES permit, there are no specific targets that are required to date. However, based on performance of similar technology, results of a preliminary anti-degradation analysis, as well as anticipated Class A Recycle Water quality requirements, the following effluent limits will be used for the design.

Table 2-2

Estimated Eastside Satellite Treatment Facility Effluent Limits

Parameter	Monthly Average Concentration
BOD_5	<5 mg/L
TSS	<5 mg/L
Ammonia	<1 mg/L
pH	> 6
Dissolved Oxygen (DO)	> 6 mg/L
Turbidity	2 NTU
Total Coliform	< 2.2 total coliform/100 mL
Temperature	< 20[1]

Notes:
[1] Exact temperature requirement varies by season, river flow, and other environmental conditions.
Abbreviations:
mg/L = milligrams per liter
NTU = nephelometric turbidity unit
mL = milliliter

2.2 Design Criteria and Planning Period

As part of the Facilities Plan, the 20-year flow and load projections for the entire system were developed as shown on **Table 2-3** through **Table 2-5**.

Table 2-3
Summary of Existing and Projected Flow

Flow	Existing Flow, MGD	2040 Flow, MGD
Annual Average Flow (AAF)	1.4	2.39
Average Dry Weather Flow (ADWF)	1.0	2.0
Average Wet Weather Flow (AWWF)	1.78	3.05
Maximum Month Dry Weather Flow (MMDWF)	1.5	2.4
Maximum Month Wet Weather Flow (MMWWF)	2.6	4.1
Peak Week Flow (PWF)	4.0	6.6
Peak Day Flow (PDF)	8.9	12.1
Peak Instantaneous Flow (PIF)	10.3	14.0

Table 2-4
Current BOD_5 and TSS Loads

2017 Population	Parameter	Monthly Average			Maximum Month		
		Concentration (mg/L)	Load (ppd)	Load Factor (ppcd)	Concentration (mg/L)	Load (ppd)	Load Factor (ppcd)
Summer Season (May 1 through October 31)							
11,800	BOD_5	286	2,500	0.209	455	3,600	0.305
11,800	TSS	280	2,400	0.201	456	3,500	0.294
Winter Season (November 1 through April 30)							
11,800	BOD_5	192	2,400	0.203	297	3,500	0.294
11,800	TSS	190	2,400	0.202	342	3,900	0.333

Notes:
1. ppd= pounds per day
2. ppcd = pound per capita per day

Table 2-5
2040 BOD_5 and TSS Loading Projections

2040 Population	Parameter	Monthly Average		Maximum Month	
		Load Factor (ppcd)	Load (ppd)	Load Factor (ppcd)	Load (ppd)
Summer Season (May 1 through October 31)					
22,400	BOD_5	0.209	4,700	0.305	6,800
22,400	TSS	0.201	4,500	0.294	6,600
Winter Season (November 1 through April 30)					
22,400	BOD_5	0.203	4,600	0.294	6,600
22,400	TSS	0.202	4,500	0.333	7,500

Notes:
1. ppd= pounds per day =
2. ppcd = pound per capita per day

There is limited historical influent Total Kjeldahl Nitrogen (TKN) and ammonia data at the plant, therefore the nitrogen loads were estimated using the ammonia data collected in 2018 from the wastewater characterization data as discussed in **Section 3.2**. The BOD_5 loads during sampling were approximately the same as the monthly average BOD_5 load; therefore, it was assumed that the ammonia loads collected during that time also represented the monthly average ammonia loads. To estimate the maximum month load for ammonia, we assumed that the multiplier between maximum month BOD_5 and monthly average BOD_5 (~1.5) is the same as maximum month ammonia and monthly average ammonia. Since the data we have available is limited, it was assumed that the wet weather and dry weather loads are the same for monthly average and maximum month. **Table 2-6** and **Table 2-7** summarizes the current and projected ammonia loads for the entire system.

Table 2-6
Current Nitrogen Loads

2018 Population	Parameter	Monthly Average		Maximum Month	
		Load (ppd)	Load Factor (ppcd)	Load (ppd)	Load Factor (ppcd)
12,180	Ammonia	287	0.024	431	0.035
12,180	TKN	413	0.034	619	0.051

Note:

1. ppd= pounds per day =
2. ppcd = pound per capita per day

Table 2-7
2040 Nitrogen Loading Projections

2040 Population	Parameter	Monthly Average		Maximum Month	
		Load Factor (ppcd)	Load (ppd)	Load Factor (ppcd)	Load (ppd)
22,400	Ammonia	0.024	528	0.035	792
22,400	TKN	0.034	760	0.051	1,139

Notes:

1. ppd= pounds per day =
2. ppcd = pound per capita per day

As outlined in the Facilities Plan, a new Eastside Satellite Treatment Facility that will treat half of the collection system flow will be constructed in two stages (2026 and 2036) by the end of the planning period; therefore, the existing treatment plant will only treat half of the 2040 flow in the long-term but will need to treat all of the current flow in the near term before stage 1 is complete. A summary of the projected flows from 2019 to 2040 to the existing Sandy WWTP based on proposed staging of the Eastside Satellite Treatment Facility are shown in **Table 2-8**, and the revised wastewater loads to the Sandy WWTP are show in **Table 2-9** and **2-10.**

Table 2-8
Summary of Current and Projected Flow (MGD) to Existing Sandy WWTP

Flow Event	2017	2020	2025	2026[1]	2030	2035	2036[2]	2040
AAF	1.4	1.45	**1.53**	0.93	1.14	**1.35**	0.76	1.20
ADWF	1.08	1.12	**1.18**	0.72	0.88	**1.05**	0.59	0.93
AWWF	1.78	1.85	**1.95**	1.19	1.45	**1.73**	0.97	1.53
MMDWF	1.41	1.46	**1.54**	0.94	1.15	**1.37**	0.77	1.21
MMWWF	2.66	2.76	**2.91**	1.8	2.17	**2.58**	1.44	2.27
PWF	5.01	5.19	**5.48**	3.34	4.08	**4.85**	2.71	4.28
PDF	5.87	6.08	**6.42**	3.91	4.77	**5.68**	3.18	5.02
PIF	9.05	9.38	**9.9**	6.40	7.73	**9.13**	5.63	7.00

Notes:

1. First stage of Eastside Satellite Treatment Facility begins operation in 2026
2. Second stage of Eastside Satellite Treatment Facility begins operation in 2036

Table 2-9
Sandy WWTP Average Day BOD_5 and TSS Loading Projections

Year	Average Dry Weather			Average Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS,ppd
2020	1.12	2,700	2,600	1.85	2,600	2,600
2025	1.18	3,100	3,000	1.95	3,000	3,000
2026[1]	0.718	1,900	1,800	1.19	1,800	1,800
2030	0.878	2,300	2,200	1.45	2,300	2,200
2035	1.05	2,800	2,700	1.73	2,700	2,700
2036[2]	0.585	1,600	1,500	0.97	1,500	1,500
2040	0.925	2,300	2,200	1.53	2,300	2,300

Notes:

1. First stage of Eastside Satellite Treatment Facility begins operation in 2026
2. Second stage of Eastside Satellite Treatment Facility begins operation in 2036

Table 2-10
Sandy WWTP Maximum Month BOD_5 and TSS Loading Projections

Year	Maximum Month Dry Weather			Maximum Month Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS, ppd
2020	1.46	3,900	3,800	2.76	3,800	4,300
2025	1.54	4,500	4,300	2.91	4,300	4,900
2026[1]	0.9375	2,700	2,600	1.78	2,700	3,000
2030	1.1475	3,400	3,300	2.17	3,300	3,700
2035	1.37	4,100	4,000	2.58	4,000	4,500
2036[2]	0.765	2,300	2,200	1.44	2,200	2,500
2040	1.205	3,400	3,300	2.27	3,300	3,700

Notes:

1. First stage of Eastside Satellite Treatment Facility begins operation in 2026
2. Second stage of Eastside Satellite Treatment Facility begins operation in 2036

Once the Eastside Satellite Treatment Facility begins operation in 2026, waste activated sludge (WAS) solids from that plant will be sent to the Sandy WWTP through the sewer collection system since the satellite treatment facility will not have solids handling facilities due to the proximity to existing residences. As a result, the design for the Sandy WWTP will account for the additional load from the Eastside Satellite Treatment Facility. **Table 2-11** estimates the additional load to the Existing Sandy WWTP from the biosolids discharged from the Eastside Satellite Treatment Facility based on the results of the Biowin process model for the facility discussed in **Section 4**. Note that while the flow is the same between dry weather and wet weather conditions, the BOD and TSS loads are different which is a better representative of the impact on the existing Sandy WWTP.

Table 2-11

Projected Eastside Satellite Treatment Facility WAS BOD_5 and TSS Loads to Existing Sandy WWTP

Parameter	Stage 1 Maximum Month (2026)		Stage 2 Maximum Month (~2036)	
	Dry Weather Load	Wet Weather	Dry Weather	Wet Weather
Flow, gpd	15,200	15,200	30,400	30,400
BOD_5, ppd	255	320	510	640
TSS, ppd	1095	1175	2100	2350

Note:

1. gpd= gallons per day

For the Eastside Satellite Treatment Facility, a summary of the projected flows is shown in **Table 2-12**, and the projected wastewater loads are show in **Table 2-13** and **2-14.**

Table 2-12

Summary of Projected Flow for Eastside Satellite Treatment Facility in MGD

Flow Event	2026[1]	2030	2035	2036[2]	2040
AAF	0.60	0.60	0.60	1.20	1.20
ADWF	0.46	0.46	0.46	0.93	0.93
AWWF	0.76	0.76	0.76	1.53	1.53
MMDWF	0.60	0.60	0.60	1.21	1.21
MMWWF	1.14	1.14	1.14	2.27	2.27
PWF	2.14	2.14	2.14	4.28	4.28
PDF	2.51	2.51	2.51	5.02	5.02
PIF	3.50	3.50	3.50	7.00	7.00

Notes:

1. First stage of Eastside Satellite Treatment Facility begins operation in 2026
2. Second stage of Eastside Satellite Treatment Facility begins operation in 2036

Table 2-13
Eastside Satellite Treatment Facility Average Day BOD_5 and TSS Loading Projections

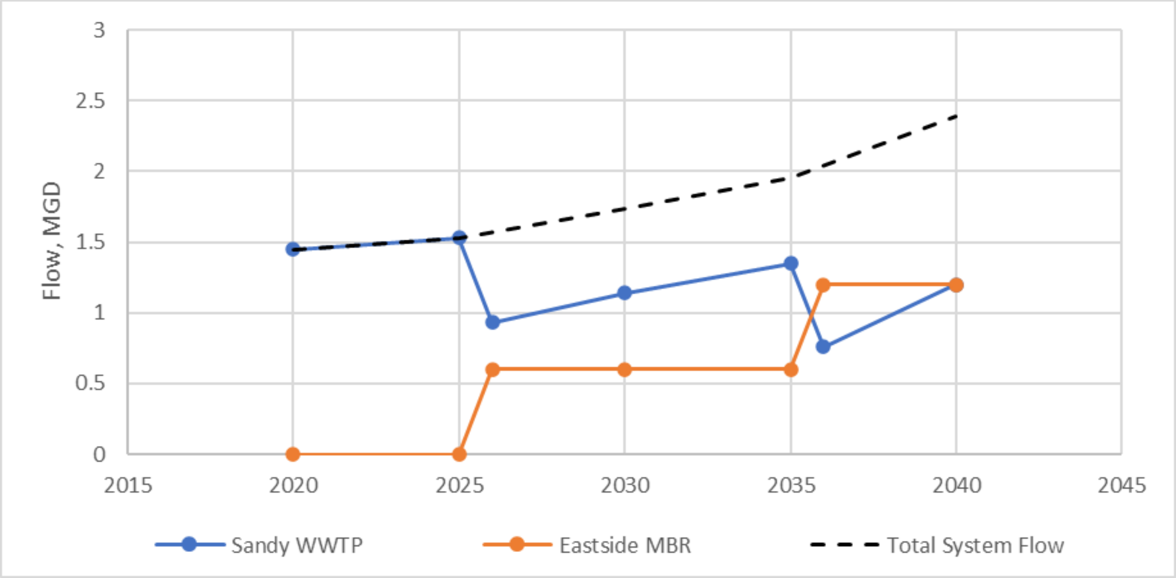
Year	Average Dry Weather			Average Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS, ppd
2026	0.46	1,211	1,164	0.76	1,173	1,167
2040	0.93	2,337	2,248	1.53	2,270	2,259

Table 2-14
Eastside Satellite Treatment Facility Maximum Month BOD_5 and TSS Loading Projections

Year	Maximum Month Dry Weather			Maximum Month Wet Weather		
	Flow, MGD	BOD_5, ppd	TSS, ppd	Flow, MGD	BOD_5, ppd	TSS,ppd
2026	0.60	1,764	1,700	1.14	1,695	1,920
2040	1.21	3,411	3,288	2.27	3,288	3,724

The projected division of flow between the two plants can be seen on **Figure 2-1**.

Figure 2-1
Projected Average Annual Flow to the Existing Sandy WWTP and Eastside Satellite Treatment Facility



The collection system was modeled to confirm that sufficient flow was available at the diversion pump station to deliver the required flow to the Eastside Satellite Treatment Facility. The following table shows the projected monthly average flows at the diversion pump station.

Table 2-15
Projected flow at Monthly Average Flows at Diversion Pump

Month	Flow (MGD)				
	2020	2026	2030	2036	2040
January	1.58	1.92	2.14	2.23	2.28
February	1.45	1.78	2.00	2.08	2.13
March	1.61	1.95	2.18	2.26	2.31
April	1.43	1.74	1.95	2.16	2.29
May	1.4	1.60	1.74	1.94	2.07
June	1.1	1.42	1.64	1.70	1.75
July	0.76	1.21	1.50	1.44	1.39
August	0.69	1.14	1.43	1.36	1.32
September	0.73	1.18	1.47	1.40	1.36
October	1.41	1.74	1.97	2.05	2.10
November	1.75	2.09	2.32	2.67	2.90
December	1.66	2.00	2.23	2.44	2.59

The table shows that there is sufficient flow at the diversion pump station to provide consistent flow to the Eastside Satellite Treatment Facility.

Section **3**

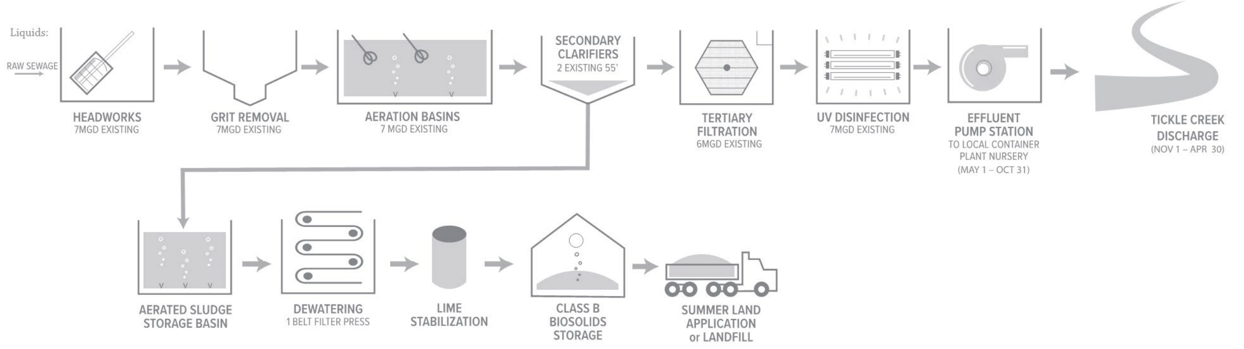
Section 3

Existing Sandy WWTP Biological Process Analysis

3.1 Background

The existing process schematic for the existing Sandy WWTP is shown on **Figure 3-1** below. A detailed list of mechanical equipment and design capacity can be found in the *Section 7.3 - Existing WWTP Capacity Evaluation* of the *Facilities Plan*.

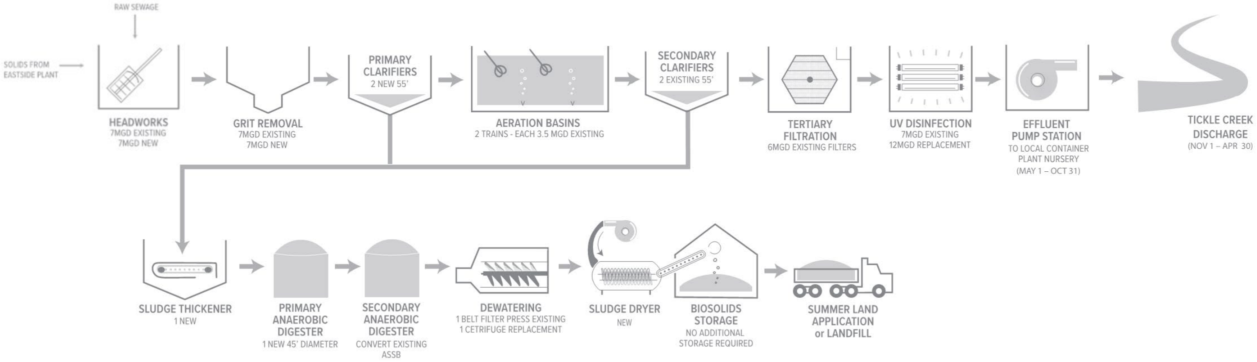
Figure 3-1
Existing WWTP Process Schematic



The plant lacks redundancy for 2040 MMWWF in the headworks, secondary treatment, and tertiary filter. To improve plant redundancy and performance, the Facilities Plan proposed several improvements to the Sandy WWTP including expanding the headworks, adding primary clarifiers, modifying the aeration basin to create plug flow and upgrading the solids processing by constructing two anaerobic digesters as summarized in Section 1.2 and shown on **Figure 3-2**.

As noted earlier, WAS solids from the Eastside Satellite Treatment Facility will be discharged into the collection system, so process improvements will have to account for the additional solids loading as noted in **Table 2-11**. The following section will evaluate the biological process capacity of the existing wastewater treatment plant in context of the planned improvements at the Sandy WWTP as well as the staged construction of the Eastside Satellite Treatment Facility.

Figure 3-2
Proposed Existing Sandy WWTP Improvements Process Schematic



3.2 Biological Process Performance Evaluation

3.2.1 Estimated WWTP Influent Characteristics and Model Input

To improve the reliability of the process model, an extensive wastewater characterization program was enacted from May to September 2018. This program involved taking samples twice monthly from various processes throughout the plant. Samples were taken from the influent (Inf), return activated sludge (RAS), aerated sludge storage basin, gravity belt filter pressate, and plant effluent.

The influent sampling values in **Table 3-1** were used to develop the wastewater fractionation for the process model. Based on the flows in **Table 2-8** and loads analysis in **Table 2-9** and **2-10** as well as the wastewater characterization data, the resulting influent characteristics used in the process model simulations are summarized in **Table 3-2**.

Table 3-1
Influent Wastewater Characterization Sampling Results

Parameter	Average Concentrations, mg/L
Chemical Oxygen Demand (COD)	500
Filtered COD	127
Flocculated-Filtered COD (FF COD)	104
BOD_5	327
TSS	229
TKN	52
Ammonia-N	37.5
Total Phosphorus (TP)	5.4
Alkalinity (as Calcium Carbonate)	172

Table 3-2
Influent Wastewater Characterization Model Input

Model Inputs	2020 ADWF	2020 MMDWF	2020 MMWWF	2025 MMDWF	2025 MMWWF	2026[1] MMDWF	2026[1] MMWWF	2040[2] MMDWF	2040[2] MMWWF
Flow, MGD	1.12	1.46	2.76	1.54	2.91	0.94	1.78	1.21	2.27
BOD_5, mg/L	288	322	164	351	179	351	179	339	174
TSS, mg/L	277	311	186	338	203	338	203	327	197
Volatile Suspended Solids (VSS), mg/L	257	289	173	314	188	314	188	304	183
Ammonia-N, mg/L	33	37	20	41	22	41	22	39	21
TKN, mg/L	47	54	28	59	31	59	31	57	30
TP, mg/L	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3

Notes:

1. First stage of Eastside Satellite Treatment Facility begins operation in 2026
2. Second stage of Eastside Satellite Treatment Facility begins operation in 2036

3.3 Process Considerations

In addition to meeting the permit requirements, other design criteria were used to evaluate the secondary process design. Those criteria are as follows:

- Mixed Liquor Suspended Solids (MLSS) concentration should not exceed 3,500 mg/L
- RAS ratio does not exceed 100 percent.

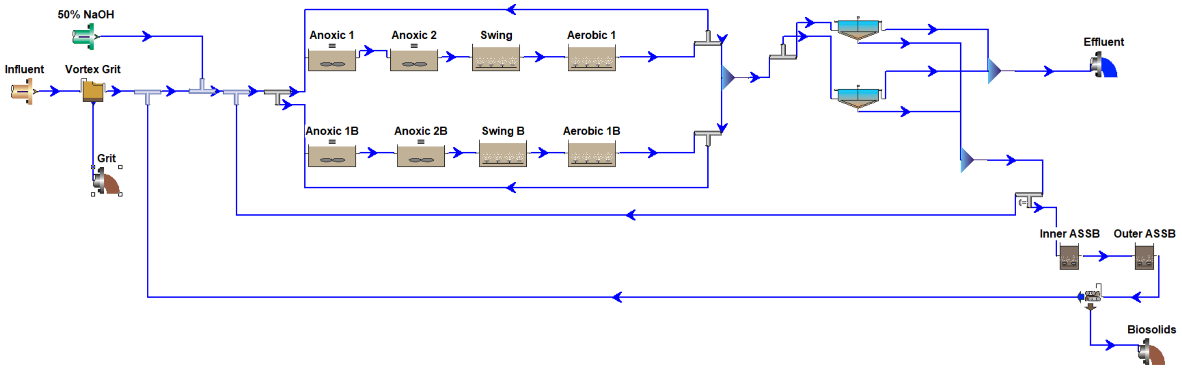
3.4 Process Model Setup

As noted earlier, the Facilities Plan outlined several improvements to the WWTP including the addition of two primary clarifiers and two anaerobic digesters to replace the existing aerated sludge storage basin (ASSB). These improvements will take place sometime between 2025-2032.

To confirm the performance capability of the WWTP during the phased implementation of the project, the flows and loads outlined in **Table 3-2** were evaluated using three different versions of the process models to account for the phased changes to the existing Sandy WWTP as outlined below.

The existing treatment system process model schematic diagram (Model 1) is shown on **Figure 3-3**. The influent screens, effluent filtration, and disinfection are not shown on the schematic. These processes have relatively minor impact on the biological process. For modeling purposes, alkalinity addition is made by feeding in 50 percent sodium hydroxide. This model was used to evaluate performance in 2020 and 2025 prior to the construction of the first stage of the Eastside Satellite Treatment Facility.

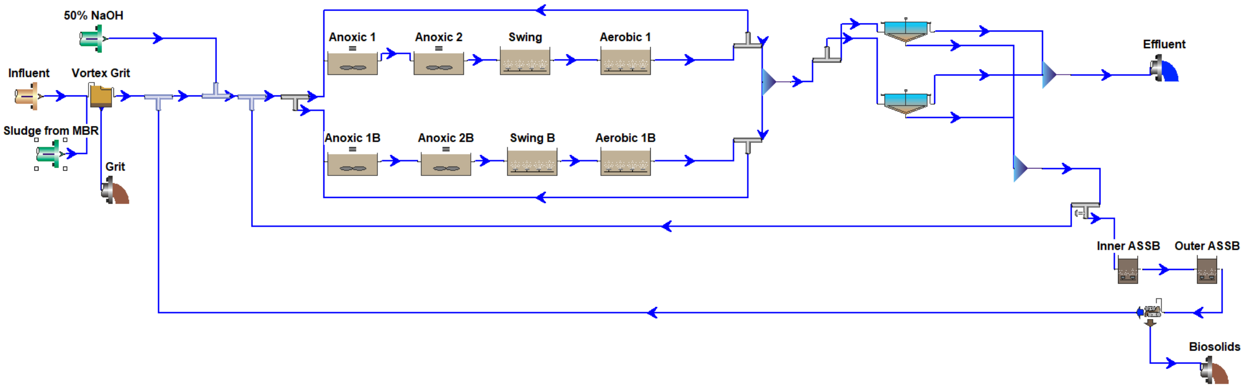
Figure 3-3
Existing Sandy WWTP - Biowin Model Process Schematic (Model 1)



The existing Sandy WWTP is expected to begin receiving waste sludge from the Eastside Satellite Treatment Facility starting in 2026 when the plant begins operation. Therefore, **Figure 3-4** shows the process model schematic diagram for the existing plant after 2026 with the only change being the input of WAS sludge as described on **Table 2-11** from the Eastside Satellite Treatment Facility

(Model 2). This model was used to evaluate performance in 2026 after construction of the Eastside Satellite Treatment Facility.

Figure 3-4
Existing Sandy WWTP with Eastside Satellite Treatment Facility Sludge Input - Biowin Model Process Schematic (Model 2)



Plant improvements at the existing Sandy WWTP are planned sometime between 2025-2032 period depending on observed population growth, as noted previously and in the facilities plan these improvements include expanding the headworks, adding primary clarifiers, modifying the aeration basin to create plug flow, and upgrading the solids processing by constructing two anaerobic digesters. **Figure 3-5** shows the process model schematic diagram for the Sandy WWTP after these improvements are implemented (Model 3). This model was used to evaluate performance in 2040 after stage 2 construction of the Eastside Satellite Treatment Facility.

Figure 3-5
Existing Sandy WWTP Improvements - Biowin Model Process Schematic (Model 3)

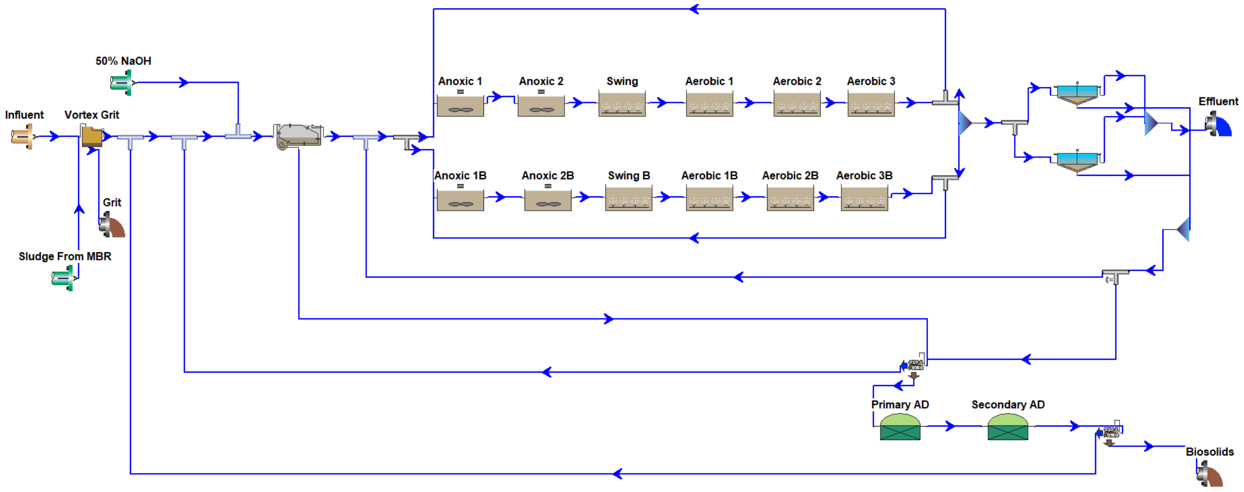


Table 3-3 presents the existing process volumes and depth of the aeration basin for each treatment train used in the process modeling for Model 1 and 2.

Table 3-3

Existing WWTP Aeration Basin Cell Volume Per Train

Cell	Volume, gallons	Average Water Depth, feet
Anoxic 1	37,700	18
Anoxic 2	37,700	18
Aerobic 1	37,700	18
Aerobic 2	257,400	18
Total volume per train	**370,500**	

Table 3-4 presents the proposed process volumes and depth of the aeration basin for each treatment train used in the process modeling for Model 3 based on the installation of baffles in Aerobic 2 Cell to promote plug flow that will lead to improved treatment performance.

Table 3-4

Proposed Aeration Basin Cell Volume Per Train

Cell	Volume, gallons	Average Water Depth, feet
Anoxic 1	37,700	18
Anoxic 2	37,700	18
Aerobic 1	37,700	18
Aerobic 2	85,800	18
Aerobic 3	85,800	18
Aerobic 4	85,800	18
Total volume per train	**370,500**	

3.5 Process Model Simulation Results

Process model simulations were run to determine the plant performance as well as to provide a range of operation requirements for process equipment under a variety of operating conditions. The process model was simulated under MMWWF and MMDWF conditions only because that is the design condition for sizing process equipment for secondary treatment. Peak flow simulations were not modeled because the flow conditions are temporary and steady-state process model simulations would not represent true performance.

The preliminary model simulations were run at steady state with influent characteristics listed in **Table 3-2**, and the results of the simulations are shown below in **Table 3-5**. The complete results from the Biowin model for the existing WWTP are included in **Appendix B**.

As shown in **Table 3-5**, the process model predicts that the City of Sandy WWTP will meet the current permitted monthly average effluent concentration limits under all the projected simulated conditions. Note that the model does not include the effluent filters, so the final effluent TSS and BOD_5 will be improved compared to the model results. The effluent filters do have a capacity limit of 6.0 MGD; therefore, under peak flow conditions some of the flow will not be filtered and the final effluent will be a blend of filtered and un-filtered effluent.

Under most cases, the process modeling indicated the system could not meet the permit pH and ammonia requirements without supplemental alkalinity addition through caustic soda addition. This was modeled by increasing the alkalinity in the influent by feeding in 50 percent caustic soda to the system. Because there is limited data on alkalinity concentrations during the winter, it is possible that the required caustic soda requirement will be more or less.

Table 3-5
Existing Sandy WWTP Process Model Simulation Results

Parameter	2020 ADWF	2020 MMWWF	2020 MMDWF	2025 MMWWF	2025 MMDWF	2026 MMWWF^1	2026 MMDWF^1	2040 MMWWF^2	2040 MMDWF^2
Flow, MGD	1.12	2.76	1.46	2.76	1.54	1.78	0.94	2.27	1.21
Temperature, °C	22	11	22	11	22	11	22	11	22
Solids Retention Time (SRT), days	7	7	4	7	5	6	6	8	7
MLSS, mg/L	2,155	3,126	2,116	3,367	2,846	2,923	2,866	2,751	3,120
Caustic Soda Addition, gpd	0	300	0	300	100	100	0	150	0
Air Demand per train, scfm^3	700	1,000	1,000	1,100	1,500	600	800	700	1,100
Secondary Effluent TSS, mg/L	4	14	6	14	6	8	4	10	5
Secondary Effluent BOD$_5$, mg/L	3	7	4	7	4	4	2	4	2
Secondary Effluent Ammonia-N, mg/L	1	3	7	3	1	2	0.5	2	0.05
Secondary Effluent Total Nitrogen, mg/L	9	9	16	10	14	9	14	15	24
Secondary Effluent pH	6.4	6.6	6.0	6.5	6.3	6.3	6.7	6.0	6.8
Primary Sludge, ppd	0	0	0	0	0	0	0	2,900	2,700
WAS Solids, ppd	1,900	2,70	3,100	3,000	3,500	3,000	3,000	2,600	2,800
ASSB SRT, days	5	5	4	5	3.6	4.4	4.4	-	-
Digester SRT, days	-	-	-	-	-	-	-	65	87
Dewatered Biosolids, ppd	1,300	1,900	2,100	2,000	2,400	2,200	2,200	2,500	2,600

Notes:

1. Stage 1 of Eastside Satellite Treatment Facility begins operation in 2026
2. Stage 2 of Eastside Satellite Treatment Facility and Improvements to the Existing WWTP in Operation in 2040
3. scfm = standard cubic feet per minute

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Section **4**

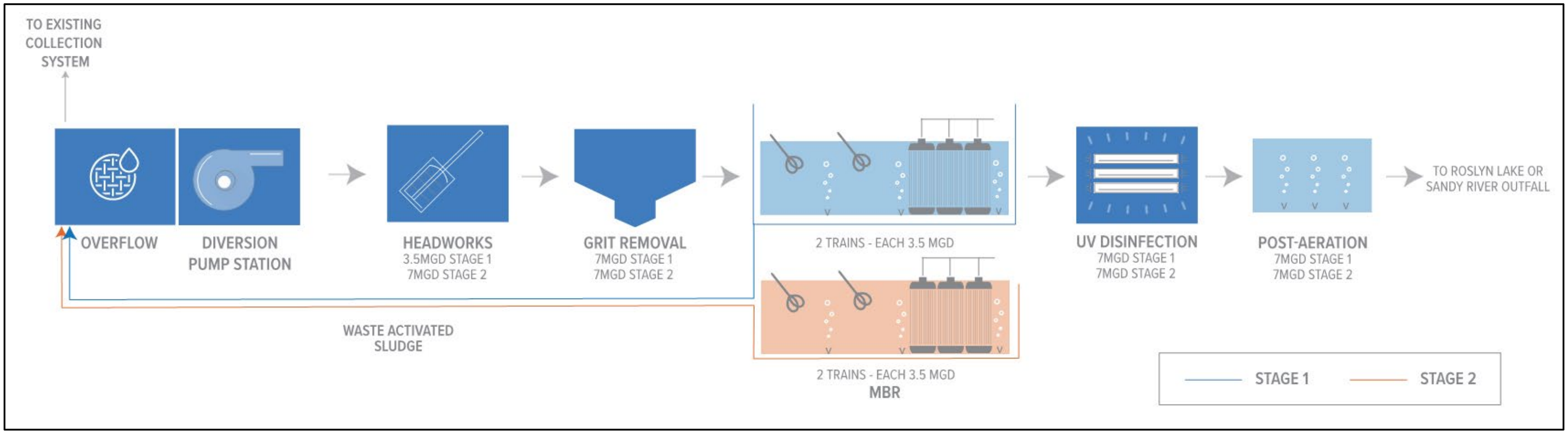
Section 4

Proposed Eastside Satellite Treatment Facility Basis of Design

4.1 Background

As outlined in the 2019 Facilities Plan, a new Eastside Satellite Treatment Facility will be constructed. The facility will be fed with wastewater from the collection system upstream of the plant and from the diversion pump station located on Dubarko Road and constructed over two Stages (Stage 1 and 2). The proposed process schematic is shown in **Figure 3-1**. The facility will consist of headworks with fine screens and grit removal, MBR, UV disinfection and post aeration. Under the first stage of construction, two MBR trains will be constructed in 2026 and the second stage will consist of two additional MBR trains constructed in 2036. **Appendix C** contains a preliminary layout of the diversion pump station in **Drawing C-1** and of the Eastside Satellite Treatment Facility in **Drawing C-2**. All process facilities and equipment will be enclosed in buildings to mitigate noise and odors. The site will also be landscaped including installing of berms and screening to provide a buffer for the surrounding residences.

Figure 4-1
Proposed Eastside Satellite Treatment Facility Process Schematic



4.2 Diversion Pump Station

The proposed diversion pump station site is located near the intersection of Dubarko Road and Ruben Lane. Upstream of the diversion pump station is a junction of a 15-inch, 12-inch and 8-inch sewer line contributing flow from basins 3, 4, 6, 7, 8, 9, and 10. This point in the collection system can capture over fifty percent of the total system flow, providing a cost-effective and flexible flow-management between the Eastside Satellite Treatment Facility and the existing WWTP. The optimal flow rates can be divided between the two treatment facilities.

Drawing C-1 in **Appendix C** shows one potential configuration to automate and control flow to the diversion pump station which will pump to the Eastside Satellite Treatment Facility. This design is a cost-effective, low maintenance configuration that will also provide operational flexibility using automated gates and stop logs for flow control. As an alternative design, the diversion pump station configuration and controls could be used to split the flow between the two treatment facilities.

The diversion pump station will have an approximate footprint of 25 feet by 50 feet. It will have a similarly sized control building structure and a valve and meter vault on the force main. The pump station will be designed as an expandable triplex pump station with a firm capacity of 3.5 MGD, expandable up to 7.0 MGD. Due to anticipated flows as low as 0.5 MGD in the summer and to make sure the DEQ mandated minimum velocities are attained, a single 12-inch forcemain to the Eastside Satellite Treatment Facility will be constructed initially and a parallel FM installed in the second phase as flows increase. The wet well will be sized for 2040 peak flows. Any flows beyond PIF flow will bypass to existing high overflow to the existing collection system.

Pumps will have VFDs to control flow to the satellite facility. The use of VFDs will allow operators flexibility to pump a larger range of flows. The VFDs will promote proper flushing velocities in the force main by ramping up to a flow rate that creates the minimum required 3.5 feet per second velocity for a short duration to resuspend solids then ramp down to a lower flow rate to manage the number of pump starts and stops per hour. The station will have a backup generator to maintain operation during loss of power.

4.3 Headworks

The headworks facility will consist of two or three fine mechanical screens and a grit chamber. The following section provides the basis of design for these unit processes. It should be noted, the staged construction of the headworks as discussed below is intended to reduce initial capital costs, however there are some operational advantages and efficiencies to building the headworks out to full capacity that should be considered as the project advances to the design stage.

4.3.1 Fine Screen

The fine screen is installed to protect the downstream treatment processes by removing large debris and rags from the influent. To meet pretreatment requirements for the secondary treatment system (MBR), the fine screen needs to have an opening less than 2 millimeters (mm) to remove any debris that could potentially impact the membrane. A total of three screens are recommended for installation. The first two screens would be installed for redundancy at start-up, and the third added in stage 2. Each fine screen will be rated for 3.5 MGD.

4.3.2 Grit Removal System

Removal of grit is important to prevent abrasive grit from damaging pipes and pumps as well as potentially damaging the membranes in the bioreactor. It is important to size the grit system for wet weather flows since this is when the velocities in the collection system are high to scour fine debris and grit. Vortex grit systems remove grit by forcing the flow to form a vortex in a circular chamber that then forces grit to settle quickly to the bottom of the chamber. Grit collected will be removed using a grit pump and sent to a hydrocyclone and grit classifier for washing and compacting before discharging to a dumpster for disposal. The vortex grit system will be rated for 7.0 MGD, the peak flow for stage 2, and will include a bypass channel to allow for the system to be shut down as needed for routine maintenance.

4.4 Secondary Treatment

4.4.1 Membrane Bioreactor

The proposed secondary treatment process at the Eastside Satellite Treatment Facility after the final stage of construction will consist of four parallel aeration basin (AB) trains. Two AB trains will be constructed as part of Stage 1, and the remaining two AB trains will be constructed in Stage 2. Flow to each train will be controlled through weir gates located on the upstream side of the train.

Each train will be configured to operate in the Modified Ludzack-Ettinger Process which consists of an anoxic zone following by an aerobic zone. Each train will consist of a 20,000-gallon anoxic tank and 60,000-gallon aerobic tank. The anoxic zone and the aerobic zone will be divided into two passes by baffle walls to promote plug flow operation. Mixing in the anoxic zones will be achieved through submersible mixers. Flow to the membrane basins will be pumped using feed forward pumps equipped with variable frequency drives that can pump up to 500 percent of the maximum month flow in the train (2,000 gallons per minute [gpm] per pump). The average depth of the aeration basin will be 18 feet.

Each membrane basin is assumed to be approximately 30,000-gallon with two MBR basins per train, but the volume will depend on the membrane supplier requirements based on the design flux rate. RAS will be delivered by gravity through a return feed channel between two aeration basins trains to the head of the anoxic zone. Three waste activated sludge pumps (two duty and one standby) rated up to 40 gpm will be installed as part of Stage 1. The WAS will be pumped in a 6-inch force main to the downstream side of the diversion pump station to send WAS solids to the Sandy WWTP. Flow meters will be installed on the 6-inch WAS pipe to track the sludge volume wasted for operational control. For Stage 2, two additional WAS pumps will be installed for Basin

3 and 4 and the WAS will be discharged into the same 6-inch forcemain as Basin 1 and 2 to be discharged downstream of the diversion pump station.

Four variable speed permeate pumps rated up to 620 gpm will be installed as part of Stage 1. The permeate will pumped through an 18-inch force main equipped with flow meters and will pump the treated effluent through the post aeration system as discussed below and to the outfall at either the Sandy River or Roslyn Lake. Four additional permeate pumps will be installed in Stage 2 when Basin 3 and 4 are installed and connected to the 18-inch force main for discharge.

4.4.2 Aeration Basin Blowers

The air demand for the aeration basin during Stage 1 (excluding air demand for sludge mixing in the membrane tanks) will range between 650 and 1,200 standard cubic feet per minute (scfm) per basin. Therefore, three variable speed blowers (two duty and one standby) will be included that have a max capacity of approximately 1,300 scfm. Two additional variable speed blowers will be installed as part of Stage 2.

For the membrane basin, three air scour blowers with a capacity of approximately 400 scfm will be required in Stage 1 for the membrane tanks to air scour for the membranes and provide air for mixing in the membrane tank. Two additional air scour blowers of the same capacity will be installed as part of Stage 2. The capacity of the membrane tank blowers could change depending on the membrane supplier requirement.

4.5 UV Disinfection System

To save capital and operational cost, the UV disinfection system will be designed to meet two different disinfection scenarios. The first scenario involves discharge in the summer season to Roslyn Lake up to 1.6 MGD which covers some flow events over the 2040 maximum month flow. The second scenario involves discharge to the Sandy River which will include summer and shoulder season storms with flows exceeding 1.6 MGD as well as winter season discharge.

Under Scenario 1, the UV disinfection will be sized to treat summer flows to provide Class A Recycle Water for irrigation or discharge to Roslyn Lake To meet Class A Recycle Water requirements, the effluent "must not exceed a median of 2.2 total coliform organisms per 100 milliliters, based on results of the last seven days that analyses have been completed, and 23 total coliform organisms per 100 milliliters in any single sample" as outlined in OAR 340-55. To meet these criteria, the UV disinfection system will be designed to provide a dose of at least 80 millijoule per centimeter squared (mJ/cm^2). For Scenario 2, the UV disinfection system will be sized to provide a dose of 30 mJ/cm^2 to meet NPDES requirements for discharge to the Sandy River.

Since the permeate pumps from the MBR will be used as the effluent pumps, in-pipe UV disinfection will be used at the site. To provide the flexibility to operate under the two different scenarios, four in-pipe UV units will be provided. The piping and valves will be configured so that four units can be operated either in parallel or in series. For Scenario 1, all four units will be operated in series to provide an 80 mJ/cm^2 for a flow up to 1.6 MGD. For Scenario 2, three units will operate in parallel to provide a 30 mJ/cm^2 dosage for a peak flow of 7.0 MGD.

4.6 Post-Aeration System

To meet dissolved oxygen requirements for discharge to Sandy River based on the anti-degradation analysis, the effluent requires a dissolved oxygen concentration of 6.0 mg/L. Effluent from the MBR will range between 2 and 5 mg/L based on review of performance data from similar facilities. A closed-pipe supplemental aeration system will be installed that is rated to increase the DO from 2 mg/L to 6 mg/L.

4.7 Biological Process Performance Evaluation

A biological process model was developed to evaluate the performance of the proposed MBR. The following sections summarize the process model development and the expected performance of the proposed design.

4.7.1 Estimated WWTP Influent Characteristics and Model Input

The same wastewater characterization values that were collected from May to September 2018 for the existing WWTP as shown on **Table 3-1** will be used for the Eastside Satellite Treatment Facility.

Based on the flows and loads analysis as well as the wastewater characterization data in **Table 3-1**, the influent characteristics used in the process model simulations for the Eastside Satellite Treatment Facility are summarized in **Table 4-1**.

Table 4-1
Eastside Satellite Treatment Facility – Influent Wastewater Characterization Model Input

Model Inputs	2026 ADWF	2026 MMDWF	2026 MMWWF	2040 MMDWF	2040 MMWWF
Flow, MGD	0.46	0.60	1.14	1.21	2.27
BOD_5, mg/L	314	351	179	339	174
TSS, mg/L	302	338	203	327	197
VSS, mg/L	280	314	188	304	183
Ammonia-N, mg/L	35	41	22	39	21
TKN, mg/L	51	59	31	57	30
TP, mg/L	5.3	5.3	5.3	5.3	5.3

4.7.2 Process Considerations

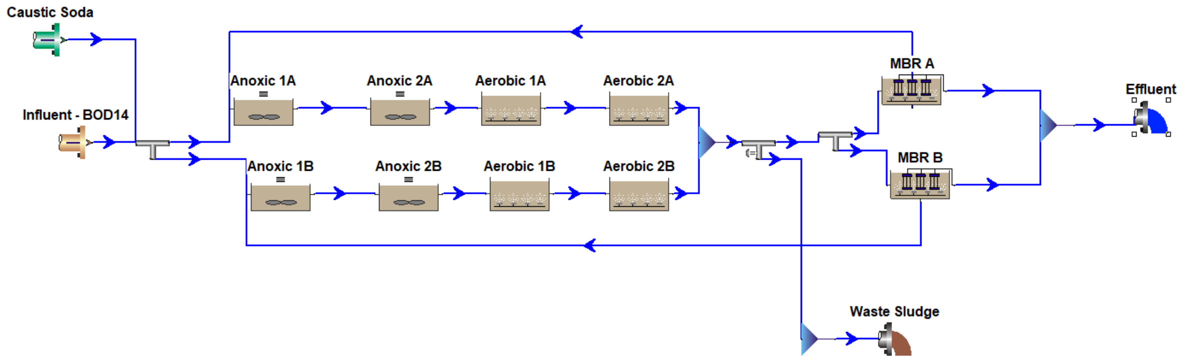
In addition to meeting the permit requirements, other design criteria were used to evaluate the secondary process design. Those criteria are as follows:

- MLSS concentration in aeration basins does not exceed 10,000 mg/L
- RAS ratio does not exceed 600%.

4.7.3 Process Model Setup

Two MBR trains will be constructed under Stage 1 and then another two trains will be constructed in a subsequent stage 2. The treatment system process model schematic diagram (Model 4) for the first stage is shown on **Figure 4-2**. The influent screens, effluent filtration, and disinfection are not shown on the schematic. These processes have relatively minor impact on the biological process. For modeling purposes, alkalinity addition is made by feeding in 50 percent sodium hydroxide. This model was used to evaluate performance in 2026.

Figure 4-2
Stage 1 Eastside Satellite Treatment Facility Biowin Model Process Schematic (Model 4)



The plant will be expanded during around 2036 based upon population growth. The expansion will include the additional of two additional trains. **Figure 4-3** shows the process model schematic diagram for the final build out in 2040 (Model 5). This model was used to evaluate performance in 2040.

Figure 4-3
Stage 2 Eastside Satellite Treatment Facility Biowin Model Process Schematic (Model 5)

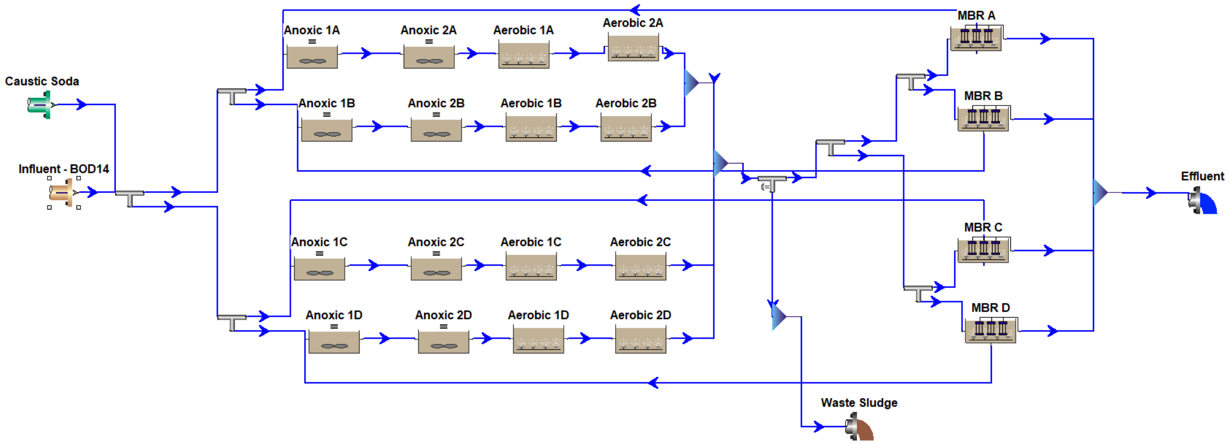


Table 4-2 presents the existing process volumes and depth of the aeration basin for each treatment train used in the process modeling for Model 4 and 5.

Table 4-2
Eastside Satellite Treatment Facility Aeration Basin Cell Volume Per Train

Cell	Volume (gallons)	Average Water Depth (feet)
Anoxic 1	10,000	18
Anoxic 2	10,000	18
Aerobic 1	30,000	18
Aerobic 2	30,000	18
MBR Basin	30,000	TBD[1]
Total volume per train	**110,000**	

Note:

1. Water depth dependent on MBR manufacturer.

4.7.4 Process Model Simulation Results

Process model simulations were run to determine the plant performance as well as to provide a range of operational requirements for process equipment under a variety of conditions. The process model was simulated under MMWWF and MMDWF conditions only because that is the design condition for sizing process equipment for secondary treatment. Peak flow simulations were not modeled because the flow conditions are temporary and steady-state process model simulations would not represent true performance.

The preliminary model simulations were run at steady state with influent characteristics listed in **Table 4-1**, and the results of the simulations are shown below in **Table 4-3**. The complete results from the Biowin model for the proposed Eastside Satellite Treatment Facility are included in **Appendix D**.

As shown in **Table 4-3**, the process model predicts that the proposed secondary treatment process will meet the anticipated permitted monthly average effluent concentration limits listed on **Table 2-2** under all simulation conditions. In our opinion, the model over-predicts the amount of TSS removal from the MBR, but based upon a review of historical data from several MBR facilities, the maximum MBR effluent is 4 mg/L.

The process modeling indicated the system could not meet the permit pH without supplemental alkalinity addition through caustic soda addition. For the modeling, it was assumed that 50 percent caustic soda was added to the system. Because there is limited data on alkalinity concentrations data available, it is possible that the required caustic soda requirement will be more or less.

Table 4-3
Eastside Satellite Treatment Facility – Process Model Simulation Results

Parameter	2026 ADWF	2026 MMWWF	2026 MMDWF	2040 MMWWF	2040 MMDWF
Flow, MGD	0.46	1.14	0.6	2.27	1.21
Temperature, °C	22	11	22	11	22
SRT, days	25	15	15	15	15
MLSS, mg/L	8,300	9,300	8,700	8,700	8,300
50% Caustic Soda Addition, gpd	0	100	100	100	100
Total Air Demand, scfm	1,300	1,800	2,400	3,200	3,800
Secondary Effluent TSS, mg/L	< 1	< 1	< 1	< 1	< 1
Secondary Effluent BOD_5, mg/L	< 1	< 1	< 1	< 1	< 1
Secondary Effluent Ammonia-N, mg/L	0.06	0.3	0.05	0.65	0.06
Secondary Effluent Total Nitrogen, mg/L	11	8	13	8	13
Secondary Effluent pH	6.3	6.4	6.8	6.1	6.5
WAS Solids, ppd	600	1,200	1,100	2,100	2,000

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Section 5

Section 5

Conclusion

5.1 Existing Sandy WWTP Biological Process Analysis

The results of the biological process analysis of the existing Sandy WWTP show that the planned improvements at the Sandy WWTP along with the staged construction of the Eastside Satellite Treatment Facility will result in the facility meeting its permit through 2040 assuming all equipment operates as designed. A summary of the design criteria can be found on **Table 5-1**. The upcoming immediate needs improvements project will improve performance of key unit processes including the aeration system in the aeration basin and the secondary clarifiers that had resulted in permit exceedances. In addition, increased capacity of sodium hydroxide feed system was found to be key for meeting the ammonia permit limit in the process model since nitrifying bacteria are increasingly inhibited by pH levels less than 7. As stated in the Facilities Plan, the phasing of the improvements to the existing Sandy WWTP outlined in Phase 2 of the Facilities Plan should be implemented based on the observation of growth in the community that results in increased flow and load to the WWTP.

Table 5-1
Sandy Wastewater Treatment Plant– Design Criteria

System	Design Criteria	
Headworks Treatment	Current	After Phase 2 Improvements
Mechanical Fine Screen		
Type	Drum Screen	Drum Screen
Quantity	1	2
Opening	¼”	¼”
Capacity, each	6.6 MGD	6.6 MGD
Grit Chamber		
Type	Vortex	Vortex
Quantity	1	1
Process Capacity	7.0 MGD	7.0 MGD
Sodium Hydroxide Feed Pumps		
Quantity	2 (1 duty + 1 standby)	2 (1 duty + 1 standby)
Pump Type	Diaphragm	Diaphragm
Design Flow Rate, each	300 gpd	300 gpd

System	Design Criteria	
Primary Treatment		
Primary Clarifier		
Type	None	Circular
Quantity	-	2
Diameter	-	65 feet
Side Water Depth		15 feet
Secondary Treatment		
Aeration Basin		
Number of Trains	2	2
Total Basin Volume	740,000 gallons	740,000 gallons
Selector Zone Cells (3 per train)	75,000 gallons each	75,000 gallons each
Aerobic Cells (1 per train)	145,000 gallons	145,000 gallons
Side Water Depth	17.8 feet	17.8 feet
Max Design SRT	7 days	8 days
Max Design MLSS	3,400 mg/L	3,100 mg/L
Air Demand at Maximum Month Per Basin	1,500 scfm	1,100 scfm
Process Air Blowers		
Multistage Centrifugal		
Number of Blowers	3	3
Blower Capacity, each	1,350 scfm	1,350 scfm
Rotary Lobe		
Number of Blowers	1	1
Blower Capacity, each	400-1,100 scfm	400-1,1100 scfm
Secondary Clarifier		
Quantity	2	2
Type	Circular	Circular
Diameter	54 feet	54 feet
Side Water Depth	15 feet	15 Feet
Volume	257,000 gallon	257,000 gallon
Capacity	3.5 MGD	3.5 MGD
Surface overflow rate at capacity	1,500 gal/day per ft^2	1,500 gal/day per ft^2
Return Activated Sludge Pump		
Quantity	2	2
Pump Type	Centrifugal	Centrifugal
Design Flow Rate, each	600 gpm	600 gpm
Waste Activated Sludge Pump		
Quantity	2	2
Pump Type	Double Diaphragm	Double Diaphragm
Design Flow Rate, each	260 gpm	260 gpm

System	Design Criteria	
Disinfection		
UV System (By UV Octo 15 May 15)		
Reactor Type	Open Channel	Open Channel
No. of Channels	1	2
Lamp Type	Medium Pressure	Low Pressure
Dosage	30 mJ/ cm^2	30 mJ/ cm^2
Design Capacity, each channel	7.0 MGD	7.0 MGD
Peak Flow Rate	3.5 MGD	14.0 MGD
Disinfection (By 12.5% Sodium Hypochlorite, May 15- Oct 15)		
Hypochlorite Storage Tanks	Two each 1,000 gallons	Two each 1,000 gallons
Sodium Hypochlorite Feed Pumps	2	2
Quantity	2	2
Pump Type	Metering	Metering
Design Flow Rate	5 gallons per hour	5 gallons per hour
Solids Handling		
Aerated Sludge Storage Basins		
Cell No. 1		
Volume	90,000 gallons	-
Side Water Depth	15 feet	-
Cell No. 2		
Volume	180,000 gallons	-
Side Water Depth	15 feet	-
Min Aerobic SRT	4 days	-
Anaerobic Digesters		
Primary Anaerobic Digester		
Volume	-	250,000 gallons
Side Water Depth	-	20 feet
Secondary Anaerobic Digester		
Volume	-	447,000 gallons
Side Water Depth	-	16 feet
Min Anaerobic SRT	-	65 days

5.2 Eastside Satellite Treatment Facility Basis of Design

As outlined in the facilities plan, the Eastside Satellite Treatment Facility will be constructed under two stages. This report provides a basis of design for the unit processes to be constructed including identifying design criteria and redundant equipment requirements. A summary of the design criteria can be found on **Table 5-2**. As part of the analysis, the flows at the Diversion Pump Station were evaluated in the collection system model to confirm that the required wastewater flow was present to divert consistent flow to the Eastside Satellite Treatment Facility.

At the treatment plant, the headworks facility will consist of the three fine screens after Stage 2 construction each with a rated capacity of 3.5 MGD with openings less than 2 mm. A single vortex grit removal system with a rated capacity of 7.0 MGD will be installed in Stage 1. The MBR will consist of a total of four trains. Two trains will be installed during Stage 1 construction and the remaining two trains will be installed under Stage 2. Four in-pipe UV disinfection systems will be installed to disinfect the secondary treated wastewater to discharge to the Sandy River or to meet either Class A Recycle Water standards for irrigation or discharge to Roslyn Lake. Finally, a post-aeration system will be installed to increase the dissolved oxygen to 6 mg/L to meet the discharge effluent requirements that were identified in the preliminary anti-degradation analysis. All process facilities and equipment will be enclosed in buildings to mitigate noise and odors. The site will also be landscaped including installing of berms and screening to provide a buffer for the surrounding residences.

The process model for the Eastside Satellite Treatment Facility found that plant could achieve all effluent goals outlined on Table 2-2, but similarly to the existing Sandy WWTP, sodium hydroxide feed will be important to achieve efficient nitrification for ammonia removal.

Table 5-2
Eastside Satellite Treatment Facility – Design Criteria

System	Design Criteria	
Headworks Treatment	Stage 1	Stage 2
Mechanical Fine Screen		
Type	Drum Screen	Drum Screen
Quantity	2	3
Opening	2 mm	2 mm
Capacity. each	3.5 MGD	3.5 MGD
Grit Chamber		
Type	Vortex	Vortex
Process Capacity	7.5 MGD	7.5 MGD
Secondary Treatment		
Membrane Bioreactor		
Number of Trains	2	4
Total Basin Volume, Per Train	110,000 gallons	110,000 gallons
Anoxic Volume Per Train	20,000 gallons	20,000 gallons
Aerobic Volume Per Train	60,000 gallons	60,000 gallons
Side Water Depth	18 feet	18 feet
No. of MBR Basins Per Train	2	2
MBR Basin Volume, Each	30,000	30,000
Max Design SRT	25 days	25 days
Max Design MLSS	9,500 mg/L	9,500 mg/L
Air Demand at Maximum Month Per Basin	1,200 scfm	1,000 scfm

System	Design Criteria	
Process Air Blowers		
Number	3 (2 duty + 1 standby)	5 (4 duty + 1 standby)
Blower Capacity, each	1,300 scfm	1,300 scfm
Scour Air Blowers		
Number	3 (2 duty + 1 standby)	5(4 duty + 1 standby)
Blower Capacity, each	400 scfm	400 scfm
Feed Forward Pumps		
Quantity	3 (2 duty + 1 standby)	5 (4 duty + 1 standby)
Pump Type	Centrifugal	Centrifugal
Design Flow Rate	2,000 gpm	2,000 gpm
Waste Activated Sludge Pump		
Quantity	3 (2 duty + 1 standby)	5 (4 duty + 1 standby)
Pump Type	Centrifugal	Centrifugal
Design Flow Rate, each	40 gpm	40 gpm
Permeate Pumps		
Quantity	5 (4 duty + 1 standby)	9 (8 duty + 1 standby)
Pump Type	Centrifugal	Centrifugal
Design Flow Rate, each	620 gpm	620 gpm
Caustic Soda Addition Pumps		
Quantity	3 (2 duty + 1 standby)	5 (5 duty + 1 standby)
Pump Type	Diaphragm	Diaphragm
Design Flow Rate, each	100 gpd	100 gpd
Disinfection		
UV System		
Sandy River Discharge		
Reactor Type	In-Pipe	In-Pipe
Lamp Type	Low Pressure High Output	Low Pressure High Output
No. of Units	3 (2 Duty + 1 Standby)	3 (2 Duty + 1 Standby)
UV Unit Configuration	Parallel	Parallel
Dosage	30 mJ/ cm^2	30 mJ/ cm^2
Peak Flow Rate	3.5 MGD	7.0 MGD
Class A Recycle Water		
Reactor Type	In-Pipe	In-Pipe
Lamp Type	Low Pressure High Output	Low Pressure High Output
No. of Units	4 (3 Duty + 1 standby)	4 (3 Duty + 1 standby)
UV Unit Configuration	Series	Series
Dosage	80 mJ/ cm^2	80 mJ/ cm^2
Peak Flow Rate	1.6 MGD	1.6 MGD

System	Design Criteria	
Tertiary Treatment		
Post-Aeration System		
Number of Units	1	1
Design Influent DO	2 mg/L	2 mg/L
Design Effluent DO	6 mg/L	6 mg/L
Peak Design Flow Rate	7.0 MGD	7.0 MGD

Appendix

murraysmith

APPENDIX A
CITY OF SANDY WWTP NPDES PERMIT

DFQ

Expiration Date: November 30, 2013
Permit Number: 1024~~29~~ 92 CMS 11/27/12
File Number: 78615

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
WASTE DISCHARGE PERMIT

Department of Environmental Quality
Northwest Region – Portland Office
2020 SW 4th Ave., Suite 400, Portland, OR 97201
Telephone: (503) 229-5263
Issued pursuant to ORS 468B.050 and The Federal Clean Water Act

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SOURCES COVERED BY THIS PERMIT:

ISSUED TO:
City of Sandy
39250 Pioneer Blvd
Sandy, OR 97005

Type of Waste	Outfall Number	Outfall Location
Treated Wastewater	001	R.M. 2.1
Reclaimed Water Reuse	002	Iseli Nursery Pond IV
Emergency Overflow	003	R.M. 3.4

FACILITY TYPE AND LOCATION:
Activated Sludge
City of Sandy Wastewater Treatment Plant
33400 SE Jarl Road
Boring, OR 97009

Treatment System Class: Level III
Collection System Class: Level II

RECEIVING STREAM INFORMATION:
Basin: Willamette
Sub-Basin: Lower Willamette

Receiving Stream: Tickle Creek
LLID: 1223744453954 2.1 D
County: Clackamas

EPA REFERENCE NO: OR-002657-3
This permit is issued in response to Application No. 977145 received September 1, 2006.
This permit is issued based on the land use findings in the permit record.

1/23/10

Greg L. Geist, Manager Water Quality Source Control Section
Northwest Region

Date

PERMITTED ACTIVITIES

Until this permit expires or is modified or revoked, the Permittee is authorized to construct, install, modify, or operate a wastewater collection, treatment, control and disposal system and discharge to public waters adequately treated wastewaters only from the authorized discharge point or points established in Schedule A and only in conformance with all the requirements, limitations, and conditions set forth in the attached schedules as follows:

Unless specifically authorized by this permit, by another NPDES or WPCF permit, or by Oregon Administrative Rule, any other direct or indirect discharge of waste is prohibited, including discharge to waters of the state or an underground injection control system.

SCHEDULE A

1. **Waste Discharge Limitations not to be exceeded after permit issuance.**

a. **Outfalls 001 & 003 - Treated Effluent**

(1) May 1 - October 31: No discharge to waters of the State.

(2) November 1 - April 30: No discharge to the waters of the state is permitted at times when ***stream dilution is less than 10.*** Stream dilution is calculated as follows:

Dilution = $(Q_s + Q_e)/Q_e \geq 10$, where
Q_s = Tickle Creek flow measured at gauge, per Schedule B, 1.e (Note7).
Q_e = Effluent flow measured, per Schedule B, 1.b.

Parameter	Average Effluent Concentrations Monthly	Average Effluent Concentrations Weekly	Monthly* Average lb/day	Weekly* Average lb/day	Daily* Maximum lbs
BOD_5	10 mg/L	15 mg/L	125	187	250
TSS	10 mg/L	15 mg/L	125	187	250

* Winter mass loads are based upon the prior permit's average wet weather design flow = 1.5 MGD. The current facility design average dry weather flow (**ADWF**) = **1.25 MGD**; and the design average wet weather flow (**AWWF**) = **1.85 MGD**. The daily mass load limit is suspended on any day in which the flow to the treatment facility exceeds 2.5 MGD (twice the design ADWF).

(3)

Other parameters	Limitations
E. coli Bacteria	Shall not exceed 126 organisms per 100 mL monthly geometric mean. No single sample shall exceed 406 organisms per 100 mL (See Note 1).
pH	Shall be within the range of 6.0 - 9.0
BOD_5 and TSS Removal Efficiency	Shall not be less than 85% monthly average for BOD_5 and 85% monthly for TSS.
Ammonia (NH3-N)	Shall not exceed 10.9 mg/L daily maximum or 3.7 mg/L monthly average.

(4) Regulatory Mixing Zone. No wastes may be discharged or activities conducted that cause or contribute to a violation of water quality standards in OAR 340-041 applicable to the Willamette basin, except as provided for in OAR 340-045-0080 and the following regulatory mixing zone:

The regulatory mixing zone (RMZ) is that portion of Tickle Creek extending 50 feet downstream and 5 feet upstream from the outfall. The zone of initial dilution (ZID) extends in the stream 5 feet from the discharge point.

(5) Chlorine. Chlorine and chlorine compounds must not be used as a disinfecting agent of the treated effluent, and no chlorine residual is allowed in the effluent discharged to the stream.

b. Outfall 002 - Recycled Wastewater

(1) No discharge to state waters is permitted. All recycled water shall be distributed on land, for dissipation by evapo-transpiration and controlled seepage by following sound irrigation practices so as to prevent:

a. Prolonged ponding of treated recycled water on the ground surface;

b. Surface runoff or subsurface drainage through drainage tile;

c. The creation of odors, fly and mosquito breeding, or other nuisance conditions;

d. The overloading of land with nutrients, organics, or other pollutant parameters; and

e. Impairment of existing or potential beneficial uses of groundwater.

(2) Prior to land application of the recycled water, it shall receive at least Class B treatment as defined in OAR 340-055:

> Class B recycled water must not exceed a median of 2.2 Total Coliform organisms per 100 milliliters, based on results of the last seven days that analyses have been completed, and 23 Total Coliform organisms per 100 milliliters in any single sample.

(3) Where an irrigation method is used to apply Class B recycled water directly to the soil, there are no setback requirements.

(4) Where sprinkler irrigation is used to apply Class B recycled water, there must be a minimum of 10 feet from the edge of the site used for irrigation and the site property line.

(5) There must be a minimum of 50 feet from the edge of the irrigation site to a water supply source used for human consumption.

(6) Where sprinkler irrigation is used to apply Class B recycled water, the recycled water must not be sprayed within 10 feet of an area where food is being prepared or served, or where a drinking fountain is located.

(7) If aerosols are generated when using recycled water for an industrial, commercial, or construction purpose, the aerosols must not create a public health hazard.

(8) The public and personnel at the use area must be notified that the water used is recycled water and is not safe for drinking. The Recycled Water Use Plan must specify how the notification will be provided.

c. Outfall 003 - Emergency Overflow of Treated Effluent

No discharge to waters of the state is permitted from Outfall 003 when the treatment facility's peak, instantaneous wet weather flow is less than 4.0 MGD.

d. Groundwater

No activities shall be conducted that could cause an adverse impact on existing or potential beneficial uses of groundwater.

NOTES:

1. If a single sample exceeds 406 organisms per 100 mL, then five consecutive re-samples may be taken at four-hour intervals beginning within 28 hours after the original sample was taken. If the log mean of the five re-samples is less than or equal to 126 organisms per 100 mL, a violation shall not be triggered.

SCHEDULE B

1. Minimum Monitoring and Reporting Requirements

The Permittee shall monitor the parameters as specified below at the locations indicated. The laboratory used by the Permittee to analyze samples shall have a quality assurance/quality control (QA/QC) program to verify the accuracy of sample analysis. If QA/QC requirements are not met for any analysis, the results shall be included in the report, but not used in calculations required by this permit. When possible, the Permittee shall re-sample in a timely manner for parameters failing the QA/QC requirements, analyze the samples, and report the results.

a. Influent

The facility influent sampling location is the following: All influent grab samples, measurements, and composite samples are taken at the Parshall flume upstream of any return flows to the headworks. The Parshall flume is located downstream of the raw screening and grit removal processes. All samples for toxics are taken in the same location.

Item or Parameter	Minimum Frequency	Type of Sample
Total Flow (MGD)	Daily	Measurement
Flow Meter Calibration	Semi-Annual	Verification (See Note 1)
BOD_5	2/Week	Composite
TSS	2/Week	Composite
pH	3/Week	Grab

b. Treated Effluent Outfalls 001 & 003

The facility effluent sampling location is the following: *Effluent grab samples and* measurements are taken at the discharge from the UV disinfection unit. Composite samples and samples for toxics are taken at the same location. Effluent temperature measurements are taken at Outfall 001.

Item or Parameter	Minimum Frequency	Type of Sample
Total Flow (MGD)	Daily	Measurement
Flow Meter Calibration	Semi-Annual	Verification (See Note 1)
BOD_5	2/Week	Composite
TSS	2/Week	Composite
pH	3/Week	Grab
E. coli	2/Week	Grab (See Note 2)
UV Radiation Intensity	Daily	Reading (See Notes 1 & 3)
NH_3-N	2/Week	Grab

Chlorine Residual	Daily	Grab
Pounds Discharged (BOD$_5$ and TSS)	2/Week	Daily Maximum Calculation
Pounds Discharged (BOD$_5$ and TSS)	1/Week	Weekly Average Calculation
Pounds Discharged (BOD$_5$ and TSS)	Monthly	Monthly Average Calculation
Average Percent Removed (BOD$_5$ and TSS)	Monthly	Calculation
Metals: As, Cd, Cr, Cu, Pb, Hg, Fe, Ni, Ag, Zn; and Alkalinity & pH.	Quarterly during winter season	24-Hour Composite (Note 4)
Effluent Temperature (°C)	5/Week	Grab (Note 5)
Whole Effluent Toxicity (WET) Testing	See Schedule D, Item #2 to determine sampling frequency.	24-Hour Composite

c. **Biosolids Management**

Item or Parameter	Minimum Frequency	Type of Sample
Sludge analysis including: Total Solids (% dry wt.) Volatile solids (% dry wt.) Biosolids nitrogen for: NH$_3$-N; NO$_3$-N; & TKN (% dry wt.) Phosphorus (% dry wt.) Potassium (% dry wt.) pH (standard units) Sludge metals content for: As, Cd, Cu, Hg, Mo, Ni, Pb, Se & Zn, measured as total in mg/kg.	Annually	Composite sample must be representative of the product that is land applied (See Note 6).
Record of locations where biosolids are applied on each ODEQ approved site. Site location maps must be maintained at the treatment facility for review upon request by ODEQ.	Each Occurrence	Date, volume, and map locations where biosolids were applied (See Note 1).
Quantity and type of alkaline product used to stabilize biosolids (when	Each occurrence	Measurement (See Note 1).

required to meet federal pathogen and vector attraction reduction requirements in 40 CFR 503.32(b)(3) and 40 CFR 503.33(b)(6)).		
Initial time when solids that received alkaline agent ascended to pH ≥ 12.	Each batch	Date, time, and actual pH measurement (corrected to standard at 25°C) (Note 1).
2 hours after initial alkaline addition and sustained at pH ≥ 12.	Each batch	Date, time, and actual pH measurement (corrected to standard at 25°C) (Note 1).
24 hours after initial alkaline addition and pH ≥ 11.5 was sustained.	Each batch	Date, time, and actual pH measurement (corrected to standard at 25°C) (Note 1).

d. **Recycled Wastewater Outfall 002***

*Grab samples must be taken at Iseli Nursery at the recycled water forcemain discharge point.

Item or Parameter	Minimum Frequency	Type of Sample
Quantity Irrigated (gallons/day)	Daily	Measurement
Flow Meter Calibration	Annually	Verification (Note 1).
Quantity Chlorine Used	Daily	Measurement
Total Chlorine Residual	Daily	Grab
pH	2/Week	Grab
Total Coliform	3/Week	Grab
Nutrients (TKN, NO_2+NO_3-N, NH_3, Total Phosphorus)	Quarterly	Grab (See Note 1).

e. **Tickle Creek (November 1 – April 30)***

Item or Parameter	Minimum Frequency	Type of Sample
Flow (upstream)	2/Week	Measurement (See Note 7)
Stream Dilution	2/Week	Calculation
Metals*: As, Cd, Cr, Cu, Pb, Fe, Ni, Ag, Zn; & Alkalinity and pH.	Quarterly during winter season	Grab (Note 4)

*Take metal grab samples at least 50 feet upstream of the Outfall 001 discharge point.

2. **Discharge Monitoring Reports (DMRs) - Reporting Procedures**

   a. Monitoring results shall be reported on approved DMR forms. The reporting period is the calendar month. Reports must be submitted to the Department's Northwest Region - Portland office by the **15th day** of the following month.

   b. DMRs shall identify the name, certificate classification and grade level of each principal operator designated by the permittee as responsible for supervising the wastewater collection and treatment systems during the reporting period. Monitoring reports shall also identify each system classification as found on Page One of this permit.

   c. DMRs must list all equipment break-downs and all bypassing events. Additionally, the facility's log book must list break-downs and bypassing events, and describe the reasons and corrective action taken to remedy the situation. The log book must be kept current and be available for ODEQ inspection during site visits.

3. **Annual Report Submittals**

   a. I&I Report. The Permittee shall have in place a program to identify and reduce inflow and infiltration (I&I) into the sewage collection system. An annual report shall be submitted to the Department by February 19 each year that details sewer collection maintenance activities to reduce I&I. The report shall state those activities that have been done in the previous year and those activities planned for the following year.

   b. Biosolids Handling Report. For any year in which biosolids are land applied, a report must be submitted to the Department by February 19 of the following year that describes solids handling activities for the previous year and includes, but is not limited to, the required information outlined in OAR 340-050-0035(6)(a)-(e).

   c. Recycled Water Use Report. By no later than February 19 of each year, the Permittee shall submit to the Department an annual report describing the effectiveness of the recycled water system to comply with approved Recycled Water Use Plan, the rules of Division 055, and the limitations and conditions of this permit applicable to use of recycled water.

***NOTES*:**

1. Mandatory Record Keeping. This data must be recorded in the treatment facility log book, per the specified minimum frequency. All data must be kept current, and be open for review by DEQ staff during site visits &/or inspections.

2. *E. coli* Monitoring. *E. coli* monitoring must be conducted according to any of the following test procedures as specified in **Standard Methods for the Examination of Water and Wastewater, 19th Edition**, or according to any test procedure that has been authorized and approved in writing by the Director or an authorized representative:

Method	Reference	Page	Method Number
mTEC agar, MF	Standard Methods, 18th Edition	9-29	9213 D
NA-MUG, MF	Standard Methods, 19th Edition	9-63	9222 G
Chromogenic Substrate, MPN	Standard Methods, 19th Edition	9-65	9223 B
Colilert QT	Idexx Laboratories, Inc.		

3. UV Radiation Intensity. The intensity of UV radiation passing through the water column will affect the system's ability to kill organisms. To track the reduction in intensity, the UV disinfection system must include a UV intensity meter with a sensor located in the water column at a specified distance from the UV bulbs. This meter will measure the intensity of UV radiation in mWatts-seconds/cm2. The daily UV radiation intensity shall be determined by reading the meter each day. If more than one meter is used, the daily recording will be an average of all meter readings each day. Intensity meter(s) must be calibrated at a frequency recommended by the manufacturer. The manufacturer's UV intensity curves shall be used to determine when UV bulbs must be replaced or cleaned. Record all daily UV intensity readings in the treatment facility's log book. Record any change of UV bulbs. Daily UV intensity readings are required for at least 5 days per week.

4. Metals Testing. Whenever possible, a permittee should always use a test method as indicated 40 CFR Part 136 with a Quantitation Limit (QL) that is lower than the permitted effluent limit or water quality criteria for priority pollutant scans. A list of the analytic methods approved by the department and of the applicable QLs is located in the amended tables for Appendix B: Non-detect Analytical Data and Minimum Practical Quantification Levels, located on the web at: http://www.deq.state.or.us/wq/pubs/imds/rpaammend.pdf. The permittee must ensure that all monitoring analysis reports contain both the QL and detection level of the method as defined below:

   Detection Level: *Same as the "**Method Detection Limit**" (MDL) derived using 40 CFR 136, Appendix B.*

   Quantitation Limit: *Same as the **Method Reporting Limit (MRL)**. It is the lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.*

Metal	*Symbol*	Nov 2007 Appendix B IMD Quantitation Limit (QL) Required ug/L
Arsenic	As	0.05
Cadmium	Cd	0.1
Chromium	Cr	0.4
Copper	Cu	10

Lead	Pb	5
Nickel	Ni	10
Silver	Ag	1.0
Zinc	Zn	5
Iron	Fe	100
Mercury	Hg	0.01

All metals in terms of "Total Recoverable." ***Effluent and Tickle Creek alkalinities must be measured whenever metal samples are taken.*** *Measure Tickle Creek alkalinity at a location at least 50 feet upstream of the Outfall 001discharge point.*

5. Temperature Measurements. Take daily temperature measurements between the hours of 1400 and 1600. Alternatively use continuous monitoring by Department approved method. When continuous monitoring is used, report the daily maximum temperature on the discharge monitoring report (DMR). After winter season Years 2009-20010 & 20010-2011, temperature measurements are not required.

6. Biosolids. Biosolids composite samples shall be taken from reference areas in the biosolids storage area pursuant to Test Methods for Evaluating Solid Waste, Volume 2; Field Manual, Physical/Chemical Methods, November 1986, Third Edition, Chapter 9. Inorganic pollutant monitoring must be conducted according to Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Second Edition (1982) with Updates I and II and third Edition (1986) with Revision I.

7. Stream Flow. Tickle Creek flow measurements shall be made at the established gauging station that is located approximately one mile upstream of Outfall 001.

SCHEDULE C

Compliance Schedules and Conditions

NOT APPLICABLE

SCHEDULE D

Special Conditions

1. Biosolids

a. Biosolids Management Plan. All biosolids must be managed in accordance with the current DEQ approved Biosolids Management Plan (the Plan), site authorization letters issued by DEQ, and land use approval from the designated municipality &/or county. Any changes in biosolids management or application activities that differ significantly from operations specified under the approved Plan require the prior written approval of the DEQ.

b. Biosolids Management Plan Update. Permittee must submit a revised Plan for Department approval within 120 days of permit issuance that reflects actual biosolids treatment, storage, and land application practice.

c. Changes in Biosolids Standards. This permit may be modified to incorporate any applicable standard for biosolids use or disposal promulgated under section 405(d) of the Clean Water Act; if the standard for biosolids use or disposal is more stringent than any requirements for biosolids use or disposal in the permit, or controls a pollutant or practice not limited in this permit.

2. Whole Effluent Toxicity Testing*.

On January 2003 the Permittee submitted its "Tickle Creek Outfall Mixing Zone Study." The report was prepared for the City on contract by Curran-McLeod, Incorporated Consulting Engineers. Since the City is only allowed to discharge to Tickle Creek during winter season (November 1 through April 30) each year, the Mixing Zone (MZ) Study focused on worst-case conditions for winter season stream flows. This permit requires the City to maintain a* ***minimum dilution of 10* *when discharging to Tickle Creek per Schedule A, 1.a (2). This dilution criterion was used with the 7-day average low creek flow with a reoccurrence interval of 10-years* ***(7Q10 low flow = 0.31 m^3/s)*** *for the MZ analysis. Conductivity measurements were taken to estimate dilution in the zone of initial dilution (ZID) and the MZ. Based on the stream conductivity study, worst-case dilution at 7Q10 low flow was determined to be approximately 1.7 at the ZID boundary and 3.7 at the MZ boundary (MZ Study, P. 13, D.2, Table).*

a. The permittee shall conduct whole effluent toxicity (WET) tests as required in Schedule B of this permit. The Permittee shall conduct whole effluent toxicity (WET) testing prior to application for renewal of this permit. Part E (Toxicity Testing Data) of U.S. EPA Form 2A prescribes WET testing requirements and options.

b. Two sampling options. The facility shall sample once per year over the first four years of the permit. The sampling events and toxicity tests should take place in a different quarter each year (i.e. Year 1, Qtr 1). Alternatively, the facility may choose to conduct all tests within a single year of the permit, in which case, the tests shall be conducted quarterly.

c. Acute Toxicity Testing - Organisms and Protocols

(1) The permittee shall conduct 48-hour static renewal tests with *Ceriodaphnia dubia* (water flea) and 96-hour static renewal tests with *Pimephales promelas* (fathead minnow).

(2) All test methods and procedures shall be in accordance with **Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms**, Fifth Edition, EPA-821-R-02-012 (October 2002). Any deviation of the bioassay procedures outlined in this method shall be submitted in writing to the Department for review and approval prior to use.

(3) Tests shall be conducted on final effluent sample collected a 24-Hour Composite sample. No treatments to the final effluent (i.e. dechlorination, etc), except those included as part of the methodology, shall be performed by the laboratory unless approved by the Department prior to analysis.

(4) Acute tests shall be conducted on a control (0% effluent) and the following dilution series, unless otherwise approved by the Department in writing: 6.25%, 12.5%, 25%, 60%, and 100%.

(5) An acute WET test shall be considered to show toxicity if there is a statistically significant difference in survival between the control and 60% percent effluent.

d. Chronic Toxicity Testing - Organisms and Protocols

(1) The permittee shall conduct tests with: *Ceriodaphnia dubia* (water flea) for reproduction and survival test endpoint, *Pimephales promelas* (fathead minnow) for growth and survival test endpoint and *Raphidocelis subcapitata* (green alga formerly known as *Selanastrum capricornutum*) for growth test endpoint.

(2) All test methods and procedures shall be in accordance with **Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms**, Fourth Edition, EPA-821-R-02-013, October 2002. Any deviation of the bioassay procedures outlined in this method shall be submitted in writing to the Department for review and approval prior to use.

(3) Tests shall be conducted on final effluent samples collected as 24-hour composite samples. No treatments to the final effluent (i.e. dechlorination, etc), except those included as part of the methodology, shall be performed by the laboratory unless approved by the Department prior to analysis.

(4) Chronic tests shall be conducted on a control (0% effluent) and the following dilution series, unless otherwise approved by the Department in writing: 6.25%, 12.5%, 25%, 60%, and 100%.

(5) A chronic WET test shall be considered to show toxicity if the IC_{25} (25% inhibition concentration) occurs at dilutions equal to or less than the dilution that is known to occur at the edge of the mixing zone, i.e. $IC_{25} \leq 25\%$.

e. Dual End-Point Tests –

(1) WET tests may be dual end-point tests in which both acute and chronic end-points can be determined from the results of a single chronic test. The acute end-point shall be based on 48-hours for the *Ceriodaphnia dubia* (water flea) and 96-hours for the *Pimephales promelas* (fathead minnow).

(2) All test methods and procedures shall be in accordance with **Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms**, Fourth Edition, EPA-821-R-02-013 (October 2002). Any deviation of the bioassay procedures outlined in this method shall be submitted in writing to the Department for review and approval prior to use.

(3) Tests shall be conducted on final effluent samples collected as described in item d. (3).

(4) Tests run as dual end-point tests shall be conducted on a control (0% effluent) and the following dilution series, unless otherwise approved by the Department in writing: 6.25%, 12.5%, 25%, 50%, 60%, and 100%.

(5) Toxicity determinations for dual end-point tests shall correspond to the acute, c. (5), and chronic, d. (5), described above.

f. Evaluation of Causes and Exceedances

(1) If any test exhibits toxicity, as defined in sections c. (5) or d. (5) of this permit condition, another toxicity test using the same species and Department approved methodology shall be conducted within two weeks, unless otherwise approved by the Department.

(2) If two consecutive WET test results indicate acute and/or chronic toxicity, as defined in sections c. (5) or d. (5) of this permit condition, the permittee shall immediately notify the Department of the results. The Department will work with the permittee to determine the appropriate course of action to evaluate and address the toxicity.

g. Quality Assurance / Reporting

(1) Quality assurance criteria, statistical analyses, and data reporting for the WET tests shall be in accordance with the EPA documents stated in this condition.

(2) A bioassay laboratory report for each test shall be prepared according to the EPA method documents referenced in this Schedule. This shall include all QA/QC documentation, statistical analysis for each test performed, standard reference toxicant test (SRT) conducted on each species required for the toxicity tests, and completed Chain of Custody forms for the samples including time of sample collection and receipt. Reports shall be submitted to the Department within 45 days of test completion.

(3) The report should include all endpoints measured in the test, i.e. NOEC, LOEC, and IC_{25}.

(4) The permittee shall make available to the Department, on request, the written standard operating procedures they, or the laboratory performing the WET tests, are using for all toxicity tests required by the Department.

h. Reopener

(1) The Department may reopen and modify this permit to include new limitations, monitoring requirements, and/or conditions as determined by the Department to be appropriate, and in accordance with procedures outlined in Oregon Administrative Rules, Chapter 340, Division 45, if:

a. WET testing data indicate acute and/or chronic toxicity.
b. The facility undergoes any process changes.
c. Discharge monitoring data indicate a change in the reasonable potential to exhibit toxicity.

3. **Priority Pollutant Scan.**

The permittee must perform all testing required in Part D of U.S. EPA Form 2A with priority pollutant scans no more than 4 ½ years old. Two of the three scans must be performed no fewer than 4 months and no more than 8 months apart. The effluent samples shall be 24-hour daily composites, except where sampling volatile compounds. In this case, six (6) discrete samples (not less than 100 mL) collected over the operating day are acceptable. The permittee shall take special precautions in compositing the individual grab samples for the volatile organics to insure sample integrity (i.e. no exposure to the outside air). Alternately, the discrete samples collected for volatiles may be analyzed separately and averaged.

Whenever possible, a permittee should always use a test method with a **Quantitation Limit (QL)** that is lower than the permitted effluent limit or water quality criteria for priority pollutant scans. A list of the analytic methods approved by the department and the applicable QLs are located in the amended tables for Appendix B: Non-detect Analytical Data and Minimum Practical Quantification Levels, located on the web at

http://www.deq.state.or.us/wq/pubs/imds/rpaammend.pdf.

The permittee must ensure that all monitoring analysis reports contain both the QL and detection level of the method as defined below:

Detection Level: *Same as the "**Method Detection Limit**" (MDL) derived using 40 CFR 136, Appendix B.*

Quantitation Limit: *Same as the **Method Reporting Limit** (MRL). It is the lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.*

Whenever possible, analysis for silver and arsenic should possess a minimum QL as described below:

- Silver 1.0 µg/L
- Arsenic 0.05 µg/L

4. **Recycled Water Requirements.**
The Permittee shall meet the requirements for use of recycled water under OAR Chapter 340, Division 055, ***Recycled Water Use*** including the following:

a. All recycled water shall be managed in accordance with the approved Recycled Water Use Plan. No substantial changes shall be made in the approved plan without written approval of the Department.

b. Any person having control over the treatment or distribution or both of recycled water may distribute recycled water only for the beneficial purposes described in this rule, and must take all reasonable steps to ensure that the recycled water is used only in accordance with the standards and requirements of the rules of this division (OAR 340-055-0012 (1)).

c. The Permittee shall notify the Department within 24 hours if it is determined that the treated effluent is being used in a manner not in compliance with OAR 340-055. When the Department offices are not open, the permittee shall report the incident of noncompliance to the ***Oregon Emergency Response System*** **(Telephone Number 1-800-452-0311)**.

5. **Recycled Water Use Plan**. The Recycled Water Use Plan must be updated to reflect changes in Sandy's wastewater treatment facility, recycled water transfer system, and irrigation practices. The Plan must reflect changes to OAR Chapter 340, Division 055, ***Recycled Water Use.*** OAR 340-055 was recently revised and the latest addition was posted by the State on June 1, 2008. An updated Recycled Water Use Plan must be submitted to the Department within 120 days of permit issuance. Should revisions be minor, the Permittee may submit an addendum to the Plan by that date.

6. **Operator Certification**. The Permittee shall comply with Oregon Administrative Rules (OAR), Chapter 340, Division 049, "Regulations Pertaining To Certification of Wastewater System Operator Personnel" and accordingly:

a. The Permittee shall have its wastewater system supervised by one or more operators who are certified in a classification and grade level (equal to or greater) that corresponds with the classification (collection and/or treatment) of the system to be supervised as specified on page one of this permit.

Note: A "supervisor" is defined as the person exercising authority for establishing and executing the specific practice and procedures of operating the system in accordance with the policies of the permittee and requirements of the waste discharge permit. "Supervise" means responsible for the technical operation of a system, which may affect its performance or the quality of the effluent produced. Supervisors are not required to be on-site at all times.

b. The Permittee's wastewater system may not be without supervision (as required by Special Condition 5.a. above) for more than thirty (30) days. During this period, and at any time that the supervisor is not available to respond on-site (i.e. vacation, sick leave or off-call), the permittee must make available another person who is certified at no less than one grade lower than the system classification.

c. If the wastewater system has more than one daily shift, the Permittee shall have the shift supervisor, if any, certified at no less than one grade lower than the system classification.

d. The Permittee is responsible for ensuring the wastewater system has a properly certified supervisor available at all times to respond on-site at the request of the Permittee and to any other operator.

e. The Permittee shall notify the Department of Environmental Quality in writing within thirty (30) days of replacement or redesignation of certified operators responsible for supervising wastewater system operation. The notice shall be filed with the Water Quality Division, Operator Certification Program, 400 East Scenic Drive, Suite 307, The Dalles, OR 97058. This requirement is in addition to the reporting requirements contained under Schedule B of this permit.

f. Upon written request, the Department may grant the Permittee reasonable time, not to exceed 120 days, to obtain the services of a qualified person to supervise the wastewater system. The written request must include a justification for a time extension, a schedule for recruiting and hiring, the date the system supervisor availability ceased, and the name of the alternate system supervisor(s), as required by 6.b. above.

7. **Notification Requirement**. The Permittee shall notify the DEQ Northwest Region - Portland Office (phone: **(503) 229-5263**) in accordance with the response times noted in the General Conditions (Schedule F) of this permit of any malfunction, so that corrective action can be coordinated between the Permittee and the Department.

8. **Groundwater**. The Permittee shall not be required to perform a hydrogeologic characterization or groundwater monitoring during the term of this permit provided:

   a. The facilities are operated in accordance with the permit conditions, and

   b. There are no adverse groundwater quality impacts (complaints or other indirect evidence) resulting from the facility's operation.

   If warranted at permit renewal, the Department may evaluate the need for a full assessment of the facilities impact on groundwater quality.

9. **Spawning Beds Investigation and Report**. Permittee shall use a qualified fisheries expert to investigate Sandy's regulatory mixing zone in Tickle Creek at Outfall 001 for active spawning during winter discharge season. The investigation shall also evaluate the area and quality of spawning habitat inside the mixing zone. The report must be submitted to the Department by June 1, 2011.

SCHEDULE F

NPDES GENERAL CONDITIONS – DOMESTIC FACILITIES

SECTION A. STANDARD CONDITIONS

1. Duty to Comply with Permit

The permittee must comply with all conditions of this permit. Failure to comply with any permit condition is a violation of Oregon Revised Statutes (ORS) 468B.025 and the federal Clean Water Act and is grounds for an enforcement action. Failure to comply is also grounds for the Department to terminate, modify and reissue, revoke, or deny renewal of a permit.

2. Penalties for Water Pollution and Permit Condition Violations

The permit is enforceable by DEQ or EPA, and in some circumstances also by third-parties under the citizen suit provisions 33 USC §1365. DEQ enforcement is generally based on provisions of state statutes and EQC rules, and EPA enforcement is generally based on provisions of federal statutes and EPA regulations.

ORS 468.140 allows the Department to impose civil penalties up to $10,000 per day for violation of a term, condition or requirement of a permit. The federal Clean Water Act provides for civil penalties not to exceed $32,500 and administrative penalties not to exceed $11,000 per day for each violation of any condition or limitation of this permit.

Under ORS 468.943, unlawful water pollution, if committed by a person with criminal negligence, is punishable by a fine of up to $25,000, imprisonment for not more than one year, or both. Each day on which a violation occurs or continues is a separately punishable offense. The federal Clean Water Act provides for criminal penalties of not more than $50,000 per day of violation, or imprisonment of not more than 2 years, or both for second or subsequent negligent violations of this permit.

Under ORS 468.946, a person who knowingly discharges, places, or causes to be placed any waste into the waters of the state or in a location where the waste is likely to escape into the waters of the state is subject to a Class B felony punishable by a fine not to exceed $200,000 and up to 10 years in prison. The federal Clean Water Act provides for criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment of not more than 3 years, or both for knowing violations of the permit. In the case of a second or subsequent conviction for knowing violation, a person shall be subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment of not more than 6 years, or both.

3. Duty to Mitigate

The permittee must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment. In addition, upon request of the Department, the permittee must correct any adverse impact on the environment or human health resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and have the permit renewed. The application must be submitted at least 180 days before the expiration date of this permit.

The Department may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date.

5. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause including, but not limited to, the following:

a. Violation of any term, condition, or requirement of this permit, a rule, or a statute
b. Obtaining this permit by misrepresentation or failure to disclose fully all material facts
c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge
d. The permittee is identified as a Designated Management Agency or allocated a wasteload under a Total Maximum Daily Load (TMDL)
e. New information or regulations
f. Modification of compliance schedules
g. Requirements of permit reopener conditions
h. Correction of technical mistakes made in determining permit conditions
i. Determination that the permitted activity endangers human health or the environment
j. Other causes as specified in 40 CFR 122.62, 122.64, and 124.5
k. For communities with combined sewer overflows (CSOs):
    (1) To comply with any state or federal law regulation that addresses CSOs that is adopted or promulgated subsequent to the effective date of this permit
    (2) If new information, not available at the time of permit issuance, indicates that CSO controls imposed under this permit have failed to ensure attainment of water quality standards, including protection of designated uses
    (3) Resulting from implementation of the Permittee's Long-Term Control Plan and/or permit conditions related to CSOs.

The filing of a request by the permittee for a permit modification, revocation or reissuance, termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

6. Toxic Pollutants

The permittee must comply with any applicable effluent standards or prohibitions established under Oregon Administrative Rules (OAR) 340-041-0033 and 307(a) of the federal Clean Water Act for toxic pollutants, and with standards for sewage sludge use or disposal established under Section 405(d) of the Clean Water Act, within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

7. Property Rights and Other Legal Requirements
The issuance of this permit does not convey any property rights of any sort, or any exclusive privilege, or authorize any injury to persons or property or invasion of any other private rights, or any infringement of federal, tribal, state, or local laws or regulations.

8. Permit References
Except for effluent standards or prohibitions established under Section 307(a) of the federal Clean Water Act and OAR 340-041-0033 for toxic pollutants, and standards for sewage sludge use or disposal established under Section 405(d) of the Clean Water Act, all rules and statutes referred to in this permit are those in effect on the date this permit is issued.

9. Permit Fees
The permittee must pay the fees required by Oregon Administrative Rules.

SECTION B. OPERATION AND MAINTENANCE OF POLLUTION CONTROLS

1. Proper Operation and Maintenance
The permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems that are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

2. Need to Halt or Reduce Activity Not a Defense
For industrial or commercial facilities, upon reduction, loss, or failure of the treatment facility, the permittee must, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It is not a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3. Bypass of Treatment Facilities
   a. Definitions
      (1) "Bypass" means intentional diversion of waste streams from any portion of the treatment facility. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, provided the diversion is to allow essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs b. and c. of this section.
      (2) "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.
   b. Prohibition of bypass.

(1) Bypass is prohibited and the Department may take enforcement action against a permittee for bypass unless:
    i. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
    ii. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventative maintenance; and
    iii. The permittee submitted notices and requests as required under General Condition B.3.c.

(2) The Department may approve an anticipated bypass, after considering its adverse effects and any alternatives to bypassing, when the Department determines that it will meet the three conditions listed above in General Condition B.3.b.(1).

c. Notice and request for bypass.
   (1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, a written notice must be submitted to the Department at least ten days before the date of the bypass.
   (2) Unanticipated bypass. The permittee must submit notice of an unanticipated bypass as required in General Condition D.5.

4. Upset

a. Definition. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operation error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

b. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of General Condition B.4.c are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

c. Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
   (1) An upset occurred and that the permittee can identify the causes(s) of the upset;
   (2) The permitted facility was at the time being properly operated;
   (3) The permittee submitted notice of the upset as required in General Condition D.5, hereof (24-hour notice); and,
   (4) The permittee complied with any remedial measures required under General Condition A.3 hereof.

d. Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

5. Treatment of Single Operational Upset

For purposes of this permit, A Single Operational Upset that leads to simultaneous violations of more than one pollutant parameter will be treated as a single violation. A single operational upset is an exceptional incident that causes simultaneous, unintentional, unknowing (not the result of a knowing act or omission), temporary noncompliance with more than one Clean Water Act effluent discharge pollutant parameter. A single operational upset does not include Clean Water Act violations involving discharge without a NPDES permit or noncompliance to the extent caused by improperly designed or inadequate treatment facilities. Each day of a single operational upset is a violation.

6. Overflows from Wastewater Conveyance Systems and Associated Pump Stations
   a. Definitions
      (1) "Overflow" means any spill, release or diversion of sewage including:
         i. An overflow that results in a discharge to waters of the United States; and
         ii. An overflow of wastewater, including a wastewater backup into a building (other than a backup caused solely by a blockage or other malfunction in a privately owned sewer or building lateral), even if that overflow does not reach waters of the United States.
   b. Prohibition of overflows. Overflows are prohibited. The Department may exercise enforcement discretion regarding overflow events. In exercising its enforcement discretion, the Department may consider various factors, including the adequacy of the conveyance system's capacity and the magnitude, duration and return frequency of storm events.
   c. Reporting required. All overflows must be reported orally to the Department within 24 hours from the time the permittee becomes aware of the overflow. Reporting procedures are described in more detail in General Condition D.5.

7. Public Notification of Effluent Violation or Overflow
   If effluent limitations specified in this permit are exceeded or an overflow occurs that threatens public health, the permittee must take such steps as are necessary to alert the public, health agencies and other affected entities (e.g., public water systems) about the extent and nature of the discharge in accordance with the notification procedures developed under General Condition B.8. Such steps may include, but are not limited to, posting of the river at access points and other places, news releases, and paid announcements on radio and television.

8. Emergency Response and Public Notification Plan
   The permittee must develop and implement an emergency response and public notification plan that identifies measures to protect public health from overflows, bypasses or upsets that may endanger public health. At a minimum the plan must include mechanisms to:
   a. Ensure that the permittee is aware (to the greatest extent possible) of such events;
   b. Ensure notification of appropriate personnel and ensure that they are immediately dispatched for investigation and response;
   c. Ensure immediate notification to the public, health agencies, and other affected public entities (including public water systems). The overflow response plan must identify the public health and other officials who will receive immediate notification;
   d. Ensure that appropriate personnel are aware of and follow the plan and are appropriately trained;
   e. Provide emergency operations; and
   f. Ensure that DEQ is notified of the public notification steps taken.

9. Removed Substances
Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters must be disposed of in such a manner as to prevent any pollutant from such materials from entering waters of the state, causing nuisance conditions, or creating a public health hazard.

SECTION C. MONITORING AND RECORDS

1. Representative Sampling
Sampling and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples must be taken at the monitoring points specified in this permit, and shall be taken, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points may not be changed without notification to and the approval of the Department.

2. Flow Measurements
Appropriate flow measurement devices and methods consistent with accepted scientific practices must be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices must be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected must be capable of measuring flows with a maximum deviation of less than ± 10 percent from true discharge rates throughout the range of expected discharge volumes.

3. Monitoring Procedures
Monitoring must be conducted according to test procedures approved under 40 CFR part 136, or in the case of sludge use and disposal, under 40 CFR part 503, unless other test procedures have been specified in this permit.

4. Penalties of Tampering
The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit may, upon conviction, be punished by a fine of not more than $10,000 per violation, imprisonment for not more than two years, or both. If a conviction of a person is for a violation committed after a first conviction of such person, punishment is a fine not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both.

5. Reporting of Monitoring Results
Monitoring results must be summarized each month on a Discharge Monitoring Report form approved by the Department. The reports must be submitted monthly and are to be mailed, delivered or otherwise transmitted by the 15th day of the following month unless specifically approved otherwise in Schedule B of this permit.

6. Additional Monitoring by the Permittee
If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR part 136, or in the case of sludge use and disposal, under 40 CFR

part 503, or as specified in this permit, the results of this monitoring must be included in the calculation and reporting of the data submitted in the Discharge Monitoring Report. Such increased frequency must also be indicated. For a pollutant parameter that may be sampled more than once per day (e.g., Total Chlorine Residual), only the average daily value must be recorded unless otherwise specified in this permit.

7. Averaging of Measurements
Calculations for all limitations that require averaging of measurements must utilize an arithmetic mean, except for bacteria which shall be averaged as specified in this permit.

8. Retention of Records
Records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities shall be retained for a period of at least five years (or longer as required by 40 CFR part 503). Records of all monitoring information including all calibration and maintenance records, all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit and records of all data used to complete the application for this permit shall be retained for a period of at least 3 years from the date of the sample, measurement, report, or application. This period may be extended by request of the Department at any time.

9. Records Contents
Records of monitoring information must include:

   a. The date, exact place, time, and methods of sampling or measurements;
   b. The individual(s) who performed the sampling or measurements;
   c. The date(s) analyses were performed;
   d. The individual(s) who performed the analyses;
   e. The analytical techniques or methods used; and
   f. The results of such analyses.

10. Inspection and Entry
The permittee must allow the Department or EPA upon the presentation of credentials to:

   a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
   b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
   c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, and
   d. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by state law, any substances or parameters at any location.

11. Confidentiality of Information
Any information relating to this permit that is submitted to or obtained by DEQ is available to the public unless classified as confidential by the Director of DEQ under ORS 468.095. The Permittee may request that information be classified as confidential if it is a trade secret as defined by that statute. The name and address of the permittee, permit applications, permits, effluent data, and information required by

NPDES application forms under 40 CFR 122.21 will not be classified as confidential. 40 CFR 122.7(b).

SECTION D. REPORTING REQUIREMENTS

1. Planned Changes
The permittee must comply with OAR chapter 340, division 52, "Review of Plans and Specifications" and 40 CFR Section 122.41(l) (1). Except where exempted under OAR chapter 340, division 52, no construction, installation, or modification involving disposal systems, treatment works, sewerage systems, or common sewers may be commenced until the plans and specifications are submitted to and approved by the Department. The permittee must give notice to the Department as soon as possible of any planned physical alternations or additions to the permitted facility.

2. Anticipated Noncompliance
The permittee must give advance notice to the Department of any planned changes in the permitted facility or activity that may result in noncompliance with permit requirements.

3. Transfers
This permit may be transferred to a new permittee provided the transferee acquires a property interest in the permitted activity and agrees in writing to fully comply with all the terms and conditions of the permit and the rules of the Commission. No permit may be transferred to a third party without prior written approval from the Department. The Department may require modification, revocation, and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under 40 CFR Section 122.61. The permittee must notify the Department when a transfer of property interest takes place.

4. Compliance Schedule
Reports of compliance or noncompliance with, or any progress reports on interim and final requirements contained in any compliance schedule of this permit must be submitted no later than 14 days following each schedule date. Any reports of noncompliance must include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirements.

5. Twenty-Four Hour Reporting
The permittee must report any noncompliance that may endanger health or the environment. Any information must be provided orally (by telephone) to DEQ or to the Oregon Emergency Response System (1-800-452-0311) as specified below within 24 hours from the time the permittee becomes aware of the circumstances.

   a. Overflows.

      (1) Oral Reporting within 24 hours.
         i. For overflows other than basement backups, the following information must be reported to the Oregon Emergency Response System (OERS) at 1-800-452-0311. For basement backups, this information should be reported directly to DEQ.
            a) The location of the overflow;

      - b) The receiving water (if there is one);
      - c) An estimate of the volume of the overflow;
      - d) A description of the sewer system component from which the release occurred (e.g., manhole, constructed overflow pipe, crack in pipe); and
      - e) The estimated date and time when the overflow began and stopped or will be stopped.
    - ii. The following information must be reported to the Department's Regional office within 24 hours, or during normal business hours, whichever is first:
      - a) The OERS incident number (if applicable) along with a brief description of the event.

(2) Written reporting within 5 days.

- i. The following information must be provided in writing to the Department's Regional office within 5 days of the time the permittee becomes aware of the overflow:
  - a) The OERS incident number (if applicable);
  - b) The cause or suspected cause of the overflow;
  - c) Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the overflow and a schedule of major milestones for those steps;
  - d) Steps taken or planned to mitigate the impact(s) of the overflow and a schedule of major milestones for those steps; and
  - e) (for storm-related overflows) The rainfall intensity (inches/hour) and duration of the storm associated with the overflow.

The Department may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

b. Other instances of noncompliance.

(1) The following instances of noncompliance must be reported:

- i. Any unanticipated bypass that exceeds any effluent limitation in this permit;
- ii. Any upset that exceeds any effluent limitation in this permit;
- iii. Violation of maximum daily discharge limitation for any of the pollutants listed by the Department in this permit; and
- iv. Any noncompliance that may endanger human health or the environment.

(2) During normal business hours, the Department's Regional office must be called. Outside of normal business hours, the Department must be contacted at 1-800-452-0311 (Oregon Emergency Response System).

(3) A written submission must be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission must contain:

- i. A description of the noncompliance and its cause;
- ii. The period of noncompliance, including exact dates and times;
- iii. The estimated time noncompliance is expected to continue if it has not been corrected;
- iv. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and
- v. Public notification steps taken, pursuant to General Condition B.7

(4) The Department may waive the written report on a case-by-case basis if the oral report has been received

within 24 hours.

6. Other Noncompliance

The permittee must report all instances of noncompliance not reported under General Condition D.4 or D.5, at the time monitoring reports are submitted. The reports must contain:

a. A description of the noncompliance and its cause;
b. The period of noncompliance, including exact dates and times;
c. The estimated time noncompliance is expected to continue if it has not been corrected; and
d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

7. Duty to Provide Information

The permittee must furnish to the Department within a reasonable time any information that the Department may request to determine compliance with the permit or to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit. The permittee must also furnish to the Department, upon request, copies of records required to be kept by this permit.

Other Information: When the permittee becomes aware that it has failed to submit any relevant facts or has submitted incorrect information in a permit application or any report to the Department, it must promptly submit such facts or information.

8. Signatory Requirements

All applications, reports or information submitted to the Department must be signed and certified in accordance with 40 CFR Section 122.22.

9. Falsification of Information

Under ORS 468.953, any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, is subject to a Class C felony punishable by a fine not to exceed $100,000 per violation and up to 5 years in prison. Additionally, according to 40 CFR 122.41(k)(2), any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a federal civil penalty not to exceed $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

10. Changes to Indirect Dischargers

The permittee must provide adequate notice to the Department of the following:

a. Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to section 301 or 306 of the Clean Water Act if it were directly discharging those pollutants and;
b. Any substantial change in the volume or character of pollutants being introduced into the POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

c. For the purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

SECTION E. DEFINITIONS

1. *BOD* means five-day biochemical oxygen demand.
2. *CBOD* means five day carbonaceous biochemical oxygen demand
3. *TSS* means total suspended solids.
4. "*Bacteria*" includes but is not limited to fecal coliform bacteria, total coliform bacteria, and E. coli bacteria.
5. *FC* means fecal coliform bacteria.
6. *Total residual chlorine* means combined chlorine forms plus free residual chlorine
7. *Technology based permit effluent limitations* means technology-based treatment requirements as defined in 40 CFR Section 125.3, and concentration and mass load effluent limitations that are based on minimum design criteria specified in OAR Chapter 340, Division 41.
8. *mg/l* means milligrams per liter.
9. *kg* means kilograms.
10. m^3/d means cubic meters per day.
11. *MGD* means million gallons per day.
12. 24-hour *Composite sample* means a sample formed by collecting and mixing discrete samples taken periodically and based on time or flow. The sample must be collected and stored in accordance with 40 CFR Part 136.
13. *Grab sample* means an individual discrete sample collected over a period of time not to exceed 15 minutes.
14. *Quarter* means January through March, April through June, July through September, or October through December.
15. *Month* means calendar month.
16. *Week* means a calendar week of Sunday through Saturday.
17. *POTW* means a publicly owned treatment works.

Schedule F, last update 9.18.2009
GLS: Sandy Permit 08Oct2009.docx
Revised: 22Jan2010

APPENDIX B
EXISTING SANDY WWTP PROCESS MODEL REPORT

BioWin user and configuration data

Project details

Project name: Unknown **Project ref.: BW1**

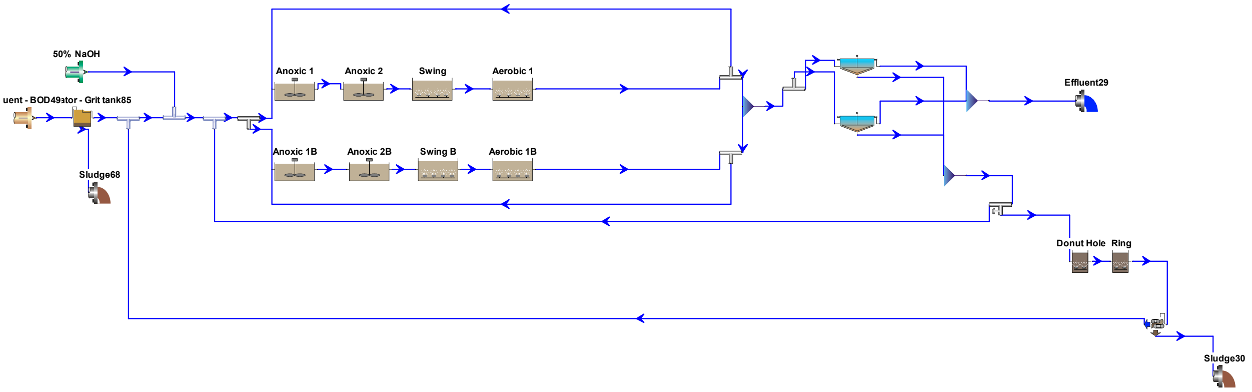
Plant name: Unknown **User name: Jason.Flowers**

Created: 5/18/2018 **Saved: 6/14/2020**

Target SRT: 7.00 days **SRT: **** days**

Temperature: 22.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated

Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.12
BOD - Total Carbonaceous mgBOD/L	288.00
Volatile suspended solids mg/L	257.00
Total suspended solids mg/L	277.00
N - Total Kjeldahl Nitrogen mgN/L	46.00
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.20
Alkalinity mmol/L	3.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.7082
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650

Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	150.00 %
Splitter12	Flow paced	150.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0529285713907653
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

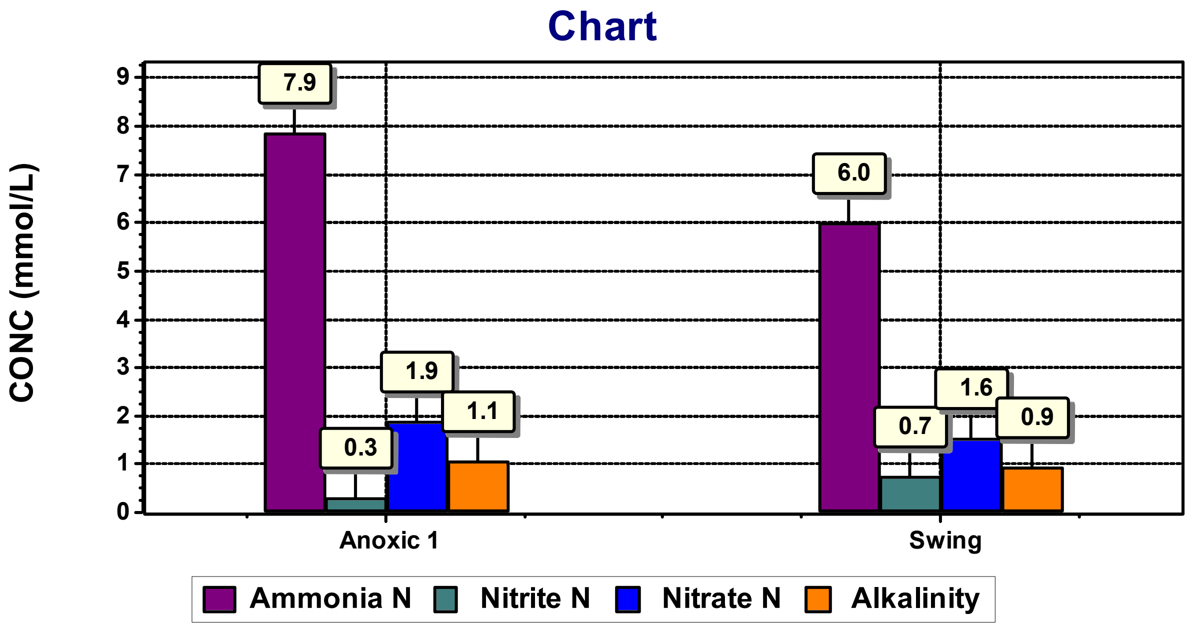
Element name	50% NaOH
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0

N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0

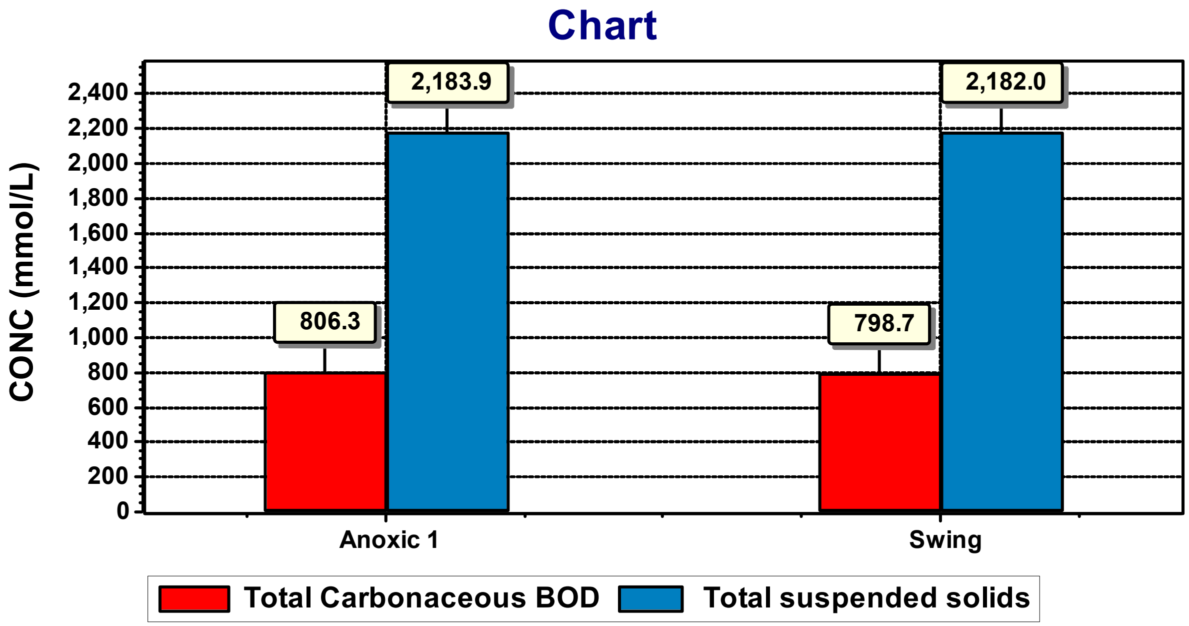
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0

BioWin Album

Album page - Nitrogen species

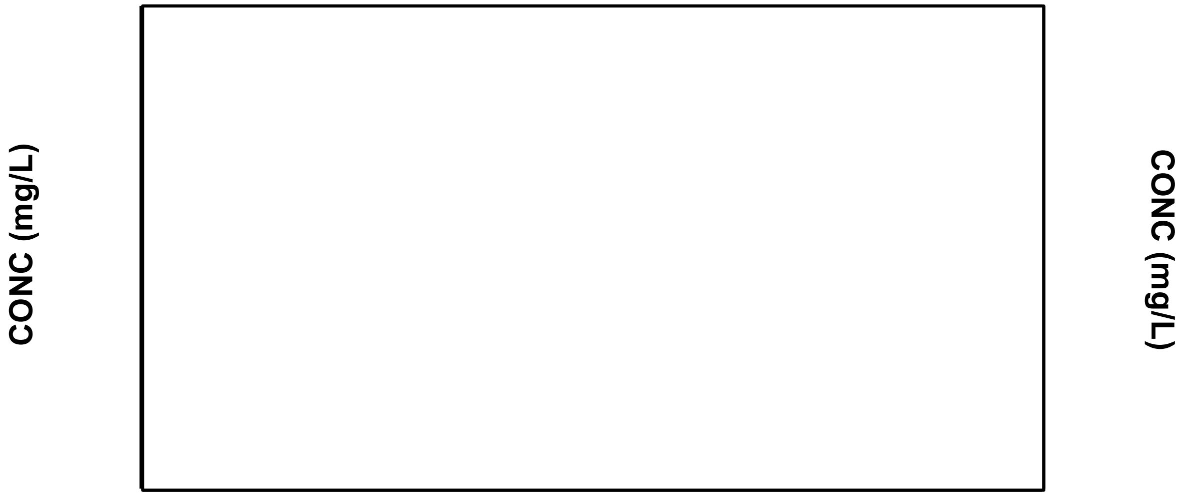


Album page - BOD_TSS



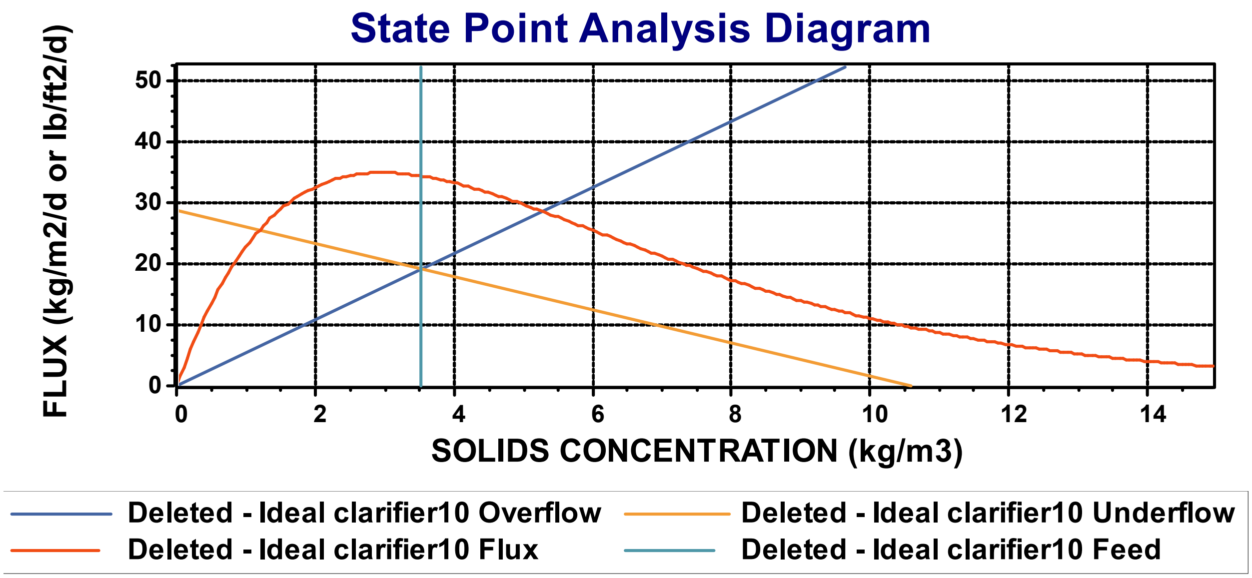
Album page - Page 3

Chart



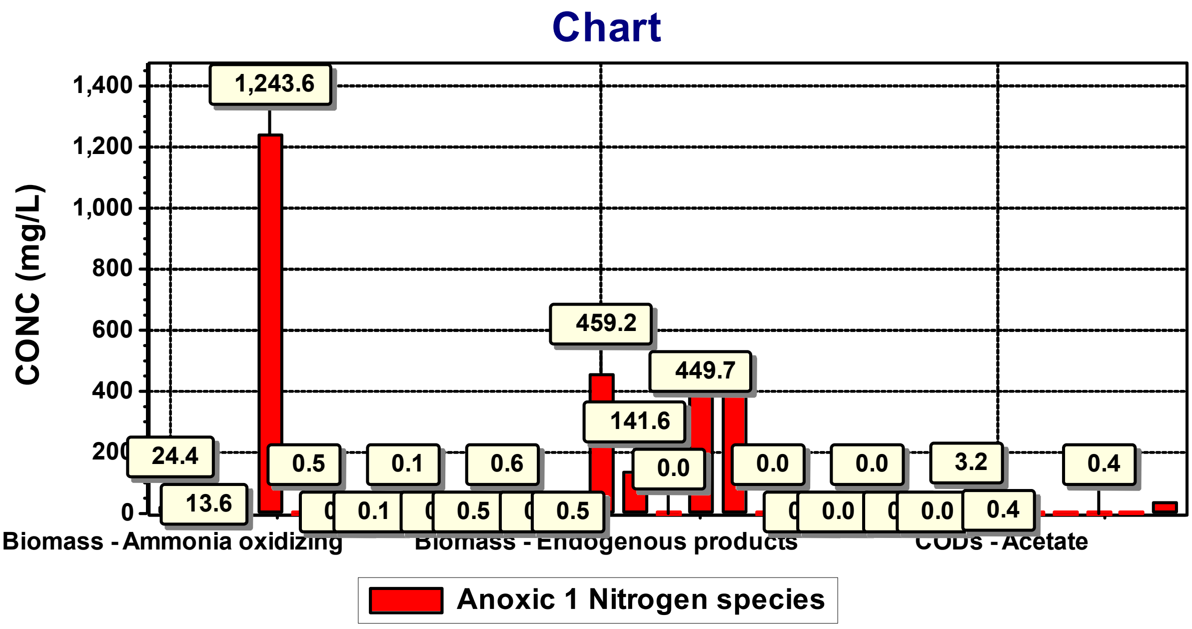
Album page - Page 4

Album page - Page 5

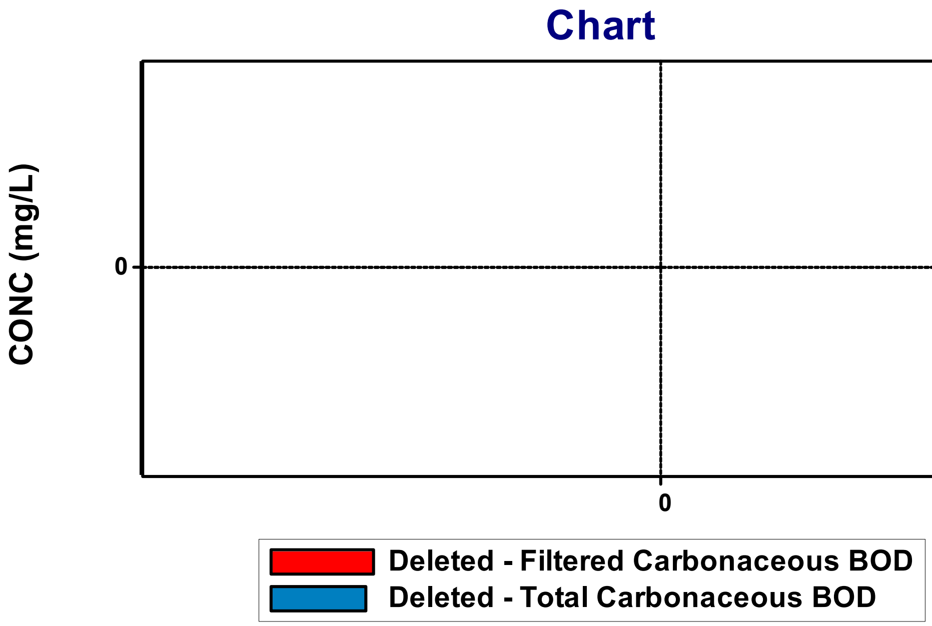


K = 0.3362 m3/kg
Vo = 511.2 ft/d

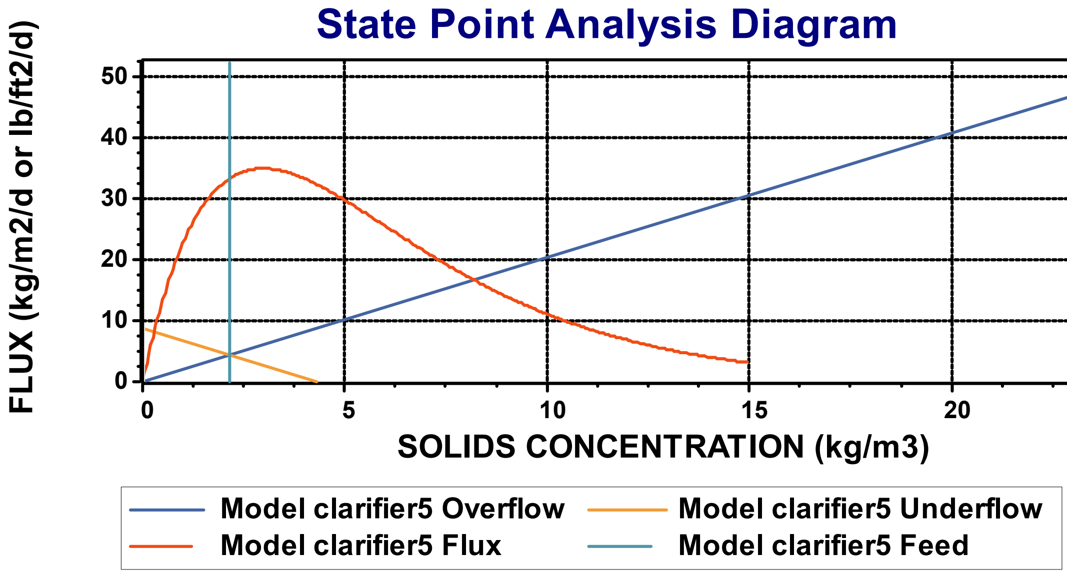
Album page - Page 6



Album page - Page 7

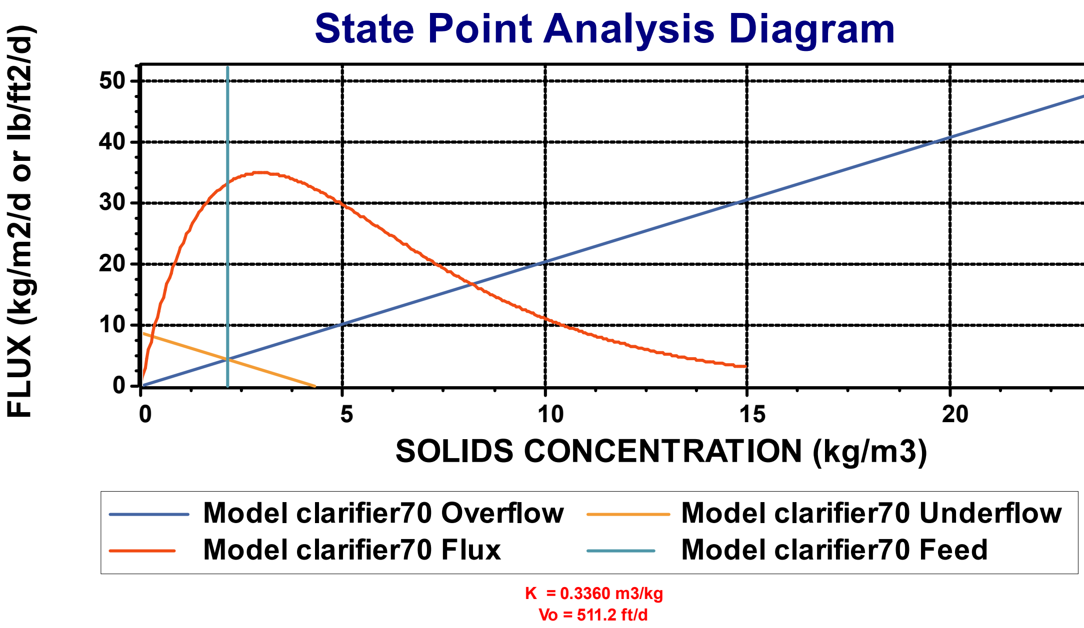


Album page - Page 8

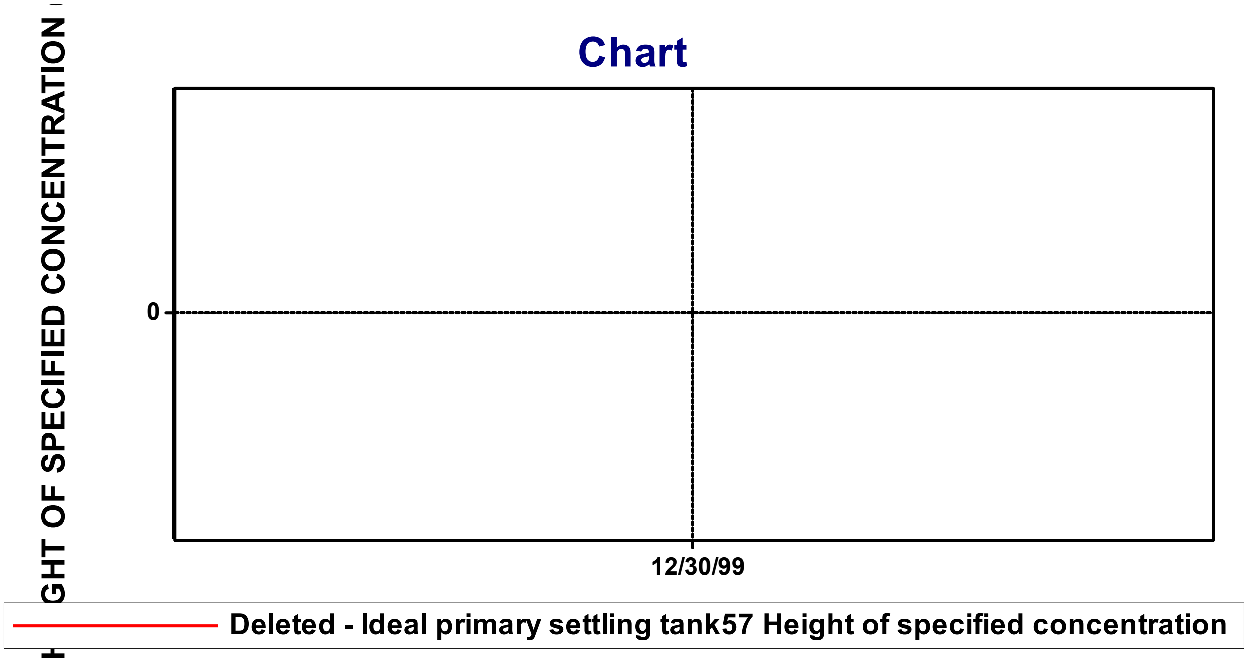


K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 9



Album page - Page 10



Album page - Page 11

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.26
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.26

Album page - Page 13

Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	166.45
Aerobic 1	538.39
Anoxic 1B	0
Anoxic 2B	0
Swing B	166.45
Aerobic 1B	538.39

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20 C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]
Influent - BOD49	1.12	22.00	287.97	124.62	600.98	236.60	277.00	257.00	7.20	3.00	46.00	33.82	0	0	-----	-----	-----	-----	-----
Anoxic 1	2.80	22.00	806.26	6.65	2836.06	50.23	2183.89	1966.37	6.38	1.07	167.14	7.87	0.31	1.90	0	0	0	0	0.50
Anoxic 2	2.80	22.00	803.27	2.04	2832.19	43.08	2186.29	1968.69	6.44	1.18	167.14	8.01	0.14	0.66	0	0	0	0	0.50
Swing	2.80	22.00	798.68	1.77	2824.42	41.90	2182.03	1964.04	6.29	0.93	165.58	6.00	0.75	1.55	166.45	15.12	41.86	61.93	0.37
Aerobic 1	2.80	22.00	771.27	1.10	2782.63	40.65	2154.57	1935.49	5.71	0.26	160.92	0.89	0.73	5.93	538.39	60.41	28.12	217.80	0.42
Modelclarifier5	0.56	22.00	2.59	1.10	45.98	40.65	4.18	3.76	5.71	0.26	2.68	0.89	0.73	5.93	-----	-----	-----	-----	-----
Modelclarifier5 (U)	0.56	22.00	1538.87	1.10	5515.40	40.65	4301.90	3864.49	5.71	0.26	318.93	0.89	0.73	5.93	-----	-----	-----	-----	-----
Modelclarifier70	0.56	22.00	2.59	1.10	45.98	40.65	4.18	3.76	5.71	0.26	2.68	0.89	0.73	5.93	-----	-----	-----	-----	-----
Modelclarifier70 (U)	0.56	22.00	1538.87	1.10	5515.40	40.65	4301.90	3864.49	5.71	0.26	318.93	0.89	0.73	5.93	-----	-----	-----	-----	-----

Effluent29	1.12	22.00	2.59	1.10	45.98	40.65	4.18	3.76	5.71	0.26	2.68	0.89	0.73	5.93	-----	-----	-----	-----	-----
Donut Hole	0.05	22.00	1082.12	0.70	4862.58	40.08	3796.65	3405.15	4.56	-0.01	293.09	17.02	0.91	26.82	120.28	13.93	18.55	42.23	0.50
Ring	0.05	22.00	599.41	0.72	4177.35	40.13	3258.66	2922.57	4.43	-0.03	265.76	37.58	0.74	49.31	116.62	14.65	9.75	44.40	0.50
Separator - Dewatering unit83	0.05	22.00	62.12	0.72	464.46	40.13	334.22	299.75	4.44	-0.03	62.27	37.58	0.74	49.31	-----	-----	-----	-----	-----
Separator - Dewatering unit83 (U)	0.00	22.00	215553.65	0.72	148979.96	40.13	117311.67	105212.38	4.44	-0.03	8202.18	37.58	0.74	49.31	-----	-----	-----	-----	-----

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD49	287.97	236.60	277.00	257.00	7.20	3.00	46.00	33.82	0	0	-----	-----	-----	-----
Anoxic 1B	806.26	50.23	2183.89	1966.37	6.38	1.07	167.14	7.87	0.31	1.90	0	0	0	0
Anoxic 2B	803.27	43.08	2186.29	1968.69	6.44	1.18	167.14	8.01	0.14	0.66	0	0	0	0

Swing B	798.68	41.90	2182.03	1964.04	6.29	0.93	165.58	6.00	0.75	1.55	166.45	15.12	41.86	61.93
Aerobic 1B	771.27	40.65	2154.57	1935.49	5.71	0.26	160.92	0.89	0.73	5.93	538.39	60.41	28.12	217.80
Model clarifier5	2.59	40.65	4.18	3.76	5.71	0.26	2.68	0.89	0.73	5.93	-----	-----	-----	-----
Model clarifier5 (U)	1538.87	40.65	4301.90	3864.49	5.71	0.26	318.93	0.89	0.73	5.93	-----	-----	-----	-----
Model clarifier70	2.59	40.65	4.18	3.76	5.71	0.26	2.68	0.89	0.73	5.93	-----	-----	-----	-----
Model clarifier70 (U)	1538.87	40.65	4301.90	3864.49	5.71	0.26	318.93	0.89	0.73	5.93	-----	-----	-----	-----
Effluent29	2.59	40.65	4.18	3.76	5.71	0.26	2.68	0.89	0.73	5.93	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000

Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000

Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

BioWin user and configuration data

Project details

Project name: Unknown **Project ref.: BW1**

Plant name: Unknown **User name: Jason.Flowers**

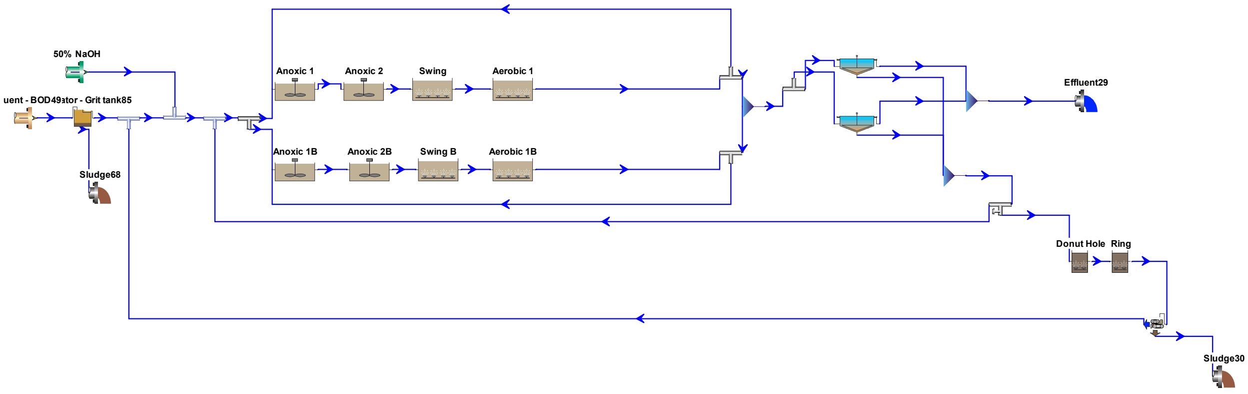
Created: 5/18/2018 **Saved: 6/14/2020**

Steady state solution

Target SRT: 5.00 days **SRT #0: 5.03 days**

Temperature: 22.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated

Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.46
BOD - Total Carbonaceous mgBOD/L	322.50
Volatile suspended solids mg/L	277.00
Total suspended solids mg/L	310.80
N - Total Kjeldahl Nitrogen mgN/L	53.70
P - Total P mgP/L	5.30
N - Nitrate mgN/L	0
pH	7.20
Alkalinity mmol/L	3.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.6725
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300

Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Effluent units

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction

Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Sludge units

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	150.00 %
Splitter12	Flow paced	150.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0740999999259
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

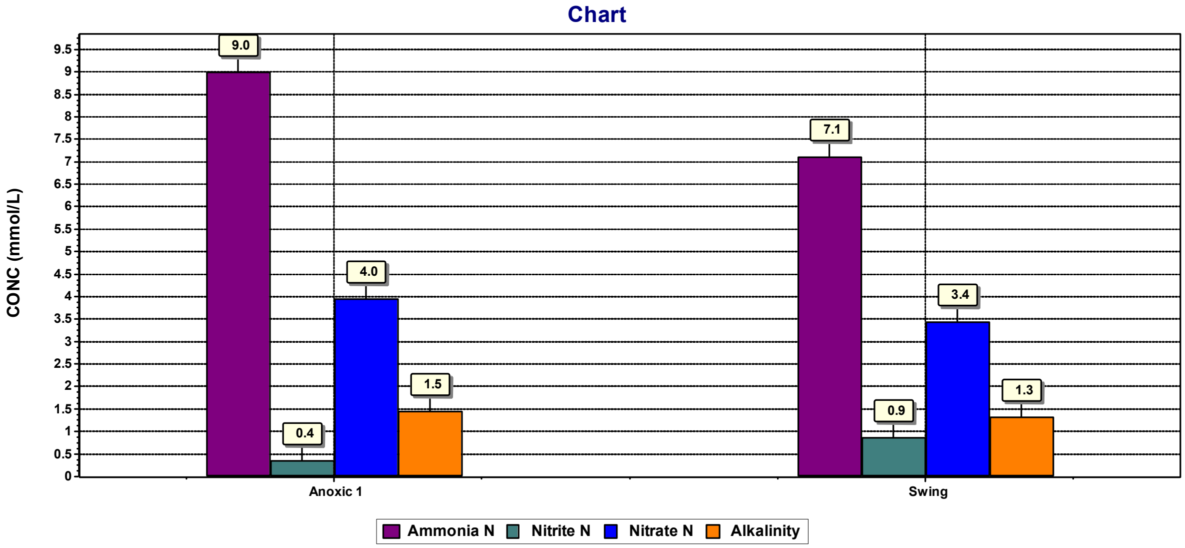
Element name	50% NaOH
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0

Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0
N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00

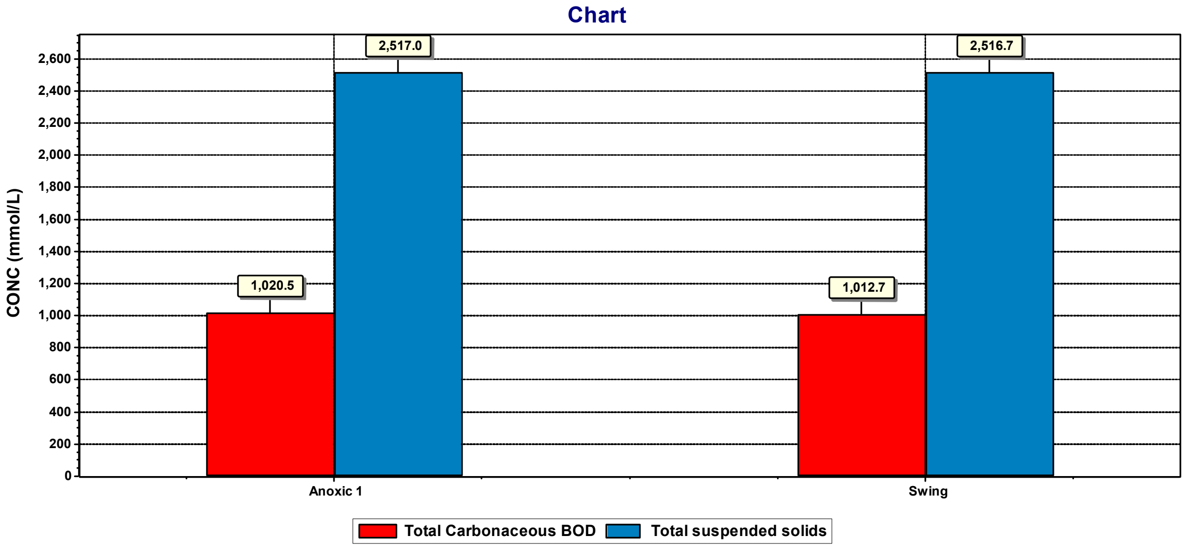
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0001

BioWin Album

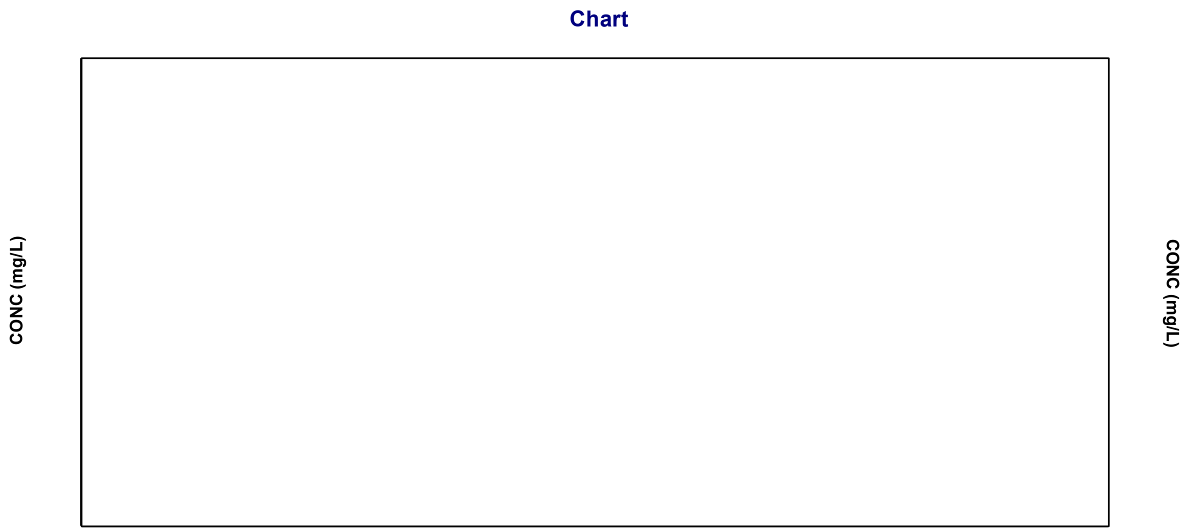
Album page - Nitrogen species



Album page - BOD_TSS

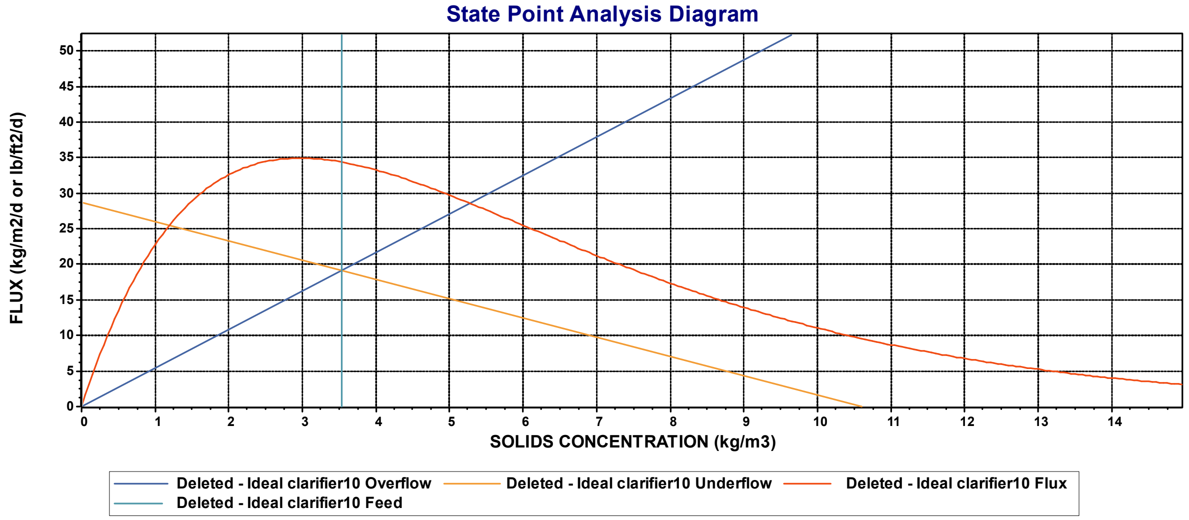


Album page - Page 3



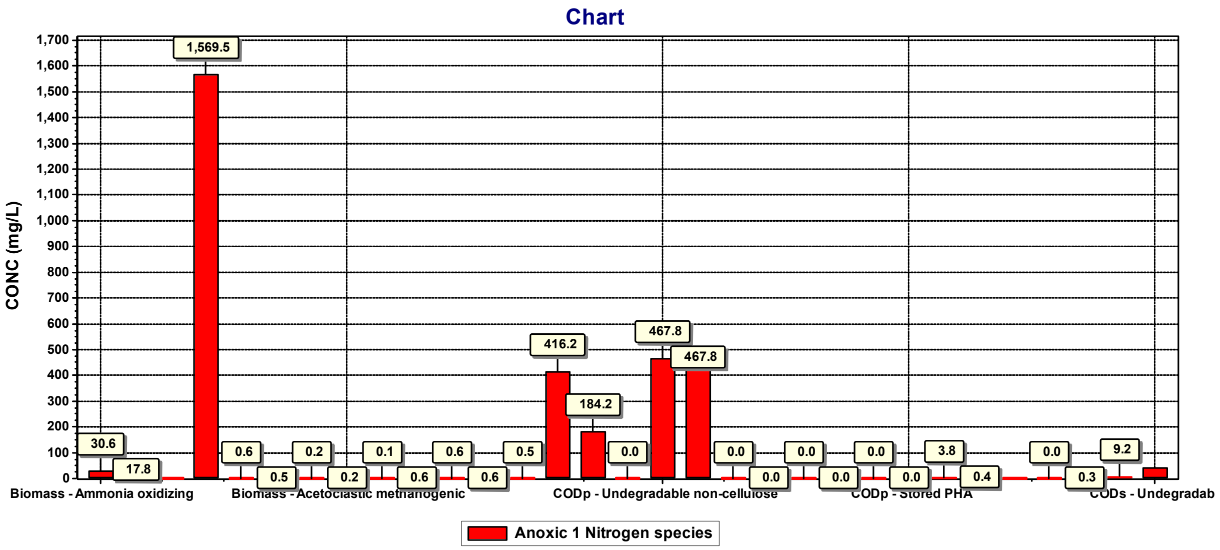
Album page - Page 4

Album page - Page 5

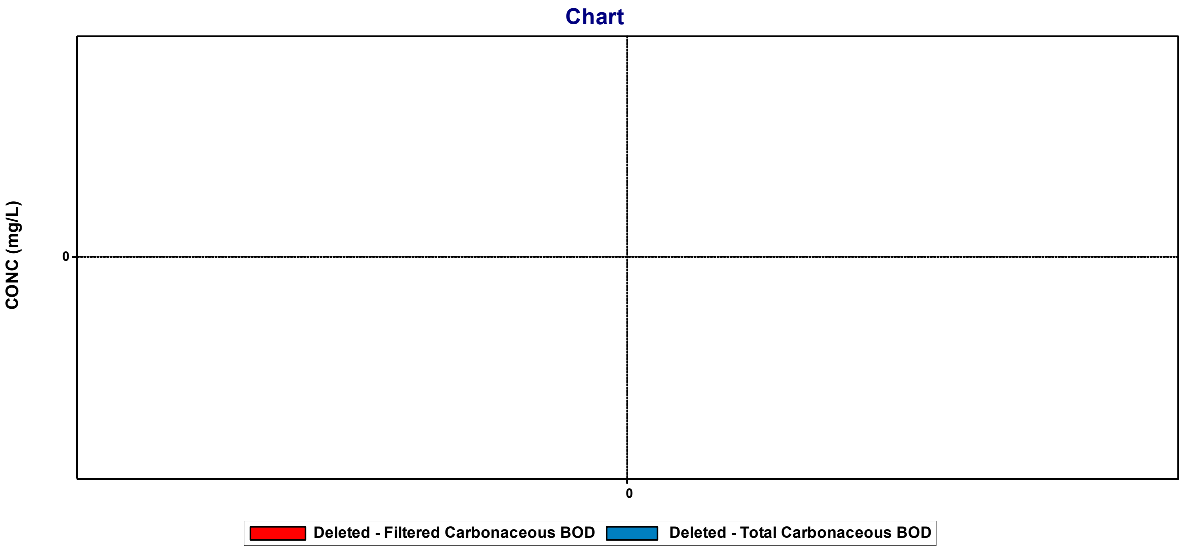


K = 0.3362 m3/kg
Vo = 511.2 ft/d

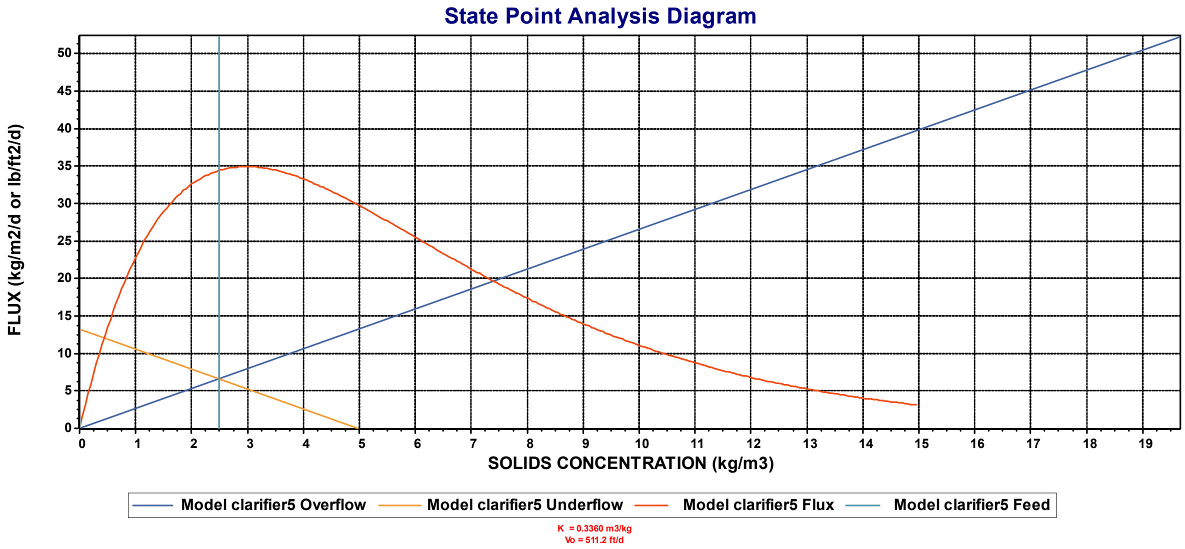
Album page - Page 6



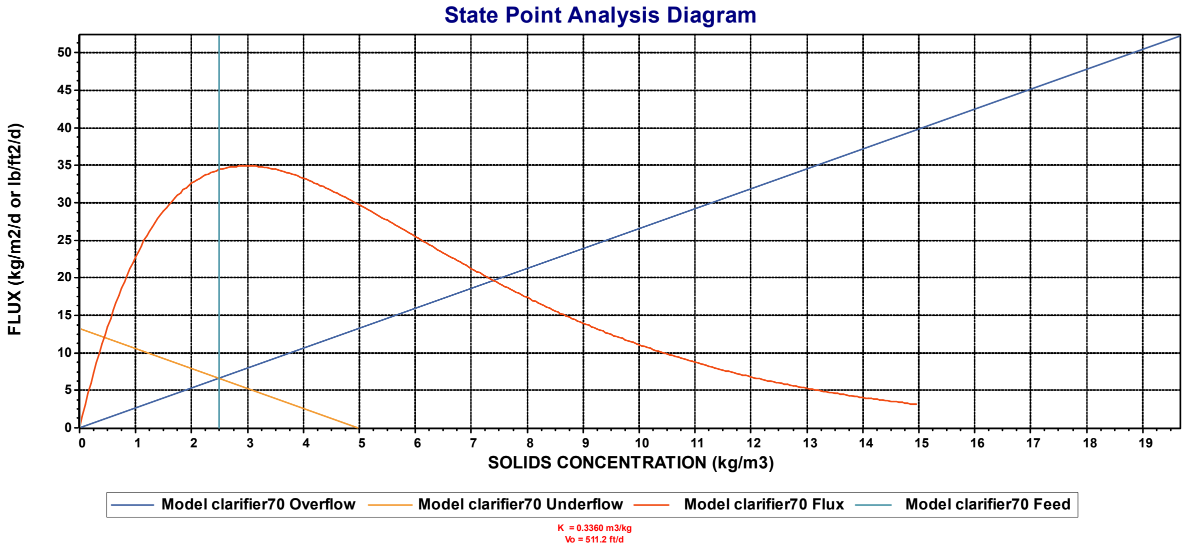
Album page - Page 7



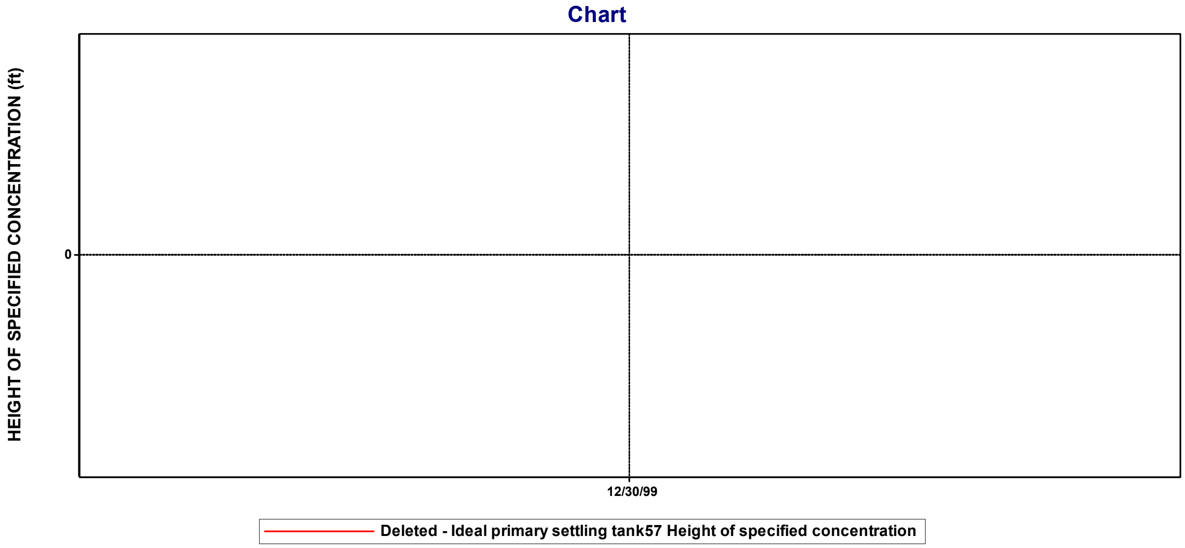
Album page - Page 8



Album page - Page 9



Album page - Page 10



Album page - Page 11

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

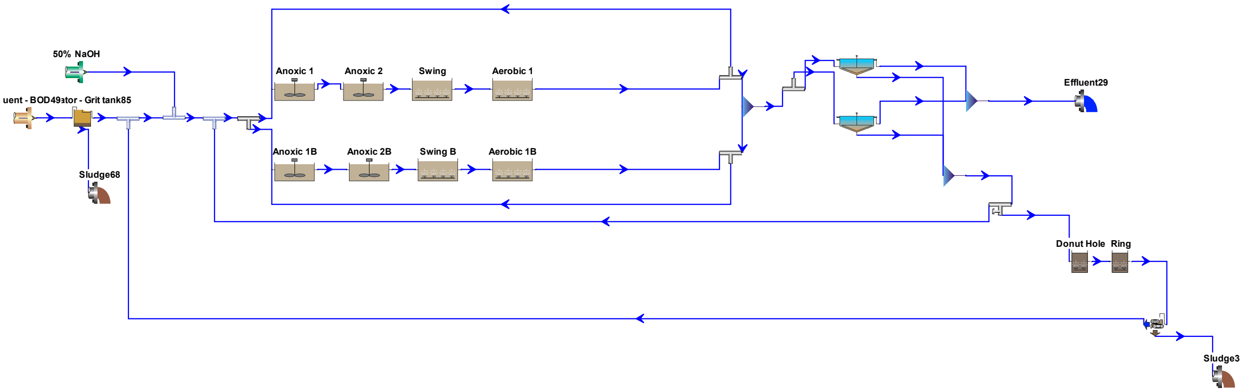
Created: 5/18/2018 Saved: 6/14/2020

Steady state solution

Target SRT: 7.00 days SRT #0: 7.03 days

Temperature: 11.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated

Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	2.76
BOD - Total Carbonaceous mgBOD/L	164.00
Volatile suspended solids mg/L	166.00
Total suspended solids mg/L	186.00
N - Total Kjeldahl Nitrogen mgN/L	28.00
P - Total P mgP/L	5.30
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8347
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300

Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Effluent units

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction

Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Sludge units

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	150.00 %
Splitter12	Flow paced	150.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0529285713907653
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

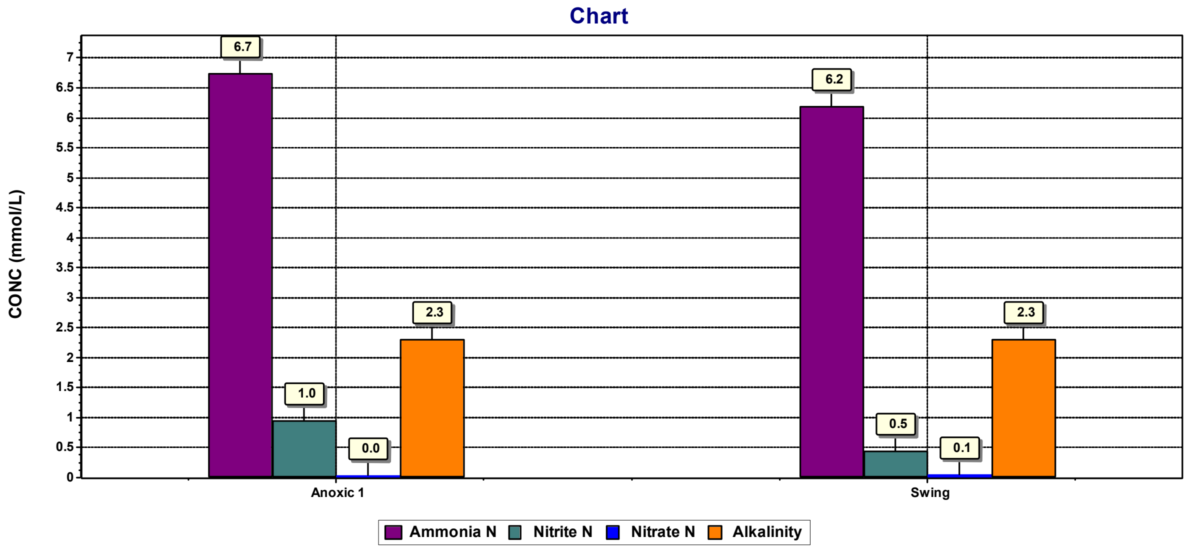
Element name	50% NaOH
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0

Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0
N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00

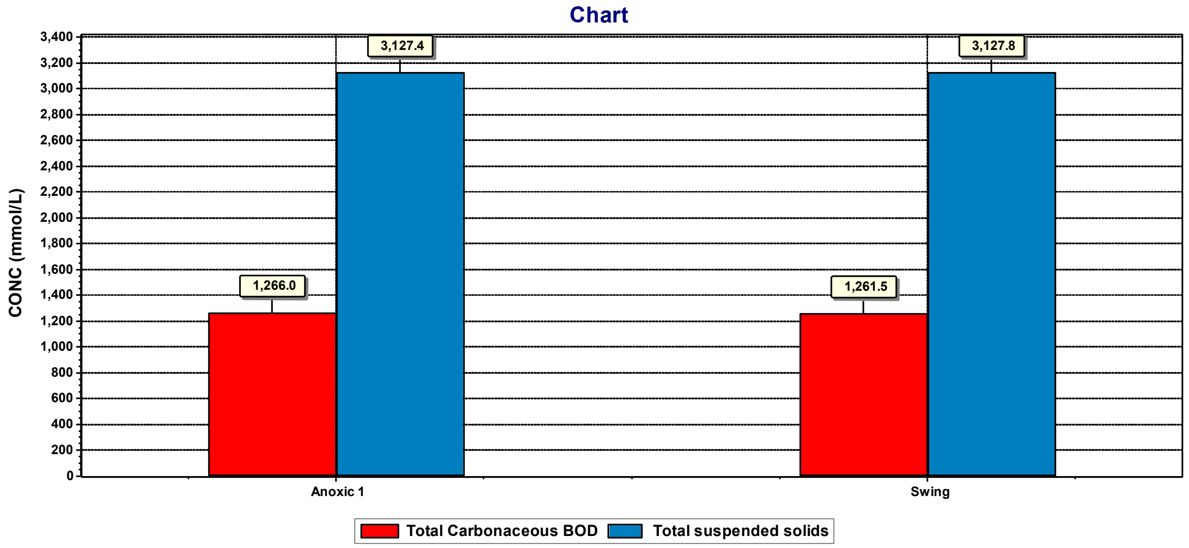
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0003

BioWin Album

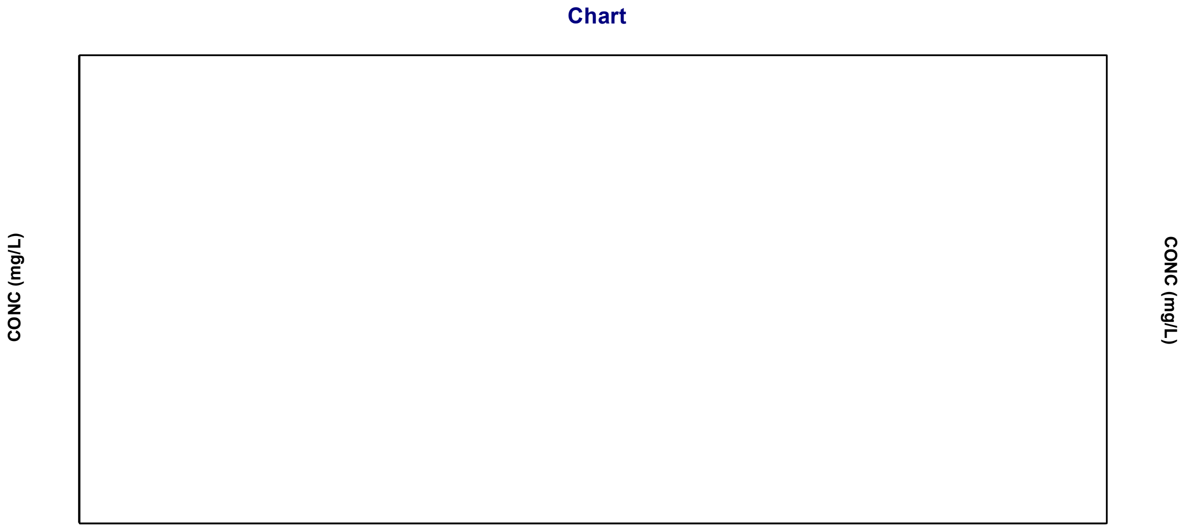
Album page - Nitrogen species



Album page - BOD_TSS

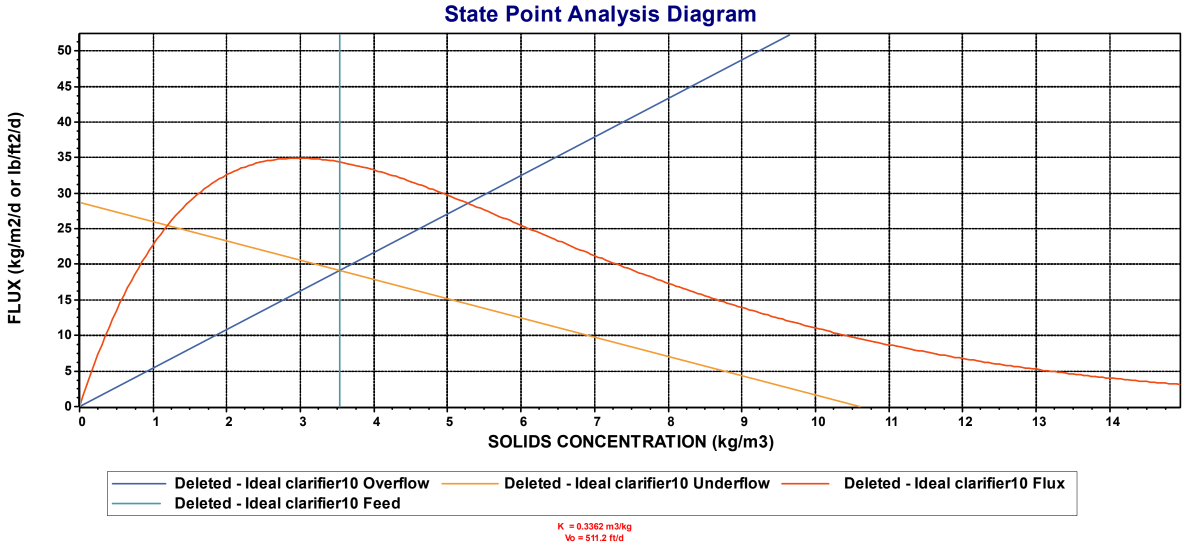


Album page - Page 3

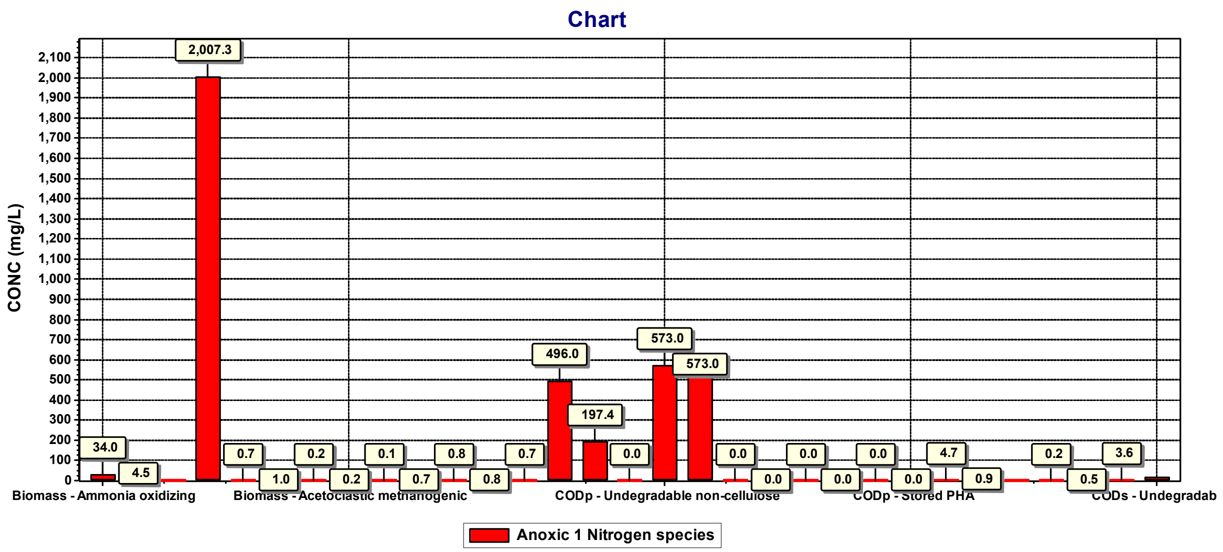


Album page - Page 4

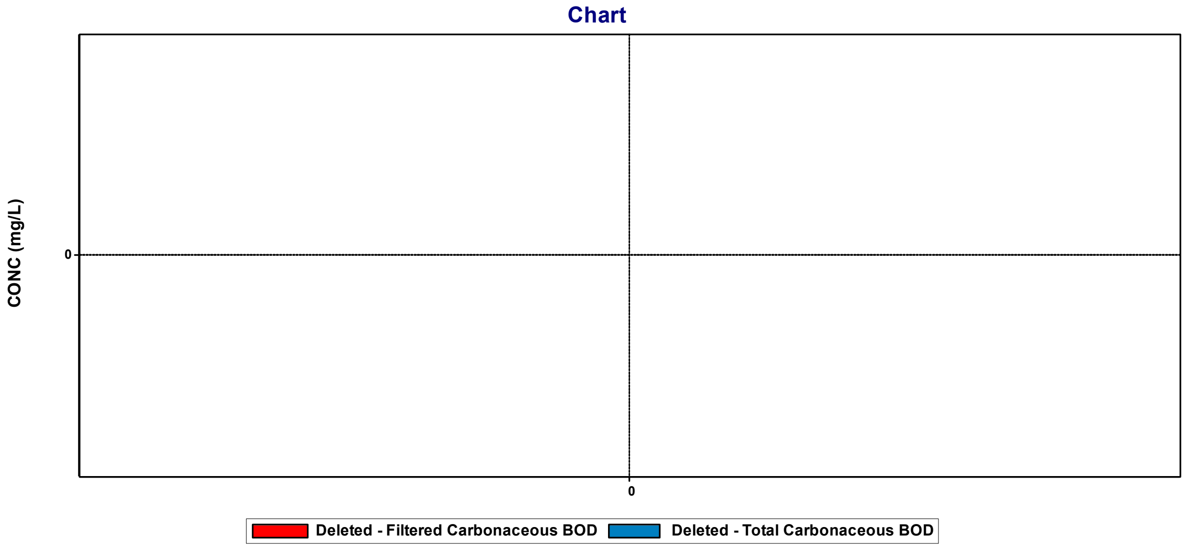
Album page - Page 5



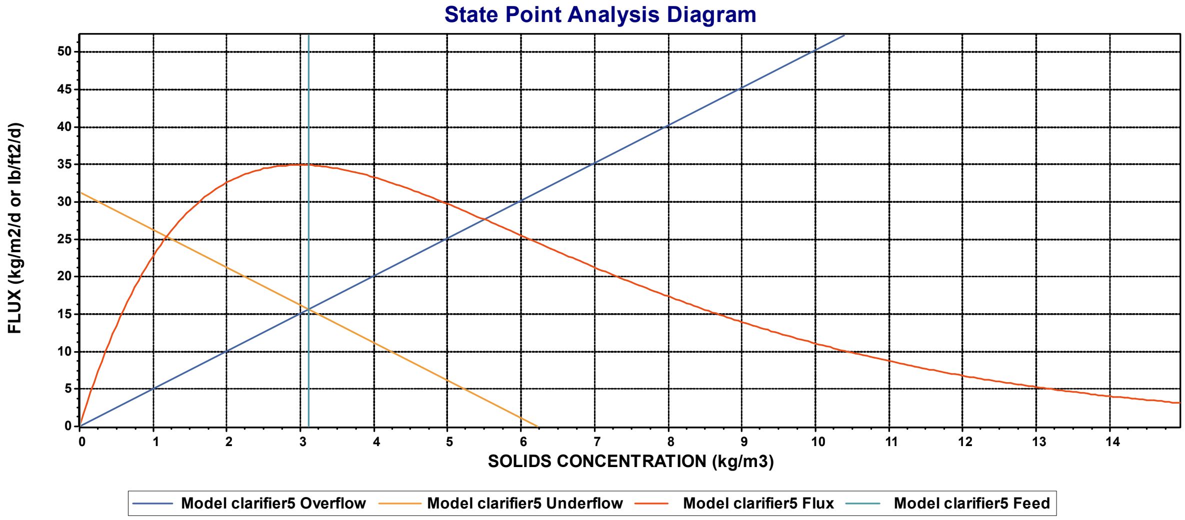
Album page - Page 6



Album page - Page 7

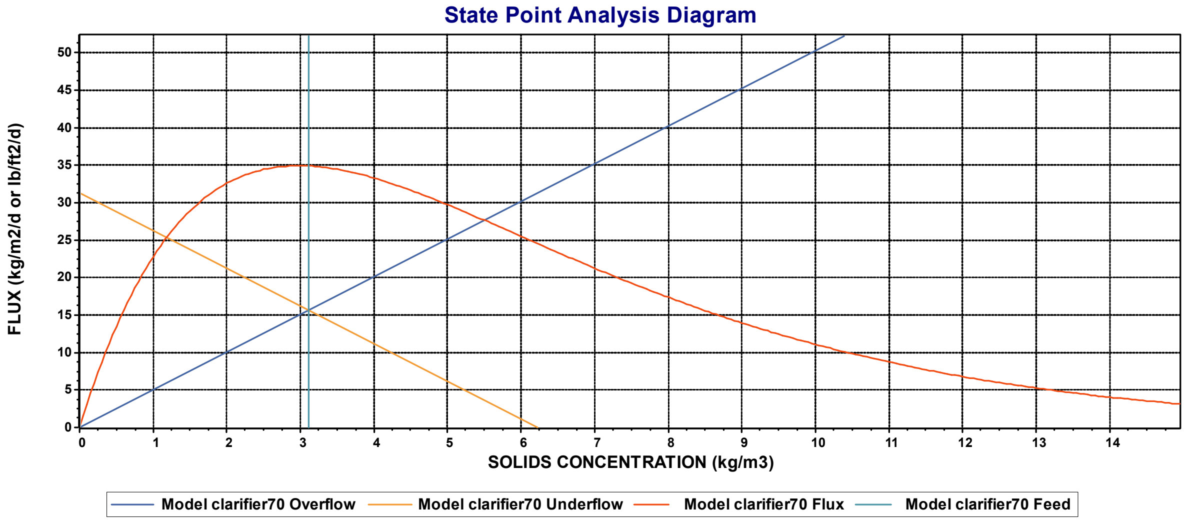


Album page - Page 8



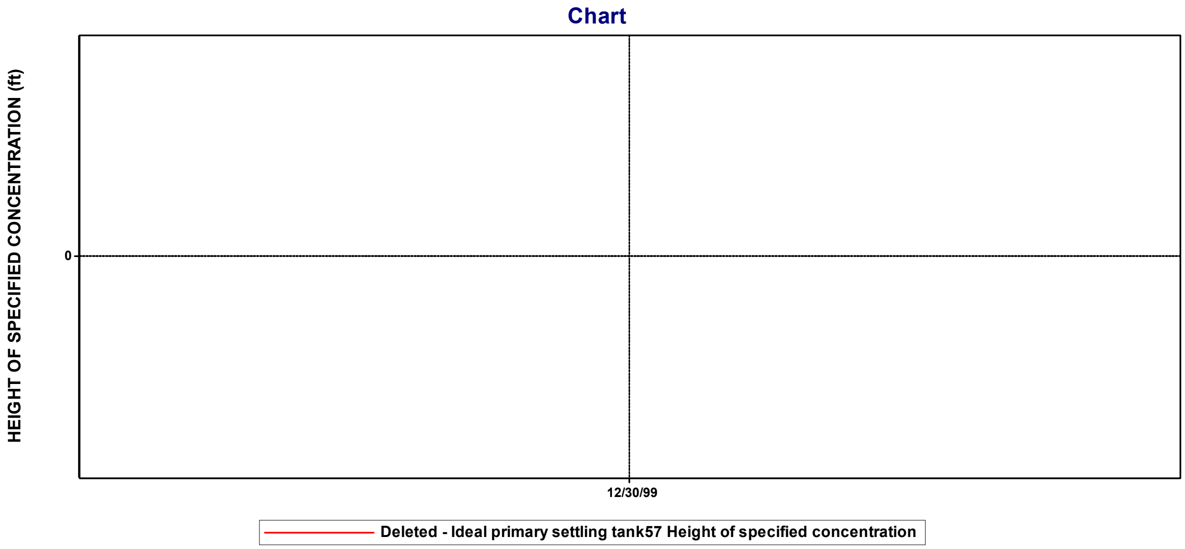
K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 9



K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 10



Album page - Page 11

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

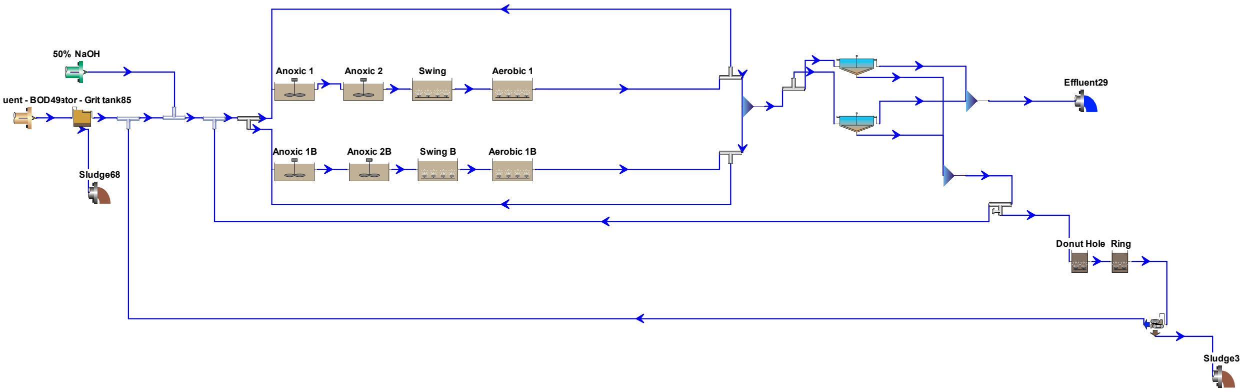
Created: 5/18/2018 Saved: 9/11/2020

Steady state solution

Target SRT: 5.00 days SRT #0: 5.03 days

Temperature: 22.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated

Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.54
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.50
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.6770
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650

Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	100.00 %
Splitter12	Flow paced	100.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0740999999259
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

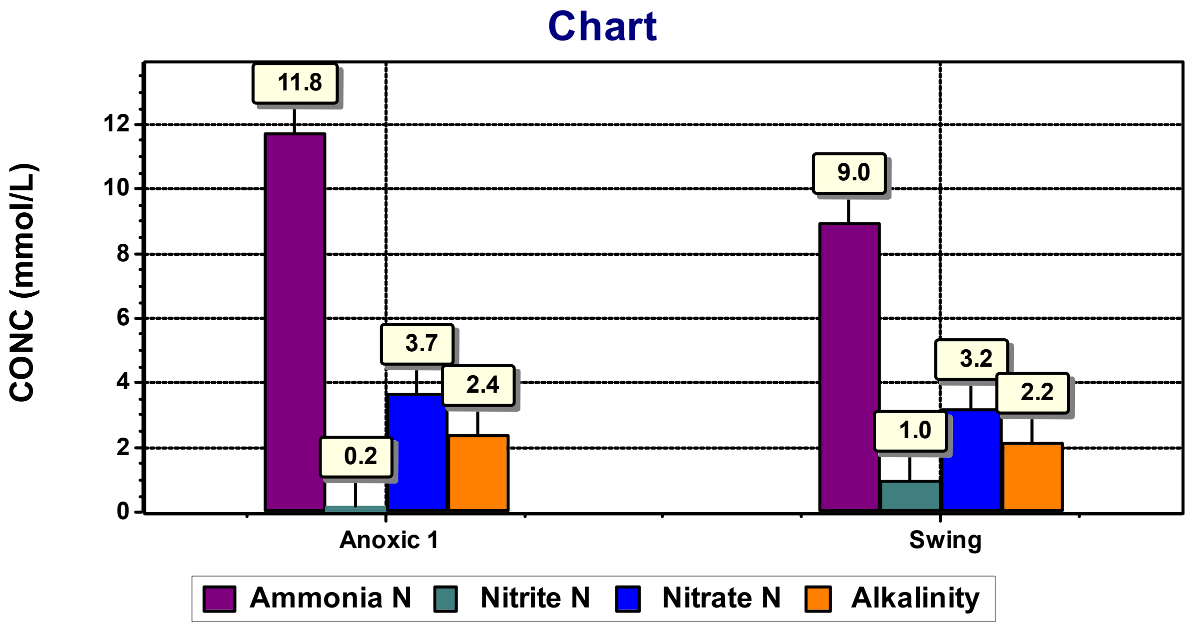
Element name	50% NaOH
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0

N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0

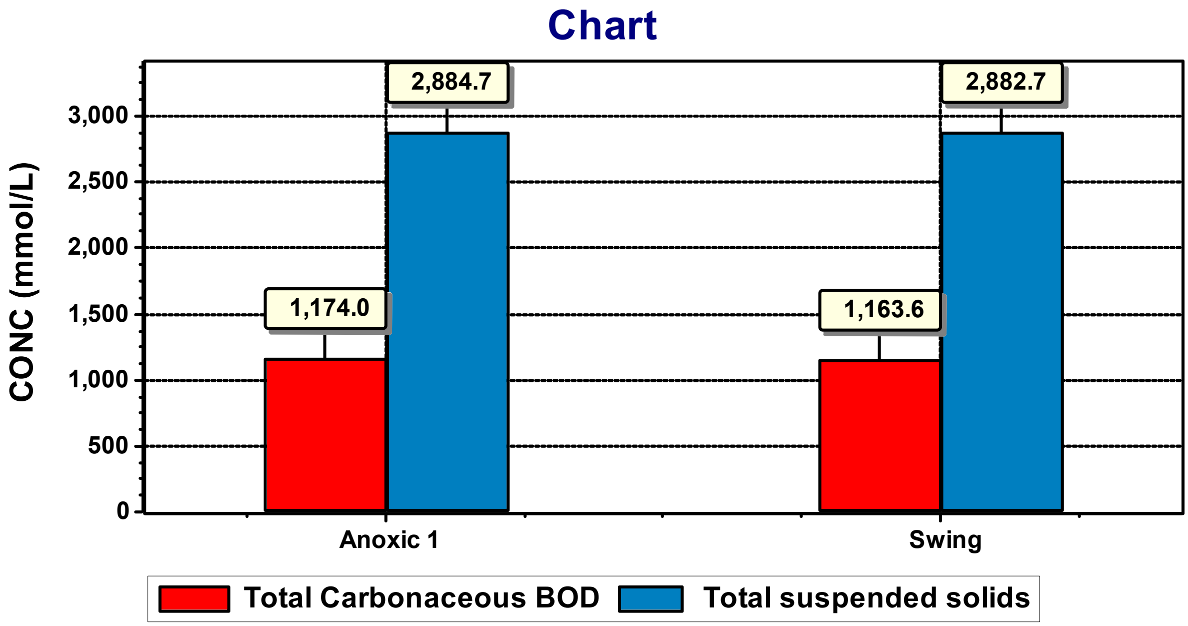
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0001

BioWin Album

Album page - Nitrogen species

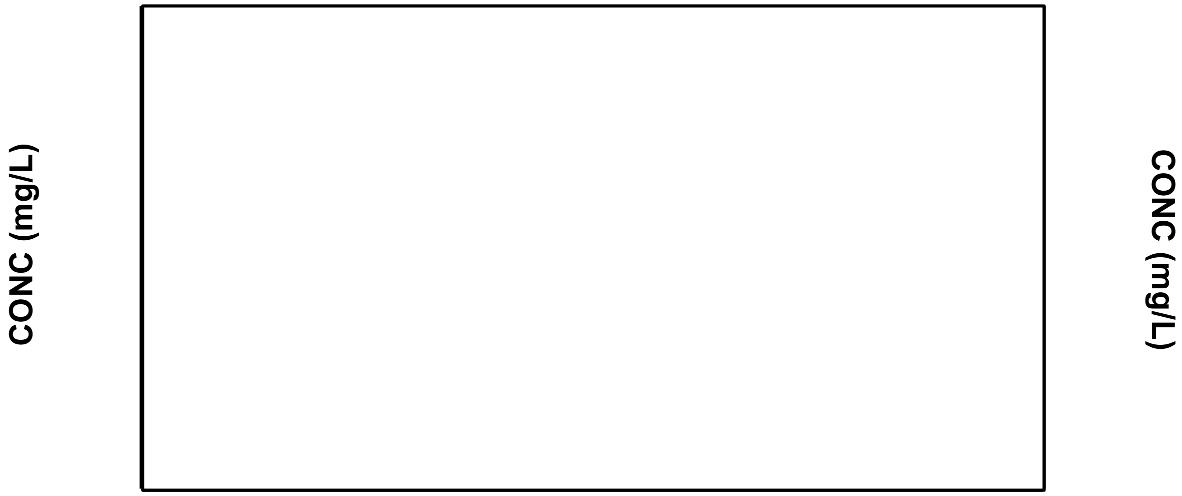


Album page - BOD_TSS



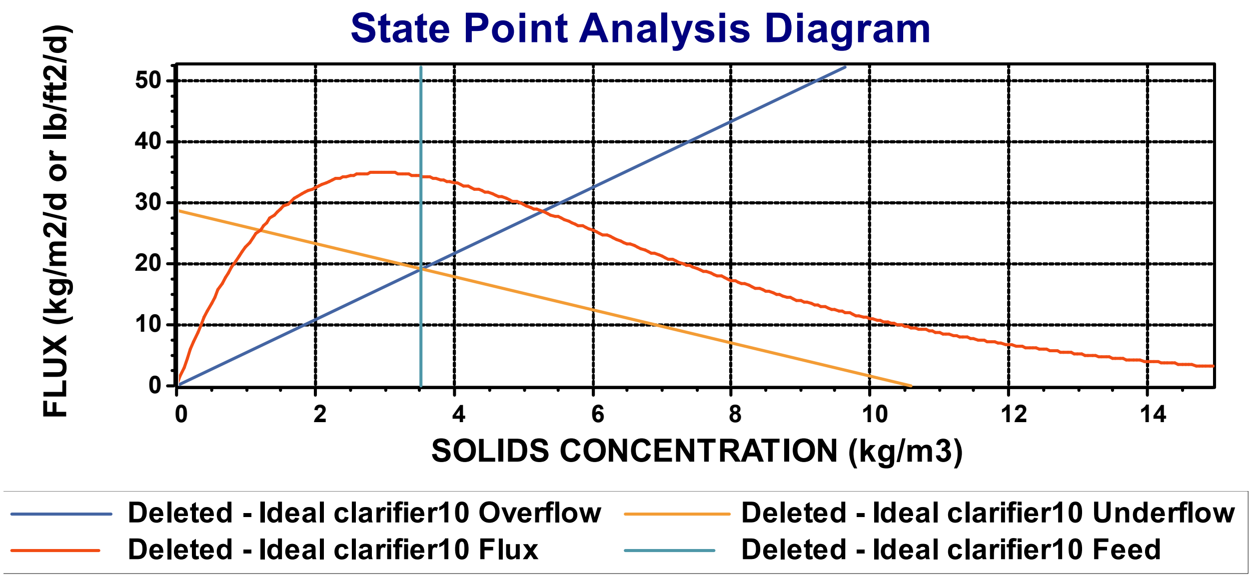
Album page - Page 3

Chart



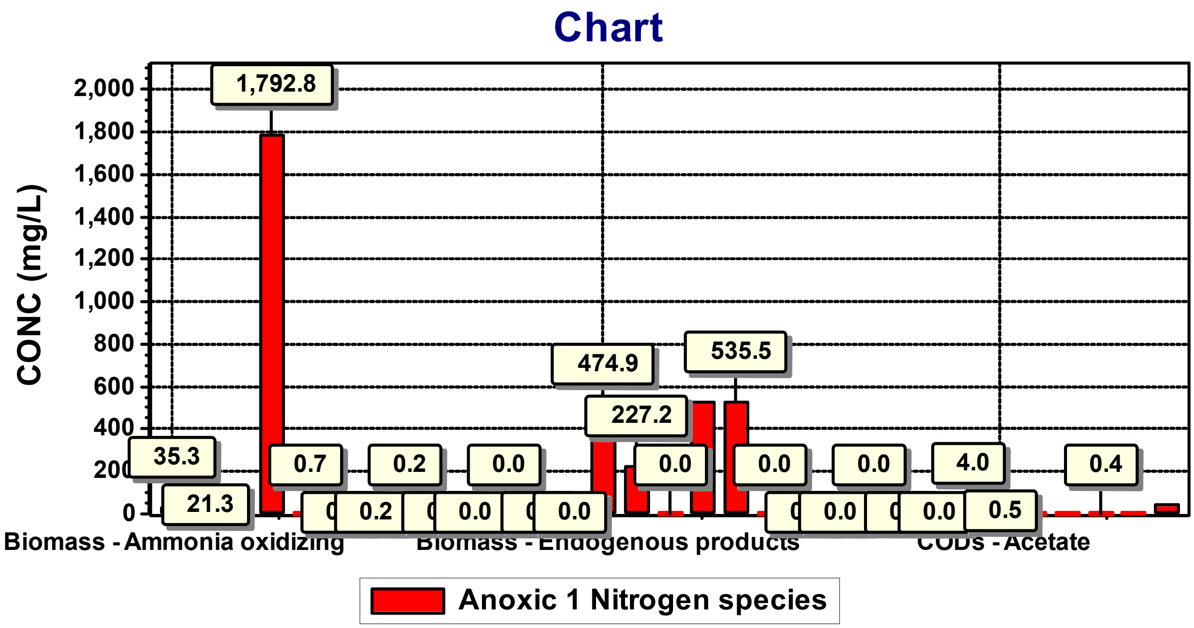
Album page - Page 4

Album page - Page 5

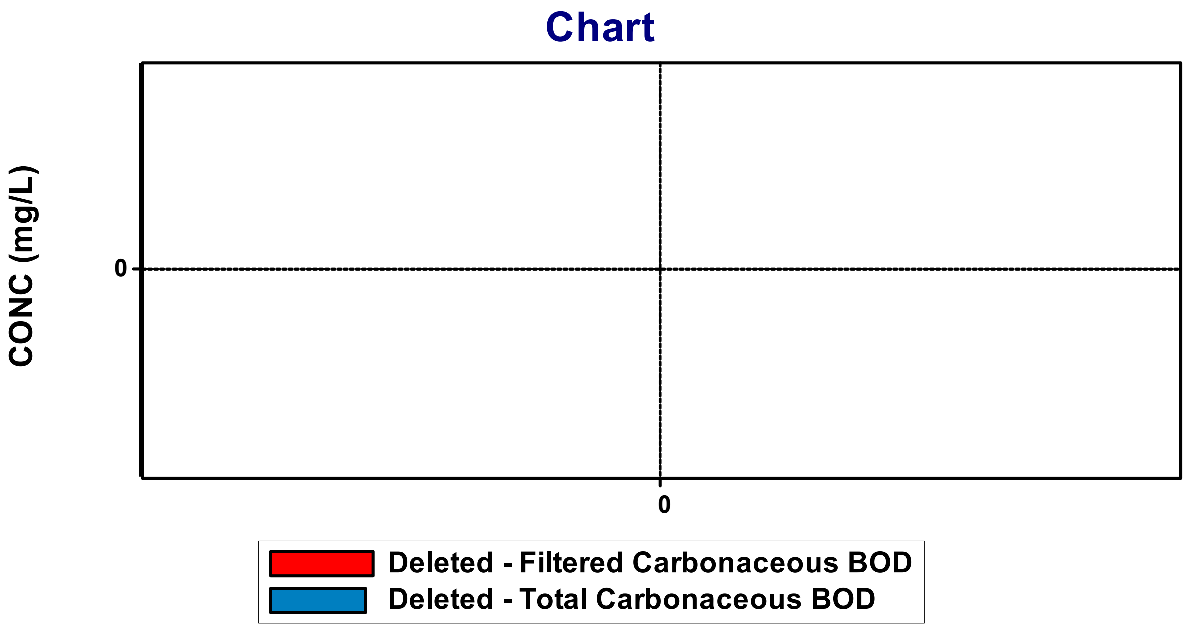


K = 0.3362 m3/kg
Vo = 511.2 ft/d

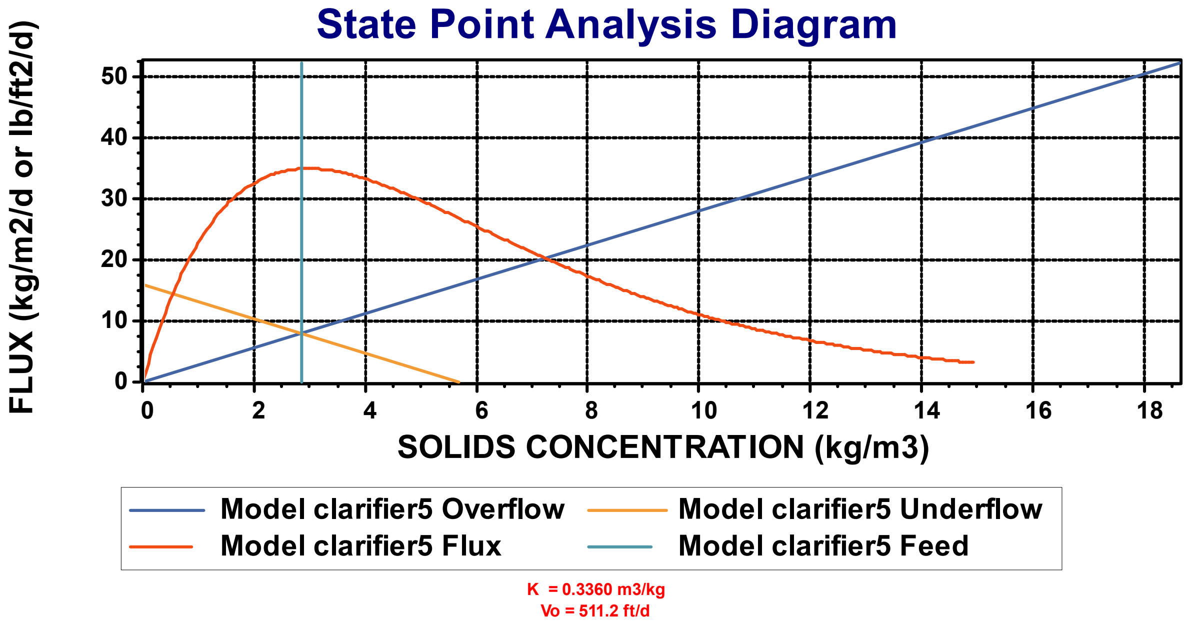
Album page - Page 6



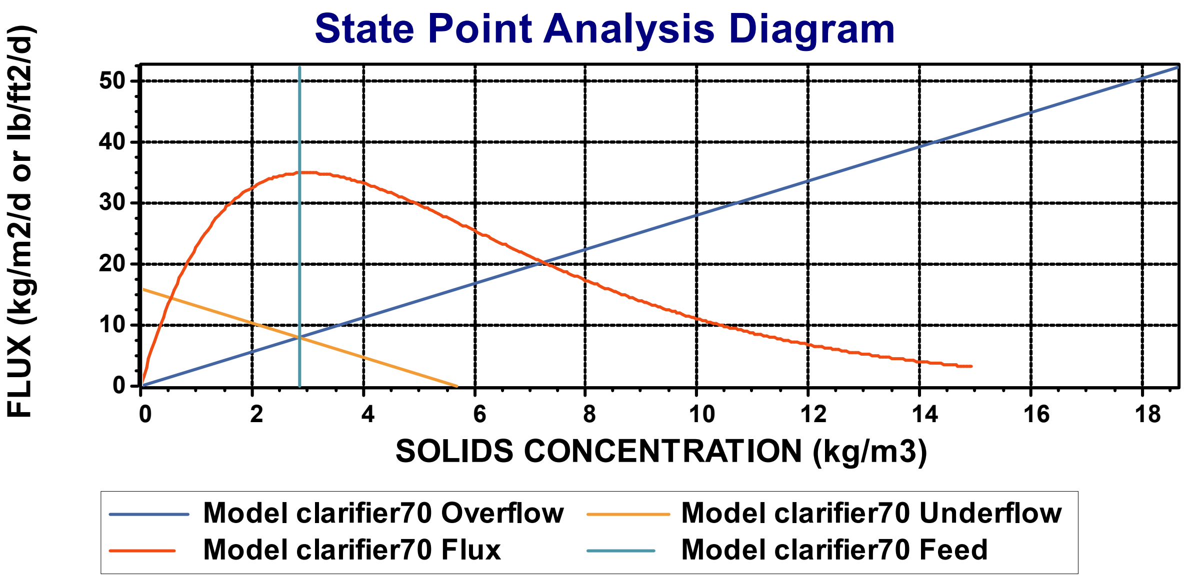
Album page - Page 7



Album page - Page 8

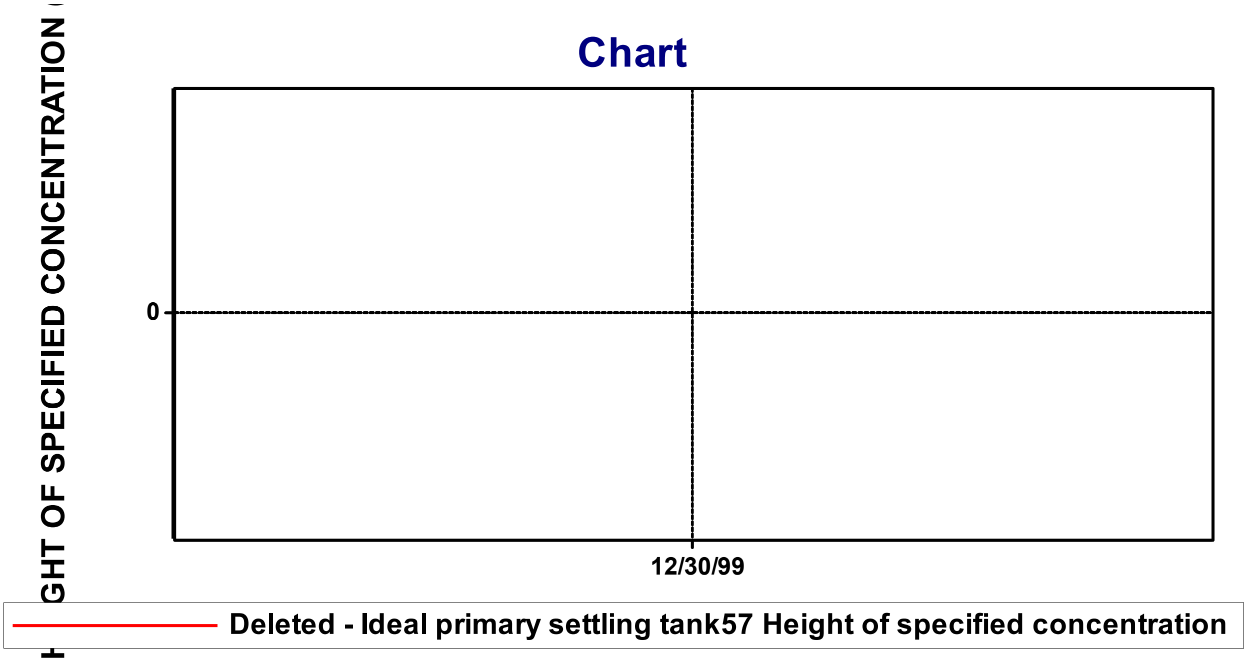


Album page - Page 9



K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 10



Album page - Page 11

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.26
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.26

Album page - Page 13

Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	333.95
Aerobic 1	1136.32
Anoxic 1B	0
Anoxic 2B	0
Swing B	333.95
Aerobic 1B	1136.32

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mg N/L]	N - Ammonia [mg N/L]	N - Nitrite [mg N/L]	N - Nitrate [mg N/L]	Air flow rate [ft3/min (20 C, 1 atm)]	OTR [lb/hr]	OUR - Total [mg O/L/hr]	SOTR [lb/hr]	Alpha [[]]	Element HRT [hours]
Influent - BOD49	1.54	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----	-----	-----
Anoxic 1	3.08	1174.03	62.40	2884.73	2558.21	6.81	2.40	220.56	11.76	0.18	3.70	0	0	0	0	0.50	0.29
Anoxic 2	3.08	1169.92	51.87	2888.38	2561.71	6.84	2.56	220.56	11.92	0.13	1.79	0	0	0	0	0.50	0.29
Swing	3.08	1163.62	50.37	2882.68	2555.43	6.67	2.19	218.23	8.97	0.97	3.21	333.95	22.93	66.08	114.93	0.30	0.29
Aerobic 1	3.08	1125.31	49.16	2844.28	2514.95	6.34	1.10	210.82	0.59	0.31	10.85	1136.32	98.42	45.82	422.80	0.35	2.01
Model clarifier 5	0.77	3.64	49.16	6.23	5.51	6.34	1.10	2.80	0.59	0.31	10.85	-----	-----	-----	-----	-----	4.01
Model clarifier 5 (U)	0.77	2245.23	49.16	5677.92	5020.50	6.34	1.10	418.51	0.59	0.31	10.85	-----	-----	-----	-----	-----	-----
Model clarifier 70	0.77	3.64	49.16	6.23	5.51	6.34	1.10	2.80	0.59	0.31	10.85	-----	-----	-----	-----	-----	4.01
Model clarifier 70 (U)	0.77	2245.23	49.16	5677.92	5020.50	6.34	1.10	418.51	0.59	0.31	10.85	-----	-----	-----	-----	-----	-----
Effluent29	1.54	3.64	49.16	6.23	5.51	6.34	1.10	2.80	0.59	0.31	10.85	-----	-----	-----	-----	-----	-----
Donut	0.07	1715.88	48.48	5094.69	4486.24	4.62	-0.01	384.18	12.68	0.83	39.10	213.41	23.18	30.86	70.26	0.50	29.15

Hole																	
Ring	0.07	1086.60	48.53	4393.51	3857.01	4.44	-0.03	348.61	39.45	0.67	68.31	229.60	26.73	17.80	81.02	0.50	58.30

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----
Anoxic 1B	1174.03	62.40	2884.73	2558.21	6.81	2.40	220.56	11.76	0.18	3.70	0	0	0	0
Anoxic 2B	1169.92	51.87	2888.38	2561.71	6.84	2.56	220.56	11.92	0.13	1.79	0	0	0	0
Swing B	1163.62	50.37	2882.68	2555.43	6.67	2.19	218.23	8.97	0.97	3.21	333.95	22.93	66.08	114.93
Aerobic 1B	1125.31	49.16	2844.28	2514.95	6.34	1.10	210.82	0.59	0.31	10.85	1136.32	98.42	45.82	422.80
Model clarifier5	3.64	49.16	6.23	5.51	6.34	1.10	2.80	0.59	0.31	10.85	-----	-----	-----	-----
Model clarifier5 (U)	2245.23	49.16	5677.92	5020.50	6.34	1.10	418.51	0.59	0.31	10.85	-----	-----	-----	-----
Model clarifier70	3.64	49.16	6.23	5.51	6.34	1.10	2.80	0.59	0.31	10.85	-----	-----	-----	-----
Model clarifier70 (U)	2245.23	49.16	5677.92	5020.50	6.34	1.10	418.51	0.59	0.31	10.85	-----	-----	-----	-----

Effluent29	3.64	49.16	6.23	5.51	6.34	1.10	2.80	0.59	0.31	10.85	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290

KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000

Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value

Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290

Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000

Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220

Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000

Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000

P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800

Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000

BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

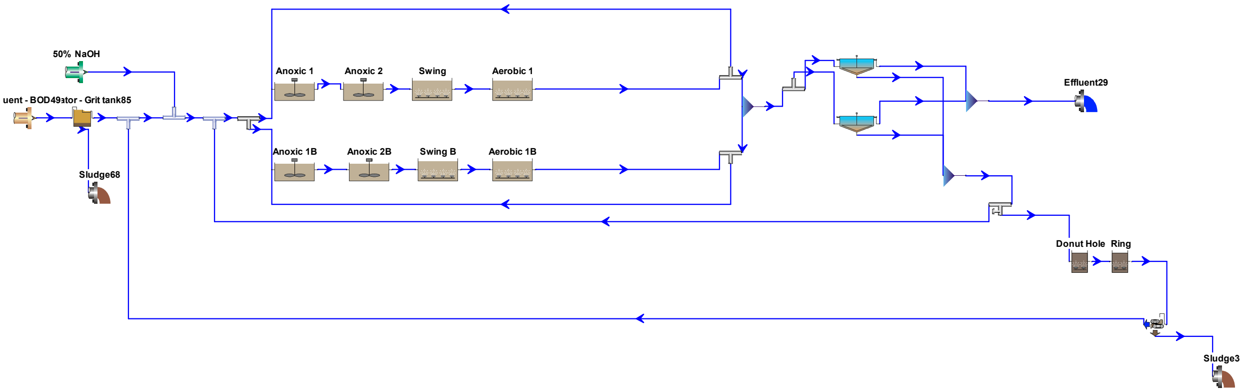
Created: 5/18/2018 Saved: 9/16/2020

Steady state solution

Target SRT: 7.00 days SRT #0: 7.03 days

Temperature: 11.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated

Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	2.76
BOD - Total Carbonaceous mgBOD/L	179.00
Volatile suspended solids mg/L	188.00
Total suspended solids mg/L	203.00
N - Total Kjeldahl Nitrogen mgN/L	31.00
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8753
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650

Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	100.00 %
Splitter12	Flow paced	100.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0529285713907653
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

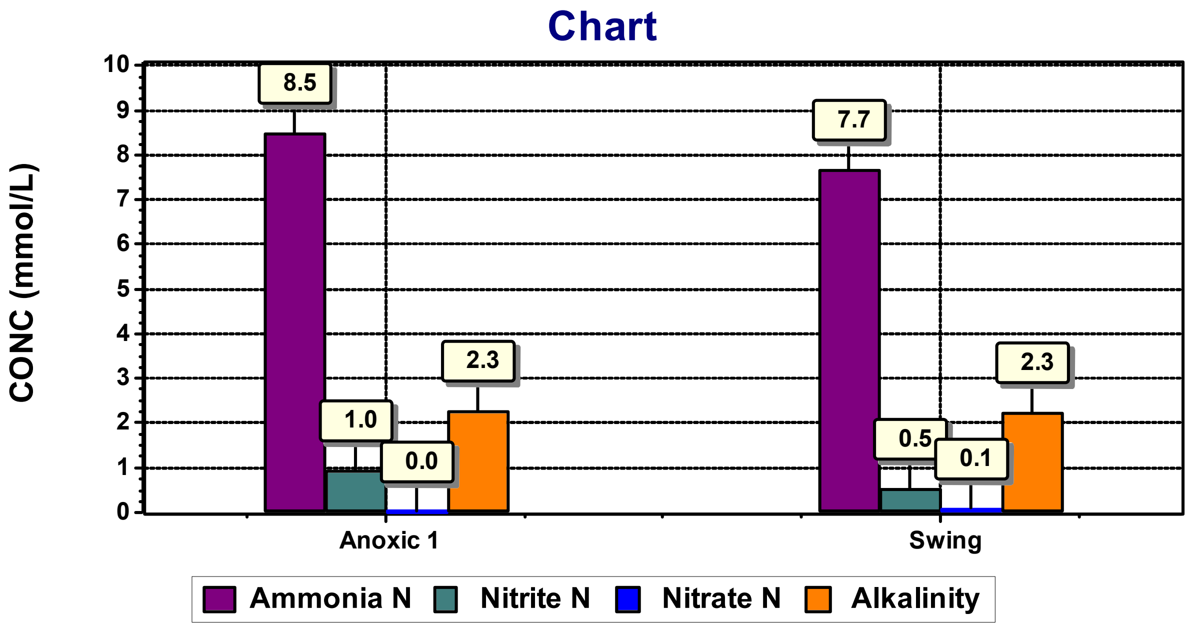
Element name	50% NaOH
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0

N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0

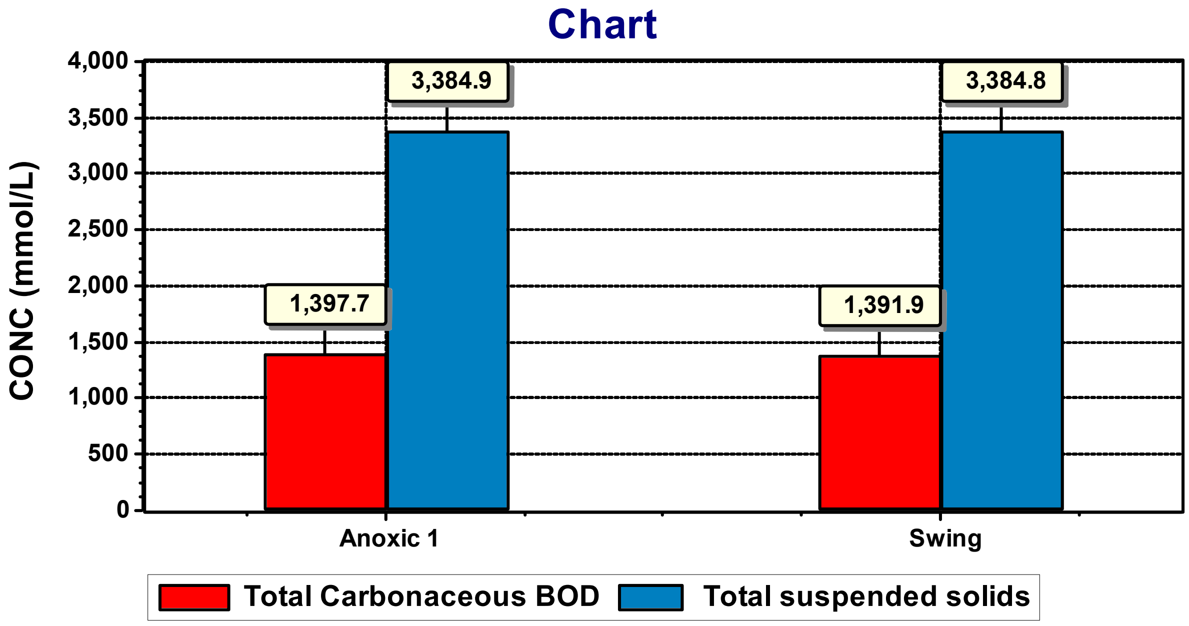
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0003

BioWin Album

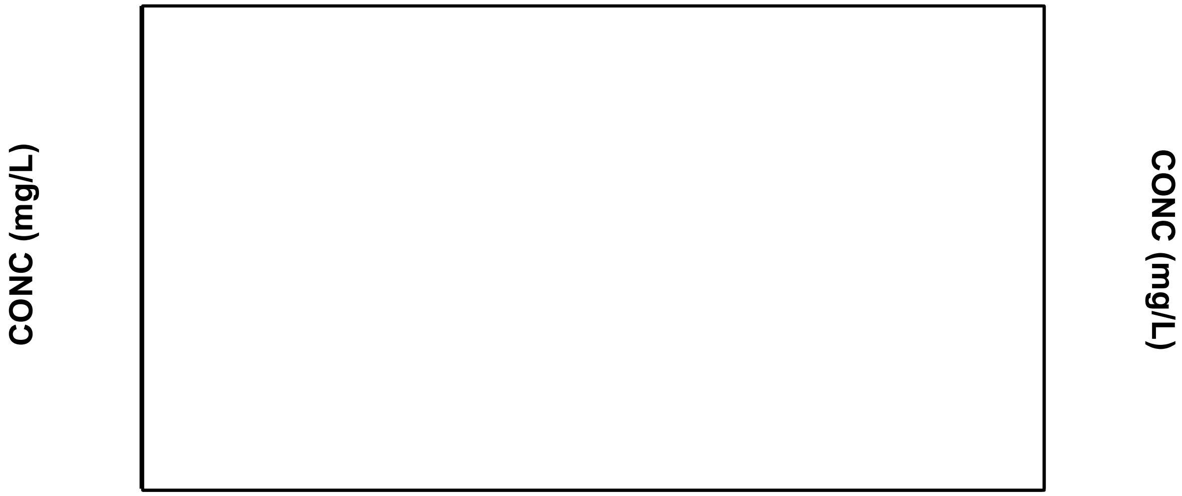
Album page - Nitrogen species



Album page - BOD_TSS

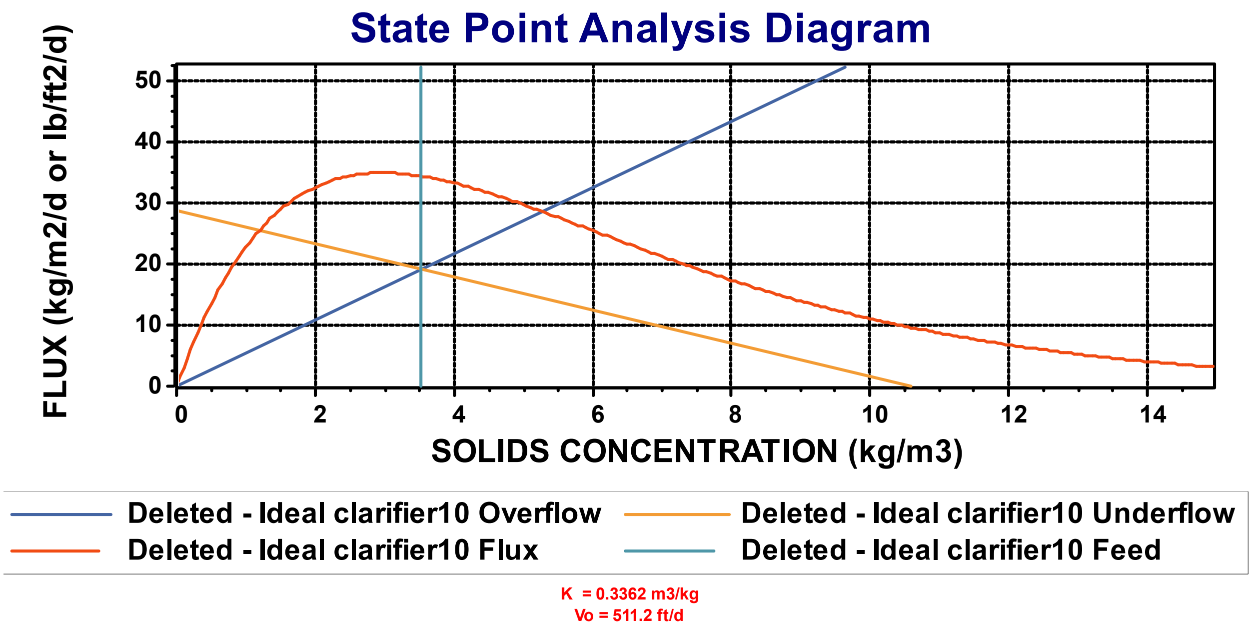


Chart

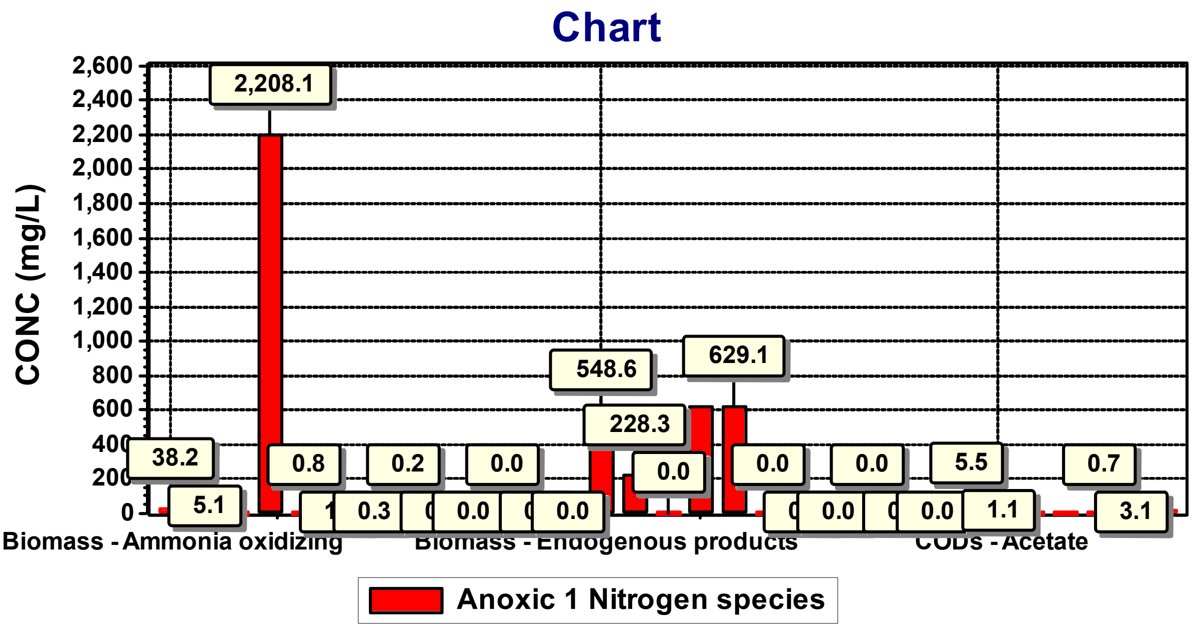


Album page - Page 4

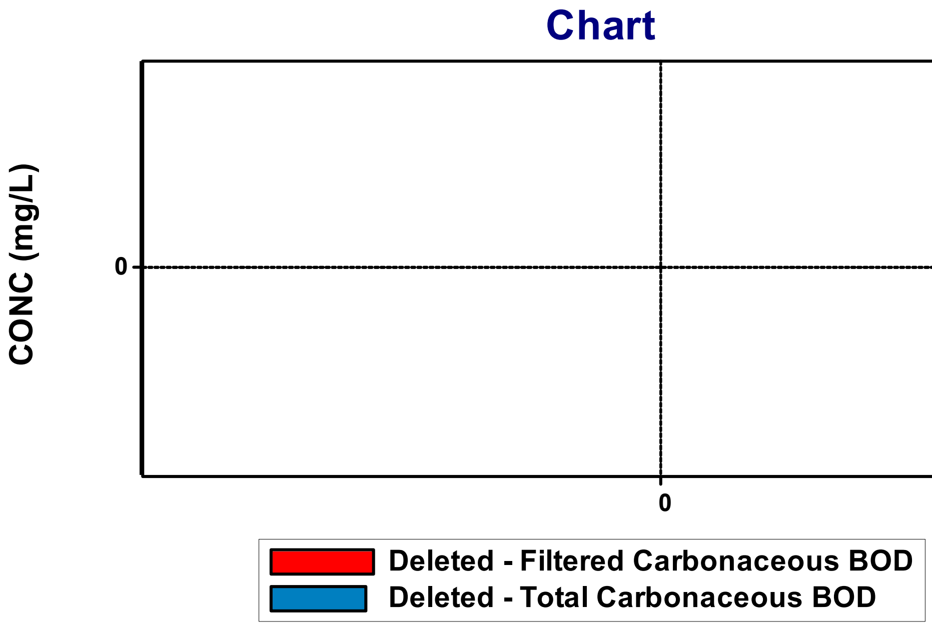
Album page - Page 5



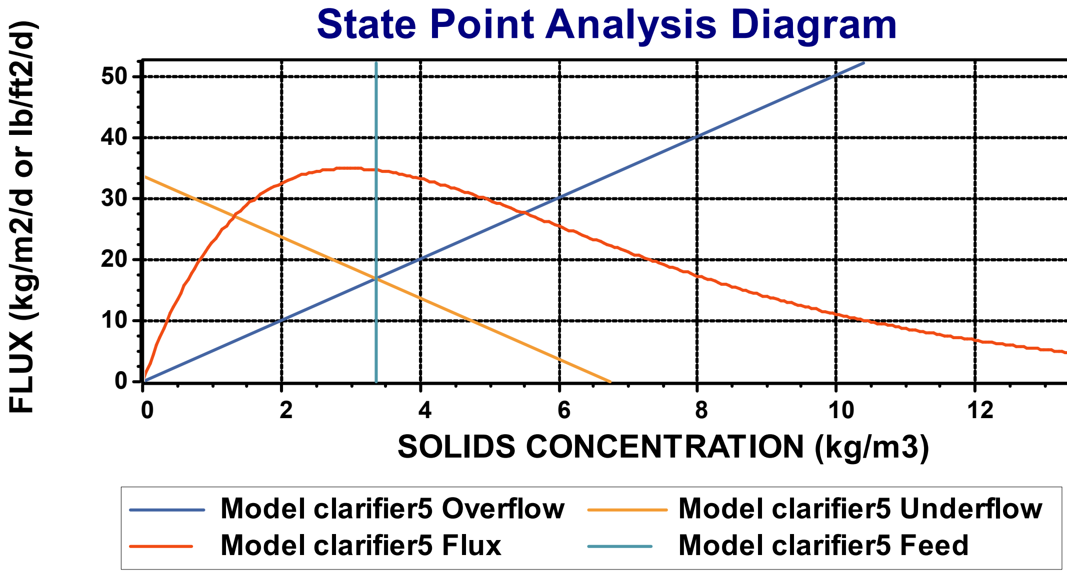
Album page - Page 6



Album page - Page 7

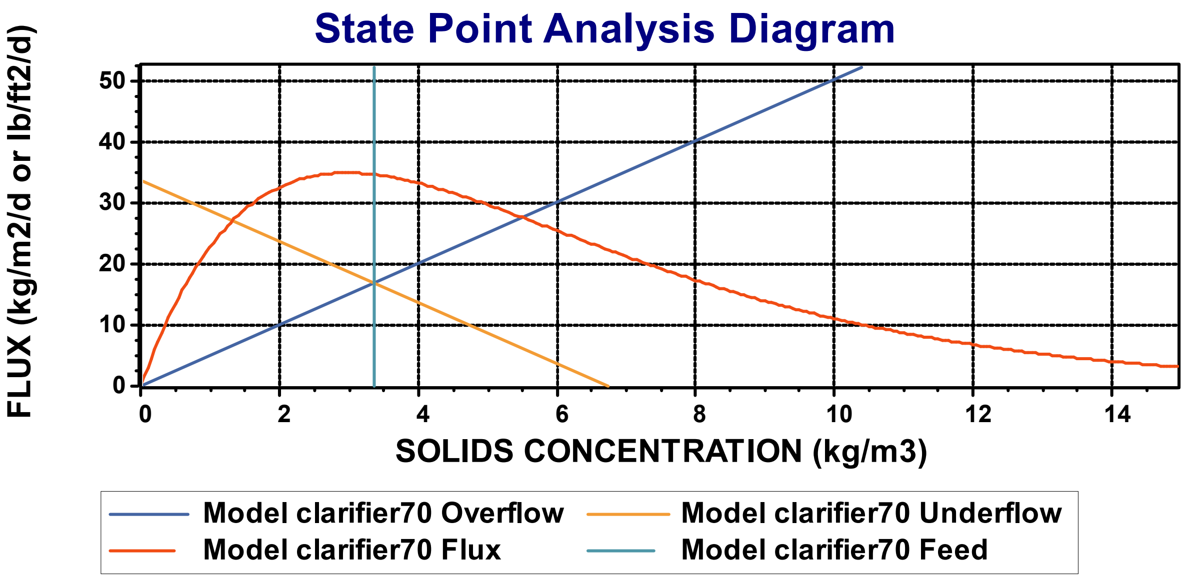


Album page - Page 8



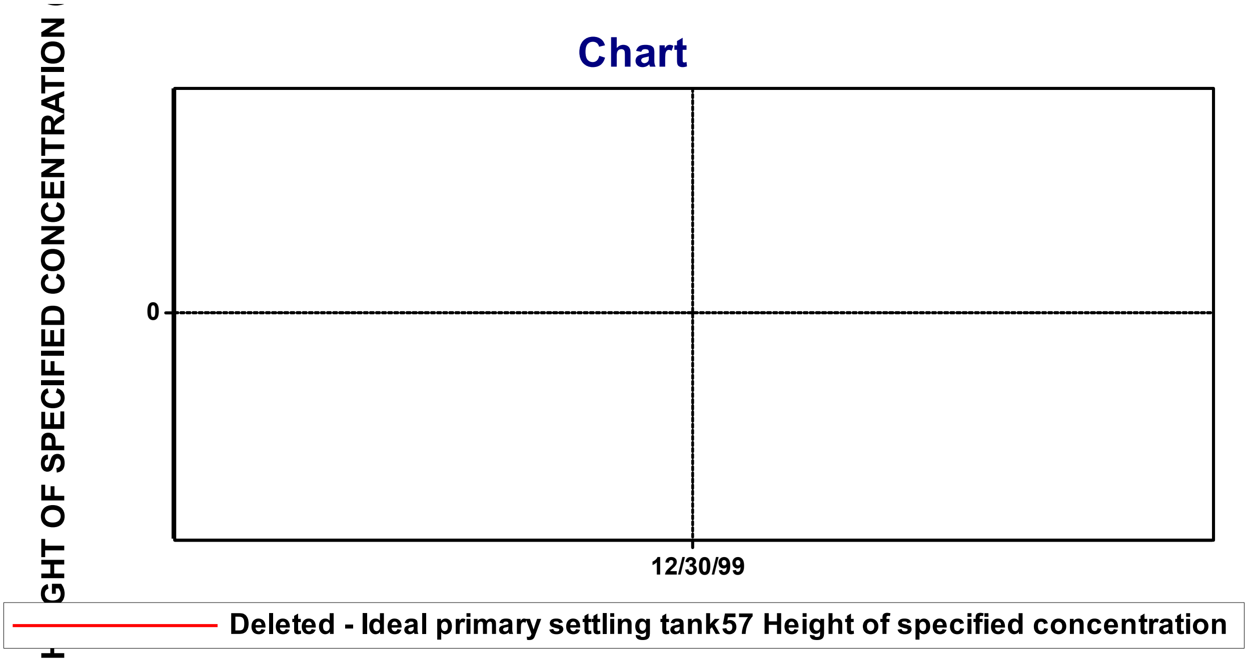
K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 9



K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 10



Album page - Page 11

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.26
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.26

Album page - Page 13

Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	212.15
Aerobic 1	835.26
Anoxic 1B	0
Anoxic 2B	0
Swing B	212.15
Aerobic 1B	835.26

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]	Element HRT [hours]
Influent - BOD49	2.76	11.00	178.98	54.53	373.52	106.91	203.00	188.00	7.10	2.00	31.00	22.79	0	0	-----	-----	-----	-----	-----	-----
Anoxic 1	5.52	11.00	1397.72	6.68	4325.05	34.95	3384.94	3027.53	6.88	2.29	257.75	8.51	0.97	0.04	0	0	0	0	0.50	0.16
Anoxic 2	5.52	11.00	1395.68	3.21	4323.29	30.39	3386.95	3029.49	6.90	2.37	257.75	8.69	0.02	0.00	0	0	0	0	0.50	0.16
Swing	5.52	11.00	1391.95	1.85	4316.90	27.51	3384.81	3027.03	6.74	2.26	257.10	7.70	0.55	0.09	212.15	18.71	47.28	76.82	0.36	0.16
Aerobic 1	5.52	11.00	1371.71	1.26	4285.38	26.14	3364.89	3005.79	6.50	1.70	253.35	3.20	3.44	0.72	835.26	84.89	39.52	321.68	0.39	1.12
Model clarifier5	1.38	11.00	6.96	1.26	43.84	26.14	13.98	12.49	6.50	1.70	5.43	3.20	3.44	0.72	-----	-----	-----	-----	-----	2.24
Model clarifier5 (U)	1.38	11.00	2735.69	1.26	8524.53	26.14	6713.92	5997.41	6.50	1.70	501.13	3.20	3.44	0.72	-----	-----	-----	-----	-----	-----
Model clarifier70	1.38	11.00	6.96	1.26	43.84	26.14	13.98	12.49	6.50	1.70	5.43	3.20	3.44	0.72	-----	-----	-----	-----	-----	2.24
Model clarifier7	1.38	11.00	2735.69	1.26	8524.53	26.14	6713.92	5997.41	6.50	1.70	501.13	3.20	3.44	0.72	-----	-----	-----	-----	-----	-----

0 (U)																				
Effluent29	2.76	11.00	6.96	1.26	43.84	26.14	13.98	12.49	6.50	1.70	5.43	3.20	3.44	0.72	-----	-----	-----	-----	-----	-----
Donut Hole	0.05	11.00	2069.74	0.57	7567.49	25.16	5981.20	5324.13	5.37	0.17	457.62	16.70	17.59	23.04	182.81	20.60	27.43	61.24	0.50	40.81
Ring	0.05	11.00	1294.59	0.53	6466.99	25.19	5117.22	4549.11	5.21	0.13	413.76	49.57	16.99	59.41	194.54	23.53	15.66	69.94	0.50	81.62

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	178.98	106.91	203.00	188.00	7.10	2.00	31.00	22.79	0	0	-----	-----	-----	-----
Anoxic 1B	1397.72	34.95	3384.94	3027.53	6.88	2.29	257.75	8.51	0.97	0.04	0	0	0	0
Anoxic 2B	1395.68	30.39	3386.95	3029.49	6.90	2.37	257.75	8.69	0.02	0.00	0	0	0	0
Swing B	1391.95	27.51	3384.81	3027.03	6.74	2.26	257.10	7.70	0.55	0.09	212.15	18.71	47.28	76.82
Aerobic 1B	1371.71	26.14	3364.89	3005.79	6.50	1.70	253.35	3.20	3.44	0.72	835.26	84.89	39.52	321.68
Model clarifier5	6.96	26.14	13.98	12.49	6.50	1.70	5.43	3.20	3.44	0.72	-----	-----	-----	-----
Model clarifier5 (U)	2735.69	26.14	6713.92	5997.41	6.50	1.70	501.13	3.20	3.44	0.72	-----	-----	-----	-----
Model	6.96	26.14	13.98	12.49	6.50	1.70	5.43	3.20	3.44	0.72	-----	-----	-----	-----

clarifier70														
Model clarifier70 (U)	2735.69	26.14	6713.92	5997.41	6.50	1.70	501.13	3.20	3.44	0.72	-----	-----	-----	-----
Effluent29	6.96	26.14	13.98	12.49	6.50	1.70	5.43	3.20	3.44	0.72	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000

Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000

Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000

Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000

Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800

COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0

Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000

Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500

Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000

N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500

Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000
H2S [M/Atm]	1.0000E-1	1.0000E-1	2200.0000
Ind 1 [M/Atm]	1.9000E+3	1.9000E+3	7300.0000
Ind 2 [M/Atm]	1.8000E-1	1.8000E-1	2200.0000
Ind 3 [M/Atm]	1.5000E-1	1.5000E-1	1900.0000

Properties constants

Name	Default	Value

K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7
A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2000	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1734.0000	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5000	-39.4800

Metal salt solution densities

Name	Default	Value
Ferric chloride solution density [kg/m3]	3820.0000	3820.0000
Ferric sulfate solution density [kg/m3]	4800.0000	4800.0000
Ferrous chloride solution density [kg/m3]	3160.0000	3160.0000
Ferrous sulfate solution density [kg/m3]	1150.0000	1150.0000
Aluminum sulfate solution density [kg/m3]	1950.0000	1950.0000
Aluminum chloride solution density [kg/m3]	2480.0000	2480.0000

Mineral precipitation rates

Name	Default	Value	
Vivianite precipitation rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite redissolution rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite half sat. [mgTSS/L]	0.0100	0.0100	1.0000
FeS precipitation rate [L/(mol d)]	1000.0000	1000.0000	1.0240
FeS redissolution rate [L/(mol d)]	10.0000	10.0000	1.0240
FeS half sat. [mgTSS/L]	0.1000	0.1000	1.0000
Struvite precipitation rate [L^2/(mol^2 d)]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [L^2/(mol^2 d)]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000

Brushite precipitation rate [L/(mol d)]	1.000E+6	1.000E+6	1.0000
Brushite redissolution rate [L/(mol d)]	10000.0000	10000.0000	1.0000
Brushite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HAP precipitation rate [g/d]	5.000E-4	5.000E-4	1.0000

Mineral precipitation constants

Name	Default	Value
Vivianite solubility product [mol/L]^5	1.710E-36	1.710E-36
FeS solubility product [mol/L]^2	4.258E-4	4.258E-4
Struvite solubility product [mol/L]^3	6.918E-14	6.918E-14
Brushite solubility product [mol/L]^2	2.490E-7	2.490E-7

Fe rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HFO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HFO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HFO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	2.000E-11	2.000E-11	1.0000
H+ competition for HFO(H) protonation sites [L/(mmol . d)]	1000.0000	1000.0000	1.0000
H+ competition for HFO(L) protonation sites [L/(mmol . d)]	100.0000	100.0000	1.0000

Fe constants

Name	Default	Value

Ferric active site factor(high) [{mol Sites}/{mol HFO(H)}]	4.0000	2.0000
Ferric active site factor(low) [{mol Sites}/{mol HFO(L)}]	2.4000	1.2000
H+ competition level for Fe(OH)3 [mol/L]	7.000E-7	7.000E-7
Equilibrium constant for FeOH3-H2PO4- [{mf HFO(H).H2PO4}/({mol H2PO4-}{mf HFO(H)}^2)]	2.000E-9	2.000E-9
Colloidal COD removed with Ferric [gCOD/Fe active site]	80.0000	130.0000
Minimum residual P level with iron addition [mgP/L]	0.0150	0.0150
HFO(H) with H2PO4- P release factor	10000.0000	10000.0000
HFO(L) with H2PO4- P release factor	10000.0000	10000.0000

Fe RedOx rates

Name	Default	Value	
Iron reduction using acetic acid	1.000E-7	1.000E-7	1.0000
Half Sat. acetic acid	0.5000	0.5000	1.0000
Iron reduction using propionic acid	1.000E-7	1.000E-7	1.0000
Half Sat. propionic acid	0.5000	0.5000	1.0000
Iron reduction using dissolved hydrogen gas	1.000E-7	1.000E-7	1.0000
Half Sat. dissolved hydrogen gas	0.5000	0.5000	1.0000
Iron reduction using hydrogen sulfide	5.000E-5	5.000E-5	1.0000
Half Sat. hydrogen sulfide	0.5000	0.5000	1.0000
Iron oxidation rate (aerobic)	1.000E-3	1.000E-3	1.0000
Abiotic iron reduction using acetic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using propionic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using dissolved hydrogen gas	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using hydrogen sulfide	2.000E-5	2.000E-5	1.0000
Abiotic iron oxidation rate (aerobic)	1.0000	1.0000	1.0000

CEPT rates

Name	Default	Value	
HFO colloidal adsorption rate	1.0000	1.0000	1.0000

Residual Xsc for adsorption to HFO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000
HAO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HAO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000

Al rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HAO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HAO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HAO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	1.000E-9	1.000E-9	1.0000

Al constants

Name	Default	Value
Al active site factor(high) [{mol Sites}/{mol HAO(H)}]	3.0000	3.0000
Al active site factor(low) [{mol Sites}/{mol HAO(L)}]	1.5000	1.5000
Equilibrium constant for AlOH3-H2PO4- [{mf HAO(H).H2PO4}/({mol H2PO4-}{mf HAO(H)}^2)]	8.000E-10	8.000E-10
Colloidal COD removed with Al [gCOD/Al active site]	30.0000	30.0000
Minimum residual P level with Al addition [mgP/L]	0.0150	0.0150
HAO(H) with H2PO4- P release factor	10000.0000	10000.0000
HAO(L) with H2PO4- P release factor	10000.0000	10000.0000

Pipe and pump parameters

Name	Default	Value
Static head [ft]	0.8202	0.8202
Pipe length (headloss calc.s) [ft]	164.0420	164.0420
Pipe inside diameter [in]	19.68504	19.68504
K(fittings) - Total minor losses K	5.0000	5.0000
Pipe roughness [in]	0.00787	0.00787
'A' in overall pump efficiency = A + B*Q + C*(Q^2)[-]	0.8500	0.8500
'B' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)]	0	0
'C' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)^2]	0	0

Fittings and loss coefficients ('K' values)

Name	Default	Value
Pipe entrance (bellmouth)	0.0500	1.0000
90° bend	0.7500	5.0000
45° bend	0.3000	2.0000
Butterfly value (open)	0.3000	1.0000
Non-return value	1.0000	0
Outlet (bellmouth)	0.2000	1.0000

Aeration

Name	Default	Value
Surface pressure [kPa]	101.3250	101.3250
Fractional effective saturation depth (Fed) [-]	0.3250	0.3250
Supply gas CO2 content [vol. %]	0.0400	0.0350
Supply gas O2 [vol. %]	20.9500	20.9500
Off-gas CO2 [vol. %]	2.0000	2.0000
Off-gas O2 [vol. %]	18.8000	18.8000
Off-gas H2 [vol. %]	0	0

Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Off-gas N2O [vol. %]	0	0
Surface turbulence factor [-]	2.0000	2.0000
Set point controller gain []	1.0000	1.0000

MABR Membrane effective diffusivities

Name	Default	Value	
O2 [m2/s]	2.500E-9	2.500E-9	1.0000
N2 [m2/s]	1.900E-9	1.900E-9	1.0000
CO2 [m2/s]	1.960E-9	1.960E-9	1.0000
H2 [m2/s]	5.850E-9	5.850E-9	1.0000
CH4 [m2/s]	1.963E-9	1.963E-9	1.0000
NH3 [m2/s]	2.000E-9	2.000E-9	1.0000
N2O [m2/s]	1.607E-9	1.607E-9	1.0000
H2S [m2/s]	1.530E-9	1.530E-9	1.0000
Ind 1 [m2/s]	7.240E-10	7.240E-10	1.0000
Ind 2 [m2/s]	8.900E-10	8.900E-10	1.0000
Ind 3 [m2/s]	7.960E-10	7.960E-10	1.0000

MABR Membrane transfer factors

Name	Default	Value	
O2 []	1.0000	1.0000	1.0000
N2 []	1.0000	1.0000	1.0000
CO2 []	1.0000	1.0000	1.0000
H2 []	1.0000	1.0000	1.0000
CH4 []	1.0000	1.0000	1.0000
NH3 []	1.0000	1.0000	1.0000
N2O []	1.0000	1.0000	1.0000

H2S []	1.0000	1.0000	1.0000
Ind 1 []	1.0000	1.0000	1.0000
Ind 2 []	1.0000	1.0000	1.0000
Ind 3 []	1.0000	1.0000	1.0000

Blower

Name	Default	Value
Intake filter pressure drop [psi]	0.5076	0.5076
Pressure drop through distribution system (piping/valves) [psi]	0.4351	0.4351
Adiabatic/polytropic compression exponent (1.4 for adiabatic)	1.4000	1.4000
'A' in blower efficiency = A + B*Qa + C*(Qa^2)[-]	0.7500	0.7500
'B' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))]	0	0
'C' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))^2]	0	0

Diffuser

Name	Default	Value
k1 in C = k1(PC)^0.25 + k2	1.2400	1.2400
k2 in C = k1(PC)^0.25 + k2	0.8960	0.8960
Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	0.8880	0.8880
Area of one diffuser [ft2]	0.4413	0.4413
Diffuser mounting height [ft]	0.8202	0.8202
Min. air flow rate per diffuser ft3/min (20C, 1 atm)	0.2943	0.2943
Max. air flow rate per diffuser ft3/min (20C, 1 atm)	5.8858	5.8858
'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 [psi]	0.4351	0.4351
'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))]	0	0
'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))^2]	0	0

Surface aerators

Name	Default	Value
Surface aerator Std. oxygen transfer rate [lb O /(hp hr)]	2.46697	2.46697

Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.387	0.355
Vesilind hindered zone settling parameter (K) [L/g]	0.370	0.336
Clarification switching function [mg/L]	100.000	100.000
Specified TSS conc.for height calc. [mg/L]	2500.000	2500.000
Maximum compactability constant [mg/L]	15000.000	15000.000
Maximum compactability slope [L/mg]	0.010	0.010

Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.934	0.934
Maximum (practical) settling velocity (Vo') [ft/min]	0.615	0.615
Hindered zone settling parameter (Kh) [L/g]	0.400	0.400
Flocculent zone settling parameter (Kf) [L/g]	2.500	2.500
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	1.000E-3	1.000E-3
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

Emission factors

Name	Default	Value

Carbon dioxide equivalence of nitrous oxide	296.0000	296.0000
Carbon dioxide equivalence of methane	23.0000	23.0000

Biofilm general

Name	Default	Value	
Attachment rate [g / (m2 d)]	8.0000	80.0000	1.0000
Attachment TSS half sat. [mg/L]	100.0000	100.0000	1.0000
Detachment rate [g/(m3 d)]	8000.0000	8.000E+4	1.0000
Solids movement factor []	10.0000	10.0000	1.0000
Diffusion neta []	0.8000	0.8000	1.0000
Thin film limit [mm]	0.5000	0.5000	1.0000
Thick film limit [mm]	3.0000	3.0000	1.0000
Assumed Film thickness for tank volume correction (temp independent) [mm]	1.2500	0.7500	1.0000
Film surface area to media area ratio - Max.[ ]	1.0000	1.0000	1.0000
Minimum biofilm conc. for streamer formation [gTSS/m2]	4.0000	4.0000	1.0000

Maximum biofilm concentrations [mg/L]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Methylotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Ammonia oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Nitrite oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Anaerobic ammonia oxidizing	5.000E+4	5.000E+4	1.0000
Biomass - Phosphorus accumulating	5.000E+4	5.000E+4	1.0000
Biomass - Propionic acetogenic	5.000E+4	5.000E+4	1.0000
Biomass - Acetoclastic methanogenic	5.000E+4	5.000E+4	1.0000
Biomass - Hydrogenotrophic methanogenic	5.000E+4	5.000E+4	1.0000
Biomass - Endogenous products	3.000E+4	3.000E+4	1.0000
CODp - Slowly degradable particulate	5000.0000	5000.0000	1.0000

CODp - Slowly degradable colloidal	4000.0000	4000.0000	1.0000
CODp - Degradable external organics	5000.0000	5000.0000	1.0000
CODp - Undegradable non-cellulose	5000.0000	5000.0000	1.0000
CODp - Undegradable cellulose	5000.0000	5000.0000	1.0000
N - Particulate degradable organic	0	0	1.0000
P - Particulate degradable organic	0	0	1.0000
N - Particulate degradable external organics	0	0	1.0000
P - Particulate degradable external organics	0	0	1.0000
N - Particulate undegradable	0	0	1.0000
P - Particulate undegradable	0	0	1.0000
CODp - Stored PHA	5000.0000	5000.0000	1.0000
P - Releasable stored polyP	1.150E+6	1.150E+6	1.0000
P - Unreleasable stored polyP	1.150E+6	1.150E+6	1.0000
CODs - Complex readily degradable	0	0	1.0000
CODs - Acetate	0	0	1.0000
CODs - Propionate	0	0	1.0000
CODs - Methanol	0	0	1.0000
Gas - Dissolved hydrogen	0	0	1.0000
Gas - Dissolved methane	0	0	1.0000
N - Ammonia	0	0	1.0000
N - Soluble degradable organic	0	0	1.0000
Gas - Dissolved nitrous oxide	0	0	1.0000
N - Nitrite	0	0	1.0000
N - Nitrate	0	0	1.0000
Gas - Dissolved nitrogen	0	0	1.0000
P - Soluble phosphate	0	0	1.0000
CODs - Undegradable	0	0	1.0000
N - Soluble undegradable organic	0	0	1.0000
Influent inorganic suspended solids	1.300E+6	1.300E+6	1.0000
Precipitate - Struvite	8.500E+5	8.500E+5	1.0000
Precipitate - Brushite	1.165E+6	1.165E+6	1.0000
Precipitate - Hydroxy - apatite	1.600E+6	1.600E+6	1.0000
Precipitate - Vivianite	1.340E+6	1.340E+6	1.0000
HFO - High surface	5.000E+4	5.000E+4	1.0000
HFO - Low surface	5.000E+4	5.000E+4	1.0000

HFO - High with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HFO - Low with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HFO - Aged	5.000E+4	5.000E+4	1.0000
HFO - Low with H+ adsorbed	5.000E+4	5.000E+4	1.0000
HFO - High with H+ adsorbed	5.000E+4	5.000E+4	1.0000
HAO - High surface	5.000E+4	5.000E+4	1.0000
HAO - Low surface	5.000E+4	5.000E+4	1.0000
HAO - High with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HAO - Low with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HAO - Aged	5.000E+4	5.000E+4	1.0000
P - Bound on aged HMO	5.000E+4	5.000E+4	1.0000
Metal soluble - Magnesium	0	0	1.0000
Metal soluble - Calcium	0	0	1.0000
Metal soluble - Ferric	0	0	1.0000
Metal soluble - Ferrous	0	0	1.0000
Metal soluble - Aluminum	0	0	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Gas - Dissolved total CO2	0	0	1.0000
User defined - UD1	0	0	1.0000
User defined - UD2	0	0	1.0000
User defined - UD3	5.000E+4	5.000E+4	1.0000
User defined - UD4	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Sulfur reducing propionic acetogenic	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur reducing acetotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur reducing hydrogenotrophic	1.000E+5	1.000E+5	1.0000
Gas - Dissolved total sulfides	0	0	1.0000
S - Soluble sulfate	0	0	1.0000
S - Particulate elemental sulfur	5.000E+4	5.000E+4	1.0000
Precipitate - Ferrous sulfide	5.000E+4	5.000E+4	1.0000
CODp - Adsorbed hydrocarbon	5.000E+4	5.000E+4	1.0000
CODs - Degradable volatile ind. #1	0	0	1.0000
CODs - Degradable volatile ind. #2	0	0	1.0000
CODs - Degradable volatile ind. #3	0	0	1.0000

CODs - Soluble hydrocarbon	0	0	1.0000
Gas - Dissolved oxygen	0	0	1.0000

Effective diffusivities [m2/s]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Methylotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Ammonia oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Nitrite oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Anaerobic ammonia oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Phosphorus accumulating	5.000E-14	5.000E-14	1.0290
Biomass - Propionic acetogenic	5.000E-14	5.000E-14	1.0290
Biomass - Acetoclastic methanogenic	5.000E-14	5.000E-14	1.0290
Biomass - Hydrogenotrophic methanogenic	5.000E-14	5.000E-14	1.0290
Biomass - Endogenous products	5.000E-14	5.000E-14	1.0290
CODp - Slowly degradable particulate	5.000E-14	5.000E-14	1.0290
CODp - Slowly degradable colloidal	5.000E-10	5.000E-10	1.0290
CODp - Degradable external organics	5.000E-14	5.000E-14	1.0290
CODp - Undegradable non-cellulose	5.000E-14	5.000E-14	1.0290
CODp - Undegradable cellulose	5.000E-14	5.000E-14	1.0290
N - Particulate degradable organic	5.000E-14	5.000E-14	1.0290
P - Particulate degradable organic	5.000E-14	5.000E-14	1.0290
N - Particulate degradable external organics	5.000E-14	5.000E-14	1.0290
P - Particulate degradable external organics	5.000E-14	5.000E-14	1.0290
N - Particulate undegradable	5.000E-14	5.000E-14	1.0290
P - Particulate undegradable	5.000E-14	5.000E-14	1.0290
CODp - Stored PHA	5.000E-14	5.000E-14	1.0290
P - Releasable stored polyP	5.000E-14	5.000E-14	1.0290
P - Unreleasable stored polyP	5.000E-14	5.000E-14	1.0290
CODs - Complex readily degradable	6.900E-10	6.900E-10	1.0290
CODs - Acetate	1.240E-9	1.240E-9	1.0290
CODs - Propionate	8.300E-10	8.300E-10	1.0290

CODs - Methanol	1.600E-9	1.600E-9	1.0290
Gas - Dissolved hydrogen	5.850E-9	5.850E-9	1.0290
Gas - Dissolved methane	1.963E-9	1.963E-9	1.0290
N - Ammonia	2.000E-9	2.000E-9	1.0290
N - Soluble degradable organic	1.370E-9	1.370E-9	1.0290
Gas - Dissolved nitrous oxide	1.607E-9	1.607E-9	1.0290
N - Nitrite	2.980E-9	2.980E-9	1.0290
N - Nitrate	2.980E-9	2.980E-9	1.0290
Gas - Dissolved nitrogen	1.900E-9	1.900E-9	1.0290
P - Soluble phosphate	2.000E-9	2.000E-9	1.0290
CODs - Undegradable	6.900E-10	6.900E-10	1.0290
N - Soluble undegradable organic	6.850E-10	6.850E-10	1.0290
Influent inorganic suspended solids	5.000E-14	5.000E-14	1.0290
Precipitate - Struvite	5.000E-14	5.000E-14	1.0290
Precipitate - Brushite	5.000E-14	5.000E-14	1.0290
Precipitate - Hydroxy - apatite	5.000E-14	5.000E-14	1.0290
Precipitate - Vivianite	5.000E-14	5.000E-14	1.0290
HFO - High surface	5.000E-14	5.000E-14	1.0290
HFO - Low surface	5.000E-14	5.000E-14	1.0290
HFO - High with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HFO - Low with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HFO - Aged	5.000E-14	5.000E-14	1.0290
HFO - Low with H+ adsorbed	5.000E-14	5.000E-14	1.0290
HFO - High with H+ adsorbed	5.000E-14	5.000E-14	1.0290
HAO - High surface	5.000E-14	5.000E-14	1.0290
HAO - Low surface	5.000E-14	5.000E-14	1.0290
HAO - High with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HAO - Low with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HAO - Aged	5.000E-14	5.000E-14	1.0290
P - Bound on aged HMO	5.000E-14	5.000E-14	1.0290
Metal soluble - Magnesium	7.200E-10	7.200E-10	1.0290
Metal soluble - Calcium	7.200E-10	7.200E-10	1.0290
Metal soluble - Ferric	4.800E-10	4.800E-10	1.0290
Metal soluble - Ferrous	4.800E-10	4.800E-10	1.0290
Metal soluble - Aluminum	4.800E-10	4.800E-10	1.0290

Other Cations (strong bases)	1.440E-9	1.440E-9	1.0290
Other Anions (strong acids)	1.440E-9	1.440E-9	1.0290
Gas - Dissolved total CO2	1.960E-9	1.960E-9	1.0290
User defined - UD1	6.900E-10	6.900E-10	1.0290
User defined - UD2	6.900E-10	6.900E-10	1.0290
User defined - UD3	5.000E-14	5.000E-14	1.0290
User defined - UD4	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing propionic acetogenic	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing acetotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing hydrogenotrophic	5.000E-14	5.000E-14	1.0290
Gas - Dissolved total sulfides	1.530E-9	1.530E-9	1.0290
S - Soluble sulfate	2.130E-10	2.130E-10	1.0290
S - Particulate elemental sulfur	5.000E-14	5.000E-14	1.0290
Precipitate - Ferrous sulfide	5.000E-14	5.000E-14	1.0290
CODp - Adsorbed hydrocarbon	5.000E-14	5.000E-14	1.0290
CODs - Degradable volatile ind. #1	7.240E-10	7.240E-10	1.0290
CODs - Degradable volatile ind. #2	8.900E-10	8.900E-10	1.0290
CODs - Degradable volatile ind. #3	7.960E-10	7.960E-10	1.0290
CODs - Soluble hydrocarbon	7.120E-10	7.120E-10	1.0290
Gas - Dissolved oxygen	2.500E-9	2.500E-9	1.0290

EPS Strength coefficients [ ]

Name	Default	Value	
Biomass - Ordinary heterotrophic	1.0000	1.0000	1.0000
Biomass - Methylotrophic	1.0000	1.0000	1.0000
Biomass - Ammonia oxidizing	5.0000	5.0000	1.0000
Biomass - Nitrite oxidizing	25.0000	25.0000	1.0000
Biomass - Anaerobic ammonia oxidizing	10.0000	10.0000	1.0000
Biomass - Phosphorus accumulating	1.0000	1.0000	1.0000
Biomass - Propionic acetogenic	1.0000	1.0000	1.0000
Biomass - Acetoclastic methanogenic	1.0000	1.0000	1.0000

Biomass - Hydrogenotrophic methanogenic	1.0000	1.0000	1.0000
Biomass - Endogenous products	1.0000	1.0000	1.0000
CODp - Slowly degradable particulate	1.0000	1.0000	1.0000
CODp - Slowly degradable colloidal	1.0000	1.0000	1.0000
CODp - Degradable external organics	1.0000	1.0000	1.0000
CODp - Undegradable non-cellulose	1.0000	1.0000	1.0000
CODp - Undegradable cellulose	1.0000	1.0000	1.0000
N - Particulate degradable organic	1.0000	1.0000	1.0000
P - Particulate degradable organic	1.0000	1.0000	1.0000
N - Particulate degradable external organics	1.0000	1.0000	1.0000
P - Particulate degradable external organics	1.0000	1.0000	1.0000
N - Particulate undegradable	1.0000	1.0000	1.0000
P - Particulate undegradable	1.0000	1.0000	1.0000
CODp - Stored PHA	1.0000	1.0000	1.0000
P - Releasable stored polyP	1.0000	1.0000	1.0000
P - Unreleasable stored polyP	1.0000	1.0000	1.0000
CODs - Complex readily degradable	0	0	1.0000
CODs - Acetate	0	0	1.0000
CODs - Propionate	0	0	1.0000
CODs - Methanol	0	0	1.0000
Gas - Dissolved hydrogen	0	0	1.0000
Gas - Dissolved methane	0	0	1.0000
N - Ammonia	0	0	1.0000
N - Soluble degradable organic	0	0	1.0000
Gas - Dissolved nitrous oxide	0	0	1.0000
N - Nitrite	0	0	1.0000
N - Nitrate	0	0	1.0000
Gas - Dissolved nitrogen	0	0	1.0000
P - Soluble phosphate	0	0	1.0000
CODs - Undegradable	0	0	1.0000
N - Soluble undegradable organic	0	0	1.0000
Influent inorganic suspended solids	0.3300	0.3300	1.0000
Precipitate - Struvite	1.0000	1.0000	1.0000
Precipitate - Brushite	1.0000	1.0000	1.0000
Precipitate - Hydroxy - apatite	1.0000	1.0000	1.0000

Precipitate - Vivianite	1.0000	1.0000	1.0000
HFO - High surface	1.0000	1.0000	1.0000
HFO - Low surface	1.0000	1.0000	1.0000
HFO - High with H2PO4- adsorbed	1.0000	1.0000	1.0000
HFO - Low with H2PO4- adsorbed	1.0000	1.0000	1.0000
HFO - Aged	1.0000	1.0000	1.0000
HFO - Low with H+ adsorbed	1.0000	1.0000	1.0000
HFO - High with H+ adsorbed	1.0000	1.0000	1.0000
HAO - High surface	1.0000	1.0000	1.0000
HAO - Low surface	1.0000	1.0000	1.0000
HAO - High with H2PO4- adsorbed	1.0000	1.0000	1.0000
HAO - Low with H2PO4- adsorbed	1.0000	1.0000	1.0000
HAO - Aged	1.0000	1.0000	1.0000
P - Bound on aged HMO	1.0000	1.0000	1.0000
Metal soluble - Magnesium	0	0	1.0000
Metal soluble - Calcium	0	0	1.0000
Metal soluble - Ferric	0	0	1.0000
Metal soluble - Ferrous	0	0	1.0000
Metal soluble - Aluminum	0	0	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Gas - Dissolved total CO2	0	0	1.0000
User defined - UD1	0	0	1.0000
User defined - UD2	0	0	1.0000
User defined - UD3	1.0000	1.0000	1.0000
User defined - UD4	1.0000	1.0000	1.0000
Biomass - Sulfur oxidizing	1.0000	1.0000	1.0000
Biomass - Sulfur reducing propionic acetogenic	1.0000	1.0000	1.0000
Biomass - Sulfur reducing acetotrophic	1.0000	1.0000	1.0000
Biomass - Sulfur reducing hydrogenotrophic	1.0000	1.0000	1.0000
Gas - Dissolved total sulfides	0	0	1.0000
S - Soluble sulfate	0	0	1.0000
S - Particulate elemental sulfur	1.0000	1.0000	1.0000
Precipitate - Ferrous sulfide	1.0000	1.0000	1.0000
CODp - Adsorbed hydrocarbon	1.0000	1.0000	1.0000

CODs - Degradable volatile ind. #1	0	0	1.0000
CODs - Degradable volatile ind. #2	0	0	1.0000
CODs - Degradable volatile ind. #3	0	0	1.0000
CODs - Soluble hydrocarbon	0	0	1.0000
Gas - Dissolved oxygen	0	0	1.0000

Steady state solution

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - F [mg/L]
Influent - BOD49	2.76	11.00	164.00	55.05	342.27	106.86
Anoxic 1	5.52	11.00	1278.58	7.15	3948.72	33.78
Anoxic 2	5.52	11.00	1276.83	3.77	3947.29	29.22
Swing	5.52	11.00	1273.24	2.04	3941.20	25.81
Aerobic 1	5.52	11.00	1254.63	1.28	3912.19	24.15
Model clarifier5	1.38	11.00	6.77	1.28	41.16	24.15
Model clarifier5 (U)	1.38	11.00	2501.75	1.28	7780.90	24.15
Model clarifier70	1.38	11.00	6.77	1.28	41.16	24.15

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - F [mg/L]
Model clarifier70 (U)	1.38	11.00	2501.75	1.28	7780.90	24.15
Effluent29	2.76	11.00	6.77	1.28	41.16	24.15

Elements	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Amm [mgN/L]
Influent - BOD49	186.00	166.00	7.10	2.00	28.00	20.59
Anoxic 1	3145.91	2762.77	6.76	1.98	235.72	8.20
Anoxic 2	3148.13	2764.97	6.78	2.04	235.72	8.38
Swing	3146.58	2763.09	6.66	1.95	235.17	7.50
Aerobic 1	3128.54	2743.82	6.44	1.46	231.96	3.57
Model clarifier5	13.68	12.00	6.44	1.46	5.69	3.57
Model clarifier5 (U)	6241.54	5474.00	6.44	1.46	458.09	3.57
Model clarifier70	13.68	12.00	6.44	1.46	5.69	3.57
Model clarifier70 (U)	6241.54	5474.00	6.44	1.46	458.09	3.57
Effluent29	13.68	12.00	6.44	1.46	5.69	3.57

Elements	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [l
Influent - BOD49	0	0	-----	-----	-----	-----
Anoxic 1	0.79	0.03	0	0	0	0
Anoxic 2	0.01	0.00	0	0	0	0
Swing	0.47	0.06	198.93	17.45	43.27	72.55
Aerobic 1	3.00	0.54	750.79	76.26	35.50	292.62
Model clarifier5	3.00	0.54	-----	-----	-----	-----
Model clarifier5 (U)	3.00	0.54	-----	-----	-----	-----
Model clarifier70	3.00	0.54	-----	-----	-----	-----
Model clarifier70 (U)	3.00	0.54	-----	-----	-----	-----
Effluent29	3.00	0.54	-----	-----	-----	-----

Elements	Alpha [[]]
Influent - BOD49	-----
Anoxic 1	0.50
Anoxic 2	0.50

Elements	Alpha [[]]
Swing	0.36
Aerobic 1	0.39
Model clarifier5	-----
Model clarifier5 (U)	-----
Model clarifier70	-----
Model clarifier70 (U)	-----
Effluent29	-----

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

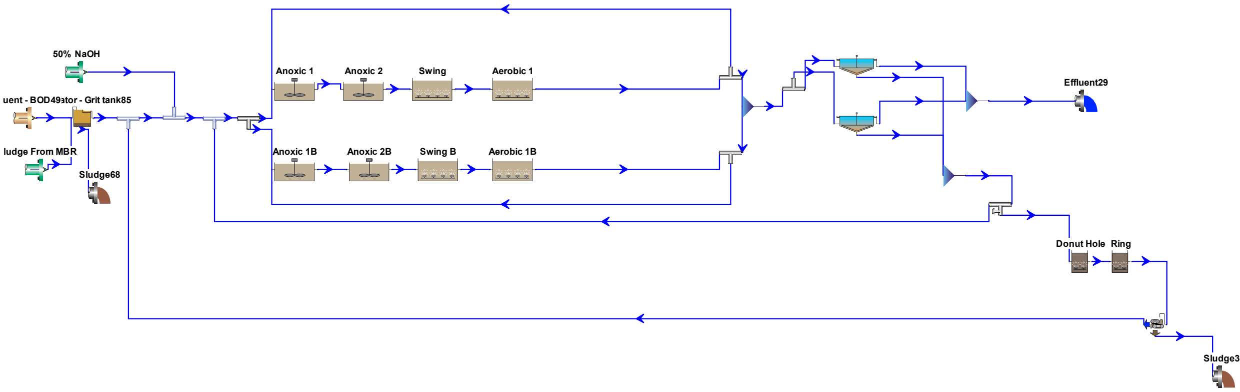
Created: 5/18/2018 Saved: 9/16/2020

Steady state solution

Target SRT: 6.00 days SRT #0: 5.99 days

Temperature: 22.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	0.94
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.50
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.6770
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220

Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	100.00 %
Splitter12	Flow paced	100.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0617499999485417
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH	Sludge From MBR
Biomass - Ordinary heterotrophic [mgCOD/L]	0	3337.76
Biomass - Methylotrophic [mgCOD/L]	0	1.70
Biomass - Ammonia oxidizing [mgCOD/L]	0	48.02
Biomass - Nitrite oxidizing [mgCOD/L]	0	28.69

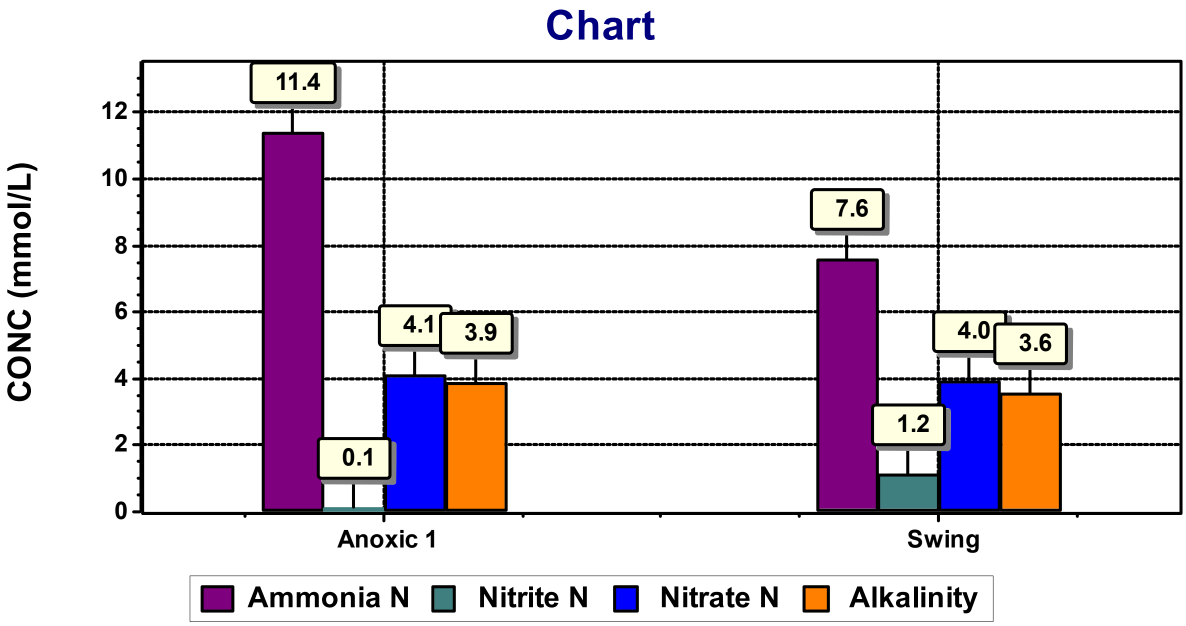
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0	2.36
Biomass - Phosphorus accumulating [mgCOD/L]	0	11.15
Biomass - Propionic acetogenic [mgCOD/L]	0	0.35
Biomass - Acetoclastic methanogenic [mgCOD/L]	0	0.30
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0	0.08
Biomass - Endogenous products [mgCOD/L]	0	2379.38
CODp - Slowly degradable particulate [mgCOD/L]	0	186.16
CODp - Slowly degradable colloidal [mgCOD/L]	0	0.02
CODp - Degradable external organics [mgCOD/L]	0	0
CODp - Undegradable non-cellulose [mgCOD/L]	0	1872.51
CODp - Undegradable cellulose [mgCOD/L]	0	1872.51
N - Particulate degradable organic [mgN/L]	0	8.06
P - Particulate degradable organic [mgP/L]	0	2.73
N - Particulate degradable external organics [mgN/L]	0	0
P - Particulate degradable external organics [mgP/L]	0	0
N - Particulate undegradable [mgN/L]	0	131.08
P - Particulate undegradable [mgP/L]	0	41.20
CODp - Stored PHA [mgCOD/L]	0	0.27
P - Releasable stored polyP [mgP/L]	0	3.62
P - Unreleasable stored polyP [mgP/L]	0	0.81
CODs - Complex readily degradable [mgCOD/L]	0	1.43
CODs - Acetate [mgCOD/L]	0	0
CODs - Propionate [mgCOD/L]	0	0
CODs - Methanol [mgCOD/L]	0	0
Gas - Dissolved hydrogen [mgCOD/L]	0	0.03
Gas - Dissolved methane [mg/L]	0	0
N - Ammonia [mgN/L]	0	0.15
N - Soluble degradable organic [mgN/L]	0	0.53
Gas - Dissolved nitrous oxide [mgN/L]	0	0
N - Nitrite [mgN/L]	0	0.07
N - Nitrate [mgN/L]	0	4.19
Gas - Dissolved nitrogen [mgN/L]	0	15.70
P - Soluble phosphate [mgP/L]	0	1.94
CODs - Undegradable [mgCOD/L]	0	47.53
N - Soluble undegradable organic [mgN/L]	0	0.80

Influent inorganic suspended solids [mgISS/L]	0	1314.50
Precipitate - Struvite [mgISS/L]	0	0
Precipitate - Brushite [mgISS/L]	0	0
Precipitate - Hydroxy - apatite [mgISS/L]	0	0
Precipitate - Vivianite [mgISS/L]	0	0
HFO - High surface [mg/L]	0	0
HFO - Low surface [mg/L]	0	0
HFO - High with H2PO4- adsorbed [mg/L]	0	0
HFO - Low with H2PO4- adsorbed [mg/L]	0	0
HFO - Aged [mg/L]	0	0
HFO - Low with H+ adsorbed [mg/L]	0	0
HFO - High with H+ adsorbed [mg/L]	0	0
HAO - High surface [mg/L]	0	0
HAO - Low surface [mg/L]	0	0
HAO - High with H2PO4- adsorbed [mg/L]	0	0
HAO - Low with H2PO4- adsorbed [mg/L]	0	0
HAO - Aged [mg/L]	0	0
P - Bound on aged HMO [mgP/L]	0	0
Metal soluble - Magnesium [mg/L]	0	14.64
Metal soluble - Calcium [mg/L]	0	81.20
Metal soluble - Ferric [mg/L]	0	0
Metal soluble - Ferrous [mg/L]	0	0
Metal soluble - Aluminum [mg/L]	0	0
Other Cations (strong bases) [meq/L]	12500.00	147.74
Other Anions (strong acids) [meq/L]	0	4.98
Gas - Dissolved total CO2 [mmol/L]	0	145.75
User defined - UD1 [mg/L]	0	0
User defined - UD2 [mg/L]	0	0
User defined - UD3 [mgVSS/L]	0	0
User defined - UD4 [mgISS/L]	0	0
Biomass - Sulfur oxidizing [mgCOD/L]	0	1.76
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0	2.22
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0	2.00
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0	1.47
Gas - Dissolved total sulfides [mgS/L]	0	0

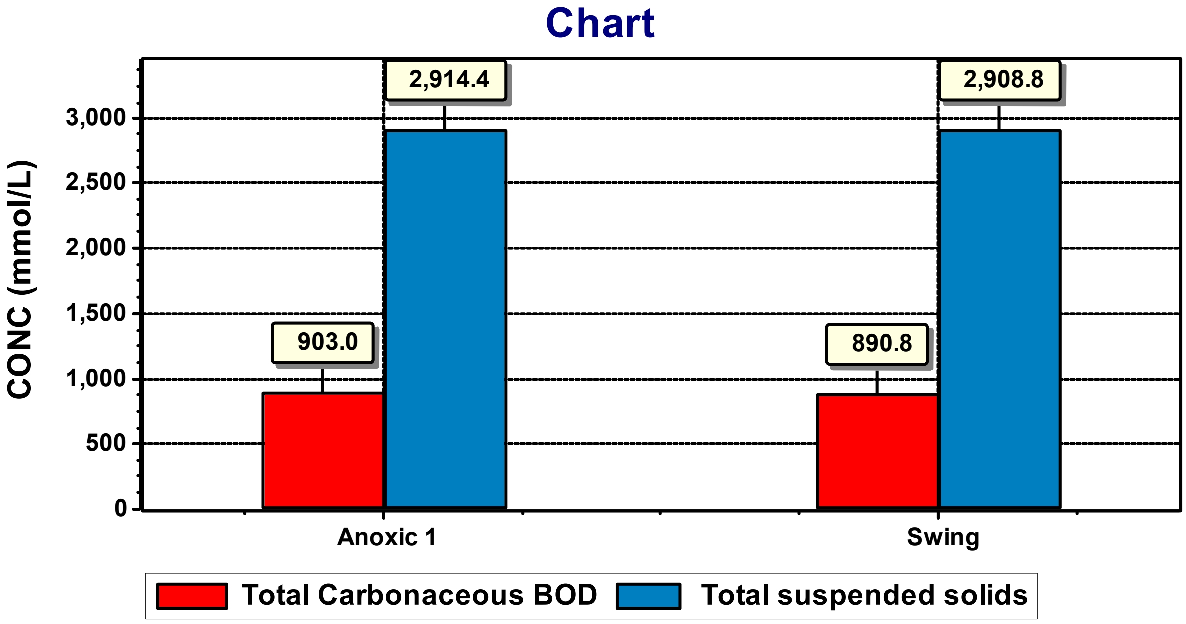
S - Soluble sulfate [mgS/L]	0	0
S - Particulate elemental sulfur [mgS/L]	0	0
Precipitate - Ferrous sulfide [mgISS/L]	0	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0	0
CODs - Soluble hydrocarbon [mgCOD/L]	0	0
Gas - Dissolved oxygen [mg/L]	0	2.00
Flow	0	0.0152

BioWin Album

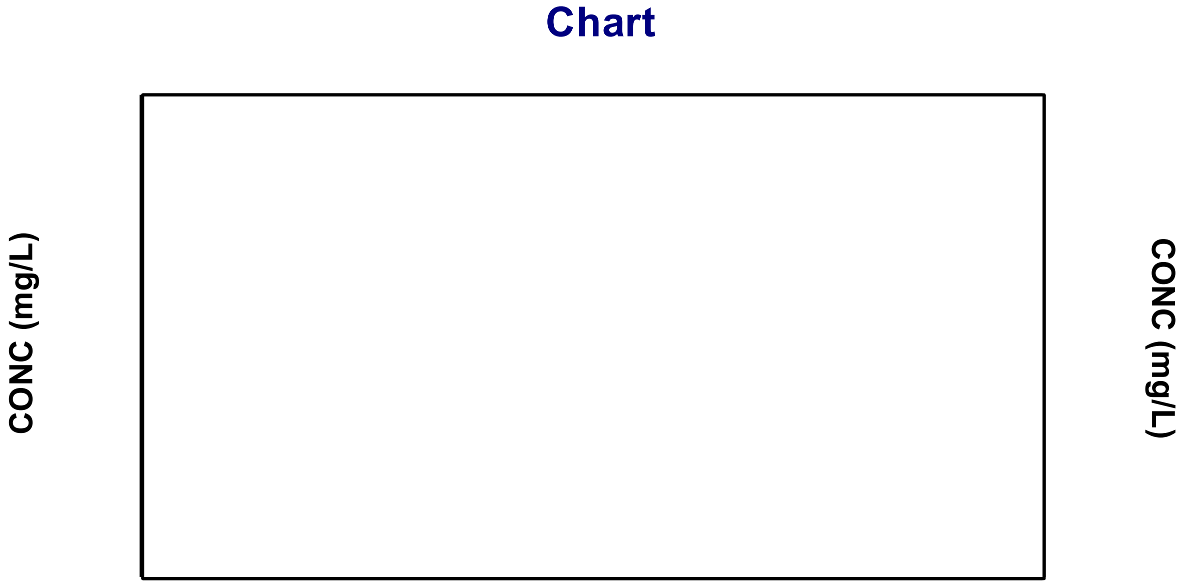
Album page - Nitrogen species



Album page - BOD_TSS



Album page - Page 3



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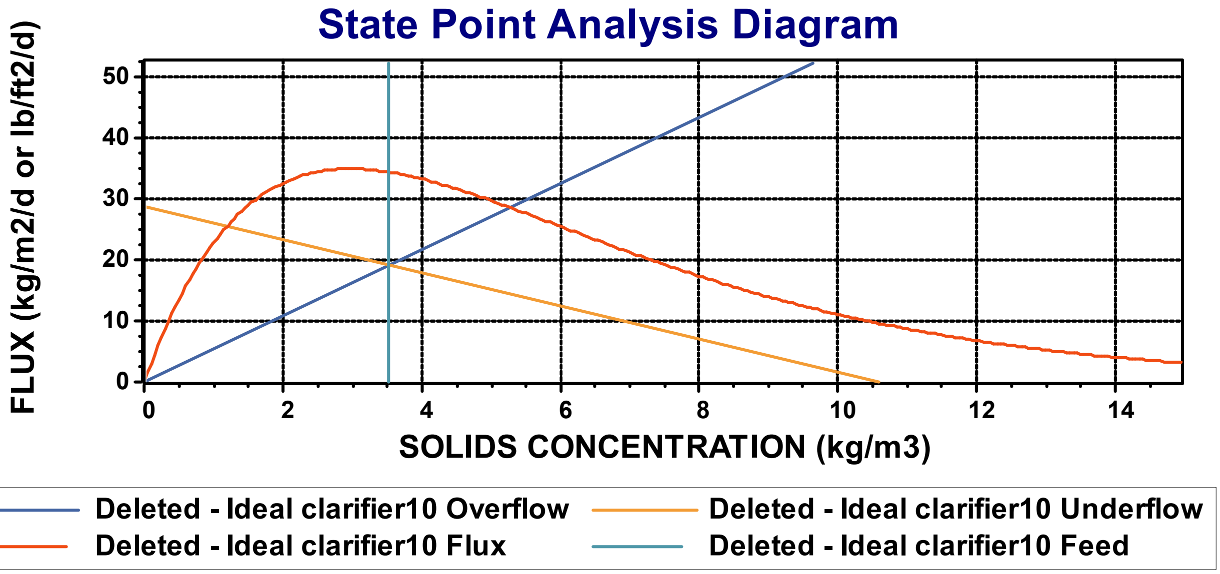
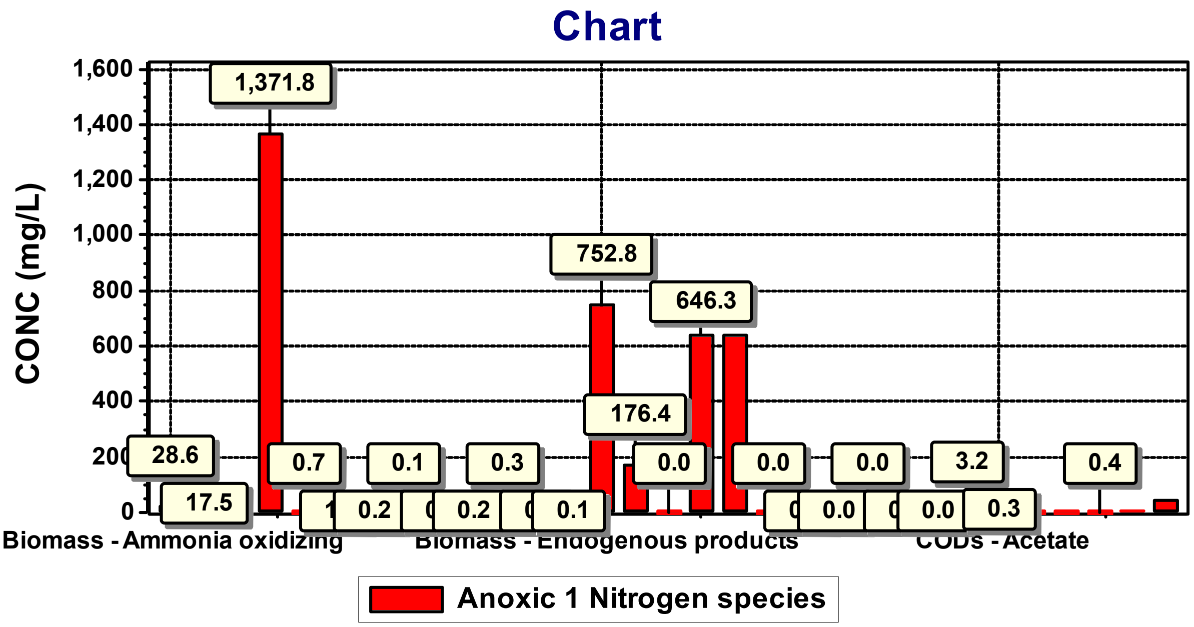
Album page - Page 5



K = 0.3362 m3/kg
Vo = 511.2 ft/d

Album page - Page 6



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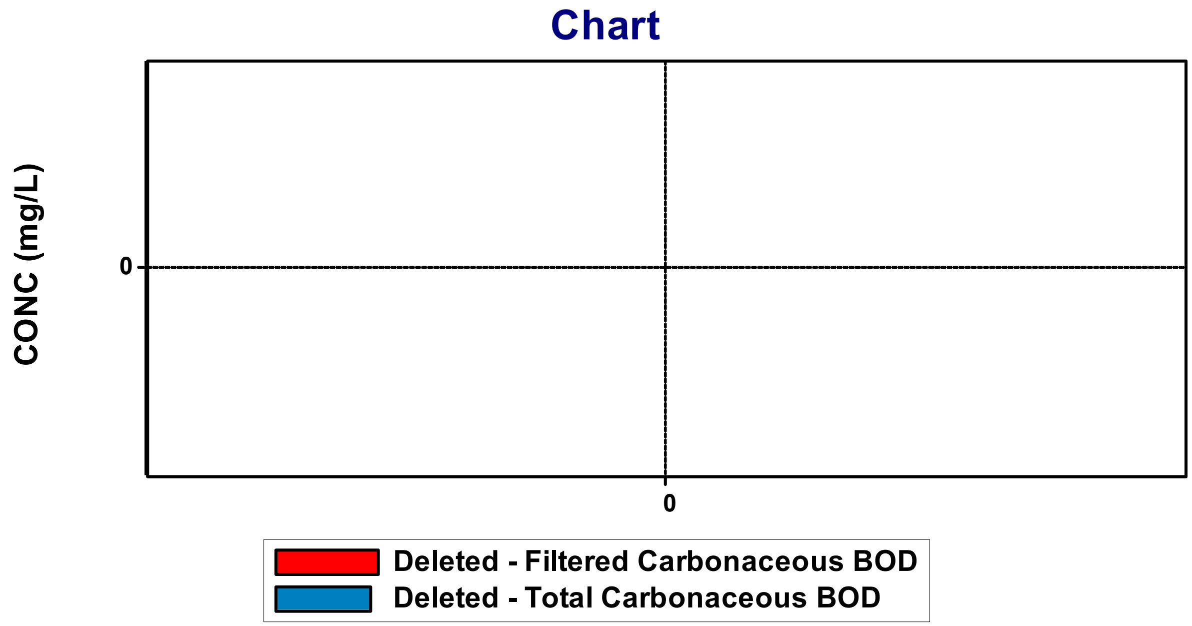

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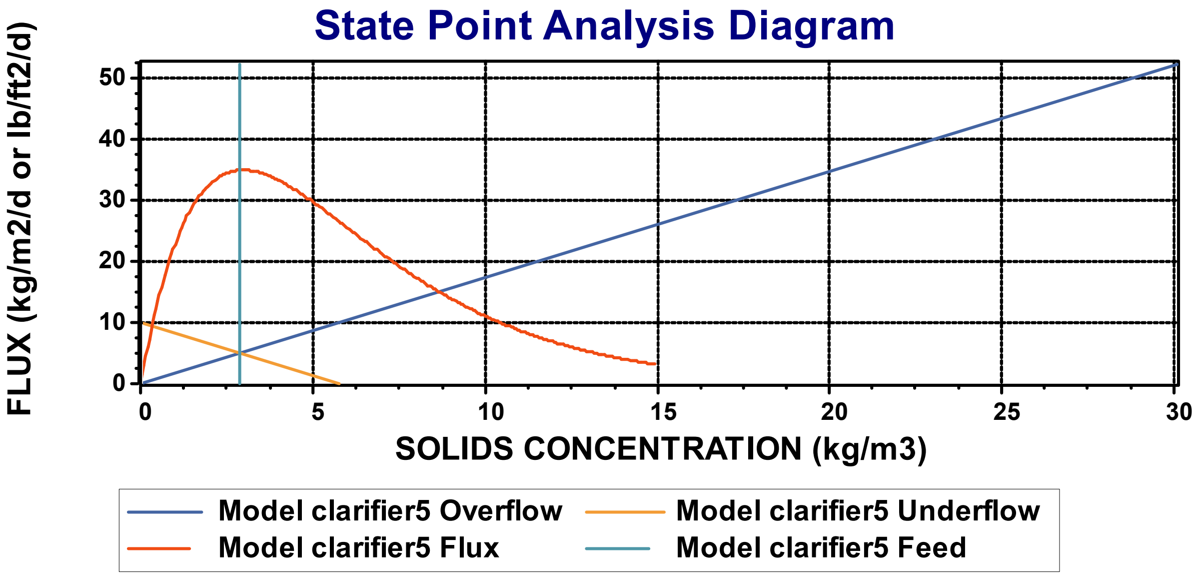

K = 0.3360 m3/kg
Vo = 511.2 ft/d

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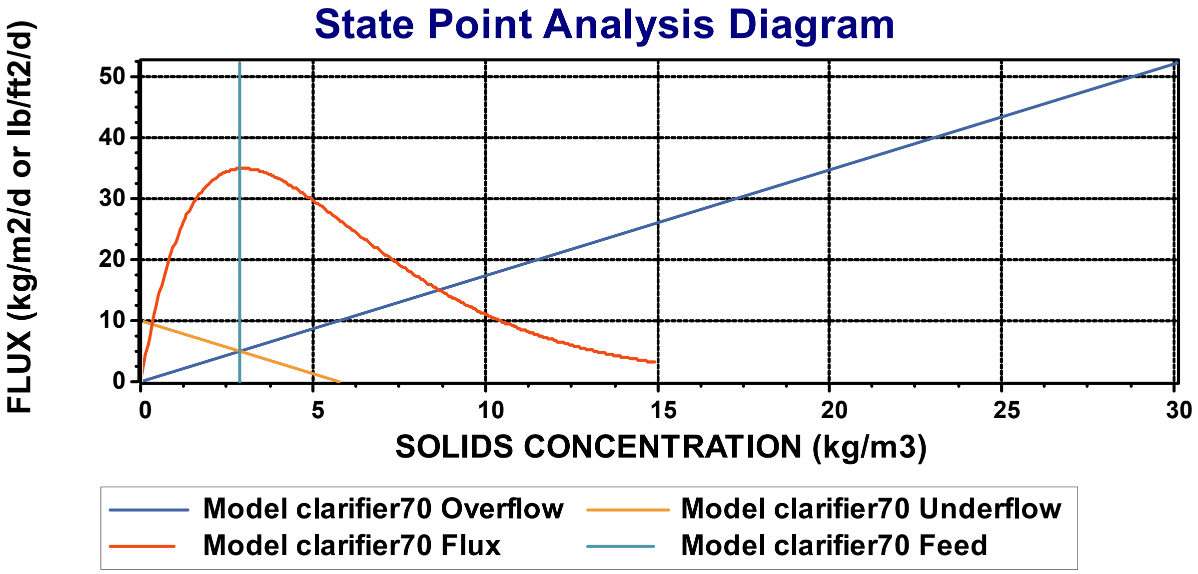

K = 0.3360 m3/kg
Vo = 511.2 ft/d

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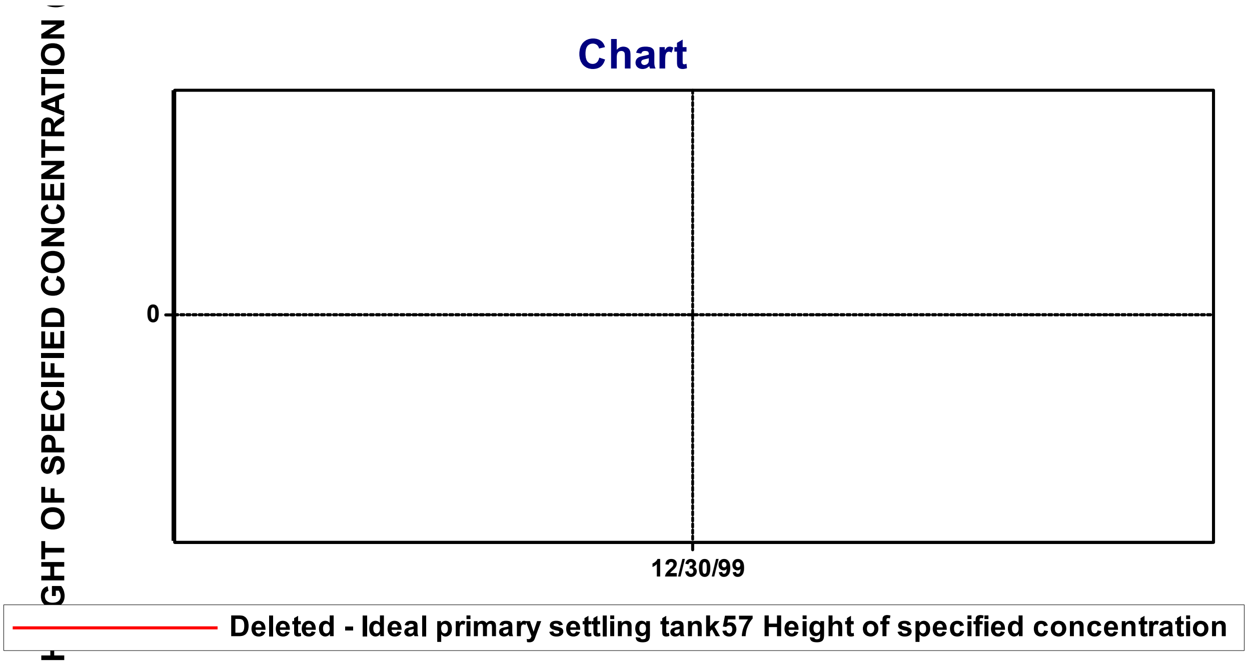

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Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.26
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.26

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Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	230.39
Aerobic 1	588.65
Anoxic 1B	0
Anoxic 2B	0
Swing B	230.39
Aerobic 1B	588.65

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	CODs - Complex readily degradable [mgCOD/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]
Influent - BOD49	0.94	22.00	349.96	159.83	730.36	302.19	88.38	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----	-----
Anoxic 1	1.89	22.00	903.01	7.36	3703.56	59.88	3.20	2914.37	2572.47	6.93	3.89	215.45	11.42	0.13	4.13	0	0	0	0	0.50
Anoxic 2	1.89	22.00	898.56	1.79	3697.34	50.98	0.93	2916.36	2574.36	6.95	4.05	215.45	11.54	0.11	1.97	0	0	0	0	0.50

Swing	1.89	22.00	890.78	1.67	3684.61	50.03	2.02	2908.77	2566.06	6.85	3.57	212.32	7.63	1.16	3.96	230.39	17.76	52.27	82.66	0.32
Aerobic 1	1.89	22.00	848.03	0.99	3619.89	48.91	1.39	2865.14	2521.28	6.71	2.56	205.09	0.32	0.12	11.77	588.65	63.98	29.78	235.77	0.41
Model clarifier5	0.48	22.00	2.06	0.99	53.41	48.91	1.39	3.61	3.18	6.71	2.56	2.31	0.32	0.12	11.77	-----	-----	-----	-----	-----
Model clarifier5 (U)	0.47	22.00	1705.77	0.99	7236.02	48.91	1.39	5766.50	5074.43	6.71	2.56	410.69	0.32	0.12	11.77	-----	-----	-----	-----	-----
Model clarifier70	0.48	22.00	2.06	0.99	53.41	48.91	1.39	3.61	3.18	6.71	2.56	2.31	0.32	0.12	11.77	-----	-----	-----	-----	-----
Model clarifier70 (U)	0.47	22.00	1705.77	0.99	7236.02	48.91	1.39	5766.50	5074.43	6.71	2.56	410.69	0.32	0.12	11.77	-----	-----	-----	-----	-----
Effluent29	0.95	22.00	2.06	0.99	53.41	48.91	1.39	3.61	3.18	6.71	2.56	2.31	0.32	0.12	11.77	-----	-----	-----	-----	-----

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----

Anoxic 1B	903.01	59.88	2914.37	2572.47	6.93	3.89	215.45	11.42	0.13	4.13	0	0	0	0
Anoxic 2B	898.56	50.98	2916.36	2574.36	6.95	4.05	215.45	11.54	0.11	1.97	0	0	0	0
Swing B	890.78	50.03	2908.77	2566.06	6.85	3.57	212.32	7.63	1.16	3.96	230.39	17.76	52.27	82.66
Aerobic 1B	848.03	48.91	2865.14	2521.28	6.71	2.56	205.09	0.32	0.12	11.77	588.65	63.98	29.78	235.77
Model clarifier5	2.06	48.91	3.61	3.18	6.71	2.56	2.31	0.32	0.12	11.77	-----	-----	-----	-----
Model clarifier5 (U)	1705.77	48.91	5766.50	5074.43	6.71	2.56	410.69	0.32	0.12	11.77	-----	-----	-----	-----
Model clarifier70	2.06	48.91	3.61	3.18	6.71	2.56	2.31	0.32	0.12	11.77	-----	-----	-----	-----
Model clarifier70 (U)	1705.77	48.91	5766.50	5074.43	6.71	2.56	410.69	0.32	0.12	11.77	-----	-----	-----	-----
Effluent29	2.06	48.91	3.61	3.18	6.71	2.56	2.31	0.32	0.12	11.77	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000

Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000

Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000

Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290

H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000

Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000

Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000

Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220

Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220

Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927

Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000

CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000
H2S [M/Atm]	1.0000E-1	1.0000E-1	2200.0000
Ind 1 [M/Atm]	1.9000E+3	1.9000E+3	7300.0000
Ind 2 [M/Atm]	1.8000E-1	1.8000E-1	2200.0000
Ind 3 [M/Atm]	1.5000E-1	1.5000E-1	1900.0000

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

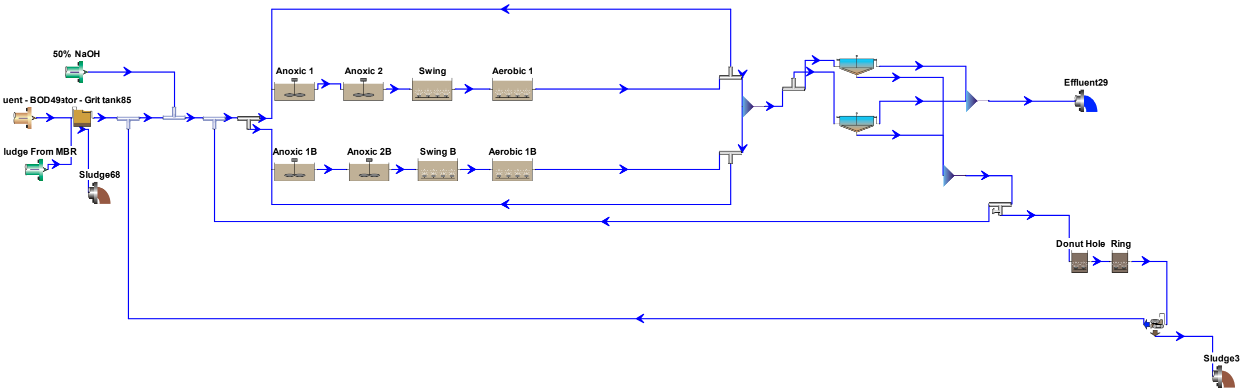
Created: 5/18/2018 Saved: 9/16/2020

Steady state solution

Target SRT: 6.00 days SRT #0: 6.00 days

Temperature: 11.0°C

Flowsheet



Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	363

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated

Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.2574	1903.1735	18.080	431
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.78
BOD - Total Carbonaceous mgBOD/L	179.04
Volatile suspended solids mg/L	188.00
Total suspended solids mg/L	202.79
N - Total Kjeldahl Nitrogen mgN/L	30.00
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8750
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650

Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.02

Element name	Percent removal
Separator - Dewatering unit83	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	100.00 %
Splitter12	Flow paced	100.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0617499999485417
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

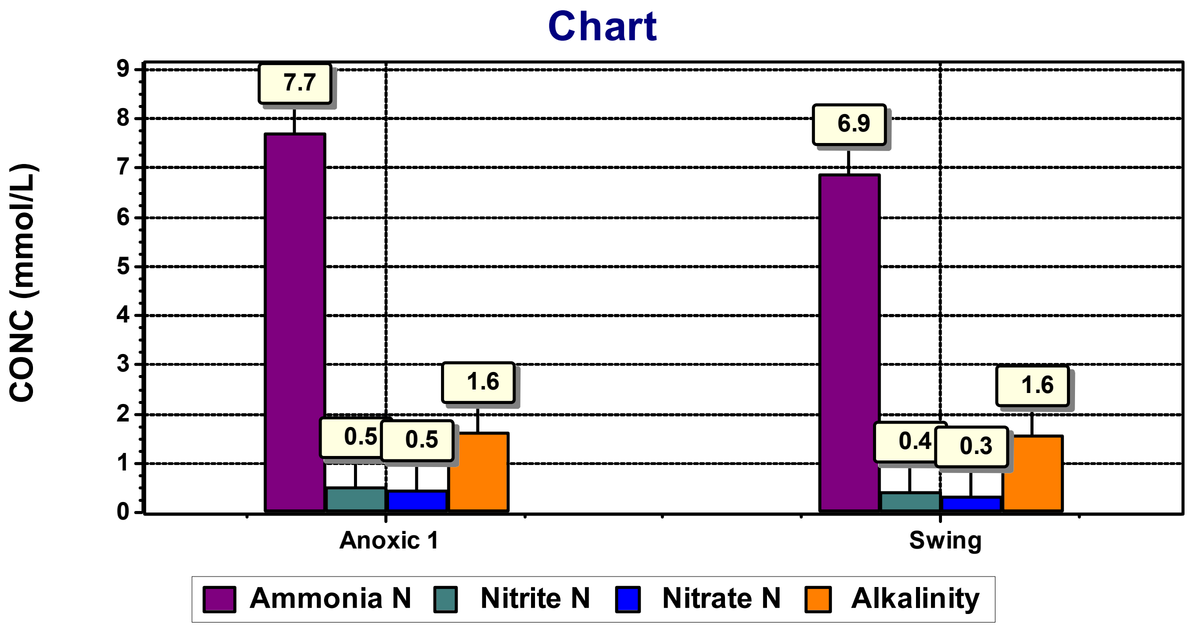
Element name	50% NaOH	Sludge From MBR
Biomass - Ordinary heterotrophic [mgCOD/L]	0	4118.29
Biomass - Methylotrophic [mgCOD/L]	0	1.92
Biomass - Ammonia oxidizing [mgCOD/L]	0	51.22
Biomass - Nitrite oxidizing [mgCOD/L]	0	28.63
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0	2.37
Biomass - Phosphorus accumulating [mgCOD/L]	0	5.40
Biomass - Propionic acetogenic [mgCOD/L]	0	0.45
Biomass - Acetoclastic methanogenic [mgCOD/L]	0	0.39
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0	0.10
Biomass - Endogenous products [mgCOD/L]	0	2142.58
CODp - Slowly degradable particulate [mgCOD/L]	0	243.55
CODp - Slowly degradable colloidal [mgCOD/L]	0	0.04
CODp - Degradable external organics [mgCOD/L]	0	0
CODp - Undegradable non-cellulose [mgCOD/L]	0	1819.21
CODp - Undegradable cellulose [mgCOD/L]	0	1819.21
N - Particulate degradable organic [mgN/L]	0	10.25
P - Particulate degradable organic [mgP/L]	0	4.22
N - Particulate degradable external organics [mgN/L]	0	0
P - Particulate degradable external organics [mgP/L]	0	0
N - Particulate undegradable [mgN/L]	0	127.35
P - Particulate undegradable [mgP/L]	0	40.02
CODp - Stored PHA [mgCOD/L]	0	0.11
P - Releasable stored polyP [mgP/L]	0	1.74
P - Unreleasable stored polyP [mgP/L]	0	0.35
CODs - Complex readily degradable [mgCOD/L]	0	1.41
CODs - Acetate [mgCOD/L]	0	0
CODs - Propionate [mgCOD/L]	0	0
CODs - Methanol [mgCOD/L]	0	0
Gas - Dissolved hydrogen [mgCOD/L]	0	0.08
Gas - Dissolved methane [mg/L]	0	0
N - Ammonia [mgN/L]	0	1.12
N - Soluble degradable organic [mgN/L]	0	0.51
Gas - Dissolved nitrous oxide [mgN/L]	0	0

N - Nitrite [mgN/L]	0	0.34
N - Nitrate [mgN/L]	0	1.29
Gas - Dissolved nitrogen [mgN/L]	0	18.83
P - Soluble phosphate [mgP/L]	0	3.91
CODs - Undegradable [mgCOD/L]	0	24.30
N - Soluble undegradable organic [mgN/L]	0	0.42
Influent inorganic suspended solids [mgISS/L]	0	1499.26
Precipitate - Struvite [mgISS/L]	0	0
Precipitate - Brushite [mgISS/L]	0	0
Precipitate - Hydroxy - apatite [mgISS/L]	0	0
Precipitate - Vivianite [mgISS/L]	0	0
HFO - High surface [mg/L]	0	0
HFO - Low surface [mg/L]	0	0
HFO - High with H2PO4- adsorbed [mg/L]	0	0
HFO - Low with H2PO4- adsorbed [mg/L]	0	0
HFO - Aged [mg/L]	0	0
HFO - Low with H+ adsorbed [mg/L]	0	0
HFO - High with H+ adsorbed [mg/L]	0	0
HAO - High surface [mg/L]	0	0
HAO - Low surface [mg/L]	0	0
HAO - High with H2PO4- adsorbed [mg/L]	0	0
HAO - Low with H2PO4- adsorbed [mg/L]	0	0
HAO - Aged [mg/L]	0	0
P - Bound on aged HMO [mgP/L]	0	0
Metal soluble - Magnesium [mg/L]	0	14.79
Metal soluble - Calcium [mg/L]	0	80.58
Metal soluble - Ferric [mg/L]	0	0
Metal soluble - Ferrous [mg/L]	0	0
Metal soluble - Aluminum [mg/L]	0	0
Other Cations (strong bases) [meq/L]	12500.00	4.96
Other Anions (strong acids) [meq/L]	0	9.17
Gas - Dissolved total CO2 [mmol/L]	0	2.14
User defined - UD1 [mg/L]	0	0
User defined - UD2 [mg/L]	0	0
User defined - UD3 [mgVSS/L]	0	0

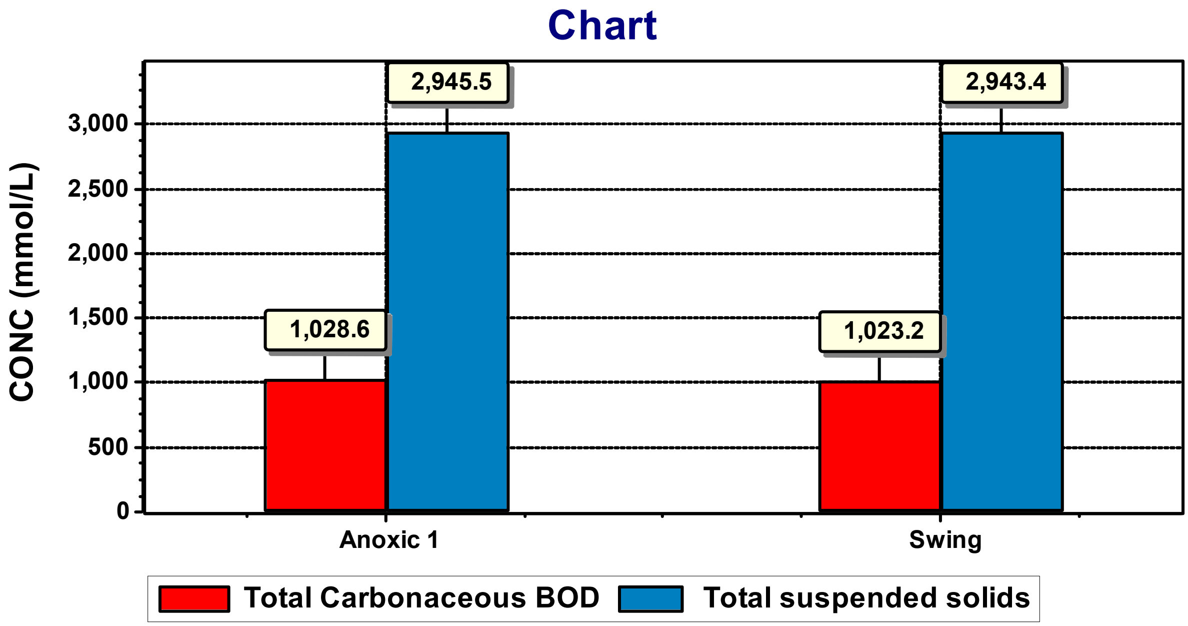
User defined - UD4 [mgISS/L]	0	0
Biomass - Sulfur oxidizing [mgCOD/L]	0	1.91
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0	2.33
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0	2.15
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0	1.69
Gas - Dissolved total sulfides [mgS/L]	0	0
S - Soluble sulfate [mgS/L]	0	0
S - Particulate elemental sulfur [mgS/L]	0	0
Precipitate - Ferrous sulfide [mgISS/L]	0	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0	0
CODs - Soluble hydrocarbon [mgCOD/L]	0	0
Gas - Dissolved oxygen [mg/L]	0	2.00
Flow	0.0001	0.0152

BioWin Album

Album page - Nitrogen species

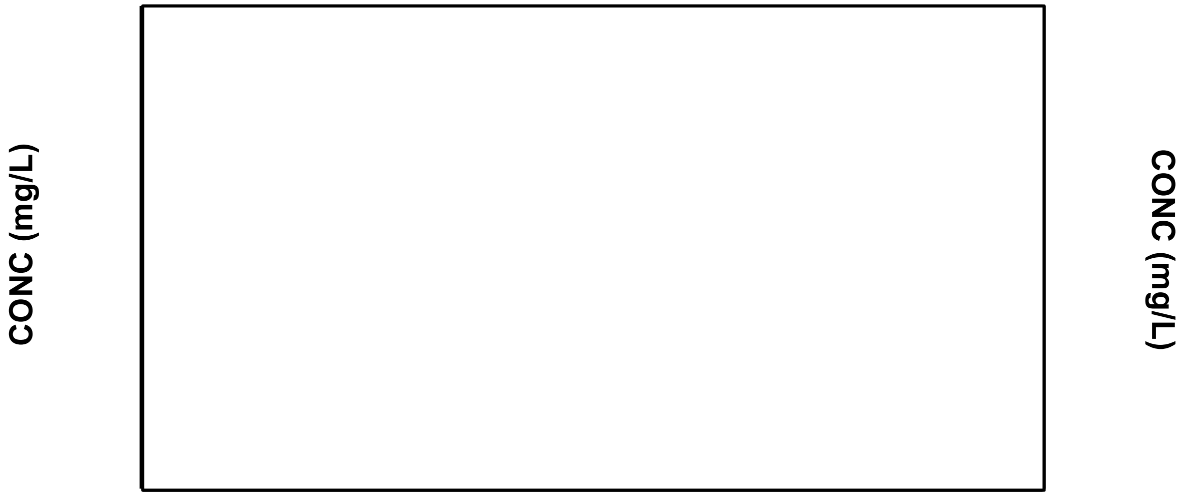


Album page - BOD_TSS



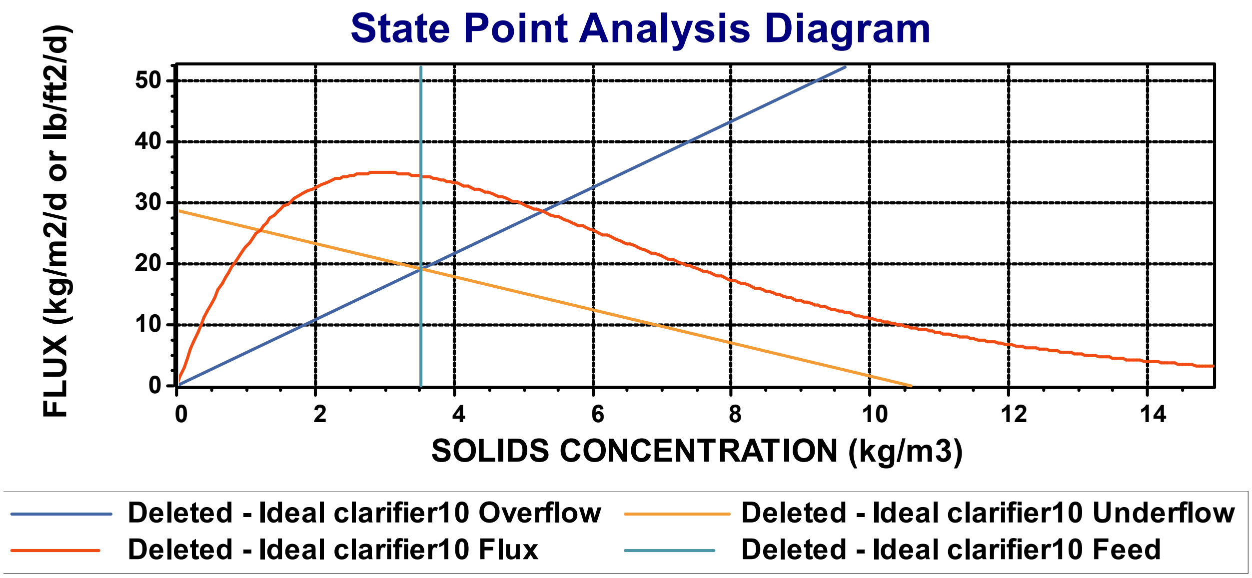
Album page - Page 3

Chart



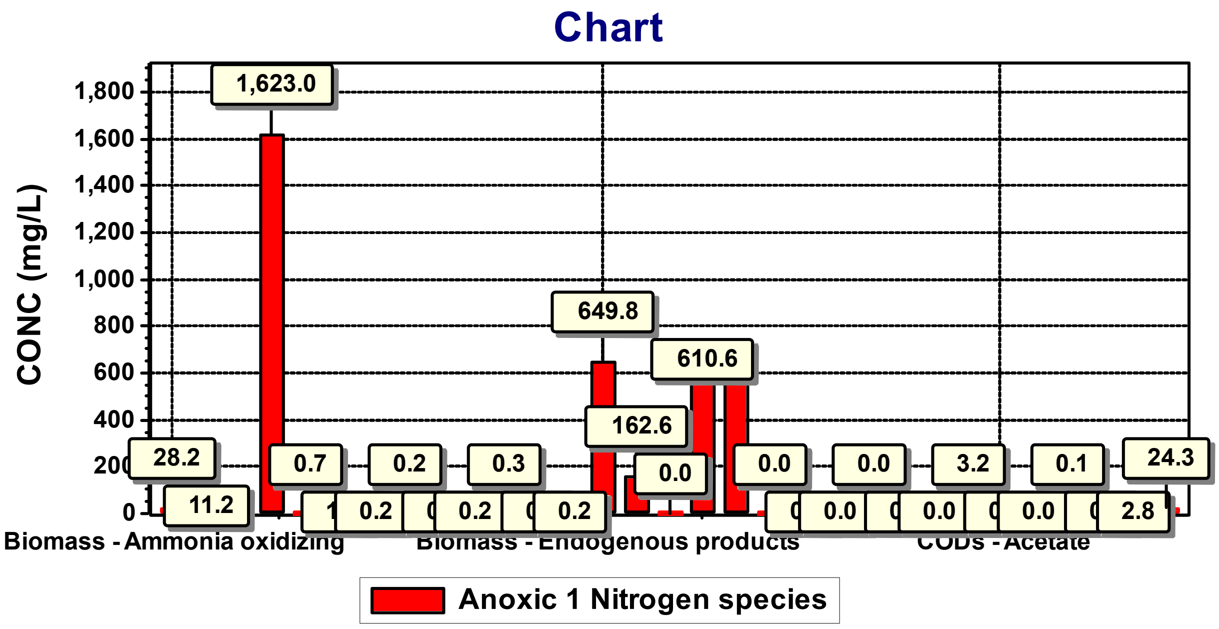
Album page - Page 4

Album page - Page 5

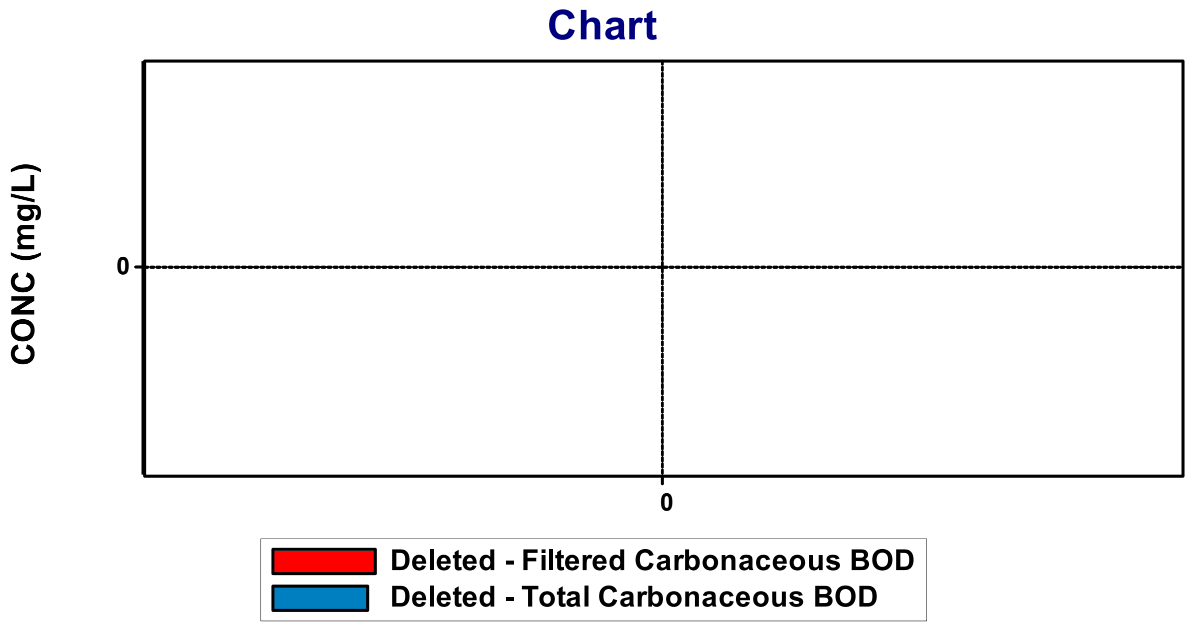


K = 0.3362 m3/kg
Vo = 511.2 ft/d

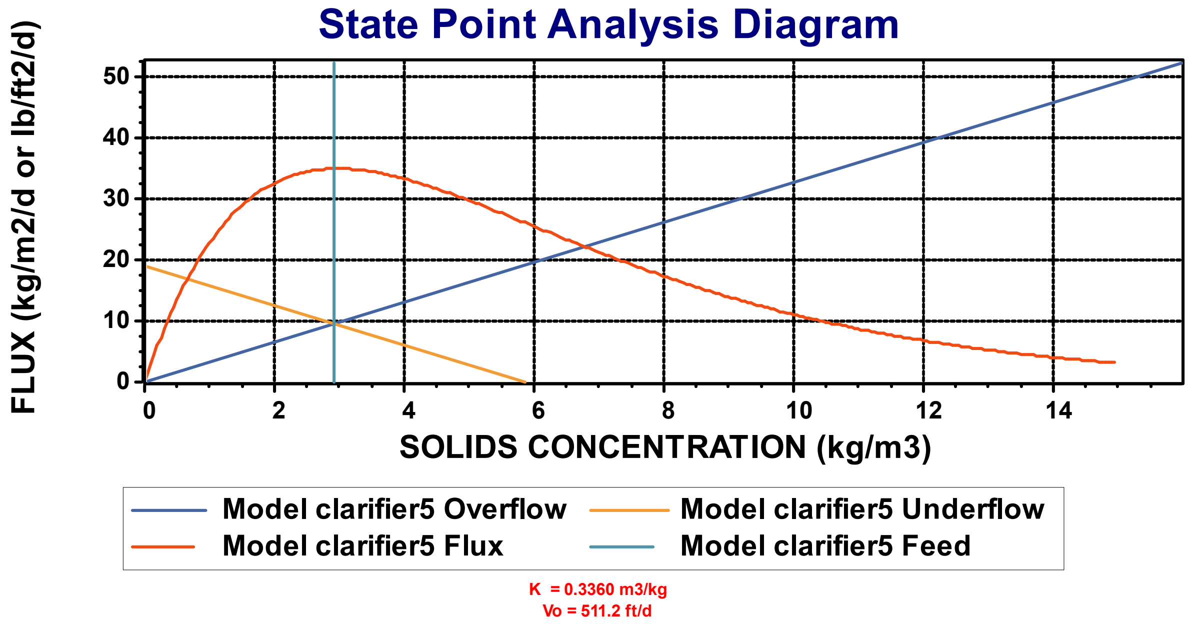
Album page - Page 6



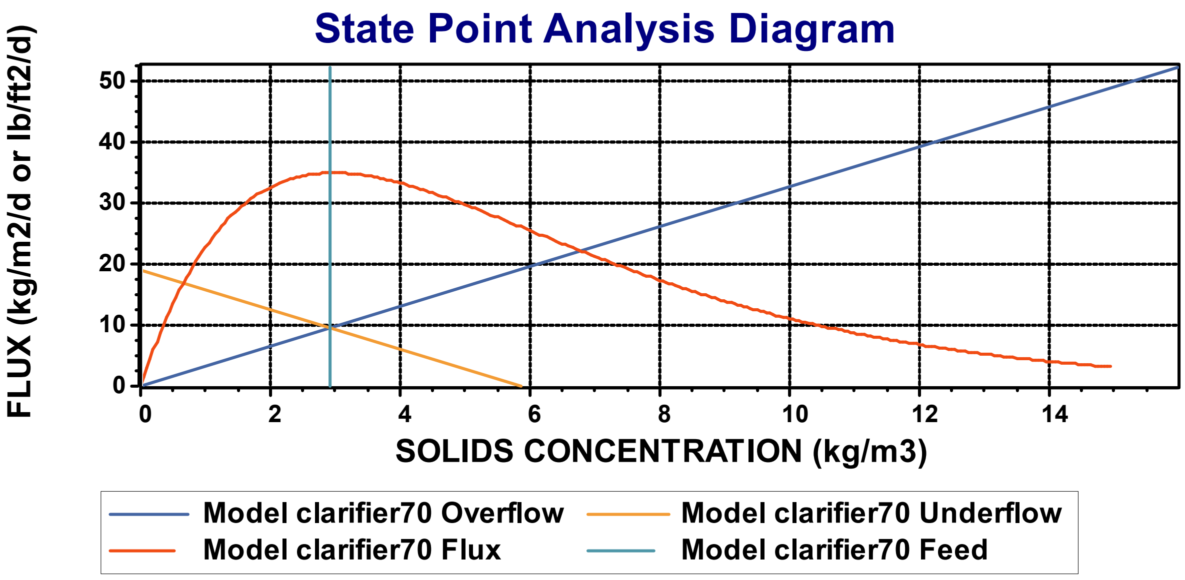
Album page - Page 7



Album page - Page 8

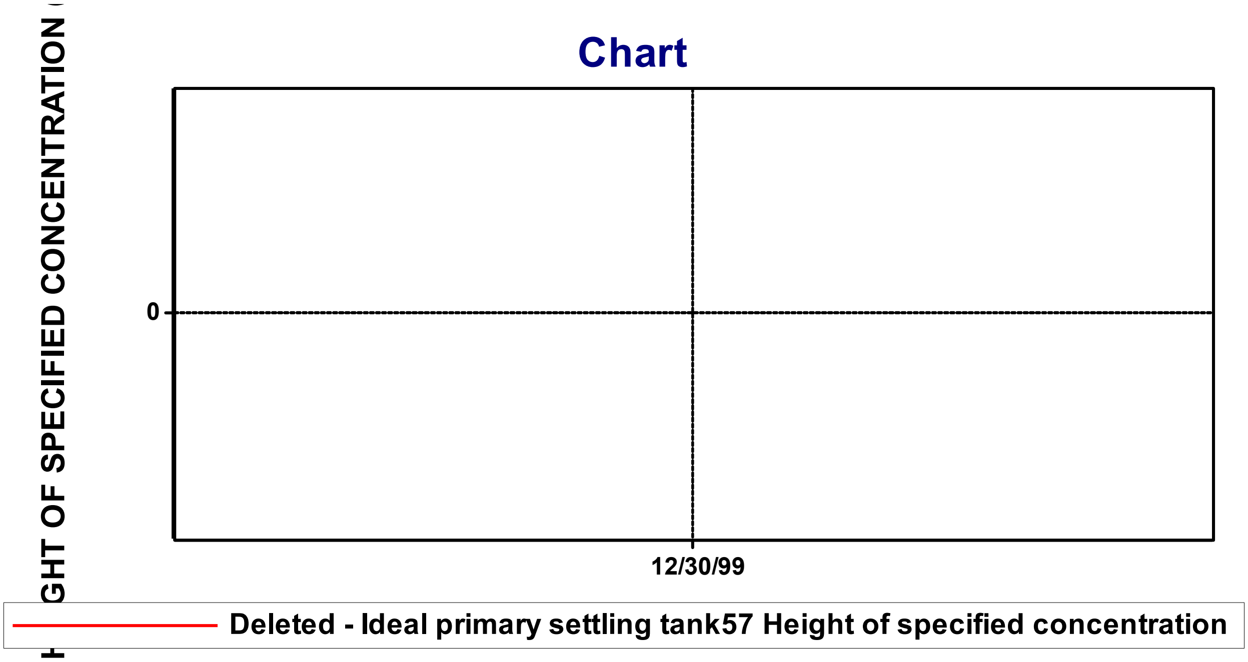


Album page - Page 9



K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 10



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Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.26
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.26

Album page - Page 13

Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	119.25
Aerobic 1	504.87
Anoxic 1B	0
Anoxic 2B	0
Swing B	119.25
Aerobic 1B	504.87

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	CODs - Complex readily degradable [mgCOD/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Airflow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]
Influent - BOD49	1.78	11.00	179.02	54.58	373.61	107.00	45.21	202.79	188.00	7.10	2.00	30.00	22.06	0	0	-----	-----	-----	-----	-----
Anoxic 1	3.57	11.00	1028.62	4.35	3731.17	31.54	3.17	2945.52	2611.51	6.65	1.64	219.04	7.73	0.53	0.45	0	0	0	0	0.50
Anoxic 2	3.57	11.00	1026.62	1.47	3729.12	27.64	0.53	2946.85	2612.82	6.68	1.71	219.04	7.91	0.04	0.04	0	0	0	0	0.50
Swing	3.57	11.00	1023.23	1.52	3723.08	26.91	1.76	2943.36	2609.08	6.55	1.60	218.33	6.89	0.43	0.33	119.25	12.45	31.70	46.06	0.40
Aerobic 1	3.57	11.00	1001.91	1.13	3690.18	25.94	1.58	2921.93	2586.59	6.28	1.02	214.47	2.49	1.86	2.51	504.87	59.34	27.62	205.72	0.43
Model clarifier5	0.90	11.00	3.72	1.13	35.41	25.94	1.58	7.55	6.68	6.28	1.02	4.19	2.49	1.86	2.51	-----	-----	-----	-----	-----
Model clarifier5 (U)	0.89	11.00	2007.84	1.13	7373.29	25.94	1.58	5858.91	5186.51	6.28	1.02	426.37	2.49	1.86	2.51	-----	-----	-----	-----	-----
Model clarifier70	0.90	11.00	3.72	1.13	35.41	25.94	1.58	7.55	6.68	6.28	1.02	4.19	2.49	1.86	2.51	-----	-----	-----	-----	-----

Model clarifier70 (U)	0.89	11.00	2007.84	1.13	7373.29	25.94	1.58	5858.91	5186.51	6.28	1.02	426.37	2.49	1.86	2.51	-----	-----	-----	-----	-----
Effluent29	1.79	11.00	3.72	1.13	35.41	25.94	1.58	7.55	6.68	6.28	1.02	4.19	2.49	1.86	2.51	-----	-----	-----	-----	-----

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD49	179.02	107.00	202.79	188.00	7.10	2.00	30.00	22.06	0	0	-----	-----	-----	-----
Anoxic 1B	1028.62	31.54	2945.52	2611.51	6.65	1.64	219.04	7.73	0.53	0.45	0	0	0	0
Anoxic 2B	1026.62	27.64	2946.85	2612.82	6.68	1.71	219.04	7.91	0.04	0.04	0	0	0	0
Swing B	1023.23	26.91	2943.36	2609.08	6.55	1.60	218.33	6.89	0.43	0.33	119.25	12.45	31.70	46.06
Aerobic 1B	1001.91	25.94	2921.93	2586.59	6.28	1.02	214.47	2.49	1.86	2.51	504.87	59.34	27.62	205.72
Model clarifier5	3.72	25.94	7.55	6.68	6.28	1.02	4.19	2.49	1.86	2.51	-----	-----	-----	-----
Model clarifier5 (U)	2007.84	25.94	5858.91	5186.51	6.28	1.02	426.37	2.49	1.86	2.51	-----	-----	-----	-----
Model clarifier70	3.72	25.94	7.55	6.68	6.28	1.02	4.19	2.49	1.86	2.51	-----	-----	-----	-----

Model clarifier70 (U)	2007.84	25.94	5858.91	5186.51	6.28	1.02	426.37	2.49	1.86	2.51	-----	-----	-----	-----
Effluent29	3.72	25.94	7.55	6.68	6.28	1.02	4.19	2.49	1.86	2.51	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000

Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290

Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000

Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000

Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700

P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400

COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500

Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800

H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3

BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240

Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000
H2S [M/Atm]	1.0000E-1	1.0000E-1	2200.0000
Ind 1 [M/Atm]	1.9000E+3	1.9000E+3	7300.0000
Ind 2 [M/Atm]	1.8000E-1	1.8000E-1	2200.0000
Ind 3 [M/Atm]	1.5000E-1	1.5000E-1	1900.0000

Properties constants

Name	Default	Value
K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7

A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2000	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1734.0000	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5000	-39.4800

Metal salt solution densities

Name	Default	Value
Ferric chloride solution density [kg/m3]	3820.0000	3820.0000
Ferric sulfate solution density [kg/m3]	4800.0000	4800.0000
Ferrous chloride solution density [kg/m3]	3160.0000	3160.0000
Ferrous sulfate solution density [kg/m3]	1150.0000	1150.0000
Aluminum sulfate solution density [kg/m3]	1950.0000	1950.0000
Aluminum chloride solution density [kg/m3]	2480.0000	2480.0000

Mineral precipitation rates

Name	Default	Value	
Vivianite precipitation rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite redissolution rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite half sat. [mgTSS/L]	0.0100	0.0100	1.0000
FeS precipitation rate [L/(mol d)]	1000.0000	1000.0000	1.0240
FeS redissolution rate [L/(mol d)]	10.0000	10.0000	1.0240
FeS half sat. [mgTSS/L]	0.1000	0.1000	1.0000
Struvite precipitation rate [L^2/(mol^2 d)]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [L^2/(mol^2 d)]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
Brushite precipitation rate [L/(mol d)]	1.000E+6	1.000E+6	1.0000
Brushite redissolution rate [L/(mol d)]	10000.0000	10000.0000	1.0000
Brushite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HAP precipitation rate [g/d]	5.000E-4	5.000E-4	1.0000

Mineral precipitation constants

Name	Default	Value
Vivianite solubility product [mol/L]^5	1.710E-36	1.710E-36
FeS solubility product [mol/L]^2	4.258E-4	4.258E-4
Struvite solubility product [mol/L]^3	6.918E-14	6.918E-14
Brushite solubility product [mol/L]^2	2.490E-7	2.490E-7

Fe rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HFO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HFO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HFO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	2.000E-11	2.000E-11	1.0000
H+ competition for HFO(H) protonation sites [L/(mmol . d)]	1000.0000	1000.0000	1.0000
H+ competition for HFO(L) protonation sites [L/(mmol . d)]	100.0000	100.0000	1.0000

Fe constants

Name	Default	Value
Ferric active site factor(high) [{mol Sites}/{mol HFO(H)}]	4.0000	2.0000
Ferric active site factor(low) [{mol Sites}/{mol HFO(L)}]	2.4000	1.2000
H+ competition level for Fe(OH)3 [mol/L]	7.000E-7	7.000E-7
Equilibrium constant for FeOH3-H2PO4- [{mf HFO(H).H2PO4}/({mol H2PO4-}{mf HFO(H)}^2)]	2.000E-9	2.000E-9

Colloidal COD removed with Ferric [gCOD/Fe active site]	80.0000	130.0000
Minimum residual P level with iron addition [mgP/L]	0.0150	0.0150
HFO(H) with H2PO4- P release factor	10000.0000	10000.0000
HFO(L) with H2PO4- P release factor	10000.0000	10000.0000

Fe RedOx rates

Name	Default	Value	
Iron reduction using acetic acid	1.000E-7	1.000E-7	1.0000
Half Sat. acetic acid	0.5000	0.5000	1.0000
Iron reduction using propionic acid	1.000E-7	1.000E-7	1.0000
Half Sat. propionic acid	0.5000	0.5000	1.0000
Iron reduction using dissolved hydrogen gas	1.000E-7	1.000E-7	1.0000
Half Sat. dissolved hydrogen gas	0.5000	0.5000	1.0000
Iron reduction using hydrogen sulfide	5.000E-5	5.000E-5	1.0000
Half Sat. hydrogen sulfide	0.5000	0.5000	1.0000
Iron oxidation rate (aerobic)	1.000E-3	1.000E-3	1.0000
Abiotic iron reduction using acetic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using propionic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using dissolved hydrogen gas	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using hydrogen sulfide	2.000E-5	2.000E-5	1.0000
Abiotic iron oxidation rate (aerobic)	1.0000	1.0000	1.0000

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

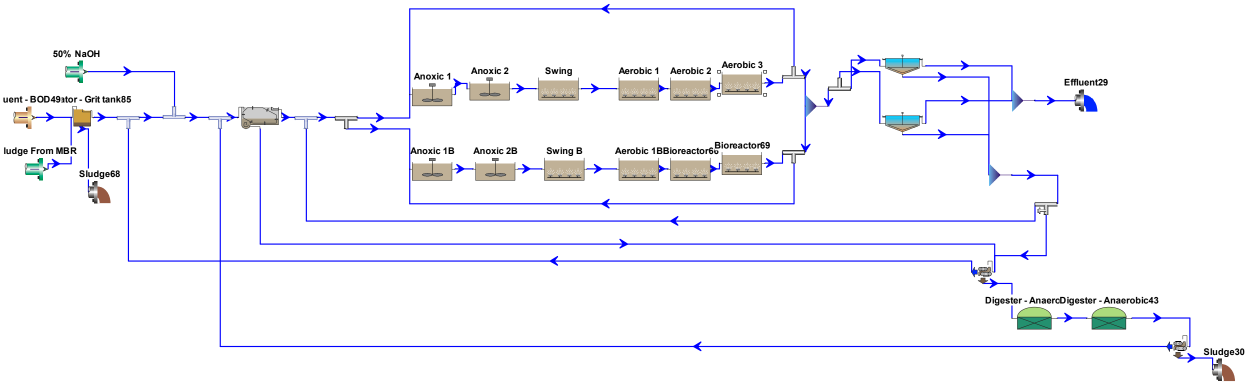
Created: 5/18/2018 Saved: 9/16/2020

Steady state solution

Target SRT: 7.00 days SRT #0: 6.96 days

Temperature: 22.0°C

Flowsheet



Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Settler - Ideal primary46	0.3723	3318.0000	15.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Settler - Ideal primary46	Flowrate [Under]	0.0164

Element name	Percent removal	Blanket fraction
Settler - Ideal primary46	45.00	0.10

Configuration information for all Digester - Anaerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	Head space volume
Digester - Anaerobic37	0.2500	1671.0070	20.000	0.1
Digester - Anaerobic43	0.4470	3734.7007	16.000	0.1

Operating data Average (flow/time weighted as required)

Element name	Pressure [psi]	pH
Digester - Anaerobic37	14.9	-
Digester - Anaerobic43	14.9	-

Element name	Average Temperature
Digester - Anaerobic37	35.0
Digester - Anaerobic43	35.0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.0858	634.3912	18.080	144
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.0858	634.3912	18.080	144
Aerobic 2	0.0858	634.3912	18.080	144
Bioreactor66	0.0858	634.3912	18.080	144
Aerobic 3	0.0858	634.3912	18.080	144
Bioreactor69	0.0858	634.3912	18.080	144

Operating data Average (flow/time weighted as required)

Aeration equipment parameters

Element name	k1 in C = k1(PC)^0.25 + k2	k2 in C = k1(PC)^0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor66	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 3	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor69	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.21
BOD - Total Carbonaceous mgBOD/L	339.38
Volatile suspended solids mg/L	303.90
Total suspended solids mg/L	327.14
N - Total Kjeldahl Nitrogen mgN/L	56.50

P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.7115
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4

FZsra - Sulfur reducing acetotrophic COD fraction	[gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction	[gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction	[gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.11
Separator - Dewatering unit48	Fraction	0.17

Element name	Percent removal
Separator - Dewatering unit83	90.00
Separator - Dewatering unit48	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	100.00 %
Splitter12	Flow paced	100.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0529285713907653
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

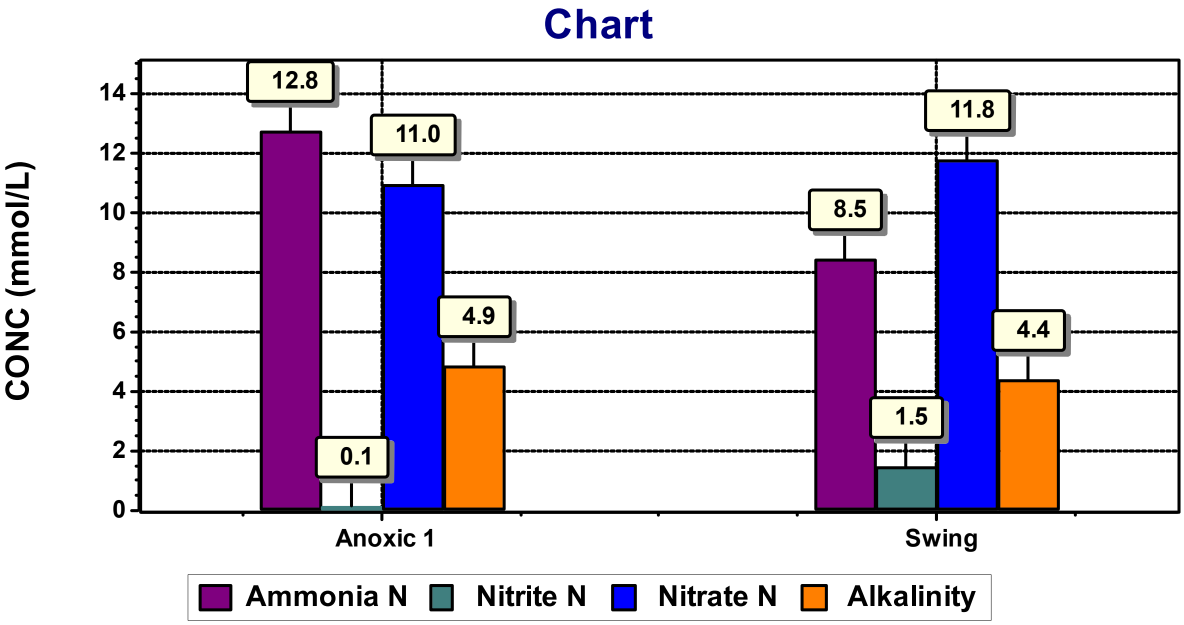
Operating data Average (flow/time weighted as required)

Element name	50% NaOH	Sludge From MBR
Biomass - Ordinary heterotrophic [mgCOD/L]	0	3337.76
Biomass - Methylotrophic [mgCOD/L]	0	1.70
Biomass - Ammonia oxidizing [mgCOD/L]	0	48.02
Biomass - Nitrite oxidizing [mgCOD/L]	0	28.69
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0	2.36
Biomass - Phosphorus accumulating [mgCOD/L]	0	11.15
Biomass - Propionic acetogenic [mgCOD/L]	0	0.35
Biomass - Acetoclastic methanogenic [mgCOD/L]	0	0.30
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0	0.08
Biomass - Endogenous products [mgCOD/L]	0	2379.38
CODp - Slowly degradable particulate [mgCOD/L]	0	186.16
CODp - Slowly degradable colloidal [mgCOD/L]	0	0.02
CODp - Degradable external organics [mgCOD/L]	0	0
CODp - Undegradable non-cellulose [mgCOD/L]	0	1872.51
CODp - Undegradable cellulose [mgCOD/L]	0	1872.51

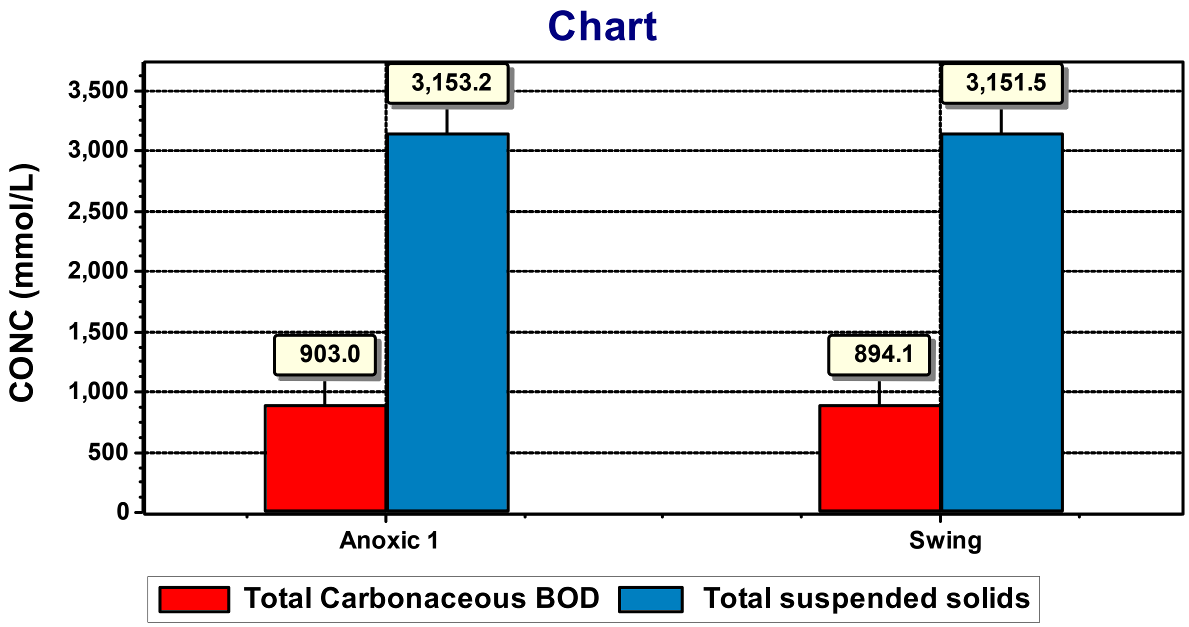
N - Particulate degradable organic [mgN/L]	0	8.06
P - Particulate degradable organic [mgP/L]	0	2.73
N - Particulate degradable external organics [mgN/L]	0	0
P - Particulate degradable external organics [mgP/L]	0	0
N - Particulate undegradable [mgN/L]	0	131.08
P - Particulate undegradable [mgP/L]	0	41.20
CODp - Stored PHA [mgCOD/L]	0	0.27
P - Releasable stored polyP [mgP/L]	0	3.62
P - Unreleasable stored polyP [mgP/L]	0	0.81
CODs - Complex readily degradable [mgCOD/L]	0	1.43
CODs - Acetate [mgCOD/L]	0	0
CODs - Propionate [mgCOD/L]	0	0
CODs - Methanol [mgCOD/L]	0	0
Gas - Dissolved hydrogen [mgCOD/L]	0	0.03
Gas - Dissolved methane [mg/L]	0	0
N - Ammonia [mgN/L]	0	0.15
N - Soluble degradable organic [mgN/L]	0	0.53
Gas - Dissolved nitrous oxide [mgN/L]	0	0
N - Nitrite [mgN/L]	0	0.07
N - Nitrate [mgN/L]	0	4.19
Gas - Dissolved nitrogen [mgN/L]	0	15.70
P - Soluble phosphate [mgP/L]	0	1.94
CODs - Undegradable [mgCOD/L]	0	47.53
N - Soluble undegradable organic [mgN/L]	0	0.80
Influent inorganic suspended solids [mgISS/L]	0	1314.50
Precipitate - Struvite [mgISS/L]	0	0
Precipitate - Brushite [mgISS/L]	0	0
Precipitate - Hydroxy - apatite [mgISS/L]	0	0
Precipitate - Vivianite [mgISS/L]	0	0
HFO - High surface [mg/L]	0	0
HFO - Low surface [mg/L]	0	0
HFO - High with H2PO4- adsorbed [mg/L]	0	0
HFO - Low with H2PO4- adsorbed [mg/L]	0	0
HFO - Aged [mg/L]	0	0
HFO - Low with H+ adsorbed [mg/L]	0	0

HFO - High with H+ adsorbed [mg/L]	0	0
HAO - High surface [mg/L]	0	0
HAO - Low surface [mg/L]	0	0
HAO - High with H2PO4- adsorbed [mg/L]	0	0
HAO - Low with H2PO4- adsorbed [mg/L]	0	0
HAO - Aged [mg/L]	0	0
P - Bound on aged HMO [mgP/L]	0	0
Metal soluble - Magnesium [mg/L]	0	14.64
Metal soluble - Calcium [mg/L]	0	81.20
Metal soluble - Ferric [mg/L]	0	0
Metal soluble - Ferrous [mg/L]	0	0
Metal soluble - Aluminum [mg/L]	0	0
Other Cations (strong bases) [meq/L]	12500.00	147.74
Other Anions (strong acids) [meq/L]	0	4.98
Gas - Dissolved total CO2 [mmol/L]	0	145.75
User defined - UD1 [mg/L]	0	0
User defined - UD2 [mg/L]	0	0
User defined - UD3 [mgVSS/L]	0	0
User defined - UD4 [mgISS/L]	0	0
Biomass - Sulfur oxidizing [mgCOD/L]	0	1.76
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0	2.22
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0	2.00
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0	1.47
Gas - Dissolved total sulfides [mgS/L]	0	0
S - Soluble sulfate [mgS/L]	0	0
S - Particulate elemental sulfur [mgS/L]	0	0
Precipitate - Ferrous sulfide [mgISS/L]	0	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0	0
CODs - Soluble hydrocarbon [mgCOD/L]	0	0
Gas - Dissolved oxygen [mg/L]	0	2.00
Flow	0	0.0304

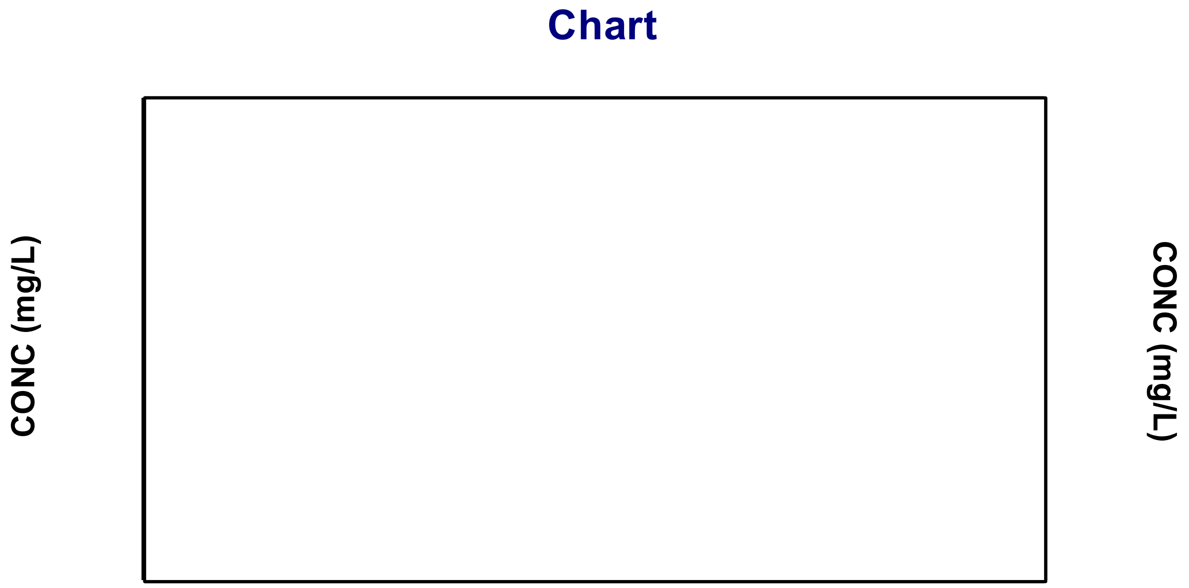
Album page - Nitrogen species



Album page - BOD_TSS

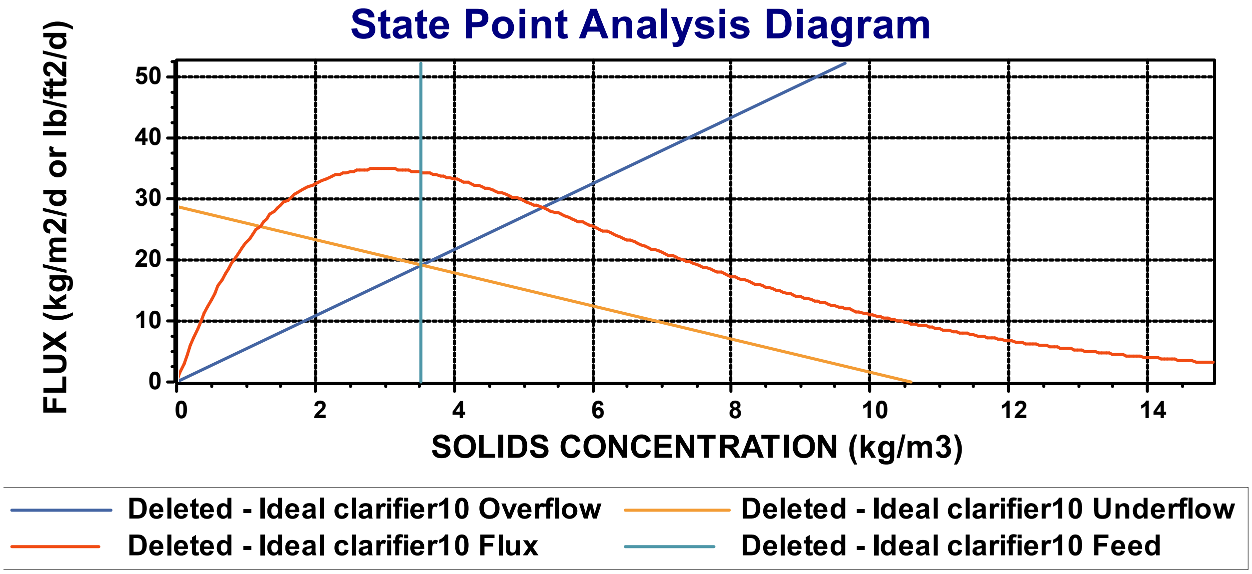


Album page - Page 3



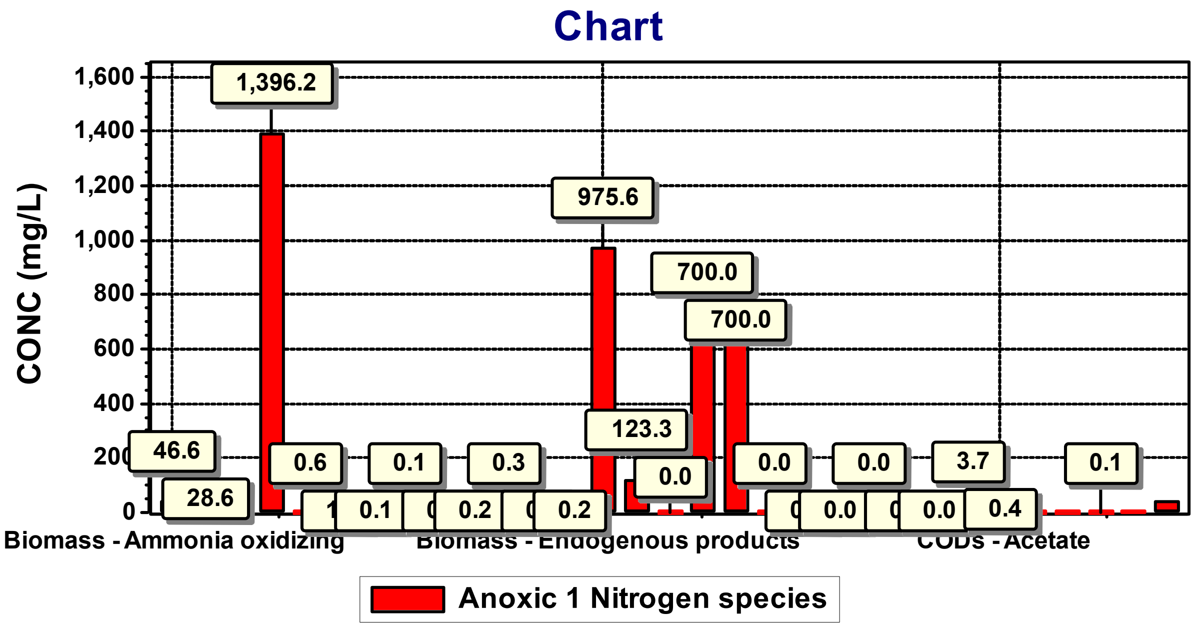
Album page - Page 4

Album page - Page 5

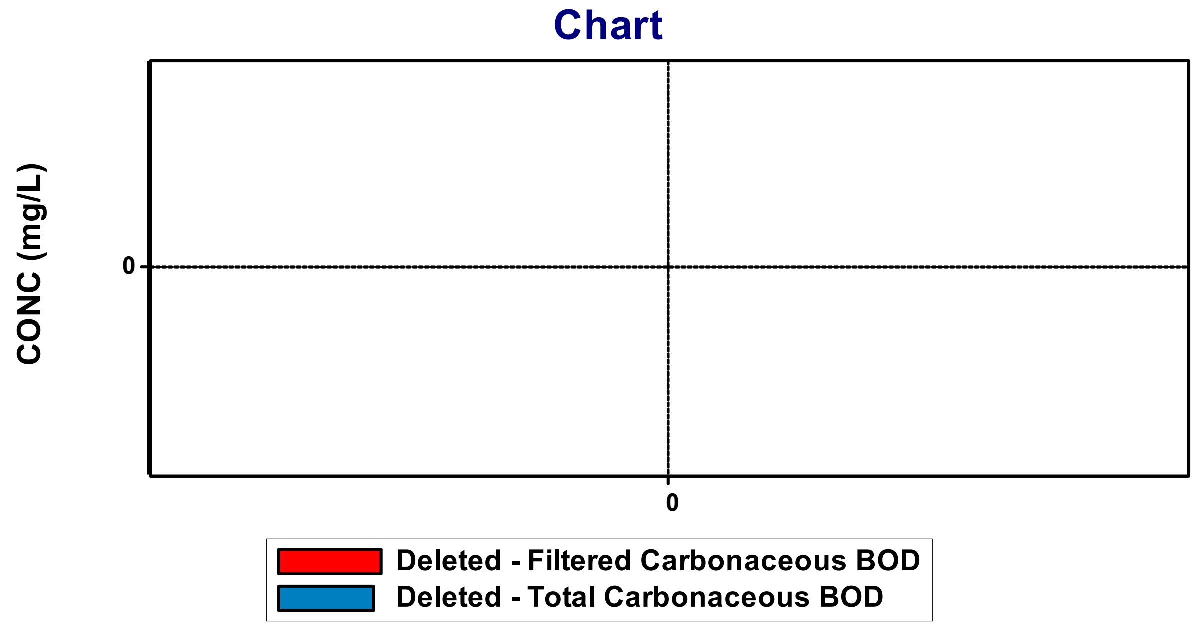


K = 0.3362 m3/kg
Vo = 511.2 ft/d

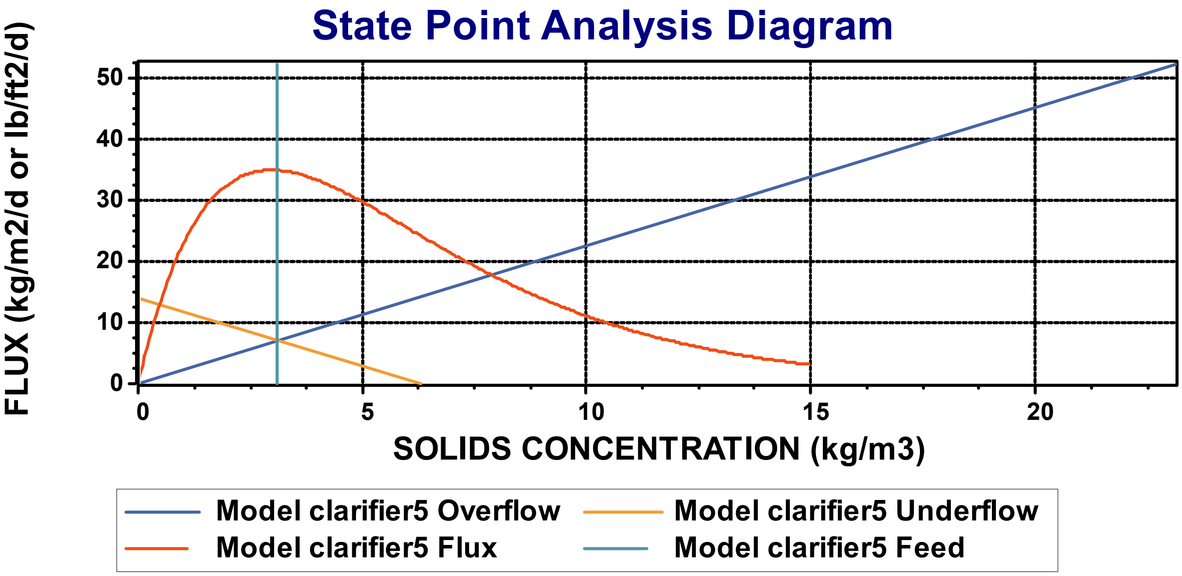
Album page - Page 6



Album page - Page 7

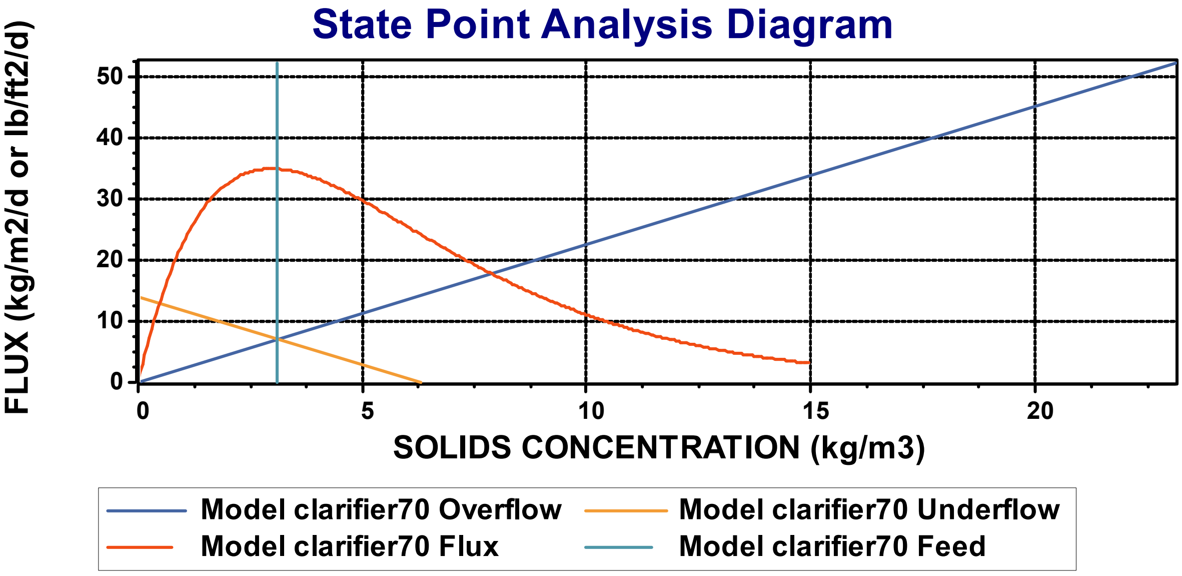


Album page - Page 8



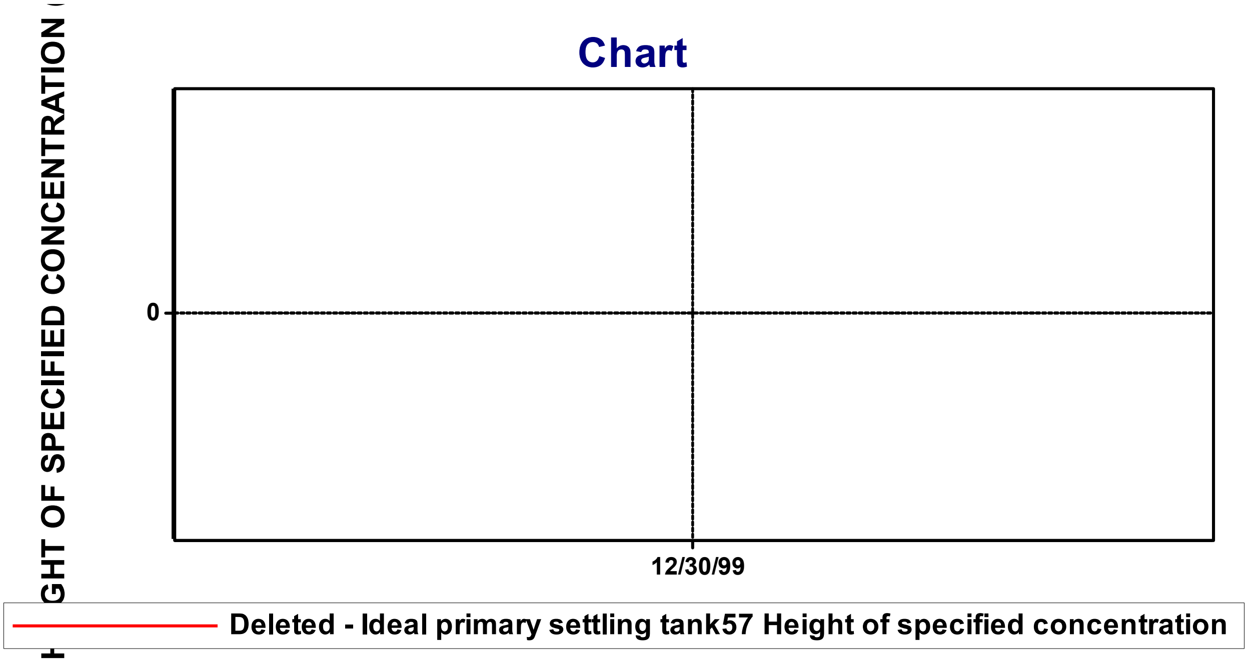
K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 9



K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 10



Album page - Page 11

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.09
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.09

Album page - Page 13

Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	334.58
Aerobic 1	504.54
Anoxic 1B	0
Anoxic 2B	0
Swing B	334.57
Aerobic 1B	406.46

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	Temperature [deg. C]	COD - Total [mg/L]	COD - Filtered [mg/L]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]
Influent - BOD49	1.21	22.00	708.19	277.31	339.34	146.00	327.14	303.90	7.10	4.00	56.50	41.54	0	0	-----	-----	-----	-----	-----
Settler - Ideal primary46	1.29	22.00	665.48	262.86	272.65	136.69	305.89	284.13	7.38	8.01	67.57	47.61	0.00	0.87	-----	-----	-----	-----	-----
Settler - Ideal	0.02	22.00	26209.62	262.86	8899.09	136.69	19712.80	18310.65	7.38	8.01	976.35	47.61	0.00	0.87	-----	-----	-----	-----	-----

primary46 (U)																		
Anoxic 1	2.43	22.00	4033.22	58.75	903.01	7.66	3153.22	2805.97	7.03	4.87	238.99	12.79	0.13	10.99	0	0	0	0	0.50
Anoxic 2	2.43	22.00	4028.11	49.54	899.30	1.94	3156.20	2808.85	7.05	5.01	238.99	12.96	0.16	9.19	0	0	0	0	0.50
Swing	2.43	22.00	4019.79	48.39	894.06	1.50	3151.55	2803.80	6.94	4.42	234.99	8.47	1.48	11.80	334.58	22.59	66.41	115.12	0.29
Aerobic 1	2.43	22.00	4002.58	47.70	882.67	1.11	3140.53	2792.17	6.82	3.45	228.40	1.41	1.77	17.96	504.54	39.42	55.05	181.80	0.33
Aerobic 2	2.43	22.00	3986.21	47.47	871.81	0.96	3129.31	2780.80	6.81	3.27	227.04	0.12	0.09	20.89	183.01	20.44	28.54	73.87	0.42
Aerobic 3	2.43	22.00	3970.93	47.35	861.64	0.87	3118.44	2770.13	6.81	3.23	226.56	0.05	0.01	21.36	116.06	14.66	20.47	49.30	0.45
Model clarifier5	0.62	22.00	53.50	47.35	2.22	0.87	4.89	4.34	6.81	3.23	2.10	0.05	0.01	21.36	-----	-----	-----	-----	-----
Model clarifier5 (U)	0.60	22.00	7981.71	47.35	1741.54	0.87	6306.17	5601.82	6.81	3.23	456.38	0.05	0.01	21.36	-----	-----	-----	-----	-----
Model clarifier70	0.62	22.00	53.50	47.35	2.22	0.87	4.89	4.34	6.81	3.23	2.10	0.05	0.01	21.36	-----	-----	-----	-----	-----
Model clarifier70 (U)	0.60	22.00	7981.71	47.35	1741.54	0.87	6306.17	5601.82	6.81	3.23	456.38	0.05	0.01	21.36	-----	-----	-----	-----	-----
Effluent29	1.24	22.00	53.50	47.35	2.22	0.87	4.89	4.34	6.81	3.23	2.10	0.05	0.01	21.36	-----	-----	-----	-----	-----
Digester - An	0.01	35.00	5894	259.04	2855.28	77.71	4691	4148	7.24	113.97	4477.96	1465.85	0.00	0.00	-----	-----	-----	-----	-----

aerobic37			1.32				5.20	2.88										
Digester - Anaerobic43	0.01	35.00	55193.92	130.70	301.35	18.72	44069.12	38934.24	7.38	132.70	4477.96	1716.79	0.00	0.00	-----	-----	-----	-----	-----
Separator - Dewatering unit48	0.01	22.00	6725.10	130.70	52.57	18.72	5277.74	4662.78	7.50	132.59	2048.91	1716.79	0.00	0.00	-----	-----	-----	-----	-----
Separator - Dewatering unit48 (U)	0.00	22.00	300475.51	130.70	1560.32	18.72	240377.02	212368.59	7.50	132.59	16770.43	1716.79	0.00	0.00	-----	-----	-----	-----	-----
Separator - Dewatering unit83	0.06	22.00	1474.77	98.33	416.94	33.00	1069.70	971.57	6.99	4.36	77.75	11.30	0.01	16.51	-----	-----	-----	-----	-----
Separator - Dewatering unit83 (U)	0.01	22.00	96376.84	98.33	26888.43	33.00	74822.95	67959.10	6.99	4.36	4478.02	11.30	0.01	16.51	-----	-----	-----	-----	-----

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	339.34	277.31	327.14	303.90	7.10	4.00	56.50	41.54	0	0	-----	-----	-----	-----
Anoxic 1B	903.01	58.75	3153.22	2805.97	7.03	4.87	238.99	12.79	0.13	10.99	0	0	0	0
Anoxic 2B	899.30	49.54	3156.20	2808.85	7.05	5.01	238.99	12.96	0.16	9.19	0	0	0	0
Swing B	894.06	48.39	3151.55	2803.80	6.94	4.42	234.99	8.47	1.48	11.80	334.57	22.59	66.41	115.12
Aerobic 1B	882.67	47.70	3140.53	2792.17	6.82	3.45	228.40	1.41	1.77	17.96	406.46	39.42	55.05	150.04
Model clarifier5	2.22	47.35	4.89	4.34	6.81	3.23	2.10	0.05	0.01	21.36	-----	-----	-----	-----
Model clarifier5 (U)	1741.54	47.35	6306.17	5601.82	6.81	3.23	456.38	0.05	0.01	21.36	-----	-----	-----	-----
Model clarifier70	2.22	47.35	4.89	4.34	6.81	3.23	2.10	0.05	0.01	21.36	-----	-----	-----	-----
Model clarifier70 (U)	1741.54	47.35	6306.17	5601.82	6.81	3.23	456.38	0.05	0.01	21.36	-----	-----	-----	-----
Effluent29	2.22	47.35	4.89	4.34	6.81	3.23	2.10	0.05	0.01	21.36	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000

Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

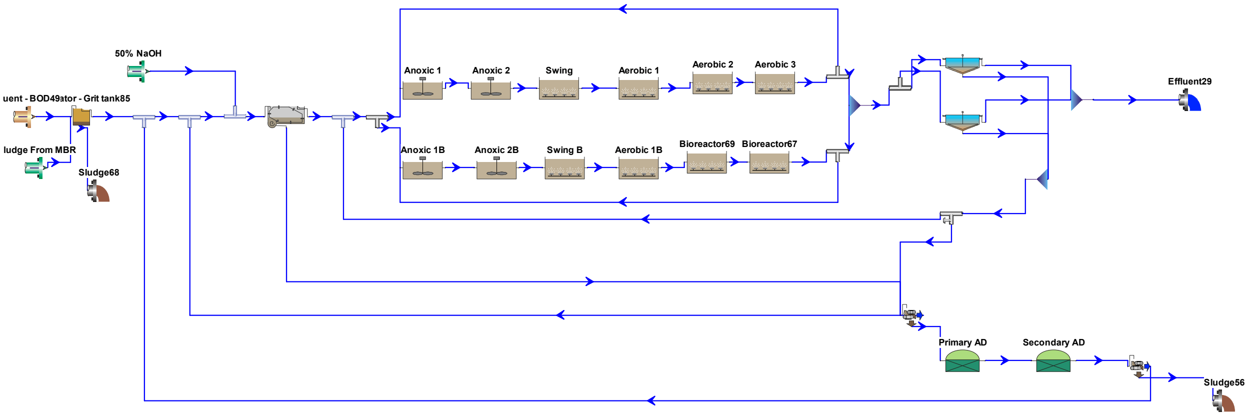
Created: 5/18/2018 Saved: 9/16/2020

Steady state solution

Target SRT: 8.00 days SRT #0: 7.98 days

Temperature: 11.0°C

Flowsheet



Configuration information for all Settler - Ideal primary units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Settler - Ideal primary46	0.3723	3318.0000	15.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Settler - Ideal primary46	Flowrate [Under]	0.0159

Element name	Percent removal	Blanket fraction
Settler - Ideal primary46	45.00	0.10

Configuration information for all Digester - Anaerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	Head space volume
Primary AD	0.2500	1591.4353	21.000	0.1
Secondary AD	0.4470	3734.7007	16.000	0.1

Operating data Average (flow/time weighted as required)

Element name	Pressure [psi]	pH
Primary AD	14.9	-
Secondary AD	14.9	-

Element name	Average Temperature
Primary AD	35.0
Secondary AD	35.0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.0858	634.3912	18.080	144
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.2574	1903.1735	18.080	431
Aerobic 3	0.0858	634.3912	18.080	144
Aerobic 2	0.0858	634.3912	18.080	144
Bioreactor67	0.0858	634.3912	18.080	144
Bioreactor69	0.0858	634.3912	18.080	144

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0

Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0
Aerobic 3	2.0
Aerobic 2	2.0
Bioreactor67	2.0
Bioreactor69	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 3	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor67	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor69	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	2.27
BOD - Total Carbonaceous mgBOD/L	173.66
Volatile suspended solids mg/L	182.72
Total suspended solids mg/L	196.69
N - Total Kjeldahl Nitrogen mgN/L	30.00
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8773
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717

FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.14
Separator - Dewatering unit51	Fraction	0.15

Element name	Percent removal
Separator - Dewatering unit83	90.00
Separator - Dewatering unit51	90.00

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flow paced	100.00 %
Splitter12	Flow paced	100.00 %
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0570374999643516
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH	Sludge From MBR
Biomass - Ordinary heterotrophic [mgCOD/L]	0	4118.29

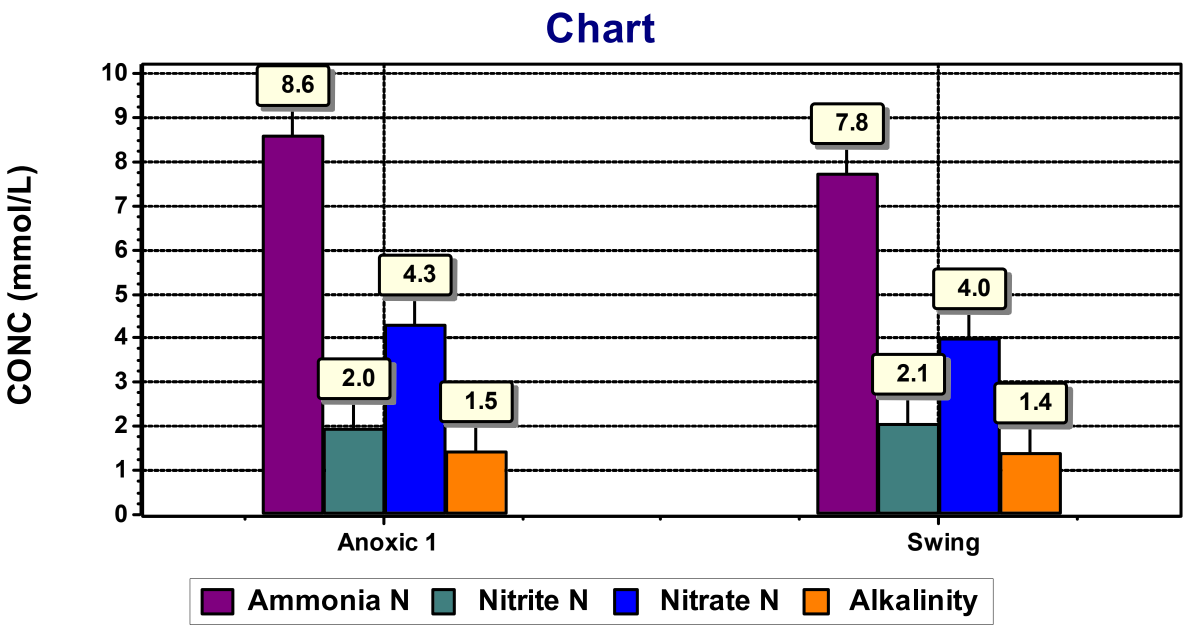
Biomass - Methylotrophic [mgCOD/L]	0	1.92
Biomass - Ammonia oxidizing [mgCOD/L]	0	51.22
Biomass - Nitrite oxidizing [mgCOD/L]	0	28.63
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0	2.37
Biomass - Phosphorus accumulating [mgCOD/L]	0	5.40
Biomass - Propionic acetogenic [mgCOD/L]	0	0.45
Biomass - Acetoclastic methanogenic [mgCOD/L]	0	0.39
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0	0.10
Biomass - Endogenous products [mgCOD/L]	0	2142.58
CODp - Slowly degradable particulate [mgCOD/L]	0	243.55
CODp - Slowly degradable colloidal [mgCOD/L]	0	0.04
CODp - Degradable external organics [mgCOD/L]	0	0
CODp - Undegradable non-cellulose [mgCOD/L]	0	1819.21
CODp - Undegradable cellulose [mgCOD/L]	0	1819.21
N - Particulate degradable organic [mgN/L]	0	10.25
P - Particulate degradable organic [mgP/L]	0	4.22
N - Particulate degradable external organics [mgN/L]	0	0
P - Particulate degradable external organics [mgP/L]	0	0
N - Particulate undegradable [mgN/L]	0	127.35
P - Particulate undegradable [mgP/L]	0	40.02
CODp - Stored PHA [mgCOD/L]	0	0.11
P - Releasable stored polyP [mgP/L]	0	1.74
P - Unreleasable stored polyP [mgP/L]	0	0.35
CODs - Complex readily degradable [mgCOD/L]	0	1.41
CODs - Acetate [mgCOD/L]	0	0
CODs - Propionate [mgCOD/L]	0	0
CODs - Methanol [mgCOD/L]	0	0
Gas - Dissolved hydrogen [mgCOD/L]	0	0.08
Gas - Dissolved methane [mg/L]	0	0
N - Ammonia [mgN/L]	0	1.12
N - Soluble degradable organic [mgN/L]	0	0.51
Gas - Dissolved nitrous oxide [mgN/L]	0	0
N - Nitrite [mgN/L]	0	0.34
N - Nitrate [mgN/L]	0	1.29
Gas - Dissolved nitrogen [mgN/L]	0	18.83

P - Soluble phosphate [mgP/L]	0	3.91
CODs - Undegradable [mgCOD/L]	0	24.30
N - Soluble undegradable organic [mgN/L]	0	0.42
Influent inorganic suspended solids [mgISS/L]	0	1499.26
Precipitate - Struvite [mgISS/L]	0	0
Precipitate - Brushite [mgISS/L]	0	0
Precipitate - Hydroxy - apatite [mgISS/L]	0	0
Precipitate - Vivianite [mgISS/L]	0	0
HFO - High surface [mg/L]	0	0
HFO - Low surface [mg/L]	0	0
HFO - High with H2PO4- adsorbed [mg/L]	0	0
HFO - Low with H2PO4- adsorbed [mg/L]	0	0
HFO - Aged [mg/L]	0	0
HFO - Low with H+ adsorbed [mg/L]	0	0
HFO - High with H+ adsorbed [mg/L]	0	0
HAO - High surface [mg/L]	0	0
HAO - Low surface [mg/L]	0	0
HAO - High with H2PO4- adsorbed [mg/L]	0	0
HAO - Low with H2PO4- adsorbed [mg/L]	0	0
HAO - Aged [mg/L]	0	0
P - Bound on aged HMO [mgP/L]	0	0
Metal soluble - Magnesium [mg/L]	0	14.79
Metal soluble - Calcium [mg/L]	0	80.58
Metal soluble - Ferric [mg/L]	0	0
Metal soluble - Ferrous [mg/L]	0	0
Metal soluble - Aluminum [mg/L]	0	0
Other Cations (strong bases) [meq/L]	12500.00	4.96
Other Anions (strong acids) [meq/L]	0	9.17
Gas - Dissolved total CO2 [mmol/L]	0	2.14
User defined - UD1 [mg/L]	0	0
User defined - UD2 [mg/L]	0	0
User defined - UD3 [mgVSS/L]	0	0
User defined - UD4 [mgISS/L]	0	0
Biomass - Sulfur oxidizing [mgCOD/L]	0	1.91
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0	2.33

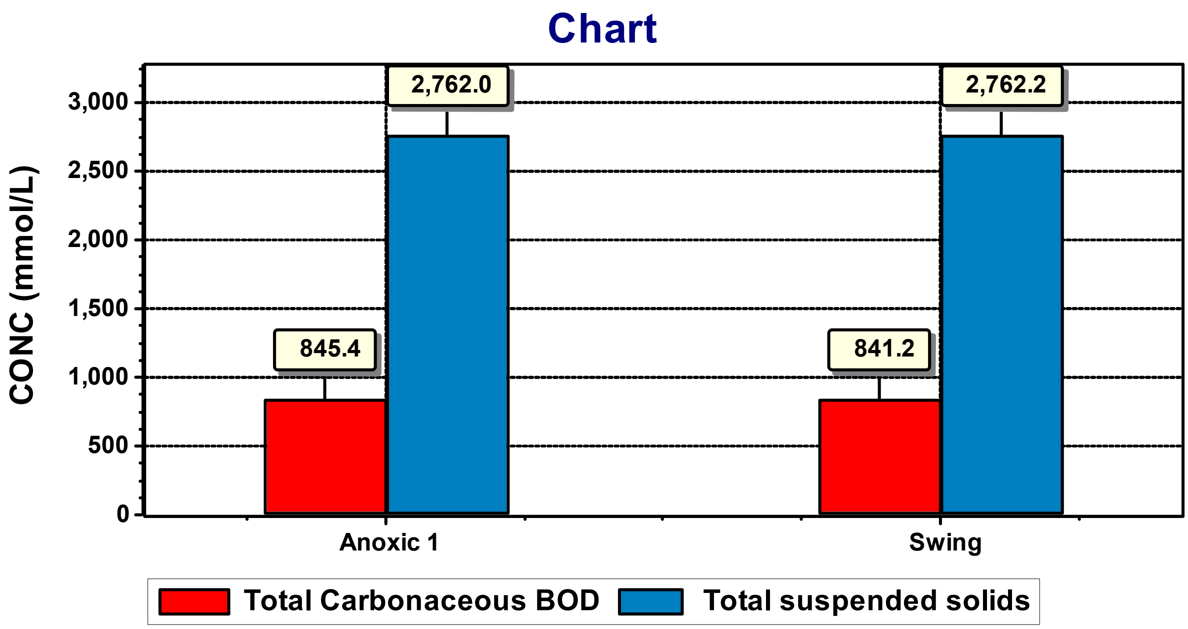
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0	2.15
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0	1.69
Gas - Dissolved total sulfides [mgS/L]	0	0
S - Soluble sulfate [mgS/L]	0	0
S - Particulate elemental sulfur [mgS/L]	0	0
Precipitate - Ferrous sulfide [mgISS/L]	0	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0	0
CODs - Soluble hydrocarbon [mgCOD/L]	0	0
Gas - Dissolved oxygen [mg/L]	0	2.00
Flow	0.00015	0.0304

BioWin Album

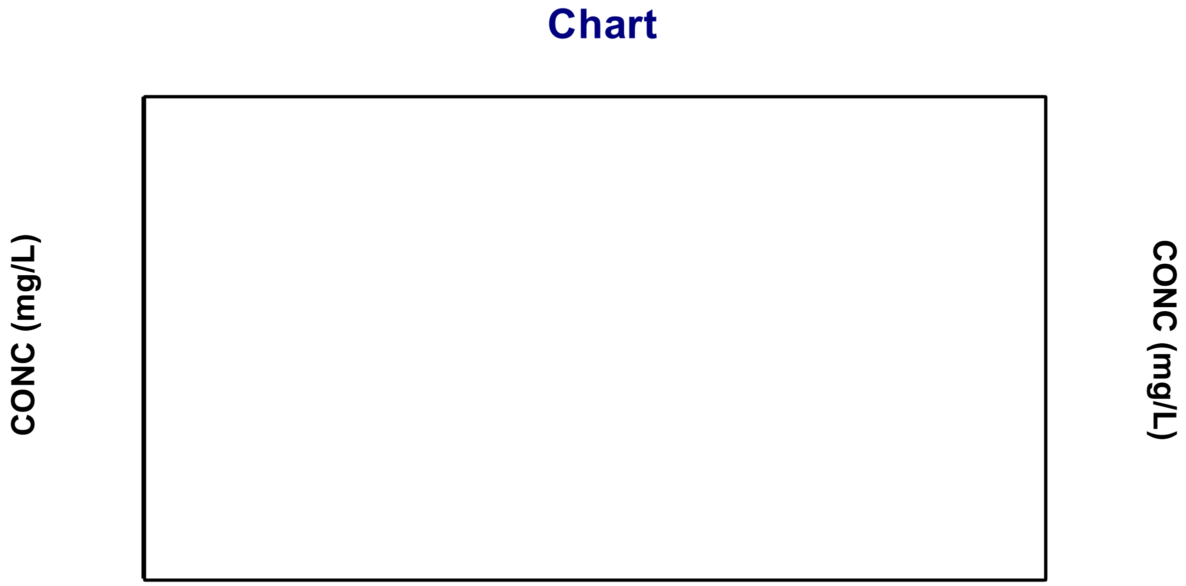
Album page - Nitrogen species



Album page - BOD_TSS

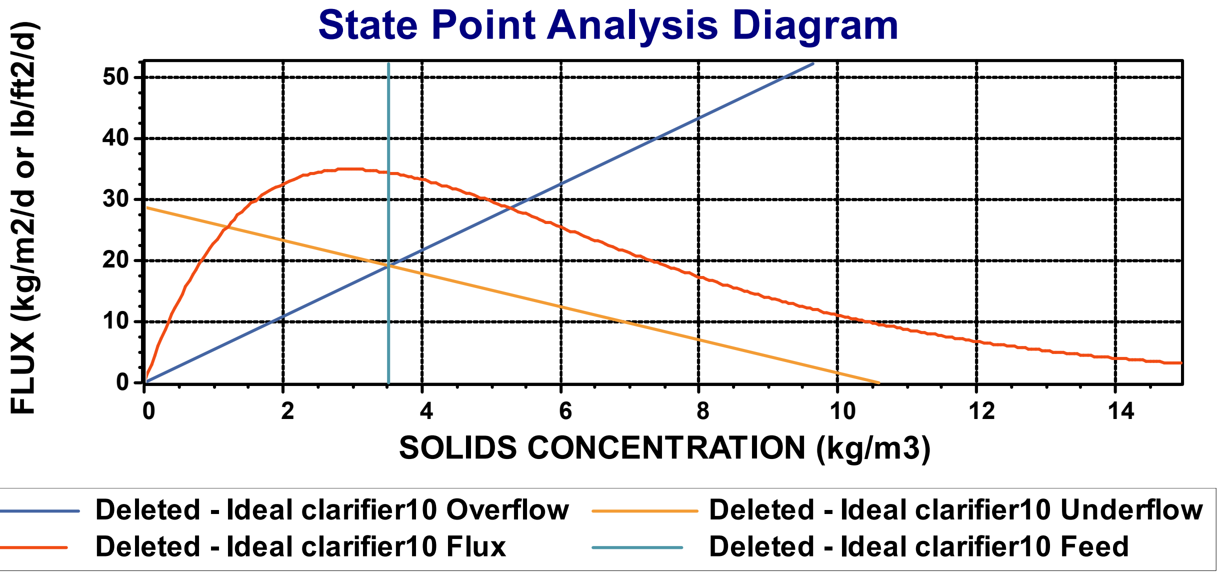


Album page - Page 3



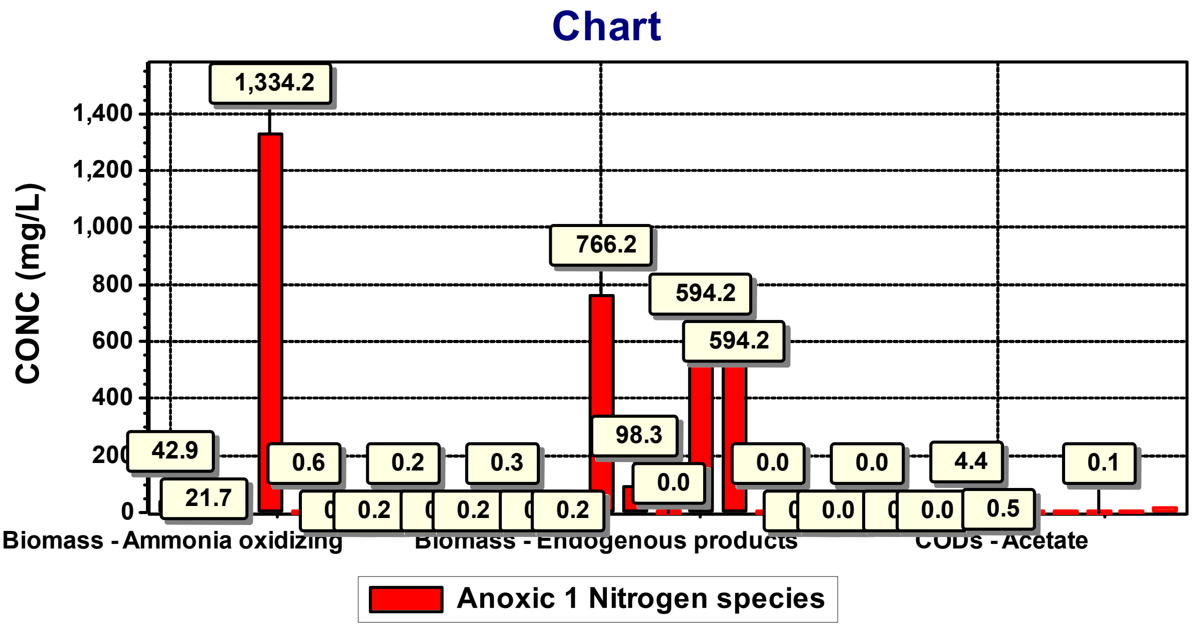
Album page - Page 4

Album page - Page 5

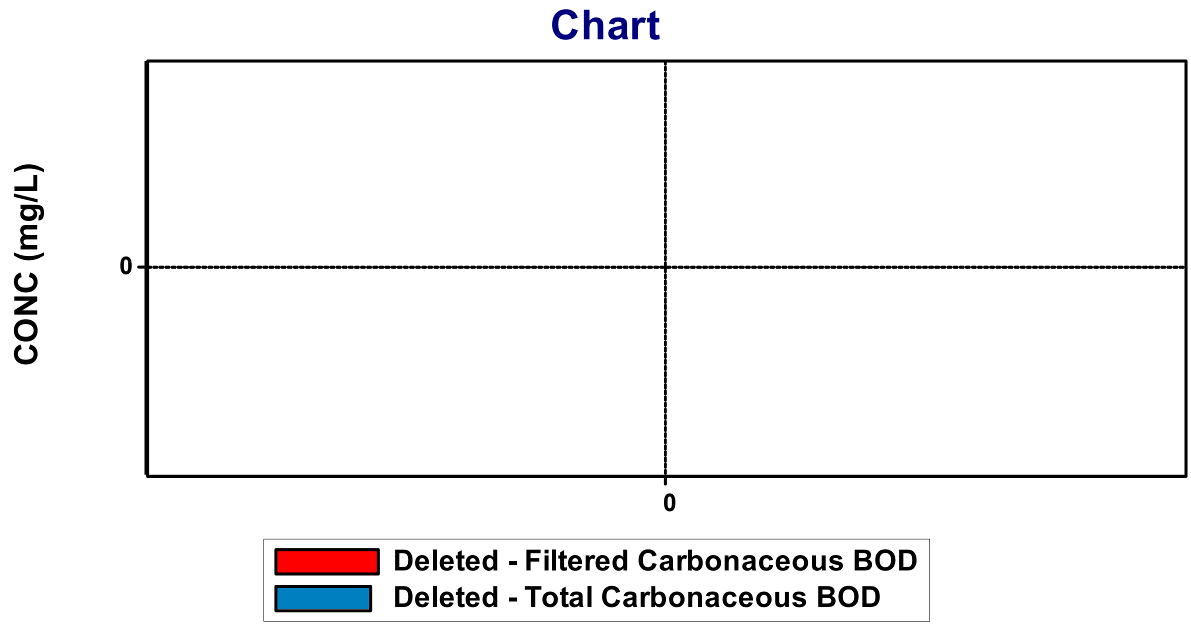


K = 0.3362 m3/kg
Vo = 511.2 ft/d

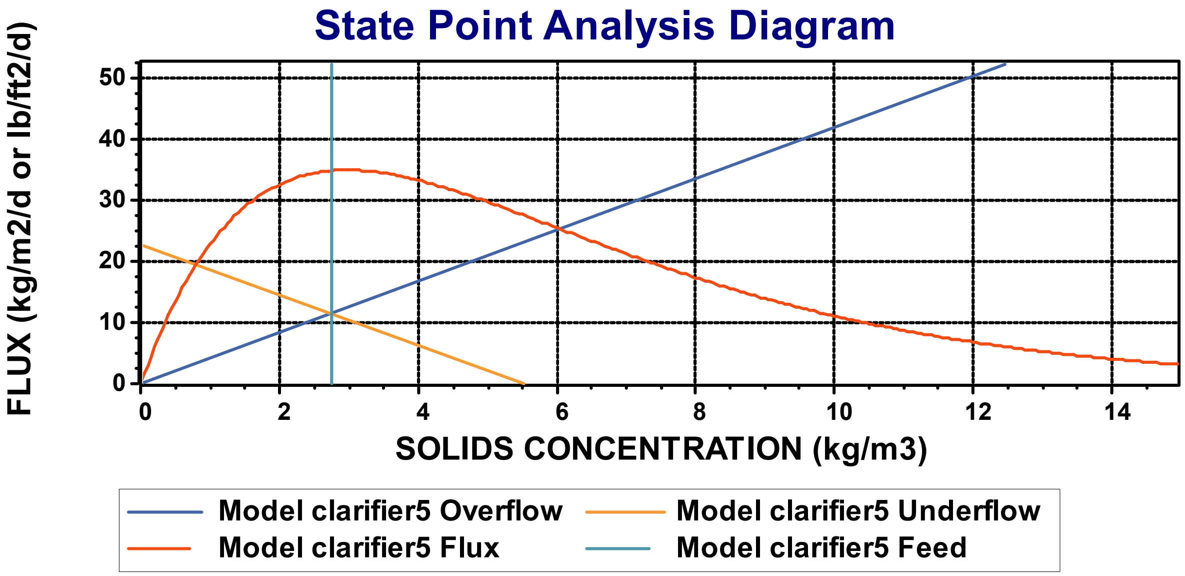
Album page - Page 6



Album page - Page 7

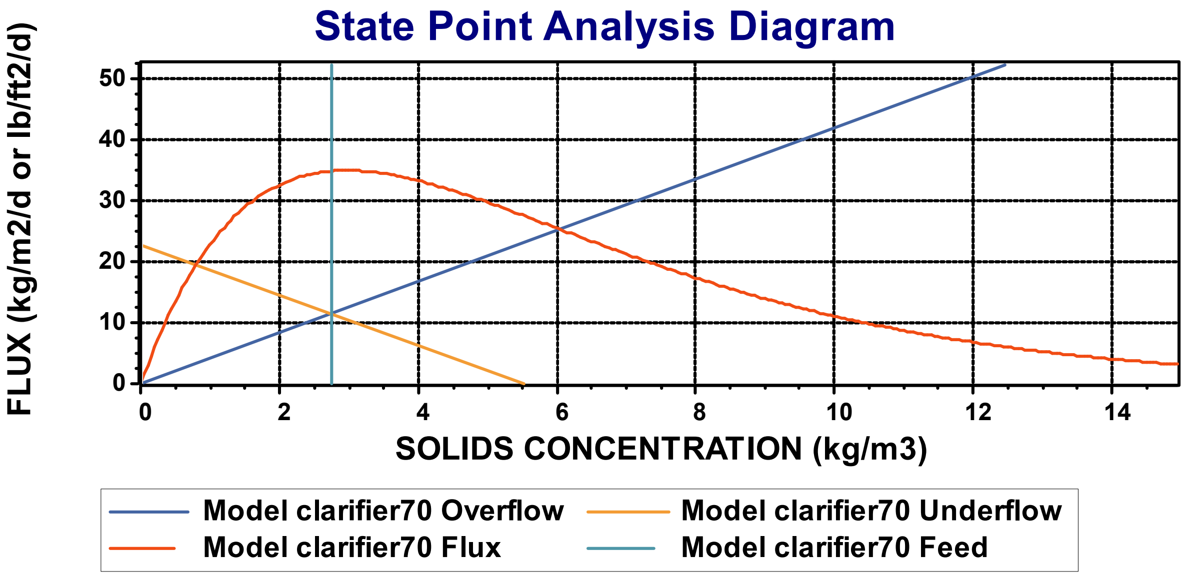


Album page - Page 8

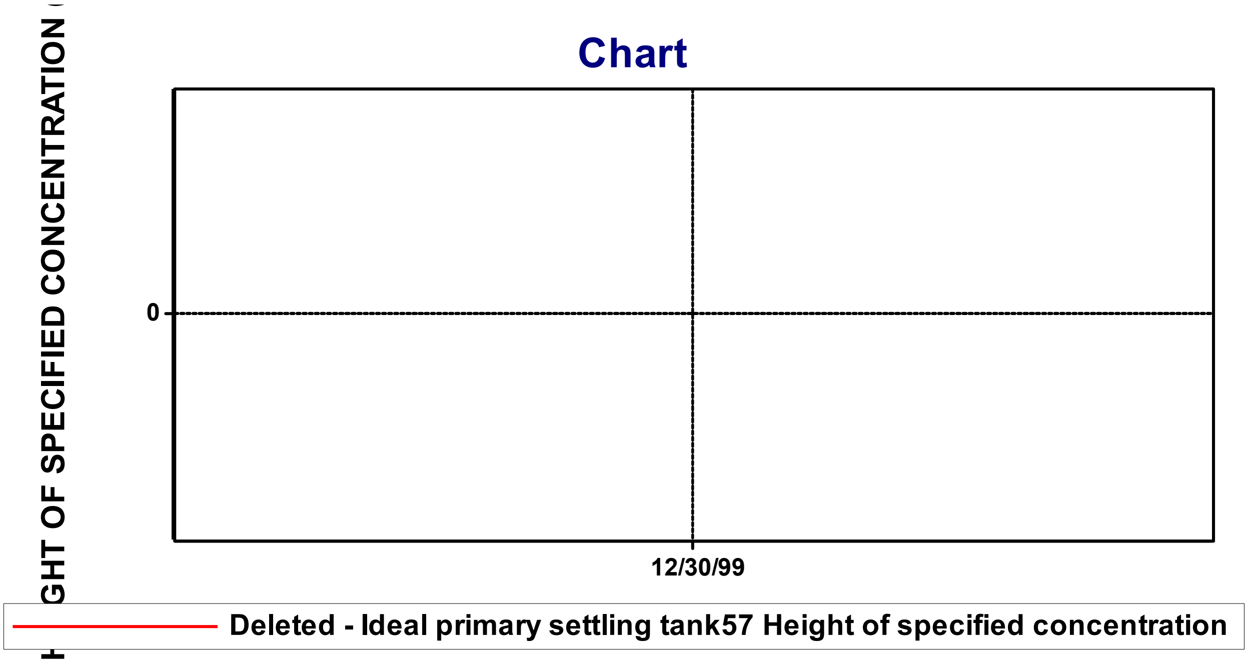


K = 0.3360 m3/kg
Vo = 511.2 ft/d

Album page - Page 9



K = 0.3360 m3/kg
Vo = 511.2 ft/d



Album page - Page 11

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.09
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.26

Album page - Page 13

Elements	Air flow rate [ft3/min (20C, 1 atm)]
Anoxic 1	0
Anoxic 2	0
Swing	130.81
Aerobic 1	202.29
Anoxic 1B	0
Anoxic 2B	0
Swing B	122.74
Aerobic 1B	461.29

Album page - Existing Plant SUmmary

Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]
Influent - BOD49	2.27	11.00	173.64	52.63	362.37	103.25	196.69	182.72	7.10	2.00	30.00	22.06	0	0	-----	-----	-----	-----	-----
Settler - Ideal primary46	2.36	11.00	138.86	50.77	340.02	100.63	181.97	168.90	8.84	3.11	37.44	26.32	0.06	0.21	-----	-----	-----	-----	-----
Settler - Ideal	0.02	11.00	10729.25	50.77	29119.15	100.63	22058.27	20473.46	8.84	3.11	1001.43	26.32	0.06	0.21	-----	-----	-----	-----	-----

primary46 (U)																			
Anoxic 1	4.55	11.00	845.42	5.39	3487.08	31.99	2761.97	2439.14	6.60	1.45	206.91	8.62	1.99	4.33	0	0	0	0	0.50
Anoxic 2	4.55	11.00	843.25	2.12	3484.35	27.10	2763.60	2440.66	6.63	1.53	206.90	8.72	1.80	3.48	0	0	0	0	0.50
Swing	4.55	11.00	841.22	1.59	3481.16	26.06	2762.20	2439.14	6.50	1.41	206.06	7.76	2.08	4.02	130.81	13.50	32.84	50.00	0.40
Aerobic 1	4.55	11.00	836.83	1.21	3474.44	25.36	2758.20	2434.91	6.35	1.15	204.29	5.81	2.60	5.22	202.29	22.18	30.98	80.74	0.41
Aerobic 2	4.55	11.00	832.63	1.05	3468.09	25.09	2754.08	2430.63	6.23	0.92	202.68	4.11	3.00	6.38	183.89	20.73	28.96	74.19	0.41
Aerobic 3	4.55	11.00	828.62	0.96	3462.06	24.95	2750.05	2426.48	6.12	0.72	201.28	2.69	3.24	7.50	163.02	19.04	26.59	66.66	0.42
Modelclarifier5	1.15	11.00	3.97	0.90	37.67	24.85	10.26	9.05	6.01	0.56	3.65	1.75	2.83	9.19	-----	-----	-----	-----	-----
Modelclarifier5 (U)	1.14	11.00	1650.76	0.90	6910.76	24.85	5510.79	4861.24	6.01	0.56	398.85	1.75	2.83	9.19	-----	-----	-----	-----	-----
Modelclarifier70	1.15	11.00	3.97	0.90	37.67	24.85	10.26	9.05	6.01	0.56	3.65	1.75	2.83	9.19	-----	-----	-----	-----	-----
Modelclarifier70 (U)	1.14	11.00	1650.76	0.90	6910.76	24.85	5510.79	4861.24	6.01	0.56	398.85	1.75	2.83	9.19	-----	-----	-----	-----	-----
Effluent29	2.30	11.00	3.97	0.90	37.67	24.85	10.26	9.05	6.01	0.56	3.65	1.75	2.83	9.19	-----	-----	-----	-----	-----
Prima	0.01	35.00	2912.29	85.01	4206	249.24	3380	2955	7.06	78.72	3245.65	1082.56	0.00	0.00	-----	-----	-----	-----	-----

ry AD					5.06		7.96	7.31											
Secondary AD	0.01	35.00	385.46	18.46	38353.98	105.30	31004.48	27045.24	7.24	97.20	3245.65	1329.74	0.00	0.00	-----	-----	-----	-----	-----
Separator - Dewatering unit51	0.01	11.00	61.89	18.46	4631.77	105.30	3669.17	3200.62	7.33	97.10	1557.25	1329.74	0.00	0.00	-----	-----	-----	-----	-----
Separator - Dewatering unit51 (U)	0.00	11.00	2149.41	18.46	222194.41	105.30	180026.00	157036.90	7.33	97.10	12450.16	1329.74	0.00	0.00	-----	-----	-----	-----	-----
Separator - Dewatering unit83	0.06	11.00	434.93	11.77	1411.04	41.37	1066.44	966.62	6.37	1.11	69.69	7.11	2.23	7.23	-----	-----	-----	-----	-----
Separator - Dewatering unit83 (U)	0.01	11.00	22468.68	11.77	72728.47	41.37	56594.84	51297.66	6.37	1.11	3245.70	7.11	2.23	7.23	-----	-----	-----	-----	-----

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	173.64	103.25	196.69	182.72	7.10	2.00	30.00	22.06	0	0	-----	-----	-----	-----
Anoxic 1B	839.02	31.80	2755.29	2432.68	6.55	1.29	205.64	7.69	1.68	5.95	0	0	0	0
Anoxic 2B	836.90	26.96	2756.92	2434.21	6.58	1.37	205.64	7.79	1.56	5.09	0	0	0	0
Swing B	834.95	25.97	2755.57	2432.74	6.45	1.25	204.82	6.87	1.83	5.62	122.74	13.21	31.90	47.25
Aerobic 1B	823.17	25.00	2744.06	2420.95	6.09	0.66	200.65	2.60	2.57	8.91	461.29	56.15	26.14	189.87
Model clarifier5	3.97	24.85	10.26	9.05	6.01	0.56	3.65	1.75	2.83	9.19	-----	-----	-----	-----
Model clarifier5 (U)	1650.76	24.85	5510.79	4861.24	6.01	0.56	398.85	1.75	2.83	9.19	-----	-----	-----	-----
Model clarifier70	3.97	24.85	10.26	9.05	6.01	0.56	3.65	1.75	2.83	9.19	-----	-----	-----	-----
Model clarifier70 (U)	1650.76	24.85	5510.79	4861.24	6.01	0.56	398.85	1.75	2.83	9.19	-----	-----	-----	-----
Effluent29	3.97	24.85	10.26	9.05	6.01	0.56	3.65	1.75	2.83	9.19	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000

Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

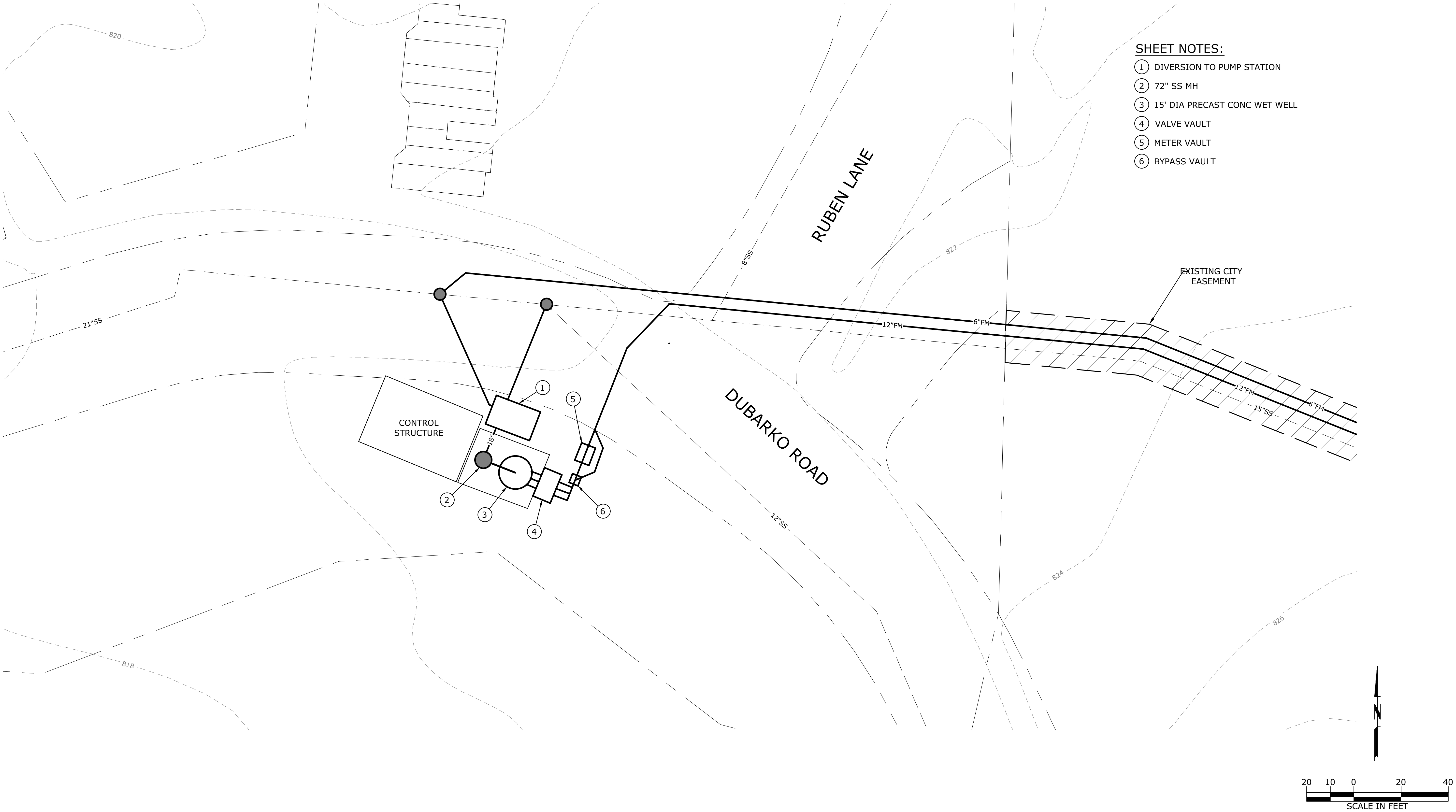
Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

APPENDIX C
DRAWINGS



SHEET NOTES:

1. DIVERSION TO PUMP STATION
2. 72" SS MH
3. 15' DIA PRECAST CONC WET WELL
4. VALVE VAULT
5. METER VAULT
6. BYPASS VAULT

NO.	DATE	BY	REVISION

NOTICE

0 ½ 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED

DRAWN

CHECKED

PRELIMINARY ONLY
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SANDY
WHERE INNOVATION MEETS ELEVATION

EASTSIDE SATELLITE TREATMENT FACILITY BASIS OF DESIGN

PRELIMINARY CONCEPTUAL DIVERSION PUMP STATION SITE PLAN

PROJECT NO.: 20-2776
SCALE: AS SHOWN
DATE: NOVEMBER 2020

SHEET
C-1
1 of 2

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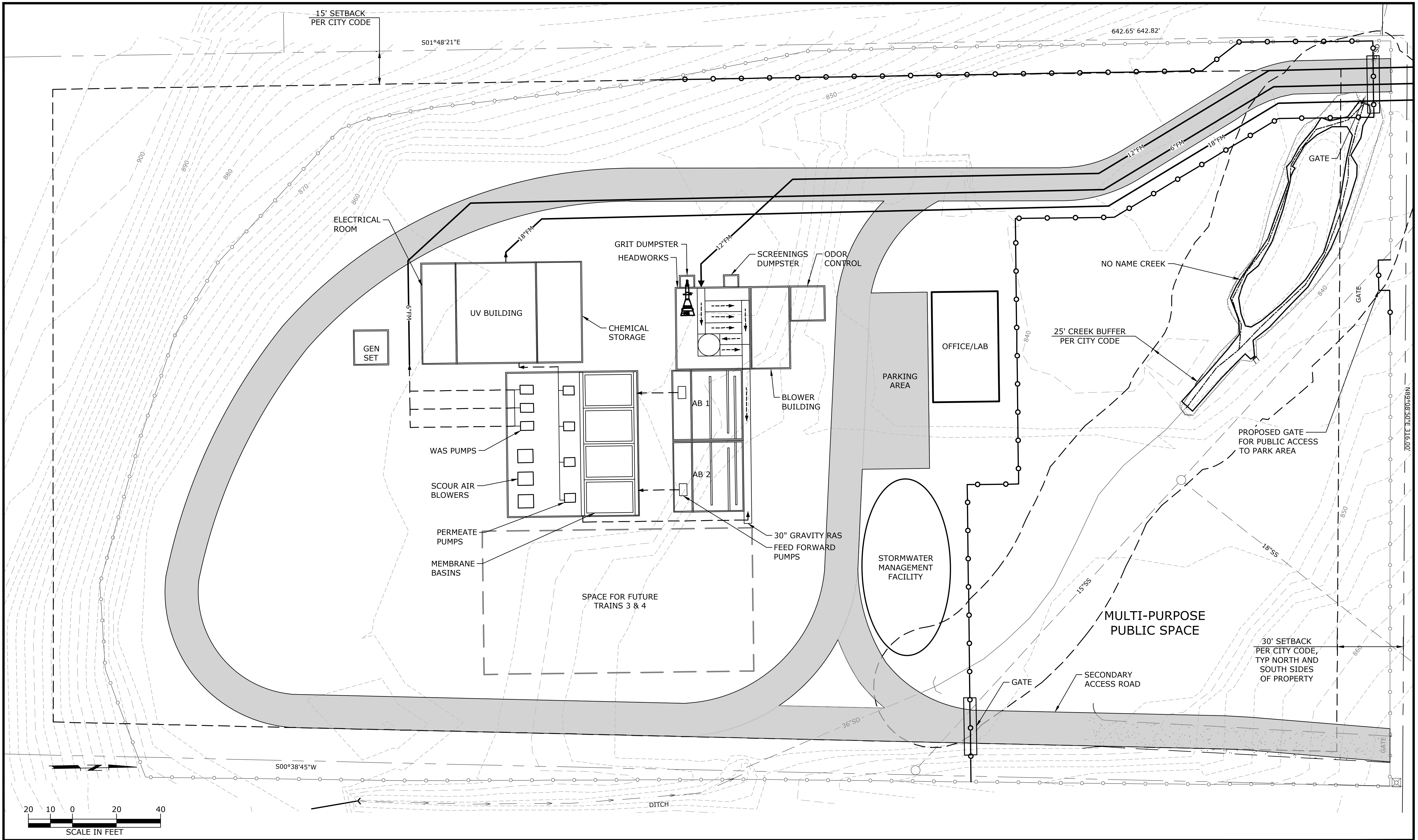

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NO.	DATE	BY	REVISION

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EASTSIDE SATELLITE TREATMENT FACILITY BASIS OF DESIGN

PRELIMINARY CONCEPTUAL EASTSIDE SATELLITE TREATMENT FACILLITY SITE PLAN

PROJECT NO.: 20-2776 SCALE: AS SHOWN DATE: NOVEMBER 2020

SHEET
C-2
2 of 2

APPENDIX D
PROPOSED EASTSIDE SATELLITE TREATMENT FACILITY PROCESS MODEL REPORT

Appendix D

New Eastside Satellite Treatment Facility – Biowin Process Model Simulation Results

Parameter	2026 ADWF	2026 MMWWF	2026 MMDWF	2040 MMWWF	2040 MMDWF
Influent					
Flow, MGD	0.46	1.14	0.6	2.27	1.21
Temperature, °C	22	11	22	11	22
MBR Operation					
No. of AB Trains	1	1	1	2	2
SRT, days	25	15	15	15	15
MLSS, mg/L	8,300	9,300	8,700	8,700	8,300
RAS ratio, %	400%	400%	400%	400%	400%
50% Caustic Soda Addition, gpd	0	100	100	100	100
Air Demand, Each AB					
Air Demand per train, scfm	650	900	1,200	800	950
Total Air Demand , scfm	1,300	1,800	2,400	3,200	3,800
Effluent Performance					
Effluent TSS, mg/L	< 1	< 1	< 1	< 1	< 1
Effluent BOD, mg/L	< 1	< 1	< 1	< 1	< 1
Effluent Ammonia-N, mg/L	0.06	0.3	0.05	0.65	0.06
Effluent Total Nitrogen, mg/L	11	8	13	8	13
Effluent pH	6.3	6.4	6.8	6.1	6.5
Solids Processing					
WAS TSS, mg/L	8,300	9,300	8,600	8,700	8,300
WAS Solids, ppd	600	1,200	1,100	2,100	2,000
WAS Flow, gpm	6	11	11	21	20

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

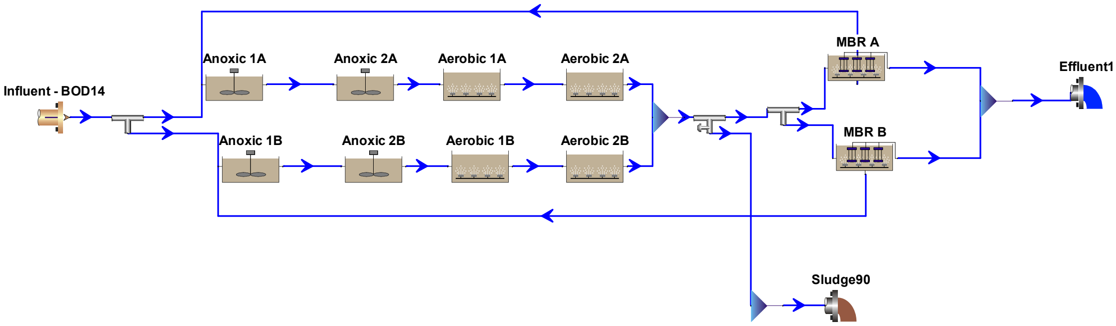
Created: 5/18/2018 Saved: 6/14/2020

Steady state solution

Target SRT: 25.00 days SRT #0: 24.99 days

Temperature: 22.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1A	0.0100	102.8312	13.000	Un-aerated
Aerobic 1A	0.0300	308.4936	13.000	70
Aerobic 2A	0.0300	308.4936	13.000	70
Anoxic 2A	0.0100	102.8312	13.000	Un-aerated
Anoxic 1B	0.0100	102.8312	13.000	Un-aerated
Aerobic 1B	0.0300	308.4936	13.000	70
Aerobic 2B	0.0300	308.4936	13.000	70
Anoxic 2B	0.0100	102.8312	13.000	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1A	0
Aerobic 1A	2.0
Aerobic 2A	2.0
Anoxic 2A	0
Anoxic 1B	0
Aerobic 1B	2.0
Aerobic 2B	2.0
Anoxic 2B	0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor - MBR units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers	# of cassettes	Displaced volume / cassette [ft3/cassette]	Membrane area / cassette [ft2/cassette]	Total displaced volume [Mil. Gal]	Membrane surface area [ft2]
MBR A	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
MBR B	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
MBR A	2.0
MBR B	2.0

Element name	Split method	Average Split specification
MBR A	Flow paced	200.00 %
MBR B	Flow paced	200.00 %

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
MBR A	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
MBR B	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0

Element name	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
MBR A	101.3250	0.3000
MBR B	101.3250	0.3000

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Off-gas N2O [vol. %]	Surface turbulence factor [-]
MBR A	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
MBR B	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD14
Flow	0.46
BOD - Total Carbonaceous mgBOD/L	313.00
Volatile suspended solids mg/L	280.00
Total suspended solids mg/L	301.00
N - Total Kjeldahl Nitrogen mgN/L	50.90
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.20
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	80.00
Metal soluble - Magnesium mg/L	15.00
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD14
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1600
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.7373
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7500
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.5000

FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0.1500
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

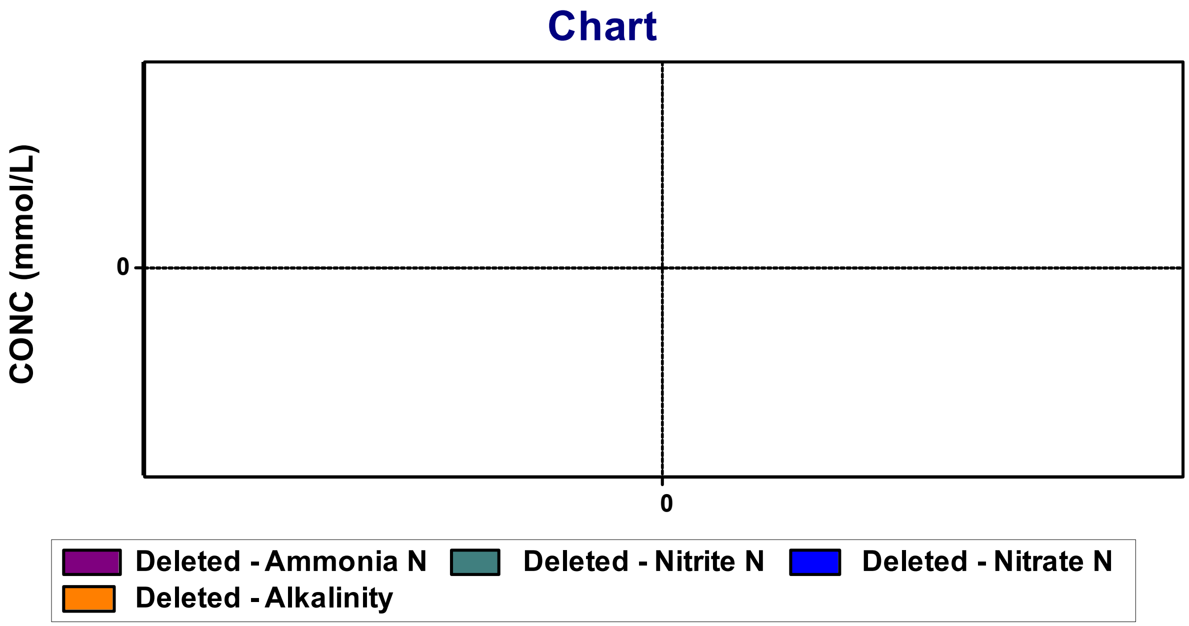
Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter66	Fraction	0.50
Splitter7	Flowrate [Side]	0.00912947584143462
Splitter8	Fraction	0.50

BioWin Album

Album page - Nitrogen species



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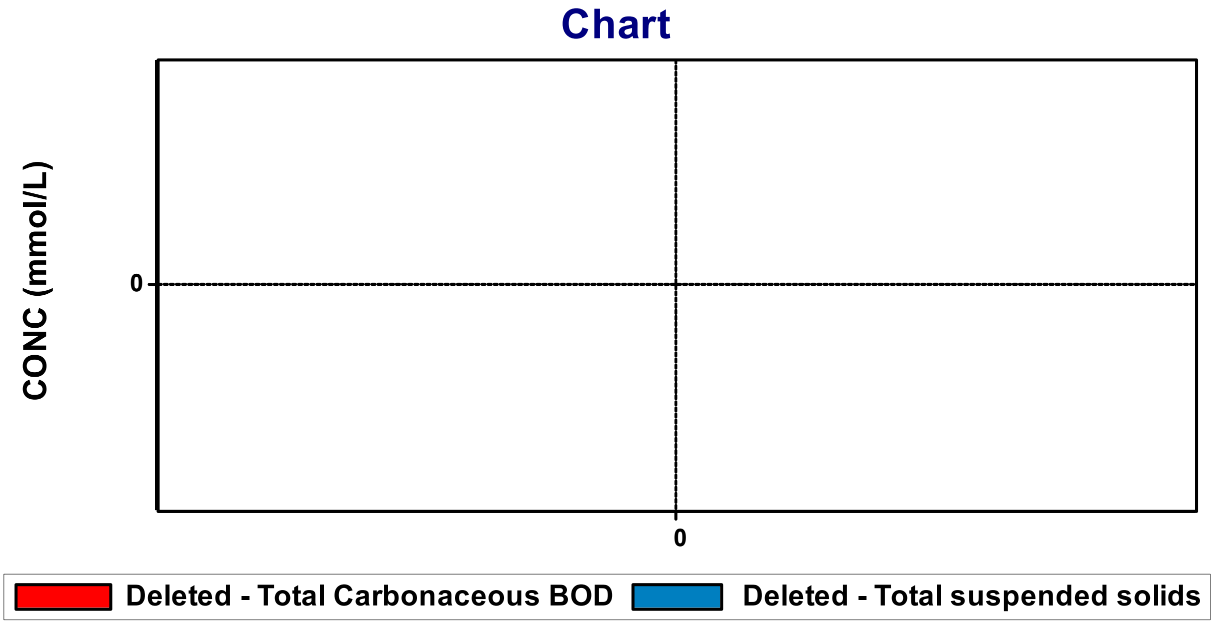
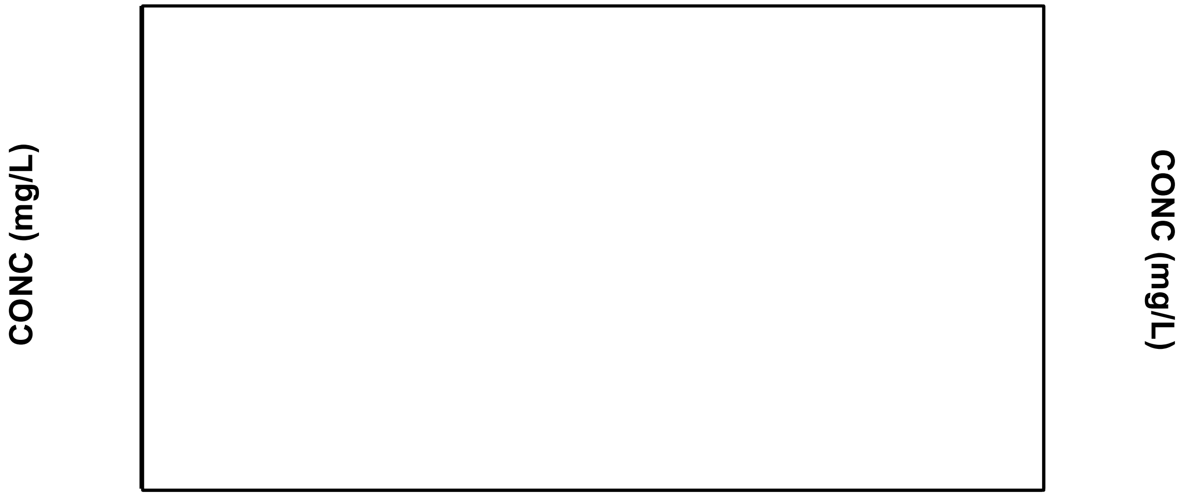


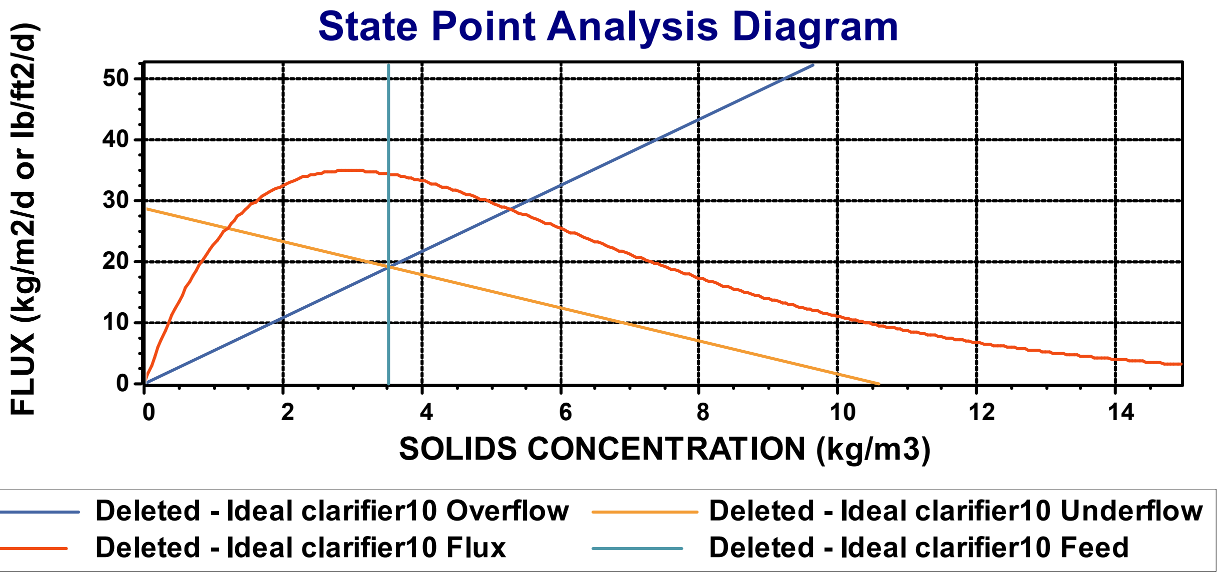
Album page - Page 3

Chart



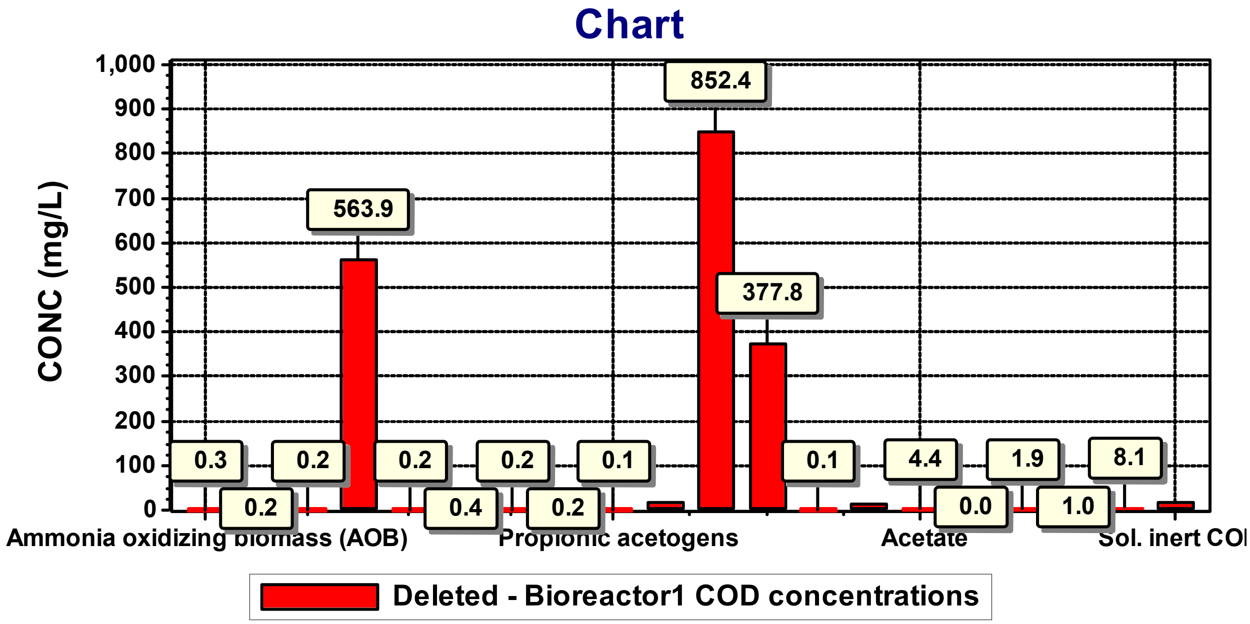
Album page - Page 4

Album page - Page 5



K = 0.3362 m3/kg
Vo = 511.2 ft/d

Album page - Page 6



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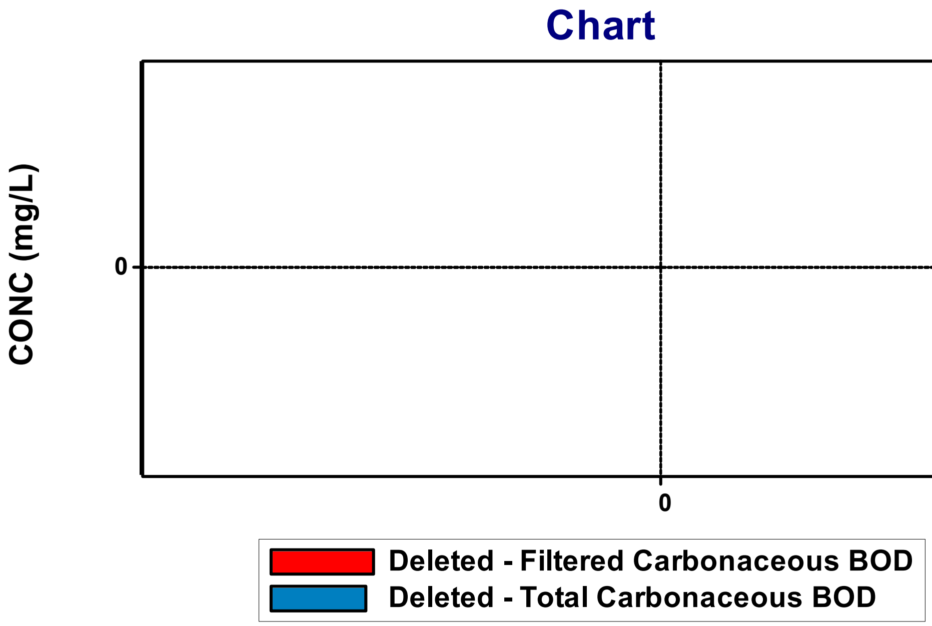

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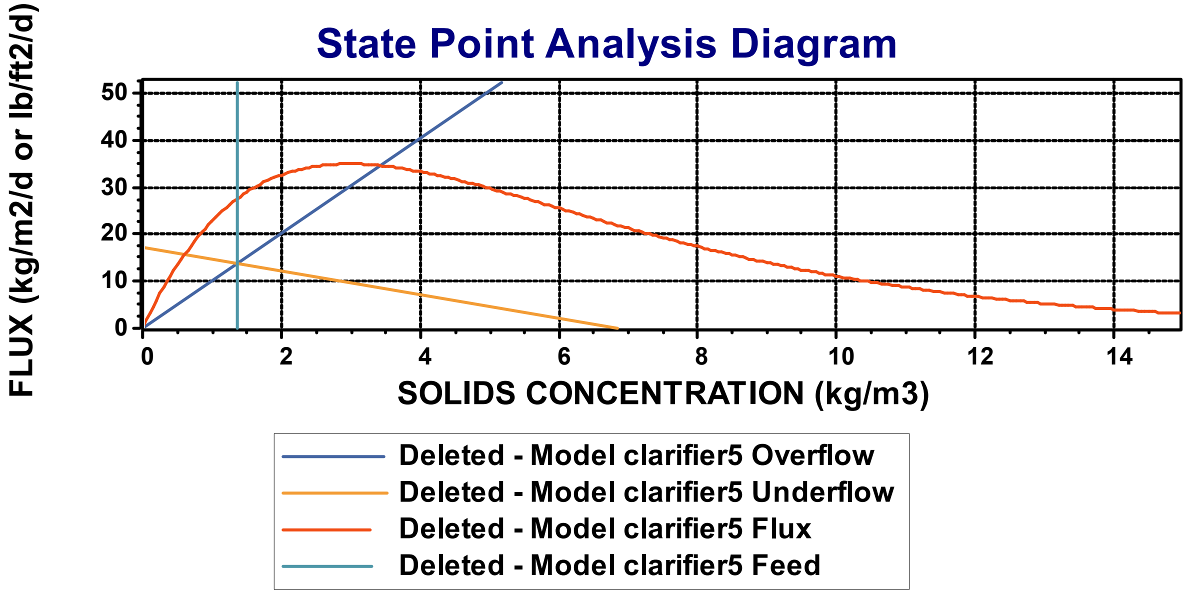

K = 0.3360 m3/kg
Vo = 511.2 ft/d

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Sludge90

State variable	Conc. (mg/L)	Mass rate (lb/d)	Notes
Biomass - Acetoclastic methanogenic	0.19	0.01	
Biomass - Ammonia oxidizing	63.92	4.87	
Biomass - Anaerobic ammonia oxidizing	2.45	0.19	
Biomass - Endogenous products	2923.70	222.75	
Biomass - Hydrogenotrophic methanogenic	0.04	0.00	
Biomass - Methylotrophic	1.48	0.11	
Biomass - Nitrite oxidizing	39.29	2.99	
Biomass - Ordinary heterotrophic	2453.23	186.91	
Biomass - Phosphorus accumulating	1.05	0.08	
Biomass - Propionic acetogenic	0.22	0.02	
Biomass - Sulfur oxidizing	0	0	
Biomass - Sulfur reducing acetotrophic	0.00	0.00	
Biomass - Sulfur reducing hydrogenotrophic	0.00	0.00	
Biomass - Sulfur reducing propionic acetogenic	0.00	0.00	
CODp - Adsorbed hydrocarbon	0	0	
CODp - Degradable external organics	0	0	
CODp - Slowly degradable colloidal	0.01	0.00	
CODp - Slowly degradable particulate	121.63	9.27	
CODp - Stored PHA	0.00	0.00	
CODp - Undegradable cellulose	2090.05	159.24	
CODp - Undegradable non-cellulose	2090.05	159.24	
CODs - Acetate	0.00	0.00	
CODs - Complex readily degradable	1.31	0.10	
CODs - Degradable volatile ind. #1	0	0	
CODs - Degradable volatile ind. #2	0	0	
CODs - Degradable volatile ind. #3	0	0	
CODs - Methanol	0.00	0.00	
CODs - Propionate	0.00	0.00	
CODs - Soluble hydrocarbon	0	0	
CODs - Undegradable	31.92	2.43	
Gas - Dissolved hydrogen	0.01	0.00	

Gas - Dissolved methane	0.00	0.00	
Gas - Dissolved nitrogen	15.67	1.19	
Gas - Dissolved nitrous oxide	0	0	
Gas - Dissolved oxygen	2.00	0.15	
Gas - Dissolved total CO2	1.79	0.06	mmol/L and kmol/d
Gas - Dissolved total sulfides	0.00	0.00	
HAO - Aged	0	0	
HAO - High surface	0	0	
HAO - High with H2PO4- adsorbed	0	0	
HAO - Low surface	0	0	
HAO - Low with H2PO4- adsorbed	0	0	
HFO - Aged	0	0	
HFO - High surface	0	0	
HFO - High with H+ adsorbed	0	0	
HFO - High with H2PO4- adsorbed	0	0	
HFO - Low surface	0	0	
HFO - Low with H+ adsorbed	0	0	
HFO - Low with H2PO4- adsorbed	0	0	
Influent inorganic suspended solids	936.65	71.36	
Metal soluble - Aluminum	0	0	
Metal soluble - Calcium	81.13	6.18	
Metal soluble - Ferric	0	0	
Metal soluble - Ferrous	0	0	
Metal soluble - Magnesium	14.76	1.12	
N - Ammonia	0.13	0.01	
N - Nitrate	8.38	0.64	
N - Nitrite	0.05	0.00	
N - Particulate degradable external organics	0	0	
N - Particulate degradable organic	5.79	0.44	
N - Particulate undegradable	146.30	11.15	
N - Soluble degradable organic	0.55	0.04	
N - Soluble undegradable organic	1.02	0.08	
Other Anions (strong acids)	8.78	0.30	meq/L and keq/d
Other Cations (strong bases)	4.95	0.17	meq/L and keq/d
P - Bound on aged HMO	0	0	

P - Particulate degradable external organics	0	0
P - Particulate degradable organic	1.84	0.14
P - Particulate undegradable	45.98	3.50
P - Releasable stored polyP	0.12	0.01
P - Soluble phosphate	1.79	0.14
P - Unreleasable stored polyP	0.01	0.00
Precipitate - Brushite	0	0
Precipitate - Ferrous sulfide	0	0
Precipitate - Hydroxy - apatite	0	0
Precipitate - Struvite	0	0
Precipitate - Vivianite	0	0
S - Particulate elemental sulfur	0	0
S - Soluble sulfate	0	0
User defined - UD1	0	0
User defined - UD2	0	0
User defined - UD3	0	0
User defined - UD4	0	0

Parameter	Value	Units
Cost (Sludge)	0	$/hour
Power	0	kW
Power cost (Excl. heating)	0	$/hour

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Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [m	BOD - Filtered Carbonaceous [m	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [m	N - Total N [mgN/L]	N - Total Kjeldahl Nitrogen [m	N - Ammonia [mgN/L]	N - Nitrate [mgN/L]	N - Nitrite [mgN/L]	pH []	Alkalinity [mmol/L]	Air flow rate [ft3/min (20C, 1 at	OUR - Carbonaceous [mgO	OUR - Nitrification [mgO/L/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Alpha [[]]

			g/L]	g/L]				g/L]		gN/L]						m)]	/L/hr]				
Influent - BOD14	0.46	22.00	312.96	133.76	638.16	241.15	301.00	280.00	50.90	50.90	38.17	0	0	7.20	4.00	-----	-----	-----	-----	-----	-----
Anoxic 1A	1.15	22.00	1534.20	5.29	9868.42	40.78	8335.26	6941.90	547.95	544.94	7.72	2.92	0.09	6.67	1.71	0	0	0	0	0	0.50
Anoxic 2A	1.15	22.00	1531.12	1.35	9864.31	34.64	8336.70	6943.33	546.51	544.93	7.89	1.50	0.08	6.70	1.82	0	0	0	0	0	0.50
Aerobic 1A	1.15	22.00	1516.71	1.06	9841.92	33.50	8322.34	6928.37	546.35	539.06	1.39	6.66	0.63	6.30	0.96	473.73	36.31	39.77	76.08	109.16	0.28
Aerobic 2A	1.15	22.00	1502.60	0.93	9820.56	33.24	8307.66	6913.50	546.21	537.78	0.13	8.38	0.05	6.21	0.79	179.51	33.30	10.47	43.77	46.11	0.36
MBR A	0.23	22.00	0.85	0.85	33.12	33.12	0	0	10.51	1.64	0.06	8.85	0.01	6.30	0.75	538.78	37.25	6.24	43.49	35.17	0.40
MBR A (U)	0.92	22.00	1851.86	0.85	12190.68	33.12	10323.35	8587.84	677.32	668.45	0.06	8.85	0.01	6.29	0.75	-----	-----	-----	-----	-----	-----
Effluent 1	0.45	22.00	0.85	0.85	33.12	33.12	0	0	10.51	1.64	0.06	8.85	0.01	6.29	0.75	-----	-----	-----	-----	-----	-----
Sludge 90	0.01	22.00	1502.60	0.93	9820.56	33.24	8307.66	6913.50	546.21	537.78	0.13	8.38	0.05	6.21	0.79	-----	-----	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000

Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000

Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000

Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4

Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000

Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700

P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583

Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value

Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000
H2S [M/Atm]	1.0000E-1	1.0000E-1	2200.0000
Ind 1 [M/Atm]	1.9000E+3	1.9000E+3	7300.0000
Ind 2 [M/Atm]	1.8000E-1	1.8000E-1	2200.0000
Ind 3 [M/Atm]	1.5000E-1	1.5000E-1	1900.0000

Properties constants

Name	Default	Value
K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7
A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2000	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1734.0000	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5000	-39.4800

Metal salt solution densities

Name	Default	Value
Ferric chloride solution density [kg/m3]	3820.0000	3820.0000
Ferric sulfate solution density [kg/m3]	4800.0000	4800.0000
Ferrous chloride solution density [kg/m3]	3160.0000	3160.0000

Ferrous sulfate solution density [kg/m3]	1150.0000	1150.0000
Aluminum sulfate solution density [kg/m3]	1950.0000	1950.0000
Aluminum chloride solution density [kg/m3]	2480.0000	2480.0000

Mineral precipitation rates

Name	Default	Value	
Vivianite precipitation rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite redissolution rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite half sat. [mgTSS/L]	0.0100	0.0100	1.0000
FeS precipitation rate [L/(mol d)]	1000.0000	1000.0000	1.0240
FeS redissolution rate [L/(mol d)]	10.0000	10.0000	1.0240
FeS half sat. [mgTSS/L]	0.1000	0.1000	1.0000
Struvite precipitation rate [L^2/(mol^2 d)]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [L^2/(mol^2 d)]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
Brushite precipitation rate [L/(mol d)]	1.000E+6	1.000E+6	1.0000
Brushite redissolution rate [L/(mol d)]	10000.0000	10000.0000	1.0000
Brushite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HAP precipitation rate [g/d]	5.000E-4	5.000E-4	1.0000

Mineral precipitation constants

Name	Default	Value
Vivianite solubility product [mol/L]^5	1.710E-36	1.710E-36
FeS solubility product [mol/L]^2	4.258E-4	4.258E-4
Struvite solubility product [mol/L]^3	6.918E-14	6.918E-14
Brushite solubility product [mol/L]^2	2.490E-7	2.490E-7

Fe rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HFO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HFO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HFO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	2.000E-11	2.000E-11	1.0000
H+ competition for HFO(H) protonation sites [L/(mmol . d)]	1000.0000	1000.0000	1.0000
H+ competition for HFO(L) protonation sites [L/(mmol . d)]	100.0000	100.0000	1.0000

Fe constants

Name	Default	Value
Ferric active site factor(high) [{mol Sites}/{mol HFO(H)}]	4.0000	2.0000
Ferric active site factor(low) [{mol Sites}/{mol HFO(L)}]	2.4000	1.2000
H+ competition level for Fe(OH)3 [mol/L]	7.000E-7	7.000E-7
Equilibrium constant for FeOH3-H2PO4- [{mf HFO(H).H2PO4}/({mol H2PO4-}{mf HFO(H)}^2)]	2.000E-9	2.000E-9
Colloidal COD removed with Ferric [gCOD/Fe active site]	80.0000	130.0000
Minimum residual P level with iron addition [mgP/L]	0.0150	0.0150
HFO(H) with H2PO4- P release factor	10000.0000	10000.0000
HFO(L) with H2PO4- P release factor	10000.0000	10000.0000

Fe RedOx rates

Name	Default	Value	
Iron reduction using acetic acid	1.000E-7	1.000E-7	1.0000
Half Sat. acetic acid	0.5000	0.5000	1.0000
Iron reduction using propionic acid	1.000E-7	1.000E-7	1.0000
Half Sat. propionic acid	0.5000	0.5000	1.0000

Iron reduction using dissolved hydrogen gas	1.000E-7	1.000E-7	1.0000
Half Sat. dissolved hydrogen gas	0.5000	0.5000	1.0000
Iron reduction using hydrogen sulfide	5.000E-5	5.000E-5	1.0000
Half Sat. hydrogen sulfide	0.5000	0.5000	1.0000
Iron oxidation rate (aerobic)	1.000E-3	1.000E-3	1.0000
Abiotic iron reduction using acetic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using propionic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using dissolved hydrogen gas	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using hydrogen sulfide	2.000E-5	2.000E-5	1.0000
Abiotic iron oxidation rate (aerobic)	1.0000	1.0000	1.0000

CEPT rates

Name	Default	Value	
HFO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HFO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000
HAO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HAO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000

Al rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HAO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HAO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HAO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	1.000E-9	1.000E-9	1.0000

Al constants

Name	Default	Value
Al active site factor(high) [{mol Sites}/{mol HAO(H)}]	3.0000	3.0000
Al active site factor(low) [{mol Sites}/{mol HAO(L)}]	1.5000	1.5000
Equilibrium constant for AlOH3-H2PO4- [{mf HAO(H).H2PO4}/({mol H2PO4-}{mf HAO(H)}^2)]	8.000E-10	8.000E-10
Colloidal COD removed with Al [gCOD/Al active site]	30.0000	30.0000
Minimum residual P level with Al addition [mgP/L]	0.0150	0.0150
HAO(H) with H2PO4- P release factor	10000.0000	10000.0000
HAO(L) with H2PO4- P release factor	10000.0000	10000.0000

Pipe and pump parameters

Name	Default	Value
Static head [ft]	0.8202	0.8202
Pipe length (headloss calc.s) [ft]	164.0420	164.0420
Pipe inside diameter [in]	19.68504	19.68504
K(fittings) - Total minor losses K	5.0000	5.0000
Pipe roughness [in]	0.00787	0.00787
'A' in overall pump efficiency = A + B*Q + C*(Q^2)[-]	0.8500	0.8500
'B' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)]	0	0
'C' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)^2]	0	0

Fittings and loss coefficients ('K' values)

Name	Default	Value
Pipe entrance (bellmouth)	0.0500	1.0000
90° bend	0.7500	5.0000

45° bend	0.3000	2.0000
Butterfly value (open)	0.3000	1.0000
Non-return value	1.0000	0
Outlet (bellmouth)	0.2000	1.0000

Aeration

Name	Default	Value
Surface pressure [kPa]	101.3250	101.3250
Fractional effective saturation depth (Fed) [-]	0.3250	0.3250
Supply gas CO2 content [vol. %]	0.0400	0.0350
Supply gas O2 [vol. %]	20.9500	20.9500
Off-gas CO2 [vol. %]	2.0000	2.0000
Off-gas O2 [vol. %]	18.8000	18.8000
Off-gas H2 [vol. %]	0	0
Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Off-gas N2O [vol. %]	0	0
Surface turbulence factor [-]	2.0000	2.0000
Set point controller gain []	1.0000	1.0000

BioWin user and configuration data

Project details

Project name: Unknown   Project ref.: BW1

Plant name: Unknown   User name: Jason.Flowers

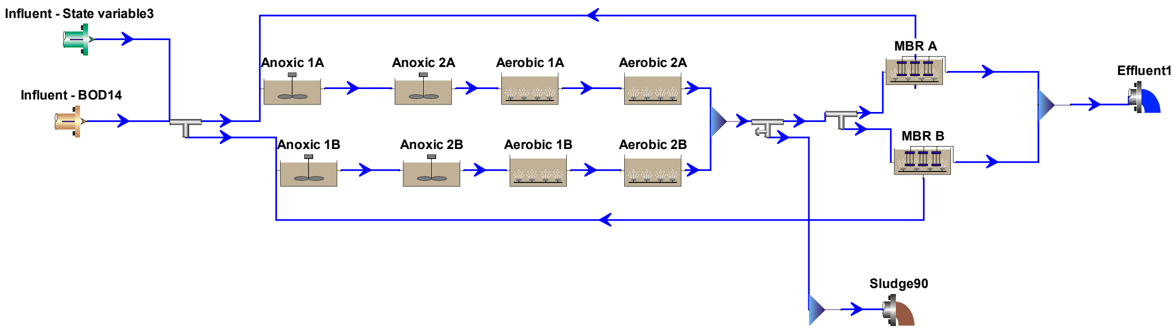
Created: 5/18/2018   Saved: 6/14/2020

Steady state solution

Target SRT: 15.00 days   SRT #0: 14.99 days

Temperature: 22.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1A	0.0100	102.8312	13.000	Un-aerated
Aerobic 1A	0.0300	308.4936	13.000	70
Aerobic 2A	0.0300	308.4936	13.000	70
Anoxic 2A	0.0100	102.8312	13.000	Un-aerated
Anoxic 1B	0.0100	102.8312	13.000	Un-aerated
Aerobic 1B	0.0300	308.4936	13.000	70
Aerobic 2B	0.0300	308.4936	13.000	70
Anoxic 2B	0.0100	102.8312	13.000	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1A	0
Aerobic 1A	2.0
Aerobic 2A	2.0
Anoxic 2A	0
Anoxic 1B	0
Aerobic 1B	2.0
Aerobic 2B	2.0
Anoxic 2B	0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor - MBR units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers	# of cassettes	Displaced volume / cassette [ft3/cassette]	Membrane area / cassette [ft2/cassette]	Total displaced volume [Mil. Gal]	Membrane surface area [ft2]
MBR A	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
MBR B	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
MBR A	2.0
MBR B	2.0

Element name	Split method	Average Split specification
MBR A	Flow paced	200.00 %
MBR B	Flow paced	200.00 %

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
MBR A	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
MBR B	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0

Element name	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
MBR A	101.3250	0.3000
MBR B	101.3250	0.3000

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Off-gas N2O [vol. %]	Surface turbulence factor [-]
MBR A	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
MBR B	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD14
Flow	0.6
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.00
P - Total P mgP/L	6.50
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.20
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.20
Metal soluble - Magnesium mg/L	3.28
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD14
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.6770
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717

FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter66	Fraction	0.50
Splitter7	Flowrate [Side]	0.015213631508132
Splitter8	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

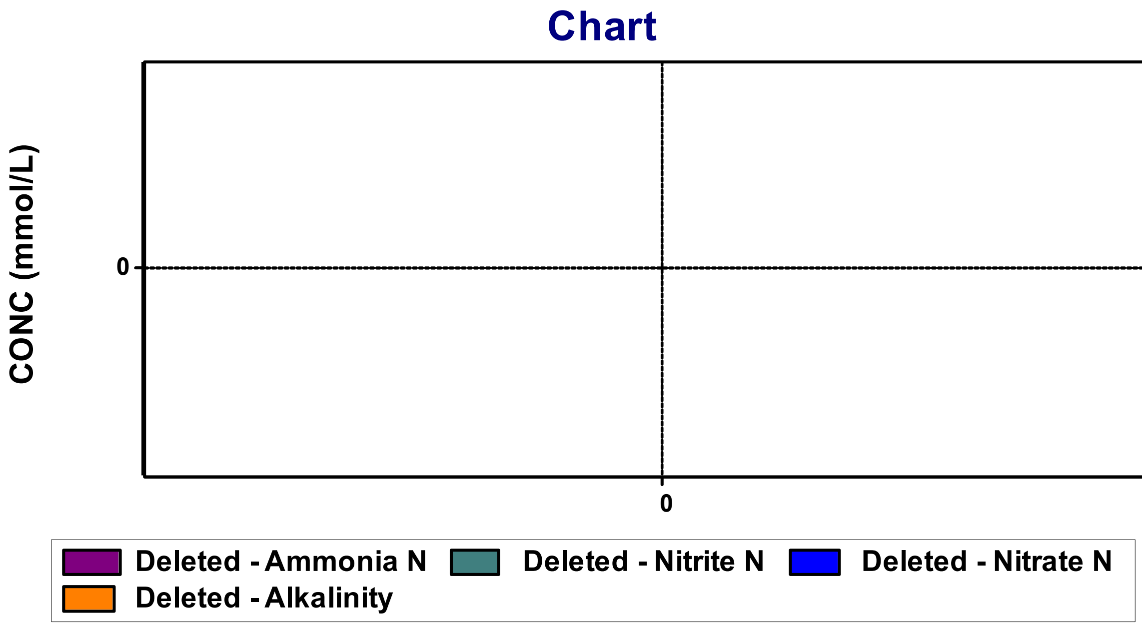
Element name	Influent - State variable3
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0

N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0

User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0001

BioWin Album

Album page - Nitrogen species



Album page - BOD_TSS

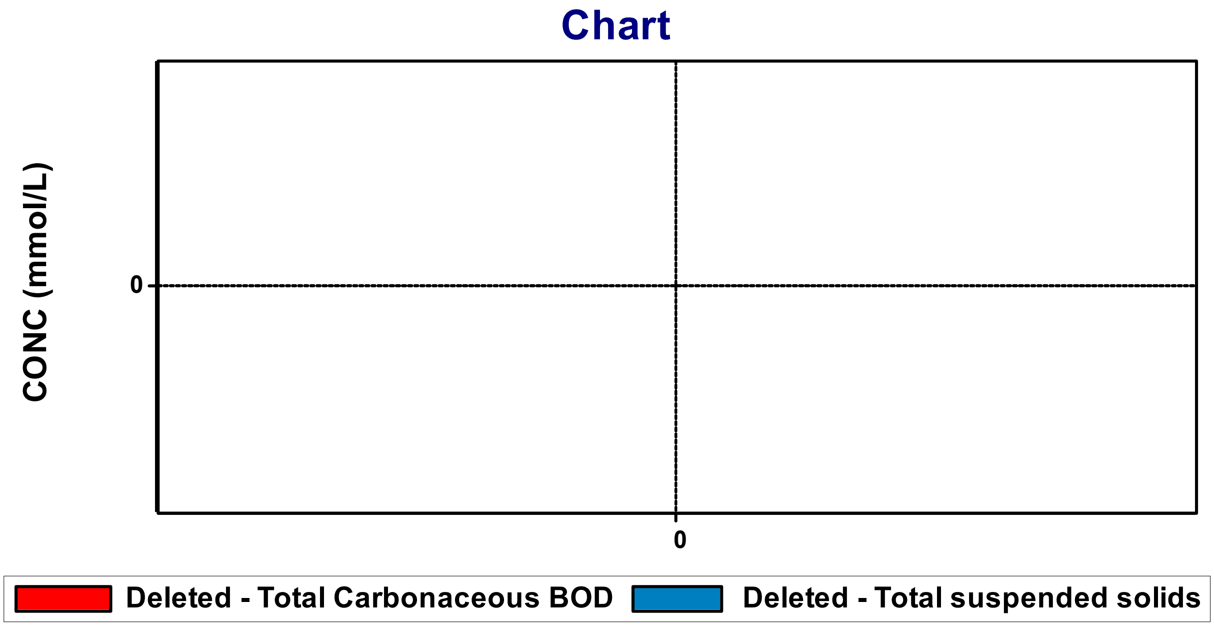


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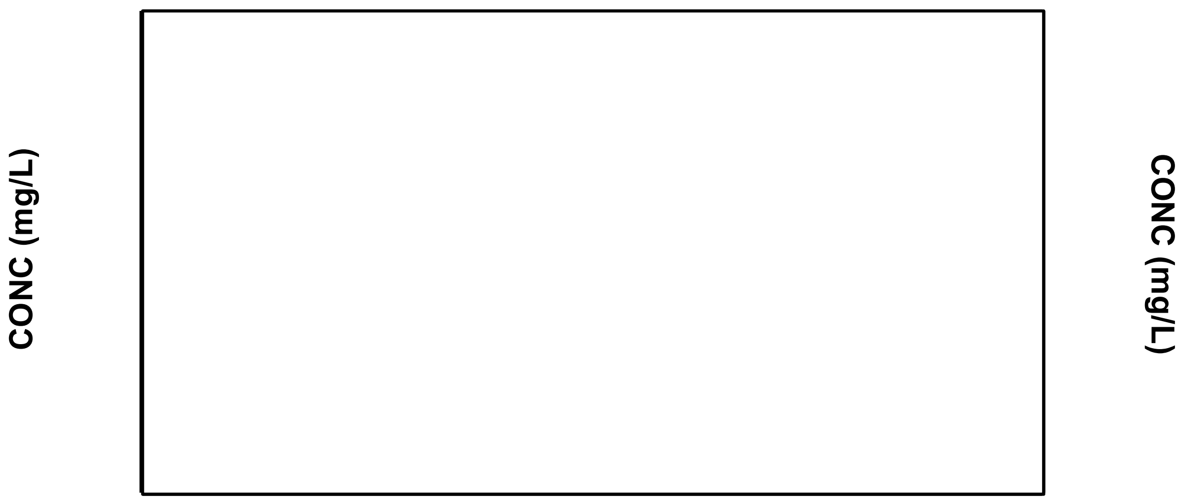
Chart



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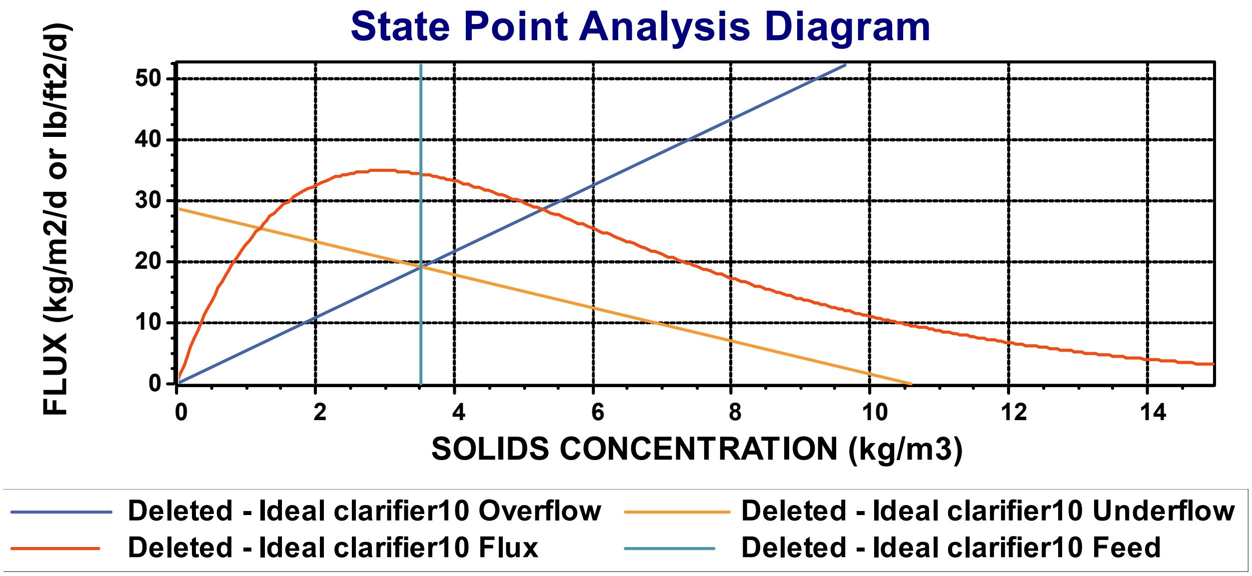

K = 0.3362 m3/kg
Vo = 511.2 ft/d

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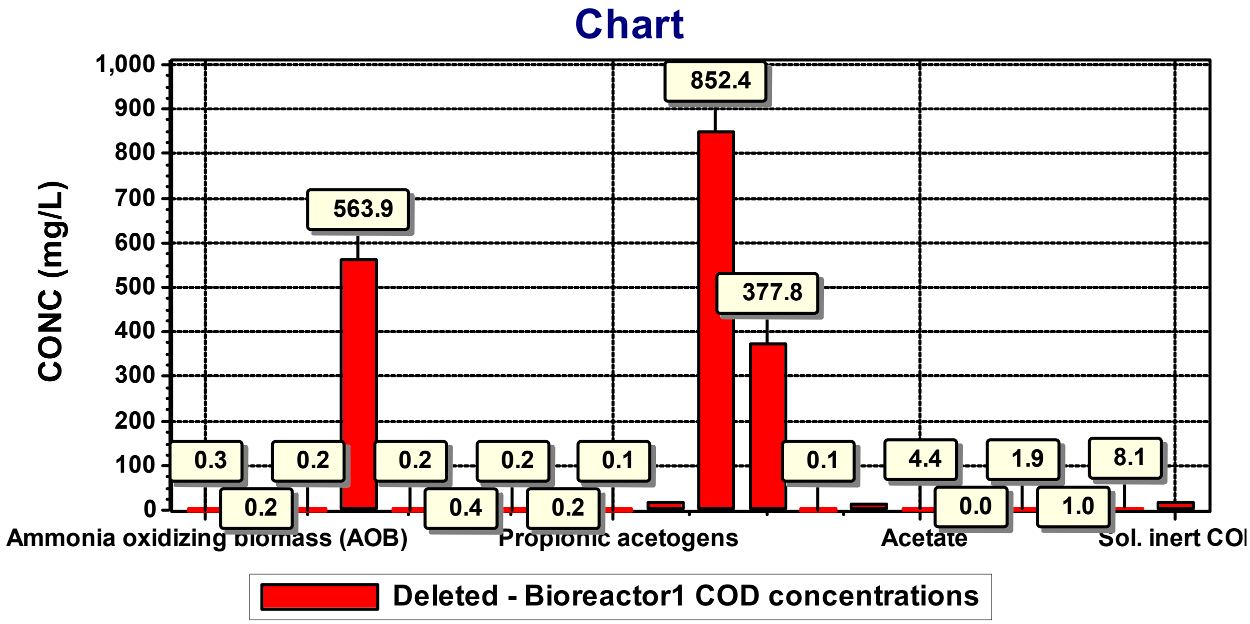

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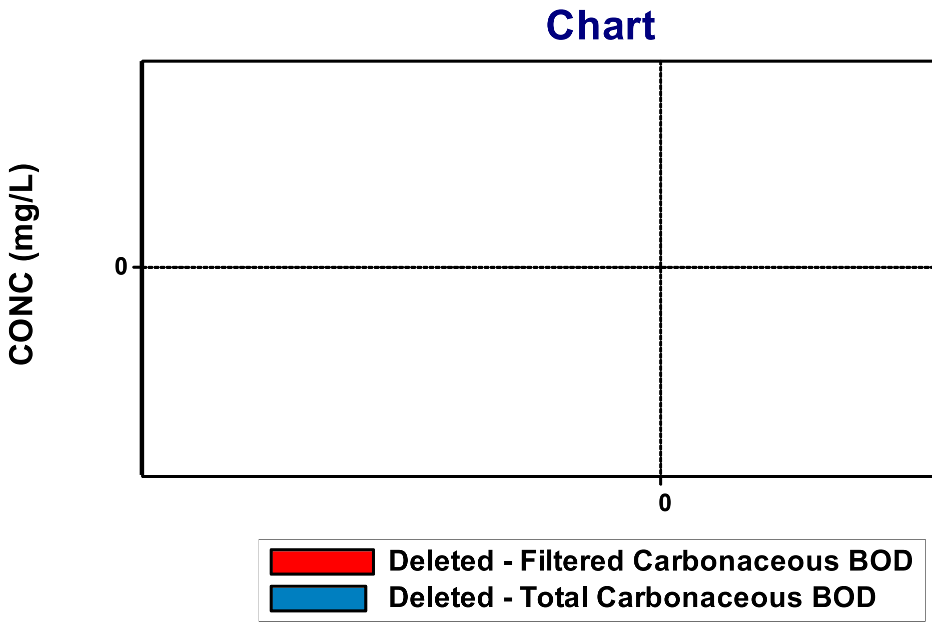

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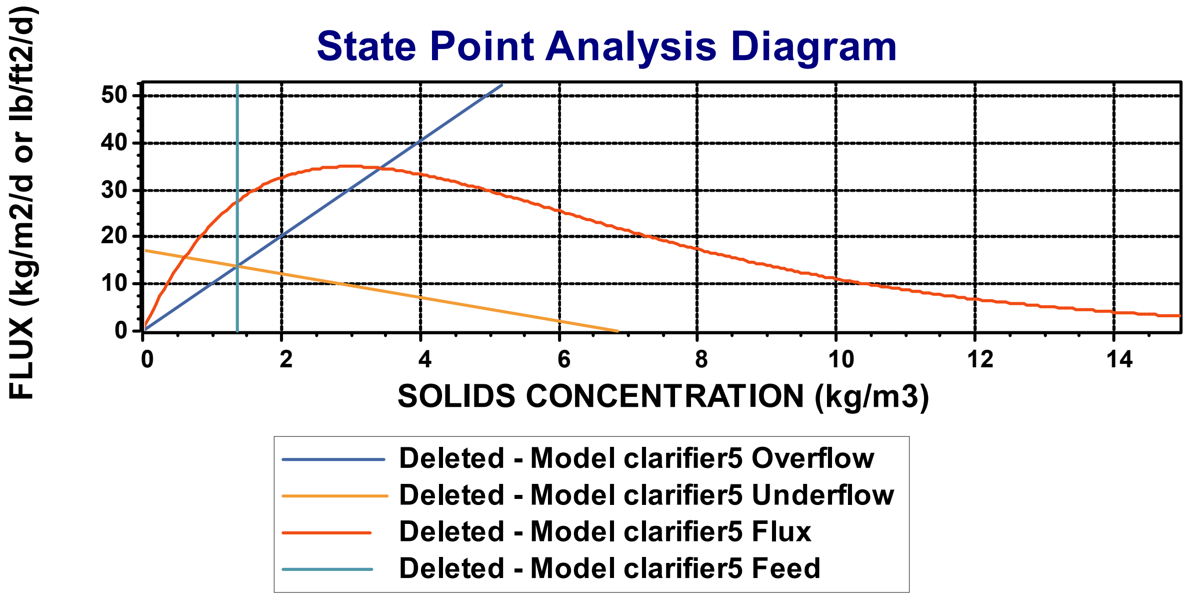

K = 0.3360 m3/kg
Vo = 511.2 ft/d

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Sludge90

State variable	Conc. (mg/L)	Mass rate (lb/d)	Notes
Biomass - Acetoclastic methanogenic	0.27	0.03	
Biomass - Ammonia oxidizing	80.84	10.26	
Biomass - Anaerobic ammonia oxidizing	2.41	0.31	
Biomass - Endogenous products	2339.55	297.04	
Biomass - Hydrogenotrophic methanogenic	0.06	0.01	
Biomass - Methylotrophic	1.68	0.21	
Biomass - Nitrite oxidizing	49.65	6.30	
Biomass - Ordinary heterotrophic	3273.73	415.65	
Biomass - Phosphorus accumulating	1.26	0.16	
Biomass - Propionic acetogenic	0.31	0.04	
Biomass - Sulfur oxidizing	0	0	
Biomass - Sulfur reducing acetotrophic	0	0	
Biomass - Sulfur reducing hydrogenotrophic	0.00	0.00	
Biomass - Sulfur reducing propionic acetogenic	0	0	
CODp - Adsorbed hydrocarbon	0	0	
CODp - Degradable external organics	0	0	
CODp - Slowly degradable colloidal	0.02	0.00	
CODp - Slowly degradable particulate	177.40	22.52	
CODp - Stored PHA	0.00	0.00	
CODp - Undegradable cellulose	1872.26	237.71	
CODp - Undegradable non-cellulose	1872.26	237.71	
CODs - Acetate	0.00	0.00	
CODs - Complex readily degradable	1.44	0.18	
CODs - Degradable volatile ind. #1	0	0	
CODs - Degradable volatile ind. #2	0	0	
CODs - Degradable volatile ind. #3	0	0	
CODs - Methanol	0.00	0.00	
CODs - Propionate	0.00	0.00	
CODs - Soluble hydrocarbon	0	0	
CODs - Undegradable	47.47	6.03	
Gas - Dissolved hydrogen	0.01	0.00	

Gas - Dissolved methane	0.00	0.00	
Gas - Dissolved nitrogen	15.67	1.99	
Gas - Dissolved nitrous oxide	0	0	
Gas - Dissolved oxygen	2.00	0.25	
Gas - Dissolved total CO2	3.31	0.19	mmol/L and kmol/d
Gas - Dissolved total sulfides	0.00	0.00	
HAO - Aged	0	0	
HAO - High surface	0	0	
HAO - High with H2PO4- adsorbed	0	0	
HAO - Low surface	0	0	
HAO - Low with H2PO4- adsorbed	0	0	
HFO - Aged	0	0	
HFO - High surface	0	0	
HFO - High with H+ adsorbed	0	0	
HFO - High with H2PO4- adsorbed	0	0	
HFO - Low surface	0	0	
HFO - Low with H+ adsorbed	0	0	
HFO - Low with H2PO4- adsorbed	0	0	
Influent inorganic suspended solids	1315.40	167.01	
Metal soluble - Aluminum	0	0	
Metal soluble - Calcium	12.41	1.58	
Metal soluble - Ferric	0	0	
Metal soluble - Ferrous	0	0	
Metal soluble - Magnesium	2.94	0.37	
N - Ammonia	0.14	0.02	
N - Nitrate	11.31	1.44	
N - Nitrite	0.06	0.01	
N - Particulate degradable external organics	0	0	
N - Particulate degradable organic	8.13	1.03	
N - Particulate undegradable	131.06	16.64	
N - Soluble degradable organic	0.55	0.07	
N - Soluble undegradable organic	1.16	0.15	
Other Anions (strong acids)	4.98	0.29	meq/L and keq/d
Other Cations (strong bases)	7.31	0.42	meq/L and keq/d
P - Bound on aged HMO	0	0	

P - Particulate degradable external organics	0	0
P - Particulate degradable organic	2.63	0.33
P - Particulate undegradable	41.19	5.23
P - Releasable stored polyP	0.14	0.02
P - Soluble phosphate	2.04	0.26
P - Unreleasable stored polyP	0.01	0.00
Precipitate - Brushite	0	0
Precipitate - Ferrous sulfide	0	0
Precipitate - Hydroxy - apatite	0	0
Precipitate - Struvite	0	0
Precipitate - Vivianite	0	0
S - Particulate elemental sulfur	0	0
S - Soluble sulfate	0	0
User defined - UD1	0	0
User defined - UD2	0	0
User defined - UD3	0	0
User defined - UD4	0	0

Parameter	Value	Units
Cost (Sludge)	0	$/hour
Power	0	kW
Power cost (Excl. heating)	0	$/hour

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Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [m	BOD - Filtered Carbonaceous [m	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [m	N - Total N [mgN/L]	N - Total Kjeldahl Nitrogen [m	N - Ammonia [mgN/L]	N - Nitrate [mgN/L]	N - Nitrite [mgN/L]	pH []	Alkalinity [mmol/L]	OUR - Carbonaceous [mgO	OUR - Nitrification [mgO/L/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Airflow rate [ft3/min (20C, 1 at	Alpha [[]]

			g/L]	g/L]				g/L]		gN/L]						/L/hr]				m)]	
Influent - BOD14	0.60	22.00	349.96	159.83	730.36	302.19	338.00	302.00	58.00	58.00	42.65	0	0	7.20	4.00	-----	-----	-----	-----	-----	-----
Anoxic 1A	1.50	22.00	2042.07	6.61	9771.05	58.50	8652.73	6858.66	556.77	551.58	8.73	5.08	0.11	7.28	3.37	0	0	0	0	0	0.50
Aerobic 1A	1.50	22.00	2023.83	1.16	9743.45	49.19	8640.61	6845.78	555.06	544.95	1.65	9.12	0.99	6.75	2.53	49.71	57.91	107.62	193.80	904.20	0.22
Aerobic 2A	1.50	22.00	2008.81	1.03	9720.63	48.93	8625.08	6829.89	554.90	543.53	0.14	11.31	0.06	6.69	2.32	46.58	15.72	62.30	76.65	318.15	0.31
Anoxic 2A	1.50	22.00	2038.86	1.69	9766.66	50.58	8655.25	6861.15	555.23	551.58	8.94	3.54	0.12	7.29	3.50	0	0	0	0	0	0.50
MBR A	0.29	22.00	0.97	0.97	48.85	48.85	0	0	13.47	1.78	0.05	11.68	0.01	6.79	2.30	53.18	7.49	60.67	51.22	784.67	0.38
MBR A (U)	1.20	22.00	2477.66	0.97	12046.63	48.85	10705.23	8472.56	686.69	675.00	0.05	11.68	0.01	6.78	2.30	-----	-----	-----	-----	-----	-----
Effluent 1	0.58	22.00	0.97	0.97	48.85	48.85	0	0	13.47	1.78	0.05	11.68	0.01	6.78	2.30	-----	-----	-----	-----	-----	-----
Sludge 90	0.02	22.00	2008.81	1.03	9720.63	48.93	8625.08	6829.89	554.90	543.53	0.14	11.31	0.06	6.69	2.32	-----	-----	-----	-----	-----	-----

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Sludge90

State variable	Conc. (mg/L)	Mass rate (lb/d)	Notes
Biomass - Acetoclastic methanogenic	0.27	0.03	
Biomass - Ammonia oxidizing	80.84	10.26	
Biomass - Anaerobic ammonia oxidizing	2.41	0.31	
Biomass - Endogenous products	2339.55	297.04	
Biomass - Hydrogenotrophic methanogenic	0.06	0.01	
Biomass - Methylotrophic	1.68	0.21	
Biomass - Nitrite oxidizing	49.65	6.30	
Biomass - Ordinary heterotrophic	3273.73	415.65	
Biomass - Phosphorus accumulating	1.26	0.16	
Biomass - Propionic acetogenic	0.31	0.04	
Biomass - Sulfur oxidizing	0	0	
Biomass - Sulfur reducing acetotrophic	0	0	
Biomass - Sulfur reducing hydrogenotrophic	0.00	0.00	
Biomass - Sulfur reducing propionic acetogenic	0	0	
CODp - Adsorbed hydrocarbon	0	0	
CODp - Degradable external organics	0	0	
CODp - Slowly degradable colloidal	0.02	0.00	
CODp - Slowly degradable particulate	177.40	22.52	
CODp - Stored PHA	0.00	0.00	
CODp - Undegradable cellulose	1872.26	237.71	
CODp - Undegradable non-cellulose	1872.26	237.71	
CODs - Acetate	0.00	0.00	
CODs - Complex readily degradable	1.44	0.18	
CODs - Degradable volatile ind. #1	0	0	
CODs - Degradable volatile ind. #2	0	0	
CODs - Degradable volatile ind. #3	0	0	
CODs - Methanol	0.00	0.00	
CODs - Propionate	0.00	0.00	
CODs - Soluble hydrocarbon	0	0	
CODs - Undegradable	47.47	6.03	
Gas - Dissolved hydrogen	0.01	0.00	
Gas - Dissolved methane	0.00	0.00	
Gas - Dissolved nitrogen	15.67	1.99	
Gas - Dissolved nitrous oxide	0	0	
Gas - Dissolved oxygen	2.00	0.25	

Gas - Dissolved total CO2	3.31	0.19	mmol/L and kmol/d
Gas - Dissolved total sulfides	0.00	0.00	
HAO - Aged	0	0	
HAO - High surface	0	0	
HAO - High with H2PO4- adsorbed	0	0	
HAO - Low surface	0	0	
HAO - Low with H2PO4- adsorbed	0	0	
HFO - Aged	0	0	
HFO - High surface	0	0	
HFO - High with H+ adsorbed	0	0	
HFO - High with H2PO4- adsorbed	0	0	
HFO - Low surface	0	0	
HFO - Low with H+ adsorbed	0	0	
HFO - Low with H2PO4- adsorbed	0	0	
Influent inorganic suspended solids	1315.40	167.01	
Metal soluble - Aluminum	0	0	
Metal soluble - Calcium	12.41	1.58	
Metal soluble - Ferric	0	0	
Metal soluble - Ferrous	0	0	
Metal soluble - Magnesium	2.94	0.37	
N - Ammonia	0.14	0.02	
N - Nitrate	11.31	1.44	
N - Nitrite	0.06	0.01	
N - Particulate degradable external organics	0	0	
N - Particulate degradable organic	8.13	1.03	
N - Particulate undegradable	131.06	16.64	
N - Soluble degradable organic	0.55	0.07	
N - Soluble undegradable organic	1.16	0.15	
Other Anions (strong acids)	4.98	0.29	meq/L and keq/d
Other Cations (strong bases)	7.31	0.42	meq/L and keq/d
P - Bound on aged HMO	0	0	
P - Particulate degradable external organics	0	0	
P - Particulate degradable organic	2.63	0.33	
P - Particulate undegradable	41.19	5.23	
P - Releasable stored polyP	0.14	0.02	

P - Soluble phosphate	2.04	0.26
P - Unreleasable stored polyP	0.01	0.00
Precipitate - Brushite	0	0
Precipitate - Ferrous sulfide	0	0
Precipitate - Hydroxy - apatite	0	0
Precipitate - Struvite	0	0
Precipitate - Vivianite	0	0
S - Particulate elemental sulfur	0	0
S - Soluble sulfate	0	0
User defined - UD1	0	0
User defined - UD2	0	0
User defined - UD3	0	0
User defined - UD4	0	0

Parameter	Value	Units
Cost (Sludge)	0	$/hour
Power	0	kW
Power cost (Excl. heating)	0	$/hour

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000

Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000

Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000

Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290

H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000

Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000

Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000

Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220

Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220

Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927

Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Properties constants

Name	Default	Value

K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7
A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2000	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1734.0000	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5000	-39.4800

Metal salt solution densities

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

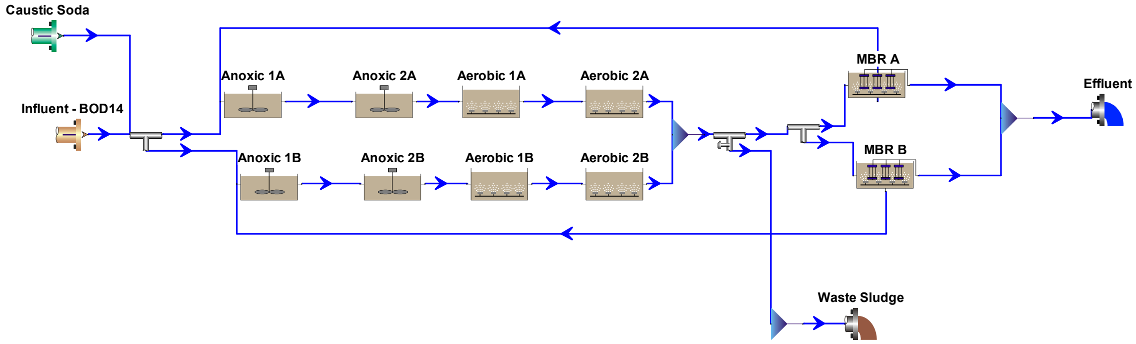
Plant name: Unknown   User name: Jason.Flowers

Created: 5/18/2018   Saved: 10/3/2020

Steady state solution

Target SRT: 15.00 days   SRT #0: 14.99 days

Temperature: 11.0°C



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1A	0.0100	102.8312	13.000	Un-aerated
Aerobic 1A	0.0300	308.4936	13.000	70
Aerobic 2A	0.0300	308.4936	13.000	70
Anoxic 2A	0.0100	102.8312	13.000	Un-aerated
Anoxic 1B	0.0100	102.8312	13.000	Un-aerated
Aerobic 1B	0.0300	308.4936	13.000	70
Aerobic 2B	0.0300	308.4936	13.000	70
Anoxic 2B	0.0100	102.8312	13.000	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1A	0
Aerobic 1A	2.0
Aerobic 2A	2.0
Anoxic 2A	0
Anoxic 1B	0
Aerobic 1B	2.0
Aerobic 2B	2.0
Anoxic 2B	0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor - MBR units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers	# of cassettes	Displaced volume / cassette [ft3/cassette]	Membrane area / cassette [ft2/cassette]	Total displaced volume [Mil. Gal]	Membrane surface area [ft2]
MBR A	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
MBR B	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
MBR A	2.0
MBR B	2.0

Element name	Split method	Average Split specification
MBR A	Flow paced	200.00 %
MBR B	Flow paced	200.00 %

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
MBR A	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
MBR B	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0

Element name	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
MBR A	101.3250	0.3000
MBR B	101.3250	0.3000

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Off-gas N2O [vol. %]	Surface turbulence factor [-]
MBR A	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
MBR B	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD14
Flow	1.14
BOD - Total Carbonaceous mgBOD/L	179.00
Volatile suspended solids mg/L	181.26
Total suspended solids mg/L	202.80
N - Total Kjeldahl Nitrogen mgN/L	30.90
P - Total P mgP/L	6.50
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	80.00
Metal soluble - Magnesium mg/L	15.00
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD14
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8354
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717

FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter66	Fraction	0.50
Splitter7	Flowrate [Side]	0.0152163268747883
Splitter8	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

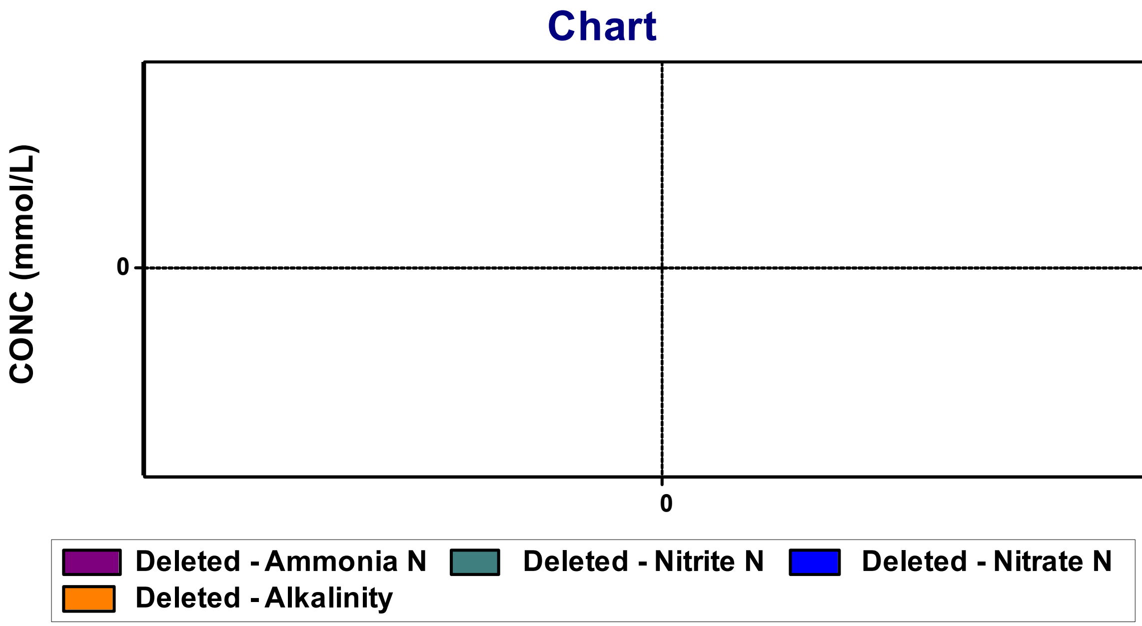
Element name	Caustic Soda
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0
N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0

N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0

User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0001

BioWin Album

Album page - Nitrogen species



Album page - BOD_TSS

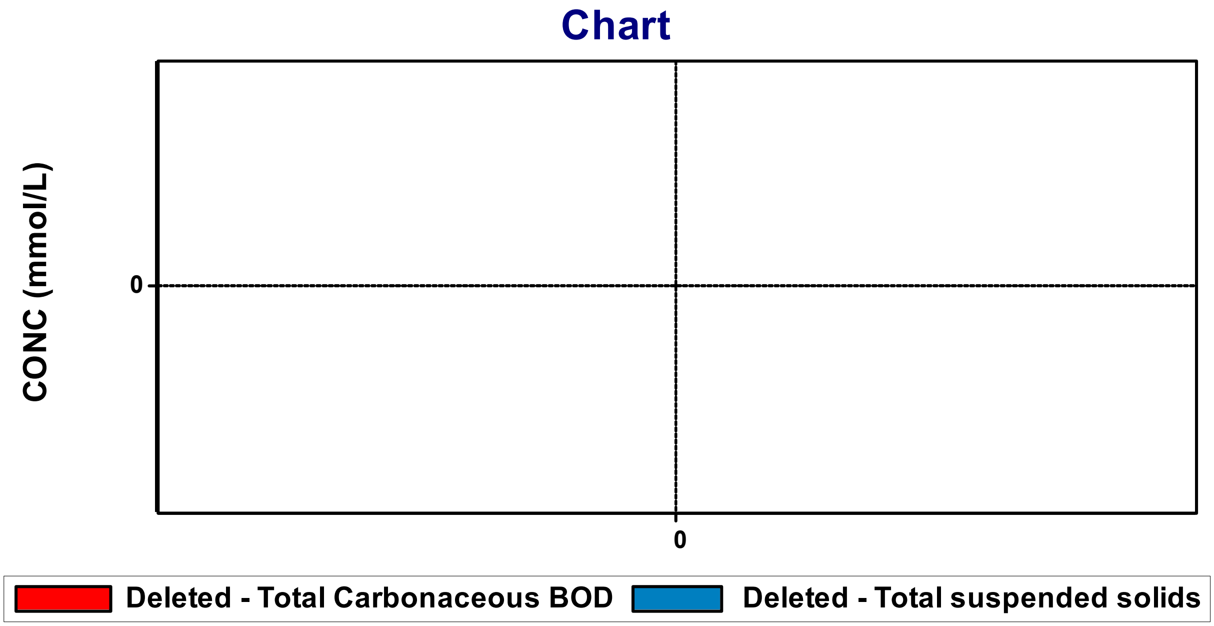


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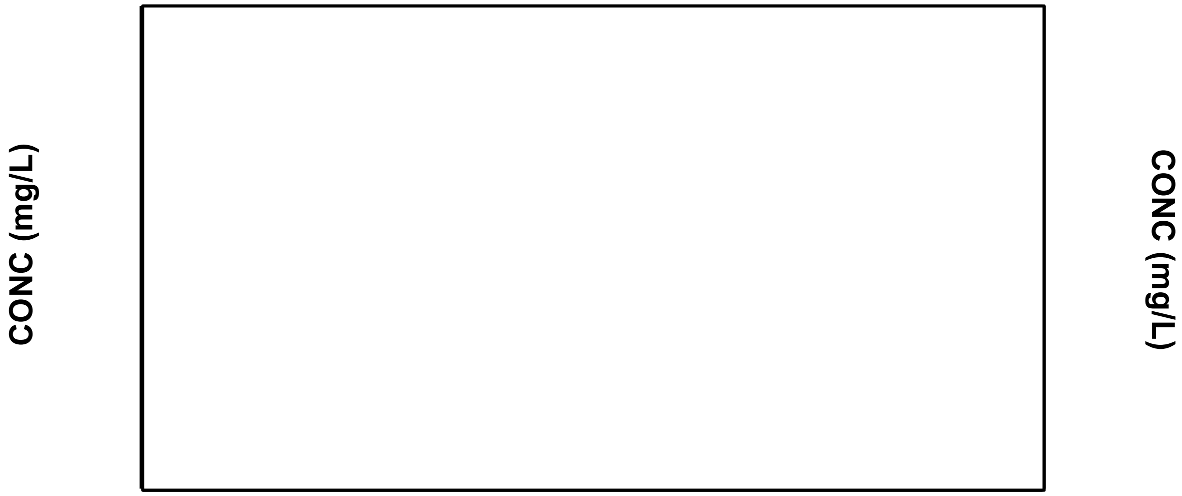
Chart



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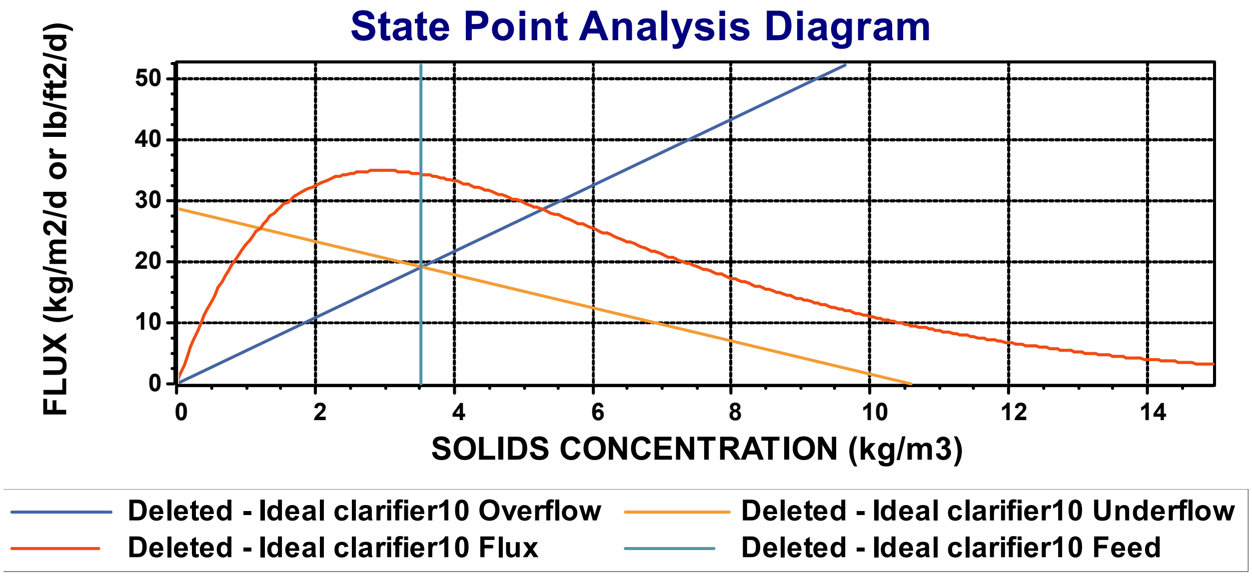
Album page - Page 5



K = 0.3362 m3/kg
Vo = 511.2 ft/d

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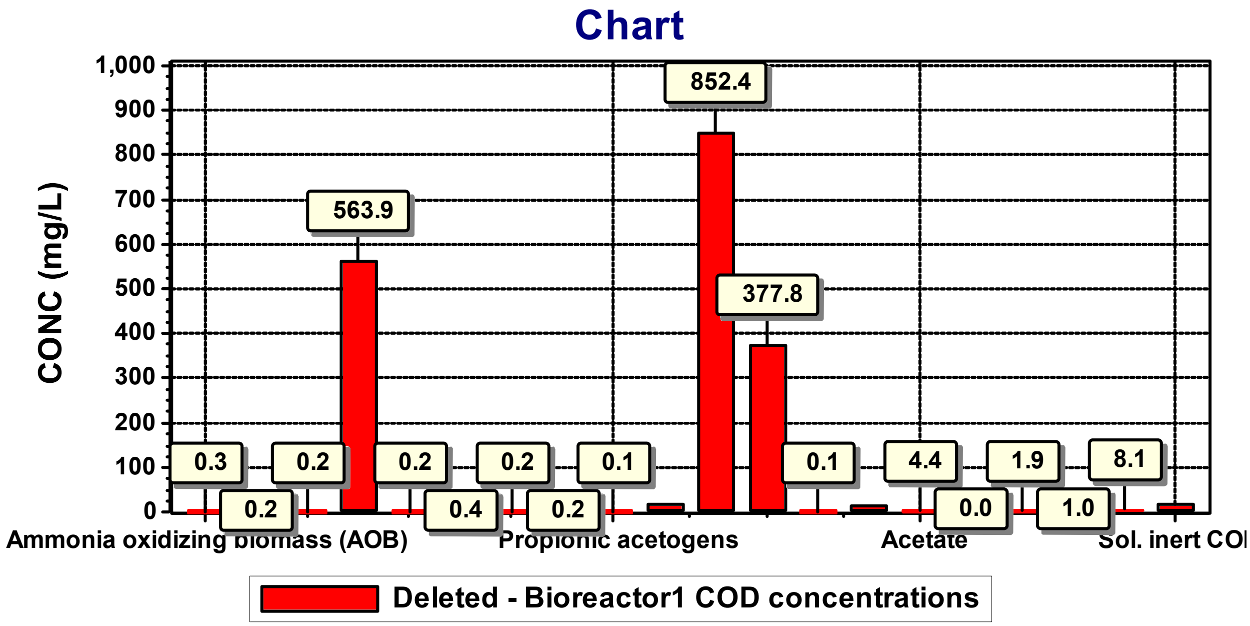

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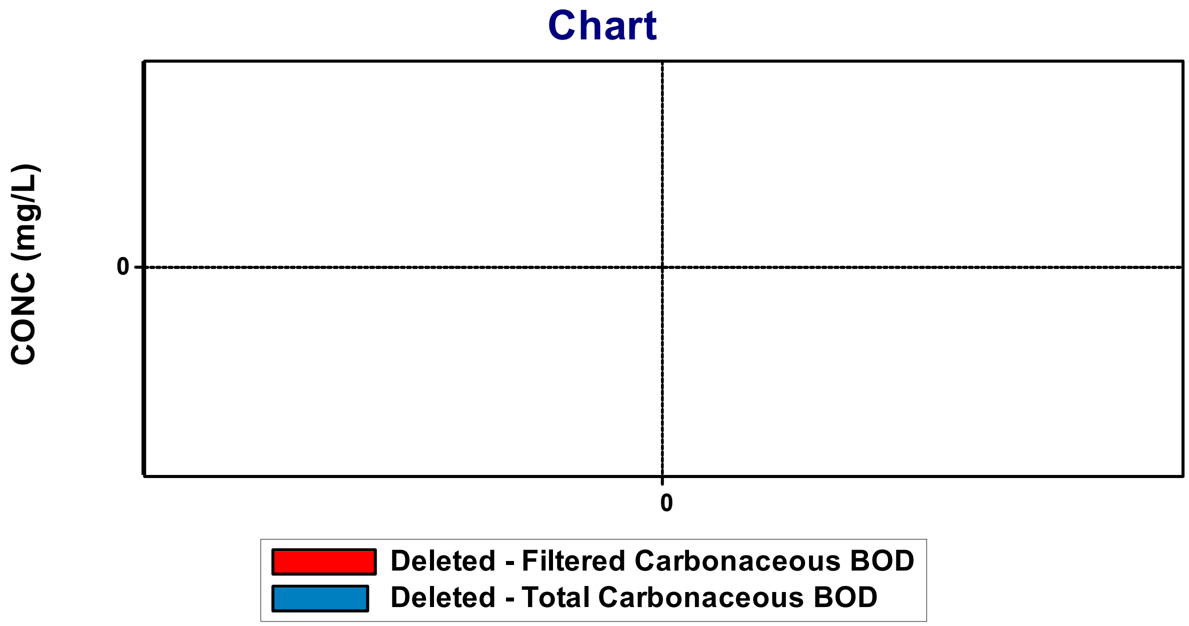

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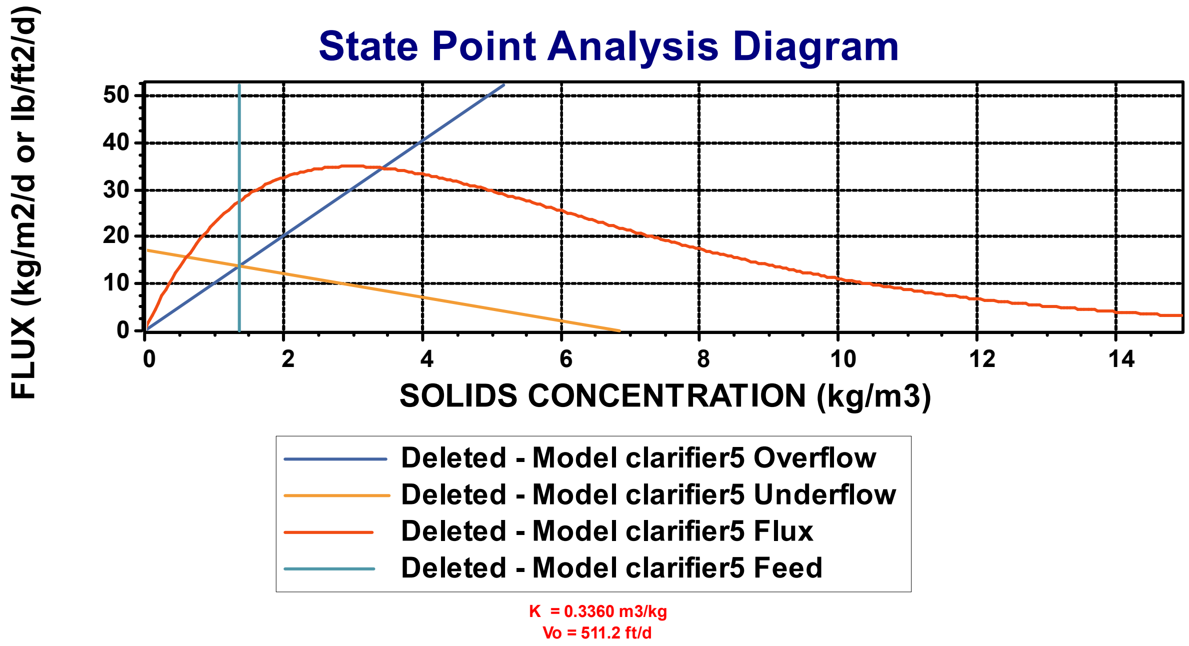

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Waste Sludge			
State variable	Conc. (mg/L)	Mass rate (lb/d)	Notes
Biomass - Acetoclastic methanogenic	0.35	0.04	
Biomass - Ammonia oxidizing	92.50	11.75	
Biomass - Anaerobic ammonia oxidizing	2.37	0.30	
Biomass - Endogenous products	2124.57	269.79	
Biomass - Hydrogenotrophic methanogenic	0.08	0.01	
Biomass - Methylotrophic	1.92	0.24	
Biomass - Nitrite oxidizing	56.85	7.22	
Biomass - Ordinary heterotrophic	4069.93	516.83	
Biomass - Phosphorus accumulating	1.23	0.16	
Biomass - Propionic acetogenic	0.40	0.05	
Biomass - Sulfur oxidizing	0.00	0.00	
Biomass - Sulfur reducing acetotrophic	0.00	0.00	
Biomass - Sulfur reducing hydrogenotrophic	0.00	0.00	
Biomass - Sulfur reducing propionic acetogenic	0	0	
CODp - Adsorbed hydrocarbon	0	0	
CODp - Degradable external organics	0.00	0.00	
CODp - Slowly degradable colloidal	0.04	0.01	
CODp - Slowly degradable particulate	233.60	29.66	
CODp - Stored PHA	0.00	0.00	
CODp - Undegradable cellulose	1818.98	230.99	
CODp - Undegradable non-cellulose	1818.98	230.99	
CODs - Acetate	0.00	0.00	
CODs - Complex readily degradable	1.38	0.17	
CODs - Degradable volatile ind. #1	0	0	
CODs - Degradable volatile ind. #2	0	0	
CODs - Degradable volatile ind. #3	0	0	
CODs - Methanol	0.00	0.00	
CODs - Propionate	0.00	0.00	
CODs - Soluble hydrocarbon	0	0	
CODs - Undegradable	24.28	3.08	
Gas - Dissolved hydrogen	0.01	0.00	

Gas - Dissolved methane	0.00	0.00	
Gas - Dissolved nitrogen	19.06	2.42	
Gas - Dissolved nitrous oxide	0	0	
Gas - Dissolved oxygen	2.00	0.25	
Gas - Dissolved total CO2	2.40	0.14	mmol/L and kmol/d
Gas - Dissolved total sulfides	0.00	0.00	
HAO - Aged	0	0	
HAO - High surface	0	0	
HAO - High with H2PO4- adsorbed	0	0	
HAO - Low surface	0	0	
HAO - Low with H2PO4- adsorbed	0	0	
HFO - Aged	0	0	
HFO - High surface	0	0	
HFO - High with H+ adsorbed	0	0	
HFO - High with H2PO4- adsorbed	0	0	
HFO - Low surface	0	0	
HFO - Low with H+ adsorbed	0	0	
HFO - Low with H2PO4- adsorbed	0	0	
Influent inorganic suspended solids	1500.15	190.50	
Metal soluble - Aluminum	0	0	
Metal soluble - Calcium	80.57	10.23	
Metal soluble - Ferric	0	0	
Metal soluble - Ferrous	0	0	
Metal soluble - Magnesium	14.79	1.88	
N - Ammonia	1.13	0.14	
N - Nitrate	5.47	0.69	
N - Nitrite	0.42	0.05	
N - Particulate degradable external organics	0.00	0.00	
N - Particulate degradable organic	10.44	1.33	
N - Particulate undegradable	127.33	16.17	
N - Soluble degradable organic	0.55	0.07	
N - Soluble undegradable organic	0.62	0.08	
Other Anions (strong acids)	9.69	0.56	meq/L and keq/d
Other Cations (strong bases)	6.06	0.35	meq/L and keq/d
P - Bound on aged HMO	0	0	

P - Particulate degradable external organics	0	0
P - Particulate degradable organic	4.07	0.52
P - Particulate undegradable	40.02	5.08
P - Releasable stored polyP	0.15	0.02
P - Soluble phosphate	3.93	0.50
P - Unreleasable stored polyP	0.01	0.00
Precipitate - Brushite	0	0
Precipitate - Ferrous sulfide	0	0
Precipitate - Hydroxy - apatite	0	0
Precipitate - Struvite	0	0
Precipitate - Vivianite	0	0
S - Particulate elemental sulfur	0.00	0.00
S - Soluble sulfate	0.00	0.00
User defined - UD1	0	0
User defined - UD2	0	0
User defined - UD3	0	0
User defined - UD4	0	0

Parameter	Value	Units
Cost (Sludge)	0	$/hour
Power	0	kW
Power cost (Excl. heating)	0	$/hour

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Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [m	BOD - Filtered Carbonaceous [m	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [m	N - Total N [mgN/L]	N - Total Kjeldahl Nitrogen [m	N - Ammonia [mgN/L]	N - Nitrate [mgN/L]	N - Nitrite [mgN/L]	pH []	Alkalinity [mmol/L]	OUR - Carbonaceous [mgO	OUR - Nitrification [mgO/L/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Air flow rate [ft3/min (20C, 1 at	Alpha [[]]

			g/L]	g/L]				g/L]		gN/L]						/L/hr]				m)]	
Influent-BOD14	1.14	11.00	178.98	60.00	373.52	116.48	202.80	181.26	30.90	30.90	22.72	0	0	7.10	2.00	-----	-----	-----	-----	-----	-----
Anoxic 1A	2.85	11.00	2512.94	3.90	10271.99	30.59	9260.14	7230.55	591.46	588.10	4.88	3.25	0.11	6.73	1.59	0	0	0	0	0	0.50
Aerobic 1A	2.85	11.00	2503.92	1.13	10258.41	25.98	9254.16	7224.24	590.55	586.09	2.76	3.99	0.47	6.47	1.36	44.27	32.95	77.22	117.77	516.02	0.27
Aerobic 2A	2.85	11.00	2496.73	1.00	10247.47	25.72	9246.89	7216.72	590.47	584.58	1.13	5.47	0.42	6.35	1.14	43.53	26.10	69.63	89.68	379.65	0.29
Anoxic 2A	2.85	11.00	2511.10	1.42	10269.62	26.82	9261.17	7231.54	590.63	588.10	5.03	2.42	0.11	6.75	1.66	0	0	0	0	0	0.50
MBRA	0.56	11.00	0.94	0.94	25.62	25.62	0	0	8.10	1.49	0.30	6.51	0.11	6.31	1.03	52.43	17.33	69.76	60.51	927.10	0.37
MBRA(U)	2.28	11.00	3102.32	0.95	12753.76	25.63	11517.51	8986.28	734.02	727.41	0.30	6.51	0.11	6.38	1.03	-----	-----	-----	-----	-----	-----
Effluent	1.12	11.00	0.94	0.94	25.62	25.62	0	0	8.10	1.49	0.30	6.51	0.11	6.38	1.03	-----	-----	-----	-----	-----	-----
Waste Sludge	0.02	11.00	2496.73	1.00	10247.47	25.72	9246.89	7216.72	590.47	584.58	1.13	5.47	0.42	6.35	1.14	-----	-----	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600

Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290

H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350

Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

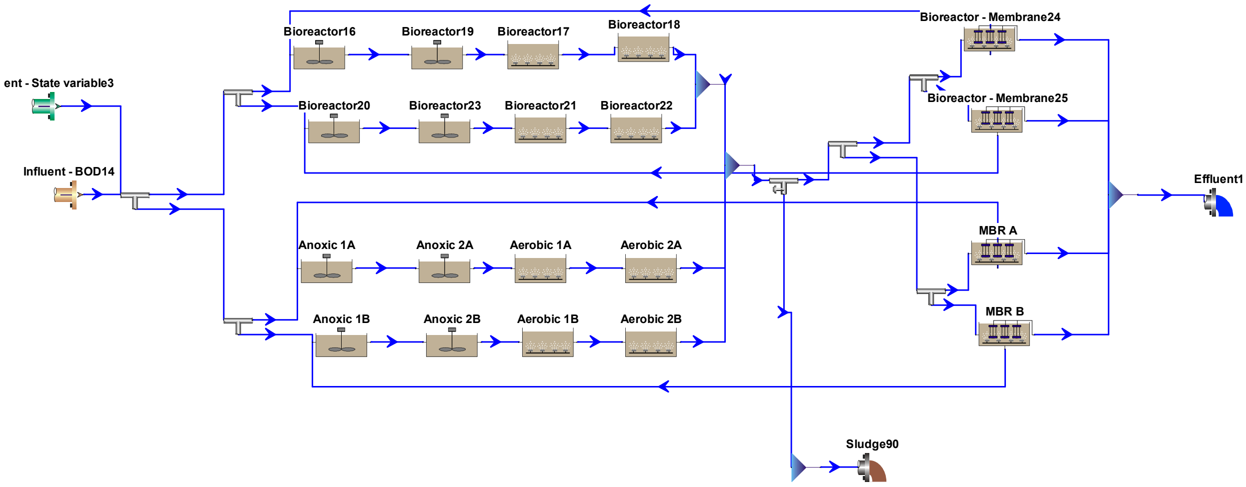
Created: 5/18/2018 Saved: 6/22/2020

Steady state solution

Target SRT: 15.00 days SRT #0: 15.00 days

Temperature: 22.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1A	0.0100	102.8312	13.000	Un-aerated
Aerobic 1A	0.0300	308.4936	13.000	70
Aerobic 2A	0.0300	308.4936	13.000	70
Anoxic 2A	0.0100	102.8312	13.000	Un-aerated
Anoxic 1B	0.0100	102.8312	13.000	Un-aerated
Aerobic 1B	0.0300	308.4936	13.000	70
Aerobic 2B	0.0300	308.4936	13.000	70
Anoxic 2B	0.0100	102.8312	13.000	Un-aerated
Bioreactor16	0.0100	102.8312	13.000	Un-aerated
Bioreactor17	0.0300	308.4936	13.000	70
Bioreactor18	0.0300	308.4936	13.000	70
Bioreactor19	0.0100	102.8312	13.000	Un-aerated
Bioreactor20	0.0100	102.8312	13.000	Un-aerated
Bioreactor21	0.0300	308.4936	13.000	70
Bioreactor22	0.0300	308.4936	13.000	70
Bioreactor23	0.0100	102.8312	13.000	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1A	0
Aerobic 1A	2.0
Aerobic 2A	2.0
Anoxic 2A	0
Anoxic 1B	0
Aerobic 1B	2.0
Aerobic 2B	2.0

Anoxic 2B	0
Bioreactor16	0
Bioreactor17	2.0
Bioreactor18	2.0
Bioreactor19	0
Bioreactor20	0
Bioreactor21	2.0
Bioreactor22	2.0
Bioreactor23	0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor16	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor17	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Bioreactor18	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor19	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor20	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor21	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor22	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor23	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor - MBR units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers	# of cassettes	Displaced volume / cassette [ft3/cassette]	Membrane area / cassette [ft2/cassette]	Total displaced volume [Mil. Gal]	Membrane surface area [ft2]
MBR A	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
MBR B	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
Bioreactor - Membrane24	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
Bioreactor - Membrane25	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
MBR A	2.0

MBR B	2.0
Bioreactor - Membrane24	2.0
Bioreactor - Membrane25	2.0

Element name	Split method	Average Split specification
MBR A	Flow paced	200.00 %
MBR B	Flow paced	200.00 %
Bioreactor - Membrane24	Flow paced	200.00 %
Bioreactor - Membrane25	Flow paced	200.00 %

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
MBR A	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
MBR B	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
Bioreactor - Membrane24	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
Bioreactor - Membrane25	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0

Element name	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
MBR A	101.3250	0.3000
MBR B	101.3250	0.3000
Bioreactor - Membrane24	101.3250	0.3000

Bioreactor - Membrane25	101.3250	0.3000	

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Off-gas N2O [vol. %]	Surface turbulence factor [-]
MBR A	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
MBR B	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
Bioreactor - Membrane24	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
Bioreactor - Membrane25	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD14
Flow	1.21
BOD - Total Carbonaceous mgBOD/L	339.00
Volatile suspended solids mg/L	303.00
Total suspended solids mg/L	327.00
N - Total Kjeldahl Nitrogen mgN/L	56.00
P - Total P mgP/L	6.50
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	80.00
Metal soluble - Magnesium mg/L	15.00
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD14
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.7097
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter66	Fraction	0.50
Splitter7	Flowrate [Side]	0.0295245821878847
Splitter8	Fraction	0.50
Splitter28	Fraction	0.50
Splitter29	Fraction	0.50
Splitter30	Fraction	0.50
Splitter37	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

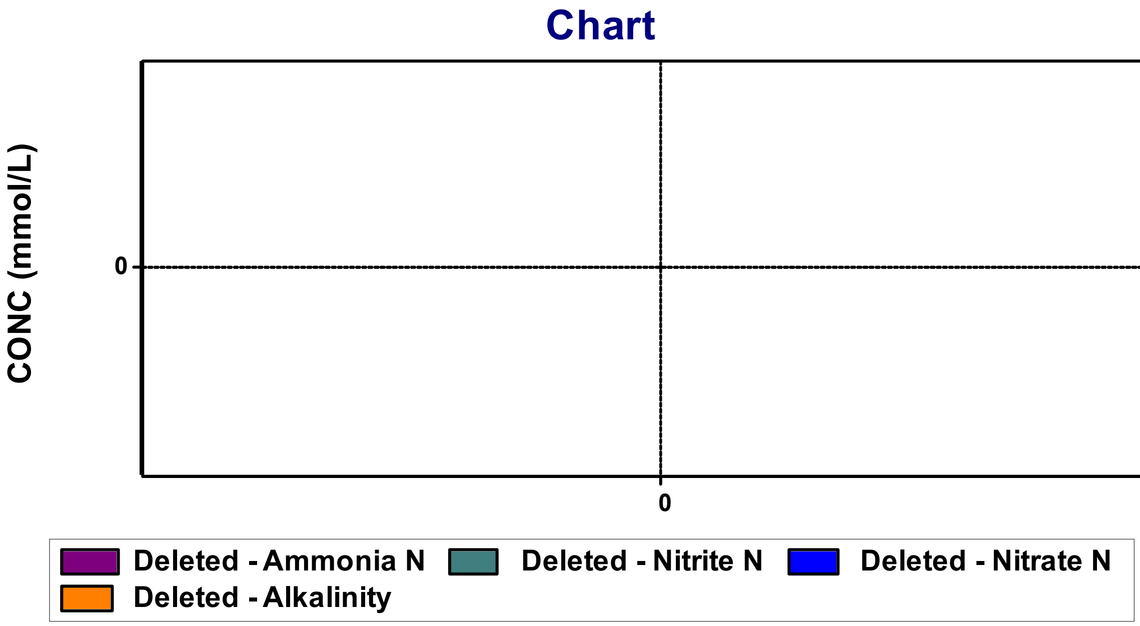
Element name	Influent - State variable3
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0

N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0
N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0

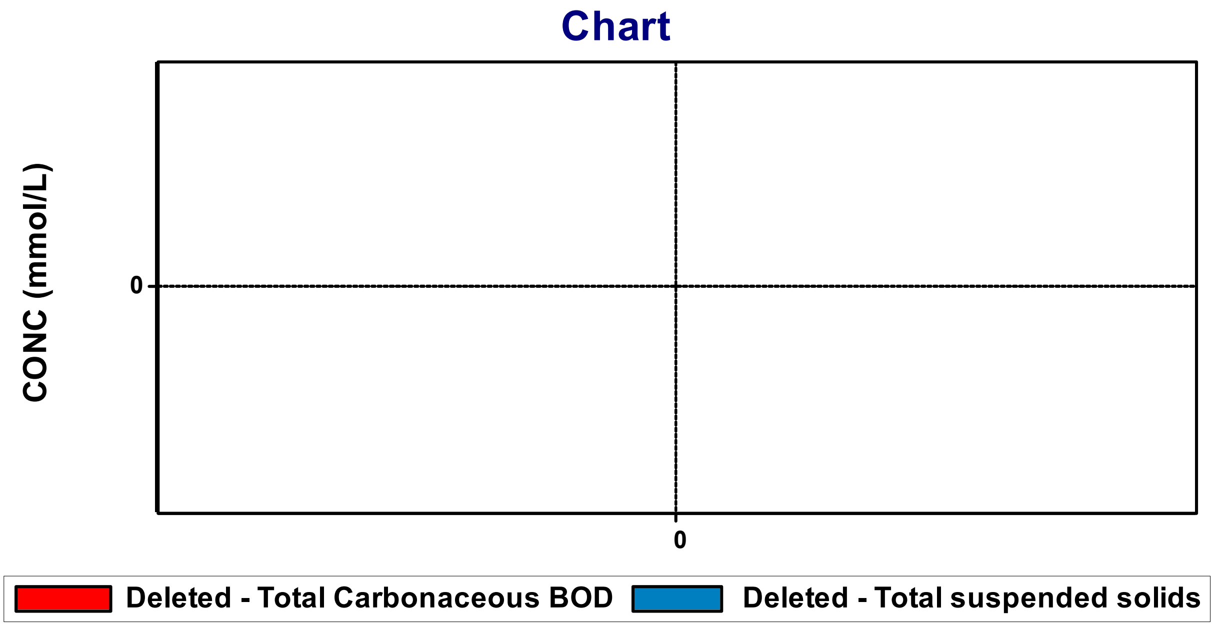
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0001

BioWin Album

Album page - Nitrogen species



Album page - BOD_TSS



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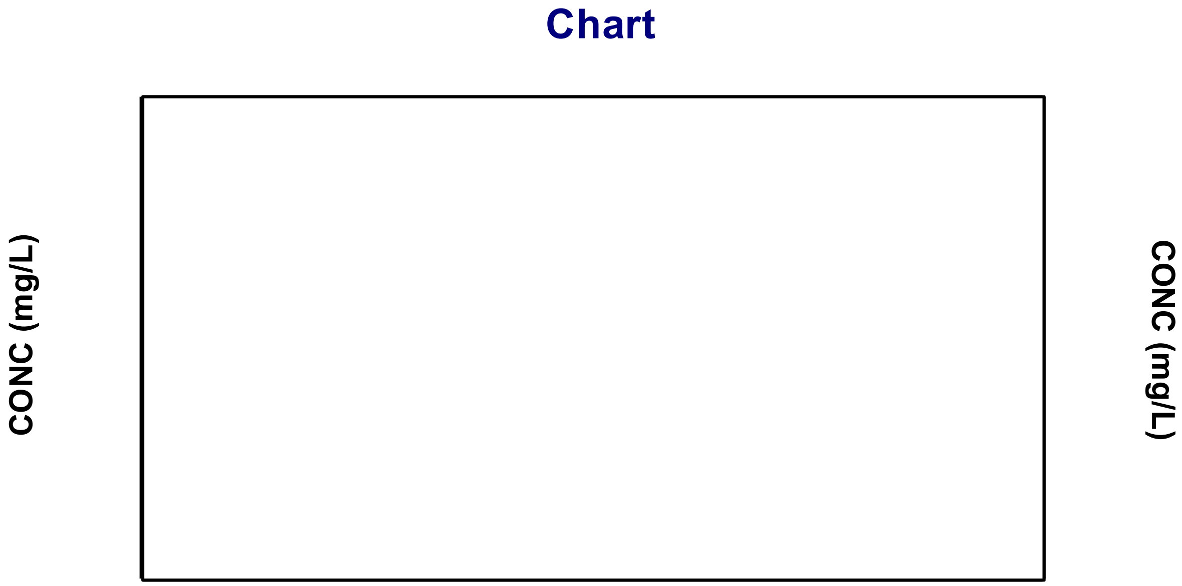

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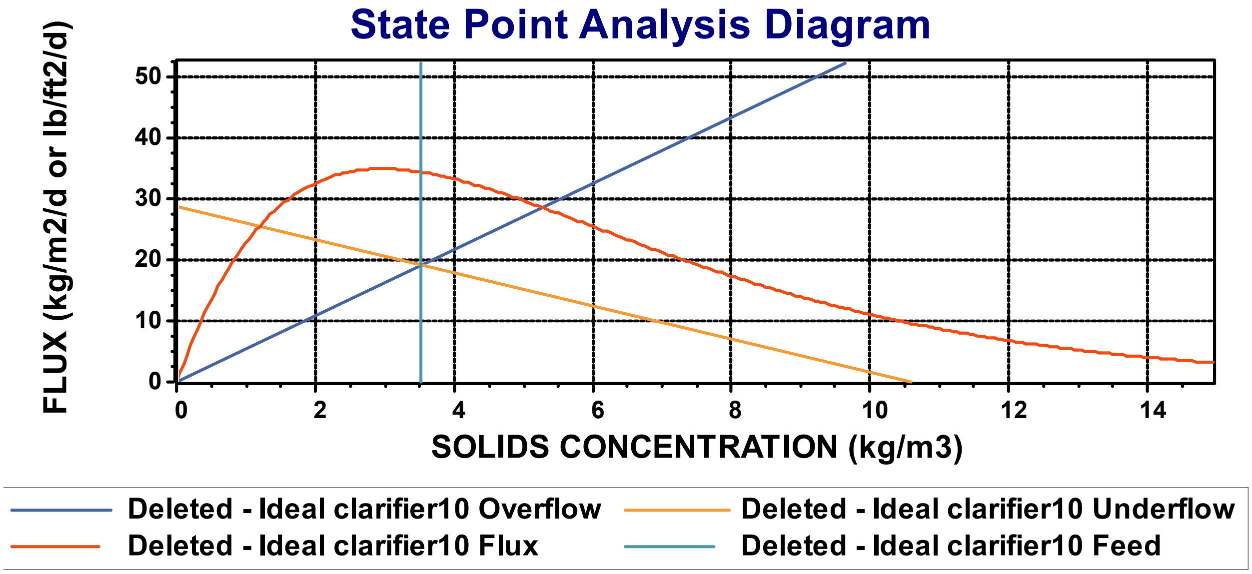

K = 0.3362 m3/kg
Vo = 511.2 ft/d

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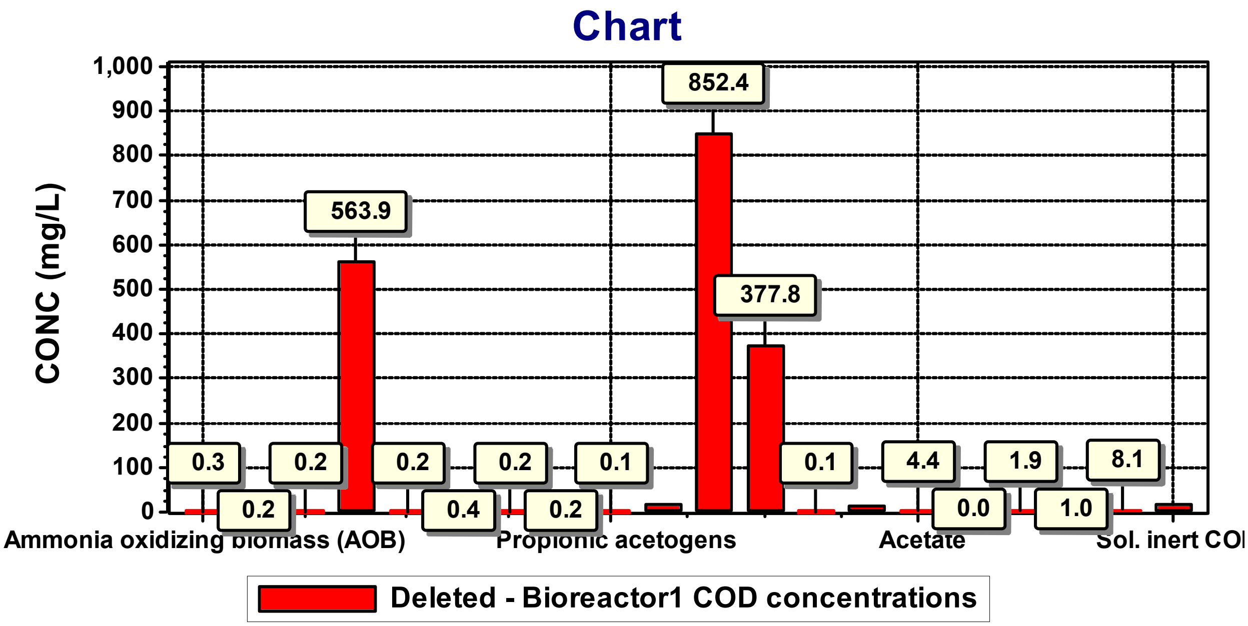

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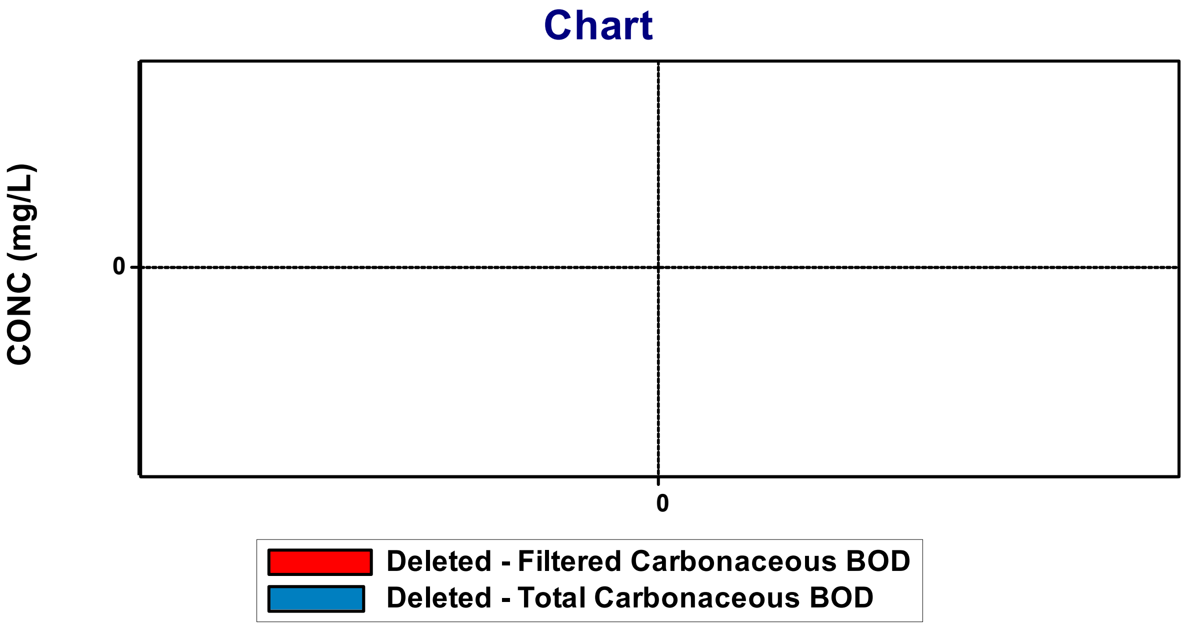

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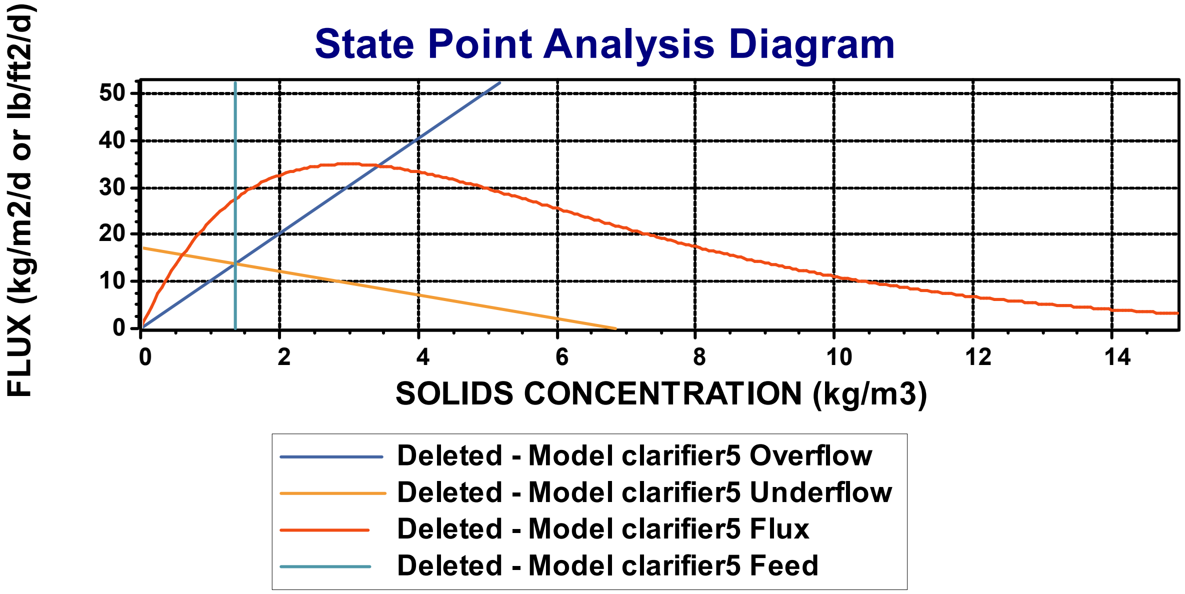

K = 0.3360 m3/kg
Vo = 511.2 ft/d

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Sludge90

State variable	Conc. (mg/L)	Mass rate (lb/d)	Notes
Biomass - Acetoclastic methanogenic	0.28	0.07	
Biomass - Ammonia oxidizing	80.42	19.81	
Biomass - Anaerobic ammonia oxidizing	2.46	0.61	
Biomass - Endogenous products	2363.52	582.36	
Biomass - Hydrogenotrophic methanogenic	0.06	0.02	
Biomass - Methylotrophic	1.71	0.42	
Biomass - Nitrite oxidizing	50.03	12.33	
Biomass - Ordinary heterotrophic	3314.44	816.66	
Biomass - Phosphorus accumulating	1.25	0.31	
Biomass - Propionic acetogenic	0.31	0.08	
Biomass - Sulfur oxidizing	0.00	0.00	
Biomass - Sulfur reducing acetotrophic	0	0	
Biomass - Sulfur reducing hydrogenotrophic	0	0	
Biomass - Sulfur reducing propionic acetogenic	0	0	

CODp - Adsorbed hydrocarbon	0	0	
CODp - Degradable external organics	0.00	0.00	
CODp - Slowly degradable colloidal	0.05	0.01	
CODp - Slowly degradable particulate	179.02	44.11	
CODp - Stored PHA	0.00	0.00	
CODp - Undegradable cellulose	1884.43	464.31	
CODp - Undegradable non-cellulose	1884.43	464.31	
CODs - Acetate	0.00	0.00	
CODs - Complex readily degradable	1.36	0.33	
CODs - Degradable volatile ind. #1	0	0	
CODs - Degradable volatile ind. #2	0	0	
CODs - Degradable volatile ind. #3	0	0	
CODs - Methanol	0.00	0.00	
CODs - Propionate	0.00	0.00	
CODs - Soluble hydrocarbon	0	0	
CODs - Undegradable	45.98	11.33	
Gas - Dissolved hydrogen	0.01	0.00	
Gas - Dissolved methane	0.00	0.00	
Gas - Dissolved nitrogen	15.71	3.87	
Gas - Dissolved nitrous oxide	0	0	
Gas - Dissolved oxygen	2.00	0.49	
Gas - Dissolved total CO2	2.40	0.27	mmol/L and kmol/d
Gas - Dissolved total sulfides	0.00	0.00	
HAO - Aged	0	0	
HAO - High surface	0	0	
HAO - High with H2PO4- adsorbed	0	0	
HAO - Low surface	0	0	
HAO - Low with H2PO4- adsorbed	0	0	
HFO - Aged	0	0	
HFO - High surface	0	0	
HFO - High with H+ adsorbed	0	0	
HFO - High with H2PO4- adsorbed	0	0	
HFO - Low surface	0	0	
HFO - Low with H+ adsorbed	0	0	
HFO - Low with H2PO4- adsorbed	0	0	

Influent inorganic suspended solids	875.92	215.82	
Metal soluble - Aluminum	0	0	
Metal soluble - Calcium	81.21	20.01	
Metal soluble - Ferric	0	0	
Metal soluble - Ferrous	0	0	
Metal soluble - Magnesium	14.67	3.61	
N - Ammonia	0.20	0.05	
N - Nitrate	10.81	2.66	
N - Nitrite	0.07	0.02	
N - Particulate degradable external organics	0.00	0.00	
N - Particulate degradable organic	8.18	2.02	
N - Particulate undegradable	131.91	32.50	
N - Soluble degradable organic	0.54	0.13	
N - Soluble undegradable organic	1.12	0.28	
Other Anions (strong acids)	8.98	1.00	meq/L and keq/d
Other Cations (strong bases)	5.97	0.67	meq/L and keq/d
P - Bound on aged HMO	0	0	
P - Particulate degradable external organics	0.00	0.00	
P - Particulate degradable organic	2.67	0.66	
P - Particulate undegradable	41.46	10.21	
P - Releasable stored polyP	0.14	0.03	
P - Soluble phosphate	2.25	0.55	
P - Unreleasable stored polyP	0.01	0.00	
Precipitate - Brushite	0	0	
Precipitate - Ferrous sulfide	0	0	
Precipitate - Hydroxy - apatite	0	0	
Precipitate - Struvite	0	0	
Precipitate - Vivianite	0	0	
S - Particulate elemental sulfur	0	0	
S - Soluble sulfate	0.00	0.00	
User defined - UD1	0	0	
User defined - UD2	0	0	
User defined - UD3	0	0	
User defined - UD4	0	0	

Parameter	Value	Units
Cost (Sludge)	0	$/hour
Power	0	kW
Power cost (Excl. heating)	0	$/hour

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Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	N - Total N [mgN/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrate [mgN/L]	N - Nitrite [mgN/L]	pH []	Alkalinity [mmol/L]	OUR - Carbonaceous [mgO/L/hr]	OUR - Nitrification [mgO/L/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Airflow rate [ft3/min (20C, 1 atm)]	Alpha [[]]
Influent - BOD14	1.21	22.00	338.96	146.30	707.40	277.80	327.00	303.00	56.00	56.00	41.18	0	0	7.10	4.00	-----	-----	-----	-----	-----	-----
Anoxic 1A	2.72	22.00	2050.86	5.05	9837.48	54.26	8269.08	6908.55	560.95	553.28	4.73	7.57	0.09	6.75	1.96	0	0	0	0	0	0.50
Aerobic 1A	2.72	22.00	2040.77	1.15	9822.36	47.70	8263.40	6902.52	559.94	550.02	1.32	9.45	0.47	6.53	1.56	48.50	52.11	100.61	137.09	612.26	0.30
Aerobic 2A	2.72	22.00	2032.48	0.99	9809.78	47.40	8254.96	6893.87	559.86	548.97	0.20	10.81	0.07	6.46	1.41	47.05	19.31	66.36	79.81	332.95	0.32
Anoxic 2A	2.72	22.00	2048.90	1.78	9834.86	49.03	8270.95	6910.39	560.04	553.28	4.90	6.64	0.11	6.77	2.04	0	0	0	0	0	0.50

MBRA	0.30	22.00	0.97	0.97	47.37	47.37	0	0	12.79	1.74	0.06	11.03	0.01	6.54	1.39	50.47	7.00	57.47	50.74	777.35	0.37
MBRA (U)	2.42	22.00	2270.70	0.98	10985.87	47.37	9251.60	7724.44	626.50	615.45	0.06	11.03	0.01	6.53	1.39	-----	-----	-----	-----	-----	-----
Effluent 1	1.18	22.00	0.97	0.97	47.37	47.37	0	0	12.79	1.74	0.06	11.03	0.01	6.53	1.39	-----	-----	-----	-----	-----	-----
Sludge 90	0.03	22.00	2032.48	0.99	9809.78	47.40	8254.96	6893.87	559.86	548.97	0.20	10.81	0.07	6.46	1.41	-----	-----	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000

Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value

Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value

Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100

VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500

Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value

Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Methylotrophic

Name	Default	Value

Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value

Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220

Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767

Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636

Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value

CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000
H2S [M/Atm]	1.0000E-1	1.0000E-1	2200.0000
Ind 1 [M/Atm]	1.9000E+3	1.9000E+3	7300.0000
Ind 2 [M/Atm]	1.8000E-1	1.8000E-1	2200.0000
Ind 3 [M/Atm]	1.5000E-1	1.5000E-1	1900.0000

Properties constants

Name	Default	Value
K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7
A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2000	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1734.0000	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5000	-39.4800

Metal salt solution densities

Name	Default	Value
Ferric chloride solution density [kg/m3]	3820.0000	3820.0000
Ferric sulfate solution density [kg/m3]	4800.0000	4800.0000
Ferrous chloride solution density [kg/m3]	3160.0000	3160.0000
Ferrous sulfate solution density [kg/m3]	1150.0000	1150.0000

Aluminum sulfate solution density [kg/m3]	1950.0000	1950.0000
Aluminum chloride solution density [kg/m3]	2480.0000	2480.0000

Mineral precipitation rates

Name	Default	Value	
Vivianite precipitation rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite redissolution rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite half sat. [mgTSS/L]	0.0100	0.0100	1.0000
FeS precipitation rate [L/(mol d)]	1000.0000	1000.0000	1.0240
FeS redissolution rate [L/(mol d)]	10.0000	10.0000	1.0240
FeS half sat. [mgTSS/L]	0.1000	0.1000	1.0000
Struvite precipitation rate [L^2/(mol^2 d)]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [L^2/(mol^2 d)]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
Brushite precipitation rate [L/(mol d)]	1.000E+6	1.000E+6	1.0000
Brushite redissolution rate [L/(mol d)]	10000.0000	10000.0000	1.0000
Brushite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HAP precipitation rate [g/d]	5.000E-4	5.000E-4	1.0000

Mineral precipitation constants

Name	Default	Value
Vivianite solubility product [mol/L]^5	1.710E-36	1.710E-36
FeS solubility product [mol/L]^2	4.258E-4	4.258E-4
Struvite solubility product [mol/L]^3	6.918E-14	6.918E-14
Brushite solubility product [mol/L]^2	2.490E-7	2.490E-7

Fe rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HFO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HFO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HFO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	2.000E-11	2.000E-11	1.0000
H+ competition for HFO(H) protonation sites [L/(mmol . d)]	1000.0000	1000.0000	1.0000
H+ competition for HFO(L) protonation sites [L/(mmol . d)]	100.0000	100.0000	1.0000

Fe constants

Name	Default	Value
Ferric active site factor(high) [{mol Sites}/{mol HFO(H)}]	4.0000	2.0000
Ferric active site factor(low) [{mol Sites}/{mol HFO(L)}]	2.4000	1.2000
H+ competition level for Fe(OH)3 [mol/L]	7.000E-7	7.000E-7
Equilibrium constant for FeOH3-H2PO4- [{mf HFO(H).H2PO4}/({mol H2PO4-}{mf HFO(H)}^2)]	2.000E-9	2.000E-9
Colloidal COD removed with Ferric [gCOD/Fe active site]	80.0000	130.0000
Minimum residual P level with iron addition [mgP/L]	0.0150	0.0150
HFO(H) with H2PO4- P release factor	10000.0000	10000.0000
HFO(L) with H2PO4- P release factor	10000.0000	10000.0000

Fe RedOx rates

Name	Default	Value	
Iron reduction using acetic acid	1.000E-7	1.000E-7	1.0000
Half Sat. acetic acid	0.5000	0.5000	1.0000
Iron reduction using propionic acid	1.000E-7	1.000E-7	1.0000
Half Sat. propionic acid	0.5000	0.5000	1.0000

Iron reduction using dissolved hydrogen gas	1.000E-7	1.000E-7	1.0000
Half Sat. dissolved hydrogen gas	0.5000	0.5000	1.0000
Iron reduction using hydrogen sulfide	5.000E-5	5.000E-5	1.0000
Half Sat. hydrogen sulfide	0.5000	0.5000	1.0000
Iron oxidation rate (aerobic)	1.000E-3	1.000E-3	1.0000
Abiotic iron reduction using acetic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using propionic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using dissolved hydrogen gas	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using hydrogen sulfide	2.000E-5	2.000E-5	1.0000
Abiotic iron oxidation rate (aerobic)	1.0000	1.0000	1.0000

CEPT rates

Name	Default	Value	
HFO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HFO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000
HAO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HAO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000

Al rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HAO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HAO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HAO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	1.000E-9	1.000E-9	1.0000

Al constants

Name	Default	Value
Al active site factor(high) [{mol Sites}/{mol HAO(H)}]	3.0000	3.0000
Al active site factor(low) [{mol Sites}/{mol HAO(L)}]	1.5000	1.5000
Equilibrium constant for AlOH3-H2PO4- [{mf HAO(H).H2PO4}/({mol H2PO4-}{mf HAO(H)}^2)]	8.000E-10	8.000E-10
Colloidal COD removed with Al [gCOD/Al active site]	30.0000	30.0000
Minimum residual P level with Al addition [mgP/L]	0.0150	0.0150
HAO(H) with H2PO4- P release factor	10000.0000	10000.0000
HAO(L) with H2PO4- P release factor	10000.0000	10000.0000

Pipe and pump parameters

Name	Default	Value
Static head [ft]	0.8202	0.8202
Pipe length (headloss calc.s) [ft]	164.0420	164.0420
Pipe inside diameter [in]	19.68504	19.68504
K(fittings) - Total minor losses K	5.0000	5.0000
Pipe roughness [in]	0.00787	0.00787
'A' in overall pump efficiency = A + B*Q + C*(Q^2)[-]	0.8500	0.8500
'B' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)]	0	0
'C' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)^2]	0	0

Fittings and loss coefficients ('K' values)

Name	Default	Value
Pipe entrance (bellmouth)	0.0500	1.0000
90° bend	0.7500	5.0000

45° bend	0.3000	2.0000
Butterfly value (open)	0.3000	1.0000
Non-return value	1.0000	0
Outlet (bellmouth)	0.2000	1.0000

Aeration

Name	Default	Value
Surface pressure [kPa]	101.3250	101.3250
Fractional effective saturation depth (Fed) [-]	0.3250	0.3250
Supply gas CO2 content [vol. %]	0.0400	0.0350
Supply gas O2 [vol. %]	20.9500	20.9500
Off-gas CO2 [vol. %]	2.0000	2.0000
Off-gas O2 [vol. %]	18.8000	18.8000
Off-gas H2 [vol. %]	0	0
Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Off-gas N2O [vol. %]	0	0
Surface turbulence factor [-]	2.0000	2.0000
Set point controller gain []	1.0000	1.0000

MABR Membrane effective diffusivities

Name	Default	Value	
O2 [m2/s]	2.500E-9	2.500E-9	1.0000
N2 [m2/s]	1.900E-9	1.900E-9	1.0000
CO2 [m2/s]	1.960E-9	1.960E-9	1.0000
H2 [m2/s]	5.850E-9	5.850E-9	1.0000
CH4 [m2/s]	1.963E-9	1.963E-9	1.0000
NH3 [m2/s]	2.000E-9	2.000E-9	1.0000
N2O [m2/s]	1.607E-9	1.607E-9	1.0000

H2S [m2/s]	1.530E-9	1.530E-9	1.0000
Ind 1 [m2/s]	7.240E-10	7.240E-10	1.0000
Ind 2 [m2/s]	8.900E-10	8.900E-10	1.0000
Ind 3 [m2/s]	7.960E-10	7.960E-10	1.0000

MABR Membrane transfer factors

Name	Default	Value	
O2 []	1.0000	1.0000	1.0000
N2 []	1.0000	1.0000	1.0000
CO2 []	1.0000	1.0000	1.0000
H2 []	1.0000	1.0000	1.0000
CH4 []	1.0000	1.0000	1.0000
NH3 []	1.0000	1.0000	1.0000
N2O []	1.0000	1.0000	1.0000
H2S []	1.0000	1.0000	1.0000
Ind 1 []	1.0000	1.0000	1.0000
Ind 2 []	1.0000	1.0000	1.0000
Ind 3 []	1.0000	1.0000	1.0000

Blower

Name	Default	Value
Intake filter pressure drop [psi]	0.5076	0.5076
Pressure drop through distribution system (piping/valves) [psi]	0.4351	0.4351
Adiabatic/polytropic compression exponent (1.4 for adiabatic)	1.4000	1.4000
'A' in blower efficiency = A + B*Qa + C*(Qa^2)[-]	0.7500	0.7500
'B' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))]	0	0
'C' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))^2]	0	0

Diffuser

Name	Default	Value
k1 in C = k1(PC)^0.25 + k2	1.2400	1.2400
k2 in C = k1(PC)^0.25 + k2	0.8960	0.8960
Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	0.8880	0.8880
Area of one diffuser [ft2]	0.4413	0.4413
Diffuser mounting height [ft]	0.8202	0.8202
Min. air flow rate per diffuser ft3/min (20C, 1 atm)	0.2943	0.2943
Max. air flow rate per diffuser ft3/min (20C, 1 atm)	5.8858	5.8858
'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 [psi]	0.4351	0.4351
'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))]	0	0
'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))^2]	0	0

Surface aerators

Name	Default	Value
Surface aerator Std. oxygen transfer rate [lb O /(hp hr)]	2.46697	2.46697

Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.387	0.355
Vesilind hindered zone settling parameter (K) [L/g]	0.370	0.336
Clarification switching function [mg/L]	100.000	100.000
Specified TSS conc.for height calc. [mg/L]	2500.000	2500.000
Maximum compactability constant [mg/L]	15000.000	15000.000
Maximum compactability slope [L/mg]	0.010	0.010

Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.934	0.934
Maximum (practical) settling velocity (Vo') [ft/min]	0.615	0.615
Hindered zone settling parameter (Kh) [L/g]	0.400	0.400
Flocculent zone settling parameter (Kf) [L/g]	2.500	2.500
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	1.000E-3	1.000E-3
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

Emission factors

Name	Default	Value
Carbon dioxide equivalence of nitrous oxide	296.0000	296.0000
Carbon dioxide equivalence of methane	23.0000	23.0000

Biofilm general

Name	Default	Value	
Attachment rate [g / (m2 d)]	8.0000	80.0000	1.0000
Attachment TSS half sat. [mg/L]	100.0000	100.0000	1.0000
Detachment rate [g/(m3 d)]	8000.0000	8.000E+4	1.0000
Solids movement factor []	10.0000	10.0000	1.0000
Diffusion neta []	0.8000	0.8000	1.0000
Thin film limit [mm]	0.5000	0.5000	1.0000
Thick film limit [mm]	3.0000	3.0000	1.0000
Assumed Film thickness for tank volume correction (temp independent) [mm]	1.2500	0.7500	1.0000
Film surface area to media area ratio - Max.[ ]	1.0000	1.0000	1.0000
Minimum biofilm conc. for streamer formation [gTSS/m2]	4.0000	4.0000	1.0000

Maximum biofilm concentrations [mg/L]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Methylotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Ammonia oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Nitrite oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Anaerobic ammonia oxidizing	5.000E+4	5.000E+4	1.0000
Biomass - Phosphorus accumulating	5.000E+4	5.000E+4	1.0000
Biomass - Propionic acetogenic	5.000E+4	5.000E+4	1.0000
Biomass - Acetoclastic methanogenic	5.000E+4	5.000E+4	1.0000
Biomass - Hydrogenotrophic methanogenic	5.000E+4	5.000E+4	1.0000
Biomass - Endogenous products	3.000E+4	3.000E+4	1.0000
CODp - Slowly degradable particulate	5000.0000	5000.0000	1.0000
CODp - Slowly degradable colloidal	4000.0000	4000.0000	1.0000
CODp - Degradable external organics	5000.0000	5000.0000	1.0000
CODp - Undegradable non-cellulose	5000.0000	5000.0000	1.0000
CODp - Undegradable cellulose	5000.0000	5000.0000	1.0000
N - Particulate degradable organic	0	0	1.0000
P - Particulate degradable organic	0	0	1.0000
N - Particulate degradable external organics	0	0	1.0000
P - Particulate degradable external organics	0	0	1.0000
N - Particulate undegradable	0	0	1.0000
P - Particulate undegradable	0	0	1.0000
CODp - Stored PHA	5000.0000	5000.0000	1.0000
P - Releasable stored polyP	1.150E+6	1.150E+6	1.0000
P - Unreleasable stored polyP	1.150E+6	1.150E+6	1.0000
CODs - Complex readily degradable	0	0	1.0000
CODs - Acetate	0	0	1.0000
CODs - Propionate	0	0	1.0000
CODs - Methanol	0	0	1.0000
Gas - Dissolved hydrogen	0	0	1.0000
Gas - Dissolved methane	0	0	1.0000
N - Ammonia	0	0	1.0000

N - Soluble degradable organic	0	0	1.0000
Gas - Dissolved nitrous oxide	0	0	1.0000
N - Nitrite	0	0	1.0000
N - Nitrate	0	0	1.0000
Gas - Dissolved nitrogen	0	0	1.0000
P - Soluble phosphate	0	0	1.0000
CODs - Undegradable	0	0	1.0000
N - Soluble undegradable organic	0	0	1.0000
Influent inorganic suspended solids	1.300E+6	1.300E+6	1.0000
Precipitate - Struvite	8.500E+5	8.500E+5	1.0000
Precipitate - Brushite	1.165E+6	1.165E+6	1.0000
Precipitate - Hydroxy - apatite	1.600E+6	1.600E+6	1.0000
Precipitate - Vivianite	1.340E+6	1.340E+6	1.0000
HFO - High surface	5.000E+4	5.000E+4	1.0000
HFO - Low surface	5.000E+4	5.000E+4	1.0000
HFO - High with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HFO - Low with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HFO - Aged	5.000E+4	5.000E+4	1.0000
HFO - Low with H+ adsorbed	5.000E+4	5.000E+4	1.0000
HFO - High with H+ adsorbed	5.000E+4	5.000E+4	1.0000
HAO - High surface	5.000E+4	5.000E+4	1.0000
HAO - Low surface	5.000E+4	5.000E+4	1.0000
HAO - High with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HAO - Low with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HAO - Aged	5.000E+4	5.000E+4	1.0000
P - Bound on aged HMO	5.000E+4	5.000E+4	1.0000
Metal soluble - Magnesium	0	0	1.0000
Metal soluble - Calcium	0	0	1.0000
Metal soluble - Ferric	0	0	1.0000
Metal soluble - Ferrous	0	0	1.0000
Metal soluble - Aluminum	0	0	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Gas - Dissolved total CO2	0	0	1.0000
User defined - UD1	0	0	1.0000

User defined - UD2	0	0	1.0000
User defined - UD3	5.000E+4	5.000E+4	1.0000
User defined - UD4	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Sulfur reducing propionic acetogenic	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur reducing acetotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur reducing hydrogenotrophic	1.000E+5	1.000E+5	1.0000
Gas - Dissolved total sulfides	0	0	1.0000
S - Soluble sulfate	0	0	1.0000
S - Particulate elemental sulfur	5.000E+4	5.000E+4	1.0000
Precipitate - Ferrous sulfide	5.000E+4	5.000E+4	1.0000
CODp - Adsorbed hydrocarbon	5.000E+4	5.000E+4	1.0000
CODs - Degradable volatile ind. #1	0	0	1.0000
CODs - Degradable volatile ind. #2	0	0	1.0000
CODs - Degradable volatile ind. #3	0	0	1.0000
CODs - Soluble hydrocarbon	0	0	1.0000
Gas - Dissolved oxygen	0	0	1.0000

Effective diffusivities [m2/s]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Methylotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Ammonia oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Nitrite oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Anaerobic ammonia oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Phosphorus accumulating	5.000E-14	5.000E-14	1.0290
Biomass - Propionic acetogenic	5.000E-14	5.000E-14	1.0290
Biomass - Acetoclastic methanogenic	5.000E-14	5.000E-14	1.0290
Biomass - Hydrogenotrophic methanogenic	5.000E-14	5.000E-14	1.0290
Biomass - Endogenous products	5.000E-14	5.000E-14	1.0290
CODp - Slowly degradable particulate	5.000E-14	5.000E-14	1.0290
CODp - Slowly degradable colloidal	5.000E-10	5.000E-10	1.0290

CODp - Degradable external organics	5.000E-14	5.000E-14	1.0290
CODp - Undegradable non-cellulose	5.000E-14	5.000E-14	1.0290
CODp - Undegradable cellulose	5.000E-14	5.000E-14	1.0290
N - Particulate degradable organic	5.000E-14	5.000E-14	1.0290
P - Particulate degradable organic	5.000E-14	5.000E-14	1.0290
N - Particulate degradable external organics	5.000E-14	5.000E-14	1.0290
P - Particulate degradable external organics	5.000E-14	5.000E-14	1.0290
N - Particulate undegradable	5.000E-14	5.000E-14	1.0290
P - Particulate undegradable	5.000E-14	5.000E-14	1.0290
CODp - Stored PHA	5.000E-14	5.000E-14	1.0290
P - Releasable stored polyP	5.000E-14	5.000E-14	1.0290
P - Unreleasable stored polyP	5.000E-14	5.000E-14	1.0290
CODs - Complex readily degradable	6.900E-10	6.900E-10	1.0290
CODs - Acetate	1.240E-9	1.240E-9	1.0290
CODs - Propionate	8.300E-10	8.300E-10	1.0290
CODs - Methanol	1.600E-9	1.600E-9	1.0290
Gas - Dissolved hydrogen	5.850E-9	5.850E-9	1.0290
Gas - Dissolved methane	1.963E-9	1.963E-9	1.0290
N - Ammonia	2.000E-9	2.000E-9	1.0290
N - Soluble degradable organic	1.370E-9	1.370E-9	1.0290
Gas - Dissolved nitrous oxide	1.607E-9	1.607E-9	1.0290
N - Nitrite	2.980E-9	2.980E-9	1.0290
N - Nitrate	2.980E-9	2.980E-9	1.0290
Gas - Dissolved nitrogen	1.900E-9	1.900E-9	1.0290
P - Soluble phosphate	2.000E-9	2.000E-9	1.0290
CODs - Undegradable	6.900E-10	6.900E-10	1.0290
N - Soluble undegradable organic	6.850E-10	6.850E-10	1.0290
Influent inorganic suspended solids	5.000E-14	5.000E-14	1.0290
Precipitate - Struvite	5.000E-14	5.000E-14	1.0290
Precipitate - Brushite	5.000E-14	5.000E-14	1.0290
Precipitate - Hydroxy - apatite	5.000E-14	5.000E-14	1.0290
Precipitate - Vivianite	5.000E-14	5.000E-14	1.0290
HFO - High surface	5.000E-14	5.000E-14	1.0290
HFO - Low surface	5.000E-14	5.000E-14	1.0290
HFO - High with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290

HFO - Low with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HFO - Aged	5.000E-14	5.000E-14	1.0290
HFO - Low with H+ adsorbed	5.000E-14	5.000E-14	1.0290
HFO - High with H+ adsorbed	5.000E-14	5.000E-14	1.0290
HAO - High surface	5.000E-14	5.000E-14	1.0290
HAO - Low surface	5.000E-14	5.000E-14	1.0290
HAO - High with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HAO - Low with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HAO - Aged	5.000E-14	5.000E-14	1.0290
P - Bound on aged HMO	5.000E-14	5.000E-14	1.0290
Metal soluble - Magnesium	7.200E-10	7.200E-10	1.0290
Metal soluble - Calcium	7.200E-10	7.200E-10	1.0290
Metal soluble - Ferric	4.800E-10	4.800E-10	1.0290
Metal soluble - Ferrous	4.800E-10	4.800E-10	1.0290
Metal soluble - Aluminum	4.800E-10	4.800E-10	1.0290
Other Cations (strong bases)	1.440E-9	1.440E-9	1.0290
Other Anions (strong acids)	1.440E-9	1.440E-9	1.0290
Gas - Dissolved total CO2	1.960E-9	1.960E-9	1.0290
User defined - UD1	6.900E-10	6.900E-10	1.0290
User defined - UD2	6.900E-10	6.900E-10	1.0290
User defined - UD3	5.000E-14	5.000E-14	1.0290
User defined - UD4	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing propionic acetogenic	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing acetotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing hydrogenotrophic	5.000E-14	5.000E-14	1.0290
Gas - Dissolved total sulfides	1.530E-9	1.530E-9	1.0290
S - Soluble sulfate	2.130E-10	2.130E-10	1.0290
S - Particulate elemental sulfur	5.000E-14	5.000E-14	1.0290
Precipitate - Ferrous sulfide	5.000E-14	5.000E-14	1.0290
CODp - Adsorbed hydrocarbon	5.000E-14	5.000E-14	1.0290
CODs - Degradable volatile ind. #1	7.240E-10	7.240E-10	1.0290
CODs - Degradable volatile ind. #2	8.900E-10	8.900E-10	1.0290
CODs - Degradable volatile ind. #3	7.960E-10	7.960E-10	1.0290
CODs - Soluble hydrocarbon	7.120E-10	7.120E-10	1.0290

Gas - Dissolved oxygen	2.500E-9	2.500E-9	1.0290

EPS Strength coefficients [ ]

Name	Default	Value	
Biomass - Ordinary heterotrophic	1.0000	1.0000	1.0000
Biomass - Methylotrophic	1.0000	1.0000	1.0000
Biomass - Ammonia oxidizing	5.0000	5.0000	1.0000
Biomass - Nitrite oxidizing	25.0000	25.0000	1.0000
Biomass - Anaerobic ammonia oxidizing	10.0000	10.0000	1.0000
Biomass - Phosphorus accumulating	1.0000	1.0000	1.0000
Biomass - Propionic acetogenic	1.0000	1.0000	1.0000
Biomass - Acetoclastic methanogenic	1.0000	1.0000	1.0000
Biomass - Hydrogenotrophic methanogenic	1.0000	1.0000	1.0000
Biomass - Endogenous products	1.0000	1.0000	1.0000
CODp - Slowly degradable particulate	1.0000	1.0000	1.0000
CODp - Slowly degradable colloidal	1.0000	1.0000	1.0000
CODp - Degradable external organics	1.0000	1.0000	1.0000
CODp - Undegradable non-cellulose	1.0000	1.0000	1.0000
CODp - Undegradable cellulose	1.0000	1.0000	1.0000
N - Particulate degradable organic	1.0000	1.0000	1.0000
P - Particulate degradable organic	1.0000	1.0000	1.0000
N - Particulate degradable external organics	1.0000	1.0000	1.0000
P - Particulate degradable external organics	1.0000	1.0000	1.0000
N - Particulate undegradable	1.0000	1.0000	1.0000
P - Particulate undegradable	1.0000	1.0000	1.0000
CODp - Stored PHA	1.0000	1.0000	1.0000
P - Releasable stored polyP	1.0000	1.0000	1.0000
P - Unreleasable stored polyP	1.0000	1.0000	1.0000
CODs - Complex readily degradable	0	0	1.0000
CODs - Acetate	0	0	1.0000
CODs - Propionate	0	0	1.0000
CODs - Methanol	0	0	1.0000

Gas - Dissolved hydrogen	0	0	1.0000
Gas - Dissolved methane	0	0	1.0000
N - Ammonia	0	0	1.0000
N - Soluble degradable organic	0	0	1.0000
Gas - Dissolved nitrous oxide	0	0	1.0000
N - Nitrite	0	0	1.0000
N - Nitrate	0	0	1.0000
Gas - Dissolved nitrogen	0	0	1.0000
P - Soluble phosphate	0	0	1.0000
CODs - Undegradable	0	0	1.0000
N - Soluble undegradable organic	0	0	1.0000
Influent inorganic suspended solids	0.3300	0.3300	1.0000
Precipitate - Struvite	1.0000	1.0000	1.0000
Precipitate - Brushite	1.0000	1.0000	1.0000
Precipitate - Hydroxy - apatite	1.0000	1.0000	1.0000
Precipitate - Vivianite	1.0000	1.0000	1.0000
HFO - High surface	1.0000	1.0000	1.0000
HFO - Low surface	1.0000	1.0000	1.0000
HFO - High with H2PO4- adsorbed	1.0000	1.0000	1.0000
HFO - Low with H2PO4- adsorbed	1.0000	1.0000	1.0000
HFO - Aged	1.0000	1.0000	1.0000
HFO - Low with H+ adsorbed	1.0000	1.0000	1.0000
HFO - High with H+ adsorbed	1.0000	1.0000	1.0000
HAO - High surface	1.0000	1.0000	1.0000
HAO - Low surface	1.0000	1.0000	1.0000
HAO - High with H2PO4- adsorbed	1.0000	1.0000	1.0000
HAO - Low with H2PO4- adsorbed	1.0000	1.0000	1.0000
HAO - Aged	1.0000	1.0000	1.0000
P - Bound on aged HMO	1.0000	1.0000	1.0000
Metal soluble - Magnesium	0	0	1.0000
Metal soluble - Calcium	0	0	1.0000
Metal soluble - Ferric	0	0	1.0000
Metal soluble - Ferrous	0	0	1.0000
Metal soluble - Aluminum	0	0	1.0000
Other Cations (strong bases)	0	0	1.0000

Other Anions (strong acids)	0	0	1.0000
Gas - Dissolved total CO2	0	0	1.0000
User defined - UD1	0	0	1.0000
User defined - UD2	0	0	1.0000
User defined - UD3	1.0000	1.0000	1.0000
User defined - UD4	1.0000	1.0000	1.0000
Biomass - Sulfur oxidizing	1.0000	1.0000	1.0000
Biomass - Sulfur reducing propionic acetogenic	1.0000	1.0000	1.0000
Biomass - Sulfur reducing acetotrophic	1.0000	1.0000	1.0000
Biomass - Sulfur reducing hydrogenotrophic	1.0000	1.0000	1.0000
Gas - Dissolved total sulfides	0	0	1.0000
S - Soluble sulfate	0	0	1.0000
S - Particulate elemental sulfur	1.0000	1.0000	1.0000
Precipitate - Ferrous sulfide	1.0000	1.0000	1.0000
CODp - Adsorbed hydrocarbon	1.0000	1.0000	1.0000
CODs - Degradable volatile ind. #1	0	0	1.0000
CODs - Degradable volatile ind. #2	0	0	1.0000
CODs - Degradable volatile ind. #3	0	0	1.0000
CODs - Soluble hydrocarbon	0	0	1.0000
Gas - Dissolved oxygen	0	0	1.0000

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Jason.Flowers

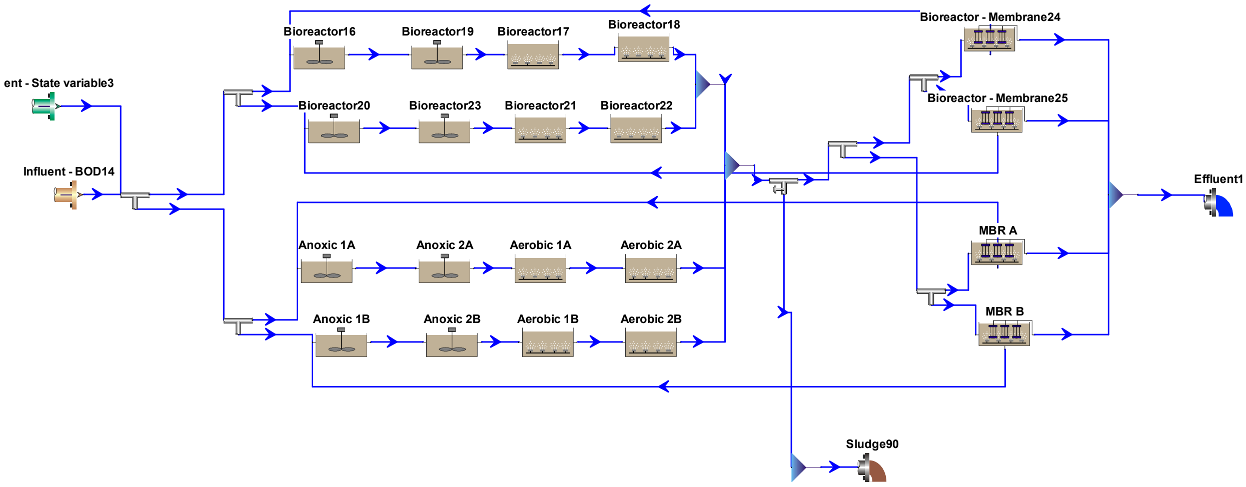
Created: 5/18/2018 Saved: 6/22/2020

Steady state solution

Target SRT: 15.00 days SRT #0: 15.00 days

Temperature: 11.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1A	0.0100	102.8312	13.000	Un-aerated
Aerobic 1A	0.0300	308.4936	13.000	70
Aerobic 2A	0.0300	308.4936	13.000	70
Anoxic 2A	0.0100	102.8312	13.000	Un-aerated
Anoxic 1B	0.0100	102.8312	13.000	Un-aerated
Aerobic 1B	0.0300	308.4936	13.000	70
Aerobic 2B	0.0300	308.4936	13.000	70
Anoxic 2B	0.0100	102.8312	13.000	Un-aerated
Bioreactor16	0.0100	102.8312	13.000	Un-aerated
Bioreactor17	0.0300	308.4936	13.000	70
Bioreactor18	0.0300	308.4936	13.000	70
Bioreactor19	0.0100	102.8312	13.000	Un-aerated
Bioreactor20	0.0100	102.8312	13.000	Un-aerated
Bioreactor21	0.0300	308.4936	13.000	70
Bioreactor22	0.0300	308.4936	13.000	70
Bioreactor23	0.0100	102.8312	13.000	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1A	0
Aerobic 1A	2.0
Aerobic 2A	2.0
Anoxic 2A	0
Anoxic 1B	0
Aerobic 1B	2.0
Aerobic 2B	2.0

Anoxic 2B	0
Bioreactor16	0
Bioreactor17	2.0
Bioreactor18	2.0
Bioreactor19	0
Bioreactor20	0
Bioreactor21	2.0
Bioreactor22	2.0
Bioreactor23	0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2A	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Aerobic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor16	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor17	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Bioreactor18	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor19	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor20	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor21	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor22	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0
Bioreactor23	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	3.0000	0	0

Configuration information for all Bioreactor - MBR units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers	# of cassettes	Displaced volume / cassette [ft3/cassette]	Membrane area / cassette [ft2/cassette]	Total displaced volume [Mil. Gal]	Membrane surface area [ft2]
MBR A	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
MBR B	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
Bioreactor - Membrane24	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18
Bioreactor - Membrane25	0.0300	308.4936	13.000	57	6.00	59.682	16320.03	0.00	97920.18

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
MBR A	2.0

MBR B	2.0
Bioreactor - Membrane24	2.0
Bioreactor - Membrane25	2.0

Element name	Split method	Average Split specification
MBR A	Flow paced	200.00 %
MBR B	Flow paced	200.00 %
Bioreactor - Membrane24	Flow paced	200.00 %
Bioreactor - Membrane25	Flow paced	200.00 %

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
MBR A	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
MBR B	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
Bioreactor - Membrane24	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0
Bioreactor - Membrane25	0.0500	0.3800	1.0000	0.5382	0.2500	1.1772	29.4289	1.0000	0	0

Element name	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
MBR A	101.3250	0.3000
MBR B	101.3250	0.3000
Bioreactor - Membrane24	101.3250	0.3000

Bioreactor - Membrane25	101.3250	0.3000

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Off-gas N2O [vol. %]	Surface turbulence factor [-]
MBR A	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
MBR B	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
Bioreactor - Membrane24	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000
Bioreactor - Membrane25	0.0350	20.9500	1.2000	19.9000	0	0	0	0	2.0000

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD14
Flow	2.27
BOD - Total Carbonaceous mgBOD/L	173.00
Volatile suspended solids mg/L	182.00
Total suspended solids mg/L	196.00
N - Total Kjeldahl Nitrogen mgN/L	30.90
P - Total P mgP/L	6.50
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	80.00
Metal soluble - Magnesium mg/L	15.00
Gas - Dissolved oxygen mg/L	0

Element name	Influent - BOD14
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8771
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter66	Fraction	0.50
Splitter7	Flowrate [Side]	0.0295267746789225
Splitter8	Fraction	0.50
Splitter28	Fraction	0.50
Splitter29	Fraction	0.50
Splitter30	Fraction	0.50
Splitter37	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

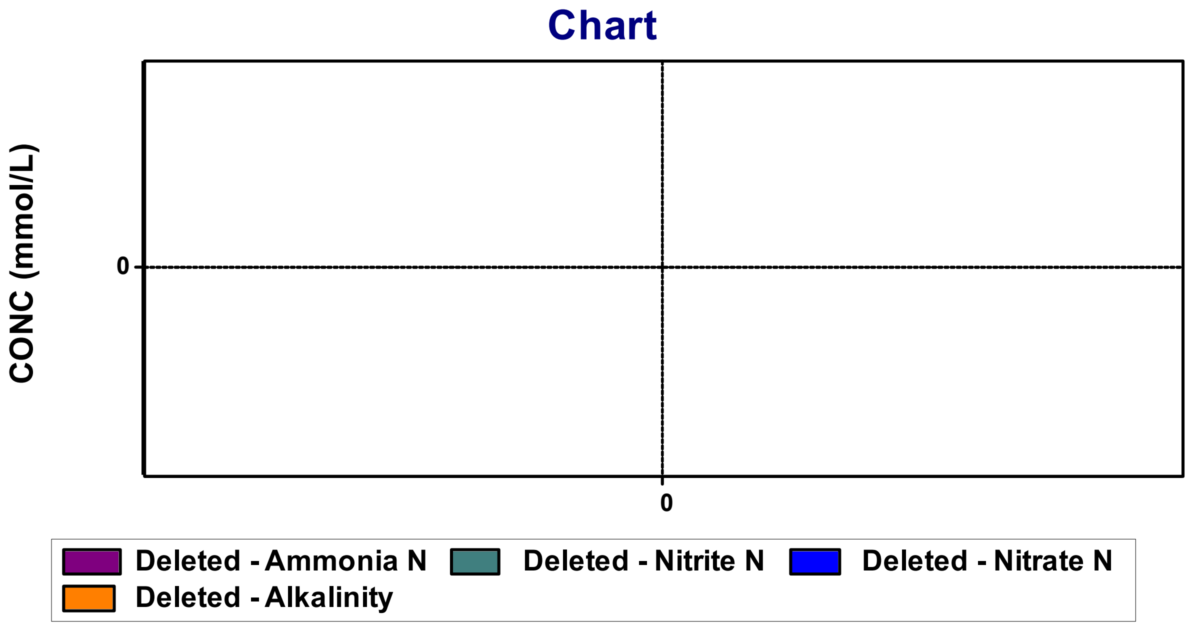
Element name	Influent - State variable3
Biomass - Ordinary heterotrophic [mgCOD/L]	0
Biomass - Methylotrophic [mgCOD/L]	0
Biomass - Ammonia oxidizing [mgCOD/L]	0
Biomass - Nitrite oxidizing [mgCOD/L]	0
Biomass - Anaerobic ammonia oxidizing [mgCOD/L]	0
Biomass - Phosphorus accumulating [mgCOD/L]	0
Biomass - Propionic acetogenic [mgCOD/L]	0
Biomass - Acetoclastic methanogenic [mgCOD/L]	0
Biomass - Hydrogenotrophic methanogenic [mgCOD/L]	0
Biomass - Endogenous products [mgCOD/L]	0
CODp - Slowly degradable particulate [mgCOD/L]	0
CODp - Slowly degradable colloidal [mgCOD/L]	0
CODp - Degradable external organics [mgCOD/L]	0
CODp - Undegradable non-cellulose [mgCOD/L]	0
CODp - Undegradable cellulose [mgCOD/L]	0

N - Particulate degradable organic [mgN/L]	0
P - Particulate degradable organic [mgP/L]	0
N - Particulate degradable external organics [mgN/L]	0
P - Particulate degradable external organics [mgP/L]	0
N - Particulate undegradable [mgN/L]	0
P - Particulate undegradable [mgP/L]	0
CODp - Stored PHA [mgCOD/L]	0
P - Releasable stored polyP [mgP/L]	0
P - Unreleasable stored polyP [mgP/L]	0
CODs - Complex readily degradable [mgCOD/L]	0
CODs - Acetate [mgCOD/L]	0
CODs - Propionate [mgCOD/L]	0
CODs - Methanol [mgCOD/L]	0
Gas - Dissolved hydrogen [mgCOD/L]	0
Gas - Dissolved methane [mg/L]	0
N - Ammonia [mgN/L]	0
N - Soluble degradable organic [mgN/L]	0
Gas - Dissolved nitrous oxide [mgN/L]	0
N - Nitrite [mgN/L]	0
N - Nitrate [mgN/L]	0
Gas - Dissolved nitrogen [mgN/L]	0
P - Soluble phosphate [mgP/L]	0
CODs - Undegradable [mgCOD/L]	0
N - Soluble undegradable organic [mgN/L]	0
Influent inorganic suspended solids [mgISS/L]	0
Precipitate - Struvite [mgISS/L]	0
Precipitate - Brushite [mgISS/L]	0
Precipitate - Hydroxy - apatite [mgISS/L]	0
Precipitate - Vivianite [mgISS/L]	0
HFO - High surface [mg/L]	0
HFO - Low surface [mg/L]	0
HFO - High with H2PO4- adsorbed [mg/L]	0
HFO - Low with H2PO4- adsorbed [mg/L]	0
HFO - Aged [mg/L]	0
HFO - Low with H+ adsorbed [mg/L]	0

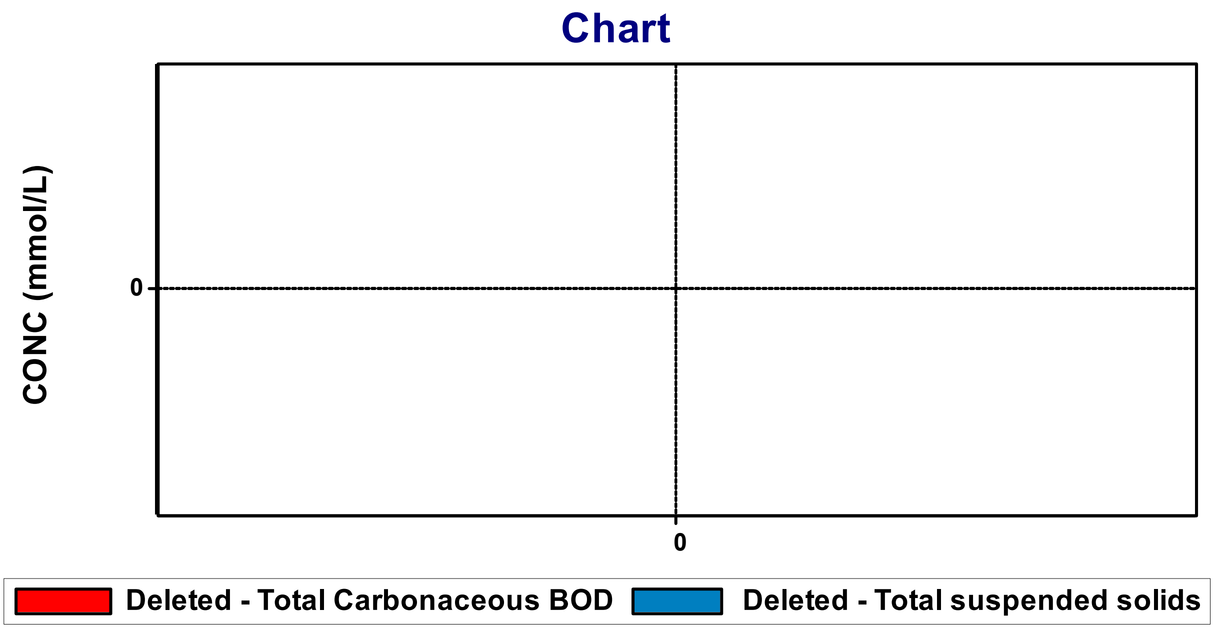
HFO - High with H+ adsorbed [mg/L]	0
HAO - High surface [mg/L]	0
HAO - Low surface [mg/L]	0
HAO - High with H2PO4- adsorbed [mg/L]	0
HAO - Low with H2PO4- adsorbed [mg/L]	0
HAO - Aged [mg/L]	0
P - Bound on aged HMO [mgP/L]	0
Metal soluble - Magnesium [mg/L]	0
Metal soluble - Calcium [mg/L]	0
Metal soluble - Ferric [mg/L]	0
Metal soluble - Ferrous [mg/L]	0
Metal soluble - Aluminum [mg/L]	0
Other Cations (strong bases) [meq/L]	12500.00
Other Anions (strong acids) [meq/L]	0
Gas - Dissolved total CO2 [mmol/L]	0
User defined - UD1 [mg/L]	0
User defined - UD2 [mg/L]	0
User defined - UD3 [mgVSS/L]	0
User defined - UD4 [mgISS/L]	0
Biomass - Sulfur oxidizing [mgCOD/L]	0
Biomass - Sulfur reducing propionic acetogenic [mgCOD/L]	0
Biomass - Sulfur reducing acetotrophic [mgCOD/L]	0
Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L]	0
Gas - Dissolved total sulfides [mgS/L]	0
S - Soluble sulfate [mgS/L]	0
S - Particulate elemental sulfur [mgS/L]	0
Precipitate - Ferrous sulfide [mgISS/L]	0
CODp - Adsorbed hydrocarbon [mgCOD/L]	0
CODs - Degradable volatile ind. #1 [mgCOD/L]	0
CODs - Degradable volatile ind. #2 [mgCOD/L]	0
CODs - Degradable volatile ind. #3 [mgCOD/L]	0
CODs - Soluble hydrocarbon [mgCOD/L]	0
Gas - Dissolved oxygen [mg/L]	0
Flow	0.0001

BioWin Album

Album page - Nitrogen species



Album page - BOD_TSS



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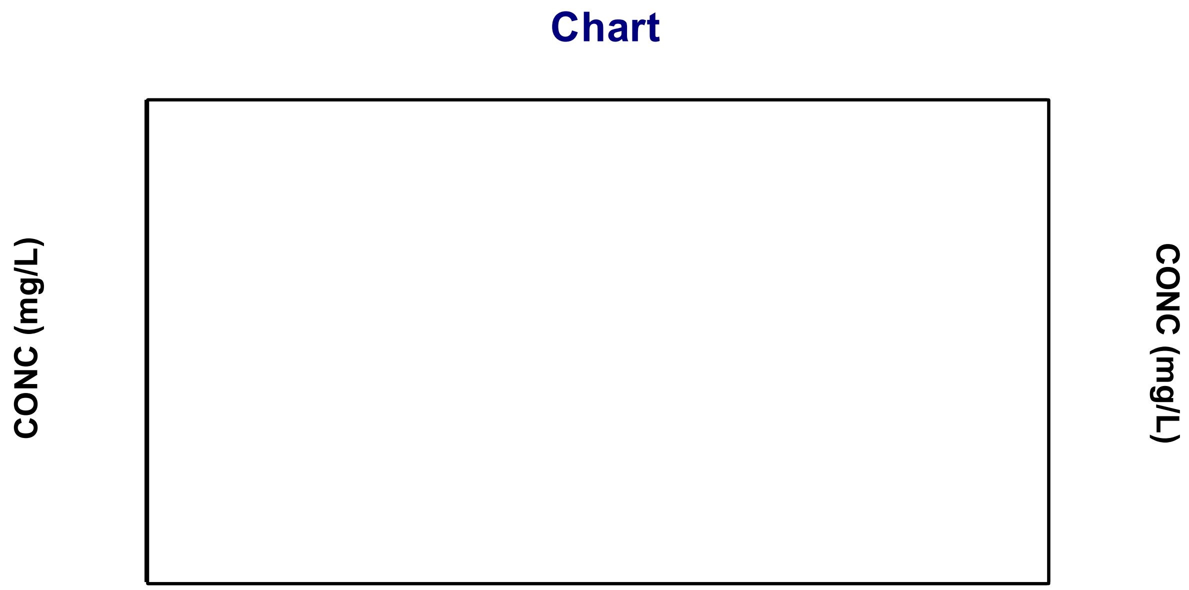

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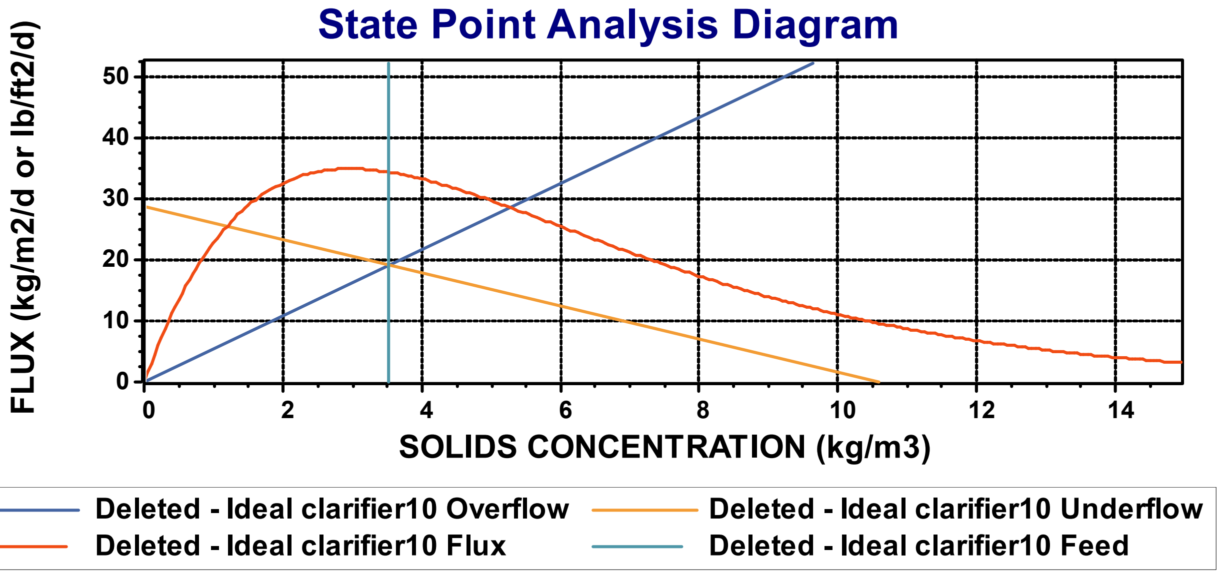

K = 0.3362 m3/kg
Vo = 511.2 ft/d

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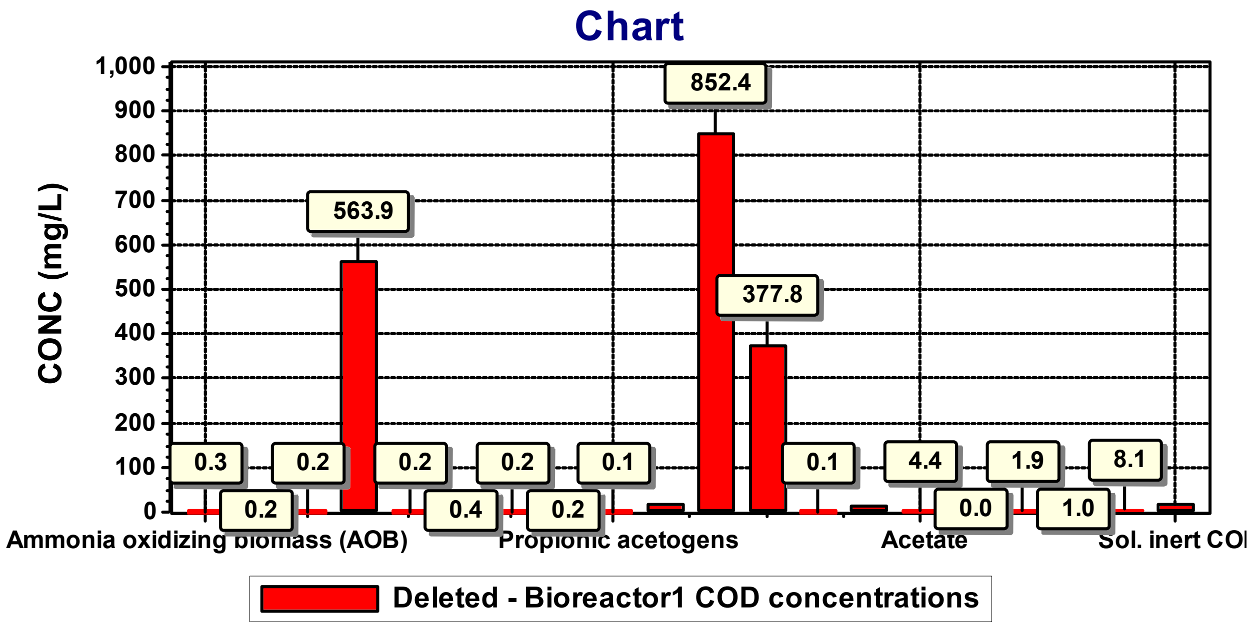

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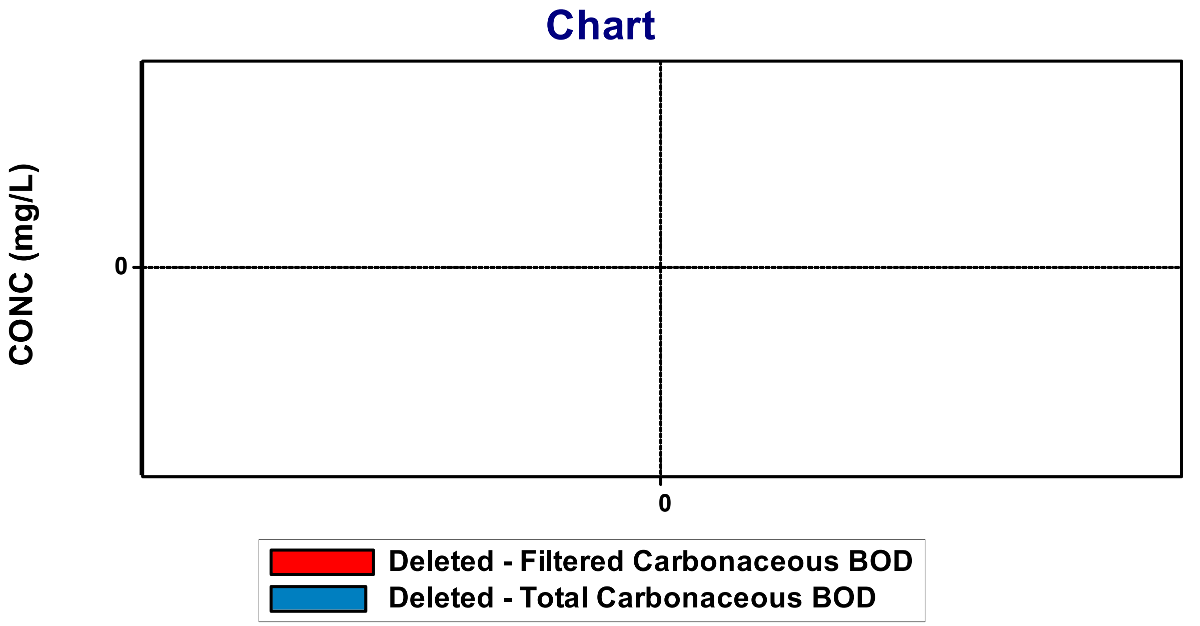

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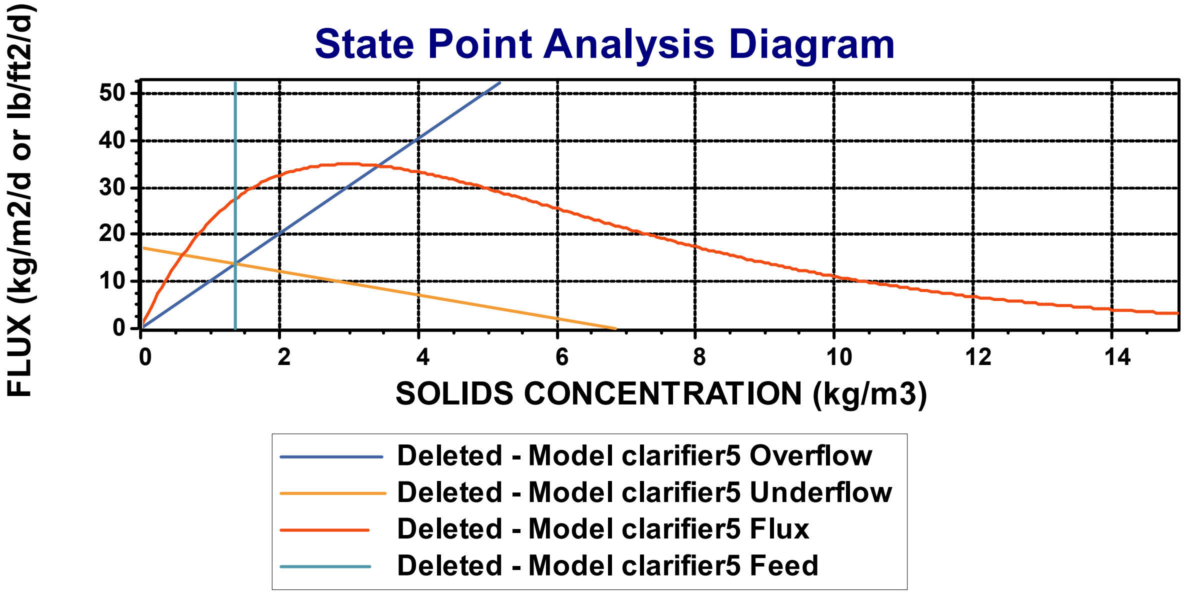

K = 0.3360 m3/kg
Vo = 511.2 ft/d

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Sludge90

State variable	Conc. (mg/L)	Mass rate (lb/d)	Notes
Biomass - Acetoclastic methanogenic	0.35	0.09	
Biomass - Ammonia oxidizing	94.04	23.17	
Biomass - Anaerobic ammonia oxidizing	2.33	0.57	
Biomass - Endogenous products	2111.28	520.25	
Biomass - Hydrogenotrophic methanogenic	0.08	0.02	
Biomass - Methylotrophic	1.91	0.47	
Biomass - Nitrite oxidizing	56.51	13.92	
Biomass - Ordinary heterotrophic	4054.91	999.18	
Biomass - Phosphorus accumulating	1.20	0.30	
Biomass - Propionic acetogenic	0.40	0.10	
Biomass - Sulfur oxidizing	0	0	
Biomass - Sulfur reducing acetotrophic	0.00	0.00	
Biomass - Sulfur reducing hydrogenotrophic	0	0	
Biomass - Sulfur reducing propionic acetogenic	0	0	

CODp - Adsorbed hydrocarbon	0	0	
CODp - Degradable external organics	0.00	0.00	
CODp - Slowly degradable colloidal	0.08	0.02	
CODp - Slowly degradable particulate	232.18	57.21	
CODp - Stored PHA	0.00	0.00	
CODp - Undegradable cellulose	1804.00	444.53	
CODp - Undegradable non-cellulose	1804.00	444.53	
CODs - Acetate	0.00	0.00	
CODs - Complex readily degradable	1.38	0.34	
CODs - Degradable volatile ind. #1	0	0	
CODs - Degradable volatile ind. #2	0	0	
CODs - Degradable volatile ind. #3	0	0	
CODs - Methanol	0.00	0.00	
CODs - Propionate	0.00	0.00	
CODs - Soluble hydrocarbon	0	0	
CODs - Undegradable	23.47	5.78	
Gas - Dissolved hydrogen	0.01	0.00	
Gas - Dissolved methane	0.00	0.00	
Gas - Dissolved nitrogen	19.09	4.70	
Gas - Dissolved nitrous oxide	0	0	
Gas - Dissolved oxygen	2.00	0.49	
Gas - Dissolved total CO2	1.84	0.21	mmol/L and kmol/d
Gas - Dissolved total sulfides	0.00	0.00	
HAO - Aged	0	0	
HAO - High surface	0	0	
HAO - High with H2PO4- adsorbed	0	0	
HAO - Low surface	0	0	
HAO - Low with H2PO4- adsorbed	0	0	
HFO - Aged	0	0	
HFO - High surface	0	0	
HFO - High with H+ adsorbed	0	0	
HFO - High with H2PO4- adsorbed	0	0	
HFO - Low surface	0	0	
HFO - Low with H+ adsorbed	0	0	
HFO - Low with H2PO4- adsorbed	0	0	

Influent inorganic suspended solids	960.44	236.67	
Metal soluble - Aluminum	0	0	
Metal soluble - Calcium	80.58	19.86	
Metal soluble - Ferric	0	0	
Metal soluble - Ferrous	0	0	
Metal soluble - Magnesium	14.80	3.65	
N - Ammonia	1.30	0.32	
N - Nitrate	5.61	1.38	
N - Nitrite	0.43	0.11	
N - Particulate degradable external organics	0	0	
N - Particulate degradable organic	10.44	2.57	
N - Particulate undegradable	126.28	31.12	
N - Soluble degradable organic	0.55	0.13	
N - Soluble undegradable organic	0.62	0.15	
Other Anions (strong acids)	9.69	1.08	meq/L and keq/d
Other Cations (strong bases)	5.51	0.62	meq/L and keq/d
P - Bound on aged HMO	0	0	
P - Particulate degradable external organics	0	0	
P - Particulate degradable organic	4.10	1.01	
P - Particulate undegradable	39.69	9.78	
P - Releasable stored polyP	0.14	0.03	
P - Soluble phosphate	4.06	1.00	
P - Unreleasable stored polyP	0.01	0.00	
Precipitate - Brushite	0	0	
Precipitate - Ferrous sulfide	0	0	
Precipitate - Hydroxy - apatite	0	0	
Precipitate - Struvite	0	0	
Precipitate - Vivianite	0	0	
S - Particulate elemental sulfur	0	0	
S - Soluble sulfate	0.00	0.00	
User defined - UD1	0	0	
User defined - UD2	0	0	
User defined - UD3	0	0	
User defined - UD4	0	0	

Parameter	Value	Units
Cost (Sludge)	0	$/hour
Power	0	kW
Power cost (Excl. heating)	0	$/hour

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Elements	Flow [mgd]	Temperature [deg. C]	BOD - Total Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [mg/L]	COD - Total [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	N - Total N [mgN/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrate [mgN/L]	N - Nitrite [mgN/L]	pH []	Alkalinity [mmol/L]	OUR - Carbonaceous [mgO/L/hr]	OUR - Nitrification [mgO/L/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]	Airflow rate [ft3/min (20C, 1 atm)]	Alpha [[]]
Influent - BOD14	2.27	11.00	172.98	52.46	361.00	102.90	196.00	182.00	30.90	30.90	22.72	0	0	7.10	2.00	-----	-----	-----	-----	-----	-----
Anoxic 1A	5.11	11.00	2497.28	2.81	10201.81	27.84	8670.77	7182.91	588.45	583.58	3.18	4.62	0.25	6.32	0.81	0	0	0	0	0	0.50
Aerobic 1A	5.11	11.00	2492.17	1.13	10194.21	25.16	8667.49	7179.45	587.88	582.59	2.17	4.88	0.41	6.18	0.71	43.41	29.05	72.45	107.52	465.73	0.30
Aerobic 2A	5.11	11.00	2488.18	1.02	10188.13	24.94	8663.50	7175.33	587.84	581.79	1.30	5.61	0.43	6.07	0.59	43.29	24.55	67.84	79.90	333.37	0.32
Anoxic 2A	5.11	11.00	2496.12	1.33	10200.32	25.64	8671.31	7183.42	587.93	583.58	3.28	4.11	0.24	6.34	0.85	0	0	0	0	0	0.50

MBRA	0.56	11.00	0.96	0.96	24.83	24.83	0	0	8.44	1.84	0.66	6.30	0.30	5.98	0.50	47.83	21.66	69.49	60.28	923.52	0.37
MBRA (U)	4.54	11.00	2790.49	0.97	11435.16	24.85	9727.73	8055.81	659.27	652.67	0.66	6.30	0.30	6.06	0.50	-----	-----	-----	-----	-----	-----
Effluent 1	2.24	11.00	0.96	0.96	24.83	24.83	0	0	8.44	1.84	0.66	6.30	0.30	6.06	0.50	-----	-----	-----	-----	-----	-----
Sludge 90	0.03	11.00	2488.18	1.02	10188.13	24.94	8663.50	7175.33	587.84	581.79	1.30	5.61	0.43	6.07	0.59	-----	-----	-----	-----	-----	-----

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000

Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value

Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value

Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000
Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100

VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500

Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value

Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000

Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700

P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

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Technical Memorandum 5

Date: April 22, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler, City Manager
Mike Walker, Public Works Director
City of Sandy, Oregon

From: Matt Hickey, PE
Ken Vigil, PE
Katie Husk, PE
Murraysmith

Re: Technical Memorandum 5 – Sandy River Temperature Compliance Evaluation
Technical Memorandum Update

Introduction

Technical Memorandum 5 is a deliverable under Task 4.2 of the Detailed Discharge Alternative Evaluation (DDAE) program. This memo includes a review of potential impacts to temperature on the Sandy River due to effluent discharges from the proposed, new membrane bioreactor facility.

Furthermore, Technical Memorandum 5 is an update to the memo prepared on May 22, 2019 as part of the WSFP Continuing Planning Services project (see attached).

This update provides the opportunity to review this topic with additional temperature data collected on the Sandy River, and updated estimates of river flows, effluent flows, and effluent temperatures.

Sandy River Temperature Data

In the May 2019 memo, temperature data for the Sandy River was not available. The mixing analysis that was done in that memo was completed using regulatory temperature criteria.

As part of the DDAE program, Waterways Consulting installed temperature probes in four locations on the Sandy River and collected temperature data. The locations of the installed temperature probes are shown in **Figure 1**. Descriptions of each of the probe locations are shown in **Table 1**.

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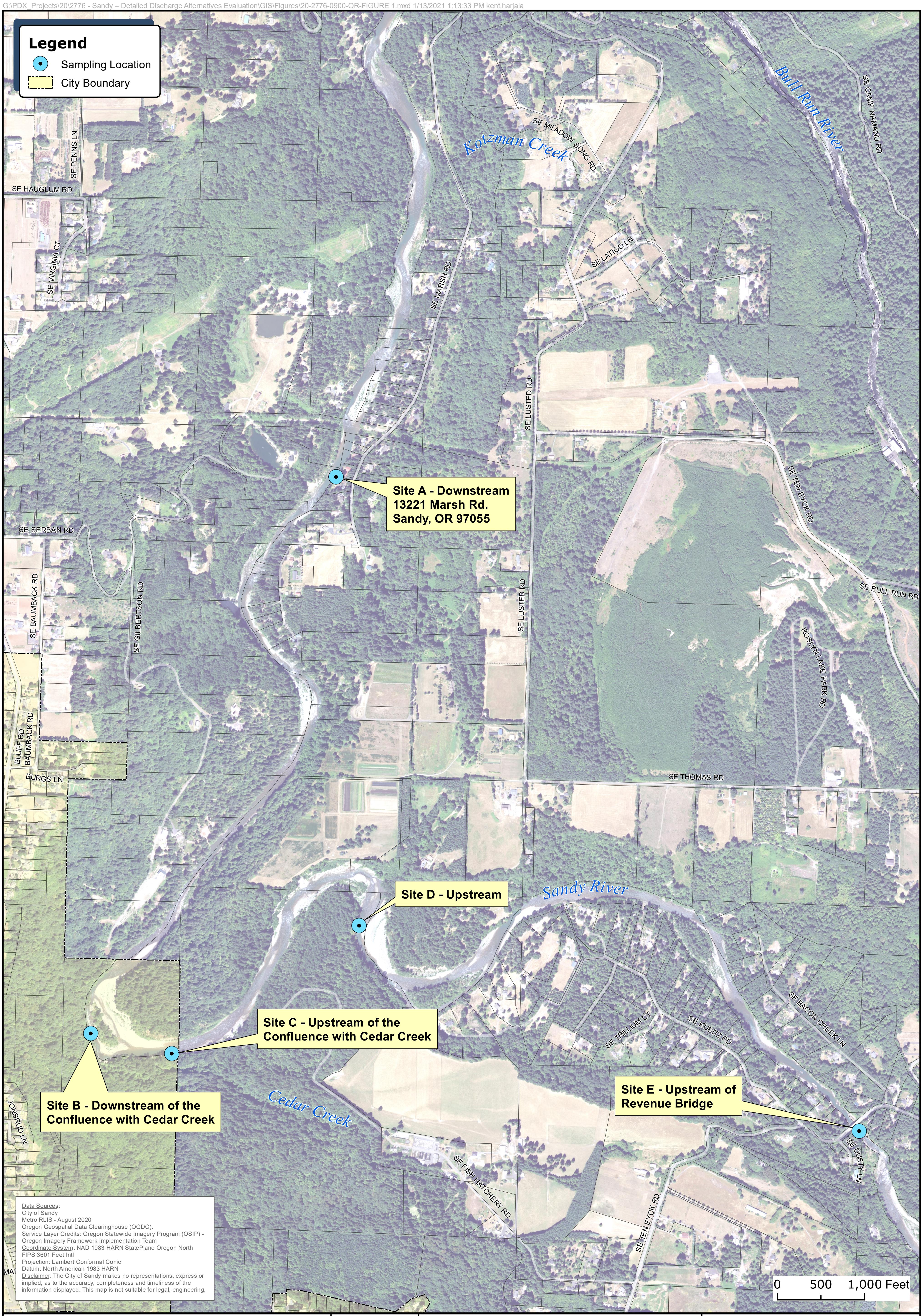
G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\GIS\Figures\20-2776-0900-OR-FIGURE 1.mxd 1/13/2021 1:13:33 PM kent.harjala



Data Sources:
City of Sandy
Metro RLIS - August 2020
Oregon Geospatial Data Clearinghouse (OGDC).
Service Layer Credits: Oregon Statewide Imagery Program (OSIP) - Oregon Imagery Framework Implementation Team
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
Disclaimer: The City of Sandy makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering,

City of Sandy, Oregon
Wastewater System Facility Plan

Figure 1
Sampling Locations

January 2021

20-2776.0900

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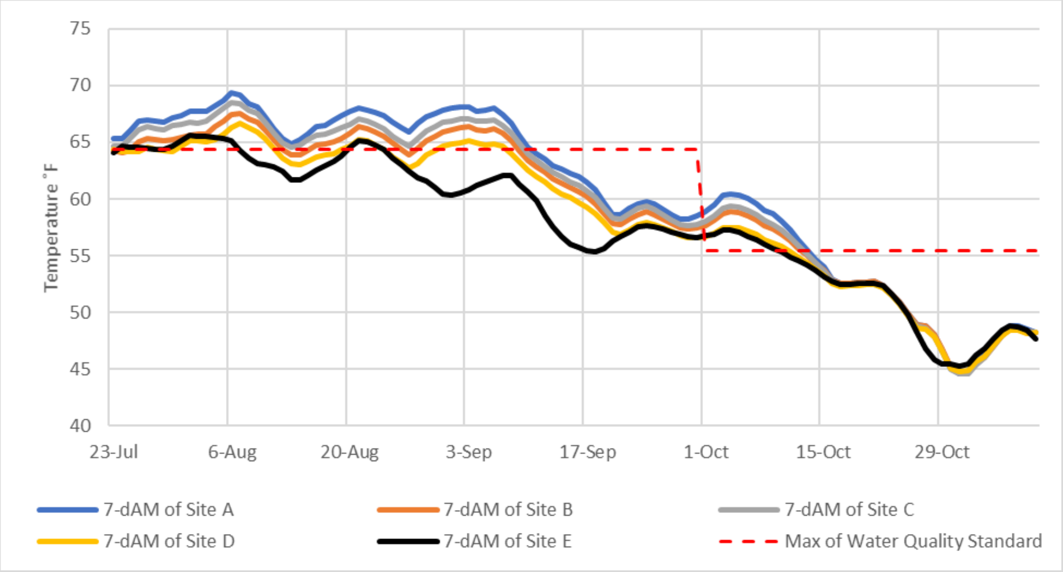
Table 1 | Water Quality Sample Locations

Site ID	Site Description	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
A	Downstream Most Site; Approximately 8,900 feet Downstream of Cedar Creek Confluence; Upstream of SE Lusted Rd. Bridge Crossing at 13221 Marsh Rd. Sandy, OR 97055; River Right	45.427673	-122.258792
B	Approximately 800 feet Downstream of Cedar Creek Confluence; River Left	45.410051	-122.269181
C	Approximately 300 feet Upstream of Cedar Creek Confluence; River Left	45.409476	-122.265549
D	Approximately 4,200 feet Upstream of Cedar Creek Confluence; River Left	45.413616	-122.257325
E	Upstream Most Site; Approximately 12,000 feet Upstream of Cedar Creek Confluence; Upstream of Revenue Bridge (SE Ten Eyck Rd.); River Left	45.407508	-122.234845

Temperature loggers were initially deployed at Sites A, B, C, and D, on July 10, 2019. An additional temperature logger was deployed at a location less than a mile downstream of Site E (Revenue Bridge Site) on July 17, 2020. On October 2, 2020, the temperature probe was moved to Site E. The temperature probes collected data at 15-minute intervals from July to October 2020. The graph below (**Figure 2**) shows the rolling 7-day average of the maximum temperature observed each day (7-dAM). The temperature was generally observed to be warmer at the more downstream sites, with Site E showing the coldest temperatures on average.

Figure 2 | 7-dAM of Temperature Probe (15-min intervals)



Sandy River Flow Data

The project team has conducted additional analysis since the May 2019 memo which has resulted in more accurate estimates of the Sandy River flow rates at the proposed outfall location. Previous analysis utilized a gauge station located upstream of the proposed outfall location, which means that a portion of the drainage basin was not considered. Additionally, the new flows have been updated to reflect more current data.

A multi-faceted approach was developed by Murraysmith and Waterways for reviewing flow rates on the Sandy River, whereby a series of flow rate measurements would be taken over the course of five years. Waterways Consulting took the first flow measurement in 2019 as a wading sample, where measurements were taken at approximately 20 points across a single cross section using a Price AA Flow Meter. Four additional wading measurements were conducted by Waterways near the Oxbow location in the summer and fall of 2019. These flow measurements were used as a calibration measure for reviewing the accuracy of data being recorded by the U. S. Geological Survey (USGS).

The closest long-term USGS river gauge is located approximately 5.5 miles downstream of the proposed outfall site at Ten Eyck Road. Additional flows from the Bull Run River enter the Sandy River between the project site and the gauging station. The USGS and the City of Portland monitor these flows, so reliable flow data is available. The Bull Run River gauging station is also located upstream of the Little Sandy River confluence, which is also monitored by USGS. The project engineers subtracted the flow rates from the Bull Run River and the Little Sandy River gauging stations to estimate the discharge rates for the Sandy River upstream of the Bull Run confluence (where the proposed outfall would be located). **Table 2** summarizes the recorded 7Q10 flow rates (the lowest 7-day average flow that occurs once every 10 years) in the Sandy River, calculated for each month. The river flow values from the 2019 memo are provided here as well for comparison.

Table 2 | Estimated 7Q10 Flows in Sandy River at Proposed Outfall

Month	River Flow (CFS)	River Flow[1] (MGD, Current Estimate)	River Flow[2] (MGD, 2019 Memo Estimate)	Difference (MGD, Current - 2019)
January	940	607	532	75
February	899	581	496	85
March	655	423	525	-102
April	1177	760	738	22
May 1 – May 15	765	494	400	94
May 16 – May 31	730	471	400	71
June	415	268	294	-26
July	331	214	207	7
August	269	174	170	4
September	245	158	146	12
Oct 1 – Oct 14	236	152	147	5
Oct 15 – Oct 31	245	158	147	11
November	381	246	354	-108
December	442	285	399	-114

Notes:

1. 7Q10 flow at downstream of USGS gauging station, calculated for approximately 10-year time period from 2010-2019 (Bull Run River and Little Sandy River flows subtracted).
2. 7Q10 flow at upstream of USGS gauging station, calculated for approximately 10-year time period from 2008-2018. River flows include 5 cfs (3 MGD) for the assumed Cedar Creek flow into the Sandy.

As shown in **Table 2**, the flow rates estimated in 2019 were relatively close to the latest flow estimates. While there is some variation in the values, ranging from 75 MGD higher to 114 MGD lower than the previous estimate for a single month, the conclusions that can be drawn from the data are largely the same. Those conclusions are discussed in greater detail in the following sections.

Effluent Flows/Temperature

The current and projected flow rates associated with the total City of Sandy wastewater flows (along with the flow rates that will be diverted to the MBR facility) are included in **Table 3.** The project team has updated these effluent flow estimates based on recent analysis from those estimated in the 2019 memo. In earlier stages of this project, it was assumed that the proposed diversion pump would direct higher flow rates to the new MBR treatment plant. The design has since been updated to a more realistic phased approach, wherein a larger amount of the flow will continue to be sent to the existing wastewater treatment facility. This change was largely due to the City's decision to update the existing Tickle Creek Plant.

Table 3 | City of Sandy Wastewater Flow Rates

Month	Est. WWTP[1] Temp. (°C)	Present (2020)		Future (2040)	
		Overall City of Sandy Wastewater Flow[2] (MGD)	Flow to MBR[3] (MGD)	Overall City of Sandy Wastewater Flow[2] (MGD)	Flow to MBR[2] (MGD)
January	15.4	1.58	0.79	3.28	1.64
February	16.2	1.45	0.73	3.07	1.54
March	15.7	1.61	0.81	3.33	1.67
April	16.4	1.43	0.72	3.2	1.6
May 1 – May 15	17.4	1.4	0.7	2.99	1.5
May 16 – May 31	17.9	1.4	0.7	2.99	1.5
June	20.9	1.1	0.55	2.61	1.31
July	21.9	0.76	0.38	2.19	1.1
August	22.8	0.69	0.35	2.08	1.04
September	22.4	0.73	0.37	2.14	1.07
Oct 1 – Oct 14	21.2	1.41	0.71	3.13	1.57
Oct 15 – Oct 31	20.5	1.41	0.71	3.13	1.57
November	20	1.75	0.88	3.99	2
December	16.7	1.66	0.83	3.63	1.82

Notes:

1. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
2. Estimated wastewater system average monthly flows using Murraysmith hydraulic model.
3. Estimated flows to MBR facility, approximately ½ of overall wastewater flow.

Monthly Temperature Impact Reviews

Several different regulatory thresholds and methodologies exist for reviewing temperature impacts. For example, the Sandy River Total Maximum Daily Load (TMDL) study lists an allowable temperature increase from point source discharges of 0.54°F (0.3°C). The TMDL study assumes 25 percent of the Sandy River 7Q10 flows would mix with point source effluent at the edge of the regulatory mixing zone. The TMDL also states, however, that under some circumstances it may be appropriate to consider 100 percent of the 7Q10 effluent flows for mixing.

Oregon Department of Environmental Quality's (DEQ) Antidegradation Internal Management Directive (IMD) for new discharges to receiving streams (such as proposed for the Sandy River) lists a lower regulatory threshold of 0.25°F (0.14°C) at the edge of the mixing zone.

For planning purposes, and to be conservative, Murraysmith engineers have reviewed impacts against the lower antidegradation threshold of 0.25°F and assumed that 25 percent of the Sandy River 7Q10 flows would mix with effluent. **Tables 4** and **5** include the results of this temperature review, using mass balance to estimate resulting temperatures after the effluent has mixed with the river.

Table 4 | Temperature Evaluation Based on Present Conditions

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
JAN	0.79	15.40	607	13.00	0.01	0.02
FEB	0.73	16.20	581	13.00	0.02	0.03
MAR	0.81	15.70	423	13.00	0.02	0.04
APR	0.72	16.40	760	13.00	0.01	0.02
MAY 1-14	0.70	17.40	494	13.00	0.02	0.04
MAY 15-31	0.70	17.90	471	18.00	0.00	0.00
JUN	0.55	20.90	268	18.00	0.02	0.04
JUL	0.38	21.90	214	18.00	0.03	0.05
AUG	0.35	22.80	174	18.00	0.04	0.07
SEP	0.37	22.40	158	18.00	0.04	0.07
OCT 1-14	0.71	21.20	152	18.00	0.06	0.10
OCT 15-31	0.71	20.50	158	13.00	0.13	0.24
NOV	0.88	20.00	246	13.00	0.10	0.18
DEC	0.83	16.70	285	13.00	0.04	0.08

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

Table 5 | Temperature Evaluation: Based on Future Conditions

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
JAN	1.64	15.40	607	13.00	0.03	0.05
FEB	1.54	16.20	581	13.00	0.03	0.06
MAR	1.67	15.70	423	13.00	0.04	0.08
APR	1.60	16.40	760	13.00	0.03	0.05
MAY 1-14	1.50	17.40	494	13.00	0.05	0.09
MAY 15-31	1.50	17.90	471	18.00	0.00	0.00
JUN	1.31	20.90	268	18.00	0.06	0.10
JUL	1.10	21.90	214	18.00	0.08	0.14
AUG	1.04	22.80	174	18.00	0.11	0.20
SEP	1.07	22.40	158	18.00	0.12	0.21
OCT 1-14	1.57	21.20	152	18.00	0.13	0.23
OCT 15-31	1.57	20.50	158	13.00	0.29	0.51
NOV	2.00	20.00	246	13.00	0.22	0.40
DEC	1.82	16.70	285	13.00	0.09	0.17

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at EMZ.

As shown in **Tables 4** and **5**, the increase in temperature associated with the City's proposed discharge into the Sandy River would be minimal during the winter and spring months for both existing and future conditions. Greater impacts could occur during the summer and fall months for future conditions. Discharges to the Sandy River during the fall could result in exceedances of the 0.25°F antidegradation policy threshold for future conditions as effluent flows from the MBR plant increase (see numbers in red in **Table 5**). Therefore, the City needs to consider reducing effluent discharges into the Sandy River during the summer and fall months to mitigate future temperature impacts. For more information on potential discharge alternatives, refer to Murraysmith's Technical Memorandum 9 & 10 – Indirect Discharge and Roslyn Lake Alternatives Site Review.

In the previous 2019 memo, the engineers reviewed biological criteria, acute impairment, and thermal shock. They concluded that temperature would not be a major concern for these categories of impairment, but that additional mitigation might be needed in the future. The latest antidegradation study supports the conclusions drawn in the 2019 memo. However, this more recent review also considers the more stringent antidegradation threshold and confirms the need to have temperature management as a key part of the design and permitting process moving forward.

Summary and Conclusions

This memorandum, (Technical Memorandum 5 of the Detailed Discharge Alternative Evaluation study) is an update to the earlier temperature review conducted by Murraysmith in 2019.

The project team has used new and updated data to review potential temperature impacts to the Sandy River from the proposed new MBR satellite treatment facility. Results from this new review are consistent with those from 2019: the planned effluent discharge into the Sandy River will need thoughtful temperature design and management to meet regulatory temperature thresholds as the community grows. In addition, the project team evaluated these temperatures under the more stringent anti-degradation requirements, which had not been considered in the previous memo. This updated temperature review results in the following conclusions.

- With population growth at the City and climate change, temperatures and heat load from the treated wastewater effluent will increase, resulting in greater need for temperature management.

- Summer and fall discharges to the Sandy river (especially in the future) are at the highest risk of violating current regulatory temperature thresholds if temperature is not managed appropriately.

- These temperature impacts may be managed by strategically reducing the effluent flow into the Sandy River.

- The DDAE planning study has identified and recommended the Roslyn Lake site for discharging portions of the effluent (into constructed wetlands) during summer and fall periods to help eliminate/minimize temperature impacts to the Sandy River now and into the future.

- The City will want to continue to work closely with DEQ to better understand which regulatory thresholds will govern final design and permitting. There are currently several thresholds listed in the TMDL study and in the Antidegradation IMD.

- Likewise, the City will want to coordinate closely with DEQ on methodology for temperature reviews. For planning purposes, we have assumed 1/4 of the Sandy 7Q10 River flows would mix with effluent (consistent with DEQ's point source temperature reviews in the Sandy River TMDL). Other methodology could assume 100 percent of 7Q10 river flows for mixing and different temperature thresholds.

- Final NPDES permitting reviews of temperature will require outfall design, dilution modeling, and related mixing zone studies to better estimate mixing and dilution of effluent when it enters the Sandy River. The regulatory temperature thresholds would need to be met after the effluent mixes and travels to the defined regulatory mixing zone boundary.

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Technical Memorandum

Date: May 22, 2019

Project: 19-2424
Sandy WSFP Continuing Planning Services

To: Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Preston Van Meter, PE
Bernadel Garstecki, EIT
Jessica Cawley, EIT

Review: Matt Hickey, PE
Jason Flowers, PE, PhD

Re: New Sandy River Outfall Preliminary Temperature Evaluation

---

The following sections are included in this TM:

- **Introduction and Background**: Overview of the proposed outfall as well as the Oregon Administrative Rules for temperature criteria.
- **Methodology**: Description of the process used for the preliminary temperature evaluation, and an overview of the data used for the analysis.
- **Analysis**: Results of the temperature evaluation for the two scenarios
- **Conclusions, Recommendations, and Next Steps**: Summary of the results and potential mitigation efforts for near-term and long-term effects.

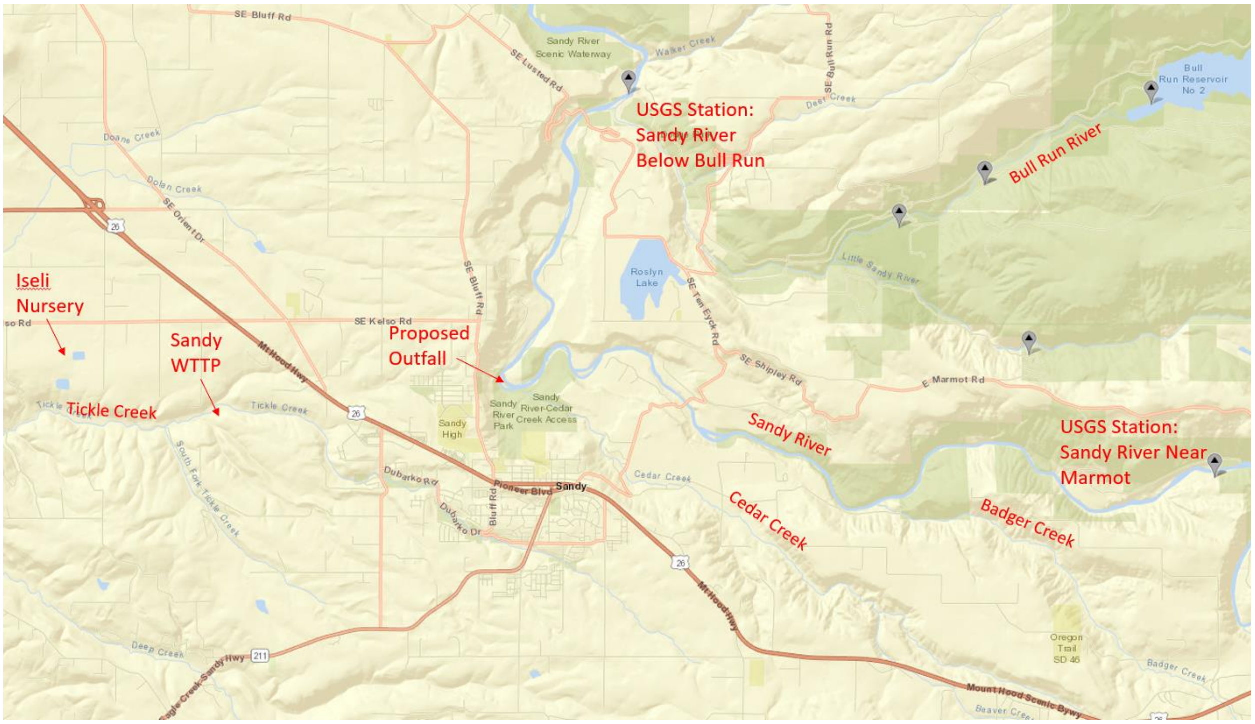
1. Introduction and Background

The purpose of this TM is to provide a preliminary temperature evaluation of the proposed outfall to the Sandy River for the effluent from the City of Sandy east side treatment facility. This report reviews the regulatory environment surrounding temperature compliance in regard to the Oregon water quality standards for the Sandy River and analyzes the specific flows of the Sandy River and projected flows from the east side treatment facility to evaluate any significant source of warming to the Sandy River. Two scenarios, existing conditions and future conditions, were analyzed to determine the impact of the outfall on the river. The scenarios were created using a hydraulic model of the collection system. Evaluation of the existing system considers sending the maximum flows that can be diverted from the proposed diversion structure to a new outfall. Evaluation of the future system (2040) considers sending the entire projected wastewater flows to a new outfall. These two scenarios were analyzed for the following temperature regulations: human use allowance, acute impairment, thermal shock, and migration blockage.

The existing Sandy WWTP is located northwest of the city via Jarl Road. Between November 1st and April 30th, the effluent is discharged to Tickle Creek, a tributary of the Clackamas River. Between May 1st and October 31st, the effluent is used by Iseli Nursery to supplement their water demand for irrigation purposes. The ponds are nearing their capacity and the expected increase in wastewater over the next 20 years will exceed the capacity of Tickle Creek. The east side treatment facility will not be able to discharge to the existing outfall and so a new outfall is proposed. The proposed outfall is located on the Sandy River at approximately river mile 23 from the mouth of the river, near Sandy River Park. While recycle water will continue to be sent to Iseli Nursery for irrigation in the summer, the proposed outfall will have the capacity for any summer flows above the capacity of the nursery in addition to entire winter season flows.

A Total Maximum Daily Load (TMDL) report was prepared by the Oregon Department of Environmental Quality in 2005 for the Sandy River Basin which outlines the temperature Human Use Allowance for the river as well as other factors that might impact the quality of the river. This report cited information obtained from USGS stream gauges located upstream (near Marmot dam) and downstream (near the mouth of the Bull Run River) of the proposed outfall. These gauges stations do not exactly measure flow at the proposed outfall location, so it is recommended that temperature and flow are recorded at the proposed outfall location. The locations of the existing WTTP, proposed outfall, and USGS gauge stations are shown below in **Figure 1**.

Figure 1 – Vicinity Map



1.1 Temperature Criteria

Table 1 on the following page summarizes the regulations and criteria from the Oregon Administrative Rules (OAR) for Water Quality Standards (OAR 340-041-0028).

Table 1 - Oregon Administrative Rules – Water Quality Standards for the Sandy River Outfall

Regulations	Description	Season	Criteria
Biological Criteria OAR 340-041-0028 (4) (c) Figure 286A	Salmon and Trout Rearing & Migration	Year round	7dAM mixed stream temperature may not exceed **Allowable 7dAM T = 18.0°C (64.4°F)**
Biological Criteria OAR 340-041-0028 (4) (a) Figure 286B	Designated Salmon and Steelhead Spawning Use	Winter (spawning) Oct. 15 – May 15	7dAM mixed stream temperature may not exceed **Allowable 7dAM T = 13.0°C (55.4°F)**
Human Use Allowance OAR 340-041-0028 (12) (b) (B)	An “insignificant” addition of thermal load anthropogenic activities	When waters exceed the applicable temperature criteria	According to the 2005 Sandy TMDL: **Singe point source:** **allowable ΔT = 0.3°C (0.54°F) in 25% of stream flow** Or **All point sources combined:** **allowable ΔT = 0.2°C (0.36°F) in 100% of stream flow**
Acute Impairment OAR 340-041-0053 (2) (d) (B)	Instantaneous lethality	Year round	**Allowable Effluent T < 32.0°C (89.6°F)**
Thermal Shock OAR 340-041-0053 (2) (d) (C)		Year round	**Allowable Mixture T < 25.0°C (77.0°F) with 5% of stream flow**
Migration Blockage OAR 340-041-0053 (2) (d) (D)		Year round	**Allowable Mixture T < 21.0°C (69.8°F) with 25% of stream flow**
Exceptions OAR 340-041-0028 (12) (c) & (d)	A water body that only exceeds the criteria set out in this rule when the exceedance is attributed to daily maximum air temperatures that exceed the 90th percentile value of annual maximum seven-day average maximum air temperatures calculated using at least 10 years of air temperature data, will not be listed on the section 303(d) list of impaired waters and sources will not be considered in violation of this rule. An exceedance of the biologically-based numeric criteria will not be considered a permit violation during stream flows that are less than the 7Q10 low flow condition for that water body.		

As of August 8, 2013, the Environmental Protection Agency disapproved rule of section 8 (Natural Conditions Criteria) of OAR 340-041-0028. This section is described below:

> *"(8) Natural Conditions Criteria. Where the department determines that the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria in section (4) of this rule, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body." – OAR 340-041-0028*

According to this change, if the river temperatures exceed the biological criteria, the allowable change in temperature will be calculated using the biological criteria as the river temperature.

Anti-degradation laws prohibit the further degradation of water quality limited waters and does not allow for new discharges to water quality waters unless a TMDL has been established with wasteload allocations, load allocations, and reserve capacity in order to assimilate the increased load. A TMDL was established for the Sandy River and includes a reserve allocation of 0.2 degrees Celsius for point source discharges.

1.2 Definitions

Seven-day-average maximum (7dAM): The average of the maximum daily temperature of seven consecutive days as reported on the 7th day.

7Q10: Seven-day averaged flow condition that occurs on a ten-year return period. This flow has a 10 percent probability of occurring every year during the specified month.

2. Methodology

Preliminary temperature evaluations for human use allowance, acute impairment, thermal shock, and migration blockage, as stated in the OARs and TMDL, were conducted for the proposed outfall. The two scenarios, existing conditions and future conditions, were analyzed to determine the impact of the outfall on the river. Evaluation of the existing system considers sending the maximum flows that can be diverted from the proposed diversion structure to a new outfall. Evaluation of the future system (2040) considers sending the entire projected wastewater flows to a new outfall.

Completion of the temperature evaluation required flow and temperature data for the WWTP and Sandy River. As noted previously, the temperature data on the Sandy River is limited and flow data used in the preliminary evaluations is from a gauge station upstream of the proposed outfall. The gauge station is at approximately river mile 30 or seven river miles upstream of the proposed outfall.

Current and projected monthly average flows for the existing Sandy Treatment Plant were calculated using a hydraulic model developed of the collection system and rainfall events with a two-year return interval. For the existing conditions, the proposed diversion structure would have the capacity to divert approximately 70 percent of the wastewater system flow up to a maximum flow of 3.5 MGD. The capacity of the proposed eastside treatment facility is 3.5 MGD after phase 1 of the proposed wastewater facilities plan, to be expanded to 7.0 MGD by 2040. The wastewater treatment plant temperatures used in the analysis were calculated for each month using the DMR reports from 2013 – 2017 to find the maximum 7dAM effluent temperatures from the existing treatment plant.

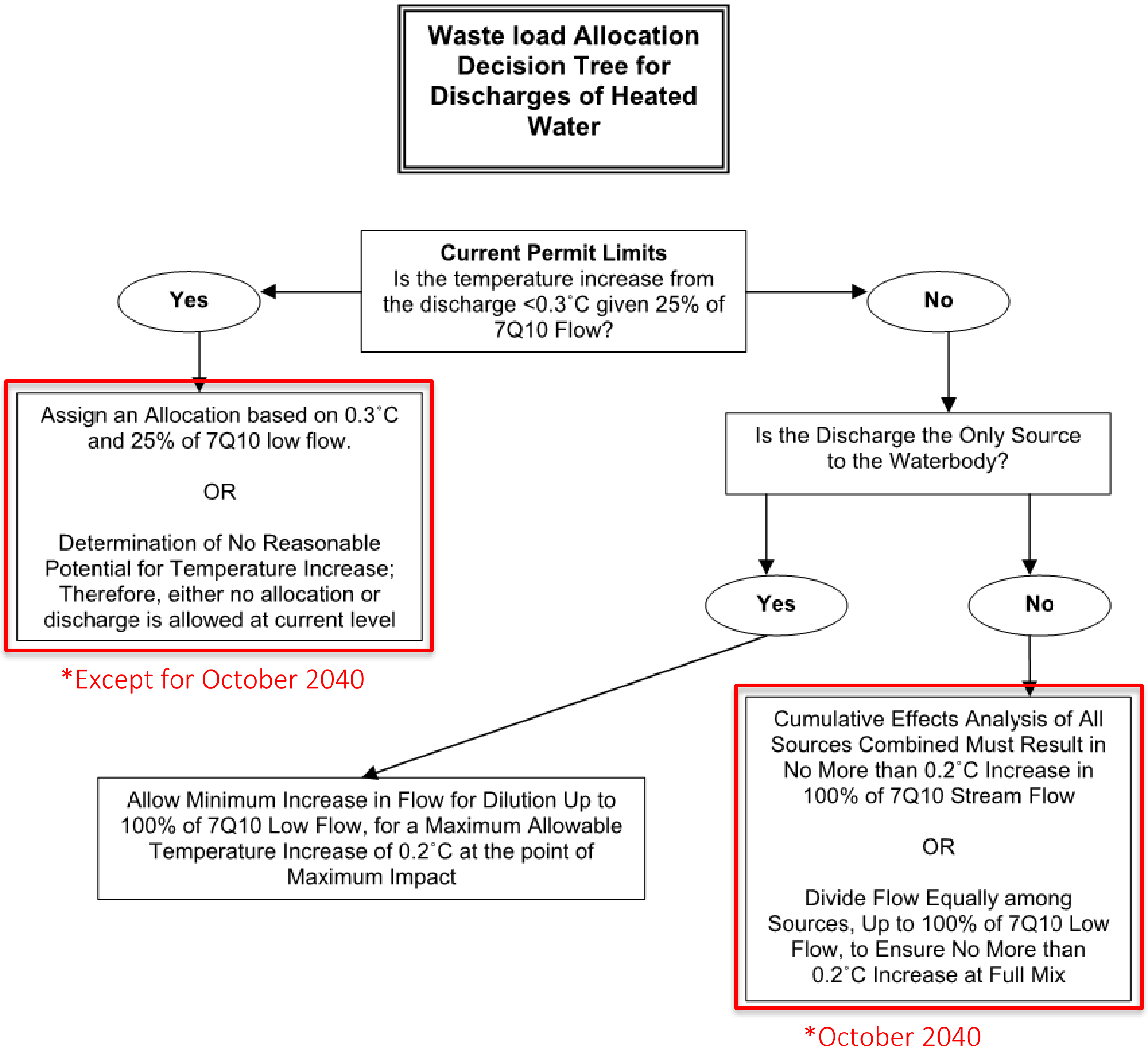
River flow data was obtained from 2008 – 2018 from the USGS gauge station: 14137000, Sandy River Near Marmot. This gauge station is located approximately eight river miles upstream of the proposed outfall. There are two small creeks, Badger Creek and Cedar Creek, that flow into the Sandy between the proposed outfall and the gauge station. The TMDL estimated the 7Q10 low flow of Cedar Creek to be 5 cfs (3 MGD). The monthly river 7Q10 low flow values were calculated from flow data from 2008 – 2018 using a Log Pearson Type III approach and then 5 cfs was added to each month to account for the flow from Cedar Creek. The flow values used in the analysis will still be lower than the actual flows the since Badger Creek flows have not been included, but this will provide a more conservative estimate.

Yearly river temperature data was not available at the proposed outfall location. The Sandy TMDL showed summer maximum river temperatures at the proposed outfall location of approximately 20 degrees Celsius which are above the summer biological criteria of 18 degrees Celsius. Winter temperature data was not provided in the TMDL. The summer and winter biological criteria were used in the data analysis in place of actual river temperatures. The biological criteria for cold-water protection is 18 degrees Celsius from May 16 to October 14, and 13 degrees Celsius from October 15 to May 15.

2.1 Human Use Allowance (HUA)

The Sandy River Basin TMDL methodology for allocating waste loads to point sources was used to determine the human use allowance for the proposed outfall. The discharge from the proposed outfall is first analyzed to determine whether the temperature increase is less than 0.3 degrees Celsius given 25 percent of the 7Q10 low flow. If the discharge passes these criteria, then a waste load allocation can be assigned based on these limits. If the anticipated temperature increase to the Sandy River does not meet this criterion, the Sandy River TMDL gives an alternative allocation methodology. Since the proposed outfall would not be the only source of discharge to the waterbody, all the discharge sources combined must result in no more than 0.2 degrees Celsius increase in 100 percent of the 7Q10 low flow. The following flow chart (**Figure 2**) from the Sandy River Basin TMDL summarizes this methodology.

Figure 2 – Point Source Methodology Flow Chart (from Sandy TMDL)



The estimated ETL from the proposed outfall was calculated for current flows and projected flows using **Equation 1** (DEQ). The estimated change in river temperature due to the outfall was calculated using **Equation 2** (DEQ).

$$Estimated\ ETL = Q_E * (T_E - T_C) * C_F \qquad \textit{(Equation 1)}$$

$$\Delta T = \frac{Q_E}{(Q_E+Q_R)} * (T_E - T_C) \qquad \textit{(Equation 2)}$$

Where,

$$ETL = the\ excess\ thermal\ load\ \left(\frac{kcal}{day}\right)$$
$$\Delta T\ = Temperature\ increase\ above\ applicable\ criteria$$
$$Q_E\ = Point\ source\ effluent\ flow\ (CFS)$$
$$Q_R\ = 25\%\ of\ the\ 7Q10\ river\ flow\ (CFS)$$
$$C_F\ = conversion\ factor = 2{,}446{,}664\ kcal \cdot \frac{s}{°\mathrm{C}} \cdot ft^3 \cdot day$$
$$T_E\ = Point\ source\ effluent\ temperature\ (°\mathrm{C})\ as\ 7dAM$$
$$T_C\ = Applicable\ temperature\ criterion\ (°\mathrm{C})$$
$$\Delta T\ = Actual\ change\ in\ river\ temperature\ (°\mathrm{C})$$

2.2 Acute Impairment, Thermal Shock, Migration Blockage

A monthly analysis of possible acute impairment, thermal shock, and migration blockage was conducted for the existing system diverted flows and 2040 total system flows using the criteria outlined in the OAR.

2.3 Data Used for Analysis

2.3.1 WWTP Flow and Temperature

Table 2 below shows the average monthly treatment plant flows and temperatures for the existing and future conditions.

Table 2 – Monthly Treatment Plant Flow and Temperature

Month	WWTP Flow (MGD)			WWTP Temp (°C)[1]
	Existing All System	Existing Diverted	2040 All System	
January	2.20	1.58	3.28	15.4
February	2.01	1.45	3.07	16.2
March	2.25	1.61	3.33	15.7
April	1.98	1.43	3.20	16.4
May 1 - May 15	1.94	1.40	2.99	17.4
May 16 - May 31	1.94	1.40	2.99	17.9
June	1.59	1.10	2.61	20.9
July	1.19	0.76	2.19	21.9
August	1.10	0.69	2.08	22.8
September	1.15	0.73	2.14	22.4
Oct 1 - Oct 14	2.04	1.41	3.13	21.2
Oct 15 - Oct 31	2.04	1.41	3.13	20.5
November	2.44	1.75	3.99	20.0
December	2.32	1.66	3.63	16.7

1. WWTP temperatures were calculated using the maximum 7dAM effluent temperatures as reported on the DMRs from 2013 to 2017

2.3.2 Sandy River Flow and Temperature Data Used for Analysis

Table 3 below shows the monthly river flows and temperatures used in the analysis.

Table 3 – Monthly River Flow and Temperature

Month	7Q10 River Flow (MGD)[1]	Biological Criteria (°C)[2]
January	532	13.0
February	496	13.0
March	525	13.0
April	738	13.0
May 1 - May 15	400	13.0
May 16 - May 31	400	18.0
June	294	18.0
July	207	18.0
August	170	18.0
September	146	18.0
Oct 1 - Oct 14	147	18.0
Oct 15 - Oct 31	147	13.0
November	354	13.0
December	399	13.0

1. River flows include 5 cfs (3 MGD) for the assumed Cedar Creek flow into the Sandy.
2. Biological criteria was used in the data analysis because no actual river temperature data was available for the proposed outfall location.

3. Analysis

Results for the two scenarios are included below. The first scenario considers current conditions with a split flow to the proposed outfall, and the second scenario considers future conditions with the full treatment plant discharge to the proposed outfall on the Sandy River. There are no temperature exceedances for the existing condition scenario and there was only one exceedance calculated for the future conditions. Table 4 below shows the estimated excess thermal loads (ETLs) and estimated increases in river temperature each month resulting from the two scenarios.

Table 4 – ETLs and ΔT

Month	Existing (diverted flows)		2040 (all system)	
	Estimated ETL (MMkcal/day)	Estimated ΔT (°C)	Estimated ETL (MMkcal/day)	Estimated ΔT (°C)
January	15	0.03	30	0.06
February	17	0.04	37	0.08
March	16	0.03	33	0.07
April	18	0.03	41	0.06
May 1 - May 15	23	0.06	50	0.13
May 16 - May 31	-1	0.00	-1	0.00
June	12	0.04	29	0.10
July	11	0.06	32	0.16
August	13	0.08	38	0.22
September	12	0.09	36	0.24
Oct 1 - Oct 14	17	0.12	38	0.25
Oct 15 - Oct 31	40	0.28	89	0.59
November	46	0.13	105	0.30
December	23	0.06	51	0.13

Acute Impairment, Thermal Shock, Migration Blockage

A monthly analysis of possible acute impairment, thermal shock, and migration blockage was conducted for the existing system diverted flows and the 2040 total system flows. Table 5 shows the river mixture temperatures for each month.

Table 5 – River Mixture Temperatures

Month	Acute Impairment T Effluent (°C) < 32 °C		Thermal Shock (5% River Flow) T Mix (°C) < 25 °C		Migration Blockage (25% River Flow) T Mix (°C) < 21 °C	
	Existing	2040	Existing	2040	Existing	2040
January	15.4	15.4	13.1	13.3	13.0	13.1
February	16.2	16.2	13.2	13.3	13.0	13.1
March	15.7	15.7	13.2	13.3	13.0	13.1
April	16.4	16.4	13.1	13.3	13.0	13.1
May 1 - May 15	17.4	17.4	13.3	13.6	13.1	13.1
May 16 - May 31	17.9	17.9	18.0	18.0	18.0	18.0
June	20.9	20.9	18.2	18.4	18.0	18.1
July	21.9	21.9	18.3	18.7	18.1	18.2
August	22.8	22.8	18.4	18.9	18.1	18.2
September	22.4	22.4	18.4	19.0	18.1	18.2
Oct 1 - Oct 14	21.2	21.2	18.5	19.0	18.1	18.3
Oct 15 - Oct 31	20.5	20.5	14.2	15.2	13.3	13.6
November	20.0	20.0	13.6	14.3	13.1	13.3
December	16.7	16.7	13.3	13.6	13.1	13.1

Conclusions, Recommendations, and Next Steps

Based on the temperature analysis and excess thermal load limits, there does not appear to be a significant potential for the wastewater effluent to violate the temperature criteria for either scenario, existing split flows or future all system flows. The river flow is much greater than the expected effluent flow, and so it is difficult for the effluent to significantly impact the river temperatures.

The only month that exceeds the 0.3-degree Celsius limit is the second half of October in 2040. November in 2040 does not exceed the limit but it is on the edge of being an exceedance. The long-term analysis shows that there is slightly more impact of the effluent on the river so it is recommended that the city plan for additional mitigation in the future. It is also recommended that the city install a thermistor and flow gauge at the location of the proposed outfall to correlate river flow data from the existing USGS gauge stations to the location of the proposed outfall. This will provide a more complete understanding of the existing river conditions and a way to very this preliminary temperature analysis.

There are no exceedances of the criteria for acute impairment, thermal shock, and migration blockage for either scenario, existing or future.

The Sandy River is considered a water quality limited water for temperature. According to DEQ's IMD for Antidegradation, a facility renewing a permit proposing an effluent increase or change in discharge location is subject to an antidegradation review. This review will be conducted by DEQ.

References

Oregon Department of Environmental Quality (DEQ). 2001. Antidegradation Policy Implementation Internal Management Directive.

Oregon Department of Environmental Quality (DEQ). 2005. Sandy River Basin Total Maximum Daily Load (TMDL).

Oregon Department of Environmental Quality (DEQ). 2008. Temperature Water Quality Standard Implementation Internal Management Directive.

Oregon Secretary of State. Oregon Administrative Rule 340-041-0028 Water Quality Standards for Temperature. Accessed 4/10/2018 via internet at https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=244176

Oregon Secretary of State. Oregon Administrative Rule 340-041-0053 Water Quality Standards for Mixing Zones. Accessed 4/10/2018 via internet at https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=68770

U.S. Geological Survey (USGS). Gauge station information accessed 4/10/2018 via internet at https://waterdata.usgs.gov/nwis/inventory

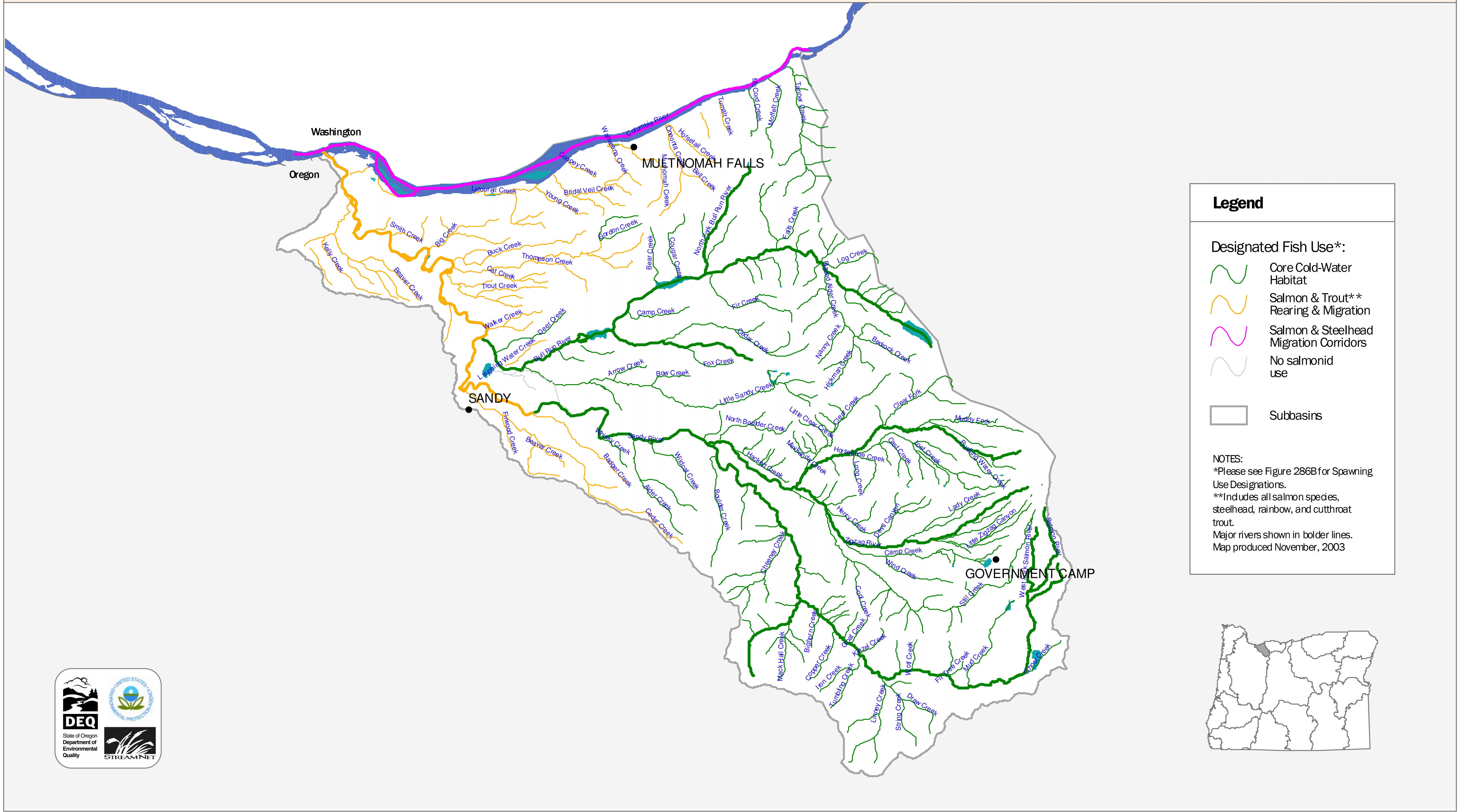
Attachments

1. Figure 286A: Fish Use Designations, Sandy Basin, Oregon
2. Figure 286B: Salmon and Steelhead Spawning Use Designations, Sandy Basin, Oregon

XXX:xxx

Cc: Name, Agency

*Figure 286A: Fish Use Designations**
Sandy Basin, Oregon



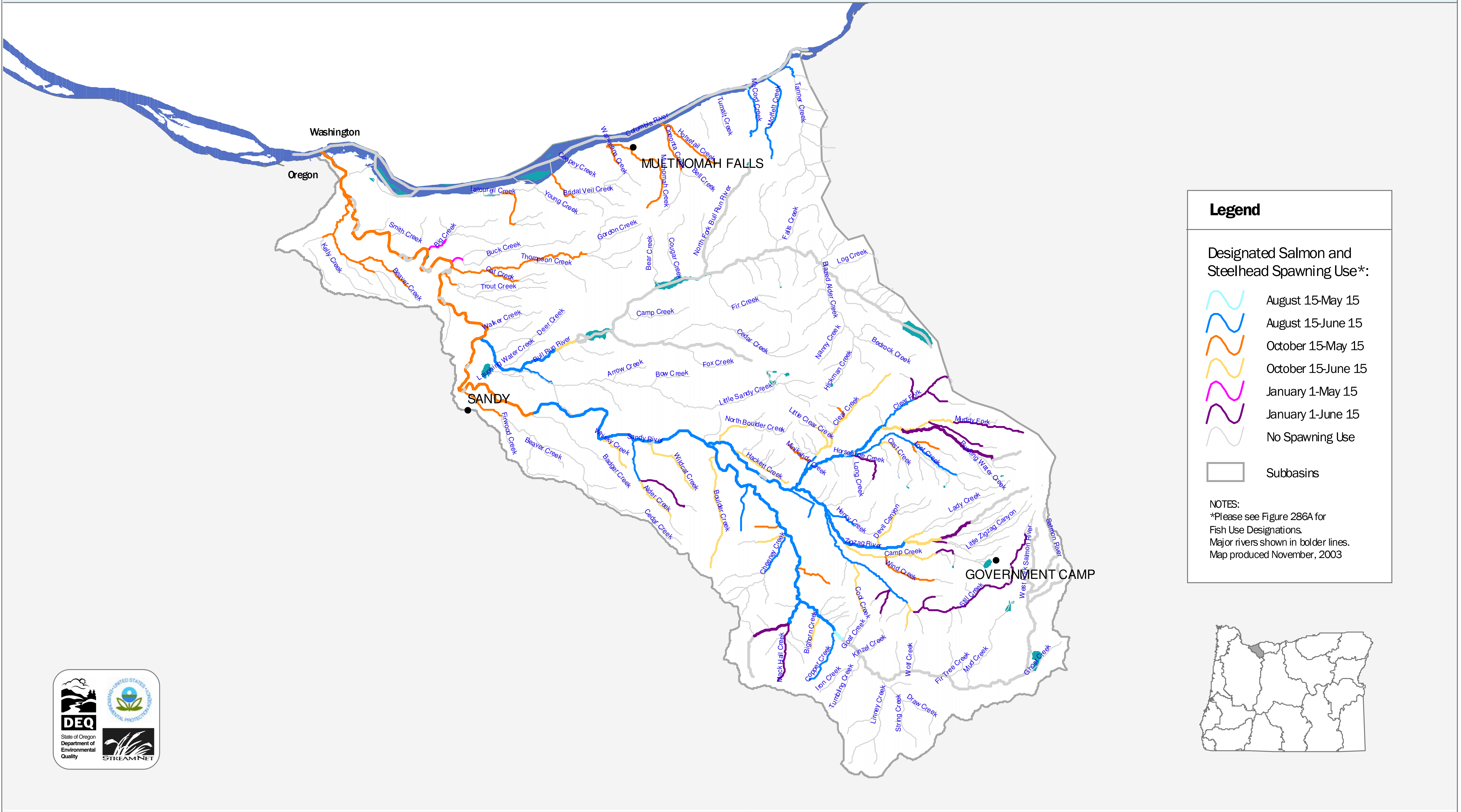
Legend

Designated Fish Use*:

- 🟩 Core Cold-Water Habitat
- 🟧 Salmon & Trout** Rearing & Migration
- 🟪 Salmon & Steelhead Migration Corridors
- ⬜ No salmonid use
- ☐ Subbasins

NOTES:
*Please see Figure 286B for Spawning Use Designations.
**Includes all salmon species, steelhead, rainbow, and cutthroat trout.
Major rivers shown in bolder lines.
Map produced November, 2003

*Figure 286B: Salmon and Steelhead Spawning Use Designations**
Sandy Basin, Oregon



Legend

Designated Salmon and Steelhead Spawning Use*:

- August 15-May 15
- August 15-June 15
- October 15-May 15
- October 15-June 15
- January 1-May 15
- January 1-June 15
- No Spawning Use
- Subbasins

NOTES:
*Please see Figure 286A for Fish Use Designations.
Major rivers shown in bolder lines.
Map produced November, 2003

DEQ
State of Oregon Department of Environmental Quality

STREAMNET

Technical Memorandum 6

Date: March 10, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler,
Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Matt Hickey, PE
Jessica Cawley, PE
Murraysmith

Re: Sandy River Water Quality Sampling and Testing Program Compilation

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Introduction

This memo contains a summary of 2019-2020 Sandy River water quality data collected in proximity to alternatives for the outfall location of the proposed Eastside Satellite Treatment Facility. The City of Sandy (City) and the Oregon Department of Environmental Quality (DEQ) hope to determine compliance with anti-degradation laws set forth in the Oregon Administrative Rules (OAR) regulated by the DEQ in the National Pollutant Discharge Elimination System (NPDES) permitting process.

Murraysmith collected grab samples and Alexin Analytical Laboratories, Inc in Tigard, Oregon analyzed the samples in accordance with the Sampling and Testing Plan prepared August 7, 2019. Waterways Consulting, Inc installed temperature probes which recorded measurements on a 15-minute interval from July through October in 2019 and 2020. River discharge was estimated using instantaneous data from USGS Gages.

The purpose of this memorandum is to report the water quality data from the Sandy River as recorded. Further conclusions and findings will be discussed in other technical memorandums for this project.

Scope

The goal of this investigation was to provide ambient water quality data on the Sandy River in support of the preparation of a new NPDES permit for the proposed Eastside Satellite Treatment Facility. The scope of this study included once per month sampling for three months in the fall of 2019 (August, September, and October) during low flows to establish a strong baseline of water quality data; as well as samples collected in the spring and fall (June and November) of 2020. It is recommended to continue this sampling program with quarterly samples through 2021.

Sandy River Sampling

Sandy River Sampling Overview

Sampling was initiated in August 2019. Murraysmith collected grab samples on the following dates.

- August 16, 2019
- September 23, 2019
- October 31, 2019
- June 18, 2020
- November 3, 2020

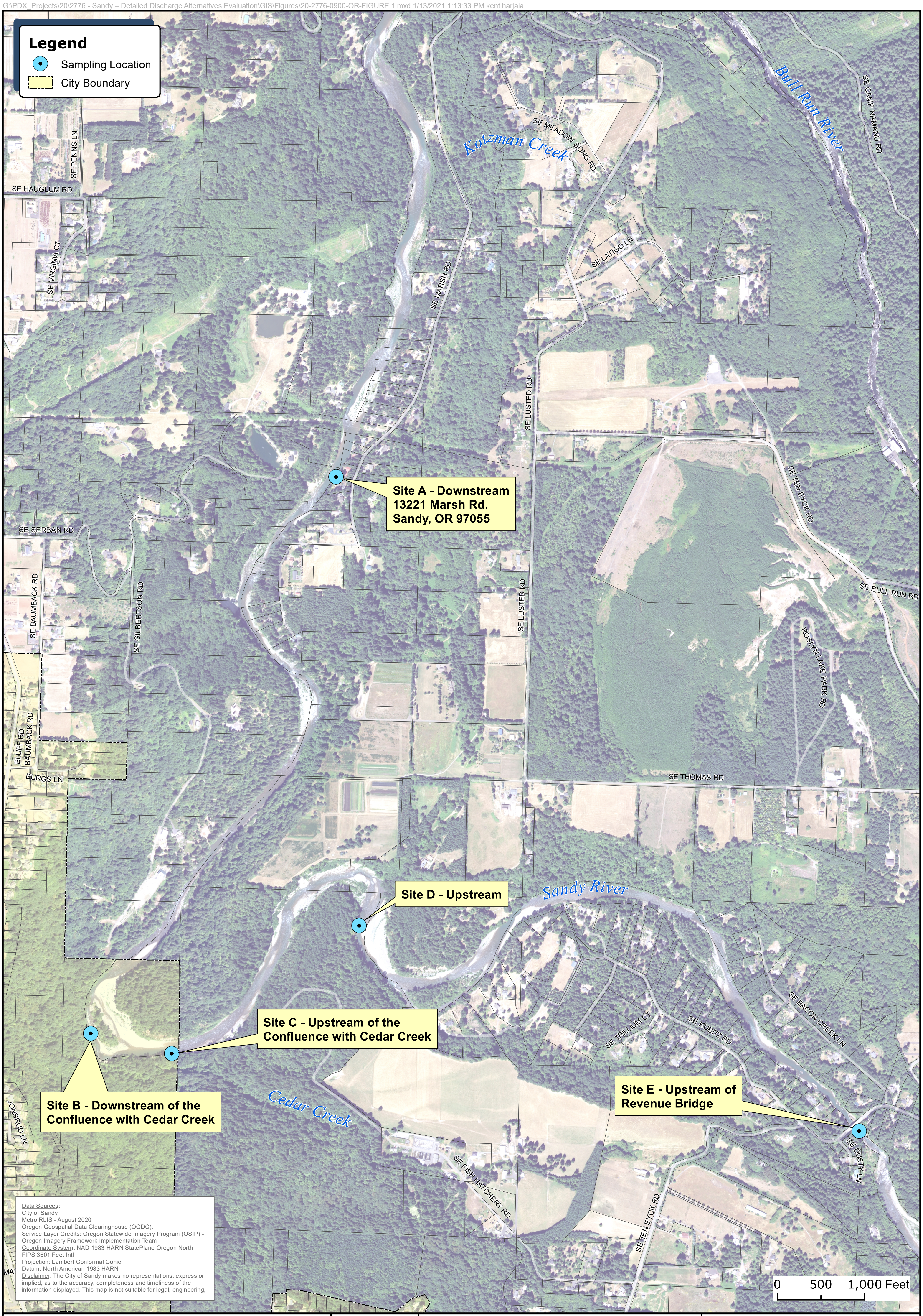
Grab samples were collected at three sites on the Sandy River (**Figure 1**). The grab sample sites include Site B, Site C, and Site E. The original scope of water quality sample focused on the Oxbow near Site B and Site C. Subsequent development of the Revenue Bridge discharge location led the City and team to replace Site B with Site E for the November 2020 sampling event. Geographic coordinates and descriptions of sample locations are included below (**Table 1**).

Table 1
Water Quality Sample Locations

Site ID	Site Description	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
A	Downstream Most Site; Approximately 8,900 feet Downstream of Cedar Creek Confluence; Upstream of SE Lusted Rd. Bridge Crossing at 13221 Marsh Rd. Sandy, OR 97055; River Right	45.427673	-122.258792
B	Approximately 800 feet Downstream of Cedar Creek Confluence; River Left	45.410051	-122.269181
C	Approximately 300 feet Upstream of Cedar Creek Confluence; River Left	45.409476	-122.265549
D	Approximately 4,200 feet Upstream of Cedar Creek Confluence; River Left	45.413616	-122.257325
E	Upstream Most Site; Approximately 12,000 feet Upstream of Cedar Creek Confluence; Upstream of Revenue Bridge (SE Ten Eyck Rd.); River Left	45.407508	-122.234845

Temperature was also sampled at Sites A, B, C, and D.

G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\GIS\Figures\20-2776-0900-OR-FIGURE 1.mxd 1/13/2021 1:13:33 PM kent.harjala



Data Sources:
City of Sandy
Metro RLIS - August 2020
Oregon Geospatial Data Clearinghouse (OGDC).
Service Layer Credits: Oregon Statewide Imagery Program (OSIP) -
Oregon Imagery Framework Implementation Team
Coordinate System: NAD 1983 HARN StatePlane Oregon North
FIPS 3601 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
Disclaimer: The City of Sandy makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering,

murraysmith

SANDY
WHERE INNOVATION MEETS ELEVATION

N
W E
S

City of Sandy, Oregon
Wastewater System Facility Plan

Figure 1
Sampling Locations

January 2021

20-2776.0900

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Table 2 shows the list of analytes analyzed for the grab samples collected at Sites B, C, and E).

Table 2
Water Quality Sampling Parameters

Alkalinity as CaCO3	Ammonia, as N	Arsenic
Bacteria - E. Coli	Bacteria - Enterococci	Bacteria - Fecal Coliform
Biochemical oxygen demand (BOD5)	Cadmium	Chemical oxygen demand (COD)
Chlorophyll-a	Chromium, total	Copper
Hardness	Iron (Total)	Kjeldahl nitrogen (TKN), as N
Lead	Manganese	Mercury
Nickel	Nitrate, as N	Nitrite, as N
Orthophosphate, as P	pH	Phaeophytin
Phosphorus (Total), as P	Total dissolved solids (TDS)	Total Suspended Solids (TSS)
Total Organic Carbon (TOC) as CaCO3		

Sandy River Sampling Results

Grab samples were collected following procedures outlined in the Sampling and Testing Plan prepared August 7, 2019. All procedures were analyzed by Alexin Analytical, an accredited analytical laboratory, in accordance with procedures established by the U.S. Environmental Protection Agency (US EPA) and National Environmental Accreditation Conference (NELAC) certification. Alexin Analytical is accredited under US EPA Accreditation Number #OR100013. Several samples produced results below the minimum reporting limits and therefore recorded as non-detect (ND). A table of all observed values and the associated minimum reporting limits (MRL) are summarized in **Appendix A**. The original laboratory results are included in **Appendix B**.

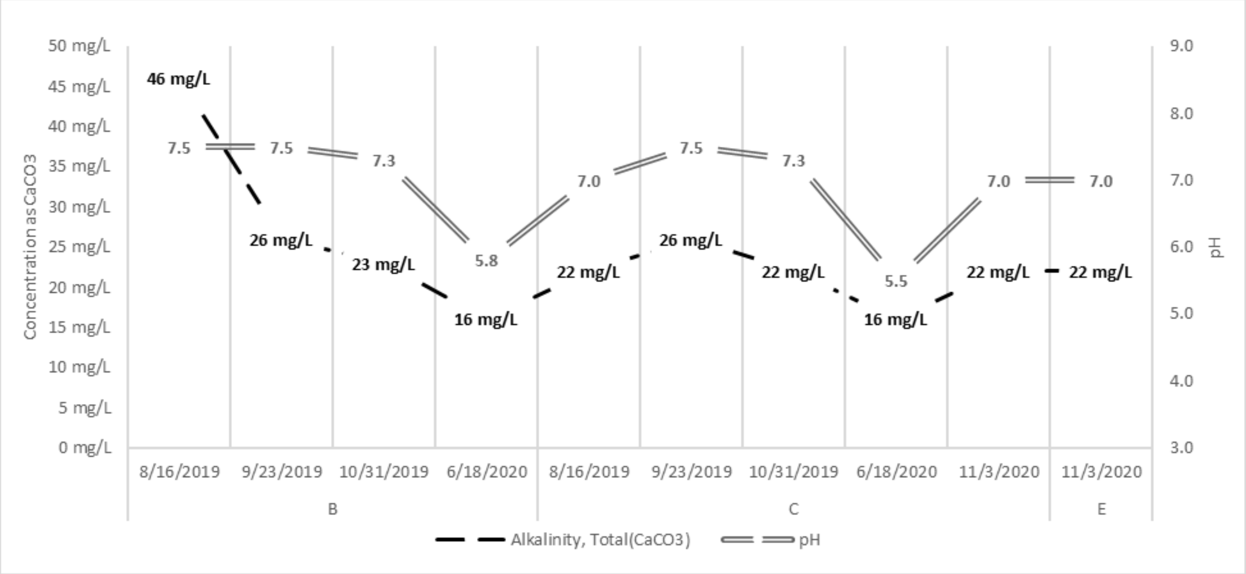
pH and Alkalinity

Standard: [1] pH between 6.5 to 8.5

The pH values ranged between 5.5 and 7.5 between the sites. Aside from the June 2020 sampling event, pH was relatively consistent between sampling locations. The June 2020 sampling event showed an acidic pH below the limit of the water quality standard; June 2020 was also the highest observed river discharge that coincided with a sampling event. All other samples observed pH within the bounds of state water quality standards.

Alkalinity values ranged from 16 mg/L to 46 mg/L between the sites. In general, the alkalinity was relatively consistent between sampling points with one sample observably higher (46 mg/L) than the rest at the furthest downstream sampling location.

Figure 2
pH and Alkalinity Grab Samples



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[1] OAR 340-041-0290 Basin-Specific Criteria (Sandy Basin): Water Quality Standards and Policies for this Basin

Bacteria

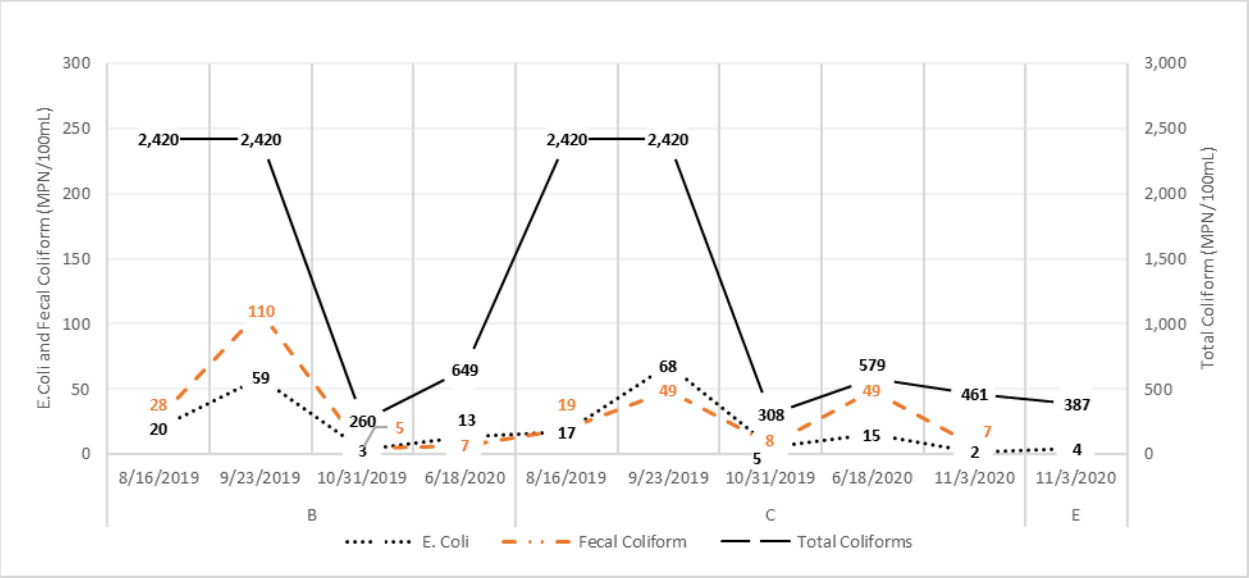
Standard: none currently specified for Sandy Basin

E. Coli values ranged from 2 MPN per 100 mL to 68 MPN per 100 mL. These values peaked in the September samples but all samples fell within Oregon Water Quality Standards. There is no TMDL on bacteria at this location on the Sandy River. The waste load allocation for point sources is limited to 126 E. Coli coliform forming units (CFU) per 100 mL of samples, which all sample results fell below.

Fecal coliform samples ranged between 5 MPN per 100 mL to 110 MPN per 100 mL. Total coliform samples ranged between 260 MPN per 100 mL to over 2,420 MPN per 100 mL. The highest total coliform values were observed in August and September.

Figure 3 below is a graph of the findings.

Figure 3
Bacteria Grab Samples

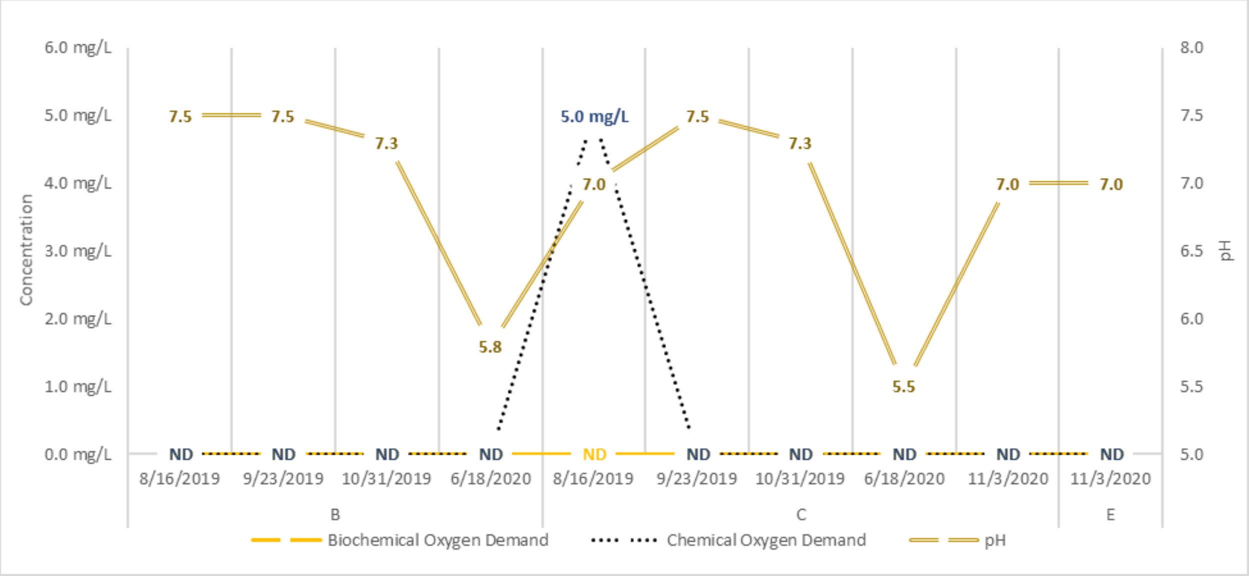


Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

Standard: none currently specified for Sandy Basin

All BOD samples observed concentrations below the detectable limit (ND) of 2 mg/L. One COD sample in August 2019 observed a concentration of 5.0 mg/L.

Figure 4
BOD and COD Grab Samples

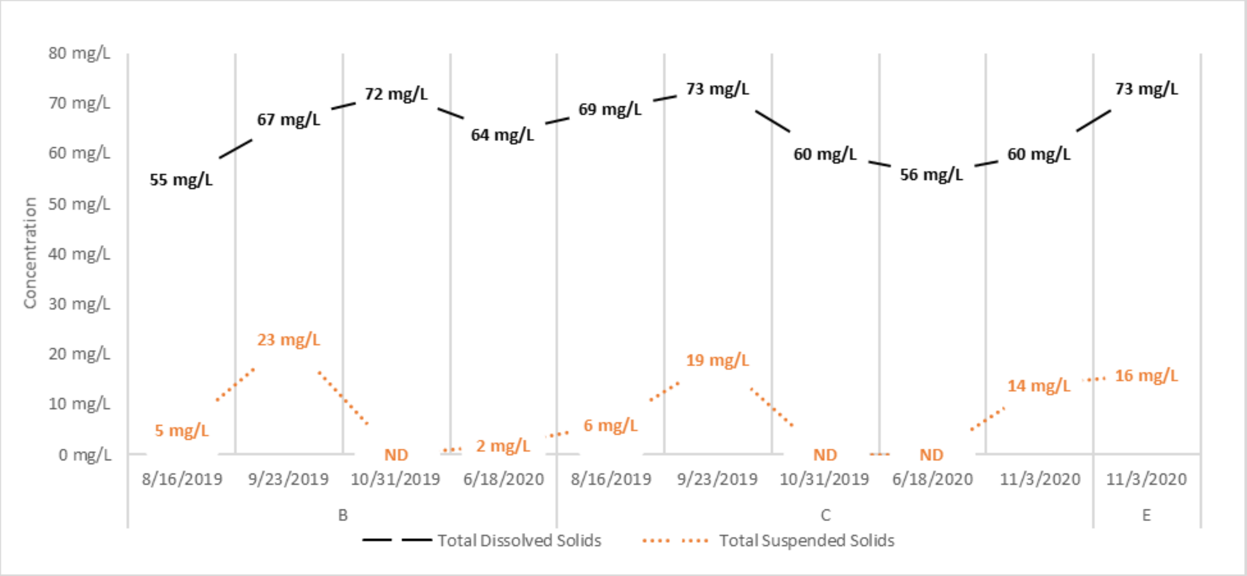


Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)

Standard: none currently specified for Sandy Basin

Values for TSS ranged between below the detectable limit of 2 mg/L and 23 mg/L. September 2019 and November 2020 grab sample data showed notable peaks. TDS values ranged between 55 mg/L and 73 mg/L.

Figure 5
TSS and TDS Grab Samples



Total Kjeldahl Nitrogen (TKN), Ammonia, Nitrate, and Nitrite

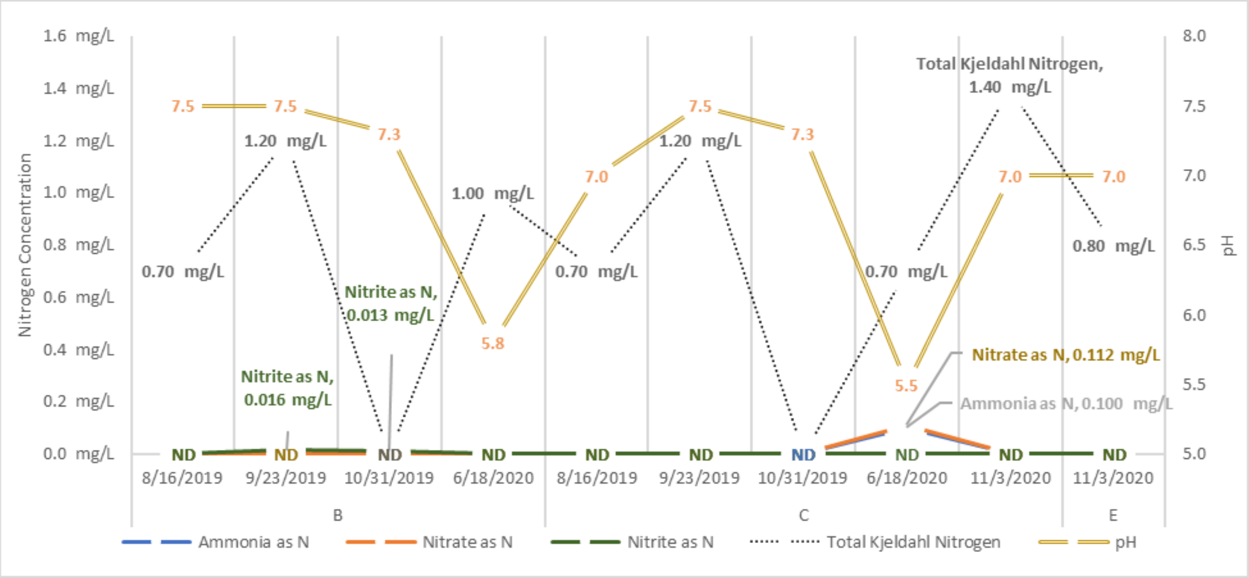
Standard: none currently specified for Sandy Basin

TKN values range between below the Not Detected (ND) limit of 0.5 mg/L and 1.4 mg/L. It is assumed this TKN is comprised of mostly Organic Nitrogen since all Ammonia concentrations were ND except for the June 2020 sampling event at site C where Ammonia was recorded at 0.100 mg/L; June 2020 was also the highest observed river discharge that coincided with a sampling event.

A Nitrate concentration of 0.112 mg/L was observed in the June 2020 sample at Site C; and this was the only sample within this study with a concentration of Nitrate above the detectable limit of 0.1 mg/L.

Nitrite concentrations between 0.013 mg/L and 0.016 mg/L were observed in October 2019 and September 2019, respectively. All other samples were below the detectable limit of 0.01 mg/L.

Figure 6
Nitrogen Grab Samples

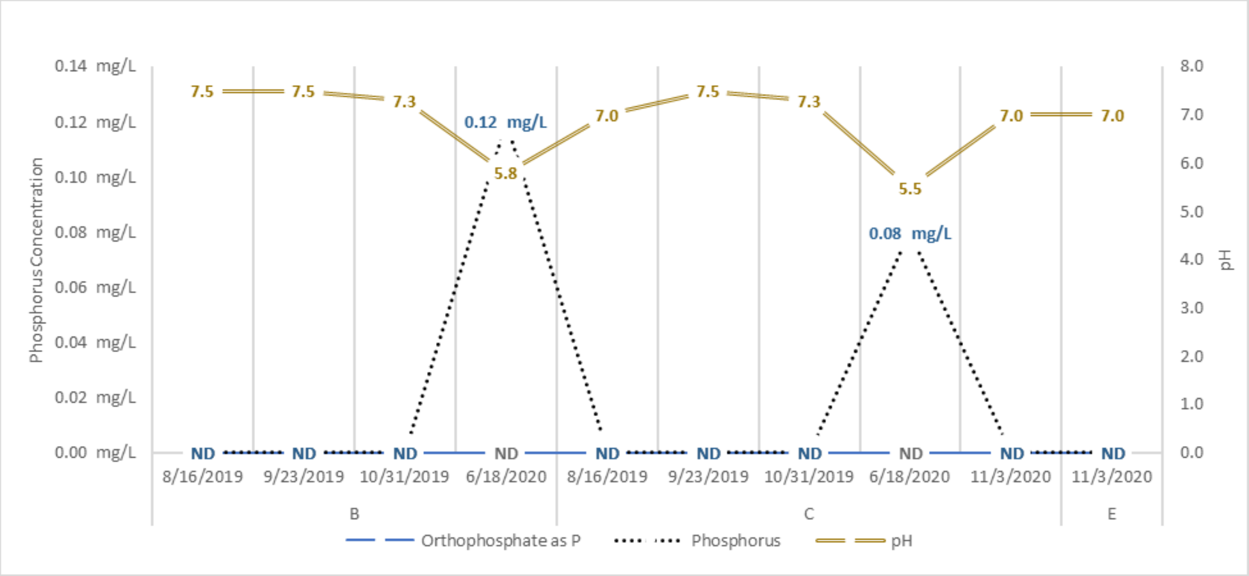


Phosphorus

<u>Standard</u>: none currently specified for Sandy Basin

Total phosphorus values range between 0.08 mg/L and 0.12 mg/L, observed at sites C and B, respectively, on the June 2020 sampling event. All other samples were below the detectable limit of 0.05 mg/L.

Figure 7
Phosphorus Grab Samples

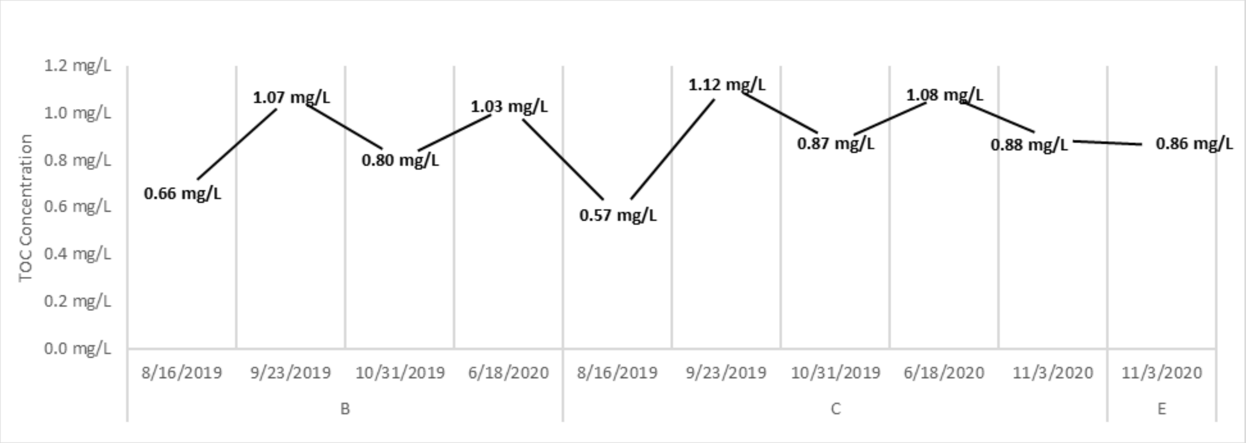


Total Organic Carbon (TOC)

Standard: none currently specified for Sandy Basin

TOC concentrations ranged between 0.57 mg/L and 1.12 mg/L. Sample values seem to exhibit slight variability but no strong correlation to location or time of year.

Figure 8
Total Organic Carbon Grab Samples

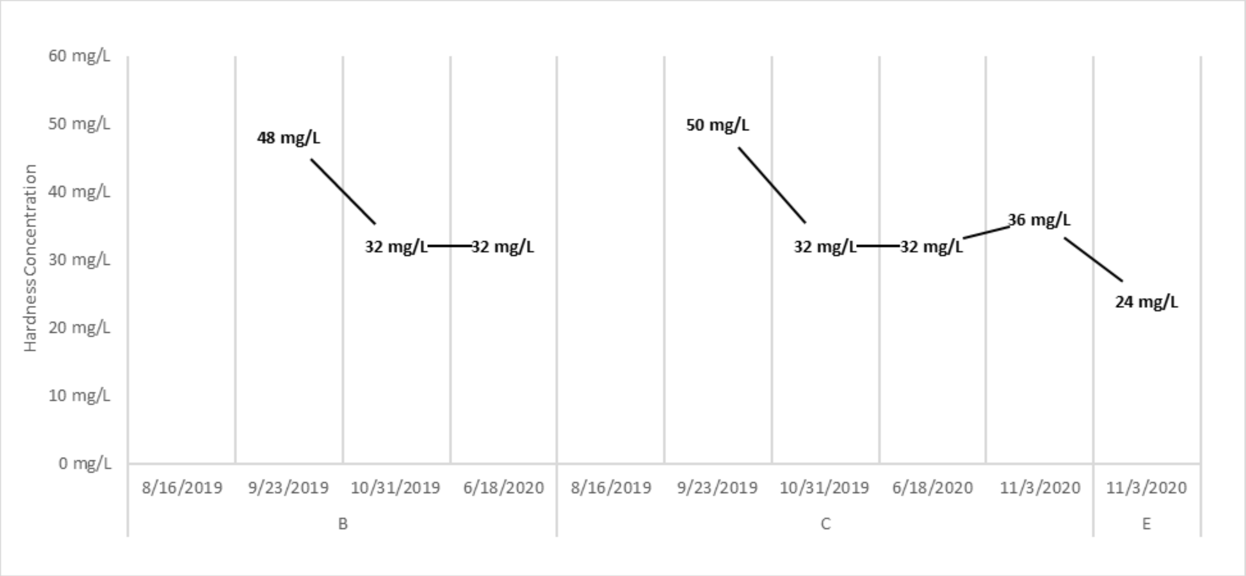


Hardness

Standard: none currently specified for Sandy Basin

Samples were not measured for hardness during the first sampling event in August 2019. Sample values ranged between 24 mg/L and 50 mg/L. The freshwater toxicity criterion is a function of hardness for toxic pollutants such as Cadmium, Chromium III, Lead, Nickle, Silver, and Zinc.

Figure 9
Hardness Concentration

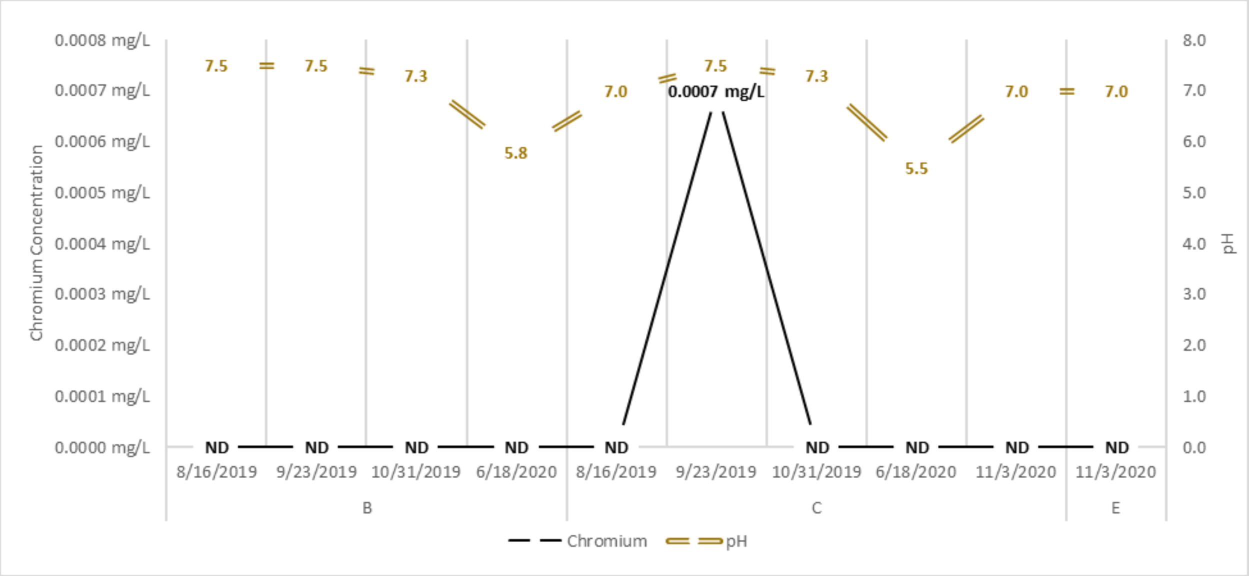


Chromium

Standard[2]:
Chromium VI: Acute Toxicity 0.016 mg/L
Chromium VI: Chronic Toxicity 0.011 mg/L

Chromium concentrations ranged below the detectable limit of 0.0004 mg/L and 0.0007 mg/L. The one sample above the detectable limit was observed in the September 2019 sample.

Figure 10
Chromium Grab Samples



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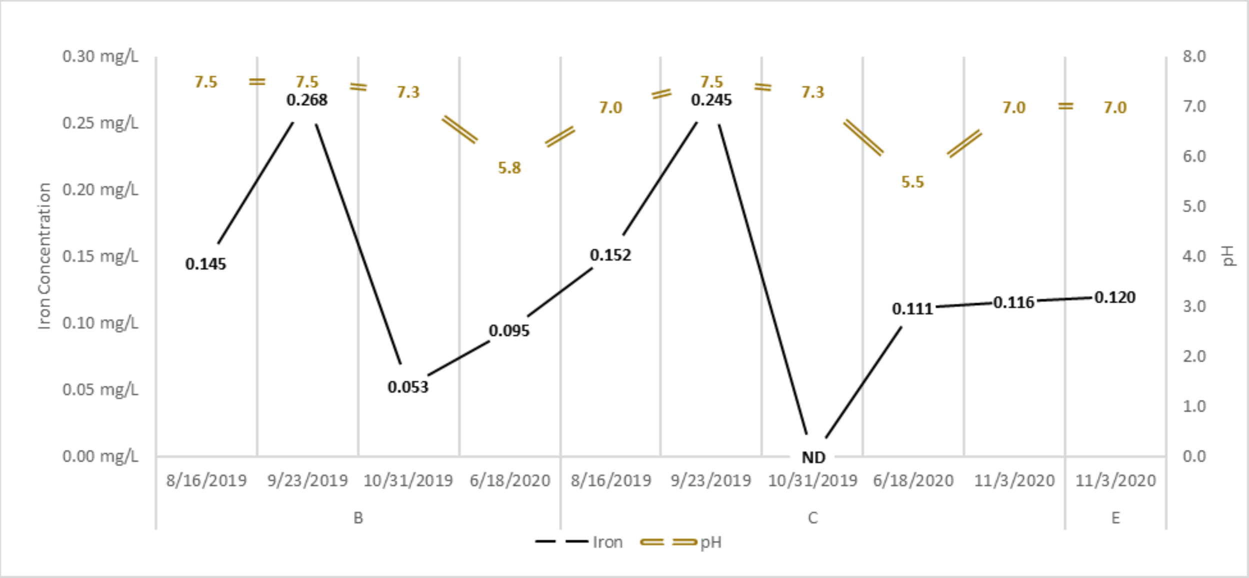
[2] OAR 340-041-8033 Aquatic Life Water Quality Criteria for Toxic Pollutants Table 30

Iron

<u>Standard</u>[3]: Chronic Toxicity 1.0 mg/L

Iron concentrations ranged between below the detectable limit of 0.050 mg/L and 0.268 mg/L. The peaks were observed in the September 2019 sampling event.

Figure 11
Iron Concentrations



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[3] OAR 340-041-8033 Aquatic Life Water Quality Criteria for Toxic Pollutants Table 30

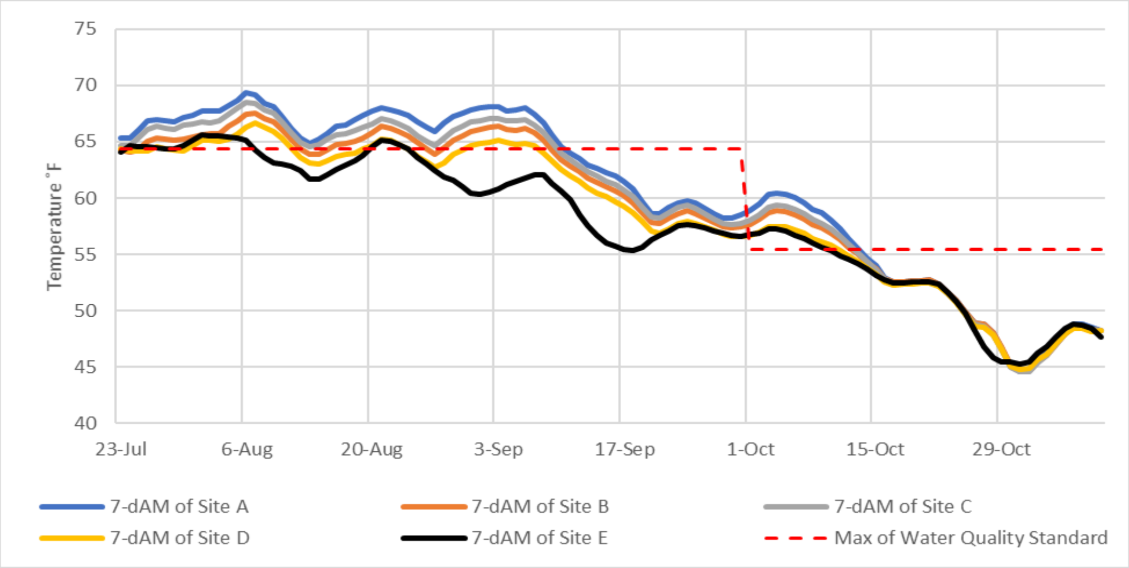
Temperature

Standard[4]:
October 15th – May 15th Salmon and Steelhead Spawning Use Designation
7-day average maximum temperature 55.4°F (13.0°C)

Salmon & Trout* * Rearing and Migration
7-day average maximum temperature 64.4°F (18.0°C)

A temperature logger was deployed Sites A, B, C, and D, on July 10, 2019. An additional temperature logger was deployed at a location less than a mile downstream of Site E (Revenue Bridge Site) on July 17, 2020. On October 2, 2020 the temperature probe was moved to Site E. The temperature probes collected data at 15-minute intervals from July to October. The graph below (**Figure 12**) shows the rolling 7-day average of the maximum temperature observed each day (7-dAM). The temperature was generally observed to be warmer at the more downstream sites, with Site E showing the coldest temperatures on average. This data was used to aid in the selection of an outfall location, as discussed further in Technical Memorandum 7.1 – Outfall Siting Study, and the Antidegradation Review .

Figure 12
7-dAM of Temperature Probe (15-min intervals)



Flow

River discharge for the sampling locations is approximated by the summation of reported instantaneous river discharge from USGS Gages: Sandy River Below Bull Run (14142500) - (Bull

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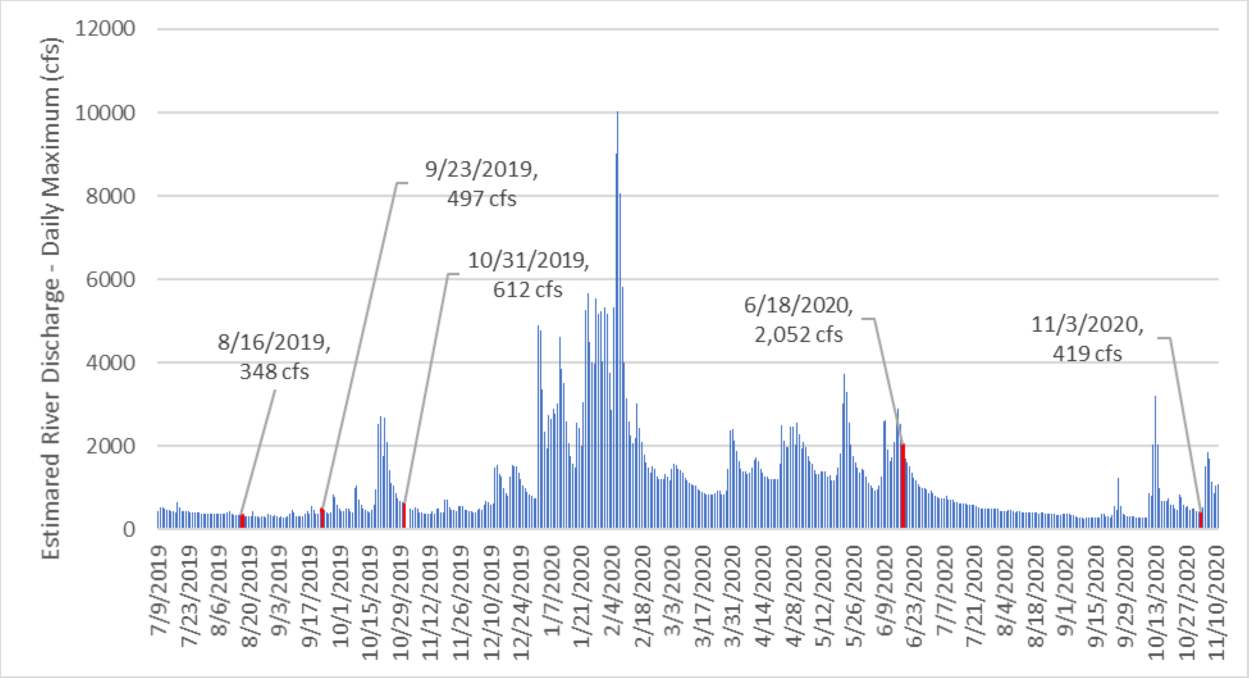
[4] OAR 340-041-0028 Water Quality Standards: Beneficial Uses, Policies, and Criterion for Oregon (all basins)
OAR 340-041-0286 Figure 286A Fish Use Designations* - Sandy Basin, Oregon
OAR 340-041-0286 Figure 286B Salmon and Steelhead Spawning Use Designations* - Sandy Basin, Oregon

Run River (14140000) - Little Sandy River (14141500)). A graph of the estimated instantaneous discharge at the sampling locations is approximated in **Figure 13** below. The sampling dates in this study are identified with June 18, 2020 being the most notable high flow event captured in the samples.

Figure 13
Estimated Instantaneous River Discharge – Daily Maximum (cfs) During Sampling Events



Conclusion

This report summarizes the water quality data collected on the Sandy River, in the proximity of the City's proposed outfall locations. This ambient water quality data has been used to inform design proposals, such as outfall site selection as described in Technical Memorandum 7.1. The data will be used as the project moves forward to better understand the water quality characteristics of the Sandy River. Murraysmith recommends continued water quality sampling on a quarterly basis to provide a robust dataset for these evaluations.

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Appendix

APPENDIX A
WATER QUALITY DATA SUMMARY TABLE

Appendix A
Water Quality Data Summary

Date	Parameter	Type	Location	Value	unit	MRL
8/16/2019	Alkalinity, Total(CaCO3)	Inorganics	B	46.00	mg/L	2
8/16/2019	Ammonia as N	Inorganics	B	ND	mg/L	0.1
8/16/2019	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
8/16/2019	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
8/16/2019	Hardness	Inorganics	B	*Not measured*	mg/L	4
8/16/2019	Nitrate as N	Inorganics	B	ND	mg/L	0.1
8/16/2019	Nitrite as N	Inorganics	B	ND	mg/L	0.01
8/16/2019	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
8/16/2019	pH	Inorganics	B	7.50	pH Units	
8/16/2019	Phosphorus	Inorganics	B	ND	mg/L	0.05
8/16/2019	Total Dissolved Solids	Inorganics	B	55.00	mg/L	1.00
8/16/2019	Total Organic Carbon	Inorganics	B	0.66	mg/L	0.50
8/16/2019	Total Kjeldahl Nitrogen	Inorganics	B	0.70	mg/L	0.5
8/16/2019	Total Suspended Solids	Inorganics	B	5.00	mg/L	2
8/16/2019	Arsenic	Metals (total)	B	ND	mg/L	0.003
8/16/2019	Cadmium	Metals (total)	B	ND	mg/L	0.0005
8/16/2019	Chromium	Metals (total)	B	ND	mg/L	0.001
8/16/2019	Copper	Metals (total)	B	ND	mg/L	0.05
8/16/2019	Iron	Metals (total)	B	0.145	mg/L	0.05
8/16/2019	Lead	Metals (total)	B	ND	mg/L	0.002
8/16/2019	Manganese	Metals (total)	B	ND	mg/L	0.025
8/16/2019	Mercury	Metals (total)	B	ND	mg/L	0.0002
8/16/2019	Nickel	Metals (total)	B	ND	mg/L	0.0005
8/16/2019	Selenium	Metals (total)	B	ND	mg/L	0.005
8/16/2019	Silver	Metals (total)	B	ND	mg/L	0.05
8/16/2019	pH	Metals (total)	B	7.50	pH Units	
8/16/2019	Total Coliforms	Microbial Analysis	B	2420.00	MPN/100mL	1
8/16/2019	E. Coli	Microbial Analysis	B	20.00	MPN/100mL	1
8/16/2019	Fecal Coliform	Microbial Analysis	B	28.00	MPN/100mL	1.8
8/16/2019	Alkalinity, Total(CaCO3)	Inorganics	C	22.00	mg/L	2
8/16/2019	Ammonia as N	Inorganics	C	ND	mg/L	0.1
8/16/2019	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
8/16/2019	Chemical Oxygen Demand	Inorganics	C	5.00	mg/L	5
8/16/2019	Hardness	Inorganics	C	*Not measured*	mg/L	4
8/16/2019	Nitrate as N	Inorganics	C	ND	mg/L	0.1
8/16/2019	Nitrite as N	Inorganics	C	ND	mg/L	0.01
8/16/2019	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
8/16/2019	pH	Inorganics	C	7.00	pH Units	
8/16/2019	Phosphorus	Inorganics	C	ND	mg/L	0.05
8/16/2019	Total Dissolved Solids	Inorganics	C	69.00	mg/L	1.00

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Date	Parameter	Type	Location	Value	unit	MRL
8/16/2019	Total Organic Carbon	Inorganics	C	0.57	mg/L	0.50
8/16/2019	Total Kjeldahl Nitrogen	Inorganics	C	0.70	mg/L	0.5
8/16/2019	Total Suspended Solids	Inorganics	C	6.00	mg/L	2
8/16/2019	Arsenic	Metals (total)	C	ND	mg/L	0.003
8/16/2019	Cadmium	Metals (total)	C	ND	mg/L	0.0005
8/16/2019	Chromium	Metals (total)	C	ND	mg/L	0.001
8/16/2019	Copper	Metals (total)	C	ND	mg/L	0.05
8/16/2019	Iron	Metals (total)	C	0.152	mg/L	0.05
8/16/2019	Lead	Metals (total)	C	ND	mg/L	0.002
8/16/2019	Manganese	Metals (total)	C	ND	mg/L	0.025
8/16/2019	Mercury	Metals (total)	C	ND	mg/L	0.0002
8/16/2019	Nickel	Metals (total)	C	ND	mg/L	0.0005
8/16/2019	Selenium	Metals (total)	C	ND	mg/L	0.005
8/16/2019	Silver	Metals (total)	C	ND	mg/L	0.05
8/16/2019	pH	Metals (total)	C	7.00	pH Units	
8/16/2019	Total Coliforms	Microbial Analysis	C	2420.00	MPN/100mL	1
8/16/2019	E. Coli	Microbial Analysis	C	17.00	MPN/100mL	1
8/16/2019	Fecal Coliform	Microbial Analysis	C	19.00	MPN/100mL	1.8
9/23/2019	Alkalinity, Total(CaCO3)	Inorganics	B	26.00	mg/L	2
9/23/2019	Ammonia as N	Inorganics	B	ND	mg/L	0.1
9/23/2019	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
9/23/2019	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
9/23/2019	Hardness	Inorganics	B	48.00	mg/L	4
9/23/2019	Nitrate as N	Inorganics	B	ND	mg/L	0.1
9/23/2019	Nitrite as N	Inorganics	B	0.02	mg/L	0.01
9/23/2019	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
9/23/2019	pH	Inorganics	B	7.50	pH Units	
9/23/2019	Phosphorus	Inorganics	B	ND	mg/L	0.05
9/23/2019	Total Dissolved Solids	Inorganics	B	67.00	mg/L	1.00
9/23/2019	Total Organic Carbon	Inorganics	B	1.07	mg/L	0.50
9/23/2019	Total Kjeldahl Nitrogen	Inorganics	B	1.20	mg/L	0.5
9/23/2019	Total Suspended Solids	Inorganics	B	23.00	mg/L	2
9/23/2019	Arsenic	Metals (total)	B	ND	mg/L	0.003
9/23/2019	Cadmium	Metals (total)	B	ND	mg/L	0.0005
9/23/2019	Chromium	Metals (total)	B	ND	mg/L	0.001
9/23/2019	Copper	Metals (total)	B	ND	mg/L	0.05
9/23/2019	Iron	Metals (total)	B	0.245	mg/L	0.05
9/23/2019	Lead	Metals (total)	B	ND	mg/L	0.002
9/23/2019	Manganese	Metals (total)	B	ND	mg/L	0.025
9/23/2019	Mercury	Metals (total)	B	ND	mg/L	0.0002

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Date	Parameter	Type	Location	Value	unit	MRL
9/23/2019	Nickel	Metals (total)	B	ND	mg/L	0.0005
9/23/2019	Selenium	Metals (total)	B	ND	mg/L	0.005
9/23/2019	Silver	Metals (total)	B	ND	mg/L	0.05
9/23/2019	pH	Metals (total)	B	7.50	pH Units	
9/23/2019	Total Coliforms	Microbial Analysis	B	2420.00	MPN/100mL	1
9/23/2019	E. Coli	Microbial Analysis	B	59.00	MPN/100mL	1
9/23/2019	Fecal Coliform	Microbial Analysis	B	110.00	MPN/100mL	1.8
9/23/2019	Alkalinity, Total(CaCO3)	Inorganics	C	26.00	mg/L	2
9/23/2019	Ammonia as N	Inorganics	C	ND	mg/L	0.1
9/23/2019	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
9/23/2019	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
9/23/2019	Hardness	Inorganics	C	50.00	mg/L	4
9/23/2019	Nitrate as N	Inorganics	C	ND	mg/L	0.1
9/23/2019	Nitrite as N	Inorganics	C	ND	mg/L	0.01
9/23/2019	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
9/23/2019	pH	Inorganics	C	7.50	pH Units	
9/23/2019	Phosphorus	Inorganics	C	ND	mg/L	0.05
9/23/2019	Total Dissolved Solids	Inorganics	C	73.00	mg/L	1.00
9/23/2019	Total Organic Carbon	Inorganics	C	1.12	mg/L	0.50
9/23/2019	Total Kjeldahl Nitrogen	Inorganics	C	1.20	mg/L	0.5
9/23/2019	Total Suspended Solids	Inorganics	C	19.00	mg/L	2
9/23/2019	Arsenic	Metals (total)	C	ND	mg/L	0.003
9/23/2019	Cadmium	Metals (total)	C	ND	mg/L	0.0005
9/23/2019	Chromium	Metals (total)	C	ND	mg/L	0.001
9/23/2019	Copper	Metals (total)	C	ND	mg/L	0.05
9/23/2019	Iron	Metals (total)	C	0.265	mg/L	0.05
9/23/2019	Lead	Metals (total)	C	ND	mg/L	0.002
9/23/2019	Manganese	Metals (total)	C	ND	mg/L	0.025
9/23/2019	Mercury	Metals (total)	C	ND	mg/L	0.0002
9/23/2019	Nickel	Metals (total)	C	ND	mg/L	0.0005
9/23/2019	Selenium	Metals (total)	C	ND	mg/L	0.005
9/23/2019	Silver	Metals (total)	C	ND	mg/L	0.05
9/23/2019	pH	Metals (total)	C	7.50	pH Units	
9/23/2019	Total Coliforms	Microbial Analysis	C	2420.00	MPN/100mL	1
9/23/2019	E. Coli	Microbial Analysis	C	68.00	MPN/100mL	1
9/23/2019	Fecal Coliform	Microbial Analysis	C	49.00	MPN/100mL	1.8
10/31/2019	Alkalinity, Total(CaCO3)	Inorganics	B	23.00	mg/L	2
10/31/2019	Ammonia as N	Inorganics	B	ND	mg/L	0.1
10/31/2019	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
10/31/2019	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
10/31/2019	Hardness	Inorganics	B	32.00	mg/L	4

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Date	Parameter	Type	Location	Value	unit	MRL
10/31/2019	Nitrate as N	Inorganics	B	ND	mg/L	0.1
10/31/2019	Nitrite as N	Inorganics	B	0.01	mg/L	0.01
10/31/2019	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
10/31/2019	pH	Inorganics	B	7.30	pH Units	
10/31/2019	Phosphorus	Inorganics	B	ND	mg/L	0.05
10/31/2019	Total Dissolved Solids	Inorganics	B	72.00	mg/L	1.00
10/31/2019	Total Organic Carbon	Inorganics	B	0.80	mg/L	0.50
10/31/2019	Total Kjeldahl Nitrogen	Inorganics	B	ND	mg/L	0.5
10/31/2019	Total Suspended Solids	Inorganics	B	ND	mg/L	2
10/31/2019	Arsenic	Metals (total)	B	ND	mg/L	0.003
10/31/2019	Cadmium	Metals (total)	B	ND	mg/L	0.0005
10/31/2019	Chromium	Metals (total)	B	ND	mg/L	0.001
10/31/2019	Copper	Metals (total)	B	ND	mg/L	0.05
10/31/2019	Iron	Metals (total)	B	0.053	mg/L	0.05
10/31/2019	Lead	Metals (total)	B	ND	mg/L	0.002
10/31/2019	Manganese	Metals (total)	B	ND	mg/L	0.025
10/31/2019	Mercury	Metals (total)	B	ND	mg/L	0.0002
10/31/2019	Nickel	Metals (total)	B	ND	mg/L	0.0005
10/31/2019	Selenium	Metals (total)	B	ND	mg/L	0.005
10/31/2019	Silver	Metals (total)	B	ND	mg/L	0.05
10/31/2019	pH	Metals (total)	B	7.30	pH Units	
10/31/2019	Total Coliforms	Microbial Analysis	B	260.00	MPN/100mL	1
10/31/2019	E. Coli	Microbial Analysis	B	3.00	MPN/100mL	1
10/31/2019	Fecal Coliform	Microbial Analysis	B	4.50	MPN/100mL	1.8
10/31/2019	Alkalinity, Total(CaCO3)	Inorganics	C	22.00	mg/L	2
10/31/2019	Ammonia as N	Inorganics	C	ND	mg/L	0.1
10/31/2019	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
10/31/2019	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
10/31/2019	Hardness	Inorganics	C	32.00	mg/L	4
10/31/2019	Nitrate as N	Inorganics	C	ND	mg/L	0.1
10/31/2019	Nitrite as N	Inorganics	C	ND	mg/L	0.01
10/31/2019	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
10/31/2019	pH	Inorganics	C	7.30	pH Units	
10/31/2019	Phosphorus	Inorganics	C	ND	mg/L	0.05
10/31/2019	Total Dissolved Solids	Inorganics	C	60.00	mg/L	1.00
10/31/2019	Total Organic Carbon	Inorganics	C	0.87	mg/L	0.50
10/31/2019	Total Kjeldahl Nitrogen	Inorganics	C	ND	mg/L	0.5
10/31/2019	Total Suspended Solids	Inorganics	C	ND	mg/L	2
10/31/2019	Arsenic	Metals (total)	C	ND	mg/L	0.003
10/31/2019	Cadmium	Metals (total)	C	ND	mg/L	0.0005
10/31/2019	Chromium	Metals (total)	C	ND	mg/L	0.001

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Date	Parameter	Type	Location	Value	unit	MRL
10/31/2019	Copper	Metals (total)	C	ND	mg/L	0.05
10/31/2019	Iron	Metals (total)	C	ND	mg/L	0.05
10/31/2019	Lead	Metals (total)	C	ND	mg/L	0.002
10/31/2019	Manganese	Metals (total)	C	ND	mg/L	0.025
10/31/2019	Mercury	Metals (total)	C	ND	mg/L	0.0002
10/31/2019	Nickel	Metals (total)	C	ND	mg/L	0.0005
10/31/2019	Selenium	Metals (total)	C	ND	mg/L	0.005
10/31/2019	Silver	Metals (total)	C	ND	mg/L	0.05
10/31/2019	pH	Metals (total)	C	7.30	pH Units	
10/31/2019	Total Coliforms	Microbial Analysis	C	308.00	MPN/100mL	1
10/31/2019	E. Coli	Microbial Analysis	C	5.00	MPN/100mL	1
10/31/2019	Fecal Coliform	Microbial Analysis	C	7.80	MPN/100mL	1.8
6/18/2020	Alkalinity, Total(CaCO3)	Inorganics	B	16.00	mg/L	2
6/18/2020	Ammonia as N	Inorganics	B	ND	mg/L	0.1
6/18/2020	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
6/18/2020	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
6/18/2020	Hardness	Inorganics	B	32.00	mg/L	4
6/18/2020	Nitrate as N	Inorganics	B	ND	mg/L	0.1
6/18/2020	Nitrite as N	Inorganics	B	ND	mg/L	0.01
6/18/2020	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
6/18/2020	pH	Inorganics	B	5.80	pH Units	
6/18/2020	Phosphorus	Inorganics	B	0.12	mg/L	0.05
6/18/2020	Total Dissolved Solids	Inorganics	B	64.00	mg/L	1.00
6/18/2020	Total Kjeldahl Nitrogen	Inorganics	B	1.00	mg/L	0.5
6/18/2020	Total Organic Carbon	Inorganics	B	1.03	mg/L	0.5
6/18/2020	Total Suspended Solids	Inorganics	B	2.00	mg/L	2
6/18/2020	Arsenic	Metals (total)	B	ND	mg/L	0.003
6/18/2020	Cadmium	Metals (total)	B	ND	mg/L	0.0005
6/18/2020	Chromium	Metals (total)	B	ND	mg/L	0.001
6/18/2020	Copper	Metals (total)	B	ND	mg/L	0.05
6/18/2020	Iron	Metals (total)	B	0.095	mg/L	0.05
6/18/2020	Lead	Metals (total)	B	ND	mg/L	0.002
6/18/2020	Manganese	Metals (total)	B	ND	mg/L	0.025
6/18/2020	Mercury	Metals (total)	B	ND	mg/L	0.0002
6/18/2020	Nickel	Metals (total)	B	ND	mg/L	0.0005
6/18/2020	pH	Metals (total)	B	5.80	pH Units	
6/18/2020	Selenium	Metals (total)	B	ND	mg/L	0.005
6/18/2020	Silver	Metals (total)	B	ND	mg/L	0.05
6/18/2020	E. Coli	Microbial Analysis	B	13.00	MPN/100mL	1
6/18/2020	Fecal Coliform	Microbial Analysis	B	6.80	MPN/100mL	1
6/18/2020	Total Coliforms	Microbial Analysis	B	649.00	MPN/100mL	1.8

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Date	Parameter	Type	Location	Value	unit	MRL
6/18/2020	Alkalinity, Total(CaCO3)	Inorganics	C	16.00	mg/L	2
6/18/2020	Ammonia as N	Inorganics	C	0.10	mg/L	0.1
6/18/2020	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
6/18/2020	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
6/18/2020	Hardness	Inorganics	C	32.00	mg/L	4
6/18/2020	Nitrate as N	Inorganics	C	0.11	mg/L	0.1
6/18/2020	Nitrite as N	Inorganics	C	ND	mg/L	0.01
6/18/2020	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
6/18/2020	pH	Inorganics	C	5.50	pH Units	
6/18/2020	Phosphorus	Inorganics	C	0.08	mg/L	0.05
6/18/2020	Total Dissolved Solids	Inorganics	C	56.00	mg/L	1.00
6/18/2020	Total Kjeldahl Nitrogen	Inorganics	C	0.70	mg/L	0.5
6/18/2020	Total Organic Carbon	Inorganics	C	1.08	mg/L	0.5
6/18/2020	Total Suspended Solids	Inorganics	C	ND	mg/L	2
6/18/2020	Arsenic	Metals (total)	C	ND	mg/L	0.003
6/18/2020	Cadmium	Metals (total)	C	ND	mg/L	0.0005
6/18/2020	Chromium	Metals (total)	C	ND	mg/L	0.001
6/18/2020	Copper	Metals (total)	C	ND	mg/L	0.05
6/18/2020	Iron	Metals (total)	C	0.111	mg/L	0.05
6/18/2020	Lead	Metals (total)	C	ND	mg/L	0.002
6/18/2020	Manganese	Metals (total)	C	ND	mg/L	0.025
6/18/2020	Mercury	Metals (total)	C	ND	mg/L	0.0002
6/18/2020	Nickel	Metals (total)	C	ND	mg/L	0.0005
6/18/2020	pH	Metals (total)	C	5.50	pH Units	
6/18/2020	Selenium	Metals (total)	C	ND	mg/L	0.005
6/18/2020	Silver	Metals (total)	C	ND	mg/L	0.05
6/18/2020	E. Coli	Microbial Analysis	C	15.00	MPN/100mL	1
6/18/2020	Fecal Coliform	Microbial Analysis	C	49.00	MPN/100mL	1
6/18/2020	Total Coliforms	Microbial Analysis	C	579.00	MPN/100mL	1.8
11/3/2020	Alkalinity, Total(CaCO3)	Inorganics	C	22.00	mg/L	2
11/3/2020	Ammonia as N	Inorganics	C	ND	mg/L	0.1
11/3/2020	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
11/3/2020	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
11/3/2020	Hardness	Inorganics	C	36.00	mg/L	4
11/3/2020	Nitrate as N	Inorganics	C	ND	mg/L	0.1
11/3/2020	Nitrite as N	Inorganics	C	ND	mg/L	0.01
11/3/2020	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
11/3/2020	pH	Inorganics	C	7.00	pH Units	
11/3/2020	Phosphorus	Inorganics	C	ND	mg/L	0.05
11/3/2020	Total Dissolved Solids	Inorganics	C	60.00	mg/L	1.00
11/3/2020	Total Organic Carbon	Inorganics	C	0.88	mg/L	0.50

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Date	Parameter	Type	Location	Value	unit	MRL
11/3/2020	Total Kjeldahl Nitrogen	Inorganics	C	1.40	mg/L	0.5
11/3/2020	Total Suspended Solids	Inorganics	C	14.00	mg/L	2
11/3/2020	Arsenic	Metals (total)	C	ND	mg/L	0.003
11/3/2020	Cadmium	Metals (total)	C	ND	mg/L	0.0005
11/3/2020	Chromium	Metals (total)	C	ND	mg/L	0.001
11/3/2020	Copper	Metals (total)	C	ND	mg/L	0.05
11/3/2020	Iron	Metals (total)	C	0.116	mg/L	0.05
11/3/2020	Lead	Metals (total)	C	ND	mg/L	0.002
11/3/2020	Manganese	Metals (total)	C	ND	mg/L	0.025
11/3/2020	Mercury	Metals (total)	C	ND	mg/L	0.0002
11/3/2020	Nickel	Metals (total)	C	ND	mg/L	0.0005
11/3/2020	Selenium	Metals (total)	C	ND	mg/L	0.005
11/3/2020	Silver	Metals (total)	C	ND	mg/L	0.05
11/3/2020	pH	Metals (total)	C	7.00	pH Units	
11/3/2020	Total Coliforms	Microbial Analysis	C	461.00	MPN/100mL	1
11/3/2020	E. Coli	Microbial Analysis	C	2.00	MPN/100mL	1
11/3/2020	Fecal Coliform	Microbial Analysis	C	6.80	MPN/100mL	1.8
11/3/2020	Alkalinity, Total(CaCO3)	Inorganics	E	22.00	mg/L	2
11/3/2020	Ammonia as N	Inorganics	E	ND	mg/L	0.1
11/3/2020	Biochemical Oxygen Demand	Inorganics	E	ND	mg/L	2
11/3/2020	Chemical Oxygen Demand	Inorganics	E	ND	mg/L	5
11/3/2020	Hardness	Inorganics	E	24.00	mg/L	4
11/3/2020	Nitrate as N	Inorganics	E	ND	mg/L	0.1
11/3/2020	Nitrite as N	Inorganics	E	ND	mg/L	0.01
11/3/2020	Orthophosphate as P	Inorganics	E	ND	mg/L	0.1
11/3/2020	pH	Inorganics	E	7.00	pH Units	
11/3/2020	Phosphorus	Inorganics	E	ND	mg/L	0.05
11/3/2020	Total Dissolved Solids	Inorganics	E	73.00	mg/L	1.00
11/3/2020	Total Organic Carbon	Inorganics	E	0.86	mg/L	0.50
11/3/2020	Total Kjeldahl Nitrogen	Inorganics	E	0.80	mg/L	0.5
11/3/2020	Total Suspended Solids	Inorganics	E	16.00	mg/L	2
11/3/2020	Arsenic	Metals (total)	E	ND	mg/L	0.003
11/3/2020	Cadmium	Metals (total)	E	ND	mg/L	0.0005
11/3/2020	Chromium	Metals (total)	E	ND	mg/L	0.001
11/3/2020	Copper	Metals (total)	E	ND	mg/L	0.05
11/3/2020	Iron	Metals (total)	E	0.120	mg/L	0.05
11/3/2020	Lead	Metals (total)	E	ND	mg/L	0.002
11/3/2020	Manganese	Metals (total)	E	ND	mg/L	0.025
11/3/2020	Mercury	Metals (total)	E	ND	mg/L	0.0002
11/3/2020	Nickel	Metals (total)	E	ND	mg/L	0.0005
11/3/2020	Selenium	Metals (total)	E	ND	mg/L	0.005

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Date	Parameter	Type	Location	Value	unit	MRL
11/3/2020	Silver	Metals (total)	E	ND	mg/L	0.05
11/3/2020	pH	Metals (total)	E	7.00	pH Units	
11/3/2020	Total Coliforms	Microbial Analysis	E	387.00	MPN/100mL	1
11/3/2020	E. Coli	Microbial Analysis	E	4.00	MPN/100mL	1
11/3/2020	Fecal Coliform	Microbial Analysis	E	4.50	MPN/100mL	1.8

Acronyms:

mg/L – milligrams per liter
mL – milliliter
MPN – Most Probable Number
MRL – Minimum Reporting Limit
ND – Not Detected

APPENDIX B
LABORATORY RESULTS

Alexin Analytical
LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

C
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Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name:** SiteB - 2019.08.16
Sampled: 8/16/19 9:30 **Sample Composition:** Raw

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time	
	Metals (Total)									
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48	
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06	
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:35	**SUB-5**
A	*Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46	
	Iron	1028	SM3111B	mg/L	0.145	0.050	-	0.3	08/26/19 15:45	
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04	
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54	
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55	
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:35	**SUB-5**
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47	
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08	
	Inorganics									
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	46	2	-		08/22/19 17:00	
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00	
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00	
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		08/20/19 11:50	
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:34	
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:34	
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:34	
	pH	1925	EPA 150.1	pH Units	7.5		-	8.5	08/16/19 16:10	**R**
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00	
	Total Dissolved Solids		EPA 160.1	mg/L	55.0	1.00	-		08/19/19 09:05	
	Total Organic Carbon	2920	SM5310-C	mg/L	0.66	0.50	-		08/22/19 23:51	
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 14:30	
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	5	2	-		08/16/19 14:00	

Alexin
Analytical
LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-02 **Sample Name:** SiteC - 2019.08.16
Sampled: 8/16/19 8:55 **Sample Composition:** Raw

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)									
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:39 SUB-5
A	*Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46
	Iron	1028	SM3111B	mg/L	0.152	0.050	-	0.3	08/26/19 15:45
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:39 SUB-5
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08
Inorganics									
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		08/22/19 17:00
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	5.00	5.00	-		08/20/19 11:50
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:51
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:51
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:51
	pH	1925	EPA 150.1	pH Units	7.0		-	8.5	08/16/19 16:14 R
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00
	Total Dissolved Solids		EPA 160.1	mg/L	69.0	1.00	-		08/19/19 09:05
	Total Organic Carbon	2920	SM5310-C	mg/L	0.57	0.50	-		08/23/19 00:32
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 15:10
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	6	2	-		08/16/19 14:00

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

Alexin Analytical Laboratories, Inc.
Professional Laboratory Services
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Tigard, OR 97223
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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name: SiteB - 2019.08.16**
Sample Type: Grab
Sampled: 8/16/19 9:30

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	20	1	08/16/19 15:45
Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	28	1	08/16/19 15:45

Analyzed: 08/17/19 10:45
Analyzed by: MKM

9228016-02 **Sample Name: SiteC - 2019.08.16**
Sample Type: Grab
Sampled: 8/16/19 8:55

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	17	1	08/16/19 15:45
Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	19	1	08/16/19 15:45

Analyzed: 08/17/19 10:45
Analyzed by: MKM

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vandana Gade
Microbiology Technical Director

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Alexin Analytical Laboratories, Inc.
Professional Laboratory Services
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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-02 **Sample Name:** SiteC - 2019.08.16
Sampled: 8/16/19 8:55 **Sample Composition:** Raw

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:39 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46
Iron	1028	SM3111B	mg/L	0.152	0.050	-	0.3	08/26/19 15:45
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:39 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		08/22/19 17:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	5.00	5.00	-		08/20/19 11:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:51
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:51
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:51
pH	1925	EPA 150.1	pH Units	7.0		-	8.5	08/16/19 16:14 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	69.0	1.00	-		08/19/19 09:05
Total Organic Carbon	2920	SM5310-C	mg/L	0.57	0.50	-		08/23/19 00:32
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 15:10
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	6	2	-		08/16/19 14:00

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

Alexin Analytical LABORATORIES, INC.
Professional Laboratory Services
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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name:** SiteB - 2019.08.16
Sampled: 8/16/19 9:30 **Sample Composition:** Raw

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:35 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46
Iron	1028	SM3111B	mg/L	0.145	0.050	-	0.3	08/26/19 15:45
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:35 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	46	2	-		08/22/19 17:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		08/20/19 11:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:34
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:34
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:34
pH	1925	EPA 150.1	pH Units	7.5		-	8.5	08/16/19 16:10 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	55.0	1.00	-		08/19/19 09:05
Total Organic Carbon	2920	SM5310-C	mg/L	0.66	0.50	-		08/22/19 23:51
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 14:30
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	5	2	-		08/16/19 14:00

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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name: SiteB - 2019.08.16**
Sample Type: Grab
Sampled: 8/16/19 9:30

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	20	1	08/16/19 15:45
Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	28	1	08/16/19 15:45

Analyzed: 08/17/19 10:45
Analyzed by: MKM

9228016-02 **Sample Name: SiteC - 2019.08.16**
Sample Type: Grab
Sampled: 8/16/19 8:55

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	17	1	08/16/19 15:45
Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	19	1	08/16/19 15:45

Analyzed: 08/17/19 10:45
Analyzed by: MKM

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by: Adriana Gonzalez-Gray
Laboratory Director

Approved by: Vandana Gade
Microbiology Technical Director

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ANALYSIS REPORT

Reported: 10/15/2019
Received: 09/23/2019
Sampled By:
Work Order: 9266030

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19 - 2424
PWSID # :

Sampling Location: Sandy River Miler - 22.0
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

9266030-01 **Sample Name: SiteB - 2019.09.23**
Sample Type: Grab
Sampled: 9/23/19 9:18

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	2420	1	09/23/19 15:13
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	59	1	09/23/19 15:13
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	110.0	1.8	09/23/19 14:15

Analyzed: 09/24/19 12:28
Analyzed by: VG

9266030-02 **Sample Name: SiteC - 2019.09.23**
Sample Type: Grab
Sampled: 9/23/19 8:45

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	09/23/19 15:13
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	68	1	09/23/19 15:13
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	49.0	1.8	09/23/19 14:15

Analyzed: 09/24/19 12:28
Analyzed by: VG

J The reported value is greater than the Method Detection Limit but less than the Reporting Limit.
R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by: ____________________
Adriana Gonzalez-Gray
Laboratory Director

Approved by: ____________________
Vahdana Gade
Microbiology Technical Director

Alexin Analytical LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
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ANALYSIS REPORT

Reported: 10/15/2019
Received: 09/23/2019
Sampled By:
Work Order: 9266030

C
L
I
E
N
T

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19 - 2424
PWSID # :

Sampling Location: Sandy River Miler - 22.0
Sample Matrix: Surface Water

Lab Number

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
9266030-02	**Sample Name:** SiteC - 2019.09.23 **Sampled:** 9/23/19 8:45 **Sample Composition:** unfiltered							
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		09/26/19 13:55
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		10/09/19 16:29
A *Chromium*	1020	EPA 200.8	mg/L	0.0007	0.0004	0.1		09/30/19 21:44 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		10/01/19 11:30
Iron	1028	SM3111B	mg/L	0.268	0.050	-	0.3	09/30/19 11:26
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		09/27/19 14:56
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	09/30/19 11:38
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		10/08/19 13:57
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		09/30/19 21:44 J, SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		10/09/19 14:32
Silver	1050	SM 3111B	mg/L	ND	0.100	-	0.1	10/14/19 16:23
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	26	2	-		09/27/19 13:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		09/24/19 16:30
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		09/30/19 14:07
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		10/01/19 11:47
Hardness	1915	EPA 130.2	mg/L	50.0***	4.00	-	250	09/30/19 13:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		09/24/19 13:28
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		09/24/19 13:28
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		09/24/19 13:28
pH	1925	EPA 150.1	pH Units	7.5		-	8.5	09/23/19 15:09 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		09/24/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	73.0	1.00	-		09/26/19 08:40
Total Organic Carbon	2920	SM5310-C	mg/L	1.12	0.50	-		10/02/19 16:01
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.2	0.5	-		09/26/19 14:52
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	19	2	-		09/27/19 15:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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OCT 17 2019

ANALYSIS REPORT

Reported: 10/15/2019
Received: 09/23/2019
Sampled By:
Work Order: 9266030

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19 - 2424
PWSID # :

Sampling Location: Sandy River Miler - 22.0
Sample Matrix: Surface Water

Lab Number

9266030-01 **Sample Name:** SiteB - 2019.09.23
Sampled: 9/23/19 9:18 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		09/26/19 13:55
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		10/09/19 16:29
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		09/30/19 21:40 J, SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		10/01/19 11:30
Iron	1028	SM3111B	mg/L	0.245	0.050	-	0.3	09/30/19 11:26
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		09/27/19 14:56
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	09/30/19 11:38
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		10/08/19 13:57
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		09/30/19 21:40 J, SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		10/09/19 14:32
Silver	1050	SM 3111B	mg/L	ND	0.100	-	0.1	10/14/19 16:23
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	26	2	-		09/27/19 13:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		09/24/19 16:30
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		09/30/19 14:07
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		10/01/19 11:47
Hardness	1915	EPA 130.2	mg/L	48.0***	4.00	-	250	09/30/19 13:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		09/24/19 13:10
A *Nitrite as N*	1041	EPA 300.0	mg/L	0.0163	0.0100	1		09/24/19 13:10
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		09/24/19 13:10
pH	1925	EPA 150.1	pH Units	7.5		-	8.5	09/23/19 15:07 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		09/24/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	67.0	1.00	-		09/26/19 08:40
Total Organic Carbon	2920	SM5310-C	mg/L	1.07	0.50	-		10/02/19 15:23
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.2	0.5	-		09/26/19 14:52
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	23	2	-		09/27/19 15:30

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Tigard, OR 97223
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ANALYSIS REPORT

Reported: 11/26/2019
Received: 10/31/2019
Sampled By:
Work Order: 9304009

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: S
Project # : N/A
PWSID # :

Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

9304009-01 **Sample Name:** SlteB - 31Oct2019
Sampled: 10/31/19 8:30 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/07/19 14:43
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/13/19 15:03
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/06/19 20:42 SUB-5
A *Copper*	1055	5M3111B	mg/L	ND	0.050	1.3		11/08/19 15:31
Iron	1028	5M3111B	mg/L	0.053	0.050	-	0.3	11/20/19 16:10
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/06/19 10:56
Manganese	1032	5M3111B	mg/L	ND	0.025	-	0.05	11/20/19 16:25
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/26/19 12:40
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/06/19 20:42 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/12/19 16:43
Silver	1050	5M 3111B	mg/L	ND	0.050	-	0.1	11/12/19 13:54
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	23	2	-		10/31/19 15:15
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/05/19 15:30
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/06/19 11:00
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/06/19 13:59
Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	11/05/19 14:20
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		10/31/19 16:52
A *Nitrite as N*	1041	EPA 300.0	mg/L	0.0133	0.0100	1		10/31/19 16:52
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		10/31/19 16:52
pH	1925	EPA 150.1	pH Units	7.3		-	8.5	10/31/19 14:15 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/05/19 11:00
Total Dissolved Solids		EPA 160.1	mg/L	72.0	1.00	-		11/05/19 10:20
Total Organic Carbon	2920	SM5310-C	mg/L	0.80	0.50	-		11/14/19 16:12
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	ND	0.5	-		11/06/19 13:43
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	ND	2	-		11/01/19 14:30

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ANALYSIS REPORT

Reported: 11/26/2019
Received: 10/31/2019
Sampled By:
Work Order: 9304009

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: S
Project # : N/A
PWSID # :

Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

9304009-02 **Sample Name:** SiteC - 31Oct2019
Sampled: 10/31/19 8:30 **Sample Composition:** unfiltered

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time	
	Metals (Total)									
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/07/19 14:43	
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/13/19 15:03	
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/06/19 20:47	SUB-5
A	*Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		11/08/19 15:31	
	Iron	1028	SM3111B	mg/L	ND	0.050	-	0.3	11/20/19 16:10	
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/06/19 10:56	
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	11/20/19 16:25	
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/26/19 12:40	
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/06/19 20:47	SUB-5
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/12/19 16:43	
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	11/12/19 13:54	
	Inorganics									
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		10/31/19 15:15	
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/05/19 15:30	
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/06/19 11:00	
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/06/19 13:59	
	Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	11/05/19 14:20	
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		10/31/19 17:09	
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		10/31/19 17:09	
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		10/31/19 17:09	
	pH	1925	EPA 150.1	pH Units	7.3		-	8.5	10/31/19 14:19	R
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/05/19 11:00	
	Total Dissolved Solids		EPA 160.1	mg/L	60.0	1.00	-		11/05/19 10:20	
	Total Organic Carbon	2920	SM5310-C	mg/L	0.87	0.50	-		11/14/19 16:50	
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	ND	0.5	-		11/06/19 14:45	
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	ND	2	-		11/01/19 14:30	

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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ANALYSIS REPORT

Reported: 11/26/2019
Received: 10/31/2019
Sampled By:
Work Order: 9304009

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: S
Project # : N/A
PWSID # :

Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

9304009-01

Sample Name: SiteB - 31Oct2019
Sample Type:

Sampled: 10/31/19 8:30

Microbiological Analysis

		Method	Units	Result	MRL	Date/ Time Analysis Begun
A	*Total Coliforms*	SM 9223B (colllert-18) 21st Ed.	MPN/100 mL	260	1	10/31/19 14:40
A	*E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	3	1	10/31/19 14:40
A	*Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	4.5	1.8	10/31/19 13:36

Analyzed: 11/01/19 12:15
Analyzed by: MKM

9304009-02

Sample Name: SiteC - 31Oct2019
Sample Type:

Sampled: 10/31/19 8:30

Microbiological Analysis

		Method	Units	Result	MRL	Date/ Time Analysis Begun
A	*Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	308	1	10/31/19 14:40
A	*E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	5	1	10/31/19 14:40
A	*Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	7.8	1.8	10/31/19 13:36

Analyzed: 11/01/19 12:15
Analyzed by: MKM

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vandana Gade
Microbiology Technical Director

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ANALYSIS REPORT

Reported: 07/21/2020
Received: 06/18/2020
Sampled By: PMD/JGC
Work Order: 0170015

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 20-2776
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
0170015-01 **Sample Name:** SiteB - 2020.06.18 **Sampled:** 6/18/20 10:48 **Sample Composition:** Raw								
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		06/25/20 14:39
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		07/07/20 12:44
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		06/25/20 18:07 **SUB-5**
A *Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		07/01/20 12:15
Iron	1028	SM3111B	mg/L	0.095	0.050	-	0.3	07/09/20 14:32
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		06/24/20 13:55
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	07/09/20 14:43
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		07/16/20 13:30
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		06/25/20 18:07 **SUB-5**
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		07/21/20 13:00
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	07/07/20 16:26
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	16	2	-		06/18/20 14:15
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		06/23/20 16:15
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		06/24/20 10:23
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		06/26/20 12:32
Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	06/18/20 14:54
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		06/18/20 17:19
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		06/18/20 17:19
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		06/18/20 17:19
pH	1925	EPA 150.1	pH Units	5.8		-	8.5	06/18/20 13:45 **R**
Phosphorus		EPA 365.3	mg/L	0.12	0.05	-		06/23/20 11:40
Total Dissolved Solids		EPA 160.1	mg/L	64.0	1.00	-		06/23/20 11:10
Total Organic Carbon	2920	SM5310-C	mg/L	1.03	0.50	-		06/26/20 01:06
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.0	0.5	-		06/22/20 13:25
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	2	2	-		06/19/20 14:30

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ANALYSIS REPORT

Reported: 07/21/2020
Received: 06/18/2020
Sampled By: PMD/JGC
Work Order: 0170015

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 20-2776
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

0170015-02 **Sample Name:** SiteCB - 2020.06.18
Sampled: 6/18/20 10:08 **Sample Composition:** Raw

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
	Metals (Total)								
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		06/25/20 14:39
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		07/07/20 12:44
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		06/25/20 18:03 **SUB-S**
A	*Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		07/01/20 12:15
	Iron	1028	SM3111B	mg/L	0.111	0.050	-	0.3	07/09/20 14:32
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		06/24/20 13:55
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	07/09/20 14:43
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		07/16/20 13:30
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		06/25/20 18:03 **SUB-5**
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		07/21/20 13:00
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	07/07/20 16:26
	Inorganics								
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	16	2	-		06/18/20 14:15
	Ammonia as N	1003	SM 4500-NH3F	mg/L	0.1	0.1	-		06/23/20 16:15
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		06/24/20 10:23
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		06/26/20 12:32
	Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	06/18/20 14:54
A	*Nitrate as N*	1040	EPA 300.0	mg/L	0.112	0.100	10		06/18/20 17:38
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		06/18/20 17:38
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		06/18/20 17:38
	pH	1925	EPA 150.1	pH Units	5.5		-	8.5	06/18/20 13:48 **R**
	Phosphorus		EPA 365.3	mg/L	0.08	0.05	-		06/23/20 11:40
	Total Dissolved Solids		EPA 160.1	mg/L	56.0	1.00	-		06/23/20 11:10
	Total Organic Carbon	2920	SM5310-C	mg/L	1.08	0.50	-		06/26/20 01:46
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		06/22/20 13:25
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	ND	2	-		06/19/20 14:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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Professional Laboratory Services
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ANALYSIS REPORT

Reported: 07/21/2020
Received: 06/18/2020
Sampled By: PMD/JGC
Work Order: 0170015

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 20-2776
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

0170015-01

Sample Name: SiteB - 2020.06.18
Sample Type: Grab

Sampled: 6/18/20 10:48

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	649	1	06/18/20 13:48
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	13	1	06/18/20 13:48
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	6.8	1.8	06/18/20 13:21

Analyzed: 06/19/20 11:36
Analyzed by: VG

0170015-02

Sample Name: SiteCB - 2020.06.18
Sample Type: Grab

Sampled: 6/18/20 10:08

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	579	1	06/18/20 13:48
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	15	1	06/18/20 13:48
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	49.0	1.8	06/18/20 13:21

Analyzed: 06/19/20 11:36
Analyzed by: VG

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by: ______________________
Adriana Gonzalez-Gray
Laboratory Director

Approved by: ______________________
Vandana Gade
Microbiology Technical Director

This report shall not be reproduced, except in full, without the written approval of the laboratory.

Alexin Analytical LABORATORIES, INC. Professional Laboratory Services

Chain of Custody Record

Laboratory Job Number: 8170015-01-02

Page 1 of 2

13035 SW Pacific Hwy Tigard, OR 97223 ph: 503.639.9311 fax: 503.684.1588 email:mail@alexinlabs.com

Client Contact Information		Results Reporting Information		Invoicing Information	
Company/Client Name:	Murraysmith	Project Manager:	Preston Van Meter	Accounts Payable Contact:	City of Sandy
Address:	888 SW 5th Ave, Suite 1170	Mailing Address:	888 SW 5th Ave, Suite 1170	Mailing Address:	39250 Pioneer Blvd.
City/State/Zip:	Portland, OR 97204	City/State/Zip:	Portland, OR 97204	City/State/Zip:	Sandy, OR 97055
phone:	503-225-9010	phone:	503-225-9010	phone:	503-668-5533
fax or email:	Preston.VanMeter@murraysmith.us	fax or email:	Jessica.Cawley@murraysmith.us	fax or email:	kmilne@ci.sandy.or.us

SAMPLING INFORMATION

Sampling Location: Sandy River Mile ~22.0

P.O. #:

PWSID #:

Sampled By: PMD / JCC

Project Name: Sandy WQ Study

Project #: ~~19-2424~~ 20-2776

Permit #:

Send results to OR State Health Division? (Please circle) Yes No

Lab ID Lab use only	Sample Identification Please enter a unique ID per line for each separate sample	Date Collected	(Begin-End if comp.) Time Collected	Sample Matrix*	# of cont. rec'd	Analysis Requested**								SEE ATTACHED	Sample Specific Notes/Field Data for *each* WW sample, specify **Grab** / **Composite** for *each* DW sample, specify **Raw** / **Treated**, **Source** / **Distribution**, **Single** / **Combined** WHERE APPLICABLE
-01	SiteB - ~~2019~~ 2020. 06.18	6/18/20	10:48	Surface Water	6									X	Grab, unfiltered
-02	SiteC - ~~2019~~ 2020. 06.18	6/18/20	10:08	Surface Water	6									X	Grab, unfiltered

Relinquished By (print):	Company:	Date/Time:	Signature:	Received By:	Company:	Date/Time:	Signature:
PATRICK DAVIS	Murraysmith						

Relinquished By (print):	Company:	Date/Time:	Signature:	Received By:	Company:	Date/Time:	Signature:

The most current revision of SOP-10-003 was used when these samples were collected ☐

Received by Laboratory Log-In Staff: TMd Date/Time: 06/18/2020 12:50 pm Temp. on receipt [illegible] °C On ice? [✓ Y] N

Containers Intact? [✓ Y] N **ID: TRM-10-** 008

* Drinking water (DW), effluent (EFF), ground water (GW), influent (INF), non-aqueous liquid (NAL), paint chips, raw water (RW), sludge, soil, solid, source water (SOURCE), spring, stormwater (SW), surface water, wastewater (WW), well water (WELL)

** Analyses for SOC, Radionuclide, Radon, and Asbestos are subcontracted out to other accredited laboratories.

Alexin Analytical Laboratories, Inc.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 11/23/2020
Received: 11/03/2020
Sampled By: KTH/JGC
Work Order: 0308007

CLIENT
Murraysmith
Attn: Matt Hickey
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : N/A
PWSID # :
PO # : 20-2776
Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

0308007-01 **Sample Name:** Site C - 2020.11.03
Sampled: 11/3/20 8:55 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/05/20 12:11
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/10/20 15:01
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/12/20 05:07 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		11/11/20 12:50
Iron	1028	SM3111B	mg/L	0.116	0.050	-	0.3	11/04/20 14:59
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/11/20 11:59
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	11/04/20 15:17
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/04/20 12:49
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/12/20 05:07 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/20/20 16:41
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	11/23/20 15:12
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		11/06/20 10:30
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/03/20 15:50
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/09/20 13:12
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/09/20 12:55
Hardness	1915	EPA 130.2	mg/L	36.0***	4.00	-	250	11/04/20 13:15
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		11/03/20 15:58
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		11/03/20 15:58
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		11/03/20 15:58
pH	1925	EPA 150.1	pH Units	7.0		-	8.5	11/03/20 12:43 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/10/20 11:00
Total Dissolved Solids		EPA 160.1	mg/L	60.0	1.00	-		11/03/20 12:40
Total Organic Carbon	2920	SM5310-C	mg/L	0.88	0.50	-		11/05/20 17:05
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.4	0.5	-		11/06/20 09:22
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	14	2	-		11/04/20 13:30

Alexin Analytical
LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 11/23/2020
Received: 11/03/2020
Sampled By: KTH/JGC
Work Order: 0308007

CLIENT

Murraysmith
Attn: Matt Hickey
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : N/A
PWSID # :
PO # : 20-2776
Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

0308007-02 **Sample Name:** Revenue Bridge - 2020.11.03
Sampled: 11/3/20 9:45 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/05/20 12:11
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/10/20 15:01
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/12/20 05:11 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		11/11/20 12:50
Iron	1028	SM3111B	mg/L	0.120	0.050	-	0.3	11/04/20 14:59
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/11/20 11:59
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	11/04/20 15:17
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/04/20 12:49
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/12/20 05:11 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/20/20 16:41
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	11/23/20 15:12
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		11/06/20 10:30
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/03/20 15:50
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/09/20 13:12
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/09/20 12:55
Hardness	1915	EPA 130.2	mg/L	24.0***	4.00	-	250	11/04/20 13:15
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		11/03/20 16:17
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		11/03/20 16:17
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		11/03/20 16:17
pH	1925	EPA 150.1	pH Units	7.0		-	8.5	11/03/20 12:44 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/10/20 11:00
Total Dissolved Solids		EPA 160.1	mg/L	73.0	1.00	-		11/03/20 12:40
Total Organic Carbon	2920	SM5310-C	mg/L	0.86	0.50	-		11/05/20 17:45
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.8	0.5	-		11/06/20 09:22
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	16	2	-		11/04/20 13:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 11/23/2020
Received: 11/03/2020
Sampled By: KTH/JGC
Work Order: 0308007

CLIENT
Murraysmith
Attn: Matt Hickey
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : N/A
PWSID # :
PO # : 20-2776
Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

0308007-01

Sample Name: Site C - 2020.11.03
Sample Type: Grab

Sampled: 11/3/20 8:55

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	461	1	11/03/20 12:50
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	2	1	11/03/20 12:50
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	6.8	1.8	11/03/20 12:32

Analyzed: 11/04/20 11:00 Analyzed by: VG

0308007-02

Sample Name: Revenue Bridge - 2020.11.03
Sample Type: Grab

Sampled: 11/3/20 9:45

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	387	1	11/03/20 12:50
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	4	1	11/03/20 12:50
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	4.5	1.8	11/03/20 12:32

Analyzed: 11/04/20 11:00 Analyzed by: VG

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vandana Gade
Microbiology Technical Director

Technical Memorandum 7.1

Date: March 01, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler, City Manager
Mike Walker, Public Works Director
City of Sandy, Oregon

From: Matt Hickey, PE
Ken Vigil, PE
Katie Husk, PE
Murraysmith

Re: Technical Memorandum 7.1 – Sandy River Outfall Siting Study

---

Introduction

This technical memorandum is a summary of Task 5: The Sandy River Outfall Siting Study, which is part of the larger Detailed Discharge Alternative Evaluation program. The purpose of Task 5 is to review alternative discharge locations on the Sandy River for placing the outfall from the proposed new membrane bioreactor treatment facility.

The reviewers conducted desktop and field studies to evaluate key river characteristics that would make for a good outfall site. These characteristics are itemized below and then summarized later in this technical memorandum and in attachments. More favorable outfall sites would include:

(1) river reaches with greater depth and velocity, which increase dilution and dispersion, to provide good water quality mixing conditions,

(2) locations with channel geologic/geomorphic stability, so that the river channel would not migrate away from the outfall over time,

(3) areas with less fish use for spawning and rearing, to minimize fisheries impacts/concerns,

(4) locations that are closer to the new treatment plant, for pipe economy, as described in Technical Memorandum 7.2, and

(5) river locations with outfall accessibility, for construction and operation and maintenance, and related characteristics.

Desktop Study

Approximately four outfall locations were immediately under consideration given the team's knowledge of the Sandy River in the project vicinity. These locations were near the City of Sandy River Park (at the large river oxbow), upstream and downstream from the park, and near the Ten Eyck Road crossing at Revenue Bridge.

Murraysmith's specialty subconsultant (Wolf Water Resources) began reviewing these sites using desktop analysis. They looked at aerial photographs, reviewed floodplain maps, and reviewed existing documentation and reports on local geology, geomorphology, and fisheries.

The results of these reviews are summarized in their Sandy River Outfall Siting Memo (see attached).

Stream Study

During the course of this study, team members have spent time in the in the field reviewing opportunities and constraints for siting the proposed outfall. Murraysmith staff and subconsultants have walked the riverbanks and viewed many potential outfall locations from various vantage points.

As part of their field reviews, Wolf Water Resources conducted stream surveys to evaluate site-specific conditions on the Sandy River study reach. They looked at stream stability, channel migration, river substrate, geometry, geomorphology, fisheries habitat, velocity, river depth, current mixing, and related conditions. The results of these stream surveys are summarized in their Sandy River Outfall Siting Memo (see attached).

Agency Coordination

On May 15, 2019, the project team held an in-person meeting to introduce the project to multiple resource agencies, including the Oregon Department of Environmental Quality, Oregon Department of State Lands, Oregon Department of Fish and Wildlife, U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration Fisheries. This "Kaizen" style meeting provided the City and consultant team with the opportunity to introduce the project and obtain immediate feedback from agency staff to help guide planning and preliminary design.

On June 30, 2020, the project team had a follow-up virtual coordination meeting with staff from these same agencies. They all have some jurisdiction over the proposed project as it relates to water quality, wetlands, fisheries, and other environmental programs.

The presenters summarized the results of some of the investigations done to date at the possible outfall sites. The consensus from the agencies was that they were concerned about the oxbow site and the downstream powerline site because of possible fisheries impacts and problems with geomorphic instability. The agency representatives all seemed to favor the upstream site near Ten Eyck Road crossing of the river (at Revenue Bridge). They thought that this location had better geomorphic stability and would have less impact on fisheries and water quality. This location is a stable, bedrock-defined reach of the river that anadromous fish would migrate through but not use for spawning or rearing.

The agency staff were interested in the possibility of applying the effluent to land during the summertime to reduce potential water quality impacts to the Sandy River. Additional information about land application of effluent at the site of the former Roslyn Lake is presented in Technical Memorandum 9-10.

Recommended Location and Outfall Configuration

Based on the results of Task 5 (The Sandy River Outfall Siting Study), the Ten Eyck Road and Revenue Bridge site is the recommended location for the new outfall. This site has several advantages over other alternatives including:

(1) this river reach is dominated by bedrock, so the channel does not migrate in this area, providing for greater geomorphic stability and consistent outfall operating conditions,

(2) this reach of the river is deep and has reasonable velocity (providing greater dilution and dispersion) and good water quality mixing characteristics,

(3) the area has less public accessibility than river reaches near the park and less potential for vandalism (although that possibility needs to be considered during final design),

(4) this location is upstream from the Cedar Creek fish hatchery, and therefore there would be less potential for impacts to hatchery fish,

(5) this reach is used for anadromous fish migration, not spawning or rearing, so anadromous fish would just be passing through,

(6) this site seems to have the greatest agency support based on preliminary meetings, and

(7) Revenue Bridge provides a good river crossing location for the effluent pipeline that would carry effluent to the Roslyn Lake area, where it could be reused for creating wetlands (as described in Tech Memo 9-10).

Again, refer to the attached memo by Wolf Water Resources for additional detail on these topics.

Figure 1 is an aerial image that shows the proposed location of the new outfall near Revenue Bridge and the proposed location of the new satellite treatment facility, for reference.

Figure 1 | Aerial Image

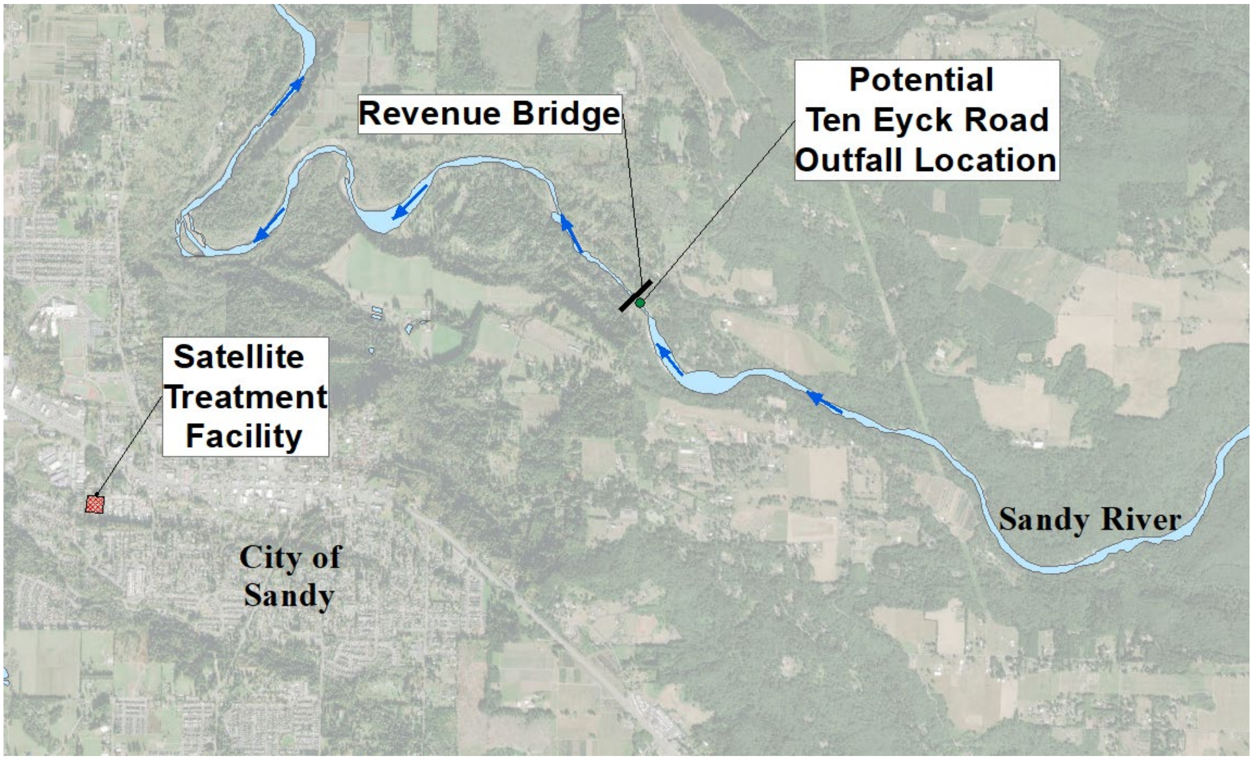

Figure 2 contains conceptual drawings of the proposed outfall and diffuser system. The proposed outfall could consist of an above-ground pipe anchored/secured to existing bedrock with concrete collars. Alternatively, portions of the pipeline could be bored through the existing bedrock and buried. However, additional site-specific geotechnical investigations will be needed to further review the option of burying the outfall pipe.

The Sandy River has substantial flows and assimilative capacity during both winter and summer months. With the proposed new discharge, the City's monthly effluent flows to the river would be less than 1% of the monthly river flows. This comparison is for general reference and is not a regulatory requirement.

This proposed in-water work would also need to be coordinated with resource agencies to obtain the required environmental permits. The proposed construction on and around the roadway and bridge would be coordinated with Clackamas County for infrastructure protection and traffic management.

Revenue Bridge Outfall Costs

Based on preliminary planning and site reviews, the cost for the outfall itself (for the recommended alternative outlined below) would be approximately $300,000 to $500,000. The outfall would consist of the pipeline and collars/attachments leading from approximately the bridge deck to the water, the end pipe, and the diffuser ports, as shown in **Figure 2** (presented later in this memo).

The biggest uncertainty in estimating costs for planning purposes is the cost of construction in rocky terrain. The area where the outfall would be placed is dominated by bedrock which makes it a good location for stability. However, until further, site-specific geotechnical investigations are conducted, we will not fully understand construction challenges and associated costs.

A summary of the alternative pipeline alignments and associated costs for conveying the effluent from the new treatment plant to the bridge is presented in Technical Memorandum 7.2.

Hydropower

The project team has been discussing very generally the possibility of using effluent for the purpose of generating hydro power. The location of the outfall would be important to determine the amount of elevation head (potential energy) that would be available. Several hundred feet of elevation drop exists between the proposed location of the new satellite treatment plant and the potential discharge and turbine locations (on either the Sandy or Bull Run River).

On June 2, 2020, members of the project team met with representatives from the Power Regeneration group at the historic Bull Run River powerhouse. This group now owns the historic powerhouse that was previously operated by Portland General Electric. They are in the process of renovating and re-purposing the powerhouse for various uses including historic preservation and education. We discussed the potential opportunity of creating micro hydropower at this site using effluent from the City's proposed new satellite plant. All parties were interested in the possibility of teaming on such a project in the future.

Conclusion

This technical memorandum and associated attachments provide a summary of Task 5: The Sandy River Outfall Siting Study.

After reviewing dozens of locations for the outfall generally, and four locations specifically, the recommended outfall location is near the Ten Eyck Road crossing of the Sandy River near Revenue Bridge.

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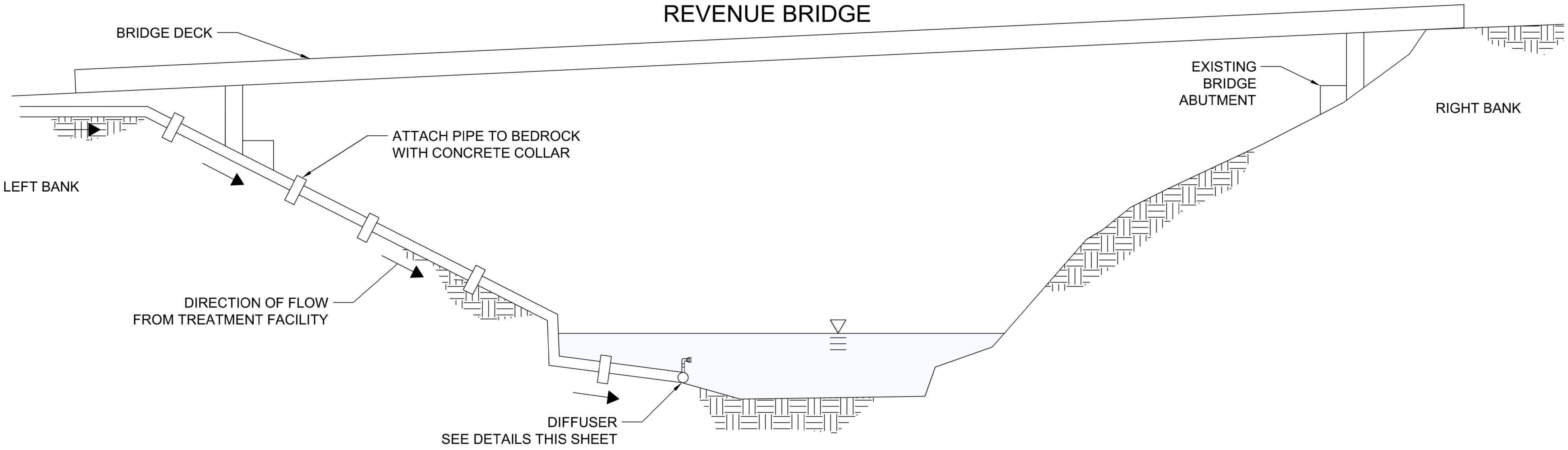
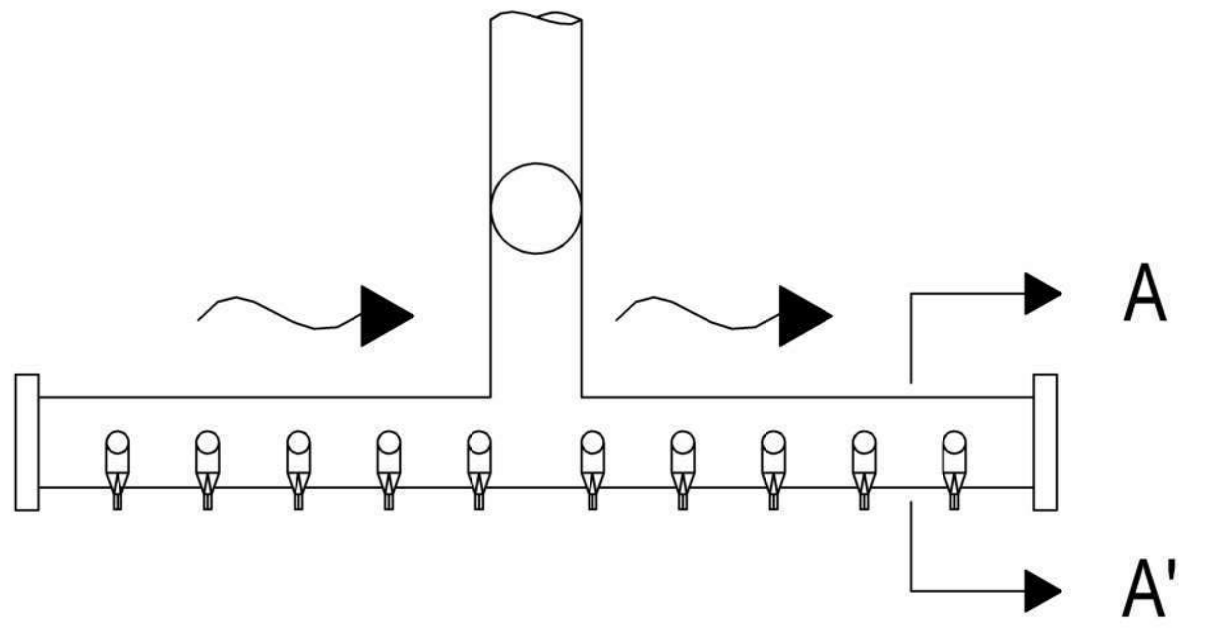
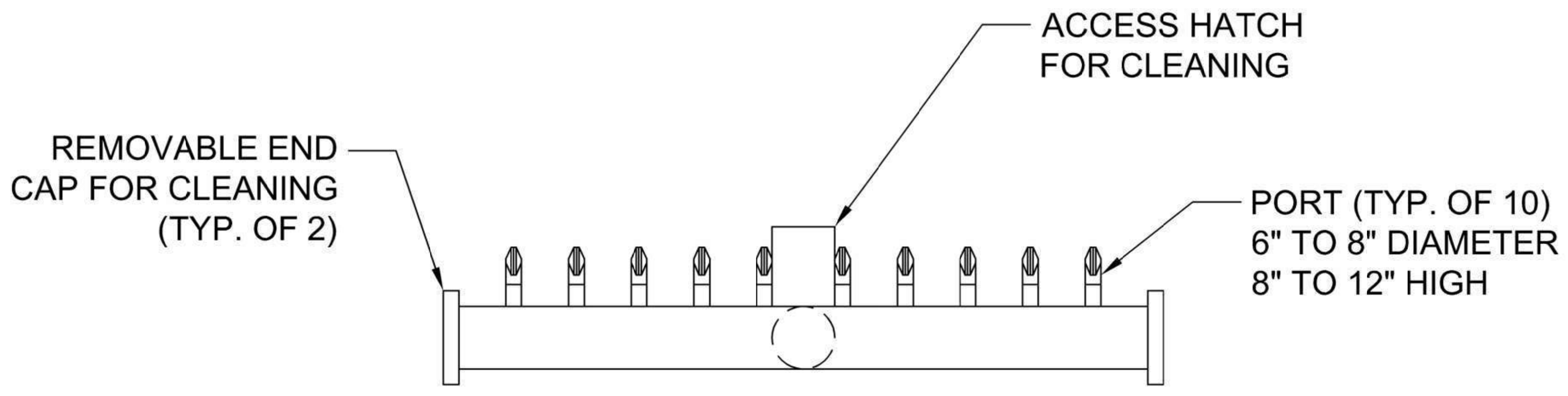


SANDY RIVER AT TEN EYCK ROAD PROFILE VIEW - NTS

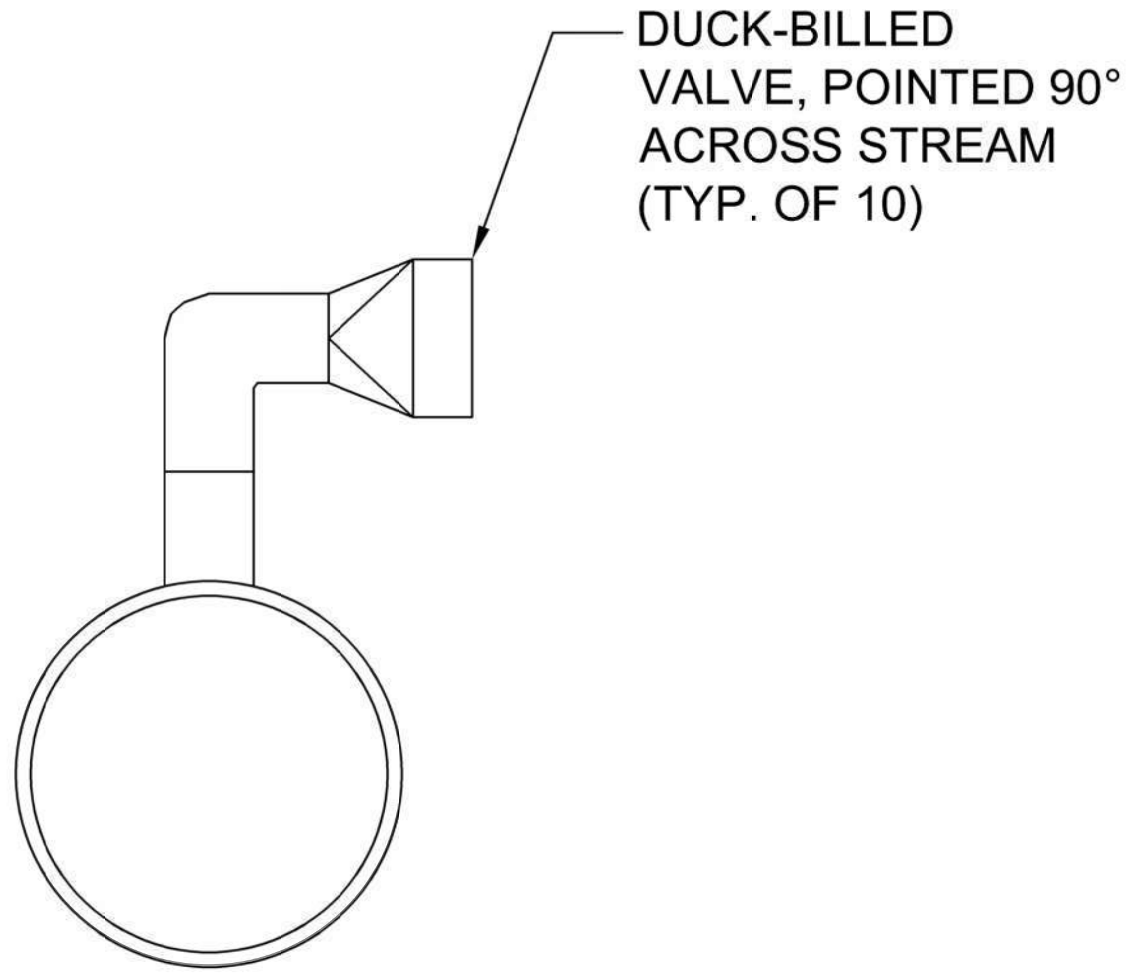


PLAN VIEW - DIFFUSER - NTS

RIVER FLOW DIRECTION PARALLEL TO DIFFUSER



PROFILE VIEW - DIFFUSER - NTS



SECTION A-A' - NTS

PRELIMINARY OUTFALL CONCEPT SUBJECT TO CHANGE

NO.	DATE	BY	REVISION

NOTICE
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

KMV
DESIGNED
KTH
DRAWN
CHECKED

PRELIMINARY ONLY
DO NOT USE FOR CONSTRUCTION
NOVEMBER 2020
Murraysmith
www.murraysmith.us

murraysmith

SANDY
WHERE INNOVATION MEETS ELEVATION

PRELIMINARY OUTFALL CONCEPT SUBJECT TO CHANGE

FIGURE 2

SHEET
FIG 2
1 of 1

PROJECT NO.: 20-2776
SCALE:
DATE: NOV 2020

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Working\KTH\Outfall_1_recover.dwg Plan 11/5/2020 4:27 PM KATIE.HUSK 23.0s (LMS Tech)

1001 SE Water Ave.
Suite 180
Portland, OR 97214
503.207.6688

Date:	September 25, 2020
To:	Ken Vigil, PE Principal Engineer Murraysmith
From:	Steven Rodriguez, PE Senior Engineer Wolf Water Resources
Project:	Sandy River Outfall Siting Evaluation
Subject:	Sandy River Outfall Siting Memo - FINAL

Technical Memorandum

Introduction

The City of Sandy is one of the fastest growing communities in Oregon, with a population that has doubled in the past 20 years and is projected to double again over the next 20. To accommodate past and future growth, the City is developing initial plans and designs to expand their wastewater system. A critical component to the new wastewater system is the siting for a proposed effluent discharge to the Sandy River.

Objectives

Wolf Water Resources (W2r), contracted by Murraysmith, has been tasked with evaluating potential wastewater outfall locations along the Sandy River to inform an appropriate site for the outfall through an evaluation of river processes (i.e. river stability, hydraulics, and fisheries biology). We understand that primary considerations in the siting of the proposed discharge locations for City of Sandy's wastewater system are:

- Channel stability (minimal erosion, deposition, and channel migration)
- Flood extents
- Adequate depth to allow for river boaters to pass over outfall infrastructure
- Avoidance of areas of high fisherperson use and high-quality fish habitat
- General constructability and feasibility of outfall infrastructure
- Hydraulic conditions that promote mixing of discharged water

W2rperformed a combination desktop and field analysis of multiple potential discharge sites to inform summary findings and recommendations.

Study Area and Potential Discharge Sites

Study Area Overview

The sites being considered for outfall alternatives are located along the Sandy River mainstem between river mile (RM)24 and RM20. This memo focuses on the geomorphic and fisheries characteristics of these sites to identify the opportunities and constraints in order to assist with the selection of a preferred location for a future discharge location for the City of Sandy's proposed wastewater facility upgrades. Initial concept designs include two potential river discharge locations (the Oxbow Site and Ten Eyck Road Crossing), and a land application at the Roslyn Lake wetland. Over the course of the investigation, three additional sites were identified as potential primary discharge locations or secondary discharge locations to be paired with land application at Roslyn Lake: the PGE Powerline Site, Upstream Oxbow Site, and Bull Run Micro-Hydro Site. At the time of this assessment, however, initial feasibility of the Bull Run Micro-Hydro was still under consideration so it was not included as part of this assessment.

This assessment covers the potential discharge sites located directly on the Sandy River mainstem and Roslyn Lake. The entire study area, along with the potential Sandy River discharge locations in addition to Roslyn Lake, are identified in Figure 1. This Vicinity Map shows each site along with potential pipeline alignments in relation to the Sandy River, the City of Sandy, the surrounding terrain, and property types. The pipeline alignments shown are preliminary in nature and will be further refined by the project team as the design progresses. A full-scale vicinity map is included as an attachment.

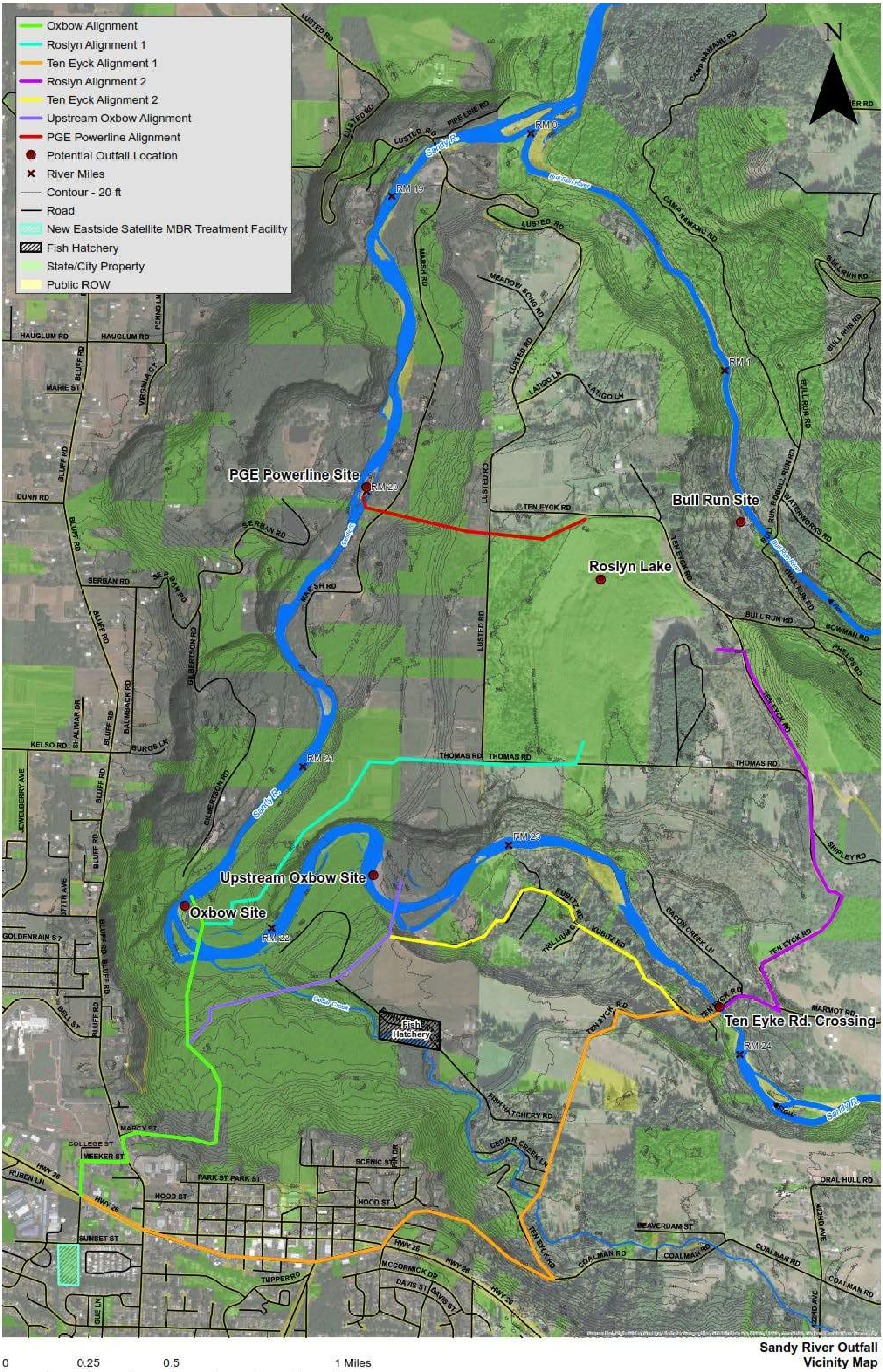


Figure 1. Sandy River Outfall Siting Evaluation Study Area and potential discharge locations and pipeline alignments. Full scale vicinity map included in attachments.

Fisheries

The Sandy River mainstem corridor has been identified as the priority anchor habitat for salmon and steelhead conservation in the basin (SRBWC 2017). The Sandy River mainstem supports four wild salmon and steelhead populations including Spring Chinook, fall Chinook, coho, and winter steelhead, all of which are listed under the Federal Endangered Species Act (ESA) as threatened. The study area primarily provides rearing and migration habitat for juvenile and adult salmonids; however, Spring Chinook and winter steelhead also spawn throughout the reach. The Sandy River Hatchery, operated by the Oregon Department of Fish and Wildlife (ODFW), maintains harvest programs for Spring Chinook, coho, and winter steelhead, in addition to summer steelhead, a popular sport fish introduced to the basin (ODFW 2020b). Other species of concern in the basin include Pacific lamprey, rainbow trout, coastal cutthroat trout, eulachon, and mountain whitefish.

Given its proximity to the Portland metro area, the Sandy River is a popular fishing and recreation destination. Heavy use by sport anglers is evident on the river. Although fishing by boat is prohibited within the study reach, boating to access bank fishing locations is common.

The Sandy Basin includes several river segments that do not attain water quality standards or support all designated beneficial uses. Oregon Department of Environmental Quality (DEQ) (2012) lists impaired waters on the Clean Water Act Section 303d list for multiple parameters within the basin. In 2005 a Total Maximum Daily Load (TMDL) Water Quality Management Plan (WQMP) was approved to reduce temperature and bacteria in the basin (DEQ 2019); however, water quality, especially high stream temperatures, is an ongoing limiting factor to fish populations.

Potential Discharge Types

With the exception of overland application at the Roslyn Lake site, the types of discharge this assessment considers are direct discharge via diffuser directly to the river within the water column and hyporheic discharge. The purpose of direct discharge diffusers is to maximize near-field mixing and dilution within the mixing zone as required by DEQ. Since diffusers can be designed in various configurations, they are not considered a factor affecting outfall siting. For that reason, no specific diffuser design was considered for this assessment.

The hyporheic zone is the region of sediment and porous space beneath and alongside a stream bed where the groundwater is sourced from the stream itself. Groundwater is supplied through water that "downwells" from the stream, commonly through bars, river islands, and underneath meander bends. Preliminary discussions with Murraysmith indicated hyporheic discharge within the river's gravels, such as within a gravel bar along the inside bend of the Oxbow Site, was under consideration for its potential to improve mixing and provide a buffer for temperature effects from effluent discharge. It provides an added benefit of eliminating potential exposure to mobilized debris, people, or watercraft.

Considering the above direct and hyporheic types of discharge, discharge site evaluations took into consideration desirable hydraulic conditions for effluent mixing, potential disturbance to discharge facility such as impact (by debris), public interaction (by boat or wading), scour/exposure (for hyporheic discharges), and deposition/burial (for water column discharges).

Site Assessments

W2r assessed alternative discharge sites according to the following key criteria:

- General Constructability – Assessment of general site constraints relative to terrain, infrastructure, and river form.
- Geomorphology – Assessment of relative stability and potential for river change with potential to impact the discharge infrastructure within its general design life.
- Fisheries – Assessment of existing fisheries resources and potential impacts from proposed discharge infrastructure.

High Resolution aerial imagery was also collected for three of the potential sites during field assessments: Oxbow, Ten Eyck Road, and PGE Powerline. Orthomosaic images of these sites are included as attachments.

Oxbow Site

Site Information and General Constructability

The Oxbow site is located at RM 21.6 of the Sandy River, at the downstream extents of a meander bend approximately 2.3 river miles downstream of the Ten Eyck Road bridge crossing (Figure 2). Based on early conceptual designs, the most probable sewer main alignment to this discharge location would follow the existing Sandy River Trail alignment, situated on City of Sandy property, from SE Marcy Street down to the Sandy River. From here, the sewer line would cross under the Sandy River by directional boring to the right bank where it would be discharged either into the water column or in the hyporheic zone within the existing gravel bar.

Due to its location relative to the proposed treatment facility, the Oxbow site would likely provide the shortest potential sewer main alignment (Figure 2). Additionally, the existing Sandy River Trail corridor provides a potential pipeline alignment on City-owned property, eliminating constraints raised by the need for temporary or permanent private property access. The trail corridor is already cleared and graded, providing good construction access.

The Oxbow site involves a number of potential construction constraints. Steep terrain as the alignment approaches the river on both banks may create construction challenges with regard to length of directional boring and equipment access (Figure 3). Visual observations of rock outcrops along the river meander bend near this location also suggest that directional boring across the river may encounter rock. The dynamic nature of the site presents risk that the channel geometry at the outfall location could change over time, leaving it shallow and at risk of contact with debris, boat, or human interaction. As well, an outfall structure such as a diffuser could become buried in gravels as bar geometries and locations migrate over time.

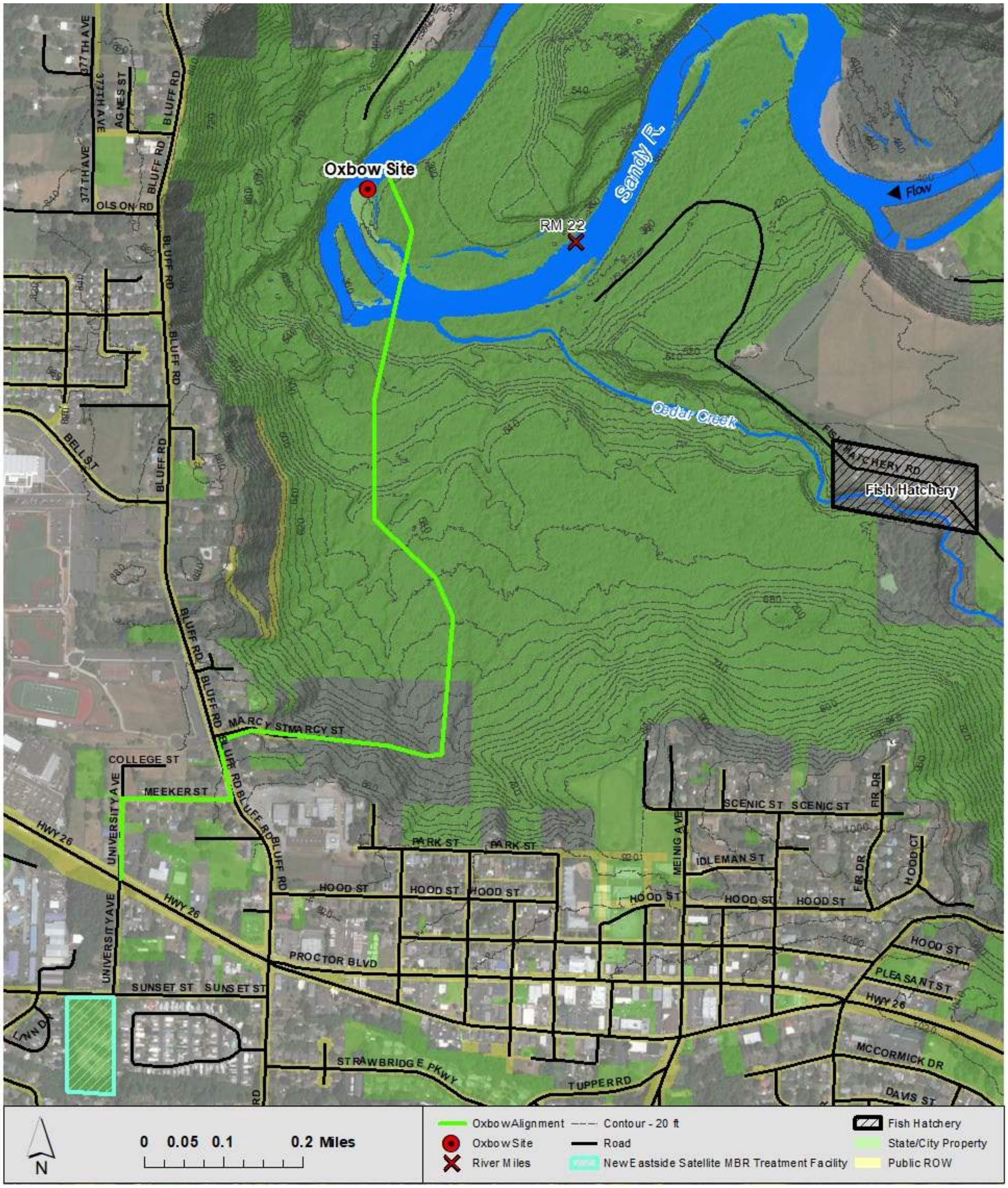


Figure 2. Vicinity map of proposed Oxbow discharge site with potential sewer main alignment (green).

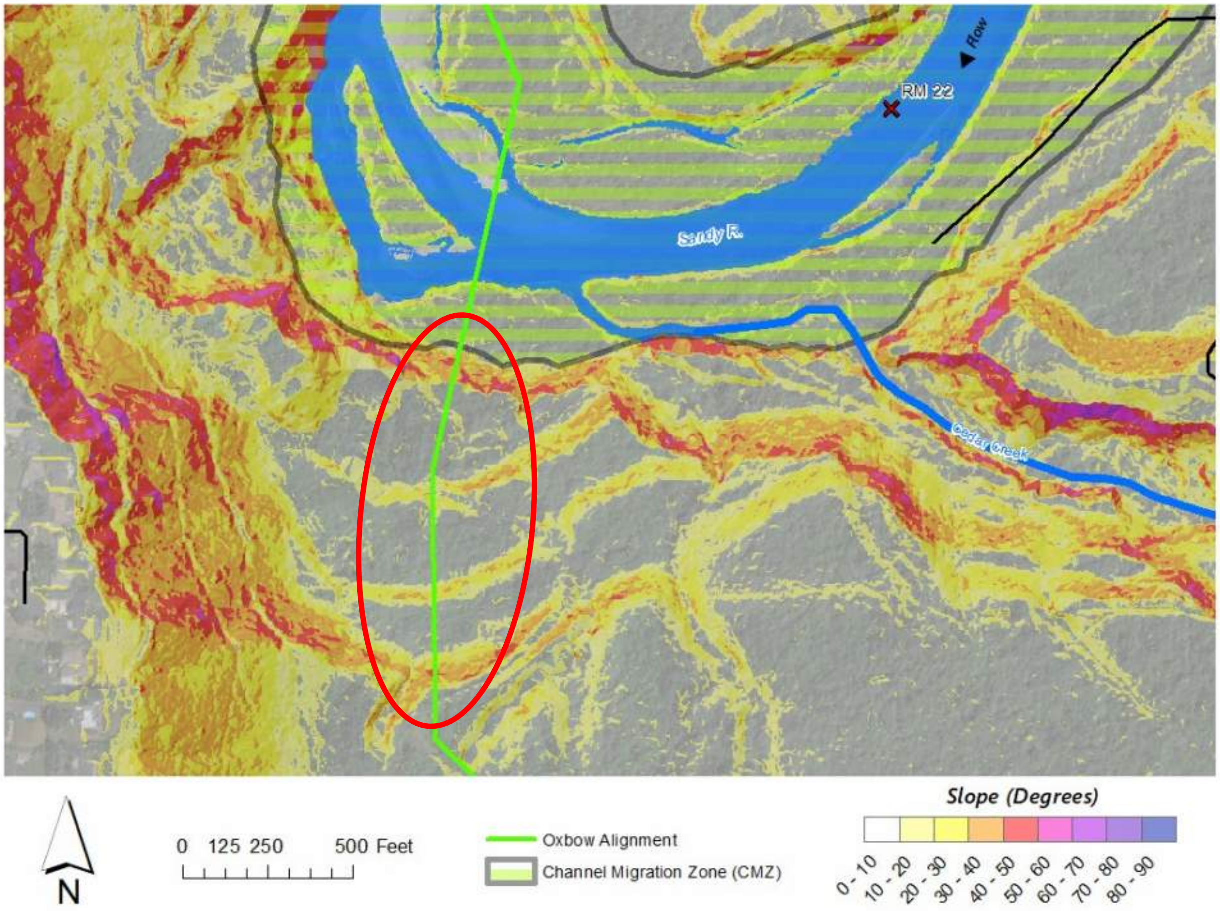


Figure 3. Steep terrain along potential Oxbow pipeline alignment (green).

Geomorphic Assessment

The Oxbow site is one of the most dynamic sites considered. Specifically, the Sandy River shows historical and present-day signs of lateral migration. Indications include major bars, active bank erosion (Figure 4) on the right floodplain, and a relatively broad (230-foot-wide) floodplain. With the exception of the east facing valley wall (comprised of fluvial mudstone, sandstone, and conglomerate from the Troutdale Formation as described by Madin (2004)), it should be assumed that the Sandy River could and likely will migrate within its floodplain within the design life of the proposed discharge infrastructure. Aerial photographs (Figure 5) show that the river has migrated modestly over the past couple decades; however, migration of the Sandy River has proved to be highly episodic in other reaches of the river. This episodic nature of migration is apparent at Metro's Oxbow Park (approximately 11 miles downstream of this site on the Sandy River mainstem) where river migration was quiescent for much of the historical record until rapid migration (of 100-200 feet per year) began threatening the park boat launch within just the last decade (W2r and KPFF, 2019). Based on this episodic river behavior, past migration should not necessarily be considered a reliable predictor of potential future migration rates or patterns when considering siting of outfall infrastructure.

Figure 4. Example of recent bank erosion at the Oxbow site.

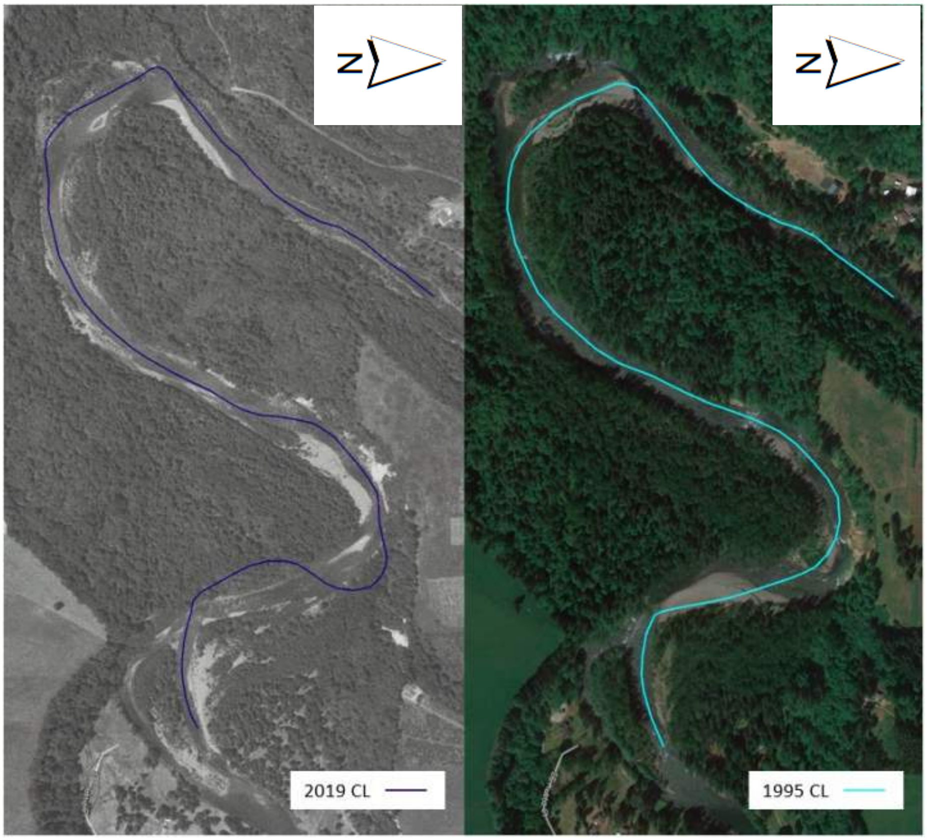


Figure 5. Aerial photograph comparison (1995 image on right; 2019 image on left) with river centerlines (CLs) shown for comparison.

DOGAMI (2017) has mapped a Channel Migration Zone (CMZ) which provides an estimate of where the river has likelihood of migrating over a 100-year timeframe (see Figure 6). Importantly, the CMZ incorporates areas likely to be impacted by both river migration and also geotechnical slope failures that may occur in response to the river migrating into high banks or valley walls along the river. In general, pipeline and infrastructure design should consider this potential migration extent to avoid conflicts into the future. These conflicts may occur as the river migrates into approach pipelines along valley margins or at the discharge point itself where changes in river thalweg location may diminish the desired mixing over time. Ultimately, the potential for these conflicts make this site a low priority site from a geomorphic perspective.

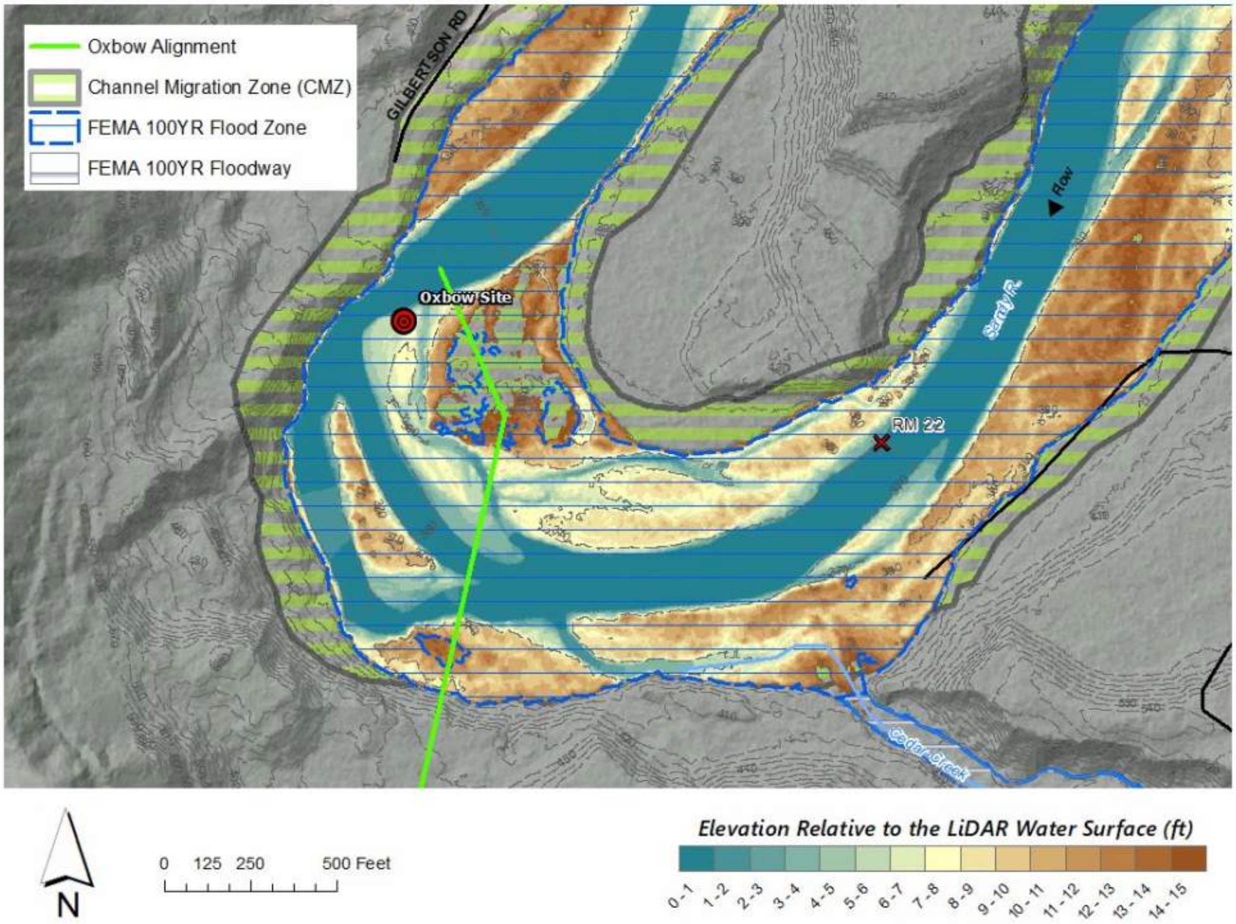


Figure 6. LiDAR map of floodplain and valley topography at the Oxbow site. Blue hatching shows the FEMA 100-year flood extent; green hatching shows the channel migration zone extent (mapped by DOGAMI).

Fisheries

The Oxbow alternative involves the pipeline crossing beneath the Sandy River at the upstream Oxbow bend and locating the outfall at the right bank of the downstream bend. The instream habitat in the vicinity of the Oxbow bends is plentiful and diverse. The Oxbow reach includes deep runs, pools, tail out riffles, and a mid-channel bar that splits the flow. Log jams are located along the banks and along gravel bars. Spawning-sized gravel substrate is plentiful, and the banks are lined with native riparian vegetation.

High fisherperson use is evident at the river crossing location. Public access to the river and the confluence with Cedar Creek, which is the intake to the ODFW Sandy fish Hatchery, is through Sandy River Park, owned by the City of Sandy. Due to the proximity to the hatchery, fish will accumulate at the base of Cedar Creek before migrating upstream. Several groups and individuals were observed fishing at this location during the site visit in June 2020. The excessive quantity of discarded fishing tackle along the banks also indicated high use.

Although the long-term impacts of the pipeline construction on the river will be minimal at the Oxbow site, care should be made toward reducing impacts to the banks and trail. Impacts and reduction of access to fishing and general recreation will be opposed by the fishing community.

The outfall location at the Oxbow site lacks direct access to the City-owned parcel and surrounding private properties. Directly at the outfall site is a popular fishing hole that is accessed by foot, from the Sandy River Park trail, or by boat. The instream habitat for salmonids at this location is also very high quality. The reach consists of deep runs and upstream side channel, and plentiful spawning gravels in the substrate. A mid-stream gravel bar is located on the right bank and the banks are lined with native riparian forests.

Communication with fisheries biologists from the National Marine Fisheries Service (NMFS) and ODFW has identified the greatest concerns regarding the Oxbow site include impacts to stream temperature, spawning gravel stabilities, and hatchery impacts. Temperature increases are a concern year-round that may affect all life stages of salmonids. The placement of the outfall in the deep pool/run located at the site would provide good mixing for water quality considerations; however, there is concern about the disruption of fish holding habitat. The high-quality holding pools at this site are important for both hatchery returns and fish migrating to spawning area further upstream. An outfall at this location sited near a pool tail-out and major riffle is inherently unstable and changes to the bed are expected. This highlights concerns of outfall exposure that could impact boating and disrupt spawning gravels. The location of the Oxbow site in proximity to the Sandy River hatchery, immediately upstream in Cedar Creek, paired with the cumulative effects of the above issues would likely impact fish returns to the hatchery.

Ten Eyck Road Crossing

Site Information and General Constructability

The Ten Eyck Road Crossing site is located at RM 23.9, where Ten Eyck Road crosses the Sandy River (Figure 7). The river is confined within bedrock as it passes under Ten Eyck Road (Figure 8). This provides a relatively stable section of river with hydraulic characteristics unlikely to change in a significant way over the life of the project. The channel is relatively deep, and velocities are fast, reducing risks of damage or conflicts with debris and boats. Private property surrounding the river in this location provides minimal public access, reducing potential for public interactions with any infrastructure in this location.

Based on early conceptual designs, one potential sewer main alignment to this discharge location would follow Ten Eyck Road from US Hwy 26. An alternative potential pipeline alignment would follow the Sandy River Trail from SE Marcy Street down to the Sandy River, then cross Cedar Creek towards the neighborhood accessed by SE Kubitz Road until it connects with Ten Eyck Road near the river (Figure 7).

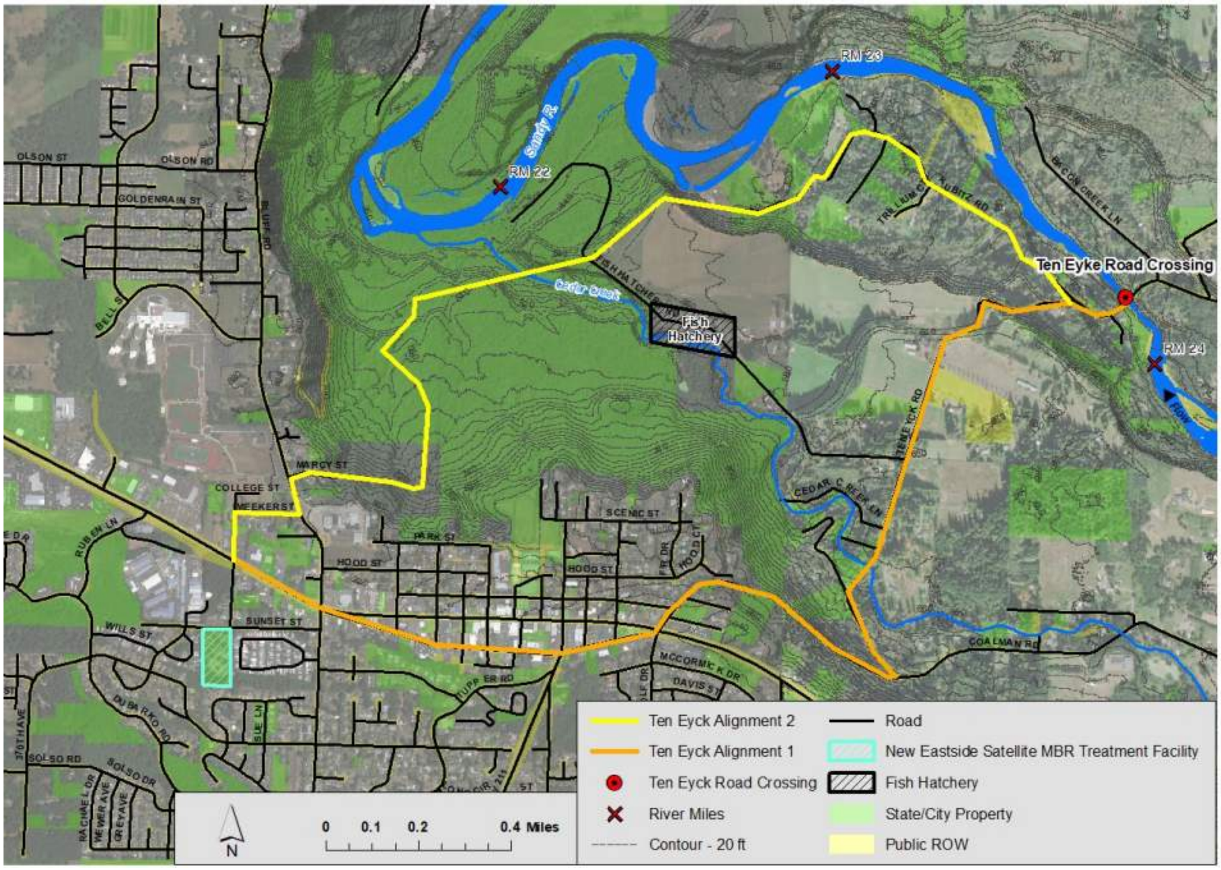


Figure 7. Vicinity map of proposed Ten Eyck Road discharge site with potential sewer main alignments (yellow and orange).

Figure 8. Sandy River channel below Ten Eyck Road crossing looking downstream (Photo courtesy of W2r). Bedrock lines the channel within this reach providing a stable, narrow and deep section of channel.

The two potential pipeline alignments are both approximately twice as long as a potential pipeline alignment to the Oxbow site. The first follows existing right-of-ways (US Hwy 26 and Ten Eyck Road) so it would not require any temporary or permanent access to private parcels, unless necessary for construction of the outfall facility at the crossing. The right-of-way provides accessibility for construction and ensures constraints related to terrain are unlikely to be encountered. Construction constraints that would accompany this proposed alignment are related to performing construction projects along existing roads and through a primary commercial and commuter corridor through the City of Sandy. Any potential alignment along US Hwy 26 and Ten Eyck Road will likely encounter numerous utility conflicts (water, gas, electric, etc.) as well as infrastructure (roads, sidewalks, etc.). These conflicts will require significant planning and coordination to mitigate, and resulting utility relocations and road repairs have the potential to increase construction costs. Construction along these primary travel corridors and through the city center also creates community nuisances in the form of road closures, detours, traffic delays, and noise, requiring traffic control planning and implementation. Although this alignment involves a number of constraints or conflicts, none are considered uncommon or cannot be mitigated.

The second potential alignment, similar to that for the Oxbow option, follows the Sandy River Trail on City-owned property, then crosses ODFW property as it turns east and crosses Cedar Creek. Once in the SE Kubitz Road neighborhood it would likely follow a road alignment until it reconnects to Ten Eyck Road. Most of this alignment, along existing trail and road corridors, is cleared and graded, which eases construction. This alignment may pose construction challenges in the form of steep terrain (Figure 9) as the alignment approaches the Sandy River and Cedar Creek. The Cedar Creek crossing would require directional boring or stream diversion and trenching. This area is uncleared and includes steep terrain, making construction access difficult. Similar to the Oxbow location, it is likely that trenching and/or directional boring to and across the Cedar Creek channel would encounter rock. Finally, based on preliminary review of County tax lots, it is likely that any alignment passing through the SE Kubitz neighborhood will require crossing private parcel(s). The portion of the alignment that follows SE Kubitz Road will likely encounter utility and infrastructure conflicts, resulting in similar constraints as the alignment following US Hwy 26 and Ten Eyck Road, but to a much lesser degree.

Completing either of these alignments and connecting to an outfall in the river from the Ten Eyck Road crossing will pose challenges. Private properties line the river in this location, providing access constraints, whether temporary or permanent. During field investigations, one nearby resident voiced negativity to siting a discharge in this location. Additionally, feasibility of design and construction of an outfall facility within a bedrock-lined channel such as this still needs determination.

If the potential Roslyn Lake land application alternative is pursued, the Ten Eyck Road site is conveniently located to function as a Sandy River discharge, a requirement of a land application alternative. To access Roslyn Lake, potential sewer main alignments would cross the Sandy River, potentially at Ten Eyck Road, then continue to Roslyn Lake. The overflow pipe alignment, if Ten Eyck is selected, could follow the same alignment as that used to Roslyn Lake, and potentially the same pipe, adding a construction cost benefit.

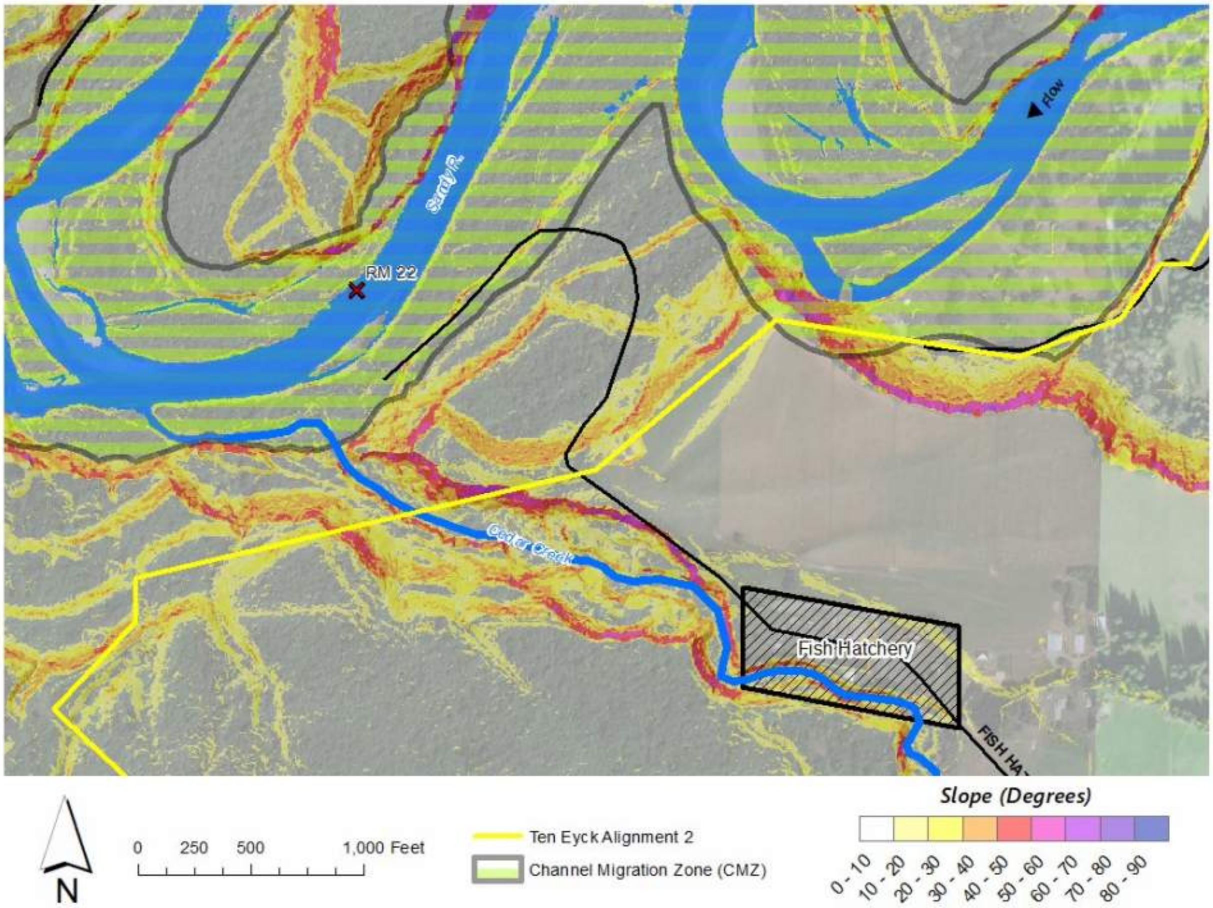


Figure 9. Steep terrain along potential Ten Eyck Road pipeline alignment (yellow).

Geomorphic Analysis

Ten Eyck Road crosses the Sandy River at a natural bedrock constriction. The bank material appears to be of volcanic origin with a welded nature and angular clasts or fragments. The bedrock in this reach is shown on the DOGAMI Geologic Map of Oregon as andesite from the Rhododendron Formation, as identified by Madin (2004). This erosion-resistant bedrock (which lines the stream bed and canyon side walls) provides significant stability, making the potential for lateral migration of the river negligible (rock fracture and failure may be a larger concern, but were not assessed). This site is the most stable of the sites considered, and thus is the highest priority site from a geomorphic perspective.

Fisheries

At the Ten Eyck Road Crossing location the Sandy River channel is confined with narrow bedrock walls, creating a high velocity single channel chute. The lack of off-channel or low flow areas within this reach provides little opportunity for fish holding. Thus, this location is primarily utilized as a transport reach for all fish species. The high velocity and deep channel would create a desirable mixing zone, so potential impacts to stream temperatures or other water quality constituents are expected to be relatively low. As a result, the impacts due to the construction of the outfall and likelihood of fish exposure to the effluent at this location is low.

Fishing opportunities are also minimal at the Ten Eyck location due to the relatively high velocity flows and channel structure, although bank angling is observed daily. The pathways from the road under the bridge provide a popular boat put-in.

Overall, the Ten Eyck Road outfall location would have fewer concerns than the other alternative sites with regard to fish habitat, fishery, and water quality impacts. Biologists from NMFS and ODFW have confirmed that this site is preferred over the Oxbow and other downstream sites.

PGE Powerline

Site Information and General Constructability

The PGE Powerline crossing site is located at RM 20 of the Sandy River, where the PGE powerlines cross over the Sandy River (Figure 10). Based on discussions with project planners and its distance from the proposed treatment facility relative to other potential discharge locations, we assume discharge at this location would function as a Sandy River discharge in conjunction with land application at Roslyn Lake. A potential overflow pipe alignment would follow the PGE powerline alignment west from Roslyn Lake to the Sandy River to its discharge location where it would be discharged either into the water column or in the hyporheic zone within the existing gravel bar.

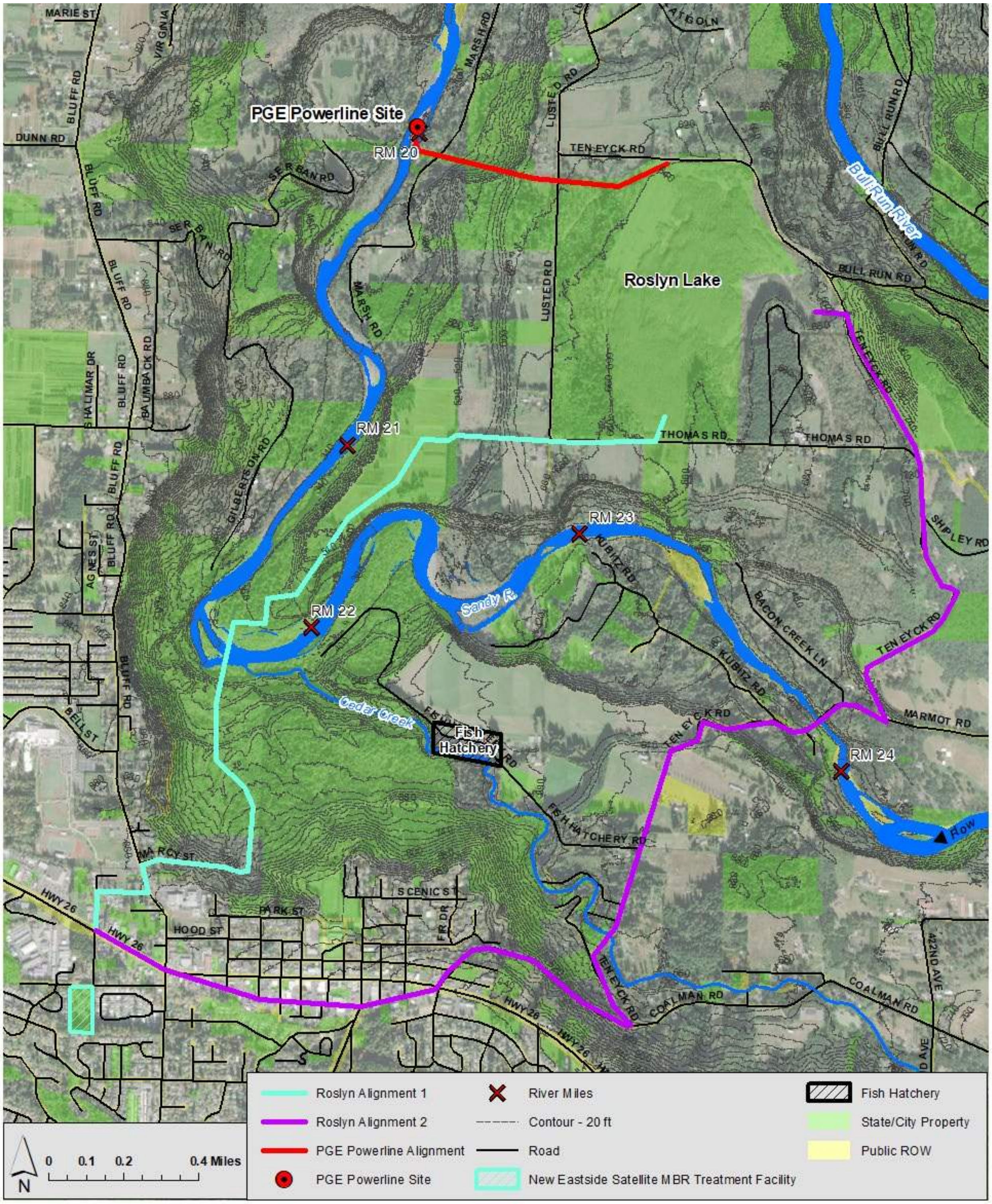


Figure 10. Vicinity map of proposed PGE Powerline discharge site with potential sewer main alignment (red) from Roslyn Lake following powerline corridor. Potential sewer main alignments for Roslyn Lake (cyan and purple) also shown.

A more detailed assessment of the Roslyn Lake discharge location alternative found later in this memorandum provides additional information on potential sewer main alignments from Sandy to Roslyn Lake. Because this discharge location would be in conjunction with an outfall at Roslyn Lake and would require pipe alignments both from the treatment facility to Roslyn Lake and from Roslyn Lake to this discharge location, this option would require the longest overall sewer main alignment regardless of alignment to Roslyn Lake (Figure 10). The existing Power Line corridor provides a potential pipe alignment with access already established for construction; however, access would need to be allowed by and coordinated with the utility. As can be seen in Figure 11, an alignment following this corridor would pass through steep terrain descending from the floodplain terrace to the river, posing construction challenges.

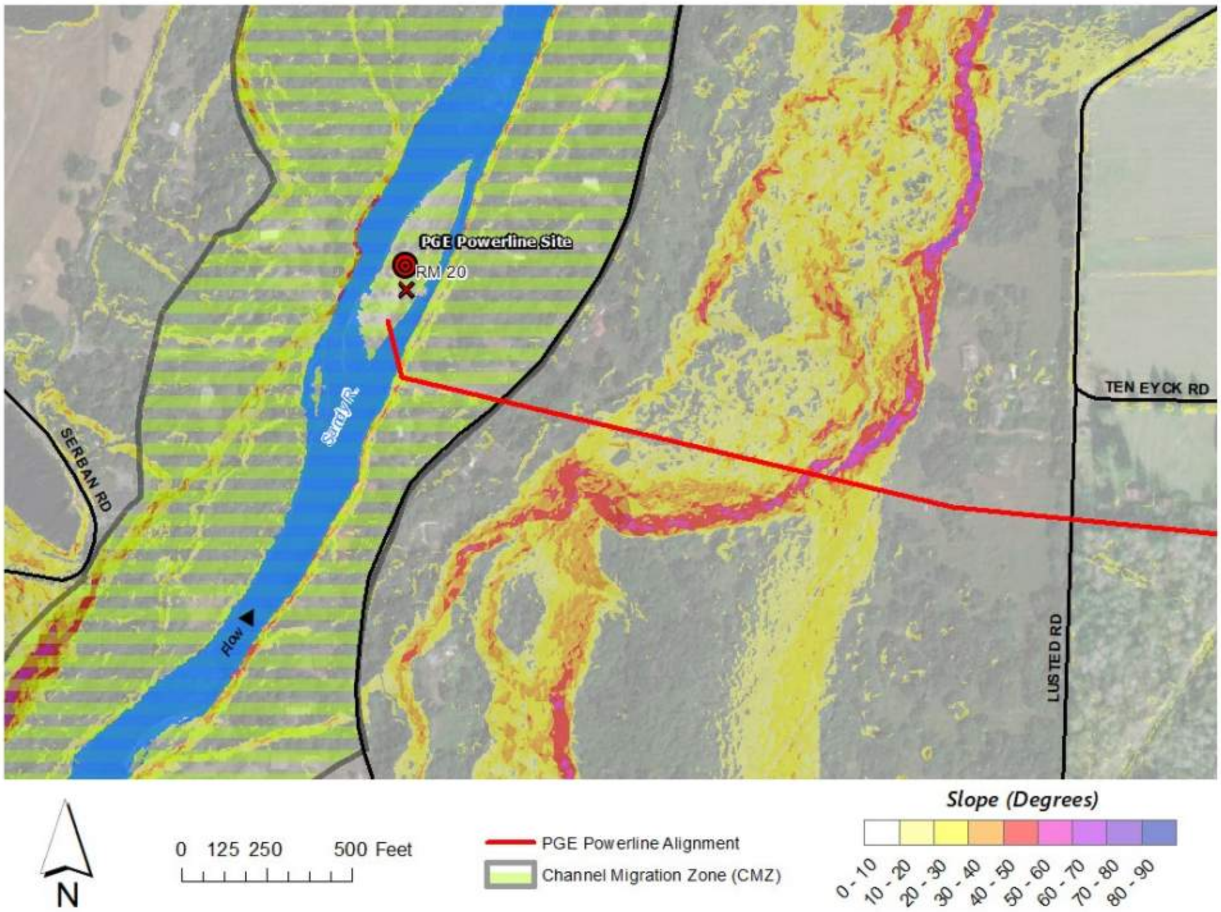


Figure 11. Terrain slopes along potential sewer main alignment from Roslyn Lake to PGE Powerline discharge site. Note steep terrain as alignment descends from floodplain terrace near Lusted Road to river.

Geomorphic Analysis

The PGE site was not accessed in the field and was assessed through aerial imagery and available geospatial information. Within recent decades aerial imagery reveals a significant mid-channel gravel bar that has changed in extent, as well as modest shifts in the river thalweg (see Figure 12). This potential site appears to have less migration potential generally than that of the Oxbow site (based on a straighter river planform overall); however, DOGAMI's CMZ mapping indicates a significant zone of potential migration into the future (Figure 13) which should be considered and generally avoided with the discharge infrastructure/pipe. Based on the moderate potential for river migration and the width of the CMZ in this location, this site is considered relatively low priority.

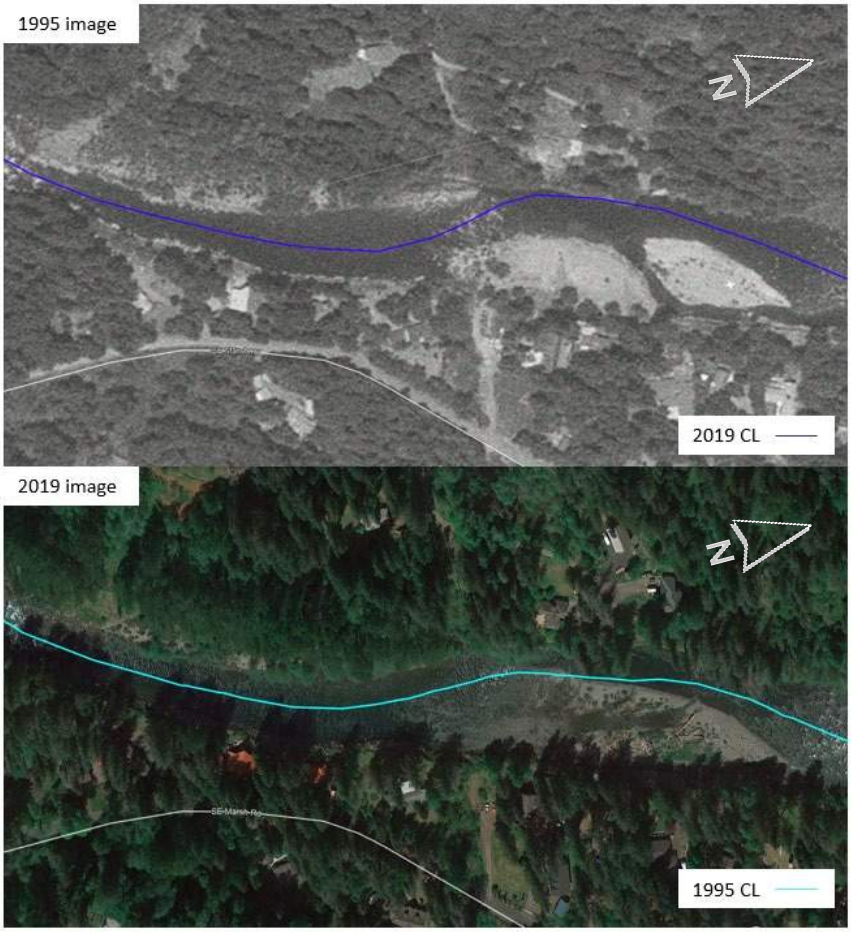


Figure 12. PGE site aerial photograph comparison (1995 image on top; 2019 image on bottom) with river centerlines (CLs) shown for comparison.

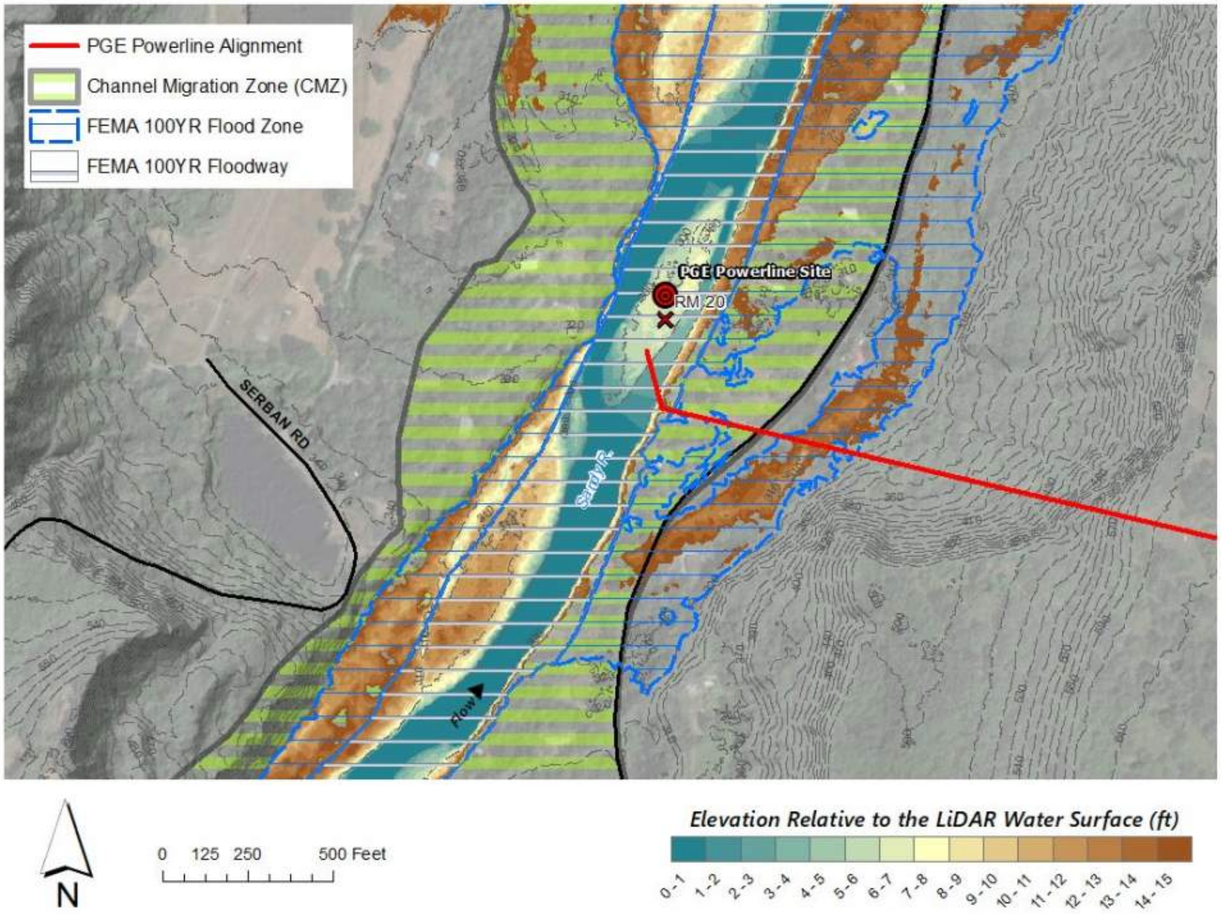


Figure 13. LiDAR map of floodplain and valley topography at the PGE site. Blue hatching shows the FEMA 100-year flood extent; green hatching shows the channel migration zone extent (mapped by DOGAMI).

Fisheries

The PGE site has similar concerns regarding potential impacts to the fishery as the Oxbow site, due to the quality of in-steam habitat identified at this location. This reach appears to be highly dynamic and complex with a continuously shifting gravel bar that adjusts flow through a single and multiple-thread channel. These characteristics would offer good low flow and off-channel habitat for holding and rearing fish. The lower depths across the gravels at this site may result in the discharge volume having a greater effect on stream dynamics, water quality, temperatures, and the stability and quality of potential spawning beds.

Fishing is popular within the pools just downstream of the discharge location. The site is commonly accessed via the riverbank from downstream Latourette Park.

Upstream Oxbow Location

Site Information and General Constructability

The Upstream Oxbow site was considered for an outfall location only after field investigations for other sites were completed. For this reason, findings for the upstream Oxbow location are based solely on desktop analysis. This location was initially recommended for consideration because it contains deep pools that are beneficial for mixing, it is not adjacent to the fish hatchery, and it offers potential pipeline alignments along public property. The Upstream Oxbow Site is located at RM 22.5 of the Sandy River, at the downstream extents of a meander bend approximately 1.4 river miles downstream of the Ten Eyck Road bridge crossing (Figure 14). Based on discussions with project planners, we assume the most probable sewer main alignment to this discharge location would follow the existing Sandy River Trail alignment situated on City of Sandy property from SE Marcy Street towards the Sandy River, where it would turn east and cross Cedar Creek, and then traverse northeast across ODFW property until it reached the Sandy River. At that point it would be directionally bored under the river to the right bank and discharged either into the water column or into the hyporheic zone within the existing gravel bar.

Due to its location relative to the proposed treatment facility, this discharge location would likely have a relatively short potential sewer main alignment compared to other discharge locations under consideration (Figure 14). Additionally, the existing Sandy River Trail corridor provides a potential alignment on City-owned property, eliminating the need for temporary or permanent private property access. The trail corridor is already cleared and graded, which eases construction.

Steep terrain as the alignment approaches the river and Cedar Creek (Figure 9) would pose construction challenges with regard to the length of directional boring and construction equipment access. Subsurface conditions are unknown at this site so it cannot be ruled out that directional boring and trenching across the river and Cedar Creek may encounter rock.

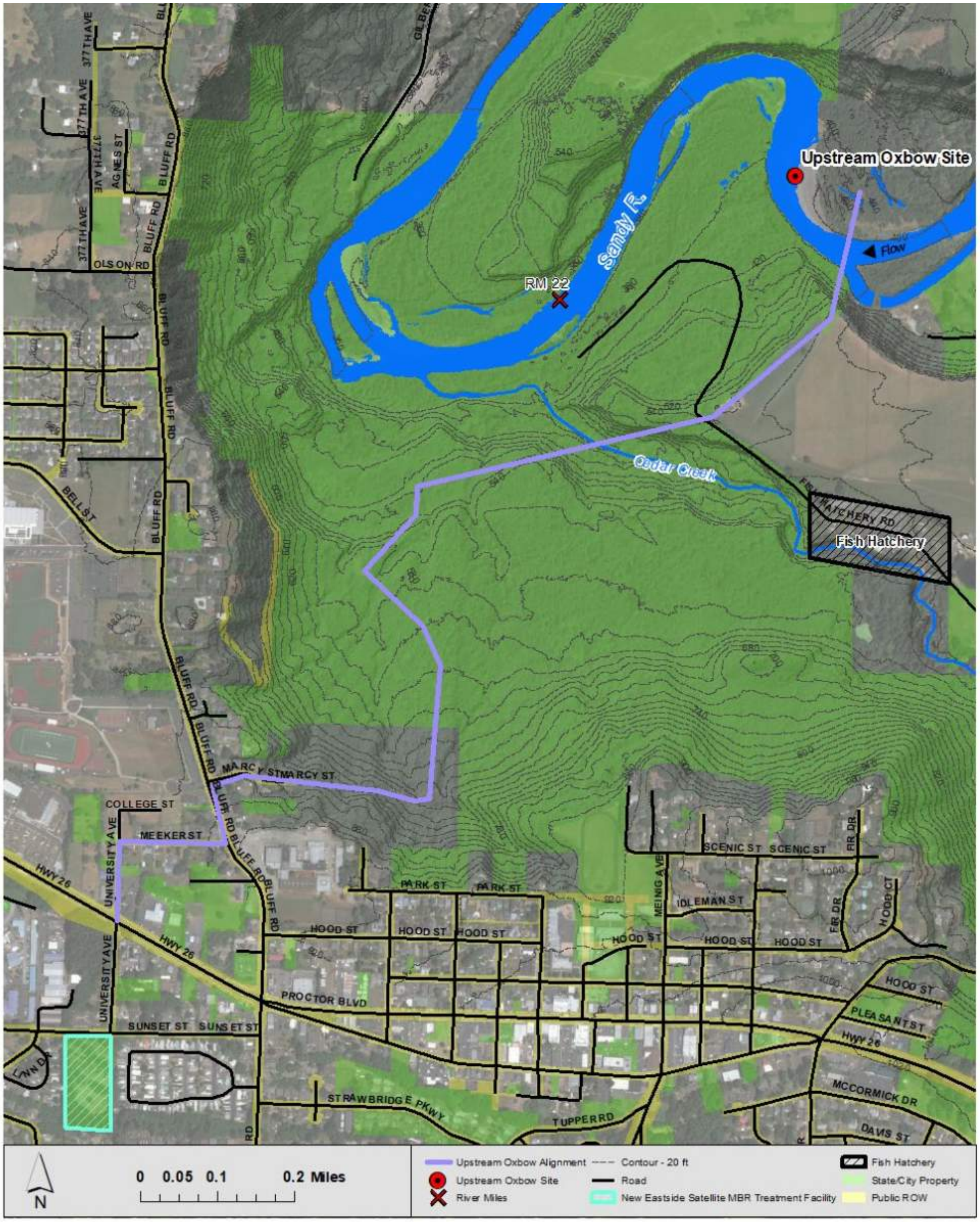


Figure 14. Upstream Oxbow Site vicinity with potential sewer main alignment (lavender).

Geomorphic Analysis

The Upper Oxbow site was not accessed directly in the field and was assessed through imagery and available geospatial information. As viewed in Figure 15, this site has the broadest active floodplain of the three sites and shows the most significant recent river migration (see Figure 5). This site, therefore, is likely the least stable of the sites considered and is considered low priority from a geomorphic perspective.

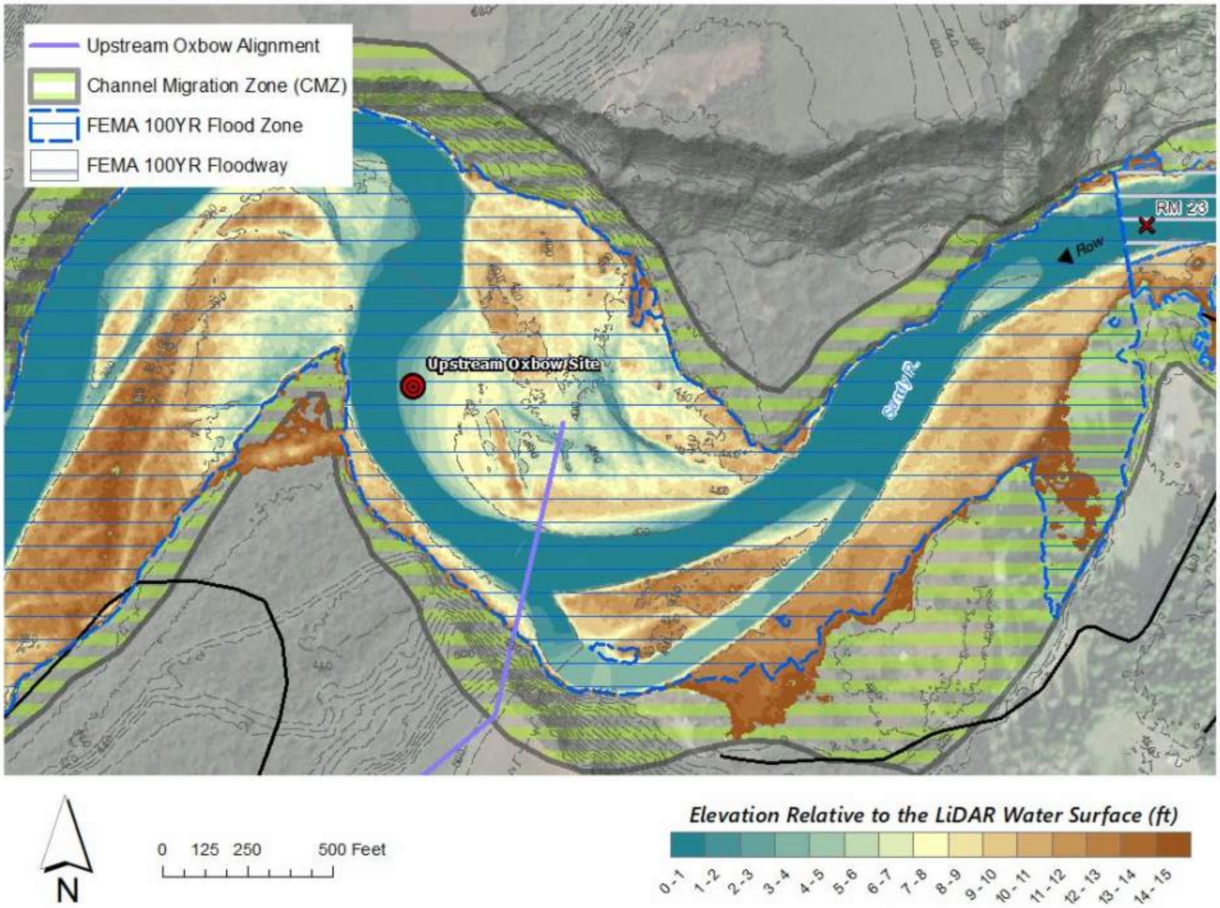


Figure 15. LiDAR map of floodplain and valley topography at the Upper Oxbow site. Blue hatching shows the FEMA 100-year flood extent; green hatching shows the channel migration zone extent (mapped by DOGAMI).

Fisheries

This site is similar to the downstream Oxbow site due to the quality of in-steam habitat identified at this location. The site is highly complex and includes a downstream gravel bar island, lateral gravel bars, and a multi-channel flow. These habitat features provide very important off-channel rearing and holding opportunities for fish. A prime native spring Chinook holding hole is located at this site that is a popular fishing spot and where ODFW nets most of their hatchery broodstock. Additionally, key off channel spawning habitat for native winter steelhead is located just upstream and downstream of the proposed outfall.

As the Upper Oxbow site is approximately 1.4 miles upstream from the hatchery, water quality impacts may be a concern if the mixing zone extends into the area where fish hold at the confluence with Cedar Creek, affecting hatchery returns.

Fishing use is heavy at the site due to the high quality of habitat supporting fish holding. Access is mostly via boat for bank angling.

Roslyn Lake Site

Site Information and General Constructability

In addition to potential discharges directly to the Sandy River, a land application alternative is being considered at the Roslyn Lake site. Since this site is not directly on the Sandy River, geomorphic and fisheries analyses were not performed for this site. Use of this site will require long term agreements to be in place with the property owner. It should also be noted that this site is not under consideration as a year-round discharge location because of heavy rainfall in the winter and spring, and it would mainly be considered for summertime discharge. And even in the summertime, because of soil capacities, a portion of the effluent would need to be discharged to the river. Because of this, a Roslyn Lake alternative would require a direct discharge to the Sandy River, such as Ten Eyck Road or PGE Powerline, in conjunction with the land application. The constructability review of potential sewer main alignments was performed considering this requirement for a Sandy River discharge site. Flow/discharge splits between land application and river discharge sites would need to be determined based on water quality needs and future permit requirements.

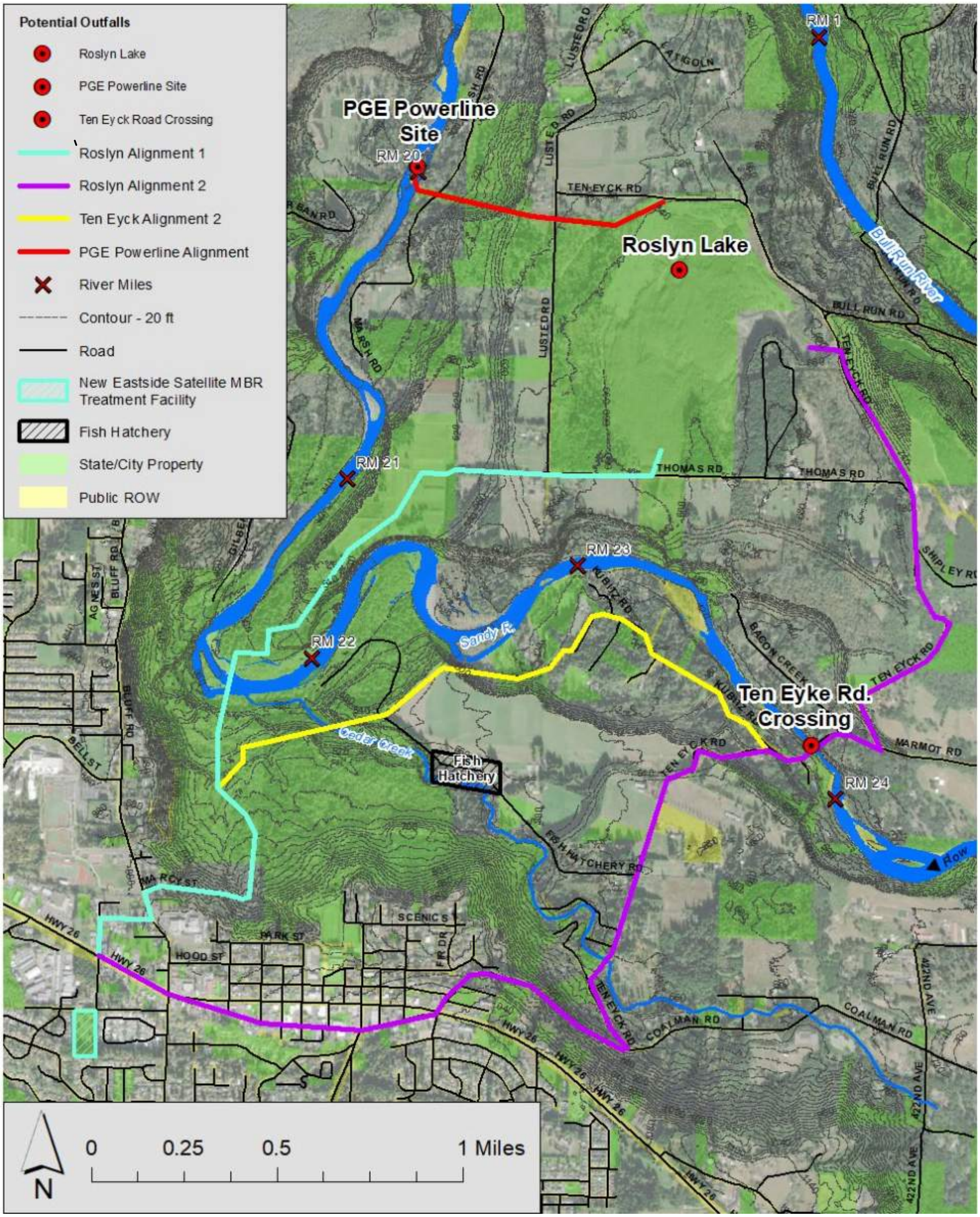


Figure 16. Roslyn Lake Site vicinity with potential pipeline alignments.

Based on early conceptual designs, two potential sewer main alignments were considered for the Roslyn Lake discharge location. The first follows the same alignment to Sandy River along the Sandy River Trail proposed for the Oxbow discharge location, where it crosses the Sandy River to the north side of the river and follows a path through private parcels to Thomas Road, from where it reaches Roslyn Lake (Figure 16). This alignment will encounter the same potential constraints with regard to terrain, potential rock, and boring across the river. On the north side of the river the alignment would cross steep terrain to reach the floodplain terrace, as well as pass through private properties until it reaches Thomas Road, which would require temporary and permanent access during and after construction.

The second alignment would follow an alignment similar to that proposed for Ten Eyck Road that follows US Hwy 26 and Ten Eyck Road to the Sandy River crossing. From there, it would continue to follow Ten Eyck Road until it reached a discharge location into the lake bed adjacent to Bull Run Road (Figure 16). Being located along existing roads, access would be good, though likely encounter numerous utility and infrastructure conflicts requiring coordination, relocation, and repairs. Significant construction inconveniences for the community may occur and traffic control would also be required. Although potentially costly, this alignment does not pose any identified unmitigable construction constraints.

Communications with NMFS and ODFW staff indicate that the Roslyn Lake alternative is preferred as this option primarily relies on land application for effluent discharge. The overflow discharge directly to the river, when needed, would be at a reduced rate compared to the other alternatives and expected fishery impacts would be reduced in kind. The overflow discharge to the river is expected to occur year-round due to land application constraints, with overflow during the winter months expected to be consistent. During the winter months the stream flows will be higher providing greater mixing and reduced thermal loading; therefore, the effects on fisheries will be lower than other times of the year. More detail of the seasonality of the overflow would be needed to have a better grasp of the fishery impacts.

ODFW and NMFS were interested in the educational opportunities with the Roslyn Lake option as there is an interesting story to be told around all the changes that have occurred in the basin over the years in regard to power generation and fisheries management. Coordination with the agencies is advised to determine if the Sandy River Habitat Conservation Plan would allow this use.

Conclusion

The focus of this assessment was to evaluate the suitability of potential treated wastewater effluent outfall locations for the City of Sandy's proposed wastewater treatment facility upgrades. Outfall locations were evaluated for channel stability, potential impacts to fisheries and public uses, and general constructability (Table 1).

Table 1 - Summary of Potential Sandy River Outfall Locations

Discharge Location	Relative Channel Stability	Potential Impact to Fisheries	Potential Impact to Public Uses	General Constructability		
				Cross Private Parcels? [1]	Channel Crossing	Relative Alignment Length
Oxbow	Low	High	High	No	Yes (Sandy River)	Short
Ten Eyck Road Crossing	High	Low	Low	Potentially[2]	Potentially[3]	Medium
PGE Powerline	Moderate	High	Moderate	Yes	Yes (Sandy River)	Long
Upstream Oxbow	Low	High	Moderate	Potentially[2]	Yes (Sandy River and Cedar Creek)	Short
Roslyn Lake	N/A	Low[4]	Low[4]	Potentially[2]	Yes (Sandy River)	Long

1. *Based on preliminary review of Clackamas County taxlot and GIS information.*
2. *Multiple potential pipe alignment considered, some of which cross private parcels based on preliminary review of available taxlot information.*
3. *Multiple potential pipe alignments considered, one of which crosses Cedar Creek.*
4. *Does not account for overflow discharge to Sandy River required in conjunction with Roslyn Lake land application.*

Three of the four potential discharge sites, Oxbow, PGE Powerline, and Upstream Oxbow, on the Sandy River mainstem corridor had similar characteristics in that they contain high value instream habitat for salmonids and have dynamic channel characteristics with likelihood of cross sectional change over the expected lifetime of the proposed treatment facility upgrades. The sites' habitat value increases the potential for impacts to fisheries and would likely receive the most resistance from the community and regulatory agencies. Additionally, two of these sites (Oxbow and Upstream Oxbow) would require directional boring across the mainstem Sandy River, increasing the complexity of construction. These characteristics are less desirable than those of the fourth potential mainstem site, Ten Eyck Road.

It is well understood that the use of Roslyn Lake for land application, which would minimize effluent discharge to the Sandy River and greatly reduce potential exposure and impacts to fisheries, is a desirable option, but is still in early phases of feasibility analysis and is not a definitive option for discharge at this time. A requirement of a land application alternative such as Roslyn Lake is that it is combined with a direct discharge site to the mainstem Sandy River.

The Ten Eyck Road potential discharge site is unique compared to the other sites in that it is a straight, bedrock-confined reach. The hydraulic characteristics of the site as a high velocity single thread chute, offers little holding habitat for fish, making it most likely only used as a transport reach, minimizing potential exposure to effluent. An additional benefit of the bedrock confinement is it provides a stable segment of channel, with little history or potential for dynamism. This site offers multiple feasible sewer main alignments, one of which is entirely within public right-of-way as it follows existing road corridors. A second alignment would require minimal private property access. The Ten Eyck Road crossing would also be well-suited to be the Sandy River discharge location in conjunction with the Roslyn Lake alternative based on the characteristics highlighted previously, as well as its location relative to a potential sewer main alignment to Roslyn Lake. Assuming design and construction of an outfall configuration within a channel with these physical characteristics (bedrock) is feasible, this site appears most suitable of those assessed for a mainstem outfall location.

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Attachments

Orthomosaic Imagery for Oxbow, Ten Eyck, and PGE Powerline Sites

Sandy River Outfall Vicinity Map

Sandy River Outfall Slope Map and Landslide Susceptibility

Sandy River Outfall Height Above Water Surface (HAWS) Map

DRAFT Technical Memorandum 7.2

Date: April 26, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler, City Manager
Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Matt Hickey, PE
Jessica Cawley, PE
Katie Husk, PE
Murraysmith

Re: Outfall Pipeline Alignments and Costs TM-7.2

Introduction

This memorandum summarizes the evaluation and findings associated with routing the effluent pipeline from the proposed MBR Satellite Wastewater Treatment Plant to potential discharge locations identified on the Sandy River, and a recommended pipeline route from the river up to Roslyn Lake. The memorandum includes a summary of route selection criteria and a summary of potential alternatives. The preliminary cost estimates presented in this memorandum are a planning estimate to be used solely for the purpose of a detailed discharge alternatives evaluation for the City of Sandy. The memorandum also outlines, on a preliminary basis, pipeline routing considerations and conceptual design elements for the recommended route for the pipeline.

Purpose

The purpose of the study is to determine a practical route for the effluent pipe relative to the selected outfall locations and assist with developing conceptual level costs estimates. The purpose of documenting the alternatives and the preferred route is to evaluate the feasibility of routing the pipeline along various alignments and identify the challenges and required engineering to develop a final pipeline route. Other key considerations to develop final alignment recommendations and final routing concepts include permitting, easement and property acquisition needs, geotechnical considerations, pipe material selection, detailed hydraulic analysis, and final designs associated with the effluent pipe. It is anticipated that these elements will be further evaluated in subsequent permitting and preliminary design phases of the project. An overview map of the pipeline routing alternatives is shown in **Figure 1**.

Scope

The following items from Task 5.3 of the Scope of Work are included in this memo:

1. Develop pipeline alignments to preferred Sandy River outfall locations
2. Develop two potential pipeline alignments to Roslyn Lake
3. Estimate capital and 20-year lifecycle costs for each pipeline alignment

This memo also includes a figure showing the pipeline alternatives and property owner information in **Appendix A**, as well as criteria developed for assessing pipe routing alternatives.

Route Selection Criteria

To compare the potential options, the team developed a list of criteria to compare the various alternatives. The key criteria for assessing the potential pipeline routes are listed below.

- Costs – The capital cost factors include the length of pipe, surface restoration, traffic control, construction methods and type of pipe materials required. A rough cost breakdown for each option may be found in **Appendix B.**

- Environmental Impacts – Environmental factors include impacts to wetlands, streams, rivers, trees, and other environmental impacts and associated permitting.

- Impacts to the Public – Potential impact to the public include traffic impacts, impacts to businesses, construction noise and impacts to recreational activities.

- Property Acquisition and Easement Needs – Property acquisition and easement needs evaluation includes assessing the need for easements on private and public property.

- Required Agency Coordination and Permitting – Agency coordination includes potential coordination with ODOT and Clackamas County (County). Pipeline construction crossing under or installed within State and County rights-of-way will require right-of-way permits.

- Opportunity Projects – Opportunity projects may include opportunities to work with other agencies to construct a trail over the pipeline route or improve roadway surfacing following pipe installation. This is discussed further in the “Additional Considerations” subsection later in this report.

- Opportunities for Additional Uses for the Effluent – The Detailed Discharge Alternatives Analysis includes assessment of potential irrigation opportunities for additional use of the effluent. This is discussed further in the “Additional Considerations” subsection later in this report.

- Constructability – Constructability considerations include constructing in areas of steep topography or other geotechnical or topographical challenges. Also, construction in routes congested with utilities can present constructability challenges.

- Proximity to Selected Discharge Location – To economically convey the effluent to the discharge locations, the pipe routes follow the shortest feasible route to these sites. The two most viable sites are site at the large oxbow in the City Park and at Revenue Bridge along Ten Eyck Road. For more information on how these locations were selected, see TM 7.1 – Sandy River Outfall Siting Study.

- Opportunities for Hydro Power – Since there is significant elevation difference between the MBR site in the City and the two discharge locations, there is opportunity to generate hydropower. This is discussed further in the "Additional Considerations" subsection later in this report.

- Seismic/Landslide Considerations – As this is a critical facility for the City, the pipe should be designed along a route that will remain stable during a seismic event. Routes that included steeply sloping areas and areas that may include liquifiable soils will be avoided where possible. Risk maps used for this evaluation can be found in **Appendix C**.

- Land Use – Land use can impact the permitting for the pipeline. For example, Timber and Exclusive Farm Use allow for reconstruction of public roads and highways for the placement of subsurface utility facilities but provides only conditional use for a hydropower facility and would require land use permitting and approval.

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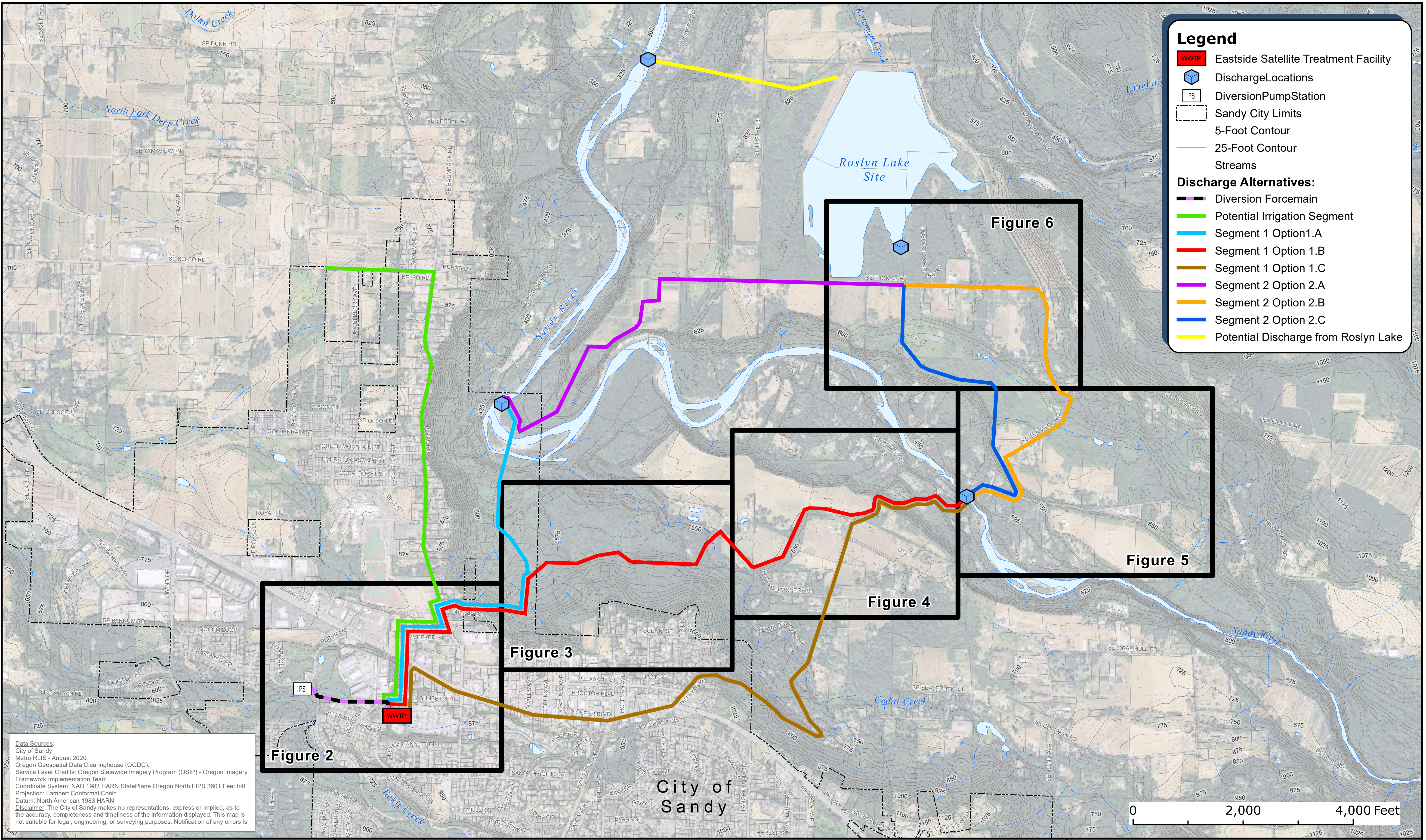

Data Sources:
City of Sandy
Metro RLIS - August 2020
Oregon Geospatial Data Clearinghouse (OGDC).
Service Layer Credits: Oregon Statewide Imagery Program (OSIP) - Oregon Imagery Framework Implementation Team
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
Disclaimer: The City of Sandy makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is

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murraysmith

SANDY WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Wastewater System Facility Plan

Figure 1
Overview Map

February 2021

20-2776

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The following sections of this report are a discussion of each pipeline alternative along with advantages and disadvantages relative to the evaluation criteria outlined above.

Pipeline Route Alternatives from Eastside Satellite Facility to Sandy River (Segment 1)

The analysis of discharge alternatives favored two outfall locations: Option1 to the Oxbow below Sandy River Park and Option 2 near Revenue Bridge. The route alternatives from the Eastside Satellite Treatment Facility to the river outfall location are labeled with Segment 1. The route alternatives from the river outfall location to Roslyn Lake are labeled Segment 2.

Segment 1 Option 1.A (Oxbow Outfall Via City Park)

Segment 1 Option 1.A includes a pipeline from the Eastside Satellite Treatment Facility to a surface water discharge at the Oxbow below Sandy River Park.

- Alignment: from Sunset St. and University Ave; north along University Ave and continuing east on Meeker St; north on Bluff Road; east on SE Marcy Street to the Sandy River trail; cross country (XC) through Sandy River Park to the Sandy River Outfall.
- Approximately 3,270 linear feet of 16 to 18-inch force main (FM) in roadway; 1,270 linear feet of 16 to 18-inch FM on undeveloped land; and 3,910 linear feet of 24 to 30-inch pressure gravity line on undeveloped land.
- The pipeline crosses the following: public right of way (ROW), Highway (HWY) 26 perpendicular crossing, and City-owned property; an unknown number of stream crossings in Sandy River Park.
- Construction Methods: Crossing HWY 26 will likely include an auger bored casing and carrier pipe. The Sandy River crossing will likely include a Horizontal Directional Drilling (HDD). HDD could be high-density polyethylene (HDPE) or steel piping to address high pressures.
- **Advantages**:
  - Construction in public ROW and City-owned property;
  - requires few right-of-way permits as the route is mostly out of the roadway through the park; and
  - low impact to public as much of the alignment is out of the right-of-way.
- **Disadvantages:**
  - Constructability challenges associated with steep slopes, benches, streams, siphon design, and native soil types that include cobbles will impact potential for HDD;

    - potential for more permitting challenges associated with the river crossing;
    - frequently used recreational area near the outfall location;
    - route not to preferred outfall location: outfall location involves poor geomorphic stability and likelihood of river channel migration away from outfall construction over time;
    - limited maintenance access and no utilities on-site for hydropower facility;
    - landslide hazards likely along this route; and
    - higher cost due to HDD construction.
- Project Cost: $15.6 M

Segment 1 Option 1.B (Revenue Bridge Outfall Via City Park and Cross County Route)

Segment 1 Option 1.B includes a pipeline from the Eastside Satellite Treatment Facility to a surface water discharge below Revenue Bridge.

- Alignment: from Sunset St and University Ave; north along University Ave and continuing east on Meeker St.; north on Bluff Road; east on SE Marcy St to the Sandy River trail; east XC through Sandy River Park; east XC through Oregon Fish and Wildlife Property, east XC through private property; continuing onto SE Ten Eyck Rd to the Sandy River below Revenue Bridge.
- Approximately 3,280 linear feet of 16 to 18-inch force main (FM) in roadway; 2,030 linear feet of 24 to 30-inch gravity line in roadway; 8,690 linear feet of 24 to 30-inch gravity line on undeveloped land.
- Crossing: ODOT ROW, City-owned property; ODFW property; an unknown number of stream crossings in Sandy River Park; 3 private property crossings.
- Construction Methods: Crossing HWY 26 will likely include auger bored casing with carrier pipe.
- Advantages:
    - Opportunity project for trail creation and expansion of Sandy River Park trail system;
    - small scale irrigator potential uses of effluent;
    - route through the preferred discharge location at Revenue Bridge; and

    - favorable for hydropower as there is good access for maintenance and the hydropower unit is readily connected to PGE facilities as there is 3 phase power along Ten Eyck Road.

- Disadvantages:
    - Environmental impacts to streams including unnamed streams in the ODFW property and Cedar Creek near the fish hatchery;
    - private property easements required;
    - requires ROW permits and coordination with Clackamas County for Revenue Bridge crossing; and
    - potential landslide hazards likely along this route.

- Project Cost: $7.8 M

Segment 1 Option 1.C (Revenue Bridge Outfall Via Hwy 26 and Ten Eyck Road)

Segment 1 Option 1.C includes a pipeline from the Eastside Satellite Treatment Facility to a surface water discharge below Revenue Bridge.

- Alignment: from Sunset St and University Ave; north along University Ave and continuing east HWY 26; continuing onto SE Ten Eyck Rd to the Sandy River below Revenue Bridge.
- Approximately 7,200 linear feet of 16 to 18-inch force main (FM) in roadway; 8,810 linear feet of 24 to 30-inch gravity line in roadway.
- Crossing: public right of way (ROW).
- Construction Methods: Crossing HWY 26 will likely include an auger bored casing with carrier pipe.
- Advantages:
    - Construction in roadway ROW which minimizes required easements;
    - Potential opportunity projects for improving the road surfacing;
    - route through the preferred discharge location; and
    - good maintenance and utility access for hydro-power facility as 3 phase power is available along Ten Eyck Road.

- **Disadvantages:**
    - Public impacts to traffic on HWY 26;
    - higher costs for pavement repair;
    - construction in congested utility corridor in Hwy 26;
    - requires permitting and coordination with ODOT and Clackamas County for HWY 26 and Revenue Bridge crossing; and
    - potential landslide hazards likely along this route along Ten Eyck Road.
- Project Cost: $9.0 M

Pipeline Route Alternatives from Sandy River to Roslyn Lake (Segment 2)

This study also included routes from discharge locations on the Sandy River to Roslyn Lake. The route alternatives from the river outfall location to Roslyn Lake are labeled Segment 2.

Segment 2 Option 2.A (Oxbow Outfall to Roslyn Lake)

Segment 2 Option 2.A includes a pipeline from the Oxbow below Sandy River Park to Roslyn Lake.

- Alignment: from the Sandy River XC northeast through private property; east along SE Thomas Rd to Roslyn Lake.
- Approximately 4,430 linear feet of 10 to 12-inch pipe in roadway; 4,930 linear feet of 10 to 12-inch pipe on undeveloped private property.
- Crossing: One private property, Clackamas County ROW
- **Advantages**:
    - Lower impact to roadways and traveling public.
- **Disadvantages:**
    - Environmental impacts to stream crossings;
    - private property easements required;
    - constructability challenges associated with steep slopes, benches, streams, and native materials for HDD; siphon design required;
    - route is not through preferred discharge location;

  - limited maintenance and utility access for hydro-power facility; and
  - landslide hazards likely along this route.
- Project Cost: $6.0 M

Segment 2 Option 2.B (Revenue Bridge Outfall to Roslyn Lake)

Segment 2 Option 2.B includes a pipeline from Revenue Bridge to a created wetland at Roslyn Lake.

- Alignment: Follows Ten Eyck Road generally northbound to Thomas Road, west along SE Thomas Rd to Roslyn Lake.
- Approximately 8,380 linear feet of 10 to 12-inch pipe in roadway (and attached to Revenue Bridge)
- Crossing: Clackamas County ROW.
- **Advantages**:
  - Construction in roadway ROW results in no easement acquisition;
  - small scale irrigator potential uses of effluent;
  - route through the preferred discharge location;
  - good maintenance and utility access for hydro-power facility; and
  - moderate potential for landslide hazards along Ten Eyck Road (advantage relative to other routes).
- **Disadvantages:**
  - Public impacts to traffic on Ten Eyck Road; and
  - requires ROW permits and coordination with Clackamas County for Revenue Bridge crossing.
- Project Cost: $3.9 M

Segment 2 Option 2.C (Revenue Bridge Outfall Via Ten Eyck Road and Cross County Route)

Segment 2 Option 2.C includes a pipeline from Revenue Bridge to a created wetland at Roslyn Lake.

- Alignment: Follows Ten Eyck Road generally northbound, XC through private property to Roslyn Lake.
- Approximately 1,683 linear feet of 10 to 12-inch pipe in roadway (or attached to Revenue Bridge); 4,380 linear feet of 10 to 12-inch pipe on undeveloped private property.
- Crossing: Clackamas County ROW, six private properties, unknown number of stream crossings.
- **Advantages**:
    - Lower impact to roadways and the traveling public Route through preferred discharge location.
- **Disadvantages:**
    - Environmental impacts associated with stream crossings;
    - private property easements required;
    - requires ROW permits and coordination with Clackamas County for Revenue Bridge crossing;
    - extensive constructability challenges associated with steep slopes, benches, streams, and native materials;
    - more extensive landslide hazard potential likely along this route; and
    - higher cost due to more challenging construction, use of specialized pipe installation techniques.
- Project Cost: $13.0 M

Life Cycle Costs

Each of the options presented in this memorandum were evaluated on a comparative relative to the life cycle costs. Factors that may affect maintenance and life cycle costs include:

- Length of force main relative to pumping costs
- Overall length of pipe

- Location / maintenance accessibility
- Geological stability

Segment 1

Segment 1 Options 1.A and 1.B are expected to have similar life cycle costs relative to power costs associated with pumping the effluent since their force mains are approximately the same length. Option 1C has a longer force main than the other options, and therefore will require more power for pumping and a higher associated cost. Other life cycle cost considerations may include potentially lower maintenance since much of the alignment is in a stable roadway section which is less susceptible to landslides or seismic damage and the pipe may be more readily accessed for maintenance. However, these lower cost factors will be offset by higher cost to work in the roadway for maintenance which may involve traffic control and pavement restoration.

Segment 2

For Segment 2, Options 2.B and 2.C may have similar life cycle costs. Option B is longer than Option C and it is in the road right-of-way. This results in higher maintenance costs relative to length of pipe and the need for pavement restoration associated with maintenance, but lower cost relative to ease of access. Option C is shorter and out of the public right-of-way, which results in lower maintenance cost relative amount of pipe and there is no need to restore pavement following repairs. However, Option C is significantly more challenging to access and the steep hillsides and creek ravines may result in more frequent and extensive repair. Option 2.A is located in both paved and unpaved areas and would have similar cost factors as Option 2.B.

Based on the discussion above, it was concluded that life cycle cost was not a significant factor when comparing alternatives. Life cycle cost was therefore not used in determining the recommended pipe route.

Evaluation of Alternatives

To summarize the findings of the alternatives analysis, three tables were developed. These tables are described below and presented on the following pages.

Table 1 provides a qualitative comparison of the advantages and disadvantages for the pipeline alignments relative to the criteria described above. Relative advantages are highlighted in green and relative disadvantages are highlighted in yellow.

Table 2 provides numerical scoring to represent the relative advantages and disadvantages for Segments 1 and 2 relative to the criteria. This more quantitative approach uses a scale from 1 to 5, with 1 representing a negative score and 5 representing the highest positive score.

Table 3 summarizes the scoring criteria for the combined route alternatives. The highest scoring route includes Segment 1 Option 1.B and Segment 2 Option 2.B. As such, this combination of alignments is the preferred route. This route avoids the challenging and high cost of construction up the steep hillsides between the river and the upper bench and avoids the high cost and disruption of construction in HWY 26 routes through the most desirable discharge location at Revenue Bridge. This route also provides advantages including opportunity projects of trail systems and a hydropower facility with favorable access for maintenance and power supply. The combined cost summary is shown in **Table 4**.

The preferred route is Segment 1 Option 1.B and Segment 2 Option 2.B. A detailed pipe alignment for this route is shown in **Figures 2** through **6**. Conceptual design layouts for the Revenue Bridge Crossing and potential hydropower facility siting can be found in **Figures 7** through **9.** The preliminary layout for the control valve vault used to control flow for hydropower production is shown in **Figure 10.**

The preferred route key property owners are listed in **Appendix A**. Based on the recommended alternative, the City will make preliminary contact with private property owners.

Table 1 | Alternatives Evaluation Summary

	Cost	Environmental Impacts and Permitting	Impacts to the public	Property Acquisition	Required Agency Coordination	Opportunity Projects	Opportunities for Additional Uses for the Effluent	Constructability	Proximity to Selected Discharge Location	Opportunities for Hydro Power	Seismic Considerations	Land Use
Segment 1												
Segment 1 Option 1.A	See Table 4	Outfall environmental impacts and stream crossings	High use recreational area	ROW or City owned property	Requires City ROW permits			Some challenges associated with steep slopes, benches, streams, and native materials for HDD. Siphon design required	Route not through preferred discharge location	Limited maintenance access	Landslide potential	POS -Parks and Open Space (City of Sandy) - not specified
Segment 1 Option 1.B	See Table 4	Impacts to streams		Private property easements required	Requires City ROW permits and coordination with ODFW	Trails project	Small-scale irrigator potential		Route through preferred discharge location	Good maintenance access and location for hydro facility	Moderate landslide potential	POS -Parks and Open Space (City of Sandy) - not specified, TBR - Conditional Use subject to 406.05(A)(1) & (6), EFU- Allowed Use
Segment 1 Option 1.C	See Table 4	Few environmentally sensitive areas in ROW	Impacts traffic on HWY 26	ROW	Requires City ROW permits and ODOT for HWY 26 construction	Improving road surfacing			Route through preferred discharge location	Good maintenance access and location for hydro facility	Moderate landslide potential	RRFF5 - public utility facilities are a conditional use
Segment 2												
Segment 2 Option 2.A	See Table 4	Outfall environmental impacts and stream crossings		Private property easements required				Some challenges associated with steep slopes, benches, streams, and native materials for HDD. Siphon design required	Route not through preferred discharge location	Limited maintenance access	High landslide potential	POS -Parks and Open Space (City of Sandy) - not specified, TBR - Conditional Use subject to 406.05(A)(1) & (6), EFU- Allowed Use
Segment 2 Option 2.B	See Table 4	Few environmentally sensitive areas in ROW	Impacts traffic on Ten Eyck Rd	ROW	Requires county ROW permits, coordination with Clackamas County for Bridge Crossing and ROW permits	Improving road surfacing	Small-scale irrigator potential		Route through preferred discharge location	Good maintenance access	Moderate landslide potential	RRFF5 - public utility facilities are a conditional use
Segment 2 Option 2.C	See Table 4	Impacts to stream crossings		Private property easements required	Requires coordination with Clackamas County for Bridge Crossing			Some challenges associated with steep slopes, benches, streams, and native materials	Route through preferred discharge location	Good maintenance access	Very high landslide potential	RRFF5 - public utility facilities are a conditional use, TBR - Conditional Use subject to 406.05(A)(1) & (6)

- *Cells highlighted in green indicate advantages (relative to other options for that criteria).*
- *Cells highlighted in yellow indicate disadvantages (relative to other options for that criteria).*

Table 2 | Alternatives Evaluation Scoring

Criteria	Cost	Environmental Impacts and Permitting	Impacts to the public	Property Acquisition	Required Agency Coordination	Opportunity Projects	Opportunities for Additional Uses for the Effluent	Constructability	Proximity to Selected Discharge Location	Opportunities for Hydro Power	Seismic Considerations	Land Use	Total
Segment 1													
Segment 1 Option 1.A	1	1	2	2	3	3	3	1	1	1	1	3	22
Segment 1 Option 1.B	4	1	4	3	3	5	5	3	5	5	2	3	43
Segment 1 Option 1.C	3	3	1	5	1	4	2	4	5	5	3	3	39
Segment 2													
Segment 2 Option 2.A	5	1	3	1	3	3	3	1	1	3	1	3	28
Segment 2 Option 2.B	5	3	1	5	1	5	5	3	5	5	3	3	44
Segment 2 Option 2.C	1	1	3	1	1	3	3	1	5	5	1	3	28

Table 3 | Combined Criteria Scoring Summary

	Option A (Oxbow)	Options B and C (Revenue Bridge)			
		1.B + 2.B	1.B + 2.C	1.C + 2.B	1.C + 2.C
Score	49	80	66	77	63

Table 4 | Capital Cost Evaluation

1.A + 2.A	
Component	**Cost**
Segment 1 Option 1.A	$15.6 M
Segment 2 Option 2.A	$6.0 M
Hydropower Facility	$1.1 M
Hydropower Facility (Option 1 Power)	$0.04 M
Total	**$22.74 M**

1.B + 2.B		**1.B + 2.C**	
Component	**Cost**	**Component**	**Cost**
Segment 1 Option 1.B	$7.8 M	Segment 1 Option 1.B	$7.8 M
Segment 2 Option 2.B	$3.9 M	Segment 2 Option 2.C	$13 M
Hydropower Facility	$1.1 M	Hydropower Facility	$1.1 M
Total	**$12.8 M**	**Total**	**$21.9 M**

1.C + 2.B		**1.C + 2.C**	
Component	**Cost**	**Component**	**Cost**
Segment 1 Option 1.C	$9.0 M	Segment 1 Option 1.C	$9.0 M
Segment 2 Option 2.B	$3.9 M	Segment 2 Option 2.C	$13 M
Hydropower Facility	$1.1 M	Hydropower Facility	$1.1 M
Total	**$14.0 M**	**Total**	**$23.1 M**

Notes:

Cost estimates represent a Class 5 budget estimate in 2020 dollars, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +50 to +100 percent on the high end, meaning the actual cost should fall in the range of 50 percent below the estimate to 100 percent above the estimate.

Additional Considerations

Additional Pipe Segments Evaluated Outside the Alternatives Analysis

Segment 3 (Potential Discharge from Roslyn Lake)

Segment 3, as shown in **Figure 1**, includes a pipeline from Roslyn Lake to an outfall on the Sandy River. This overflow from Roslyn Lake was originally considered as part of the overall concepts, however this outfall location was not recommended due to geological and geomorphological constraints including steep slopes, benches, streams, native materials, and liquefaction and landslide hazards. Additionally, the concepts for wetland creation at Roslyn Lake were developed to avoid discharging from the lake site back to the Sandy River, since water could be retained in the wetlands to maintain aquatic plant life and habitat. This approach is based on the evaluation that showed there is potentially enough area at Roslyn Lake to manage summertime flows without a discharge back to the river through evaporation, evapotranspiration and moderate infiltration into the soils at the site.

Irrigation

Multiple routes for irrigation reuse were also considered as part of the Detailed Discharge Alternatives Evaluation. A description of the routes and the market study findings can be found in TM 8 – Water Recycling Market Assessment. The most promising location for an irrigation pipeline was along Kelso Road, as shown in **Figure 1**. However, the market analysis concluded that there was not enough demand for recycled water at that location, and this option was determined to be impractical based on added cost and the lack of capacity to discharge a large portion of the effluent at this site.

Conceptual Design Considerations for Selected Route

Highway 26 Crossing

The proposed effluent force main crosses US Highway 26 along the pipeline alignment between the proposed satellite treatment facility and the proposed Sandy River outfall locations. This is a large, busy roadway, and an auger bore would likely be required to construct Segment 1 without significant disruption to traffic. This pipe installation technique would require a bore pit on the south side of the highway, a smaller receiving pit on the north side, as well as approximately 130 linear feet of bored casing along with a carrier pipe installed in the casing. Potential bore and receiving pit locations as well as the associated cost of this method of pipe installation were considered in the pipeline design and selected recommendation. Potential locations for the bore and receiving pits are shown on **Figure 2.**

Utility Congestion at University Avenue

Numerous utilities are located along University Avenue, where Segment 1 would likely need to be located. NW Natural recently installed a high-pressure gas main in University Avenue and Meeker Street which further reduces the available corridor for the effluent force main. In order to facilitate the wastewater effluent pipe installation, an existing 2-inch gas line may need to be moved.

Pipe Material

Pipe material may be selected for each individual segment based on cost and working pressures. For the force main portion of the pipeline which extends from the satellite plant to Bluff Road, AWWA C900 PVC or ductile iron are potential viable pipeline materials. HPDE for the force main may be a challenge in this area due the large number of utilities that makes it challenging to install long pipe segments which have had joints welded above ground. Preliminary calculations utilizing the Manning's Equation indicate that a 16-inch to 18-inch diameter pipe will be sufficient for this section. The gravity portion of the pipe which extends from Bluff Road to the Sandy River and from the Sandy River to the Roslyn Lake site could be AWWA C900 PVC, ductile iron, or HDPE. It is estimated that a 24-inch or 30-inch diameter pipe will be required for the gravity portion from the MBR to the Sandy River, and a 10 to 12-inch diameter pipe may be installed from the Sandy River outfall to Roslyn Lake. The pipe sizing between the MBR and the Sandy River is based on a maximum flow rate of 7 MGD, which is the maximum future capacity of the plant. The piping between the Sandy River and the Roslyn Lake site is sized for a flow rate of 2 MGD, which is the maximum effluent flow rate from the MBR calculated for 2040.

Some of the piping considered to be operating by gravity as it will generally not be pressurized from the effluent pump station. However, the pipe will be pressurized for much of its length between Bluff Road and the Roslyn Lake Site based on the pipe being configured as a siphon with the low point at the Sandy River. Also, it is anticipated that hydropower facilities will be installed at the Sandy River and at Roslyn Lake, and operations of these facilities will be configured to maintain pressure in the pipeline to promote power generation. The operating pressure of the pipeline will increase as it approaches the Sandy River. These pressures may range up to 250 psi. As the pressures exceed 200 psi, ductile iron pipe should be considered as pipe walls for PVC and HDPE become very thick, less cost effective and less hydraulically efficient. Additionally, ductile iron for these higher-pressure areas should be considered as the piping should all be restrained to provide improved seismic resiliency and the restraint system for PVC and flanges for HDPE have maximum working pressures around 200 psi.

Hydropower

Background and Piping Considerations

The elevation between the MBR site and the discharge sites at the Sandy River and at Roslyn Lake along with the anticipated flow rates from the MBR plant provide an opportunity to generate electricity from hydropower installations on the MBR discharge lines. See **Figure 11** for a drawing of one potential hydroturbine design. See **Figure 12** for a photo of this type of hydroturbine.

Another option could be to install the turbine in a vault, which would require implementation of confined space protocols.

The MBR will pump treated effluent from the plant through a force main to a point on Marcy Road where the effluent force main will discharge to a gravity main manhole. From there the effluent will flow by gravity through the City's Sandy River Park, then through Oregon Department of Fish and Wildlife property, then through private properties until the pipe meets Ten Eyck Road near Kubitz Road. From there the pipeline will follow Ten Eyck Road to Revenue Bridge where it will discharge to the Sandy River. See **Figures 2 through 6** for the proposed pipe route. The intersection of Ten Eyck Road and Kubitz Road provides an area on private property that is relatively level and large enough to accommodate a control valve vault and a building housing the hydro power mechanical and electrical equipment. The City would need to acquire the property or obtain an easement for the installation.

Power Generation Potential

The point at which the effluent piping force main discharges to the gravity main is at an elevation of 900 feet and the location of the turbine at the Sandy River outfall is at approximately 430 feet. The elevation of Roslyn Lake is approximately 630 feet, which provides an opportunity to generate power at this location as well.

At the control valve vault there will be piping that directs flow to the Sandy River hydro power unit, to a by-pass line around the power generation facility and to a pipeline that extends to Roslyn Lake. Since the pressure head will not be interrupted at the control valve vault at Kubitz Road before the flow is directed to the Roslyn Lake discharge pipeline, there will be opportunity to generate power at the Roslyn Lake site as well.

Power Sale/Recovery

The power can be either sold directly to the existing power grid near the site where it is generated or run back to the City's facilities at the MBR site. It is reported that PGE has 3 phase power along Ten Eyck Road. As such, power generated at the site can be readily directed to the grid which is required to be purchased by PGE at a set rate.

At the Roslyn Lake site, there is also PGE 3 phase power nearby where the power will be generated. Specifically, there is 3 phase power in Ten Eyck Road and there are existing facilities at the existing PGE hydro power facility on the Bull Run River. Power could be routed to these facilities and supplied to the grid.

System Control

To meet regulatory requirements relative to temperature impacts to the Sandy River, flows will need to be split between the Sandy River and the Roslyn Lake discharge points. During the dryer months when the Sandy River has less flow, the effluent can be directed to the Roslyn Lake site. During the wetter months, the Sandy River will have adequate flow to assimilate the effluent and avoid temperature increases that exceed the limits determined by DEQ. Also, during the wetter months, the Roslyn Lake site will have less capacity to accept flows due to rainfall and natural hydrology at the site.

To effectively split flows between the two discharge locations, a control strategy will need to be developed. The control strategy will involve varying flows to the two discharge points based on MBR effluent flow rates and temperatures, flows in the Sandy River and water levels at the Roslyn Lake site wetlands.

Dry Season Strategy

During the drier times of the year, flow will be routed to the Roslyn Lake site. If the water levels reach a level that could cause discharge from the lake to the downstream water way, the control valves at the hydropower facility will slow the flow to the Roslyn Lake site and allow flow to discharge to the Sandy River. It is anticipated that if Roslyn Lake levels increase due to rainfall, the Sandy River flows will increase and provide additional assimilative capacity and opportunity to discharge to the river.

Wet Season Strategy

During the wetter times of the year, the effluent flows will generally flow to the Sandy River, but the flows can still be diverted to the Roslyn Lake site until the water level reaches a preset high level. Once the water level reaches the preset level, more flow will be diverted to the Sandy River.

Control Signal Transmission

It is anticipated the signals to monitor and control the system will be transmitted through fiber optic lines conduit installed along the invert of the proposed effluent pipeline. The fiber optic can be connected to the City's fiber optic network on Bluff Road near Marcy Road.

Federal Energy Regulatory Commission (FERC) Approvals

All grid-connected, non-federal hydroelectric facilities, regardless of size, must receive approval of the Federal Energy Regulatory Commission (FERC). Small hydropower projects may apply for an exemption if the power generated is less than 5 megawatts. This project would be well under the 5 MW threshold.

Bridge Crossing

The preferred pipeline route includes a crossing on Revenue Bridge. This installation would require designs for pipe on the bridge and coordination with and permitting through the Clackamas County. The preliminary concepts for the bridge crossing are shown in **Figures 7 through 9**.

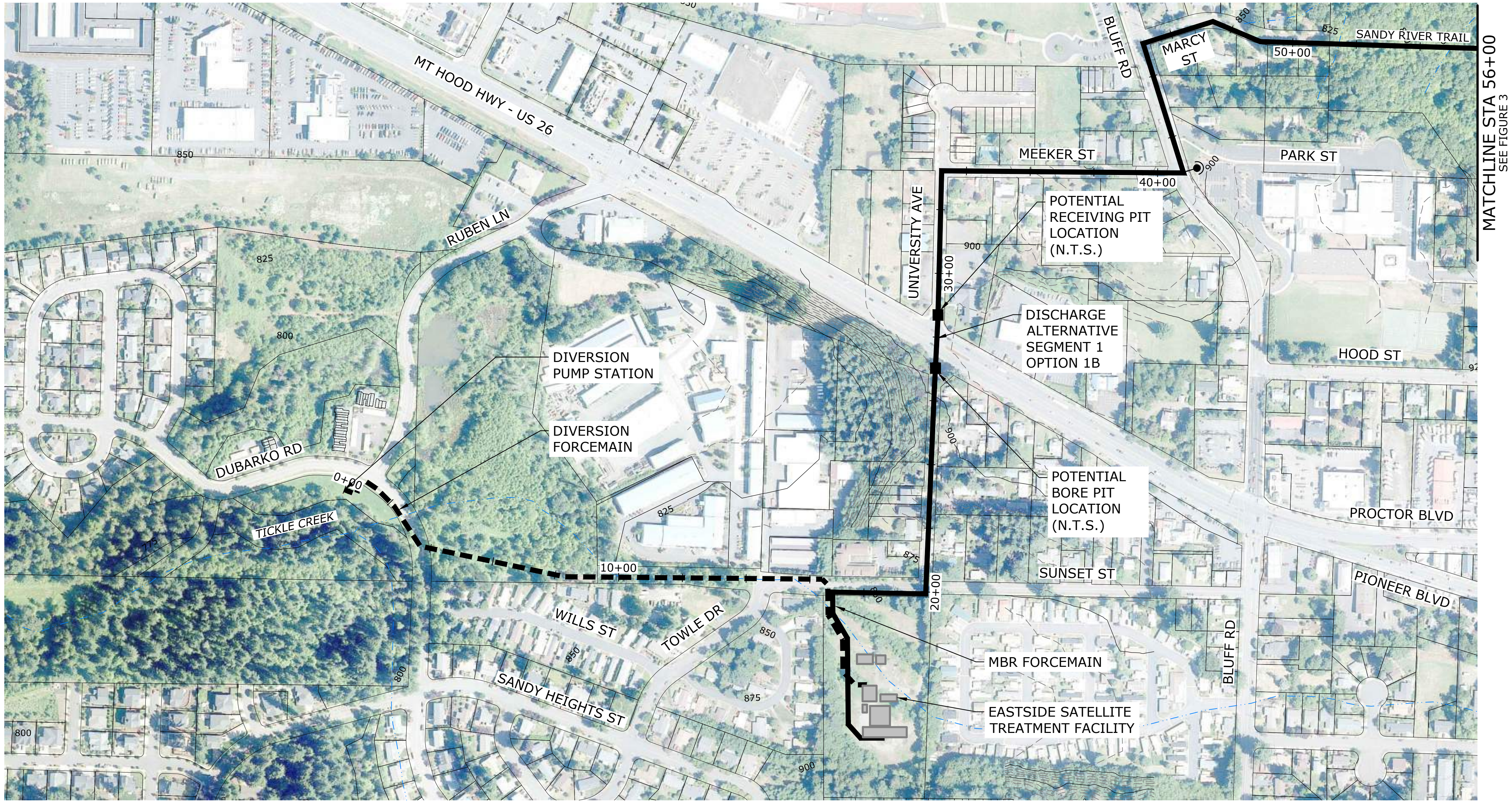
Potential Trail Construction

The preferred pipeline route crosses Oregon Department of Fish and Wildlife (ODFW) property east of the City Park. Installation of the pipeline along this alignment may present an opportunity to partner with ODFW to construct a trail along the pipeline route. The City currently maintains a trail in the Sandy River Park which is adjacent to the ODFW property. Based on a field visit in fall of 2020, it appears the trail in the City Park may be able to readily connect to a trail on the ODFW property. It appears a trail on the ODFW property would extend east to a point where it reaches private property. The City may consider including the trail in an easement that crosses private property and extends to Fish Hatchery Road. Extending the trail to this point would create a trail from the City Park to the Fish Hatchery. The design team has begun discussions with ODFW to further assess the feasibility of the trail and further coordination required to develop a trail along the pipeline route.

Conclusions and Recommendation

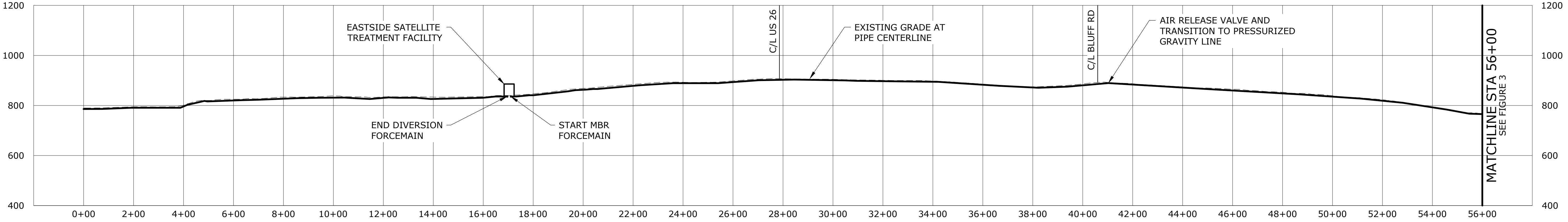
The purpose of this assessment was to evaluate options for routing an effluent pipeline between the proposed satellite MBR plant to the proposed Sandy River discharge and a discharge at Roslyn Lake. The team reviewed three options for routing the pipeline between the plant and the river (Segment 1) and three options between the river and the Roslyn Lake site (Segment 2). The alternatives were assessed relative to several criteria outlined above including construction at highway and bridge crossings, maintenance accessibility, system control, geological stability, opportunity projects, and the cost factors associated with each criterion. Based on the evaluation, the preferred route appears to include Segment 1 Option 1.B and Segment 2 Option 2.B. Segment 1 Option 1.B offers the best opportunity for additional projects, such as trail creation and hydropower generation, while minimizing the impacts to the public such as traffic disruption. Segment 2 Option 2.B. was found to be the best route to avoid major constructability challenges and related costs. Both segments were also chosen in relation to the selected outfall location. The estimated cost for this proposed pipeline is approximately $12.8 M.

Additional data collection and analysis is recommended to verify the concepts presented in this memorandum. Further evaluations should include geotechnical investigations, outreach to private property owners regarding easements, discussions with ODFW, ODOT and the County to confirm routing, opportunity projects and permit requirements.



PLAN

SCALE: 1"=400'



PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

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SANDY
WHERE INNOVATION MEETS ELEVATION

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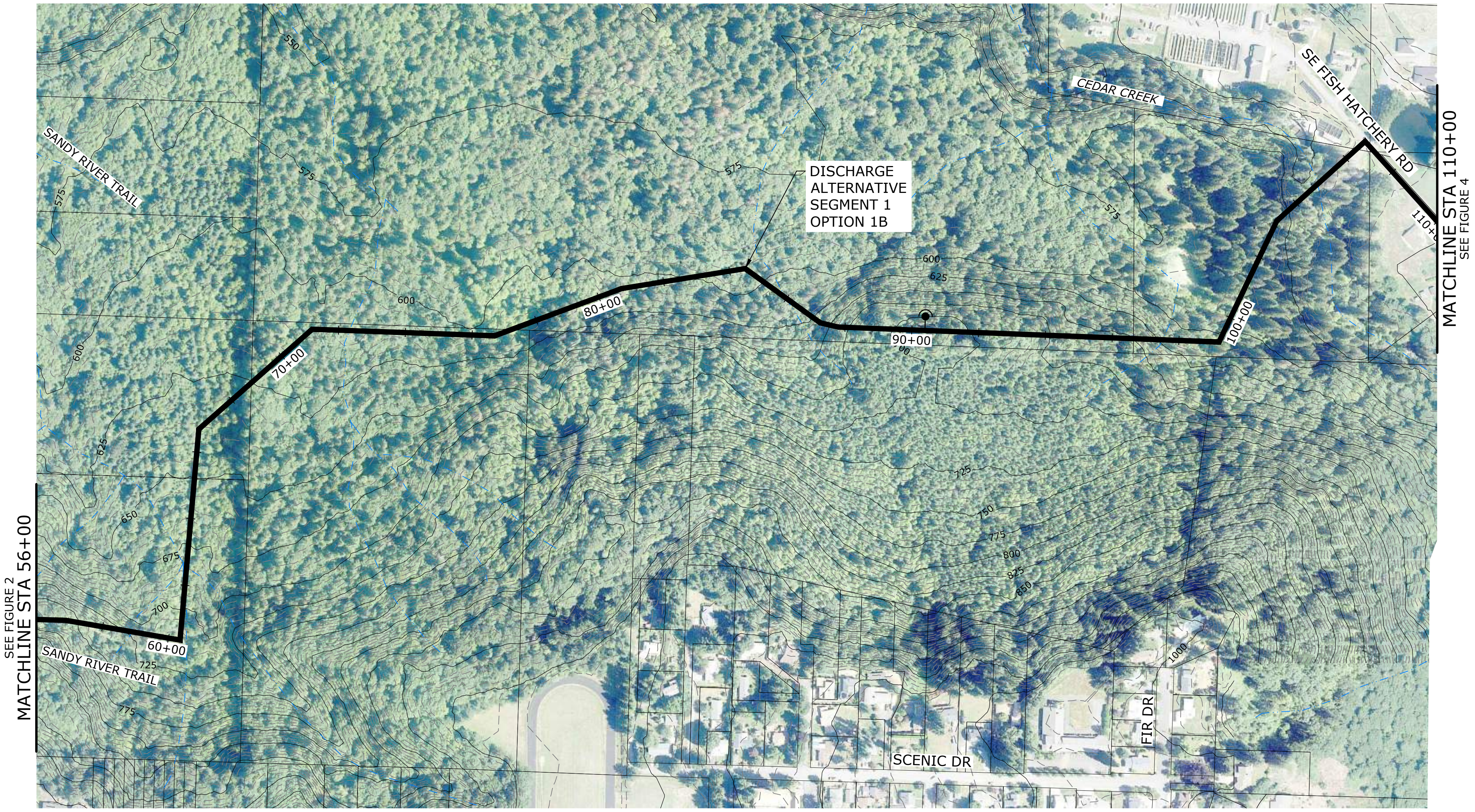
City of Sandy
Wastewater System Facility Plan

Figure 2
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 2 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)



PLAN

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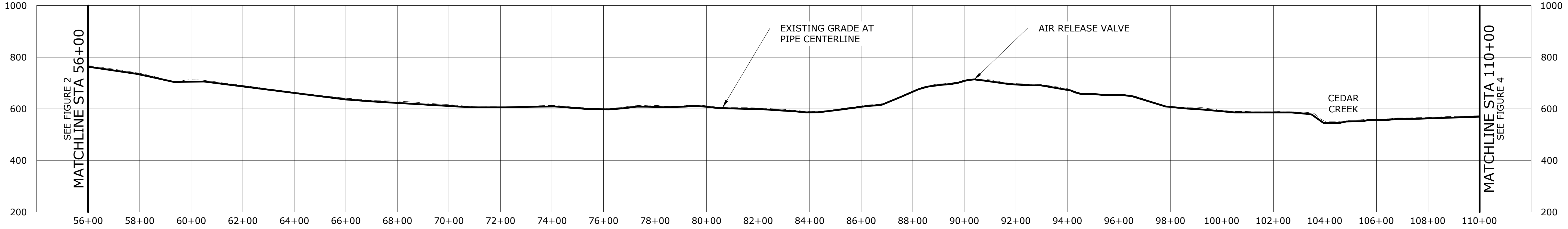

PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

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SANDY
WHERE INNOVATION MEETS ELEVATION

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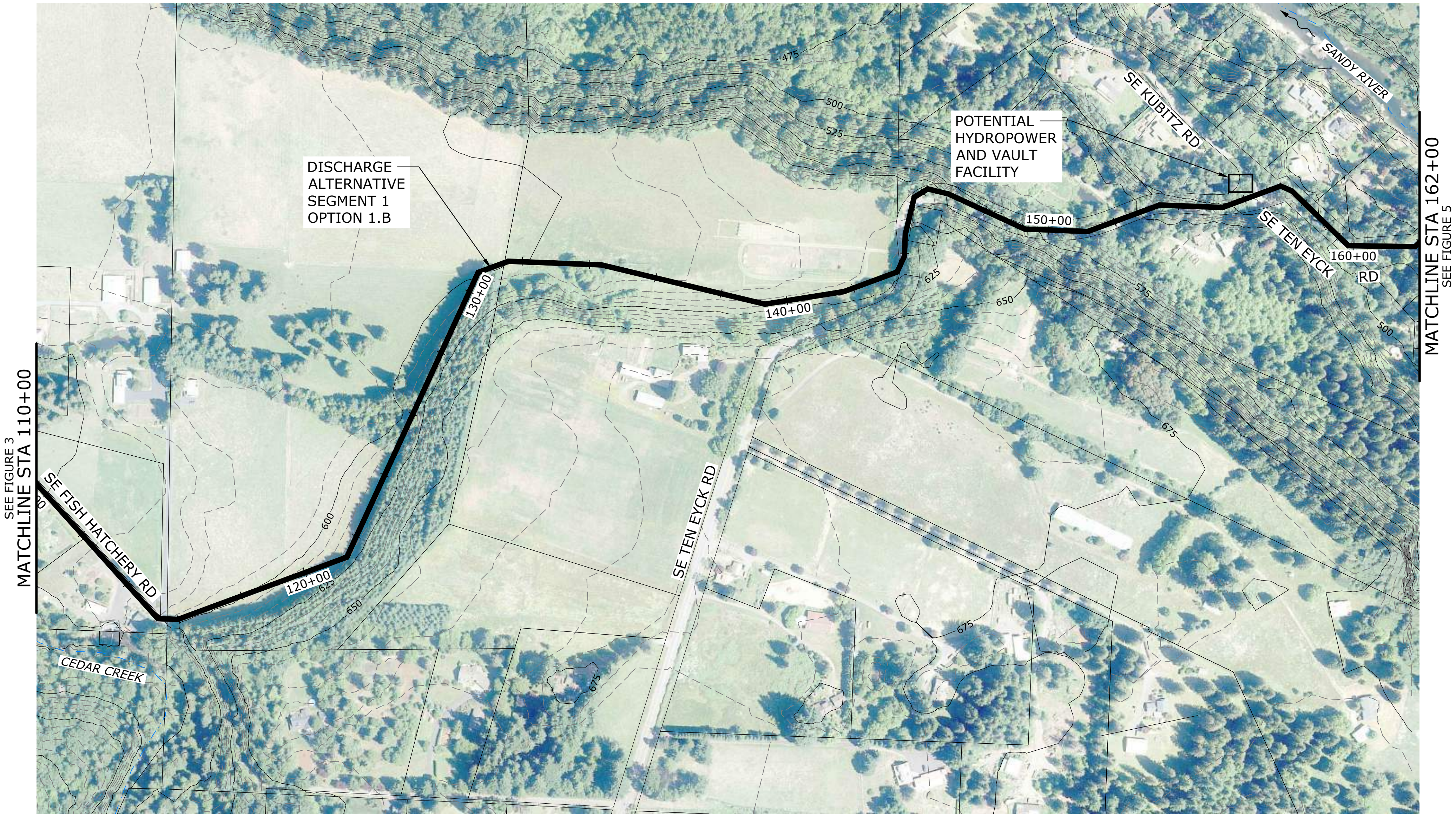
City of Sandy
Wastewater System Facility Plan

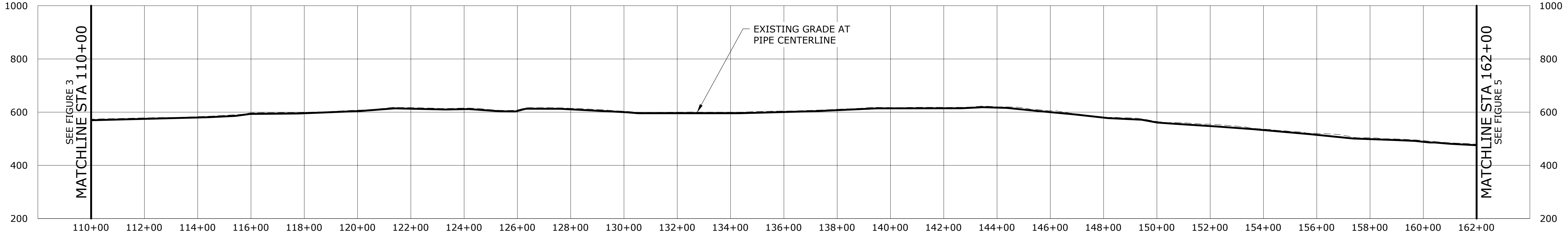
Figure 3
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 3 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)



PLAN

SCALE: 1"=400'



PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

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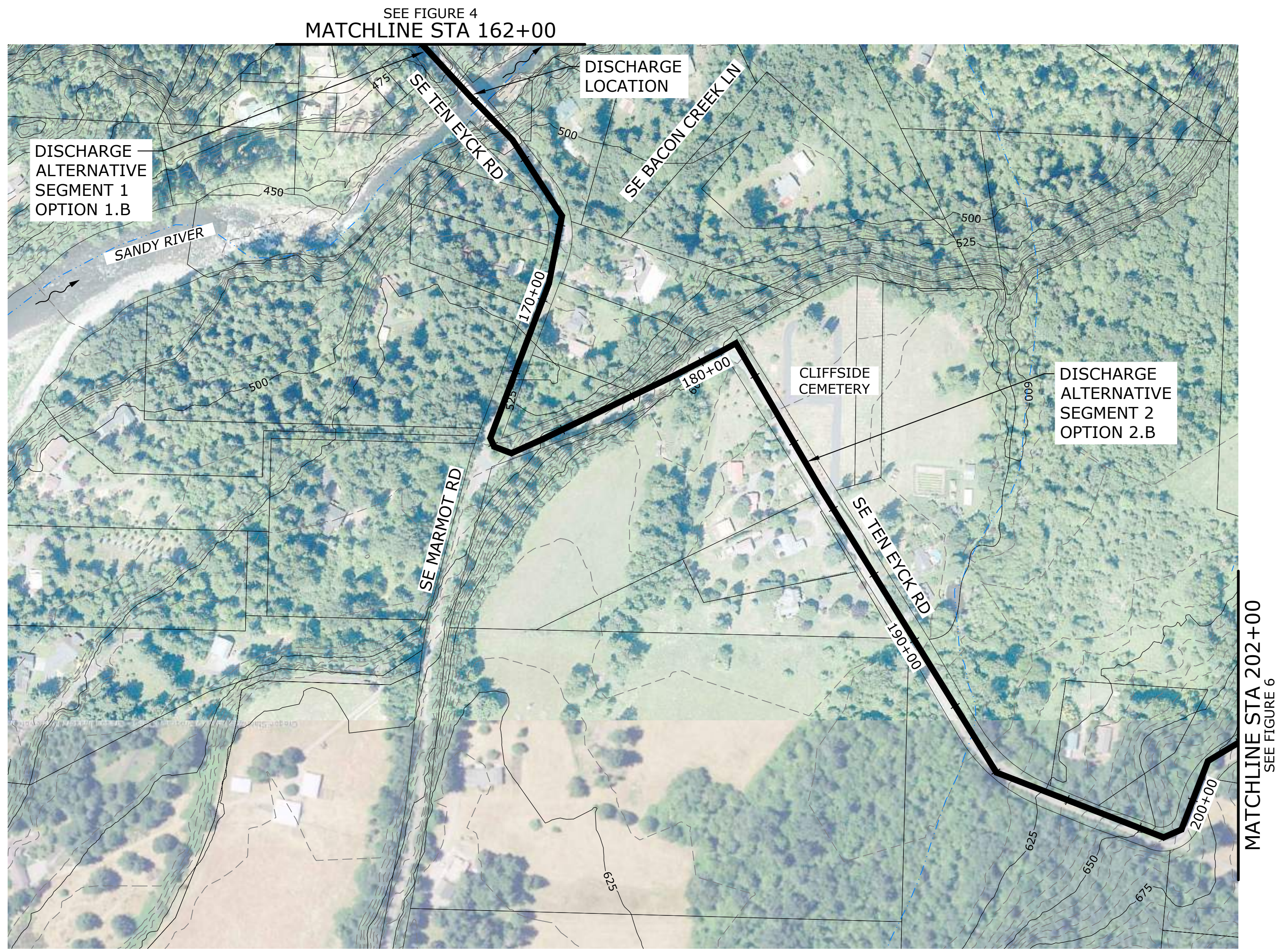
SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy
Wastewater System Facility Plan

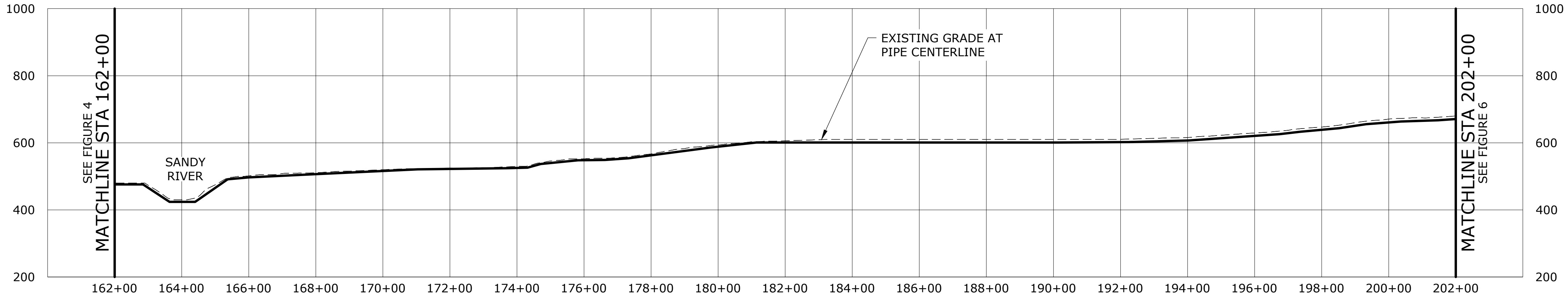
Figure 4
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 4 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)



PLAN

SCALE: 1"=400'



PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

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SANDY
WHERE INNOVATION MEETS ELEVATION

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City of Sandy
Wastewater System Facility Plan

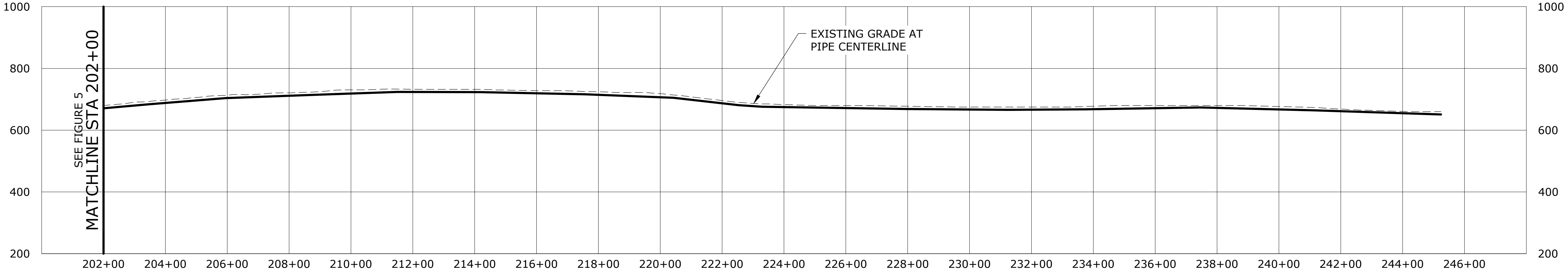
Figure 5
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 5 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 6 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)

MATCHLINE STA 202+00
SEE FIGURE 5

PLAN
SCALE: 1"=400'



PROFILE
SCALE: 1"=400' HORIZ, 1"=400' VERT

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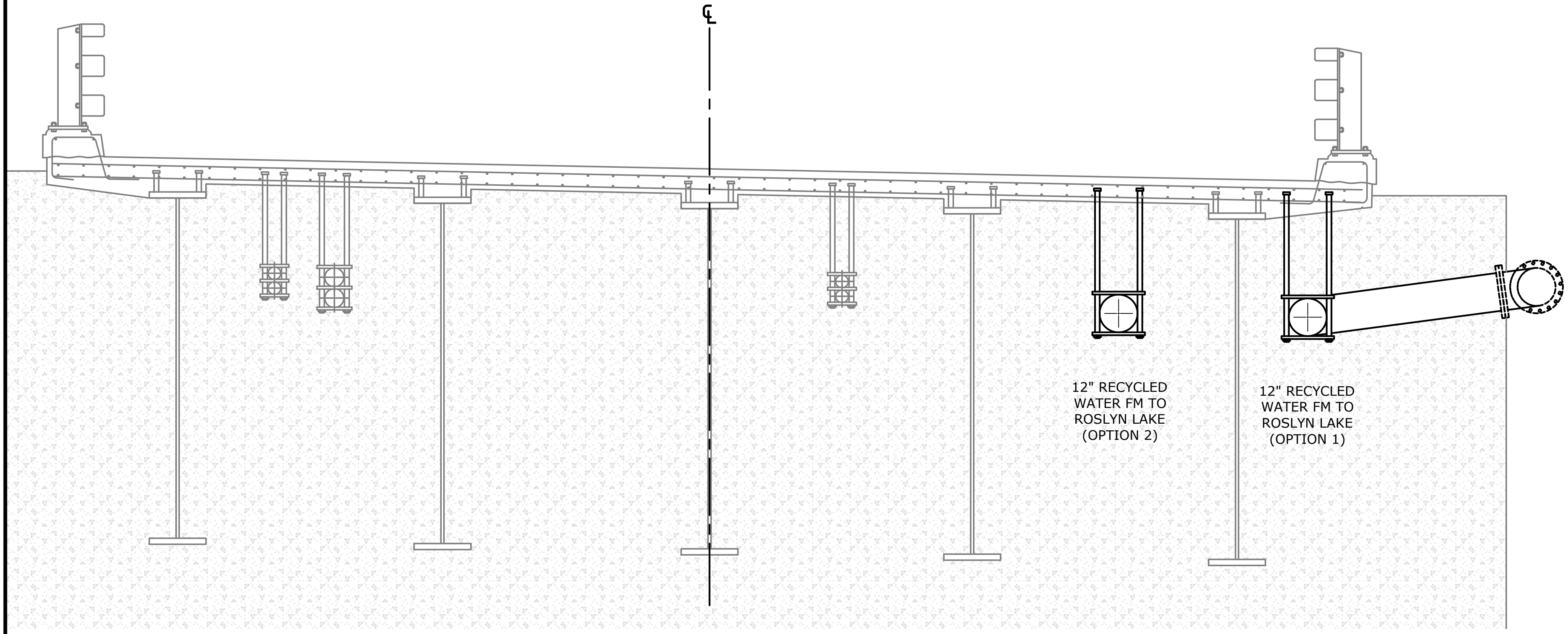
SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy
Wastewater System Facility Plan

Figure 6
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-SITE FIGURE-12-18-20.dwg FIGURE 2 (4) 1/7/2021 2:15 PM JESSICA.CAWLEY 23.0s (LMS Tech)



1 0 1
1/4 Inch = 1 Feet

SECTION (B/-)
SCALE: NTS

NOTE:

ALTERNATIVE UTILITY CROSSING LOCATION (OPTION 2) DEPENDENT ON COORDINATION WITH CLACKAMAS COUNTY AND ABILITY TO CORE INTO BRIDGE ABUTMENT.

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 7

DETAILED DISCHARGE ALTERNATIVE EVALUATION

REVENUE BRIDGE UTILITY CROSSING

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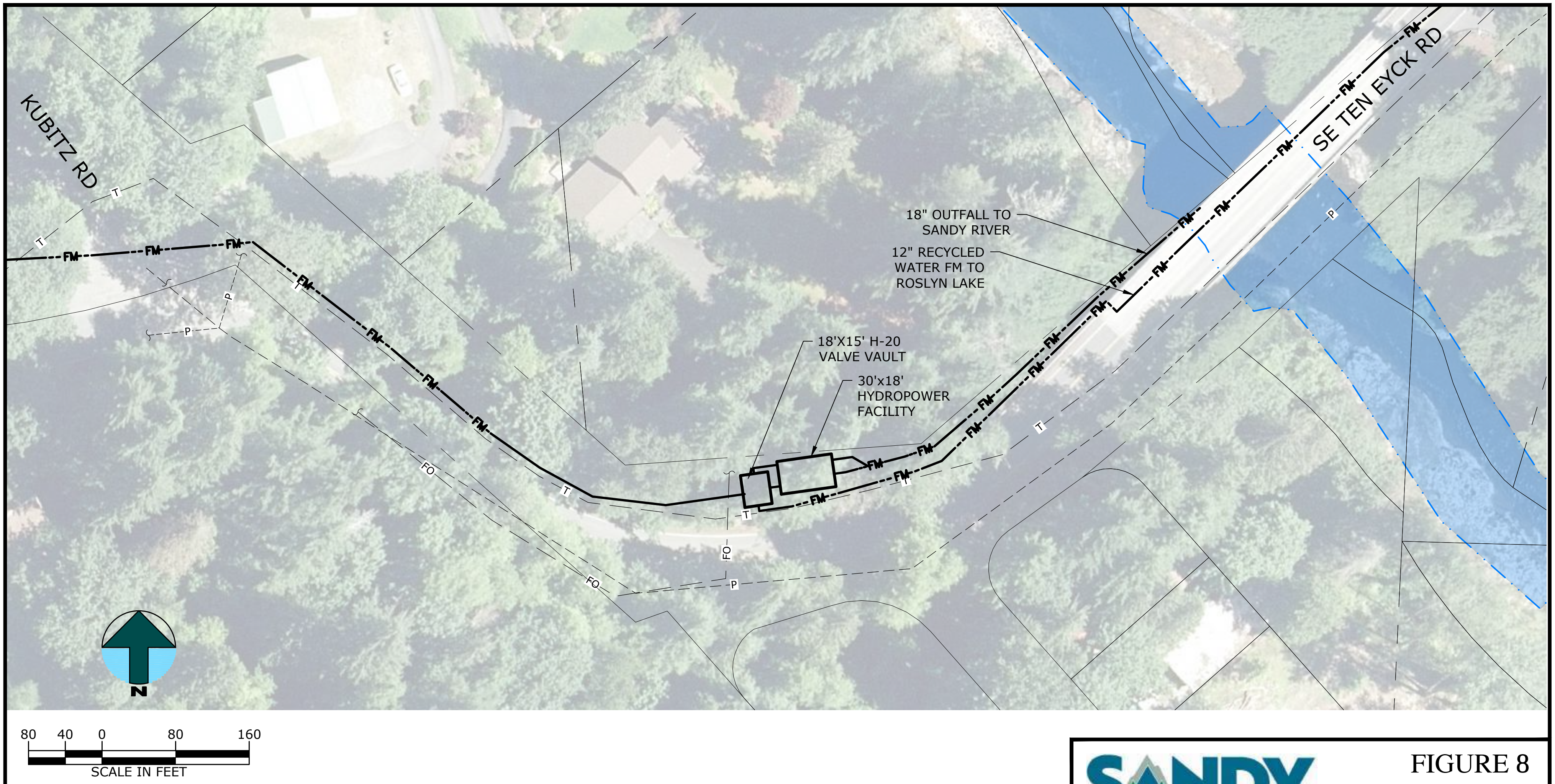
JANUARY 2021
20-2776

G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-SITE FIGURE-12-18-20.dwg FIGURE 2 (5) 1/7/2021 2:15 PM JESSICA.CAWLEY 23.0s (LMS Tech)



LEGEND:

	EXISTING	PROPOSED
OVERHEAD POWER	— — -P- — —	
UNDERGROUND TELEPHONE	— — -T- — —	
FIBER OPTIC	— — -FO- — —	
PROPERTY LINE	———————	
RECYCLED WATER FORCE MAIN		———-FM-———-FM-
ROADWAY	▨	
BUILDING		▭

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 8

DETAILED DISCHARGE ALTERNATIVE EVALUATION

SANDY RIVER SITE PLAN

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JANUARY 2021
20-2776

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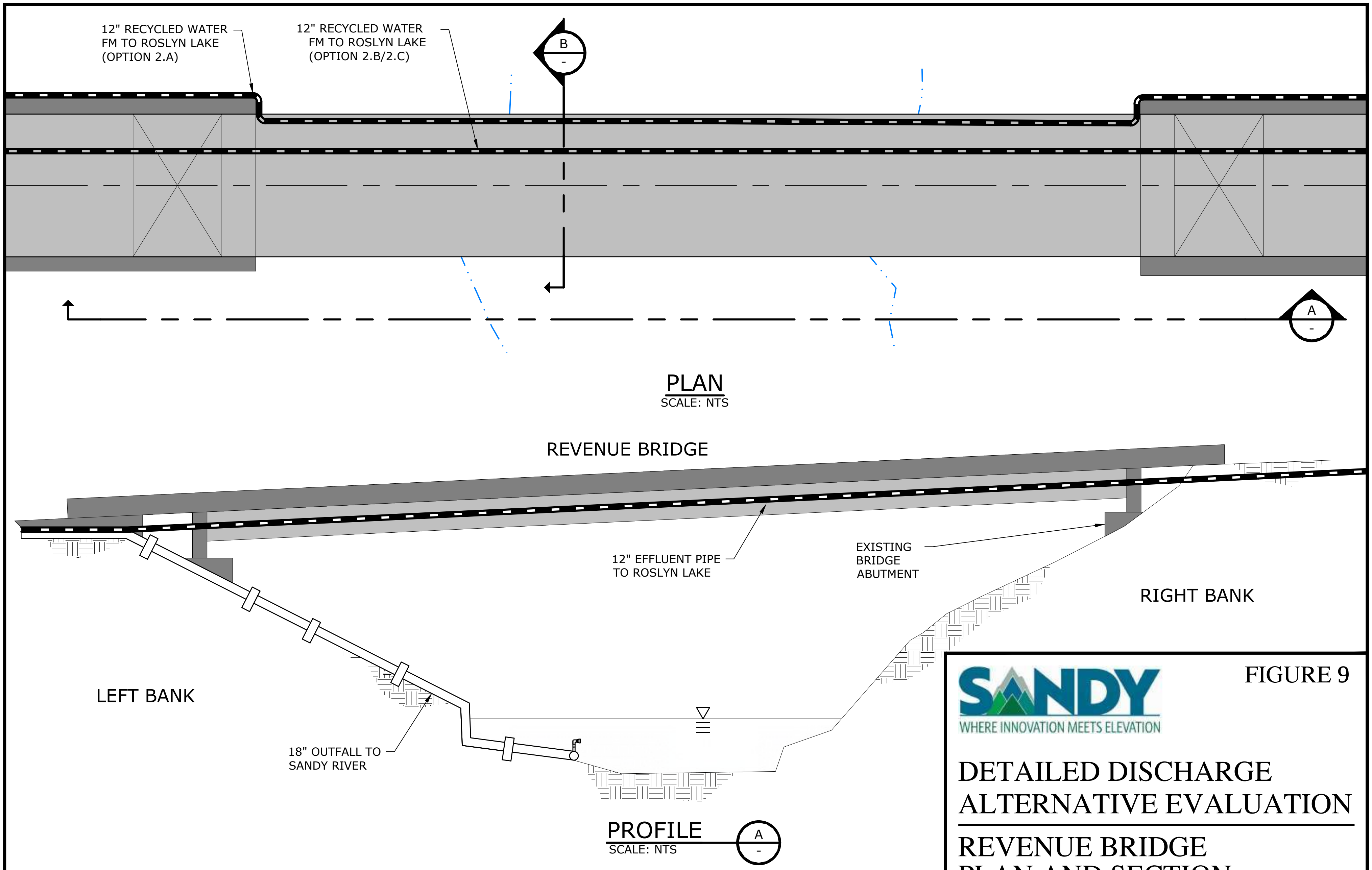

FIGURE 9

SANDY
WHERE INNOVATION MEETS ELEVATION

DETAILED DISCHARGE ALTERNATIVE EVALUATION

REVENUE BRIDGE PLAN AND SECTION

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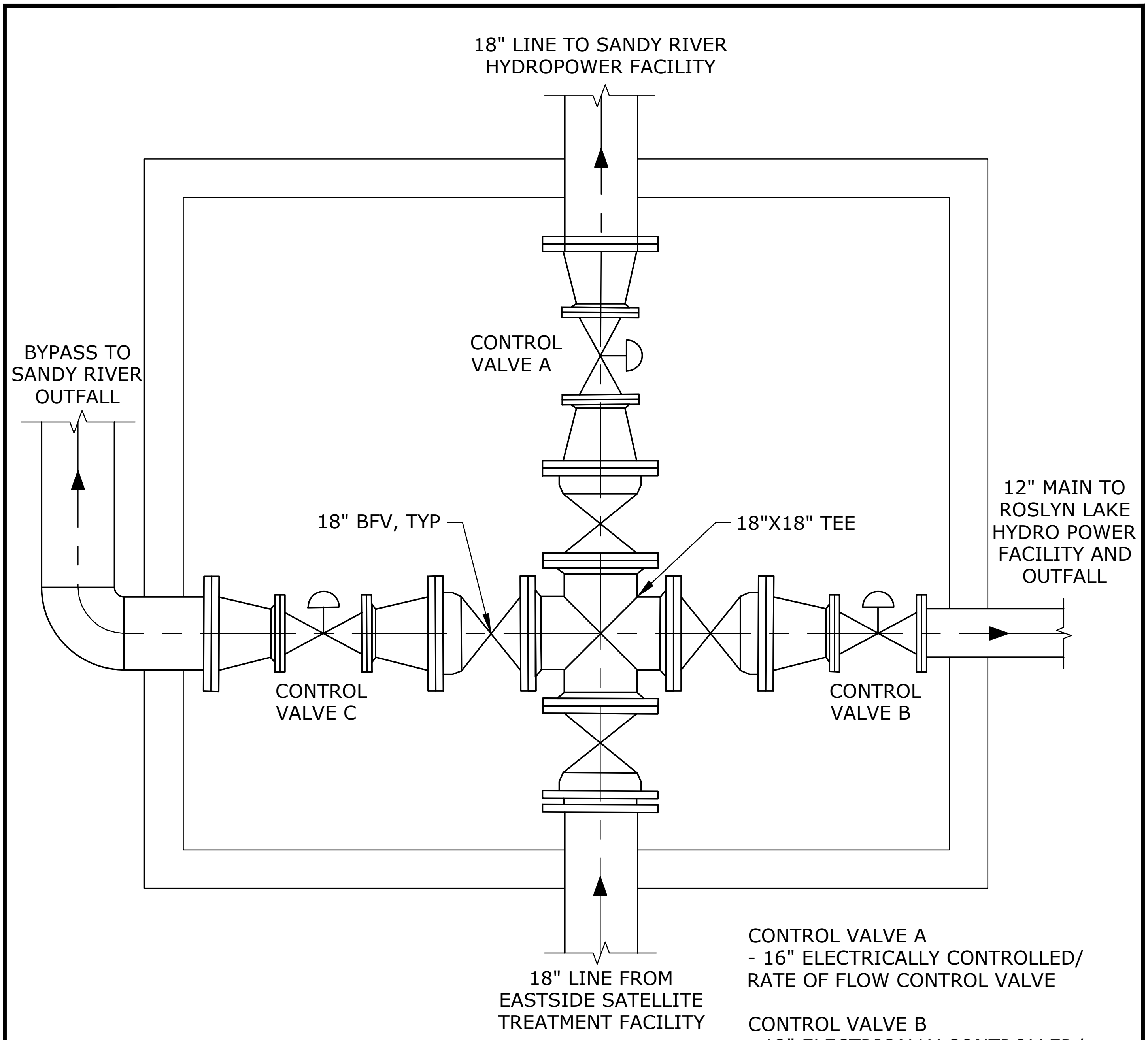
JANUARY 2021
20-2776



CONTROL VALVE A
- 16" ELECTRICALLY CONTROLLED/ RATE OF FLOW CONTROL VALVE

CONTROL VALVE B
- 12" ELECTRICALLY CONTROLLED/ RATE OF FLOW CONTROL VALVE

CONTROL VALVE C
- 16" ELECTRICALLY CONTROLLED VALVE (OPEN CLOSE)
(COULD USE BFV FOR THIS)

CONCEPTUAL CONTROL STRATEGY

WINTER TIME OPERATION

- BASED ON LEVEL OF WATER AT ROSLYN LAKE, THE RATE OF FLOW CONTROL VALVE WILL RELEASE WATER TO ROSLYN LAKE. ONCE ROSLYN LAKE REACHES A CERTAIN LEVEL BUT STILL HAS A BUFFER TO ALLOW FOR RAINFALL IMPACTS, THE VALVE WILL CLOSE OR MODULATE TO SLOW THE FLOWS TO THE LAKE.

- BASED ON FLOW IN SANDY RIVER, CONTROL VALVE A WILL CONTROL RATE OF FLOW TO THE RIVER. IF THE WINTER TIME FLOWS DROP BELOW A CERTAIN LEVEL MORE FLOW WILL BE DIRECTED TO ROSLYN LAKE. IF ROSLYN LAKE IS FULL TO MAX LEVEL AND STILL ALLOWING A BUFFER, VALVE A WILL DISCHARGE MORE TO THE RIVER

- IF THE SANDY RIVER HYDRO POWER FACILITY IS BEING MAINTAINED, AND ALL THE FLOW CANNOT BE DISCHARGED TO ROSLYN LAKE, CONTROL VALVE C CAN BE OPENED FOR DIRECT DISCHARGE TO THE RIVER.

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 10

Detailed Discharge
Alternatives Evaluation

SANDY RIVER
CONTROL VALVE VAULT

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NOVEMBER 2020

20-2776

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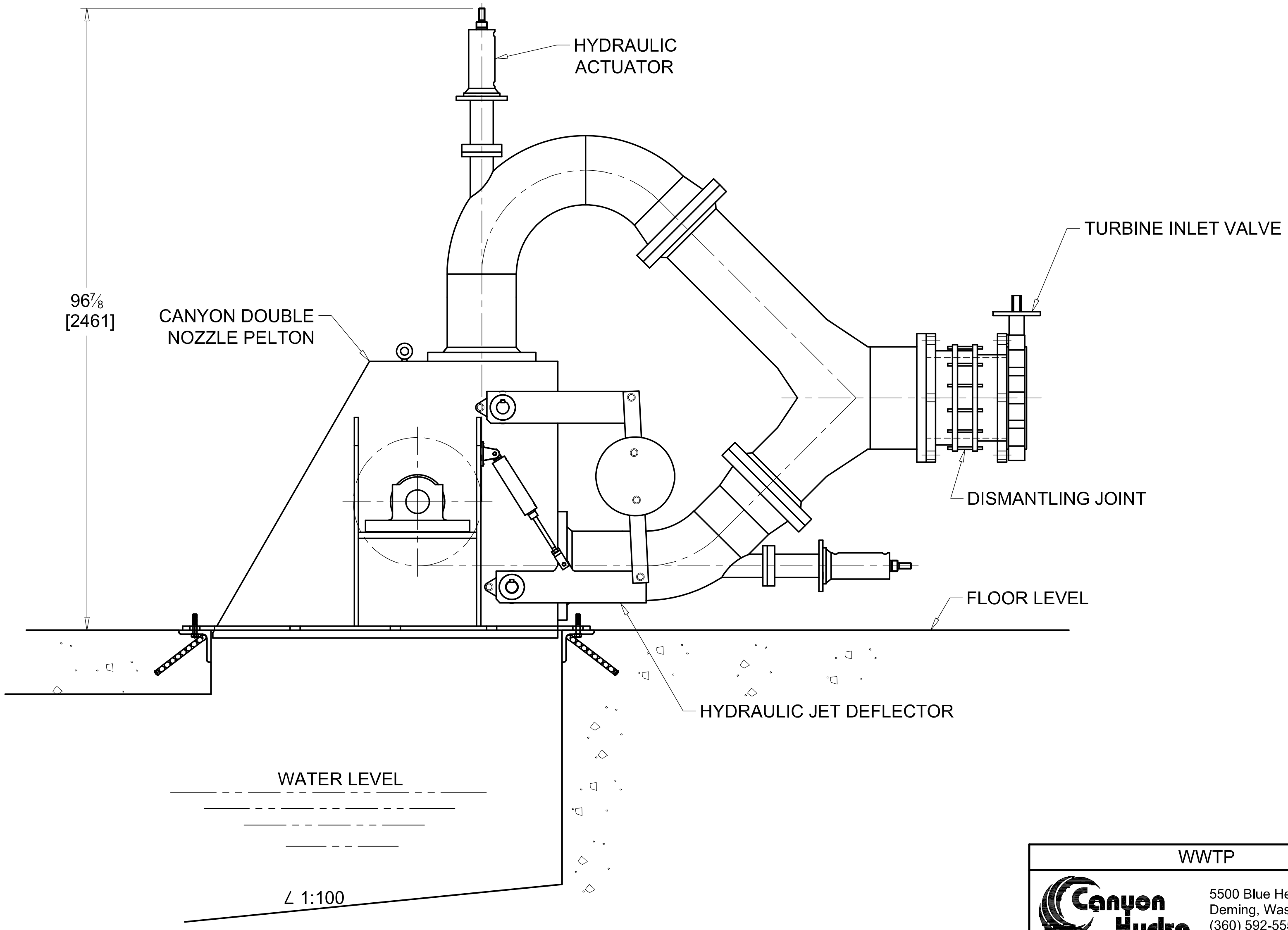

DIMENSIONS IN INCHES [mm] ARE APPROXIMATE
NOT INTENDED FOR CONSTRUCTION

WWTP

Canyon Hydro

5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552

the water power division of Canyon Industries, Inc

FILE: ELEVATION VIEW
DATE: 2020-09-22

Figure 11

Figure 12

Appendix

APPENDIX A

ID	TAXLOT	PARCEL NUMBER	TAXPAYER	MAILING ADDRESS	MAILCITY	MAILSTATE	MAILZIP	SITUS ADDRESS	SITUS_CITY	SITUSZIP
1	100	00657033	CITY OF SANDY	39250 PIONEER BLV	SANDY	OR	97055	38275 MARCY ST	SANDY	97055
2	101	01345869	CITY OF SANDY	39250 PIONEER BLV	SANDY	OR	97055	NO SITUS	ADDRESS	0
3	701	01345850	CITY OF SANDY	39250 PIONEER BLV	SANDY	OR	97055	NO SITUS	ADDRESS	0
4	400	00655400	OREGON STATE G	3406 CHERRY AVE N	SALEM	OR	97303	NO SITUS	ADDRESS	0
5	900	00655516	CARMONY GLEN I	40191 SE FISH HATC	SANDY	OR	97055	40191 SE FISH HATCHE	SANDY	97055
6	1201	05024089	REIMER JUNE J	1456 TARA LN	TERRY	MS	39170	NO SITUS	ADDRESS	0
7	1200	00655534	REIMER JUNE J	1456 TARA LN	TERRY	MS	39170	40170 SE FISH HATCHE	SANDY	97055
8	1300	00655543	CARMONY MARIA	40191 SE FISH HATC	SANDY	OR	97055	NO SITUS	ADDRESS	0
9	4705	00687527	CARMONY GLEN I	40191 SE FISH HATC	SANDY	OR	97055	40205 SE FISH HATCHE	SANDY	97055
10	4703	00687509	TWIN SPRINGS LL	19779 SE LANGENS	SANDY	OR	97055	16261 SE TEN EYCK RD	SANDY	97055

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SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Wastewater System Facility Plan

Detailed Discharge Alternatives Evaluation

December 2020 20-2776

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APPENDIX B

Appendix B

Segment 1 Option 1.A

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$450,000	$450,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and Grubbing	1.5	AC	$15,000	$22,500
Furnish and Install 16-inch Force Main in Roadway	3270	LF	$285	$931,950
Furnish and Install 24-inch Gravity Main out of Roadway	5180	LF	$270	$1,398,600
Special Structures	10	EA	$20,000	$200,000
Surface Restoration Natural Areas	1.5	AC	$8,000	$12,000
HDD Installed Pipeline	1119	LF	$5,500	$6,154,500
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$9,261,550**
Construction Contingency			30%	$2,779,000
Construction Management:			15%	$1,390,000
Public Involvement/Permitting:			3%	$278,000
Engineering			20%	$1,853,000
			Total Project Cost[1]	**$15,561,550**

Appendix B

Segment 1 Option 1.B

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$230,000	$230,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and Grubbing	1	AC	$15,000	$15,000
Easement	3	EA	$40,000	$120,000
Furnish and Install 24 to 30-inch Gravity Main in Roadway	2030	LF	$295	$598,850
Furnish and Install 16 to 18-inch Force Main in Roadway	3280	LF	$285	$934,800
Furnish and Install 24 to 30-inch Gravity Main out of Roadway	8690	LF	$270	$2,346,300
Special Structures	15	EA	$20,000	$300,000
Surface Restoration Natural Areas	2	AC	$9,000	$18,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$4,654,950**
Construction Contingency			30%	$1,397,000
Construction Management:			15%	$699,000
Public Involvement/Permitting:			3%	$140,000
Design:			20%	$931,000
			Total Project Cost[1]	**$7,821,950**

Appendix B

Segment 1 Option 1.C

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$310,000	$310,000
Erosion Control	1	LS	$25,000	$25,000
Furnish and Install 24 to 30-inch Gravity Main in Roadway	8810	LF	$295	$2,598,950
Furnish and Install 16 to 18-inch Force Main in Roadway	7200	LF	$285	$2,052,000
Special Structures	15	EA	$20,000	$300,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$5,352,950**
Construction Contingency			30%	$1,606,000
Construction Management:			15%	$803,000
Public Involvement/Permitting:			3%	$161,000
Design:			20%	$1,071,000
			Total Project Cost[1]	**$8,993,950**

Appendix B

Segment 2 Option 2.A

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$170,000	$170,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and Grubbing	1.5	AC	$15,000	$22,500
Easement	1	EA	$40,000	$40,000
Furnish and Install 10 to 12-inch Pipe in Roadway	4430	LF	$215	$952,450
Furnish and Install 10 to 12-inch Pipe out of Roadway	4930	LF	$195	$961,350
Special Structures	15	EA	$20,000	$300,000
Additional cost for installtion of piping in steep hillside areas	500	LF	$2,000	$1,000,000
Surface Restoration Natural Areas	1.5	AC	$8,000	$12,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$3,550,300**
Construction Contingency			30%	$1,066,000
Construction Management:			15%	$533,000
Public Involvement/Permitting:			3%	$107,000
Design:			20%	$711,000
			Total Project Cost[1]	**$5,967,300**

Appendix B

Segment 2 Option 2.B

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$110,000	$110,000
Erosion Control	1	LS	$25,000	$25,000
Furnish and Install 10 to 12-inch Pipe in Roadway	8380	LF	$215	$1,801,700
Special Structures	15	EA	$20,000	$300,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$2,303,700**
Construction Contingency			30%	$692,000
Construction Management:			15%	$346,000
Public Involvement/Permitting:			3%	$70,000
Design:			20%	$461,000
			Total Project Cost[1]	**$3,872,700**

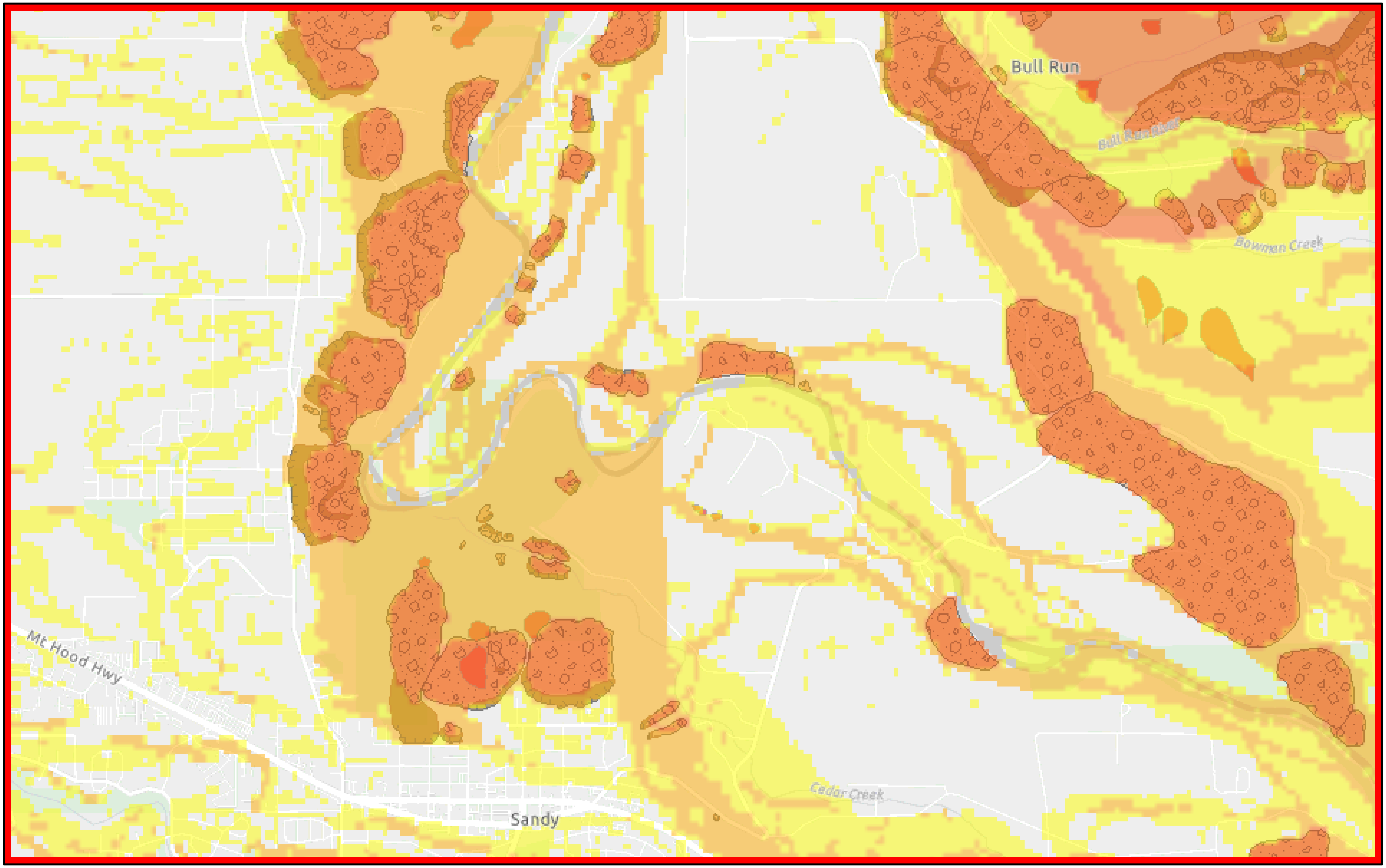
Appendix B

Segment 2 Option 2.C

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, bonds, insurance, and demob	1	LS	$370,000	$370,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and grubbing	1.5	AC	$15,000	$22,500
Easement	5	EA	$40,000	$200,000
Furnish and Install 10-inch Force Main in Roadway	1683	LF	$215	$361,845
Special structures	15	EA	$20,000	$300,000
Temporary Traffice Control	1	LS	$50,000	$50,000
Furnish and Install 10 to 12-inch Pipe out of Roadway	4380	LF	$195	$854,100
Trenchless or shaft for steep slope construction	1000	LF	$5,500	$5,500,000
Surface Restoration Natural Areas	1.5	AC	$8,000	$12,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$7,762,445**
		Construction Contingency	30%	$2,329,000
		Construction Management:	15%	$1,165,000
		Public Involvement/Permitting:	3%	$233,000
		Design:	20%	$1,553,000
			Total Project Cost[1]	**$13,042,445**

APPENDIX C

Landslide Hazards



February 2, 2021

Landslide Hazard

☐ Low - Landsliding Unlikely

🟨 Moderate - Landsliding Possible

🟧 High - Landsliding Likely

🟧 Very High - Existing Landslide

Scarp

Head Scarp

Deposits

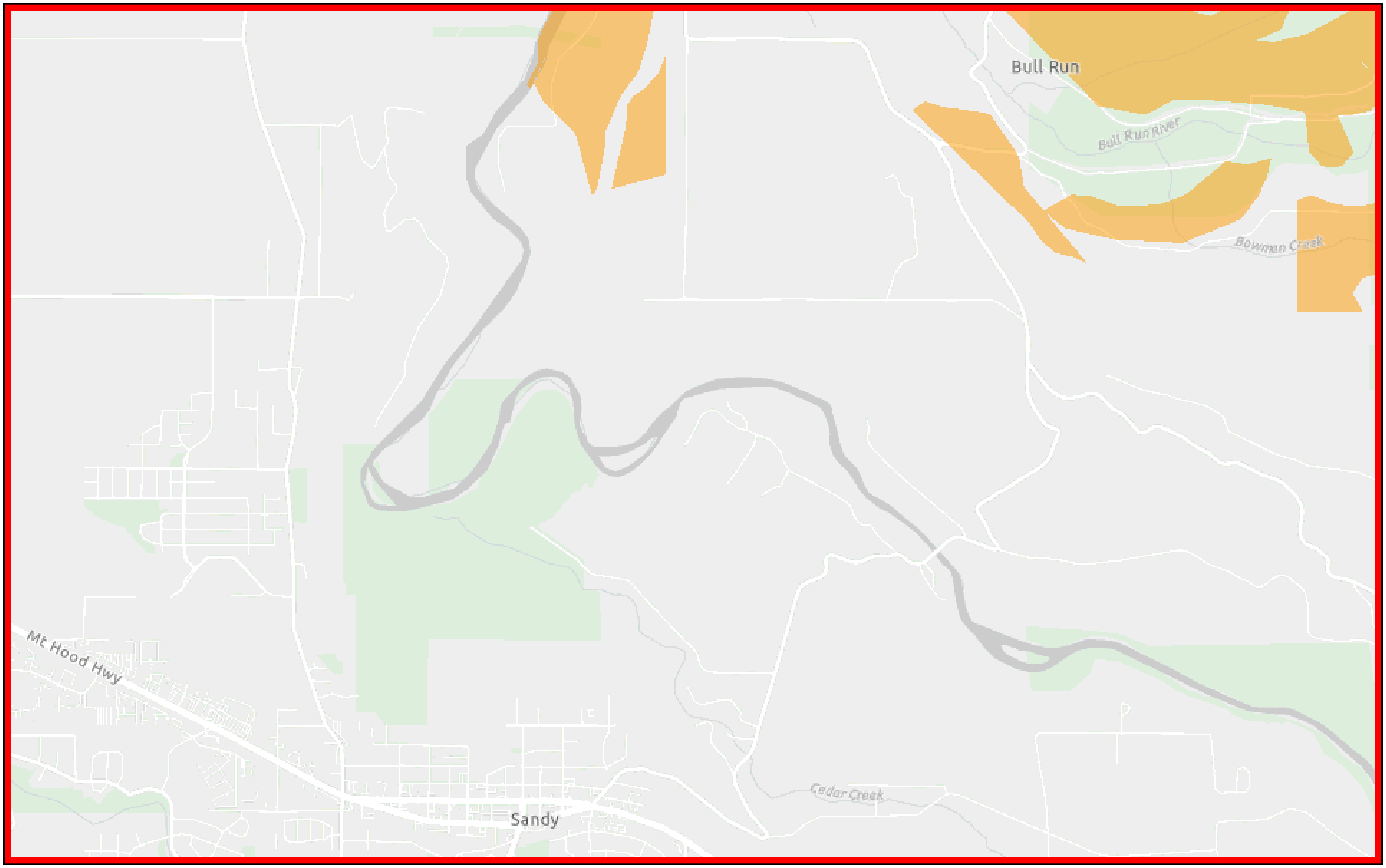
Talus-Colluvium

1:36,000

0 0.2 0.4 0.8 mi

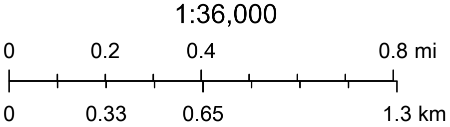
0 0.33 0.65 1.3 km

Liquefaction Hazards



February 2, 2021

🟥 High 🟧 Moderate 🟩 Low



Technical Memorandum 8

Date: October 19, 2020

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler,
Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Matt Hickey, PE
Jessica Cawley, PE
Murraysmith

Re: Water Recycling Market Assessment TM-8

Introduction

This memorandum contains a summary of information collected during the Water Recycling Program Customer Outreach study as part of the City's Detail Discharge Alternatives Evaluation. The initial Water Recycling Program Customer Outreach conducted by Barney & Worth, Inc. (B&W) evaluated several sites to determine if a property or properties near the City or along the proposed effluent pipe route had the irrigation demands to take all or most of the effluent from the City's proposed satellite wastewater treatment plant. The goal was to find an irrigator or irrigators which could take effluent during the summer and shoulder seasons (late spring and early fall) to help minimize the flows to the Sandy River during these times of year. The B&W memorandum is provided as an attachment to this document for reference. Additionally, this memorandum provides an analysis which evaluates the options for providing recycled water to potential customers including the pumping requirements, pipeline alignments, and capital and lifecycle costs. Eight options were initially considered relative to large irrigators and five options are considered for small use irrigators.

Purpose

The purpose of this memorandum is to document the evaluation of potential options and opportunities to expand the City's successful water recycling program based on effluent from the Eastside Satellite MBR Facility.

Scope

The evaluation will include a desktop study of potential water recycling customers and uses, outreach to property and business owners to gauge interest and an assessment of potential demands. Deliverables include the following:

- Prepare talking points for potential water recycling customers (**Attachment 1**)
- Characterize potential customers
- Inventory Current Water Sources
- Customer Interviews (**Attachment 2**)
- Water Recycling Opportunities Cost Analysis and Alternatives Comparison

Study Area

The study area included opportunities near the preferred pipeline alignments from the Eastside Satellite MBR Facility to preferred discharge locations. Murraysmith organized a team comprised of public outreach experts and agricultural specialists from B&W and Globalwise, Inc. They identified and investigated farm cluster sites with over 20 acres of irrigatable land and within a mile of the proposed pipeline alignments. After identifying potential sites, the team interviewed landowners to understand the market demand for recycled water.

Potential Large-Scale Water Recycling Customers

Farm clusters identified are shown in **Figure 1**. Below is a summary of the findings from the B&W study. It is noted that one site outside of the one-mile radius of the proposed pipeline alignments was identified as the Kelso Road Cluster as a potential for irrigation use of the effluent. For this evaluation, it will be considered “Farm Cluster 8”.

Description of Farm Clusters

Farm Cluster 1 – West of Roslyn Lake

Over 200 acres of land zone for Exclusive Farm Use (EFU) in Clackamas County is referred to as Farm Cluster 1. Of this area, approximately 100 to 130 acres has suitable slopes and irrigatable land. Approximately 60 to 70 percent of this land is already irrigated for annual crop cultivation. Much of this land has a sustainable supply of ground water, water rights and irrigation wells to supply their irrigation demands. The three property owners in Farm Cluster 1 use 145 to 180-acre feet of water annually.

Soils in this area are principally Bull Run silt loam with 3 to 8 percent slopes. These are generally deep and well drained soils but can be prone to erosion on sloped fields.

After conducting interviews, the primary farmer from the cluster stated recycled water is not suitable for their “biodynamic growing methods” and organic certification and the farmer stated they are not interested in the City’s treated water.

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Detailed Discharge Alternatives Evaluation

LEGEND

Discharge Alternatives

- Option 1a
- Option 1b
- Option 2a
- Option 2b
- Option 2c
- Option 2d
- Option 2e
- Irrigation Alternatives
- Urban Growth Boundary
- ● DischargeLocations
- Farm Cluster
- ▨ Satellite MBR

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Figure 1
Recycled Water Alternatives

October 2020 20-2776

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Farm Cluster 2 – West of Ten Eyck Road

Over 270 acres is zoned EFU in this area, however many of which are residential properties. The most applicable site in this area is a 39-acre site used for food crop agricultural production. They have a new irrigation well and no usage statistics were reported.

The soils in this area are also Bull Run silt loams with slopes up to 5 percent. After conducting interviews, one owner indicated no reason to consider supplemental irrigation, another indicated a reluctance to consider recycled water for their food crops because of their organic farming practices and concern for their consumers.

Farm Cluster 3 – Coalman Road and Oral Hull Road

Three properties totally 55 acres of pasture and hay production. These sites do not currently irrigate and are reported to have two springs which provide sufficient water for seepage irrigation. These properties are not recommended as a recycled water customer.

Farm Cluster 4 – Marmot Road

Five sites over 20-acres on Marmot Road are north of the Sandy River. These properties are currently used for pasture and hay production. These sites do not currently irrigate and are reported to have two springs which provide sufficient water for seepage irrigation. These properties are not recommended as a recycled water customer.

Farm Cluster 5 – Phelps Road

Three sites over 20-acres on Phelps Road are north of the Sandy River. These properties are currently used for agriculture. A limited supply of irrigation water is used on two of the properties. Based on the volume of water irrigated on these sites these properties are not recommended as a recycled water customer.

Farm Cluster 6 – Highway 26

Five sites over 20-acres south of Highway 26. These properties are currently used for agriculture, primarily Christmas tree production. These sites do not currently irrigate. These properties are not recommended as a recycled water customer.

Farm Cluster 7 – Highway 211

Three sites over 20-acres south of Highway 211. These properties are currently used for pasture or are otherwise unmanaged. These sites do not currently irrigate. These properties are not recommended as a recycled water customer.

Farm Cluster 8 – Kelso Road

Six sites ranging from 25-acres to 43-acres along Kelso Road north of Highway 26. New irrigation wells are prohibited in this area. Some irrigators in this area report that water levels drop in their wells in the hottest weeks of the summer when maximum groundwater pumping occurs. The six sites are described as Property A to E below.

- **Farm Cluster 8 - Property A** the first property for consideration to use recycled water, is an operating nursery currently for sale. It totals 88.8 acres with approximately 62 acres in irrigable nursery production. The table below estimates the potential total recycled water use. Four additional properties near Kelso Road are also prospects for Sandy recycled water:

- **Farm Cluster 8 - Property B** is a 39-acre parcel located south of Kelso Road, within Sandy's UGB. The property is in very low management and is suited for a container nursery. No irrigation well water is currently available.

- **Farm Cluster 8 - Property C** is a 43.2-acre parcel leased by a commercial nursery and managed for in-ground tree production. It has a groundwater well but could be improved with supplemental irrigation. About 41.5 acres is irrigable. This property is in the Sandy Urban Reserve.

- **Farm Cluster 8 - Property D** is in two parcels that together total 76.4 acres with about 68 acres irrigable. The land is leased by the same nursery that leases Property C and is also in ornamental tree production. This property is also served by a well.

- **Farm Cluster 8 - Property E** is a 25-acre container nursery located near Kelso Road and Orient Road. It has about 20 acres in container production at full capacity. This property has two wells, but the owner would consider adding City recycled water to enhance their irrigation requirements.

Cost Analysis for Large-Scale Irrigators

To evaluate the costs relative to the potential discharge rates, preliminary estimates to extend the pipelines to the farm clusters shown in **Figure 1** were developed. These costs are outlined below in **Table 1**. The design flow for any of these farm clusters is less than 0.4 cubic feet per second (0.26 MGD) assuming an irrigation season between May 1st and October 31st. The length of the force main is specified in the table below. The preliminary cost analysis includes a 0.5 million gallon per day pump station and a 4-inch force main. These costs include labor and installation costs and includes design, construction management, contractor overhead and profit, and construction contingency costs.

Table 1 | Preliminary Cost-Benefit Analysis for Large-Scale Irrigators

Potential Customer		Distance from Pipeline Alignment	Projected Annual Water Demand Quantity	Preliminary Cost	Percentage of Sandy WW Summer Flow	Demand for Recycled Water
Farm Cluster 1		352 ft	180 acre-feet	$1.23 M	31%	No
Farm Cluster 2		188 ft	0 acre-feet	$1.16 M	0%	No
Farm Cluster 3		7,145 ft	0 acre-feet	$3.94 M	0%	No
Farm Cluster 4		7,207 ft	0 acre-feet	$3.97 M	0%	No
Farm Cluster 5		4,310 ft	0 acre-feet	$2.81 M	0%	No
Farm Cluster 6		3,908 ft	0 acre-feet	$2.65 M	0%	No
Farm Cluster 7		7,441 ft	0 acre-feet	$4.06 M	0%	No
Farm Cluster 8	Property A	10,859 ft	34.3 to 50.5 acre-feet	$5.43 M	6% to 8.6%	Yes
Farm Cluster 8	Property B	10,859 ft	54 acre-feet	$5.43 M	9%	Maybe
Farm Cluster 8	Property C	10,859 ft	4 acre-feet	$5.43 M	1%	Yes
Farm Cluster 8	Property D	10,859 ft	7 acre-feet	$5.43 M	1%	Yes
Farm Cluster 8	Property E	10,859 ft	16 acre-feet	$5.43 M	3%	Yes

Summary of Large-Scale Irrigation Investigation

As shown above, the only viable Farm Cluster for recycled water irrigation, based on the current interest, is Farm Cluster 8. The preliminary cost for building a pipeline to serve this area would cost approximately $5.43 million dollars and the total percentage of the summer flow could be in the range of 1 to 22 percent. Since this option only uses a portion of the summer flows and requires a substantial capital investment, it is not as preferable as a discharge alternative than some of the other discharge alternatives considered in this study, and also prompted the investigation of a conglomeration of smaller-scale farms who are currently irrigating as discussed in the following section.

Potential Small-Scale Aggregated Water Recycling Customers

In addition to reviewing large-scale farm sites or clusters who might be able to receive the majority of flow, a study was done to evaluate current irrigators who are very close to preferred pipeline alignments and might benefit from recycled water and use a portion of the total flow. The Oregon Water Resources Department Water Rights Mapping Tool was used to determine current water rights used for Irrigation along the preferred pipeline alignments. A summary of the irrigators and the distance from the pipeline alignments are included in a cost-benefit analysis below however, no interviews with these property owners have been conducted so far. A map of these sites is shown in **Figure 2.**

Description of Small-Scale Irrigation Sites

Irrigation Site a – Ten Eyck Road

Site a is located at the intersection of Ten Eyck Road and Thomas Road north of the Sandy River. One well at *Site a* serves approximately 3.5 acres and is designated for irrigation. The property is currently zoned "TBR" for timber use. The quantity of water claimed and used is 12 gallons per minute.

Irrigation Site b – SE Phelps Road

Site b is located along SE Phelps Road, north of the Sandy River. Two wells at Site b serve approximately 16 acres and is designated for irrigation. The property is currently zoned "EFU" for exclusive farm use. The quantify of water claimed and used is 90 gallons per minute. The property owners of this site produce organic herbal supplements – based on experience from the large-scale irrigators, this property owner may be detracted from recycled water use due to public perception surrounding organic status.

Irrigation Site c – Cedar Creek Area

Site C is located east of the Sandy River Park, south of the Sandy River. One well at Site c serves approximately 6.8 acres; was originally used for gardening, pasture, and hay crops; and is designated for irrigation. The site is currently zone "TBR" for timber use. The quantity of water claimed and used is 30 gallons per minute.

Irrigation Site d – Sandy Bluff Park

One well at Site d currently serves approximately 50 acres for irrigation purposes. The original purpose was designated for irrigating plant nursery stock. The property is designated "R1" for residential use. As of the well report from 1978, only about one acre of canyard was supplied by this well. The quantity of water claimed and used is 43 gallons per minute.

Irrigation Site e – Sandy Union High School

Site e has a grounder water and surface water rights for irrigation use within the school and serves approximately 19 acres. The surface water point of diversion comes from Sump Springs. The quantity of water claimed and used is 25 gallons per minute. Of the total allocation, 5 gallons per minute are allocated for shower and sanitary facilities, and 20 gallons per minute are allocated for irrigation.

Cost Estimates for Supplying Effluent to Small-Scale Irrigators

Preliminary costs to extend the pipeline to the irrigation sites was estimated and are outlined below in **Table 2**. The design flow for the proposed satellite plant is approximately 0.5 MGD for the time of year when irrigation is feasible. With an average user rate of 0.06 MGD and a cumulative usage rate of 0.28 MGD, the farm clusters require only a portion of the design flow for the proposed satellite plant assuming an irrigation season between May 1st and October 31st. The length of the force main is specified in the table below. The preliminary cost analysis includes only a 4-inch force main. These costs include labor and installation costs a includes design, construction management, contractor overhead and profit, and construction contingency costs.

Table 2: | Preliminary Cost-Benefit Analysis to small-scall irrigators

Potential Customer	Distance from Pipeline Alignment	Projected Annual Water Demand Quantity	Preliminary Cost	Percentage of Sandy WW Summer Flow	Demand for Recycled Water
Irrigation Site a	0 ft	10 acre-feet	$0.00 M	2%	TBD
Irrigation Site b	4,310 ft	72 acre-feet	$1.73 M	12%	TBD
Irrigation Site c	0 ft	25 acre-feet	$0.00 M	4%	TBD
Irrigation Site d	5,152 ft	36 acre-feet	$2.07 M	6%	TBD
Irrigation Site e	1,806 ft	16 acre-feet	$0.73 M	3%	TBD
	Total		$4.53 M	27%	TBD

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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City of Sandy, Oregon
Detailed Discharge Alternatives Evaluation

LEGEND

Discharge Alternatives

- Option 1a
- Option 1b
- Option 2a
- Option 2b
- Option 2c
- Option 2d
- Option 2e
- Small-scale Irrigators
- Urban Growth Boundary
- ● DischargeLocations
- Irrigator Site
- ▨ Satellite MBR

Figure 2
Recycled Water Alternatives

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Review of Costs Relative to Discharge Rates

The cost to send flows to Kelso Road is $5.4M and only allows for 22% of the flow to be discharged while small irrigators costs $4.53M and potentially allows for 27% of the flows to use for irrigation. There is also more certainty with the small irrigators since we know they are currently irrigating. However, interest will have to be determined on a case-by-case basis. The range of costs per flow (in gallons per minute) to extend service to the large-scale irrigators is between $5k and $1.0M. The range of costs per flow (in gallons per minute) to extend service for the small scale-irrigates discussed is from less than $5k to $46k.

Recommendation

The alternatives outlined in this memo involve using recycled water to irrigate potential customers. Based on the analysis of cost and potential discharge rates, the large-scale irrigator sites didn't show real market demand for the recycled water and required larger capital investments because of the longer pipeline lengths required between the main effluent piping routed to the Sandy River and the potential irrigation sites. The small-scale irrigator sites showed greater current irrigation utilization rates and required a much smaller capital investment due to the shorter pipeline lengths from the preferred pipeline alignments.

It is recommended to pursue a recycled water program for irrigators close to the preferred pipeline alignment. Murraysmith recommends the City establish a fair basis to extend recycled water to interested users based on the length of pipe required for service and the total supply of recycled water requested. Some of these potential users of the recycled water will require little capital investment to connect to the main pipeline and these users will benefit from the availability of recycled water. Additionally, irrigation use of the recycled water will help reduce discharges to the Sandy river during the critical dry months of the year.

Cc: Matt Hickey, Murraysmith

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Technical Memorandum 9 and 10

Date: March 01, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler, City Manager
Mike Walker, Public Works Director
City of Sandy, Oregon

From: Matt Hickey, PE
Ken Vigil, PE
Katie Husk, PE
Murraysmith

Re: Indirect Discharge and Roslyn Lake Alternatives Site Review (TM-9) and Analysis of Indirect Discharge (TM-10)

Introduction

Task 7 of the Detailed Discharge Alternatives Evaluation involves reviewing Indirect Discharge and Roslyn Lake Alternatives. The regulations surrounding indirect discharge (Technical Memorandum 9) and site reviews and analysis of indirect discharge (Technical Memorandum 10) are related. Thus, we are summarizing both aspects in this one document, calling it Technical Memorandum 9 and 10.

Discharge Options

The project team conducted a thorough review of indirect discharge options. These options included irrigation on crops, hyporheic flow (discharge into river gravels), infiltration ponds, and various constructed wetland options. Some of these options also provide opportunities for habitat enhancement and creation.

Please refer to Technical Memorandum 7.1 for a summary of direct discharge into the Sandy River options.

Indirect Discharge Locations

Murraysmith's subconsultant Barney & Worth (through Globalwise) started by conducting a market review of effluent reuse and possible land application sites in the general vicinity of the proposed new satellite treatment facility, as summarized in their 2020 report. That review focused on identifying properties and locations where effluent could be used beneficially on land, primarily for irrigation of crops. That review did not result in an ideal location or recommended alternative due in part to the abundance of rainfall in the area, resulting in less need for irrigation.

Through recommendations from the City, the consultant team also began reviewing options for land application of effluent near the historic Roslyn Lake, previously owned and managed by Portland General Electric. That location has become the primary site of interest as the project has moved forward and is the focus of this memorandum.

Regulatory Aspects

In order to apply effluent to land, the City must meet surface water and groundwater regulations and obtain applicable permits. The Oregon Department of Environmental Quality (DEQ) typically regulates discharges to land only with Water Pollution Control Facility (WPCF) permits. When effluent is discharged to surface waters, DEQ regulates those discharges through National Pollutant Discharge Elimination System (NPDES) permits. DEQ currently regulates the City's discharge to Tickle Creek and land application at the nursery both through one NDPES permit. DEQ will likely regulate the new discharge from the proposed satellite treatment facility through a single NPDES permit. It is not clear at this time if DEQ will issue a new NPDES permit to the City for the new satellite plant, or if DEQ will amend the existing Tickle Creek permit to add the new treatment facility and discharge options.

Murraysmith's specialty groundwater subconsultant (GSI Water Solutions, Inc. or GSI) reviewed the regulatory aspects of indirect discharge and summarized their findings in the attached technical memorandum titled "Regulatory Framework for Alternative Wastewater Discharge System Permitting, City of Sandy, Oregon", September 20, 2020.

Desktop and Field Studies

In addition to their regulatory review, GSI completed a desktop study (and limited field work) to further review soils, groundwater, and geologic conditions in the Roslyn Lake area. They found that the soils in the Roslyn Lake area are primarily Alspaugh Clay Loams and Bull Run Silt Loams. These soil groups reportedly have poor infiltration capacity. The underlying bedrock in the area is from the Springwater and Troutdale formations. GSI documented that several groundwater wells exist in the project area.

GSI's desktop study is summarized in the attached technical memorandum titled "Evaluation of Sites for Alternative Wastewater Discharge Systems, City of Sandy, Oregon", September 18, 2020.

Because of the importance of understanding infiltration at the site, GSI also conducted planning-level infiltration tests in the field at two test pits near the recommended alternative (outlined below). Those tests found higher infiltration rates in area soils than reported in the literature, as summarized in their attached technical memorandum titled "Infiltration Testing to Estimate Soil Permeability, Roslyn Lake, Sandy, Oregon", January 11, 2021. These results suggest that additional, design-level, soils and infiltration testing will be needed in the future to better understand the soil characteristics across the site. Soil amendments and compaction may be needed to control infiltration.

Recommended Alternative

The recommended indirect discharge alternative is conveying treated effluent to a series of constructed wetlands in the historic Roslyn Lake area. Figures 1 and 2 are plan and section views, respectively, of the recommended indirect discharge alternative. For reference, Technical Memorandum 7.1 outlines direct discharge into the Sandy River alternatives.

As shown in Figure 1, the initial concept is to create separate constructed wetlands. The City could construct these wetlands over time and as needed to manage costs. For example, the City may wish to construct Wetland A (about 28 acres as shown) and Wetland B (about 12 acres) in the first phase of construction. We have placed these wetlands in areas that take advantage of existing site topography and contours to minimize earthwork costs. With continued population growth, the City could construct Wetland C (approximately 10 acres) to add capacity. However, the natural topography is not as conducive for Wetland C and more earthwork would be required.

To protect existing habitat and preserve natural hydrology, the proposed wetlands are purposefully not connected to existing water features on the site (at this time). It seems reasonable to assume that the existing wetland/pond features on the site may need to be maintained separate from the proposed constructed wetlands. These existing features are currently providing habitat and are likely protected by wetland regulations. The existing flow channels currently pass water from the upper watershed through the site to downstream properties and habitat. These channels also likely need to be maintained.

As the design progresses, there may be an opportunity to consider enhancing the existing wetlands by providing additional effluent hydrology, particularly during the summer. The design team will explore these options with regulators in the future, to see if any wetland impacts could be mitigated by enhancing and expanding these natural wetland areas.

The exact size, number, and location of constructed wetlands will be determined after additional studies are completed. For example, the project team will need to prepare a new topographic survey, conduct additional soil infiltration tests, review existing regulated wetland boundaries, and further refine site hydrology and flow balance projections.

The section view of the proposed wetlands (Figure 2) illustrates how a diversity of native vegetation could be planted based on site hydrology (amount and depth of water), habitat creation objectives, and operation and maintenance needs. During final design, the project team would complete a planting plan for the area using desirable native species. The design could retain most of the conifers but replace the abundant monoculture of Cottonwood trees (currently dominating parts of the site) with a more diverse assemblage of native plants.

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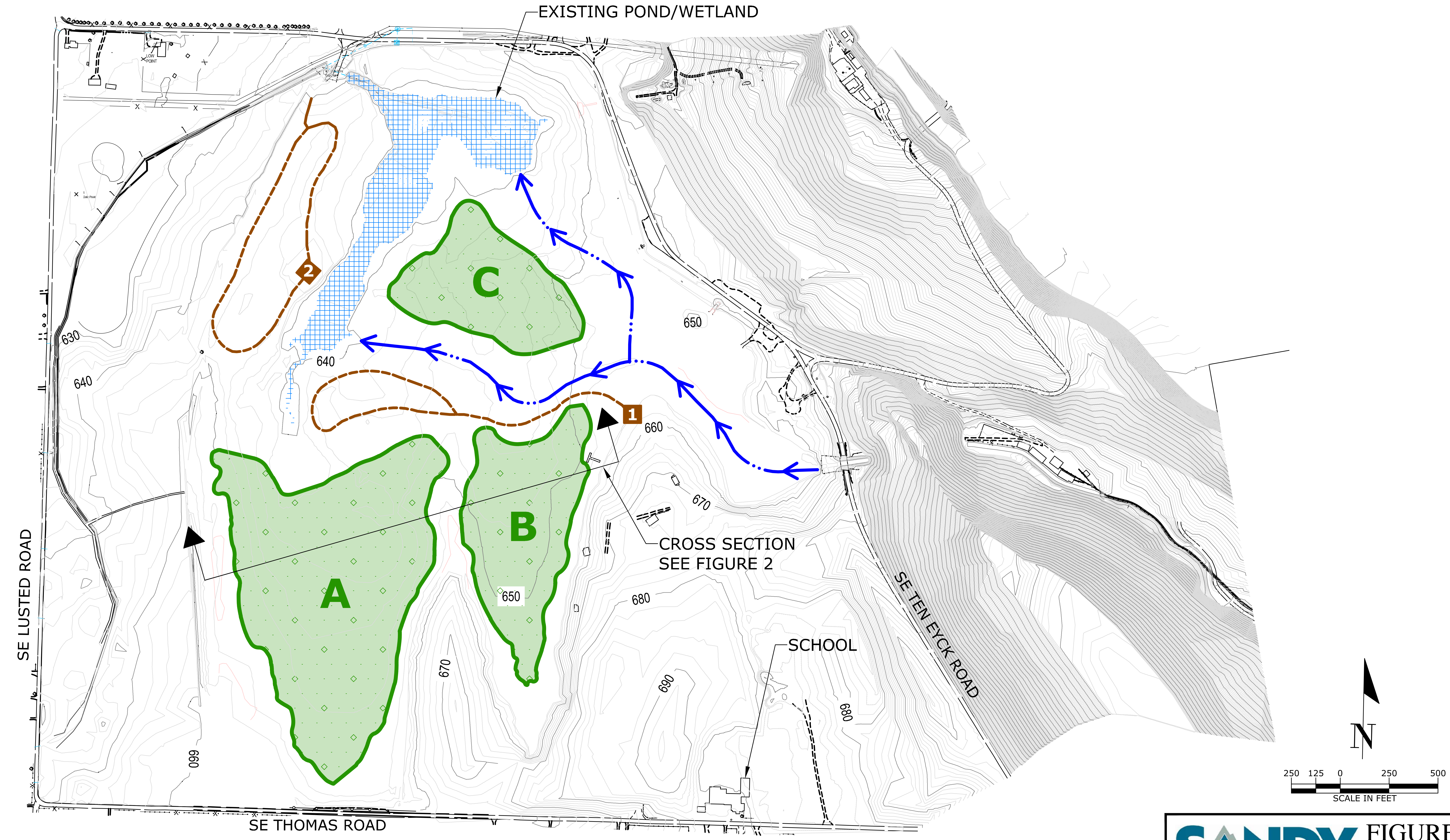

LEGEND

TRAILS ╌╌╌╌╌╌
WETLANDS ━━━━
VIEWING PLATFORM LOCATION ■
NATURAL WATERS ←‥–‥–

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 1

Detailed Discharge
Alternatives Evaluation

WETLAND CONCEPT PLAN

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NOVEMBER 2020
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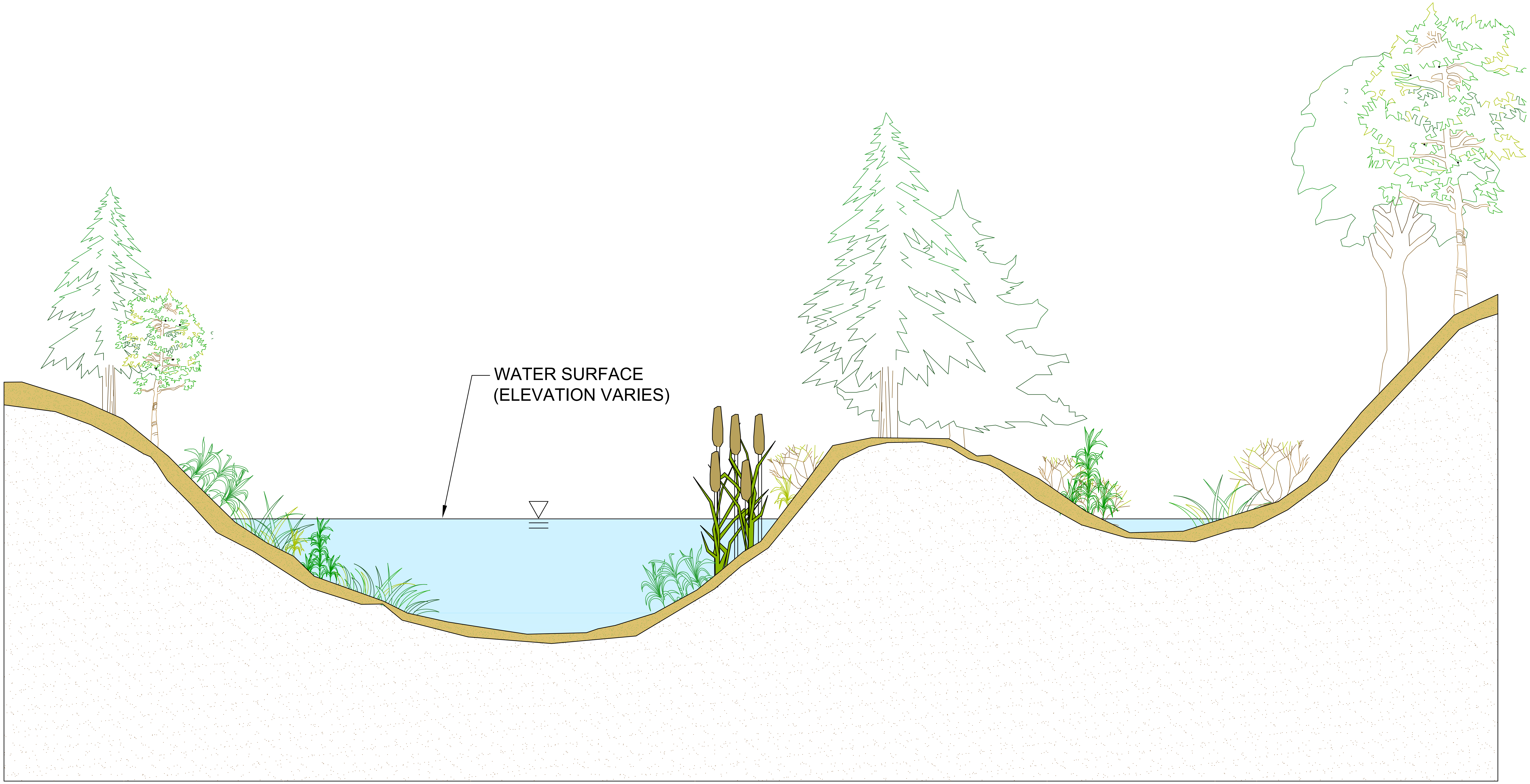

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 2

Detailed Discharge
Alternatives Evaluation

WETLAND CONCEPT SECTION

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NOVEMBER 2020
20-2276

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Water Balance

The project team reviewed the inflows, outflows, and the amount of water that would be stored in the wetlands to determine a water balance for the system.

The engineers first calculated the amount of storage volume that could be needed in the wetlands to hold the recycle/reuse water as a preliminary estimate of the required wetland area. For example, if the City discharged about 0.5 Million Gallons per Day (MGD) of flow to the wetlands over a five-month period (approximately 150 days), then that volume of reuse water (approximately 230 acre-feet) would result in about 50 acres of wetland area at an average depth of about 4.6 feet.

In practice, the City would discharge recycled water into the constructed wetlands in a way that maintains a desirable depth of water in the wetlands to support the healthy growth of wetland vegetation. The depth would increase and decrease throughout the year based on the balance of four flow variables: (1) the amount of recycled water flow entering the wetlands, plus (2) the amount of freshwater flow falling on the wetlands as precipitation, minus (3) any flow that is infiltrating into the soils below the wetlands, and minus (4) evapotranspiration from the surface of the wetlands, including evaporation and plant uptake.

Table 1 is a summary of a preliminary annual water balance for a proposed 50-acre wetland area (Cells A, B, and C as shown in Figure 1).

Table 1 | Preliminary Annual Water Balance

Month	Recycle Water Inflow (gal/day)	Recycle Water Inflow (gal/mo)	Wetland Area (acres)	Recycle Water Depth (in/mo)	Precip[1] (in/mo)	Infil[2] (in/mo)	ET[3] (in/mo)	Difference (in/mo)	Wetland Water Depth (inches)
START DEPTH									24.0
JAN	0	0	50	0.00	10.2	5.0	0.4	4.80	**28.80**
FEB	0	0	50	0.00	8.0	5.0	0.9	2.10	**30.90**
MAR	0	0	50	0.00	8.1	5.0	2.2	0.90	**31.80**
APR	0	0	50	0.00	6.9	5.0	3.4	-1.50	**30.30**
MAY	0	0	50	0.00	5.7	5.0	5.4	-4.70	**25.60**
JUN	500,000	15,000,000	50	11.02	4.1	10.0	7.0	-1.88	**23.72**
JUL	500,000	15,500,000	50	11.39	1.3	10.0	8.6	-5.91	**17.81**
AUG	500,000	15,500,000	50	11.39	1.4	10.0	6.7	-3.91	**13.89**
SEP	500,000	15,000,000	50	11.02	3.6	10.0	4.0	0.62	**14.51**
OCT	500,000	15,500,000	50	11.39	6.5	10.0	1.8	6.09	**20.60**
NOV	0	0	50	0.00	11.2	5.0	0.6	5.60	**26.20**
DEC	0	0	50	0.00	11.2	5.0	0.3	5.90	**32.10**

1. Precipitation - USClimatedata.com for Sandy, OR
2. Infiltration - Estimate assuming soil amendment used to reduce infiltration rate of native soils
3. Evapotranspiration - US Bureau of Reclamation Agrimet, Dee Flat, OR

As shown in Table 1, the depth of water in the wetlands would increase and decrease throughout the year based on the four variables outlined above. The City would have control over how much recycled water to deliver to the wetlands. The design of the new wetlands is assumed to include using clay as an amendment to native soils to limit infiltration.

The project team will review these water balance variables in more detail during the design phase of the project. Moreover, the actual amount of monthly precipitation, infiltration, and evapotranspiration will always vary based on climatic conditions. Thus, the City's operation of the facilities will need to take into consideration changing weather conditions.

The desirable depth of water will depend on the type of wetland plants selected and habitat creation goals. It is likely that the three proposed wetland areas would all have different depths to provide more diversity of wetland habitat.

Based on the preliminary water balance reviews summarized above, Murraysmith engineers estimate that the City would want to build approximately 30 to 60 acres of constructed wetlands.

The City would discharge to the constructed wetlands during the summer period and also to the Sandy River through a new outfall. The Sandy River has substantial flows and assimilative capacity during both summer and winter months. For general reference, with the proposed new discharge, the City's monthly effluent flows to the river would be less than 1% of the monthly river flows.

Discharging to both the Roslyn Lake constructed wetlands and the Sandy River is consistent with the approach outlined in the recently completed antidegradation review for new proposed discharges into the Sandy River. Moreover, this approach provides the City with a more robust, flexible, long-term wastewater management program.

Costs and Benefits

As noted above, much of the cost of the constructed wetlands will be associated with the earthwork for excavation or berm building. For planning purposes, the project team has been using an older topographic map created for PGE a decade ago. That topographic information will need to be updated as the project moves towards final design. Based on our current understanding of the site and potential size and depth of a 50-acre wetland complex, we estimate that approximately 100,000 to 200,000 cubic yards of earthwork may be required for the project.

As the design moves forward, the team will have a better idea of final wetland locations/depths/topography, length of discharge pipe, number of control structures, type of plant species to be planted, and amount of existing vegetation (like cottonwood trees) to be removed, any access roads that will be needed, trails and signage, etc.

For planning purposes, we estimate that the construction cost of the proposed wetlands would be approximately $3 million to $6 million dollars.

For reference, the Fernhill South Wetlands project (which members of the project team have visited) created approximately 50 acres of new wetlands from 90 acres of old sewage lagoons. The construction cost for that project was approximately $3.6 million dollars in 2014. That project included approximately 200,000 cubic yards of earthwork, and it was constructed in an area with native clay soils and existing impoundments.

Although similar, these two projects have different initial site conditions. We anticipate that the cost of the Roslyn Lake wetlands will be higher since the existing soils are much more permeable. These more permeable soils will likely require soil amendments and some degree of compaction to help them retain water for wetland plants.

The benefits of this project are many, as itemized below.

- Beneficial use of high-quality effluent
- Recycle/Reuse of valuable resources (water and nutrients)
- Wetland enhancement and creation
- Habitat enhancement and creation
- Provides hydrology for new, desirable native plants and animals
- Minimizes or eliminates negative impacts to water quality from summertime discharges to the Sandy River
- Minimizes or eliminates negative impacts to fisheries on the Sandy River from summertime effluent discharges
- Further cooling and natural treatment of effluent
- Opportunities for environmental education/recreation
- Creation of trails and interpretive signs
- Possible use of the created wetlands for wetland mitigation banking

Property Owner Coordination

The Roslyn Lake site is owned by Trackers Earth, a company that specializes in outdoor and environmental education. Staff from Murraysmith first met with a representative of Trackers Earth at the Site in May of 2020. We walked portions of the site and discussed opportunities and constraints by looking at existing operations, site topography, existing wetlands and water features, native vegetation, and current access points and infrastructure.

Our specialty groundwater subconsultant (GSI) met with Trackers Earth to visit the site and conduct preliminary soils investigations on June 23, 2020. We have continued to coordinate with Trackers Earth through e-mails and phone calls as the project has progressed.

Because of the importance of the opportunity for teaming with Trackers Earth and to ensure good communication and cooperation, the City prepared a letter of Interest/Understanding with Tracker's Earth (see attached) and that letter was signed by both parties on September 8, 2020.

Additional Coordination

The consultant team has been coordinating with City staff and City elected officials throughout the course of the project. We have conducted virtual meetings with City staff every two weeks and these meetings have included discussions of the indirect discharge alternatives, including Roslyn Lake.

Murraysmith staff had a virtual workshop/meeting with City staff (Mike Walker and Jordan Wheeler) on July 23, 2020 for the purpose of reviewing the outfall location studies and work being done on the Roslyn Lake area wetland opportunities. The workshop was facilitated by a PowerPoint presentation that summarized progress to date.

On September 8, 2020, Murraysmith had a virtual workshop/meeting with the Sandy City Council and City Staff. This workshop/meeting was facilitated by a PowerPoint presentation and the public was invited (including interested citizens and members of the local watershed councils). Murraysmith staff again presented a summary of the overall project and focused on the possible outfall sites and opportunity for wetland creation using effluent near historic Roslyn Lake.

On October 16, 2020, the City invited State Representative Anna Williams to visit the Roslyn Lake area in cooperation with the property owner. The site visit gave City representatives the opportunity to thank Representative Williams for her earlier support of legislation to secure funding for this Detailed Discharge Alternatives Analysis. It also gave the team the opportunity to explain the proposed constructed wetland project for reusing the high-quality effluent from the new satellite treatment facility. That meeting also included coordination with representatives from the Sandy River Watershed Council and the Clackamas River Basin Council. Those attending the field meeting practiced social distancing and wearing of masks because of the pandemic.

The project team held a virtual workshop meeting with the Clackamas and Sandy River Councils on December 16, 2020. The presentation focused on reviewing project elements that would affect these two watersheds. For example, team members described upgrades to the existing treatment plant and collection system improvements. These improvements primarily affect the Clackamas River Basin because the existing plant discharges into Tickle Creek, a tributary of the Clackamas River. Other team members reviewed the proposed new satellite treatment plant, recommended Sandy River outfall location, and proposed constructed wetlands at Roslyn Lake. These project elements are all located in the Sandy River watershed.

On June 30, 2020, the project team had a virtual coordination meeting with agency representatives from: the Oregon Department of Environmental Quality, Oregon Department of State Lands, Oregon Department of Fish and Wildlife, U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration Fisheries. These agencies all have some jurisdiction over the proposed project as it relates to water quality, wetlands, fisheries, and other environmental programs.

The presenters summarized the results of some of the investigations done to date at the possible outfall sites. The agency representatives all seemed to favor the upstream site near Ten Eyck Road crossing of the river (at Revenue Bridge). Moreover, the agency staff were interested in the possibility of applying the effluent to land during the summertime (at the proposed Roslyn Lake wetland site), to reduce potential impacts to the Sandy River.

This meeting on June 30, 2020 was a follow-up to an earlier agency “Kaizen” style meeting held on May 15, 2019 where the project was initially introduced.

Conclusion

This technical memorandum summarizes Task 7 of the Detailed Discharge Alternatives Evaluation: Indirect Discharge and Roslyn Lake Alternatives. The regulations surrounding indirect discharge (Technical Memorandum 9) and site reviews and analysis of indirect discharge (Technical Memorandum 10) are related. Thus, we summarized both aspects in this one document, calling it Technical Memorandum 9 and 10.

Based on this review, we anticipate that DEQ will regulate the proposed discharge to the Sandy River and the Roslyn Lake constructed wetlands through a single NDPES permit. DEQ currently regulates the City’s discharge to Tickle Creek and the container nursery that way. It is not clear if DEQ will modify the existing Tickle Creek permit by adding the Sandy River and Roslyn Lake discharges, or if they will issue a new permit for the Sandy River and Roslyn Lake discharges.

The City has the opportunity to construct wetlands to beneficially recycle/reuse the high-quality effluent from the proposed satellite treatment plant. The Roslyn Lake site seems well suited for this approach and Trackers Earth (the property owner) is interested in partnering with the City on this type of a project, given successful negotiation of an agreement between both parties. The project team will need to conduct further reviews of soils/infiltration and of existing wetlands and waterways on the Roslyn Lake property as the project moves into final design to better understand associated opportunities and constraints.

Based on these planning level reviews, the City would need to construct approximately 30 to 60 acres of wetlands and the construction cost would be approximately $3 million to $6 million dollars.

TECHNICAL MEMORANDUM

Regulatory Framework for Alternative Wastewater Discharge System Permitting, City of Sandy, Oregon

To: Ken Vigil, PE / Murraysmith Associates, Inc.
Matt Hickey, PE / Murraysmith Associates, Inc.
Jessica Cawley, PE / Murraysmith Associates, Inc.

From: Dennis Orlowski, RG / GSI Water Solutions, Inc.
Matt Kohlbecker, RG / GSI Water Solutions, Inc.
Jason Melady, RG / GSI Water Solutions, Inc.

Date: September 20, 2020

Exp: 5/1/2021

This technical memorandum (TM), prepared by GSI Water Solutions, Inc., (GSI), summarizes an evaluation of permitting requirements for municipal wastewater discharge systems that do not discharge directly to surface water. The TM considers a system that would be owned and operated by the City of Sandy (City), and is organized as follows:

- Section 1: Summarizes background information about the City's wastewater project.
- Section 2: Reviews Department of Environmental Quality (DEQ) permitting criteria for wastewater discharge systems.
- Section 3: Applies the DEQ permitting criteria to the City's Study Area.
- Section 4: Develops recommendations for determining the most likely DEQ permit requirements based on the wastewater discharge system location.

1 Project Background

The City of Sandy is evaluating discharge alternatives for treated wastewater in lieu of or in combination with a direct year-round discharge to the Sandy River. In this TM, treated wastewater discharge systems that *do not* directly discharge to surface water are called "alternative wastewater discharge systems." For example, one type of alternative wastewater discharge system discussed in this TM is an indirect discharge system. Indirect discharge systems are typically located adjacent to rivers, and enhance effluent quality through various natural physical, chemical, and biological processes in soil and groundwater by infiltrating wastewater and diffusely discharging the wastewater to surface water via groundwater.

The types of alternative wastewater discharge systems under consideration are infiltration basins with shallow groundwater discharge, constructed wetlands, evaporation ponds, and hyporheic discharge along the Sandy River or other stream corridors. The study area for the City's discharge alternatives evaluation is shown in Figure 1. Figure 1 also shows sites for alternative wastewater discharge systems currently under consideration by the City. The Roslyn Lake site is a candidate for infiltration basins and constructed wetlands, and the Sandy River Oxbow sites are candidates for hyporheic discharge.

Oregon law requires that wastewater discharge systems are authorized by a permit from the DEQ. There are two options permitting a wastewater discharge: (1) a National Pollutant Discharge Elimination System (NPDES) permit, or (2) a Water Pollution Control Facility (WPCF) permit. For a wastewater discharge system, the type of permit required depends fundamentally on whether or not the wastewater is to be discharged to surface water (directly or indirectly).

- NPDES permits: required for discharges of pollutants *to surface waters*, whether done so directly via an outfall, or *indirectly* via groundwater or within a hyporheic zone. An NPDES permit is a requirement of the Federal Clean Water Act and Oregon law [Oregon Administrative Rules (OAR) 340-045].
- WPCF permits: required for the discharge of wastewater to the ground; *discharge to surface water is not allowed*. The primary purposes of a WPCF permit are to prevent discharges to surface waters and to ensure that discharges to the ground meet Oregon's Groundwater Protection Rules (OAR 340-040).

There is often uncertainty related to whether an NPDES or WPCF permit is required to operate an alternative wastewater discharge system. Whether an NPDES permit would be required for discharges of wastes to groundwater with a direct or otherwise significant hydrological connection to surface water (i.e., an *indirect* discharge) is a nuanced question that depends on several site-specific factors. Because NPDES permits may contain limits on pollutant loading that are not found in WPCF permits (e.g., temperature), the type of permit required for an alternative wastewater discharge system is an important consideration that may affect project feasibility. This TM summarizes the site-specific criteria that inform whether an NPDES or WPCF permit is required for an alternative wastewater discharge system (Section 2), and apply the criteria to potential alternative discharge sites in the City of Sandy's study area (Section 3).

2 Permitting Criteria for Alternative Discharge Systems (NPDES or WPCF)

This section summarizes regulatory guidance documents (Section 2.1), a recent court decision (Section 2.2), and site-specific criteria (Section 2.3) that inform the type of permit that may be required for an alternative wastewater discharge system.

2.1 Regulatory Guidance Documents

Some of the uncertainty around permitting of alternative wastewater discharge systems was reduced in 2007, when DEQ issued an internal management directive (IMD) for disposal of municipal wastewater by indirect discharge to surface water. In the IMD, DEQ defined *indirect discharge systems* as those that "dispose of municipal wastewater plant effluent by indirect discharge to surface water via groundwater or hyporheic water" (DEQ, 2007). As such, indirect discharge systems are intentionally designed such that the wastewater effluent will ultimately discharge to a receiving surface water body. Based on DEQ's indirect discharge IMD, DEQ would require an NPDES permit rather than a WPCF permit for systems that intentionally discharge treated wastewater to surface water, albeit indirectly along a groundwater pathway.

2.2 Recent Court Decisions

A recent US Supreme Court decision is expected to eventually provide DEQ with future guidance and perhaps rule changes for the regulation and permitting of alternative wastewater discharge systems (*County of Maui, Hawaii v. Hawaii Wildlife Fund, et al.).* The case argued whether the Clean Water Act requires a permit when pollutants that originate from a waste disposal facility (in this case, an underground injection control that was permitted under the Safe Drinking Water Act) can be traced to reach navigable waters of the US through mechanisms such as groundwater transport, regardless of whether discharge to surface water was intended. On April 23, 2020, the Court ruled that such discharges must have an NPDES permit when they are the "functional equivalent of a direct discharge," a new test defined by the ruling. The Court decision will require the Environmental Protection Agency (EPA) to develop specific rules related to the "functional equivalent" test to be promulgated after public review. These federal rules will eventually be adopted by DEQ for implementation in Oregon. Alternative wastewater discharge systems could be the focus of a "functional equivalent" test. However, it will likely be years before such a test is developed and implemented into Oregon wastewater permitting regulations (pers. comm., Pat Heins/DEQ, 5/26/2020).

2.3 Site-Specific Criteria

Based on the recent Supreme Court decision, there may be alternative wastewater discharge systems that are not intended to function as an indirect discharge (such as infiltration basins located some distance from a stream), but for which there could be varying degrees of subsurface migration of effluent to a stream.

As discussed in Section 2.2, DEQ does not have *specific, formal* criteria or guidance to determine whether these types of alternative discharge systems would be considered either an indirect system subject to NPDES permitting requirements, or a system that is sufficiently hydraulically isolated from a surface water body (i.e., discharges to ground only) and subject to WPCF permit requirements. It should also be noted that project-specific factors will affect DEQ's permitting decision. For example, an infiltration basin may require a WPCF permit at a given site; however, at the same site, a constructed wetland that is designed *not* to infiltrate water (i.e., due to low permeability or amended soils) and is a component of a surface water discharge system may require an NPDES permit. Consequently, DEQ will use site- and project-specific information to determine whether an NPDES permit or a WPCF permit is required (pers. comm., Pat Heins/DEQ, 5/26/2020). The site- and project-specific information would include evaluation of:

- Hydrologic conditions (whether stream reaches are gaining or losing).
- Hydrogeologic conditions (geologic units and hydraulic connection to surface water).
- Other considerations (e.g., fate and transport of pollutants in infiltrated effluent, which is affected by the physical setting of the system, and facility design and intent).

The following sections provide additional detail about this site-specific information. When making a determination about whether an alternative wastewater discharge system is subject to NPDES or WPCF permit requirements, DEQ will consider all of the criteria to make a permit determination based on multiple lines of evidence.

2.3.1 Hydrologic Conditions

Alternative wastewater discharge systems located near gaining streams (i.e., streams where groundwater seeps into the stream) are more likely to be considered an indirect discharge to surface water, and, therefore, permitted under the NPDES regulations. Alternatively, alternative wastewater discharge systems located near losing streams (i.e., streams where stream water seeps into the groundwater) may not be subject to NPDES permit requirements because an indirect discharge to the stream may not occur (unless the discharge system infiltrates a large volume of water that raises the groundwater table to a point where the stream becomes a gaining stream)[1]. However, both of these are generalized conditions that would depend not only on the relative proximity of an alternative discharge system to a stream, but also on other inter-related factors discussed in following sections.

2.3.2 Hydrogeologic Conditions

Geologic units are grouped into aquifers (units that transmit significant quantities of groundwater) and aquitards (units that do not transmit groundwater). The presence and spatial distribution of aquifers and aquitards can affect the degree of hydraulic connection between surface water and groundwater. Aquitards may act as barriers that limit the degree of hydraulic connection between groundwater and surface water. If an aquifer is separated from a stream by an aquitard, then DEQ may conclude that a WPCF permit is required

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[1] Note that wastewater discharge system may alter the local groundwater system by creating a water table mound beneath the discharge system, which could cause a losing stream to become a gaining stream.

for an alternative wastewater discharge system because the aquifer and stream are not hydraulically connected. Alternatively, if an aquifer is in direct contact with a stream, then DEQ is likely to conclude that an NPDES permit is required for an alternative wastewater discharge system due to the hydraulic connection.

2.3.3 Physical Setting

Whether an NPDES or WPCF permit is required also depends on the physical setting of the project. Alternative wastewater discharge systems located further from a stream would be less likely to require a NPDES permit because pollutants from the system are attenuated to varying degrees in the subsurface, and would thus be less likely to reach the stream. Alternative wastewater discharge systems located adjacent to a stream would be more likely to require an NPDES permit because pollutants do not travel sufficiently far through soil to be attenuated.

DEQ has not established a setback distance between a stream and an alternative wastewater discharge system for determining whether an indirect discharge condition exists. But a groundwater modeling analysis based on site-specific soil and aquifer properties can be used to estimate the expected attenuation of pollutants before reaching surface water.

3 Application of Permitting Criteria to Potential Sites in the Study Area

The City is evaluating potential sites for alternative wastewater discharge systems throughout the Study Area, which is shown in Figure 1. As discussed in Section 2.2, the permitting requirements (i.e., NPDES or WPCF) for the potential sites will be impacted by the hydrologic conditions (Section 3.1), hydrogeologic conditions (Section 3.2), and physical setting (Section 3.3) at each site. <u>It should also be noted that the alternative wastewater disposal system design may affect the fate and transport of pollutants and the volume and rate of infiltration, and should be considered in permitting determinations along with the permitting criteria discussed in the following sections.</u>

3.1 Hydrologic Conditions

In low-lying areas of the Willamette Valley, the depth to groundwater is generally shallow, and, as a result, streams are generally gaining. However, exceptions do exist (see Figure 15 in Conlon et al., 2005, for losing streams in low-lying areas of the Willamette Valley). Groundwater flow directions and seepage runs in the Study Area indicate that the streams are gaining. Specifically, groundwater flows towards streams (see groundwater elevation contour maps in Snyder [2008]) and seepage measurements presented in McFarland and Morgan (1996) indicate that groundwater discharges to surface water on the Sandy River, Deep Creek, and Tickle Creek. In other words, these three are all gaining streams.

3.2 Hydrogeologic Conditions

The geologic units in the study area are shown in Figure 2 (surficial geology) and Figure 3 (geologic cross section. The Quaternary Alluvium (Qal), Terrace Deposits (Qtg), and Springwater Formation (Qts) are present in the Study Area at ground surface and are characterized by relatively flat slopes. As such, these units comprise the surficial geology at candidate infiltration sites, and are described in the following bullets. Organized from youngest to oldest, the units are (Schlicker and Finlayson, 1979; Beaulieu, 1974):

- **Quaternary Alluvium (Qal).** The Quaternary Alluvium is comprised of recently-deposited sand, gravel and cobbles within the channel of the Sandy River.
- **Terrace Deposits (QTg).** Located just west and east of the Sandy River, the Terrace Gravels were deposited by the ancestral Sandy River during the Pleistocene Epoch[2], a time of relatively higher sea levels when the river was a lower-energy environment. The deposits are comprised of fluvial and glaciofluvial cobble to boulder gravels with relatively poor drainage[3].

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[2] The Pleistocene Epoch is a geologic timer period that lasted from about 2.6 million years ago to 12,000 years ago.

[3] Schlicker and Finlayson (1979) notes that the Terrace Deposits are not suitable for septic drainfields.

- **Springwater Formation (QTs).** Located west of the Sandy River, the Springwater Formation is comprised of mudflows and gravels that are deeply-weathered to a clayey soil characterized by poor drainage.

As shown on the cross section in Figure 3, the Quaternary Alluvium is directly connected to the Sandy River, while the Terrace Deposits are assumed to be mostly hydraulically isolated from the Sandy River due to the Sandy River Mudstone, which is a thick (over 200 feet) sequence of predominantly siltstone and claystone. As shown on Figure 2, the Springwater Formation is likely connected to the surface water features west of the Sandy River in much of the Study Area (i.e., Tickle Creek, Dolan Creek, etc.).

3.3 Physical Setting

The study area is large, and the City may be able to locate an alternative wastewater discharge system sufficiently far from surface water so that pollutants will be attenuated in soil and a WPCF permit is required. However, facility siting is more likely to be determined based on soil suitability for the type of disposal, property ownership, and existing pipeline alignments, as opposed to permitting implications.

4 Conclusions and Recommendations

DEQ will make a permitting determination (WPCF or NPDES) based on hydrologic conditions, hydrogeologic conditions, and the overall physical setting of the site for the alternative wastewater discharge system. DEQ will also consider the design of the system (i.e., whether the system is designed to infiltrate water). Because streams in the Study Area are gaining, it is more likely that DEQ will consider wastewater discharges to the ground as being an indirect discharge system, unless other physical factors or design factors suggest otherwise.

We make the following conclusions about DEQ's likely permitting determination based on the geologic unit where the facility is located and site setting:

- Discharge systems located in **Quaternary Alluvium**, which is the unconfined aquifer over which the Sandy River flows, will likely be considered to be strongly hydraulically connected to the river, and will be sufficiently close to the river that pollutants will not be fully attenuated prior to discharge. As such, wastewater discharge facilities in the Quaternary alluvium are likely to be permitted as an indirect discharge (i.e., NPDES permit). The Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2 sites are located in the Quaternary Alluvium (see Figure 2).

- Discharge systems located in the **Springwater Formation**, which is an unconfined to semi-confined aquifer and features multiple creeks (e.g., Tickle Creek, Dolan Creek, Deep Creek, etc.) are also likely to be considered weakly hydraulically connected to surface water. If a weak hydraulic connection can be demonstrated and the facility is designed to infiltrate water, then DEQ may determine that a WPCF permit is required. In order demonstrate a weak hydraulic connection, the City would need to show that contaminants would not reach the surface water using site-specific data, or that infiltration is minimal [Schlicker and Finlayson (1979) indicate that the Springwater Formation is characterized by poor drainage, and the system design would also be an important consideration]. The City will be more likely to successfully demonstrate a weak hydraulic connection for facilities located further from surface water features, which affords greater time and distance for pollutants to attenuate. If the City could not demonstrate a weak hydraulic connection, then DEQ would likely make a NPDES permit determination for the Springwater Formation.

- Discharge systems located on **Terrace Deposits** above the river may be considered to be hydraulically isolated from the river due to the Sandy River Mudstone, which separates the terrace deposits from the river alluvium. In addition, because the Terrace Deposits are characterized by poor drainage (Schlicker and Finlayson, 1979), DEQ may not consider facilities in this unit to indirectly discharge to surface water along a groundwater pathway. Therefore, alternative discharge systems located on

Terrace Deposits may therefore require a WPCF permit, if the facility is designed to infiltrate water. Additional field investigation and data analysis will be required to demonstrate the lack of a hydraulic connection. The Roslyn Lake site is located on the Terrace Deposits (see Figure 2).

We recommend that the City continue to actively engage with DEQ as prospective sites and methods for an alternative wastewater discharge system are selected. In particular, any planned site characterization work should proceed with concurrence from DEQ. We recommend that the City collect the following data from candidate sites for an alternative wastewater discharge system, to inform the types of systems that may be feasible (i.e., whether or not a system would infiltrate water) at a candidate site, and to provide DEQ with data on which to make a permitting decision:

- Soil and water quality data from a candidate site, including permeability, groundwater quality, and factors affecting pollutant fate and transport (e.g., distribution coefficients, soil pH, etc.).
- Geologic and hydrogeologic information near the candidate infiltration site, including cross sections, groundwater table elevation maps, and maps showing surficial geology.
- An inventory of water wells near the candidate site.
- Modeling of contaminant attenuation to determine if pollutants from the discharge facility are likely to reach surface water.

5 References

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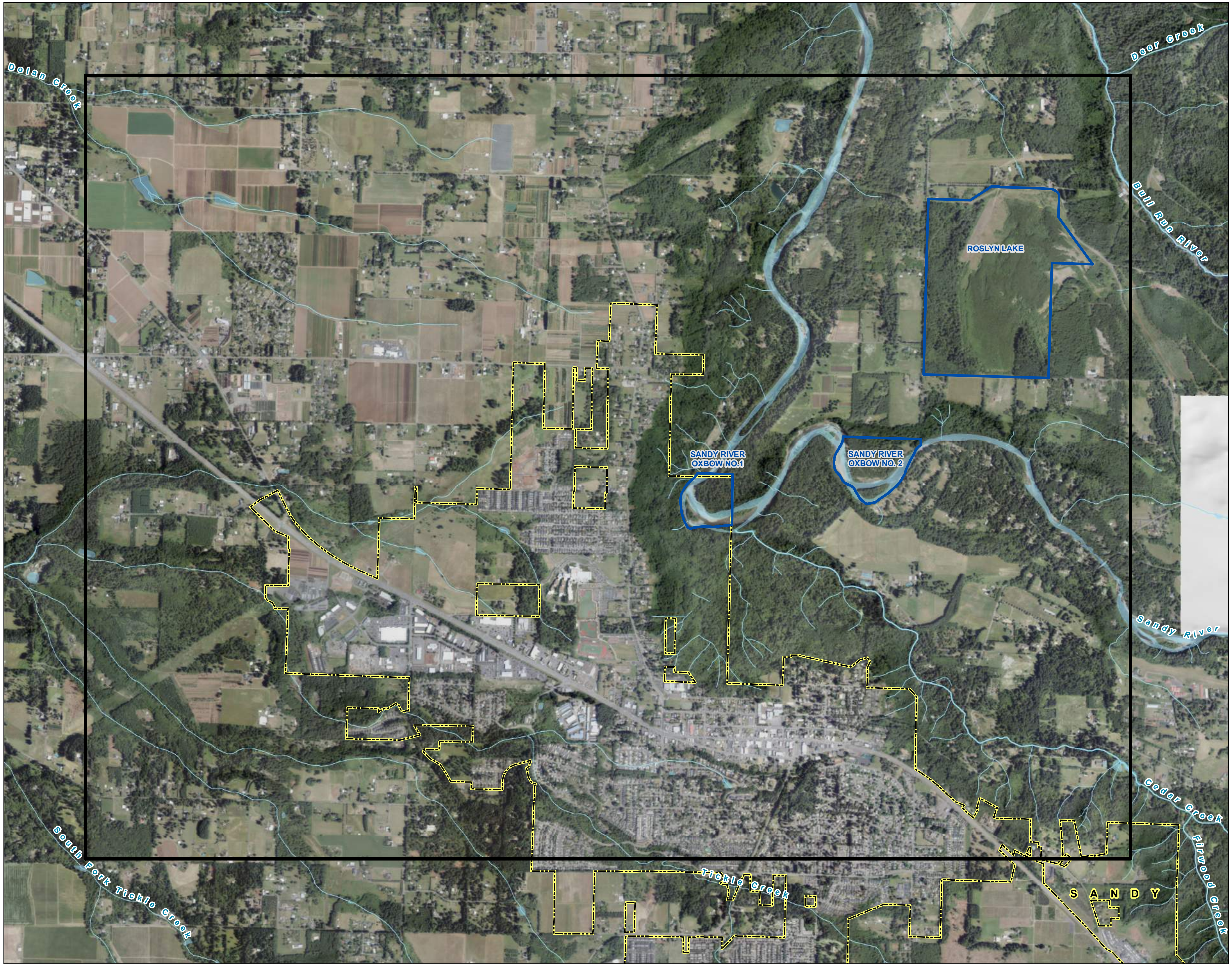

FIGURE 1

Study Area

City of Sandy
Wastewater Discharge
Alternatives Analysis

LEGEND

▢	Area of Interest
▢	Study Area
▢	City Boundary
〜	Watercourse
▨	Waterbody

N

0 1,100 2,200 3,300
Feet

Date: July 30, 2020
Data Sources: USGS, COP Imagery Summer 2019, METRO

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Figure1_Study_Area.mxd

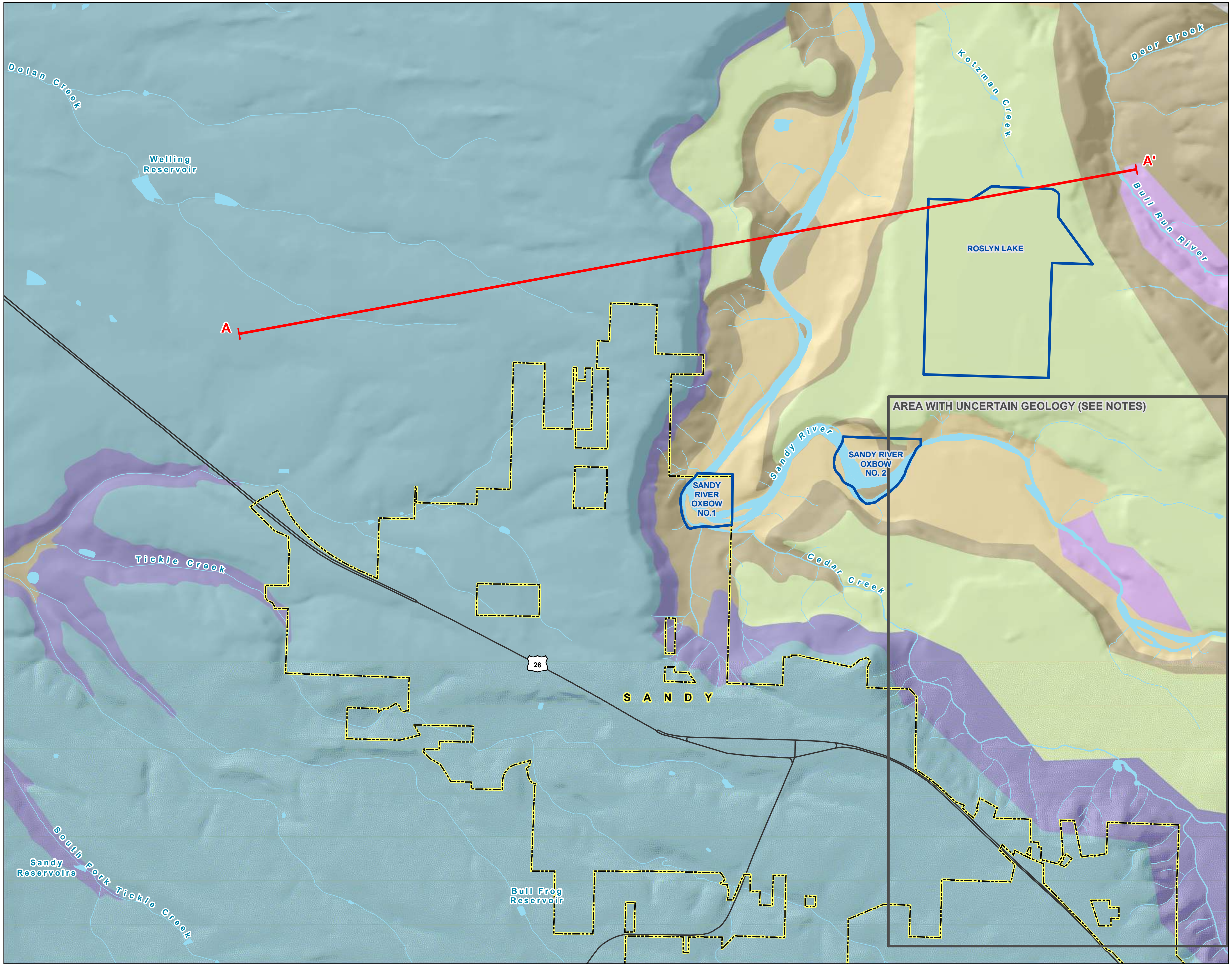

FIGURE 2

Geologic Map

City of Sandy
Wastewater Infiltration Analysis

LEGEND

- Cross Section Line

Geology

- 🟨 Qal = Quarternary Alluvium
- 🟩 Qtg = Terrace Deposits
- 🟦 Qts = Springwater Formation
- 🟪 Tts = Troutdale Formation Sandstone
- 🟫 Ttm = Troutdale Formation Mudstone (Sandy River Mudstone)
- 🟪 Ta2 = Rhododendron Formation

All Other Features

- Area of Interest
- Study Area
- City Boundary
- Major Road
- Watercourse
- Waterbody

NOTE

Geologic maps lump units in this area into a single, undifferentiated sedimentary unit; geology is based on GSI extrapolating units from other maps into this area.

N

0 1,100 2,200 3,300
Feet

Date: August 7, 2020
Data Sources: USGS, Oregon Explorer OSIP, 2018.
Schlicker, 1963.

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Figure2_Geologic_Map.mxd

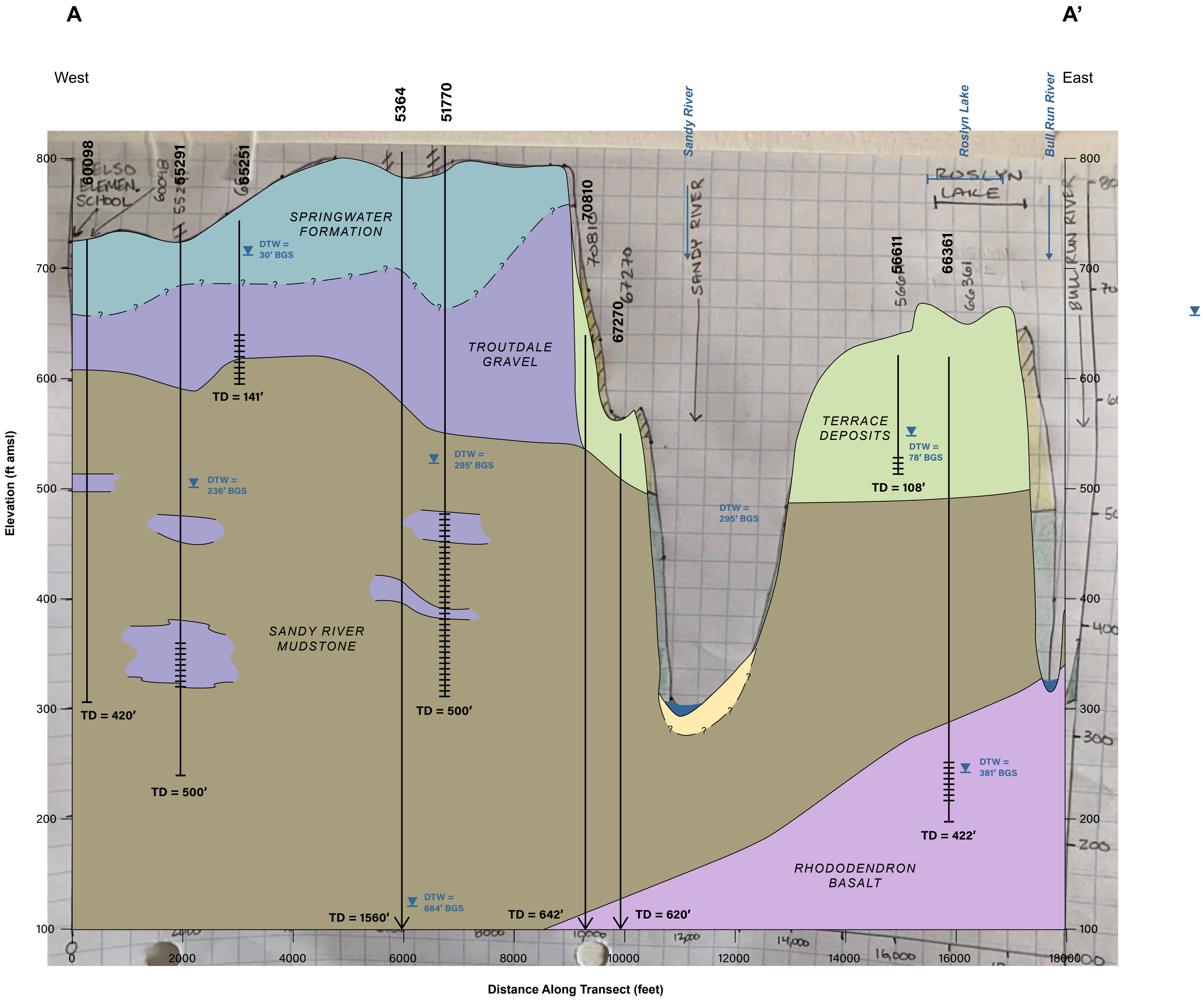

FIGURE 3

Cross Section A - A’

City of Sandy Wastewater
Infiltration Analysis

LEGEND

▼ Static Water Level

GEOLOGY LEGEND

▨ Quaternary Alluvium (Qal)

▨ Terrace Deposits (Qtg)

▨ Springwater Formation (Qts)

▨ Troutdale Formation Sandstone (Tts)

▨ Troutdale Formation Mudstone (Sandy River Mudstone) (Ttm)

▨ Rhododendron Formation (Ta2)

WELL LEGEND

Screen

TD = XXX’

NOTES

AMSL: Above Mean Sea Level
BGS: Below Ground Surface
DTW: Depth to Water
TD: Total Depth

GSI Water Solutions, Inc.

TECHNICAL MEMORANDUM

Evaluation of Sites for Alternative Wastewater Discharge Systems, City of Sandy, Oregon

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This technical memorandum (TM), prepared by GSI Water Solutions, Inc. (GSI), summarizes a desktop and limited field evaluation of sites for an alternative wastewater discharge system owned and operated by the City of Sandy (City). The TM is organized as follows:

- Section 1: Summarizes background information about the City's wastewater project.
- Section 2: Summarizes geology, hydrogeology, and shallow soil infiltration characteristics in the Study Area.
- Section 3: Summarizes results of a desktop and limited field evaluation at three candidate sites for an alternative wastewater discharge system, including soil infiltration characteristics with implications on facility type, likely Department of Environmental Quality (DEQ) water quality program permitting requirements, and recommended next steps for facility permitting and evaluation (data collection, modeling, etc.).
- Section 4: Conclusions.

1 Project Background

The City of Sandy is evaluating discharge alternatives for treated wastewater in lieu of or in combination with a direct year-round discharge to the Sandy River. In this TM, treated wastewater discharge systems that *do not* directly discharge to surface water are called "alternative wastewater discharge systems." For example, one type of alternative wastewater discharge system discussed in this TM is an indirect discharge system. Indirect discharge systems are typically located adjacent to rivers, and enhance effluent quality through various natural physical, chemical, and biological processes in soil and groundwater by infiltrating wastewater and diffusely discharging the wastewater to surface water via groundwater. The types of alternative wastewater discharge systems under consideration by the project team are infiltration basins with shallow groundwater discharge, constructed wetlands, evaporation ponds, and hyporheic discharge along the Sandy River or other stream corridors.

The overall Study Area for the City's discharge alternatives evaluation is shown in Figure 1. Figure 1 also shows three sites for alternative wastewater discharge systems currently under consideration by the City. The Roslyn Lake site is a candidate for infiltration basins and constructed treatment wetlands, and the Sandy River Oxbow sites are candidates for hyporheic discharge.

2 Geology, Hydrogeology, and Soil Conditions in the Study Area

This section provides an overview of the geologic and hydrogeologic setting, which is important because it affects permitting, feasibility of a certain type of system, and fate and transport of pollutants (Section 2.1), and surficial soil conditions, which are important because they affect feasibility of a certain type of system (Section 2.2).

2.1 Geologic and Hydrogeologic Setting in the Study Area

The Study Area is located on the eastern margin of the Portland Basin, which is a topographic and structural depression located in northwestern Oregon and southwestern Washington covering approximately 1,300 square miles. The sides of and bottom of the basin are formed by basalt bedrock, and, in the Study Area, the basin has been filled with between approximately 200 feet (eastern portion) to 1,000 feet (western portion) of unconsolidated sediments (Swanson et al., 1993).

The unconsolidated sediments in the Study Area have been grouped into geologic units, which are packages of soil or rock that share common features (e.g., age, lithology, origin, etc.). Geologic units in the Study Area are shown in Figure 2 (surficial geology) and Figure 3 (geologic cross section). The Quaternary Alluvium (Qal), Terrace Deposits (Qtg), and Springwater Formation (Qts) are present in the Study Area at ground surface and are characterized by relatively flat slopes (<10%). As such, these units comprise the surficial geology at candidate infiltration sites, and are described in the following bullets, which are organized from the youngest to the oldest geologic unit (Schlicker and Finlayson, 1979; Beaulieu, 1974):

- **Quaternary Alluvium (Qal).** The Quaternary Alluvium is comprised of recently-deposited sand, gravel and cobbles within the channel of the Sandy River.

- **Terrace Deposits (QTg).** Terrace deposits occur as benches above the Sandy River, and were deposited by the ancestral Sandy River during the Pleistocene Epoch[1], a time of relatively higher sea levels when the river was a lower-energy environment. The deposits are comprised of fluvial and glaciofluvial cobble- to boulder-sized gravels with relatively poor drainage due to extensive weathering.

- **Springwater Formation (QTs).** Located west of the Sandy River, the Springwater Formation is comprised of mudflows and gravels that are deeply-weathered to a clayey soil characterized by poor drainage.

As shown on the cross section in Figure 3, the Quaternary Alluvium is directly connected to the Sandy River, while the Terrace Deposits are hydraulically isolated from the Sandy River due to the underlying Sandy River Mudstone, which is a thick (over 200 feet) sequence of siltstone and claystone. As shown on Figure 2, the Springwater Formation is likely connected to the surface water features west of the Sandy River in much of the Study Area (i.e., Tickle Creek, Dolan Creek, etc.).

2.2 Surficial Soil Conditions in the Study Area

Figure 4 shows the ground slope, soil favorability to infiltration, and thickness of surficial silts and clays in the Study Area. Figure 4 is based on surficial soil data from the U.S. Department of Agriculture Natural Resources Conservation Service (USDA, 2020) and driller logs from the Oregon Water Resources Department on-line well

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[1] The Pleistocene Epoch is a geologic time period that lasted from about 2.6 million years ago to 12,000 years ago.

log query (OWRD, 2020)[2]. Note that surficial soil data from the USDA is a planning-level tool because the data is from a large-scale, generalized mapping effort, and soil types provided by USDA can thus vary from soil types at the site-scale. The following sections provide additional detail about ground slope (Section 2.2.1), surficial soil favorability to infiltration (Section 2.2.2), and thickness of surficial silts and clays (Section 2.2.3) in the Study Area. The soil properties were used to select candidate sites for a focused evaluation, in conjunction with an analysis conducted by Murraysmith that considered property ownership, existing pipeline alignments, and regulatory requirements (e.g., from the U.S. Army Corps of Engineers, etc.).

2.2.1 Ground Slope

Areas with steep ground slope are not ideal for an alternative wastewater disposal system, either because the slopes are too steep to accommodate a system or because significant earthwork would be required to grade the site. Hatched areas in Figure 4 indicate that ground slope exceeds 10%. Areas with ground slope exceeding 10% typically occur along hillsides that have been incised by rivers, and are typically characterized by slopes of over 40%.

2.2.2 Surficial Soil Favorability to Infiltration

The favorability of shallow soil to infiltration may affect whether a certain type of alternative wastewater discharge system is feasible at a site. Shallow soil favorability to infiltration is shown in Figure 4, and is based on saturated hydraulic conductivity (K_{sat}), a physical property that measures the ability of a soil to transmit water (specifically, the rate that a soil transmits water per unit area per unit hydraulic gradient).

In the Study Area, shallow soil favorability to infiltration ranges from “poor” (a K_{sat} of less than 0.5 inches per hour) to “good” (a K_{sat} of over 2 inches per hour). Areas with “good” infiltration correspond with the Quaternary Alluvium geologic unit that occurs adjacent to the Sandy River (see Figure 2). Most other shallow soil in the Study Area is characterized as “poor” to “moderate” favorability to infiltration, corresponding to the Terrace Deposits and Springwater Formation. The low saturated hydraulic conductivities of the Terrace Deposits and Springwater Formation are consistent with Schlicker and Finlayson (1979), who note that the Terrace Deposits are not suitable for septic drainfields, and that the Springwater Formation is characterized by poor drainage.

2.2.3 Thickness of Surface Silt/Clay

The poor and moderate infiltration favorability of shallow soil are caused by extensive weathering of the shallow Terrace Deposits and Springwater Formation to silt and clay (Schlicker and Finlayson, 1979; Beaulieu, 1974). The thickness of this surficial silt/clay is an important consideration in alternative wastewater discharge facility siting because thin surficial silts and clays may be removed with a moderate amount of earthwork. Conversely, thicker accumulations of silt and clay may preclude some types of systems, or make them less cost-effective to construct and/or operate (e.g., infiltration systems).

In order to evaluate the thickness of the shallow silt/clay, GSI downloaded water well driller logs from the OWRD well log database (OWRD, 2020), and, at each well location, classified the silt/clay thickness as “<15 feet” (green wells in Figure 4), “15 to 30 feet” (orange wells in Figure 4), or “>30 feet” (red wells in Figure 4). West of the Sandy River, where the Springwater Formation is present at ground surface, the shallow silt/clay soils are generally over 30 feet thick. East and just south of the Sandy River, where the Terrace Deposits are present at ground surface, the shallow silt/clay soils are typically less than 15 feet thick, although they are reported to be 15 to 30 feet thick in some areas.

3 Evaluation of Candidate Sites for an Alternative Wastewater Discharge System

The City of Sandy selected three (3) candidate sites for an alternative wastewater discharge system based on existing pipeline alignments, regulatory requirements (e.g., from DEQ, U.S. Army Corps, etc.), property

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[2] Only well logs that could be exactly located (i.e., to a property address or latitude/longitude) were used in this study.

ownership, and the soil conditions discussed in Section 2.2. The following sections summarize a desktop and limited field evaluation of these three sites, and include information about the soil infiltration characteristics, DEQ water quality program permitting requirements, potential fatal flaws, and recommended next steps for facility permitting with the DEQ water quality program. Refer to GSI (2020) for a detailed analysis of permitting an alternative wastewater discharge system with the DEQ water quality program.

3.1 Roslyn Lake

In 1912, an artificial lake was constructed at the Roslyn Lake site to provide water storage for the Bull Run power plant (Ebasco Infrastructure, 1992). In 2008, the lake was drained and regraded, resulting in a 285 acre basin defined by natural topography to the south and raised roadways and embankments to the east, west and north (MSA, 2009). The approximate footprint of the former lake, and the Roslyn Lake property boundary are shown in Figure 5.

3.1.1 Roslyn Lake Soils

As shown in Figure 5, three soil types are present at the site, all of which are characterized by the following drainage rates:

- The Alspaugh Clay Loam (2B and 2C) underlies the former Roslyn Lake footprint, and is characterized by saturated hydraulic conductivities ranging from 0.20 inches per hour (0.40 feet per day) to 0.57 inches per hour (1.14 feet per day),
- The Bull Run Silt Loam (9B) is present in the southwest corner of the property outside of the former Roslyn Lake footprint, and is characterized by saturated hydraulic conductivities ranging from 0.57 inches per hour (1.14 feet per day) to about 2 inches per hour (4 feet per day).

Note that saturated hydraulic conductivity, a measure of soil permeability, is not equivalent to infiltration rate. Hydraulic conductivity is the rate that water moves through soil per unit area per unit hydraulic gradient, infiltration rate is the rate that water moves through soil under a given set of head and facility design conditions.

On June 23, 2020, GSI staff collected soil samples at the Roslyn Lake site using a hand auger at the boring locations shown in Figure 5, and logged the soils in general accordance with the Unified Soil Classification System visual-manual method (ASTM, 2017). The observed soil types were generally consistent with the soils reported by the USDA. At boring B-1, shallow soils were a fine sand to 1.5 feet below ground surface (bgs) underlain by a light brown silt to the maximum depth explored (about 4 feet bgs). The fine sand was likely deposited by the inlet creek to Roslyn Lake, and is present in the northeast area of the former lake area (see tan area in the aerial photo in Figure 5). Soils in boring B-2 and boring B-3 were silt to the maximum depth explored at those locations (about 2 feet bgs).

3.1.2 Roslyn Lake Infiltration Potential

We used the Hantush (1967) equation to estimate the volume of treated wastewater that may be infiltrated at the Roslyn Lake. It is important to note that the Hantush (1967) infiltration estimate is a planning-level estimate that may change based on site-specific conditions (e.g., soil hydraulic conductivity, depth to groundwater, infiltration facility size, duration of infiltration, etc.). The Hantush (1967) infiltration estimate is based on the following assumptions:

- Infiltration occurs in a rectangular-shaped basin in the southwest corner of the former lake that is 475 feet by 675 feet and about 320,500 square feet in area (about 7.6 acres), shown in Figure 5.

- The unsaturated zone thickness is 96 feet, which is based on a depth to median groundwater of 120 feet from Snyder (2008) and a 20 percent factor of safety.

- Each year, the infiltration facility is operational (i.e., continuously infiltrating) for 180 days, followed by an inactive period of 180 days.

- The specific yield [i.e., the ratio of: (1) the volume of water that a saturated soil yields by gravity drainage to (2) the total volume of the soil] of the terrace deposits is 0.19[3], and the hydraulic conductivity of the terrace deposits is 4.03 feet per day[4].

According to the Hantush (1967) calculations, the Roslyn Lake site would infiltrate about 65,500 cubic feet per day (a little less than 0.5 million gallons per day). This relatively low infiltration rate is consistent with the fact that permeability of soils at the property were sufficiently low to create an artificial lake. This estimated infiltration rate could likely be refined by direct measurement of hydraulic conductivity at the site.

3.1.3 DEQ Water Quality Permitting Requirements

An alternative wastewater disposal system at the Roslyn Lake site would be hydraulically separated from surface water bodies (i.e., the Sandy River) by the low permeability Sandy River Mudstone (see the cross section in Figure 3). Therefore, DEQ's water quality program may require a WPCF permit for the Roslyn Lake site (as opposed to a NPDES permit) if the facility is designed to infiltrate treated wastewater. However, we recommend discussing the Roslyn Lake site with DEQ to understand the site-specific data that DEQ will require to support a DEQ permitting decision because, as discussed in GSI (2020), recent court decisions have created some uncertainty about whether a WPCF or a NPDES permit is required for a facility that infiltrates treated wastewater, and DEQ will require site- and project-specific information to inform the required permit type.

3.1.4 Next Steps

We recommend the following next steps at the Roslyn Lake site to help inform DEQ permitting decisions and the type of alternative wastewater disposal system that is feasible. Throughout each step, we recommend communication with DEQ to solicit regulator input.

- **Infiltration Testing.** Conduct infiltration tests to verify the suitability of the site for various alternative wastewater disposal systems (infiltration basins with shallow groundwater discharge, constructed treatment wetlands and evaporation ponds, etc.) and quantify the amount of water that is likely to infiltrate at the site. The infiltration test data may inform DEQ water quality program permitting requirements.

- **Antidegradation Evaluation.** If the alternative discharge system is designed to infiltrate water, then protection of groundwater quality is likely to be a focus of DEQ's permitting actions because several domestic water supply wells have been completed in the Terrace Deposits around Roslyn Lake (see Figure 5). DEQ will require that the facility meet the groundwater antidegradation requirements in Oregon Administrative Rules (OAR) 340-040. We recommend that the City evaluate whether the treated wastewater meets background groundwater quality, which will involve collecting groundwater samples from the Roslyn Lake site, and comparing groundwater quality to treated water quality. Groundwater samples could be collected from existing water wells (if access can be arranged) or from newly-installed monitoring wells installed at the site.

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[3] A typical specific yield for a gravel, from Heath (1983).

[4] Calculated from specific capacity data reported on driller logs at two wells completed in the Terrace Deposits near Roslyn Lake. The specific capacity of CLAC 6679 is 4.0 gallons per minute per foot (bailer test, 20 gpm, 5 feet of drawdown) and the specific capacity of CLAC 18013 is 0.33 gallons per minute per foot (air test, 10 gpm, 30 feet of drawdown). Specific capacity was used to calculate transmissivity using the exact equation for unconfined aquifers (Driscoll, 1986). All variables were from the CLAC 6679 or CLAC 18013 well log, with the exception of storage [taken from Heath (1983)] and the bottom of the Sandy River Mudstone (taken from CLAC 66361). The calculated hydraulic conductivity of CLAC 6679 was 7.81 feet per day, and the calculated hydraulic conductivity of CLAC 18013 was 0.26 feet per day; the median hydraulic conductivity was 4.03 feet per day.

> If constituent concentrations in treated wastewater exceed background concentrations, then DEQ may require the City to develop and implement a plan to evaluate whether the project meets DEQ's groundwater antidegradation requirements. The City can meet DEQ's groundwater antidegradation requirements by showing that constituents in treated wastewater exceeding groundwater background do not reach a compliance point that DEQ chooses (i.e., typically DEQ chooses a water well or the property boundary). The evaluation may be comprised of installing and sampling monitoring wells and/or contaminant fate and transport modeling. Because the depth to groundwater at the Roslyn Lake site is about 120 feet below ground surface (Snyder, 2008), it is likely that unsaturated soils will provide sufficient natural treatment to reduce concentrations of elevated constituents to below background. However, we recommend site-specific data collection and potentially modeling to confirm that unsaturated soils provide sufficient natural treatment.

3.2 Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2

Alternative wastewater disposal systems at the Sandy River Oxbow sites would be intended to diffusely discharge treated wastewater to the Sandy River via groundwater; therefore, the Sandy River Oxbow sites comprise a hyporheic discharge. More specifically, DEQ has defined this type of alternative system as an *indirect discharge system*, by which municipal wastewater plant effluent is indirectly discharged to surface water via groundwater or hyporheic water. This classification has specific permitting implications discussed later in this section.

The Sandy River Oxbow sites (denoted by their property boundaries) are shown in Figure 5. On June 23, 2020, GSI staff visited the Sandy River Oxbow No. 1 site; no site visits have been made to the Sandy River Oxbow No. 2 site. The following analysis assumes that the soil types at the Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2 sites are similar.

3.2.1 Sandy River Oxbow Soils

As shown in Figure 5, the course of the Sandy River as denoted by the soil survey (tan polygon with translucent blue fill) does not precisely match the course of the Sandy River in the aerial photo. The lack of a match occurs because rivers are dynamic systems that change over time, and the soil mapping was conducted at a relatively large scale (i.e., 1:20,000). However, it is reasonable to assume that the gravels that underlie the Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2 are "73-Riverwash," which is a well-drained, stratified sand and gravel (USDA does not provide infiltration rate estimates for Riverwash). On June 23, 2020, GSI staff visited the Sandy River Oxbow No. 1 site and confirmed that the soils were comprised of clast-supported sandy gravel with clasts ranging from fine gravel to boulders.

The Sandy River Oxbow sites are situated on the Quaternary Alluvium geologic unit. GSI reviewed water well driller logs to estimate the thickness of the Quaternary Alluvium geologic unit, and found that it ranges from about 10 feet to 40 feet thick[5].

3.2.2 Sandy River Oxbow No. 1 and No. 2 Infiltration Potential

Although the USDA does not provide permeability data for the Riverwash in the Study Area, literature values of gravel hydraulic conductivity range from 40 in/hr to 4,000 in/hr (Domenico and Scwhartz, 1990) for clean gravels like the gravels observed during the June 23, 2020, site visit to the Sandy River Oxbow No. 1 site. Therefore, the Sandy River Oxbow sites are likely to have a high infiltration potential. Note that hydraulic conductivity, a measure of soil permeability, is not equivalent to infiltration rate; hydraulic conductivity is the rate that water moves through soil per unit area per unit hydraulic gradient.

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[5] See CLAC 73054 (9 feet thick) and CLAC 6688 (43 feet thick).

3.2.3 DEQ Water Quality Permitting Requirements for Sandy River Oxbow No. 1 and No. 2

Because an alternative waste disposal system at the Sandy River Oxbow No. 1 and No. 2 sites would dispose of municipal wastewater plant effluent by indirect discharge to surface water via groundwater or hyporheic water, the system would require an NPDES permit from DEQ's water quality program (see DEQ [2007] and GSI [2020]).

3.2.4 Next Steps

We recommend the following next steps at the Sandy River Oxbow sites to help inform DEQ permitting decisions and the type of alternative wastewater disposal system that is most feasible. Throughout each step, we recommend communication with DEQ to solicit regulator input.

- **Permitting Considerations.** An alternative waste disposal system on the Sandy River Oxbow site would be permitted under an NPDES permit. As such, we recommend that siting and design of a system consider NPDES permit conditions and discharge limitations on the Sandy River.

- **Sandy River Oxbow No. 2 Site Walk.** We recommend a site walk at the Sandy River Oxbow No. 2 site to verify that the soil conditions are similar to conditions at the Sandy River Oxbow No. 1 site.

- **Preliminary Evaluation of Sandy River Hydrologic Conditions.** The effectiveness and physical viability of a hyporheic (indirect) discharge system depends largely on the range of hydrologic conditions in the receiving stream, in this case the Sandy River. For example, seasonal stage fluctuations in the river will alter the hydraulic gradient between an indirect discharge system (e.g., infiltration galleries) and the river, such that discharge efficacy could be reduced, or even stopped, during high river stages. Also, potential flood conditions could significantly reduce the feasibility of a particular site. A preliminary evaluation of Sandy River hydrologic conditions, including a review of historic stage ranges and flood levels, is thus recommended as a next step for evaluating the Sandy River Oxbow sites.

4 Conclusions

The City of Sandy is considering alternative wastewater disposal systems at Roslyn Lake and at the Sandy River Oxbow sites (No. 1 and No. 2). Each site has unique soil conditions and permitting considerations that will affect the type of system that may be designed and constructed. The following sections summarize the results of the desktop and limited field evaluation. We recommend collecting site-specific data (e.g., infiltration tests) and engaging regulatory agencies on permitting framework to confirm these findings.

4.1 Roslyn Lake Site

- Surficial soils have a "poor" favorability to infiltration, and, based on several assumptions about soil and groundwater conditions, may infiltrate 0.5 MGD (planning-level estimate assuming a 7.6 acre infiltration basin). As such, alternative wastewater discharge systems that are not designed to infiltrate (e.g., constructed wetlands) are the most suitable types of systems at the site.

- If the facility is designed to infiltrate, then DEQ's water quality program may permit the facility under a WPCF permit. If the facility is not designed to infiltrate water (i.e., a constructed wetland created on low permeability or amended soils) and is a component of a surface water discharge system, then DEQ may permit the system under an NPDES permit.

- A key consideration for moving forward with development of the Roslyn Lake site is whether the system will be able to meet DEQ's groundwater antidegradation requirements, if a system is designed to infiltrate water. A comparison of treated water quality to native groundwater quality is the first step in this analysis; additional steps may involve pollutant fate and transport modeling and installation of monitoring wells.

It is important to implement the recommended next steps in Section 3.1.4 (for the Roslyn Lake site) and to successfully permit the site and design the alternative wastewater discharge system.

4.2 Sandy River Oxbow Sites

- Surficial soils have "good" favorability to infiltration, and are a strong candidate for a hyporheic discharge system.
- DEQ's water quality program will most likely permit the facility under an NPDES permit.
- Key considerations for moving forward with development of the Sandy River Oxbow sites will be to evaluate hydrologic conditions at the sites, and to understand how NPDES permitting regulations would affect the feasibility and operation of the system.

It is important to implement the recommended next steps in Section 3.2.4 (for the Sandy River Oxbow site) to successfully permit the site and design the alternative wastewater discharge system.

5 References

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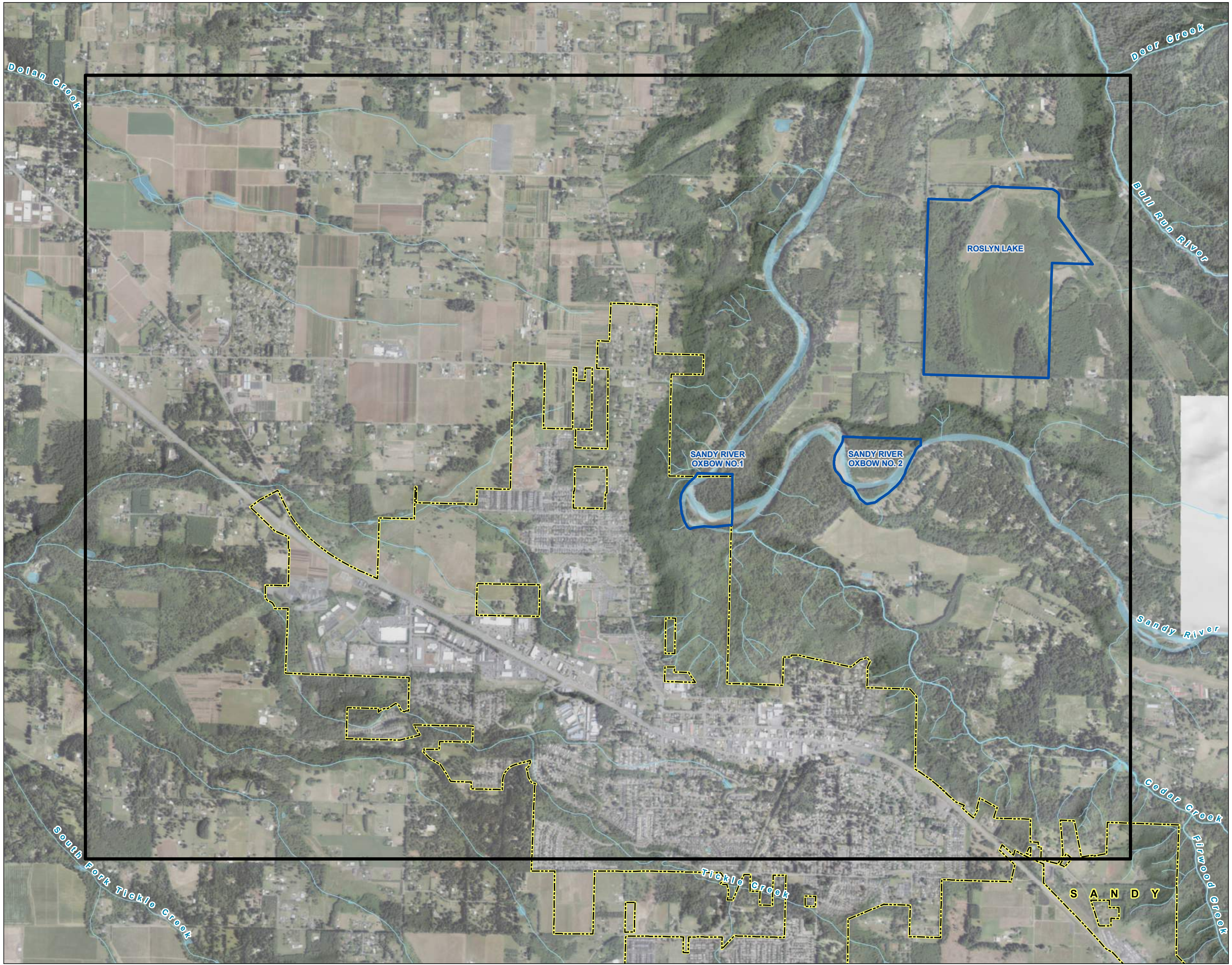
FIGURE 1

Study Area

Evaluation of Alternative Wastewater Discharge System Sites



LEGEND

- Area of Interest
- Study Area
- City Boundary
- Watercourse
- Waterbody

N

0 1,000 2,000 3,000

Feet

Date: September 1, 2020
Data Sources: USGS, COP Imagery Summer 2019, METRO

GSI Water Solutions, Inc.

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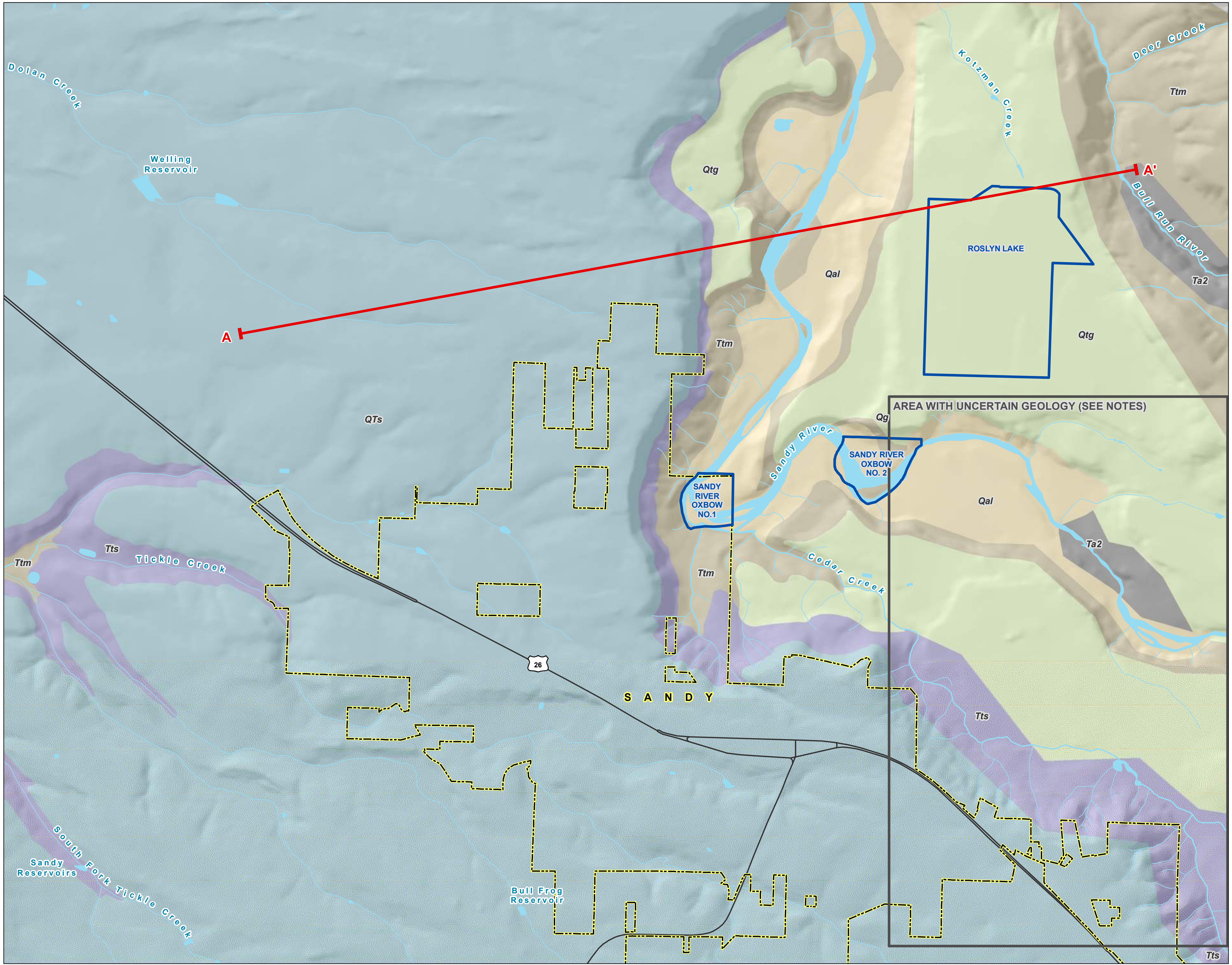

FIGURE 2

Geologic Map

Evaluation of Alternative
Wastewater Discharge System Sites

LEGEND

Cross Section Line

Geology

- Qal = Quarternary Alluvium
- Qtg = Terrace Deposits
- Qts = Springwater Formation
- Tts = Troutdale Formation Sandstone
- Ttm = Troutdale Formation Mudstone (Sandy River Mudstone)
- Ta2 = Rhododendron Formation

All Other Features

- Area of Interest
- City Boundary
- Major Road
- Watercourse
- Waterbody

NOTE

Geologic maps lump units in this area into a single, undifferentiated sedimentary unit; geology is based on GSI extrapolating units from other maps into this area.

N

0 1,000 2,000 3,000
Feet

Date: September 1, 2020
Data Sources: USGS, Oregon Explorer OSIP, 2018.
Schlicker, 1963.

GSI Water Solutions, Inc.

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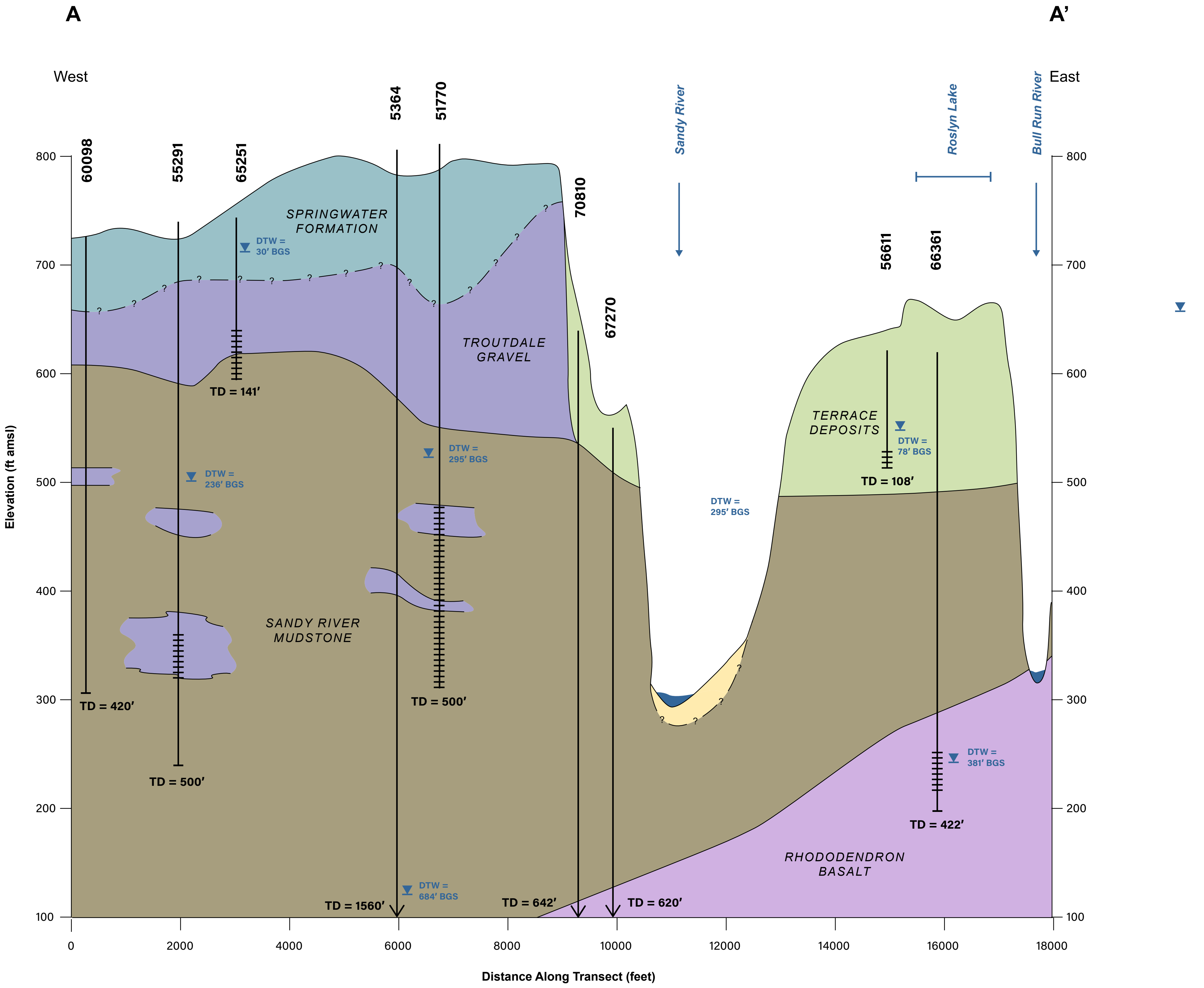

FIGURE 3

Cross Section A - A’

Evaluation of Alternative
Wastewater Discharge System Sites

LEGEND

▼ Static Water Level

GEOLOGY LEGEND

- 🟨 Quaternary Alluvium (Qal)
- 🟩 Terrace Deposits (Qtg)
- 🟦 Springwater Formation (Qts)
- 🟪 Troutdale Formation Sandstone (Tts)
- 🟫 Troutdale Formation Mudstone (Sandy River Mudstone) (Ttm)
- 🟪 Rhododendron Formation (Ta2)

WELL LEGEND

Screen

TD = XXX’

NOTES

AMSL: Above Mean Sea Level
BGS: Below Ground Surface
DTW: Depth to Water
TD: Total Depth

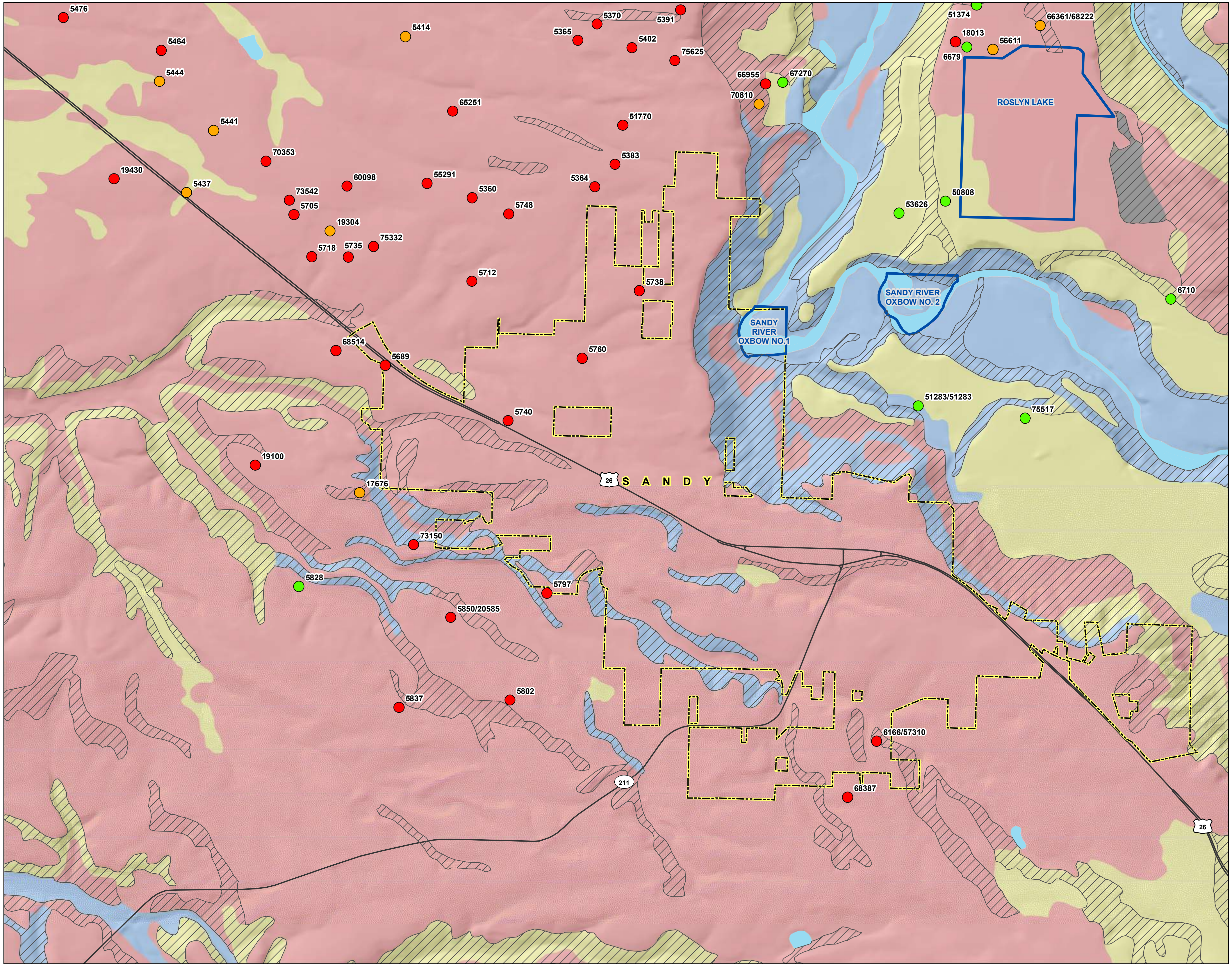

FIGURE 4

Favorability of Surficial Soils to Infiltration and Surficial Silt/Clay Thickness

Evaluation of Alternative Wastewater Discharge System Sites

LEGEND

Shallow Soil Favorability to Infiltration

- 🟥 Poor (Ksat from 0.0 to 0.5 in/hr)
- 🟨 Moderate (Ksat from 0.5 to 2 in/hr)
- 🟦 Good (Ksat >2 in/hr)

Surface Clay/Silt Thickness

- 🟩 <15 feet
- 🟧 15 to 30 feet
- 🟥 >30 feet

All Other Features

- ⬛ Gravel Pit
- ▨ Slope is Greater Than 10%
- ☐ Area of Interest
- ☐ City Boundary
- ╱ Major Road
- ～ Watercourse
- 🟦 Waterbody

NOTE

Soil data is representative of soils from ground surface to 6.5 feet below ground surface.

N

0 1,100 2,200 3,300
Feet

Date: September 1, 2020
Data Sources: NRCS, USGS

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Focused_Evaluation_Memo\Figure4_Favorability_of_Surficial_Soils_to_Infiltration_Thickness.mxd

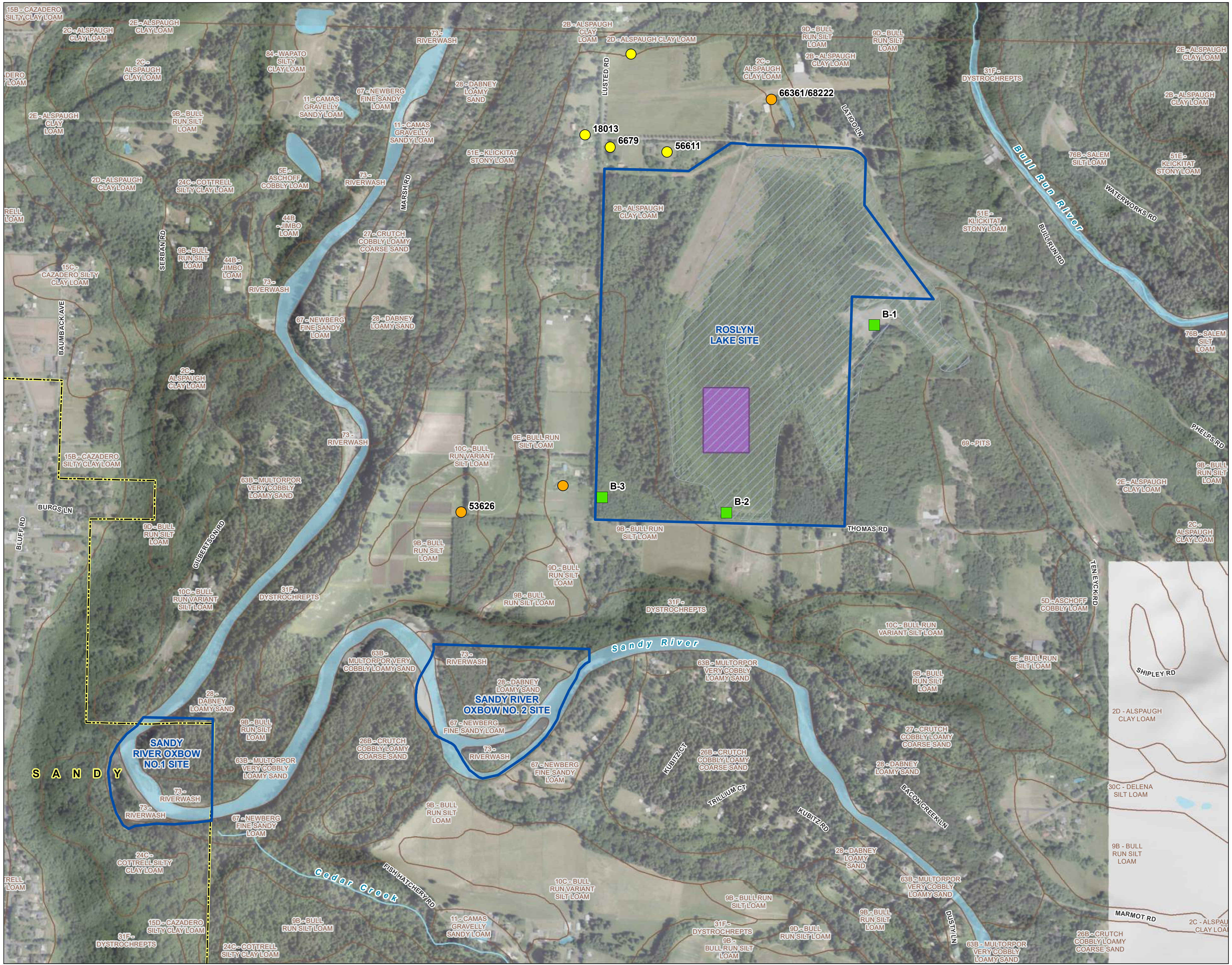

FIGURE 5

Roslyn Lake Site Detail

Evaluation of Alternative Wastewater Discharge System Sites

LEGEND

🟩 Boring

Water Well Completed In:

● Terrace Deposits

● Rhododendron Deposits

All Other Features

▭ Soil Type

▨ Recharge Basin

▭ Property Boundary

▭ City Boundary

▨ Former Lake Footprint

▨ Waterbody

N

0 500 1,000 1,500
Feet

Date: September 1, 2020
Data Sources: USGS

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Focused_Evaluation_Memo\Figure5_Roslyn_Lake_Site_Detail.mxd, npalmer

TECHNICAL MEMORANDUM

Infiltration Testing to Estimate Soil Permeability, Roslyn Lake, Sandy, Oregon

To: Ken Vigil, PE / Murraysmith Associates, Inc.
Katie Husk, PE / Murraysmith Associates, Inc.
Matt Hickey, PE / Murraysmith Associates, Inc.

From: Ellen Svadlenak, GIT / GSI Water Solutions, Inc.
Matt Kohlbecker, RG / GSI Water Solutions, Inc.
Jason Melady, RG / GSI Water Solutions, Inc.
Josh Bale, PE / GSI Water Solutions, Inc.

Date: January 12, 2021

Exp: 5/1/2021

This technical memorandum, prepared by GSI Water Solutions, Inc. (GSI), summarizes infiltration testing conducted to measure the permeability of soils at Roslyn Lake in Sandy, Oregon (Site), and discusses implications of the testing for developing constructed wetlands at the Site.

1. Introduction

Roslyn Lake was an artificial lake created in 1912 to provide water storage for the Bull Run power plant (Ebasco Infrastructure, 1992). In 2008, the lake was drained and regraded, resulting in a 285 acre basin defined by natural topography to the south and raised roadways and embankments to the west, north and east (MSA, 2009). The City of Sandy (City) is evaluating the site as a potential location for reuse of treated wastewater using constructed wetlands. Two of the wetlands ("Proposed Wetland A" and "Proposed Wetland B") are shown in Figure 1, and occupy natural topographic depressions within the former lake footprint.

Because the regional groundwater table at the Site is deep (about 120 feet below ground surface [Snyder, 2008]), constructed wetlands will require relatively low permeability surficial soils. If the permeability of native soils is too high, then soil permeability would need to be reduced (e.g., by adding a soil amendment) to support a constructed wetland. During the summer of 2020, GSI conducted a desktop evaluation and limited field investigation of the potential to dispose of treated wastewater at the Site assuming a variety of reuse methods (GSI, 2020). Based on regional-scale soil maps from the U.S. Department of Agriculture (USDA), the desktop evaluation assumed that the Asplaugh Clay Loam is the native soil type within the former Roslyn Lake footprint[1]. Table 1 shows the permeability profile for the Asplaugh Clay Loam as reported by the USDA. The USDA indicates that native soils at the Site are characterized by a relatively low permeability.

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[1] USDA soil surveys have not been updated to include Roslyn Lake since it was drained in 2008. Therefore, GSI assumed that the Asplaugh Clay Loam, which surrounds the former lake footprint, is also present beneath the former lake footprint.

Table 1. Roslyn Lake USDA Soil Properties

Property	USDA Soil Group	USDA Saturated Hydraulic Conductivity		USDA Average Saturated Hydraulic Conductivity*
		Depth	Saturated K	
Roslyn Lake	2B – Asplaugh Clay Loam	0" – 14"	0.6 – 2 in/hr	0.48 in/hr
		14" – 43"	0.2 – 0.6 in/hr	
		43" – 60"	0.2 – 0.6 in/hr	

Note:
* Average saturated hydraulic conductivity was calculated by taking the geometric mean of the soil horizons' midrange permeability
K = Saturated Hydraulic Conductivity

Because the USDA permeability profile is a regional-scale summary of soil properties, GSI recommended infiltration testing at the Site to verify suitability for various alternative wastewater reuse systems (e.g., constructed wetlands and evaporation ponds) and to inform Department of Environmental Quality (DEQ) water quality program permitting requirements. This memo documents the results of the infiltration testing, which was conducted on December 11, 2020.

2. Methods

GSI conducted two infiltration tests at the Site. Locations for the two infiltration tests were chosen to be as close to the footprints of the proposed wetlands as practical (i.e., based on accessibility by heavy equipment and to minimize disturbance to the Site). Test locations are shown in Figure 1. Both tests were located within the footprint of Proposed Wetland B.

The infiltration test data were used to estimate soil permeability at each test location in general accordance with the United States Department of the Interior (USDI) Test Pit Method (USDI, 1993). Specifically, the USDI test pit method measures saturated hydraulic conductivity, which is defined as infiltration rate per unit hydraulic gradient. The City of Sandy excavated test pits and a GSI geologist logged the soils in accordance with the Unified Soil Classification System (USCS) visual-manual method (ASTM, 2017). Test pits were excavated into native soils beneath the ancestral lakebed deposits, to a depth of up to four feet below ground surface. At each testing location, potable water was introduced into the test pit for up to 3 hours and measurements of water column height and flow rate were recorded every five minutes. The purpose of monitoring water column height and flow rate is to ensure that the measured saturated hydraulic conductivity is representative of flow under the saturated conditions that occur in soil beneath an infiltration facility. Specifically, due to matric (negative pressure) forces, water added to dry soils moves faster than water added to saturated soils; a stable flow rate and water column height indicates that matric forces have become negligible as soils have become saturated, and that gravity is the primary force causing infiltration (USDA, 1982; Iowa DNR, 2020). After infiltration rate and water column height had stabilized for at least 20 minutes, the saturated hydraulic conductivity was calculated using Equation (4) of USDI (pg. 103, 1993):

$$K = \frac{1{,}440(Q)}{(C)(a)(D)} \tag{1}$$

Where:

K is saturated hydraulic conductivity in feet per day,
1,440 is a conversion factor to convert minutes to days,
Q is the flow rate into the test pit during the test in cubic feet per minute,
D is the water column height in the test pit in feet,
a is the smallest surface dimension of the test pit in feet, and
C is the conductivity coefficient, which is a constant based on the shape of the test pit (i.e., rectangle, square, or circle) and ratio of water column height to test pit surface dimension (i.e., *D* / *a*).

Following the infiltration test, excavated soils were returned to the pit and soils were tamped down using the excavator.

3. Results

As shown in the test pit logs (Attachment A), subsurface soils were comprised of Lakebed Sediments overlying Native Soil. Lakebed sediments were silts and silty sands, and ranged from one foot thick (RL-TP-2) to 1.6 feet thick (RL-TP-1). Native soils ranged from a sandy silt to a sand.

Flow rate and water column height stabilized about 30 minutes (RL-TP-1) to 90 minutes (RL-TP-2) into the infiltration test (see infiltration test data sheets in Attachment B). Table 2 shows the variables that were used to calculate saturated hydraulic conductivity at each test pit location, and the values of saturated hydraulic conductivity calculated using Equation (1). The calculated saturated hydraulic conductivities ranged from 31.6 inches per hour to 432.7 inches per hour, which are two to three orders of magnitude higher than the range provided by USDA the soil survey (0.48 inches per hour). The higher calculated hydraulic conductivities are consistent with the fact that the native soils were coarser than described in the USDA soil survey (i.e., sandy silt and sand in Attachment A as compared to a clayey silt in the USDA soil survey). Note that the calculated saturated hydraulic conductivities are reasonable given the expected range for hydraulic conductivity of a poorly graded sand (SP) and sandy silt (ML) (see permeability ranges in Anderson and Woessner, Table 3.3, 1992)[2].

Table 2. Tested Sites and Calculated Soil Properties

Test Location	USCS Classification	Flow Rate, *Q*	Conductivity Coefficient, *C*	Surface Dimension, *a*	Water Column Height, *D*	Saturated Hydraulic Conductivity, *K*	Saturated Hydraulic Conductivity, *K*
RL-IT-1*	Poorly Graded SAND (SP)	2.975 gpm 0.398 ft^3/min	5.294	1.0 ft	0.125 ft	865.4 ft/day	432.7 in/hr
RL-IT-2	Sandy SILT (ML)	1.689 gpm 0.31 ft^3/min	5.914	1.5 ft	0.583 ft	63.1 ft/day	31.6 in/hr

Notes

*K calculated based on about 2 hours of infiltration. After 2 hours, a constant flow rate could no longer be maintained due to a decrease in head in the portable water tanks that supplied water to the test pit.
ft^3/min = cubic feet per minute
ft/day = feet per day
in/hr = inches per hour
ft = feet
gpm = gallons per minute
USDA = United States Department of Agriculture
USCS = Unified Soil Classification System

4. Conclusions and Recommendations

This technical memorandum provides estimates of soil permeability (hydraulic conductivity) at Roslyn Lake based on testing at two locations that were selected due to ease of access and to minimize disturbance to the Site. These estimates are intended as a planning-level data; additional soil permeability characterization is necessary to guide future implementation efforts for constructed wetlands (specifically, higher-resolution soil permeability will need to be measured within the footprints of the proposed wetlands). We make the following conclusions based on this analysis:

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[2] According to Anderson and Woessner (Table 3.3, 1992), the hydraulic conductivity of a “clean sand” is between 1 feet/day and 750 feet/day, and the hydraulic conductivity of a “silty sand” is between 0.1 feet/day and 50 feet/day.

- Infiltration testing targeted native soils that were inferred to be relatively impermeable based on USDA soil surveys. The infiltration testing revealed that soils at the locations tested within the Site are in fact more coarse-grained and permeable than reported by the USDA.

- Native soils are heterogeneous across the site, ranging from a sandy silt to a sand, with saturated hydraulic conductivities ranging from about 60 feet per day to 860 feet per day.

We make the following recommendations for implementing a constructed wetland project at Roslyn Lake:

- This memo provides estimates for the *hydraulic conductivity* of soils at the former Roslyn Lake property. Constructed wetland design will be based on assumptions about the *infiltration rate* of soil. As discussed earlier, hydraulic conductivity is not necessarily the same as infiltration rate (specifically, hydraulic conductivity is the infiltration rate under a hydraulic gradient of 1.0). For constructed wetland design purposes, we recommend calculating an infiltration rate that assumes a unit hydraulic gradient or less, depending on the desired level of conservatism involved in the design[3]. Note that a factor safety should also be applied to the infiltration rate to account for reductions in infiltration over the lifetime of the infiltration facility (e.g., clogging of soil pores due to sediment).

- To assist in evaluating the extent of modification necessary to reduce soil permeability to a level that can support wetland development, GSI recommends conducting additional infiltration testing and soil profiles to determine the depth and spatial distribution of permeable soils. Testing should occur within the footprints of “Proposed Wetland Area A” and Proposed Wetland Area B,” which are currently the wetland areas proposed for development.

- Soils at the Roslyn Lake site are permeable. Therefore, it may be necessary to reduce the soil permeability in order to: (1) establish wetlands at the site and (2) meet the Department of Environmental Quality’s groundwater protection rules.

    - **Permeability Reduction.** Permeability reduction can be achieved in a variety of ways. One option for reducing permeability is compacting site soil, either by stripping soil to a design depth and recompacting in lifts or simply applying sheep-foot or smooth drum roller compaction at sufficient ground pressure. However, permeability reduction may be limited by the soil types present in surface soil, and creating a highly compacted surface may increase runoff rates to unacceptable levels and inhibit growth of plant media in the short- or long-term. Another option for permeability reduction is blending a soil amendment into native soils to a design depth. However, soil amendments must be weighed against geochemical changes in the soil, physical and/or chemical changes in run-off characteristics, nutrient needs of re-stablished plant communities, and compatibility with the plant communities that are to be re-established. A third option for reducing soil permeability is to install impermeable or low-permeability engineered layers (geosynthetics or low-permeability blankets) (EPA, 1995) to limit or prevent infiltration. However, installation of engineered layers involves significant construction activities, will likely change the geochemistry of any soil present

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[3] According to the equation that relates hydraulic conductivity to infiltration rate, hydraulic conductivity and infiltration rate are positively correlated at a 1:1 ratio (i.e., doubling the hydraulic gradient would double the infiltration rate). However, in practice, the relationship between hydraulic conductivity and infiltration rate is non-linear due to the increased presence of non-laminar flow and other hydraulic factors as hydraulic gradient increases. As such, doubling the hydraulic gradient would increase, but not double, the infiltration rate.

above the layer, and may interfere with the natural wetting and drying cycles that most plants, including wetland plants, experience.

- **DEQ Groundwater Protection Rules.** DEQ's groundwater protection rules[4] require that groundwater quality beneath the Site not be degraded by application of treated wastewater. Given the highly permeable soils at the site, it is possible that residual levels of highly mobile pollutants in the treated wastewater (e.g., nitrate) may migrate to groundwater. DEQ may require fate and transport modeling and/or groundwater quality monitoring to demonstrate that the project meets the groundwater protection rules. However, if soil permeability is reduced, then DEQ may not require additional work to demonstrate that the project meets the groundwater protection rules because permeability reduction may reduce or eliminate infiltration of treated wastewater.

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[4] Oregon Administrative Rules 340-040

5. References

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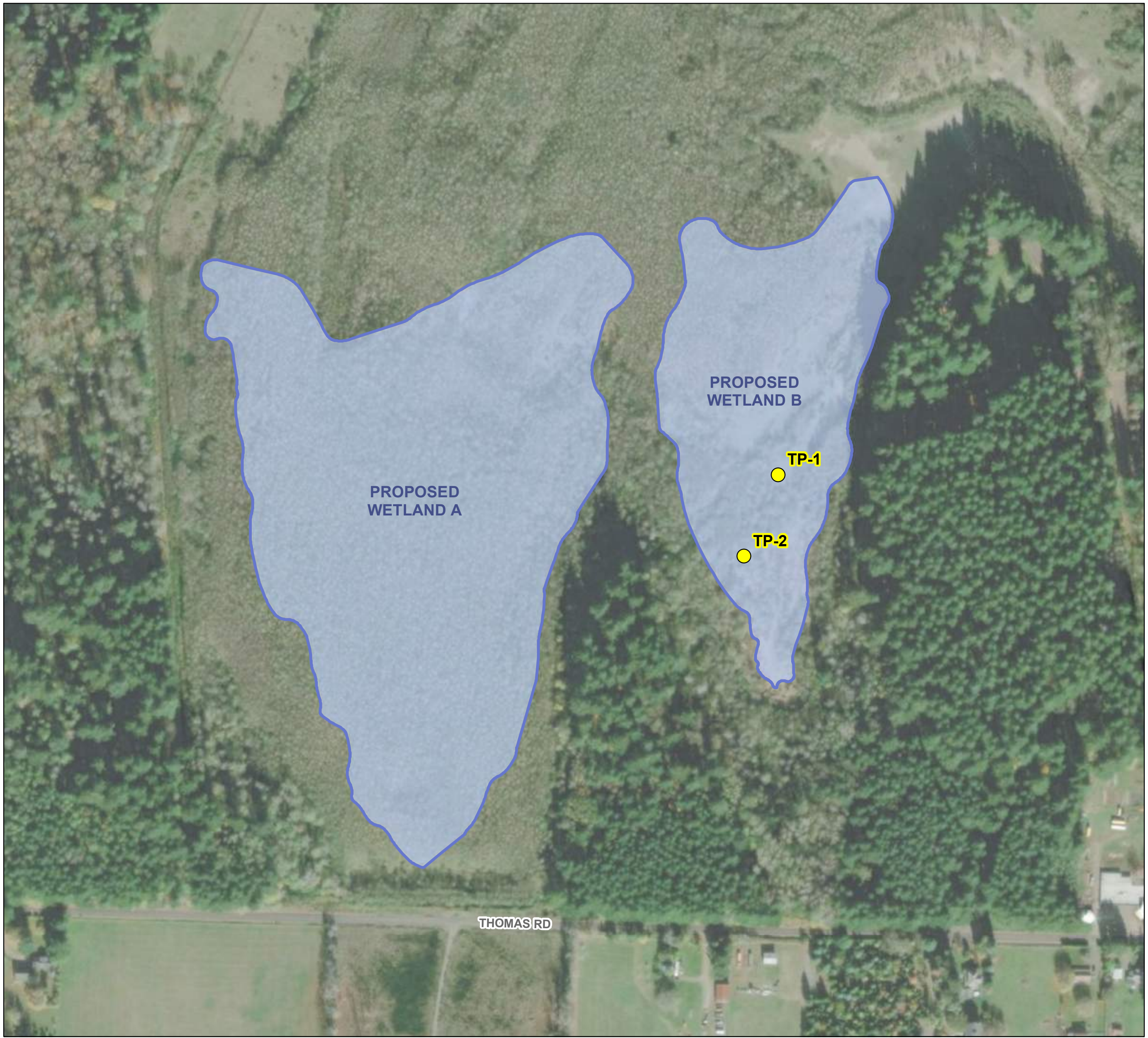
USDI. 1993. Drainage Manual: A Water Resources Technical Publication. U.S. Department of the Interior, Bureau of Reclamation. 340 pp.

FIGURE 1

Locations of Test Pits and Proposed Wetlands

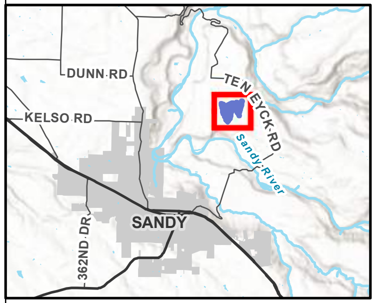
Roslyn Lake
Infiltration Testing



LEGEND

- ● Test Pit
- ▨ Proposed Wetland
- ☐ Tax Lot
- 〰 Watercourse

LOCATOR MAP



N

0 200 400
Feet

Date: December 21, 2020
Data Sources: USGS, ESRI

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Figure1_TestPits_ProposedWetlands.mxd, abarry

ATTACHMENT A

Test Pit Logs

GSI Water Solutions, Inc.

Test Pit ID: RL-IT-1

PROJECT: Sandy WWTP Infiltration Evaluation

LOCATION: Roslyn Lake, Sandy, OR

EXCAV. CONTRACTOR: City of Sandy

SAMPLING METHOD: Grab samples

EXCAVATION METHOD: Backhoe

GROUND SURFACE ELEVATION AND DATUM: 656 ft (WGS84)

TOTAL DEPTH (ft): 4.2

DATE STARTED: 12/11/2020

LOGGED BY: E. Svadlenak, M. Kohlbecker

DATE FINISHED: 12/11/2020

DEPTH TO WATER (ft bgs) **FIRST:** **COMPLETED:**

DEPTH (feet)	**SAMPLES** Sample ID	Sample Interval	**SAMPLE DESCRIPTION** Density, color, moisture, modifiers and MAJOR CONSTITUENT (USCS), grain size, shape, and gradation, dtructure, bedding, cementation, minerology, organics, odor, (FORMATION ACRONYM)		**NOTES**
0.0			ML	Soft, brown, moist, SILT (ML), some clay, abundant roots [TOPSOIL]	*Soil log is from a 3 foot wide, 6 foot long, 4.2 foot deep test pit located about 15 feet south from the 1 foot wide, 2 foot long, 2.4 foot deep test pit where the infiltration test was conducted.
0.5			SM	Loose, gray, moist, silty SAND (SM), poorly graded [LAKEBED SEDIMENTS]	
1.0					
1.5			ML	Stiff, brown, moist, SILT (ML), some clay, medium plasticity, red/orange mottling [LAKEBED SEDIMENTS]	
2.0			SP	Very loose, gray, moist, poorly graded SAND (SP), sand is fine to medium, subrounded, with trace silt [NATIVE SOIL]	
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

Test Pit ID: RL-IT-2

PROJECT:	Sandy WWTP Infiltration Evaluation	**GROUND SURFACE ELEVATION AND DATUM:** 656 ft (WGS84)	
LOCATION:	Roslyn Lake, Sandy, OR	**TOTAL DEPTH (ft):** 2.2	DATE STARTED: 12/11/2020
EXCAV. CONTRACTOR:	City of Sandy	**LOGGED BY:** E. Svadlenak	**DATE FINISHED:** 12/11/2020
SAMPLING METHOD:	Grab samples	**DEPTH TO WATER (ft bgs)** **FIRST:**	**COMPLETED:**
EXCAVATION METHOD:	Backhoe		

DEPTH (feet)	**SAMPLES** Sample ID	Sample Interval		**SAMPLE DESCRIPTION** Density, color, moisture, modifiers and MAJOR CONSTITUENT (USCS), grain size, shape, and gradation, dtructure, bedding, cementation, minerology, organics, odor, (FORMATION ACRONYM)	**NOTES**
0.0					
0.5			**ML**	Soft, light brown, moist clayey SILT (ML) with some clay and little fine sand,medium plasticity, faint iron mottling, abundant roots in top 4 inches [LAKEBED SILTS]	
1.0					
1.5			**ML**	Very soft, dark brown, moist sandy SILT (ML), some fine sand, trace clay, trace gravel (cobbles <1" to 3" size), low to medium plasticity [NATIVE SOIL]	
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

ATTACHMENT B

Infiltration Test Data Sheets

Infiltration Test Pit Measurements

Project ~~RL TP 2b~~ Sandy Infiltration
Site ID Roslyn Lake

Page 1 **of** 2
Date 12/11/20

Test ID RL-TP-~~2b~~ 1
Test Start 0910 (pre-soak)
Test Stop 1206
Initial Water Level 0
Final Water Level
Measuring Point Descrip. Staff gage
Remarks
2 x 250 gal totes available

Pit Depth 2.4' ft
Pit Area 1 X 2 ft

Date/Time	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
910	0	0	19.6	~2.25	water on
0915	5	1.75"	29.9	2.258	
0918	8		~~4~~	~~3.222~~	↑Q to ~3.2 gpm
0920	10	2.5"	40.9	3.222	
0925	15	~2.6"	56.9	3.164	
0930	20	~2.5"	72.8	3.139	
0935	25	2.5"	88.4	3.098	
0940	30	2.5"	104.0	3.057	
0945	35	2.5"	119.1	3.024	
0950	40	2.5"	134.2	2.983	↑Q to 3.02 gpm
0955	hose disconnected from tank,				down for
	repairs				
1005		WL = 0			lifted gage back to 0
1010	60	"		3.009	running again @ 3gpm
1015	65	~1"	161.5	3.041	
1020	70	1.5"	177.2	3.024	
1025	75	1.5"	192.3	2.975	↑Q back to 3
1030	80	1.5"	207.1	2.975	↑Q back to 3.016
1035	85	1.5"	222.8	3.008	
1040	90	1.5"	237.1	2.958	↑Q to 3.024
1045	95	1.5"	252.3	2.991	
1050	100	1.5"	267.3	2.999	
1055	105	1.5"	282.2	2.905	↑Q to 3.024
1100	110	1.5"	298.1	2.983	

Infiltration Test Pit Measurements

Project Sandy WWTP

Site ID RL-TP-~~3~~1

Page 2 **of** 2

Date 12/11/20

Date/Time 12/11/20	Elapsed Time (min)	Water Depth level ~~(ft)~~ in	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
1105	115	1.5"	317.6	2.975	
1110	120	1.25"-1.5"	328.2	2.966	FR to 3.024
1115	125	~1.4"	344.4	2.983	*late reading
1120	130	~1.4"	358.7	2.958	valve fully open
1125	135	~1.4"	374.3	2.909	
1130	140	~1.4"	386.9	2.868	
1135	145	~1.3"	400.9	2.836	(had to switch ~~[illegible]~~ totes
1140	150	1.25"	411.8	2.835	WL dropped to ~1")
1145	155	1.25"	426.0	2.785	valve fully open
1150	160	1.25"	446.1	2.736	
1155	165	1.25"	454.2	2.703	
1200	170	1"	467.3	2.662	
1205	175	1"	480.5	2.620	
1206	176				water off
1207		0"			

Infiltration Test Pit Measurements

Project Sandy WWTP
Site ID RL-TP-1a

Page 1 of ___
Date 12/11/20

Test ID RL-TP-1
Test Start 840 (pre soak)
Test Stop ___
Initial Water Level ___
Final Water Level ___
Measuring Point Descrip. ___

Pit Depth 4.2' ft
Pit Area 2 x 4 'ft

Remarks
250 gal totes x 2

Date/Time 12/11/20	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
0839	0	0	0	0	
0840	0	0	0	3.75gpm	start
08[illegible]	still	0		4gpm	
	↳ cancel test, dig smaller pit				

Infiltration Test Pit Measurements

Project Sandy WWTP
Site ID Roslyn Lake

Page 1 **of** 2
Date 12/11

Test ID RL-TP-2
Test Start 1315
Test Stop 1550
Initial Water Level 0
Final Water Level 7''
Measuring Point Descrip. staff gage
Remarks
2x 250 gal totes available

Pit Depth ~~1.8~~ 2.2' ft
Pit Area 1.5 X 3 ft

Date/Time	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
1314	pre-test		482.7	0	
1315	0	0	482.7	~3.2	water on
1320	5	5.75''	492.7	3.197	
1325	10	7.25''	509.0	2.192	↓Q to ~2.2gpm @ 1322
1330	15	7''	518.6	1.829	↓Q to ~1.8 @ 1327
1335	20	6.75''	527.9	1.838	
1340	25	7''	537.0	1.829	
1345	30	7''	546.5	1.805	
1350	35	7''	555.2	1.780	
1355	40	7''	564.1	1.772	
1400	45	7''	572.9	1.760	
1410	55	7''	590.4	1.739	
1415	60	7''	599.6	1.730	
1425	70	7''	616.4	1.714	↓Q to 1.6 gpm
1430	75	6.75''	624.7	1.648	↑Q back to 1.7 gpm
1435	80	6.75''	633.4	1.755	
1440	85	7''	642.4	1.747	target Q closer to 1.7
1445	90	7''	651.0	1.689	
1450	95	7''	659.6	1.681	
1455	100	7''	668.0	1.664	
1500	105	7''	676.2	1.640	↑Q to 1.706 gpm
1505	110	7''	685.6	1.681	slightly late read
1510	115	7''	693.1	1.643	↑Q to 1.714 gpm
1515	120				missed

Infiltration Test Pit Measurements

Project Sandy
Site ID RL-TP-2

Page 2 of 2
Date 12/11/20

Date/Time 12/11/20	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
1520	125	7"	710.1	1.697	
1525	130	7"	718.4	1.689	
1530	135	7"	727.1	1.656	↑Q to 1.730
1535	140	7"	735.5	1.714	
1540	145	7"	744.2	1.689	
1545	150	7"	753.8	1.614	
1550	155	~7"	761	0.634	Tote pretty much out of water
1551	156	END			Water off, disconnect
1552		6"			falling head
1553		5.5"			
1554		5.25"			
1555		4.75"			
1556		4.5"			
1557		4"			
1558		3.75"			
1559		3.5"			
1600		3.25"			

SANDY
WHERE INNOVATION MEETS ELEVATION

39250 Pioneer Blvd
Sandy, OR 97055
503-668-5533

September 8, 2020

Tony Deis
Molly Strand Deis
Trackers Earth
41515 SE Thomas Rd
Sandy, OR 97055

RE: Letter of Mutual Interest for Roslyn Lake Wetlands Exploration

Dear Tony and Molly,

Thank you for continuing to work with the City of Sandy on the possibility of constructing wetlands and enhancing habitat on your property (the former Roslyn Lake). This letter outlines our joint interest in the city further exploring the possibility with your close involvement.

Since this effort will require city resources, site access, and coordination with you to conduct the studies, executing this letter of mutual interest provides a level of certainty for us in moving forward with the project. Additionally, the city's project team will soon be presenting the findings of our discharge alternatives analysis to the City Council which will include the recommendation to further study the Roslyn Lake option. Acknowledging our mutual interest studying this alternative is important before proceeding on a process that will soon become more public. If the studies confirm the project is feasible and approved by City Council, a formal long-term agreement would be negotiated with you for the use and delivery of recycled water to your property.

The city has been analyzing alternatives for discharging the highly treated wastewater that would be produced by a new wastewater treatment plant in the City of Sandy. High level planning efforts indicate that the concept to pipe the highly treated effluent from a state-of-the-art treatment new plant to a few constructed wetlands at the former Roslyn Lake site would conceptually work. This is a more sustainable, environmentally and habitat friendly alternative than only piping the effluent from a new discharge into the Sandy River. As we have discussed, it can also provide benefits to your operations and plans at the property with regards to outdoor education and recreation and natural area restoration. Early concepts show a potential need of 30-60 acres to construct the wetlands and native vegetation.

This letter of mutual interest outlines the commitments between the city and you, the property owner, in our carrying out of the feasibility work for this project.

Purpose

The city's contracted engineers and consultants will be conducting a feasibility review of applying highly treated effluent on the property for the purposes of creating a wetland habitat.

Project Coordination

The city and its project consultants will coordinate with the property owner throughout the process.

Site Access

During the term of this letter of interest, the property owner agrees to allow access to the property for the city to conduct its feasibility studies. This may include reviews of soils, vegetation, hydrology, topography, and surveys of existing infrastructure. However, to the extent that any investigations, surveys or other work is to be performed on the property, the city will provide reasonable written advance notice and obtain the property owner's, which consent shall not be unreasonably withheld, conditioned or delayed. The city shall restore the properties and improvements to the same condition they were in prior to any inspections, investigations, surveys, or other work by the city, its contractors, or its agents. The city shall indemnify, hold harmless, and defend the property owner from all liens, costs, and expenses, including reasonable attorneys' fees and experts' fees, arising from or relating to the city's, its contractors', or its agents' entry on and inspections investigations, surveys, or other work of the property, including all testing activities. This agreement to restore, indemnify, hold harmless, and defend the property owner shall survive closing or any termination of this letter of interest.

Schedule and Termination

The feasibility study is expected to take 6 months. The city will inform the property owner of any changes to the anticipated timeline. Either party can terminate this letter of mutual interest without cause by notifying the other in writing.

Long Term Agreement

If the feasibility study determines that enhancing or creating wetlands and a natural habitat at the site is feasible, the intention of the parties is to enter into a long-term agreement.

Thank you again for working with us on this exciting opportunity for this important project. If these terms are agreeable to you, please sign and date on the following page.

SANDY
WHERE INNOVATION MEETS ELEVATION

39250 Pioneer Blvd
Sandy, OR 97055
503-668-5533

City of Sandy

____ 09/8/2020
Jordan Wheeler Date
City Manager, City of Sandy
39250 SE Pioneer Blvd
Sandy, OR 97055

Trackers Conservation Properties, LLC

By:____ 9/8/2020
Molly Strand Deis, Manager Date

Bull Run Educational Properties, LLC

By:____ 9/8/2020
Molly Strand Deis, Manager Date

Trackers Ranch, LLC

By:____ 9/8/2020
Molly Strand Deis, Manager Date

City of Sandy, Oregon

Antidegradation Review

For Proposed Discharges to the Sandy River

December 2020

WHERE INNOVATION MEETS ELEVATION

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Acronyms & Abbreviations

A	
ACOE	Army Corps of Engineers
B	
BAT	Best Available Technology
BOD	Biochemical Oxygen Demand
C	
C	Celsius
CFS	Cubic Feet per Second
CW/CWA	Clean Water Act
D	
DADM	7-Day running average of daily maximum values
DEQ	Department of Environmental Quality
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
E	
EMZ	Edge of Mixing Zone
EPA	Environmental Protection Agency
F	
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
I	
IMD	Internal Management Directive
L	
L	Liter
LUCS	Land Use Compatibility Statement
M	
MBR	Membrane Bioreactor
MGD	Million Gallons per Day
mg	milligrams
N	
ND	Not Detected
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
O	
OAR	Oregon Administrative Rule
ODEQ	Oregon Department of Environmental Quality
R	
RM	River Mile

T	
TMDL	Total Maximum Daily load
TSS	Total Suspended Solids
U	
USFWS	United States Fish and Wildlife Service
USFG	United States Federal Government
USGS	United States Geological Survey
UV	Ultraviolet
V	
VOCs	Volatile Organic Contaminants
W	
WQLW	Water Quality Limited Waters
WWTP	Wastewater Treatment Plant

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Executive Summary

Executive Summary

The City of Sandy is proposing to construct new wastewater treatment facilities to meet the needs of their growing community and make other wastewater system improvements. Some of these improvements will be at the existing treatment plant where they have a permitted discharge to Tickle Creek.

They also propose to construct a new satellite treatment facility, using best available technology, where some of the community's wastewater would be treated. This membrane bioreactor (MBR) facility would require a new, permitted discharge to the Sandy River.

Under the terms of the State of Oregon's surface water antidegradation policy, this proposed new discharge to the Sandy River is subject to an antidegradation review, the subject of this report.

The project engineers have completed that review. They found that the proposed discharge would not exceed the State's antidegradation thresholds for temperature and dissolved oxygen with the present (2020) effluent flows. However, as the community grows and effluent flows from the MBR increase, the City will need to land apply a portion of the effluent (during some summer and fall months) to meet the antidegradation thresholds.

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Section 1

Section 1

Introduction

1.1 Introduction

The City of Sandy plans to construct a new, best available technology (BAT) satellite wastewater treatment facility using a membrane biological reactor (MBR). They propose to discharge the high-quality effluent into the Sandy River year-round. However, during the summer and early fall they plan to land apply a portion of the effluent for beneficial purposes. The land application part of the project is still in the planning phases. However, it is likely that the highly treated effluent will be used to create constructed wetlands on a site that was formerly called Roslyn Lake (an artificial impoundment originally created by Portland General Electric, drained some years ago). That land is now undeveloped woods and fields. Based on preliminary site reviews and discussions with the current property owner, the reuse water could be used to create wetland and open water features that enhance the existing wetlands and natural resources features of the site.

The City may also reuse some of the highly treated effluent for creating renewable energy from hydropower. The topography of the area would result in the City having a steady flow of water with substantial elevation head (hydrostatic energy). Micro-hydropower generation, in particular, may be feasible using effluent. There is an existing powerhouse in the project vicinity on the Bull Run River, which is owned and managed by a non-profit organization that has expressed interest in partnering with the City on a micro-hydro project. It is also possible that the City could generate hydropower from effluent and discharge into the Sandy River at a different site. The small amount of hydropower that would be generated would not require licensing by the Federal Energy Regulatory Commission (FERC).

Sandy River Basin streams are water quality limited and covered by the terms of the Total Maximum Daily Load (TMDL) study for the basin (ODEQ, 2005).

Based on the City's planned approach and this review, the proposed action would not result in a lowering of water quality on the Sandy River as explained in this report.

1.2 Purpose

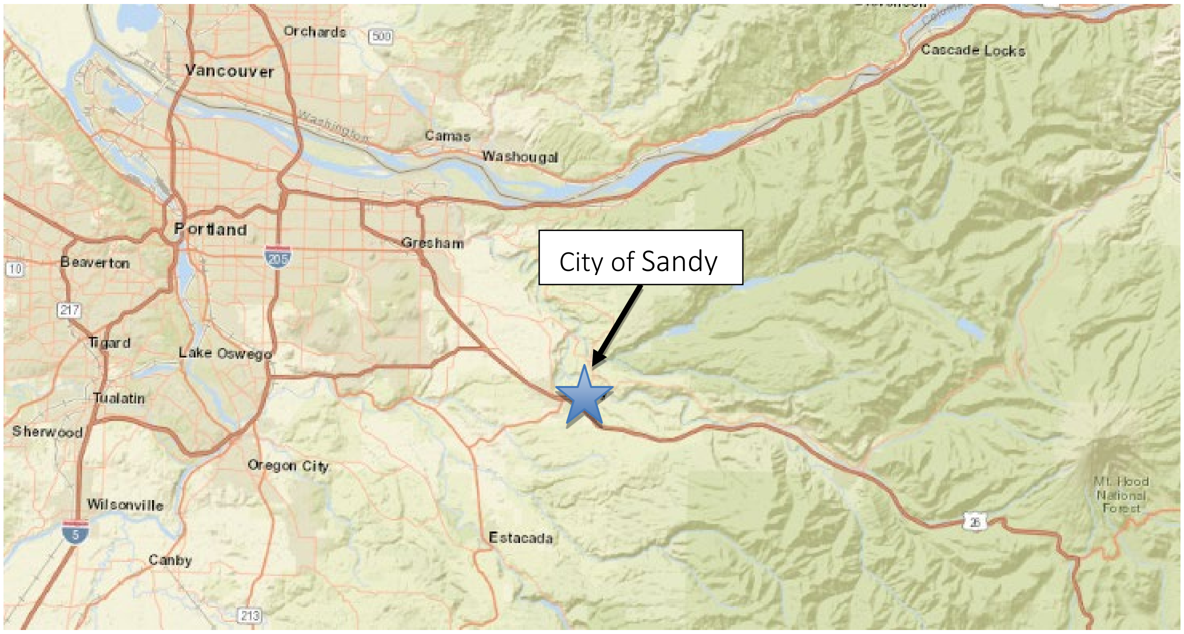
This report describes the proposed satellite wastewater treatment plant and the proposed discharge into the Sandy River. The discharge into the Sandy River would constitute a new, permitted effluent discharge. Therefore, the proposed project is subject to a water quality antidegradation review (OAR-340-041-0026). Furthermore, since the proposed discharge would be to a water quality limited waterbody, the antidegradation review would follow the approach outlined for these waterbodies in the Internal Management Direct (IMD) for antidegradation reviews (ODEQ, 2001).

The purpose of this report is to describe the proposed project and summarize the antidegradation review and findings.

1.3 Geography

The City of Sandy is in Clackamas County, Oregon, located between the Sandy and Clackamas Rivers (see **Figure 1-1**). The City covers a total area of 3.6 square miles and has an average elevation of about 1,000 feet above mean sea level. Sandy is located approximately 25 miles southeast of the City of Portland along Oregon State Highway 26. Neighboring communities include Boring and the City of Gresham to the northwest, and Eagle Creek and Estacada to the south.

Figure 1-1
Vicinity Map



1.2 Regulatory Compliance

The City's proposal to construct and operate a new satellite treatment facility is subject to the key regulatory programs listed in **Table 1-1** below, and others.

Table 1–1
Key Regulatory Programs

Program	Responsible Agency
Antidegradation	DEQ/EPA
Sandy River Basin TMDL	DEQ/EPA
National Pollutant Discharge Elimination System (NPDES) Permit	DEQ/EPA
Water Quality Certification (CWA Sec. 401)	DEQ/EPA
Endangered Species Act	NMFS/USFWS
National Environmental Policy Act	NMFS/ACOE
Wetlands Protection (CWA Sec. 404)	ACOE
Fill and Removal (State Statutes)	Oregon Department of State Lands

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Section **2**

Section 2

Existing Conditions

1.1 Introduction

Recorded data on the Sandy River gives insight into how the river changes on a seasonal basis and how it may be affected by discharges from a new wastewater treatment plant. The Sandy River was previously monitored in the 1990s as a potential receiving water for the City of Sandy wastewater effluent and additional data are being collected now for the purpose of this project.

2.2 Prior Analysis of the Sandy River

The City of Sandy investigated the concept of a new outfall into the Sandy River in the 1990s. The Oregon DEQ and the Bureau of Land Management (BLM) established a water quality sampling program and collected samples throughout the summer and fall of 1992. These samples were collected at the following five locations along the Sandy river:

- RM 3.0 – Lewis and Clark State Park
- RM 6.0 – Dabney State Park
- RM 12.0 – Oxbow County Park
- RM 18.4 – USGS Gaging Station, Dodge Park
- RM 22.0 – below confluence with Cedar Creek

Samples at these locations were analyzed for the parameters listed in **Table 2-1** below. The data collected during this study can be found in the tables included in **Appendix A.**

Table 2–1
Previous Water Quality Sampling Parameters

Parameter		
Temperature	Alkalinity	Boron
Dissolved Oxygen	pH	Cadmium
Biochemical Oxygen Demand	Electrical Conductivity	Chromium
Chemical Oxygen Demand	Fecal Coliform	Copper
Kjeldahl Nitrogen (TKN)	Enterococci	Iron
Ammonia	Chlorophyll-a	Lead
Nitrate and Nitrite	Phaeophytin	Manganese
Total Phosphorus	Total Solids	Selenium
Orthophosphate	Turbidity	Silver
Total Suspended Solids	Total Organic Carbon	Zinc
Total Dissolved Solids	Barium	

2.3 Sandy River Sampling Plan

Murraysmith and Waterways Consulting, Inc. developed a new water quality sampling plan for the Sandy River. We began sampling in 2019 and will continue through 2024. The purpose of this program is to validate the river flows at the proposed outfall locations, monitor the temperatures, and evaluate additional water quality parameters for the Sandy River. A copy of this sampling plan may be found in **Appendix C.**

2.4 Terms of Sandy River Basin TMDL

The Sandy River Basin Total Maximum Daily Load (TMDL) study places restrictions on temperature for the Sandy River. The maximum cumulative temperature increase for point and nonpoint sources combined is listed as 0.3 °C. The cumulative temperature change of all point sources must not result in a maximum stream temperature increase of 0.2 °C. The TMDL methodology assumes that 25% of the stream would be mixed with the higher temperature wastewater flows.

The antidegradation policy provides a temperature threshold of 0.14 °C (0.25 °F) increase in receiving stream temperature, for a new discharge.

2.5 Existing Data

2.5.1 Flow Rates

A multi-faceted approach was developed by Murraysmith and Waterways for reviewing flow rates on the Sandy River, whereby a series of flow rate measurements would be taken over the course of five years. Waterways Consulting took the first flow measurement in 2019 as a wading sample, where measurements were taken at approximately 20 points across a single cross section using a Price AA Flow Meter. Four additional wading measurements were conducted by Waterways near the Oxbow location in the summer and fall of 2019. These flow measurements were used as a calibration measure for reviewing the accuracy of data being recorded by the U. S. Geological Survey (USGS).

The closest long-term USGS river gage is located approximately 5.5 miles downstream of the proposed outfall site at Ten Eyck Road. Additional flows from the Bull Run River enter the Sandy River between the project site and the gaging station. The USGS and the City of Portland monitor these flows so reliable flow data is available. The Bull Run River gauging station is also located upstream of the Little Sandy River confluence, which is also monitored by USGS. The project engineers subtracted the flow rates from the Bull Run River and the Little Sandy River gaging stations to estimate the discharge rates for the Sandy River upstream of the Bull Run confluence (where the proposed outfall would be located). **Figure 2-1** illustrates the locations of each of the gauging stations used in these calculations. **Table 2-2** summarizes the recorded 7Q10 flow rates in the Sandy River, calculated for each month.

Figure 2-1
River Gauging Stations on Sandy River and Adjacent Tributaries

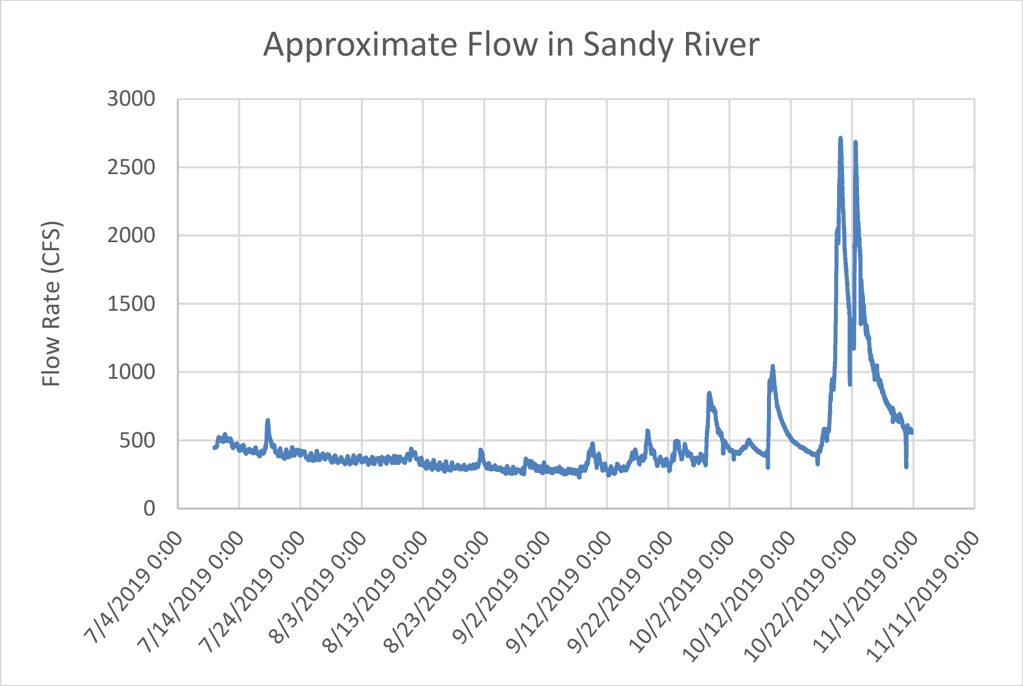
Table 2–2
Estimated 7Q10 Flows in Sandy River at Proposed Outfall

Month	River Flow (CFS)	River Flow[1] (MGD)
January	940	607
February	899	581
March	655	423
April	1177	760
May 1 – May 15	765	494
May 16 – May 31	730	471
June	415	268
July	331	214
August	269	174
September	245	158
Oct 1 – Oct 14	236	152
Oct 15 – Oct 31	245	158
November	381	246
December	442	285

1. 7Q10 flow at downstream of USGS gauging station, calculated for approximately 10-year time period from 2010-2019 (Bull Run River and Little Sandy River flows subtracted).

Figure 2-2 is a graph of USGS flow data captured in 15-minute intervals from July through October of 2019. These flows represent the flows at the confluence of the Sandy River and the Bull run river (in the reach where the new outfall would be located), with the Bull Run River and the Little Sandy River flows subtracted. Therefore, the flows listed in Table 2-2 and shown in Figure 2-2 are comparable.

Figure 2-2
Approximate Flows in Sandy River, July 09, 2019 to October 31, 2019 at Proposed Outfall Location

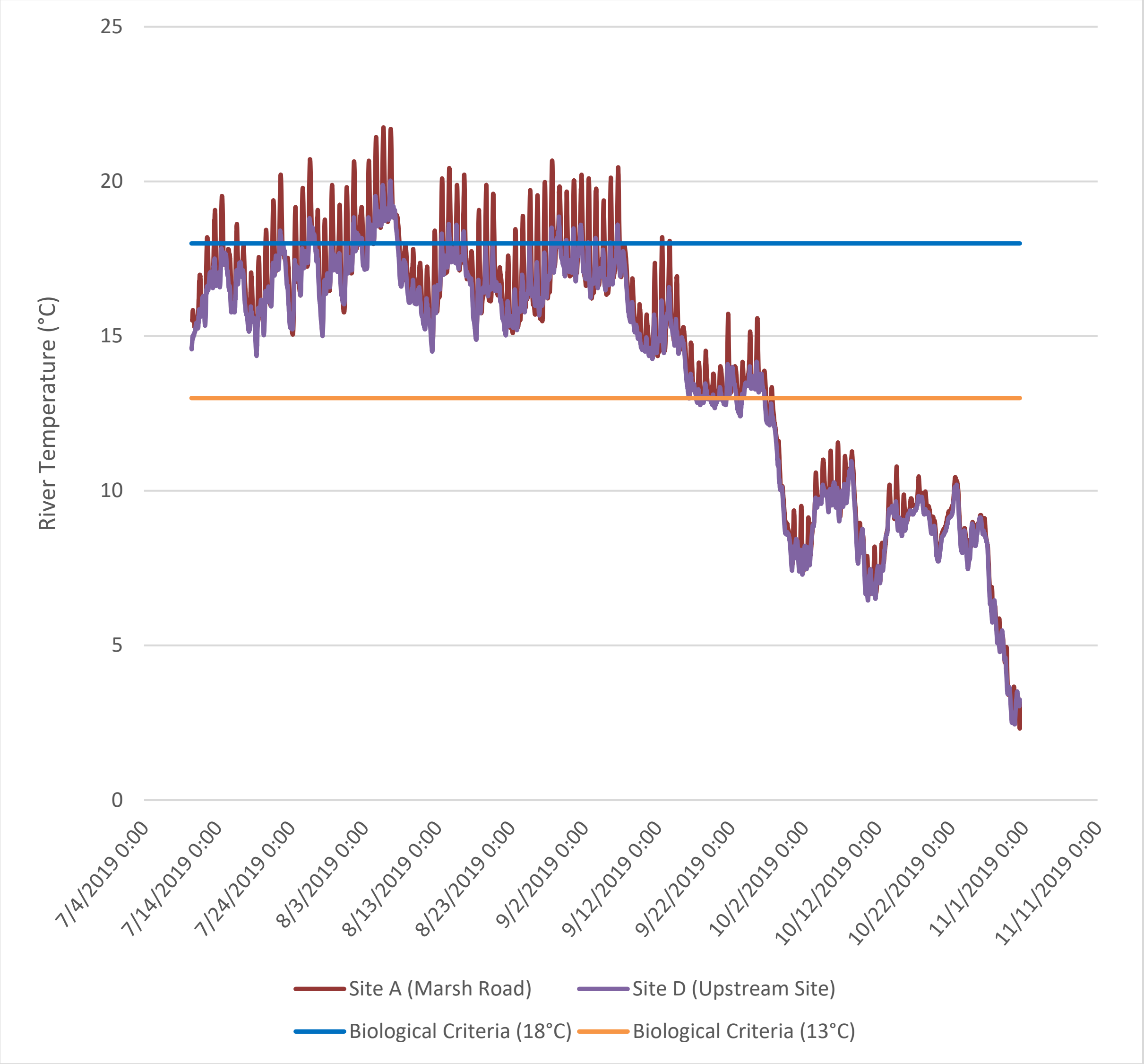


2.5.2 Temperature

Waterways Consulting, Inc. recorded temperature data on the Sandy River by installing temperature probes. They installed these probes upstream and downstream of the Sandy River Oxbow and set them to continuously record temperature data.

See **Appendix B** for a map of the temperature gaging locations. Site A is located near Marsh Road, which is downstream and to the north of the project site. Site D is located approximately 1 mile upstream of the Sandy River Oxbow. Waterways will continue to deploy, download, and report the results of the temperature monitoring twice each year through 2024. A sample of this data from summer of 2019 may be found in **Figure 2-3** below.

Figure 2-3
Temperature Data for the Sandy River, July 10 – October 31, 2019



These results strongly suggest a seasonality for stream temperatures (and flows), as would be expected. Continuous temperature data also shows fluctuations throughout the day, with temperatures trending higher for the summer (mid-July through mid-October) and lower river temperatures for the rest of the year. The variation in temperature between the upstream and downstream sites (Sites D and A, respectively) on the same day is significant. Biological temperature criteria are shown in the above figure for context. This difference can be observed in greater detail in **Figure 2-4** and **Figure 2-5** below. During the warmest part of the day, the difference in stream temperature between the two sites can be two or more degrees. Site D (the site with the lower temperatures) is approximately 2.5 miles upstream from Site A, suggesting better receiving water temperatures further upstream for any future discharge.

Figure 2-4
Daily Temperature at 15:00 for Month of August

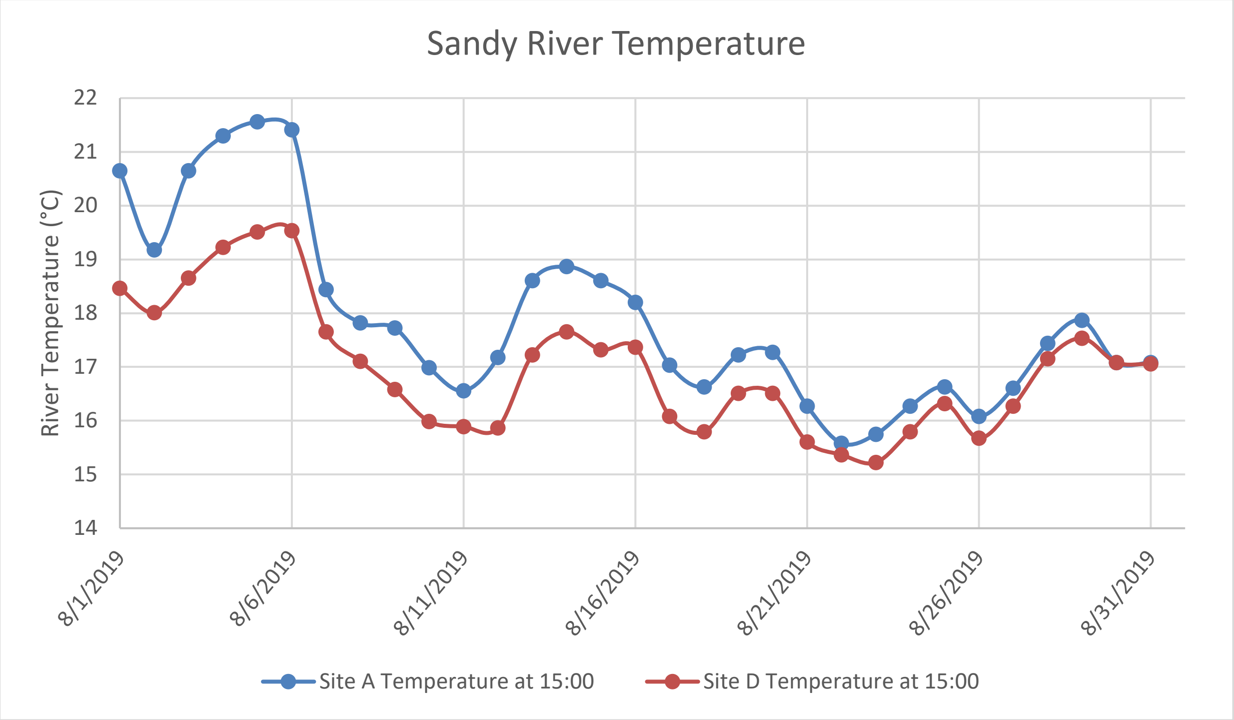
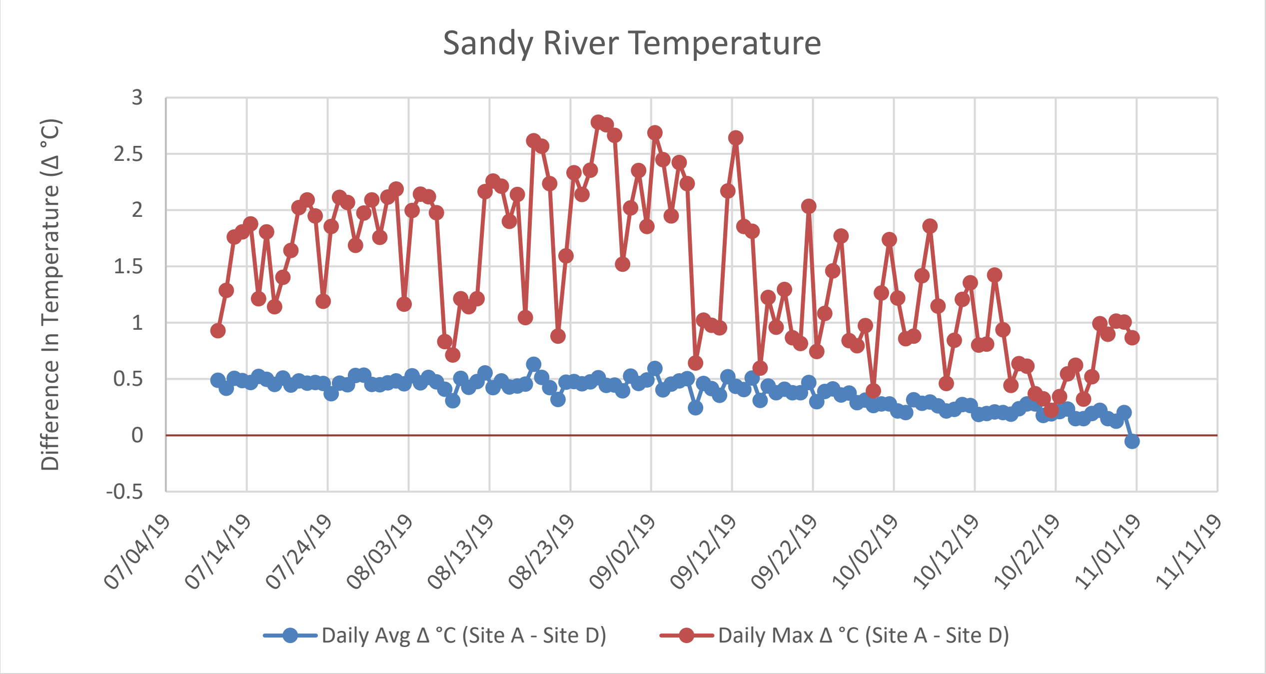


Figure 2-5
Daily Temperature Differences Between Site A and Site D, 2019



Section 3

Section 3

Proposed Activity

3.1 Introduction

To determine a good solution for the City of Sandy's increasing wastewater treatment needs, the design engineers at Murraysmith evaluated numerous options based on cost, regulatory compliance, and constructability. The Wastewater Facilities Plan (Murraysmith, 2019) concluded that the best option would be to make improvements to the existing facility and to build a satellite wastewater treatment plant with Membrane Bioreactor (MBR) technology. The existing plant, which discharges into Tickle Creek in the Clackamas River Basin, will be upgraded to produce effluent that meets regulatory requirements. More information on these upgrades may be found in the referenced Wastewater Facilities Plan. **Because the existing plant already has a permitted discharge and will not produce any new discharge into Tickle Creek, this antidegradation report focuses solely on the discharge from the new MBR facility.** This MBR satellite plant will produce high quality effluent and discharge into the Sandy River. This plan for a new discharge into the Sandy River requires compliance with the state water quality antidegradation policies.

3.2 Alternatives Evaluation

3.2.1 Overview of Alternatives

The project engineers previously developed and evaluated four alternative options for wastewater treatment plant (WWTP) improvements. The four alternatives were as follows:

<u>Alternative A</u> – Expansion of the existing WWTP treatment process including upgrades to the headworks, new aeration basins, new secondary clarifiers, expansion of the cloth-media tertiary filtration system, replacement and expansion of UV disinfection, dewatering system rehabilitation and the addition of a new solids dryer allowing the existing covered cake storage area to be utilized long-term.

<u>Alternative B</u> – Construction of a new membrane bioreactor (MBR) facility for secondary and tertiary treatment of approximately 7 MGD at the existing WWTP site, operating in parallel with the existing WWTP. Other upgrades include expansion of the headworks, dewatering upgrades and addition of a solids dryer.

<u>Alternative C</u> – Conversion of the existing WWTP to incorporate primary clarification and anaerobic digestion to better utilize the limited site footprint, reduce solids production through increased volatile solids destruction and reduce energy consumption by expanding the headworks, adding primary clarifiers, reduced aeration basin expansion, new secondary clarifiers, expansion

of the cloth-media tertiary filtration system, replacement and expansion of UV disinfection, dewatering system rehabilitation and the addition of a new solids dryer.

Alternative D – Construction of a new Eastside Satellite Treatment Facility for an ultimate peak design flow of approximately 7 MGD with existing WWTP upgrades primarily focused on the needed improvements for treating and processing solids from both facilities including expansion of the headworks, addition of primary clarifiers, tertiary filtration system rehabilitation, UV system rehabilitation, solids dewatering system rehabilitation and the addition of a new solids dryer.

Section 10.3 of the Final Facilities Plan shows an analysis and comparison of these four alternatives. Alternative D was ultimately selected as the best long-term approach for the City based on a weighted comparison of both cost and non-cost factors, which is included in **Table 3-1** below and in greater detail within the Final Facilities Plan.

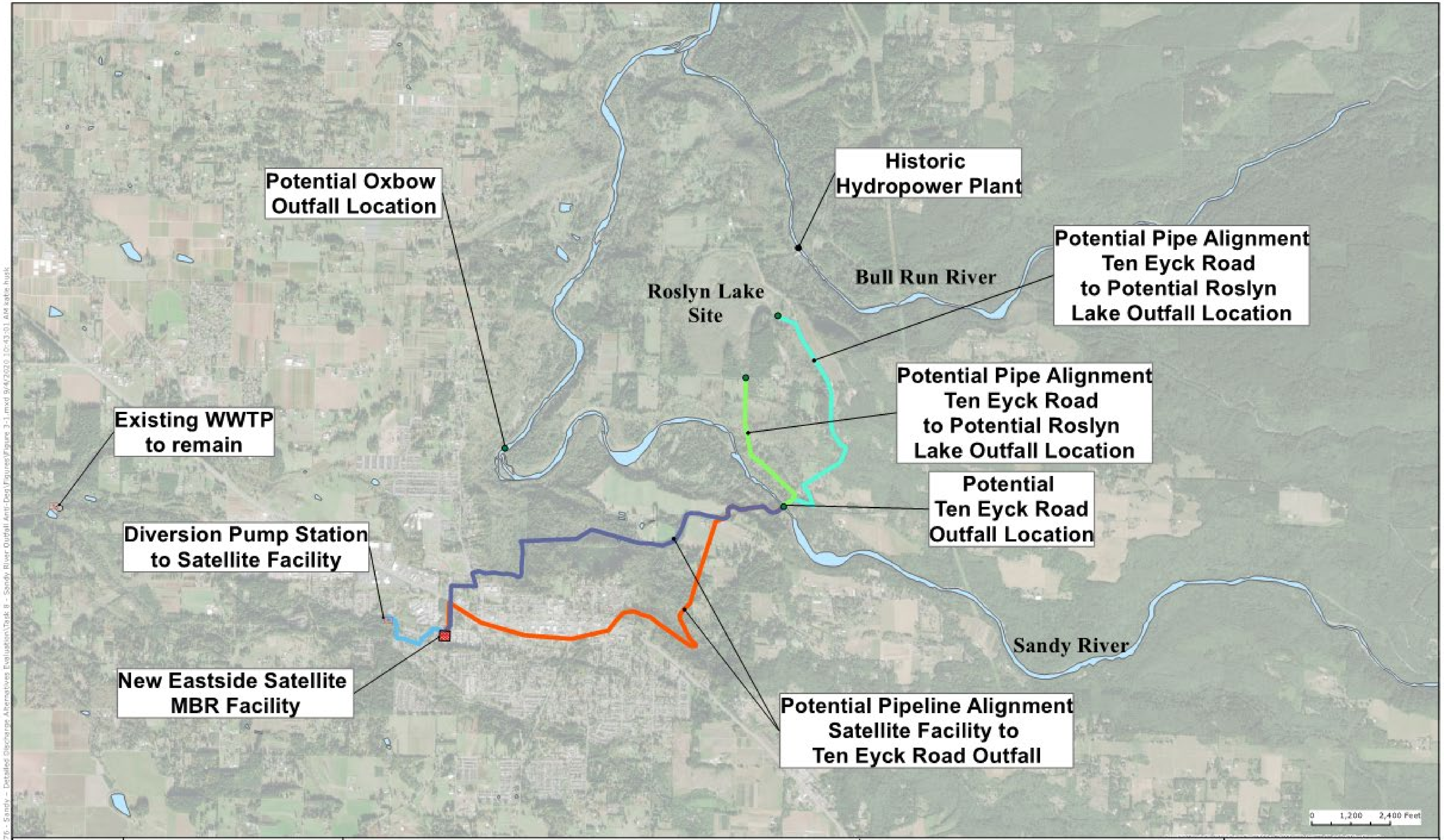
Table 3-1
Alternative Scoring based on Cost and Non-Cost Factors

	Weight	Alt A	Alt B	Alt C	Alt D
Capital Cost	30%	3.0	2.0	2.5	3.5
20-year Life-Cycle Cost	20%	2.5	2.5	2.5	3.5
Regulatory Compliance	20%	2.0	2.5	2.5	3.0
Environmental Permitting	10%	2.0	2.5	2.5	3.0
Constructability	10%	2.0	2.0	2.0	3.5
Reliability/Resiliency	5%	2.0	2.5	2.5	3.0
Phasing	5%	2.0	2.0	2.0	4.0
Total	**100%**	**2.4**	**2.3**	**2.4**	**3.4**

As shown in Table 3-1, Alternative D ranked highest in this matrix evaluation, and was selected by the City as the preferred alternative. Therefore, this antidegradation report focuses solely on reviewing Alternative D, the satellite MBR facility.

3.2.2 Overview of Selected Alternative

The new satellite treatment facility would be constructed in two stages along with construction of a new outfall to the Sandy River. Following completion of the permitting process for the new outfall, the satellite facility would operate year-round, discharging highly treated effluent to the Sandy River while sending waste solids from the new facility back to the existing WWTP for solids process and disposal. During summer and fall months, when river temperatures are higher, a portion of the effluent would be land-applied to reduce potential for river temperature increases. The City is also considering the option of diverting some effluent to a separate facility for power generation. **Figure 3-1** is a site map with the relative locations of each of these proposed alternatives. **Figure 3-2** is a schematic of a typical MBR wastewater treatment facility.



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City of Sandy, Oregon
Antidegradation Review
Site Overview

LEGEND
● Discharge Locations

Figure 3-1

September 2020 20-2776

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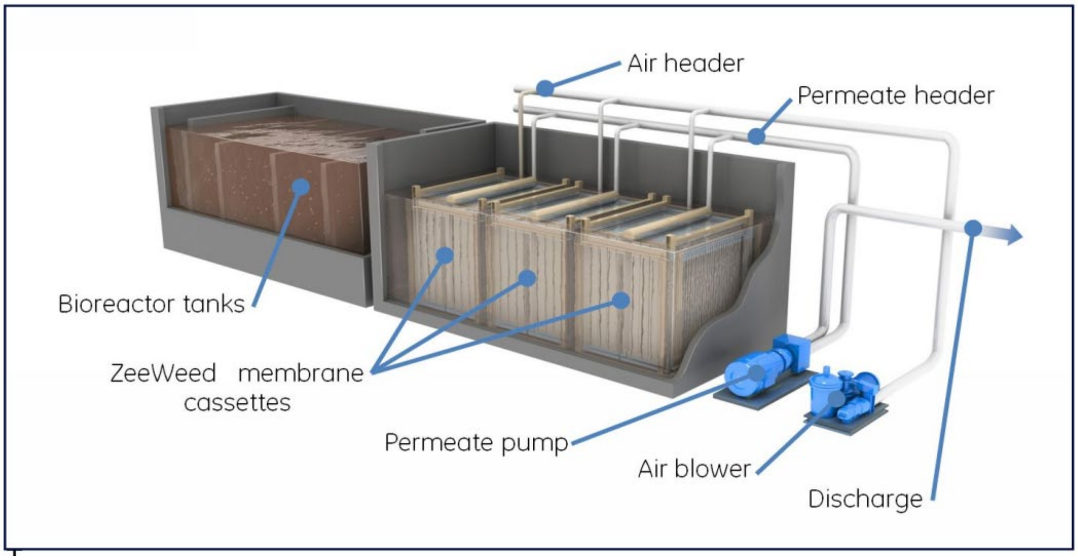
Figure 3-2
MBR Facility Schematic



3.2.3 Eastside Satellite Treatment Facility

The new satellite treatment facility will include 4 trains, each with 1.75 MGD instantaneous peak flow capacity and will be built in 2 stages. Stage 1 (design and construction of a new diversion pump station and 3.5 MGD satellite wastewater treatment facility on the east side of the City) will be completed by 2026. The treatment facility will be constructed on a 4.5-acre City-owned parcel and will provide liquids stream treatment only. Solids from the Eastside Satellite Treatment Facility will be pumped downstream from the new diversion pump station for treatment at the existing WWTP. Stage 2 would be constructed as needed after 2026.

The satellite treatment plant will use MBR technology, which produces high-quality effluent. The post-treatment water is considered Class A wastewater, which is suitable for most reuse purposes. Typical effluent quality from a MBR facility is shown in **Table 3-2** below (USBR 2000, Murraysmith 2020). The current and projected wastewater flow rates associated with the City of Sandy along with the flow rate that will be diverted to the MBR facility are included in **Table 3-3.**

Table 3-2
Typical MBR Effluent Quality

Parameter	Effluent Quality	% Removal
BOD_5	<5 mg/L	98%
Total Nitrogen	<10 mg/L	99%
TSS	<1 mg/L	99%
Total Phosphorus	<1 mg/L	99%
Total Coliform	ND	ND
Turbidity	<0.2 NTU	

Table 3-3
City of Sandy Wastewater Flow Rates

Present (2020) Flow Rates			Future (2040) Flow Rates		
Month	Overall City of Sandy Wastewater Flow[1] (MGD)	Flow to MBR[2] (MGD)	Month	Overall City of Sandy Wastewater Flow[1] (MGD)	Flow to MBR[2] (MGD)
January	1.58	0.79	January	3.28	1.64
February	1.45	0.73	February	3.07	1.54
March	1.61	0.81	March	3.33	1.67
April	1.43	0.72	April	3.2	1.60
May 1 – May 15	1.4	0.70	May 1 – May 15	2.99	1.50
May 16 – May 31	1.4	0.70	May 16 – May 31	2.99	1.50
June	1.1	0.55	June	2.61	1.31
July	0.76	0.38	July	2.19	1.10
August	0.69	0.35	August	2.08	1.04
September	0.73	0.37	September	2.14	1.07
Oct 1 – Oct 14	1.41	0.71	Oct 1 – Oct 14	3.13	1.57
Oct 15 – Oct 31	1.41	0.71	Oct 15 – Oct 31	3.13	1.57
November	1.75	0.88	November	3.99	2.00
December	1.66	0.83	December	3.63	1.82

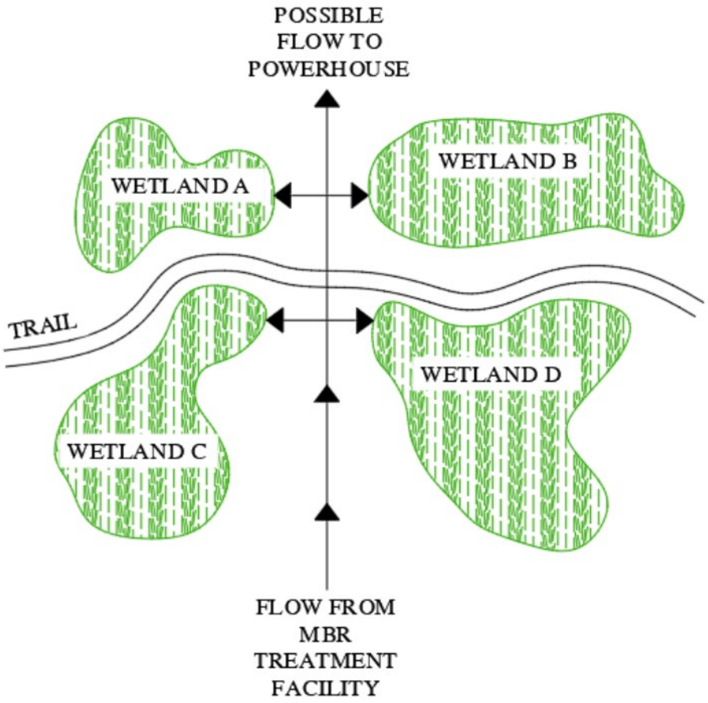
Notes:

1. Estimated wastewater system average monthly flows using Murraysmith hydraulic model.
2. Estimated flows to MBR facility, approximately ½ of overall wastewater flow.

3.2.4 Land Application of Effluent

As the City grows and wastewater flows increase, water quality calculations indicate that effluent discharge from the new MBR facility during the summer and fall months could potentially increase the Sandy River temperature beyond the antidegradation threshold (See Chapter 4). One promising option for limiting these discharges would be land application of treated wastewater. This approach would reduce discharges into the Sandy River and provide for beneficial use of the high-quality effluent, perhaps creating wetlands and otherwise improving natural resources conditions at an appropriate site. A simple schematic of this concept is shown in **Figure 3-3** below.

Figure 3-3
Constructed Wetlands Concept



3.2.5 Hydropower Generation

There is also potential for power generation from the wastewater effluent from this satellite treatment plant. A small, historic powerhouse exists in the project vicinity on the Bull Run River, as shown in **Figure 3-1**. This undertaking would provide additional power supply for the area without directing any additional flows away from the Sandy or Bull Run Rivers, and simultaneously repurpose a historic site. The City could also investigate building a new power generating facility with outflow to the Sandy River. The small amount of power generated through a possible micro-hydropower project would not likely require Federal Energy Regulation Commission (FERC) licensing or review.

3.2.6 New Sandy River Outfall

The project team has reviewed multiple locations for placing the outfall from the satellite treatment facility. The two primary locations are at the oxbow of the Sandy River (near the City's Sandy River Park), and further upstream where Ten Eyck Road crosses the River. **Figure 3-1** shows both potential locations and the associated force mains through the City. Recent discussions and analysis favor the outfall located at Ten Eyck Road.

While this location requires a longer force main to be constructed, it provides benefits over the oxbow location. First, the Ten Eyck Road outfall location has a riverbed largely consisting of exposed bedrock, which is much less likely to migrate over time than the loose material at the oxbow. Additionally, the Ten Eyck Road location is characterized by a channel that is much narrower, deeper, and with higher velocities than the oxbow, meaning that the natural mixing potential of the Ten Eyck location is better (Wolf Water Resources, 2020). Finally, the Ten Eyck Road location would have less possible impact to fisheries since it is in a migration corridor (not spawning and rearing area) and away from the Cedar Creek fish hatchery.

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Section **4**

Section 4

Water Quality Analysis and Review

4.2 Introduction

The proposed new discharge to the Sandy River is subject to an antidegradation review. Therefore, the engineers reviewed the impact on water quality from the proposed discharge, focusing on the antidegradation thresholds for temperature and dissolved oxygen.

4.3 Water Quality Analysis

4.3.1 Water Quality Limited Waters

As defined in OAR 340-041-0006(30), Water Quality Limited Waters (WQLW) are those which: a) do not meet the water quality standards during the entire year or defined season even after implementation of standard technology, b) only meet water quality standards through the use of higher than standard technology, or c) insufficient information exists to determine if water quality standards are being met. Observations and existing data indicate that the Sandy River is a Water Quality Limited Water. To address these water quality deficiencies, DEQ completed a Total Maximum Daily Load (TMDL) study for the Sandy River Basin (ODEQ, 2005).

Furthermore, the engineers followed the methodology outlined in DEQ's antidegradation internal management directive for Water Quality Limited TMDL waters to complete this antidegradation review.

4.3.2 Temperature

Based on OAR 340-041-0026(3)(a)(F)(ii), an activity that results in more than 0.25°F change in temperature (at the edge of the mixing zone, if existing) will constitute a lowering of water quality. **Therefore, 0.25°F is the antidegradation threshold for temperature used in this analysis.**

4.3.2.1 Temperature Analysis

The water quality engineers at Murraysmith used the same approach for this water quality analysis as done by DEQ for the TMDL study. That is, we have assumed that 25% of the Sandy River stream flow would be mixed with effluent, and then used mass balance calculations to estimate the resultant mixed temperature and river temperature change. Moreover, we have used the biological temperature criteria as an estimate for stream temperatures because that approach yields the appropriate river temperature change/response for evaluating biological effects. **Table 4-1** below summarizes the calculated overall temperature effect of effluent flow mixing under present (2020) flow conditions. **Table 4-2** summarizes temperature conditions in twenty years, when effluent flows from the satellite wastewater treatment plant are higher and assuming the flows in the Sandy River would be approximately the same.

Table 4–1
Temperature Evaluation: Present (2020) MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
JAN	0.79	15.40	607	13.00	0.01	0.02
FEB	0.73	16.20	581	13.00	0.02	0.03
MAR	0.81	15.70	423	13.00	0.02	0.04
APR	0.72	16.40	760	13.00	0.01	0.02
MAY 1-14	0.70	17.40	494	13.00	0.02	0.04
MAY 15-31	0.70	17.90	471	18.00	0.00	0.00
JUN	0.55	20.90	268	18.00	0.02	0.04
JUL	0.38	21.90	214	18.00	0.03	0.05
AUG	0.35	22.80	174	18.00	0.04	0.07
SEP	0.37	22.40	158	18.00	0.04	0.07
OCT 1-14	0.71	21.20	152	18.00	0.06	0.10
OCT 15-31	0.71	20.50	158	13.00	0.13	0.24
NOV	0.88	20.00	246	13.00	0.10	0.18
DEC	0.83	16.70	285	13.00	0.04	0.08

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

Table 4–2

Temperature Evaluation: Future (2040) MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
JAN	1.64	15.40	607	13.00	0.03	0.05
FEB	1.54	16.20	581	13.00	0.03	0.06
MAR	1.67	15.70	423	13.00	0.04	0.08
APR	1.60	16.40	760	13.00	0.03	0.05
MAY 1-14	1.50	17.40	494	13.00	0.05	0.09
MAY 15-31	1.50	17.90	471	18.00	0.00	0.00
JUN	1.31	20.90	268	18.00	0.06	0.10
JUL	1.10	21.90	214	18.00	0.08	0.14
AUG	1.04	22.80	174	18.00	0.11	0.20
SEP	1.07	22.40	158	18.00	0.12	0.21
OCT 1-14	1.57	21.20	152	18.00	0.13	0.23
OCT 15-31	1.57	20.50	158	13.00	0.29	0.51
NOV	2.00	20.00	246	13.00	0.22	0.40
DEC	1.82	16.70	285	13.00	0.09	0.17

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

As shown in Tables 4-1 and 4-2, the increase in temperature associated with the City's proposed discharge into the Sandy River would be minimal during the winter and spring months for both existing and future conditions. Greater impacts could occur during the summer and fall months for future conditions. Discharges to the Sandy River during the fall could result in exceedances of the 0.25 °F antidegradation policy threshold for future conditions as flows from the plant increase.

Therefore, the City would propose to reduce effluent discharges into the Sandy River during the summer and fall months to mitigate future temperature impacts as described below.

4.3.2.2 Temperature Management Plan

To protect aquatic organisms and meet regulatory requirements, the City proposes to provide new treatment and discharge facilities (and flow controls) that do not exceed the antidegradation thresholds. Thus, the City is planning to discharge into the Sandy River when temperatures in the effluent from the plant would not increase river temperatures beyond the 0.25 °F threshold. They plan to employ land application of some amount of effluent at other times. In general, the City would discharge into the Sandy River year-round but would also land apply a portion of the effluent during the summer and fall months. The results of the revised 2040 temperature analysis (with the effluent flow into the Sandy River reduced to about 0.75 to 1.0 MGD during the summer and fall) can be viewed in **Table 4-3** below.

Table 4–3
Temperature Evaluation: Future (2040) With Reduced MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
AUG	1.00	22.80	174	18.00	0.11	0.19
SEP	1.00	22.40	158	18.00	0.11	0.20
OCT 1-14	1.00	21.20	152	18.00	0.08	0.15
OCT 15-31	0.75	20.50	158	13.00	0.14	0.25
NOV	1.00	20.00	246	13.00	0.11	0.20

Notes:

1. Wastewater system flow diversion capped at specified flow rate.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

The exact flow rates for stream discharge and land application (and associated time periods) will be determined as part of the final design of the new wastewater facilities, and through the National Pollutant Discharge Elimination System (NPDES) permitting process.

1.3.3 Dissolved Oxygen

Dissolved oxygen (DO) concentration is an important indicator of the suitability of a water body for maintaining the health of aquatic life. In the 2005 Sandy River Basin TMDL, the lower Sandy River downstream of the former site of the Marmot Dam was listed as impaired due to low dissolved oxygen levels, which were below the threshold listed by OAR 340-041-0016. Because no anthropogenic sources of DO depletion were identified, ODEQ proposed to remove this listing. Regardless of the existence of an active TMDL for DO, any new inflows into the Sandy River need sufficient DO concentrations to provide healthy habitat for aquatic life.

Based on OAR 340-041-0026(3)(a)(C)(iii), an activity that results in more than 0.10 mg/L decrease in dissolved oxygen (at the edge of the mixing zone, if existing) will constitute a lowering of water quality. **Therefore, 0.10 mg/L is the antidegradation threshold for dissolved oxygen used in this review.**

4.3.2.3 Dissolved Oxygen Analysis

Murraysmith completed a similar mass balance evaluation for dissolved oxygen (DO) as we did for temperature. We evaluated potential changes in DO in the Sandy River due to monthly effluent discharges from the new membrane biological reactor (MBR) facilities. The DO concentrations in the effluent were estimated based on process design capabilities (providing aeration, for example). Thus, we estimated that DO concentrations in the effluent can reliably be maintained as high as 6 mg/L, as needed.

The results of this analysis are shown in **Tables 4-4 and 4-5** for existing and future conditions, respectively. The effect of dissolved oxygen discharges would be greatest during low flow summer and fall conditions (similar to temperature effects). With higher stream temperatures, this is also the period where dissolved oxygen concentrations in the stream are at their lowest. During the winter and spring months, the effect of the discharge would be minimal, and below the 0.1 mg/L antidegradation threshold for existing and future conditions. For future conditions, there is some possibility that the City could exceed the antidegradation threshold if all the effluent were discharged into the Sandy River. However, as noted in the temperature evaluation, some of the effluent would be land applied in the summer and fall months to not exceed the antidegradation threshold.

Table 4–4
Dissolved Oxygen Evaluation: Present (2020) MBR Effluent

Month	WWTP Flow[1] (MGD)	WWTP DO[2] (mg/L)	River Flow[3] (MGD)	River Temp[4] (°C)	100% Saturation DO[5] (mg/L)	Delta DO at EMZ[6] (mg/L)
JAN	0.79	2.00	607	13.00	10.53	-0.04
FEB	0.73	2.00	581	13.00	10.53	-0.04
MAR	0.81	2.00	423	13.00	10.53	-0.06
APR	0.72	2.00	760	13.00	10.53	-0.03
MAY 1-15	0.70	2.00	494	13.00	10.53	-0.05
MAY 16-31	0.70	2.00	471	18.00	9.44	-0.04
JUN	0.55	2.00	268	18.00	9.44	-0.06
JUL	0.38	2.00	214	18.00	9.44	-0.05
AUG	0.35	6.00	174	18.00	9.44	-0.03
SEP	0.37	6.00	158	18.00	9.44	-0.03
OCT 1-14	0.71	6.00	152	18.00	9.44	-0.06
OCT 15-31	0.71	6.00	158	13.00	10.53	-0.08
NOV	0.88	6.00	246	13.00	10.53	-0.06
DEC	0.83	6.00	285	13.00	10.53	-0.05

Notes

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. DO in MBR effluent, estimated by Murraysmith.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. DO in Sandy River, at assumed saturation concentration based on temperature.
6. Calculated change in river DO based on 25% of river flow, at edge of assumed mixing zone.

Table 4–5
Dissolved Oxygen Evaluation: Future (2040) MBR Effluent

Month	WWTP Flow[1] (MGD)	WWTP DO[2] (mg/L)	River Flow[3] (MGD)	River Temp[4] (°C)	100% Saturation DO[5] (mg/L)	Delta DO at EMZ[6] (mg/L)
JAN	1.64	4.00	607	13.00	10.53	-0.07
FEB	1.54	4.00	581	13.00	10.53	-0.07
MAR	1.67	4.00	423	13.00	10.53	-0.10
APR	1.60	4.00	760	13.00	10.53	-0.05
MAY 1-15	1.50	4.00	494	13.00	10.53	-0.08
MAY 16-31	1.50	4.00	471	18.00	9.44	-0.07
JUN	1.31	4.00	268	18.00	9.44	-0.10
JUL	1.10	6.00	214	18.00	9.44	-0.07
AUG	1.04	6.00	174	18.00	9.44	-0.08
SEP	1.07	6.00	158	18.00	9.44	-0.09
OCT 1-14	1.57	6.00	152	18.00	9.44	-0.14
OCT 15-31	1.57	6.00	158	13.00	10.53	-0.17
NOV	2.00	6.00	246	13.00	10.53	-0.14
DEC	1.82	6.00	285	13.00	10.53	-0.11

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. DO in MBR effluent, estimated by Murraysmith.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. DO in Sandy River, at assumed saturation concentration based on temperature.
6. Calculated change in river DO based on 25% of river flow, at edge of assumed mixing zone.

4.3.2.4 Dissolved Oxygen Management Plan

The DO management plan would have two major components: (1) aerating the effluent to provide higher concentrations of DO, as needed, and (2) reducing the quantity of effluent discharged to the Sandy River by discharging to land during the summer and fall months.

As noted above for temperature management, effluent flows above about 0.8 to 1.0 MGD would be land applied, as needed, during summer and fall to mitigate DO impacts. The results of the revised 2040 DO analysis with the effluent flow into the Sandy River below about 0.8 to 1.0 MGD can be viewed in **Table 4-6** below.

Table 4–6
Dissolved Oxygen Evaluation: Future (2040) With Reduced MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP DO[2] (mg/L)	River Flow[3] (MGD)	River Temp[4] (°C)	100% Saturation DO[5] (mg/L)	Delta DO at EMZ[6] (mg/L)
AUG	1.04	6.00	174	18.00	9.44	-0.08
SEP	1.07	6.00	158	18.00	9.44	-0.09
OCT 1-14	1.00	6.00	152	18.00	9.44	-0.09
OCT 15-31	0.80	6.00	158	13.00	10.53	-0.09
NOV	1.00	6.00	246	13.00	10.53	-0.07
DEC	1.00	6.00	285	13.00	10.53	-0.06

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. DO in MBR effluent, estimated by Murraysmith.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. DO in Sandy River, at assumed saturation concentration based on temperature.
3. Calculated change in river DO based on 25% of river flow, at edge of assumed mixing zone.

The exact flow rates for stream discharge and land application (and associated time periods) will be determined as part of the final design of the new wastewater facilities, and through the National Pollutant Discharge Elimination System (NPDES) permitting process.

4.3.3 Other Parameters

The antidegradation guidance from DEQ (the internal management directive) focuses on temperature and dissolved oxygen, which are the two main parameters assessed in this report. The membranes within the MBR facilities have been observed to capture and remove a large percentage of constituents that adhere to the membrane surface, including the particulate fraction of nutrients, toxics, and heavy metals. Additional analysis for these other parameters will be provided, as needed, during the forthcoming NPDES permitting process. The exact location of the proposed, new outfall will be better known at that time, as will the mixing zone boundaries and dilution values.

4.4 Additional Considerations

DEQ's internal management directive (IMD) for antidegradation mentions several other topics that are not applicable here. The City will be addressing these topics later as the project moves forward, and as needed.

4.4.1 Land Use

The City will be doing a land use review and securing the appropriate Land Use Compatibility Statement (LUCS) from their own planning department as the project progresses. They would also conduct a land use review for any project elements located outside of the City limits, with Clackamas County, for example, for land application of effluent.

4.4.2 Social Benefits Versus Environmental Costs

An economic review of social benefits versus environmental costs is not needed since the City is proposing to meet the antidegradation thresholds for DO and temperature.

4.4.3 Other Regulatory Programs

As noted in the introduction, the City is aware of the many additional regulatory approvals required for this project. They will be working with the various local, state, and federal agencies for review and approval of land use, Clean Water Act, Endangered Species Act, and related regulations.

Section **5**

Section 5

Summary and Conclusions

The City of Sandy is proposing to construct new wastewater treatment facilities to meet the needs of their growing community and make other wastewater system improvements. Some of these improvements will be at the existing treatment plant where they have a permitted discharge to Tickle Creek.

They also propose to construct a new satellite treatment facility, using best available technology, where some of the community's wastewater would be treated. This membrane bioreactor (MBR) facility would require a new, permitted discharge to the Sandy River.

Under the terms of the State of Oregon's antidegradation policy, this proposed new discharge is subject to an antidegradation review. The following conclusions are based on the results of that review.

1. The new MBR facility would discharge into the Sandy River using a new pipeline and outfall. The final pipe alignment and outfall location are currently being determined.
2. The new MBR facility would generate high-quality effluent using modern technology.
3. The project engineers have evaluated the potential impacts from the proposed discharge using DEQ's methodology for evaluating discharges into the Sandy River from the Sandy River Basin TMDL (assuming 25% of the 7Q10 river flows mix with effluent).
4. The antidegradation thresholds under review include: (1) no greater than 0.25 °F temperature increase, and (2) no greater than 0.1 mg/L decrease in dissolved oxygen, after mixing at the end of an assumed mixing zone.
5. With estimated effluent flows from the MBR for existing (2020) conditions, the discharge would not exceed the antidegradation thresholds for temperature or dissolved oxygen.
6. With estimated flows from the MBR for future (2040) conditions (as the community grows), the discharge would start to exceed the antidegradation thresholds for temperature and dissolved oxygen during the summer and fall months.
7. The City proposes a temperature management plan where they would land apply a portion of the high-quality effluent during summer and fall to prevent possible thermal impacts to the river.
8. The exact months and amount of effluent to be land applied will be determined during final design and through the NPDES permitting process.

9. To prevent possible impacts to dissolved oxygen, the City proposes a DO management plan where they would land apply a portion of the effluent during the summer and fall, and also oxygenate the effluent as needed.
10. The exact months and amount of effluent to be land applied will be determined during final design and through the NPDES permitting process.
11. The review of other water quality parameters will occur, as needed, during the NPDES permitting process once a new outfall location has been identified and when mixing zone boundaries and estimated dilution are better known.
12. Other environmental reviews for the project under local, state, and federal regulations will progress as the project moves from the planning to design phases.

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Section **6**

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Appendix

APPENDIX A
SANDY RIVER HISTORIC DATA

Table 8-9
Sandy River Water Quality, June 1992 (DEQ)

Constituent	Troutdale	Dabney State Park	USGS Gage	Near Cedar Creek
	RM 3.0	RM 6.0	RM 18.4	RM 22.0
Temperature, °C	17.5	17.0	16.0	15.0
DO, mg/L	8.7	9.0	9.9	10.1
DO, percent saturation	91	93	99	99
BODY, mg/L	1.3	1.3	1. 1	1.4
$CBOD_{5,}$ mg/L	0.2	0.0	0.1	0.2
TKN, mg/L	0.30	0.20	0.50	< 0.20
NH_3 as N, mg/L	0.020	0.030	< 0.020	< 0.020
NO_2 + NO_3 as N, mg/L	0.040	0.030	< 0.020	4 0.020
Total P as P, mg/L	0.020	0.020	0.020	0.020
Ortho PO_4 as P, mg/L	0.007	0.006	0.008	0.009
TSS, mg/L	< 1	< 1	< 1	< 1
TDS, mg/L	50	47	52	54
Alkalinity as $CaCO_3$, mg/L	19	19	19	19
pH	7.1	7.1	7.2	7.4
Ec, field, μmohs/cm	61	61	61	62
Fecal Coliform (FC), MPN/100 mL	33	110	49	240
Enterococci, #/100 mL	5	20	< 5	15
Chlorophyll-a, μg/L	2.2	2.1	2.0	1.7
Phaeophytin; μg/L	2.1	2.1	2.6	2.4
TS, mg/L	62	64	67	72
Turbidity, NTU	1	1	1	1
COD, mg/L	< 5	< 5	< 5	< 5
TOC, mg/L	1	< 1	< 1	< 1

Table 8-10
Sandy River Water Quality, August 1992 (CH2M Hill)

Constituent	Troutdale RM 1.5	Dabney State Park RM 6.0	USGS Gage RM 18.4	Near Cedar Creek RM 22.0
Temperature, °C	20.8	19.9	[a]	[a]
DO, mg/L	8.8	9.2	[a]	[a]
DO, percent saturation	98.5	102.7	[a]	[a]
BOD$_5$, mg/L	< 3	< 3	< 3	< 3
TKN, mg/L	0.42	< 0.10	< 0.10	< 0.10
NH$_3$ as *N*, mg/L	< 0.06	< 4	0.06	< 0.06
NO$_2$ + NO$_3$ as N, mg/L	0.030	0.020	0.113	0.087
Total P as P, mg/L	0.050	< 0.03	< 0.03	0.030
Ortho PO$_4$ as P, mg/L	< 0.032	< 0.032	40.032	< 0.032
TSS, mg/L	5	4	< 3	6
TDS, mg/L	41	67	6d	64
Alkalinity as CaCO$_3$, mg/L	27	25	23	23
pH, field	7.5	7.8	[a]	[a]
pH, lab	7.6	7.7	7.8	7.8
Ec, field, μmohs/cm	68	62	[a]	[a]
Ec, lab, μmohs/cm	74	66	65	65
Fecal Coliform (FC), MPN/100 mL	140	2	4	8
Fecal Streptococci (FS), #/100 mL	1500	100	200	200
Enterococci, #/100 mL	700	100	200	100
FC/FS Ratio	0.09	0.02	0.02	0.04
Chlorophyll-a, μg/L	-	-	-	-
Periphyton, g/m^2 (dry weight)	0.134	0.175	0.444	0.04

[a] Data logger not working.

Table 8-11
Sandy River Water Quality, September 1992 (DEQ)

Constituent	Troutdale RM 1.5	Dabney State Park RM 6.0	USGS Gage RM 18.4	Near Cedar RM 22.0	Oxbow Park RM 12.0
Temperature, °C	16.0	15.0	12.0	12.5	15.5
DO, mg/L	12.0	11.8	11.0	10.8	11.5
DO, percent saturation	121	116	101	101	115
BOD_5, mg/L	1.7	1.6	1.3	1.1	1.4
$CBOD_5$, mg/L	-	-	-	-	-
TKN, mg/L	< 0.020	< 0.20	< 0.20	< 0.20	< 0.20
NH_3 as N, mg/L	< 0.020	< 0.020	0.020	0.020	0.020
NO_2 + NO_3 as N, mg/L	< 0.020	< 0.020	< 0.020	< 0.020	<0.02
Total PO_4 as P, mg/L	0.040	0.030	0.040	0.060	0.030
Ortho PO_4 as P, mg/L	0.009	0.009	0.013	0.016	0.011
TSS, mg/L	2	5	7	11	6
TDS, mg/L	75	71	78	76	68
Alkalinity as $CaCO_3$, mg/L	-	-	-	-	-
pH	8.6	8.3	7.7	7.8	8.3
Ec, μmohs/cm	73	73	71	73	70
Fecal Coliform (FC), MPN/100 mL	49	11	170	240	23
Enterococci, #/100 mL	20	5	55	50	10
Chlorophyll-a, μg/L	-	-	-	-	-
Phaeophytin, μg/L	-	-	-	-	-
TS, mg/L	77	76	85	87	74
Turbidity, NTU	3	3	4	6	4
COD, mg/L	< 5	7	7	7	< 5
TOC, mg/L	1	1	1	< 1	1

Table 8-12
Hydraulic Sampling Data for the Sandy River—June 1992 (DEQ)

Sampling Site No.	Date	Measured Q, cfs	Cross-Section Area, ft^2	Range of Measured Velocity, fps	Flow Balance[a] Q, cfs	Computed Average[b] Velocity, fps
2 (RM 3.1)	6/11/1992	530	147	1.2 to 5.2	540	3.7
3 (RM 5.9)	6/11/1992	575	179	0.3 to 5.2	540	3.0
5 (RM 12.6)	6/10/1992	492	492	0.4 to 3.3	522	1.1
6 (RM 18.8)	6/10/1992	500	246	0.5 to 3.2	456	1.9
7 (RM 23.8)	6/10/1992	560	299	0.6 to 2.5	420	1.4

[a] Approximate Sandy River flow at specified station was based on preliminary 1992 USGS gage records and tributary flows referenced to the 1988 sampling of ungaged tributaries by the USGS. Both 1988 and 1992 were considered low flow years.

[b] Average cross-section velocity computed from Flow Balance Q/Cross-Section Area.

Table 8-13
Hydraulic Sampling Data for the Sandy River-July 1992 (CH2M HILL)

Sampling Site No.	Date	Measured Q, cfs	Cross-Section Area, ft^2	Range of Measured Velocity, fps	Flow Balance[a] Q, cfs	Computed Average[b] Velocity, fps
1 (RM 1.5)	7/17/1992	416	302	0.7 to 1.9	420	1.4
2 (RM 3.0)	7/17/1992	434	236	1.4 to 2.1	419	1.8
3 (RM 6.0)	7/16/1992	389	371	0.1 to 1.7	419	1.1
4 (RM 10.0)	7/16/1992	432	358	0.1 to 2.2	413	1.2
5 (RM 12.0)	7/15/1992	274	1,526	0.1 to 0.2	413	0.3
6 (RM 18.4)	7/15/1992	319	757	0.1 to 0.6	391	0.5
7 (RM 22.0)	7/16/1992	334	164	1.0 to 2.5	214	1.3

[a] Approximate Sandy River flow at specified station was based on preliminary 1992 USGS gage records and tributary flows referenced to the 1988 sampling of ungaged tributaries by the USGS. Both 1988 and 1992 were considered low flow years.

[b] Average cross-section velocity computed from Flow Balance Q/Cross-Section Area.

Table 8-14
Mean Flow (cfs) Summary for Sandy River and Four Similar Rivers (USGS 1990)

Month	Proposed Minimum Flows for the Sandy River[a]	Sandy River at Oxbow Park D.A. = 600 mi^2 (1927-1980)	Clackamas River near Clackamas D.A. = 930 mi^2 (1963-1983)	North Santiam River at Mehama D.A. = 655 mi^2 (1954-1987)	South Santiam River at Waterloo D.A. = 640 mi^2 (1967-1987)	McKenzie River at Coburg D.A. = 930 mi^2 (1969-1987)
January	1,900	4,044	7,020	5,610	5,790	6,170
February	1,900	3,489	5,500	4,140	4,090	5,020
March	2,000	3,317	4,620	3,370	3,250	4,510
April	2,000	3,567	4,300	3,200	2,670	4,000
May	2,000	3,315	4,210	3,550	2,300	4,450
June	1700/1500	2,111	2,660	2,590	1,580	3,710
July	800/700	1,091	1,360	1,430	782	2,790
August	550	807	1,000	1,310	816	2,860
September	550	747	1,070	2,040	1,420	2,680
October	700	1,465	1,610	2,780	2,250	2,890
November	1,700	3,322	3,870	5,400	4,900	4,870
December	1,700	4,385	6,910	6,480	6,730	6,700

[a] Several beneficial uses were considered in this 1992 recommendation including recreation, boating, and fishery.

Note: D.A. = Drainage Area.

Source: USGS, 1990 Open File Report 90-118. Statistical Summaries of Streamflow Data in Oregon: Volume 1.

Table 8-15
Fisheries Water Quality Summary for Sandy River and Four Similar Rivers (DEQ 1992)

Water Quality Parameters	Optimal Salmonid *Range*	Sandy River at Various Locations (1965-1992)	Clackamas River at High Rocks (1987-1992)	North Santiam River at Green's Bridge (1987-1992)	South Santiam River at Crabtree (1987-1992)	McKenzie River at Coburg Road (1987-1992)
Temperature (°C)	2.2 to 10.0	2.0 to 25.0	1.5 to 24.0	3.S to 22.0	4.5 to 20.8	4.0 to 22.1
Dissolved Oxygen (mg/l)	> 5.0	7.9 to 14.2	7.2 to 14.2	8.3 to 13.2	8.8 to 13.2	8.8 to 13.1
pH (units)	6.5 to 8.5	6.1 to 8.1	6.7 to 8.7	6.6 to 8.6	6.7 to 8.2	6.9 to 8.6
Alkalinity (mg/l as $CaCO_3$)	NA	5 to 113	10 to 35	2 to 22	14 to 23	17 to 30
Total Ammonia (mg/l)	< 1.5	0.01 to 0.58	0.02 to 0.15	0.02 to 0.40	0.02 to 0.23	0.02 to 0.07
Nitrate and Nitrite (mg/l)	< 0.5	0.02 to 0.30	0.02 to 0.76	0.03 to 0.61	0.02 to 0.35	0.02 to 0.14
Total Kjeldahl Nitrogen (mg/l)	NA	0.10 to 0.80	0.20 to 0.90	0.20 to 0.80	0.01 to 0.40	0.20 to 0.70
Total Phosphorus (mg/l)	NA	0.01 to 0.65	0.01 to 0.14	0.01 to 0.12	0.01 to 0.14	0.03 to 0.12

Source: Oregon DEQ 1992. Storet Retrieval System.

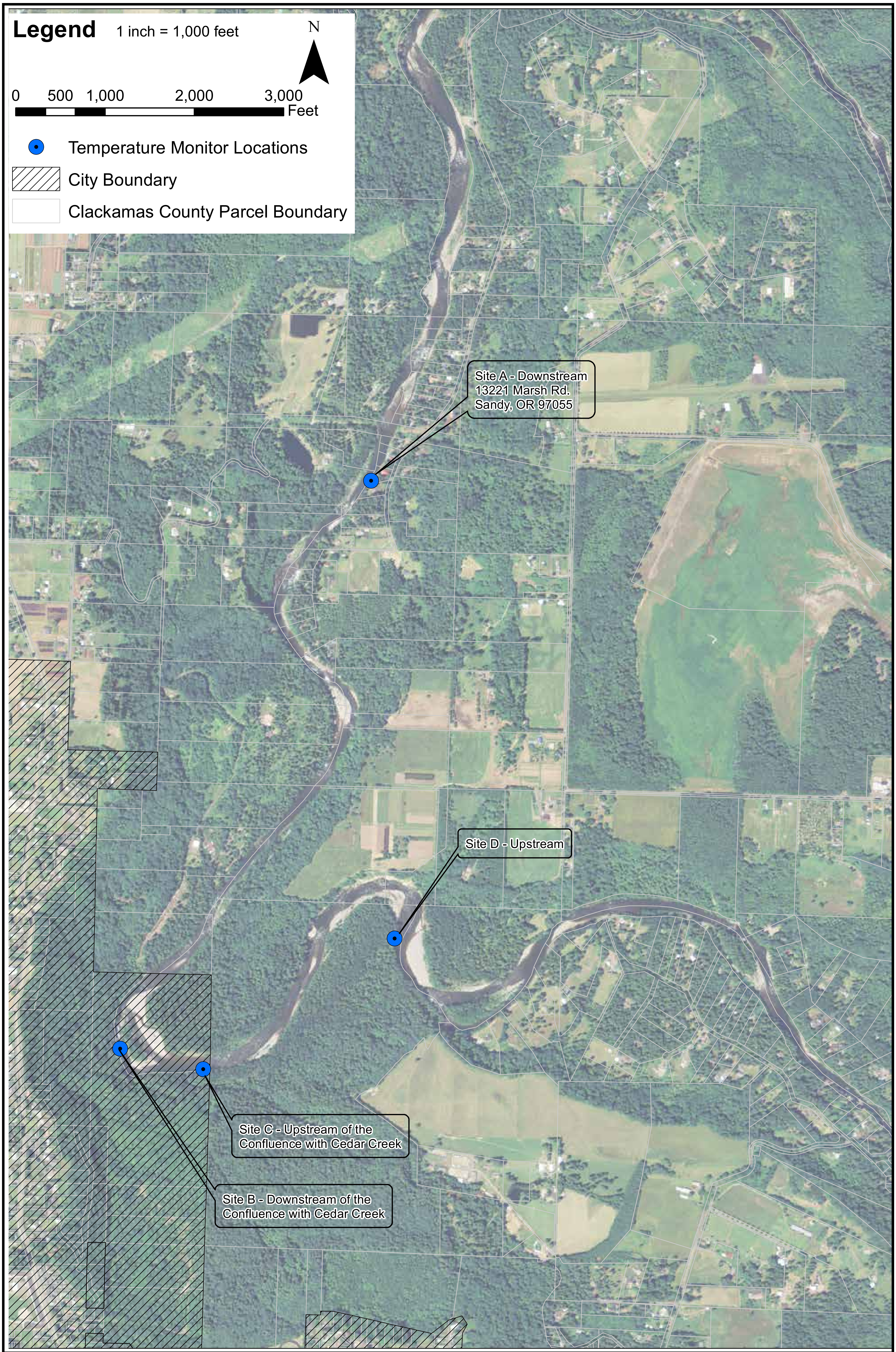
Table 8-16
Sandy River Metals Data - Near Troutdale, RM 2.8 (BLM ~1983)

	Annual Average, (μg/L)			Water Quality Criteria[b] (μg/L)		
				Toxicity to Aquatic Life		Human Health
Metal, Total[a]	1979	1980	1981	Acute	Chronic	
Barium, Ba	< 100	< 1004	100	--	--	1,000.0
Boron, B	< 200	< 200	< 200	-	-	-
Cadmium, Cd	< 1	< 2	< 1	3.9	1.1	10.0
Chromium, Cr	< 50	< 2	< 2	16.0	11.0	30.0
Copper, C	< 50	<30	< 2	18.0	12.0	-
Iron, Fe	< 50	98	88	-	1,000.0	300.0
Lead, Pb	< 10	<10	< 10	82.0	3.2	50.0
Manganese, Mn	< 20	<70	< 20	-	-	50.0
Selenium, Se	< 5	<5	-	260.0	35.0	10.0
Silver, Ag	< 10	< 1	< 1	4.1	0.12	50.0
Zinc, Zn	< 10	< 10	< 25	120.0	110.0	-

[a] Storet Retrieval by Bureau of Land Management, John Barber.

[b] Toxic metals limits for aquatic life and human health, OAR Chapter 340, Division 41, Table 20 data.

APPENDIX B
SANDY RIVER TEMPERATURE MONITORING LOCATIONS



Sandy River Temperature Gage Locations for Effluent Pipe Project

Sandy River Effluent Pipe Gaging

August 2019

WATERWAYS CONSULTING, INC.
Santa Cruz, CA | watways.com | Portland, OR

FIGURE
3

APPENDIX C
SANDY RIVER SAMPLING PLAN

Memorandum

Date: August 7, 2019

Project: City of Sandy WSFP – Continuing Services

To: Mike Walker, Sandy Public Works Director
Public Works Director
City of Sandy, OR

From: Preston Van Meter, Project Manager
Jason Flowers, Project Engineer
Jessica Cawley, Staff Engineer

Review: Matt Hickey, Principal-in-Charge

Re: Sandy River Anti-degradation Evaluation – WQ Sampling and Testing Program

Introduction & Purpose

The purpose of this memo is to summarize the proposed ambient Sandy River water quality sampling and testing program in support of a completing a river anti-degradation evaluation as part of the City's application for a new NPDES discharge permit and outfall on the Sandy River. These data collection efforts are three-fold:

1. **Sandy River Flows.** River flows at the proposed new Sandy River outfall location will be estimated through a local validation process and comparison with historical gauging stations on the Sandy River to provide a long-term flow record to support permitting-related evaluations.
2. **Sandy River Ambient Temperature.** Temperature data will be collected at four locations upstream and downstream of the proposed new Sandy River outfall location during lower flow and critical periods in the spring, summer and fall months over the next 5 years.
3. **Other Sandy River Water Quality Parameters.** Potential water quality (WQ) impacts of the City's proposed new Sandy River outfall will also be assessed in the anti-degradation evaluation by collecting water quality data for other pollutants of concern identified in the river.

Background

In 2019, Murraysmith prepared the City of Sandy Wastewater System Facilities Plan (WSFP) that determined the City's current discharge to Tickle Creek is not a viable long-term option due to the limited flow in the creek and the strict limitations on increasing mass load limits associated with Oregon's Three Basin Rule.

Following a detailed evaluation of cost and a non-cost factors, the recommended long-term alternative involves construction of a new satellite membrane bioreactor (MBR) treatment facility and new year-round discharge to the Sandy River that is not subject to the Three Basin Rule limitations. The proposed Sandy River outfall location is shown in **Figure 1**.

This concept of a new Sandy River outfall was previously investigated by the City in the early 1990's as part of a previous facilities planning effort (CH2M 1994). This previous evaluation included a similar Sandy River water quality sampling and testing program, which included documented historical Sandy River water quality data collected by the Oregon Department of Environment Quality (DEQ) and the Bureau of Land Management (BLM) at five Sandy River locations summarized below. These Sandy River WQ sampling locations are shown in **Figure 2** are summarized as follows:

- RM 3.0 – Lewis and Clark State Park
- RM 6.0 – Dabney State Park
- RM 12.0 – Oxbow County Park
- RM 18.4 – USGS Gaging Station, Dodge Park
- RM 22.0 – Below confluence with Cedar Creek

These previous data are included in **Attachment A**. The previous water quality sampling included the parameters summarized in **Table 1**.

Table 1 – Previous Water Quality Sampling Parameters

Parameters		
Temperature	Alkalinity	Boron
Dissolved Oxygen	pH	Cadmium
Biochemical Oxygen Demand	Electrical conductivity	Chromium
Chemical Oxygen Demand	Fecal Coliform	Copper
Kjeldahl Nitrogen (TKN)	Enterococci	Iron
Ammonia	Chlorophyll-a	Lead
Nitrate and Nitrite	Phaeophytin	Manganese
Total Phosphorus	Total Solids	Selenium
Orthophosphate	Turbidity	Silver
Total Suspended Solids	Total Organic Carbon	Zinc
Total Dissolved Solids	Barium	

This proposed new Sandy River sampling and testing program builds on the previous data collection efforts, but also expanded to include additional water quality parameters as summarized in Oregon's 2012 Integrated Report and 303(d) list, as well as constituents of emerging concern (CECs) that are known at the present time. The 2012 Integrated Report includes the following listings for the Sandy River in the vicinity of the proposed new outfall location:

- **Category 4a (Impaired):** temperature and dissolved oxygen.
- **Category 3 (insufficient data):** iron, lead, copper, alkalinity, chlorophyll-a, manganese, and total suspended solids.
- **Category 2 (partially attaining):** pH, chlorophyll-a, fecal coliform, zinc, nickel, cadmium, dissolved oxygen, E. Coli, ammonia, silver, selenium, arsenic, chromium, and phosphate phosphorus.

Proposed Sandy River Flow and WQ Sampling and Testing Program

The proposed Sandy River sampling and testing program includes three primary elements:

1. Validation of river flows at the proposed outfall location;
2. Long-term temperature monitoring; and
3. Additional water quality parameters.

These data will then be used to support the completion of the anti-degradation evaluation required by Oregon DEQ as part of the permitting process for the City's proposed new Sandy River outfall from the future satellite MBR treatment facility.

Each of these program elements is discussed in the sections that follow.

Sandy River Flow

To establish flow monitoring data, Waterways Consulting, Inc. has been contracted to conduct a site validation of Sandy River flows at the City's proposed new Sandy River outfall location on five occasions over the next year. These data will then be compared to the continuous flow measurements on USGS gauging stations on the Sandy River upstream, approximately 3.5 miles downstream, the Bull Run River, and Little Sandy River. These measurements will then be used to adjust the historical gauge data to estimate flows at the proposed new outfall location. A copy of the proposal from Waterways Consulting (Waterways) for completion of flow estimates is included in **Attachment B.**

Sandy River Temperature

Sandy River temperature will be collected by thermistors placed at four (4) different locations upstream and downstream of the proposed new outfall location. The thermistors will log temperature data continuously from May through October. The Sandy River locations where thermistors have been deployed is shown in **Figure 3**.

The temperature monitoring will be completed by Waterways Consulting on a contract basis with the City over the next five (5) years. The proposal from Waterways Consulting included in

Attachment B also includes a summary the proposed temperature data collection program in addition to the flow validation support previously noted.

Additional Water Quality Parameters

As part of the antidegradation analysis, water quality (WQ) data collection will include the same data collected back in the previous 1990's era sampling and testing program as well as additional parameters included on the 303(d)-list summarized previously. The proposed ambient WQ sampling and testing program will include the WQ parameters summarized in **Table 2**.

Additional Sandy River WQ Data Collection – Costs and Schedule

This section summarizes cost and other coordination items for the proposed Sandy River ambient water quality sampling and testing program. River flow and temperature data collection will be provided by Waterways Consulting, with a total proposed cost of summarized in **Attachment B**.

The schedule for collection of these additional data is based on both near- and long-term goals:

1. **Near-Term Goal:** conduct river water quality sampling and testing events once per month over the next 3 months to support preparation of the Sandy River anti-degradation evaluation for the NPDES Permit application. Near-term river sampling events will be conducted in early August, September and October 2019.
2. **Long-Term Goal:** continue monitoring river water quality through quarterly sampling events in 2020 and 2021 to validate assumptions in the river anti-degradation evaluation. Four river sampling events will be conducted each year.

It is recommended that testing be conducted both upstream and downstream of Cedar Creek (Site B and Site C) as shown in **Figure 3**, allowing an assessment of the impact of the Cedar Creek fish hatchery seasonally on Sandy River water quality.

The additional WQ parameters recommended to be monitored on the Sandy River is summarized in **Table 2** along with the number of samples and lab testing costs for each parameter. This list is informed by the previous testing summarized in Table 1, additional WQ parameters included in the 2012 Integrated Report and current constituents of emerging concern (CECs).

Table 2 – Estimated Sampling and Testing Costs

Parameter	Locations Sampled	2019 Sampling events	2020/21 Sampling Events	Total Samples Collected	Lab Testing Cost/Sample	Lab Cost
Total Organic Carbon (TOC) as $CaCO_3$	2	3	8	22	$55	$1,210
Chlorophyll-a	2	3	8	22	-	-

Parameter	Locations Sampled	2019 Sampling events	2020/21 Sampling Events	Total Samples Collected	Lab Testing Cost/Sample	Lab Cost
Alkalinity as $CaCO_3$	2	3	8	22	$25	$550
Biochemical oxygen demand (BOD_5)	2	3	8	22	$45	$990
Chemical oxygen demand (COD)	2	3	8	22	$30	$660
Bacteria - Fecal Coliform	2	3	8	22	$60	$1,320
Bacteria - E. Coli	2	3	8	22	$40	$880
Bacteria - Enterococci	2	3	8	22	$50	$1,100
pH	2	3	8	22	$10	$220
Total Suspended Solids (TSS)	2	3	8	22	$20	$440
Ammonia, as N	2	3	8	22	$25	$550
Dissolved oxygen	2	3	8	22	$15	$330
Nitrate, as N	2	3	8	22	$25	$550
Nitrite, as N	2	3	8	22	$25	$550
Kjeldahl nitrogen (TKN), as N	2	3	8	22	$45	$990
Phosphorus (Total), as P	2	3	8	22	$30	$660
Orthophosphate, as P	2	3	8	22	$25	$550
Total dissolved solids (TDS)	2	3	8	22	$20	$440
Arsenic	2	3	8	22	$30	$660
Chromium, total	2	3	8	22	$30	$660
Cadmium	2	3	8	22	$20	$440
Copper	2	3	8	22	$15	$330
Iron (Total)	2	3	8	22	$15	$330
Lead	2	3	8	22	$20	$440
Manganese	2	3	8	22	$15	$330
Mercury	2	3	8	22	$35	$770
Nickel	2	3	8	22	$25	$550
Selenium	2	3	8	22	$20	$440
Silver	2	3	8	22	$15	$330
TOTAL					**$785**	**$17,270**

In addition to the lab testing fees summarized in Table 1 above, other costs for implementation of the Sandy River Flow and WQ sampling and testing program are summarized in **Table 3**. For each river WQ sampling event, it is proposed that Murraysmith will coordinate with the testing laboratory and Waterways will collect the river samples.

Table 3 – Sandy River Sampling and Testing Program Costs

Description	Cost
Year 1 Temperature Probe Install and Flow Measurements	$16,700
Year 2 through 5 (2020-2024) Temperature Monitoring and Reporting	$13,100
Analytical testing laboratory	$17,270
River sample collection, lab coordination, and data validation	$27,500
Total Estimated Program Cost	**$74,570**

Other Considerations and Next Steps

Following City review, this proposed plan will be submitted to DEQ for review. Concurrence with DEQ regarding the proposed flow, temperature and additional WQ parameterswill support the preparation of a river anti-degradation evaluation required as part of the City's application for a new Sandy River NPDES Permit.

Concurrent with DEQ review, it is recommended the City complete the August river sampling event. Any modifications of the additional WQ testing parameters would then be implemented in the second or third 2019 sampling events.

References

CH2M Hill. (1994) *Sewerage System Facilities Plan.* City of Sandy.

PLVM:jjf

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