

Port of Sunnyside Industrial Wastewater Treatment Facility

Draft Engineering Report

Anaerobic Pretreatment System for SBR Influent

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1.0 The PORT of SUNNYSIDE INDUSTRIAL WASTEWATER TREATMENT FACILITY

The Port of Sunnyside was formed in 1964 as a municipal corporation of the State of Washington under Title 53 of the Revised Code of Washington (RCW). It is governed by a Board of Commissioners. The three elected Commissioners represent three geographic subdistricts, of approximately equal populations, within the Port district. The Port is independent from all other state and local governments; although Yakima County collects, on the Port's behalf, property taxes levied by the Port. Under provisions of RCW 53.08.040, the Port is prohibited from utilizing any of these taxes for the benefit of its Industrial Wastewater Treatment Facility (IWWTF).

The Port of Sunnyside operates a wastewater treatment system serving the industries in, and within the vicinity of, the City of Sunnyside, Washington. The industrial users of the IWWTF are principally food processors. The wastewater treated is generated through the processing of food products, along with small quantities of noncontact cooling water and stormwater. Discharge from the sanitary facilities of the industries, along with all other domestic wastewater except the industrial wastewater, is treated by the City of Sunnyside treatment plant.

The Port of Sunnyside and the City of Sunnyside are two separate and distinct entities. The Port of Sunnyside IWWTF exclusively treats industrial wastewater. The City of Sunnyside POTW treats domestic wastewater.

The currently existing treatment units of the system consist of Lagoon No. 1, Lagoon No. 2/3, two sequencing batch reactor (SBR) basins, Lagoon No. 4, and a land application system. A solids dewatering system processes waste activated sludge from the SBRs through a screw press.

The original IWWTF was essentially a land treatment system. Industrial wastewater was received into an equalization basin, Lagoon No. 1, from which it was land applied throughout the year. In 1992, a storage lagoon, Lagoon No. 4, was added to the system. Lagoon No. 4 enabled wastewater to be stored during the winter, and discharged to the land only during the growing season. In 1995, the overflow basins for Lagoon No. 1, Lagoon No. 2 and Lagoon No. 3, were combined into a single plug-flow lagoon, Lagoon No. 2/3. A schematic diagram of the existing components of the IWWTF system is provided in Figure 1-1.

Influent to the Port treatment system is received into the Influent Pumping Station. Primary treatment of the influent consists solely of bar screens upstream of the pumps in this pumping station.

Wastewater is lifted from the Influent Pumping Station to a flume for flow measurement. The flume is located in the dike of Lagoon No. 1. Wastewater flows through the flume to the Diversion Structure, also located in the dike of Lagoon No. 1. Slide gates in the Diversion

Structure control the flow path of the wastewater passing through it. Water can gravity flow from this routing structure to Lagoon No. 1, to Lagoon No. 2/3, or to the Mixing Structure for the SBR basins. Normally, all wastewater is routed through the Diversion Structure to Lagoon No. 1.

Effluent from Lagoon No. 1 can be routed to Lagoon No. 2/3 or to Lagoon No. 4 by means of slide gates in the lagoon's effluent structure. In the normal operation of the IWWTF, Lagoon No. 1 effluent is routed into Lagoon No. 2/3. In addition to effluent flowing through the lagoon effluent structure, however, there is a pipe that penetrates directly in the lagoon. This pipe allows effluent to be conveyed from the lagoon to the SBR Mixing Structure.

Effluent from Lagoon No. 2/3 flows through the lagoon's effluent structure to Lagoon No. 4. As in the case of Lagoon No. 1, a pipe penetrates Lagoon No. 2/3 near its effluent structure. This pipe allows effluent from this lagoon to flow to the SBR Mixing Structure.

The SBR Mixing Structure controls the source of influent to the SBR basins. Slide gates in the Mixing Structure allow influent to the SBR to consist of effluent from Lagoon No. 1, effluent from Lagoon No. 2/3, raw influent to the IWWTF, or mixtures of these waters. Currently, influent to the SBRs is generally a blend of the effluents from Lagoon No. 1 and Lagoon No. 2/3. The proportions of the mixture of these two lagoon effluents are controlled, through a programmable logic controller (PLC), by motor-driven actuators on the slide gates regulating flow from each of the lagoons into the Mixing Structure.

Effluent from the SBRs is decanted to the Flow Equalization Basin. It is pumped at a controlled rate from this basin to either surface water, or to the 24-inch pipe that also conveys Lagoon No. 1 and Lagoon No. 2/3 effluent to the storage lagoon, Lagoon No. 4. SBR effluent that complies with NPDES Permit discharge limitations is discharged to surface water during the period of October through June. During the period of July through September, SBR effluent is discharged to Lagoon No. 4 where it is held for land application. SBR effluent that is not in compliance with permit limitations for discharge to surface water is diverted to Lagoon No. 4.

Water held in Lagoon No. 4 is discharged to the land application unit of the IWWTF. The Port's permit allows discharge to land from February through October. The hydraulic loading permitted for each month during this period is a function of that month's evapotranspiration.

2.0 INDUSTRIAL USERS of the PORT of SUNNYSIDE IWWTF

The industries currently maintaining contracts to discharge wastewater to the Port of Sunnyside IWWTF are listed in Table 2-1. In addition to the contract with the Port, the industries are required to hold a permit to discharge to the publically owned treatment works (POTW) issued by the State of Washington Department of Ecology.

Table 2-1. Industries Contracting to Discharge to the IWWTF

Industry	Type of Industry	Discharge Permit Number
Andrus & Roberts Produce Co., now owned by Seneca Foods, LLC	Fresh fruit packing.	WAG 43-5252
Centennial Tank Cleaning, Inc.	Tank truck washing. The company cleans tanker trucks, intermodal bulk containers and drums hauling food grade or food grade compatible non-hazmat products.	ST-9125
Darigold, Inc.	Cheese production. Products include cheese, dry whey, and milk protein concentrate.	WA-005207-8
DRR Fuit Products, Inc.	Fresh and frozen apples and cherries processing.	ST-9218
JM Eagle	Production of HDPE pipe.	ST-9112
Johnson Foods, Inc.	Fruit and vegetable processing. Products are fresh and frozen asparagus and cherries, pickled vegetables, and maraschino cherries.	ST-9214
LTI, Inc.	Tank truck washing. The company cleans milk tankers.	ST-9173
Seneca Foods, LLC	Fresh fruit canning. Products are canned pears, apples, and cherries.	ST-9099

Industry	Type of Industry	Discharge Permit Number
Valley Processing, Inc. – Plant #1	Processing of fruit into fruit juice concentrates, purees, and essences. Fruits processed are apple, grape, blackberry, boysenberry, cranberry, currant, cherry, pear, raspberry, and strawberry.	WA-005206-0
Valley Processing, Inc. – Plant #2	Cold storage of grape concentrates.	ST-9223
Yakima Chief, Inc.	Production of hop extracts.	ST-9216

3.0 IWWTF CAPACITIES APPROVED by WASHINGTON STATE DEPARTMENT of ECOLOGY

Treatment capacities that have been approved by the Washington State Department of Ecology are developed in the *Port of Sunnyside Industrial Wastewater Treatment Facility Engineering Report* (Earth Tech, Inc. 2003) and the *Port of Sunnyside Industrial Wastewater Treatment Facility Design Criteria* (Port of Sunnyside. May 2008a). These capacities are summarized in Table 3-1.

Table 3-1. IWWTF Capacities Approved by Washington State Department of Ecology

	Hydraulic Volume		Wastewater Constituents		
	System with Phase 1 SBR	System with Phase 2 SBR	Biochemical Oxygen Demand (lbs/day)	Total Nitrogen (lbs/day)	Total Kjeldahl Nitrogen (lbs/day)
Industry Wastewater Discharge to IWWTF (million gallons per day, Mgd)	1.45	2.00			
Sequencing Batch Reactors (Mgd)	0.55	1.10			
Land Application System, Outfall 002 (cubic feet per year)					
Wet Year	65,335,100	65,335,100			
Average Year	71,116,900	71,116,900			
Dry Year	77,766,100	77,766,100			
IWWTF Influent and Lagoon System			58,165	2,125	
Phase 1 SBR			14,793		757
Outfall 002 (123-day average)			77,550	1,530	

4.0 IWWTF ANAEROBIC PRETREATMENT SYSTEM

The essential components of the current IWWTF system, and their general configuration in the treatment train, are described in Section 1.0. The following paragraph is quoted from the 2010 Port of Sunnyside IWWTF engineering report, and provides a basis for the addition of the anaerobic pretreatment system described in the subsequent sections of this document.

The Port of Sunnyside Engineering Report submitted to the Washington State Department of Ecology in 2003 includes the projected addition of a Phase 2 SBR when the average annual daily influent flow to the system exceeds 1.45 million gallons per day (Mgd). An analysis of system treatment capacity conducted for the Port by HDR Engineering, Inc. demonstrates that the existing Phase 1 SBR is capable of treating double its current influent volume of approximately 0.55 Mgd if an anaerobic pretreatment lagoon is incorporated into the system that feeds into the SBR. The anaerobic lagoon reduces the loading of oxygen demand constituents to the SBR to such an extent that a vastly greater hydraulic volume can be treated. Consequently, as the growth of industry in the vicinity of Sunnyside, Washington causes the hydraulic and constituent loadings to the IWWTF to increase, the Port will evaluate the addition of an anaerobic lagoon to the treatment system before adding Phase 2 SBRs. (Port of Sunnyside. 2010. p. 13)

The dairy products processor that discharges to the IWWTF wishes to expand the capacity of its existing plant in Sunnyside. This expansion is intended to allow this plant to process all of the milk that is currently being produced by the dairies within the vicinity of Sunnyside.

The Port has considered the alternatives of increasing the capacity of its treatment system by either the addition of Phase 2 SBRs, or by adding anaerobic pretreatment of SBR influent into the treatment train. Modifying the IWWTF to enable anaerobic pretreatment of influent to the existing SBRs is deemed to be the better option. Construction of a lined earthen basin with a floating membrane cover is less expensive than the construction of two prestressed concrete basins with aeration equipment. Less energy is required to treat a given mass of biochemical oxygen demand (BOD) anaerobically than to treat that mass aerobically. A smaller mass of waste biomass is generated through the anaerobic removal of oxygen demand wastewater constituents than through the aerobic treatment of those wastewater constituents. Less waste biological solids are produced during anaerobic treatment because a portion of the wastewater constituents utilized as food by the microbes of the process is converted to methane, as a metabolic byproduct, rather than to cell mass, as in the aerobic treatment process. This methane is potentially a valuable energy source.

In addition to these generally recognized benefits of anaerobic wastewater treatment, it is anticipated that anaerobic pretreatment of the influent to the SBR system will improve the stability of the treatment provided by this portion of the IWWTF treatment train. Oxygen

demand loadings influent to the IWWTF are highly variable; both seasonally and day-to-day. Pretreating the SBR influent through the covered anaerobic pretreatment lagoon will mitigate this variability and improve the consistency of SBR effluent quality.

4.1 Modifications to Existing IWWTF System

The following modifications will be made to the existing treatment train of the IWWTF in order to incorporate anaerobic pretreatment of influent to the SBR system. A second pump station will be constructed to lift a portion of the IWWTF influent into a Preacidulation Basin. Effluent from this Preacidulation Basin will gravity flow to a Covered Anaerobic Lagoon (CAL). Effluent from the anaerobic lagoon will flow by gravity to a new Flow Splitter Structure, from which the SBR basins will receive influent. Excess biological sludge will be removed from the anaerobic lagoon through a system of pipes and a rotary lobe pump. The biogas generated through the anaerobic process will be removed from beneath the cover of the CAL through a system of pipes and blowers. Initially, the recovered biogas will be flared. Beneficial uses of the biogas will be investigated and implemented in the future.

A schematic diagram, presented at Appendix A, shows the flow paths through the IWWTF treatment units after incorporation of the anaerobic pretreatment system. This diagram displays primary flow paths, provisions for bypass around the various units, as well as provisions for overflow from one unit to another to prevent spills. The provisions for bypass are denoted as secondary flow paths on the diagram.

Memoranda provided by HDR Engineering, Inc. regarding design of various elements of the anaerobic pretreatment system are provided in Appendix B.

4.1.1 Influent Lift Station

Most of the influent to the anaerobic pretreatment system will be dairy processing wastewater. The dairy processing wastewater influent to the IWWTF will be diverted to the anaerobic system by inserting a tee into the existing 18-inch PVC pipe that conveys this wastewater to the existing Influent Pumping Station. New gate valves will be installed into the lines from this tee. The valve in the line leading to the existing pumping station will be normally closed, while the valve in the branch leading to the new Influent Lift Station will be normally open.

The principal design criteria for the new pump station are a design flow rate of 1.0 million gallons per day (Mgd); a peak flow of 2.0 Mgd; and n+1 redundancy for the number of pumps. The pumps will be equipped with variable frequency drives. The peak operating design point for each of the pumps is 1.0 Mgd at 49-feet total dynamic head (TDH). The minimum flow design point for each pump is 0.5 Mgd at 40.9-feet TDH.

The new lift station will consist of a precast concrete wet well and three vertical centrifugal pumps. The pumps selected are chopper pumps, eliminating concerns about any small solids that may be carried in the wastewater. The vertical centrifugal configuration has been selected for the pumps in order to reduce the amount of corrosion resistant material that must be used for the pumps. Periodic excursions of wastewater pH to low values are possible. Therefore, any portion of the pump mechanism that is immersed in the wastewater must be stainless steel, or be specially coated to resist corrosion. When compared to submersible pumps, the vertical centrifugal configuration removes the pump motor from the wastewater, facilitating maintenance of the motor; it is less expensive than a submersible pump; and is more efficient.

The wet well will be a 12-foot diameter precast concrete manhole, consisting of two 6-foot long riser sections, set on a standard 1-foot thick base. The interior of the wet well will be protected from corrosion with Utilithane[®] 1600 Polyurethane coating. The wet well will be covered with a precast lid, cut to accommodate the pumps and an access hatch.

Overflow from the wet well will be directed to the existing 18-inch PVC pipe that now conveys the dairy processing wastewater to the existing Influent Pumping Station. The overflow from the new lift station wet well will then be lifted into existing Lagoon No. 1, or gravity flow to existing Lagoon No. 4 in the event of backup power failure.

4.1.2 Preacidulation Tank

Anaerobic treatment is dependent upon a complex microbial consortium engaged in a series of metabolic processes. More complex organic compounds are hydrolyzed into simpler compounds, which are then fermented into volatile acids. The volatile acids are ultimately converted into acetate and hydrogen gas. Finally, the acetate and hydrogen gas are metabolized into methane. Since this complex series of metabolic processes proceed at differing rates, and are accomplished by different organisms requiring different environmental conditions, better control of the process is achieved if the initial stages of anaerobic treatment are separated from the later stages.

During the initial stages of anaerobic treatment, acid is generated through the process of acidogenesis. The microbes involved in subsequent stages of the anaerobic process, however, require near neutral pH conditions. Therefore, the IWWTF anaerobic pretreatment system will separate acidogenesis from the subsequent methanogenesis occurring in the CAL. The acidogenesis will be accomplished in a Preacidulation Tank.

Adequate detention time of wastewater within the Preacidulation Tank is critical for the successful separation of acidogenesis from methanogenesis. Bench scale testing of the dairy processing wastewater by the IWWTF laboratory, conducted under the guidance of HDR Engineering, Inc., indicates that minimum pH levels occur within 2 hours to 4 hours.

A standard, vendor supplied, tank is available with a diameter of 55.95 feet, and a sidewall height of 28.43 feet. Allowing 2 feet of freeboard, the volume of this tank is about 486,000 gallons. Detention time within this tank is more than 14.5 hours at a flow rate of 0.8 Mgd, and more than 11.5 hours at 1.0 Mgd. Thus this size tank will provide ample detention time for the acidulation process to occur.

The tank is a glass-lined, bolted-steel tank. This material is less expensive than stainless steel construction, but has better corrosion resistance than baked-epoxy coating. The tank will be set on a concrete slab, estimated to be 12-inches thick. This slab thickness is estimated to be required due to the settling predicted to occur as a result of the load of the full tank.

The tank will be mixed by means of a floating mixer. Preliminary sizing of this mixer indicates that a single 20-hp unit is adequate. Capital costs for this type of mixer are significantly less than for the alternative use of mixing pumps, in which the pumps are external to the tank with a system of nozzles within the tank.

An insulated floating cover will be used to help maintain the temperature of the wastewater while it is in the acidulation tank. The insulating value of an insulated HDPE floating cover is estimated to be about R-5.

Effluent from the Preacidulation Tank will gravity flow to the CAL. Any overflow from the tank will go to the existing flume sluice box, from which it will flow to existing Lagoon No. 1.

4.1.2.1 Chemical Injection

The alkalinity of the wastewater influent to the CAL will be maintained to provide a pH value near neutral. The buffering agent used will be the 60% magnesium hydroxide slurry that is now used by the IWWTF to buffer influent to the aerated lagoon and SBR systems.

The results from the previously mentioned bench scale testing of dairy processing wastewater indicate that 765 gallons per day of 60% magnesium hydroxide slurry will be required to assure adequate bicarbonate alkalinity for a flow of 0.8 Mgd. This will provide the 2:1 bicarbonate to organic acid ratio recommended for stable anaerobic operation (McKinney. *Alkalinity Measurements and Organic Acids*. Included at Appendix C).

The magnesium hydroxide slurry will be injected into the new Lift Station wet well for the anaerobic pretreatment system using peristaltic pumps. Peristaltic pumps with a capacity of 60 gallons per hour will provide approximately double the estimated requirement. Injection of the buffering agent into the wet well will ensure complete mixing of it into the wastewater as it passes through the centrifugal pumps.

Early attempts to treat industrial wastewaters anaerobically often were of limited success. In many instances, the reasons for this can be traced to deficiencies of micronutrients. Although

dairy processing wastewater generally provides adequate micronutrients, provisions will be made to allow injection of a micronutrient mixture into the anaerobic pretreatment system Lift Station wet well. A peristaltic pump will be used for this chemical injection as well. Injection into the wet well will provide complete mixing of this micronutrient solution into the CAL influent.

4.1.3 Covered Anaerobic Lagoon

The Covered Anaerobic Lagoon will be constructed with earthen dikes impounding a total volume of approximately 9.4 million gallons. The height of the dikes will be 20 feet, with interior slopes of 1:2.5, and exterior slopes of 1:3. At maximum capacity, the lagoon will operate with 2 feet of freeboard. The bottom of the lagoon will be at grade, with a slope of about 2 percent.

The CAL will utilize a double liner system with leak detection to provide protection of groundwater quality. The primary and secondary liner membranes will be constructed of 60 mil HDPE. Between these two membranes will be a geocomposite drainage layer.

The lagoon will be covered with a 100 mil HDPE membrane to trap biogas. This biogas will be recovered in a perforated HDPE pipe system along the top interior perimeter of the lagoon dikes. The biogas will be moved from under the lagoon cover membrane to a flare by means of a regenerative blower, housed in a new Biogas Building.

The design of the CAL is based upon BOD₅ loading rate of 20 pounds per day per thousand cubic feet of reactor volume. The desired hydraulic retention time is about 10 days. With a design influent BOD₅ concentration of 3100 mg/L, and an average flow rate of 0.8 Mgd, the required volume of the anaerobic lagoon for the average day loading is approximately 7.7 million gallons. This reactor volume results in the desired hydraulic retention time of about 10 days at the average daily flow rate. The BOD₅ removal efficiency of the CAL is projected to range between about 88% and 95%.

The actual detention time in the CAL is a function of the amount of biomass solids retained in the reactor. The design of the CAL includes additional volume to accommodate accumulated solids. This additional volume is based upon a biomass yield of 0.05 pounds of solids for each pound of chemical oxygen demand (COD) removed, and the solids settling to a concentration ranging between 2.5% and 4%. With a design average COD concentration of about 5200 mg/L, the estimated biomass yield is 1,380 pounds per day (dry). Assuming that the solids will be allowed to settle to a concentration of 4% before removal, the volume occupied by solids accumulated over a 12-month period should not exceed about 1.7 million gallons.

The total volume of the CAL, therefore, will be 9.4 million gallons. This volume provides a minimum of 7.7 million gallons for organic treatment, and a maximum of 1.7 million gallons of sludge storage.

It is anticipated that in actual operation, the volume of solids will not be allowed to accumulate to greater than 1.4 million gallons. Thus the minimum treatment volume is projected to be 8.0 million gallons.

The anaerobic lagoon will be constructed on property owned by the Port of Sunnyside. The CAL will be located south of existing Lagoon No. 2/3, and east of the existing SBR basins. The proximity of this location to existing treatment units makes it the best possible site. This area is not included in the IWWTF land application system. Consequently, the use of this site does not impact the capacity of that portion of the treatment train.

4.1.3.1 Waste Biomass Removal System

The accumulated sludge will be removed from the CAL through a system of 6-inch HDPE pipes, and a positive displacement pump located in a new Sludge Pumping Building. There are several types of positive displacement pumps, but the type selected for this application is the rotary lobe type. The rotary lobe pump was selected because of the anticipated density of the sludge; the velocity required in the pipeline to minimize friction losses; and the distances that the sludge must be pumped. Since it is not operationally critical that sludge be removed at any particular frequency, such as daily, weekly, or even monthly, redundancy of the sludge pump is not necessary.

The sludge removed from the CAL will be pumped to the existing SBR Sludge Storage Basin, from which it will be pumped to the existing Dewatering Facility. Dewatered cake is removed from the IWWTF, under contract to Natural Selection Farms, where it is composted.

The total distance from the CAL to the Sludge Storage is about 1630 feet, with 710 feet of pipe on the suction side of the pump, and 920 feet of pipe on the discharge side of the pump. Pump selection is based upon 6% solids concentration of the sludge, a design flow of 400 gallons per minute, and a total dynamic head of approximately 87 feet.

4.1.3.2 Biogas Removal System

The biogas that will be generated in the CAL will be collected through a system of HDPE pipes, and regenerative blowers. The biogas will be burned at a flare. Although not part of the current project, it is anticipated that a beneficial use for the biogas will be determined, and that a future system will be developed to exploit this energy source.

The biogas will be collected from beneath the floating cover membrane of the CAL through perforated HDPE pipes. These pipes are positioned at the top, interior of the lagoon embankments.

The sizing of the regenerative blower is based upon the estimated biogas production resulting from the methanogenesis occurring in the CAL. COD removal efficiency is projected to range between 75% and 85%, with 5.4 cubic feet of methane produced for each pound of COD removed. The biogas that will be generated is estimated to be about 68% methane. Using an average flow of 0.8 Mgd, about 136 standard cubic feet per minute (SCFM) of biogas will be produced. Using a peak design flow of 1.0 Mgd, the biogas production is computed to be 170 SCFM. Given the highly variable nature of industrial wastewater loadings to the IWWTF, a peaking factor of 1.5 was used to estimate an average biogas production rate of 204 SCFM, and a peak production rate of 255 SCFM. The biogas blowers will be controlled through variable frequency drives in order to maintain a specific pressure under the floating membrane cover.

The flare requires a minimum of 4-inches of water column operating pressure. It will be sized to comply with 40 CFR Part 60.18. An automatic natural gas pilot ignition system is used to ensure proper combustion of the biogas under varying flow rates, varying heat content of the gas, and high wind conditions.

4.1.4 Flow Splitter Structure

Effluent from the covered anaerobic lagoon will gravity flow through an HDPE manhole in the west dike of the lagoon to a new Flow Splitter Structure in the vicinity of the existing SBR Mixing Structure located in the south dike of Lagoon No. 1 and Lagoon No. 2/3. The Flow Splitter Structure allows effluent from the CAL to be commingled with flow from the SBR Mixing Structure to provide influent to the SBR system. The existing SBR Mixing Structure allows effluent from Lagoon No. 1 or Lagoon No. 2/3 to be used as influent to the SBR basins. In conjunction with the existing Diversion Structure, the Mixing Structure also enables influent to the IWWTF, which has been routed around Lagoon No. 1, to be taken directly into the SBRs as influent. Thus the new Flow Splitter Structure, operated in tandem with the existing Mixing Structure, will supply influent to the SBR system consisting exclusively of CAL effluent, or a combination of effluents from the anaerobic pretreatment lagoon and the aerated lagoons system.

In addition to supplying the influent to the SBR system, the Flow Splitter Structure provides for effluent from the CAL to flow to the existing Lagoon No. 2/3 whenever the SBR basins are not receiving influent. This provision for bypass of the CAL effluent to Lagoon No. 2/3 is through an unrestricted overflow from the Flow Splitter Structure to Lagoon No. 2/3. Valving in the pipe from the Flow Splitter Structure to Lagoon No. 2/3 provides the option of diverting the CAL effluent to Lagoon No. 4 rather than Lagoon No. 2/3, if necessary.

4.1.5 Modifications to Existing IWWTF Treatment Units

The previous sections of this report chapter describe new structures and equipment that will be added to the IWWTF in order to increase the treatment capacity of the existing SBR system.

This section describes modifications required to existing equipment to accommodate the increased volume of SBR effluent.

The existing SBR decanters, furnished by Aqua-Aerobic Systems, Inc. will be replaced with decanters capable of transmitting a greater rate of flow. The existing decanters are capable of a decant flow rate of 1833 gallons per minute (gpm), as an average from high water level to low water level, through an 8-inch hose. These decanters will be replaced with units capable of a decant flow rate of 3056 gpm, as an average from high to low water level, through a 12-inch pipe.

The SBR effluent is conveyed to a Flow Equalization Basin, from which effluent is pumped at a controlled rate. Currently, the pumps remove effluent from this basin at a rate of about 382 gpm. The design point for these pumps is 500 gpm at 22 feet of total dynamic head. With the treatment capacity of the SBR basins doubling, from 0.55 Mgd to 1.1 Mgd, the flow rate through the pumps must increase to about 764 gpm. The new design point for the effluent pumps will be 764 gpm at 30.9 feet TDH.

The sump pumps of the sludge Dewatering Facility will also be changed. The existing pumps have never been able to meet the specified design point of 190 gpm at 18 feet TDH. This design point will not be modified.

The existing standby generator that provides backup power to the IWWTF Influent Pump Station will be replaced. The new generator will be sized to provide backup power to both the existing influent pump station and the new lift station for the anaerobic pretreatment system, as well as the existing mixer on the magnesium hydroxide storage tank.

5.0 TREATMENT PROCESS and OPERATION

The addition of an anaerobic pretreatment system to the IWWTF treatment train will result in two possible pretreatment systems supplying influent to the existing SBR system. The existing aerated lagoon system, composed of Lagoon No. 1 and Lagoon No. 2/3, will continue to receive industrial wastewater. With the construction of the anaerobic pretreatment system, the fruit processing wastewater will be treated primarily through the aerated lagoon system. Dairy processing wastewater will be treated principally through the anaerobic pretreatment system, and the SBR system. Any portion of the effluent from the aerated lagoon system that is not further treated in the SBRs will flow to the Land Application System storage lagoon, Lagoon No. 4. Effluent from the SBR system that complies with National Pollutant Discharge Elimination System (NPDES) Permit effluent limitations will be discharged to the receiving water, Joint Drain 33.4 (JD 33.4). Effluent from the SBR system that does not comply with NPDES permit discharge limitations will be diverted to Lagoon No. 4 for discharge to the Land Application System.

The wastewater flows and constituent loadings expected to be influent to the modified IWWTF system are presented in Table 5-1. The parameters listed for the IWWTF are the flows and loadings to the entire treatment system. These parameters for the treatment system are provided as annual daily averages, and the daily averages for the maximum month. The parameters for the maximum month are tabulated for the influent to the treatment system because a significant portion of the influent results from the autumn processing of the fruit harvest. The fraction of the IWWTF influent that will be diverted to the anaerobic pretreatment system, on the other hand, is not subject to the seasonal variations of the fruit processing industry. This portion of IWWTF influent is more consistent in its flow and loadings. Loadings to this system are expected to spike to greater values periodically, but a significantly greater loading occurring consistently in one month is not likely. Therefore, the maximum day loadings for this waste stream are tabulated, along with the annual daily averages.

Table 5-1. Anticipated Influent Flow and Loadings to IWWTF and Anaerobic Pretreatment System

	IWWTF		Anaerobic Pretreatment System	
	Annual Average	Maximum Month	Annual Average	Maximum Day
Flow (Mgd)	1.32	1.67	0.8	1.1
BOD ₅ (lbs/d)	28,700	41,850	20,700	25,900
TSS(lbs/d)	8,050	11,700	4,670	5,840
TKN(lbs/d)	1,300	1,460	1,000	1,380

In order to provide the operational flexibility required to optimize the quality of IWWTF effluent, valves allow modification of the flow path of wastewater through the treatment system. Although most of the fruit processing wastewater will be directed to the aerated lagoon system, it is possible to send influent received into the IWWTF from the fruit processors to the anaerobic pretreatment system lift station by means of the sluice box upstream of the existing influent flow measurement flume. Similarly, dairy processing wastewater may be diverted to the aerated lagoon system, rather than being pretreated through the anaerobic system.

In general, dairy processing wastewater will be received into the new anaerobic pretreatment Lift Station. This pump station will send wastewater to the Acidulation Tank, where the initial anaerobic process of acidogenesis, or fermentation, will occur. The pH of the effluent from the Acidulation Tank will be buffered to near neutral by means of magnesium hydroxide injection. The fermented/buffered effluent from the Acidulation Tank will gravity flow to the covered anaerobic lagoon. With a hydraulic detention time of about ten days at an influent flow rate of 0.8 Mgd, the wastewater in the anaerobic lagoon will undergo the anaerobic process of methanogenesis. During this process of methanogenesis, a significant fraction of the influent

COD is converted to methane. The biogas generated through this process will be collected under an HDPE membrane, from which the collected biogas will be recovered through a system of perforated pipes, and be delivered to a flare to be destroyed by means of combustion.

Effluent from the covered anaerobic lagoon will gravity flow to a new flow splitter structure. The primary purpose of the flow splitter structure is to provide flow to the SBR influent pumps. This structure also enables a portion of the effluents from the aerated lagoon system to be commingled with the CAL effluent to supply the influent to the SBR system. It is anticipated that the 1.1 Mgd of influent to the SBR system will be comprised of about 0.8 Mgd of CAL effluent and 0.3 Mgd of Lagoon No. 1 effluent. In addition to this, however, the flow splitter structure will direct effluent from the CAL to Lagoon No. 2/3 in the event the SBR system is not receiving influent.

It is anticipated that the two SBR basins of the existing IWWTF SBR system will each treat two 12-hour cycles per day. The basins will operate out of phase, so that one basin will be filling and reacting, while the second basin is completing its react, settling, and decanting phases. The probable structure of the SBR cycle phases will result in a modified Bardenpho process in order to enhance the treatment for nutrients.

SBR effluent conforming to NPDES Permit discharge limitations will flow to the existing Flow Equalization Basin (FEB). This effluent will be pumped from the FEB and discharged to the JD 33.4 at a controlled rate. SBR effluent that does not comply with permit discharge limitations is diverted to Lagoon No.4, where it is stored until discharged to the IWWTF Land Application System.

Currently, diversion of noncompliant effluent to Lagoon No. 4 is controlled by an on-line Total Suspended Solids (TSS) sensor. When effluent with a TSS concentration exceeding the setpoint is detected, the signal to a PLC causes a valve in the influent pipe to the FEB to close, and a valve in a pipe that conveys the SBR discharge to Lagoon No. 4 to open.

Maintaining an appropriate concentration of treatment biology in the SBR basins is the principal method of controlling the SBR treatment process. Excess treatment biology is removed from each basin at the end of the decant phase of the SBR cycle. This waste activated sludge (WAS) is pumped from the SBR basin to the existing Sludge Storage Basin. The WAS is held in the Sludge Storage Basin until rotary lobe pumps transfer it to the existing Dewatering Facility.

The design capacity of this Dewatering Facility is 10,360 pounds per day of dry solids. The essential components of the dewatering system are a polymer injection system, a flocculation tank, and a screw press. WAS pumped from the Sludge Storage Basin and received at the Dewatering Facility is injected with a polymer that facilitates the flocculation of the solids. The polymerized WAS is pumped to a flocculation tank, where mixing and residence time in the tank enhances the formation of floc. The WAS flows from the flocculation tank to the screw press

where the water drains from the solids and sludge cake is formed. The pressate from the screw press is pumped to Lagoon No. 4 for discharge to the Land Application System. The sludge cake is conveyed to roll-off bins. The sludge cake is removed from the IWWTF to Natural Selection Farms, a Beneficial Use Facility permitted by the Washington State Department of Ecology.

6.0 EXPECTED TREATMENT RESULTS

Based upon the performance of covered anaerobic lagoons HDR Engineering, Inc. has designed for similar types of industrial wastewater, the BOD₅ removal efficiency of the covered anaerobic lagoon is anticipated to range between 88% and 95%. The resulting BOD₅ concentration in the CAL effluent is expected to range between 200 mg/L and 400 mg/L. The expected effluent TSS concentration from the CAL ranges from 300 mg/L to 500 mg/L.

The estimated removal efficiency of the COD through the anaerobic lagoon ranges from 75% to 85%. Methane generation is expected to average 5.4 cubic feet per pound of COD removed, with the methane content of the biogas ranging between 65% and 75%. Thus the average rate of biogas production is estimated to amount to approximately 196,000 cubic feet per day (ft³/d); peak production is estimated to be about 245,000 ft³/d.

Sludge generation within the CAL is anticipated to average about 1,380 pounds per day as dry solids. The average wet sludge volume is estimated to be about 5,500 gallons per day. The BiowinTM modeling described in the following paragraphs indicates that 4,100 pounds per day of activated sludge, as dry solids, will be wasted from the SBR basins after the addition of the anaerobic pretreatment system. Assuming that the WAS is about 1% solids, this amounts to a volume of less than 50,000 gallons per day.

In order to ascertain the SBR effluent quality resulting from anaerobic pretreatment of a portion of SBR influent, HDR Engineering has conducted BiowinTM modeling. In addition to this modeling conducted by HDR Engineering, Aqua-Aerobic Systems, Inc. has revised the design criteria for the existing SBR system in consideration of the modified constituent loadings predicted to result from this pretreatment.

Influent to the SBR system was modeled in BiowinTM as 1.1 Mgd. Two different sets of influent wastewater constituent concentrations were modeled. One set of influent wastewater parameters consisted of 503 mg/L BOD, 546 mg/L TSS, 127 mg-N/L TKN, and 36 mg-P/L total phosphorus. The second set of influent parameters were 687 mg/L BOD, 680 mg/L TSS, 109 mg-N/L TKN, and 30 mg-P/L total phosphorus. The first set of parameters is based upon the SBR influent being comprised of 1.0 Mgd CAL effluent and 0.1 Mgd aerated lagoon effluent. The second set is based upon SBR influent composed of 0.8 Mgd of CAL effluent and 0.3 Mgd of aerated lagoon effluent. The treatment goals for the model are effluent concentrations of 30 mg/L for BOD and TSS, and an ammonia concentration of 1.0 mg-N/L.

For both sets of influent wastewater constituent concentrations, the model yielded a projected SBR effluent quality of less than 30 mg/L BOD, and less than 30 mg/L TSS. Similarly, the effluent ammonia concentration is projected to be 1 mg-N/L or less for both sets of influent parameters.

The sensitivity of the modeled effluent ammonia concentration to the length of the aerated react phase was tested in a series of model runs. The fraction of the total cycle time that is aerated was varied from more than 0.50 to less than 0.20. This evaluation indicates that with a solids retention time (SRT) of approximately 17 days, the system supports adequate nitrification with the aerated fraction of the cycle as short as 0.27 of the total cycle; an aerobic SRT of about 4.6 days. When the aerated fraction of the cycle is reduced to less than 0.27 of the total cycle duration, the effluent ammonia concentration increases significantly.

The model was calibrated against actual performance results achieved by the IWWTF SBR system during October 2011. The calibration demonstrates that the model is conservative in predicting effluent nitrogen concentrations. The model predicts a lower effluent TSS concentration than the actual operating data. The model posits a slightly lower SRT, however, than that at which the SBR system was operating at the time. This difference in SRTs accounts for the discrepancy between modeled TSS results, and actual operating results. A synopsis of this calibration is presented in Appendix D.

The following table provides a comparison between the original design basis for the existing SBR system, the modified design basis proposed by Aqua-Aerobic Systems, Inc. and the Biowin™ SBR model by HDR Engineering, Inc. The Biowin™ model presented in the table is for SBR influent composed of 0.8 Mgd of CAL effluent and 0.3 Mgd of aerated lagoon effluent.

Table 6-1. Comparison of Original and Proposed SBR Design Basis, and SBR Biowin Model

Design Element	Units	Original SBR Design Basis	Proposed SBR Design Basis	SBR Biowin™ Model	Notes
SBR Cycles per day		2	2	2	
SBR Loading					
Volumetric Flow Rate	Mgd	0.55	1.1	1.1	
cBOD	lb/d	14,793	6,303	6,303	
TSS	lb/d	4,312	6,240	6,240	

Design Element	Units	Original SBR Design Basis	Proposed SBR Design Basis	SBR Biowin™ Model	Notes
TKN	lb-N/d	757	997	997	
Oxygen Demand	lb-O ₂ /d	19,000	12,465	12,465	Estimate based on BOD*1.25 + TKN*4.6; not used in model
Denitrification Credit	lb-O ₂ /d	-	2,598	2,598	Not taken in original design; estimate based on (TKN _{in} – TN _{eff})*2.86
SBR Operational Parameters					
Water Depth (Maximum)	ft	23.4	23.4	23.4	
SRT	d	16	18.4	18.4	
MLSS	mg/L	4,500	2,600	2,600	Original based on low water level; proposed based on high water level
WAS Production	lb/d	6,467	4,100	4,100	Dry solids basis
Oxygen Demand (Average)	lb/hr	396	155	155	Proposed includes denitrification credit
Oxygen Volume (Average)	scfm	1,560	999	999	Estimated for proposed
Blower Capacity (Each SBR)	scfm	1,560	1,560	1,560	
Blower Capacity Required (Each SBR)	HP	98.20	98.20	98.20	

Design Element	Units	Original SBR Design Basis	Proposed SBR Design Basis	SBR Biowin TM Model	Notes
Blower Capacity Available (Each SBR)	HP	200	200	200	
Projected Effluent Quality					
BOD	mg/L	30	≤ 30	≤ 30	Based on 24-hour composite
TSS	mg/L	30	≤ 30	≤ 30	Based on 24-hour composite
Ammonia	mg-N/L	5	≤ 1	≤ 1	Based on 24-hour composite
Total Phosphorus	mg-P/L		11	11	Based on 24-hour composite. Not included in original design.

7.0 RECEIVING WATER

The receiving water for the Port of Sunnyside IWWTF SBR effluent is Rosa-Sunnyside Board of Joint Control Joint Drain 33.4 (JD 33.4). The outfall to this agricultural drain is located at approximately 46.29502° latitude, and -120.01990° longitude. JD 33.4 flows in an 84-inch diameter corrugated metal pipe in the vicinity of this outfall. A receiving water quality assessment is included in the 2010 *Port of Sunnyside Industrial Wastewater Treatment Facility Engineering Report*.

A portion of JD 33.4, both upstream and downstream from the location of the IWWTF outfall, is included in the 2012 Section 303(d) listing of Washington State waters of impaired quality. It is listed as a Category 2, water of concern, for the parameter of bacteria. Category 2 indicates that “there is some evidence of a water quality problem, but not enough to require production of a water quality improvement project” (Washington State Department of Ecology Website).

7.1 Water Quality of Receiving Water Body JD 33.4

The Port of Sunnyside conducted an assessment of JD 33.4 water quality from June 2008 to July 2009. This assessment also included measurement of flow in the irrigation drain upstream of the Port outfall to the receiving water.

The 7-day averages of flow were calculated for the period during which samples were collected from the receiving water. The minimum 7-day average was determined for each quarter of the year. These minimum 7-day averages for each quarter of the year are used to assess the effect of SBR effluent upon the receiving water quality.

The design condition for the ambient flow rate is normally the 7Q10. The 7Q10 is generally defined as the minimum average 7-day flow that is expected to occur once during every 10 year period. It is derived statistically from a relatively long hydrologic record. Since only one year of flow data were collected, it is not possible to estimate the minimum 7-day average flow occurring during the critical period. The critical period, in terms of temperature of the receiving water, occurs during July and August (Washington State Department of Ecology. 2007. *Water Quality Program Guidance for Implementing Washington State Temperature Standards through TMDLs and NPDES Permits*. p. 3).

The 90th percentile is generally used as the design value for receiving water quality parameters. The 90th percentile receiving water temperature, however, is defined as the 7-day average of the daily maximum temperature (Ibid. p. 3). This is referred to as the 7DADMax. The 10th percentile is used for dissolved oxygen concentration in the receiving water (Washington State Department of Ecology. 2011. *Water Quality Program Permit Writer’s Manual, Appendix 6*. p. 40).

The Port had a YSI Model 6920 sonde deployed in JD 33.4 beginning in 2005 through the end of the receiving body water quality assessment period. Since the protocol for deploying this instrument was included in the Department of Ecology approved *Port of Sunnyside Quality Assurance Project Plan for JD 33.4 Receiving Water Data Collection*, and since the temperatures recorded by this instrument are within $\pm 0.1^{\circ}\text{C}$ of those recorded by the Onset StowAway TidbiT[®] temperature logger, the temperature data collected by the YSI sonde from previous years were included in the analyses deriving the 7DADMaxima. The longer data record is more representative of the temperature conditions of the receiving water.

Table 7-1 provides the minimum 7-day average flow rates for JD 33.4, the 7DADMax temperatures, the 10th percentile dissolved oxygen concentrations, and the 30-day geometric mean fecal coliform values for the month of the quarter with the greatest geometric mean value. The dissolved oxygen concentrations listed in the table are the 10th percentile of the average daily DO concentrations.

The 2010 Port of Sunnyside IWWTF Engineering Report presents the geometric average of the fecal coliform samples collected during each month of the receiving water quality assessment. The 90th percentile value for these twelve fecal coliform geometric means is 11,076 colony forming units (CFU/100 mL). The 90th percentile value of the individual sample counts is 19,340 CFU/100 mL. The geometric mean of all of the individual sample counts is 6,294 CFU/100 mL. This geometric mean of all of the individual sample counts is used as the ambient value in estimating the effect of the SBR effluent on the receiving water.

Table 7-1. JD 33.4 Flow Rate, Temperature, Dissolved Oxygen, and Fecal Coliform

Period of Interest	Minimum 7-D Average Flow Rate (cfs)	7DADMax Temperature (°C)	10th Percentile Dissolved Oxygen (mg/L)	Fecal Coliform (CFU/100 mL)
Q1: Jan - Mar	10.4520	17.7	9.48	11463
Q2: Apr - Jun	11.6533	20.7	8.56	14388
Q3: Jul - Sep	20.4083	22.8	7.82	6397
Q4: Oct - Dec	9.7081	18.2	7.87	7597

Table 7-2 provides the 90th percentile values of the ambient water quality parameters. These values are used for evaluating the effect of the SBR discharge on the receiving water.

Descriptive statistics for receiving body water quality are provided at Appendix A of the Port of Sunnyside IWWTF 2010 Engineering Report.

Table 7-2. JD 33.4 Ambient Water Quality

Receiving Water Quality Parameter	90 th Percentile Value
pH	8.17
Alkalinity (mg/L as CaCO ₃)	256
BOD (mg/L)	9.4
Ammonia Nitrogen (mg/L N)	0.58

8.0 EFFECT of SBR EFFLUENT on JD 33.4 WATER QUALITY after ADDITION of ANAEROBIC PRETREATMENT SYSTEM

The Port of Sunnyside IWWTF is permitted to discharge effluent to Joint Drain 33.4 (JD 33.4). Formerly known as DID #3 (Drainage Improvement District #3), the name was changed to Joint Drain 33.4 when the governing bodies of the Roza Irrigation District and the Sunnyside Valley Irrigation District (SVID) combined to form the Roza-Sunnyside Board of Joint Control. The “33.4” of JD 33.4 indicates that this irrigation drain originates near mile 33.4 of the SVID irrigation canal.

JD 33.4 is piped through much of the City of Sunnyside. In the vicinity of the IWWTF it is contained within an 84-inch diameter corrugated pipe.

Dilution factors for the discharge of IWWTF effluent to JD 33.4 during each quarter of the year were estimated using Washington State Department of Ecology *Rivplum6*. The design conditions for mixing zone analysis are set forth in Table VI-3 of the Washington State Department of Ecology *Water Quality Permit Writer's Manual* (December 2011) for industrial plant effluent.

The chronic effluent flow is defined as the highest monthly average monthly flow for the past three years during the critical flow or condition is likely to occur. The acute effluent flow is the largest daily maximum effluent flow during the critical flow or condition is likely to occur. When plant effluent is expected to increase, however, the critical design condition for the chronic mixing zone is the estimated maximum average monthly effluent flow. The critical design

condition for the acute mixing zone when the plant effluent is expected to increase is the maximum daily flow.

The discharge from the IWWTF will increase when the anaerobic pretreatment system is incorporated into the treatment train. Influent to the SBR will increase to 1.1 Mgd. The volume of waste activated sludge is projected to be about 50,000 gallons per day. Thus the effluent volume discharged to the receiving water is estimated to be about 1.05 Mgd. This is the volume of effluent used for both the chronic and acute conditions.

Critical flow and condition in the lower Yakima River basin occur beginning in July, and may extend into October. Irrigation withdrawals reduce the flow of the river, at the same time that ambient conditions increase temperature. Although minimum flow in JD 33.4 occurs during the winter, water temperature causes the critical period to be during the summer and early autumn.

Flow in JD 33.4 was measured and recorded using a Marsh McBirney Flo-Dar, an open channel velocity/area type flow meter. This device utilizes an ultrasonic transponder to estimate the depth of water in a partially filled pipe, and radar to determine the velocity of flow. Pipe size and shape parameters are entered into the memory of the instrument, allowing it to estimate the flooded cross-sectional area of the pipe from the measured depth. Since flow rate is the dot product of velocity and cross-sectional area vectors, the instrument calculates flow from the two parameters it measures directly.

Inputs to *Rivplum6* include not only the effluent discharge rate, but also the characteristics of the receiving water downstream from the effluent outfall. A regression of depth and flow data from the Flo-Dar was used to estimate depth downstream of the outfall. The flow for each condition of interest is the sum of the chronic or acute effluent flow and the minimum 7-day average JD 33.4 flow. The channel section geometry of the JD 33.4 pipe is employed to estimate the velocity of the commingled flows from the area occupied by the flow in the channel. Since the channel cross-section is a circle, but the dilution model is based upon a rectangular channel of a given depth (Washington State Department of Ecology *Water Quality Permit Writer's Manual* p. App6-45), the dimensions of a hydraulically equivalent rectangular channel section are estimated for input to *Rivplum6*. An example of these calculations are provided at Appendix E

Dilution factors were derived for each quarter of the year. Receiving water minimum 7-day average flows for each quarter were calculated from flow data collected during 2008 and 2009. The minimum 7-day average flow for each quarter was used as the receiving water flow rate for that quarter.

Rivplum6 output for chronic and acute flow conditions is available at Appendix E. Although a transverse mixing coefficient constant of 0.6 is recommended for most natural channels, since JD 33.4 is contained within a pipe in the vicinity of the IWWTF outfall, a coefficient of 0.15 is used. Appendix 6 of the Washington State Department of Ecology *Water Quality Program Permit*

Writer's Manual notes that the transverse mixing coefficient ranges from 0.1 to 0.2 for straight artificial channels (p. App6-45.) Table 8-1 summarizes the dilution factors estimated by *Rivplum6*.

Table 8-1. Rivplum6 Dilution Factors for JD 33.4

	<i>Rivplum6</i> Dilution Factors	
	Chronic Flow Conditions	Acute Flow Conditions
First Quarter of Year	3.992	1.255
Second Quarter of Year	4.397	1.390
Third Quarter of Year	7.961	2.518
Fourth Quarter of Year	3.711	1.174

Regulations stipulate that a mixing zone may not utilize more than twenty-five percent of the flow. When acute criteria are under consideration, the mixing zone may not utilize more than two and a half percent of the flow of the receiving water. (WAC 73-201A-400) Consequently, when the effect of IWWTF discharge on JD 33.4 water quality is evaluated in the following sections, 25% of the receiving water flow is used for chronic criteria, and 2.5% of the flow is used for acute criteria; unless a spreadsheet program provided by the Department of Ecology specifically requires the use of the dilution factor.

8.1 Effect of SBR Effluent Temperature on JD 33.4 Water Quality

For fresh water aquatic life uses, water temperature of the receiving body is the 7-day average of the daily maximum temperatures, which is referred to as the 7-DADMax (WAC 173-201A-200). The Department of Ecology Water Quality Program Guidance for *Implementing Washington State Temperature Standards through TMDLs and NPDES Permits* (Implementing Temperature Standards Guidance) prescribes that the design condition for the ambient background temperature of the receiving water, when evaluating the reasonable potential to exceed the water temperature criterion, should be the 90th percentile of the annual maximum 7DADMax. This latter document further recommends that the highest upstream ambient temperature observed from three or more years of monitoring should be used to represent the 90th percentile background temperature (Implementing Temperature Standards Guidance, p. 3 and p. 10).

The monitoring of the ambient temperature of JD 33.4 was conducted from June 2008, through July 2009. The data collected during this period were evaluated the 7-DADMax for each quarter of the year. The results of these evaluations are presented in Table 8-2.

Table 8-2. 90th Percentile 7-DADMax Temperature of JD 33.4 Upstream of IWWTF Outfall 001

Monitoring Period	90th Percentile 7-DADMax Temperature (°C)
First Quarter of Year	17.7
Second Quarter of Year	20.7
Third Quarter of Year	22.8
Fourth Quarter of Year	18.2

The design criteria for effluent temperature are the 95th percentile 7-DADMax for the chronic criterion, and the 99th percentile 7-DADMax for the acute criterion. Both the 95th percentile 7-DADMax and the 99th percentile 7-DADMax are represented by the highest 7-DADMax observed during three or more years of monitoring effluent temperatures. (Implementing Temperature Standards Guidance, pp. 3-4)

The SBR system has not been operated with the anaerobic pretreatment system. Therefore, the actual effluent temperature is not known. It is estimated from the expected operational temperature of the covered anaerobic lagoon, the average effluent temperatures of the aerated lagoon system for the most recent three years, and the fraction of SBR influent from each of these pretreatment sources. If the estimated SBR effluent temperature is less than the 7-DADMax effluent temperature reported in Table 8-4 of the 2010 Port of Sunnyside IWWTF Engineering Report, then the maximum monthly value from this table is used as the quarterly value for evaluating the effect of the effluent temperature on the receiving water.

The anaerobic lagoon is expected to operate at a temperature of about 35°C. The volume of CAL effluent that is expected to be into the SBRs as influent is 0.8 Mgd. Effluent from the aerated lagoon system is anticipated to contribute 0.3 Mgd to the SBR influent. The estimated SBR effluent temperature for each quarter is listed in Table 8-3. The quarterly 7-DADMax effluent temperature reported in the 2010 IWWTF Engineering Report is also provided in this table.

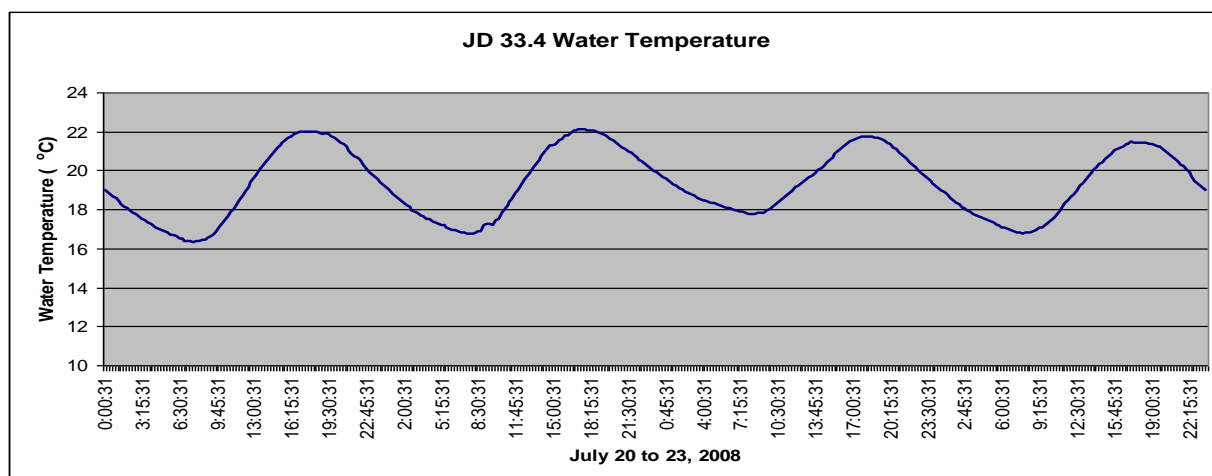
Table 8-3. Estimated SBR Effluent Temperature and Quarterly 7-DADMax from 2010 IWWTF Engineering Report

	Estimated SBR Effluent Temperature (°C)	95th and 99th Percentile 7-DADMax Effluent Temperature (°C)
First Quarter of Year	27.6	18.5
Second Quarter of Year	30.3	28.9
Third Quarter of Year	31.3	32.1
Fourth Quarter of Year	29.1	24.5

When a water body is warmer than the criterion because of natural conditions, all human sources of warming must not cumulatively warm the water more than 0.3°C. Prior to a TMDL, however, each point source may warm the water at the edge of a mixing zone by 0.3°C. (Implementing Temperature Standards Guidance, p. 6)

The quarterly 7-DADMax temperature values for JD 33.4 presented in Table 8-2 indicate that the temperature of this receiving water often is greater than the criterion value of 17.5°C. JD 33.4 is a man-made irrigation drain whose temperature is controlled by solar radiation and ambient temperature. This is graphically substantiated by Figure 8-1 from the 2010 IWWTF Engineering Report, reproduced here.

Figure 8-1. Diurnal Fluctuation of JD 33.4 Water Temperatures



The Guidance for *Implementing Washington State Temperature Standards through TMDLs and NPDES Permits* provides a method to determine if there is a reasonable potential to exceed the 0.3°C warming allowance for naturally warm waters using effluent temperature data and the dilution factor (Implementing Temperature Standards Guidance, p. 7). No reasonable potential to exceed the criterion exists if the 90th percentile 7-DADMax of the receiving water, plus 0.3°C, is greater than the term of the expression computed from the criterion, the 95th percentile effluent temperature ($T_{effluent95}$), and the dilution factor. This screening analysis relationship was used with the estimated SBR effluent temperatures, and dilution factors, for each quarter of the year to determine if there is a reasonable potential to exceed the 0.3°C incremental warming allowance. Results of these analyses are furnished in Table 8-4.

Table 8-4. Potential to Exceed 0.3°C Warming Allowance

Period for Analysis	$T_{effluent}$ (°C)	Dilution Factor	$T_{chronic}$ (°C)	$T_{ambient90} +$ 0.3 (°C)	Potential to Exceed Allowance (°C)
First Quarter of Year	27.6	3.992	20.8	18.0	Yes
Second Quarter of Year	30.3	4.397	22.9	21.0	Yes
Third Quarter of Year	32.1	7.961	24.0	23.1	Yes
Fourth Quarter of Year	29.1	3.711	21.1	18.5	Yes

Based upon limited data for the receiving water temperatures, and only estimates of SBR effluent temperatures, these results suggest that there may be a potential to exceed the 0.3°C warming allowance for naturally warm waters. If effluent is required to be cooled prior to discharge to the receiving water, methods of evaporative cooling will be investigated.

8.2 Effect of SBR Effluent BOD on JD 33.4 Water Quality

Substances exerting a biochemical oxygen demand (BOD) in effluent deplete the oxygen dissolved in the receiving water. While water quality criteria do not specifically address the discharge of BOD to receiving water, there are criteria for minimum dissolved oxygen concentrations that must be maintained in the receiving water.

The mechanisms controlling the depletion of dissolved oxygen, and the reaeration of the water, are modeled using mathematical expressions. The classic formulation of these two competing mechanisms is the Streeter-Phelps equation.

The Washington State Department of Ecology utilizes a version of the Streeter-Phelps equation in a spreadsheet program, *DOSAG2*, to calculate the critical dissolved oxygen sag, and the dissolved oxygen concentration, downstream from a point source outfall to receiving water. The critical dissolved oxygen sag is the maximum depletion of dissolved oxygen resulting from the discharge of effluent to the receiving water. It corresponds to the minimum dissolved oxygen concentration in the receiving water resulting from BOD discharged to it. It occurs at a location in the receiving water where the rate of dissolved oxygen depletion resulting from BOD degradation equals the rate of reaeration of the water. *DOSAG2* is intended to be used as a screening tool to determine the potential for violation of dissolved oxygen criteria.

In addition to *DOSAG2*, the Department of Ecology uses a spreadsheet called *IDOD2* to estimate the dissolved oxygen (DO) concentration at the chronic condition mixing zone boundary. This spreadsheet calculates the DO at this location from the ambient DO of the receiving water, the DO of the effluent, and the chronic condition dilution factor.

IDOD2 was used to estimate the receiving water DO at the mixing zone boundary resulting from the discharge of SBR effluent to JD 33.4. Since the effluent is aerated in the Flow Equalization Basin prior to discharge to the irrigation ditch, the immediate oxygen demand of the effluent is presumed to be zero. The average dissolved oxygen concentration of effluent grab samples collected over several months during 2009 was entered into the spreadsheet as the effluent DO. This value was maintained constant as the dilution factor and the ambient DO values were varied for each quarter of the year. The ambient dissolved oxygen concentration is the 10th percentile concentration for each quarter. The calculated results produced by *IDOD2* are provided in Table 8-5, along with the values of the input parameters.

DOSAG2 was used as a screening tool to estimate the critical dissolved oxygen sag, or deficit, the critical dissolved oxygen concentration, and the distance from the IWWTF outfall to the location of the critical DO concentration. The program was run twice for each quarter of the year.

Inputs for the effluent characteristics include both 5-day carbonaceous biochemical oxygen demand (CBOD₅) and nitrogenous biochemical oxygen demand (NBOD). Nitrogenous BOD consists of ammonia nitrogen, and organic nitrogen that is susceptible to hydrolysis and deamination to ammonia. Ammonia in water is oxidized under aerobic conditions through a series of biologically mediated reactions. Total Kjeldahl nitrogen (TKN) is a measure of the combined ammonia nitrogen and the organic nitrogen of a sample. Each gram of TKN utilizes 4.57 grams of oxygen to oxidize the nitrogen to nitrate. Consequently, the instructions for *DOSAG2* recommend estimating NBOD as $4.57 * (\text{ammonia N} + \text{organic N})$, if nitrification is not significant in the wastewater treatment process.

Table 8-5. DO Concentration at Mixing Zone Boundary Resulting from Immediate Oxygen Demand of IWWTF Effluent

Period of Interest	Chronic Dilution Factor	Ambient DO (mg/L)	Effluent (mg/L)	Mixing Zone Boundary DO (mg/L)
First Quarter of Year	3.992	9.48	5.16	8.40
Second Quarter of Year	4.397	8.56	5.16	7.79
Third Quarter of Year	7.961	7.82	5.16	7.49
Fourth Quarter of Year	3.711	7.87	5.16	7.14

Nitrification is expected to be significant in the SBR treatment process. Nevertheless, in order to ascertain the possible effect of residual NBOD within the SBR effluent discharge to JD 33.4, one run of the *DOSAG2* model for each quarter assumes that the total nitrogen concentration estimated to be in the effluent will be NBOD. In addition, the receiving water TKN is assumed to be NBOD, and is included with the ammonia to estimate the NBOD of JD 33.4. The other *DOSAG2* model run for each quarter uses only the projected CBOD concentration of the SBR effluent, along with the receiving water CBOD, as input oxygen demands to the model.

Model inputs for the receiving water are the minimum seven day average flow for each quarter, the minimum 10th percentile dissolved oxygen concentration for the quarter, and the 7DADMax temperature for each quarter. The minimum dissolved oxygen concentration and maximum temperature do not necessarily occur in the same month that the minimum flow occurs. It is possible that each of these parameters occur in different months of the quarter. Regardless of the month of occurrence, the minimum flow, the minimum DO, and the maximum temperature for each quarter are used as receiving water parameter inputs to the model. Results from the *DOSAG2* model are summarized in Table 8-6. Copies of each model run are provided in Appendix E.

Table 8-6. DOSAG2 Model Results

Period of Interest	Critical DO Concentration (mg/L)	Travel Time to Critical DO Concentration (days)	Distance to Critical DO Concentration (miles)	Critical DO Deficit (mg/L)
Q1: CBOD	7.40	0.09	5.61	1.64
Q1: CBOD + NBOD	5.33	0.10	5.71	3.71
Q2: CBOD	6.91	0.08	4.86	1.64
Q2: CBOD + NBOD	4.71	0.09	5.09	3.84
Q3: CBOD	7.07	0.07	4.35	1.23
Q3: CBOD + NBOD	5.62	0.08	5.21	2.68
Q4: CBOD	6.99	0.06	3.68	1.92
Q4: CBOD + NBOD	4.70	0.08	4.85	4.21

The *DOSAG2* model indicates that the distance to the critical DO concentration in JD 33.4 ranges from about 3.7 miles to about 5.7 miles. The distance from the IWWTF outfall to the drain, to the drain's confluence with Sulphur Creek Wasteway, however, is significantly less than this. The distance from the outfall to the end of the first piped portion of JD 33.4 downstream from the outfall is about 935 ft. A second agricultural drain flows into JD 33.4 at this location and continues in a pipe for an additional 1200 ft. to 1400 ft. The distance from the confluence of irrigation drains, to the confluence of JD 33.4 with Sulphur Creek Wasteway is about 8300 ft. Consequently, the total distance from the IWWTF outfall into JD 33.4, to the confluence of JD 33.4 with Sulphur Creek Wasteway is about 9235 ft, or about 1.75 miles. The distance from the confluence of JD 33.4 with Sulphur Creek Wasteway to the Yakima River, is more than 2 miles. Thus the critical DO deficit resulting from the SBR discharge to surface water probably occurs in Sulphur Creek Wasteway or the Yakima River. Consequently, the

actual magnitude of the DO deficit induced by the SBR discharge is controlled by characteristics of these waters.

8.3 Effect of SBR Effluent pH on JD 33.4 Water Quality

The Washington State Department of Ecology provides a Microsoft Excel spreadsheet, based upon the USEPA's DESCONE program, to assist in calculating the pH resulting from the mixture of two flows. The hydrogen ion activity, symbolized by the term "pH," is a function of temperature, and in natural systems, tends to be highly influenced by carbonate chemistry. Thus, this spreadsheet, *pHmix2*, incorporates the temperatures, the pHs, and the alkalinities of the two commingling streams to estimate the pH of the combined flow, utilizing the dilution factor.

Effluent temperature, pH, and alkalinity are critical parameters for estimating the effect of a discharge upon the pH of a receiving water. Effluent temperature is estimated as described earlier in Section 8.1 of this report. Estimating effluent pH and alkalinity are more problematic. The pH is dependent upon the concentrations of the various chemical species contributing to total alkalinity. The alkalinity of the SBR effluent will be highly influenced by the alkalinity of the effluent from the anaerobic lagoon, as well as the processes of nitrification and denitrification occurring in the SBR. Influent to the anaerobic lagoon will be buffered to a pH near neutral. Much of this CAL influent will include proteinaceous nitrogen, however. For each gram per liter (g/L) of $\text{NH}_4\text{-N}$ formed during the degradation of protein, 5.6 g/L of NH_4HCO_3 alkalinity, or 3.6 g/L of alkalinity as CaCO_3 , is formed (Speece. 2008. p. 371). The fraction of TKN that is protein nitrogen is not known at this time. Consequently, the alkalinity that will be gained in the anaerobic lagoon is not estimated. Nevertheless, the alkalinity of the SBR effluent will be controlled by the processes of nitrification and denitrification occurring within the SBR basins as the alkalinity of the discharge is now. Therefore, the alkalinity and pH of the existing SBR effluent is used as input for *pHmix2*.

Using these values, and the estimated effluent temperatures, the effect of the IWWTF effluent on the pH of the receiving water was calculated using *pHmix2* for the quarterly chronic and acute conditions. Outputs from *pHmix2* are available at Appendix E. Table 8-7 summarizes the pH of the receiving water downstream of the IWWTF outfall as estimated by *pHmix2*.

Table 8-7. Estimated JD 33.4 pH at Mixing Zone Boundary Downstream from IWWTF Outfall 001

Period of Interest	Chronic Condition	Acute Condition
First Quarter of Year	8.26	8.27
Second Quarter of Year	8.26	8.29

Period of Interest	Chronic Condition	Acute Condition
Third Quarter of Year	8.22	8.26
Fourth Quarter of Year	8.26	8.28

8.4 Effect of SBR Effluent Ammonia Nitrogen on JD 33.4 Water Quality

Un-ionized ammonia is toxic to fish. The equilibrium between ammonium and un-ionized ammonia is a function of temperature and pH. Therefore, the criterion concentration for un-ionized ammonia changes as the temperature and pH of the receiving water changes.

To aid in determining the criteria concentrations for un-ionized ammonia as stipulated in WAC 173-201A-240, the Department of Ecology provides a spreadsheet program *NH3fresh3*. This spreadsheet program calculates the ammonia criteria in fresh water based upon the temperature and pH of the receiving water. The temperature and pH conditions of JD 33.4 for each quarter of the year were entered into this spreadsheet to calculate both the chronic and acute criteria for un-ionized ammonia nitrogen, and for total ammonia nitrogen. The temperature and pH conditions entered into *NH3fresh3* are the receiving water conditions presented in Table 8-2 and Table 7-2, respectively.

The ammonia nitrogen criteria calculated by *NH3fresh3* are dependent upon whether or not the receiving water body is salmonid habitat. The Sunnyside Valley Irrigation District has constructed a fish barrier in Sulphur Creek Wasteway near Holady Road. The purpose of this barrier is to prevent salmon from attempting to swim upstream in Sulphur Creek Wasteway. Since JD 33.4 is tributary to Sulphur Creek Wasteway, and upstream of this fish barrier, the ammonia criteria shown in Table 8-8 are for receiving waters that are not salmonid habitat. Output for *NH3fresh3* are available in Appendix E.

To assess compliance with the criteria under chronic conditions, the concentration of ammonia at the boundary of the mixing zone was computed using 25% of the JD 33.4 flow and the 90th percentile receiving water ammonia concentration. In similar fashion, compliance with the acute criteria was evaluated using 2.5% of the flow in the irrigation drain and the 90th percentile receiving water ammonia concentration. The effluent ammonia nitrogen concentration used for these calculations is the concentration estimated by the BiowinTM model. The completely mixed concentration of total ammonia nitrogen in JD 33.4, estimated through these computations, are compared to the total ammonia nitrogen criteria calculated by *NH3fresh3* in Table 8-8. An example of this calculation is contained in Appendix E.

Table 8-8. Comparison of Ammonia Nitrogen Concentration at JD 33.4 Mixing Zone Boundary to Total Ammonia Nitrogen Criteria

	Chronic Condition		Acute Condition	
Period of Interest	Total Ammonia Nitrogen Criteria (mg/L)	Mixing Zone Boundary Total Ammonia Nitrogen Concentration (mg/L)	Total Ammonia Nitrogen Criteria (mg/L)	Mixing Zone Boundary Total Ammonia Nitrogen Concentration (mg/L)
First Quarter of Year	1.529	0.741	6.070	0.942
Second Quarter of Year	1.260	0.730	6.070	0.936
Third Quarter of Year	1.100	0.681	6.070	0.899
Fourth Quarter of Year	1.461	0.748	6.070	0.945

8.5 Effect of SBR Effluent Fecal Coliform on JD 33.4 Water Quality

The absence of fecal coliform bacteria in water is used as an indication that disease causing organisms are not present. On the other hand, the presence of fecal coliform indicates that there may be disease causing organisms in the water, but it is not definitive proof. There may be organisms present that test positively as coliform, but which do not originate in the gut of warm-blooded animals (APHA. 1998. p. 9-1).

The Port IWWTF does not receive human excrement in its wastewater. The wastewater treated by the IWWTF is principally generated by food processing activities, such as rinsing and peeling fruit, and cleaning processing vessels. It also includes small amounts of non-contact cooling

water from a plastic pipe manufacturer, and boiler blow-down water from some of the food processors.

The current NPDES Permit for the IWWTF does not include a requirement for monitoring fecal coliform bacteria in the effluent of the treatment facility. Nevertheless, the Port performs fecal coliform analysis on the SBR effluent once each week. The fecal coliform counts yielded by these analyses are wildly variable. For the period of December 2010 through November 2013, they range from a minimum of 60 CFU/100 mL to a maximum of 1,080,000 CFU/100 mL.

In order to provide an evaluation of the effect of SBR effluent fecal coliform on JD 33.4 water quality, the geometric mean of all fecal coliform analyses performed on SBR effluent from December 6, 2010 through November 25, 2013 was used for the discharge value of this quality parameter. This geometric mean value for the SBR effluent is 16,959 CFU/100 mL. The geometric mean of all samples collected during the receiving water quality analysis is used for the fecal coliform count of JD 33.4.

The water quality in the receiving water is estimated for each quarter of the year at the edge of the mixing zone for both the chronic and acute flow conditions. For the chronic flow condition, 25% of the minimum 7-day average flow for each quarter is used for the receiving water flow. For the acute flow condition, 2.5% of the minimum 7-day flow for each quarter is used for JD 33.4 flow. The estimated effects of the increased volume of SBR effluent on the receiving water fecal coliform counts are provided in Table 8-9.

Table 8-9. Estimated JD 33.4 Fecal Coliform at Mixing Zone Boundary Downstream from IWWTF Outfall 001

Period of Interest	Fecal Coliform (CFU/100 mL)	
	Chronic Condition	Acute Condition
First Quarter of Year	10376	15478
Second Quarter of Year	10105	15333
Third Quarter of Year	8864	14405
Fourth Quarter of Year	10563	15569

9.0 COMPLIANCE with STATE ENVIRONMENTAL POLICY ACT (SEPA)

The Port of Sunnyside completed, and distributed for comment, a SEPA Checklist on November 1, 2013. Functioning as Lead Agency, the Port issued a SEPA Preliminary Determination of Nonsignificance on November 13, 2013. Comments that were received in response to the SEPA Checklist were addressed and resolved. The Port issued a SEPA Final Determination of Nonsignificance on December 20, 2013.

10.0 SCHEDULE for FINAL DESIGN and CONSTRUCTION of IWWTF ANAEROBIC PRETREATMENT SYSTEM

The schedule for completing final design of the anaerobic pretreatment system is mid-February 2014. Solicitation for bids is scheduled to occur from February 21 through February 26, 2014, with bid opening on February 27, 2014.

Construction is scheduled to begin in April 2014. Notice of Substantial Completion is to be issued by the contractor by November 10, 2014. The IWWTF is to have beneficial use of the facility by November 21, 2014.

11.0 REFERENCES

APHA. 1998, *Standard Methods for the Examination of Water and Wastewater*. 20th Ed.

Earth Tech, Inc. 2003. *Port of Sunnyside Industrial Wastewater Treatment Facility Engineering Report*.

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Washington State Department of Ecology. April 2007. *Water Quality Program Guidance: Implementing Washington State Temperature Standards through TMDLs and NPDES Permits*.

Washington State Department of Ecology. December 2011. *Water Quality Permit Writer's Manual*.

APPENDIX A

Schematic Diagram of IWWTF Flow Paths

APPENDIX B

HDR, Engineering, Inc. Design Memoranda

APPENDIX C

McKinney: *Alkalinity Measurements and Organic Acids*

APPENDIX D

SBR BiowinTM Model Calibration

APPENDIX E

Rivplum6: Example Calculations for Model Input

Rivplum6 Output

DOSAG2 Output

pHmix2 Output

NH3fresh3 Output and Ammonia Concentration at Mixing Zone Boundary Calculations

Fecal Coliform Counts at Mixing Zone Boundary Calculations