WASTEWATER TREATMENT PLANT OPERATIONS & MAINTENANCE MANUAL

Woodard & Curran

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Perdue Draper Valley Farms

June 2023

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

Appendix L: SYSTEM LOG SHEETS
Appendix M: CRITICAL SPARE PARTS
Appendix N: PLUMBING AND HVAC DRAWINGS
Appendix O: ADDITIONAL RESOURCES
Appendix P: MATH FOR OPERATORS
Appendix Q: DRAFT PERMIT

MANUAL DESCRIPTION

This Operation and Maintenance (O&M) Manual provides the information necessary to operate and maintain the upgraded Wastewater Treatment Plant (WWTP) at the Perdue Draper Valley Farms (DVF) facility in Mount Vernon, Washington. This Operations & Maintenance Manual was developed in accordance with WAC 173-240-150.

REVISION RECORD

REVISION	AUTHOR	DATE	STATUS
A	Woodard & Curran	9 June 2023	Draft

Name of electronic document: Perdue DVF O&M Manual - DRAFT

SAFETY

Throughout the manual, the reader will find important notes and warnings located at the beginning of the respective sections. Always read the manufacturers' operation and maintenance manuals for additional safety and cautionary information.

Warning	is used when there is a risk to health and safety;
Caution	designates a threat to a piece of equipment or treatment process; and
Note	signifies especially important information about the process.

CONTROL SYSTEM PASSWORDS

System usernames and passwords will be determined during commissioning and set by system programmer.

Security Access	Username	Password	Privileges
Administrator			• Monitor process • All process adjustments
Operator			• Monitor process • All process adjustments except PID loops

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1. INTRODUCTION

1.1 Plant Overview

The Perdue Draper Valley Farms (DVF) facility is located at 1000 Jason Lane approximately 0.7 miles southwest of the intersection of Riverside Drive and East College Way. The industrial activity at the facility is the slaughter and further processing of chicken portions. This includes slaughtering live birds, cutting and packaging operations, and sanitation activities. The facility processes approximately 80,000 live chickens per day and produces approximately 425,000 pounds of processed chicken per day. The DVF facility processes both standard and organic chickens. It is believed that the original facility was constructed in 1972. The industrial activity at the site has been the same since the facility was constructed. The DVF facility generates process wastewater (PW) that is pretreated in the site's existing wastewater treatment plant (WWTP) prior to discharge to the City of Mount Vernon Publicly Owned Treatment Works (POTW) under Ecology Permit Number ST-0003861. The existing WWTP consists of equalization, solids separation via Dissolved Air Flotation (DAF), and pH adjustment. Sludge skimmed from the DAF is collected and hauled off-site for disposal.

In addition to wastewater organics originating from chicken meat processing, the facility utilizes peracetic acid sanitizer for microbial intervention processing steps which contributes soluble BOD to the wastewater. The existing WWTP does not remove soluble BOD or provide enhanced pH control. Soluble BOD loading has increased since the primary treatment system was last upgraded. This loading is primarily driven by USDA Food Safety Inspection Service requirements for control of chicken contaminants that has required the facility to use microbial interventions to prevent product contamination. The chemical currently used and required is peracetic acid. Peracetic acid and other interventions used introduced increasing amounts of soluble BOD to the wastewater causing DVF to experience intermittent exceedances of its BOD limit in September 2018 and from April 2019 until January 2021. Recent operational changes, including the type and quantity of microbial intervention chemicals used, have allowed the facility to maintain compliance with the prior 1,430 pounds per day (ppd) limit and the new, temporary 1,520 ppd BOD limit effective through June 30, 2023. Specifically, Citric acid was previously used as part of the acidified sodium hypochlorite disinfection process but has since been removed from the microbial intervention program at Draper Valley. The recent introduction of air-cooled chillers has further reduced water and peracetic acid use by replacing the water-based chilling processes. While these changes have reduced the contribution of soluble BOD to the wastewater treatment plant, the current mode of operations limits Perdue's flexibility to change or adapt microbial intervention methods in the future should shifting Federal Food Safety regulations or market conditions require while maintaining effluent compliance.

Therefore, WWTP upgrades to reduce soluble BOD were installed and commissioned in June 2023. The WWTP upgrades include a pH adjustment system, a Moving Bed Bioreactor (MBBR) biological treatment system, a Secondary DAF with additional processes for storing and transferring waste biological solids, a new Combined Effluent Tank, and flow monitoring of the effluent flow to the POTW.

Under normal operation, the PW from the DVF facility is collected in the Equalization Tank, processed through the Primary DAF system, neutralized in the Primary DAF Effluent pH Adjustment Tank, and then split between two flow paths. An average of 55% Primary DAF Effluent pH Adjustment Tank effluent flow is sent to the downstream MBBR and Secondary DAF systems for treatment which then feeds into the Combined Effluent Tank while the other 45% of effluent flow is pumped into the Combined Effluent Tank directly. Sludge produced during the Primary and Secondary DAF treatment processes are stored in two separate storage tanks and then pumped into a sludge trailer for off-site disposal. Treated wastewater from the Combined Effluent Tank is either pumped directly to the sewer, if pH is compliant with the discharge permit, or pumped to the Secondary Screen Tank and recirculated back to the Equalization Tank if out of compliance for pH or another parameter. Compliance sampling will continue to be conducted at the Wastewater Sampling Manhole as per the permit.

1.2 Design Basis

Table 1-1 summarizes the influent design basis for the WWTP upgrade. The design basis incorporates the 2019 Discharge Monitoring Report (DMR) and process control data as a baseline. The latest flow data, including January 2019 through June 2021 is also used. Adjustments were made to the data to account for possible future increases in microbial intervention chemical usage (peracetic acid and citric acid) or changes in the types of chemicals used, and to account for future effluent flow monitoring and allow for flexibility in future processing operations. The development of the design basis is discussed in detail in the Final 90% Design Engineering Report submitted to Ecology by Woodard & Curran, Inc. (W&C) on July 22, 2022.

Table 1-1 WWTP Upgrade Design Basis (Primary DAF Effluent)

Parameter	Units	Future Average	Future Peak (95th Percentile)
Flow	MGD	0.373	0.443
pH	S.U.	Range: 4.8 to 10.1 Average: 7.0	
Temperature	°F	Range: 50 to 90 Average: 75	
Total Suspended Solids (TSS)	mg/L	35	86
	ppd	109	317
Total COD	mg/L	658	787
	ppd	2,050	2,913
Soluble COD	mg/L	658	787
	ppd	2,050	2,913
Total BOD	mg/L	367	524
	ppd	1,144	1,938
Soluble BOD	mg/L	367	524
	ppd	1,144	1,938
Oil & Grease	mg/L	< 10	

1.3 Discharge Permit

DVF discharges pretreated process wastewater to the Mount Vernon POTW under the facility's Industrial Pretreatment Permit Number ST0003861. The effluent permit limits are listed Table 1-2.

Table 1-2 Effluent Limits

Parameter	Units	Maximum Consecutive 3-day Average	Daily Maximum	Monitoring Frequency	Sample Type
Flow	gpd	720,000	-	Daily meter reading	Continuous metering
BOD_5	ppd	1,520[1] 1,450[2]	-	Daily	Flow-proportional composite
TSS	ppd	825	-	Daily	Flow-proportional composite
O&G	mg/L	-	100	Quarterly	Grab
pH	s.u.	6.2 (min.) – 11.0 (max.)		Continuous	Continuous metering

Notes:
BOD_5 = 5-day biochemical oxygen demand
TSS = total suspended solids
O&G = oil and grease
gpd = gallons per day
ppd = pounds per day
mg/L = milligrams per liter of wastewater
s.u. = standard pH units
"-" = no limit or not applicable
[1] Effective through June 30, 2023
[2] Effective beginning July 1, 2023

1.4 Reporting Requirements

The reporting requirements provided in this section are pursuant to State Discharge Permit ST0003861 issued by the Department of Ecology for Perdue Foods, LLC – Draper Valley Farms poultry processing facility in Mount Vernon, Washington. Additional information can be found in the reference documentation for the discharge permit (Appendix Q).

The permit document specifies both standard and permit violation-based reporting protocols for DVF which are summarized below. Following these guidelines is essential for ensuring seamless facility and WWTP operation in accordance with the relevant regulatory bodies.

Standard Reporting

Discharge monitoring reports (DMR's) must be submitted with data obtained during each specified monitoring period via the DMR form provided by Ecology within the Water Quality Permitting Portal. Data for all parameters tabulated in Special Condition S2 and as required by the form must be included. Additional instructions detailing how to complete the DMR form can be found in section S3.A. of the draft permit.

All other written permit-required reports must be submitted through the Water Quality Permitting Portal – Permit Submittals application. The permit application, S10, requires submittal of a paper (hard copy) application form. The Permittee must ensure that it is postmarked or received by Ecology no later than the dates specified by this permit. Send these paper reports to Ecology at:

Water Quality Permit Coordinator

Department of Ecology
Northwest Regional Office
PO Box 330316
Shoreline, WA 98113-9716

Furthermore, the permittee must retain records of all monitoring information for a minimum of three years. Such information must include all calibration and maintenance records and all original 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. The Permittee must extend this period of retention during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology. Information outlining measurement/sample collection data needs and additional monitoring requirements can be found in sections S3.D and S3.E. respectively.

Noncompliance Reporting - Immediate

Non-compliance that may endanger health or the environment shall be reported immediately to the Department of Ecology's Regional Office 24-hr. number and to the City of Mount Vernon number listed below per the requirements of the discharge permit.

- Northwest Regional Office: (206) 594-0000
- City of Mount Vernon (360) 336-6219

Noncompliance Reporting: Twenty-Four-Hour

The Permittee must report all occurrences of non-compliance listed in subpart S3.F.b. of the draft permit within 24 hours from the time the Permittee becomes aware of such circumstances.

Noncompliance Reporting: Within Five Days

The Permittee must also submit a written report within five days of the time that the Permittee becomes aware of any reportable event under subparts S3.F.a. or S3.F.b. Required elements of the report are listed in subpart S3.F.c of the draft permit.

Waiver of Written Reports

Ecology may waive the written report required in subpart S3.F.c on a case-by-case basis upon request if the Permittee has submitted a timely oral report.

All Other Permit Violation Reporting

The Permittee must report all permit violations, which do not require immediate or within 24 hours reporting, when it submits monitoring reports for S3.A ("Reporting"). The reports must contain the information listed in subpart S3.F.c. Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of the permit or the resulting liability for failure to comply.

1.5 Personnel

A WWTP is a complex system that needs skilled operators and managers. Their quality directly affects the operation of the facility. Each party must be aware of their respective roles and responsibilities. It is the responsibility of both groups to ensure that the treatment of the wastewater is environmentally sound and abides by the regulations.

1.5.1 WWTP Manager/Administrator Responsibilities and Requirements

The WWTP Administrators' major duties and responsibilities are listed below. In the case of DVF, the environmental manager is designated as the head administrator at the WWTP.

Administrative Scope:

- File all required regulatory reports which address conformance of the WWTP operation to established effluent limits in a timely fashion.
- Maintain regular communication and working relationships with regulatory agencies (i.e., City of Mount Vernon & Department of Ecology).
- Provide a staff that is conscientious and capable of operating and maintaining the WWTP after being provided with proper instruction and orientation.
- Ensure operations and maintenance records are being documented and discuss this information with acting operators.
- Establish contingency plans and contact the appropriate personnel for emergency response to upset conditions.
- Coordinate contracted work (e.g., dewatered solids hauling, laboratory testing, and similar functions) for the WWTP and associated systems.
- Advise management of potential major problems in operation and maintenance of the system.
- Coordinate and follow up on requisitions and receipt of items needed to operate and maintain the system.
- Keep abreast of regulatory changes and training requirements. Participate in training courses when available and read current periodicals related to the field to keep informed of the latest operation and maintenance techniques.
- Develop an operation and maintenance budget that provides enough funds for effective daily operations and includes a reserve fund for future operations.

1.5.2 WWTP Operator Responsibilities and Requirements

The WWTP operator's major duties and responsibilities are listed below. These expectations encompass both standard and maintenance-based tasks. Any questions pertaining to the following list should be directed to the facility manager before any subsequent action is taken.

Operator Scope:

- Schedule the workload in an efficient manner. Develop specific procedures, both written and verbal, for completing the work.
- Upgrade training by attending available seminars and special training courses and utilizing other available opportunities to increase knowledge.
- Provide a safe working environment with proper safety equipment and tools.

- Implement an effective emergency response program.
- Promote good public relations by maintaining all facilities at a high level of performance.
- Monitor, evaluate, and adjust treatment processes and the associated equipment.
- Coordinate special projects that extend beyond routine maintenance.
- Develop an understanding of the entire WWTP, including raw wastewater sources and the final effluent monitoring point.
- Practice good housekeeping to maintain the WWTP appearance, maximize safety, minimize odors, and improve operations.
- Establish safety plans and apply safety procedures.
- Perform and interpret laboratory tests required for process control and adjustment.
- Maintain a "Critical Spare Parts Inventory List" for the WWTP.
- Maintain a "Daily Operations Logbook" for the WWTP.

1.6 Process Design Theory and Application

The WWTP includes pH adjustment, biological treatment for soluble organics reduction, DAF for suspended solids, and provisions for solids storage and handling. The theory and some key performance/monitoring parameters for the treatment processes are described below.

1.6.1 pH

Water dissociates into hydrogen (H^+) and hydroxyl (OH^-) ions (Equation 1-1). The pH of a solution is a measurement of its hydrogen ion (H+) concentration.

$$H_2O = H^+ + OH^- \qquad \text{Equation 1-1}$$

The pH scale ranges from 1 to 14, with 7.0 representing a neutral pH, values below 7.0 being acidic (e.g., vinegar), and values above 7.0 being alkaline, or basic. If the pH of a solution is too low, a base (e.g., sodium hydroxide or lime) can be added to raise the pH. In general terms, in this condition the concentration of H^+ decreases and the concentration of OH^- increases.
Equation 1-2 illustrates the equation for calculating the pH, where $[H^+]$ is the molar concentration of hydrogen ions.

$$pH = -\log [H^+] \qquad \text{Equation 1-2}$$

Because pH is a logarithmic function, a solution at pH of 6.0 has 10 times the [H+] ions as a solution at pH of 7.0, and 100 times the number compared to a solution at pH 8.0.
When calculating the average of several pH values, first convert the pH to the [H+] concentration using Equation 1-3.

$$[H+] = 10^{-pH} \qquad \text{Equation 1-3}$$

Calculate the average of the [H+] concentrations and then convert the average [H+] concentration to pH using Equation 1-2.

1.6.2 Alkalinity

Alkalinity, the measure of a solution's capacity to neutralize acid, is important for the growth of healthy biomass in both anaerobic and aerobic treatment systems.

Bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) ions are the dominant alkalinity species in natural water systems. In industrial waters, other constituents influencing alkalinity include ammonia (NH_3) and hydroxide (OH^-).

The typical units for alkalinity are milligrams per liter as calcium carbonate (mg/L as $CaCO_3$). This allows different forms of alkalinity to be represented using the same units.

Suppose one needs to calculate the total alkalinity of a solution that contains 30.5 mg/L of bicarbonate and 5 mg/L carbonate. The combined alkalinity from these species may be calculated using the conversion factors in Table 1-3 (Note the table includes conversion factors for substances that do not contribute alkalinity but do contribute to hardness such as Ca^{2+}). Multiply 30.5 mg/L of bicarbonate by 0.82 to convert bicarbonate to 25.0 mg/L as CaCO3 and multiply 5 mg/L of carbonate by 1.67 to convert carbonate to 8.4 mg/L as $CaCO_3$. The total alkalinity from these two substances is 33.4 mg/L as $CaCO_3$.

Table 1-3 Conversions from mg/L as a Substance to mg/L as $CaCO_3$

Substance as mg/L	Abbr.	Conversion to $CaCO^3$	Substance as mg/L	Abbr.	Conversion to $CaCO^3$
Aluminum	Al^{3+}	5.56	Hydrogen	H^+	50
Bicarbonate	HCO_3^-	0.82	Magnesium	Mg^{2+}	4.10
Calcium	Ca^{2+}	2.50	Manganese	Mn^{2+}	1.82
Carbonate	CO_3^{2-}	1.67	Ammonia	NH_3	2.94
Copper	Cu^{2+}	1.57	Ammonium	NH_4^+	2.78
Iron, ferrous	Fe^{2+}	1.79	Hydroxide	OH^-	2.94
Iron, ferric	Fe^{3+}	2.69			

1.6.3 Hardness

Hardness is the measure of soluble multivalent cations (positively charged ions with a charge or valence of 2^+ or higher). These include ions such as calcium, magnesium, manganese, and others.

The units for hardness are the same as alkalinity: mg/L as $CaCO_3$ (refer to Table 1-3 for conversion factors). Water is classified as "soft" when the hardness is less than 50 mg/L as $CaCO_3$, as "hard" when the hardness ranges from 100 to 300 mg/L as $CaCO_3$, and as "very hard" to brackish above 300 mg/L as $CaCO_3$.

Hardness is important because it can combine with anions (negatively charged ions), and under the right conditions, form a precipitate.

1.6.4 Nutrient Requirements and Species

Nutrients are substances that are critical for sustaining life. In wastewater treatment, these can be classified into two categories: macronutrients and micronutrients. The prefixes macro and micro refer to the relative amount of each that is required and not the size of the nutrient molecules.

Macronutrients

In aerobic wastewater treatment, the terms nutrients (or less commonly macronutrients) refer to carbon, nitrogen, and phosphorus. These are the basic constituents of a bacterial cell, and their ratio is based on the formula for a bacterial cell $C_5H_7NO_2$. This equates to the standard ratio of 100:5:1 for carbon (measured as BOD or estimated from COD using the typical BOD to COD ratio), nitrogen and phosphorus. However, this ratio is general and depends on the solid's retention time and environmental conditions.

- **Carbon** comes from the organic substrate in wastewater in the form of carbohydrates. It can take on many forms and some are more biodegradable than others. Carbon is often associated with both chemical oxygen demand (COD) and biochemical oxygen demand (BOD).
    - Aerobic Biological Treatment Consideration: There is no limit on influent concentrations so long as enough oxygen, nutrients, and biomass are available for treatment and the influent is not toxic to the biomass. Soluble (no suspended solids) effluent levels can be as low as 50 mg/L COD, but this will depend on the acclimation of the biomass and the degradability of the carbon source.
- **Nitrogen** is found in organic compounds such as protein or urea but can also be found as inorganic species such as ammonia (NH_4), nitrate (NO_3), nitrite (NO_2), or nitrogen gas (N_2). Nitrogen can be transformed within a treatment system from organic forms to ammonia. Bacteria also turn ammonia to nitrate (nitrification) and nitrate to nitrogen gas (denitrification). Refer to Metcalf and Eddy () for more detail on nitrogen transformation and removal.
    - Aerobic Biological Treatment Consideration: supplemental nitrogen addition feed rate should be set based on 5 parts nitrogen to 100 parts BOD. The addition rate can be further optimized by monitoring the wastewater influent ammonia nitrogen and effluent ammonia nitrogen residual.
- **Phosphorus** is often found as phosphate or other inorganic forms that may come from cleaning compounds. The mechanism for phosphorus removal is via assimilation or the incorporation of nutrients into biomass.
    - Aerobic Biological Treatment Consideration: supplemental phosphorus addition feed rate should be set based on 1 part phosphorus to 100 parts BOD. The addition rate can be further optimized by monitoring the wastewater influent reactive phosphate and effluent reactive phosphate residual.

Micronutrients

Micronutrients are required by aerobic bacteria for healthy growth, but the required levels are much lower than macronutrients. Micronutrients are often the first thing to check when noticing long term reactor performance decline. These include iron, copper, selenium, cobalt, manganese, tungsten, nickel, molybdenum, boron, calcium, magnesium, zinc, and sulfides. Wastewater produced from poultry processing is not expected to be deficient in micronutrient supply, however the importance of these levels and their impact on reactor function should be noted and can be checked by a certified laboratory if the biological reactor treatment performance is lower than expected.

1.6.5 Dissolved vs. Suspended Solids

Solids in water consist of suspended particles and dissolved solids.

- The total dissolved solids (TDS) analysis measures those solids that pass through a 0.45-micron filter.
- The fixed dissolved solids (FDS) analysis measures those inorganic solids which are dissolved but not volatile (VDS) or dissolved solids that are converted to carbon dioxide and water being treated in a furnace at 510 ^oC.
- The total suspended solids (TSS) analysis measures those solids large enough to be trapped by a glass fiber filter.
- The volatile suspended solids (VSS) measures the suspended solids fraction that is volatilized from the glass fiber filter after being treated in a furnace at 510 ^oC.
- The total solids (TS) analysis measures the combination of suspended solids and dissolved solids.

1.6.6 Fixed Film Aerobic Treatment

Fixed-film aerobic biological treatment utilizes microorganisms to break down both soluble and particulate organic substances (i.e., BOD_5, COD, etc.) found in wastewater. These microbes use organics as food to grow new cells (i.e., biosolids).

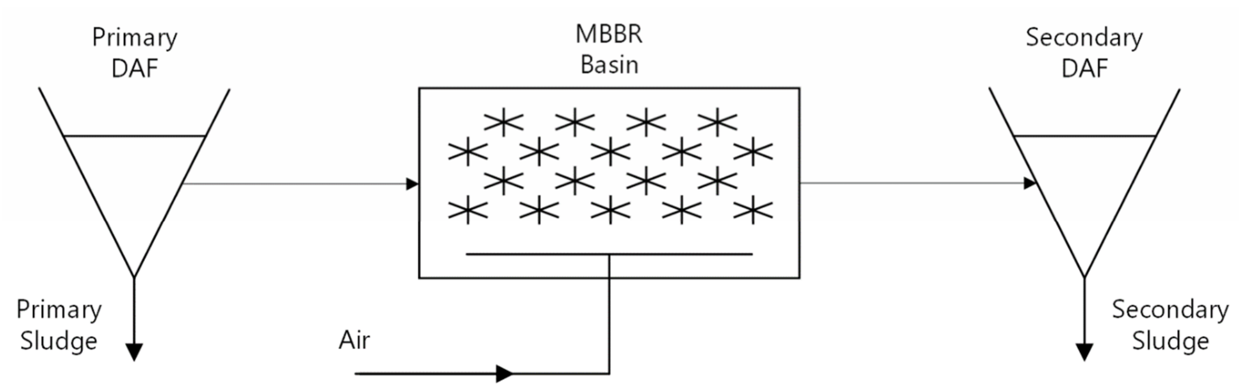

Figure 1-1 Conventional MBBR Configuration for Single-Stage BOD/COD Removal

Figure 1-1 illustrates a conventional moving bed bio-film reactor (MBBR) treatment system similar to the system used at DVF. Primary solids removal is performed, in this case with a DAF system. Effluent from the Primary DAF is then sent downstream for biological treatment in the MBBR. The MBBR is equipped with carriers or media which provide a protected habitat on which the biomass grows. Nutrients (e.g., aqua ammonia for nitrogen and phosphoric acid for phosphorus) can be added if the wastewater is deficient. Blowers feed air to the tank, maintaining a steady supply of dissolved oxygen (DO). The MBBR is sized to hold enough biomass and provide enough hydraulic residence time (HRT) for biological decomposition of the organics contained in the wastewater. Following MBBR treatment, a portion of the excess suspended solids that are not attached to the media are separated from the water using a secondary DAF system. Sludge generated during the primary and secondary DAF treatment phases are stored in separate holding tanks and then pumped to a waste trailer for offsite disposal. Unlike conventional activated sludge, no solids are recycled back to the bioreactor as part of this treatment process.

The surface area loading rate (SALR) for an MBBR is determined during the design phase and maintained in order to optimize organics removal. Values for SALR range from 15 - 25 g/m2-d for high-rate reactors targeting 75% BOD reduction down to a range of 5-15 g/m2-d for normal-rate reactors targeting up to 90% BOD reduction[1]. An SALR is selected and then used for subsequent calculations of required carrier surface area, required carrier volume, required tank volume, liquid volume in the tank, design-average HRT and peak-hour HRT. The SALR for DVF falls within the normal-rate range of BOD loading and removal as described by Table 1-4.

Table 1-4 Typical Design SALR Values for BOD Removal

Typical Design Values for MBBR reactors at 15°C		
BOD Removal	Treatment Target % Removal	Design SALR g/m^2-d
High Rate	75-80 (BOD_5)	15-25 (BOD_5)
Normal Rate	85-90 (BOD_5)	5-15 (BOD_5)

Successful biological treatment requires several conditions:

- There must be a steady source of biologically degradable food (e.g., alcohols, sugars, and other carbon sources). The concentration of organics is typically measured as BOD, COD, or total organic carbon (TOC). DVF will use COD analyses onsite to track influent and effluent organic levels in the influent to the bioreactor and periodic BOD analyses performed by offsite certified laboratories to access bioreactor performance and monitor effluent quality.
- Microbes must have electron receptors to derive energy from the oxidation of organic matter. In aerobic treatment systems, dissolved oxygen is the electron receptor (much like humans). Oxygen must be continuously fed to the system to maintain aerobic conditions. In low-oxygen (anoxic) or oxygen-free (anaerobic) systems, bound forms of oxygen (e.g., nitrate, sulfate) are the electron receptors. Depending on the treatment needs, a treatment system may have an anaerobic unit process, an anoxic unit process, an aerobic unit process, or a combination of these. DVF uses a strictly aerobic treatment process to meet its discharge effluent quality requirements.
- To maintain a steady state condition, the system must receive influent with nutrient levels proportional to the carbon loading to satisfy growth requirements of new organisms. Some of the microbial population will starve if the cell mass grows out of proportion to the food supply, and conversely, the treatment performance will suffer if the food supply exceeds the capacity of the population to consume of oxidize it. This relationship between influent flow and organics removal is known as the SALR.

The bacteria and microorganisms require nutrients, such as nitrogen and phosphorus, in balance with carbon. The molecular formula $C_5H_7NO_2$ represents a simplified characterization of cell tissue, with approximately 12.4% and 2.5% of the cell being nitrogen and phosphorus, respectively. The actual percentages vary with cell age and other conditions. Domestic wastewater typically has more nutrients than needed for biological treatment, and in nutrient deficient industrial wastewater, the operator must add

[1] SALR for Normal Rate Biofilm Reactors from *Biofilm Reactors* Published by the Water Environment Federation in 2010. WEF Manual of Practice No. 35. 2010.

excess nutrients to ensure proper treatment. The typical ratio of carbon-to-nitrogen-to-phosphorus needed for treatment is 100:5:1. Wastewater produced from poultry processing is not expected to be deficient in nitrogen or phosphorous but the DVF's WWTP is equipped to perform onsite lab tests for monitoring these parameters and to add appropriate chemicals as needed to meet the levels to meet the required biological treatment efficiency.

1.6.7 Solids Separation

Both the Primary and Secondary DAF treatment process utilize a combination of compressed air and coagulant/flocculant injection to form, coalesce and float suspended solids to the tank surface. The Primary DAF removes suspended solids and oil & grease from the raw wastewater. The Secondary DAF removed suspended biological solids from MBBR effluent. In both cases, once floated, the solids are skimmed with DAF rakes and transferred to individual sludge hoppers which are transferred at regular intervals specified by the operator to the Primary and Secondary DAF Sludge Tanks. Some passive solids separation is achieved during sludge tank storage before the solids are then pumped to a waste hauler and transported off-site to a permitted end user for anaerobic digestion.

2. OPERATIONS AND CONTROL

Initial startup and commissioning procedures for the WWTP upgrade are to be performed, per the Commissioning Plan and at the direction of the primary equipment vendor, World Water Works. Startup information for individual equipment prior to operations is detailed in the equipment vendor O&M Manuals which are referenced in subsequent sections.

The WWTP's control system includes the Main Control Panel (MCP) and associated OIT and remote Operator Interface Terminal (OIT) located in the chemical storage building. Critical alarms are transmitted to operators and administrative personnel via autodialer.

2.1 Existing Equalization and Primary DAF System

2.1.1 System Objectives

This tie in conveys Primary DAF Effluent to WWTP Upgrade (Secondary Treatment System) installed after the existing Primary DAF process. The operator will continue to follow existing procedures for operating the EQ and Primary DAF systems which are outlined elsewhere in DVF's existing operations manuals and standard operating procedures (SOPs). Treated process wastewater flows by gravity from the Primary DAF Effluent Trough to the Primary DAF Effluent pH Adjustment Tank (TK-10301) through piping installed on the south end of the trough. The trough includes pH/Temperature and Turbidity Probes (AE/AIT-10301 & AE/AIT-10302). Control valve (XV-10301) is typically open, allowing the process wastewater to flow by gravity into the Primary DAF Effluent pH Adjustment Tank (TK-10301). XV-10301 may be closed, automatically or by the operator during the primary DAF startup process, if the water is out of spec for turbidity as measured by AE/AIT-10301 or AE/AIT-10302, respectively. If XV-10301 is closed, control valve (XV-10302) must open allowing process wastewater to be diverted back to the EQ Tank via the Offal Room Wastewater Pit. This recirculation of wastewater back to the EQ tank must be monitored carefully by the operator to prevent overflow of the EQ tank.

2.1.2 Operations

This section summarizes the operational transition from the EQ and Primary DAF System to the Secondary Treatment System.

2.1.2.1 Control Panel

Some equipment signals associated with the EQ and Primary DAF are integrated into the vendor supplied MCP. This includes continuous display of pH/temperature & Turbidity probes and EQ tank level. Data received from this equipment is displayed on the OIT and is available for monitoring equipment status and to inform adjustment of operator setpoints and mode of operation to maintain optimal conditions for downstream treatment. For more information on equipment controls related to the Primary DAF Effluent Transition to the Secondary Treatment System, refer to the control narrative (Appendix C).

2.1.2.2 System Startup

Upon Primary DAF startup, which typically occurs every Monday morning, typically for 45 minutes to 1 hour, coinciding with the production plant startup Primary DAF Effluent Control Valve (XV-10301) will be open to the Primary DAF Effluent pH Adjustment Tank. The system will startup in bypass mode where the MBBR tank is bypassed temporarily until the Primary DAF performance has stabilized; however, the Primary DAF effluent is still treated in the pH Adjustment Tank and Combined Effluent Tank. This operation is described in the MBBR operation section in more detail. Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) is open and Combined Effluent Discharge to City Control Valve (XV-10505) is closed. This recirculation of wastewater back to the EQ tank must be monitored carefully by the operator to prevent overflow of the EQ tank. Once process wastewater turbidity readings have stabilized and are in-spec (below the setpoint) as measured by the Primary DAF Effluent Trough Turbidity Probe (AE/AIT-10302), XV-10505 will open and XV-10504 will close allowing wastewater to flow to the City.

2.1.2.3 Normal Operation

Primary DAF Effluent Turbidity In Spec: The Primary DAF Effluent Control Valve (XV-10301) shall remain open allowing process water to flow into the Primary DAF Effluent pH Adjustment Tank (TK-10301). The Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) shall remain closed and Combined Effluent Discharge to City Control Valve (XV-10505) shall remain open.

- INTERLOCK: The Combined Effluent Discharge to Secondary Screen Tank Control Valve (XV-10504) can only Open when the level in the existing equalization tank is below the level setpoint.
- Primary DAF Effluent Turbidity Out of Spec: refer to System Startup in 2.1.2.2

2.1.2.4 System Shutdown

When Primary DAF effluent flow stops, typically following the completion of sanitation activities at the close of the production week, wastewater will stop flowing to the Primary pH Adjustment Tank. The Primary pH adjustment pumps will empty the tank to the low level setpoint. At this time, the operator should follow existing procedures for Primary DAF shutdown. The pumps will start pumping again to the downstream treatment processes when the tank begins filling with the start of production and startup of the Primary DAF on Monday morning.

2.1.2.5 Alternative Operation

The operator can operate the flow control valves by selecting Hand operation from the OIT screen and selecting valves open or closed.

2.1.2.6 Emergency Operation

- If the Primary DAF Effluent Trough Turbidity Analyzer (AE/AIT-10302) readings exceed the setpoint an alarm will be triggered and the Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) will open and Combined Effluent Discharge to City Control Valve will close. Outside of the typical Monday morning Primary DAF Startup procedure, this is a critical situation which must be monitored closely by the operator to troubleshoot chemical treatment in Primary DAF and prevent overflow of the EQ tank.
- Manual valves are available to isolate the Secondary Treatment system and utilize only the Primary DAF for treatment with gravity flow to the City via the flanged connection on the north end of the Primary DAF Effluent Trough. These valves should only be used in the event of an emergency or if the Secondary Treatment System needs to be removed from service for an extended period for

extensive repair or maintenance. Whenever possible, this work should be conducted over the weekend when the production plant is down.

Caution These are critical situations which must be monitored closely by the operator. Proper notifications and coordination must be conducted with the City, following all applicable permit requirements, because the wastewater will not be receiving enhanced pH neutralization secondary treatment for soluble organics under these operational scenarios.

2.2 Primary DAF Effluent pH Adjustment System

2.2.1 System Objectives

The Primary DAF Effluent pH Adjustment Tank is an open top, cylindrical tank constructed of fiberglass reinforced plastic (FRP). The tank is gravity fed from the south end of the Primary DAF Effluent Trough. Chemical feed pumps supply 50% caustic (P-10701A) and ferric chloride (P-10702A) to the tank for pH neutralization. A vertical turbine mixer (AG-10301) provides mixing. Switches for High-High (LS-10301) and Low-Low (LS-10302) Level conditions are installed within the tank along with a level transmitter (LIT-10301), all of which transmit signal to the MCP. Two 24" manways are installed on top of the tank at the tank base to allow operator access for maintenance. The objective of this treatment step is pH neutralization of the Primary to a range of 6.5 to 8 s.u. for MBBR treatment. This range is well within DVF's pH discharge limit to the city. Redundant pH analyzers (AE/AIT-10303A&B) in primary and backup configuration are used to control chemical dosing of base (sodium hydroxide) or acid (ferric chloride) for pH neutralization. Following treatment, one of two Primary DAF Effluent Transfer Pumps (P-10301A or B) in duty/standby configuration will transfer the neutralized process wastewater to either the MBBR Tank or Combined Effluent according to the current operating mode. This process is described in more detail in subsequent sections.

2.2.2 System Components

Effluent from the Primary DAF discharges into the Primary DAF Effluent Trough which then feeds into the Primary DAF Effluent pH Adjustment Tank via a gravity line. Signals from all instrumentation related to the Primary DAF Effluent pH Adjustment System are integrated to the MCP.

The major equipment associated with the Primary DAF pH Adjustment system is listed in Table 2-1. Refer to the P&IDs provided in Appendix A for system details including piping, valves, and instrumentation. The control narrative included in Appendix D provides further details on the operation of the individual system components.

Table 2-1 Primary DAF Effluent pH Adjustment System Components

Tag	P&ID	Description	Capacity/Size
TK-10301	P-103	Primary DAF Effluent pH Adjustment Tank	6,000 gal (working volume) 14 ft. ϕ x 8 ft ht.
MX-10301	P-103	Primary DAF Effluent pH Adjustment Tank Mixer	5 HP
P-10701A	P-107	Sodium Hydroxide Chemical Metering Pump	8 gph @ 60 psig
P-10702A	P-107	Ferric Chloride Chemical Metering Pump	8 gph @ 60 psig

Tag	P&ID	Description	Capacity/Size
P-10301A	P-103	Primary DAF Effluent Transfer Pumps	500 gpm @ 34' TDH
P-10301B			

2.2.3 Basic Design Data

The Primary DAF Effluent pH Adjustment Tank is sized to process wastewater flow neutralization with a minimum hydraulic retention time of 12 minutes at the peak design flow of 500 gpm. Redundant pH analyzers control chemical dosing of 50% caustic or 40% ferric chloride for pH neutralization. Two Primary DAF Effluent Transfer Pumps run in a duty/standby configuration to transfer wastewater to the MBBR Tank and/or the Combined Effluent Tank.

2.2.4 Operations

This section summarizes the operational procedures for the Primary DAF Effluent pH Adjustment System. Vendor-supplied IOM manuals for the individual equipment should be consulted directly prior to starting and operating the system or attempting to perform maintenance. The alarms, setpoints, control description details, and interlocks for the WWTP (excluding those within individual vendor control systems) are included in the Control Narrative (Appendix C), Setpoint and Range List (Appendix B), and OIT Description (Appendix D).

2.2.4.1 Control Panel

All Primary DAF Effluent pH Adjustment System equipment signals are integrated into the MCP. This includes run/fault statuses, VFD statuses, run time, trends, instantaneous readings, and setpoints, as applicable for the Analyzers (i.e. pH/temperature & DO probes), Effluent Transfer Pumps, Chemical Feed Pumps, Level Sensor, High-High & Low-Low Level Switches, Vertical Turbine Mixer, and Control Valves. Data received from these instruments is displayed on the OIT and is available for monitoring equipment status, and to inform adjustment of operator setpoints and mode of operation to maintain stable tank conditions. For more information on Primary DAF Effluent pH Adjustment System controls, refer to the control narrative (Appendix C).

2.2.4.2 System Startup

Effluent from the Primary DAF pH adjustment tank can be alternatively sent to the Offal Room Wastewater Pit for recirculation to the EQ Tank using control valves XV-10504 and XV-10505. Once turbidity readings have stabilized, process wastewater flows to the Primary DAF Effluent pH Adjustment System begins. This operation is described in more detail in 2.1.2.2.

2.2.4.3 Normal Operation

- The Primary DAF Effluent Control Valve (XV-10301) is open.
- Normal automatic operation is selected from the OIT screen – system runs to maintain pH between 6.5 and 8.0 standard units.
- Operator can select at the OIT which of the two pH probes (AE-10303A or B) is primary.

- Under normal conditions the Ferric Chloride Metering Pump 1 (P-10702A) will start once the Ferric Chloride Metering Pump 1 On Level setpoint, as measured at the Primary DAF Effluent pH Adjustment Tank pH Probes (AE-10303A&B), is reached. Ferric Chloride Metering Pump 1 (P-10702A) will stop once the Ferric Chloride Metering Pump 1 Off Level, as measured at the Primary DAF Effluent pH Adjustment Tank pH Probes (AE-10303A&B), is reached.
- Under normal conditions Sodium Hydroxide Metering Pump 1 (P-10701A) will start once the Sodium Hydroxide Metering Pump 1 On Level, as measured at the Primary DAF Effluent pH Adjustment Tank pH Probes (AE-10303A&B), is reached. Sodium Hydroxide Metering Pump 1 (P-10701A) will stop once the Sodium Hydroxide Metering Pump 1 Off Level, as measured at the Primary DAF Effluent pH Adjustment Tank pH Probes (AE-10303A&B), is reached.
- The Primary DAF Effluent pH Adjustment Tank Mixer (AG-10301) will start when the tank level reaches the level setpoint and stop if the tank falls below the mixer off setpoint.
- Primary DAF Effluent Transfer Pumps (P-10301A & B) operate in duty/standby mode. The duty pump will start once the Primary DAF Effluent Transfer Pump On Level, as measured by LIT-10301, is reached. The Primary DAF Effluent Transfer Pumps Discharge Flow Control Valves (FCV-10305 & FCV-10306) modulate to convey wastewater to the MBBR Tank or Combined Effluent tank according to the operating mode. The operation of these valves and operating modes are described in more detail in the next section. The Primary DAF Effluent Transfer Pumps (P-10301A&B) will stop once the Primary DAF Effluent Transfer Pump Off Level, as measured by LIT-10301, is reached. The Primary DAF Effluent Transfer Pumps will operate to maintain the adjustable level setpoint as measured by LIT-10301. The VFD speed of the pumps will be adjusted based on the level measured by LIT-10301. The pumps shall alternate daily and when maintenance is required.

2.2.4.4 System Shutdown

The system will shutdown automatically (pumps and mixer) if the tank falls below the low level setpoint to stop these components and will essentially enter standby mode until the tank level fills to the level setpoints to start the mixer and pumps.

2.2.4.5 Alternative Operation

- Manual Mode: The Primary DAF Effluent Transfer Pumps, Sodium Hydroxide & Ferric Chloride Chemical Metering Pumps, and mixer can be operated in manual mode by selecting Local operation from the screen. The equipment shall remain running until either shut off or placed into Remote operation. Shutting the Primary DAF Effluent Transfer pumps down manually and not running them in Auto/remote creates a risk of overflowing the Primary DAF Effluent pH Adjustment Tank and/or disrupting downstream treatment processes.

2.2.4.6 Emergency Operation

<u>Level Instrument Failure</u>

- If the Primary DAF pH Adjustment Tank level indicator (LIT-10301) fails, a failure alarm will be triggered at the OIT. The backup instruments are High-High Level Switch (LSHH-10301) and Low-Low Level Switch LSLL-10301. LSHH-10301 starts the standby Primary DAF Effluent Transfer Pump (P-10301A or B).

- If level instrumentation fails, it's possible that the tank may overflow onto the ground. If this occurs, the overflow will flow to a sump which pumps water back to the pit. **While the wastewater is contained, this is a critical situation, and the operator should immediately investigate and resolve this issue.**

Monitoring Instrumentation Failure

- If the Controlling pH probe (AIT-10301A or AIT-10301B) fails, a failure alarm will be triggered at the OIT, and the other instrument will become the Controlling instrument. If both pH probes fail, failure alarms will be triggered at the OIT workstation. A deviation alarm will also be triggered if the difference in the instruments' readings exceed the deviation setpoint.
- If monitoring instrument failures are not addressed promptly, the pH leaving the Primary pH Adjustment Tank may operate outside of the ideal ranges for MBBR treatment or outside of the range for pH discharge compliance. The operator should maintain onsite spare probes and work to resolve instrument failures as quickly as possible.

Pump Failure

- If Primary DAF Effluent Transfer Pump (P-10301A or B) fails to run when called to run, a failure alarm will be triggered at the OIT, the duty pump will shut down, and the standby pump will become the duty pump.
- If both Primary DAF Effluent Transfer Pumps fail, pump failure alarms will be triggered at the OIT.
    - For the Primary DAF Effluent Transfer Pumps, this is a critical situation. If the pump(s) are not restored and operations continue as normal, eventually a high-high level alarm will trigger. If the pump(s) are not restored, the operator may have to consider shutting down the secondary treatment system and manually reverting treatment with the Primary DAF only. This is an emergency operation described in more detail in Section 2.1.2.6.
- The Sodium Hydroxide Metering Pump 1 (P-10701A) and Ferric Chloride Metering Pump (P-10702A) do not have failure alarms. An alarm will occur if the pH setpoint is not achieved, as measured at pH Probe (AE-10301A or B) after the setpoint time has elapsed. If this alarm occurs, the operator must investigate the chemical feed systems.

Mixer Failure

- If Primary DAF Effluent pH Adjustment Tank Mixer (AG-10301) fails to run when called to run, a failure alarm will be triggered at the OIT. It is critical that the operator investigate the cause of the failure as a lack of mixing could impact pH neutralization. It is recommended that a spare mixer motor be maintained onsite.

Caution Maintain spare parts as recommended by the equipment manufacturers. These are critical situations which must be responded to promptly to troubleshoot and perform repair and maintenance. Provide proper notice and coordination must be conducted with the City, following all applicable permit requirements, is treatment is interrupted or impacted.

2.3 MBBR/Aeration Tank System

2.3.1 System Objectives

The MBBR is a fixed-film biological process that provides BOD reduction. Effluent transfer pumps convey an average of 55% of Primary DAF Effluent pH Adjustment Tank flow (or more up to the hydraulic capacity of the Secondary DAF) through a 4" line to the MBBR soluble BOD treatment. The remainder of the flow will be processed in the Combined Effluent Tank. The tank is partially filled with media or carriers on which aerobic bacteria grow (fixed film biomass).

Figure 2-1 MBBR Carrier with Fixed Film Growth

Continuous coarse-bubble aeration is provided to the reactor via aeration manifolds fed by external blowers to provide 2.5-3.0 mg/L of dissolved oxygen (DO) for the support of aerobic bacteria growth on the carrier media. This aeration also maintains the media in suspension and provides the agitation necessary to facilitate adequate contact with wastewater and the biomass on the carriers. The MBBR influent line is fitted with chemical injection ports for phosphoric acid and aqua ammonia to be added as supplemental nutrients when influent levels alone cannot sustain the biomass. Defoamer can be injected at the liquid surface for foam level control, while separate injection quills located on the reactor sidewall can be used to add caustic to raise pH and a supplemental carbon source (glycerin) during plant shutdowns. The need for supplemental carbon during typical weekend shutdowns will be evaluated during startup. Effluent from the MBBR flows through a screen (overflow sieve) which is sized to retain the carrier media while allowing process flow conveyance through a 6" gravity line to the Secondary DAF for solids removal.

2.3.2 System Components

The primary equipment included in the MBBR Tank system is listed in Table 2-2 MBBR System Components. The MBBR reactor is an open top, bolted carbon steel tank (TK-10401). A coarse bubble aeration grid (AD-10401) installed on the tank bottom is fed by two positive displacement blowers which operate in a duty/duty-assist configuration (B-10401A&B). Chemical feed pumps transport ammonium hydroxide (P-10801) and phosphoric acid (P-10802) to injection ports on the MBBR Influent line for supplemental nutrient addition. Separate chemical feed pumps supply defoamer (P-10803) to the liquid surface, along with caustic (P-10701B) and supplemental carbon (P-10804) directly to the reactor volume via injection quills. Remote monitoring equipment installed within the tank includes a foam detection transmitter (LIT-10401), high-high level switch (LSHH-10401), level sensor (LS-10401), pH/temperature probe (AE-10401) and a DO probe (AE-10402). Output from these devices is displayed on the OIT and is used for the automatic operation of blowers (DO), caustic addition (pH), and defoamer addition (foam level switch). The operator can also use this information to adjust setpoints and troubleshoot the system. Effluent from the MBBR flows through a 12" diameter by 5-foot-long sieve which is fully submerged in the tank and sized to retain carrier media in the reactor while maintaining a flux of 11.4 gpm/ft^2 which is less than half of the vendor's design criteria of 24 gpm/ft^2 under peak flow conditions. An air scour is included to release compressed air for dislodging any solids accumulation on the effluent sieve. The air scour compressed air solenoid valve can be operated automatically on a timer, or manually by the operator. The tank also includes a 12" overflow and 4" drain. Both include sieves to drain liquid while retaining the media in the tank. The reactor tank has a 30" manway located at the base of the tank.

Table 2-2 MBBR System Components

Tag	P&ID	Description	Capacity/Size
TK-10401	P-104	Aeration Tank	54,700 gal. (working volume) 18 ft. ϕ x 32 ft ht.
AD-10401	P-104	Aeration Diffuser Manifold	14 diffusers w/ 22 x 5/32" holes each
B-10401A B-10401B	P-104	Aeration Blowers	
P-10701B	P-107	Sodium Hydroxide Feed Pump	8 gph @ 60 psig
P-10803	P-108	Defoamer Feed Pump	20 gph @ 25 psig
P-10802	P-108	Phosphoric Acid Feed Pump	2 gph @ 50 psig
P-10801	P-108	Ammonium Hydroxide Feed Pump	4 gph @ 50 psig
P-10804	P-108	Supplemental Carbon Feed Pump	2 gph @ 50 psig

2.3.3 Basic Design Data

Mass balances were developed during the design process to show the anticipated treatment performance for average and peak day loading conditions. They can be found on the PFD in Appendix A. These mass balances have been reviewed and confirmed through biological treatment modeling conducted by WWW. The results of this biological treatment can be found in WWW's design memo included as Appendix E. The system design conditions are:

Table 2-3 MBBR Summary of Design Conditions

Parameter	Value
Design Flow	0.382 MGD (265.3 gpm)
Peak Flow	382 gpm – for sieve design only
MBBR Influent BOD_5	463.8 mg/L (1,478 lb/day) – at design flows
MBBR Influent Soluble BOD_5	463.8 mg/L (1,478 lb/day) – at design flows
MBBR Influent TSS	41.4 mg/L (132 lb/day) – at design flows
MBBR Influent NH3-N	Deficient, supplement with 5 parts N to 100 parts BOD using Ammonium Hydroxide
MBBR Influent PO4-P	Deficient, supplement with 1 part P to 100 parts BOD using Phosphoric Acid
MBBR Effluent Soluble BOD_5	< 90 mg/L (287 lb/day) – at design flow)
Secondary DAF Total BOD_5	< 130 mg/L (414 lb/day) – at design flow)
Secondary DAF TSS	< 40 mg/L (128 lb/day) – at design flow)
Wastewater temperature	10 – 30° C (50 – 86° F)
Reactor pH	6.5 – 8.0 s.u.

Parameter	Value
Reactor DO	2 – 3 mg/L

It is important to note that based on limited hourly flow and COD data provided by DVF during the design process, 62% of the total daily flow and 75% of the mass loading occur during the production shift. The production shift flow is distributed over a 10-to-12-hour period including the use of the Equalization Tank. The treatment system is designed to produce a combined Primary and Secondary DAF effluent for discharge that meets the effluent limitations under these circumstances. Perdue has the ability to direct more flow to the MBBR, if necessary, to compensate for higher organic loading in the primary DAF effluent wastewater up to the hydraulic capacity of the secondary DAF (320 gpm); however, the BOD removal efficiency will be temporarily reduced due to the diminished hydraulic retention time in the MBBR. It is conservatively estimated that the MBBR can remove at least 36.8 pounds per hour of BOD based on the blower sizing and oxygen transfer efficiency of the system.

2.3.4 Process Calculations

Theory of MBBRs, operational information, and process calculations can be found in WWW's MBBR Design Memo (Appendix E) and the WWW MBBR Installation, Operation, & Maintenance Manual (Appendix F). A summary of key design criteria and process calculations for the MBBR in these documents is presented below. Refer the referenced appendices for more detail.

Table 2-4 MBBR System Sizing Summary

Parameter	Value
MBBR Reactor Tanks	1
MBBR Tank Volume & Dimensions	54,700 gal. (working volume) 18 ft. ϕ x 32 ft ht.
Recommended freeboard	2 – 3 ft minimum
Minimum Reactor HRT	3.44 hr. @ Maximum Influent Flow
Media volume provided	120 m^3 (4,237 ft^3)
Effective Surface Area Provided	78,000 m^2 (839,585 ft^2)
% fill of biofilm carrier elements	58%
% Fill Maximum	65%
Blowers	2
Blower Sizing	40 hp, 360 SCFM @ 12.5 psig

Equation 1: Surface Area Loading Rate (SALR)

As discussed in Section 1.6.6, a surface area loading rate (SALR) is selected during design to calculate the quantity of media required to provide the required BOD reduction. For the DVF MBBR system, an initial SALR of 15 g BOD_7/m^2-day at 15°C was selected which is the upper range for a normal-rate system. The SALR must be adjusted for the design minimum reactor temperature as biological activity slows with decreasing temperature and conversion from BOD_7 to BOD_5. Two compensation factors were applied to the SALR value to account for the minimum design temperature of 10°C or 50°F and conversion from BOD_7 to BOD_5.

$$\mathrm{BOD_5\ SALR}\ (10^0\mathrm{C}) = \frac{15*1.06^{(10\text{-}15)}}{1.16} = 9.66\ {}^{\mathrm{g\ BOD_5}}\!/_{\mathrm{m^2\text{-}day}}$$

Where:

$$Temperature\ Compensation = 1.06^{(10°C\text{-}15°C)}$$

$$\mathrm{BOD_5/BOD_7} = 1/1.16$$

$$8.34 = Conversion\ from \frac{mg}{L} to \frac{lb}{MG}$$

WWW further adjusted design SALR from 9.66 g BOD_5/m^2-day at 10°C to a more conservative value of **8.64 g BOD_5/m^2-day at 15°C** based on their extensive experience designing industrial MBBR systems. Further information on the determination and explanation of the design SALR value can be found in the WWW MBBR Design Memo attached as Appendix E.

Equation 2: BOD Loading Rate

MBBR Influent BOD Loading Rate is first calculated as it is the dependent variable in determining all subsequent values necessary for carrier media selection, tank sizing and overall system design:

$$BOD\ Loading\ Rate\ \left(\frac{g}{day}\right) = Q * S_o * 8.34 * 453.69$$

Where:

$$Q = MBBR\ Influent\ Flow\ Rate\ (MGD)$$

$$S_o = Influent\ BOD\ Concentration\ (\frac{mg}{L})$$

$$8.34 = Conversion\ from \frac{mg}{L} to \frac{lb}{MG}$$

$$453.59 = Conversion\ from\ lb\ to\ g$$

Giving:

$$BOD\ Loading\ Rate\ \left(\frac{g}{day}\right) = 0.382\ MGD * 463.8 \frac{mg}{L} BOD * 8.34 * 453.69$$

$$BOD\ Loading\ Rate\ \left(\frac{g}{day}\right) = 670{,}230$$

Equation 3: Required Carrier Media Surface Area

The carrier media surface area required for fixed film bacterial growth to treat the BOD mass loading is then determined using the BOD loading rate and SALR calculated in Equations 1 and 2 above.

$$Required\ Carrier\ Surface\ Area\ (m^2) = BOD\ Loading\ Rate\ \left(\frac{g}{day}\right) \div SALR\ (\frac{g\ BOD_5}{m^2 - day})$$

$$Required\ Carrier\ Surface\ Area\ (m^2) = 670{,}230 \frac{g}{day} \div 8.64 \frac{g\ BOD_5}{m^2 - day}$$

$$Required\ Carrier\ Surface\ Area\ (m^2) = 77{,}573$$

Equation 4: Required Carrier Media Volume

The required carrier volume is then calculated using the carrier surface area from Equation 3 and the carrier specific surface area (a property that varies based on the carrier media selected). The media in use at DVF has an effective surface area of 650 m^2/m^3. The required volume of carrier for the MBBR tank is thus calculated as:

$$Required\ Carrier\ Volume\ (m^3) = Required\ Carrier\ Surf.Area\ (m^2) \div Carrier\ Specific\ Surf.\ Area\ (\frac{m^2}{m^3})$$

$$Required\ Carrier\ Volume\ (m^3) = 77{,}573\ m^2\ \div 650\ \frac{m^2}{m^3}$$

$$Required\ Carrier\ Volume\ (m^3) = 120$$

Equation 5: Carrier Fill %

The MBBR tank has a working volume of 54,700 gallons (207 m^3). The estimated carrier fill percentage (%) is calculated as:

$$Carrier\ Fill\ \% = \frac{Carrier\ Volume\ (m^3)}{Tank\ Volume\ (m^3)} * 100$$

$$Carrier\ Fill\ \% = \frac{120\ m^3}{207\ m^3} * 100$$

$$Carrier\ Fill\ \% = 58$$

The maximum carrier fill fraction for the MBBR is 65%, thus providing some extra capacity to add media should the influent BOD loading increase.

Equation 6: Hydraulic Residence Time

Finally, the hydraulic residence times (HRT) for the MBBR under a range of influent flow conditions are calculated.

- Average Flow: 0.205 MGD (142 gpm)
- Peak (95th Percentile) Flow: 0.244 MGD (169 gpm)
- Design Maximum flow for MBBR: 0.382 MGD (265 gpm)

$$HRT(hrs) = \frac{Tank\ Volume\ (gal)}{Q\ (MGD) * 10^6\ (\frac{gal}{MG})} * 24\ (\frac{hr}{d})$$

Where:

$$Q = MBBR\ Influent\ Flow\ Rate\ (MGD)$$

$Tank\ Volume = 54{,}700\ gallons$

$10^6\ = Conversion\ from\ MG\ to\ gal.$

$24\ = Conversion\ from\ days\ to\ hours$

Giving:

$$HRT_{ave.}\ (hrs) = \frac{54{,}700\ gallons}{0.205\ MGD * 10^6} * 24$$

$$HRT_{ave.}\ (hrs) = 6.40$$

$$HRT_{peak}\ \ (hrs) = \frac{54{,}700\ gallons}{0.244\ MGD * 10^6} * 24$$

$$HRT_{peak}\ \ (hrs) = 5.38$$

$$HRT_{Design\ Max.}\ (hrs) = \frac{54{,}700\ gallons}{0.382\ MGD * 10^6} * 24$$

$$HRT_{Design\ Max.}\ (hrs) = 3.44$$

The treatment system is designed to produce a combined effluent discharge that is 80% or less of the permit limitations under both average and peak loading conditions. This includes loading distributed evenly over 24 hours and most of the loading (75%) hitting the MBBR over a minimum of 8 hours. Refer to WWW's design cases in Appendix E for more details on loading cases and aeration design (blower and diffuser manifold sizing).

Caution If flow to the MBBR exceeds the design maximum, the BOD removal efficiency in the MBBR will be temporarily reduced because there will be insufficient HRT for organics treatment.

2.3.4.1 Nutrient Addition

Nutrient addition of ammonia nitrogen (NH_3-N) and phosphate phosphorus (PO_4-P) to the MBBR will be performed continuously when there is flow to the MBBR. The step-by-step process for calculating the required dose rate and chemical pump feed flow is summarized below. An Excel calculator for nutrient addition is provided by WWW. A PDF is included as Appendix G.

1. Test Primary DAF Effluent COD or BOD concentration. The approximate ratio of COD to BOD in the Primary DAF effluent is 2:1. **The chemical dosing ratio for BOD is 100:5:1 – BOD removed: Nitrogen: Phosphorous.** Nitrogen in this form is represented at NH3-N (Ammonia-N) while the phosphorus is represented as PO4-P (Orthophosphate-P). **The ratio for COD is 200:5:1 – COD removed: Nitrogen: Phosphorous.** WWW's calculation spreadsheet assumes that COD will be used to set the nutrient dosing.
2. Values for Influent BOD, MBBR effluent soluble BOD, MBBR effluent solution COD and influent nitrogen and phosphorus concentrations can also be added if available to refine the dosing calculations. If not, use spreadsheet defaults.

3. Use the spreadsheet to calculate the target mg/L of Nitrogen (N) and Phosphorus (P) required and flowrates for ammonium hydroxide and acid based on their chemical properties.

   The calculations below walk through example calculations assuming:

   - MBBR Influent Flow = 142 gpm (0.205 MGD)
   - MBBR Influent COD = 658 mg/L
   - MBBR Influent N and P = 0 mg/L
   - MBBR Effluent Soluble COD = 100 mg/L
   - MBBR Effluent Soluble BOD = 40 mg/L
   - MBBR Effluent Residual P = 2 mg/L
   - MBBR Effluent Residual N = 4 mg/L

   $$Total\ BOD_{MBBR\ Inf.}(\frac{mg}{L}) = \frac{658}{2}$$

   $$Total\ BOD_{MBBR\ Inf.}\left(\frac{mg}{L}\right) = 329$$

4. Calculate required nutrient dose in mg/L

   $$P_{req.}(mg/L) = \frac{\frac{Influent\ COD - Effluent\ Soluble\ COD}{200\frac{mg}{L}COD}}{1\frac{mg}{L}P} \text{-}(Influent\ P + Effluent\ Residual\ P)$$

   $$P_{req.}(mg/L) = \frac{\frac{658-100}{200\frac{mg}{L}COD}}{1\frac{mg}{L}P} \text{-}(0 + 2)$$

   $$P_{req.}(mg/L) = 4.8$$

   $$N_{req.}(mg/L) = \frac{\frac{Influent\ COD - Effluent\ Soluble\ COD}{200\frac{mg}{L}COD}}{5\frac{mg}{L}N} \text{-}(Influent\ N + Effluent\ Residual\ N)$$

   $$N_{req.}(mg/L) = \frac{\frac{658-100}{200\frac{mg}{L}COD}}{5\frac{mg}{L}N} \text{-}(0 + 4)$$

   $$N_{req.}(mg/L) = 18$$

5. Calculate the flowrates of 29% aqua ammonia and 75% phosphoric acid required in gallons per day:

   <u>75% Phosphoric Acid (H_3PO_4) w/ specific gravity of 1.63</u>

   $$P_{req.}(lb/d) = 4.8\frac{\mathrm{mg}}{\mathrm{L}} * 0.205\ MGD * 8.34 = 8.2\ lb/d$$

   $$75\%\ \mathrm{H3PO4}\ (gpd) = 8.2\frac{\mathrm{lb}}{\mathrm{d}} * \left(\frac{99\frac{g}{mol}\mathrm{H3PO4}}{32\frac{g}{mol}\ P}\right) * \left(\frac{1}{8.34 * 1.63}\right) * \left(\frac{1}{0.75}\right) = 2.5$$

   <u>29% Ammonium Hydroxide (NH_4OH) w/ specific gravity of 0.897</u>

$$N_{req.}(lb/d) = 18\frac{\text{mg}}{\text{L}} * 0.205\ MGD * 8.34 = \ 30.8\ lb/d$$

$$29\%\ NH_4OH\ (gpd) = 30.8\frac{\text{lb}}{\text{d}} * \left(\frac{35\frac{g}{mol}NH_4OH}{14\frac{g}{mol}\ N}\right) * \left(\frac{1}{8.34 * 0.897}\right) * \left(\frac{1}{0.29}\right) = \ 35$$

The nutrient dosage rates calculated above are intended as an example of how initial flowrates would be calculated for the chemical feed pumps. Following startup, Primary DAF effluent and MBBR effluent residual N & P concentrations should be monitored and integrated with the nutrient dosage calculation spreadsheet provided by WWW (Appendix G) for calibration & fine tuning.

2.3.5 Operations

This section summarizes the operational procedures for running the MBBR System and references information and procedures provided by the following vendors O&M Manuals and drawings: World Water Works (Appendix F), Tank Connection (Appendix H), Aerzen (Appendix I), the manual does not supersede the information in these manuals and they should be consulted directly prior to starting and operating the system or attempting to perform maintenance. The alarms, setpoints, control description details, and interlocks for the WWTP (excluding those within individual vendor control systems) are included in the Control Narrative (Appendix C), Setpoint and Range List (Appendix B), and OIT Description (Appendix D).

2.3.5.1 Control Panel

All MBBR equipment signals are integrated into the vendor supplied Main Control Panel (MCP). This includes run/fault statuses, VFD statuses, run time, trends, instantaneous readings, and setpoints, as applicable for the Aeration Blowers, Foam Detection Sensor, Level Sensor, High-High Level Switch, Analyzers (i.e., pH/temperature & DO probes), and Air Blast Solenoid Valve. Data received from these instruments is displayed on the OIT and is available for monitoring equipment status, MBBR process health, and to inform adjustment of operator setpoints and mode of operation to maintain stable reactor conditions. For more information on MBBR system controls, refer to the control narrative (Appendix C).

2.3.5.2 System Startup

- The DVF WWTP system typically starts up on Monday mornings at approximately 4 AM and shuts down at 8 AM Friday morning. During the initial startup, the MBBR and Secondary DAF are bypassed, and Primary DAF effluent is recirculated back to the EQ Tank via the Offal Room Wastewater Pit while Primary DAF operation stabilizes.

- The system will startup in bypass mode where the MBBR tank is bypassed temporarily until the Primary DAF performance has stabilized; however, the Primary DAF effluent is still treated in the pH Adjustment Tank and Combined Effluent Tank. This operation is described in the MBBR operation section in more detail. Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) is open and Combined Effluent Discharge to City Control Valve (XV-10505) is closed. Once process wastewater turbidity readings have stabilized and are in-spec (below the setpoint) as measured by the Primary DAF Effluent Trough Turbidity Probe (AE/AIT-10302), XV-10505 will open and XV-10504 will close allowing wastewater to flow to the City. When the DAF Effluent turbidity alarm is no longer active, normal, automatic operation commences. Primary DAF Effluent will flow to the MBBR according to one of the operational modes described in the next section.

2.3.5.3 MBBR Feed Modes

There are three operator-selectable modes of automatic operation which control the feed of wastewater from the Primary DAF Effluent pH Adjustment Tank to the MBBR.

- Production Mode
- Sanitation Mode
- Bypass Mode

Following Primary DAF startup, the MBBR feed mode will default to Production Mode unless the operator selects a different mode of operation. The operator must monitor MBBR operation during both production and sanitation shifts and make adjustments as needed.

2.3.5.3.1 Production Mode

- Production Mode, automatic operation is selected from the OIT screen, or the MBBR system goes into production mode automatically following Primary DAF startup if the operator does not make a selection.
- One of the MBBR Aeration Blowers (B-10401A or B) will ramp up and run at a constant speed (85% - 100%).
- MBBR DO Probe (AE-10402) monitors DO. The target operating range is 2 – 3 mg/L.
- The Primary DAF Effluent Transfer Pumps Discharge Flow Control Valves (FCV-10305 & FCV-10306) modulate, increasing or restricting feed flow to the MBBR, to maintain DO within the desired range. Flowrates up to the MBBR's maximum treatment capacity of 265 gpm can be sent to the MBBR if DO conditions permit.
  - FCV-10305 & FCV-10306 will modulate to restrict flow to the MBBR if MBBR DO is at the low level setpoint (2.0 mg/L) and the blower speed is >97% for 10 minutes. The valves will modulate to maintain a DO setpoint of 2.5 mg/L.
  - FCV-10305 & FCV-10306 will modulate to increase flow to the MBBR if MBBR DO is at the high level setpoint (3.0 mg/L) and the blower speed is <85% for 10 minutes. The valves will modulate to maintain a DO setpoint of 2.5 mg/L.

2.3.5.3.2 Sanitation Mode

- Sanitation Mode, automatic operation is selected from the OIT screen. The operator should switch the operation to sanitation or flow control mode, when the plant changes over from the production to sanitation shift. If not selected by the operator, the system will switch to sanitation mode automatically at the setpoint time.
- The flow to the MBBR will be controlled by an operator adjustable flow set point. The anticipated MBBR feed flow range during sanitation is 0-120 gpm with an initial target of 80 gpm. This is flexible

and will be verified during startup to minimize the potential for impact to the MBBR system from cleaning chemicals which are expected to have low organic loadings.

- DAF Effluent Transfer Pumps Discharge Flow Control Valves (FCV-10305 & FCV-10306) shall modulate open and closed to continuously send the setpoint flow to the MBBR, as measured at the MBBR Feed Flow Meter (FE/FIT-10301).
- One of the MBBR Aeration Blowers (B-10401A or B) will ramp up and down to maintain a DO setpoint between 2 and 3 mg/L, as measured at the MBBR DO Probe (AE-10402).

2.3.5.3.3 Bypass Mode

- Bypass Mode, automatic operation is selected from the OIT screen. In this operating mode, no flow is sent to the MBBR. All flow goes to the Combined Effluent Tank.
- The Primary DAF Effluent Transfer Pumps Discharge Flow Control Valve (FCV-10305) will be Closed, and the Primary DAF Effluent Transfer Pumps Discharge Flow Control Valve (FCV-10306) will be Open.
- MBBR Aeration Blowers (B-10401A or B) will ramp down and run at its minimum speed to maintain mixing.

2.3.5.3.4 Manual Mode

- Manual mode is selected from the OIT screen. Under manual mode, the operator can operate the flow control valves by selecting Hand operation from the screen and entering the desired valve position.

2.3.5.4 Aeration Blowers (B-10401A, B-101401B) and DO

The Aeration Blowers are equipped with VFDs to allow the speed to be adjusted to maintain the DO concentration between 2 and 3 mg/L as measured by AE/AIT-10402. Normal operation is one Blower running (duty); the other operates as standby. The duty blower shall alternate daily and when maintenance is required. The DO probe should be cleaned and calibrated per the manufacturer’s recommendations.

The operator can run the blowers in manual mode by selecting Hand operation from the screen. The blower(s) shall remain running until either shut off or placed into Automatic operation.

2.3.5.5 Aeration Tank pH Control

The Sodium Hydroxide Metering Pump 2 (P-10701B) is operated based on the pH in the Aeration Tank, as measured AE/AIT-10401A. The Primary DAF effluent wastewater is typically acidic. The sodium hydroxide feed will start if the pH drops below 6.9 and run to maintain a pH of 7.0, stopping at 7.3. If pH increases to above 8.3, the high pH alarm is triggered, prompting the operator to investigate and adjust the setpoints in the Primary DAF pH Adjustment Tank. pH probe should be cleaned and calibrated per the manufacturer’s recommendations.

2.3.5.6 Aeration Tank Foam Control

The Aeration Tank is equipped with a foam sensor (LIT-10401) to detect foam and initiate foam control actions. Normal operation of the Defoamer Metering Pump (P-10803) is that the pump runs continuously when the MBBR system is running to send a small dose of defoamer based on the flow into the MBBR, as measured at the MBBR Feed Flow Meter (FE/FIT-10301). If High Foam is detected, as measured at the MBBR Foam Detection Transmitter (LIT-10401) defoamer pump pacing increases until the foam level high alarm has cleared.

The operator can run the defoamer pump in manual mode by selecting Hand Local operation from the screen. The pump shall remain running until either shut off or placed into Automatic Remote operation.

2.3.5.7 MBBR Effluent Sieve Air Scour and DO Air Blast

The Aeration Tank overflow sieve is equipped with an Air Blast Solenoid valve (SV-10401) that can release compressed air through a diffuser header to dislodge biological solids buildup from the sieve.

The Air Blast Solenoid is set to automatically operate for a set number of minutes when the operator pushes the Air Blast software button on the OIT.

Under manual mode, the operator can operate the solenoid valve by selecting Hand operation from the screen and setting the valve to open.

The Aeration Tank DO probe also includes a solenoid valve for compressed air to dislodge biological solids from the probe. This valve is controlled by the analyzer and transmitter. Refer to the vendor IOM manual for additional detail.

2.3.5.8 Ammonium Hydroxide Addition System

The Ammonia Hydroxide feed system provides supplemental nitrogen for biological growth in the MBBR. Under normal conditions Ammonium Hydroxide Metering Pump (P-10801) runs continuously at an operator adjustable setpoint, when there is flow to the MBBR, as measured at the MBBR Feed Flow Meter (FE/FIT-10301).

Under manual mode, the operator can run the pump by selecting Local operation from the screen. The pump shall remain running until either shut off or placed into Remote operation.

INTERLOCK: Ammonium Hydroxide Metering Pump (P-10801) will not run when there is no flow to the MBBR or the MBBR system is in Bypass Mode.

2.3.5.9 Phosphoric Acid Addition System

The Phosphoric Acid feed system provides supplemental phosphorus for biological growth in the MBBR. Under normal conditions Phosphoric Acid Metering Pump (P-10802) runs continuously at an operator adjustable setpoint, when there is flow to the MBBR, as measured at the MBBR Feed Flow Meter (FE/FIT-10301).

Under manual mode, the operator can run the pump by selecting Local operation from the screen. The pump shall remain running until either shut off or placed into Remote operation.

INTERLOCK: Phosphoric Acid Metering Pump (P-10802) will not run when there is no flow to the MBBR or the MBBR system is in Bypass Mode.

2.3.5.10 Supplemental Carbon Addition System

The Supplemental Carbon feed system provides a supplemental carbon source (glycerin) to sustain biological growth over the weekend and during extended shutdowns. The need for supplemental carbon feed during typical weekend shutdowns will be determined during startup; however, supplemental carbon feed is recommended when shutdowns are greater than two days.

Under normal conditions the Supplemental Carbon Metering Pump (P-10804) operation will be operator initiated at the MCP. When initiated, the pump will run to feed 60 lb./d COD to the MBBR during shutdown periods. To achieve this, the pump operates for 30 minutes at full speed (approximately 2 gph) every 4 hours.

Under manual mode, the operator can run the pump by selecting Local operation from the screen. The pump shall remain running until either shut off or placed into Remote operation.

INTERLOCK: Supplemental Carbon Metering Pump (P-10804) will not run when there is flow to the MBBR.

2.3.5.11 System Shutdown

The MBBR System feed will shut down automatically when feed flow to the Primary DAF pH adjustment tank stops. At that point, Primary DAF Effluent Transfer Pumps (P-10301 A&B) will drain TK-10301 to the low level setpoint.

The pumps can be shut down locally by the operator at the OIT. Shutting the pumps down manually and not running them in Auto creates a risk of overflowing TK-10301 at which point the wastewater flows to the ground where it will be captured in site catch basins for conveyance to the Equalization Tank.

Weekend shutdowns typically last from Saturdays at 8 AM through Mondays at 4 AM. During this time, the following systems will continue to operate:

- One of the MBBR Aeration Blowers (B-10401A or B) continues to run to maintain a DO setpoint between 2 and 3 mg/L, as measured at the MBBR DO Probe (AE-10402) and to mix the Aeration Tank.
- The Sodium Hydroxide Metering Pump 2 (P-10701B) operates as needed based on pH Probe AE - 10401A readings to maintain pH in the neutral range.
- Tank instrumentation continues to monitor tank liquid level and foam level. Defoamer Metering Pump (P-10803) will run if the MBBR Foam Detection Transmitter (LIT-10401) high foam level alarm is triggered.

The operator must initiate Supplemental Carbon Metering Pump (P-10804) operation for shutdowns exceeding two days. The need for Supplemental Carbon during typical weekend shutdowns will be determined during startup.

NOTE:	MBBR system monitoring is necessary during weekends and shutdowns to maintain biological health. Operators should conduct basic monitoring and a system walkdown twice daily during weekends and shutdowns, once in the morning, and once at night.

2.3.5.12 Emergency Operation

Emergency operation scenarios and actions are discussed below for this system. The operator should follow the applicable Perdue SOPs and vendor equipment manual instructions when performing any maintenance on the system.

Control Valve Failure

- If either of the Primary DAF Effluent Transfer Pump Discharge Control Valves (FCV-10305 & FCV-10306) fail, a failure alarm will be triggered at the OIT. The operator must investigate the cause of the valve failure.
- FCV-10305, which opens to allow flow to the Aeration Tank, fails CLOSED. FCV-10306, which opens to allow flow to the Combined Effluent Tank, fails OPEN. If either or both valves fail, the MBBR System will operate in Bypass Mode until the situation is resolved. This is a critical situation that must be monitored carefully to ensure compliance with the discharge permit.

Pump Failure

- The Sodium Hydroxide Metering Pump 2 (P-10701B) does not have a failure alarm. An alarm will occur if the pH setpoint is not achieved, as measured at the MBBR pH Probe (AE-10401) after the setpoint time has elapsed. If this alarm occurs, the operator must investigate sodium hydroxide feed system to the Aeration tank.
- The Defoamer Metering Pump (P-10803) does not have a failure alarm. If High Foam is detected, as measured at the MBBR Foam Detection Transmitter (LIT-10401) and doesn’t clear after the setpoint time has elapsed for running the pump at 100% speed, MBBR blower speed will be reduced to minimum speed for mixing MBBR. If this occurs, the operator must investigate the defoamer feed system.
- The remaining chemical feed pumps related to the MBBR system do not have failure alarms. These pumps are the Ammonium Hydroxide Metering Pump (P-10804), Phosphoric Acid Metering Pump (P-10802), and supplemental carbon pump The operator must conduct regular monitoring and maintenance for these pumps to verify that they are operating and feeding chemical to the MBBR system when needed.

Blower Failure

- If the duty blower fails, a failure alarm will be triggered at OIT, the duty blower will shut down, and the standby blower will become the duty blower.

- If both blowers fail, blower failure alarms will be triggered. This is a critical situation since an extended period with no aeration can cause the Aeration Tank biomass to go septic. If the blower(s) are not restored, the operator may have to consider decreasing loading to the Aeration Tank, changing to Bypass Mode operation, or using temporary blowers to provide aeration.

Flow Meter Failure

- If MBBR Feed Flow Meter (FE/FIT-10301) fails, a failure alarm will be triggered at the OIT. If this occurs it is recommended that the MBBR be operated in Bypass mode until the failure is resolved.

Level Indicator Failure

- If the MBBR Foam Detection Transmitter (LIT-10401) fails, a failure alarm will be triggered at the OIT. The backup instrument is MBBR High-High Level Switch (LSHH-10401).
    - If the MBBR High-High Level Switch (LSHH-10401) is triggered the MBBR will default to bypass mode, stopping flow to the MBBR and Primary DAF Effluent Transfer Pumps (P-10302A&B).
- If level instrumentation fails, it's possible that the MBBR may foam over or overflow onto the ground. If this occurs, the overflow will flow to catch basins that convey the wastewater to the EQ tank. **While the wastewater is contained, this is a critical situation, and the operator should immediately investigate and resolve this issue.**

Monitoring Instrumentation Failure

- If MBBR pH (AE-10401) or DO Probe (AE-10402) fail, a failure alarm will be triggered at the OIT.
- The DO Probe will fail to the current position which will allow the blowers to continue aerating the tank at their current set point until the DO probe is restored. Although this may result in the DO increasing above it's set point, it avoids the opposite effect of low DO which is more detrimental to the system.
- If monitoring instrument failures are not addressed promptly, the MBBR may operate outside of the ideal ranges for pH and DO which could be detrimental to treatment performance. The operator should maintain onsite spare probes and work to resolve instrument failures as quickly as possible.

2.4 Secondary DAF System

2.4.1 System Objectives

The primary function of the Secondary DAF is to remove suspended biological solids discharged from the MBBR for TSS compliance of the final effluent discharged to the City. The Secondary DAF is fed by a 6" gravity line connected to the MBBR discharge sieve. The Secondary DAF system includes chemical injection of coagulant (optional, future addition) followed by a static mixer and injection of flocculant (high-weight cationic polymer) to the influent pipe. Chemical types and dosage rates will be adjusted during startup with assistance from DVF's chemical vendor. The influent is then injected with "whitewater" which has been recirculated from the DAF and contains microbubbles of entrained air that "float" solids to the DAF tank surface. The precipitated solids are comprised of biological total suspended solids (TSS), fats oil and grease (FOG), and insoluble (particulate) biological oxygen demand (BOD). Periodic transfers of DAF float to the sludge hopper are performed with a skimming rake. The skimmed solids are then pumped at regular intervals from the sludge hopper to the Secondary DAF Sludge Tank via Secondary DAF Sludge Transfer Pumps, along with settled sludge from the bottom cones of the Secondary DAF on an as-needed basis to prevent solids accumulation on the DAF floor (see Section 2.5). Treated effluent from the Secondary DAF flows via gravity to the combined effluent tank where it combines with neutralized Primary DAF effluent from the Primary DAF Effluent pH Adjustment Tank (see Section 0). Emergency operation scenarios and actions are discussed below for this system. The Sludge Handling System does not include built-in redundancy for major equipment. Critical spare parts shall be maintained onsite to minimize downtime associated with equipment failures. See Appendix M for a list of critical spare parts. The operator should follow the applicable Perdue SOPs and vendor equipment manual instructions when performing any maintenance on the system.

<u>Pump Failure</u>

- A failure alarm will be generated when either of the Secondary DAF Sludge Transfer Pumps DAF Sludge Transfer Pumps (P-10601A&B) are called to run and fail to run for the setpoint duration.
- If Sludge Transfer Pumps (P-10601A) fails to run, sludge will back up in the Secondary DAF sludge hopper triggering the high-level alarm (LSH-10502).
- If Sludge Transfer Pumps (P-10601B) fails to run, sludge will back up in the Secondary DAF Sludge Tank (TK-10601) triggering the high and then high-level level alarms via LIT-10601 and LSH-10601.
- The operator should also check that the air compressor (AC-10901) and Solenoid Valves (SV-10601A&B) if pumps fail to run. If sludge pumps fail to run, this is a critical situation that could cause an overflow of the DAF hopper or Secondary Sludge Tank. The overflow would be to a contained area.
    - Maintain a spare AOD pump onsite and spares per Appendix M. Maintain air compressor spare parts per the manufacturer’s recommendations.

<u>Level Indicator Failure</u>

- If Secondary Sludge Tank Level Indicator (LIT-10601) fails, a failure alarm will be triggered at the OIT. High level switch LSH-10601 is the backup instrument. Running dry for short periods of time is not detrimental to the AOD sludge pumps.
    - Maintain a spare pressure sensor per Appendix M.

2.4.2 System Components

The primary equipment included in the Secondary DAF system is listed in Table 2-5. The main treatment component is the polypropylene DAF tank (DAF-10501). The DAF influent line is equipped with injection ports for coagulant (ferric chloride – future optional) before and high-weight cationic polymer (required) after an inline static mixer (SM-10501). Dissolved air pump (P-10502) recirculates DAF effluent from the overflow chamber and generates “whitewater” through the entrainment of atmospheric air. Air enters the system through the Dissolved Air Feed Solenoid Valve (SV-10501) and Pressure Transmitter (PIT-10501) provides continuous monitoring of the pump discharge pressure. The system generates 5-to-12-micron diameter bubbles at high saturation efficiencies. The Secondary DAF Effluent Chamber is equipped with a Low-level Switch (LSL-10501) which turns off P-10502 if triggered, and a Turbidity Probe (AE-10501) which is used to troubleshoot Secondary DAF Effluent quality, DAF operation, and chemical dosing. A DAF rake (CR-10501) is installed at the tank surface to periodically skim and transfer floated solids to a sludge hopper attached to the apparatus. Signaling from the DAF Sludge Hopper High Level Switch (LSH-10502) will halt operation of CR-10501. DAF Sludge Drain Control Valves (XV-10501 & XV-10502) installed at the bottom of the DAF tank to transfer settled solids to the Secondary DAF Sludge Tank. DAF Instrument Air Pressure Low-Level Switch (PSL-10501) is installed on the unit to alert the operator to low instrument air supply to XV-10501 & XV-10502.

Table 2-5 Secondary DAF System Components

Tag	P&ID	Description	Capacity/Size
DAF-10501	P-105	Secondary DAF Unit	6,800 gallons (working volume)
			320 gpm 6’7”x13’10”x10’ (tank exoskeleton)
CR-10501	P-105	Skimmer/DAF Rake	1.5 HP
P-10502	P-105	Secondary DAF Dissolved Air Pump	75 gpm @ 60-80 psig

2.4.3 Basic Design Data

The Secondary DAF is designed to operate at a maximum temperature of 170°F and can process up to 320 gpm at TSS loadings up to 2,500 mg/L. The DAF tank is constructed of polypropylene. Interior lamella plates installed on the interior of the tank provide additional surface area to improve solids settling and floating. Detailed design information on the DAF and ancillary components, keys to optimum efficiency, and jar testing procedure (to optimize chemical dosing) can be found in WWW’s Ideal DAF Manual (Appendix J).

Caution While the DAF can process up to 320 gpm, it is recommended that flow to the DAF remain below the MBBR design maximum of 265 gpm.

2.4.4 Operations

This section summarizes the operational procedures for running the Secondary DAF System and references information and procedures provided by WWW in their Ideal DAF Manual (Appendix J). This manual does not supersede the information in WWW’s document, it should be consulted directly prior to starting and operating the system or attempting to perform maintenance.

2.4.4.1 Control Panel

All Secondary DAF equipment signals are integrated into the vendor supplied Main Control Panel (MCP). This includes run/fault statuses, VFD statuses, run time, trends, instantaneous readings, and setpoints, as applicable for the Dissolved Air Pump, Pressure Transmitter, Dissolved Air Feed Solenoid Valve, Dissolved Air Pump, DAF Effluent Chamber Low-Level Switch & Turbidity Probe, DAF Rake, DAF Sludge Hopper High-Level Switch, DAF Sludge Drain Control Valves, and DAF Instrument Air Pressure Low-Level Switch. Data received from these instruments is displayed on the OIT and is available for monitoring equipment status and to inform adjustment of operator setpoints and mode of operation to maintain optimal treatment conditions. For more information on MBBR system controls, refer to the control narrative (Appendix C).

2.4.4.2 System Startup

Once the level in the MBBR has reached the discharge sieve, effluent flows by gravity to the Secondary DAF. The coagulant (optional) and flocculent are injected into the pipeline between the MBBR and the Secondary DAF at the dose specified in the OIT. The Dissolved Air Pump starts, and the DAF enters normal, automatic operation when the level in the DAF overflow chamber exceeds the low-level switch (LSL-10501). DAF components will start and stop as necessary with the influent feed water as long as they are in Automatic mode.

Upon first startup and after extended shutdown, the operator shall reference WWW's commissioning plan (Appendix K) for startup setpoints for the DAF equipment.

2.4.4.3 Normal Operation

- Normal automatic operation is selected from the OIT screen.
- Under normal conditions the Polymer Metering Pump (P-10704) will be flow paced based on the flow into the DAF, as measured at the MBBR Feed Flow Meter (FE/FIT-10301). The polymer dose is an operator adjustable setpoint. Routine jar testing is recommended to check polymer dose.
- Under normal conditions, the Dissolved Air Feed Solenoid Valve (SV-10501) shall remain closed until the dissolved air pump discharge pressure is within the setpoint range, as measured at the Dissolved Air Pump Discharge Pressure Transmitter (PIT-10501). Note, check that the manual air injection throttling valve is properly adjusted to achieve the airflow setpoint established during startup.
- The Dissolved Air Pump (P-10502) will start once the water level in the DAF effluent overflow chamber is above the Low-Level condition (Effluent Chamber Low Level Switch LSL-10501) AND flow is detected at MBBR feed flow meter (FE-10301).
    - INTERLOCK: DAF Effluent Chamber Low Level alarm, as measured at the DAF Effluent Chamber Low Level Switch (LSL-10501), will turn OFF the Dissolved Air Pump (P-10502).
    - Dissolved Air Pump Discharge High Pressure alarm, as measured at the Dissolved Air Pump Discharge Pressure Transmitter (PIT-10501) will Close the Dissolved Air Feed Solenoid Valve (SV-10501) and will turn OFF the Dissolved Air Pump (P-10502).
    - Dissolved Air Pump Discharge Low Pressure alarm, as measured at the Dissolved Air Pump Discharge Pressure Transmitter (PIT-10501) will Close the Dissolved Air Feed Solenoid Valve (SV-10501) and will turn OFF the Dissolved Air Pump (P-10502).
- Under normal conditions the DAF Rake (R-10501) will operate at an operator adjustable speed setpoint based on the OFF and RUN timer settings. Note, the DAF effluent weirs, rake OFF/RUN timer settings, and speed settings should be adjusted to achieve the sludge layer thickness setpoint established during startup.
    - INTERLOCK: DAF Sludge Hopper High Level alarm, as measured at the DAF Sludge Hopper High Level Switch (LSH-10502), will turn OFF the DAF Rake (R-10501).
- The DAF Sludge Drain Control Valve 1 (XV-10501) will operate at an operator adjustable speed setpoint based on the OFF and RUN timer settings. Once the DAF Sludge Drain Control Valve 1

(XV-10501) completes its open sequence, DAF Sludge Drain Control Valve 2 (XV-10502) will follow the same sequencing.

  - INTERLOCK: Secondary DAF Sludge Tank High-High Level alarm, as measured at the Secondary DAF Sludge Tank High-High Level Switch (LSHH-10601), will prevent the DAF Sludge Drain Control Valves (XV-10501 & XV-10502) from opening.

- The control system will provide continuous display of the turbidity (AE-10501) in the DAF Effluent Chamber. An alarm for DAF Effluent Chamber High Turbidity, as measured at the DAF Effluent Chamber Turbidity Probe (AE-10501) is an indicator of solids removal performances prompts the operator to investigate the cause(s) of deteriorating quality.
- Solenoid Valve SV-10601A controls the flow of air to Secondary DAF Sludge Transfer Pump P-10601A. The solenoid valve opens automatically when rake is on, or bottom cone valve opens. After the rake stops running there is a timer for additional pumping to help clear the sludge line. See Section 2.5 for additional detail on the sludge handling system.
- The control system will monitor the status of the DAF Instrument Air Pressure Low Level Switch (LSL-10501) which will be set to alarm at the Instrument Air Low Pressure setpoint.

The operator shall routinely check the following per WWW DAF Manual (Appendix J) and complete system log sheets each shift (Appendix L):

- Solids Blanket
- Dissolved air pump pressure, vacuum, and air flow settings
- Check for proper operation of the feed chemicals
- Check for proper dosage of the feed chemicals, conduct routine jar testing to optimize chemical addition and solids removal.

This will help the operators troubleshoot treatment issues in the future and provide daily information to each shift.

2.4.4.4 System Shutdown

Normal automatic shutdown of the Secondary DAF system will occur when DAF Effluent Chamber Low Level alarm, as measured at the DAF Effluent Chamber Low Level Switch (LSL-10501) is triggered. This turns OFF the Dissolved Air Pump (P-10502). Upon automatic shutdown, the top skimmer will activate for the “On” time as set on the control panel. This will help prevent the solids build up on the DAF unit.

For long term shutdowns exceeding the typical weekend shutdown, WWW recommends putting the components in the “Off” positions on the panel and draining the DAF system.

2.4.4.5 Alternative Operation

Components of the DAF System may be operated manually. If maintenance is to be performed, appropriate lock-out/tag-out procedures should be followed.

- For the DAF Rake (R-10501) and Dissolved Air Pump (P-10502) Manual mode is selected from the OIT screen. Under manual mode, the operator can operate the equipment by selecting Hand operation from the screen. The equipment will remain running until shut off or placed into Automatic operation.
- Dissolved Air Feed Solenoid Valve (SV-10501), Sludge Transfer Pump Solenoid Valves (SV-10601A), and DAF Sludge Drain Control Valves (XV-10501 & XV-10502), Manual mode is selected from the OIT screen. Under manual mode, the operator can operate the valves by selecting Hand operation from the screen.

2.4.4.6 Emergency Operation

Emergency operation scenarios and actions are discussed below for this system. The Secondary DAF does not include redundancy for major equipment. Critical spare parts shall be maintained onsite to minimize downtime associated with equipment failures. See Appendix M for a list of critical spare parts. The operator should follow the applicable Perdue SOPs and vendor equipment manual instructions when performing any maintenance on the system.

<u>Control Valve Failure</u>

- If DAF Sludge Drain Control Valves (XV-10501 or XV-10502) fail to open or close as commanded, a failure alarm will be triggered at the OIT. The operator must investigate the cause of the valve failure. Secondary DAF Sludge Tank High-High Level alarm, as measured at the Secondary DAF Sludge Tank High-High Level Switch (LSHH-10601), prevents the DAF Sludge Drain Control Valves (XV-10501 & XV-10502) from opening.

- FCV-10305, which opens to allow flow to the Aeration Tank, fails CLOSED. FCV-10306, which opens to allow flow to the Combined Effluent Tank, fails OPEN. If either or both valves fail, the MBBR System will operate in Bypass Mode until the situation is resolved. This is a critical situation that must be monitored carefully to ensure compliance with the discharge permit.

<u>Pump Failure</u>

- The Polymer Feed System (P-10701B) does not have a failure alarm. An alarm will occur if the dilution water pressure is low as measured by Pressure Switch PS-10701 or if the peristaltic pump (P-10704) tubing fails. A turbidity alarm will be triggered at the DAF Effluent Turbidity Analyzer (AE-10501) if DAF solids removal performance has deteriorated. If this alarm is triggered, the operator must troubleshoot the chemical feed system and conduct jar testing as appropriate.
- If Dissolved Air Pump (P-10502) fails to run when called to run, a failure alarm will be triggered at the OIT.
    - This is a critical situation that impacts solids removal Performance in the Secondary DAF. The system can be run in Bypass Mode temporarily until the pump is restored. Maintain a set of pump spare parts onsite per Appendix M.

<u>Pressure Indicator Failure</u>

- If Dissolved Air Pump Discharge Pressure Transmitter (PIT-10501) fails, a failure alarm will be triggered at the OIT.

- Maintain a spare pressure transmitter per Appendix M. Manually check pump discharge pressure at PI-10502 to make sure it's within the setpoint range.

Monitoring Instrumentation Failure

- If Secondary DAF Effluent Turbidity Meter (AE-10501) fails, a failure alarm will be triggered at the OIT.
    - Maintain a spare turbidity per Appendix M. Manually check turbidity using a handheld probe, if needed

Rake Failure

- The rake includes an E-Stop pull cords along the length of the DAF. This stops the rake VFD and triggers a notification at the OIT.
- If the DAF Rake (R-10501) fails to run when commanded to run, a failure alarm will be triggered at the OIT.
    - This is a critical situation that impacts solids removal Performance in the Secondary DAF. The system can be run in Bypass Mode temporarily, if needed, until the rake is restored. Maintain a set of spare parts onsite per Appendix M.

2.5 Sludge Handling System

2.5.1 System Objectives

2.5.1.1 Primary DAF Sludge

DVF will continue to operate this pump manually to transfer Primary DAF sludge. Pipe and valves have been added to provide additional options for handling the primary sludge. The Primary DAF sludge can be pumped via a relocated manifold and valves to the following locations:

1) Floor drain near the Secondary DAF Sludge Tank. This floor drain discharges to a catch basin and ultimately to the Offal Room Wastewater Pit. DVF will use this method to decant clear water from the concentrated sludge.

2) The Secondary DAF Sludge Tank (TK-10601) which combines and stores both Primary and Secondary DAF Sludges.

3) To a trailer for offsite disposal.

2.5.1.2 Secondary DAF Sludge

Secondary DAF sludge collects in the Secondary DAF sludge hopper which is located on the south end of the Secondary DAF. The hopper is equipped with a High-Level Switch (LSH-10502). Secondary DAF Sludge Transfer Pump solenoid valve SV-10601A operates on a timer to run Secondary DAF Sludge Transfer Pump (P-10601A) which conveys sludge to the Secondary DAF Sludge Tank (TK-10601) for storage. The Secondary DAF Sludge Tank is a closed top, cone bottom tank constructed of HDPE. A level transmitter (LIT-10601) and High-Level Switch (LSH-10601) are installed on the tank for level indication and alarms. The tank is also equipment with multiple connections for manually decanting sludge supernatant to a floor drain to produce a more concentrated sludge for hauling. The floor drain discharges to a catch basin which flows via gravity to the Offal Room Wastewater Pit. Secondary DAF Sludge Transfer Pump (P-10601B) is operated manually by the operator to pump concentrated sludge from TK-10601 to a closed-top sludge trailer for offsite disposal.

2.5.2 System Components

The primary equipment associated with the Sludge Handling System is listed in Table 2-6. Refer to the P&IDs provided in Appendix A for system details including piping, valves, and instrumentation. WWW O&M Manual included in Appendix J and the Manufacturer's AOD Pump Manual provide more information.

Table 2-6 Secondary DAF Sludge Handling System Components

Tag	P&ID	Description	Capacity/Size
P-10601A P-10601B	P-106	Secondary DAF Sludge Transfer Pump	225 gpm @ 35 PSI225 (100 PSI inlet air)
TK-10601	P-106	Secondary DAF Sludge Tank	6,000 gal. (working volume) 8.5 ft. ϕ x 14 ft ht.
None Assigned	P-106	Primary DAF Sludge Transfer Pump (Relocated)	Existing

2.5.3 Basic Design Data

Secondary DAF Sludge is estimated to be 3-4% dry solids. Under average MBBR loading, about 2,000 GPD of 3-4% solids Secondary DAF Sludge is generated. Under sustained 95th percentile (peak) loading to the MBBR, up to 2,900 GPD of 3-4% solids Secondary DAF Sludge could be generated.

The Secondary DAF Sludge Tank (6,000-gallon) provides a 3-day retention time to store average MBBR solids generation and 2-day retention time to store peak MBBR solids generation. If the Primary Sludge is added to the tank, available retention time will be less. The operation may be able to increase retention time by regularly decanting the sludge supernatant as it separates in the holding tank.

Primary DAF sludge generation ranges from an average of 3,000 gpd to 5,000 gpd for peak conditions. The sludge hauling trailers have a capacity of 7,840 gallons and sludge is typically generated 5 days per week. The combined Primary and Secondary DAF sludge disposal rates are expected to increase to 3 trailers per week on average and 5 trailers per week for peak conditions.

2.5.4 Operations

This section summarizes the operational procedures for the Sludge Handling System and references information and procedures provided by WWW in their Ideal DAF Manual (Appendix J). This manual does not supersede the information in WWW's document, it should be consulted directly, along with the manufacturer's manuals for individual equipment shall be consulted prior to operating the system or attempting to perform maintenance.

2.5.4.1 Control Panel

Sludge Handling System equipment signals are integrated into the vendor supplied Main Control Panel (MCP). This includes run/fault statuses, run time, trends, instantaneous readings, and setpoints, as applicable for the Secondary DAF Sludge Transfer Pumps, Secondary DAF Sludge Transfer Pump Solenoid Valves, and

Secondary DAF Sludge Tank Level Transmitter & High-High Level Switch. Data received from these instruments is displayed on the OIT to inform operator adjustment of setpoints and alarm when manual pump out of the holding tank is required. For more information on Sludge Collection & Transport System controls, refer to the control narrative (Appendix C).

2.5.4.2 System Startup

There are no specific startup procedures for the Sludge Handling System beyond what is required for commissioning and initially configuring the system. Upon first startup and after extended shutdown, the operator shall reference WWW's commissioning plan (Appendix K) for startup setpoints for the DAF equipment.

When the Secondary DAF starts up, Secondary DAF Sludge Transfer Pump Solenoid Valve (SV-10601A) opens on a timer and Secondary DAF Sludge Transfer Pump (P-10901A) will run. Specifically, this pump operates for a setpoint time when either the rake is operating, or when one of the bottom cone valves is open to transfer sludge to TK-10601.

Decanting sludge supernatant from TK-10601, pumping to the sludge trailer using DAF Sludge Transfer Pump (P-10601B), and operating the Primary DAF Sludge Pump are manual procedures. The operator should check that all compressed airlines are connected and that pump solenoid valves are operating correctly prior to using the pumps. The operator should monitor levels in the Primary DAF Sludge Tank and Secondary DAF Sludge Tank regularly.

2.5.4.3 Normal Operation

- Normal automatic operation is selected from the OIT screen.
- When the Secondary DAF is running in automatic, the Secondary DAF Sludge Transfer Pump Solenoid Valve (SV-10601A) opens on a timer and Secondary DAF Sludge Transfer Pump (P-10901A) will operate for a setpoint time when either the rake is operating, or when one of the bottom cone valves is open to transfer sludge to TK-10601.
- The secondary DAF Sludge Hopper High Level Switch (LSH-10502) alerts the operator to high level in the hopper, but it does not automatically operate the pump. If this alarm occurs, the operator should perform troubleshooting and adjust the time setpoints, as needed, to run the pump for longer.
- The Secondary DAF Sludge Tank (TK-10601) level transmitter (LIT-10601) monitors and displays tank level at the OIT. The control system will also monitor the status of the Secondary DAF Sludge Tank High-High Level Switch (LSHH-10601). The control system will provide the following operator adjustable set points:
    - Alarm for Secondary DAF Sludge Tank High Level, as measured at the Secondary DAF Sludge Tank Transmitter (LIT-10601), when the corresponding tank level is equal to or greater than the set point. When this alarm occurs, the operator must respond by manually performing the sludge tank decant procedure and pumping concentrated sludge to the sludge trailer.
    - INTERLOCK: Secondary DAF Sludge Tank High-High Level alarm, as measured at the Secondary DAF Sludge Tank High-High Level Switch (LSHH-10601), will shut the Secondary

DAF Sludge Transfer Pump Solenoid Valves (SV-10601A) and prevent DAF Sludge Transfer Pump P-10601A from overfilling the tank.

  - INTERLOCK: Secondary DAF Sludge Tank High-High Level alarm, as measured at the Secondary DAF Sludge Tank High-High Level Switch (LSHH-10601), will prevent the DAF Sludge Drain Control Valves (XV-10501 & XV-10502) from opening and Rake from running.
  - INTERLOCK: Secondary DAF Sludge Tank Low-Low Level alarm, as measured at the Secondary DAF Sludge Tank Level Transmitter (LIT-10601), will shut the Secondary DAF Sludge Transfer Pump Solenoid Valves (SV-10601B).

- Emptying the Secondary DAF Sludge Tank is operator-initiated and must occur when the Tank High Level alarm is triggered or before. The following steps should be followed:
  - Decant sludge supernatant from the tank using two manual valves (V200-10621 & V200-10622) located on the side of the tank.
  - Open the top valve (V200-10621) to drain supernatant to a floor drain through the clear PVC spool piece until concentrated sludge is visible.
  - Once concentrated sludge is visible, close the valve, open lower valve (V200-10622) to drain supernatant to a floor drain through the clear PVC spool piece until concentrated sludge is visible. Close the valve.
  - Check that manual valves are appropriately adjusted to pump sludge to the trailer using Secondary DAF Sludge Transfer Pump P-10601B.
  - Operate Secondary DAF Sludge Pump (P-10601B) from the OIT. The pump will shut down automatically (SV-10601B closes) when the tank reaches the Low-Low level setpoint.
    - It is recommended that an operator be present near the sludge tank for the duration of sludge transfer to the Tanker.
- The procedure for manually emptying the Primary DAF sludge tank remains unchanged; however, the operator has the option to transfer the sludge to Secondary DAF Sludge Tank (TK-10601).

2.5.4.4 System Shutdown

DAF Sludge Tank Low-Low Level alarm, as measured at the Secondary DAF Sludge Tank Level Transmitter (LIT-10601), will shut the Secondary DAF Sludge Transfer Pump Solenoid Valves (SV-10601B).

When the Secondary DAF system shuts down, there is an additional clean up timer that runs Secondary DAF Sludge Transfer Pump P-10601A to clear sludge from the hopper and piping. This timer is programmed by WWW and is not operator adjustable.

If the Sludge Handling System shuts down for longer than a weekend, the tank should be fully emptied and the drain pipe located at the base of the tank should be flushed out using the available hose connection and manual valve.

2.5.4.5 Alternative Operation

Components of the Sludge Handling System may be operated manually. If maintenance is to be performed, appropriate lock-out/tag-out procedures should be followed.

- DAF Sludge Transfer Pumps (P-10601A&B) can be operated manually via Secondary DAF Sludge Transfer Pumps Solenoid Valves (SV-10601A&B). Manual mode is selected from the OIT screen. Under manual mode, the operator can run the pumps by selecting Hand operation from the screen. The pump shall remain running until either shut off or placed into Automatic operation.

2.5.4.6 Emergency Operation

Emergency operation scenarios and actions are discussed below for this system. The Sludge Handling System does not include built-in redundancy for major equipment. Critical spare parts shall be maintained onsite to minimize downtime associated with equipment failures. See Appendix M for a list of critical spare parts. The operator should follow the applicable Perdue SOPs and vendor equipment manual instructions when performing any maintenance on the system.

<u>Pump Failure</u>

- A failure alarm will be generated when either of the Secondary DAF Sludge Transfer Pumps DAF Sludge Transfer Pumps (P-10601A&B) are called to run and fail to run for the setpoint duration.
- If Sludge Transfer Pumps (P-10601A) fails to run, sludge will back up in the Secondary DAF sludge hopper triggering the high-level alarm (LSH-10502).
- If Sludge Transfer Pumps (P-10601B) fails to run, sludge will back up in the Secondary DAF Sludge Tank (TK-10601) triggering the high and then high-level level alarms via LIT-10601 and LSH-10601.
- The operator should also check that the air compressor (AC-10901) and Solenoid Valves (SV-10601A&B) if pumps fail to run. If sludge pumps fail to run, this is a critical situation that could cause an overflow of the DAF hopper or Secondary Sludge Tank. The overflow would be to a contained area.
    - o Maintain a spare AOD pump onsite and spares per Appendix M. Maintain air compressor spare parts per the manufacturer's recommendations.

<u>Level Indicator Failure</u>

- If Secondary Sludge Tank Level Indicator (LIT-10601) fails, a failure alarm will be triggered at the OIT. High level switch LSH-10601 is the backup instrument. Running dry for short periods of time is not detrimental to the AOD sludge pumps.
    - o Maintain a spare pressure sensor per Appendix M.

2.6 Combined Effluent Tank System

2.6.1 System Objectives

From the Primary DAF Effluent pH Adjustment System, all process wastewater flows to the Combined Effluent Tank (TK-10501), or it is split with approximately 55% of flow being sent to the MBBR and Secondary DAF systems depending on the MBBR operation. This is described in 2.3.5.3. Neutralized effluent from the

Primary DAF Effluent pH Adjustment Tank (TK-10301) combines with Secondary DAF Effluent in the Combined Effluent Tank. The Combined Effluent Tank is equipped with a level transmitter (LIT-10501) along with both High-High and Low-Low Level Switches (LSHH-10503 & LSLL-10503) for tank level measurement. Combined Effluent Pumps (P-10501A&B) convey the combined effluent from TK-10501 to the City or back to the Offal Room Wastewater Pit using control valves. Control Valve XV-10504 opens to convey wastewater to the Offal Room Wastewater Pit. Control Valve XV-10505 opens to discharge wastewater to the City. The effluent is discharged to the pit during Primary DAF startup or if pH is outside of discharge specifications for the City. The pumps operate in a duty/duty-assist configuration. Redundant pH/Temperature Analyzers (AE-10502A&B) monitor final effluent pH prior to discharge. Flow Meter (FE/FIT-10501) monitors the effluent flow to the City.

2.6.2 System Components

The primary equipment associated with the Combined Effluent System is listed in Table 2-7. Refer to the P&IDs provided in Appendix A for system details including piping, valves, and instrumentation. Consult manufacturer's manuals on the operation of the individual system components.

Table 2-7 Effluent Discharge System Components

Tag	P&ID	Description	Capacity/Size
TK-10501	P-105	Combined Effluent Tank	2,900 gal. (working volume) 8.5 ft. ϕ x 9.9 ft ht.
P-10501A P-10501B	P-105	Combined Effluent Pump	500 gpm @ 20' TDH

2.6.3 Basic Design Data

The Combined Effluent Tank is closed-top cylindrical HPDE tank with a working volume of 2,900 gallons and a minimum retention time of about five minutes at the peak design flow of 500 gpm.

The Combined Effluent Pumps are duty/duty-assist, end-suction centrifugal pumps, each with a capacity of 500 gpm at 20 feet TDH. The pumps are operated with VFDs and will be controlled by the Combined Effluent Tank level as measured by LIT-10501.

2.6.4 Operations

This section summarizes the operational procedures for the Combined Effluent System.

2.6.4.1 Control Panel

Combined Effluent System equipment signals are integrated into the vendor supplied Main Control Panel (MCP). This includes run/fault statuses, VFD statuses, run time, trends, instantaneous readings, and setpoints, as applicable for the Combined Effluent Tank Level Transmitter, High-High & Low-Low Level Switches, Combined Effluent Pumps, Analyzers (pH & Temperature Probes), and Control Valves. Data received from these instruments is displayed on the OIT and is available for monitoring equipment status, and to inform adjustment of operator setpoints and mode of operation to maintain effluent discharge in compliance with relevant permit limits. For more information on Combined Effluent System controls, refer to the control narrative (Appendix C).

2.6.4.2 System Startup

The Combined Effluent System will start up with the Primary DAF pH Adjustment System. Specifically, one of the Combined Effluent Pumps (P-10503A or B) will start once the Combined Effluent Pump On Level, as measured at the Combined Effluent Tank Level Transmitter (LIT-10501), is reached. The systems start in bypass mode where the MBBR tank is bypassed temporarily until the Primary DAF performance has stabilized; however, the Primary DAF effluent is still treated in the pH Adjustment Tank and Combined Effluent Tank. This operation is described in the MBBR operation section in more detail. During Primary DAF startup, Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) is open and Combined Effluent Discharge to City Control Valve (XV-10505) is closed. This recirculation of wastewater back to the EQ tank must be monitored carefully by the operator to prevent overflow of the EQ tank. Once process wastewater turbidity readings have stabilized and are in-spec (below the setpoint) as measured by the Primary DAF Effluent Trough Turbidity Probe (AE/AIT-10302), XV-10505 will open and XV-10504 will close allowing wastewater to flow to the City.

2.6.4.3 Normal Operation

- Normal automatic operation is selected from the OIT screen
- The control system will provide continuous display of level in Combined Effluent Tank (TK-10501) using level transmitter (LIT-10501). The control system will also monitor the status of the Combined Effluent Tank High-High and Low-Low Level Switches (LSHH-10503 & LSLL-10503). The control system will provide the following operator adjustable set points:
    - Alarm for Combined Effluent Tank High-High Level, as measured at the Combined Effluent Tank High-High Level Switch (LSHH-10503). This alarm will start the second Combined Effluent Pump (P-10503A or B).
    - Alarm for Combined Effluent Tank High Level, as measured at the Combined Effluent Tank Transmitter (LIT-10501), when the corresponding tank level is equal to or greater than the set point.
    - Combined Effluent Pump On Level, as measured at the Combined Effluent Tank Level Transmitter (LIT-10501), when the corresponding tank level is equal to or greater than the set point.
    - Combined Effluent Pump Off Level, as measured at the Combined Effluent Tank Level Transmitter (LIT-10501), when the corresponding tank level is equal to or less than the set point.
    - Alarm for Combined Effluent Tank Low Level, as measured at the Combined Effluent Tank Level Transmitter (LIT-10501), when the corresponding tank level is equal to or less than the set point.
    - Alarm for Combined Effluent Tank Low-Low Level, as measured at the existing Combined Effluent Tank Low-Low Level Switch (LSLL-10503). This alarm turns OFF the Combined Effluent Pumps (P-10503A&B).
- Combined Effluent Transfer Pumps (P-10501A & B) operate in duty/standby mode. The duty pump will start once the Primary DAF Effluent Transfer Pump On Level, as measured by LIT-10501, is reached. The Primary DAF Effluent Transfer Pumps (P-10501A&B) will stop once the Primary DAF

Effluent Transfer Pump Off Level, as measured by LIT-10301, is reached. The Primary DAF Effluent Transfer Pumps will operate to maintain the adjustable level setpoint as measured by LIT-10501. The VFD speed of the pumps will be adjusted based on the level measured by LIT-10501. The pumps shall alternate daily and when maintenance is required.

- Under normal, automatic operation, Combined Effluent Discharge Control Valve (XV-10505) is open allowing effluent to be discharged to the City and open Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) is closed.
  - INTERLOCK: The Combined Effluent Discharge to Offal Room Pit Valve (XV-10504) can only Open when the level in the existing equalization tank is below the level setpoint.
- Operator can select at the OIT which of the two pH probes (AE-10502A or B) is primary.
  - Effluent Discharge Out of Compliance Alarm, as measured at the Effluent Discharge pH Analyzer Probes (AE-10502A&B), will close Combined Effluent Discharge Control Valve (XV-10505) and open Combined Effluent Discharge to Offal Pit Control Valve (XV-10504) if the effluent is outside the setpoint range of 6.2 to 11 s.u.
- Flow meter (FE/FIT-10501) provides instantaneous flow and the totalized daily flows for the prior 40 days. The totalized flow measurement will be for the period of 00:00 to 23:59.
  - INTERLOCK: Effluent Discharge Low Flow alarm, as measured at the Effluent Discharge Flow Meter (FE/FIT-10501), will turn OFF the Combined Effluent Pumps (P-10503A&B).

2.6.4.4 System Shutdown

When flow to the Combined Effluent Tank stops, typically following the completion of sanitation activities at the close of the production week. The Combined Effluent Pumps will empty the tank to the low level setpoint. The pumps will start pumping again to the City or Offal Pit when the tank begins filling with the start of production and startup of the Primary DAF on Monday morning.

2.6.4.5 Alternative Operation

- The Combined Effluent Transfer Pumps can be operated in manual mode by selecting Local operation from the screen. The equipment shall remain running until either shut off or placed into Remote operation. Shutting the Combined Effluent Transfer pumps down manually and not running them in Auto/remote creates a risk of overflowing the Combined Effluent Tank.
- Combined Effluent Discharge to Secondary Screen Tank Control Valve (XV-10504) and Combined Effluent Discharge Control Valve (XV-10505) can be operated manually. Manual mode is selected from the OIT screen. Under manual mode, the operator can operate the flow control valves by selecting Hand operation from the screen and selecting valves open or closed. (XV-10504) can only Open when the level in the existing equalization tank is below the level setpoint.

2.6.4.6 Emergency Operation

Level Instrument Failure

- If the Combined Effluent Tank level indicator (LIT-10501) fails, a failure alarm will be triggered at the OIT. The backup instruments are High-High Level Switch (LSHH-10501) and Low-Low Level Switch LSLL-10501. LSHH-10501 starts the standby Combined Transfer Pump (P-10501A or B).

- If level instrumentation fails, it's possible that the tank may overflow onto the ground. If this occurs, the overflow will flow to a sump/catch basin that conveys the wastewater to the EQ tank. **While the wastewater is contained, this is a critical situation, and the operator should immediately investigate and resolve this issue.**

Monitoring Instrumentation Failure

- If the Controlling pH probe (AIT-10502A or AIT-10502B) fails, a failure alarm will be triggered at the OIT and the other instrument will become the Controlling instrument. If both pH probes fail, failure alarms will be triggered at the OIT workstation. A deviation alarm will also be triggered if the difference in the instruments' readings exceed the deviation setpoint.
- If monitoring instrument failures are not addressed promptly, the pH leaving the Combined Effluent Tank be outside the range required for discharge compliance. The operator should maintain onsite spare probes and work to resolve instrument failures as quickly as possible.

Pump Failure

- If Combined Effluent Transfer Pump (P-10501A or B) fails to run when called to run, a failure alarm will be triggered at the OIT, the duty pump will shut down, and the standby pump will become the duty pump.
- If both Combined Effluent Transfer Pumps fail, pump failure alarms will be triggered at the OIT.
  - For the Combined Effluent Transfer Pumps, this is a critical situation. If the pump(s) are not restored and operations continue as normal, eventually a high-high level alarm will trigger. If the pump(s) are not restored, the operator may have to consider shutting down the secondary treatment system and manually reverting treatment with the Primary DAF only. This is an emergency operation described in more detail in Section 2.1.2.6.

Control Valve Failure

- If either Combined Effluent Discharge to Secondary Screen Tank Control Valve (XV-10504) or Combined Effluent Discharge Control Valve (XV-10505) fail, a failure alarm will be triggered at the OIT. The operator must investigate the cause of the valve failure.
- XV-10504, which opens to allow flow to the Offal Pit, fails OPEN. XV-10505, which opens to allow flow to the City, fails CLOSED. If either or both valves fail, the system will recirculate wastewater to the EQ tank until the high-level set point is triggered. This is a critical situation that must be monitored carefully to prevent overflowing the EQ tank or violating the discharge permit.

Flow Meter Failure

- If Combined Effluent Flow Meter (FE/FIT-10501) fails, a failure alarm will be triggered at the OIT.

Caution Maintain spare parts as recommended by the equipment manufacturers. These are critical situations which must be responded to promptly to troubleshoot and perform repair and maintenance. Provide proper notice and coordination must be conducted with the City, following all applicable permit requirements, is treatment is interrupted or impacted.

2.7 Chemical Feed & Storage System

2.7.1 System Objectives

Operations and maintenance for the chemical feed systems are largely discussed as part of the unit processes with which they're associated. This section provides an overall summary of the chemical addition and treatment associated with the WWTP and general maintenance and operations activities associated with the chemical feed systems. The operator should periodically monitor the tank levels and order replacement chemicals as the levels begin to run low.

The Chemical Feed & Storage Systems include sodium hydroxide, ferric chloride, phosphoric acid, aqua ammonia, non-silicone based defoamer, cationic polymer and a supplemental carbon source (glycerin).

Sodium hydroxide and ferric chloride are used to neutralize pH in the Primary DAF Effluent pH Adjustment System. Sodium Hydroxide is stored in the existing stacked totes located in the Offal Room (TK-10701) and is distributed with two Feed Pumps (P-1070A&B) which supply the Primary DAF pH Adjustment Tank and MBBR, respectively. Ferric chloride is stored in the Day Tank (TK-10702) located in the Offal Room and is distributed via the Feed Pump (P-10702A) which supplies the Primary DAF pH Adjustment System.

Phosphoric acid and aqua ammonia are used as supplemental nutrients to support biological growth in the MBBR. These chemicals are stored at the south end of the Secondary DAF. Phosphoric Acid is stored in two 55-GAL Drums and Containment (TK-10802) and distributed by a Feed Pump (P-10802) to the MBBR. Aqua Ammonia is stored in two 55-GAL Drums and Containment (TK-10801) and distributed by a Feed Pump (P-10801) to the MBBR.

Defoamer is used in the MBBR system to manage foaming. It is stored in two 55-GAL Drums and Containment (TK-10801) and fed by a Feed Pump (P-10803) to the MBBR on an as-needed basis determined by the MBBR foam level transmitter.

Polymer is used for solids separation in the Secondary DAF. It is stored in two 55-GAL Drums and Containment (TK-10703). From TK-10703, the Polymer AOD Pump (P-10703) conveys neat chemical to an in-line static mixing loop (SM-10701) which blends Polymer with plant water. Once properly mixed, the Polymer Feed Pump (P-10704) conveys diluted polymer to the Secondary DAF. There is an injection point to add ferric chloride as a coagulant to the Secondary DAF influent, but it is not expected to be necessary. A ferric chloride pump can be added in the future if needed. The pump would be located in the Offal Room.

Supplemental carbon (glycerin) can be fed to the MBBR to maintain the biology during plant shutdowns that exceed the weekend. The supplemental carbon is stored in two 55-GAL Drums and Containment (TK-10804) and distributed by a Feed Pump (P-10804) to the MBBR if needed.

2.7.2 System Components

The primary chemical feed systems are listed in the tables of previous sections. A summary of the equipment is listed in Table 2-8. Refer to the P&IDs provided in Appendix A for system details including piping, valves, instrumentation, and equipment.

Table 2-8 Chemical Feed & Storage System Components

Tag	P&ID	Description	Capacity/Size
TK-10701	P-107	Secondary DAF Polymer Spill Containment Pallet	66 gal. (storage volume) *Insert Dimensions*
TK-10801	P-108	Ammonium Hydroxide Spill Containment Pallet	
TK-10802	P-108	Phosphoric Acid Spill Containment Pallet	
TK-10803	P-108	Defoamer Spill Containment Pallet	
TK-10804	P-108	Supplemental Carbon Spill Containment Pallet	
P-10701A P-10701B	P-107	50% Sodium Hydroxide Metering Pump	8 gph @ 60 psig
P-10702A	P-107	Ferric Chloride Metering Pump	
P-10801	P-108	29% Ammonium Hydroxide Metering Pump	4 gph @ 50 psig
P-10802	P-108	85% Phosphoric Acid Metering Pump	2 gpd @ 50 psig
P-10803	P-108	Defoamer Metering Pump	20 gph @ 25 psig
P-10804	P-108	Supplemental Carbon Metering Pump	2 gph @ 50 psig
P-10703	P-107	Polymer Feed AOD Pump	0.5 gpm @ 80 psig
P-10704	P-107	Polymer Feed Peristaltic Pump	0.24 gph @ 65 psig
MX-10710	P-107	DAF Polymer Mixer (Static)	N/A

2.7.3 Basic Design Data

The estimated chemical usage rate ranges are provided in Table 2-9 below.

Table 2-9 Chemical Usage Rates

Chemical	Storage Container	Maximum Volume Stored Onsite	Usage Rate (gpd)
Aqua Ammonia (29%)[1]	55-gallon drums	110 gal	28 to 64
Phosphoric Acid (75%)[2]	55-gallon drums	110 gal	2 to 6
Defoamer (100%)	55-gallon drums	110 gal	2 to 11
Neat Cationic Polymer	55-gallon drums	110 gal	8 to 12
Supplemental Carbon (Glycerin)	55-gallon drums	110 gal	7
Sodium Hydroxide	Existing	Existing	Existing * 1.15
Ferric Chloride	Existing	Existing	Existing * 1.2

[1] Aqua Ammonia addition rate is based on a nutrient demand of 5 lb. nitrogen per 100 lb. BOD
[2] Phosphoric acid addition rate is based on a nutrient demand ratio of 1 lb. phosphorus per 100 lb. BOD.

2.7.4 Operations

Chemical Feed & Storage equipment signals are integrated into the vendor supplied Main Control Panel (MCP) and displayed at the OIT. This includes chemical feed pump runtime, pump enabled status, pump speed settings, and setpoints as applicable Chemical Metering Pumps. Status of the chemical Containment Pallet lead detection switches will also be displayed. Data received from these instruments is displayed on the OIT and is available for monitoring equipment status, and to inform adjustment of operator setpoints and operation. For more information on Chemical Feed & Storage System controls, refer to the control narrative (Appendix C).

2.7.4.1 Storage and Handling

Multiple levels of containment are included for chemical storage. Each drum is stored on a chemical containment pallet with leak detection. Caustic and ferric chloride are stored in the Offal Room which is a contained area. Both the Offal Room and WWTP area are graded and include floor drains that convey leaked material to the Offal Pit and ultimately the EQ tank for treatment and neutralization.

Warning	Proper PPE must be worn when handling any chemical in the WWTP.

Safety Data Sheets (SDS) for each chemical are maintained onsite in the WWTP operator area. The operator should be familiar with the proper use and handling of each chemical.

When there is a need to access any of the chemical feed pumps or tubing the manual drain valves should be used to drain any standing chemical into the appropriate container before performing maintenance. The operator should follow the DVF SOP for conducting chemical feed pump maintenance and consult the manufacturer's manuals.

2.7.4.2 Operator Responsibilities

Chemical feed is controlled by the MCP at the operator adjustable setpoint for pump speed or by analyzer readings (e.g., pH). The chemical storage drums do not include level detection to alert the operator when the vessel reaches low level.

The operator is responsible for visually monitoring the chemical levels and refilling, obtaining additional chemical containers, changing out empty containers, as needed. The operator is also responsible for investigating and rectifying any faults or shutdowns that were triggered due to low chemical tank levels or issues with the chemical feed system equipment. The operator should follow the log sheet, to be completed each shift, by walking down the equipment, including the chemical systems for the WWTP.

2.8 WWTP Area Drains & Catch Basins

The WWTP, exterior dock, and byproduct truck loading areas are contained are contained by curbing and grading and drain through a series of catch basins to the Offal Room Pit for conveyance to the EQ tank. These catch basins receive stormwater, drainage from waste hauling trailers, sludge supernatant, wastewater, and chemicals in the event of leaks or spills. The raised pad and chemical storage buildings are equipped with floor drains and sub slab piping that tie into the catch basin system.

Note The catch basins and floor drains must be regularly inspected and cleaned to prevent backups and the accumulation of standing water.

2.9 Utility Systems (Air, Water, Ventilation)

2.9.1 System Objectives

The utility building that houses the chemical feed and storage system also holds the compressed air and city water distribution systems. The compressed air is generated by Instrument Air Compressor (AC-10901) which flows through Refrigerated Air Dryer (AD-10901) and Desiccant Air Dryer (AD-10902) for the valves and other instruments. Pressure Transmitter (PIT-10901) monitors the instrument air delivery pressure. Instrument air is utilized to actuate pneumatic control valves and run AOD pumps.

The city water supply enters the utility building which houses a water heater expansion tank to provide tempered water to two Safety Eyewash/Shower Stations (EWS-10901 & EWS-10902). One is located on the raised WWTP pad and the other is in the chemical storage building. Each shower is equipped with a Flow Switch (FS-10901 & FS-10902). City water is also fed to hose bibs and the Secondary DAF polymer system which includes a Backflow Preventor (RPZ-10901).

Building heating and ventilation includes an electric unit heater to prevent chemicals from freezing, an exhaust fan, and a combination louver/damper.

2.9.2 System Components

The primary equipment associated with the Utility Systems are listed in Table 2-8 below. Refer to the P&IDs provided in Appendix A for system details including piping, valves, and instrumentation and Plumbing and HVAC drawings provided in Appendix N. Vendor IOM Manuals should be consulted before conducting maintenance on the equipment.

Table 2-10 Utility System Components

Tag	Drawing	Description	Capacity/Size
AC-10901	P-109	Instrument Air Compressor	60 cfm @ 100 psig
AD-10901	P-109	Refrigerated Air Dryer	
AD-10902	P-109	Desiccant Instrument Air Dryer	20 cfm (as per P-201)
EWS-10901 EWS-10902	P-109	Eyewash/Shower Station	80°F @ 25 gpm
HB-1	L-101	Outdoor hose bibs (2)	-
HB-2	L-101	Indoor hose bibs (1)	-
WH-1	L-101	Electric Water Heater and Expansion Tank	119 gal. @ 160°F
EUH-1	H-101	Electric Unit Heater	26 MBH, 650 CFM
L-1	H-101	Louver/Damper	500 CFM
EF-1	H-101	Exhaust Fan	500 CFM

2.9.3 Operations

This section summarizes the operational procedures for the utility systems. Refer to the Manufacturer's IOM Manuals for more information before performing maintenance on any utility system equipment.

2.9.3.1 Control Panel

Some Utility System equipment signals are integrated into the vendor supplied Main Control Panel (MCP). The Instrument Air Compressor and Safety Eyewash/Shower flow switches. For more information on Utility System controls, refer to the control narrative (Appendix C). The building heating and ventilation equipment has separate, independent controls.

2.9.3.2 System Startup

No additional startup procedures are required after successful completion of the commissioning and startup phases.

2.9.3.3 Normal Operation

The air compressor includes an integrated controller and will run as needed at its rated capacity to maintain pressure. The MCP will provide continuous display (PSI) of the pressure of the instrument air using pressure transmitter (PIT-10901) at the OIT. An alarm will be triggered if the pressure is below the low level setpoint or above the high level setpoint alerting the operator to troubleshoot the compressor.

The plant water systems rely on incoming City water flow and pressure. The water heater will operate using its own controls to maintain a set temperature to supply hot water to the tempered water mixing valves for the Safety Shower/Eyewash stations. The stations are equipped with flow switches that alarm when the stations are active. Eyewash Station Flow Switch (FS-10901) alarms for Station EWS-10901. Eyewash Station Flow Switch (FS-10902) alarms when Station EWS-10902 is used.

Note	Safety Shower/Eyewash Stations must be tested periodically.

The heating and ventilation equipment (unit heater, fan, and motorized louver/damper) include a temperature controllers mounted to the wall of the chemical storage building. The louver is interlocked to open when the fan runs. The main purpose of the system is to ventilate the space and prevent the chemicals from freezing.

2.9.3.4 System Shutdown

The air compressor can be shut down and manually isolated using isolation valve V250-10903. Isolation valves have been located to isolate and bypass the dryers as well as for isolation of drop legs to equipment and instruments. Ensure all valves are opened when the system is returned to use.

The City water system can be shut down by closing manual isolation valve V250-10919. Once the system has been isolated, it must be properly drained if pipe fittings, instrumentation, or equipment are disconnected. Ensure that the valve is opened when the system is returned to use.

2.9.3.5 Emergency Operation

Emergency operation scenarios and actions are discussed below for this system.

Pressure Indicator Failure

Instrument air using pressure transmitter (PIT-10901) includes a failure alarm and will alarm for high or low instrument air pressure. This alerts the operator to troubleshoot the compressed air system.

Air Compressor Failure

Maintenance on the air compressor should be performed when the plant is shutdown whenever possible. If the compressor fails when treatment is needed, it is recommended that a temporary means of compressed air, either a rental unit, or temporary tie into another existing air compressor onsite is recommended.

Caution Maintain spare parts as recommended by the equipment manufacturers. These are critical situations which must be responded to promptly to troubleshoot and perform repair and maintenance. Provide proper notice and coordination must be conducted with the City, following all applicable permit requirements, is treatment is interrupted or impacted.

3. PROCESS MONITORING, SAMPLING AND ANALYSIS

3.1 Introduction

Operation and maintenance of the treatment system requires periodic measurements of the operational parameters. A combination of field instruments and laboratory tests are used to monitor and optimize the process. The following section outlines day to day monitoring of the WWTP operations at the Perdue DVF WWTP. Note that this section is meant to outline the recommended onsite sampling for WWTP operation and process control and is not meant to provide all information required for compliance purposes, or any characterization that may be required by waste disposal contractors.

3.2 Process Monitoring

3.2.1 Field Instrumentation

Key process field instruments, their physical locations, and units of displays are listed in Table 3-1. Monitoring parameters are listed for the major system components. This is not intended to be an exhaustive list but is intended to summarize key process monitoring parameters and their locations. Refer to the individual system operations sections of this report, P&IDs, and control narrative for more detail.

Table 3-1 Key Process Field Instruments

Parameter	Units	Tag No.	Location	Monitoring Frequency	Trend
1) Primary DAF Tie-In					
pH	s.u.	AE/AIT-10301	Primary DAF Effluent Trough	Continuous	✓
Turbidity	NTU	AE/AIT-10302	Primary DAF Effluent Trough	Continuous	✓
Tank Liquid Level	inches and %	Unassigned	EQ Tank	Continuous	✓
2) Primary DAF Effluent pH Adjustment System					
Tank Liquid Level	inches or %	LIT-10301	Primary DAF Effluent pH Adjustment Tank	Continuous	
High-High Level	Switch	LS-10301	Primary DAF Effluent pH Adjustment Tank	On/Off	
Low-Low Level	Switch	LS-10302	Primary DAF Effluent pH Adjustment Tank	On/Off	
pH	s.u.	AE-10301A&B	Primary DAF Effluent pH Adjustment Tank	Continuous	✓
MBBR Feed Flow	gpm	FE/FIT-10301	Primary DAF Effluent to MBBR Line (4")	Continuous	✓
3) MBBR System					
Foam Level Detector	inches	LIT-10401	MBBR Tank	Continuous	✓
High-High Level	Switch	LS-10401	MBBR Tank	On/Off	
pH	s.u.	AE-10401	MBBR Tank	Continuous	✓

Parameter	Units	Tag No.	Location	Monitoring Frequency	Trend
Temperature	°C				
DO	ppm	AE-10402	MBBR Tank	Continuous	✓
4) Secondary DAF System					
Pressure	bar	PIT-10501	Dissolved Air Pump Discharge Header	Continuous	✓
Low-Level	Switch	LS-10501	Secondary DAF Tank Effluent Chamber	On/Off	
Turbidity	NTU	AE-10501	Secondary DAF Tank Effluent Chamber	Continuous	✓
High-Level	Switch	LS-10502	Secondary DAF Sludge Hopper	On/Off	
DAF Instrument Air Pressure Low Level	Switch	LSL-10501	Secondary DAF Tank	On/Off	
5) Effluent Discharge					
Tank Liquid Level	inches or %	LIT-10501	Combined Effluent Tank	Continuous	✓
High-High Level	Switch	LSH-10503	Combined Effluent Tank	On/Off	
Low-Low Level	Switch	LSL-10503			
pH	s.u.	AE-10502A&B	Combined Effluent Discharge Pipe to City	Continuous	✓
Temperature	°C				
Flow	gpm	FE/FIT-10501	Combined Effluent Discharge Pipe to City	Continuous	✓
6) Sludge Handling					
Tank Liquid Level	inches or %	LIT-10601	Secondary DAF Sludge Tank	Continuous	✓
High-High Level	Switch	LSHH-10601	Secondary DAF Sludge Tank	On/Off	
7) Chemical Feed Systems					
Leak Detection	Switch	LD-10701	Polymer Drum Containment	On/Off	
Leak Detection	Switch	LD-10804	Supplemental Carbon Drum	On/Off	
Leak Detection	Switch	LD-10803	Defoamer Drum Containment	On/Off	
Leak Detection	Switch	LD-10802	Phosphoric Acid Drum Containment	On/Off	
Leak Detection	Switch	LD-10801	Ammonium Hydroxide Containment	On/Off	
8) Utility Systems					
Pressure	bar	PIT-10901	Utility Building Compressed Air Distribution Line	Continuous	✓
Flow	Switch	FS-10901	Utility Building Eyewash Station	On/Off	
		FS-10902			

3.2.2 Data Trends

A typical data trend is illustrated in Figure 3-1. It is important to note that the screenshot shown is an example of a typical trending screen – the final OIT screen display at the Perdue DVF WWTP may vary from the image shown. The Y-axis units will change when the user selects a variable (in this example, flow). The user can move back and forth in time by using the arrows at the base of the graph.

Figure 3-1 Typical Process Data Trend

3.2.3 Equipment Run Times

The operator can review mechanical equipment run times and number of starts at the OIT via the Pump Running Hours screen depicted below. The operator can reset the runtime after maintenance is complete.

Figure 3-2 Equipment Run Time Screen

Online spare mechanical equipment is automatically rotated each day or can be manually adjusted by the operator.

3.3 Sampling Procedures

WARNING:	Always wear proper PPE when collecting samples (gloves and safety glasses). Use caution when collecting samples from overhead locations such as the MBBR tank overflow. Use a foldable ladder or step stool to access the sample tap.
WARNING:	Samples collected for offsite analysis may contain preservatives. Preservatives may be acids, caustics or other chemicals meant to preserve the state of the sample at the time of collection so that analysis can be completed later. Preservatives, though low in quantity, can be dangerous.

The process water and solids are tested and characterized based on portions or samples of their entire flows. A sample must represent the entire flow to ensure accurate analyses. Collect samples where the flow is turbulent, and the same sampling location should be used consistently. Label all samples with the date, time, sample name, type, and location.

Each test requires a specific sample type, which can fall into one of the following categories: grab, time-proportional composite, flow-proportional composite, or continuous monitoring. Continuous monitoring is performed using in-line monitoring devices such as those discussed in Section 3.2.1

3.3.1 Grab Samples

NOTE:	Collect grab samples in the jar in which they will be analyzed whenever possible to avoid handling the sample multiple times and changing any characteristics of the sample.

Grab samples are used when the test must be completed immediately before the sample has a chance to deteriorate (e.g., pH, temperature, and DO) or when composite sampling is inherently inaccurate (e.g., oily wastewater) or impractical, and when the sample is not expected to vary over time.

Grab sample collection must be consistent. Once established, a grab sample location should remain the same unless there is reason to believe that it no longer provides a representative sample of the entire flow.

3.3.2 Composite Samples

The City of Mount Vernon utilizes a composite sampler at the "Combined Effluent Sewer Manhole" for compliance sampling. Additional composite sampling may be required during commissioning and startup and for the performance test. No additional composite sampling is required for normal, long-term operation; however, operators are still responsible for meeting the reporting requirements outlined in Section 1.4.

3.3.3 Sample Locations

The sample locations are identified in Section 3.4. Additional samples may be taken from other sample ports. Refer to the P&IDs (Appendix A) for sample port locations.

3.4 Process Sampling and Analysis Requirements

Sampling of wastewater between each unit process is necessary for assessing operations and treatment efficiency. Sampling results will help to alert the operator to changing conditions, potential treatment failures, maintenance issues, and the need for operational modifications. The sampling points for process monitoring and sample valves or locations are as follows:

1. Primary DAF Influent (existing sample location in Offal Room)
2. Primary DAF Effluent (V200-10319)
3. MBBR Effluent (MBBR tank overflow sample valve)
4. Secondary DAF Effluent (V200-10507)
5. Secondary DAF Float (Sludge Hopper)
6. Combined Effluent (V200-10510)

Table 3-2 summarizes the sampling parameters and minimum frequency during system startup, biological acclimation period, and performance testing (approximately 3 months) and minimum during long-term operations following full biomass acclimation and the completion of performance testing.

Table 3-2 WWTP Sampling Parameters and Frequency

Parameter	Units	Sample Type	Testing/Monitoring Location and Notes	Minimum Frequency (Startup and approx. 3 months)	Minimum Frequency (Post-Startup)
1) Primary DAF Influent (existing sample location in Offal Room)					
Total COD	mg/L	Grab	Onsite Lab	3/week	As needed
Total BOD	mg/L	Grab	Offsite Lab	3/week	As needed
TSS	mg/L	Grab	Offsite Lab	3/week	As needed
2) Primary DAF Effluent (V200-10319)					
pH	s.u.	Grab	Onsite Lab – portable probe	Daily	1/week
Turbidity	NTU	Grab	Onsite Lab – portable meter	Daily	1/week
Total COD	mg/L	Grab	Onsite Lab	3/week	3x/week
Soluble COD	mg/L	Grab	Onsite Lab	3/week	1/week
Ammonia – N (filtered)	mg/L	Grab	Onsite Lab	3/week	1/week
Reactive Phosphate – P (filtered)	mg/L	Grab	Onsite Lab	3/week	1/week
Soluble BOD	mg/L	Grab	Offsite Lab	3/week	As needed
Total BOD	mg/L	Grab	Offsite Lab	3/week	As needed
TSS	mg/L	Grab	Offsite Lab	3/week	As needed
Oil & Grease	mg/L	Grab	Offsite Lab	1/week	As needed
Alkalinity	mg/L	Grab	Offsite Lab	1/week	As needed
3) MBBR Effluent (MBBR tank overflow sample valve)					
Temp	Deg C	Grab	Onsite Lab – portable probe	Daily	1/week
pH	s.u.	Grab	Onsite Lab – portable meter	Daily	1/week
DO	mg/L	Grab	Onsite Lab – portable probe	3/week	1/week
OUR	mg/L/hr	Grab	Onsite Lab – portable probe	3/week	As needed
OUR_{FED}	mg/L/hr	Grab	Onsite Lab – portable probe	3/week	As needed
Ammonia – N (filtered)	mg/L	Grab	Onsite Lab	3/week	1/week
Reactive Phosphate – P (filtered)	mg/L	Grab	Onsite Lab	3/week	1/week
TSS	mg/L	Grab	Offsite Lab	3/week	As needed
Alkalinity	mg/L	Grab	Offsite Lab	1/week	As needed
Jar Testing	-	Grab	Onsite Lab – to dial in DAF polymer dose	3/week	As needed

Parameter	Units	Sample Type	Testing/Monitoring Location and Notes	Minimum Frequency (Startup and approx. 3 months)	Minimum Frequency (Post-Startup)
3) Secondary DAF Effluent (V200-10507)					
Turbidity	NTU	Grab	Onsite Lab – portable meter	Daily	1/week
TSS	mg/L	Grab	Offsite Lab	3/week	As needed
Total COD	mg/L	Grab	Onsite Lab	3/week	3x/week
Soluble COD	mg/L	Grab	Onsite Lab	3/week	1/week
Total BOD	mg/L	Grab	Offsite Lab	3/week	As needed
Soluble BOD	mg/L	Grab	Offsite Lab	3/week	As needed
TSS	mg/L	Grab	Offsite Lab	3/week	As needed
4) Secondary DAF Float (Sludge Hopper)					
Total Solids	mg/L or %	Grab	Offsite Lab	3/week	Quarterly
5) Combined Effluent Tank (V200-10510) or City Compliance Sample Collected @ Manhole					
Temp	Deg C	Grab	Onsite Lab – portable probe	Daily	1/week
pH	s.u.	Grab	Onsite Lab – portable meter	Daily	1/week
Total COD	mg/L	Grab	Onsite Lab	3/week	3x/week
Soluble COD	mg/L	Grab	Onsite Lab	3/week	1/week
TSS	mg/L	24-hr Composite	Compliance Sample by City	Daily	Daily
Total BOD	mg/L	24-hr Composite	Compliance Sample by City	Daily	Daily
Oil & Grease	mg/L	Grab	Offsite Lab	1/week	Per Permit at Compliance Point

3.5 Process and Analytical Data Collection and Tracking

The operator shall conduct regular process monitoring (once per shift) of instruments included in Table 3-1 at the OIT accompanied by a walk down of the system and verification of field instrument readings. Operators shall fill out a system log sheet each shift. Figure 3-3 provides an example. The full log sheet for DVF is included as Appendix L.

Sample collection and analyses should be performed following the schedule presented in Table 3-2 or as needed to troubleshoot and resolve any process operations issues. Onsite analytical data is to be recorded on the Daily Lab Log Sheet. An example sheet is depicted in Figure 3-4.

OPERATOR LOG SHEET - COMPLETE ONCE PER SHIFT

Date	Time	Operator Initials

Primary DAF Effluent pH Adjustment Tank

pH	Temperature	Tank Level
AE-10301A&B		LIT-10301

MBBR (R-1)

pH	Temp	Dissolved Oxygen	Tank Foam Level	Feed Flow Rate	Yesterday 24-hour Totalized
AE-10401		AE-10402	LIT-10401	FE/FIT-10301	OIT

Secondary DAF

Turbidty	DAF White Water Pressure	DAF Rake On Time	DAF Rake Off Time	DAF Rake Speed	DAF Cones Open Time	DAF Cones Close Time	Sludge Tank Level
AE-10501	OIT	OIT	OIT	CR-10501	AD-10401		LIT-10601

Combined Effluent Tank

pH	Temp	Tank Level	Discharge Flow Rate	Yesterday 24-hour Combined Effluent
AE-10502A&B		LIT-10501	FE/FIT-10501	OIT

Chemical Storage & Transport

Ferric Chloride Pump Speed	pH Adjust. Caustic Pump Speed	MBBR Ammonium Pump Speed	MBBR Phos. Acid Pump Speed	MBBR Anti-Foam Pump Speed	MBBR Caustic Pump Speed	MBBR Supp. Carbon Pump Speed	DAF Polymer Pump
P-10702A	Existing Caustic Feed Pump	P-10801	P-10802	P-10803	P-10701B	P-10804	P-10703

Ammonium Hydroxide Setpoint	Phos. Acid Setpoint	Anti-Foam ON Time	Anti-Foam OFF Time	MBBR Caustic Setpoint	MBBR Supp. Carbon Setpoint	DAF Polymer Setpoint
P-10801	P-10802	P-10803		P-10701B	P-10804	P-10703

Ferric Chloride Tank Level	Caustic Tote Level	Phos. Acid Drum Level	Supp. Carbon Drum Level	Ammonium Drum Level	Anti-Foam Drum Level	DAF Polymer Drum Level
TK-10702	TK-10701	TK-10802	TK-10804	TK-10801	TK01803	TK-10703

NOTES:

Figure 3-3 Example Operator Log Sheet

Results of the system monitoring, onsite lab testing, offsite lab testing, and compliance sampling conducted by the City, shall be inputted into the Process Monitoring EXCEL Spreadsheet on a regular basis to trend key WWTP process parameters (influent waste characteristics, organic loading, treatment performance, nutrient levels, solids production, and final effluent quality) to monitor unit process performance, and overall WWTP performance. The data file should be updated daily and reviewed to verify that all parameters fall within their expected ranges as defined in the EXCEL Spreadsheet. The data are also used to verify performance, plan operations activities (e.g., probe cleaning/calibration, chemical ordering, Aeration Tank solids wasting, and if additional testing is required), and to troubleshoot process performance issues.

DAILY ANALYTICAL LOG SHEET

DATE: ____________

Process Control Samples

Location	Type	Flask #	Reading	Dilution	COD		Reading	Dilution	NH_3-N		Reading	Dilution	PO_4	
Raw Influent	Total	1		*		mg/L								
	Soluble	2												
DAF #1 Effluent	Total	3		*		mg/L								
	Soluble	4		*		mg/L		*		mg/L		*		mg/L
MBBR R-1	Total	5				mg/L								
	Soluble	6		*				*		mg/L		*		mg/L
DAF #2 Effluent	Total	7		*		mg/L								
	Soluble	8						*		mg/L		*		mg/L
Combined Effluent	Total	7		*		mg/L								
	Soluble	8						*		mg/L		*		mg/L

SUGGESTED DILUTIONS: COD (0 - 1,500 mg/L) NO Dilution (2 mL sample, 0 mL DI), 2:1 (1.0 mL sample, 1.0 mL DI)

Ammonia (1 - 12 mg/L) NO Dilution (0.5 mL sample, 0 mL DI) 5:1 (0.1 mL sample, 0.4 mL DI)

Phosphorus (0 - 1.5 mg/L) 4:1 (0.5 mL sample, 1.5 mL DI), 10:1 (0.2 mL sample, 1.8 mL DI) **NOTE - Divide PO4 by 3 to get PO4-P**

Figure 3-4 Example Onsite Lab Log Sheet

3.6 Onsite Analytical Tests

Table 3-3 lists the parameters performed in DVF's onsite laboratory using a Hanna Instruments Photometer and reagent vial sets. Additional information on analytical methods can be found in *Standard Methods for the Examination of Water and Wastewater* (*Standard Methods*) latest edition and the Hanna Instrument's method instructions and Photometer instruction manual.

Table 3-3 Onsite Lab Analyses

Parameter	Units	Analytical Test Method	Range
pH	s.u.	Portable Multi-Parameter Meter	-2 - 20
Temperature	°C		-5 - 105 °C
DO	mg/L		0.00 - 90.0 mg/L
Turbidity	NTU	Portable Meter	-
COD (Total & Soluble)	mg/L	Hanna High Range COD	High Range Vials: 100 – 1,500
		Hanna Low Range COD	Low Range Vials: 0 – 150

Parameter	Units	Analytical Test Method	Range
Reactive Phosphorus – as PO_4	mg/L	Low Range Hanna Reagent Set	0 – 5.0
Ammonia - N	mg/L	Hanna Reagent Set	0 – 3.0

3.6.1 pH Analysis

CAUTION:	The pH probes must be calibrated weekly using fresh pH buffer solutions of 4, 7 and 10. Use fresh solution weekly and do not use buffer solutions beyond their expiration dates. Refer to Section 5.3.2 of this manual and the manufacturer's manual for recommended calibration procedures.
NOTE:	The pH test must be compensated for temperature. The inline and lab sensors include temperature compensation.

The pH is the measurement of the hydrogen ion activity in a sample. The pH scale measures from 0 to 14 standard units, with pH 7 being neutral. A measurement below 7 is considered acidic and a pH above 7 is basic. The pH scale is logarithmic, meaning that a pH of 9 is ten times more alkaline than a pH of 8.

The approved method for measuring pH is Standard Method 4500-H+.

3.6.2 DO Analysis

DO is the available oxygen for biomass consumption. This can be read from the in-situ meter located in the MBBR from the OIT. A handheld meter should be used int the lab to measure DO while conducting oxygen uptake rate (OUR) testing and to verify inline meter readings.

3.6.3 Oxygen Uptake Rate (OUR) and Specific Oxygen Uptake Rate (SOUR) Testing

The oxygen uptake rate (OUR) is the rate at which the biological population that makes up the MBBR Tank mixed liquor consumes oxygen. The more active the bacteria, the higher the oxygen uptake rate will be. OUR indicates overall health of biomass by assessing the amount of DO used over time. Typically, an increase in loading results in an increase in OUR and a decrease in loading results in a decrease in OUR. If influent loading remains the same, a decrease in OUR usually indicates biomass inhibition which may result in an upset system. Thus, OUR provides an important tool to monitor the performance of an aerobic biological treatment system and troubleshoot biomass inhibition. This testing can be conducted in the lab or the field using the handheld DO probe. The procedure to measure OUR in the lab is as follows:

1. Gather required equipment and supplies:
   a) Handheld DO meter and probe. Ensure probe is calibrated and in good operating condition;
   b) Stir plate;
   c) Magnetic stir bar;
   d) BOD bottle;
   e) Oxygen supply such as an aquarium air pump and diffuser stone connected by plastic tubing;
   f) Timer/watch; and
   g) OUR data sheet.

2. Conduct test:

a) Collect a 1 L sample of MBBR Tank mixed liquor and 100 mL of MBBR influent.
b) If the DO of the sample is less than 5 mg/L, aerate using the air pump and diffuser stone.
c) Transfer the sample to a standard BOD bottle (300 mL) containing a magnetic stir bar.
d) Place the bottle on the stir plate and start stirring until a vortex forms in the neck of the bottle.
e) Add 2 mL of influent wastewater if performing a Fed OUR test. No wastewater is required for an Unfed OUR Test.
f) Insert the DO probe into the BOD bottle by sliding it down one side of the neck of the bottle, allowing air to escape from the other side.
g) DO NOT ALLOW AIR TO GET TRAPPED UNDER THE DO PROBE.
h) The DO reading on the meter will rise once the probe is placed in the aerated sample. Once it has reached a peak value, it will begin to drop.
i) Record the DO and the time interval between each reading. Collect a minimum of 4 readings per test. Use the OUR Data sheet to record and analyze the data.
j) Use only the readings measured during the normal (i.e. straight-line portion) respiration zone to calculate the oxygen uptake.
k) Use Excel to plot the mixed liquor DO concentration over time as shown in the example below.

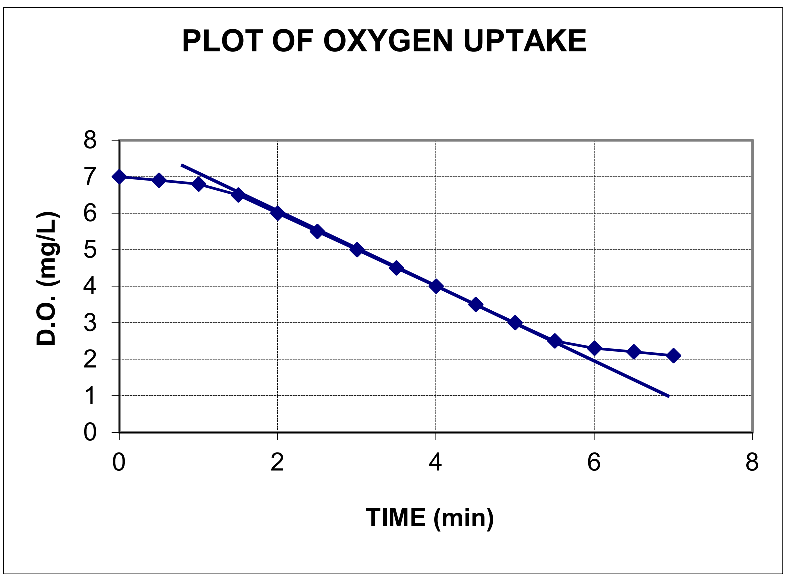

Figure 3-5 Example OUR Plot

1. To calculate OUR select the straight-line portion of the plot and calculate the slope of the straight line. The OUR equals the slope of the straight line of the DO vs. time curve.

$$OUR\,(mg/L-hr)=\left(\frac{DO_A\,(mg/L)-DO_B\,(mg/L)}{Time\,(min)}\times 60\,\frac{min}{hr}\right)$$

The procedure for measuring OUR in the MBBR tank is as follows:

1) Check that the in-situ probe is calibrated and in good operating condition;

2) Verify that the DO level is > 2.0 mg/L at the OIT on DO probe transmitter;

3) Turn off aeration blowers;

4) Record initial DO reading (time = 0 seconds);

5) Record DO readings every 15-30 seconds until the DO level is < 1 mg/L;

6) Turn ON aeration and verify blower operation is returned to auto.

3.6.4 TSS Testing

Total suspended solids and volatile suspended solids are measures of the particulate matter in a wastewater system. Samples are typically grab samples taken from the location of interest.

The approved methods for measuring TSS and VSS are Method 2540 D and 2540 E respectively. The laboratory at Perdue's DVF WWTP does not have the equipment required to measure wastewater solids content in the various forms described above, therefore offsite analysis is utilized for determination of these results.

3.6.5 HANNA Testing

There are several process parameters that utilize the Hanna Instruments for analysis. These parameters include COD, NH_3-N, and Ortho P. The Hanna Instrument relies on spectrophotometry and utilizes premeasured reagents. Refer to the published test procedure to determine test range, sample dilution required, and potential test interferences.

3.7 Process Equipment or Set Point Change

CAUTION	Only change process set points when there is a reason. Justify process changes with analytical data. Make incremental set point changes and limit the changes to 10-15% of the current set point. Monitor process changes over the course of a work shift, as most changes will take 2-4 hours before they begin to take effect. Use online trending when possible.

During startup or following a major process change, more frequent process control testing and observation are required when compared to steady state plant operation. Depending on the nature of the change, one or more of the processes set points may require reevaluation before steady state operation can resume. Performing lab analysis, reviewing trends, and properly interpreting the results are key components of process control monitoring and are necessary for returning a unit process to steady state operation.

Tips for successful process control monitoring and managing process changes are as follows:

- Only change process set points when there is a reason to, and justify process changes with analytical data;
- Make incremental set point changes and limit the changes to 10-15% of the current set point;
- Monitor process changes over the course of your shift, as most changes will take 2-4 hours before they begin to take effect;
- Use process parameter trending to monitor the process; and
- When troubleshooting specific issues, use the guides located in Section 4.2.

Experience will make conducting and implementing process control changes more intuitive. When operating the process, it is important to understand the qualitative operation of the WWTP in addition to collecting the quantitative data. It is important to understand how instantaneous quantitative data compares to historical values through time.

4. TROUBLESHOOTING

4.1 Introduction

This section is intended to be a guide to assist the operator in identifying the proper reference for troubleshooting various processes. This section is not intended to be the sole resource for troubleshooting issues but is meant to point to the appropriate resources for each unit process.

4.2 Process Troubleshooting Guide

WARNING:	Follow Perdue Lockout/Tagout procedures before servicing any electrical equipment.
WARNING:	Follow Perdue Confined Space procedures before entering any tank, sump, or other area in the WWTP that is included in the Confined Space Program.

Table 4-1 presents a troubleshooting guide that will enable the operator to readily identify major problems with the unit processes and determine solutions. It is recommended that the operator also consult the manufacturer's manual for the specific equipment in addition to this guide. Manufacturer O&M manuals for major equipment are included as appendices to this document.

For process performance issues, refer to the process monitoring spreadsheet data to check for normal operating ranges and to identify abnormal conditions. The following troubleshooting guide or Section 2 of this O&M Manual should be used for troubleshooting performance issues once the conditions are identified.

Table 4-1 Process Troubleshooting Guide

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
pH difficult to control or fluctuates	pH Adjustment Tank MBBR Secondary DAF	pH probe not calibrated	Confirm the pH probe readings with the lab pH meter	Calibrate pH probe and plan to do it monthly (or more frequently as required)
				Establish inspection schedule
		pH probe is dirty	Inspect probe for accumulation of scale	Clean scale from pH probe using dilute (5%) solution of hydrochloric acid
		pH probe not positioned correctly in tank/pipe	Relocate probe to area with greater agitation in the tank (if possible)	Check pH with handheld sensor at different locations in the tank
		Acid or caustic feed pipe clogged	Inspect acid or caustic piping and valves	Clean lines and/or valves
		Acid or caustic feed pump failed	Inspect acid or caustic feed pumps	Repair(refer to vendor pump user O&M manual) or replace pump (as needed)
				Do not rely solely on OIT workstation to confirm the acid and caustic pumping rates; observe the pump system operation visually and use calibration column to verify flow rates
		Low level in acid or caustic tank	Check acid or caustic tank levels	Establish replenishment schedule for acid and caustic or revise the current one based on recent consumption history
Low DO	MBBR	High COD loading depleting all available DO Low blower air flow	Check COD and FDS loading rates and other condition trends (e.g., pH, temperature, TSS, etc.) and performance trends (OUR, VSS, COD removal, etc.)	Make any necessary adjustments to operating settings or loading,

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
		Mechanical issue (e.g., plugged aeration line or diffusers)	Verify online DO measurement on MBBR Effluent with portable probe	depending on the results of the evaluation Calibrate DO probe, troubleshoot, or perform maintenance if needed.
			Check blowers for proper operation and make necessary adjustments	Increase blower speed to ensure minimum DO setpoint is met
			Visually check the aeration in the MBBR at top of tank	Start lag blower in Hand if PLC cannot meet DO demands with the lag blower in Auto
			Increase blower speed and check for increased DO	
			Increase DO setpoint and check for increased DO	Clean Aeration Grid (Refer to World Water Works MBBR O&M manual troubleshooting guide for additional guidance.
			Note that changes in airflow may take a while to affect the aerobic system and DO, and that operators should implement these changes slowly.	
High DO	MBBR	Excessive oxygen for the biological load demands	Check COD and FDS loading rates and other condition trends (e.g., pH, temperature, TSS, etc.) and performance trends (OUR, VSS, COD removal, etc.)	Make any necessary adjustments to operating settings or loading, depending on the results of the evaluation
		Declining biomass population	Check blowers for proper operation and make necessary adjustments	Decrease blower speed
		Low COD loading	Decrease airflow to MBBR and check for decreased DO	
			Verify online DO measurement on MBBR Effluent with portable probe	Calibrate DO probe, troubleshoot, or perform maintenance if needed.

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
			Note that changes in airflow may take a while to affect the aerobic system and DO, and that operators should implement these changes slowly.	
		Toxic Substance /Cleaning Agent inhibiting Biomass Growth	Low Endogenous and Fed OUR lab test results	Lower organic loading rate/feed flow rate to MBBR and Monitor OUR test results. Slowly increase loading rate when
			Low Residual Nitrogen and Phosphorous levels in MBBR effluent	Increase Nitrogen and/or Phosphorous chemical loading inline with organic loading
Excessive foam	MBBR	Insufficient or no anti-foam dosing	Visually inspect foam layer for abnormal height, color, and type of foam (small or large bubbles)	Perform regularly inspections of foam layer to familiarize with normal physical characteristics
			Check anti-foam feed system	Initiate (or increase) anti-foam feed rate
			Check performance and loading data	
			Check DO and blower speed for over aeration	Clean anti-foam feed system
		Process upset or shock load (e.g., organics, pH, fixed dissolved solids, toxins)	Collect sample from the MBBR and perform lab tests (i.e., aeration of the sample to simulate foaming) to verify defoamer performance and proper anti-foam dose to control foam	If a process upset has occurred, make necessary adjustments to operating settings or loading, depending on the details of the upset. This may include reducing blower speed to limit foaming if the system is exhibiting high DO values
	MBBR	**Stressed biomass population due to:**	Check related equipment and operating settings, and make necessary adjustments	Make necessary adjustments to operating settings or

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
Declining MBBR biomass OUR and OUR_{FED}		High Organic	Check COD loading rate, and make necessary adjustments	loading, depending on the results of the evaluation
		Introduction of a new/different waste stream or toxic compound	Review performance trends (OUR, COD, and Effluent TSS - visual)	
		pH out of range	Check with Perdue DVF manufacturing personnel regarding any new waste streams, microbial additives, cleaning/sanitation chemicals or dumps to the WWTP	
		Low nutrient concentrations (nitrogen and/or phosphorous)		
Increasing COD concentration in MBBR	MBBR	Overloaded system	Check COD loading rate and make necessary adjustments	Make necessary adjustments to operating (e.g., wasting) or loading
		High Effluent TSS (sludge) concentrations from visual inspection	Check condition trends (e.g., Effluent TSS, Effluent COD, etc.)	
High nutrient (nitrogen and phosphorous) concentrations in the MBBR	MBBR	Changed nutrient concentrations in the influent wastewater	Check the influent wastewater concentration trends (i.e., ammonia and reactive phosphorous)	Consider reducing nutrient dosage rates and/or influent flow rate.
High TSS concentration in the MBBR Effluent	MBBR	pH shock	Check the MBBR operating/monitoring parameters and trends	Adjust pH to normal operating range
		Toxic Chemical Shock (Peracetic Acid, Quaternary Ammonia, other)		Reduce or stop feed flow to MBBR until normal Production Cycle starts. Slowly increase feed flow and monitor OUR's

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
Level in MBBR tank rising beyond Std. side water depth of 21 ft.-21.5 ft.	MBBR	Media blockage at effluent sieve	Check effluent sieve to confirm no obstructions are increasing head loss in the tank.	Either turn on or turn up air sparge system and keep on. Maintain good mixing in the tank to keep carrier media mobilized and reduce congregation.
	Secondary DAF	MBBR influent flow > effluent flow as result of reduced hydraulic capacity in Secondary DAF	Monitor influent and effluent flow rate setpoints and MBBR liquid depth levels under standard operation to develop a baseline for comparison.	Adjust flow rate setpoints based on MBBR liquid depth and hydraulic capacity of Secondary DAF
NH_3-N residual <0.5 mg/L in DAF Effluent	MBBR	Insufficient nutrient dosage rate of 29% Aqua Ammonia to MBBR	Compare nutrient dosage rate for aqua ammonia and DO concentration in MBBR to design parameters. Check influent COD and NH_3- N concentrations.	Reduce air flow/DO to MBBR for purpose of decreasing nitrification rate to compensate for lower residual ammonia in the effluent.
Reactive Phosphorus <1 mg/L in DAF Effluent	MBBR	Insufficient nutrient dosage rate of 75% Phosphoric Acid to MBBR	Check phosphoric acid supply in storage tote & containment along with associated chemical metering pump function.	Increase phosphoric acid nutrient dosage rate
				Refer to the LMI IOM to review the installation, startup, operation, and error message summary sections for guidance on the acid pump.
Blower back Pressure to MBBR outside of target value range (9.6-9.8 PSI)	MBBR	Clogging of diffuser cones resulting in non-uniform aeration of MBBR tank	Check for any aeration pattern disturbances which would indicate clogging.	Implement protocol for cleaning diffuser heads (refer to MBBR IOM Manual)
		Aeration blower malfunction	Check aeration blower function	Repair/replace damaged aeration components.
		Leaks in diffused air transmission line	Check for any air leaks in transmission line which could be bleeding off air instead of going to the system.	Repair damaged transmission line sections and seal any observed air leaks

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
		Low liquid level in MBBR basin	Compare current liquid depth against standard operating conditions	Increase the water level in the tank by adjusting MBBR influent & effluent flow rate setpoints.
Aeration Blower troubleshooting	MBBR	Refer to Aerzen's troubleshooting guide in their O&M manual for specific troubleshooting guidance.		
DAF DAG pump fail alarm	Secondary DAF System	Low pressure	Check influent valve, make sure pump is getting enough flow volume and pump is primed properly.	
			Verify pressure transmitter is reading the same as the pressure gauge, if not check transmitter connections.	Replace Transmitter if necessary
			Carefully throttle discharge (white water injection) valves closed while pump is in operation to increase discharge pressure.	
			Check mechanical seal.	Replace Mechanical Seal if necessary
		High pressure	Verify pressure transmitter is reading the same as the pressure gauge, if not check transmitter connections.	Replace Transmitter if necessary
			Throttle discharge (white water injection) valves open.	
		Pressure Transmitter PIT0709-21 Failure	Replace pressure transmitter	Replace pressure transmitter
		Motor overload	Reset overload heater in panel. Check wiring. Monitor motor temperature during operation. Check amp draw of pump during operation.	
Insufficient dissolved air	Secondary DAF System	Insufficient air supply	Check rotameter.	Clean if necessary
		Insufficient vacuum	Adjust suction gate valve to achieve a registerable vacuum	

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
		Insufficient discharge pressure	Verify pressure gauge is reading the same as the pressure transmitter, if not check gauge for fouling and check transmitter connections.	Replace pressure transmitter and/or gauge if necessary. Adjust injection valves to PSI indicated on Operational One Sheet.
		Solenoid failure	Check solenoid at suction side of pump for its action. There is a delay time when the pump is turned on.	Replace solenoid valve if necessary
Rake motor not running	Secondary DAF System	VFD not functioning properly	Check VFD operation	Replace any damaged components of VFD if necessary.
		Output speed set too low	Change output speed to greater than 20 Hz	Adjust rake motor output speed setpoint.
		Timers not set properly	Check timer settings	Change timer settings.
		No power to motor	Check power supply and make sure motor disconnect is on	Replace damaged electrical transmission lines or faulty motor components if necessary.
Rake stalling out	Secondary DAF System	Solids too thick	Inspect orientation of weir pipes	Adjust weir pipes for wetter solids
			Check DAF rake on-time log in PLC	Increase on time of rakes
			Cross reference thickness of solids with polymer dosage	Lower polymer dosage
		Flight hung on beach		Tighten chain tension, remove link if necessary
Bottom cone not opening	Secondary DAF System	Timers not set properly	Check timer settings and compare with design criteria as well as	Change timer settings.
		Insufficient air supply	Check compressed air supply (50 PSI minimum, 80 PSI recommended) and equipment function	Adjust compressed air setpoint Replace faulty air compressor components if necessary

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
		Malfunctioning solenoid	Check solenoid valve for proper operation	Replace solenoid valve if necessary
		Fouled valve	Manually open valve to verify fouled condition	Service automatic valve
Water level in DAF rising	MBBR	Increased flow	Check flow rate into DAF unit	Lower MBBR effluent flow setpoint based on hydraulic capacity of Secondary DAF
	Secondary DAF System	Solids build up in DAF	Visually inspect float for any abnormalities in solids accumulation including viscosity and color.	Open lateral cleanout valves located on effluent cleanouts on DAF, one at a time.
			Monitor DAF influent and effluent line flow rates and check for any disruptions to process wastewater conveyance potentially attributed to solids accumulation	Drain DAF unit and clean thoroughly.
Solids carry over in effluent	Secondary DAF System	Improper chemical dosage(s)	Check chemical supply, check pumps for prime, check turbidity meter calibration/cleaning	Replenish chemical storage totes as needed
			Check desired chemical dosage with actual chemical dosage with a drawdown	Verify and notate desired chemical dosage matches with actual chemical dosage or adjust feed rates based on findings of comparative analysis
			Conduct Jar test to verify/adjust dosage on pumps if needed.	Adjust or maintain polymer and coagulant dosages based on results of Jar Test.
		DAG pump failure or settings out of range	Inspect DAG pump pressure valves, suction valve, atmospheric air rotameter, gauges, influent air check valve and tubing, verify motor rotation, observe alarms for motor failure	Perform cleanout of valves and tubing along with replacement of faulty gauges and motor components as necessary.

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
Other Water Quality Issues	Primary DAF Primary DAF pH Adjustment Tank MBBR Secondary DAF Combined Effluent Tank	Tank pH out of range at Primary DAF, Primary DAF Effluent pH Adjustment Tank, MBBR, or Combined Effluent Tank	Consider testing different chemical injection points for more or less mixing to better match jar test results	Ensure injection ports and probe heads are clean and free of calcification.
			Check pH, calibrate probe if needed at Primary DAF, Primary DAF Effluent pH Adjustment Tank, and Combined Effluent Tank	Recirculate combined effluent tank flow back to equalization tank for retreatment with specific focus on Primary DAF Effluent pH Adjustment Tank phase if necessary
		Primary DAF or Secondary DAF effluent turbidity out of range	Compare turbidity analyzer reading with initial design criteria and trended data	Clean probe head, focus on chemical dosing optimization at the Primary DAF and Secondary DAF treatment units. Preform jar testing if necessary
		Solids mat too light on DAF	Compare skimmer setpoints with initial design criteria	Decrease skimmer run times (should be about a 6" thick mat in middle of DAF).
		Solids mat too heavy on DAF	Monitor effluent turbidity from Primary DAF Effluent pH Adjustment Tank and Secondary DAF, compare with initial design criteria.	Increase cone purge times
				Shut down unit and clean
Chemical Metering Pump Failure	Primary DAF Primary DAF pH Adjustment Tank MBBR Secondary DAF Combined Effluent Tank	Refer to LMI's troubleshooting guide in their O&M manual for specific troubleshooting guidance.		

Issue	Affected Unit Processes	Possible Causes	Evaluation Procedures	Corrective Action / Future Prevention
Chemical feed rates are incorrect	All chemical metering pump systems	Pump settings (e.g., pump speed %) do not match OTI inputs	Perform pump calibration and compare to records	Perform pump calibrations annually
			Check pump (e.g., pump speed %) settings on the OTI	Check the control system inputs for chemical feed equipment
			Review control system interlocks that may prevent chemical feed	
		Pump components are wearing	Inspect physical condition of pumps and valves. Check safety relief valve to make sure it has not tripped	Perform pump preventive maintenance and replace wear parts per LMI's recommendations.
				Maintain record of tubing replacements
		Valves are partially or completely closed	Check positions of suction and discharge valves from tank through pump to point of injection	Keep marked up set of drawings showing the correct position of each valve
		Chemical storage tank level is low	Check tank level	Maintain a minimum of two weeks of inventory in the storage tank
		Incorrect chemical concentrations delivered	Check that chemical data from supplier matches the design/requirements	Maintain records of the Certificates of Analysis provided by chemical suppliers
		Pump has lost its prime	Check for air bubbles on chemical tubing	Periodically check for air bubbles in tubing as part of operator checklists
			Check TREND on the OTI to see if the level in chemical tank has moved down or remained static	

4.3 Power Loss

The power for the WWTP is supplied by a Motor Control Center (MCC) which receives power from the main supply to the production plant. If power supply is interrupted, the production plant and WWTP will shut down, ending wastewater feed to the WWTP. In the event of a power outage, the operator should perform a walkdown of the system. When power is restored, the operator should perform a walkthrough of the WWTP to confirm that equipment was not affected, and that the equipment is still operating properly.

5. MAINTENANCE

5.1 Introduction

The WWTP requires regular maintenance for operations (e.g., pH probe cleaning and calibration) and preventive maintenance (PM) and corrective maintenance of equipment. The vendor O&M manuals, included with the appendices, describe PM and corrective maintenance of the major process equipment components. The operator should review these manuals and incorporate these requirements into the Perdue DVF's maintenance program.

Warning	Perdue DVF's site safety plan should be consulted before accessing any areas for maintenance deemed high-risk/restricted (e.g., inside process tanks).

5.2 Inspections, Monitoring, and Maintenance Tasks

The operator should inspect the WWTP daily in accordance with Table 5-1. If potential problems are observed, refer to Section 4.2 for troubleshooting. Observations should be recorded on the WWTP log sheets.

CAUTION	Do not rely on the OIT workstations for inspections because actual conditions in the WWTP may differ. For example, a pump may be signaled to run, but a clogged pipe might block the flow.

Table 5-1 Daily Inspections & Monitoring

Activity	Description
Complete walkdown and WWTP Log Sheet	Complete the shift walkdown and WWTP Log Sheet
	Inspect the WWTP equipment for correct operation and note any unusual noises, air or liquid leaks, damage, contamination, or corrosion.
	Check for vibration and/or leaks and cracks in all pipes.
	Check the installation point of instrumentation and pressure gauges into the process pipes for leaks
	Visually inspect effluent quality and performance of Primary and Secondary DAF (turbidity and TSS)
	Check Tanks (Primary DAF Effluent pH Adjustment Tank, MBBR, Combined Effluent Tank for high foam level
	Check pH probes for proper insertion depth in pipes
Review trends and alarms on OIT	Review WWTP operating trends for the last 24 hours, noting any unusual operating data.

Activity	Description
	Review any alarms that have occurred in the last 24 hours. Review the relevant alarm list and determine which equipment may be causing the alarms.
Housekeeping	Check the cleanliness of the WWTP areas, cleaning up any spills or debris found, and putting tools or other loose equipment back in their correct storage locations.
Check Primary DAF Effluent pH Adjustment Tank, MBBR Tank and Combined Effluent Tank Parameters	Check both the local readouts and OIT workstation for the following monitoring instruments and ensure they match:
	Temperature, pH, and DO of the MBBR Tank
	Temperature and pH of the Primary DAF Effluent pH Adjustment Tank and Combined Effluent Tank
Check Primary DAF Effluent and Secondary DAF Effluent Parameters	Check both the local readouts and OIT workstation for the following monitoring instruments and ensure they match:
	Turbidity (perform visual inspection of effluent for high TSS)
Complete analytical laboratory testing and sampling	Complete the analytical laboratory testing and sampling, per the requirements in Section 3.4.
Review chemical inventory in tanks	Check the level in each of the chemical storage tanks in Offal Room, Utility Building and under the Secondary DAF to ensure sufficient volume
Check Sludge Tank level and Sludge Tanker level to schedule sludge transfer to Tanker and Tanker changeout (as required)	Schedule the changeout of the sludge tanker with the disposal vendor, if necessary, based on the level in the Sludge Tank

In addition to daily inspections and monitoring, regular operation and maintenance tasks are required by the operator for the WWTP equipment. The list of these tasks is presented in Table 5-2 and are sorted by frequency and unit process (system/sub-system number or General). **Please note that this list does not encompass all tasks required by the vendors as part of their equipment. Refer to the vendor O&M manuals for the complete listing of required regular operation and maintenance tasks for their packages.**

Warning	Perdue DVF's site safety plan should be consulted, and all applicable Perdue DVF SOPs should be followed to prevent injury when performing any maintenance tasks.

NOTE:	Table 5-2 does not include all tasks required by the vendors as part of their equipment. Refer to the vendor O&M manuals for the complete listing of required regular operation and maintenance tasks for their packages.

Table 5-2 Regular Operations and Maintenance Activities

Unit Process	Activity	Task	Location	Frequency
General	Rotate equipment	Rotate standby/redundant equipment Look, listen and feel for abnormal rotating equipment operation.	Various	Weekly
General	Instrumentation cleaning	Clean the exterior of all instruments and ensure local displays (where applicable) are visible. Don't forget to use agents that do not attack the surface of the housing and seals.	Various	Weekly
General	Valve Inspection	Inspect valves for leakage, especially around shafts and on pneumatic actuators (where applicable)	Various	Weekly
General	Compressed Air System	Check air pressure regulators are correctly set	Various	Weekly
General	Motors, Gearboxes and Pumps	Check oil levels (where applicable) and top up or refill if necessary	Various	Weekly
General	Inspection	Run the safety shower and eye wash stations per Perdue's current maintenance plan.	Various	Weekly
	Test			Monthly
General	Motors and Pumps	Follow vendor inspection and maintenance instructions for each motor/pump. Inspect bearings for evidence of rust or moisture condensation or excessive noise or heat generation.	Various	Monthly

Unit Process	Activity	Task	Location	Frequency
		Check pumps, flanges, pipework and ancillary lines for leaks.		
General	Instrumentation Inspection	Check for any damage, leakage, cracks or any sign of media seepage	Various	Monthly
		Check for discoloration of gauge dials that may impact on readability		
General	Instrumentation calibration (pH)	Calibrate/clean pH sensors	Various	Quarterly (or more frequently if required)
General	Instrumentation calibration (DO)	Calibrate/clean DO sensor	MBBR	Monthly (or more frequently if required)
General	Instrumentation calibration (Turbidity)	Calibrate/clean Turbidity sensors	Primary DAF Secondary DAF	Monthly (or more frequently if required)
General	Emergency Lighting Test	Follow Perdue's current maintenance plan and incorporate plan at the WWTP	Outside Conveyors and New WWTP Area	Monthly
General	Fire Extinguisher inspection	Follow Perdue's current maintenance plan and incorporate plan at the WWTP	Utility Shed	Monthly
General	Inspect and Clean Catch Basins	Inspect the catch basins and clean debris / remove blockages as necessary	Tanker Loading Area	Monthly (or more frequently if required)
General	Motors and Pumps	Where possible, inspect fans and air vents. If necessary, remove fan covers and clean off dust from fans and airways by using low-pressure air and/or dry cloth	Various	Monthly (or more frequently if required)
		Change gear box oil, where applicable, every 5000 running hours or follow the instructions in vendor's O&M manuals		Annually (minimum, and more frequently if required by vendors)

Unit Process	Activity	Task	Location	Frequency
General	Instrumentation calibration (all others)	Calibrations or calibration checks for various instrumentation: flow meters, flow sensors, temperature, level, pressure, turbidity, conductivity, ORP	Various	Annually (minimum, and more frequently if required by vendors)
		See vendor O&M Manuals for specifics		Annually
General	Exercise valves	All valves	Various	Various
Primary DAF	Existing activities	Continue existing operation and maintenance activities as currently required for this system	Existing WWTP Area	Daily
Equalization Tank	Drain and inspect tank and components	Drain tank, remove settled solids, and inspect all internal components (i.e., Mixer manifold, sensors, nozzles, etc.)	Equalization Tank	Annually (or more/less frequently if required)
Primary DAF Effluent pH Adjustment Tank	Drain and inspect tank and components	Drain tank, remove settled solids, and inspect all internal components (i.e., Mixer shaft, mixer impeller, chemical feeds, sensors, nozzles, etc.)	Primary DAF Effluent pH Adjustment Tank	Annually (or more/less frequently if required)
Aeration System	Check filters on the intake of the Aeration Blowers	Check air filters on the Aeration Blowers' intakes and clean or change if necessary, following the vendor's instructions	Blowers	Monthly
MBBR Tank	Drain and inspect tank and components	Drain the MBBR Tank contents (biomass & Media) to external storage tanks or Frac Tanks and aerate the during the tank inspection[1]	MBBR	Every 5-7 years, or more frequently if deemed necessary from inspections of the tank exterior)
		Inspect the top of tank and all internal components (i.e., internal shell, chemical feeds, sensors, nozzles, etc.)		Weekly (or more/less frequently if required)

Unit Process	Activity	Task	Location	Frequency
Secondary DAF	Drain and inspect DAF and components	Drain and clean DAF Tank unit with medium pressure water stream. Inspect internal components (i.e., sensors, skimmer, nozzles, etc.)	Secondary DAF	Monthly
	Inspect Skimmer Assembly	Check top skimmer assembly for proper chain tension		Monthly
		Inspect UHMW wear blocks on skimmer assembly - replace if necessary		Quarterly
	Check and Lubricate Mechanical Components	Lubricate take-up frame bearings and 4 bolt flange bearings on top skimmer assembly. Lubricate the chain flight system motor per manufacturer's requirements. Lubricate DAG pump motor per manufacturer's requirements. Check DAG pump coupling for proper alignment		Quarterly
Combined Effluent Tank	Drain and inspect tank and components	Drain tank, remove settled solids, and inspect all internal components (i.e., Mixer shaft, mixer impeller, chemical feeds, sensors, nozzles, etc.)	Combined Effluent Tank	Annually (or more/less frequently if required)

Notes:

1. A Perdue SOP needs to be developed for tank draining and biomass preservation as part of maintenance on the MBBR every 5 to 7 years. Refer to vendor O&M Manual for proper shutdown procedure

5.3 Periodic Maintenance Procedures

This section provides information regarding the procedures for some of the periodic maintenance tasks required as part of Table 5-2 in Section 5.2. The O&M manuals provided with the equipment and instrumentation should be consulted prior to performing any maintenance.

5.3.1 pH/Temperature Probe Cleaning and Calibration

CAUTION:	Transfer a small amount of the buffer solutions to first clean any dry containers that will be used for pH calibration**. Discard the used buffer solutions after each use. Do not reuse.**
CAUTION:	**The pH probes should be entered into Calibration mode at the OIT workstation before cleaning and/or calibration begins.** If Calibration mode is not entered, the control system will alarm and attempt to control pH based on the readings during cleaning and calibration.
NOTE:	Enter the calibration data in the WWTP Logbook

pH probes in the WWTP should be cleaned weekly. Calibration frequency is variable depending on the service but quarterly at a minimum. Vendor requirements may call for more frequent cleaning based on operations.

The pH probe is cleaned with potable water and dish soap to remove biological buildup. Rinse the probe with water after cleaning and prior to calibration. The operator should follow the manufacturer's instructions for cleaning and calibration of the pH probes.

The operator should calibrate the pH probes using a two-point calibration. Two-point calibration involves testing the pH meter with two different buffers of known pH (pH = 4.0 and 7.0 for this water).

Follow the pH probe manufacturer's instructions for specific calibration procedures. The general steps are listed below:

1. Use only fresh buffer solutions. Record the expiration dates of the buffer solutions in the WWTP Logbook.
2. The pH probes should be entered into Calibration mode at the OIT workstation before cleaning and/or calibration begins.
3. Dispense a small amount of pH = 7.0 and 10.0 buffer solutions into clean, dry containers. The calibration solutions should be used for only one calibration and then discarded.
4. Remove the probe from the process piping.
5. Rinse the probe tip with de-ionized water and blot dry with paper tissues.
6. Calibrate the probe using pH = 7.0 and pH 10.0 buffer solutions. Check the calibration using the pH = 7.0 buffer solution. Rinse the tip of the electrode with de-ionized water and blot dry after each buffer to minimize contamination of the buffer solutions.
7. Record the calibration information in the WWTP Logbook and include the following information (at a minimum): the operator's name, date, time, expiration dates of buffer solutions, and the calibration results.

5.3.2 DO Probe Cleaning and Calibration

CAUTION:	Set the DO transmitter into the Hold or Calibrate mode before removing the meter from the water. This will prevent issues with the blowers' DO control.

NOTE:	Enter the calibration data in the WWTP Logbook.

Clean the DO probe weekly or more frequently if needed. Calibration frequency is variable depending on the service, but monthly at a minimum.

See the DO probe manufacturer's instructions for specifics on the calibration requirements and procedure. The operator should follow the Perdue DVF SOP for cleaning and calibration.

5.3.3 Turbidity Probe Cleaning and Calibration

See the DO probe manufacturer's instructions for specifics on the calibration requirements and procedure.

5.3.4 Chemical Metering (Feed) Pump Calibration

WARNING:	Calibrate the chemical metering pumps only after pressure testing the piping.
CAUTION:	The calibration must be completed with the chemical and **NEVER with water**. The pumping rates may differ and water in the piping can react with some chemicals to form excessive heat.
NOTE:	Enter the calibration data in the WWTP Logbook.

Calibration of the chemical metering pumps will simplify the process of adjusting future chemical doses. Calibration means determining and recording the pumped flow for a given pump speed. The following procedure is recommended for calibrating the pumps. A stopwatch is needed to perform the calibration. Calibrating the metering pumps should be completed during the Startup phase and then annually or whenever the tube size of a pump is changed.

Refer to chemical feed pump manufacturer manuals for addition detail on the procedure for calibrating the pumps. The operator should follow the Perdue DVF SOP whenever operating the pumps. The general steps are listed below:

1. Read the manufacturer's manual for each chemical metering pump.
2. Don proper PPE for potential chemical exposure. The operators should be protected from the chemicals while calibrating particularly because chances of exposure are higher than under normal operations.
3. Check that all valves on the suction and discharge piping are in their proper positions for running the pumps in a calibration mode. Once the calibration column is filled, isolate the chemical storage tank from the pump suction piping so that the pump draws only from the calibration column.
4. Set up a calibration table with various pump speeds as column headings (refer to Table 5-3 for a blank template). Both pump speed and stroke can be adjusted, but only the pump speed is adjustable at the OIT. The stroke must be adjusted locally at the pump. The calibration should be performed for various pump speeds at designated strokes.

NOTE:	As part of the calibration mode for the pumps, the local pump displays may request volumes (measured below in steps 4 through 7) to be input when calibrating at different speeds. These volumes are used by the pump

to calculate flows (similar to this manual method) and are recorded within the pump, but this should be skipped (unless otherwise decided by the operator later) since the MCP will only send speed signals (not flow rate signals) to the pumps during normal operations.

5. As part of the calibration mode for the pumps, the local pump displays request volumes (measured below in steps 4 through 7) to be input when pumping at different speeds to be recorded with the pump, but this should be skipped (unless otherwise decided by the operator) since the Master PLC will only send speed signals (not flow rate signals) to the pumps during normal operations.
6. Adjust the pump speed at the OIT workstation per the manufacturer's recommendations.
7. Perform the calibration test at the given pump speed setting.
8. Note the initial volume in the calibration column. Start the pump and stopwatch simultaneously. After at least 500 mL have been pumped or 30 seconds have passed, record the exact volume pumped and time needed to pump it. Calculate the flow at the selected pump speed and record the results in the table. For example, assume the pump speed was set to 25% and 500 mL were pumped in 300 seconds. The resulting flow would be as follows:
9. $\text{Flow at 25\% @ stroke rate} = \frac{500\ \text{mL}}{(300\ \text{seconds} \times \frac{1\ \text{minute}}{60\ seconds})} = 100\ \text{mL/min}$
10. Repeat tests at new pump speed settings until the table is complete. Refill the calibration column as needed during testing. The testing can be repeated for any additional stroke rates that may be used.

Table 5-3 Metering Pump Calibration Table Template

Tubing Size	Pump Speed (___%) @ ___ Stroke			
	25%	50%	75%	100%

5.3.5 Flow Meter Calibration

The WWTP should calibrate its flow meters annually. An outside contractor experienced in calibration should perform the work. It is recommended that whoever currently calibrates Perdue DVF's flow meters be utilized for the new WWTP flow meters. The calibrations should be traceable through a chain of calibrations to the appropriate national or international organization, such as the National Institute of Standards and Technology (NIST).

5.4 Preventative and Corrective Maintenance

Refer to vendor O&M Manuals included in the appendices for PM and corrective maintenance and for lubrication requirements for each piece of equipment. The operator should also follow the Perdue DVF PM program requirements (including schedule) developed for the following pieces of equipment/components/instrumentation:

- WWTP area drains and catch basins;

- Safety shower and eye wash stations;
- Water heater;
- Heating and ventilation equipment;
- All instrumentation.

5.5 Recommend Spare Parts

Spare parts lists for major equipment are included as part of the vendor O&M Manuals included in the Appendices. Outside the vendor packages, the following general list of spare parts is recommended to maintain in storage at the WWTP:

- pH and DO probes;
- Flow switches;
- Pressure gauges and differential pressure switches;
- Control valves.

The inclusion of other spare parts on this list will be based on Perdue DVF's preferences and the outcome of the Commissioning and Startup phases.

6. SAFETY

6.1 Introduction

Refer to the site safety manuals for guidance for a safe workplace. This chapter only summarizes some of the key points and is not a substitute for Perdue DVF's site safety requirements.

WWTP operators should notify the local authorities about all life-threatening emergencies.

WARNING:	Follow all Perdue DVF WWTP safety requirements and regulations.
WARNING:	Wear appropriate personal protective equipment as required per task.
WARNING:	Individuals should not attempt to perform any rescue operations they are not trained or do not have the equipment for. Call local emergency personnel for any life-threatening emergencies.
NOTE:	Maintain up-to-date safety plans

6.2 Post Incident Reporting Instructions

Refer to Perdue guidelines for incident reporting. Prominently post incident response information near all treatment areas in accordance with Perdue and regulatory requirements. Such information may include:

1. Telephone number of nearest fire station, hospital, and emergency response;
2. First aid directions for common physical injuries;
3. Location of emergency shower and eyewash locations; and
4. Perdue DVF horn/siren warning system instructions.

6.3 Housekeeping

Good housekeeping is an indispensable aid to safety. The list below includes common housekeeping requirements and tips.

1. Treatment process area structures, walkways, and equipment should be kept in good repair and maintained in a neat condition.
2. Loose tools and equipment should be put away when not in use.
3. Walkways should be kept free of grease, oil and scum.
4. In any biological waste treatment plant, there is an opportunity for walkways to become slippery from the collection of slime in areas where biomass is present. Wash slimes off walkways to reduce the potential hazards from slipping. In some instances, sand sprinkled on a slippery walk will provide the needed traction for safe walking.
5. Polymer and other chemical spills can be slippery. Concentrated polymer will become more slippery when water is applied. It is best to use spill pads to clean up and dispose of as much polymer as possible before hosing down the spill area. Sunlight will degrade the polymer over time and make it less slippery. Follow common procedures to clean up spills of this nature.

6.4 Confined Spaces

Normal operation does not require entry into confined spaces. If the tanks are out-of-service and need to be entered for any reason, they should be considered confined spaces. Perdue DVF confined space entry protocol should be strictly followed when entering these tanks, sumps, or any other WWTP areas that are included as part of the Perdue DVF Confined Space Program. All the relevant precautions, engineering controls, and precautions should be in place.

6.5 Electrical Hazards

When working on or around any electrical equipment, lockout and tag out procedures according to Perdue DVF protocols must be followed. Extra care should be taken when working with equipment that may become wet with water, mist or slime build-up, as discussed above in Section 6.3.

6.6 Mechanical Hazards

Mechanical equipment (pumps, blowers, fans, etc.) should be equipped with safety guards as required. Generally, all moving machinery parts and hot surfaces require guards. Post adequate warning signs near all dangerous machinery, hidden obstacles, or hazardous locations. If it is necessary to remove the guards before adjusting equipment, lock out and tag out the equipment to prevent accidental operation. Make sure that all guards are reinstalled before starting the unit.

6.7 Noise

Loud noises from equipment can cause permanent hearing loss. Operators and maintenance workers must wear proper ear protection when working in noisy areas in accordance with Perdue DVF safety requirements. All equipment is required to produce less than 80 decibels at 1-meter distance. Ear protection MUST be worn when entering any area where ear protection signage is displayed.

6.8 Bacterial Infection (Health Hazards)

Wastewater and biological treatment represent potential hazards to treatment plant personnel. Although treatment of sanitary wastewater is currently not included as part of the Perdue DVF WWTP, it is covered here as a precaution and because the biomass seed is obtained from a sanitary treatment plant. It is possible for bacterial infections and water-borne diseases such as typhoid fever, paratyphoid fever, dysentery, infectious jaundice, and hepatitis to be transmitted from the treatment of sanitary wastewater. Danger from tetanus at treatment plants exists due to the potential for moist, rusty environments. Any cuts should be immediately treated with an anti-bacterial agent.

Water-borne diseases usually enter the body through the mouth. Most often they are carried to the mouth by the hands or by objects carried in the hands. The best defense against infection from water-borne diseases is good personal hygiene and careful attention to anything that enters the mouth. Other infections enter through breaks in the skin, so a good defense against infection is prompt medical attention to any injury or cut that breaks the skin.

Proper personal hygiene is an important defense against infections and diseases. This includes the following precautions:

1. A soapy shower and clean change of clothes should be used after the end of a work shift;

2. Hands should be washed with warm soapy water after bathroom use and before eating, smoking, and upon leaving the laboratory.
3. The hands carry the majority of infectious materials in this work. "Keep your hands below your collar" is good advice to follow while working with pipes, tanks or while handling wastewater or sludge. Operators should keep their fingers away from their nose, mouth, and eyes.
4. Care should be exercised when smoking.
5. Proper gloves should be used to protect the hands from contact with infectious materials while cleaning pumps, handling sludge, or wastewater.
6. During shifts, coveralls or dedicated work clothes should be worn. Rubber shoe covers help keep the shoes clean and dry when working around sludge pumps and other operating areas. Operators should avoid wearing work clothes at home because bacteria may be transmitted to family members. If work clothing must be taken home, launder them separately from regular clothing.

6.9 Laboratory Hazards

Work in the WWTP laboratory involves using various glassware, instruments, distillation apparatus, etc. The following safety practices are pertinent to the laboratory work and should be followed in addition to the Perdue DVF safety requirements for laboratories:

1. All chipped or cracked glassware should be discarded and placed in a special container for disposal.
2. When using volatile solvents, bases, or acids, work under a ventilated hood. Use special explosion-proof cans to store solvents.
3. After using volatile chemicals, make sure that their containers are closed tightly and stored in the designated area.
4. Ammonia, nitric, acetic and perchloric acids react violently with some organic materials. If they are used, always keep the possibility of fire or explosion in mind when using these chemicals.
5. Do not handle chemicals with bare hands. Concentrated acids and bases require particular care. Add concentrated acids to water, not water to the acids (COD testing is an exception). A person splashed with acid requires large volumes of water (i.e., a safety shower) immediately to prevent serious burns.
6. Use suction bulbs on pipettes in preference to mouth suction, to avoid possible contact of the mouth with a contaminated pipette. Consider substituting burettes for pipettes.
7. Rubber aprons should be worn when working with corrosive chemicals. The use of proper safety goggles or a face shield is highly desirable when handling dangerous chemicals.
8. Clearly label all chemicals. Always check the label to select the proper chemical.
9. When making rubber to glass connections, the worker should wear gloves, and lubricate both the glass and rubber with water and a small amount of soap. The most frequent laboratory accident occurs while inserting glass tubing in a rubber stopper.
10. Ventilation in laboratories should always be adequate to prevent accumulating fumes and dust.

11. Avoid smoking and eating when working with possibly infectious materials, such as raw sludge. Thoroughly wash your hands before smoking or eating.
12. A carbon dioxide fire extinguisher should be mounted in a readily accessible location in the laboratory.
13. Remove samples from hot plates, ovens, or furnaces with tongs or other suitable tools.
14. Electrical equipment used in the laboratory should be properly grounded.
15. Do not use laboratory glassware for a drinking cup or food dish.
16. Do not store food in the refrigerator designated for chemicals and sample storage.

6.10 Sample Collection

Operators should follow guidelines for personnel protection when collecting samples. The following represent some additional general guidelines:

1. Wear rubber gloves when collecting wastewater or sludge samples. Wash the gloves thoroughly before removing them. Wash your hands thoroughly with a disinfectant.
2. Do not collect a sample with bare hands, especially if there are areas on the hands where the skin is broken with cuts or scratches.
3. Stay behind handrails when collecting samples. Use poles, ropes, etc., as necessary to safely collect the samples.

6.11 Chemicals and Safety Data Sheets

The tables below include basic property information on the chemicals used in the WWTP. The CAS numbers are for the active ingredient and do not include other chemicals, such as water. Refer to the specific chemical Safety Data Sheets (SDS) for potential hazards and safety and handling information. The SDSs should be maintained onsite in a separate binder and are not included in this manual.

WARNING:	Use personal protective equipment when handling chemicals.
WARNING:	Maintain accurate and up to date SDS records for first responders.
WARNING:	Use the emergency shower and eyewash stations to wash chemicals from operators.
WARNING:	Immediately clean up spills of all chemicals.

Operators should follow Perdue DVF's safety protocol for addressing all spills.

Table 6-1 Chemical Information Summary

Name	Phosphoric Acid
Synonyms	Orthophosphoric Acid
CAS Number	7664-38-2
Formula	H_3PO_4
Form	Solution
Molecular Weight	98 g/mol

Concentration	75%
Specific Gravity	1.63 g/cm^3
Density	1.57-1.58 g/cm^3 @ 25°C
Freezing Point	-17°C
Name	**Ferric Chloride**
Synonyms	Iron Chloride III
CAS Number	7705-08-0
Formula	$FeCl_3$
Form	Solution
Molecular Weight	161 g/mol
Concentration	40%
Specific Gravity	1.63 g/cm^3
Density	1.415 g/cm^3 @ 20°C
Freezing Point	-9°C
Name	**Sodium Hydroxide**
Synonyms	Caustic Soda Liquid 50%,
CAS Number	1310-73-2
Formula	NaOH
Form	Solution
Molecular Weight	40 g/mol
Concentration	50%
Specific Gravity	1.52 g/cm^3
Density	1.5 g/cm^3 @ 20°C
Freezing Point	14°C
Name	**Anti-Foam**
Synonyms	FOAMTROL AF3001 or similar
CAS Number	64742-46-7
Formula	N/A
Form	Solution
Molecular Weight	NA
Concentration	100%
Specific Gravity	0.91 g/cm^3
Density	1.5 g/cm^3 @ 20°C
Freezing Point	-1°C
Name	**Ammonium Hydroxide**
Synonyms	N/A

CAS Number	1336-21-6
Formula	NH_4OH
Form	Solution
Molecular Weight	35.04 g/mol
Concentration	28%
Specific Gravity	0.9 g/cm³
Density	1.2 g/cm³ @ 20°C
Freezing Point	-92°C
Name	**Polymer**
Synonyms	CORE SHELL 71306 or similar
CAS Number	64742-47-8
Formula	N/A
Form	Solution
Molecular Weight	N/A
Concentration	10-30%
Specific Gravity	0.9 g/cm³
Density	1.01 - 1.08 g/cm³ @ 20°C
Freezing Point	N/A

6.12 Personal Protective Equipment and Clothing

Personal protective equipment (PPE) and clothing are required when onsite. Minimum PPE includes the following:

- Safety Glasses with side shields;
- Steel-toed (or other approved protection) boots;
- Reflective vest when working outside around equipment;
- Long sleeved shirt and pants; and
- Hard hat.

Additional PPE is required to handle chemicals. This PPE includes the following:

- Full face shield for corrosive chemical;
- Full Tyvek suit for corrosive chemicals when receiving bulk loads or entering the containment area;
- Rubber gloves suitable for the chemical; and
- Rubber boots suitable for the chemical.

6.13 Safety References

The following safety references should be considered for purchase and storage at the WWTP:

- Water Pollution Control Federation (WPCF) Manual of Practice (MOP) No.1: Safety in Wastewater Works;
- WPCF MOP No. 11: Operation of Wastewater Treatment Plants;
- WPCF MOP No. 18: Simplified Laboratory Procedures for Wastewater Examination; and
- EPA Technical Bulletin: Safety in the Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324

7. RECORDS

7.1 Introduction

The maintenance of good records is important to the efficient and orderly operation of the WWTP. Pertinent and complete records are a necessary aid to control procedures since these records can be used as a basis for system operation and for interpreting the results of wastewater treatment. When accurately kept, records can be used to provide an essential basis for the design of future changes or expansions of the treatment system. In addition, these records can serve as proof of performance and thereby justify decisions on expenditure of money for improvements of the system facilities should the records show that they are needed.

The following types of records or reports should be kept for the treatment system:

- Operational Records
- Maintenance Records
- Repair Records
- Compliance Monitoring Records

Once made, these records should be carefully preserved and filed where they can be located rapidly. This requires the establishment of a file system that can be used and understood by everyone concerned with making and using the records. Records should be made at the time the data is obtained by the person directly concerned with making the measurement or performing the particular task. The responsibility for the proper filing, care, and use of the records rests with the personnel. All records should be neat and accurate.

7.2 Operational Records

Records of operation consist of daily logs, laboratory records, operating costs, and monthly operating records.

7.2.1 Daily Records

Daily records are usually recorded in two forms: plant logs and routine reports. A continuing diary, or plant log, may contain a wide variety of factual information on matters such as the progress of construction or maintenance work, failure of a piece of equipment, accidents to personnel, floods or unusual storms, bypassing of a unit process, complaints registered, and names and affiliations of visitors. This information is valuable for reference.

Appendix L will contain a daily sample sheet (to be developed by the commissioning team during startup and commissioning). It includes information about the influent wastewater conditions, weather and temperature. An Excel file for data logging and computation should be developed by the commissioning team during commissioning and startup.

7.2.2 Laboratory Logs

Daily bench sheets (to be developed by the commissioning team during commissioning and startup) are used in the calculations for laboratory determinations. Final bench sheets will be included in Appendix L.

7.2.3 Operating Costs

By tracking all operating costs, the operator can determine if the system is operating within budget and the data can be used to prepare future operating budgets. Operating cost records should include a breakdown for labor, utilities, chemicals, and supplies. Labor should be divided into operation, maintenance, and administration. Supplies include items such as cleaning materials and maintenance supplies. Costs should include information on unit costs, total costs, and quantities used.

7.2.4 Monthly Operating Records

Monthly operating records should contain a summary of all data collected daily or weekly. By using monthly average figures, calculations of operating parameters that are helpful in process control may be made to reflect consistency with past performance or changing conditions. A partial list of the parameters that are useful for process control in many plants includes influent flow, organic loading, dewatered sludge quantity, residue volume, chemical dosages, and effluent flow.

7.3 Maintenance Records

To meet discharge requirements, it is necessary to minimize mechanical equipment breakdowns. Systems of breakdown maintenance, otherwise known as corrective maintenance, must be converted to preventive maintenance. Although the complexity of equipment maintenance requires that Perdue DVF employ competent maintenance staff, specialty maintenance may have to be performed by service contractors.

Records consisting of the equipment record system, schedule of work, storeroom and inventory system, and budgets and maintenance costs will provide the necessary history of equipment.

7.4 Repair Records

Maintenance of storeroom and inventory system records should be stressed, especially in view of potential extended delivery dates by equipment suppliers. A catalog of parts and equipment in stock should be maintained. A card system to record item number, description, purchase date, cost, and vendor is useful. When items are used and replaced, this must be noted in the card file, using a record showing when an item was used and for what purpose is necessary to coordinate reordering with use. A purchase ordering system showing the date an item was ordered and received, its cost, supplier, and quantity should be used.

Budgets can be prepared as accurately as possible when maintenance records are used. The records should show the costs of preventive maintenance and corrective maintenance separately. Also, the costs of work performed by plant personnel and work performed by service contractors should be shown separately.

7.5 Compliance Reporting

All monitoring reports must be signed by the highest-ranking employee having day-to-day managerial and operational responsibilities for the WWTP. This employee may, however, delegate this responsibility. The monitoring reports are to be completed in accordance with the Washington Department of Ecology's requirements.

8. APPENDICES

The individual appendices listed below are maintained in the facility files and can be provided for review if needed.

APPENDIX A: WWTP SYSTEM DRAWINGS

APPENDIX B: SETPOINT AND RANGE LIST

APPENDIX C: CONTROL NARRATIVE

APPENDIX D: OIT DESCRIPTION

APPENDIX E: WWW MBBR DESIGN MEMO

APPENDIX F: WWW MBBR O&M MANUAL

APPENDIX G: NUTRIENT ADDITION CALCULATION SHEET

APPENDIX H: MBBR TANK O&M MANUAL

APPENDIX I: BLOWER O&M MANUAL

APPENDIX J: WWW IDEAL DAF MANUAL

APPENDIX K: WWW COMMISSIONING PLAN

APPENDIX L: SYSTEM LOG SHEETS

APPENDIX M: CRITICAL SPARE PARTS

APPENDIX N: PLUMBING AND HVAC DRAWINGS

APPENDIX O: ADDITIONAL RESOURCES

The following resources should be considered for purchase for the WWTP:

Safety

- Water Pollution Control Federation (WPCF) Manual of Practice (MOP) No.1: Safety in Wastewater Works;
- EPA Technical Bulletin: Safety in the Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324;
- Supervisor's Guide to Safety & Health Programs, Water Environment Federation;
- Occupational Safety and Health Administration, 29 CFR 1910.

Laboratory

- WPCF MOP No. 18: Simplified Laboratory Procedures for Wastewater Examination;
- Standard Methods for the Examination of Water and Wastewater, Water Environment Federation, latest edition;

Operations & Design Theory

- WPCF MOP No. 11: Operation of Wastewater Treatment Plants; and
- Metcalf & Eddy, Inc. Wastewater Engineering: Treatment and Reuse, 2003.

APPENDIX P: MATH FOR OPERATORS

This section describes common units, conversions, calculations, and examples used to operate and control the WWTP. Examples of calculations are also included.

Units

Table 1 lists common units used in wastewater treatment.

Table 1 US and Metric Units

Parameter	Symbol	Metric Units		US Units	
Chemistry					
Concentration	c	% Total solids Milligrams/liter	%TS mg/L	% total solids	%TS
Dose	c	Parts per million (volume) Parts per million (weight) Milligrams/liter	ppmv ppm mg/L	Parts per million (volume) Parts per million (weight) Pounds per ton	ppmv ppm lbs/ton
Flow	Q	Milliliter per minute Liters per hour Cubic meters (tonnes) per day	mL/min LPH TPD	Gallons per minute Gallons per hour Million gallons per day Cubic feet per second	gpm GPH MGD cfs
Mass	M	Milligram Gram Kilogram	mg g kg	Pounds Ton Troy ounce	lbs ton oz
Percent	%	Per 100	%	Per 100	%
pH	pH	Standard units	s.u.	Standard units	s.u.
Specific gravity	SG	Grams/cubic centimeter	g/cc	Pounds per gallon	lbs/gal
Equipment					
Distance	D	Centimeter Meter	cm m	Feet Inch	ft in
Pressure	P	Bar	bar	Pounds per square inch	psi
Rotational speed	S	Revolutions per minute	rpm	Revolutions per minute	rpm
Torque	W	Newton-meter	N-m	Foot-pounds	ft-lbs
Velocity	v	Meters per second	m/s	Feet per second	fps
Volume	V	Cubic centimeter Milliliter Liter	cc mL L	Gallons Million gallons	gals MGal
Electrical					

Electrical current	A	Amperes	amps	Amperes	amps
Electrical power	P	Kilowatts	kW	Horsepower	HP
Electrical voltage	V	Volts	V	Volts	V

Unit Conversions

Table 2 lists factors to convert between Metric and US units.

Table 2 Common Conversions for Metric and US Units

Type	Metric			US		
Area	1 m^2	=	10.76 ft^2	1 ft^2	=	0.09290 m^2
Concentration and Dose	1 mg/L 1 ppmv 1 ppmv 1 mg/L	= = = =	1ppm (mass basis) 1 mL/1000 L 1L/ 1 cubic meter 0.00000834 lbs/gal	1 ppmv 1 lb/gal	= =	1 gal/MGal 119,841 mg/L
Density	1 g/cc	=	0.062 lb/CF	1 lb/CF	=	16 g/cc
Distance	1 mm 1 mm 1 cm 100 cm 1 m	= = = = =	0.01 cm 0.001 m 0.01 m 1 m 1000 mm	1 ft 1 ft 1 m 1 m 1 in	= = = = =	30.48 cm 0.3048 m 3.2808 ft 39.4 in 2.54
Mass	1 mg 1000 mg 1000 g 1 g	= = = =	0.001 g 1 g 1 kg 0.00220 lb	1 lb 1 lb 1 lb 2.205 lb 2000 lb 1 troy oz 1 lb	= = = = = = =	453,600 mg 453.6 g 0.4536 kg 1 kg 1 ton 31.1 g 14.58 troy oz
Flow	1 mL/min 1000 lpm 1 lph 1 lph 1 lph 1 lph	= = = = = =	0.001 lpm 1 cubic meter/min 16.66 mL/min 0.264 gph 0.0044 gpm 6.336 gpd	1 gpm 1 gpm 1 gph 1 MGD 1 gpm 1 cfs	= = = = = =	3.785 lpm 0.001440 MGD 60 gpm 694.4 gpm 0.00144 MGD 448.8 gpm
Percent	1 % 100%	= =	1/100 = 0.01 100/100 = 1	1 % 100%	= =	1/100 = 0.01 100/100 = 1
Pressure	1 bar 1 kPa 1 kPa	= = =	14.5 psi 0.145 psi 0.01 bar	1 psi 1 psi 1 psi	= = =	2.31 ft water 0.069 bar 0.0069 kPa
Specific gravity	1 g/cc	=	8.34 lb/gal	1 lb/gal	=	0.12 g/cc
Velocity	1 m/s	=	196.8 fps	1 fps	=	0.3048 m/s

Volume	1 mL = 0.001 L 1000 mL = 1 L	1 gal = 3.785 L 1 gal = 3785 mL 1,000,000 gal = 1 MGal 1 CF = 7.48 gal

Sample Calculations

The following calculations in Table 3 are typical of those needed to run the WWTP. They are grouped in categories such as general topics, or specific calculations for systems and laboratory work.

Table 3 Sample Calculations

Areas		**Example Calculations**	
Rectangle	Area =Length x Width A = L x W	L = 3 m W = 5 m	A = 3 m x 5 m A = 15 m^2
Circle	Area =π x $radius^2$ A = π x r^2	Diameter = 10 m r = (10 m)/2 = 5 m π = 3.14	A = 3.14 x $(5\ m)^2$ A = 78.5 m^2
Triangle	Area = (Base x Height)/2 A = (b x h)/2	b = 3 m h = 4 m	A = (3 m x 4 m)/2 A = 6 m^2
Volumes		**Example Calculations**	
Rectangular box	Volume =Length x Width x Height V = L x W x h	L = 3 m W = 5 m H = 2 m	V = 3 ft x 5 ft x 2 ft V = 30 m^3
Cylinder	V =Area x Height V =π x r^2 x h	Diameter = 10 m r = (10 m)/2 = 5 m π = 3.14 H = 2 m	V = 3.14 x $(5\ m)^2$ x 2 m V = 157 m^3
Cone	Volume =1/3 x π x $radius^2$ x Height V = 1/3 (π x r^2 x h)	r = 3 m h = 4 m	V = 1/3 x 3.14 x $(3\ m)^2$ x 4 m V = 37.7 m^3
Percentages		**Example Calculations**	
% as decimal	Decimal = %/100	5%	Decimal = 5%/100 Decimal = 0.05
Decimal as %	% = Decimal x 100	0.002	% = 0.002 x 100 % = 0.2%
Flows		**Example Calculations**	
Flow	Flow = Area x Velocity Q = A x v	12-inch pipe 0.152 m v = 10 m/s	r = (1 ft)/2 = 0.5 ft r = 0.5 ft x (1 m/3.2808 ft) = A = 3.14 x $(0.152\ m)^2$ A = 0.0725 m^2 Q = 0.0725 m^2 x 10 m/s

			Q = 0.725 m^3/s
Flow	Convert from lph to gpm Q = 0.0044 x lph	Q = 5 lph	Q = 0.0044 x 5 lph Q = 0.022 gpm
Flow	Convert from lph to gpd Q = 6.336 x lph	Q = 5 lph	Q = 6.336 x 5 lph Q = 31.7 gpd
Concentrations		**Example Calculations**	
Parts per million	Convert from ppm to mg/L Concentration = ppm x 1 mg/L / ppm C = ppm x 1 mg/L / ppm	8 ppm	C = 8 ppm x 1 mg/L / ppm C = 8 mg/L
Percent solids	Convert from mg/L to %TS $\%TS = \frac{mg}{L} \times \frac{1}{10{,}000}$	58,000 mg/L	$\%TS = \frac{58000\ mg}{L} \times \frac{1}{10000}$ %TS = 5.8%
Percent solids decimal	Convert from mg/L to TS as $TS = \frac{mg}{L} \times \frac{1}{10{,}000} \times \frac{1}{100}$ $TS = \frac{mg}{L} \times \frac{1}{1{,}000{,}000}$	58,000 mg/L	$TS = \frac{58000\ mg}{L} \times \frac{1}{1{,}000{,}000}$ TS = 0.058
Solids		**Example Calculations**	
Mass	Calculate mass of solids Mass = Q x C / 1000 where, Q = m^3/d, C = mg/L	TSS = 10 mg/L 1000 Q = 100 m^3/d	Mass = 100 m^3/d x 10 mg/L / Mass = 1 kg/d
Volume of solids	$Volume = \frac{M}{1000 \times SG \times C}$ where, V = volume (m^3) M = mass (kg) SG = specific gravity (g/cc) C = concentration (decimal TS) 1000 kg / m^3 water	M = 1000 kg Filter cake = 20% TS SG = 1.06	Calculate volume of filter cake $V = \frac{1000\ kg}{1000 \times 1.06 \times 0.2}$ V = 4.72 m^3
Solids removed	Removal = Influent – Effluent TSS removed = TSS_{in} - TSS_e	TSS_{in} = 20 mg/L =18 mg/L TSS_e = 2 mg/L Q = 100 m^3/d 1000	Removal = 20 mg/L – 2 mg/L Calculate mass removed Mass = 100 m^3/d x 18 mg/L / Mass = 1.8 kg
TSS removal efficiency	Efficiency = TSS removed/TSS_{in} x 100	TSS removed = 2 mg/L TSSin = 20 mg/L 100	 Efficiency = 2 mg/L / 20 mg/L x Efficiency = 10%
Solids inventory (mass) in tanks		MLSS = 1000 mg/L	

	Mass = Tank volume x MLSS / 1000	Vol = 100 m^3	Mass = 100 m^3 x 1000 mg/L / 1000 Mass = 100 kg
Tanks		**Example Calculations**	
Velocity	velocity = distance/time V = d/t	d = 10 m t = 5 s	V = 10 m / 5 s V = 2 m/s
Residence time / Flow	Hydraulic residence time = Volume HRT = Vol/Q where, units are similar	Vol = 600 m^3 Q = 60 m^3/hr	HRT = 600 m^3 / 60 m^3/hr = 10 hr

APPENDIX Q: DRAFT PERMIT

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