Operation and Maintenance Manual

DRAFT

Sections 1-6

City of Memphis, Tennessee
T.E. Maxson WWTF

April 2025

CDM Smith

Draft T.E. Maxson WWTF

Operations and Maintenance Manual

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Section 1

Introduction

1.1 Purpose of the Manual

The purpose of this operation and maintenance (O&M) manual is to provide management and staff of the T.E. Maxson Wastewater Treatment Facility (WWTF) with the information needed to operate and maintain the treatment plant in a cost-effective and efficient manner.

By accessing and utilizing the information contained in this O&M manual and the associated manufacturers' O&M manuals, drawings, and other associated data, the treatment plant staff will have the resources needed to make certain that the equipment and components constructed and installed as part of this project are properly operated and maintained, thereby ensuring that the quality of the effluent being used as reclaimed water or discharged into Mississippi River always remains in compliance with the discharge requirements of the permit.

1.2 Overview

The T.E. Maxson WWTF is in the southwestern portion of Memphis, Tennessee in Shelby County at 2685 Steam Plant Road. The Maxson WWTF has served the City of Memphis (City) since its commissioning in 1975. The current liquid treatment process consists of coarse bar screens, grit removal, fine bar screens, primary clarification, trickling filters, aeration basins, secondary clarification, and effluent disinfection. Biosolids treatment consists of anaerobic digestion lagoons, dewatering presses, and a biosolids gas treatment system. Dewatered solids are disposed in a landfill.

The plant operates to maintain compliance with National Pollution Discharge Elimination System (NPDES) permit TN0020729.

Figures associated with this system can be found in ***Appendix H Figures***.

- ***Figure 1.1-1 Process Flow Diagram***
- ***Figure 1.1-2 Hydraulic Profile No. 1***
- ***Figure 1.1-3 Effluent Pumping Station Hydraulic Profile***
- ***Figure 1.1-4 Site Plan***

1.3 Type of Treatment

The Maxson WWTF consists of the following treatment processes:

- Pretreatment and Influent Pumping
  - Influent Junction Box
  - Coarse Screening
  - Influent Pumping
  - Aerated Grit Removal
  - Fine Screening
- Primary Treatment
  - Primary Clarification
  - Primary Sludge and Scum Pumping
- Biological Treatment
  - Trickling Filter Pump Station
  - Trickling Filters
  - Trickling Filter Recycle
  - Intermediate Pump Station
  - Aeration Basins
  - Aeration Blowers and Aeration System
- Final Clarification and Pumping
  - Final Clarifiers
  - Final Clarifiers 1N through 4N and 1S through 4S RAS/WAS Pump Station
  - Final Clarifiers 5N and 5S RAS Pump Station
  - RAS Reaeration Basin
  - RAS Reaeration Blowers

- Effluent Treatment and Pumping
  - Disinfection Contact Tank
  - Acetic Acid Feed System
  - Disinfected Effluent Water Pumps
  - Non-Potable Water Pumping
  - Gravity Effluent Outfall
  - Effluent Discharge Pump Station
- Biosolids Treatment
  - Biosolids Lagoons
  - Lagoon Pumping System
  - Belt Filter Presses
  - Gas treatment system
- Odor Control
  - Biotrickling Filters

The processes listed above are discussed briefly below and in more detail in the associated section of this O&M manual.

Figure 1.1-1 Process Flow Diagram provides a process flow diagram of the T.E. Maxson WWTF.

The Maxson WWTF biological process provides secondary treatment in aerated trickling filters and activated sludge aeration basins. The treatment process uses organic material that is measured as biochemical oxygen demand (BOD) contained in the influent wastewater as a food source. The biological process is located after the headworks and primary clarifiers and prior to the final clarification system and disinfection contact tank.

Flow to the plant is through three interceptors that discharge into the Influent Junction Box. Prior to the junction box, recycle flows from the sludge lagoons are mixed with the influent flow. A bypass line from the junction box provides an emergency means of bypassing the treatment process and discharging untreated flow directly to the river. Typically, this bypass remains closed and flow from the junction box passes through coarse screens for removal of undesirable, large debris before entering the Influent Pump Station wet well. The screenings are compressed to remove as much water as possible before being hauled off site for disposal.

Pumps pull from the Influent Pump Station wet well as needed to maintain a level setpoint and discharge to an aerated grit removal system followed by fine screens. The degritted, screened flow travels to primary clarifiers for gravity settling of solids which are pumped to the biosolids processing system. Clarified effluent from the primary clarifiers enters the Primary Effluent Diversion Structure located at the Intermediate Pump Station. Normally, flow from the diversion structure flows through a gate to the Trickling Filter Pump Station from where it is then pumped to the trickling filters. Alternately, depending on the position of the gates in the diversion structure, primary effluent will bypass the trickling filters and flow directly to the Intermediate Pump Station inlet channel and where it is pumped directly to the aeration basins via a flow control structure ("splitter box") located near the grit structure.

Most of the effluent from the trickling filters flows to the Intermediate Pump Station inlet channel and is lifted by screw pumps in the Intermediate Pump Station to a flow distribution structure before the aeration basins while a portion of the flow is returned to the Trickling Filter Pump Station as recycle flow. Dispersion fans supply air to the trickling filters for aeration.

A bypass line located between the aerated grit system and the fine screens can be used to bypass the primary clarification and trickling filter processes and send flow directly to the aeration basin influent flow structure. Flow passing through the aeration basins is aerated and mixed with air through fine bubble diffusers supplied by aeration blowers.

Flow from the aeration basins travels to secondary clarifiers for gravity settling of solids. Most of the solids removed from the secondary clarifiers are pumped to the return activated sludge (RAS) reaeration basin. Blowers provide aeration through fine bubble diffusers to the contents of the RAS Reaeration Basin. The remaining solids pumped from the secondary clarifiers are removed from the system as waste activated sludge (WAS) and pumped to the biosolids processing system, similar to the primary settled solids.

Clarified effluent from the secondary clarifiers flows to a common junction box. From the junction box, flow enters the disinfection contact tank for disinfection by acetic acid or an effluent junction box. The non-potable water system pulls disinfected flow from the contact tank and the remaining flow enters the effluent junction box. Depending on the current level in the Mississippi River, effluent flow travels through the gravity outfall to the river or is pumped to the river by the Effluent Pump Station.

Solids removed from the primary and secondary clarifiers is pumped to a lagoon system for holding prior to dewatering by belt filter presses. The dewatering biosolids are hauled off site for disposal in a landfill.

1.4 Design Data

The Maxson WWTF has a design capacity of 90 million gallons per day (mgd), average daily flow. The current daily and monthly permit effluent requirements are outlined in the table below.

Table 1.4-1 Effluent Permit Requirements

Parameter	Limit	Sample Type	Monitoring Frequency	Statistical Base
Hydrogen Peroxide	Report, mg/L	Grab	5 days per week	Monthly Average
Hydrogen Peroxide	Report, mg/L	Grab	5 days per week	Daily Maximum
Dissolved Oxygen (DO)	>/=1.0 mg/L	Grab	Daily	Instantaneous Minimum
Biochemical Oxygen Demand (BOD), 5-day	</=51.1 mg/L	Composite	Daily	Daily Maximum
BOD, 5-day	</=34.8 mg/L	Composite	Daily	Monthly Average
BOD, 5-day	</=52.2 mg/L	Composite	Daily	Weekly Average
pH	>/=6.0 Standard Units (SU)	Grab	Daily	Daily Minimum
pH	</=9.0 SU	Grab	Daily	Daily Maximum
Total Suspended Solids (TSS)	</=37.8 mg/L	Composite	Daily	Monthly Average
TSS	</=54.0 mg/L	Composite	Daily	Daily Maximum
TSS	</=56.8 mg/L	Composite	Daily	Weekly Average
Settleable Solids	</= 1.0 mL/L	Grab	Daily	Daily Maximum
Nitrogen, total (as N)	Report, mg/L	Composite	Monthly	Monthly Average
Nitrogen, total (as N)	Report, pounds per day (lb/d)	Composite	Monthly	Monthly Average
Nitrogen, total (as N)	Report, mg/L	Composite	Monthly	Daily Maximum
Nitrogen, Ammonia, total (as N)	Report, mg/L	Composite	Monthly	Monthly Average
Nitrogen, Ammonia, total (as N)	Report, lb/d	Composite	Monthly	Monthly Average
Nitrogen, Ammonia, total (as N)	Report, mg/L	Composite	Monthly	Daily Maximum
Phosphorus, total (as P)	Report, mg/L	Composite	Monthly	Monthly Average
Phosphorus, total (as P)	Report, lb/d	Composite	Monthly	Monthly Average
Phosphorus, total (as P)	Report, mg/L	Composite	Monthly	Daily Maximum
Flow	Report, mgd	Continuous	Daily	Weekly Average
Flow	Report, mgd	Continuous	Daily	Monthly Average
Flow	Report, mgd	Continuous	Daily	Daily Maximum
Escherichia coli (E. coli)	</=126 #/100mL	Grab	Daily	Daily Maximum
E. coli	</=487 #/100mL	Grab	Daily	Monthly Geometric Mean
Peracetic Acid (PAA)	Report, mg/L	Grab	5 days per week	Monthly Average
PAA	Report, mg/L	Grab	5 days per week	Daily Maximum
BOD, 5-day, % removal	>/=85	Composite	Daily	Monthly Average Minimum
BOD, 5-day, % removal	>/=40	Composite	Daily	Daily Minimum
TSS, % removal	>/=85	Composite	Daily	Monthly Average Minimum
TSS, % removal	>/=40	Composite	Daily	Daily Minimum

1.5 Organization of the O&M Manual

The purpose of this O&M Manual is to provide a basis for employee training and, when combined with the manufacturers' O&M manuals, to serve as a complete reference library regarding the operation and maintenance of the T.E. Maxson WWTF. Utilizing this information, coupled with periodic updates to reflect operational changes in the treatment plant, will ensure that this manual continue to serve as a valuable aid in achieving and maintaining proper operation of the WWTF. When used in this manner, treatment plant personnel can be assured of attaining high performance and efficiency levels from the treatment facility.

Each section of this O&M manual provides detailed information addressing recommended operating procedures for each process, as well as providing specific equipment needs related to maintaining process performance and control. Each section also contains critical information that operations personnel can utilize, such as preparing for and addressing alarm conditions, preparing for, and executing bypass provisions, and ensuring that the treatment plant continues to maintain a normal state of operation when unexpected or unplanned conditions occur.

To develop a better understanding of the contents of this document, the following provides a brief description of each of the sections of the O&M manual.

- **Section 1 — Introduction** provides a brief background on the T.E. Maxson WWTF, the organization of this O&M manual, an overview of the treatment facility, and the treatment plant design criteria.
- **Section 2 — Pretreatment and Influent Pumping** describes influent flow monitoring, screenings (coarse and fine) removal, grit removal, and influent pumping.
- **Section 3 — Primary Treatment** describes the primary clarification process and associated primary sludge pumping station, and scum collection and handling.
- **Section 4 — Biological Treatment** describes the trickling filter pump station, trickling filters, intermediate pump station, flow control structure, aeration basins and aeration blowers, return activated sludge (RAS) reaeration basin, and the RAS blower building.
- **Section 5 — Final Clarification and Pumping** describes the final clarifiers, scum collection and handling system, and RAS and Waste Activated Sludge (WAS) pumping.
- **Section 6 — Effluent Treatment and Pumping** describes the disinfection contact tank, non-potable (effluent) water system, the levee gate structure and plant outfall structure, effluent pump station, effluent pump station outfall structure, and drain pump station.
- **Section 7 — Biosolids Treatment** describes the lagoon storage and treatment system, belt press feed pumps, sludge dewatering and conveyance, sludge disposal, and the biogas system.
- **Section 8 — Chemical Systems** describes the peracetic acid and polymer feed systems.

- **Section 9 — Facility Support Systems** describes the power distribution system, backup power facilities, instrumentation and control systems, heating, ventilation, and air conditioning (HVAC), security systems, administration building, and odor control.

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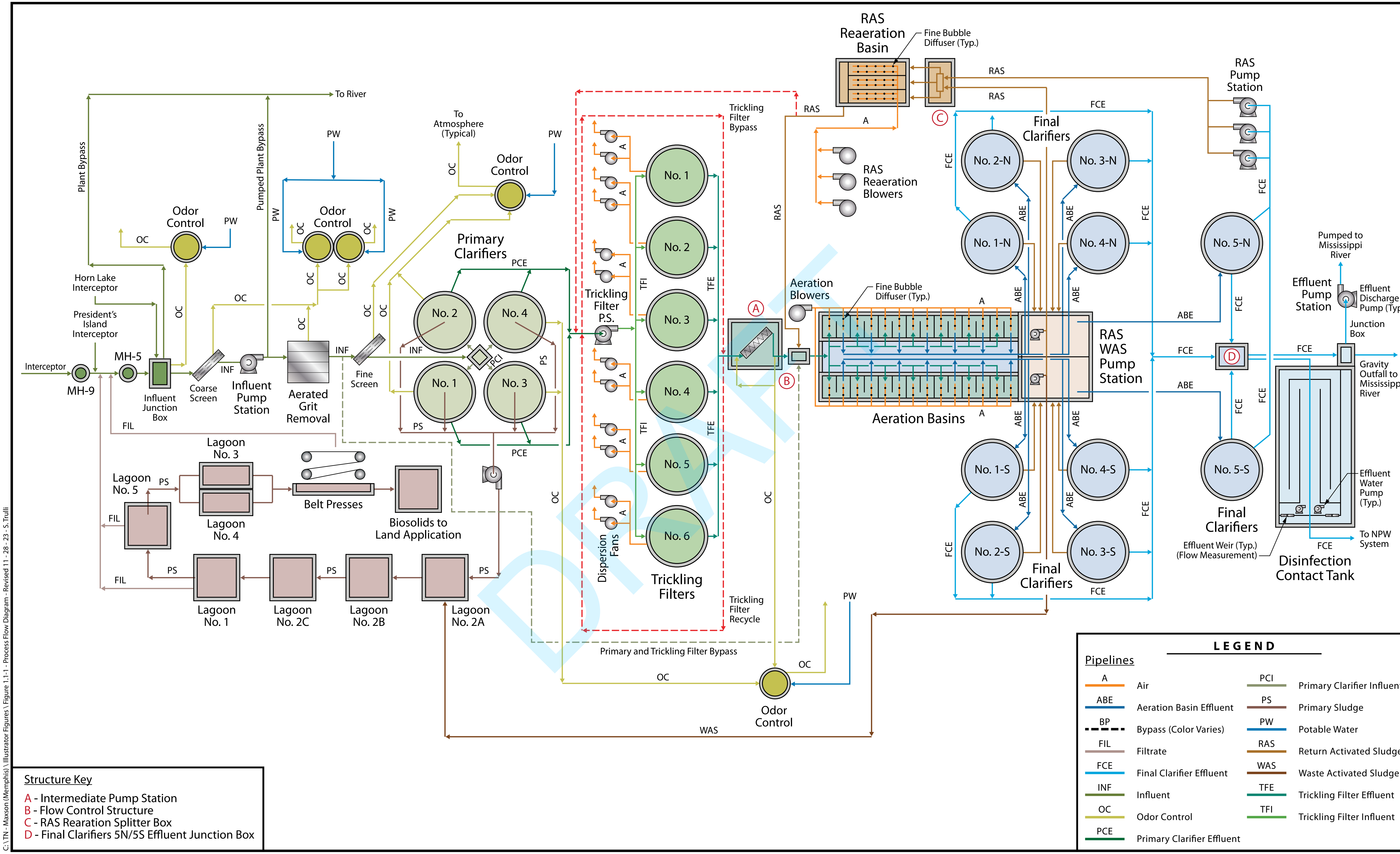

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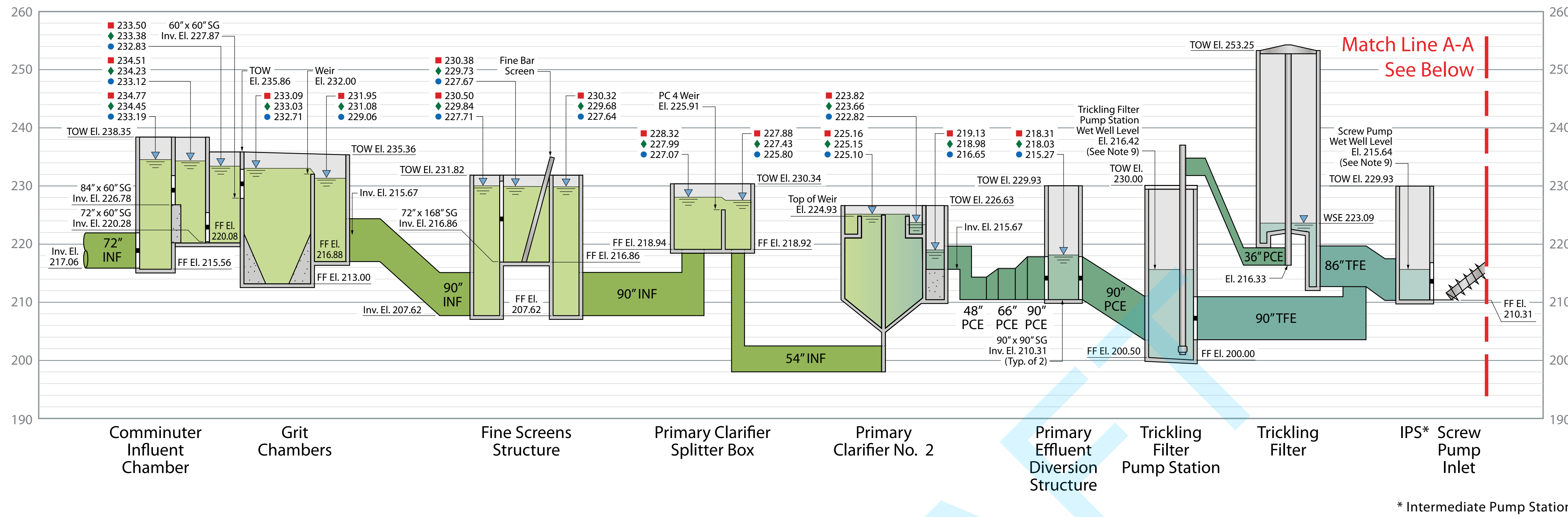
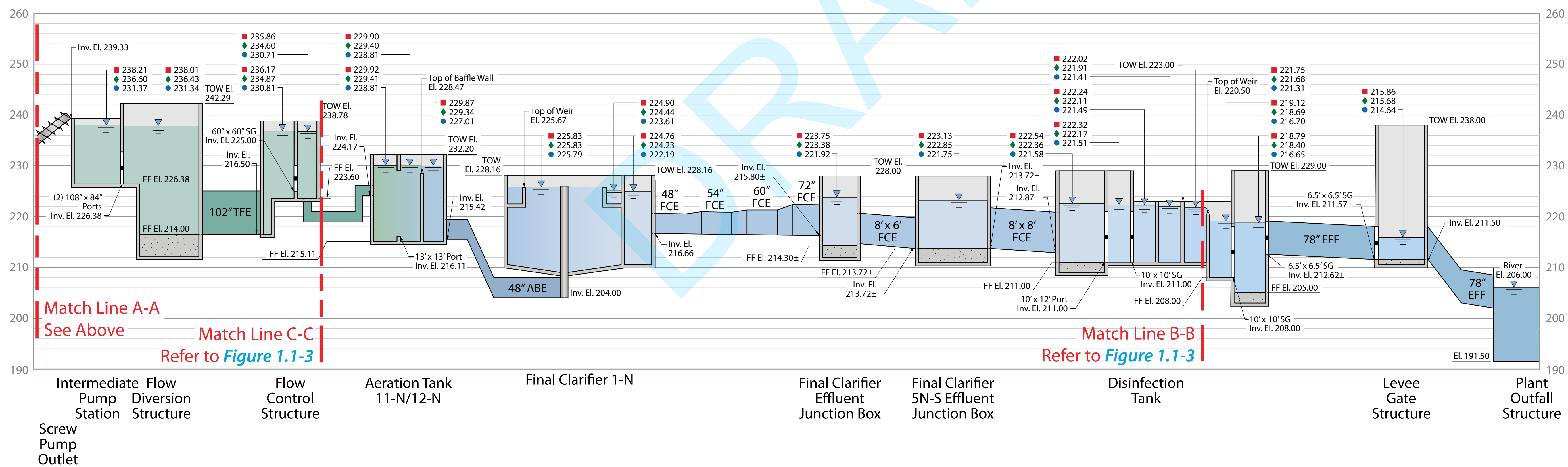
Figure 1.1-1
Process Flow Diagram





NOTES:

1. Peak hour flow (PHF) computed for 170 MGD total flow with 48 MGD RAS flow. Maximum day flow (MDF) water levels computed for 156 MGD total flow with 47 MGD RAS flow. Average day flow (ADF) water levels computed for 90 MGD total flow with 30 MGD RAS flow.
2. Downstream water surface elevation in the Intermediate Pump Station Wet Well and Trickling Filter Pump Station Wet Well is assumed to be 215.64 feet, based on measured field conditions.
3. All elevations referenced to NAVD88 datum.
4. Profile assumes 4 primary clarifiers, 14 aeration tanks, 10 final clarifiers, and 2 PAA tanks in service.
5. Headloss through fine screens calculated with a 30% blinding factor.
6. Starting water surface elevation in cooling channel is 206 feet at plant outfall.
7. Flows up to and including MDF, RAS flow is combined with forward flow at the Flow Control Structure. For flows above MDF, RAS flow will be diverted to the North and South Mixed Liquor Conduits downstream of the Flow Control Structure.
8. The primary clarifier, aeration tank and final clarifier shown in this hydraulic profile represent the worst case hydraulic condition for all units.
9. Water surface elevation (WSE) in the trickling filters effluent troughs is based on 270 MGD (8 pumps in operation) through trickling filters. Wet well levels in the Intermediate Pump Station (IPS) and Trickling Filters Pump Station impact the WSE in trickling filter effluent troughs.

LEGEND

- ■ Peak Hour Flow (PHF)
- ◆ Maximum Day Flow (MDF)
- ● Average Day Flow (ADF)

ABE	Aeration Basin Effluent
EFF	Effluent
FCE	Final Clarifier Effluent
INF	Influent
PCE	Primary ClarifierEffluent
TFE	Trickling Filter Effluent

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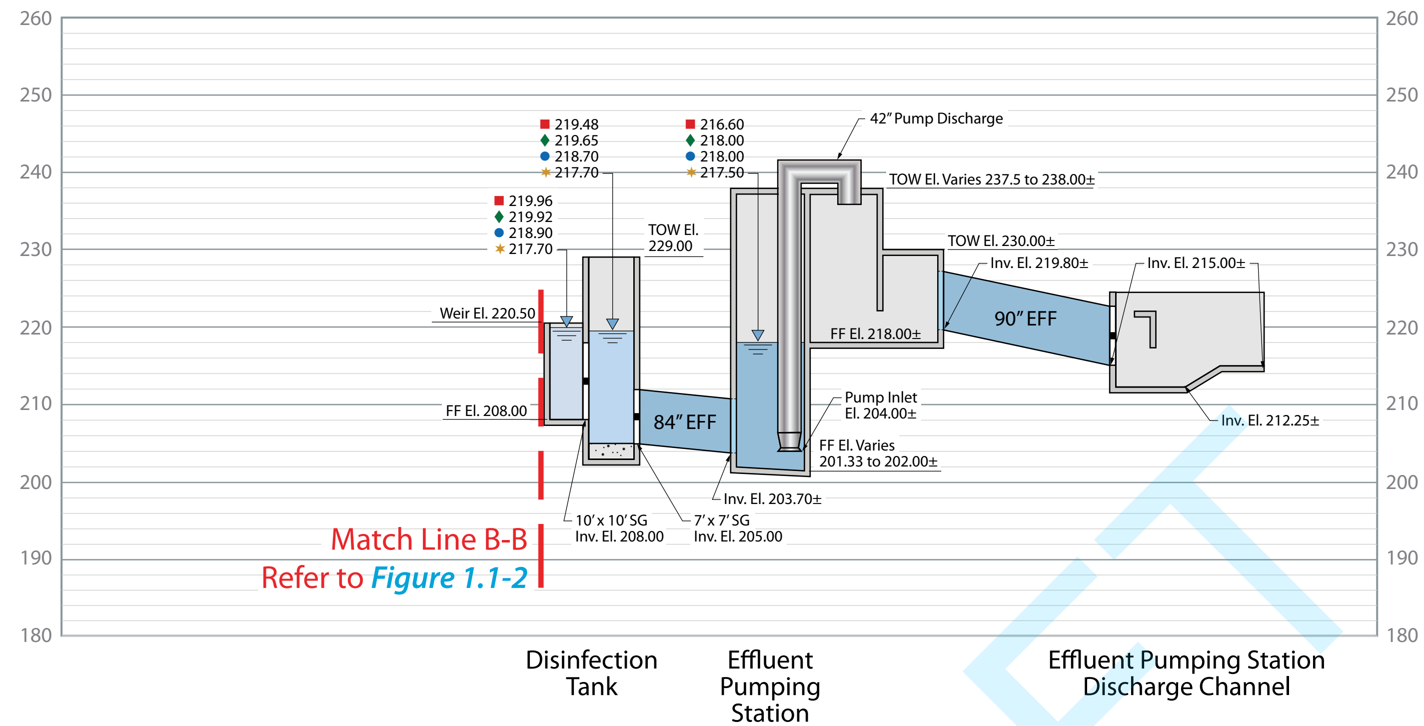
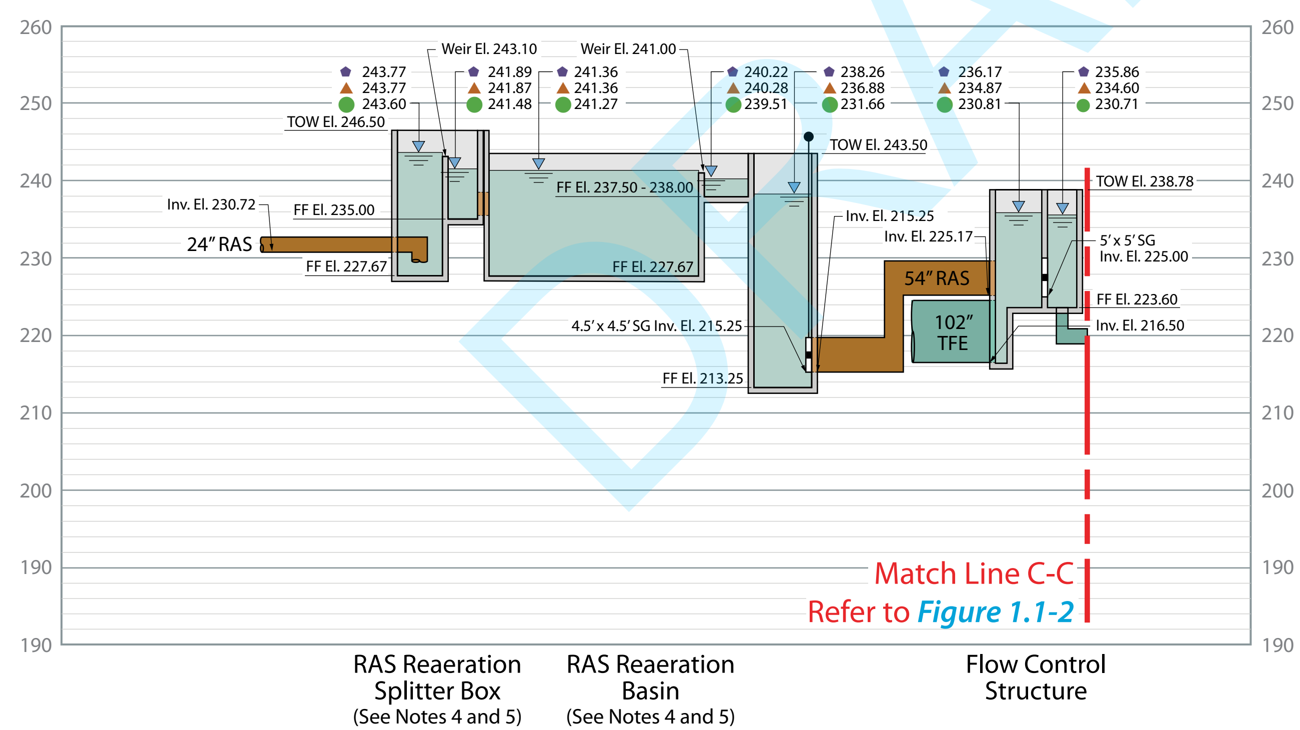
Figure 1.1-2
Hydraulic Profile No. 1





NOTES:

1. Flows shown correspond to number of pumps in operation:

   1 pump in operation = 53 MGD
   2 pumps in operation = 106 MGD
   3 pumps in operation = 160 MGD
   4 pumps in operation = 212 MGD

2. Pump station wetwell elevations shown are based on maximum level for each flow condition.

3. All elevations referenced to NAVD88 datum.

4. Water surface levels in RAS Reaeration Basin computed for Peak Hour Flow (PHF) of 48 MGD RAS flow, Max Day Flow (MDF) of 47 MGD RAS flow and Average Day Flow (ADF) of 30 MGD RAS flow.

LEGEND

Symbols

- 53 MGD
- 106 MGD
- 160 MGD
- 212 MGD
- Peak Hour Flow (PHF)
- Maximum Day Flow (MDF)
- Average Day Flow (ADF)

Pipelines

- EFF Effluent
- RAS Return Activated Sludge
- TFE Trickling Filter Effluent

Abbreviations

FF	Finished Floor
Inv. El.	Invert Elevation
TOW	Top of Wall

C:\TN - Maxson (Memphis) \ Illustrator Figures \ Figure 1.1-3 - Effluent Pumping Station Hydraulic Profile - Revised 06 - 01 - 23 - S. Trulli

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Figure 1.1-3
Effluent Pumping Station Hydraulic Profile

Section 2

Preliminary Treatment and Influent Pumping

2.1 Overview

Preliminary treatment at the T.E. Maxson (Maxson) Wastewater Treatment Facility (WWTF) consists of all processes upstream of the primary clarifiers. Influent flow enters the plant at the dual influent channel of the Headworks Building, where mechanical coarse bar screens remove large debris and prevent untreatable constituents from entering the downstream treatment processes. Flow combines from the two coarse screening channels and flows to the Influent Pump Station (IPS), where it splits into four channels, one dedicated to each pump of the IPS.

The IPS pumps discharge into a 60-inch header that increases to 72-inch diameter upstream of the Grit Chamber. A buried tee located near the southwest corner of the Grit Chamber is installed on the 60-inch line for the emergency plant pumped bypass. The influent plant flow meter is installed in a vertical section of the IPS discharge pipe inside the IPS building, two levels above the pumps. The Grit Chamber consists of three comminutor chambers and four grit chambers. The original comminutors are longer in service. The purpose of the Grit Chamber is to remove grit and organic material from the screened wastewater.

Flow leaves the Grit Chamber effluent channel via a 90-inch pipe to the south toward the Fine Screens structure. Slide gates are installed in the Grit Chamber effluent channel to allow for bypass of the Fine Screens, Primary Clarifiers, and Trickling Filters, but these are not typically open. The Fine Screens Structure consists of three channels with mechanical bar screens installed to remove any rags and small material that is not captured by the coarse bar screens installed in the Headworks Building. Each channel can be isolated with slide gates and stop logs, and a bypass channel is included to bypass the Fine Screens entirely. Flow exits the Fine Screens Structure via a 90-inch pipe toward the Primary Clarifier Splitter Box for primary treatment.

2.2 Influent Flow

The Maxson WWTF treats the wastewater from the southern portion of Memphis's wastewater collection system, which consists of three major sewer basins: President's Island, Nonconnah Creek, and Horn Lake Creek. The President's Island interceptor ties into the Nonconnah Creek interceptor upstream of the WWTF property, and the Horn Lake Creek Interceptor combines with the Nonconnah Creek interceptor in the Influent Junction Box east of the Headworks Building.

Filtrate, supernatant, and rain run-off flows from the Biosolids Processing facilities near the WWTF discharge upstream of the Influent Junction Box.

The 90-inch Nonconnah Creek interceptor enters the Influent Junction Box from the southeast, and the 108-inch Horn Lake Creek interceptor enters from the south. Typically, flow exits from a 108-inch pipe to the northwest to the Headworks Building for conveyance to the plant's treatment processes. A 60-inch pipe also exits this junction box from the southwest, and this pipe serves as the emergency gravity bypass to the Mississippi River. An unused 48-inch wall sleeve is also installed on the north wall of the structure.

A sluice gate is installed within the Influent Junction Box to isolate flow from the Horn Lake Creek interceptor. A bypass structure is located upstream on the interceptor to facilitate temporary bypass pumping. Sluice gates are also installed on the 108-inch concrete pipe to the Headworks Building and the 60-inch emergency plant bypass. Typically, the sluice gate for the emergency bypass is closed and the sluice gate on the 108-inch pipe is open to allow incoming flow to enter the plant. The sluice gates are powered by electric motor operators. A bio-trickling odor control system pulls air from the Influent Junction Structure for odor control. The bio-trickling system is discussed in ***Section 9 Facility Support Systems***.

The 108-inch pipe travels east for approximately 400 feet before reaching the dual channels of the Headworks Building for the first phase of preliminary treatment.

2.3 Coarse Screenings Removal

2.3.1 Overview

Screenings removal is necessary to protect downstream equipment and basins (pumps, tanks, pipelines, valves, etc.). Sticks, rocks, rags, and other sizable debris found in the waste stream are removed to prevent equipment damage while also preventing untreatable constituents from entering the treatment process. The Maxson WWTF is equipped with a screenings removal system located at the plant's Headworks structure. This system provides coarse screening prior to influent pumping and subsequent treatment.

Two mechanical bar screens (CS-0100 and CS-0200) are utilized for coarse screening. Untreated wastewater is conveyed to the Headworks structure via a 108-inch pipe from the Influent Junction Structure. Flow initially enters the Headwork's influent chamber before being routed to one of two screening channels. Screened wastewater exits the mechanical screens, flowing through an effluent chamber before being routed to the Influent Pump Station wet well.

Each bar screen channel can be isolated by upstream and downstream stop logs (HW-SP-1, HW-SP-2, HW-SP-3, and HW-SP-4). Stop logs are installed and removed using a portable davit crane and can be stored in one of two (upstream/ or downstream) adjacent stop log storage racks.

Trash and other debris are collected on the bar rack of each bar screen. The mechanical bar screen's rake assembly collects accumulated screenings and transfers them to a Wash Press (WP-0110 and WP-0210). Screenings are washed and dewatering within the washer/compactor and discharged into a 30-yard dumpster.

Coarse Screen and Wash Press (Typical)

The major components of the screenings removal system include:

- 2 - Mechanical Bar Screens
- 2- Wash Presses
- 2- Level Transducers
- High Level Float
- 30 cubic yard screenings dumpster

Figure 2.3-1 Headworks P&ID provides a process flow schematic for the coarse screenings removal system and associated equipment.

Figure 2.3-2 Headworks Plans provides a plan view of the Headworks and associated screening equipment.

Figure 2.3-3 Headworks Sections 1 and 2 provides a sectional view of the mechanical bar screen and wash press.

2.3.2 Description

The major components associated with the coarse screening removal system are summarized below. In addition, the design criteria associated with the screening equipment is provided in tabular form.

Influent Sewers

A 108-inch pipe conveys raw wastewater to the Headworks and associated screenings facility. Upstream of the piping inlet into the IPS and screening area, a manhole collects raw wastewater from three pipelines (President's Island, Nonconnah Creek, and Horn Lake Creek).

Stop Logs (HW-SP-1, HW-SP-2, HW-SP-3, and HW-SP-4)

Both coarse screening channels are provided with upstream and downstream manually operated stop logs for isolation of the channel and of the associated bar screen for inspection and maintenance. Each stop log is 5-feet wide provide leak tight isolation of the screen channels up to the high-water elevation.

Mechanical Bar Screens (CS-0100 and CS-0200)

Each mechanical bar screen is designed to pass a maximum flow of 85 mgd. Each mechanical bar screen consists of bars set at 85 degrees from horizontal with 1-inch clear openings that capture and remove coarse materials and rags. Debris is removed from the rack by a stainless-steel traveling rake assembly meshing with the bar screen. Overflow bypasses are available from each bar screen to allow raw wastewater to enter the plant in the event the screenings removal equipment has failed or is out of service.

The debris is removed from the bar rack by a 316 stainless steel rake assembly designed to mesh with the bar rack. The rake assembly consists of a shelf and rake tines attached to the rake arm. The rake assembly is supported and driven by a motor carriage assembly with drive and guide shafts and rollers to support the assembly from the side channels. The main drive shaft, mounted to the motor carriage assembly, includes a cog wheel attached at each end. The cog wheels rotate on and are supported by pin racks or gear racks in the guide frame assembly. The rake assembly is held in a fixed position relative to the bar rack by rubber-covered coil springs. Proper alignment of the rake assembly is accomplished by guide shaft rollers which travel in guide tracks attached to the side frame.

The rake arm can lift up to 100 pounds of screenings per foot of rake width per cycle. The rake arm assembly is held in a fixed position relative to the bar rack by heavy duty coil springs. Guide follower rollers, traveling in tracks, are attached to the side to direct the travel of the rake arm and maintain proper alignment. Each mechanical bar screen is equipped with positive overload protection against objects too large to be bypassed. If the load on the rake carriage mechanism increases beyond a predetermined set point, the drive and linkage will rotate causing a limit switch to activate stopping the drive.

Each mechanical bar screen is driven by a fully submersible electric motor and associated gear box. The motor is rated at 5 horsepower. The drive unit is designed to operate continuously in a severe duty environment.

The bar screens are designed so that the rake can climb over and be free of an object encountered that cannot be removed. After the object has been bypassed the rake will again mesh with and continue to clean the bar rack. Positive overload protection against an object which is too large to be bypassed is provided by connecting the lower rake arms to the fixed upper rake arms via a spring-restrained rotating support. If the load on the rake carriage mechanism increases beyond a predetermined value, the rake arm will rotate, causing a limit switch to reverse the drive. The screen is designed that if any part of the rake system becomes jammed in reverse, the unit will automatically stop.

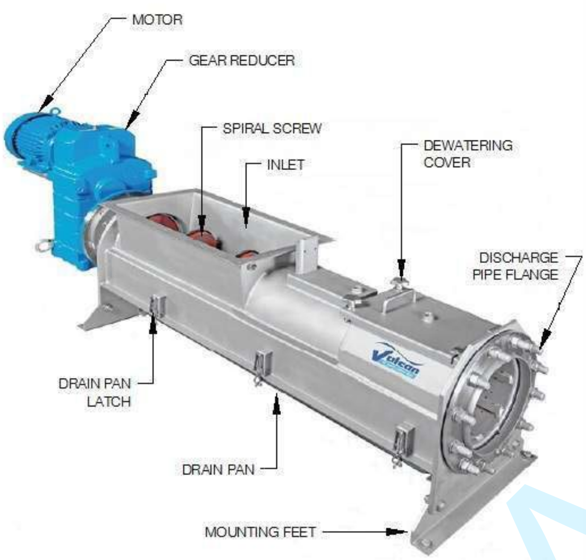
Coarse Screen Rake (Typical)

The dead plate, guide frame and pin racks, and traveling rake are constructed of 316 stainless steel to provide long service and prevent corrosion. A safety cage is located on each unit at the floor level. The safety cage is constructed of 316 stainless steel and will immediately stop the screen if the cage door is opened during operation.

The screen rake travels forward over the discharge chute apex by action of the guide shaft in conjunction with cams in the side frames. The accumulated debris is removed by a wiper blade. The wiper assembly is designed to pivot to allow efficient cleaning of the rake on each pass and is gently repositioned by the travel of the rake assembly. The wiper assembly is constructed of 316 stainless steel, with a replaceable wiper blade constructed of ultra-high molecular weight (UHMW) polyethylene. Captured rags and debris are discharged to the washing press.

Washing Presses (WP-0110 and WP-0210)

Captured rags and debris collected by a mechanical bar screen are discharged into the inlet hopper of an associated washing press. The washing press is provided to remove organics and reduce the moisture content and volume of screenings material collected by the mechanical bar screens. Screenings enter the inlet hopper of the washing press and are transported by a rotating screw into the washing zone. While in the washing zone, washwater is sprayed through the hollow shaft screw and into the screenings material to help dissolve and remove organic material.



Washing Press Overview WP-0110 and WP-0210

The washing press can be operated locally or remotely and may also be operated continuously or intermittently. Emergency stops have been installed on each press's LCP for deactivating the unit during an emergency condition. The unit may be deactivated by pressing the emergency "Stop" push button adjacent to the equipment.

Inlet Hopper and Housing

The inlet hopper is designed to direct screenings material from the bar screen into the screw housing. The screw housing is constructed of 316L stainless steel and surrounds the compacting screw and screen. The dewatering section contains anti-rotation bars around the circumference of the housing to contain the screenings material and prevent rotation of the screenings during the dewatering process. Washwater inlets are located on top of the washing and dewatering zones to allow for periodic flushing. A removable cover, located at the dewatering section, is held in place by a latching mechanism.

Wash Press Screw

Each wash press is equipped with a hollow-shaft screw constructed of alloy steel with an outside diameter of 11.5 inches. The hollow shaft is 2.75-inches in diameter and includes perforations located in the washing zone to allow washwater to be injected into the screenings from the inside out. The flights are 1-inch thick move the screenings into the washing zone and compaction dewatering zones. A stainless-steel reinforced nylon brush is attached to the hollow shaft screw with setscrews in the drainage area to help prevent debris from blinding the drain.

Drive Motor and Gear Reducer

The washing press is powered by 7.5 horsepower, close-coupled motor attached to a gear reducer. The motor is protected from overcurrent by a current sensing relay located in the screening system main control panel. The gear reducer is a right-angle helical bevel gear reducer.

Washwater Manifold

The washwater manifold includes five solenoid valves, five stainless steel ball valves and a pressure gauge. The solenoid valves are activated by the programmable logic controller (PLC) in the main control panel to provide washwater intermittently during cleaning and flushing cycles. The washwater manifold is mounted on a support stand. Braided flexible hoses connect the wash water manifold and the spray connections on a washing press.

Drain Pan and Screenings Discharge

Each press's drain pan is mounted to the bottom of the screw housing along the full length of the housing. The drain pan, constructed of 316L stainless steel, is sloped towards the drain and is provided with a flushing nozzle on the dewatering end and a 4-inch diameter drainpipe on the drive end. The pan is held in place by a latching system to allow fast and easy removal. A watertight seal is located on pan's top edge to form a watertight seal with the screw housing to prevent leakage.

The compacted screenings' discharge pipe is mounted to the pipe flange on the press body and is designed to transport the washed, dewatered and compacted screenings to the roll off dumpster. The discharge pipe is constructed of 316L stainless steel includes a 6-inch square opening and 8-inch square cover for inspection of the screenings.

Safety Lanyard

An emergency safety lanyard type pull cord is supplied around the perimeter of the washing press. This cable can be pulled in an emergency, immediately stopping the press.

Gas Detector (AIT/ASH-0300)

The screenings area is equipped with a gas detection analyzer. The analyzer is set to generate an alarm that will activate at 10-perecent Lower Explosive Level (LEL) for methane gas. An alarm will also activate at the plant's control room.

Ventilation

The Headworks is equipped with exhaust fans providing forced air ventilation.

Table 2.3-1 provides the design criteria for the screenings systems.

Table 2.3-1 System Data – Screenings Removal Equipment

Component	Value
Mechanical Bar Screens	
Quantity:	2
Tag:	CS-0100 and CS-0200
Manufacturer:	Vulcan
Model:	FT-78
Serial Number:	18514-450-1 and 18514-401-1
Type:	FT-78 Severe duty Mensch
Capacity/Screen: Flow, average per screen (both in service) Flow, maximum per screen (both in service)	 45 mgd 85 mgd
Bar Spacing:	1-inch
Mechanical Bar Screen Motors	
Quantity:	2
Manufacturer:	Vulcan
Serial Number:	119-06921-01 and 119-06921-02
Enclosure:	TENV
Frame:	C210CZ
Horsepower:	5
RPM:	1770
Phase:	3
Volts:	460
Hertz:	60
Full Load Amps:	7
Service Factor:	1.15
Duty:	Continuous
Class:	B
NEMA Code:	H
Drive End Bearing:	30BC02XDD30
Opposite End Bearing:	40BC02XDD30
Mechanical Bar Screen Gear Reducers	
Quantity:	2
Manufacturer:	SEW Eurodrive
Model:	87.7787935101.0001.19.50
Type:	SA97AM213/215
Mount:	M3A
Ratio:	161:74

Table 2.3-1 System Data – Screenings Removal Equipment

Component	Value
Bar Screen Brake Motors	
Quantity:	2
Manufacturer:	Stearns
Model:	106536105039
Horsepower:	5
RPM:	1770
Serial Number:	1238206020-00001-0919-01 1238206020-00001-0919-02
Ft lbs-Torque:	15
Voltage:	460
Washing Presses	
Quantity:	2
Tag:	WP-0110 and WP-0210
Manufacturer:	Vulcan
Model:	EWP
Screw Diameter:	12 in (OD)
Dry Solids Content:	30 %
Minimum Organic Removal:	90 %
Minimum Volume Reduction:	50 %
Capacity/Wash Press: Batch Continuous	 53 Ft^3/hr 159 Ft^3/hr
Washwater Requirements:	27 gpm maximum between 35 and 60 psi
Washing Press Motors	
Manufacturer:	Baldor-Reliance
Model Number:	07J475X790G1
Frame:	213TC
Enclosure:	XPFC
RPM:	1770
Horsepower:	7.5
Phase:	3
Volts:	230/460
Hertz:	60
Full Load Amps:	19/9.5
Service Factor:	1.15
Duty:	Continuous
Insulation:	Class F

Table 2.3-1 System Data – Screenings Removal Equipment

Component	Value
Washing Press Gear Reducers	
Manufacturer:	Siemens
Model:	FKAF129-K5-(210)
Type:	Parallel Helical Gear
Ratio:	114.06:1
Input RPM:	1770
Output RPM:	16
Influent Chamber Level Transducers	
Tag:	LT-0100
Quantity:	1
Manufacturer:	TE Connectivity
Type:	Hydrostatic submersible level transducer
Accuracy:	+/-0.25%
Influent Chamber High Level Float	
Tag:	LSH-0100
Quantity:	1
Manufacturer:	Dwyer
Type:	Vertical float switch
Model:	F7-ST713
Material:	316 stainless-steel

A separate local control panel (LCP) is provided for each mechanical bar screen (LCP-0100 and LCP-0200) and each washing press (LCP-0110 and (LCP-0210).

Each mechanical bar screen and associated wash press are provided with independent local emergency stop pushbuttons that deactivate the equipment immediately in an emergency condition. Emergency Stop activation requires pushing the red mushroom pushbutton to the in (engaged) position and restarting equipment will require the push button to be pulled back out to the normal (disengaged) position.

Screen System Monitoring

High Level Float

A high-level float has been installed in the influent channel to detect elevated water levels entering the bar screens. When the high-level float is activated, the screens will activate and operate until the high-level float return to its normal position.

Motor and Brake High Temperature Protection

A high temperature sensor in the screen's brake and motor has been provided to prevent elevated brake temperatures from causing harm to the bar screen. The motor and brake thermals are wired in series. When a sensor detects high brake temperatures, the screen will shut down, the high temperature alarm light will illuminate, and the audio alarm will sound. The cause of the temperature rise must be corrected before restarting the bar screen.

Solid State Motor Overload Device

The motor starter is equipped with solid-state circuitry that will shut down the motor and associated screen. The overload can be reset by pushing the overload reset once the overload condition has been corrected.

High Torque Protection

An over-torque current sensing relay (CSR) is provided as part of the rake alarm assembly. Once tripped, the screen will stop immediately, illuminate the screen over-torque alarm light. When the motor is overloaded, the CSR senses the amp draw and de-energizes the motor starter, stopping the motor. The CSR is calibrated in the field at start-up and should be tested periodically.

Over Rotate Protection

A over rotation limit switch is mounted on the rake and trips when the maximum collapsibility of the rake has been reached and prevents the rake from possible damage caused by overly large objects.

Phase Monitor

The installed mechanical bar screens are powered by 3-phase power rated at 460 volts. Each screen is equipped with a phase monitor to ensure all three legs are providing adequate voltage +/- 5 percent. The monitor is provided to prevent single phasing.

Emergency Stop Push Buttons and Safety Lanyard

E-stop push buttons are located at the local control stations. Pushing the button in will shut down the equipment, whether in hand or auto mode. To reset the e-stop, the button must be manually pulled out. Each mechanical bar screen and washing press is provided with a local emergency stop push button that deactivates the equipment immediately when the Emergency Stop pushbutton is pressed. An emergency stop safety lanyard also surrounds each washing press.

2.3.3 Equipment Control

The following tables identify the local controls associated with the Headwork's coarse screening removal system. Each mechanical bar screen and associated washing press work as a pair and have a combined Main Control Panel (MCP) and individual LCPs. The MCP contains selector switches, alarm resets, and an Operator Interface Panel (OIP) that provides touchscreen control for operating and monitoring the screening equipment. An Ethernet switch is included in the control panel to allow connection between the PLC and the OIP. This switch will also enable communication between the control panel and plant SCADA system. Each MCP is also equipped with a local disconnect switch for isolation purposes.

In addition, individual LCPs are provided for each screen. Each LCP is located adjacent to its respective equipment and housed in a NEMA 4X enclosure. The LCPs that provide operational capabilities for the mechanical screens and washing/compacting equipment.

The Headworks screening area is also monitored for explosive gases by a gas detector. An annunciation panel is provided to identify excessive gas levels.

Main Control Panel (MCP) (Typical)

Table 2.3-2 provides the controls and monitoring located at the Main Control Panels (MCP-0100 and MCP-0200) for the mechanical bar screens and washing presses. Each NEMA 4x MCP is powered by a 480 volts feed from panelboard PDP-HW.

Table 2.3-2 Main Control Panel – Mechanical Bar Screen/Washing Press

Control Name/Location	Features	Function
On-Trip-Reset	Panel Local Disconnect	"On" position allows electrical power from the electrical panel to the equipment controls. "Off" position stops all power from the electrical panel to the equipment controls. "Reset" allows breaker to be reset after circuit overload has been corrected.
On-Off	Control Power	In the "On" position, the panel is energized. In the "Off" position, the panel is not energized.
Control Power On	White Lamp	Illumination indicates that the local control panel is energized.
Over Rotate Retreat	On-Off Switch	On enables the over rotate protection for the press. The "Off" position disables the over rotate protection
Alarm Silence	Black Pushbutton	Depressing the pushbutton will silence the alarm horn. The condition will remain until the alarm condition has been corrected.

Table 2.3-2 Main Control Panel – Mechanical Bar Screen/Washing Press

Control Name/Location	Features	Function
Screen Common Reset	Black Pushbutton	Depressing the pushbutton will clear the screen alarm once the alarm condition has been corrected.
Press Common Reset	Black Pushbutton	Depressing the pushbutton will clear the washing press alarm once the alarm condition has been corrected.
Operator Interface Panel	Control/Monitoring/Alarms	Allows for operating and monitoring the screen and associated wash press at the MCP touch screen.
	Main Menu	Provides navigation buttons to the screens
	Screen Overview	▪ Operational status ▪ Motor status ▪ Upstream level ▪ Downstream level ▪ Differential Level ▪ Direction status ▪ Last Cycle ▪ Next Cycle ▪ Total Hours ▪ Park Limit Switch status
	Screen Settings	▪ Frequency Timer Preset ▪ Duration Counter Preset
	Level Settings	▪ Display upstream, downstream and differential level. High Differential On/Off set points ▪ High Differential Active/Inactive status ▪ High-high Differential On/Off set points ▪ High-high Differential Active/Inactive status
	Wash Press Overview	▪ Operational status ▪ Motor status ▪ Screen Cycles ▪ Wash Cycles ▪ Total Batch Time ▪ Remaining Batch Time ▪ Total Hours
	Wash Press Settings	▪ Acknowledge Alarms ▪ Silence Alarms ▪ Alarm Status ▪ Acknowledge All ▪ Clear All ▪ Sort Alarms
	Alarm Banner	▪ Acknowledge Alarm ▪ Silence Alarms ▪ Clear Alarm
	Alarm History	▪ Acknowledge Alarms ▪ Silence Alarms ▪ Alarm Status ▪ Acknowledge All ▪ Clear All ▪ Sort Alarms

Table 2.3-2 Main Control Panel – Mechanical Bar Screen/Washing Press

Control Name/Location	Features	Function
	System Information	▪ Job # ▪ Installed Date ▪ PLC IP address ▪ HMI IP address ▪ Vulcan Setup
Horn	Audible Alarm	Activation of the horn indicates that an alarm condition is present.
Strobe	Amber Strobe	Activation of the strobe indicates that an alarm condition is present.
Alarm Silence	Black Pushbutton	The horn can be silenced by pressing the "Silence" pushbutton. The alarm will remain until the alarm condition has been removed.

Table 2.3-3 provides the local controls at the LCPs (LCP-0100 and LCP-0200) for each coarse screen. The control is located in close proximity to its respective screen and is housed in a NEMA 4X enclosure.

Table 2.3-3 Local Control Panel – Mechanical Bar Screen (LCP-0100 and LCP-0200)

Control Name/Location	Features	Function
Hand/Off/Auto	Selector Switch	The "Hand" position will allow the screen to run continuously. The "Off" position will not allow the screen to run. The "Auto" position will allow the screen to run automatically based on time or level.
Forward-Off-Reverse	Three-way Switch	Allows the operator to control the screen when the H-O-A switch is placed in the "Hand" position. Placing the F-O-R selector switch in "Reverse" will operate the bar screen in counterclockwise. Placing the F-O-R switch in "Off" will prevent the screen from operating. Placing the F-O-R switch in "Forward" will operate the screen clockwise.
Emergency Stop	Red Mushroom Pushbutton	Depressing the E-Stop will stop the screen immediately. Pulling the E-Stop button out is required to reset the E-Stop and allow for a screen to restart.

Table 2.3-4 provides the local controls at the LCPs (LCP-0110) for each washing press. Each LCP is located in close proximity to its respective washing press and is housed in a NEMA 4X enclosure.

Table 2.3-4 Local Control Panel – Washing Press (WP-0110 and WP-0210)

Control Name/Location	Features	Function
Hand/Off/Auto	Selector Switch	The "Hand" position will allow the press screw to run continuously. The "Off" position will not allow the press screw to run. The "Auto" position will allow the press to run automatically.
Initiate Batch	Pushbutton	Initiates washing press operation.
Forward-Off-Reverse	Three-way Switch	Allows the operator to control the press when the H-O-A switch is placed in the "Hand" position. Placing the F-O-R selector switch in "Reverse" will operate the press in counterclockwise. Placing the F-O-R switch in "Off" will prevent the press from operating. Placing the F-O-R switch in "Forward" will operate the press clockwise.
Emergency Stop	Red Mushroom Pushbutton	Depressing the E-Stop will stop the press immediately. Pulling the E-Stop button out is required to reset the E-Stop and allow for a washing press to restart.

The following provides a description of the loops associated with the coarse screens and the washing press. The bar screens will normally be operated in Auto controlled by the MCP-PLC.

Bar Screen Influent Channel Level

An analog signal proportional to the water level measured is hardwired from the transmitter to MCP-PLC. A high-level float switch is hardwired to PLC, indicating emergency high level, and turning on all bar screens and the washing press. High level and high-high level setpoints are set in the PLC. The high-high level setpoint is set the same as the float switch elevation and will generate alarm when high level is detected. The water level measured, and active alarms are indicated at the OIP, located on the front panel of the PLC.

Mechanical Bar Screens

Control of the coarse bar screens is programmed in the MCP-PLC. The running status and common trouble alarms are hardwired from each bar screen control panel to PLC. Elapsed run time is also calculated for each bar screen. These conditions are displayed at the OIP.

Combustible Gas Monitoring

The combustible gas concentration (0-100 percent LEL) and high alarm (10 percent LEL; adjustable) signals are hardwired from each instrument to PLC-1. These conditions are indicated/alarmed at the OIP.

2.3.4 Operation

Normal Operation

The normal mode of operation for the coarse screen and associated wash press are in the automatic mode as selected at the MCP and controlled by the operator at the OIP at MCP-PLC. In the automatic mode of operation, inlet channel water level and adjustable timers activate each screen and subsequently the associated wash press. A typical screening cycle activates the lead screen with the other screen remaining idle unless the water level in the inlet channel continues to rise. The lead screen rotates following each cycle to the next available screen. Once activated by the level set-point, the screen operates for the duration set on the timer. Once the screens shut down, the wash press continues to operate for the duration set on an adjustable timer prior to shutting down. When operation of the screening system has been initiated, the cleaning cycle proceeds until the carriage travels to the top of the frame.

The bar screen can be started by any of the three parameters below.

1. Repeat cycle timer within the PLC
2. Pressure differential level sensor
3. High water level float switch

When the PLC based repeat cycle timer “off” time times out the repeat cycle timer “on” time will be initiated. The motor starter coil, the running indicator on the OIP and run relay is energized. If the time set in the repeat cycle timers “on” time is set for a short time period, the bar screen makes one cycle and parks at the end travel limit switch (LS-1). The pressure differential level sensors may also start the bar screen. When the preset/adjustable differential level set point is reached, the screen starts in the forward direction. The bar screen continues to run as long as a differential level condition is present. If a high-high differential level condition is detected above high-high set point OR if the high-water level float switch closes, the bar screen starts and continues to run until this condition is no longer present. This condition also causes the Washing Press to run continuously in Storm Water Mode until the high-high condition is no longer present. The end travel limit switch forms the holding circuit for the bar screen. The bar screen will park at this limit switch when a run signal is no longer present.

During normal loading conditions, the washing press utilizes an adjustable cleaning process that includes a minimum of four washing cycles to ensure thorough cleaning of the collected screenings. During peak loading conditions, the washing process automatically switches to operate in the forward direction to handle the larger increased load of screenings with only short intervals of reversing to ensure that material does not accumulate on the shaft of the screw. In addition, manual ball valves are provided at each washwater solenoid valve to allow Maxson plant operations staff to isolate the solenoid valves and/or throttle the flow of washwater to the washing press screw.

Note: There is a power transfer relay mounted in MCP-0100 connected to the secondary side of the control power transformer. The relay is used to transfer power to the level transmitters and the high-level float switch. When control power is lost or the main breaker is off within MCP-0100, the relays transfer control power to the level transmitter and float switch from the second control panel MCP-0200. The single differential level system and single float switch controls both screens when either is system is activated.

Alternate Operation

Alternate operations indicate that one or more components of the screenings removal system will be out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control. For instance, all pieces of equipment associated with screenings system can be operated locally at the LCP or through the MCP-PLC.

Shutdown Considerations

1. At the MCP, Place control switches for both the mechanical bar screens and the washing press in the "Off" position.
2. At the LCP for each mechanical bar screen, place the Hand/Off/Auto selector switch in the "Off" position.
3. At the LCP for each mechanical bar screen Place the Reverse/Off/Forward switch at each mechanical bar screen in the "Off" position.
4. At the LCP for each washing press, place the Hand/Off/Auto selector switch in the "Off" position.
5. Place the mechanical bar screen and washing press local disconnect on the MCP in the "Off" position.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Confirm the gas monitor is operating and has been calibrated properly.
3. Confirm the odor control system is operating all odor control withdrawal piping is functional and all dampers are properly set.
4. Inspect the screenings equipment for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the screenings equipment only when it is in good working condition.
5. Ensure that only authorized personnel are allowed in the in the screenings area and no one might be injured when equipment is activated.
6. Ensure all motors, gears, and bearings have been properly lubricated using the manufacturers recommended lubricant.
7. Confirm all maintenance and/or repairs have been completed.
8. Remove any existing lockout devices and follow lockout/tagout procedures for each mechanical bar screens and the washing/compacting equipment.

9. Verify that the local disconnect at the MCP for each mechanical bar screen and washing press to be started is in the “Off” position.

10. Verify that the Local/Off/Auto switch at each LCP is in the “Off” position.

Mechanical Bar Screen LCP (Typical)

11. Check on the readiness of all upstream and downstream equipment such as the pumps, level controls, etc.

12. Confirm the influent chamber high level float and influent and effluent level transducers are functioning properly.

13. Check each bar screen channel for heavy debris.

14. Verify that there are no obstructions at each bar screen or the screenings washing press.

15. Visually inspect the chamber water level and incoming flow to ensure safe operating conditions.

16. Energize the MCP, by placing the local disconnect and control power switch in the “On” position.

17. At the LCP. Momentarily place the Hand/Off/Auto selector switch in “Local.” Place the Reverse/Off/Forward switch in “Forward” position.

18. Observe the carriage assembly for proper rotation.

19. After confirming rotation, return the F-O-R selector switch to "Forward" position and allow the screen to make one complete cycle. Be prepared to turn the switch to "Off" in case of a problem.
20. After one complete cycle, check the operation of the reverse motion switch. Visually locate the reverse motion switch. Place the F-O-R switch in the "Reverse" position and allow the carriage to pass the reverse motion switch. At this point, stop the machine by returning the Reverse/Off/Forward switch to the "Off" position. Place the Hand/Off/Auto switch in the "Off" position.
21. Confirm all safety devices and proximity switches are functioning properly.
22. Place the local disconnect and control power switch at the MCP in the "Off" position.

Startup

1. At the MCP, place the main breaker for each mechanical bar screen and washing press in the "On" position.
2. At the MCP, place the control power switch in the "On" position.
3. At the LCP for the screen, place the Reverse/Off/Forward switch in the "Forward" position.
4. At the LCP for the screen, place the Hand/Off/Auto switch in the "Forward" position.
5. At the LCP for the washing press, place the Hand/Off/Auto switch in the "Auto" position.
6. Each operating bar screen and associated washing press will be started remotely, controlled by the MCP and influent channel level.

Routine Checklist

The mechanical bar screens and washing press system should be inspected for the following items when in operation:

1. Closely monitor the bar screen to be sure the screen is tracking smoothly on the guide rails and sprockets.
2. Verify the rake arm is removing screenings properly.
3. Visually inspect the screening elements to check for possible damage.
4. Check that screenings are not hanging up in the discharge area.
5. Check the screen and press drive motor for unusual noise, vibration, misalignment, and/or excess heat.
6. Inspect all control panel switches for proper positioning.
7. Confirm the end of travel limit switch "stop" position is correct.

8. Confirm automatic greaser cups are operating proper and the grease level inside cups is showing an adequate level.
9. Check that power cable carrier links are snapped together with no binding, smooth transition to the trough.
10. Confirm the power cable and over-rotate switch cable is secure with no binding.
11. Confirm all cable grips are functioning properly with no visual corrosion.
12. Confirm the wiper is engaging the rake shelf properly with the wiper is in full contact, side to side, with the rake shelf. Confirm the wiper removes all screenings from rake shelf.
13. Confirm the rake stops smoothly with no grinding noise or excessive coasting.
14. Record the volume of screenings being removed.
15. Document any equipment malfunction and the corrective action implemented.
16. Check to see that all safety guards are in place and personnel are clear of the equipment.
17. Observe the rakes on the bar screen. Confirm rake teeth are aligned between the openings between the bars.
18. Check the screen forward indicating light at the OIP. The red screen forward indicating light on the local control panel and the distribution control system should be illuminated when the screen is in operation.
19. Check the screen reverse indicating light on the local control panel. The red screen reserve indication light on the local control panel should not normally be illuminated.
20. Check the torque overload indicating light on the OIP. The alarm will activate when the screen has shut down due to a mechanical bind or heavy object in or on the rake arm or screen. Removing the object or reducing the binding by reversing the screen will reset this alarm.
21. Check for high chamber level alarms and indicating lights at the OIP. If the screen is operating when the high-level probe detects a high-water level in the influent channel, the unit will complete its cycle and park at the top of the machine.
22. Confirm the screenings and washing press conveyor gearbox oil level at the proper level.
23. Check the screenings press for unusual noise or accumulation of debris in the screenings.
24. Confirm screening are being discharged for the bar screens.
25. Confirm washed and compacted screenings are being discharged from the washing press outlet pipe.
26. Check the storage hopper for the level of material, and empty hopper as needed. Do not allow dumpster to sit with screenings debris over long periods of time.

Troubleshooting

The following identifies problems that may be encountered during the operation of the screenings system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 2.3-5 provides troubleshooting information for operational issues associated with the mechanical bar screens.

Table 2.3-5 Troubleshooting Guide - Mechanical Bar Screens

Problem	Probable Cause	Recommended Action
Rake moves in opposite direction as indicated on the control panel	Incorrect wiring	Reverse leads on motor
Rake running rough, bouncing or chattering	Rake fasteners loose	Check all rake fasteners
	Rake not adjusted properly	Verify rake is adjusted properly to the bars and dead plate. Adjust the block gap equally on both sides to keep shafts parallel.
	Bearing wear or failure	Check Drive Roller Bearings; replace failed bearings. Check Guide Roller bearings, replace failed bearings.
	Worn cog wheel(s)	Cogwheel(s) worn, replace as matched set only!
	Worn/seized pin rack	Check for worn/seized pin rack Rollers, replace as required.
	Brake not adjusted properly	Verify brake is properly adjusted. Secure rake before inspecting.
Grinding/chattering noise emitting from drive	Brake not adjusted properly	Check brake adjustment, adequately secure rake before conducting inspection, follow proper safety guidelines established within the facility.
	Motor bearing problems	Remove and repair motor; follow proper safety guidelines established within the facility.
	Spider wear	Check spider for wear. Replace as needed.
	Gear wear	Check for gear wear. Rake removal required, follow proper safety guidelines established within the facility.
Rake operating intermittently	Damage to power cables	Inspect power cables for damage and fraying; follow safety guidelines established within the facility.
	Object obstructing rake path causing overload,	Manually operate and watch for unusual operation.
Rake does not stop in parked position	Check the gap between the limit switch and the read angle	Gap should be less than ½ inch.
Rake does not engage bar rack properly	Misalignment	Realign rake teeth to bar rack.

Table 2.3-5 Troubleshooting Guide - Mechanical Bar Screens

Problem	Probable Cause	Recommended Action
Rake tooth penetration too deep or too shallow	Rake jumps off dead plate or screenings dropping off rake shelf after cleaning bars.	Verify spring tension jam nuts are secured above and below rake tension springs. Adjust lower jam nuts to increase/decrease tooth penetration. (Teeth should travel 1/16" to 1/4" off dead plate)
Rake shelf misaligned with bars, rubbing pin rack		Verify Spring Tension Jam Nuts are secured above and below rake tension springs.
	Rake teeth out of alignment	Adjust the rake shelf support tubes to square rake teeth with bars.
	Cogwheel timing out of adjustment	Verify cogwheel timing. If found out of time correct the problem.
Cogwheel timing not set properly	Rake installed incorrectly	Correct rake Installation.
	Roller missing for pin rack	Pin rack roller missing.
	Drive roller bad	Bad drive roller allowing cogwheel to jump.
	Worn key seats	Check key seats for wear.
Bar screen fails to start	Open circuit	Check with voltmeter or test light.
	Blown fuse	Check fuses with voltmeter, replace if necessary.
	Magnetic starter failure	Check overload reset.
Bar screen trips while operating	Check alarm status	Correct alarm conditions.
	Low line voltage	Check voltage at motor leads.
Bar screen vibrates	Misalignment	Check alignment, correct wear necessary.
	Bearing failure	Check bearings, replace or lubricate as necessary.
Bar screen motor draws excessive current	Low voltage	Check leads with voltmeter.
	Gearbox over pressure	Check fluid level, adjust to proper level.
	Bearing seized	Check bearings, replace or lubricate as necessary.
	Blockage in tracking	Remove blockage.
Bar screen motor hums	Motor is single phasing	Check phasing.
	Brake does not disengage, brake coil failure	Replace coil.
Excessive noise when bar screen operating	Worn bearings	Check bearings for wear, replace as necessary, lubricate adequately.
Oil leaking from drive unit	Seals defective	Check the following seal for leaks: motor flange, motor oil seal, gear unit flange, and output end oil seal. Replace faulty seals.
	Gear unit not vented	Vent gear unit.

Table 2.3-5 Troubleshooting Guide - Mechanical Bar Screens

Problem	Probable Cause	Recommended Action
No control power available	Control panel disconnect turned "Off.	Turn control panel disconnect to the "On" position.
	Supply voltage to control panel turned "Off"	Turn the supply voltage source to the "On" position.
	Control Power switch turned "Off"	Turn Control Power switch to the "On" position.
	Control power fuse blown.	Replace control power fuse. Check for short circuit.
	Emergency Stop button pushed.	Pull Emergency Stop button out.
	Hand-Off-Auto switch in the "Off" position	Turn switch to the “Auto” position.
	Motor overloaded or over current	Investigate and correct cause. Push Press Common Reset push button to reset.
	Motor overload	Check for phase loss or short circuit in high voltage feed. Press reset on solid-state motor overload to reset. Monitor operation.
Screen runs continuously	End Travel limit switch failed.	Replace limit switch.
	Channel level condition not met	Check level measurement device and observe operation.
	Hand-Off-Auto switch is in "Hand" and For-Off-Rev switch is in "For”	Place the Hand-Off-Auto switch in the “Auto” position.
	No time preset in the PLC based Duration timer	Use OIT on control panel to check set point of duration. Adjust as required. Observe operation, re-enter if necessary.
Overcurrent Indication on OIT.	Current sensing relay tripped.	Check for large debris on the front of the screen. Remove debris. Check for binding of rake. Adjust as needed. Press Screen Reset push button to reset.
Over rotate Indication on OIT.	Over rotate sensing relay tripped.	Place Hand-Off-Auto switch in “Off” position. Press Screen Common Reset push button to reset. Place Hand-Off-Auto switch in "Hand" and “For-Off-Rev” switch in “Rev” to run rake in reverse away from obstruction. Remove obstruction before resuming automatic operation.
Motor Overload Indication on OIT.	Solid-state motor overload tripped	Check for short circuit or phase loss in the high voltage circuit. Check for loose terminal connections in the high voltage circuit. Press Screen Common Reset push button to reset.

Table 2.3-6 provides troubleshooting guidance for the operational issues associated with the washing press.

Table 2.3-6 Troubleshooting Guide – Washing Press

Problem	Probable Cause	Recommended Action
Wash press will not run	Not receiving run signal	Check controls and confirm run signal to press.
	E-Stop switch is open	Reset E-Stop switch.
	Other permissive not allowing press to start	Check permissive, such as zero speed switch.
	Screw jammed	Remove or clear jam.
	Motor failure	Replace motor.
	Motor overloaded or over current	Investigate and correct cause. Push Press Common Reset push button to reset.
Compactor motor trips on overload	Foreign body in the screw	Remove foreign body. Push Press Common Reset push button to reset.
	Obstruction in the outlet piping	Ensure no obstructions present in outlet piping.
Washing press not running and water running into press	Foreign material in solenoid valve.	Use ball valve to isolate affected valve. Disassemble valve, clean & inspect valve, reassemble valve.
	Solenoid valve failed.	Replace solenoid valve.
Motor overload	Phase loss or short circuit	Check for phase loss or short circuit in high voltage feed. Push Press Common Reset push button to reset. Monitor operation.

2.3.5 Maintenance

Process Maintenance

The general maintenance for the coarse bar screens equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the coarse bar screens consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 2.3-7 provides the manufacturer's and service representative's contact information for the mechanical bar screens.

Table 2.3-7 Contact Information – Mechanical Bar Screens

Manufacturer	
Name:	Vulcan Industries, Inc.
Address:	212 S. Kirlin St. Missouri Valley, IA 51555
Phone:	712-642-2755
Fax:	712-642-4256
Website:	**www.vulcanindustries.com**
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-377-3952
Fax:	615-373-2701
Website:	**www.jtguthrie.com**

Table 2.3-8 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the mechanical bar screens.

Table 2.3-8 Maintenance Schedule - Mechanical Bar Screens

Frequency	Maintenance Task to be Performed
Daily	1. Inspect bar screen for proper operation, excessive vibration or unusual noise.
Weekly	1. Grease drive shaft and pillow block bearings 2. Clean and lubricate pin racks and cam tracks using recommended lubricant. 3. Check gear box for proper level and /or leaks, fill to appropriate level. 4. Visually inspect and clean area. 5. Confirm grease is flowing from lubricator reservoir. Refillable canisters should be checked weekly to verify grease flow to the bearings (this can be a visual inspection). Canisters should be refilled when half empty.
Monthly	1. Check torque on fasteners (pin rack bolts, latch bolts, rack to rack arm bolts, wiper brackets, knockout bolts, and pillow block collars, cogwheel collar, and set screws. 2. Lubricate all rake pivot points where zerk fittings are present. 3. Grease guide tracks and wiper bar and pivot points. 4. Ensure pin rack is clean and lubricated. 5. Check for proper operation of motor brake. 6. Check that rollers and bushing spin freely. 7. Check guide roller for excessive wear. 8. Ensure pin is secure and tight. 9. Inspect wiper blade. Adjust for proper contact. 10. Check gap on rake teeth and deadplate (rake teeth should be ¼” off deadplate) 11. Check location and function of proximity switches. 12. Check for proper functionality of screen, level transducer and high-level float.
Every 3 Months	1. Check Pin Rack alignment. 2. Replace grease cartridges on idler roller bearings and pillow block bearings. 3. Inspect wiper shock absorber for proper operation. 4. Check cog wheel teeth for excessive wear. 5. Check rake teeth and dead plate gap. 6. Check gear reducer expansion chamber. 7. Purge grease on gear box side seals.
Semi-Annually	1. Check wear on rollers, bushings, sprockets cam followers, latch, and wiper blade. 2. Check the oil level in the gearbox. A sample of the gear oil should be sent to the oil supplier for analysis. Periodic analysis will establish oil change intervals, based on the degradation of the oil.
Every 2 Years	1. Change oil in gear drives, replace anti friction bearing grease.

Note: The bar screens are equipped with grease cups that are located on the rake’s idler rollers and drive rollers. When conducting visual inspection and/or routine lubrication the lubricant level of the cup should be monitored. Grease should slowly dissipate. The cups are designed to lubricate for 3-month intervals. Continuous operation of the rake may reduce the change out time. Failure of the cup will result in rapid bearing deterioration.

Table 2.3-9 provides the manufacturer's and service representative's contact information for the washing press.

Table 2.3-9 Contact Information – Washing Press

Manufacturer	
Name:	Vulcan Industries, Inc.
Address:	212 S. Kirlin St. Missouri Valley, IA 51555
Phone:	712-642-2755
Fax:	712-642-4256
Website:	www.vulcanindustries.com
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-377-3952
Fax:	615-373-2701
Website:	www.jtguthrie.com

Table 2.3-10 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the washing press.

Table 2.3-10 Maintenance Schedule - Washing Press

Frequency	Maintenance Task to be Performed
Daily	Ensure all covers and guards are installed properly. Check drive and washing press for unusual noise or excessive vibration. Check for material spill at inlets and outlet.
Quarterly	Check shaft seals and maintain as necessary. Check shaft coupling bolts for tightness. Open trough covers and inspect for wear. Inspect flights for wear and wear pattern. Lubricate external conveyor bearings at drive end.
Semi-Annually	Change reducer oil initially after 500 operating hours. Drain and refill oil reducer. Regular oil changes should occur every 6 months. Check for misalignment of screw assembly.
Every 1200 Operating Hours	Lubricate motor bearings.

2.3.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

2.4 Influent Pump Station

2.4.1 Overview

The Influent Pump Station (IPS) at the T.E. Maxson WWTF is used to convey screened wastewater to the Grit Chamber downstream. Four dry-pit centrifugal pumps are installed in the IPS, and the speed of Influent Pumps 1, 2, and 3 are controlled by variable frequency drive controllers. Influent Pump 4 has a constant speed drive. Flow exits the dual coarse screening channels of the Headworks Building and splits into four separate channels, one for each pump in the IPS. Each pump in the IPS discharges into a 36-inch pipe, which combine into a 60-inch discharge header that conveys flow to the Grit Chamber. A tee is installed in the yard on this line downstream of the IPS for the emergency pumped plant bypass.

A plan and section figure of the IPS is presented as ***Figure 2.4-1 Influent Pump Station Plan and Section.***

2.4.2 Description

Pumps

The IPS contains four centrifugal pumps for conveying screened wastewater to the Grit Chamber for further treatment. The pumps are dry-pit submersible, non-clog, centrifugal pumps with three-phase induction squirrel cage motors. Each pump withdraws wastewater from a dedicated channel downstream of the coarse screens in the Headworks Building. The 1,200-horsepower motor for Pump 1 was replaced in 2002, and the 1,200 horsepower motors for IPS Pumps 2 and 3 were replaced in 2016 as part of an electrical upgrades project. Information on the IPS pumps is provided in ***Table 2.4-1***.

Table 2.4-1 System Data - Influent Pumps

Component/Criteria	Value	
Manufacturer:	Allis-Chalmers	
Model:	112-312-506	
Number of Pumps:	4	
Tag:	IPS-P-1, IPS-P-2, IPS-P-3	IPS-P-4
Motor Manufacturer:	Hyundai	General Electric
Model	HRN3 563-58V	5N635XJ1A
Rated Horsepower:	1200	700
Minimum Motor Full Load Speed (rpm):	509	445
Maximum Allowed Motor (FLA):	190.5	106.5
Motor Voltage/Phase:	4160 / 3	4160 / 3
Suction Size (inches):	36	36
Discharge Size (inches):	36	36
Capacity per pump (gpm):	50.4	50.4
TDH (feet):	58.5	58.5
Impeller Diameter (inches):	43.0	43.0
Motor Duty Rating:	Continuous	
Service Factor:	1.1	1.0
Motor Insulation Class:	F	F

All pumps are equipped with vibration switches manufactured by VibraSwitch to protect the equipment from excessive vibration. The motors for Pumps 2 and 3 are equipped with air coolers. The 1,200 horsepower motors are equipped with winding temperature detectors, bearing temperature detectors, space heaters, leakage detectors, and vibration sensors.

The IPS must be in service to maintain plant operations. It is extremely important to ensure adequate pumping capacity is available to convey screened wastewater to the grit removal system. If pump performance deteriorates or alarm conditions are recurring, investigation must take place to eliminate the risk of pump failure. The following alarms are associated with the Influent Pumps:

- Pump Discharge Pressure Low Alarm
- Pump Cutout Alarm
- Speed Controller Failure Alarm
- High Temperature in Speed Controller Alarm
- High Temperature in Motor Bearings Alarm
- High Temperature in Pump Bearings Alarm
- High Temperature in Motor Windings Alarm

- High Temperature in Motor Air Alarm
- Motor Vibration Alarm

Piping and Valves

Screened wastewater is conveyed to the IPS by the influent channel downstream of the coarse screens in the Headworks Building. This channel splits into four 15'-0" wide channels upstream of each pump. The suction side of the pumps consists of a 72" x 60" reducer and 60" x 36" reducing elbow cast into the slab beneath the IPS. Each pump has a manually operated 36" knife gate valve installed on the suction side for isolation.

A 36" x 30" hydraulically operated cone valve is installed immediately downstream of the discharge flange of each pump and is used for flow control and as a check valve. A double-acting piston operating in the hydraulic cylinder furnishes power to the crosshead of the operating mechanism of the valve. The discharge cone valves are electrically connected to the pump motor starting circuits. Alarms will sound if any of the discharge valves fail to either open or close.

A 36" manually operated knife gate valve is installed downstream of the cone valve on the discharge line for each pump. The 36" pipes combine into a 60" header in the lowest level of the IPS. A 6" manually operated plug valve is installed downstream of the 36" discharge piping connections to allow for draining of the header. The header pipe turns up, necks down to 48" for the magnetic flow meter in the first lower level, then expands back to 60" diameter before leaving the IPS below grade.

Information for the knife gate valves is provided in ***Table 2.4-2***.

Table 2.4-2 Influent Pump Station – Knife Gate Valves

Parameter	Value	Value
Application:	Suction	Discharge
Tags:	IPS-KGV-1A IPS-KGV-2A IPS-KGV-3A IPS-KGV-4A	IPS-KGV-1B IPS-KGV-2B IPS-KGV-3B IPS-KGV-4B

Information for the cone valves is provided in ***Table 2.4-3***.

Table 2.4-3 Influent Pump Station – Discharge Cone Valves

Parameter	Value
Tags:	IPS-CV-1 IPS-CV-2 IPS-CV-3 IPS-CV-4

The cone valves are equipped with position indicating transmitters that transmit the valve positions to SCADA. Alarms associated with the valves include the following:

- Failed to Move from Seat
- Failed to Open Fully
- Failed to Close Fully

The cone valves are actuated via a double-acting hydraulic cylinder with a piston rod firmly attached to the crosshead. The cylinders are separate, not cast integrally with the valves, so they are more accessible for servicing. The cylinders are hydraulically controlled with oil piping supplied by an oil accumulator located upstairs.

Instruments

The 48-inch flow meter is installed in a vertical position of the discharge piping in the second lower level of the IPS. Flanged fittings are installed upstream and downstream of the flow meter to reduce the pipe diameter from 60-inch to 48-inch. Information for the flow meter is provided in ***Table 2.4-4***.

Table 2.4-4 Influent Pump Station – Flow Meter

Parameter	Value
Tag:	IPS-FE-001
Manufacturer:	ABB Instrumentation
Model:	MagMaster
Size:	48”

Miscellaneous Equipment

A 15-ton bridge crane manufactured by Robbins-Myers is installed at the ground level of the IPS for lifting equipment from the lower levels. A column-mounted monorail with motorized hoist is installed at the first lower level. A boiler manufactured by Allis-Chambers is installed on the second lower level of the IPS, along with a compressor and air storage tank manufactured by Speedaire. Two sump pumps are installed in the lowest level of the IPS. The sump pumps are activated by float switches and are designed to pump out any water that may have accumulated in the IPS.

2.4.3 Equipment Control

The IPS pump control centers are located in the second lower level of the IPS. The level in the Headworks Building effluent chamber, upstream of the IPS, is measured by a submersible level transducer LT-0200 and sent to plant SCADA network. Controls for each pump include a pushbutton for starting and an emergency-stop. Indicator lights are provided at the pump control centers for the position of the discharge cone valve (open/close), the motor status, the discharge pressure switch status, control power failure, moisture sensor, and an alarm for the discharge cone valve if it fails to open. Vibration and temperatures are also monitored at the pump control centers. Temperatures for the upper motor bearings, pump bearings, and motor air are displayed, along with the status of two vibration sensors mounted on the pumps.

The level measurement upstream of the IPS is typically used to control the speed of the pumps automatically. The pump speeds can be controlled manually at the pump control centers human machine interface (HMI) by changing the settings from remote to local. The local pump control centers provide for manual starting, stopping, and varying the speed of each pump. Remote control of the pumps is provided from the plant SCADA system. Switching of pump control between the local pump control centers and SCADA is accomplished at the pump control center for each pump. A description of the pump local control components is provided in ***Table 2.4-5***.

Table 2.4-5 Control/Instrumentation Description – IPS Pumps

Control Name/Location	Features	Function
Motor Control Center On-Trip-Off	Main Breaker	"ON" position allows electrical power from the electrical panel to the local disconnect. "OFF" position stops all electrical power at the MCC. "TRIP" position stops all equipment and indicates electrical circuit overload.
On-Off	Local Disconnect	"ON" position allows electrical power from the VFD transformer to the local control panel. "OFF" position stops all electrical power at the MCC.
Local-Off-Remote	Selector Switch	"LOCAL" position allows the influent pumps to be controlled locally at the LCP. "OFF" position prevents the influent pumps from being operated. "REMOTE" position allows the influent pumps to be operated through the VFDs controlled by a remote signal from the PLC.
Start Pushbutton	Green Pushbutton	"Green" pushbutton is depressed to start the influent pump.
Stop Pushbutton	Red Pushbutton	"Red" pushbutton is depressed to stop the influent pump.
Motor On	Green Lamp	Indicates the influent pump is energized and operating. The light will go out when the pump stops.
Manual Speed Potentiometer	Minimum–Maximum speed 0 – 100%	Provides control of pump drive speed from 0-100% (minimum-maximum) when operating pumps in manual mode locally.
Speed Display	Displays Speed 0-60Hz	Operating pump speed is displayed in Hertz.
Temperature Display	Indicator	Displays temperature for pump bearing, lower motor bearing, upper motor bearing, and mag drive.
Vibration	Red Lamp	Vibration switch located on the drive motor will shut down its respective pump when excessive vibration is detected.
Power Failure	Red Lamp	Indicates that power supply to the pump has failed.
Pressure Switch	Red Lamp	Indicates the discharge pressure switch has been triggered, shutting down the pump.
Monitor Failure	Red Lamp	Indicates if a problem has occurred with the monitor.
Discharge Valve Failed to Open	Red Lamp	Indicates if a problem has occurred to cause the discharge cone valve to fail to open.
Cabinet Temperature	Red Lamp	Indicates if cabinet temperature is too high.

Magnetic drives are used to vary the speed of the IPS pumps and to provide a soft start. The speed can be manually controlled using the keypad on the magnetic drive panel.

2.4.4 Operation

During normal operation, the IPS is placed in the automatic mode of operation and the pump speeds controlled by the level downstream of the coarse bar screens.

Pre-Start Checklist

1. Inspect all electrical connections for completion.
2. Inspect the suction and discharge valves for proper operation and function. Verify that the discharge cone valves move freely with no evidence of obstruction.
3. Confirm that each pump is properly installed. Once pumps are operating, check to confirm no leakage.

Start-Up

1. Place the main breaker for each pump in the "ON" position.
2. Place the local disconnect at the pump control center in the "ON" position.
3. Select "Remote" from the pump HMI.
4. Start the desired pumps through SCADA control. Pump operation will be controlled by the wet well level downstream of the coarse bar screens.
5. Monitor the operation of the IPS pumps.

Shutdown

1. Select the "OFF" position for the intended pump at SCADA.
2. Pull out the "STOP" button at the pump control center.
3. Place the main breaker at the pump control center in the "OFF" position.

Typical Operation

The IPS normally operates continuously and is controlled remotely from plant SCADA network. The settings at the pump control centers are set to "Remote" operation. Pumps start, stop, and adjust speed based on the level measured downstream of the coarse bar screens and the operating time required to lower the water level. As a backup mode of operation, Pumps 1 through 3 can be started and stopped and their speeds varied manually at each pump control center and magnetic drive. Pumps 2 and 3 are controlled locally from the electrical building adjacent to the IPS.

Routine Checklist

1. Monitor the operation of the IPS.
2. Check that a level signal is provided from the instrument downstream of the coarse bar screens.
3. Inspect the pump control centers for proper settings.
4. Observe each pump operating, listening for unusual noise or excessive vibration.
5. Periodically inspect the operating and alarm control functions.
6. Ensure the bridge crane at the ground level is operational in case any equipment needs to be removed.

A troubleshooting guide for the influent pumps is provided in ***Table 2.4-6***.

Table 2.4-6 Troubleshooting Guide – Influent Pumps

Problem	Probable Cause	Corrective Action
Motor fails to start	Loose or poor connections in control circuits	Visually inspect all connections in control switch
	Motor overload	Reset motor overload at control panel
	Check level regulator	Confirm start level regulator is functioning. Clean or replace if necessary.
Motor fails to come up to speed	Low or incorrect voltage	Check voltage in control panel and at motor leads
	Mechanical overload	Check impeller setting, check for tight or locked shaft
Motor noisy	Worn thrust bearing	Remove dust cover and rotate rotor by hand, visually examine balls and races.
Failure to deliver water or insufficient capacity	Pump not primed	Prime pump.
	Speed to low	Adjust speed to proper setting.
	Impeller and/or suction/discharge piping plugged	Remove debris from plugged area.
	Rotation incorrect	Reverse two leads.
	Upstream/downstream valves not open	Open valves.
	Impeller damaged	Repair or replace impeller.
Power consumption too high	Speed too high	Lower speed to proper level.
	Packing gland too tight	Loosen packing gland.

Table 2.4-6 Troubleshooting Guide – Influent Pumps

Problem	Probable Cause	Corrective Action
Bearings overheat or have reduced operating life	Internal misalignment due to pipe strain or improper foundation	Confirm piping and foundation are aligned properly.
	Shaft bent or damaged	Replace shaft.
	Excessive lubrication of bearings	Remove excessive grease.
	Insufficient lubrication of bearings	Lubricate bearings properly.
	Incorrect type of lubricant used	Use only manufacturer recommended lubricants.
	Lubricant contaminated	Remove contaminated lubricant and replace with recommended lubricant.
	Bearings rusted due to water present in bearing frame	Locate and prevent water intrusion in bearing frame, replace bearings.
	Pump vibrating excessively	Correct excessive vibration.
	Worn bearings	Replace bearings.
	Rotating assembly not balanced	Balance rotating assembly.

2.4.5 Maintenance

Process Maintenance

The general maintenance for the influent pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the influent pumps consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

The service representative for the pumps is provided in ***Table 2.4-7***.

Table 2.4-7 Contact Information – Influent Pumps

Service Representative	
Name:	MAM Machine and Manufacturing LLC
Address:	8490 Tulane Rd. Southaven, MS 38671
Phone:	901-216-1960
Contact Person:	Don McCommon
Email:	Dynodonfab1@gmail.com

Provided in ***Table 2.4-8*** is a series of maintenance, inspection, and lubrication guidelines with the recommended frequency of these inspections and the nature of the tasks to be performed.

Table 2.4-8 Maintenance Schedule - Influent Pumps

Frequency	Maintenance Task to be Performed
Daily	Check pumping system for proper operation. Confirm level indicators are calibrated and functioning properly. Measure and record the bearing temperatures. Vent the cooler while in operation.
Monthly	Confirm pumps can produce the design capacity.
Every 2 years or 8,000 operating hours	Check cables. If the outer jacket is damaged, replace the cable. Check that the cables do not have any sharp bends and are not pinched. Check that the connections are properly tightened. Check the impeller clearance. Adjust the impeller, if necessary. Check that the resistance between the earth (ground) and phase lead is more than 5 megohms. Conduct a phase-to-phase resistance check. Check O-rings. Replace the oil plug O-rings. Replace the O-rings at the entrance or junction cover. Grease the new O-rings. Check Overload protection and other protections. Check the impeller rotation. Fill pump with new coolant, if necessary. Check that the freezing point is lower than -13°C (9°F). Check the resistance of the leakage sensor. Normally closed circuit; interval 0–1 ohm. For thermistor, check the resistance is between 20–250 ohms and the measured voltage is maximum 2 V DC. Check the running values for voltage and amperage. Check the oil level and inspect the oil filters and oil coolers. Check and record the insulation resistance of windings. For water air cooler, check the leads of the stator winding, slip ring leads of wound rotor machine and their locking elements for tightness. Check the cooler, connections, and piping for leaks. Check the external and internal fan for damage or corrosion.

2.4.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

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2.5 Grit Removal

2.5.1 Overview

This section of the manual describes procedures for operating and maintaining the grit removal system. Major components are discussed and how they relate to the removal of grit and inorganic matter from the waste stream.

Grit and screenings removal are important elements of proper wastewater treatment ensuring the waste stream is manageable and consistent entering the next phase of treatment. The grit removal system is an integrated system consisting of several equipment components operating as required to properly aerate, settle, and remove the grit and inorganic material from coarse screened raw wastewater.

Grit Removal System Overview

The major components of the grit removal system are:

- 1 - Grit system inlet channel
- 4 - Aerated grit chambers
- 1 - Aeration and diffuser system
- 15 - Inlet and outlet sluice gates

- 1 - Clam shell hoist and trolley system
- 1 - Grit system drain system

Raw wastewater enters the grit removal system following coarse screening. Each grit channel and chamber are isolated by inlet and outlet sluice gates. The grit removal system at the Maxson WWTF is an aerated system comprising off an inlet channel and four grit chambers. Diffused air is supplied to the system to suspend organic material while forcing grit and inorganic material to settle in a grit chamber. Periodically, grit is removed from each chamber using a bridge crane hoist and trolley system equipped with a clam shell.

The grit removal system is designed to operate continuously. Grit removed by the crane and clam shell is dewatered and deposited in a roll off container prior to disposal offsite. De-gritted wastewater flows from the grit system's outlet chamber and is conveyed to the fine screens for additional screening.

Figure 2.5-1 Grit Chamber P&ID provides a process flow diagram of the grit removal system.

Figure 2.5-2 Grit Chamber Plan provides a plan view of the grit removal system.

Figure 2.5-3 Grit Chamber Section provides a sectional view of the grit removal system.

2.5.2 Process Control

Grit Removal System

The grit removal system receives coarse screened wastewater pumped from the IPS. Flow is transferred through a 60-inch piping interconnect that increases to 72-inches just upstream of the comminutor system's inlet channel. The inlet channel of the comminutor system contains a sample pump (E-196) equipped with a strainer and 1.5-inch discharge piping. Flow then passes through the out of service comminutor system before flowing into the grit system's inlet channel.

The grit removal system is equipped with a series of motorized sluice gates to route flow through the comminutor and aerated grit chambers. Flow exits the comminutor system and enters the grit system inlet channel traveling through one of three slide gates (CG-SG-3A, CG-SG-3B, and CG-SG-3C). The grit inlet channel collects the inlet flow and routes it to one of four aerated grit chambers, each isolated by an independent sluice gate. The inlet channel is equipped with aeration piping fed from a 3-inch air supply pipe used to suspend organic and inorganic matter prior to entering the separation process in the grit chamber. The inlet channel's air supply piping includes four 3-inch droplegs equipped with non-clog air diffusers that can be individually regulated using adjacent manually controlled valves. Flow exiting the grit system inlet channel enters one of four aerated grit chambers. Each grit chamber has a volume of 91,000 gallons and capable of treating 20 mgd. Each chamber is isolated by an independent sluice gate (CG-SG-4A, CG-SG-4B, CG-SG-4C, and CG-SG-4D). The grit chamber's main air supply manifold piping is sized at 8-inches and reduces to 6-inches at a tee connection for each grit chamber. Two droplegs, located in each chamber are sized at 4-inches and include diffusers to help separate organic and inorganic matter. Butterfly control valves are provided for regulating flow to the chamber.

Grit chamber side walls are slopped to aid in settling out grit separated from suspended wastewater organics. Air is introduced into the tank through an air supply system with diffusers by any one of the three variable speed blowers, delivering 1,200 scfm. These blowers are shared with the activated sludge aeration basins. Degritted flow exists each chamber overflowing a fixed weir enroute to the fine screening process located south of the grit removal system.

Air fed to the grit system causes a spiral of water to flow through the tank and heavier particles are thrown out of the water's streamline. The air roll pattern sweeps grit along the bottom to the low side of the chamber. The air rates should be adjusted to create a velocity near the tank floor low enough to allow the grit to settle. It can be assumed that at a surface flow of two feet per second the required tank floor velocity will be obtained. Periodic observation of the collected grit will assist in determining the effectiveness of the washing action.

Large quantities of organics in the grit would dictate an increased supply of air. Properly settled grit should contain no more than 30 percent organics. If the air bubble pattern on the tank water surface indicates a plugged or malfunctioning diffuser, the entire diffuser should be inspected and repaired. On the bottom of the grit chamber, below the diffuser header, is a trough that runs the width of the tank. Grit settles on the sloped tank bottom and slides into the trough. The clam shell is the used to remove settled grit, typically 3 days per week. During normal operation, approximately 60 tons of grit is removed monthly.

Each chamber is equipped with a 10-inch drainpipe that drains the associated chamber by gravity to an adjacent manhole. Each drain line is equipped with a plug type isolation valve (V-412, V-413, V-414, and V-415). The drain lines discharge into adjacent manholes located on the west side of the structure. Periodically, draining, cleaning, and inspecting each grit chamber is necessary to ensure proper grit system performance.

The grit system is connected to a biofilter odor control system to help control odors generated at the grit removal area. The odor control system is discussed in ***Section 9 Facility Support Systems***.

Sluice gates can be controlled locally at their associated actuator or remotely using the plant control system. Local disconnects are provided adjacent to each gate identified by the gates tag number.

Table 2.5-1 identifies the sluice gate/valve service and associated tag number.

Table 2.5-1 Grit Removal System Sluice Gates/Valves

Tag Number	Slide Gate Service
GC-SG -1	Comminutor System Influent Channel Inlet Sluice Gate
GC-SG-2A	Comminutor 1 Inlet Sluice Gate
GC-SG-2B	Comminutor 2 Inlet Sluice Gate
GC-SG-2C	Comminutor 3 Inlet Sluice Gate
GC-SG-3A	Comminutor 1 Outlet Sluice Gate
GC-SG-3B	Comminutor 2 Outlet Sluice Gate
GC-SG-3C	Comminutor 3 Outlet Sluice Gate
GC-SG-4A	Grit Chamber 1 Inlet Sluice Gate
GC-SG-4B	Grit Chamber 2 Inlet Sluice Gate
GC-SG-4C	Grit Chamber 3 Inlet Sluice Gate
GC-SG-4D	Grit Chamber 4 Inlet Sluice Gate
GC-SG-5D	Grit System Outlet/Fine Screen Inlet Sluice Gate
GC-SG-5A	Trickling Filter and Clarifier Bypass Channel Sluice Gate
GC-SG-5B	Trickling Filter and Clarifier Bypass Channel Sluice Gate
GC-SG-5C	Trickling Filter and Clarifier Bypass Channel Sluice Gate
V-412	Drain for Grit Chamber 1
V-413	Drain for Grit Chamber 2
V-414	Drain for Grit Chamber 3
V-415	Drain for Grit Chamber 4

Table 2.5-2 provides the design criteria for the grit removal system.

Table 2.5-2 System Data – Grit Removal System

Component	Value
Grit Chambers	
Quantity:	4
Capacity/Chamber, mgd:	20
Volume/Chamber, gallons:	91,200
Air Flow, scfm:	1,200
Detention Time, minutes:	2.2 – 6.6
Sluice Actuators	
Quantity:	15
Manufacturer:	Limitorque
Tag Number:	GC-SG-01 thru GC-SG-15
Grit Chamber Trolley Hoist	
Manufacturer:	Chester Hoist (Coffing)
Model:	WD 1002 2B181
Serial Number:	B181
Type:	Trolley
Capacity, ton:	2
Bridge Speed, fpm:	45
Bridge Motor Horsepower:	1
Trolley Speed, fpm:	150
Trolley Motor Horsepower:	3/4
Hoist Speed, fpm:	100
Hoist Motor Horsepower:	15
Lifting Height, feet:	25
Grit Removal Bucket	
Manufacturer:	Hayward
Model:	F-5
Type:	Calm Shell
Size, yards:	1.5

2.5.3 Equipment Control

The following tables provide a detailed description of the controls for the sluice gate actuators and the hoist and trolley system. The inlet and outlet sluice gates that can be controlled locally or remotely to open or close sluice gates using actuators. The hoist and trolley system are controlled locally at the local control station.

Table 2.5-3 provides the controls for the sluice gate actuators.

Table 2.5-3 Control/Instrumentation Description – Sluice Gate Actuators

Control Name/Location	Features	Function
On-Trip-Off	Main Breaker	"On" position allows electrical power from the MCC to the local disconnect at the disconnect. "Off" position stops all electrical power at the MCC. "Trip" position stops all electrical power and indicates electrical circuit overload.
On-Off	Local Disconnect	In the "On" position, electrical power from the local disconnect is supplied to the actuator motor. In the "Off" position all electrical power is stopped at the local disconnect.
Local-Off-Remote	Three-way Switch	The "Local" position allows the actuator to be controlled locally using the Open-Stop-Close. The "Off" position will prevent the actuator from operating. The "Remote" position allows the actuator to be controlled through the plant control system.
Open-Stop-Close	Pushbuttons	Pressing the "Open" pushbutton will open the sluice gate. Pressing the "Stop" pushbutton will stop sluice gate travel at its current position. Pressing the "Open" pushbutton will open the sluice gate.

Table 2.5-4 identifies the controls and monitoring for the hoist and trolley system.

Table 2.5-4 Control Instrumentation Description – Hoist and Trolley

Control Name/Location	Features	Function
On-Trip-Off	Main Breaker	"On" position allows electrical power from the MCC to the local disconnect at the hoist. "Off" position stops all electrical power at the MCC. "Trip" position stops all electrical power and indicates electrical circuit overload.
On-Off	Local Disconnect	In the "On" position, electrical power from the local disconnect is supplied to the hoist motor. In the "Off" position all electrical power is stopped at the local disconnect.
On-Off	Control Power	In the "On" position, the panel is energized. In the "Off" position, the panel is not energized.
Main Power On	Green Lamp	Illumination indicates that the local control panel is energized.
Trolley Travel Control	Left to Right - Control Lever	Placing the lever to the left will travel the trolley to the left. Placing the lever to the right will travel the trolley to the left.
Trolley Travel Fault	Amber Lamp	Illuminated lamp indicates the trolley travel mechanism has faulted.
Hoist Level Control	Up or Down - Control Lever	Placing the lever to the "Up" position cause the hoist to lift the clam shell. Placing the lever in the "Down" position will cause the hoist to lower the clam shell.
Hoist Lifting/Lowering Fault	Amber Lamp	Illuminated lamp indicates the hoist lifting mechanism has faulted.
Calm Shell Control	Open or Close - Control Lever	Placing the lever to the "Up" position cause the hoist to lift the clam shell. Placing the lever in the "Down" position will cause the hoist to lower the clam shell.
Calm Shell Fault	Amber Lamp	Illuminated lamp indicates the clam shell has faulted.
Bridge Travel Control	Forward or Reverse - Control Lever	Placing the lever to the "Forward" position cause the bridge to travel forward. Placing the lever in the "Reverse" position will cause the bridge to travel in reverse.
Bridge Travel Fault	Amber Lamp	Illuminated lamp indicates the bridge travel has faulted.
Emergency Stop	Emergency Stop Red Mushroom	Depressing the pushbutton will immediately stop operation of hoist. The E-Stop pushbutton must be pulled out to allow for hoist operation.
Elapsed Time Meter	Trolley and Hoist Run Time	Displays the amount of time in tenths of an hour that the unit has been in operation.

2.5.4 Operation

Normal Operation

The normal mode of operation for the grit removal system is to operate continuously with all four grit chambers in service. The inlet sluice gates to each grit chamber should be open and each chamber's drain valve should be closed. The outlet sluice gate that allows degritted flow to be conveyed to the fine screens should be open. Bypass sluice gates allowing the trickling filter and primary clarification process to be bypassed should remain closed.

Air flow to the inlet channel should operate continuously and create enough turbulence to suspend particulates and prevent settling. Air flow to each grit chamber should be controlled to deliver 300 standard cubic feet per minute (scfm). Air is introduced along one side wall, causing a perpendicular spiral velocity pattern to flow through the tank. Heavier particles are accelerated and diverge from the streamlines, dropping to the bottom of the tank, while lighter organic particles are suspended and eventually removed.

Grit should be removed using the hoist and trolley system with the clam shell 3 times per week or as often as needed to ensure grit is not carried into the outlet channel. Grit removed from the system using the clam shell is placed in a haul off container and transported offsite for disposal.

Alternate Operation

Alternate operations indicate that one or more components of the grit removal system will be out of service or cannot controlled normally. Provisions have been made to operate the system during abnormal conditions through redundancy to allow for one chamber to be out of service. Also, all sluice gates can be operated locally at the actuator or through the control system. In addition, bypass sluice gates allowing the trickling filter and primary clarification process should be opened to allow for excessive flow to bypass initial treatment processes.

Note: Bypassing the trickling filter and primary clarification process should only be done during an emergency and at the direction of plant supervision.

Pre-Startup Checks

1. Verify the grit system is ready to receive flow, and all piping is in good working order. Verify there is no debris in any of the tanks that will prevent proper operation.

2. Confirm the aeration system is ready for operation. Check that inlet channel and each chamber's air supply valves are in the correct position. All valves should be open for tanks being placed in service.

3. Confirm the hoist and trolley system is ready for operation to allow for grit removal using the clam shell once sufficient accumulation occurs. See maintenance recommendations for details concerning equipment lubrication.

4. Confirm sluice gate actuators for the grit removal system are ready for operation. Ensure all equipment has been properly lubricated. See maintenance recommendations for details concerning equipment lubrication.

5. Confirm all drain valves are closed for tanks being placed in service (V-412, V-413, V-414, V-415).

6. Check all safety devices and ensure all devices have been installed and operate properly. Verify all aluminum planking/grating is secure.

Restart Considerations

1. Once all grit system components have been properly inspected for service, open the required sluice gates to allow flow through the out of service comminutor system.
   - GC-SG-1 Comminutor System Influent Channel Inlet Sluice Gate
   - GC-SG-2A Comminutor 1 Inlet Sluice Gate
   - GC-SG-2B Comminutor 2 Inlet Sluice Gate
   - GC-SG-2C Comminutor 3 Inlet Sluice Gate
   - GC-SG-3A Comminutor 1 Outlet Sluice Gate
   - GC-SG-3B Comminutor 2 Outlet Sluice Gate
   - GC-SG-3C Comminutor 3 Outlet Sluice Gate
2. Open the required sluice gates to allow flow into the grit chambers being placed in service.
   - GC-SG-4A Grit Chamber 1 Inlet Sluice Gate
   - GC-SG-4B Grit Chamber 2 Inlet Sluice Gate
   - GC-SG-4C Grit Chamber 3 Inlet Sluice Gate
   - GC-SG-4D Grit Chamber 4 Inlet Sluice Gate
3. Open the required sluice gate to allow flow to exit the grit chamber and be routed to the fine screens.
   - GC-SC-5D
4. Confirm the bypass sluice gates are closed to prevent the trickling filter and primary clarification system from being bypassed.
   - GC-SG-5A Trickling Filter and Primary Clarifier Bypass Channel Sluice Gate
   - GC-SG-5B Trickling Filter and Primary Clarifier Bypass Channel Sluice Gate
   - GC-SG-5C Trickling Filter and Primary Clarifier Bypass Channel Sluice Gate

5. Once and adequate water level has accumulated within the grit system's inlet channel and grit chambers, open the required air control valves to allow for air flow to be discharged within the inlet channels and grit chambers. Air flow to the system should be 1,200 scfm with four chambers in serviced and 900 scfm with three chambers in service.

Shutdown Considerations

1. Close the inlet sluice gate to prevent flow from entering the grit chamber.
2. Prior to turning off the air supply to the chamber, visually inspect the air patterns to locate any zones of short circuiting or areas where air discharge is too low or absent.
3. Turn off the air supply to the diffuser system on the chamber being taken out of service. The air can be isolated by closing manual valves for each drop leg.
4. Operate the hoist system and clam shell to remove settled grit from the hopper.
5. Once grit have been removed, open the chambers associated drain valve to allow the chamber to drain to an adjacent manhole on the west side of the structure.
6. While draining the chamber, hose down the tank's side walls to remove as much debris as possible.
7. Once the chamber is drained, inspect the tank and associated air supply piping and diffusers. Thoroughly inspect areas where air patterns were abnormal prior to tank draining.

Note: A grit chamber can be taken out of service without draining the tank for short periods. If a chamber is to be taken offline but not drained, remove as much grit as possible and allow diffused air to continue to discharge in the chamber to reduce odors and prevent solids from settling. The chamber should be drained and cleaned if it is to remain offline for an extended period.

Note: The grit separation system is designed to operate continuously. Three grit chambers should always stay in service.

Routine Checklist

1. Monitor the operation of the grit removal system.
2. Ensure the diffused air system is operating properly, and no diffuser clogging is present.
3. Ensure air flow to the grit system's inlet channel is providing sufficient turbulence to suspend organics and inorganics prior to entering the grit chambers.
4. Ensure air flow to each online grit chamber is providing sufficient turbulence to suspend organics and drive grit and inorganics to chamber's slopped side walls and floor.
5. Check grit system sluice gates for proper positioning.
6. Inspect the hoist and trolley control panel selector switches for proper positioning.
7. Ensure grit chamber hoppers are emptied, typically before reaching 2/3 full.

8. Ensure the grit chamber outlet weir is free of rags and debris.

9. Check grit storage hopper level and empty as needed.

10. Periodically take samples of incoming and outgoing wastewater to determine grit removal efficiency.

2.5.5 Maintenance

Process Maintenance

The general maintenance for the grit removal system equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the grit removal system consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 2.5-5 provides the manufacturer's and service representative's contact information for the grit system bridge crane.

Table 2.5-5 Contact Information– Grit System Bridge Crane

Manufacturer	
Name:	Flowserve Corporation
Address:	5114 Woodall Road Lynchburg, VA 27896
Phone:	434-528-8595
Fax:	434-845-9736
Website:	www.flowserve.com
Local Representative	
Name:	Chester Hoist
Address:	7573 State Route 45 Lisbon, OH 44432
Phone:	330-424-7248, Toll Free 800-424-7248
Fax:	330-424-3126
Website:	www.chesterhoist.com

Table 2.5-6 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the grit system bridge crane.

Table 2.5-6 Maintenance Schedule – Grit System Bridge Crane

Frequency	Tasks to be Performed
Daily	Inspect hoist and hoist rope for damage.
Monthly	Complete thorough inspection of hoist rope. Lubricate wire rope using heavy oil or cable compound. Lubricate load block using Darina #2 or equivalent.
Semi-Annually	Lubricate transmission using Mobilgear 634 or equivalent. Lubricate trolley motor and gearbox using Mobilgear 634 or equivalent.

Table 2.5-7 provides the manufacturer's and service representative's contact information for electric actuators.

Table 2.5-7 Contact Information – Electric Actuators

Manufacturer	
Name:	Flow Serve Corporation
Address:	51114 Woodall Road Lynchburg, Va 21896
Phone:	434-528-8595
Fax:	434-845-9736
Website:	www.flowserve.com
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-377-3952
Fax:	615-373-2701
Website:	www.jtguthrie.com

Table 2.5-8 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the electric actuators.

Table 2.5-8 Maintenance Schedule - Actuators

Frequency	Tasks to be Performed
Daily	Inspect actuator for proper operation.
Weekly	Inspect actuator for wear or leakage.
Annually	Check oil level of actuator. Replace all actuator ball bearings, oil seals, O-rings and quad-rings. Change actuator gear oil (Mobil SHC 632 or equal).

2.5.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the T.E. Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

2.6 Fine Screenings Removal

2.6.1 Overview

The T.E. Maxson WWTF uses fine screens to capture and remove rags and small material from the incoming wastewater flow that is not captured by the coarse screens. From a process perspective, the fine screens are located downstream of the grit chamber and upstream of the primary clarifiers. Influent wastewater exits the grit chamber effluent channel though a 90-inch gravity pipe to the fine screens structure, where flow splits between three 6-ft wide screening channels. After passing through the facility, screened wastewater flows through another 90-inch gravity pipe to the primary clarifier splitter box. Materials captured by the fine screens are dewatered through a washing press and discharged into a dumpster.

Fine Screens Aerial

The fine screens' structure was constructed in 2011 and is located immediately north of the primary clarifiers. The facility was constructed around the existing 90-inch grit chamber effluent pipe. Equipment in the facility includes three fine bar screens with associated washing presses, motorized and manual slide gates, stop logs, mud valves, and a portable gantry crane. The bar screen control panels and a portable air compressor are housed in a prefabricated aluminum frame equipment shelter. The top slab of the structure is approximately five feet above grade, and stairs are provided to access the equipment. A biofilter odor control system is located adjacent to the structure to control odors from the fine screens structure and two of the primary clarifiers. The odor control system is discussed in ***Section 9 Facility Support Systems***.

Three mechanical fine screens (FS-0100, FS-0200, FS-0300) are installed in the fine screens structure. Each screen has an associated washing press (FS-WP-0100, FS-WP-0200, FS-WP-0300) for dewatering and discharging captured materials through 16-inch discharge pipes into a common dumpster.

Two sets of stop logs are included in the facility, one upstream and one downstream of the fine screens. The stop logs can be moved from the bypass channel to the influent and effluent channels when bypassing the fine screens is desired. Stop logs are installed and removed using a portable gantry crane, and they can be stored in a set of racks south of the facility. Each bar screen channel can be isolated by an upstream motorized slide gate and a downstream set of stop logs.

The major components of the fine screens system include:

- 3 - Mechanical Fine Bar Screens
- 3 – Washing Presses
- 3 – Level Transducers (one upstream of each screen)
- 3 – Motorized Slide Gates
- 5 – Sets of Stop Logs
- 1 – Screenings Dumpster
- 3 – Fine Bar Screen Control Panels

2.6.2 Description

Flow Configuration

A 90-inch prestressed concrete cylinder pipe conveys wastewater from the grit chamber to the fine screens. The fine screens structure contains a bypass channel, influent channel, and effluent channel. Stop logs within the facility can be rearranged to allow the fine screens to be bypassed. The three individual screenings channels can be isolated through upstream slide gates and downstream stop logs. Flow exits the fine screens structure through the same 90-inch pipe to the splitter box for the primary clarifiers.

Stop Logs (FS-SP-1, FS-SP-2, FS-SP-3, FS-SP-4, FS-SP-5)

The fine screens structure contains five sets of stop logs. One set (FS-SP-1) can be moved between the influent channel and bypass channel, and another set (FS-SP-2) can be moved between the effluent channel and bypass channel. When these stop logs are installed in the influent and effluent channels, the fine screens are completely bypassed. The remaining sets of stop logs can be installed on the effluent side of each screenings channel to isolate individual screens. When not in use, stop logs are stored in a set of racks adjacent to the facility, and they are installed and removed by a portable gantry crane. Details for these pieces of equipment are provided in ***Table 2.6-1.***

Table 2.6-1 System Data – Fine Screens Stop Logs

Component	Value
Primary Stop Logs	
Quantity:	2
Tag:	FS-SP-1 and FS-SP-2
Manufacturer:	Whipps
Material:	Stainless Steel
Dimensions per Stop Log: Opening Width: Height:	 138” 30”
Seating Head:	20’
Unseating Head:	20’
Total Quantity of Stop Logs:	18
Secondary Stop Logs	
Quantity:	3
Tag:	FS-SP-3, FS-SP-4, FS-SP-5
Manufacturer:	Whipps
Material:	Stainless Steel
Dimensions per Stop Log: Opening Width Height	 72” 24”
Seating Head:	14’
Unseating Head:	14’
Total Quantity of Stop Logs:	14
Gantry Crane	
Manufacturer:	Spanco Inc.
Model:	1ALU0810B
Capacity:	1 Ton
Material:	Aluminum
Overall Span:	8’-0”
Height (Max/Min):	10’-2” / 7’-8”

Table 2.6-1 System Data – Fine Screens Stop Logs

Component	Value
Hoist and Trolley	
Manufacturer:	CM Cyclone
Type:	Hand Chain Hoist
Model:	331317
Capacity:	1 Ton
Lift:	30'-0"
Trolley Style:	Army Style, Geared

Slide Gates (FS-SG-1, FS-SG-2, FS-SG-3, FS-SG-4)

Each of the three screenings channels is equipped with a motorized slide gate upstream of each screen to allow for isolation and performance of maintenance activities.

Fine Screen and Inlet Slide Gate (Typical)

These gates are equipped with NEMA 4X electric actuators and control modules mounted adjacent to the gates. An additional manual slide gate is provided on the 8" drain that can be used to drain the section of the bypass channel between the two sets of stop logs. Details are provided in ***Table 2.6-2*** for the slide gates.

Table 2.6-2 System Data – Fine Screens Slide Gates

Component	Value
Screenings Channel Slide Gates	
Quantity:	3
Tag:	FS-SG-1, FS-SG-2, FS-SG-3
Manufacturer:	Whipps
Material:	Stainless Steel
Opening Dimensions: Width Height	 72” 168”
Seating Head:	14’
Unseating Head:	14’
Type:	Self-Contained w/ Non-Rising Stem
Actuator:	NEMA 4X Electric
Drain Slide Gate	
Quantity:	1
Tag:	FS-SG-4
Manufacturer:	Whipps
Material:	Stainless Steel
Opening Dimensions: Width Height	 8” 8”
Seating Head:	20’
Unseating Head:	16’
Type:	Wall-Mounted w/ Rising Stem
Actuator:	Removable Handcrank

Mechanical Fine Bar Screens (FS-0100, FS-0200, FS-0300)

Each mechanical bar screen is designed to pass an average daily flow of 35 mgd and a peak hourly flow of 80 mgd with a flow channel depth between 10 and 14 feet. Each mechanical bar screen consists of bars with 3/8-inch clear openings that capture and remove materials. The screens can be operated locally or remotely, as well as continuously or intermittently.

Each screening mechanism consists of a stainless-steel frame, bar rack, wiper mechanism, pin rack, and rake assembly. The rake assembly is driven up and down by a 5-horsepower motor and is spring-loaded with a dual-arm articulating configuration to provide the ability to bypass large objects in the channel. The typical sequence of operation for a screening cycle is as follows:

- The cycle begins with the rake assembly traveling downward after activation from the raised “park” position.

- As the rake assembly rotates around the lower end of the pin rack, the teeth of the rake mechanism engage the spacing in the bar rack.
- The rake assembly travels up the pin rack, lifting debris caught in the bar rack and discharging them into the chute upstream of the washing press.
- The rake assembly engages the wiper blade to clean the rake head, and the rake returns to the raised “park” position.

Each screen is housed in a separate screening channel, measuring 14 feet in depth and 6 feet in width. The maximum water level upstream of the screens is 230.38 and the maximum water level downstream is 230.32. Since the invert of the screenings channels is at 217.00, the maximum water depth in the channels is approximately 13’-4”.

Each screen operates as a system with its associated washing press. Local control stations are provided for each fine bar screen and washing press, and a control panel for each set is installed in the equipment shelter north of the screens. Methods of operation for the screens are as follows:

- Primary: Screening system operation is initiated by the level upstream of the screens, which is measured by an ultrasonic level indicator installed in each screenings channel.
- Secondary: Screening system is activated by an adjustable timer. The maximum time between cleaning cycles is 60 minutes.

Washing Presses (WP-0100, WP-0200, WP-0300)

Captured rags and debris collected by the fine screen are discharged into the inlet hopper of an associated washing press. The washing press is provided to remove organics and reduce the moisture content and volume of screenings material collected by the mechanical bar screens. Screenings enter the inlet hopper of the washing press and are transported by a rotating screw into the washing zone. While in the washing zone, washwater is sprayed through the hollow shaft screw and into the screenings material to help dissolve and remove organic material. Washwater is supplied to each washing press control panel by a potable water line tapped from a 3-inch line south of the fine screens structure.

The washing press can be operated locally or remotely and may also be operated continuously or intermittently. Emergency stops have been installed on each press’s LCP for deactivating the unit during an emergency condition. The unit may be deactivated by pressing the emergency “Stop” push button adjacent to the equipment.

Inlet Hopper and Housing

The inlet hopper is designed to direct screenings material from the bar screen into the screw housing. The screw housing is constructed of 316L stainless steel and surrounds the compacting screw and screen. The dewatering section contains anti-rotation bars around the circumference of the housing to contain the screenings material and prevent rotation of the screenings during the dewatering process. Washwater inlets are located on top of the washing and dewatering zones to allow for periodic flushing. A removable cover, located at the dewatering section, is held in place by a latching mechanism.

Wash Press Screw

Each wash press is equipped with a hollow-shaft screw constructed of alloy steel and includes perforations located in the washing zone to allow washwater to be injected into the screenings from the inside out. The flights move the screenings into the washing zone and compaction dewatering zones. A stainless-steel reinforced nylon brush is attached to the hollow shaft screw with setscrews in the drainage area to help prevent debris from blinding the drain.

Drive Motor and Gear Reducer

The washing press is powered by 7.5 horsepower, close-coupled motor attached to a gear reducer. The motor is protected from overcurrent by a current sensing relay located in the screening system main control panel. The gear reducer is a right-angle helical bevel gear reducer.

Washwater Manifold

Non-potable washwater is supplied by the plant water system for the washing press. The washwater manifold includes four solenoid valves, four stainless steel ball valves and a pressure gauge. The solenoid valves are activated by the PLC in the main control panel to provide washwater intermittently during cleaning and flushing cycles. The washwater manifold is mounted on a support stand. Braided flexible hoses connect the wash water manifold and the spray connections on the washing press. The typical valve and shaft sequence is as follows:

1. Screw forward, valves 1 and 2 (hollow shaft and hopper) energized.
2. Screw stopped, valves 1 and 3 (hollow shaft and washing zone) energized.
3. Screw reverse, valves 1 and 3 (hollow shaft and washing zone) energized.
4. Screw stopped, valve 3 (washing zone) energized.
5. Screw forward, valve 1 (hollow shaft) energized.

   Steps 2-5 are repeated for a minimum of 9 cycles. The number of cycles can be adjusted at the operator interface.

6. Screw forward, valve 1 (hollow shaft) energized.
7. Screw forward, no valves energized.
8. Screw stopped, valve 4 (flush dewatering zone and drain pain) energized.

The time setting for each step can be adjusted at the operator interface.

Drain Pan and Screenings Discharge

Each drain pan is mounted to the bottom of the screw housing along the full length of the housing. The drain pan, constructed of 316L stainless steel, is sloped towards the drain, and is provided with a flushing nozzle on the dewatering end and a 4-inch diameter drainpipe on the drive end. The pan is held in place by a latching system to allow fast and easy removal. A watertight seal is located on pan's top edge to form a watertight seal with the screw housing to prevent leakage. A 5-inch floor drain funnel is installed below each drainpipe and connected to a 2-inch floor drain to drain into the screenings channel.

The 12-inch compacted screening's discharge pipe is mounted to the pipe flange on the press body and is designed to transport the washed, dewatered, and compacted screenings to the roll off dumpster. The discharge pipe is constructed of 316L stainless steel and increases to 16-inch diameter prior to discharging.

Safety Lanyard

An emergency safety lanyard type pull cord is supplied around the perimeter of the washing press. This cable can be pulled in an emergency, immediately stopping the press.

Compacted Screenings Collection Container

Washed and compacted screenings are discharged from each washing press into a common dumpster located south of the structure. Straight lengths of the discharge pipes run overhead and are supported from the washing presses to the dumpster.

Figure 2.6-1 Fine Bar Screens Base Plan and ***Figure 2.6-2 Fine Bar Screens Top Plan*** provide base and top plan views of the fine screens structure and associated equipment.

Figure 2.6-3 Fine Bar Screens Section provides a sectional view of the mechanical fine bar screen and washing press.

Table 2.6-3 provides the design criteria for the screenings systems.

Table 2.6-3 System Data – Screenings Removal Equipment

Component	Value
Mechanical Bar Screens	
Quantity:	3
Tag:	FS-0100, FS-0200, and FS-0300
Manufacturer:	Vulcan
Model:	FT-78 Crawler Screen
Type:	FT-78 Severe duty Mensch
Capacity/Screen: Flow	 80 mgd
Bar Spacing:	3/8-inch
Mechanical Bar Screen Motors	
Quantity:	3
Manufacturer:	Vulcan
Model:	A-5532393
Enclosure:	TEFC
Frame:	C210CZ
Horsepower:	7.5
RPM:	1770
Phase:	3
Volts:	230/460
Hertz:	60

Table 2.6-3 System Data – Screenings Removal Equipment

Component	Value
Full Load Amps:	7.6
Service Factor:	1.15
Duty:	Continuous
Class:	B
NEMA Code:	H
Drive End Bearing:	30BC02XDD30
Opposite End Bearing:	40BC02XDD30
Washing Presses	
Quantity:	3
Tag:	WP-0100, WP-0200, WP-0300
Manufacturer:	Vulcan
Model:	EWP 300/1200
Screw Diameter:	12 in (OD)
Dry Solids Content:	30 percent
Minimum Organic Removal:	90 percent
Minimum Volume Reduction:	50 percent
Washwater Requirements:	27 gpm max between 35 and 60 psi
Washing Press Motors	
Manufacturer:	Baldor
Model Number:	CB307361
Frame:	213TC
Enclosure:	TEFC
RPM:	1770
Horsepower:	7.5
Phase:	3
Volts:	230/460
Hertz:	60
Full Load Amps:	11
Service Factor:	1.15
Duty:	Continuous
Insulation:	Class F
Influent Channel Level Transducers	
Tag:	LT-0100, LT-0200, LT-0300
Quantity:	3
Manufacturer:	Siemens Sitrans L
Type:	Hydrostatic submersible level transducer
Accuracy:	+/-0.25%

A separate local control station is provided for each mechanical bar screen and washing press. Each system, consisting of a mechanical bar screen and washing press, includes a main control panel located under the equipment shelter.

Each mechanical bar screen is provided with independent local emergency stop pushbuttons and the associated washing press has an e-stop pull cord that deactivate the equipment immediately in an emergency condition. Emergency Stop activation requires pushing the red mushroom pushbutton (mechanical bar screen) or pulling the Emergency Stop pull cord (washing press) to the in (engaged) position while restarting equipment will require the push button to be pulled back out to the normal (disengaged) position or pulling the cord taut by rotating the Emergency Stop cord lever until the switch locks and the alarm clears.

Screen System Monitoring

Motor and Brake High Temperature Protection

A high temperature sensor in the screen's brake and motor has been provided to prevent elevated brake temperatures from causing harm to the bar screen. The motor and brake thermals are wired in series. When a sensor detects high brake temperatures, the screen will shut down, the high temperature alarm light will illuminate, and the audio alarm will sound. The cause of the temperature rise must be corrected before restarting the bar screen.

Solid State Motor Overload Device

The motor starter is equipped with solid-state circuitry that will shut down the motor and associated screen. The overload can be reset by pushing the overload reset once the overload condition has been corrected.

High Torque Protection

An over-torque current sensing relay (CSR) is provided as part of the rake alarm assembly. Once tripped, the screen will stop immediately, illuminate the screen over-torque alarm light. When the motor is overloaded, the CSR senses the amp draw and de-energizes the motor starter, stopping the motor. The CSR is calibrated in the field at start-up and should be tested periodically.

Over Rotate Protection

A over rotation limit switch is mounted on the rake and trips when the maximum collapsibility of the rake has been reached and prevents the rake from possible damage caused by overly large objects.

Phase Monitor

The installed mechanical bar screens are powered by 3-phase power rated at 460 volts. Each screen is equipped with a phase monitor to ensure all three legs are providing adequate voltage +/- 5 percent. The monitor is provided to prevent single phasing.

Emergency Stop Push Buttons and Safety Lanyard

E-stop push buttons are located at the local control stations. Pushing the button in will shut down the equipment, whether in hand or auto mode. To reset the e-stop, the button must be manually pulled out. Each mechanical bar screen and washing press is provided with a local emergency stop push button that deactivates the equipment immediately when the Emergency Stop pushbutton is pressed. An emergency stop safety lanyard also surrounds each washing press.

2.6.3 Equipment Control

The following tables identify the local controls associated with the fine screens removal system. Each mechanical bar screen and associated washing press work as a pair and have a combined Fine Bar Screen Control Panel (FBS CP) and individual local control panels (LCP). The FBS CP contains selector switches, alarm resets, and an Operator Interface Panel (OIP) that provides touchscreen control for operating and monitoring the screening equipment. An Ethernet switch is included in the control panel to allow connection between the PLC and the OIT. This switch will also enable communication between the control panel and plant SCADA system. Each FBS CP is also equipped with a local disconnect switch for isolation purposes.

In addition, individual LCPs are provided for each screen and washing press for a total of six LCPs. Each LCP is located adjacent to its respective equipment and housed in a NEMA 4X enclosure. The LCPs that provide operational capabilities for the mechanical screens and washing/compacting equipment.

Table 2.6-4 provides the controls and monitoring located at the Fine Bar Screen Control Panels (MCP-0100, MCP-0200, and MCP-0300) for the fine bar screens and washing presses. Each NEMA 4X MCP is powered by a 480 volts feed from panelboard DP-5.

Table 2.6-4 Fine Bar Screen Control Panel – Mechanical Bar Screen/Washing Press

Control Name/Location	Features	Function
On-Trip-Reset	Panel Local Disconnect	"On" position allows electrical power from the electrical panel to the equipment controls. "Off" position stops all power from the electrical panel to the equipment controls. "Reset" allows breaker to be reset after circuit overload has been corrected.
On-Off	Control Power	In the "On" position, the panel is energized. In the "Off" position, the panel is not energized.
Control Power On	White Lamp	Illumination indicates that the local control panel is energized.
Over rotate Retreat	On-Off Switch	On enables the over rotate protection for the press. The "Off" position disables the over rotate protection
Alarm Silence	Black Pushbutton	Depressing the pushbutton will silence the alarm horn. The condition will remain until the alarm condition has been corrected.
Screen Alarm Reset	Black Pushbutton	Depressing the pushbutton will clear the screen alarm once the alarm condition has been corrected.
Press Alarm Reset	Black Pushbutton	Depressing the pushbutton will clear the washing press alarm once the alarm condition has been corrected.

Table 2.6-4 Fine Bar Screen Control Panel – Mechanical Bar Screen/Washing Press

Control Name/Location	Features	Function
Operator Interface Panel	Control/Monitoring/Alarms	Allows for operating and monitoring the screen and associated wash press at the MCP touch screen.
	Main Menu	Provides navigation buttons to the screens
	Screen Overview	▪ Operational status ▪ Motor status ▪ Upstream level ▪ Direction status ▪ Last Cycle ▪ Next Cycle ▪ Total Hours ▪ Park Limit Switch status
	Screen Settings	▪ Frequency Timer Preset ▪ Duration Counter Preset
	Level Settings	▪ Display upstream level ▪ High level Active/Inactive status ▪ High-high level On/Off set points ▪ High-high level Active/Inactive status
	Wash Press Overview	▪ Operational status ▪ Motor status ▪ Barscreen Counts ▪ Total Batch Time ▪ Remaining Batch Time
	Wash Press Settings	▪ Step 2 Preset ▪ Step 4 Preset ▪ Flush Preset ▪ Wash Cycles Preset ▪ Total Batch Time ▪ Screen Cycles Preset
	Alarm Banner	▪ Acknowledge Alarm ▪ Silence Alarms ▪ Clear Alarm
	Active Alarms	▪ Alarm Viewer
	Alarm History	▪ Acknowledge Alarms ▪ Silence Alarms ▪ Alarm Status ▪ Acknowledge All ▪ Clear All ▪ Sort Alarms
	System Information	▪ Job # ▪ Installed Date ▪ PLC IP address ▪ HMI IP address ▪ Vulcan Setup
	Terminal Setup	▪ PLC Status ▪ Time/Date Setup ▪ Touch Calibration ▪ User Manager
Horn	Audible Alarm	Activation of the horn indicates that an alarm condition is present.

Table 2.6-4 Fine Bar Screen Control Panel – Mechanical Bar Screen/Washing Press

Control Name/Location	Features	Function
Strobe	Amber Strobe	Activation of the strobe indicates that an alarm condition is present.
Alarm Silence	Black Pushbutton	The horn can be silenced by pressing the "Silence" pushbutton. The alarm will remain until the alarm condition has been removed.

Table 2.6-5 provides the local controls at the LCPs for each mechanical bar screen. The control is located in close proximity to its respective screen and is housed in a NEMA 4X enclosure.

Table 2.6-5 Local Control Panel – Mechanical Bar Screen (FS-0100, FS-0200, and FS-0300)

Control Name/Location	Features	Function
Hand/Off/Auto	Selector Switch	The "Hand" position will allow the screen to run continuously. The "Off" position will not allow the screen to run. The "Auto" position will allow the screen to run automatically based on time or level.
Forward-Off-Reverse	Three-way Switch	Allows the operator to control the screen when the H-O-A switch is placed in the "Hand" position. Placing the F-O-R selector switch in "Reverse" will operate the bar screen in counterclockwise. Placing the F-O-R switch in "Off" will prevent the screen from operating. Placing the F-O-R switch in "Forward" will operate the screen clockwise.
Emergency Stop	Red Mushroom Pushbutton	Depressing the E-Stop will stop the screen immediately. Pulling the E-Stop button out is required to reset the E-Stop and allow for a screen to restart.

Table 2.6-6 provides the local controls at the LCPs for each washing press. Each LCP is located in close proximity to its respective washing press and is housed in a NEMA 4X enclosure.

Table 2.6-6 Local Control Panel – Washing Press (WP-0100, WP-0200, and WP-0300)

Control Name/Location	Features	Function
Hand/Off/Auto	Selector Switch	The "Hand" position will allow the press screw to run continuously. The "Off" position will not allow the press screw to run. The "Auto" position will allow the press to run automatically.
Initiate Switch	Pushbutton	Initiates washing press operation.
Forward-Off-Reverse	Three-way Switch	Allows the operator to control the press when the H-O-A switch is placed in the "Hand" position. Placing the F-O-R selector switch in "Reverse" will operate the press in counterclockwise. Placing the F-O-R switch in "Off" will prevent the press from operating. Placing the F-O-R switch in "Forward" will operate the press clockwise.
Emergency Stop	Red Mushroom Pushbutton	Depressing the E-Stop will stop the press immediately. Pulling the E-Stop button out is required to reset the E-Stop and allow for a washing press to restart.

The following provides a description of the loops associated with the fine screens and the washing presses. The bar screens are normally operated in Auto controlled by the FBS CP PLC.

Bar Screen Influent Channel Level

An analog signal proportional to the water level measured is hardwired from each transmitter to its associated FBS CP PLC. The water level measured, and active alarms are indicated at the OIP, located on the front panel of the PLC.

Mechanical Bar Screens

Control of the bar screens is programmed in the MCP PLC. The running status and common trouble alarms are hardwired from each bar screen control panel to PLC. Elapsed run time is also calculated for each bar screen. These conditions are displayed at the OIP.

2.6.4 Operation

Normal Operation

The normal mode of operation for the fine screens and washing press is in the automatic mode as selected at the MCP and controlled by the operator at the OIP at each FBS CP PLC. In the automatic mode of operation, inlet channel water level and adjustable timers activate each screen and subsequently the washing press. A typical screening cycle activates the lead screen with the other screens remaining idle unless the water level in the inlet channel continues to rise. The lead screen rotates following each cycle to the next available screen. Once activated by the level set-point, the screen operates for the duration set on the timer. Once the screens shut down, the washing press continues to operate for the duration set on an adjustable timer prior to shutting down. When operation of the screening system has been initiated, the cleaning cycle proceeds until the carriage travels to the top of the frame.

The bar screen can be started by any of the two parameters below.

1. Repeat cycle timer within the PLC
2. High water level upstream of the screen

When the PLC based repeat cycle timer “off” time times out the repeat cycle timer “on” time is initiated. The motor starter coil, the running indicator on the OIT and run relay are energized. If the time set in the repeat cycle timers “on” time is set for a short time period, the bar screen makes one cycle and parks at the end travel limit switch (LS-1). The level sensor may also start the bar screen. When the preset/adjustable level set point is reached, the screen is started in the forward direction. The bar screen continues to run as long as a level condition is present. If a high-high level condition is detected above high-high set point, the bar screen is started and continues to run until this condition is no longer present. This condition also causes the washing press to run continuously in Storm Water Mode until the high-high condition is no longer present. The end travel limit switch forms the holding circuit for the bar screen. The bar screen parks at this limit switch when a run signal is no longer present.

During normal loading conditions, the washing press utilizes an adjustable cleaning process that includes a minimum of four washing cycles to ensure thorough cleaning of the collected screenings. During peak loading conditions, the washing process automatically switches to operate in the forward direction to handle the larger increased load of screenings with only short intervals of reversing to ensure that material does not accumulate on the shaft of the screw. In addition, manual ball valves are provided at each washwater solenoid valve to allow Maxson plant operations staff to isolate the solenoid valves and/or throttle the flow of washwater to the washing press screw.

Alternate Operation

Alternate operations indicate that one or more components of the screenings removal system are out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control. For instance, all pieces of equipment associated with screenings system can be operated locally at the LCP or through its FBS CP PLC.

Shutdown Considerations

1. At the FBS CP, place control switches for both the mechanical bar screens and the washing press in the “Off” position.
2. At the LCP for each mechanical bar screen, place the Hand/Off/Auto selector switch in the “Off” position.
3. At the LCP for each mechanical bar screen Place the Reverse/Off/Forward switch at each mechanical bar screen in the “Off” position.
4. At the LCP for each washing press, place the Hand/Off/Auto selector switch in the “Off” position.

5. Place the mechanical bar screen and washing press local disconnect on the MCP in the "Off" position.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect the screenings equipment for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the screenings equipment only when it is in good working condition.
3. Ensure that only authorized personnel are allowed in the in the screenings area and no one might be injured when equipment is activated.
4. Ensure all motors, gears, and bearings have been properly lubricated using the manufacturers recommended lubricant.
5. Confirm all maintenance and/or repairs have been completed.
6. Remove any existing lockout devices and follow lockout/tagout procedures for each mechanical bar screens and the washing/compacting equipment.
7. Verify that the local disconnect at the FBS CP for each mechanical bar screen and washing press to be started is in the "Off" position.
8. Verify that the Local/Off/Auto switch at each LCP is in the "Off" position.
9. Check on the readiness of all upstream and downstream equipment such as the pumps, level controls, etc.
10. Confirm the influent level transducer is functioning properly for the screening system to be restarted.
11. Check each bar screen channel for heavy debris.
12. Verify that there are no obstructions at each bar screen or the screenings washing press.
13. Visually inspect the chamber water level and incoming flow to ensure safe operating conditions.
14. Energize the FBS CP, by placing the local disconnect and control power switch in the "On" position.
15. At the LCP. Momentarily place the Hand/Off/Auto selector switch in "Local." Place the Reverse/Off/Forward switch in "Forward" position.
16. Observe the carriage assembly for proper rotation.

17. After confirming rotation, return the F-O-R selector switch to “Forward” position and allow the screen to make one complete cycle. Be prepared to turn the switch to “Off” in case of a problem.

18. After one complete cycle, check the operation of the reverse motion switch. Visually locate the reverse motion switch. Place the F-O-R switch in the “Reverse” position and allow the carriage to pass the reverse motion switch. At this point, stop the machine by returning the Reverse/Off/Forward switch to the “Off” position. Place the Hand/Off/Auto switch in the “Off” position.

19. Confirm all safety devices and proximity switches are functioning properly.

20. Place the local disconnect and control power switch at the FBS CP in the “Off” position.

21. Ensure screenings floor area is clean and free of screenings and debris. Use washdown water to clean floor area as needed.

Startup

1. At the FBS CP, place the main breaker for each mechanical bar screen and washing press in the “On” position.

2. At the FBS CP, place the control power switch in the “On” position.

3. At the LCP for the screen, place the Reverse/Off/Forward switch in the “Forward” position.

4. At the LCP for the screen, place the Hand/Off/Auto switch in the “Auto” position.

5. At the LCP for the washing press, place the Hand/Off/Auto switch in the “Auto” position.

6. Each operating bar screen and associated washing press will be started remotely, controlled by the FBS CP and influent channel level or by cycle time.

Routine Checklist

The mechanical bar screens and washing press system should be inspected for the following items when in operation:

1. Closely monitor the bar screen to be sure the screen is tracking smoothly on the guide rails and sprockets.

2. Verify the rake arm is removing screenings properly.

3. Visually inspect the screening elements to check for possible damage.

4. Check that screenings are not hanging up in the discharge area.

5. Check the screen and press drive motor for unusual noise, vibration, misalignment, and/or excess heat.

6. Inspect the control panel switches for proper positioning.

7. Confirm the end of travel limit switch "stop" position is correct.
8. Confirm automatic greaser cups are operating proper and the grease level inside cups is showing an adequate level.
9. Check that power cable carrier links are snapped together with no binding, smooth transition to the trough.
10. Confirm the power cable and over-rotate switch cable is secure with no binding.
11. Confirm all cable grips are functioning properly with no visual corrosion.
12. Confirm the wiper is engaging the rake shelf properly with the wiper is in full contact, side to side, with the rake shelf. Confirm the wiper removes all screenings from rake shelf.
13. Confirm the rake stops smoothly with no grinding noise or excessive coasting.
14. Record the volume of screenings being removed.
15. Document any equipment malfunction and the corrective action implemented.
16. Check to see that all safety guards are in place and personnel are clear of the equipment.
17. Observe the rakes on the bar screen. Confirm rake teeth are aligned between the openings between the bars.
18. Check the screen forward indicating light at the OIP. The red screen forward indicating light on the local control panel and the distribution control system should be illuminated when the screen is in operation.
19. Check the screen reverse indicating light on the local control panel. The red screen reverse indication light on the local control panel should not normally be illuminated.
20. Check the torque overload indicating light on the OIP. The alarm will activate when the screen has shut down due to a mechanical bind or heavy object in or on the rake arm or screen. Removing the object or reducing the binding by reversing the screen will reset this alarm.
21. Check for high chamber level alarms and indicating lights at the OIP. If the screen is operating when the high-level probe detects a high water level in the influent channel, the unit will complete its cycle and park at the top of the machine.
22. Confirm the screenings and washing press conveyor gearbox oil level at the proper level.
23. Check the screenings press for unusual noise or accumulation of debris in the screenings.
24. Confirm screenings are being discharged for the bar screens.

25. Confirm washed and compacted screenings are being discharged from the washing press outlet pipe.

26. Check the storage hopper for the level of material, and empty hopper as needed. Do not allow dumpsters to sit with screenings debris over long periods of time.

Troubleshooting

The following identifies problems that may be encountered during the operation of the screenings system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 2.6-7 provides troubleshooting information for operational issues associated with the mechanical bar screens.

Table 2.6-7 Troubleshooting Guide - Mechanical Bar Screens

Problem	Probable Cause	Recommended Action
Rake moves in opposite direction as indicated on the control panel	Incorrect wiring	Reverse leads on motor
Rake running rough, bouncing or chattering	Rake fasteners loose	Check all rake fasteners
	Rake not adjusted properly	Verify rake is adjusted properly to the bars and dead plate. Adjust the block gap equally on both sides to keep shafts parallel.
	Bearing wear or failure	Check Drive Roller Bearings, replace failed bearings Check Guide Roller bearings, replace failed bearings
	Worn cog wheel(s)	Cogwheel(s) worn, replace as matched set only!
	Worn/seized pin rack	Check for worn/seized pin rack Rollers, replace as required.
	Brake not adjusted properly	Verify brake is properly adjusted. Secure rake before inspecting.
Grinding/chattering noise emitting from drive	Brake not adjusted properly	Check brake adjustment, adequately secure rake before conducting inspection, follow proper safety guidelines established within the facility.
	Motor bearing problems	Remove and Repair Motor, follow proper safety guidelines established within the facility.
	Spider wear	Check spider for wear. Replace as needed.
	Gear wear	Check for gear wear. Rake removal required, follow proper safety guidelines established within the facility.

Table 2.6-7 Troubleshooting Guide - Mechanical Bar Screens

Problem	Probable Cause	Recommended Action
Rake operating intermittently	Damage to power cables	Inspect power cables for damage and fraying, follow safety guidelines established within the facility.
	Object obstructing rake path causing overload,	Manually operate and watch for unusual operation.
Rake does not stop in parked position	Check the gap between the limit switch and the read angle	Gap should be less than ½ inch
Rake does not engage bar rack properly	Misalignment	Realign rake teeth to bar rack
Rake tooth penetration too deep or too shallow	Rake jumps off dead plate or screenings dropping off rake shelf after cleaning bars.	Verify spring tension jam nuts are secured above and below rake tension springs. Adjust lower jam nuts to increase/decrease tooth penetration. (Teeth should travel 1/16” to 1/4” off dead plate)
Rake shelf misaligned with bars, rubbing pin rack	Spring tension jam nuts improperly secured	Verify Spring Tension Jam Nuts are secured above and below rake tension springs.
	Rake teeth out of alignment	Adjust the rake shelf support tubes to square rake teeth with bars.
	Cogwheel timing out of adjustment	Verify cogwheel timing. If found out of time correct the problem.
Cogwheel timing not set properly	Rake Installed Incorrectly	Correct rake Installation
	Roller missing for pin rack	Pin rack roller missing
	Drive roller bad	Bad drive roller allowing cogwheel to jump. Replace roller.
	Worn Key Seats	Check key seats for wear
Bar screen fails to start	Open circuit	Check with voltmeter or test light
	Blown fuse	Check fuses with voltmeter, replace if necessary
	Magnetic starter failure	Check overload reset
Bar screen trips while operating	Check alarm status	Correct alarm conditions
	Low line voltage	Check voltage at motor leads
Bar screen vibrates	Misalignment	Check alignment, correct wear necessary
	Bearing failure	Check bearings, replace or lubricate as necessary
Bar screen motor draws excessive current	Low voltage	Check leads with voltmeter
	Gearbox over pressure	Check fluid level, adjust to proper level
	Bearing seized	Check bearings, replace or lubricate as necessary
	Blockage in tracking	Remove blockage
Bar screen motor hums	Motor is single phasing	Check phasing
	Brake does not disengage, brake coil failure	Replace coil
Excessive noise when bar screen is operating	Worn bearings	Check bearings for wear, replace as necessary, lubricate adequately

Table 2.6-7 Troubleshooting Guide - Mechanical Bar Screens

Problem	Probable Cause	Recommended Action
Oil leaking from drive unit	Seal's defective	Check the following seal for leaks: motor flange, motor oil seal, gear unit flange, and output end oil seal. Replace faulty seals.
	Gear unit not vented	Vent gear unit
No control power available, screen will not run	Control panel disconnect turned "Off.	Turn control panel disconnect to the "On" position.
	Supply voltage to control panel turned "Off"	Turn the supply voltage source to the "On" position.
	Control Power switch turned "Off"	Turn Control Power switch to the "On" position.
	Control power fuse blown.	Replace control power fuse. Check for short circuit.
Control power available, screen will not run	Emergency Stop button pushed.	Pull Emergency Stop button out.
	Hand-Off-Auto switch in the "Off" position	
	Motor overloaded or over current	Investigate and correct cause. Push Press Common Reset push button to reset.
	Motor overload	Check for phase loss or short circuit in high voltage feed. Press reset on solid-state motor overload to reset. Monitor operation.
Screen runs continuously	End Travel limit switch failed.	Replace limit switch.
	Channel level condition not met	Check level measurement device and observe operation.
	H/O/A switch is in "Hand" and F/O/R switch is in "Forward".	Place the H/O/A switch or the F/O/R switch in the "Off" position.
	No time preset in the PLC based Duration timer	Use OIT on control panel to check set point of duration. Adjust as required. Observe operation, re-enter if necessary.
Overcurrent Indication on OIT.	Current sensing relay tripped.	Check for large debris on the front of the screen. Remove debris. Check for binding of rake. Adjust as needed. Press Screen Reset push button to reset.
Over rotate Indication on OIT.	Over rotate sensing relay tripped.	Place H/O/A in Off. Press Screen Common Reset push button to reset. Place H/O/R in "Hand" and run rake in reverse away from obstruction. Remove obstruction before automatic operation continues.
Motor Overload Indication on OIT.	Solid-state motor overload tripped	Check for short circuit or phase loss in the high voltage circuit. Check for loose terminal connections in the high voltage circuit. Press Screen Common Reset push button to reset.

Table 2.6-8 provides troubleshooting guidance for the operational issues associated with the washing press.

Table 2.6-8 Troubleshooting Guide – Washing Press

Problem	Probable Cause	Recommended Action
Washing press won't run	Not receiving run signal	Check controls and confirm run signal to press
	E-Stop switch is open	Reset E-Stop switch
	Other permissive not allowing press to start	Check permissive, such as zero speed switch
	Screw jammed	Remove or clear jam
	Motor failure	Replace motor
	Motor overloaded or over current	Investigate and correct cause. Push Press Common Reset push button to reset.
Compactor motor trips on overload	Foreign body in the screw	Remove foreign body. Push Press Common Reset push button to reset.
	Obstruction in the outlet piping	Ensure no obstructions present in outlet piping
Washing press not running and water running into press	Foreign material in solenoid valve.	Use ball valve to isolate affected valve. Disassemble valve, clean & inspect valve, reassemble valve.
	Solenoid valve failed.	Replace solenoid valve
Motor overload	Phase loss or short circuit	Check for phase loss or short circuit in high voltage feed. Push Press Common Reset push button to reset. Monitor operation.
Washing Press Over torque pilot light "On"	Current sensing relay tripped	Check for large debris in hopper. Manually reverse press. Remove debris. Push Press Reset push button to reset condition.
Washing Press Motor Overload pilot light "On"	Motor overload tripped.	Press MOL reset on front of control panel.

2.6.5 Maintenance

Process Maintenance

The general maintenance for the mechanical fine screen equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the mechanical fine screens consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 2.6-9 provides the manufacturer's and service representative's contact information for the mechanical bar screens.

Table 2.6-9 Contact Information – Mechanical Bar Screens

Manufacturer	
Name:	Vulcan Industries, Inc.
Address:	212 S. Kirlin St. Missouri Valley, IA 51555
Phone:	712-642-2755
Fax:	712-642-42-4256
Website:	www.vulcanindustries.com
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-377-3952
Fax:	615-373-2701
Website:	www.jtguthrie.com

Table 2.6-10 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the mechanical bar screens.

Table 2.6-10 Maintenance Schedule - Mechanical Bar Screens

Frequency	Maintenance Task to be Performed
Daily	1. Inspect bar screen for proper operation, excessive vibration, or unusual noise.
Weekly	1. Grease drive shaft and pillow block bearings 2. Clean and lubricate pin racks and cam tracks using recommended lubricant. 3. Check gear box for proper level and /or leaks, fill to appropriate level. 4. Visually inspect and clean area. 5. Confirm grease is flowing from lubricator reservoir. Refillable canisters should be checked weekly to verify grease flow to the bearings (this can be a visual inspection). Canisters should be refilled when half empty.
Monthly	1. Check torque on fasteners (pin rack bolts, latch bolts, rack to rack arm bolts, wiper brackets, knockout bolts, and pillow block collars, cogwheel collar, and set screws. 2. Lubricate all rake pivot points where zerk fittings are present. 3. Grease guide tracks and wiper bar and pivot points. 4. Ensure pin rack is clean and lubricated. 5. Check for proper operation of motor brake. 6. Check that rollers and bushing spin freely. 7. Check guide roller for excessive wear. 8. Ensure pin is secure and tight. 9. Inspect wiper blade. Adjust for proper contact. 10. Check gap on rake teeth and deadplate (rake teeth should be ¼" off deadplate) 11. Check location and function of proximity switches. 12. Check for proper functionality of screen, level transducer and high-level float
Every 3 Months	1. Check Pin Rack alignment. 2. Replace grease cartridges on idler roller bearings and pillow block bearings. 3. Inspect wiper shock absorber for proper operation. 4. Check cog wheel teeth for excessive wear. 5. Check rake teeth and dead plate gap. 6. Check gear reducer expansion chamber. 7. Purge grease on gear box side seals.
Semi-Annually	1. Check wear on rollers, bushings, sprockets cam followers, latch, and wiper blade. 2. Check the oil level in the gearbox. A sample of the gear oil should be sent to the oil supplier for analysis. Periodic analysis will establish oil change intervals, based on the degradation of the oil.
Every 2 Years	1. Change oil in gear drives, replace anti friction bearing grease.

Note: The bar screens are equipped with grease cups that are located on the rake's idler rollers and drive rollers. When conducting visual inspection and/or routine lubrication the lubricant level of the cup should be monitored. Grease should slowly dissipate. The cups are designed to lubricate for 3-month intervals. Continuous operation of the rake may reduce the change out time. Failure of the cup will result in rapid bearing deterioration.

Table 2.6-11 provides the manufacturer's and service representative's contact information for the washing press. This is the same service representative as the bar screens.

Table 2.6-11 Contact Information – Washing Press

Manufacturer	
Name:	Vulcan Industries, Inc.
Address:	212 S. Kirlin St. Missouri Valley, IA 51555
Phone:	712-642-2755
Fax:	712-642-4256
Website:	www.vulcanindustries.com
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-377-3952
Fax:	615-373-2701
Website:	www.jtguthrie.com

Table 2.6-12 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the washing press.

Table 2.6-12 Maintenance Schedule - Washing Press

Frequency	Maintenance Task to be Performed
Daily	1. Check for the following: 2. Any unusual noises as the machine is running 3. Any oil leakage from the gearbox 4. If the motor is running abnormally hot 5. Obstructions at the inlet due to oversized materials 6. Water flow at all water outlets. Confirm adequate supply water and adequate flushing. Drain pan may need to be removed and flushed manually. 7. Record hours of run time.
Weekly	1. Clean the machine. Avoid cleaning electrical components with a water jet. 2. Flush the dewatering sieve and drain pan. If an extraordinary amount of grease is observed in the screenings, more frequent cleaning may be necessary.
Monthly	1. Lubricate the thrust bearing/seal assembly using a manual grease gun. Do NOT use pressurized grease fillers as this could damage the seals. 2. Check spiral and bearing unit rotation for vibration and noise. Adjust as necessary. 3. Visually inspect the slot sieve at the bottom of the press for deformation or blockage. 4. Check cleaning brush on the spiral for wear. Replace if necessary. 5. Check all safety devices.

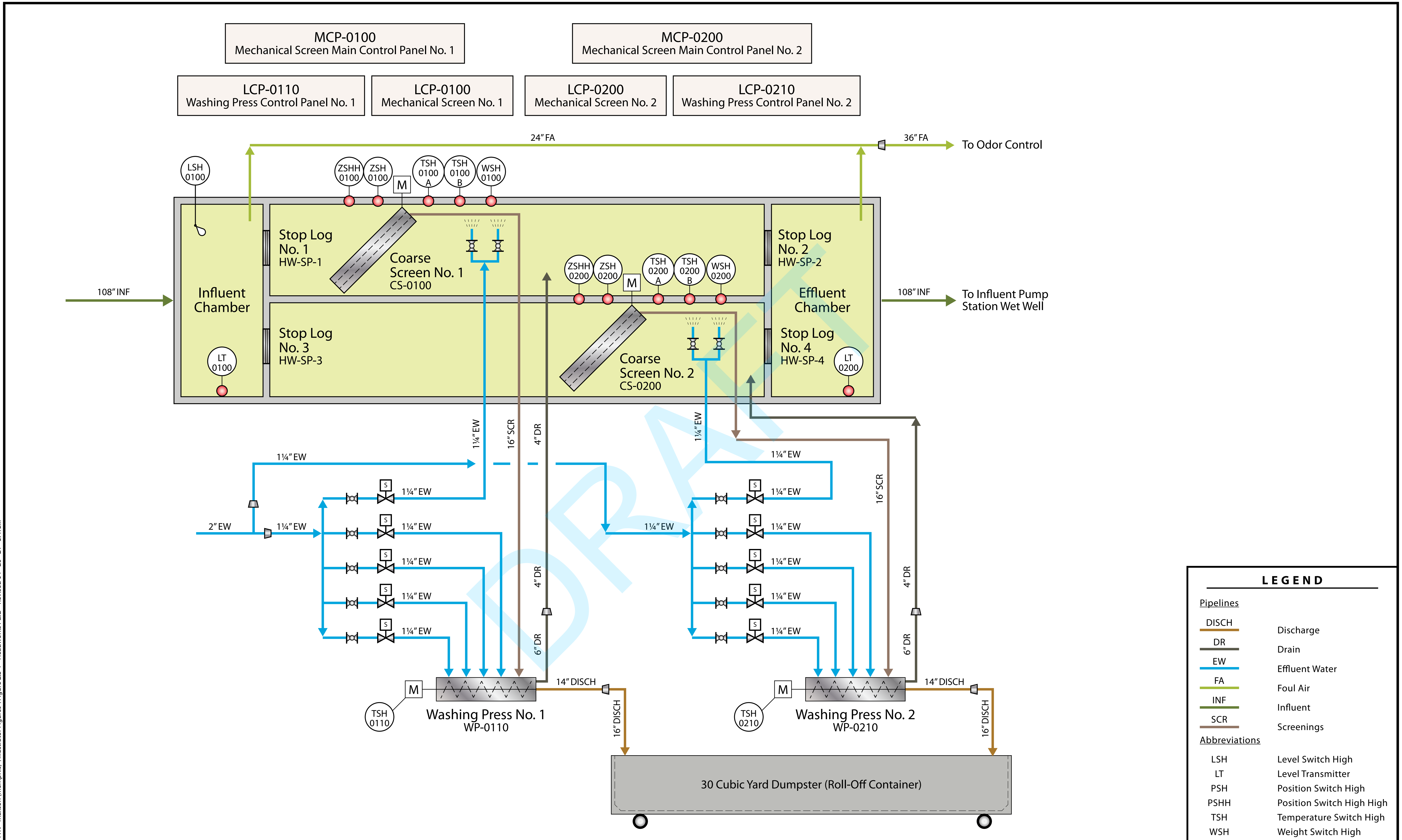
Table 2.6-12 Maintenance Schedule - Washing Press

Frequency	Maintenance Task to be Performed
Semi-Annually	1. Check all fasteners for tightness. 2. Check all electrical connections for cleanliness and secure fits. 3. Visually evaluate the conveying and compacting performance: 4. Observe performance of water pressure 5. Observe screw press compaction 6. Check gearbox oil level and consistency 7. Clean drive and gearbox ventilation

2.6.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.



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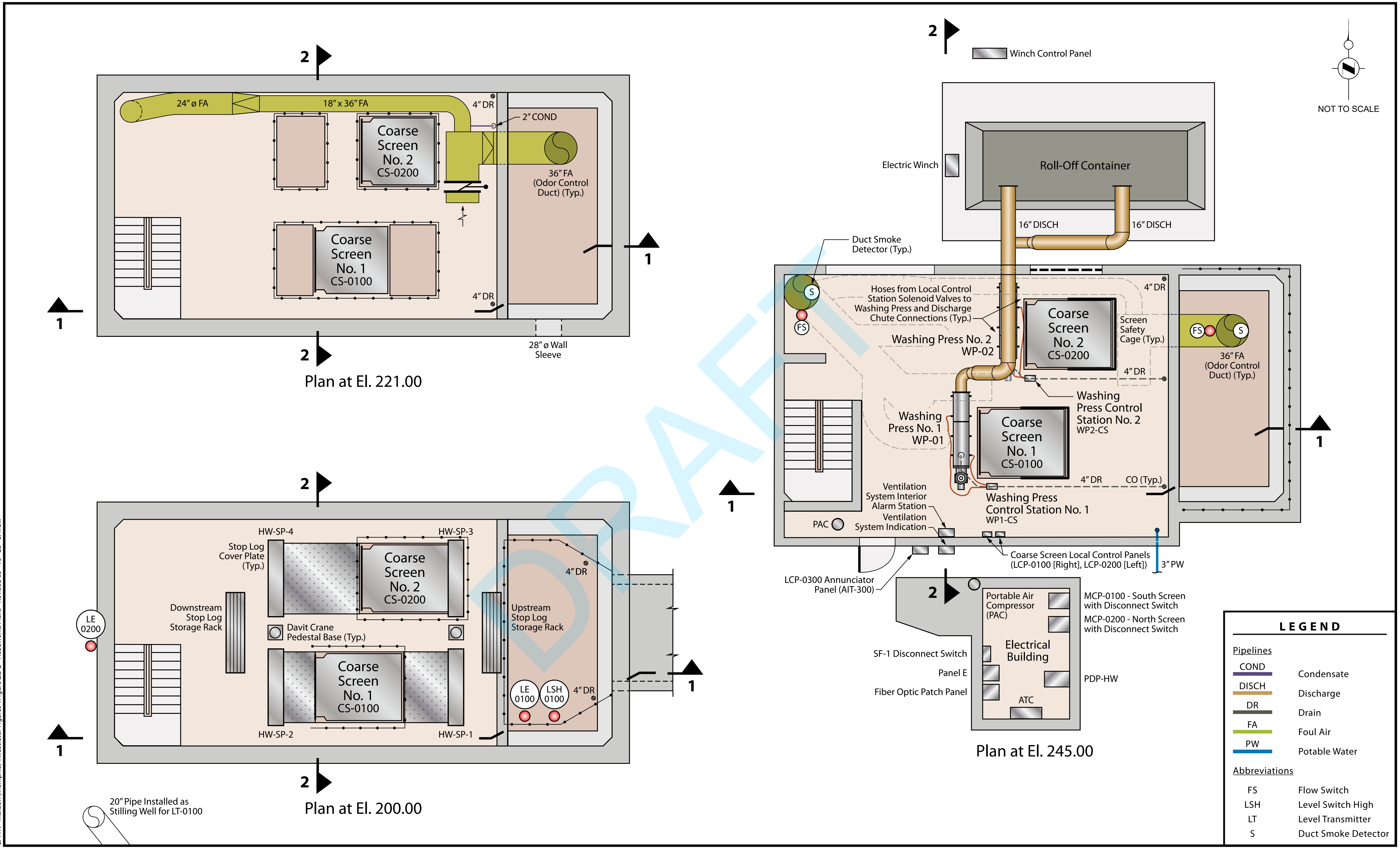
CDM Smith

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 2.3-1
Headworks P&ID



C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 2.3-2 - Headworks Plans - Revised 05 - 18 - 23 - S. Trulli

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Figure 2.3-2
Headworks Plans

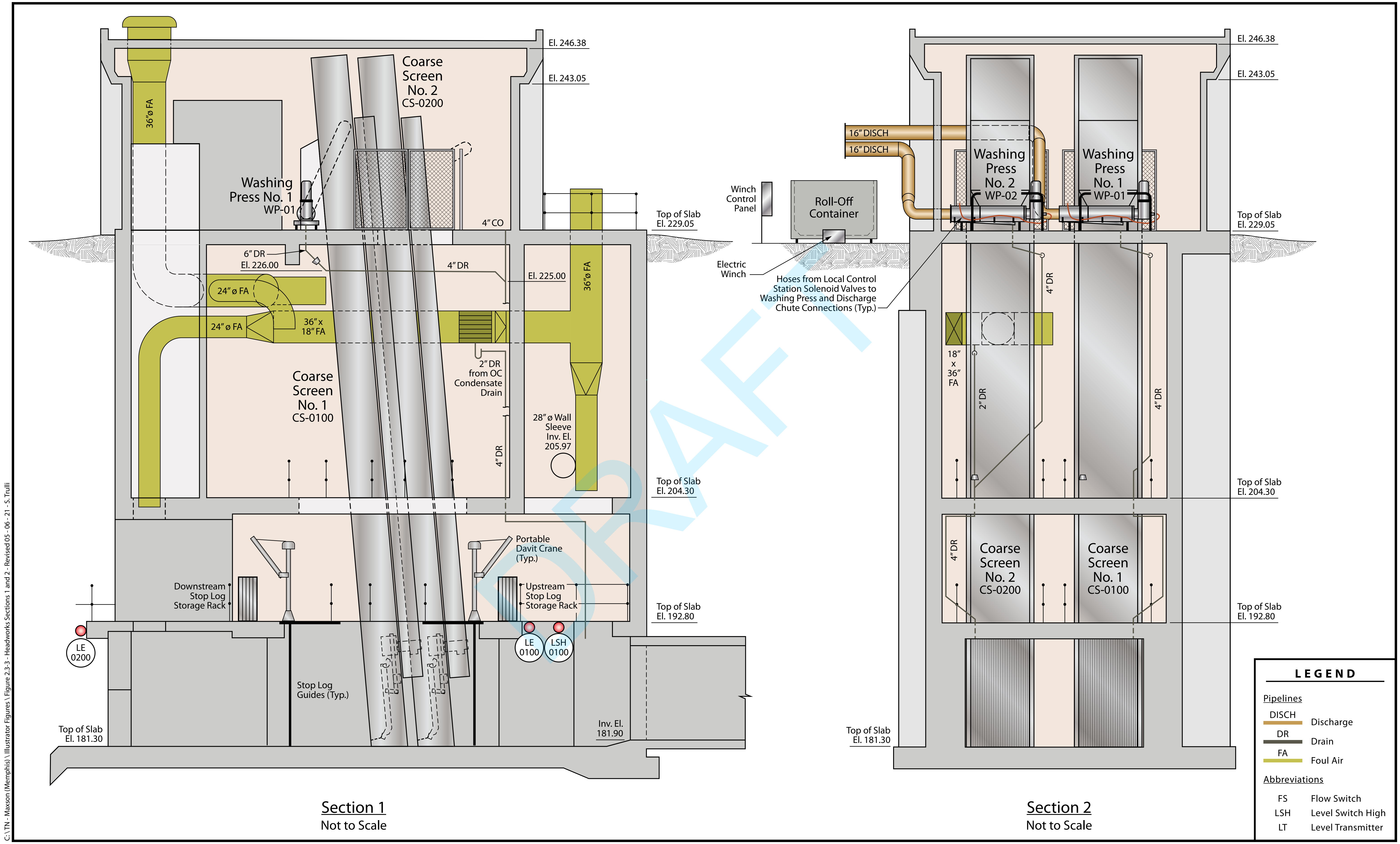

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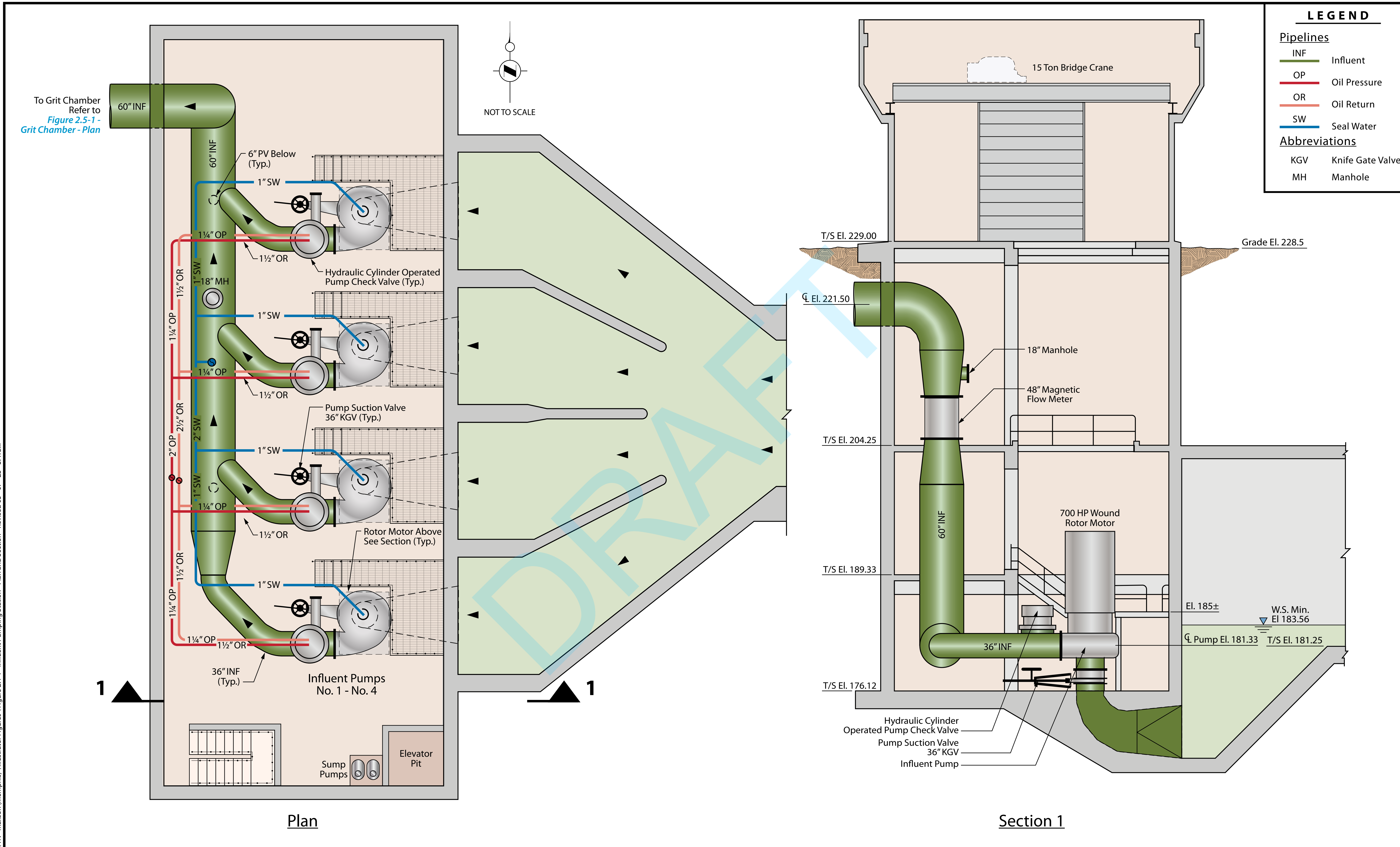
Figure 2.3-3
Headworks Sections 1 and 2



Plan

Section 1

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Figure 2.4-1
Influent Pumping Station - Plan and Section

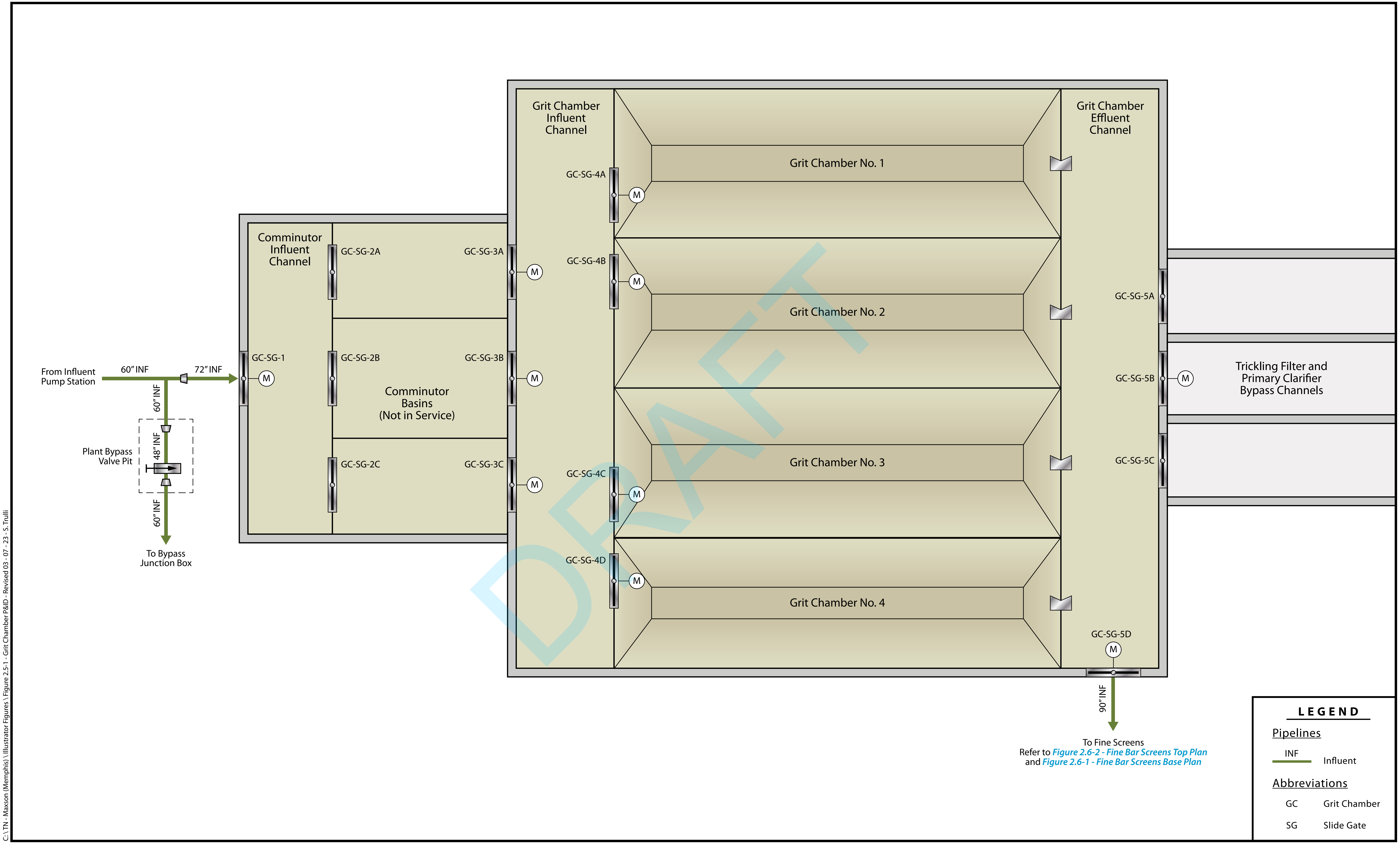

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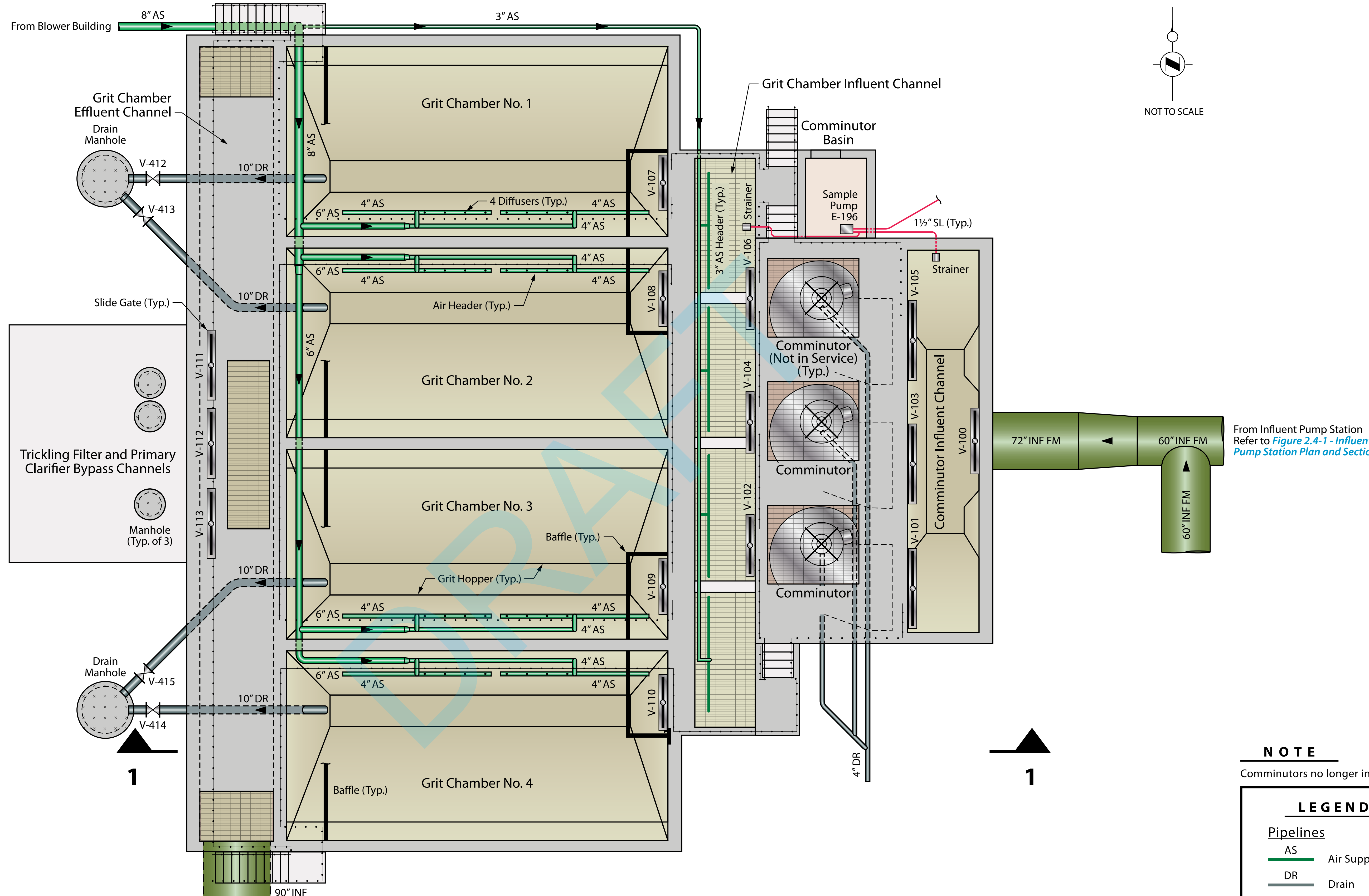
Figure 2.5-1
Grit Chamber P&ID



From Influent Pump Station
Refer to *Figure 2.4-1 - Influent Pump Station Plan and Section*

To Fine Screens
Refer to *Figure 2.6-2 - Fine Bar Screens Top Plan* and *Figure 2.6-1 - Fine Bar Screens Base Plan*

NOTE

Comminutors no longer in service.

LEGEND

Pipelines

AS	Air Supply
DR	Drain
INF	Influent
SL	Sample Line

C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 2.5-2 - Grit Chamber Plan - Revised 03 - 07 - 23 - S. Trulli

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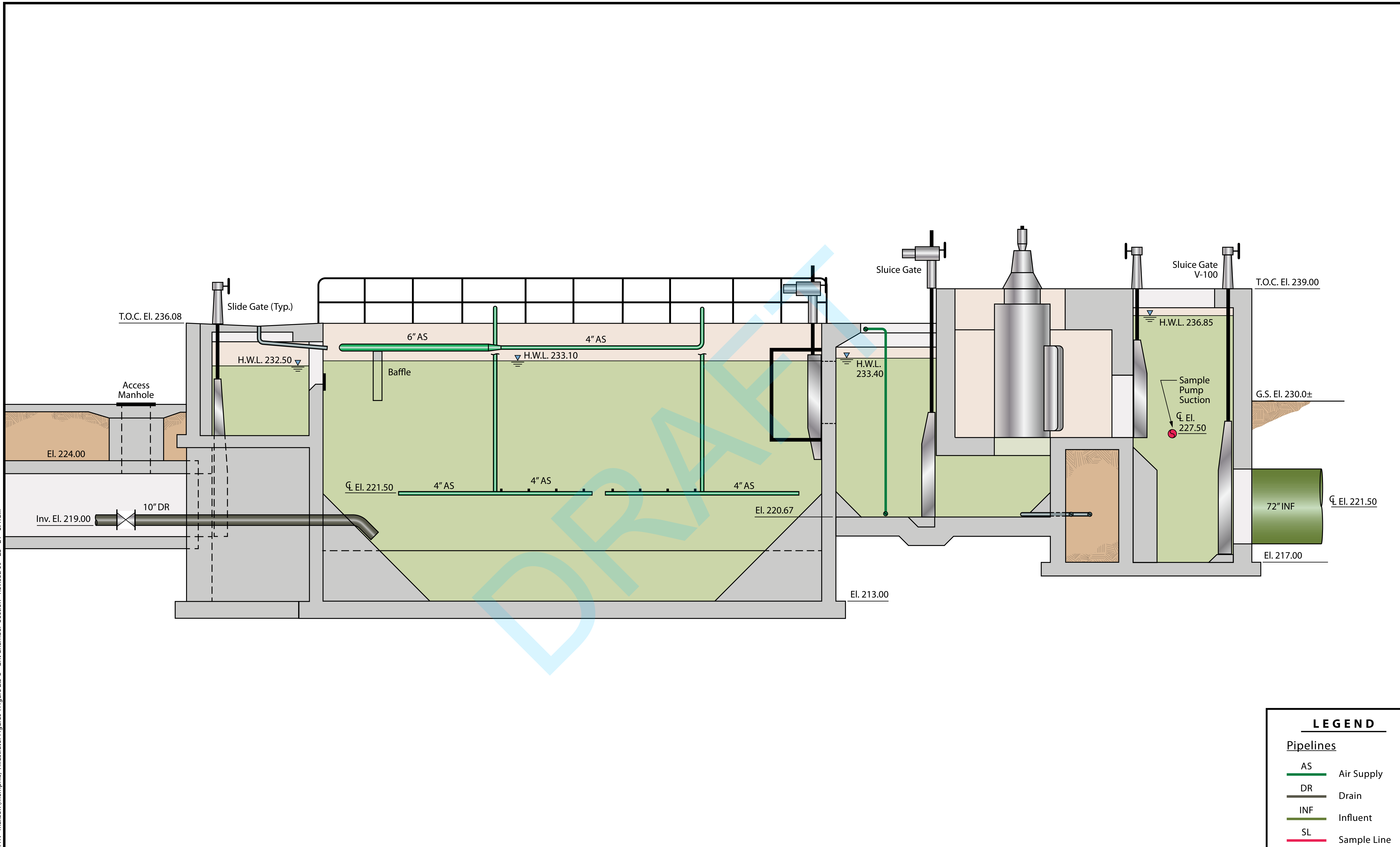
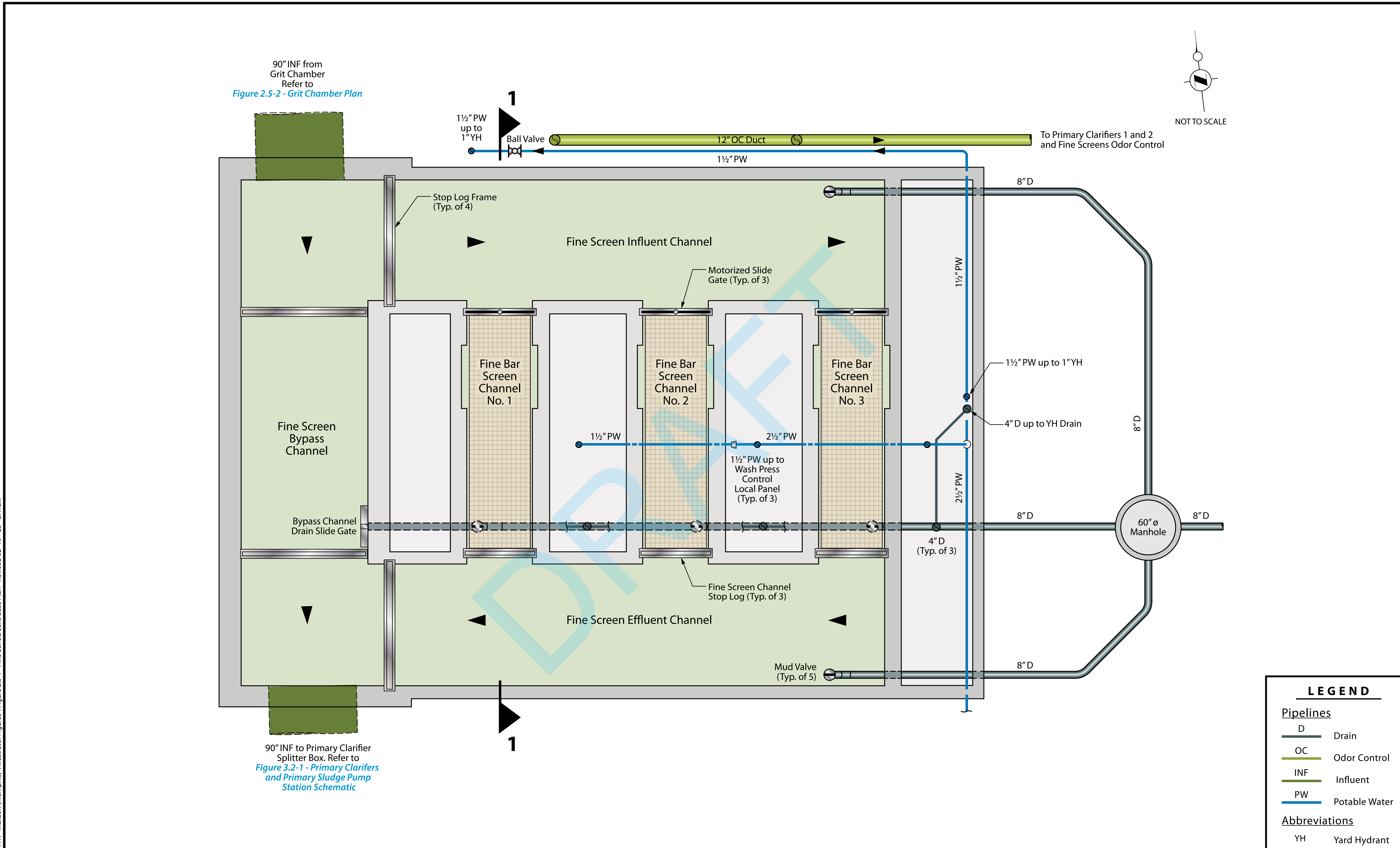
Figure 2.5-2
Grit Chamber Plan



C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 2.5-3 - Grit Chamber Section - Revised 09 - 23 - 21 - S. Trulli

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

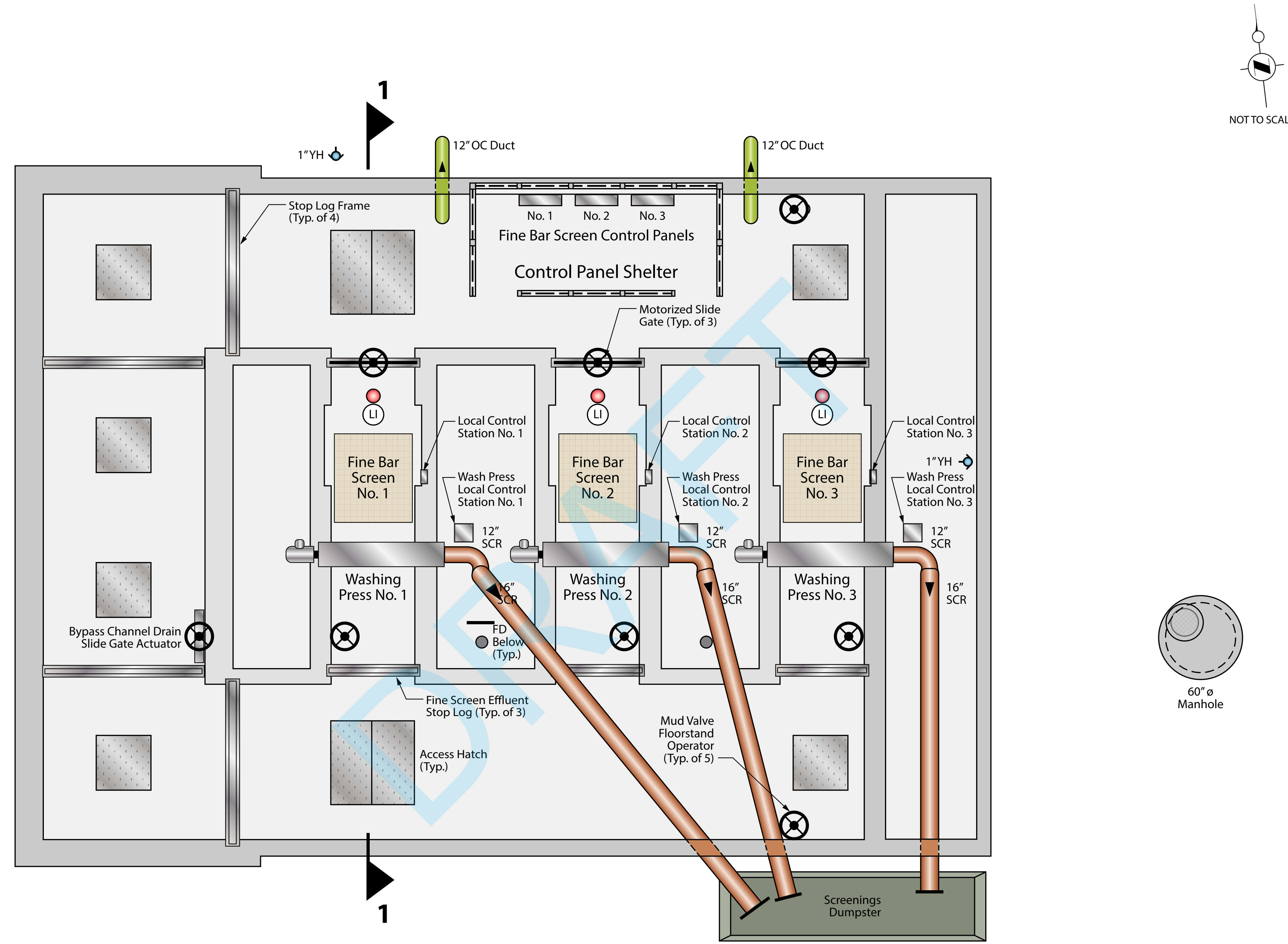
Figure 2.5-3
Grit Chamber Section



C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 2.6-1 - Fine Bar Screens Base Plan - Revised 02-19-25 - S. Trulli

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 2.6-1
Fine Bar Screens Base Plan



LEGEND

Pipelines

OC	Odor Control
SCR	Screenings

Abbreviations

FD	Floor Drain
LI	Level Instrument
YH	Yard Hydrant

C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 2.6-2 - Fine Bar Screens -Top Plan - Revised 02-19-25 - S.Trulli

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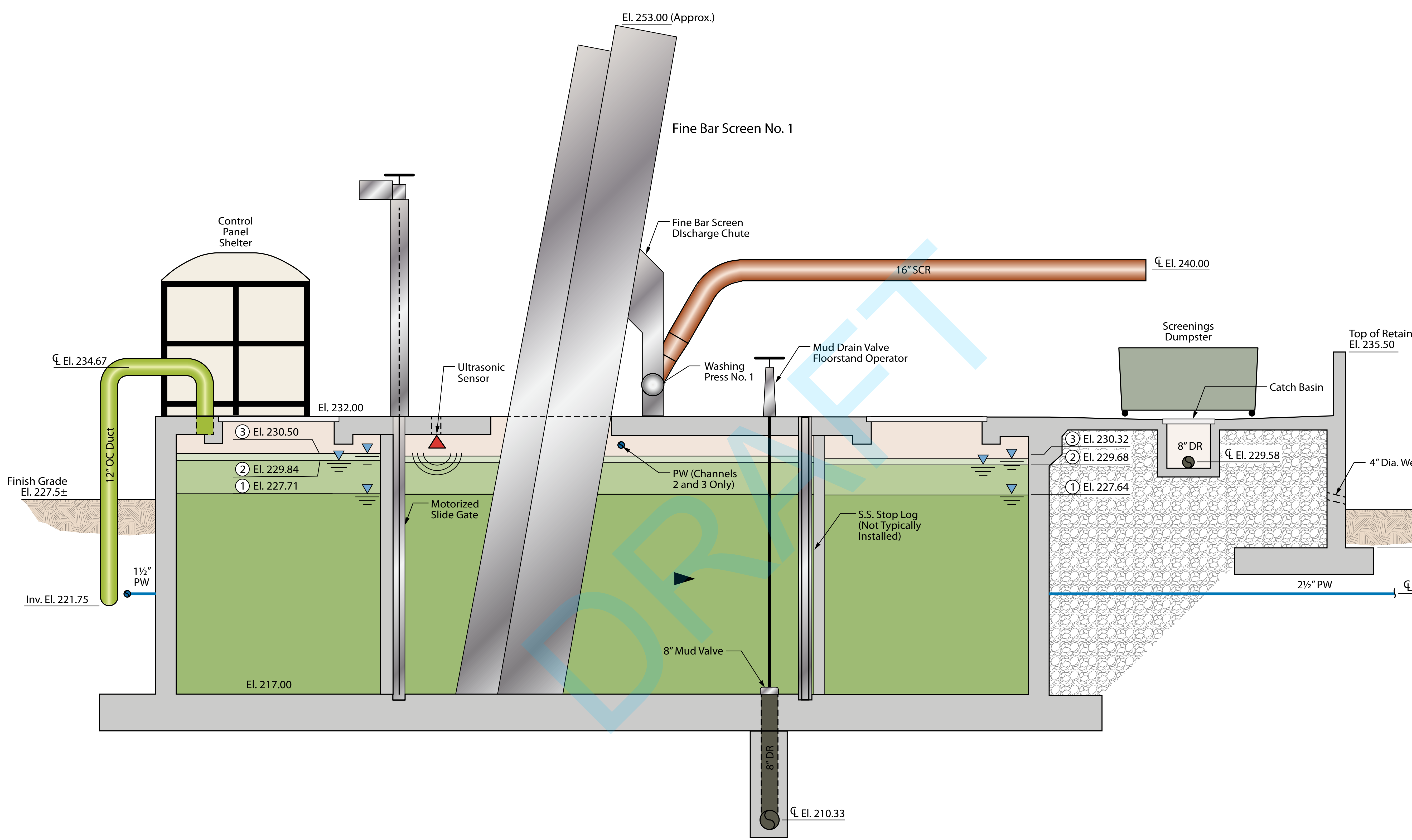
Figure 2.6-2
Fine Bar Screens Top Plan



Water Elevation Key

1. Average Day Flow of 90 MGD with 30 MGD RAS Flow
2. Maximum Day Flow of 156 MGD with 47 MGD RAS Flow
3. Peak Hour Flow of 170 MGD with 48 MGD RAS Flow

LEGEND

Pipelines

DR	Drain
OC	Odor Control
PW	Potable Water
SCR	Screenings

C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 2.6-3 - Fine Bar Screens Section - Revised 02-19-25-S. Trulli

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T.E. Maxson WWTF Process Upgrades

Figure 2.6-3
Fine Bar Screens Section

Section 3

Primary Treatment

3.1 Overview

The Maxson Wastewater Treatment Facility (WWTF) receives raw, untreated wastewater conveyed to the wastewater treatment plant from the City's collection system. This raw wastewater passes through preliminary treatment for removal of non-soluble debris such as rags, sticks, grease, grit, and other debris collected in the sanitary sewer system. Following preliminary treatment, the screened and degritted flow passes into primary treatment for the next stage of wastewater treatment.

The primary treatment system is comprised of primary clarification and an associated sludge pump station, odor control systems, and a scum collection and pumping system.

Figures associated with this system can be found in ***Appendix XX Figures***.

3.2 Primary Clarification

3.2.1 Overview

The pollutants in domestic wastewater are primarily found in two forms: dissolved and particulate. The dissolved pollutants are comparable to sugar in a well-stirred cup of coffee – they will not settle to the bottom, even after standing for a long time. Most particulate pollutants (suspended solids) will settle if they are not excessively disturbed. The particulate pollutants are reduced in the primary clarifiers. A relatively clear fluid (supernatant) is taken from the clarifier surface and a fluid containing most of the particulate pollutants (referred to here as primary sludge) and resembling thin mud is pumped from the bottom of the clarifiers to the solids handling facilities. The supernatant, which contains the dissolved pollutants, proceeds to downstream processes and biological treatment.

The Maxson WWTF has four primary clarifiers located near the southeast corner of the plant and on the east side of the Intermediate Pump Station. Of the four primary clarifiers, Primary Clarifier 1 is the northwest tank, Primary Clarifier 2 is the northeast tank, Primary Clarifier 3 is the southwest tank, and Primary Clarifier 4 is the southeast tank. A primary clarifier splitter box is located between Primary Clarifiers 1 and 2 and is used to evenly distribute flow to the primary clarifiers that are in service. A primary sludge pump station, located between Primary Clarifiers 3 and 4, houses pumping equipment used to pump settled sludge from the primary clarifiers to the solids handling processes.

Flow to the primary clarifiers consists mainly of wastewater from the collection system that has undergone preliminary treatment through the coarse screening, grit removal, and fine screening processes. Additionally, recycle flows from the solids handling processes (sludge lagoons and belt filter presses) mix with the plant influent flow prior to the Influent Junction Box.

See the following figures for the schematic and plans of the primary clarifiers: ***Figure 3.2-1 Primary Clarifiers and Primary Sludge Pump Station Schematic, Figure 3.2-2 Primary Clarifiers Site Plan*** and ***Figure 3.2-3 Primary Clarifier Plan.***

3.2.2 Process Control

The Maxson WWTF utilizes WesTech primary clarifier systems. Details on the clarifier components can be found in the respective O&M manual. The primary clarifiers consist of the following components.

- Primary Clarifier Distribution Box
- Clarifier Tank
- Collector Mechanism and Controls
- Center Influent Column
- Feed Well
- Center Cage
- Sludge Removal Assembly
- Scum Removal Mechanism
- Scum Skimmer Assembly
- Scum Flushing Valve
- Scum Baffle and V-Notch Weir

Primary Clarification Distribution Box

The primary clarification distribution box receives flow from the fine screens through a 90-inch pipe. The Primary Clarifier Distribution Box has 4 slide gates designated as SLG-1, SLG-2, SLG-3, and SLG-4. Flow from the distribution box enters a 54-inch line to each primary clarifier.

Primary Clarification Distribution Box

Clarifier Tank

The primary clarifiers measure 180-feet diameter with a sidewater depth of 10.3-feet (Primary Clarifiers 1, 2, and 3) and 15-feet (Primary Clarifier 4). All the clarifiers contain a collector mechanism and other components. Since Primary Clarifier 4 has a deeper sidewater depth and steeper floor slope, it treats approximately 50 percent more flow than Primary Clarifiers 1, 2, and 3. With all four clarifiers in service, at a design flow of 80 mgd, wastewater remains in Primary Clarifiers 1, 2, and 3 for approximately 2.7 hours and in Primary Clarifier 4 for approximately 2.6 hours.

Collector Mechanism

A collector mechanism is installed in the clarifier tank. Each mechanism performs the following functions:

1. Disperses the flow into the tank and controls short-circuiting.
2. Collects and removes settleable solids from the primary effluent.
3. Removes primary effluent equally from the clarifier to prevent short-circuiting.
4. Collects, moves, and thickens settled sludge.
5. Prevents dilution of the sludge at sludge withdrawal points by continually pushing settled sludge into the center hopper.
6. Collects floating scum from the clarifier surface and discharges the scum into the scum and primary sludge force main.

Each collector is a center-column feed type with peripheral weir overflow to an annular inboard discharge clarifier launder. The center column supports the entire mechanical drive and collector mechanism and the inboard end of the access walkway. This walkway extends from the outside wall of the tank to the drive mechanism in the center of the tank, thus allowing personnel access to the drive mechanism, as well as for the purpose of taking sludge blanket readings.

Primary Clarifier #3 Drive Mechanism (Typical)

Stationary Center Influent Column

Each primary clarifier has a stationary cylindrical steel influent column that has a diameter of 54-inches. One end has a support flange bolted to the tank floor over the influent line. The other end has a similar flange at the top for supporting the drive unit and walkway. There are openings in the upper portion of the column to allow unrestricted passage of the flow into the energy dissipating inlet chamber.

Feed Well

A flocculating feed well is in the center of the tank to diffuse the liquid into the tank without disturbing solids separation or formation of velocity currents. Baffled openings near the water surface allow scum to exit the feed well.

Primary Clarifier Feed Well (Typical)

Center Cage

The top of the cage is attached to the main drive gear to rotate the cage and attached arms and feed well.

Sludge Removal Assembly

The sludge collection equipment consists of a two-arm assembly, supported from the rotating turntable, which sweeps the entire bottom of the tank. The equipment moves activated sludge from the tank floor to the center of the tank where it enters a sump.

Scum Removal

Each clarifier has scum skimming devices as part of the clarifier's mechanism. These skimming mechanisms sweep the surface of each primary clarifier, moving scum and floating material to a scum box at the periphery of the tank. The scum is then directed into the scum box and drains to the scum pump system.

Scum Skimmer Assembly

A hinged scum skimmer assembly is located on the outer end of each skimmer blade. Each assembly collects the scum and traps the scum against the beach plate of the scum box. A squeegee is mounted at the end of each skimmer assembly to wipe the scum into the scum box. The scum skimmer assembly includes brushes to keep the weirs and trough clean.

The photo below shows the scum skimmer assembly in one of the clarifiers.

Primary Clarifier Scum Skimmer Assembly (Typical)

Scum Flushing Valve

A valve is built into each scum box that automatically opens and allows clarified liquid into the scum box aid in flushing out the sticky scum and settled solids. Every pass of a scum skimmer over a scum box actuates these valves, allowing sufficient delay after deposit of the solids before flushing begins.

Scum Baffle and V-Notch Weir

A scum baffle is provided in curved baffle sections fastened to the launder wall with adjustable fiberglass reinforced plastic (FRP) support brackets, stainless steel fasteners, and anchor bolts. This scum baffle helps to prevent short-circuiting in the secondary clarifier. A V-notched weir is installed just outside of the scum baffles. The weir is set hydraulically to provide even flow around the periphery of the clarifier without short-circuiting. The photo below shows the scum baffle, weir, and effluent launder in a primary clarifier. The primary clarifier effluent launders are covered with interlocked sections of aluminum for odor control. Each section is capable of being opened to allow access for maintenance and inspection.

Scum Baffle, Effluent Weirs, and Launder (Typical)

Liquid and Solids Flow Paths

Flow exits the fine screens through a 90-inch effluent pipe. Slide gates located in the Primary Clarifier Splitter Box direct flow through slide gates into a 54-inch pipe discharging at the center of each clarifier.

The settleable solids that enter the primary clarifiers are separated by gravity. The settleable solids settle to the bottom of the clarifier forming a sludge blanket, and the clear liquid, referred to as clarifier supernatant or primary clarifier effluent, travels over the clarifier weirs to downstream treatment systems for biological treatment through a 48-inch clarifier effluent line. The clarifier effluent lines increase from 48-inch to 66-inch and then to 90-inch before proceeding to the Primary Effluent Diversion Structure adjacent to the Intermediate Pump Station.

The settled suspended solids are raked to the center sump of the clarifier and conveyed to the primary pump station. Collected solids are conveyed through two 8-inch diameter primary sludge pipes that combine at the primary sludge pump station suction manifold. Primary sludge is then pumped to the solids handling system.

Operation and Control

Each primary clarifier collector mechanism has a local On/Off selector switch. When in the On position, the clarifier drive runs continuously. When in the Off position, the drive will not run.

Primary Clarifier Local Control Panel (Typical)

Depth of Sludge Blanket

The depth of sludge blanket test primarily indicates to the operator the sludge volume at the bottom of the clarifier. Low depth of sludge blankets in the primary clarifiers results in reduced solids concentrations in the sludge pumped to the solids processing systems, and high depth of sludge blankets may result in anaerobic conditions and the potential for floating sludge. The primary clarifiers have been designed for rapid removal of sludge to minimize the chances of anaerobic conditions. Sludge detention time in the primary clarifiers should be kept to a minimum compatible with maximizing settleable solids removal.

The depth of the sludge blanket should be routinely measured using a “Sludge Judge” or similar device. When using the sludge blanket level device, care should be taken to lower the device slowly until the dense sludge blanket is reached. In some cases, a cloudiness is detected above the blanket. The depth of this material is not measured. Measurements should be made at least twice per shift, or more frequently during a process upset. It is a good idea to make sure that all operators take the blanket depth readings and interpret the results using the same procedure to make the data collected meaningful.

Major Process Gates

Table 3.2-1 provides a list of the gates associated with the primary clarifiers.

Table 3.2-1 Primary Clarifier Gates

Gate ID	Gate Location	Clarifier ID
SLG-1	Primary Influent Splitter Box	Primary Clarifier 1
SLG-2	Primary Influent Splitter Box	Primary Clarifier 2
SLG-3	Primary Influent Splitter Box	Primary Clarifier 3
SLG-4	Primary Influent Splitter Box	Primary Clarifier 4
SG-2	Primary Clarifier 1 Effluent	Primary Clarifier 1
SG-3	Primary Clarifier 2 Effluent	Primary Clarifier 2
SG-4	Primary Clarifier 3 Effluent	Primary Clarifier 3
No Gate	Primary Clarifier 4 Effluent	Primary Clarifier 4

Design Criteria and Nameplate Data

Table 3.2-2 presents the primary clarifier design criteria.

Table 3.2-2 System Data - Primary Clarifiers

Component/Criteria		
Primary Clarifiers		
	Primary Clarifier 1 through 3	Primary Clarifier 4
Number	3	1
Manufacturer	WesTech	WesTech
Model	COP	COP C2
Diameter, feet	180	180
Sidewater depth, feet	10.3	15
Flow at 55/80/160 mgd, each	12.22/17.78/35.56	18.33/26.67/53.33
Overflow rate, gpd/ft[2] at 55/80/160, each	480/699/1397	720/1048/2096
Weir loading, gpd/ft at 55/80/160, each	22500/32700/65300	33700/49000/98000
Detention time, hours at 55/80/160, each	3.85/2.65/1.32	3.74/2.57/1.28
Collector speed, rpm	0.018	0.024/0.036
Tip speed, fpm	9.9	14/21
Motor manufacturer	Sterling	Sterling
Motor horsepower	0.5	2.0
Motor speed	20	1200/1800

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

Information of the Primary Sludge pumps and Scum pumps can be found in ***Sections 3.3 Primary Sludge Pump*** and ***3.4 Scum Collection and Handling,*** respectively.

Liquid Flow Paths

Primary clarifier influent flow enters the Primary Clarifier Influent Box from the preliminary treatment process. Flow is distributed to the in-service primary clarifiers. Effluent from the clarifiers flows over weirs and to the Primary Effluent Diversion Structure at the Intermediate Pump Station.

Solids Flow Paths

Settled solids from the bottom of the primary clarifiers and floatables from the clarifier surface are pumped to the sludge lagoons and dewatering process before being trucked from the site for disposal.

3.2.3 Equipment Control

General

There are three basic equipment systems: the primary settling basin rotating sludge collectors, the scum pumps, and the sludge pumps. Each system is powered through MCC-3 located on the operating floor of the primary sludge pump station. The locations of the controls and indicators and functions for each equipment system are listed in the tables below.

Table 3.2-3 Primary Clarifier Equipment Locations of Controls

Control or Indicator	Number of Units	At MCC-3	At Equipment	At SCADA
Sludge Collectors – Clarifiers 1 through 4				
Circuit breaker	4	X		
Combination magnetic motor starter – circuit breaker	4		X	
Selector Switch				
Hand-Off-Com	4			X
Slow/Fast	4		X	
Pushbuttons				
Start	4		X	
Stop	4		X	
On	4			X
Off	4			X
Alarm Silence	4		X	
Reset	4		X	
Alarm Test	4		X	
Torque overload alarm switch	4		X	
Torque overload cutout switch	4		X	
Backup torque overload cutout switch	4		X	
Red alarm light	4		X	
Alarm horn	4		X	
Green Indicating Light				
Off	4		X	
Start	4			X

Table 3.2-3 Primary Clarifier Equipment Locations of Controls

Control or Indicator	Number of Units	At MCC-3	At Equipment	At SCADA
Red Indicating Light				
On	4		X	
Stop	4			X
Off	4			X
Computer monitoring of operating status	4			X
Yellow Indicating Light				
Sweep Alarm	4			X
Sludge Pumps				
Combination magnetic motor starter – circuit breaker (Pumps 1 through 5)	5	X		
Circuit breaker (Pump 6)	1	X		
Motor starter (Pump 6)	1	Near MCC-3		
Selector Switch				
Hand-Off-Auto (Pumps 1 through 5)	5		X	
Hand-Off-Auto	1	At starter panel		
Hand-Off-Com	6			X
Pushbuttons				
On	6			X
Off	6			X
Sludge Density Meter	1			X
Red Indicating Light				
Run (Pumps 1 through 5)	5	X		
Off	6			X
Stop	6			X
Green Indicating Light (Pumps 1 through 5)				
Stop	5	X		
Start On				X
Power On				X
Red Indicating Light (Pump 6)	1	At starter panel		
Green Run Indicating Light (Pump 6)	1	At starter panel		
Elapsed Time Meter	5	X		
Computer monitoring of operating status				X
Seal water solenoid valve	6		X	
Start-Stop timed cycle control	6			X
Sludge holding tank water level float switch	1		In Sludge Holding Tank	

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

Table 3.2-4 Primary Clarifier Equipment Functions of Controls

Control or Indicator	Functions
Sludge Collecting Equipment	
Circuit breaker	Energize equipment.
Combination magnetic motor starter – circuit breaker	Locally supply power and motor protection.
Selector switch	**Hand** – Operate sweeps using adjacent pushbuttons (On/Off).
	Off – Remote controls deactivated.
	Com – Sweep controls through computer.
	Slow – Selects sludge collecting equipment to operate at slow speed (14 fpm tip speed).
	Fast – Sludge collector operates at high speed.
Pushbutton	**Start** – When pressed, sludge collecting equipment operates continuously at speed selected by **Slow/Fast** switch until manually stopped, motor overload occurs, or torque overload occurs.
	Stop – When pressed, stops sludge collecting equipment.
	On – Activate primary clarifier sweep with Start pushbutton.
	Off – Deactivate primary clarifier sweep.
	Alarm Silence – When pressed, silences the alarm horn.
	Reset – When pressed, resets the torque overload relay after a torque overload alarm event to reinstate torque overload alarm protection.
	Alarm Test – When pressed, test the torque overload alarm circuit and the torque overload cutout circuit for proper operation.
Torque overload alarm switch	Illuminates red alarm light and sounds alarm horn when the load on the equipment reaches approximately 115 percent of the continuous operating torque of the drive unit (which equals a reading of 54 percent on the visual torque indicator at the drive head).
Torque overload cutout switch	Stops the sludge collecting equipment and activates remote annunciation at the computer when the load on the equipment reaches approximately 140 percent of the continuous operating torque of the drive unit (which equals a reading of 67 percent on the visual torque indicator at the drive head).
Backup torque overload cutout switch	If the torque overload cutout switch fails, it stops the sludge collecting equipment and activates remote annunciation at the computer when the load on the equipment reaches approximately 180 percent of the continuous operating torque of the drive unit.
Red alarm light	Illuminates when load on the equipment reaches approximately 115 percent of the continuous operating torque of the drive unit.
Alarm horn	sounds when load on the equipment reaches approximately 115 percent of the continuous operating torque of the drive unit.
Green indicating light	**Off** – Power source deenergized.
	On – Sweep is running.
	Start – Activate sweep.
Red indicating light	**On** – Power is available to sweep.
	Stop – Deactivate sweep.
Computer monitoring of operating status	Computer continuously monitors operating status of equipment and will display or print status upon operator request.

Table 3.2-4 Primary Clarifier Equipment Functions of Controls

Control or Indicator	Functions
Primary Sludge Pumps	
Circuit breaker	Energizes equipment.
Combination magnetic motor starter – circuit breaker	Locally supply power and motor protection.
Selector switch	**Hand** – Operate primary sludge pump using adjacent pushbuttons (On/Off).
	Off – Remote controls deactivated.
	Com – Operate pumps through computer interface.
	Hand – Pump operates continuously.
	Off – Pumps does not operate.
	Auto – Control of operation is transferred to the computer.
Pushbuttons	**On** – Activate pump.
	Off – Deactivate pump.
Sludge Density Meter	Measures density of sludge. At a preset time, shut off pump operation when solids concentration is less than 6 percent.
Seal water solenoid valve	Opens whenever pump is operating to provide seal water to pump.
Computer monitoring of operating status	Computer continuously monitors operating status of equipment and will display or print status upon operator request.
Sludge holding tank high water level float switch	Computer receives signal and stops pump when level rises to 9 inches below the overflow.
Elapsed time meter	Displays accumulated hours of operation.
Green indicating light	**Run** – Sludge Pump 6 is running.
	Start – Start pump operation.
	On – Pump is running.
	Stop – Pump is not operating.
Red indicating light	**Power On** – Sludge Pump 6 has power.
	Stop – Stop pump operation.
	Off – Pump is not running.
	Run – Pump is operating.

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

3.2.4 Operation

Normal Operation

The normal operation for the primary clarifier is in the "Automatic" mode. Normally, the sludge collecting and skimming mechanisms run continuously. The basins should be inspected several times each shift for effective removal of sludge and surface scum. The sludge collecting and surface skimming mechanism should be observed for smooth movement and freedom from binding. The torque on the sludge collecting mechanism should be checked periodically to determine whether it is constant or is building to a full load.

The center inlet well of each basin should be checked during each shift for floating solids. If solids accumulate rapidly, the scum port openings should be adjusted to allow continuous flow of the floating material out of the center well.

Alternate Operation

Alternate operations indicate that one or more components of the primary system will be out of service or cannot be operated in the normal mode. Equipment needed for operations that is normally operated in Automatic mode can be operated in the Manual Mode. In the manual mode, the sludge and scum pumps will operate continuously and will require monitoring to avoid over-pumping.

Shutdown Considerations

Shutting down a primary clarifier increases the hydraulic load on the remaining primary clarifiers that are in service. During higher flow conditions, sludge removal efficiency may be reduced.

Prior to any draining activity, the level of the groundwater should be determined. High ground water levels can exert enough pressure on a drained clarifier that can float the clarifier out of the ground. A ground water piezometer is located near Primary Clarifier 4. Connect the pressure gauge to the squeeze bulb which is attached to the flexible tubing. Place the free end of the tubing over the ¼-inch diameter pipe that extends from the top of the piezometer. Force air into the pipe by squeezing the bulb – the pressure gauge needle should rise as air is forced into the pipe. When the pressure gauge reading no longer increases, read the pressure off the gauge. Use this reading to determine the ground water level.

Example: Determine ground water level.

Known:

▪ Bottom elevation of ground water piezometer, feet	196.0
▪ Bottom elevation of primary clarifier, feet	204.0
▪ Pressure gauge reading, psi	6.5

1. Convert pressure in piezometer to distance, feet

   (6.5 ~~psi~~) (2.307 feet/~~psi~~) = 15 feet

2. Determine ground water level

Bottom elevation of piezometer, feet + water in piezometer, feet

196.0 feet + 15 feet = Ground water level, feet

211.0 feet

The bottom elevation of the primary clarifier slab is 204.0 feet. The basin should not be dewatered when the groundwater elevation is above this elevation.

Once it has been determined that the ground water level is low enough to allow clarifier draining, complete the following steps.

1. Close the clarifier influent gate at the primary clarifier splitter box.
2. Continue pumping sludge from the clarifier until the blanket has been pumped out.
3. Turn off the primary sludge pump.
4. Open the clarifier drain.
5. If possible, hose the walls and internal clarifier mechanisms as the basin is draining.
6. Once the clarifier is drained, turn off the collector mechanism.
7. The primary clarifier is now shut down.

Restart Considerations

This section explains the startup procedures for a primary clarifier and its associated equipment.

1. Verify that the primary clarifier, sludge and scum collector mechanism, sludge pump, and scum pump are prepared for operation by checking valve positions and confirms any locks have been removed from equipment to be used.
2. Verify that all required maintenance has been completed on the primary clarifier and its associated equipment.
3. Visually inspect the primary clarifier for any abnormal conditions that would adversely affect clarifier operation, i.e., confirm no ladders, tools, etc. remain in the tank.
4. Confirm the clarifier drain valve is closed.
5. Slightly open the inlet gate at the primary clarifier splitter box to begin introducing flow to the clarifier.
6. Once the sludge collector arm is partially submerged, start the mechanism drive.
7. Observe the sludge collector mechanism to confirm smooth operation and the torque is reading within normal limits.

8. Once a blanket is detected in the bottom of the clarifier, place the sludge pump in service.

9. When flow begins over the weirs, open the inlet gate completely.

10. The primary clarifier is now operational.

11. Notify pertinent personnel that the system is in operation.

Routine Checklist

The primary clarifiers should be observed for the following:

1. Closely monitor the sludge and scum collector mechanism to be sure they are operating smoothly without skipping or binding and torque is within normal limits.

2. Visually inspect the sludge and scum pumps and check for possible damage.

3. Check the pump and drive motor for unusual noise, vibration, misalignment, and/or excess heat.

4. Check the sludge blanket to confirm sludge removal rate is adequate.

5. Visually inspect clarifier surface to confirm no excessive scum accumulation.

6. Document any equipment malfunction and the corrective action implemented.

Troubleshooting

The following identifies problems that may be encountered during the operation of the primary clarifiers. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are symptoms followed by the problem that may be causing the symptom.

Table 3.2-5 provides general troubleshooting guidance for the primary clarifiers.

Table 3.2-5 Troubleshooting Guide - Primary Clarifier

Problem	Probable Cause	Recommended Action
Poor TSS and BOD removal	High overflow rate	Bring additional units on-line to reduce hydraulic loading rate.
	Underflow too low	Increase sludge pumping rate to achieve target primary sludge concentration.
Clarifier drive mechanism overload	Insufficient sludge withdrawal	Bypass feed. Open discharge line and run mechanism, if possible. If not possible, drain tank and remove sludge.
	Plugged discharge line	Backflush line.
	Excessive sludge loading	Increase rate of sludge withdrawal.
Uneven primary sludge withdrawal	Obstructed line	Flush all lines in service to prevent mechanism from disrupting header operation. Measure blanket depth to confirm even withdrawal across clarifiers.

Table 3.2-5 Troubleshooting Guide - Primary Clarifier

Problem	Probable Cause	Recommended Action
Foreign objects dropped into tank	Obstruction	Stop mechanism. Do not restart until object is removed. Remove object or drain tank, if necessary, to remove. If tank is drained, inspect for any damage caused by object and repair.
Drive fails to start or restart	Overload alarm	Remove overload.
	Incorrect control position selected	Check control mode.
	Defective motor or controls	Refer to the vendor O&M manual.
Pump does not start	Incorrect control position selected	Check control mode.
	Defective motor or controls	Refer to the vendor O&M manual.
Pump is running, but little or no sludge/scum is being delivered	Damaged sludge pump	Check pump for broken shaft, worn rotor/stator, or clogged.
	Pump discharge valve is closed or partially closed	Check pump discharge valve is fully open.
	Clogged pump Influent or discharge line	Flush or clean out pump discharge line.

3.2.5 Maintenance

Process Maintenance

The general maintenance for the primary clarifiers and associated equipment can be found in the manufacturers operations and maintenance manual(s) linked below. The process maintenance for primary clarifier equipment includes keeping the area clean of debris, inspecting the clarifier drives for proper operation and ensuring pumps and motors units are properly lubricated.

Facility staff should conduct daily inspections of the primary clarifiers.

Please view maintenance requirements for the primary clarifier equipment in their respective original equipment manufacturer recommendations.

- Driver mechanism
- Plug Valve
- Check Valve
- Sump Pump
- Sludge Pump
- Scum Pump

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 3.2-6 provides the major equipment manufacturer's contact information for the primary clarifier equipment.

Table 3.2-6 Contact Information – Primary Clarifiers

Manufacturer	
Name:	WesTech
Address:	3665 S. West Temple Salt Lake City, UT 84115
Phone:	801-265-1000
Fax:	801-265-1080
Website:	***www.westechwater.com***
Service Representative	
Name:	Gulf States Engineering Co., Inc.
Address:	8381 Industrial Drive Olive Branch, MS 38654
Phone:	662-890-4768
Fax:	662-890-4769
Website:	www.gsengr.com
Email:	info@gsengr.com
Website	***www.westech-inc.com***

3.2.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the T.E. Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

3.3 Primary Sludge Pump Station

3.3.1 Overview

The Primary Sludge Pump Station is an essential component of the wastewater treatment process, specifically designed to handle the conveyance of primary sludge from primary clarifiers to further treatment or disposal stages (discussed in ***Section 7 Biosolids Treatment***). There is an 8-inch sludge line from each of the primary clarifiers into the Primary Sludge Pump Station. The Primary Pump Station is located between the Primary Clarifiers No. 3 and No. 4. The primary sludge pumps are in the basement. The primary sludge pumps are powered through the Motor Control Center MCC-3, located on the operating floor of the Primary Sludge Pump Station.

Primary Sludge Pump Station

The primary function of the Primary Sludge Pump Station is to transfer primary sludge, which consists of settled solids from the primary clarifiers to the Anaerobic Lagoon 2A for sludge treatment and stabilization. This process is vital for reducing the volume of sludge and preparing it for safe disposal or beneficial reuse.

Refer to ***Section 7 Biosolids Treatment*** for more information.

See the following figures for the schematic and plan of the primary sludge pump station: ***Figure 3.2-1 Primary Clarifiers and Primary Sludge Pump Station Schematic*** and ***Figure 3.3-1 Primary Sludge Pump Station Plan.***

3.3.2 Process Control

Process Components

The clarifier scum handling system consists of the following:

- 6 – primary sludge pumps
- Suction and discharge piping and valves
- Local control panels
- Instrumentation and related controls

Sludge is continuously removed from the bottom of each Primary Clarifier through 8-inch lines that connects to a header where the suction of the Primary Sludge Pumps No. 1 through 6 are connected. Primary Sludge Pumps No. 1 through 6 also discharge to a header. This provides the flexibility to assign a primary sludge pump to remove the sludge from a specific primary clarifier and have two pumps on standby.

The 8-inch primary pump discharge header connects into a 12-inch force main that conveys the primary sludge to the Anaerobic Lagoon 2A for treatment. After the sludge in the lagoon has been treated it will then be transferred to the Belt Filter Press (BFP) for additional treatment and stabilization before dewatering and land field application.

Major Process Gates

Table 3.3-1 provides a list of the gates associated with the primary sludge pumps.

Table 3.3-1 Primary Sludge Pump Gates

Valve ID	Size	Function
SV-31	8-inches	Primary Pump No. 1 Sludge Pump suction valve
SV-32	8-inches	Primary Pump No. 2 Sludge Pump suction valve
SV-33	8-inches	Primary Pump No. 3 Sludge Pump suction valve
SV-34	8-inches	Primary Pump No. 4 Sludge Pump suction valve
SV-35	8-inches	Primary Pump No. 5 Sludge Pump suction valve
SV-133	8-inches	Primary Pump No. 6 Sludge Pump suction valve
SV-37	8-inches	Primary Pump No. 1 Sludge Pump discharge valve
SV-38	8-inches	Primary Pump No. 2 Sludge Pump discharge valve
SV-39	8-inches	Primary Pump No. 3 Sludge Pump discharge valve
SV-46	8-inches	Primary Pump No. 4 Sludge Pump discharge valve
SV-47	8-inches	Primary Pump No. 5 Sludge Pump discharge valve
SV-132	8-inches	Primary Pump No. 6 Sludge Pump discharge valve

Design Criteria and Nameplate Data

Table 3.3-2 presents the primary sludge pumps design criteria.

Table 3.3-2 System Data – Primary Sludge Pumps

Component	Primary Sludge Pump	Thickened Primary Sludge Pump
Quantity	5	1
Manufacturer	Moyno (Robbins & Meyers)	Moyno (Robbins & Meyers)
Model	1K345G1 CDC3ASX	1K345G1 CDC3ASX
Type	Progressing Cavity	Progressing Cavity
Tag	E305 through E309	SP-6 (E310)
Capacity at rated head, gpm	350	533
Rated head, psi	10	30
Speed, rpm	330	885
Motor manufacturer	Baldor-Reliance	Siemens
Motor Model	P28G456	SD100
Motor horsepower	20	50
Motor speed, rpm	1200	900
Volts/Phase/Frequency	460/3/60	460/3/60
Frame	286T	404T
Service Factor	1.15	1.15

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

3.3.3 Equipment Control

The following tables identify the local controls associated with the Primary Sludge Pump Station pumps. The primary sludge pumps have local start stop control panels (LCP) and local disconnect switches.

Primary Sludge Pumps Local Control Panel (Typical)

Table 3.3-3 provides the location of controls associated with the scum pumps.

Table 3.3-3 Primary Sludge Pumps Equipment Locations of Controls

Control or Indicator	Number of Units	At MCC-3	At Equipment	At SCADA
Sludge Pumps				
Combination magnetic motor starter – circuit breaker (Pumps 1 through 5)	5	X		
Circuit breaker (Pump 6)	1	X		
Motor starter (Pump 6)	1	Near MCC-3		
Selector Switch				
Hand-Off-Auto (Pumps 1 through 5)	5		X	
Hand-Off-Auto	1	At starter panel		
Hand-Off-Com	6			X
Pushbuttons				
On	6			X
Off	6			X
Sludge Density Meter	1			X
Red Indicating Light				
Run (Pumps 1 through 5)	5	X		
Off	6			X
Stop	6			X
Green Indicating Light (Pumps 1 through 5)				
Stop	5	X		
Start On				X
Power On				X
Red Indicating Light (Pump 6)	1	At starter panel		
Green Run Indicating Light (Pump 6)	1	At starter panel		
Elapsed Time Meter	5	X		
Computer monitoring of operating status				X
Seal water solenoid valve	6		X	
Start-Stop timed cycle control	6			X
Sludge holding tank water level float switch	1		In Sludge Holding Tank	

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

3.3.4 Operation

Normal Operation

The normal operation of the primary sludge pumps is in the Automatic mode. This allows the process to be controlled by the SCADA System. They can also be operated in Manual mode by the Local Control Panel of each pump. Usually, one pump will serve one primary clarifier with one pump on standby.

Alternate Operations

The alternate operation of the primary sludge pumps is to place the pumps in the Hand mode. Operating the pumps in this mode should be done only for maintenance or emergency purposes. In the event of one primary sludge pump is out of service for any reason the standby primary sludge pump can be used to serve the primary clarifier that the out of service pump was serving. Any of the primary sludge pumps may also be used, since all the primary sludge suction pipes are interconnected.

Shutdown Considerations

The following steps are related to shutting down the primary sludge pumping system. When the primary sludge pumps (and related equipment) are going to be worked on, remember to follow all safety recommendations/requirements of the equipment manufacturer and T.E Maxson WWTF.

Completely shutting down the primary sludge pumping system may result in scum being transferred to downstream processes or the system needing to be unplugged if it remains idle for too long without having first been flushed with water. If the primary sludge pumping system is not being shut down completely, place the Hand/Off/Automatic selector switch for the pump identified for shutdown into the Off position and isolate the pump's discharge line using the discharge isolation valve if required.

Taking the primary sludge pump system completely offline, monitor the sludge level in the associated primary clarifiers. The use of a vacuum truck or other device capable of removing accumulated primary sludge during the period that the primary sludge pumping system is offline may be necessary.

The following identifies the steps involved in taking the primary sludge pumping system out-of-service:

1. Turn off the primary sludge pumping system by de-energizing the equipment control panel and switching the equipment in the Off position at the respective control panel. Verify that the primary sludge pumping system is off.

2. The primary sludge pumping system is now shutdown.

Restart Considerations

The startup of the primary sludge pumping system requires the clarification scum system and primary sludge systems equipment are ready to be placed into operation.

This section explains the startup procedures for the primary sludge pumping system only. The following list is a step-by-step method to start the primary sludge pumping equipment.

1. Verify with facility management and associated pertinent personnel that the primary sludge pumping system is ready to be started.
2. Verify that all required maintenance has been completed on the primary sludge pumping system's equipment and all Lockout/Tagout devices have been removed.
3. Perform a safety meeting that includes emergency procedures for equipment shutdown, how participating personnel will communicate, and all other related facility safety issues that need to be identified prior to startup.
4. Visually inspect the primary sludge pumping system for any abnormal conditions that would adversely affect the startup.
5. Open the associated valves upstream and downstream of the primary sludge pumps.
6. Activate the primary sludge pumping system by energizing the primary sludge pump station control panel and switching the equipment into the "Automatic" mode.
7. Verify that the primary sludge system is in operation and that no alarms were activated.
8. The primary sludge pumping system is now operational.
9. Notify pertinent personnel that the system is in operation. Confirm that the Primary Sludge Pump Station is displayed as being fully operational by observing the station's operating status on the treatment plant's SCADA system. If the system appears functional and no alarm conditions exist, normal operation can commence.

Routine Checklist

The primary sludge pumps should be observed for the following:

1. Visually inspect the sludge pumps and check for possible damage.
2. Check the pump and drive motor for unusual noise, vibration, misalignment, and/or excess heat.
3. Check the sludge blanket to confirm sludge removal rate is adequate.
4. Visually inspect clarifier surface to confirm no excessive scum accumulation.
5. Document any equipment malfunction and the corrective action implemented.

Troubleshooting

The following identifies problems that may be encountered during the operation of the primary sludge pumping system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are symptoms followed by the problem that may be causing the symptom.

Table 3.3-4 provides troubleshooting information for operating the mechanical screens, conveyor, and screw compactor.

Table 3.3-4 Troubleshooting Guide - Primary Sludge Pumps

Problem	Probable Cause	Recommended Action
Pumps fails to prime	Low liquid level inside the pump casing	Add liquid to casing
	Suction check valve malfunction	Clean or replace check valve
	Air leaking into suction line	Correct leak
	Leaking or worn seal or pump gasket	Check pump vacuum. Replace leaking or worn seal or gasket
	Discharge head too high	Check piping installation and install bypass line if needed
	Strainer plugged or blocked	Check strainer and clean if necessary
Pump stops or fails to deliver flow or pressure	Air leaking into suction line	Correct leak
	Leaking or worn seal or pump gasket	Check pump vacuum. Replace leaking or worn seal or gasket
	Strainer plugged or blocked	Check strainer and clean if necessary
	Suction intake vortexing	Check installation and correct submergence as needed
	Impeller/wear plate worn or damaged	Replace worn or damaged parts. Check that impeller is properly centered and rotates freely
	Impeller plugged or blocked	Free impeller of debris
	Pump speed not running fast enough	Check driver output; check belts
	Discharge pressure too high	Install bypass line
	Suction lift too high	Measure lift w/ vacuum gauge. Reduce lift and/or friction losses in suction line
Pump requires too much power	Pump speed is too fast	Check driver output: check that sheaves or coupling are correctly sized
	Discharge head too low	Adjust discharge valve
	Liquid is too viscous	Dilute if possible
	Bearing(s) seized	Disassemble pump, check bearings and replace
Pump clogs frequently	Liquid is too viscous	Dilute if possible

3.3.5 Maintenance

Process Maintenance

The general maintenance for the primary pumping system can be found in the original manufacturers operations and maintenance manual linked below. The process maintenance for the pumping equipment includes keeping the area clean of debris, inspecting the pumps for leaks, confirming proper operation, and ensuring units are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Data

Table 3.3-5 provides the manufacturer's and service representative's contact information for the Primary Sludge Pumps.

Table 3.3-5 Contact Information – Primary Sludge Pumps

Manufacturer	
Name:	Moyno, Inc.
Address:	5870 Poe Avenue Dayton, OH 45414
Phone:	937-454-3300
Website:	www.moyno.com
Service Representative	
Name:	D.J. Shubeck Company
Address:	3144 Stage Post Drive, Suite 104 Bartlett, TN 38133
Phone:	901-372-2400
Fax:	901-372-4777
Website:	www.djshubeck.com

3.3.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the T.E. Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

3.4 Scum Collection and Handling

3.4.1 Overview

The scum pumping system's purpose is to remove scum and skimmed items collected from the primary clarifier surfaces. The scum removal process is dependent on the primary clarifier surface skimmer mechanisms to collect scum and move the scum to the beach plate/scum box in each operating primary clarifier. The scum system consists of a collector mechanism on each clarifier, one scum pump, and associated ancillary equipment.

The primary clarifier's collector/skimming mechanisms rotate and sweep the scum from the surface of each of the primary clarifiers. The skimmer arm on each clarifier pushes the scum over the scum beach and into a scum box on each of these clarifiers. Scum flows down through the scum lines to the scum pump.

The primary clarifier's collector/skimming mechanisms rotate and sweep the scum from the surface of each of the primary clarifiers. The skimmer arm on each clarifier pushes the scum over the scum beach and into a scum box on each of these clarifiers.

3.4.2 Process Control

Process Components

The primary scum collection and handling components include:

- 4 – Scum manholes
- 1- scum pump
- Discharge piping and valves
- Local control panel
- Instrumentation and automation controls

The main treatment goal of the scum removal system is to remove non-soluble floating debris that enter the clarification system and remove these from the treatment process. The process control is to verify that the scum pumps operate properly in the automatic lead / lag sequence as the scum is pumped to the sludge holding tanks. If automatic operation is not available, the treatment goals remain the same and plant staff will have to operate the pumps in the manual mode on an operational basis sufficient to prevent the scum wet well from overflowing.

The scum pump station components are described in greater detail in the following text.

Scum Manhole

Each primary clarifier scum beach discharges to a scum manhole located adjacent to its clarifier. From the manhole, scum flows into piping to the scum pumps located in the lower level of the Primary Sludge Pump Station. Normally, Scum Pump 1 serves Primary Clarifiers 1 and 2 and scum from Clarifiers 3 and 4 is removed using a vacuum truck.

Removal of scum from the primary clarifiers is automatically controlled by a timed cycle at the plant computer. The frequency of pumping depends on operating conditions and should be determined by experience. For efficient removal, scum should be pumped before the liquid level in the manhole reaches the liquid level in the clarifier.

Scum Pumps

The scum pump is a centrifugal pump rated for approximately 1,300 gpm at 90-feet TDH. If the scum mixture becomes too thick to pump, a plug valve near each manhole can be opened to direct sludge into the manhole to mix with the scum.

Local Control Panel

An LCP houses the local controls for the scum pump. The control panel contains the pump motor starters, Hand/Off/Automatic selector switch, Pump Run indicating lights, Pump Running elapsed time meters, a thermostatically- (adjustable) controlled condensate heater, phase monitor, and transient voltage surge protection. The panel also houses the alarm horns and indicators used to indicate trouble.

Design Criteria and Nameplate Data

Table 3.4-1 provides the design specifications for the scum pumping system.

Table 3.4-1 System Data - Scum Pumping System

Component/Criteria	Value
Scum Pumps	
Number of units	1
Tag numbers	Scum Pump 1
Manufacturer	Wemco – Trillium Flow Technologies
Model number	Model E
Type	Centrifugal
Capacity, gpm at TDH	1,300 at 90
Frame	417TS
Motor manufacturer	General Electric
Horsepower	50

3.4.3 Equipment Control

Table 3.4-2 provides the location of controls associated with the scum pumps.

Table 3.4-2 Primary Scum Pump Controls

Control or Indicator	Number of Units	At MCC-3	At Equipment	At SCADA
Scum Pumps				
Combination magnetic motor starter – circuit breaker	1	X		
Selector Switch				
Hand-Off-Auto	1		X	
Hand-Off-Com	1		X	
Pushbutton				
Start	1			
Stop	1			
On	1			X
Off	1			X
Seal water solenoid valve	1		X	
Low water cutoff float switch	4	One unit in each scum manhole		
High scum level alarm float switch	4	One unit in each scum manhole		
Start-Stop timed cycle control	1			X
Computer monitoring of operating status				X
Sludge holding tank high water level float switch	1	In Sludge Holding Tank		
Elapsed Time Meter	1	X		
Green Indicating Light				
On	1			X
Start	1			X
Run	1	X		X
Red Indicating Light				
Off	1			X
Stop	1		X	
Yellow Indicating Light				
Primary Scum	1			X

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

Table 3.4-3 provides descriptions of the functions of controls associated with the scum pumps.

Table 3.4-3 Primary Scum Pump Control Functions

Control or Indicator	Functions
Scum Pumps	
Circuit breaker	Energizes equipment.
Combination magnetic motor starter – circuit breaker	Locally supply power and motor protection.
Selector switch	**Hand** – Operate primary scum pump using adjacent pushbuttons (On/Off).
Low liquid level cutoff float switch	**Off** – Remote controls deactivated.
High liquid level alarm float switch	**Com** – Operate pumps through computer interface.
Red indicating light	**Hand** – Pump operates continuously.
Green indicating light	**Off** – Pump does not operate.
	Auto – Control of operation is transferred to the computer.
Pushbuttons	**On** – Pump running.
	Off – Pump stopped.
	Start – Activate pump.
	Stop – Deactivate pump.
Elapsed time meter	Displays accumulated hours of operation.
Seal water solenoid valve	Opens whenever pump is operating to provide seal water to pump.
Low water cutoff float switch	Computer receives signal and stops pump when scum level drops to the top of the fillets (liquid depth of 5.3 feet).
High scum level alarm float switch	Signals alarm conditions to computer when scum rises to 3 feet below the site wall.
Start-Stop timed cycle control	Cycles on-off pump operating periods. Cycle length is adjustable from 0 to 24 hours. Computer activates alarm condition when pump is operating during off period.
Computer monitoring of operating status	Computer continuously monitors operating status of equipment and will display or print status upon operator request.
Sludge holding tank high water level float switch	Computer receives signal and stops pump when level rises to 9 inches below the overflow.
Green indicating light	**On** – Pump running.
	Start – Activate pump.
	Run – Pump running.
Red indicating light	**Off**- Pump is not running.
	Stop – Halt pump operation.
Yellow indicating light	Primary scum alarm – Check primary scum operation – motor overload.

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

3.4.4 Operation

Normal Operation

The normal operation for the scum pumping system is in the Automatic mode and functions in conjunction with the clarifier surface skimmers. Staff should inspect the scum pump station once per shift or more often if problems are occurring.

Alternate Operations

The scum pumping system can be operated in Manual mode. This would require the operations staff to turn the pumps on manually, monitor the pumps and scum manhole level during this time. This method is not recommended and should be used only under direction of facility management.

Scum can be removed with a vacuum truck from the Scum boxes.

Startup and Restart

The startup of the scum pumping system requires the clarification system, and the scum systems equipment are ready to be placed into operation.

This section explains the startup procedures for the scum pumping system only. The following list is a step-by-step method to start the scum pumping equipment.

1. Verify with facility management and associated pertinent personnel that the scum pumping system is ready to be started.
2. Verify that all required maintenance has been completed on the scum pumping system's equipment.
3. Perform a safety meeting that includes emergency procedures for equipment shutdown, how participating personnel will communicate, and all other related facility safety issues that need to be identified prior to startup.
4. Visually inspect the scum pumping system for any abnormal conditions that would adversely affect the startup.
5. Open the associated valves upstream and downstream of the scum pumps.
6. Activate the scum pumping system by energizing the scum pump station control panel and switching the equipment into the “Automatic” mode.
7. Verify that the scum system is in operation and that no alarms were activated.
8. The scum pumping system is now operational.
9. Notify pertinent personnel that the system is in operation. Confirm that the scum pump station is displayed as being fully operational by observing the facility’s operating status on the treatment plant’s SCADA system. If the system appears functional and no alarm conditions exist, normal operation can commence.

Shutdown

Completely shutting down the scum pumping system may result in scum being transferred to downstream processes or the scum pumping system overflowing. If the scum pumping system is not being shut down completely, place the Hand/Off/Automatic selector switch for the pump identified for shutdown into the Off position and isolate the pump's discharge line using the discharge isolation valve if required.

Taking the scum pump system completely offline, monitor the scum in the associated secondary clarifiers and physically remove the scum by sending the scum to drain. Use of a vacuum truck or other device capable of removing accumulated scum during the period that the scum pumping system is offline may be necessary.

The following identifies the steps involved in taking the scum pumping system out-of-service:

1. Turn off the scum pumping system by de-energizing the equipment control panel and switching the equipment in the Off position at the respective control panel. Verify that the scum pumping system is off.

2. The scum pumping system is now shutdown.

Process Troubleshooting

If there are excessive amounts of scum, examine the upstream process for operational problems including the influent for excessive fats, oils, and grease (FOG).

Table 3.4-4 provides a general outline of process troubleshooting. Refer to the original equipment manufacturers (OEM) O&M manuals troubleshooting section for more information on specific troubleshooting information.

Table 3.4-4 Troubleshooting Guide - Scum Pumping System Process

Problem	Probable Cause	Recommended Action
Low Station Discharge Flow	Gas is binding in the eye of the impeller	Confirm that gas or air has a relief point so the gas or air is not trapped in the volute or impeller.
	There is a vortex developing near the pump suction in scum pit	Raise pump start level to a point where vortexing is not occurring.
	Intake openings are blocked	Clear inlet ports at pump suction.
	Rotation is incorrect. A pump can pump in the wrong direction, just not very efficiently.	Swap motor phases to change direction of rotation.
	Pump discharge blocked	Remove blockage and restart operation.
High Tank Level	Pump intake openings are blocked	Clear inlet ports at pump suction.
	Pump discharge blocked	Remove blockage and restart operation.
	Scum thicker, higher density or viscosity than design concentration	Operate scum system to have thinner scum. Pump more frequently or add spray water to lessen density/viscosity of scum.
Low station level	Scum box pipeline blocked	Clear obstruction and monitor station for proper operation.
	Scum box isolation valve closed	Open isolation valve and monitor station for proper operation.
	Scum pumps operating excessively	Inspect floats to assess if floats are hanging up. Confirm that the pumps are not in Manual mode. Correct condition(s) and return to service in the Automatic mode.

3.4.5 Maintenance

Process Maintenance

The general maintenance for the flow EQ system equipment can be found in the original manufacturers operations and maintenance manuals linked below. The process maintenance for the EQ system consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated. EQ tank inlet and out control systems must remain in service and should be checked for proper operation.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 3.4-5 provides the manufacturer's and service representative's contact information for the primary scum pumping equipment.

Table 3.4-5 Contact Information – Primary Scum Pumps

Manufacturer	
Name:	Wemco – Trillium Flow Technologies
Address:	440 West 800 South Salt Lake City, UT 87101
Phone:	801-359-8731
Fax	801-530-7828
Website:	***www.trilliumflow.com***
Email:	***wemco@tilliumflow.com***
Service Representative	
Name:	JR Stewart
Address:	313 S. Second Street West Memphis, AR 72301
Phone:	870-735-2484
Fax:	870-735-0765
Website:	***www.jrspump.com***
Email:	hughey@jrspump.com

3.4.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the T.E. Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the water reclamation facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

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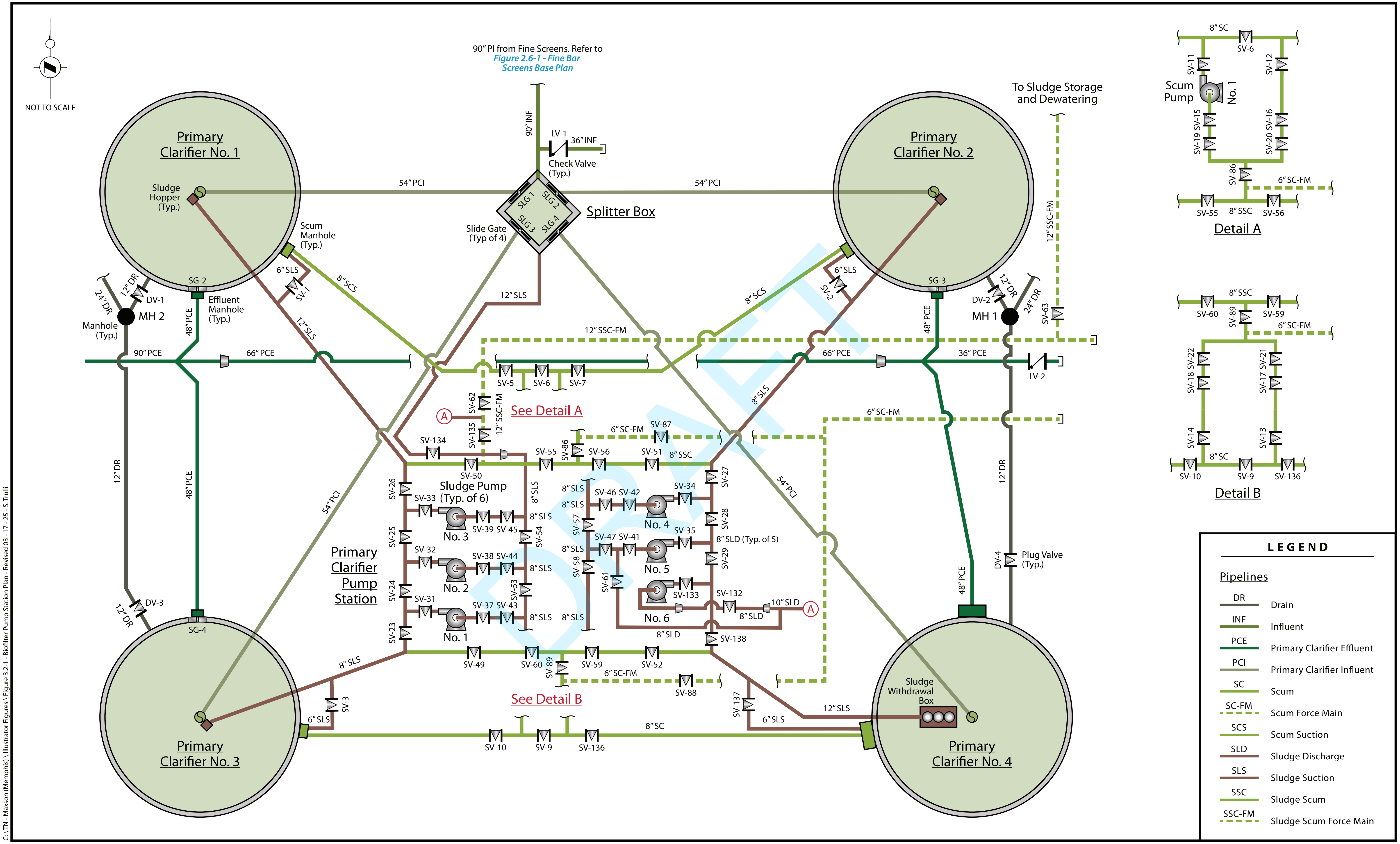
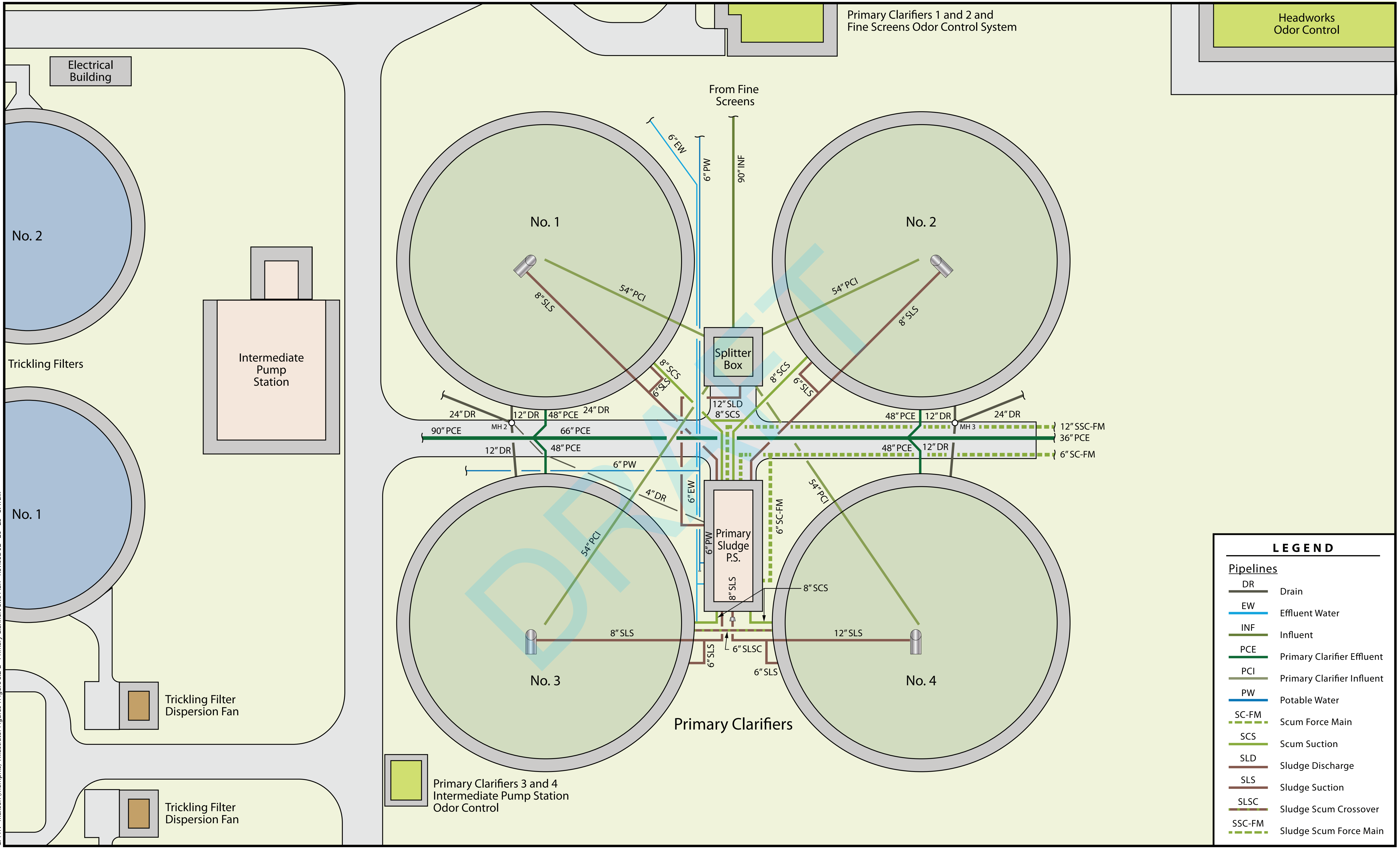


C:\TN - Maxson (Memphis)\ Illustrator Figures\ Figure 3.2-1 - Biofilter Pump Station Plan - Revised 03 - 17 - 25 - S. Trulli

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 3.2-1
Primary Clarifiers and Primary Sludge Pump Station Schematic

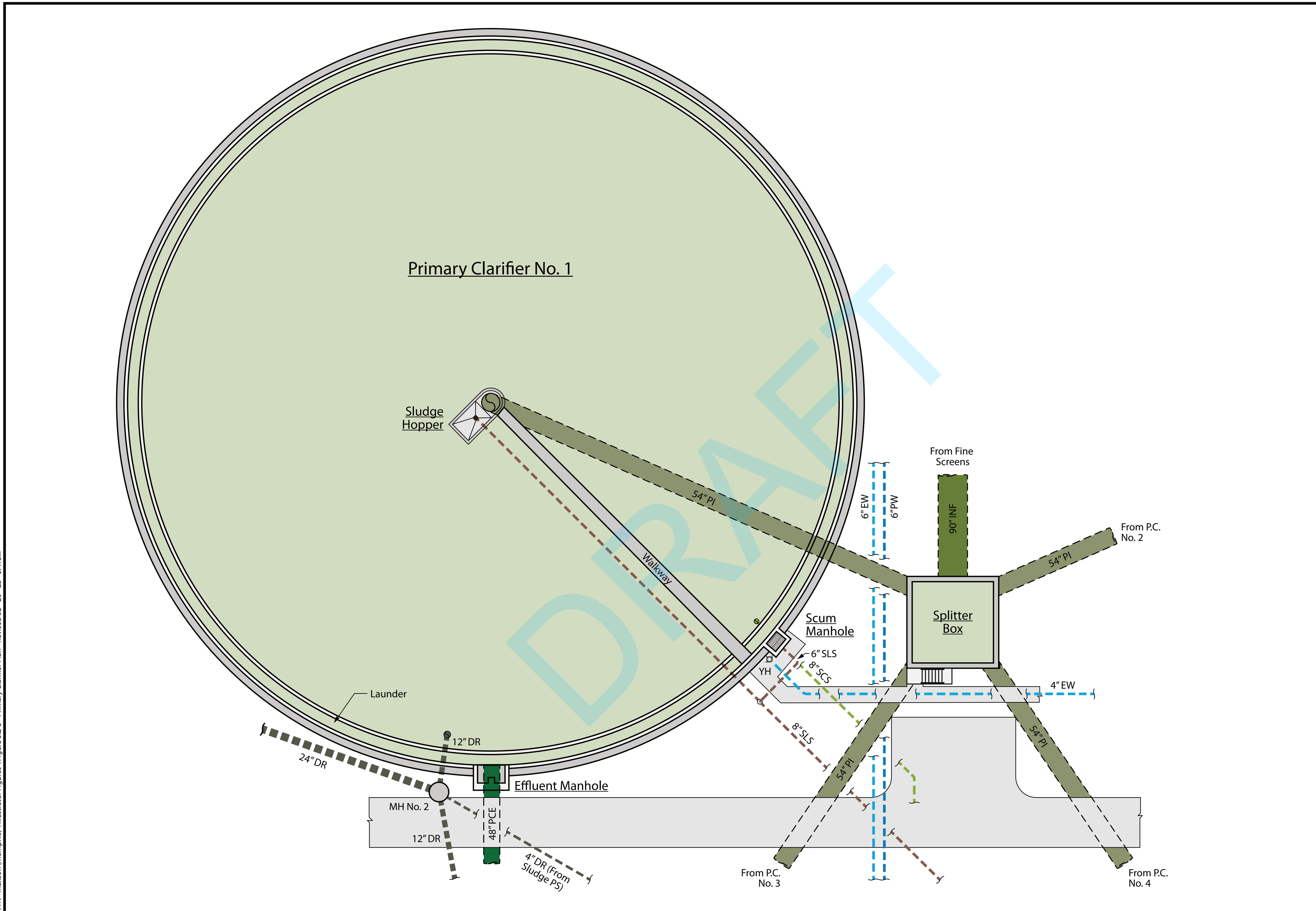


C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 3.2-2 - Primary Clarifiers Site Plan - Revised 02 - 20 - 25 - S. Trulli

CDM Smith

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 3.2-2
Primary Clarifiers Site Plan



LEGEND

Pipelines

DR	Drain
EW	Effluent Water
INF	Influent
PCE	Primary Clarifier Effluent
PCI	Primary Clarifier Influent
PW	Potable Water
SCS	Scum Suction
SLS	Sludge Suction

Abbreviations

MH	Manhole
YH	Yard Hydrant

C:\TN - Maxson (Memphis) \ Illustrator Figures \ Figure 3.2-3 - Primary Clarifier Plan - Revised 02 - 20 - 25 - S. Trulli

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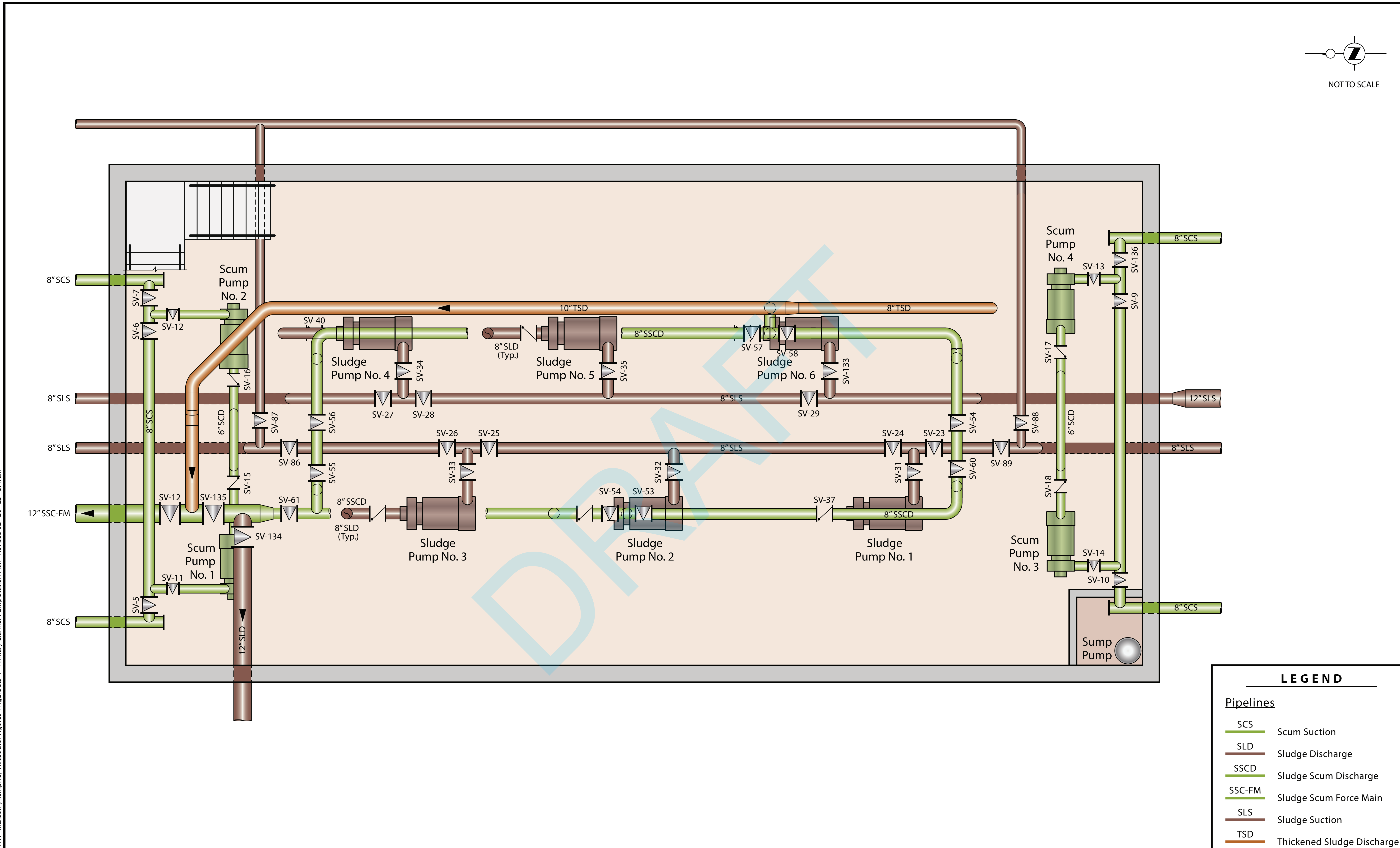
Figure 3.2-3
Primary Clarifier Plan



C:\TN - Maxson (Memphis)\ Illustrator Figures \ Figure 3.3-1 - Primary Clarifier Pump Station Plan - Revised 02 - 20 - 25 - S. Trulli

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Figure 3.3-1
Primary Clarifier Pump Station Plan

Section 4

Biological Treatment

4.1 Overview

Biological Treatment systems begin with treatment in the trickling filters, continues in the aeration basins, and is completed in the final clarifiers (discussed in ***Section 5 Final Clarification and Pumping***). Primary treated wastewater flows to the Primary Clarifier Diversion Structure and is conveyed to the Trickling Filter Pump Station where it is then conveyed by the trickling filter pumps in the to the trickling filter system. The diversion structure is located on the west side of Primary Clarifiers 1 and 3 and is adjacent to the Intermediate Pump Station (discussed later in this chapter) on its southeast corner. In the trickling filter system, the wastewater is treated by fixed microbial growth on the trickling filter media in an aerobic environment. A portion of the trickling filter effluent is recycled back to the trickling filters by gravity through the trickling filter wet well at the Trickling Filter Pump Station. The remainder of the tricking filter effluent is conveyed by the screw pumps in the Intermediate Pump Station (IPS) through a 102-inch discharge line to the Flow Control Structure ("splitter box") to the aeration basins. The trickling filter effluent is combined with return activated sludge (RAS) from the RAS Reaeration Basin prior to the combined flows entering the flow control structure.

4.2 Trickling Filter Pump Station

4.2.1 Overview

The Trickling Filter Pump Station consists of ten vertical turbine pumps designated 1 through 10 and a wet well that receive primary effluent from the Primary Effluent Diversion Structure. The trickling filter pumps convey primary effluent and trickling filter recycle flow to the on-line trickling filters through their respective 36-inch trickling filter rotary distributor influent line.

Trickling Filter Pump Station

The 90-inch Trickling Filter Recycle Line returns a portion of the trickling filter effluent to the Trickling Filter Pump Station influent flow. The trickling filter pumps provide trickling filter effluent recycle flow to the trickling filters, the delta difference of the influent and effluent flow is self-sustaining and affected by how many pumps are online. This system provides pumping of the primary treated influent and recycle of the trickling filter effluent as the system is hydraulically tied to the diversion structure and Intermediate Pump Station.

During conditions where it is necessary to divert some flow from the trickling filters, the 48-inch Trickling Filter Diversion Line is used. The line takes flow following primary clarification and diverts it directly to the Flow Control Structure downstream of the Intermediate Pump Station.

48-inch Trickling Filter Diversion Line and Valve

When the flow through the trickling filters exceeds the capacity of the downstream screw pumps in the Intermediate Pump Station as the result of a pump or power failure, then the necessary number of trickling filter pumps may be configured to pump through the 48-inch Trickling Filter Diversion line to divert the Intermediate Pump Station to makeup the deficit. No more than three pumps should be dedicated to diversion pumping, which should result in a maximum flow of 80 mgd. The trickling filter pumps selected to pump the deficit flow must be isolated from the remaining trickling filter pumps by closing the necessary discharge header valves. Diversion valve BFV-1 on the diversion line should be opened but should not be used to throttle flow or pump cavitation and valve damage will result. One trickling filter (Filter 4 and/or 6) normally served by the pumps taken offline to pump to the Intermediate Pump Station must be removed from service for the duration of the diversion pumping.

Each trickling filter pump can be isolated by its discharge isolation valve.

The major components of the trickling filter pump station include:

- 10 – Trickling Filter Pumps
- 90-inch Trickling Filter Recycle Line
- 48-inch Trickling Filter Diversion Line
- Trickling Filter Pump Test Pit

Figure 4.2-1 Trickling Filter Flow Schematic provides a process flow schematic for the Trickling Filter Pump Station system and associated equipment.

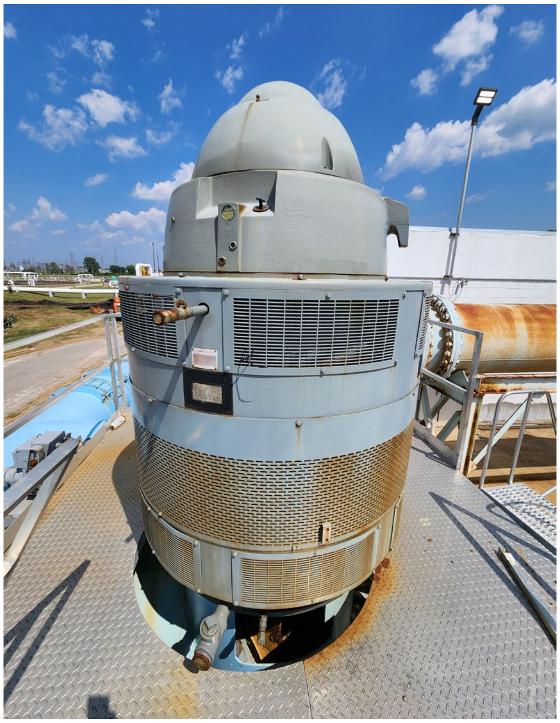
Figure 4.2-2 Trickling Filter Pump Station Plan provides a plan view of the Trickling Filter Pump Station system and associated equipment.

4.2.2 Description

The major components associated with the Trickling Filter Pump Station are summarized below. In addition, the design criteria associated with the pump station equipment is provided in tabular form.

Trickling Filter Pumps

Ten vertical turbine trickling filter pumps convey primary effluent and trickling filter recycle to the trickling filters. Each pump is rated for 33 million gallons per day (mgd) at 43-feet rated head.



Trickling Filter Pump BFP-1 Motor

90-inch Trickling Filter Recycle Line

Effluent from each pair of trickling filters is through an 84-inch line. Effluent from Trickling Filters 1 through 4 flows into a single 84-inch line and effluent from Trickling Filters 5 and 6 flows into a single 84-inch line. Both 84-inch lines converge into a single 90-inch line at a “cross.” The 90-inch line runs from the Trickling Filter Pump Station wet well to the Intermediate Pump Station wet well. The inverts at both ends of the 90-inch line are at the same elevation and point where the filter effluent flows into the line is at a lower elevation. Normally, the flow entering the Trickling Filter Pump Station is less than the uniform pump discharge flow, so a portion of the filter effluent returns to the pump station to supply the pump suctions. As the primary clarifier effluent flow and the return activated sludge (RAS) flow from the RAS reaeration basin increase to a flow rate above the capacity of the pumps, the trickling filter pump station wet well contents above the station flow capacity flows to the Intermediate Pump Station wet well.

Trickling Filter Flow Bypass Options

There are two options for bypassing the trickling filters should it become necessary. Each is explained below.

Primary and Trickling Filter Bypass

Normally, all the primary clarifiers should not be taken out of service at one time. Each clarifier can be isolated for equipment servicing and repairs. However, if unavoidable, the basins can be bypassed by diverting the wastewater flow at the grit chambers. This diversion will also result in bypassing the fine screens and the trickling filters.

When the primary clarifiers are used, degritted wastewater flows through the 90-inch sluice gate at the south end of the grit chamber effluent channel.

90-inch Degritted Flow to Primary Clarifiers Sluice Gate

The sluice gates which provide bypassing are located on the west side of the grit chamber effluent channel. When open, the two outer sluice gates permit wastewater to flow to the Flow Control Structure prior to the aeration basins. The gate nearest in the below photo diverts flow to the south aeration basins and the farthest gate diverts flow to the north aeration basins. The center gate diverts flow directly to the final clarifier effluent junction structure for conveyance to the Disinfection Contact Tank.

Flow Diversion Gates at Grit Effluent Channel

Trickling Filter Bypass at Primary Effluent Diversion Structure

Primary clarifier effluent enters the Primary Effluent Diversion Structure (located adjacent to the Intermediate Pump Station) from the east side. The control sluice gates are on the north and south sides of the structure. Flow to the Trickling Filter Pump Station wet well is through south sluice gate and flow to the Intermediate Pump Station wet well is through the north gate.

To activate trickling filter bypass at the Primary Effluent Diversion Structure, the position of the two sluice gates is reversed to send primary effluent directly to the Intermediate Pump Station wet well. It is important to open the sluice gate to the wet well before closing the gate to the Trickling Filter Pump Station. In the photo below, the nearest gate is the sluice gate that sends primary effluent directly to the Intermediate Pump Station wet well. It is normally closed. The farthest gate is the sluice gate that sends primary effluent to the Trickling Filter Pump Station wet well. It is normally open.

Primary Effluent Diversion Structure Sluice Gates

Table 4.2-1 provides the design criteria for the Trickling Filter Pump Station systems.

Table 4.2-1 System Data - Trickling Filter Pumps

Component	Value	
Trickling Filter Pumps		
Quantity:	8	2
Tag:	BFP-1 (E-350) – Pump 1 BFP-2 (E-351) – Pump 2 BFP-3 (E-352) – Pump 3 BFP-4 (E-353) – Pump 4 BFP-5 (E-354) – Pump 5 BFP-7 (E-366) – Pump 7 BFP-8 (E-367) – Pump 8 BFP-9 (E-368) – Pump 9	BFP-6 (E-365) – Pump 6 BFP-10 (E-369) – Pump 10
Manufacturer:	Goulds Pumps	Ingersoll-Rand
Type:	Vertical diffusion vane wet pit	Vertical diffusion vane wet pit
Model:	VIT-FF 36X42 LHC	0291-9018
Capacity:	23,000 gpm at 43’	23,000 gpm at 43’
Operating Speed, rpm:	600	592

Table 4.2-1 System Data - Trickling Filter Pumps

Component	Value	
Trickling Filter Pump Motors		
Manufacturer:	Westinghouse	US Electric Motors
Enclosure:	WP-II	WP-II
Frame:	5810P36	6808PA
Horsepower:	350	350
RPM:	600	600
Phase:	3	3
Volts:	4000	4000
Hertz:	60	60
Full Load Amps:	59.9	63
Service Factor:	1.15	1.15
Duty:	CONT	CONT
Class:	F	F
NEMA Code:	G	G
Drive End Bearing:	29330	6226-J
Opposite End Bearing:	6224C3	7238-BCB

Table 4.2-2 provides the major valves associated with the Trickling Filter Pump Station.

Table 4.2-2 Trickling Filter Pump Station Major Valves

Tag	Location
LV-50	Trickling Filter Pump 1 discharge
LV-51	Trickling Filter Pump 2 discharge
LV-52	Trickling Filter Pump 3 discharge
LV-53	Trickling Filter Pump 4 discharge
LV-54	Trickling Filter Pump 5 discharge
LV-55	Discharge between Trickling Filter Pump 1 and Trickling Filter Pump 2
LV-56	Discharge (East) between Trickling Filter Pump 2 and Trickling Filter Pump 3
LV-57	Discharge (West) between Trickling Filter Pump 2 and Trickling Filter Pump 3
LV-58	Discharge (East) between Trickling Filter Pump 3 and Trickling Filter Pump 4
LV-59	Discharge (West) between Trickling Filter Pump 3 and Trickling Filter Pump 4
LV-60	Discharge between Trickling Filter Pump 4 and Trickling Filter Pump 5
LV-61	Discharge to Trickling Filter 1
LV-62	Discharge to Trickling Filter 2
LV-63	Discharge to Trickling Filter 3
LV-64	Discharge to Trickling Filter 4
LV-65	Trickling Filter Pump 10 discharge
LV-66	Trickling Filter Pump 9 discharge

Table 4.2-2 Trickling Filter Pump Station Major Valves

Tag	Location
LV-67	Trickling Filter Pump 8 discharge
LV-68	Trickling Filter Pump 7 discharge
LV-69	Trickling Filter Pump 6 discharge
LV-70	Discharge West of Trickling Filter Pump 10
LV-71	Discharge between Trickling Filter Pump 9 and Trickling Filter Pump 10
LV-72	Discharge (West) between Trickling Filter Pump 8 and Trickling Filter Pump 9
LV-73	Discharge (East) between Trickling Filter Pump 8 and Trickling Filter Pump 9
LV-74	Discharge (West) between Trickling Filter Pump 7 and Trickling Filter Pump 8
LV-75	Discharge (East) between Trickling Filter Pump 7 and Trickling Filter Pump 8
LV-76	Discharge between Trickling Filter Pump 6 and Trickling Filter Pump 7
LV-77	Discharge between Trickling Filter Pump 6 and Trickling Filter Pump 1
LV-78	Discharge to Trickling Filter 5
LV-79	Discharge to Trickling Filter 8 (future)
LV-80	Discharge to Trickling Filter 7 (future)
LV-81	Discharge to Trickling Filter 6

System Monitoring

Flow

Six strap-on flow meters are on discharge lines to the trickling filters. Each trickling filter has a dedicated flow meter.

Motor Monitor

An Eaton motor monitor is provided at the MCC-5 for trickling filter pump motors.

4.2.3 Equipment Control

The following tables identify the local controls associated with the trickling filter pump station pumps. The trickling filter pump discharge valves have local start stop control panels (LCP) and local disconnect switches.

Trickling Filter Discharge Valve Local Control Panel (typical)

Table 4.2-3 provides the controls and monitoring. The trickling filter pumps are powered through the adjacent Motor Control Center 5 (MCC-5). Pumps 1, 3, 5, 7, and 9 are powered from MCC-5 Rear. Pumps 2, 4, 6, 8, and 10 are powered from MCC-5 Front.

Table 4.2-3 provides the location of controls associated with the trickling filter pumps.

Table 4.2-3 Trickling Filter Pump Controls

Control or Indicator	Number of Units	At Equipment	MCC-5	At Computer
Trickling Filter Pumps				
Hand-Off-Remote selector switch			X	
Hand-Off-Auto selector switch			X	
On-Off (Pumps 6 and 10)		X		
Start-Stop (Pumps 1 through 5 and 10)		X		
Disconnect switch	10		X	
Timer (Pumps 8, 9, and 10)	3		X	
Motor space heater	10	X		
Starter space heater	10		X	
Computer monitoring of operating status				X
Lubricating water flow switch	10	X		
Elapsed time meter	10	X		
Red indicating light	10		X	
Green indicating light	10		X	
White indicating light	10		X	
Alarm relay	10		X	
Low level float switch	1 (at wet well of station)			
Discharge Valve				
Disconnect switch	10	X		
Hand-Off-Auto selector switch	10	X		
Open-Close pushbuttons	20	X		
Valve operator motor space heater	7	X		
Valve limit switch space heater	7	X		
Sight glass (Pumps 1 through 5)	5	X		

Table 4.2-4 provides descriptions of the functions of controls associated with the trickling filter pumps.

Table 4.2-4 Trickling Filter Pump Control Functions

Control or Indicator	Functions
Trickling Filter Pumps	
Selector switch (Pumps 1 through 6 and 10)	**Start** – Pump operates continuously provided wet well level is above el. 210.00 (10 feet) and lubrication water is being supplied.
	Stop – Pump will not operate.
	Remote – Not used.
Selector switch (Pumps 7, 8, and 9)	**On** - Pump operates continuously provided wet well level is above el. 210.00 (10 feet) and lubrication water is being supplied.
	Off – Pump will not operate.
Computer controls	**Hand** – Pump operation is controlled using pushbutton located on Backup Board.
	Off – Pump controls are disengaged.
	Com – Pump is controlled from computer console.
Pushbuttons	**Start** – When pushed, the pump is activated.
	Stop – When pushed, pump operation is halted.
Motor space heater	Operates whenever the motor is not running to prevent motor damage from condensation.
Starter space heater	Operates whenever the motor is not running to prevent starter damage from condensation.
Computer monitoring of operating status	Computer continuously monitors and displays operating status of pumps.
Lubricating water flow switch	Verifies water is flowing. Pump start sequence is terminated if flow is not detected within 10 seconds.
Discharge valve control relay	Initiates discharge valve opening when energized. Pump start sequence is terminated if valve does not fully open within 45 seconds.
Red indicating light	**Run** – Illuminates when pump is operating.
	Off – Pump is not running.
Green indicating light	**Off** – Illuminates when pump is not operating.
	On – Pump is running.
White indicating light	**Tripped** – Illuminates when alarm condition exists, such as motor overload, incorrect power phase, ground fault, or low level in wet well.
Alarm relay	Provides alarm input to computer upon "fault" stoppage on pump. Fault stoppage can be the result of motor overload, incorrect power phase, ground fault, loss of lubricating water flow, or low wet well level. Prevents simultaneous restart of pumps.
Low level float switch	Stops pump and sends alarm signal to computer when wet well level drops to el. 210.00 (10 feet).

Table 4.2-4 Trickling Filter Pump Control Functions

Control or Indicator	Functions
Discharge Valve	
Selector switch	**Hand** – Transfers valve position control to electric operator **Open** and **Close** pushbuttons.
	Off – Valve operator does not function.
	Auto – Valve operator is electrically interlocked with adjacent pump control circuit. Valve opens when pump control circuit is energized and closes when pump control circuit is deenergized. Valve must be fully open within 45 seconds or pump sequence is terminated.
Pushbutton	**Open** – When pressed, initiates valve opening provided the valve operator **Hand-Off-Auto** selector switch is in the **Hand** position. Valve opens to fully open position.
	Close – When pressed initiates valve closing provided the valve operator **Hand-Off-Auto** selector switch is in the **Hand** position. Valve closes to the full closed position.
Electric valve operator motor space heater	Heat prevents motor damage from condensation. Heater is energized continuously.
Limit switch enclosure space heater	Heat prevents moisture damage from condensation. Heater is energized continuously.
Sight glass	View bearing oil level.

4.2.4 Operation

Normal Operation

Note: Individual pump discharges must be isolated from the other pump discharges when not operating to prevent possible equipment damage by reverse rotation.

The normal mode of operation for the trickling filter pumps is in manual local mode and controlled by the operator.

Alternate Operation

Alternate operations indicate that one or more components of the trickling filter pump system will be out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment as well as remote and local control. For instance, all pieces of equipment associated with the trickling filter pumping system can be operated locally at MCC-5.

Shutdown Considerations

1. Confirm that there are sufficient trickling filter pumps online to manage the flow to the trickling filters online.

2. At the LCP, place control switches for the trickling filter pump being taken out of service in the "Off" position.

3. Confirm the discharge valve for the pump closes once the pump shuts down.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.

2. Inspect the trickling filter pumps for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the trickling filter pumps only when it is in good working condition.

3. Ensure that only authorized personnel are allowed in the in the trickling filter pump area and no one might be injured when equipment is activated.

4. Ensure all motor bearing have been properly lubricated using the manufacturers recommended lubricant.

5. Confirm all maintenance and/or repairs have been completed.

6. Remove any existing lockout devices and follow lockout/tagout procedures for the trickling filter pumps.

7. Verify that the local disconnect for each trickling filter pump to be started is in the "Off" position.

8. Verify that the Hand-Off-Auto selector switch at MCC-5 is in the "Off" position.

9. Check on the readiness of all upstream and downstream equipment such as the pumps, trickling filters, level controls, etc.

10. Confirm all safety devices are functioning properly.

Startup

1. At the MCC-5, place the main breaker for the trickling filter pump in the "On" position.

2. At the LCP for the trickling filter pump, place the control selector switch in the position that allows remote control.

3. At the computer, place the pump in "Com."

4. From the computer, start the pump.

5. For starting the pump manually:

    a. At the MCC-5, place the main breaker for the trickling filter pump in the "Local" position.

    b. At the LCP for the trickling filter pump, press the start button to start the desired pump.

Routine Checklist

The trickling filter pumping system should be inspected for the following items when in operation:

1. Check the trickling filter pump drive motor for unusual noise, vibration, and/or excess heat.
2. Inspect all control panel switches for proper positioning.
3. Document any equipment malfunction and the corrective action implemented.
4. Check to see that all safety guards are in place and personnel are clear of the equipment.
5. On the SCADA screen – Trickling Filters and Pumps, confirm the selected pump has switched from yellow to green.

Troubleshooting

The following identifies problems that may be encountered during the operation of the trickling filter pumping system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 4.2-5 provides troubleshooting information for operational issues associated with the trickling filter pumps.

Table 4.2-5 Troubleshooting Guide – Trickling Filter Pumps

Problem	Probable Cause	Recommended Action
Pump does not start	Incorrect control position selected.	Check control mode.
	Defective motor or controls.	Consult the vendor O&M manual.
Little or no liquid delivered	Discharge valve closed	Ensure the discharge valve is in fully open position.
	Obstruction in liquid passage.	Pull pump, inspect impeller and bowls.
	Damaged pump.	Check pump for broken shaft or worn or clogged impeller.

4.2.5 Maintenance

Process Maintenance

The general maintenance for the trickling pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the trickling pumps consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 4.2-6 provides the local service representative's contact information for the trickling filter pumps.

Table 4.2-6 Contact Information – Trickling Filter Pumps

Manufacturer		
Name:	ITT Goulds Pumps	Ingersoll-Rand
Address:	240 Fall Steet Seneca Falls, NY 13148	12500 South Pulaski Rd Alsip, IL 60803
Phone:	315-598-2811	708-389-2500
Fax:	315-568-2418	NA
Website:	**www.gouldspump.com**	**www.ingersollrand.com/pumps**
Service Representative		
Name:	GMW Inc.	
Address:	1509 Castalia ST. Memphis TN 38114	
Phone:	901-276-4593	
Fax:	901-276-2729	
Website:	**www.gmwinc-memphis.com**	
Email:	**info@gmwinc.co**	

Table 4.2-7 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the trickling filter pumps.

Table 4.2-7 Maintenance Schedule – Trickling Filter Pumps

Frequency	Maintenance Task to be Performed
Daily	Check for unusual noise, vibration and bearing temperatures. Check the pump and piping for leaks.
Weekly	Check the level and condition of the oil through the sight glass of the bearing frame. Inspect the packing of mechanical seal for any signs of wear.
Monthly	Check the alignment of the pump and motor. Inspect condition of the coupling and adjust if necessary.
Every 3 Months	Check that the foundation and the hold-down are tight. Check the packing if the pump has been left idle and replace if required. Lubricate the bearings as per the manufacturer's recommendations.
Annually	Perform a thorough inspection of all the pumps components. Check the pump capacity Check the pump pressure. Check the pump power

4.2.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the T.E. Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

4.3 Trickling Filters

4.3.1 Overview

Trickling filters provide biological treatment of the primary effluent using fixed microbial slime (zoogleal film) attached on the trickling filter vertical flow media in an aerobic environment. The media is supported on a pier and grating type support system.

The trickling filters receive flow from the Trickling Filter Pump Station (refer to ***Section 4.2 Trickling Filter Pump Station***). Primary clarifier effluent and trickling filter recycle are pumped to the on-line trickling filters through each online trickling filter 36-inch influent line to the motorized rotary distribution arm. The distribution arm drive rotates the arm and flow from the distribution arm orifices trickles over and down through the media bed. Aerobic conditions are maintained by splashing, diffusion, and by air supplied by dispersion fans flowing through the bed.

There are six trickling filters, 1 through 6, and twelve high plume dispersion fans, two for each trickling filter, 1A/B through 6A/B.

The major components of the trickling filter system include:

- 6 – Trickling Filters
- 12- High Plume Dispersion Fans (two per trickling filter, OCF-1A/B through OCF-6A/B)
- 3 – Air Compressor Buildings (one for each pair of trickling filters, 1 and 4, 2 and 3, 5 and 6)

Each trickling filter has the following components:

- PVC Plastic Media
- Media Pier and Grating Support System
- Center Pier
- 36-inch Influent Line
- Motorized Rotary Distribution Arm and Drive
- Air Compressor Systems
- Plenum Chamber

- Effluent Collection Trough
- Peripheral Ventilation Ductwork
- Forced Ventilation High Plume Dispersion Fans

See ***Figure 4.2-1 Trickling Filter Flow Schematic*** which provides a process flow schematic for the trickling filter system and associated equipment.

See ***Figure 4.2-2 Trickling Filter Pump Station Plan*** which provides a plan view of the Trickling Filter Pump Station system and associated equipment.

4.3.2 Description

The major components associated with the trickling filters are summarized below. In addition, the design criteria associated with the equipment is provided in tabular form.

Trickling Filters

Each trickling filter is 134 feet in diameter and 23.0 feet deep and consists of trickling filter media supported on a plenum. The influent wastewater enters center pier through the 36-inch influent pipe to the rotary distributor.

Trickling Filter Rotary Distributor (typical)

Trickling Filter Rotary Distributor

The HydroDoc Trickling Filter Rotary Distributor has automatically adjusted gates which are pneumatically controlled to open and close the orifices in equal proportion on both sides of the distributor arms. A sensor on the center assembly transmits speed readings to the control box, which automatically adjusts the speed to match the preset operational or flushing program. As flow to the trickling filter varies, the speed is maintained by automatically adjusting the gates over the orifices.

By regulating the dosing through the filter media, the biomass becomes healthy throughout the depth of the trickling filter. A daily flushing cycle cleans the media and flushes dead biomass, leaving an optimally active film on the media. Healthy media results in optimal treatment process.

Process Guidelines

Optimum operational speed of a rotary distributor is a function of wastewater flow and loading. Studies have found that slower rotation often yields better treatment results. This is because the media is more completely wetted through its entire depth, and because excess biomass can be flushed away which helps keep media surface area at a maximum. Initially, the rotary distributor should be set at the appropriate speed for normal operation. No flushing should happen until the biological film on the media (biomass) has fully formed. The length of time this takes will vary depending on local climate and weather conditions as well as wastewater content. Typical plants require from 3 to 6 weeks for full biological growth when media is new or has not been recently used. After there has been sufficient biological growth, the rotary distributor speed should be adjusted to flush periodically (typically, each day). Operating speeds may be calculated based on typical wastewater flow, loading, seasonal temperatures, etc. WesTech can assist with these calculations, if desired.

Periodic flushing of the media is an important part of maximizing trickling filter performance. This is done by slowing the rotary distributor to the flushing speed for a period of time, such that the entire tank is flushed. It is important to note that too little flushing will allow excessive amounts of biological growth to build up on the media. This can result in poor flow through the trickling filter media and sloughing of biomass. The proper flushing speed, frequency, and duration for this plant must be determined by the operators based on testing and process results. Finally, as part of operating this equipment, ensure that a schedule is developed for performing maintenance, both according to this manual, and for any other observed needs. Equipment that is well maintained will give better performance and thus better tricking filter process results.

Based on work done by the German wastewater treatment industry, the industry has developed a term to describe the instantaneous application rate. This term is the "Spül Kraft" or SK rate that has the units of mm of water per pass of the distributor arms.

Table 4.3-1 provides the SK rates for the trickling filters.

Table 4.3-1 Operating and Flushing Rates for Distributors

Total Frequency load, lb. BOD_5/d/1000 cu ft.	Operating dosing rate, mm/pass (in./pass)	Flushing dosing rate, mm/pass (in./pass)
<0.4 (<25)	25-75 (1-3)	100 (4)
0.8 (50)	50-150 (2-6)	150 (6)
1.2 (75)	75-225 (3-9)	225 (9)
1.66 (100)	100-300 (4-12)	300 (12)
2.4 (150)	150-450 (6-18)	450 (18)
3.2 (200)	200-600 (8-24)	600 (24)

To calculate the Organic Loading to the trickling filter, use the following formula:

$$\text{Organic Load} = \frac{\left(BOD, \frac{mg}{L}\right) x \; (Flow, mgd) x \left(8.34\,\frac{lbs}{gallon}\right) x \; 1{,}000\; ft^3}{Volume, ft^3}$$

Air Compressors

Each trickling filter pair (1 and 4, 2 and 3, 5 and 6) has an Air Compressor Building that houses an air compressor and receiver, air dryer, air purification system and air conditioning system and control panels for the associated trickling filter pair's motorized rotary distributors.

Trickling Filter Air Compressor (typical)

High Plume Dispersion Fans

Each trickling filter has two high plume dispersion fans that draw air from the respective trickling filter through the trickling filter peripheral air duct system. Generally, both fans are operated to meet the ventilation needs for the system.

Dispersion Fan Pair (typical)

Note: The operating pressure of the high plume dispersion fan should be within a range between -2.5 and -4.5 psi. As the zoogleal film grows in the crossflow media, the media begins to clog. When the pressure readings on the high plume dispersion fans decreases may be indicative that the zoogleal film has grown in excess, in which case flushing should be increased.

Trickling Filter Ventilation Air Duct System

Sixteen 18-inch air duct lines, each with adjustable damper and a 6-inch condensate drain. The 18-inch ducts connect to the associated trickling filter perimeter exhaust manifolds that tie into the associated high plume dispersion fans.

Note: If the pressure of the high plume dispersion fan decreases below -6.0 psi, the vents will open to prevent damage on the ventilation duct system. It is important to maintain the vent control in AUTO mode in SCADA.

Note: Under freezing temperatures, if a fan is not in operations but will be started open the casing access door to verify if there is any build up since this could damage the equipment. Also verify the isolation dampers for buildup on the damper blades.

Table 4.3-2 provides the design criteria for the trickling filter system.

Table 4.3-2 System Data - Trickling Filters

Component	Value
Trickling Filters	
Quantity:	6
Tag:	TF-1, TF-2, TF-3, TF-4, TF-5, TF-6
Diameter, feet:	134
Media Manufacturer:	Brentwood
Media Depth:	Approximately 134'-0" ID x 23'-0"
Trickling Filter Rotary Distributors	
Quantity:	6
Manufacturer:	Westech
Model:	Hydrodoc RDS13S
Trickling Filter Air Compressors	
Quantity:	3
Manufacturer:	Gardner Denver
Compressor Model:	VR5-12
Pump No.:	R15
Motor Model:	EM3615T
Horsepower:	5
RPM:	1755
Phase:	3
Volts:	230/460
Hertz:	60
Full Load Amps:	13.4/6.7
Service Factor:	1.15
Duty:	Continuous
Class:	F
NEMA Code:	J
Drive End Bearing:	6206
Opposite End Bearing:	6205
Trickling Filter High Plume Dispersion Fans	
Tags:	OCF-1A/B – OCF-6A/B
Quantity:	12
Manufacturer:	M.K. Plastics
Model:	AXIJET
Type:	Centrifugal
Fan Size:	4450
Diameter:	47.13 inches
SP:	4
BHP:	4415
RPM:	991
CFM:	32,500

Table 4.3-2 System Data - Trickling Filters

Component	Value
Trickling Filter Fan Motors	
Quantity:	12
Manufacturer:	Toshiba
Model:	0504XDSB41A-P
Horsepower:	50
RPM:	1775
SF:	1.15
Phase:	3
Volts:	460
Hertz:	60

A separate local control panel (LCP) is provided for each trickling filter rotary distributor (LCP-1000-1 through -6) and each air compressor (CCP-1000-1 through -3). Each air compressor serves two filters.

Emergency Stop Push Buttons

Each High Plume Dispersion Fan is provided with independent local emergency stop pushbuttons that, when used, deactivate the equipment immediately in an emergency condition. Emergency Stop activation requires pushing the red mushroom pushbutton while restarting equipment will require the push button to be pulled back out to the normal (disengaged) position until the switch locks and the alarm clears.

Vibration Monitoring

Each High Plume Dispersion Fan is provided with vibration monitoring device that monitors vibration and has a reset button on it.

4.3.3 Equipment Control

The following tables identify the local controls associated with the trickling filter system. Each trickling filter has a rotary distributor drive and associated air compressor and two high flow dispersion fans.

Table 4.3-3 provides the controls and monitoring for the trickling filter rotary distributor drive located at the Compressor Buildings and the local controls for the High Plume Dispersion Fans Main Control Panels. Each NEMA 4X MCP is powered by a 480 volts feed from DCU-2.

Table 4.3-3 Local Control Panel – Trickling Filter Rotary Distributor (LCP-1000-1, -2, -3, -4, -5, and -6)

Control Name/Location	Features	Function
Hand-Remote-Auto	Three-way Switch	In the "Hand" position, the positioners and gates move to the position by the control panel potentiometer. The PLC makes no adjustment based on actual speed. In the "Remote" position, the speed setpoint is taken from a 4-20 mA supplied by a remote source. The PLC attempts to hold speed by compensating for flow changes, wind forces, and other external effects. In the "Auto" position, the distributor is controlled by the PLC. The PLC adjusts the distributor gates to compensate for changes in flow, wind forces, clogged nozzles, etc.
Speed	Potentiometer	The speed dial is used when the Hand-Remote-Auto selector switch is in the "Hand" position to control the positioner and gates.
Zero Speed	Red mushroom button	When the Hand-Remote-Auto selector switch is in the Auto position, depressing the Zero Speed mushroom button brings the distributor close to zero speed.

Table 4.3-4 provides the local controls at the Compressor Building and High Plume Dispersion Fans. The control is next to its respective trickling filter and is housed in a NEMA 4X enclosure.

Table 4.3-4 Local Control Panel – Air Compressor (CCP-1000-1, -2, and -3)

Control Name/Location	Features	Function
Test-Off-Auto	Three-way Switch	**Test** - Used to test the system to ensure it is functioning correctly. It might run the system for a short period to check for any issues. **Off -** Turns the system off completely, stopping all operations. **Auto** - Allows the system to operate automatically on pre-set conditions or schedules.
Green "Run"	Indicator Light	Illuminates when the compressor is running.
Red "Motor Overload"	Indicator Light	Illuminates when the motor is in overload condition.
Red "Low Oil Level"	Indicator Light	Illuminates when the low oil level sensor is activated.
Start/Reset	Pushbutton	Activates the compressor when the Test-Off-Auto selector switch is in the "Auto" position.
Red "High Temp"	Indicator Light	Illuminates when the high temperature sensor is activated.
Reset	Pushbutton	Resets the compressor when a fault has been remedied and the compressor can be returned to service.

Table 4.3-5 provides the local controls at the Compressor Building. The control is near its respective trickling filter and is housed in a NEMA 4X enclosure.

Table 4.3-5 Local Control Panel – Air Dryer

Control Name/Location	Features	Function
Power Off/On	Selector Switch	Enables power to the dryer when in the "On" position. Disables power to the dryer when in the "Off' position.

Table 4.3-6 provides the local controls at the LCPs for each high plume dispersion fan. Each LCP is near its respective fan and is housed in a NEMA 4X enclosure.

Table 4.3-6 Local Control Panel – High Plume Dispersion Fans

Control Name/Location	Features	Function
Hand-Off-Auto	Three-way Selector Switch	When in the "Hand" position, the dispersion fan will run continuously. When in the "Off" position, the fan will not run. When in the "Auto" position, the dispersion fan operation is controlled by the VFD.
Reset	Pushbutton	When pressed, will reset the fan when alarm conditions have been remedied.
Emergency Stop	Push-Pull Button	Disables operation of the fan when pressed in. Requires the button to be pulled back out before the fan can be restarted.

Motorized Rotary Distributors Arm (RDA)

The Distributor Control Panel to operate each rotary distributor is mounted in a NEMA 4X enclosure within the associated trickling filters' Air Compressor Building. The panel has an Allen-Bradley Compact Logix PLC controller, Allen-Bradley PanelView operator interface terminal. The rotary distributors are controlled as described below.

1. In Hand mode, the operator manually controls the rotational speed of the distributor between the minimum and maximum speeds listed.
2. In Auto mode, an operator adjustable program sets up operational and flushing speeds that operate on an automatic and daily basis.
3. In Remote mode, the PLC receives the following:
    a. A 4-20 mA analog signal from the SCADA system to control drive speed.
    b. A Start command from the SCADA system.
4. In either Hand or Remote mode, the PLC sends the following signals to SCADA:
    a. Rotary Drive Control Panel in Remote
    b. Rotary Drive Control Panel in Auto
    c. Rotary Drive PLC Enabled
    d. 4-20 mA output for rotary drive speed feedback

The HydroDoc™ mechanism provides the means of controlling the rotational speed of a rotary distributor mechanism using the hydraulic energy available from the influent stream. HydroDoc™ provides the means to direct the flow through ports in the front and the back of each arm in varying proportions resulting in thrust (speed) control. Discharge ports with spreaders are appropriately placed along the front wall and back wall of the outer arm sections. A gate is placed in front of the ports, inside the arm and against each wall. The front and rear gates are raised and lowered in opposite directions to each other, i.e., as one closes the other opens. The gate linkage is set to maintain one full port in the sum of the areas of the front and back ports to give uniform flow distribution over the media. The gate linkage is moved by an air cylinder fitted with a pneumatic positioner. The positioner receives a 3-15 psi signal representing the desired cylinder extension. The positioner causes the cylinder to extend or retract as required. Each positioner is configured such that when the rod is extended, the distributor speed increases.

The HydroDoc™ control system consists of a PLC providing comparative monitoring of the actual rotating speed of the arms and a set point representing the desired rotational speed. Based on the results of the comparison, a signal is generated and sent to the air control panel. There the signal is converted by an I/P transducer from a 4-20mA electrical signal to the 3-15 psi pneumatic signal which is sent to the positioners. Feedback to the PLC is generated by an encoder mounted within the speed sensor assembled at the top of the distributor. This sensor returns a signal that gives both rotational speed and the direction of rotation. This discrimination allows the control logic to make very responsive speed changes and gives the ability to maintain a zero (stop or maintenance) speed.

Operation

The HydroDoc™ control system offers four modes of operation including Off. Three of these modes are offered by the selector switch on the control panel: Hand, Remote, and Auto.

Hand – The positioners and gates simply move to the position selected by the control panel pot. The PLC makes no adjustment based on actual speed.

Remote – The speed set point is taken from a 4-20 mA signal supplied by a remote source. As in Auto mode, the PLC will attempt to hold the desired speed by compensating for flow changes, wind forces, and other external effects.

Auto – The distributor is controlled by the PLC in accordance with the program set in the previous section. The PLC will adjust the distributor gates to compensate for changes in flow, wind forces, clogged nozzles, etc.

Air Compressors

An air compressor, receiver and dryer are located within the associated trickling filter's Air Compressor Building. The air compressor system provides a minimum air pressure (50 psig) needed for the proper operation of the hydraulically speed controlled distributors.

Trickling Filter Air Compressor Control Panel (typical)

High Plume Dispersion Fans

Each trickling filter has a pair of high plume dispersion fans that draw air through the trickling filter through the peripheral air ducting system. The dispersion fans are controlled from their respective local control panel.

Dispersion Fan Pair Local Control Panels (typical)

4.3.4 Operation

Normal Operations

The normal mode of operation for the trickling filter equipment is to have all six trickling filters online with the air compressors, dispersion fans, and distributor arms in Auto.

Alternate Operations

Alternate operations indicate that one or more components of the trickling filter system will be out of service or cannot be automatically controlled.

Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control.

Shutdown Considerations

1. Ensure that there are sufficient trickling filters online to manage the anticipated flow and loadings.
2. At the LCP, press the "**STOP**" pushbutton for the trickling filter pump being taken out of service. Place the disconnect switch in the "**OFF**" position and perform LOTO procedure if maintenance is being performed or if the pump will be out of service for extended period.
3. Confirm the discharge valve for the pump closes once the pump shuts down.
4. Close the inlet valve to the trickling filter being taken off-line.
5. At the associated Compressor Building, Place control switches for the motorized distributor, air compressor in the "Off" position.
6. At the LCP for the high plume dispersion fans, place the Hand/Off/Auto selector switch in the "Off" position.
7. At the LCP for the high plume dispersion fans, place the Hand/Off/Auto selector switch in the "**OFF**" position.
8. Place the motorized distributor, air compressor, and fans local disconnects on the MCP in the "**OFF**" position
9. A shut-down procedure is necessary to prevent possible generation of offensive odors, accumulation of dried biomass that may clog the filter when re-started and to protect the media from extremes of heat or cold.
10. Use the mechanical distributor at the slowest speed recommended by the manufacturer for an extended period of time to flush the biomass from the media. The flushing water may be chlorinated to clean the media and kill the biomass. Recirculate the chlorinated water until the chlorine residual is safe to discharge.

Shut-Down

Stopping the Arms

The HydroDoc™ distributor arms can be stopped by shutting off the flow of wastewater to the unit and locking out power to the controls.

The red, mushroom button can be pushed to bring the distributor to a zero-speed setting while there is flow to the distributor. This will result in the arms gates continually adjusting to keep the distributor close to a zero speed.

Auto Mode Zero Speed – To bring the distributor close to a zero speed while the control panel selector switch is in Auto mode, press the red, mushroom button. This will bring the arms and hold them close to a zero speed.

Remote Mode Zero Speed – To bring the distributor close to a zero speed while the control panel selector switch is in Remote mode, press the red, mushroom button. This will bring the arms and hold them close to a zero speed.

Hand Mode Zero Speed – To bring the distributor close to a zero speed in Hand mode, rotate the Speed knob to the position at which forward and reverse thrust is balanced. This will cause the arms to coast to a stop. The arms may be stopped more quickly by turning the Speed knob to zero until the arms are almost stopped, and then turning the Speed knob back to the balanced position.

Shut-Down

The HydroDoc™ rotary distributor does not require an extensive shut-down procedure to briefly take the equipment out of service.

The arms may optionally be stopped at a particular location using the control system's Hand mode. When flow is stopped to the distributor, it will cease to rotate. Power and air to the distributor should be shut off along with the flow, and the air system bled of pressure to prevent the control mechanism from moving unexpectedly. If the equipment will be shut down for a period longer than one week, or if it will be exposed to freezing conditions, the procedures for Short and Long Term Shut Down given in the Maintenance section of the Trickling Filter Vendor Manual must be followed.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect the trickling filter pumps for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the trickling filter pumps only when it is in good working condition.
3. Inspect the trickling filter equipment for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the trickling filter equipment only when it is in good working condition.

4. Ensure that only authorized personnel are allowed in the in the trickling filter area and no one might be injured when equipment is activated.

5. Ensure all motors, gears, and bearings have been properly lubricated using the manufacturers recommended lubricant.

6. Confirm all maintenance and/or repairs have been completed.

7. Remove any existing lockout devices and follow lockout/tagout procedures for any of the equipment's associated with the trickling filters, this includes but not limited to, pumps dispersion fans, RDA, etc.

8. Verify that the local disconnect for every of the equipment's associated with the trickling filters to be started are in the "**OFF**" position.

9. Verify that the Local-Off-Auto switch at each LCP is in the "**OFF**" position.

10. In the Trickling Filter Pump Station electrical building, verify that the Hand-Off-Auto selector switch at MCC-5 is in the "**OFF**" position.

11. Check on the readiness of all upstream and downstream equipment such as the pumps, trickling filters, level controls, etc.

12. Confirm all safety devices and proximity switches are functioning properly.

Startup

1. At the associated Compressor Building, confirm the air compressor inlet and discharge line are open.

2. At the air compressor local control panel, place the air compressor selector switch in the "Auto" position.

3. At the air compressor local control panel, press the "**START/RESET**" pushbutton to start the air compressor.

4. At the Rotating Distributor Arm (RDA) local control panel for the selected Trickling Filter, place the selector switch in the "**AUTO**" position and confirm that the Zero Speed red mushroom pushbutton in Not Activated.

5. At the (RDA) local control panel touchscreen for the selected Trickling Filter, confirm there is no active Alarms. If there is an active Alarm press the Alarm Box and verify the active alarm. Once the condition for the Alarm is corrected, proceed to Acknowledge the Alarm.

6. At the (RDA) local control panel touchscreen, press the "**TIME SETUP**" key.

7. In the Time Setup screen, confirm the Default MPR speed is in the desired setpoint. To change the setpoint, touch the Default MPR box, enter the desired setpoint and press **OK/Enter**. This will change the speed of the RDA rotation.

8. In the Time Setup screen, enter the desired "flushing" setpoints by pressing the START HOUR, START MINUTE, STOP HOUR STOP MINUTE AND SPEED MPR boxes. Example: if desired flushing time is to start at 8:00 AM and Stop at 9:30 AM at a Speed of 20 MPR, see image below.

9. At the Dispersion Fan local control panel, place the main breaker in the "**ON**" position.

10. For turning the dispersion fan "**ON**" locally, place the selector switch in the "**HAND**" position and the dispersion fan will turn On. (This mode is used usually while performing maintenance work).

11. For turning the dispersion fan "**ON**" remotely (normal operating mode):

    a. At the local control panel, place the selector switch in the "**REMOTE**" position.

    b. At the Trickling Filter IPA building Main Control Panel place the selector switch in the "REMOTE" position and press the "**START**" button. The "ON" red indicator light should turn On.

    c. At the SCADA Trickling Filter Forced Air Ventilation screen, verify that the selected dispersion fan is On.

12. Verify the pressure indicator for the corresponding fan is reading between -2.5 and -4.5 psi.

13. At the Trickling Filter Pump Station, confirm the valve is open for the selected Trickling Filter.

14. At MCC-5, place the main breaker for the selected trickling filter pump in the "**ON**" position.

15. At MCC-5, place the selector switch in the "**LOCA**L" Position.

16. At the pump local control panel, place the disconnect switch in the "**ON**" position,

17. To start the desired trickling filter pump, press the start button.

18. Start flow to the RDA. Allow the arms to fill. Clean any orifices that are seen to be clogged.

19. Adjust the flow until the minimum specified flow is achieved. Confirm that the arms are rotating freely.

20. Startup of the trickling filter system at the lowest rate possible, while maintaining the highest recirculation rate possible.

21. Increase the influent wastewater flow after 48 hours and maintain a high recycle rate.

22. After 96 hours, increase the influent flow to full flow and reduce the recycle to provide an appropriate wetting rate to the filter or place the recycle pump on automatic control if available.

Routine Checklist

The trickling filters should be inspected for the following items when in operation:

1. Closely monitor the distributor arm to be sure it is moving smoothly. Clean orifices as needed.

2. Check the distributor, air compressor and fan drive motors for unusual noise, vibration, misalignment, and/or excess heat.

3. Inspect all control panel switches for proper positioning.

4. Check to see that all safety guards are in place and personnel are clear of the equipment.

5. HydroDoc™ gates, linkage, and positioner component inspection. Check all parts for loose fasteners, signs of overload damage, or corrosion.

6. Drainage of condensate. Regularly open the condensate drain valves on the drip legs near each positioner assembly. Allow any collected condensate to blow out. The frequency of this check must be determined based on plant conditions and the quality of the air supply.

7. Flushing the arms. After there has been sufficient biological growth on a filter that has been placed in service, the rotary distributor speed is adjusted to flush periodically (typically each day). Operating speeds are calculated based on typical wastewater flow, loading, seasonal temperatures, etc. The proper flushing speed, frequency, and duration are determined by the operators based on testing and process results. WesTech can assist with calculations, if desired.

Troubleshooting

The following identifies problems that may be encountered during the operation of the trickling filter system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 4.3-7 provides troubleshooting information for operational issues associated with the trickling filter media.

Table 4.3-7 Troubleshooting Guide – Trickling Filters Media

Problem	Probable Cause	Recommended Action
Odors	Odors occur when the trickling-filter is highly loaded with organic matter and/or is poorly ventilated.	If possible, increase the wetting rate of the filter by increasing recycle rates. The latter will increase oxygen transfer efficiency within the body of the filter.
		If possible, apply a high SK (flushing rate) to the filter daily (usually during off peak hours) to flush excess biomass from the tower.
		Poor distribution or low wetting rate of the tower may be causing semi-dry areas within the filter. Putrefaction of existing biomass may occur under these conditions leading to odor problems. Increase the SK value by slowing the distributor arm with reversing jets or using the motorized distributor drive if installed.
		Make sure ventilation windows (screens, louvers, etc.) are clean and permit a free flow of air. If the tower is stagnant be sure the vents are full open to minimize any blockage to air movement
Filter Flies	Filter flies occur when the filters have semi-dry pockets of old biomass available for incubation of the fly larvae.	Increasing SK and/or wetting rates of the filter will assist in reducing the suitability of the environment for propagation of the filter flies.
Ponding	This is a problem normally associated with rock trickling-filters. It occurs when the buildup of biomass in the filter forms plugs which do not permit proper flow of the wastewater through the rock matrix. This problem is not very prevalent in plastic filter media because of the greater void volume of the plastic media.	To avert plugging of plastic media under high organic loading apply high SK values to the filter once a day for several hours, if possible, to flush accumulated biomass and/or trapped solids from the filter bed.

Table 4.3-7 Troubleshooting Guide – Trickling Filters Media

Problem	Probable Cause	Recommended Action
Snails	Snails can become a significant problem, particularly in nitrification trickling-filters. Snails consume biological slimes as a source of food and grow in dark moist environments such as the body of a trickling-filter. Snails consume nitrifying bacteria faster than they are produced in some cases and can result in loss of ammonia removal efficiencies. To reduce snail populations in trickling-filters there are several approaches.	1 Ammonia Washing: Isolate the trickling-filter tower during off peak hours and charge the influent/re-circulation sump with a water containing ~100 ppm of ammonia. Sludge centrates, digester supernatants or other ammonia rich water may be used for this purpose. Add sufficient caustic (sodium hydroxide solution) to the sump to raise the pH to 9.5 or 10 and initiate recirculation of this liquid through the tower. The high strength of dissolved gaseous ammonia will discourage snail growth and help purge the snail shells and eggs from the tower. The procedure does not appear to cause permanent damage to the nitrifiers. Re-circulate the ammonia solution for several hours or a day if possible. Maintain the elevated pH by adding more caustic if necessary. Repeat this procedure as necessary to mitigate the snail population. This procedure or variations thereof, is practiced at a number of WWTP plants. 2 Tower Dry-Out: Long term shut down of the trickling-filter to allow the tower to dry out and kill the predatory snails has been successful. This is not a practical solution for many plants however.

Table 4.3-8 provides troubleshooting guidance for the operational issues associated with the trickling filter distributor.

Table 4.3-8 Troubleshooting Guide – Trickling Filter Rotating Distributor Arm

Problem	Probable Cause	Recommended Action
Non-uniform flow over media or low spreader flow.	Obstructed flow in some of the spreaders.	Clean orifices and flush arms. Schedule for regular maintenance.
Visible oil around outside of center mast pipe under upper bearing.	Oil leakage or overflow from upper bearing housing. Overflow can be caused by condensate accumulation in bearing housing.	Drain condensate from housing. Ensure oil level is correct. If oil is leaking from around drain plugs or sight glass, tighten or reseal threads.
Distributor not operating level or non-uniform flow over media.	Clogged arm vent pipes.	Clean obstructions from vent pipes. Schedule for regular maintenance.
Popping or grinding noise in bearing. Failure to rotate.	Bearing failure.	Inspect bearings. Replace as required.

Table 4.3-8 Troubleshooting Guide – Trickling Filter Rotating Distributor Arm

Problem	Probable Cause	Recommended Action
Leakage from flush gate, barrel seal, or seal gasket.	Worn or damaged gaskets or seals, or particles trapped between sealing surfaces.	Inspect, clean or replace as required, however, some leaking is expected
Positioner on one arm does not operate or function properly.	Debris or condensate in positioner ports. Condensate in air cylinder. Loss of signal air pressure	Check for signal air and control air at positioner. Drain condensate. Check positioner arm is moving with cylinder ram. Check for debris in positioner spool valve. See Mfg. info.

Table 4.3-9 provides troubleshooting guidance for the operational issues associated with the trickling filter air compressor.

Table 4.3-9 Troubleshooting Guide – Air Compressor

Problem	Probable Cause	Recommended Action
Motor will not start.	Main switch and fuses open.	Check all fuses and switches. Check for loose or faulty wires.
	Started magnetic coils open.	Check overload relay in starter. Reset starter.
	Thermal overload tripped.	Reset starter. If starter trips repeatedly, have electrical system inspected by an electrician.
	Defective pressure switch contacts will not close.	Repair or replace pressure switch. Warning: Relieve tank pressure before servicing.
	Low voltage.	Check with voltmeter. Be sure voltage corresponds to unit specifications.
Starter trips repeatedly.	Improperly adjusted pressure switch.	Adjust or replace. Warning: Relieve tank pressure before servicing.
	Faulty check valve.	Clean or replace. Warning: Relieve tank pressure before servicing.
	Incorrect fuse size pr magnetic starter coil.	Be sure that fuses and coils are properly rated.
	Low voltage.	Check with voltmeter. Be sure voltage corresponds to unit specifications.
	Defective motor.	Replace motor.
Tank pressure builds up slowly.	Air leaks.	Tighten fittings.
	Dirty air filter.	Clean or replace.
	Defective compressor valves.	Install new valves.
Tank pressure builds up quickly.	Excessive water in tank.	Drain tank.
Discharge pressure relief valve pops off while compressor is running.	Wrong pressure switch setting.	Adjust to correct setting.
	Defective ASME relief valve.	Replace valve. Warning: Relieve tank pressure before servicing.

Table 4.3-9 Troubleshooting Guide – Air Compressor

Problem	Probable Cause	Recommended Action
Compressor will not unload (units with head unloaders)	Wrong pilot valve setting.	Adjust to correct setting.
	Defective pilot valve.	Replace pilot valve.
	Lack of air to pilot valve.	Open ball valve to pilot valve.
Excessive belt wear.	Pulley out of alignment.	Realign motor pulley.
	Belts too tight or too loose.	Adjust belt tension.
Compressor runs hot.	Improper flywheel rotation.	Check for correct rotation (counter-clockwise when viewed from drive side).
	Defective compressor valves.	Install new valve plate assembly.
	Dirty air filter.	Clean or replace.
	Dirty cylinder and/or intercooler.	Clean cylinder fins and/or intercooler.
Interstage pressure relief valve pops off.	Defective compressor valves.	Install new valves.
	Improper valve installation.	Verify proper valve placement.
Excessive oil consumption.	Dirty air filter.	Clean or replace.
	Wrong oil viscosity.	Refill with proper viscosity oil.
	Oil leaks.	Tighten bolts. Replace gaskets.
	Worn piston rings.	Replace rings.
	Scored cylinder.	Replace cylinder.
Air escapes from centrifugal unloader when unit is running.	Centrifugal unloader release valve dirty or defective.	Clean or replace valve.
Air escapes from centrifugal unloader when unit is stopped.	Check valve stuck in open position.	Replace check valve. Warning: Relieve tank pressure before servicing.
System does not alternate (duplex units only)	Starter tripped.	Reset starter. If starter trips repeatedly, have electrical system inspected by an electrician.
	Loose wire in alternator.	Check and tighten all wiring connections.
	Defective alternator.	Replace alternator.
	Defective motor.	Replace motor.

4.3.5 Maintenance

Process Maintenance

The general maintenance for the trickling filter equipment (Rotary Distributor Arms and High Dispersion Fans) can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the trickling filter equipment (Rotary Distributor Arms and High Dispersion Fans) consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 4.3-10 provides the manufacturer's and service representative's contact information for the trickling filters media.

Table 4.3-10 Contact Information – Trickling Filter Media

Manufacturer	
Name:	Brentwood Industries
Address:	500 Spring Ridge Drive Reading PA 19610
Phone:	610-374-5109
Fax:	610-376-6022
Website:	www.brentwoodindustries.com
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-933-7815
Fax:	615-373-2701
Website:	www.jtguthrie.com
Email:	tom@guthrie.com

Table 4.3-11 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the trickling filters.

Table 4.3-11 Maintenance Schedule – Trickling Filters

Frequency	Maintenance Task to be Performed
Daily	Keep the surface of the trickling filter media clean and the distributor nozzles free of debris with a daily inspection and cleaning if necessary
Semi-Annually	The alignment of the rotary distributor arms, horizontal and radial may need adjustment on a seasonal basis to compensate for temperature generated expansion and contraction of support wires and spacing wires. Make these adjustments as necessary for the orientation of the distributor arms can affect the uniformity of distribution across the radial width of the media bed.

Note: maintenance schedule for associated equipment (influent pumps, fans, etc.) should be followed.

Table 4.3-12 provides the service representative's contact information for the trickling filter rotary distributors.

Table 4.3-12 Contact Information – Rotary Distributor Arm

Manufacturer	
Name:	WesTech Engineering Co., Inc.
Address:	3665 South West Temple Salt Lake City Utah 84115
Phone:	801-265-1000
Fax:	801-265-1080
Website:	www.westechwater.com
Email:	kball@westech-inc.com
Service Representative	
Name:	Gulf States Engineering Co., Inc.
Address:	8381 Industrial Drive Olive Branch, MS 38654
Phone:	662-890-4768
Fax:	662-890-4769
Website:	www.gsengr.com
Email:	info@gsengr.com

Table 4.3-13 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the trickling filter rotary distributor equipment.

Table 4.3-13 Maintenance Schedule – Trickling Filter Rotary Distributors

Frequency	Maintenance Task to be Performed
Daily/Weekly	To ensure proper flow on the new rotary distributor, plant personnel should inspect the orifices daily. The orifices should be cleaned whenever there is an obstruction that prevents the proper water flow. HydroDoc gates, linkage, and positioner components inspection. Check all parts for loose fasteners, signs of overload damage, or corrosion. Drainage of condensate. Regularly open the condensate drain valves on the drip legs near each positioner assembly. Allow any collected condensate to blow out. Flushing the arms. Periodically, open the flush gate at the ends of the arms and allow any accumulated material to flush from the arms.
Monthly	**Thrust Bearing** Check for proper oil level and for the presence of condensate every 30 days. Drain condensate using the oil drain valve. Top-off oil level as required. To change the oil, open the drain valve and catch the oil in a small can or bucket. Remove fill cap to increase drainage rate. After draining, close the drain valve. Remove the 2” plug and add new oil into reducing coupling until level reaches oil level cap. Replace level and fill plugs, ensuring that threads are sealed with pipe dope or tape to prevent moisture from entering bearing housing. Specified upper bearing oil is needed, verify that it has the following characteristics: The oil must be ISO 460 grade. The oil must have EP additives for low speed, heavy load bearing applications. The oil must have an effective demulsifying agent to help avoid forming condensate emulsions. WesTech recommends that the oil be synthetic type as this will flow more readily during cold weather oil changes. **Stabilizing Bearing** Add 10 shots of grease to the bearing monthly. For best results, rotate the arms 90 degrees between every 2-3 shots. When greasing the lower bearing, inspect the bearing housing and covers for signs of corrosion or damage. Check that the sealant on the split covers is intact to prevent moisture entry into the bearing housing. **Positioner Extension Rods** Wipe a small amount of waterproof silicone grease on each positioner extension rod near the enclosure seals.
Semi-Annually	The alignment of the rotary distributor arms, horizontal and radial may need adjustment on a seasonal basis to compensate for temperature generated expansion and contraction of support wires and spacing wires. Make these adjustments as necessary for the orientation of the distributor arms can affect the uniformity of distribution across the radial width of the media bed.
Annually	Check oil level The barrel seal and all arm gaskets should be inspected at least once a year for cracking, severe leakage, or other deterioration. These must be replaced as needed; however, some dripping can be expected. Anchors and fasteners check. All anchors and fasteners should be annually verified as tight. Any corroding fasteners should be replaced. Tie rod and support cable check. Annually, all tie rods and support cables should be checked for proper tensioning and load sharing. Arms should also be rechecked for level if any tie rod adjustments are required. See the Installation Instructions section of the Westech OM Manual for leveling procedures.

Table 4.3-14 provides the service representative's contact information for the trickling filter compressors.

Table 4.3-14 Contact Information – Trickling Filter Compressors

Manufacturer	
Name:	Gardner Denver
Address:	1800 Gardner Expressway Quincy, IL 62305
Phone:	800-682-9868
Website:	**www.gardnerdenver.com**
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-377-3952
Fax:	615-373-2701
Website:	www.jtguthrie.com

Table 4.3-15 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the trickling filters compressors.

Table 4.3-15 Maintenance Schedule – Trickling Filter Compressors

Frequency	Maintenance Task to be Performed
Daily	Check oil level of both compressor and engine is equipped. Add quality lubricating oil as required. Drain moisture from tank by operating tank drain valve located in the bottom of the tank. Do not open drain valve if pressure exceeds 25 psig.
Weekly	Remove and clean intake air filters. Check V-belts for proper alignment and tightness: • Remove bolts and guard to access compressor drive. • See "Setting Belt Tension" section in the manufacturer's manual for details on how to check and set proper tension. • If necessary, loosen mounting hardware which secures motor to base. Slide motor within slots of baseplate to achieve proper tension. • Check the alignment of pulleys. The compressor flywheel and motor sheave should be aligned within ±½° with notched belts and ±2° with wrapped belts. Adjust if necessary. • Tighten mounting hardware to secure motor on base. • Re-install guard and secure with bolts.
Every 90 days or 500 Hours Maintenance	Check crankcase oil. Use type and grade oil as specified by manufacturer. Check entire system for air leakage around fittings, connections, and gaskets, using soap solution and brush. Tighten nuts and cap screws as required. Check and clean compressor valves. Replace valves when worn or damaged. Replace valve gaskets after each inspection. Pull ring on all relief valves to assure free movement.

Table 4.3-16 provides the manufacturer and service representative's contact information for the trickling filter high plume dispersion fans.

Table 4.3-16 Contact Information – Trickling Filter High Plume Dispersion Fans

Manufacturer	
Name:	M.K. Plastics Corporation
Address:	4955 De Coutrai Montreal, Quebec, H3W 1A6, Canada
Phone:	514-871-9999
Fax:	514-871-1753
Website:	***www.mkplastics.com***
Service Representative	
Name:	Tom Barrow Company
Address:	2837 Appling Way Suite 102 Memphis, TN 38133
Phone:	901-367-1180
Fax:	901-367-1350
Website:	***www.tombarrow.com***

Table 4.3-17 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the trickling filter high plume dispersion fans.

Table 4.3-17 Maintenance Schedule – Trickling Filter High Plume Dispersion Fans

Frequency	Maintenance Task to be Performed
Daily/Weekly	Visual inspection of all the fan parts for any signs of wear or damage. Check for unusual noise.
Monthly	Inspect belts and pulleys for proper tension and alignment. Check motor bearing s and lubricants as necessary Verify fan operations and ensure that is free of debris.
Every three months	Fans exhausting contaminated air (airborne particles) should be inspected every three months or sooner.
Semi-Annually	Inspect bolts and setscrews for tightness. Tighten, as necessary. Worn setscrews should be replaced immediately. Inspect belt wear and alignment. Replace worn belts with new belts and adjust alignment as needed. Inspect springs and rubber isolators for deterioration and replace as needed. Inspect for cleanliness. Clean exterior surfaces only. Removing dust and grease on motor housing assures proper motor cooling. Removing dirt from the wheel and housing prevents imbalance and damage.
After 3 years	It is recommended to remove and disassemble the motor and lubricate the bearing after 3 years of operation in excessive heat and/or in a contaminated air stream consisting or airborne particles.

4.3.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

4.4 Intermediate Pump Station

4.4.1 Overview

The Intermediate Pump Station consists of seven screw pumps that convey trickling filter effluent (or primary effluent if the trickling filters are being bypassed) to the Flow Control Structure where it is combined with RAS prior to distribution to the on-line aeration basins.

The major components of the intermediate pump station include:

- 7 – Screw Pumps
- 7 – Grease Pumps

Figure 4.4-1 Intermediate Pump Station Open Screw Alternate provides a process flow schematic for the intermediate pump station and associated equipment's.

4.4.2 Description

The major components associated with the intermediate pump station are summarized below. In addition, the design criteria associated with the pump station equipment is provided in tabular form.

Screw Pumps

Seven screw pumps convey trickling filter effluent (or primary effluent if the trickling filters are bypassed) to the Flow Control Structure to the aeration basins. Screw pumps (Archimedes' screw pump or 'water screw'), consist of a single screw at an angle that rotates in a cylindrical cavity, gravitationally trapping water on top of a section of the screw and progressively moving it along the screw's axle until it is discharged at the top. Each pump is provided with an automatic lubrication system to grease the lower bearing. The automatic lubrication system is interlocked with the pump to prevent the screw pump from operating if the lubrication system malfunctions. Each pump is rated for 29 mgd at 24.7-feet rated head.

Intermediate Pumps

Table 4.4-1 provides the design criteria for the intermediate pump station pumps.

Table 4.4-1 System Data – Intermediate Pumps

Component	Value
Intermediate Pumps	
Quantity:	7
Tag:	E-315 through E-321
Manufacturer:	Lakeside Equipment Corporation
Type:	Screw
Capacity:	29 mgd
Rated Head, feet:	24.66
Speed, rpm:	28
Screw Diameter, inches:	96
Number of Screw Flights:	3
Nominal Screw Inclination Angle, degrees:	38
Flex Coupling Size:	50
Ridgit Coupling:	Kop-Flex 6H FHUB

Table 4.4-1 System Data – Intermediate Pumps

Component	Value
Intermediate Pump Motors	
Manufacturer:	General Electric
Model:	5K449SL2097
Frame:	449T
Horsepower:	200
RPM:	1790
Phase:	3
Volts:	4160
Hertz:	60
Full Load Amps:	26.2
Service Factor:	1.15
Duty:	Continuous
NEMA Code:	G
Drive End Bearing:	6318ZC3
Opposite End Bearing:	6318ZC3

4.4.3 Equipment Control

The following table identifies the local controls associated with the intermediate pump station pumps. Each intermediate pump has a local control switch that can be used to start the pump locally to transfer start control to the operator remotely through SCADA.

Each LCP is located adjacent to its respective equipment and housed in a NEMA 4X enclosure.

Intermediate Pump Local Control Panel (typical)

Table 4.4-2 provides the location of controls associated with the screw pumps.

Table 4.4-2 Intermediate Pump Station Screw Pump Controls

Control or Indicator	Number of Units	At Equipment	MCC-4	At Computer
Screw Pumps				
Main Disconnect Switch	7		X	
Selector switch **Hand-Off-Auto** **Hand-Off-Com**	 7 7	 X 		 X
Pushbutton **Start** **Stop**	 7 7			 X X
Motor space heater	7	X		
Timer	7		X	
Red indicating light - **Run**	7		X	X
Green indicating light - **Off**	7		X	X
White indicating light - **Tripped**	7		X	
Yellow indicating lights	7		X	
Alarm relay	9			X
Computer control				X
Computer initiated alarm				X

Table 4.4-2 Intermediate Pump Station Screw Pump Controls

Control or Indicator	Number of Units	At Equipment	MCC-4	At Computer
Grease Pumps				
Selector switch **Hand-Off-Auto**	7		X	
Pushbuttons **Start** **Stop**	 7 7			 X X

Table 4.4-3 provides descriptions of the functions of controls associated with the screw pumps.

Table 4.4-3 Intermediate Pump Station Screw Pump Control Functions

Control or Indicator	Functions
Screw Pumps	
Selector Switch	**Hand** – Pump runs continuously.
	Off – Pump does not operate.
	Auto – Pump operation is based on timer settings.
	Hand – Pump controlled using pushbuttons on Backup Board.
	Off – Pump computer controls are off.
	Com – Pump is controlled from computer console.
Pushbuttons	**Start** – Initiate pump operation when operated in Hand from Backup Board.
	Stop – Halt pump operation when operated in Hand from Backup Board.
Timer	Set pump operation duration to stagger pump use and operation.
Green indicating light	**Off** – Pump is not running.
	On – Pump is running.
Red indicating light	**Run** – Pump is operating.
	Stop – Pump is not running.
White indicating light	**Tripped** – Check motor for condition that initiated fault.
Yellow indicating light	**Pump alarm** – Check pump operation.
	Screw Pump Hi – Level in screw pump is high. Start another pump.
	Wet Well Hi – Check for high wet well level.
Alarm relay	Delay starts of pump motor by adjustable time (1 to 300 seconds). Times after energization. The factory set time delay for each pump is as follows: Pump 1 – 5 seconds Pump 2 – 10 seconds Pump 3 – 15 seconds Pump 4 – 20 seconds Pump 5 – 25 seconds Pump 6 – 30 seconds Pump 7 – 35 seconds

Table 4.4-3 Intermediate Pump Station Screw Pump Control Functions

Control or Indicator	Functions
Computer control	Starting pumps – Pumps will automatically start in response to rising wet well or manually started by the operator. Automatic start is initiated when the wet well liquid level reaches 6.5 feet.
	Stopping pumps – Pumps must be stopped by operator command.
Computer initiated alarm	Sounds each time a pump starts and when the wet well liquid level reaches 6,5 feet with all available pumps operating.
Grease Pumps	
Selector switch	**On** – Pump operates continuously.
	Off – Pump does not operate.
	Auto – Pump operates continuously when screw pump is operating.

4.4.4 Operation

Normal Operation

The pumps operate in the Auto position at the equipment. The pump Hand-Off-Remote selector switches at the switch gear are not used. The pump lead position and starting sequence should be rotated frequently enough so that each pump operates at least 8 hours per week. At the design flow of 80 mgd, three pumps will operate.

The automatic lubricating systems should be checked every day to ensure that the reservoir contains an adequate supply of grease, and the bearings are being adequately lubricated. The visual flow indicating nozzle indicate flow of lubricant to the bearings. The grease pumps will not shut off if the grease is depleted. Operation of a screw pump without adequate grease being supplied to the lower bearing will result in costly damage to the pump.

Alternate Operation

Alternate operations indicate that one or more components of the intermediate pump system will be out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control.

If a pumping unit fails, the corresponding inlet sluice gate should be closed, the Hand-Off-Auto selector switch should be placed in the Off position, and the disconnect switch at MCC-4 tripped to Open and locked out. While repairs are being made, the other pumps automatically operate as required under normal operation. When the pump is repaired, it should be started manually for testing and then operated as required by the pumping sequence.

When the Intermediate Pump Station influent flow exceeds the capacity of the screw pumps as result of a pump or power failure, then the necessary number of trickling filter feed pumps at the Trickling Filter Pump Station may be placed in service to pump through the 48-inch trickling filter diversion line around the Intermediate Pump Station the flow necessary to make up the deficit. Note: No more than three pumps should be dedicated to diversion pumping, which should result in a maximum flow of approximately 80 mgd. The trickling filter pumps selected to pump the deficit flow must be isolated from the remaining trickling filter pumps by closing the necessary discharge header valves. Butterfly valve BFV-1 in the diversion line should be opened. This valve should not be used to throttle flow or excess cavitation, and valve damage may result. One trickling filter (Trickling Filter 4 and/or 6) normally served by the trickling filter pumps taken offline to pump to the Intermediate Pump Station must be removed from service for the duration of the diversion pumping.

Protective relays will shut down a pump upon thermal overload, ground faults, phase unbalance, or lubricating system failure. The grease pump and screw pump will not shut off if the grease supply is depleted.

Shutdown Considerations

1. Confirm that there are sufficient intermediate pumps online to manage the flow from the trickling filters and aeration basins online.
2. At the MCP, place control switches for the intermediate pump being taken out of service in the "Off" position.
3. At the LCP for the intermediate pump being taken out of service, place the Hand-Off-Auto selector switch in the "Off" position.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect intermediate pumps for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the trickling filter pumps only when it is in good working condition.
3. Ensure that only authorized personnel are allowed in the in the intermediate pump area and no one might be injured when equipment is activated.
4. Ensure all motor bearing and gear reducers have been properly lubricated using the manufacturers recommended lubricants.
5. Confirm all maintenance and/or repairs have been completed.
6. Remove any existing lockout devices and follow lockout/tagout procedures for the intermediate pumps.
7. Verify that the local disconnect at the MCP for each intermediate pump to be started is in the "Off" position.
8. Verify that the Local-Off-Auto switch at each LCP is in the "Off" position.
9. Check on the readiness of all upstream and downstream equipment such as the trickling filters, intermediate pumps, flow control structure, level controls, etc.

10. Confirm all safety devices are functioning properly.

11. Place the local disconnect and control power switch at the MCP in the "Off" position.

Startup

1. At the MCP, place the main breaker for the intermediate pumps in the "On" position.

2. At the MCP, place the control power switch in the "On" position.

3. At the LCP for the intermediate pump, place the Hand-Off-Auto switch in the "Auto" position.

4. Confirm the pumps start.

Routine Checklist

The intermediate pumping system should be inspected for the following items when in operation:

1. Check the intermediate pump drive motor and gear reducer for unusual noise, vibration, misalignment, and/or excess heat.

2. Inspect all control panel switches for proper positioning.

3. Document any equipment malfunction and the corrective action implemented.

4. Check to see that all safety guards are in place and personnel are clear of the equipment.

Troubleshooting

The following identifies problems that may be encountered during the operation of the intermediate pumping system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 4.4-4 provides troubleshooting information for operational issues associated with the intermediate pumps.

Table 4.4-4 Troubleshooting Guide – Intermediate Pumps

Problem	Probable Cause	Recommended Action
Screw pump will not start.	Pump is not in the correct control mode.	Switch pump to the correct control mode and confirm pump starts as expected.
	Timer setting requires adjusting.	Adjust timer setting to start pump.
	Grease pump is not operating.	Determine cause of grease pump not running and rectify.

4.4.5 Maintenance

Process Maintenance

The general maintenance for the intermediate pump equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the intermediate pumps consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 4.4-5 provides the service representative's contact information for the intermediate pumps.

Table 4.4-5 Contact Information – Intermediate Pumps

Manufacturer	
Name:	Lakeside Equipment Corporation
Address:	1022 E. Devon Ave. Bartlett, IL 60103
Phone:	(630) 837-5640
Fax:	(630) 837-5647
Website:	***www.lakeside-equipment.com***
Service Representative	
Name:	Guthrie Sales & Service
Address:	7003 Chadwick Drive, Suite 300 Brentwood, TN 37027
Phone:	615-933-7815
Fax:	615-373-2701
Website:	**www.jtguthrie.com**

Table 4.4-6 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the intermediate pumps.

Table 4.4-6 Maintenance Schedule – Intermediate Pumps

Frequency	Maintenance Task to be Performed
Daily	Inspect for leaks. Check the exterior of the pump for any signs of leaks Clean debris. Remove any debris around the pump to ensure it operates efficiently
Weekly	Lubricate bearings. Ensure that the upper and lower bearings are properly lubricated using the recommended lubricant from the manufacturer. Check alignment. Verify that the pump and motor are properly aligned to prevent wear and tear.
Monthly	Inspect internal parts. Check the internal clearances and look for signs of wear on the rotors, bores and liners. Monitor suction pressure. Clean the pump strainer frequently to avoid abrasive particles in the fluid.
Every 3 Months	Check mechanical seals. Inspect the condition of the mechanical seals, paying attention to the mating faces and O-rings. Replace if necessary. Tighten nuts and screws. Ensure all fasteners are secure to prevent any operational issues.
Semi-Annually	Overhaul the pump. Conduct a thorough inspection and overhaul of the pump. This includes checking for abnormal noise, vibration, loss of capacity, and reduction in discharge pressure.
Every 2 Years	Inspect for leaks. Check the exterior of the pump for any signs of leaks Clean debris. Remove any debris around the pump to ensure it operates efficiently

4.4.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

4.5 Flow Control Structure

4.5.1 Overview

The Flow Control Structure (FCS) receives flow from the Intermediate Pump Station where it is combined with return activated sludge (RAS) prior to distribution to the on-line aeration basins. The structure also receives flow from the primary and trickling filter bypass during events when that line is active.

The major components of the flow control structure include:

- 1 – Flow Control Structure (FCS)
- 1 – 54-inch RAS Influent Pipe
- 3 – Flow Conduits

4.5.2 Description

The major components associated with the flow control structure are summarized below. In addition, the design criteria associated with the flow control structure equipment is provided in tabular form.

Flow Control Structure

54-inch RAS Influent Pipe

Reaerated sludge from the RAS Reaeration Basin is discharged through a 54-inch ductile iron pipe (DIP) running east along the southern edge of the south aeration basin battery before joining the trickling filter effluent downstream of the Intermediate Pump Station (IPS). The termination point of the 54-inch pipe is in the center of the western wall of structure above the floor of the main influent chamber. This discharge point allows for the reaerated RAS to mix with the forward plant flow upstream of the flow split between the north and south aeration basin batteries to form mixed liquor prior to distribution among the in-service aeration basins.

Flow Conduits

There are three 5-foot by 5-foot orifices that split incoming flow into three potential conduits in the pipe gallery located below. Each square opening is dedicated to a conduit. The two outer (north and south) conduits send mixed liquor to the north and south aeration basin batteries, respectively. The middle conduit is a secondary treatment process bypass which runs along the center of the pipe gallery. Since the 1980s, the slide gate to the central conduit has been closed and all forward flow is split in half to the north and south aeration basin batteries through the north and south flow splitting openings.

Table 4.5-1 provides the design criteria for the flow control structure.

Table 4.5-1 System Data – Flow Control Structure

Component	Value
Tag:	FCS
Dimensions:	27' x 20'-4"

4.5.3 Equipment Control

There are no controls associated with the Flow Control Structure.

4.5.4 Operation

Normal Operation

The normal mode of operation for the Flow Control Structure is to receive return flow from the RAS Reaeration Basin and discharge from the Intermediate Pump Station. This blended flow then proceeds to the aeration basins that are in service.

Alternate Operation

Alternate operations indicate that one or more components of the Flow Control Structure are configured contrary to normal operations. During conditions requiring bypassing of the primary clarifiers and trickling filters, the Primary and Trickling Filter Bypass line is open to allow flow directly to the Flow Control Structure.

Shutdown Considerations

Stopping flow to the Flow Control Structure would be a major undertaking requiring planning and coordination. The gravity and pumped bypass lines would be activated to manage influent flow. The plant gravity bypass gate at the Influent Junction Box will completely bypass the treatment process and divert flow to the Mississippi River. The plant pumped bypass line will divert flow from the Influent Pump Station to the Mississippi River. **These bypass actions require approval of management prior to being utilized.**

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect Flow Control Structure for visible damage. Immediately rectify defects or report them to supervising personnel.
3. Ensure that only authorized personnel are allowed in the structure area, and no one might be injured when flow is activated.
4. Confirm all maintenance and/or repairs have been completed.
5. Remove any existing lockout devices and follow lockout/tagout procedures for the flow control gates.
6. Check on the readiness of all upstream and downstream equipment such as the trickling filters, intermediate pumps, aeration basins, level controls, etc.

Startup

1. Confirm the gates are in the correct operating position.

Routine Checklist

The Flow Control Structure should be inspected for the following items when in operation:

1. Visually check the structure to confirm there are no leaks.
2. Confirm gates are in the correct positions.

4.5.5 Maintenance

Maintenance of the Flow Control Structure involves exercising the three sluice gates on the structure.

4.5.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

4.6 Activated Sludge System

4.6.1 Overview

The function of the secondary treatment process is to reduce the amount of colloidal and dissolved organic solids from the primary effluent. The activated sludge process converts the dissolved and colloidal organic materials in the wastewater to settleable biological flocs and other stable end products. The secondary clarifiers provide separation of these solids from the treated wastewater.

There are seven two-pass aeration basins, for a total of 14 basins, referred to as the North and South Aeration Batteries. Aerated sludge from the RAS Reaeration Basin is discharged to the Flow Control Structure (FCS) to mix with incoming trickling filter effluent upstream of the aeration basins creating mixed liquor suspended solids (MLSS).

Most of the settled sludge is returned to the aeration basins as return activated sludge (RAS) to maintain the required population of microorganisms and to permit rapid breakdown of its organics. The RAS pumps provide a controlled removal of settled solids from the related secondary clarifiers for return to the aeration basins to maintain the proper microorganism population for most efficient operation of the activated sludge system. Because more microorganisms are produced than needed, waste activated sludge (WAS) is removed from the system to maintain a steady condition.

The major components of the aeration basins include:

- 14 – Aeration Basins
- 2 – Sluice Gates from Flow Control Structure
- 14 – Influent Valves
- 14 – Effluent Sluice Gates
- 6 – Single Stage Aeration Blowers
- 112 – Drop Legs
- 784 – Fine Bubble Diffuser Aeration Grids
- 90,540 – Fine Bubble Diffusers
- 28 - DO probes

Figure 4.6-1 Aeration Basins No.1-14 provides a process flow schematic for the aeration basins and associated equipment.

4.6.2 Description

The major components associated with the aeration basins are summarized below. In addition, the design criteria associated with the aeration basin equipment is provided in tabular form.

Aeration Basins

There are 14 two-pass aeration basins (7 on the north side and 7 on the south) installed at the Maxson WWTF. Basins 1 through 10 on the north and south side have an overall footprint of 500 feet by 24 feet. Basins 11 through 14 on the north and south side have an overall footprint of 450 feet by 24 feet. The basins have a design sidewater depth of 13.75 feet yielding an overall treatment volume of 16.8 million gallons (MG). Six 1,500 horsepower single-stage blowers provide air.

A 3.5-million-gallon RAS reaeration basin is located on the west side of the south aeration basins. The RAS reaeration basin is discussed in ***Section 4.8 Return Activated Sludge (RAS) Reaeration Basin***.

Table 4.6-1 provides the design criteria for the aeration basin system.

Table 4.6-1 System Data – Aeration Basins

Component	Value	
Aeration Basins		
Quantity:	10	4
Tag:	1-2S, 3-4S, 5-6S, 7-8S, 9-10S, 1-2N, 3-4N, 5-6N, 7-8N, 9-10N	11-12S, 13-14S, 11-12N, 13-14N
Length x Width x Depth:	500 x 24 x 14.25	450 x 24 x 14.25
Volume:	1,279,251	1,151,326
Diffusers		
Manufacturer:	EDI Aeration/Mixing Equipment	
Type:	FlexAir™ ISM Disc	
Size	9-inch	
Design Airflow	0 to 6 SCFM	
Number of Diffusers (Active/Blank) Each Basin		
Basins 1 through 10 North and South	3361/355	
Basins 11 through 14 North and South	2915/326	

The most basic activated sludge wastewater treatment systems are designed to introduce wastewater into an aerated tank where a population of microorganisms or Mixed Liquor Suspended Solids (MLSS) is brought into contact with the organic material (BOD) present in the wastewater. This organic material, which acts as an energy, or carbon, source is converted into new cells (microorganisms) and oxidized end products, such as carbon dioxide (CO_2) and water (H_2O). Activated sludge, or MLSS, consists primarily of microorganisms and inert, non-biodegradable materials. There are several interrelated components associated with all activated sludge processes, including:

- One or more aeration basins where the microorganisms contact the wastewater; these basins must be sized to contain sufficient microorganisms (Inventory) to treat the organic loading in the wastewater.
- Aeration equipment that can provide sufficient oxygen and mixing.
- One or more final clarifiers, or settling tanks, to allow the activated sludge to separate from the treated wastewater.

The mixed liquor flows out of the aeration basins by gravity to the final clarifiers. As noted in ***Section 5 Final Clarification and Pumping***, the functions of the clarifiers are two-fold:

1. The effluent from the aeration basins is discharged to the final clarifiers to allow for separation of the liquid and solids. Since the MLSS has a higher specific gravity than the wastewater, the quiescent conditions in the final clarifiers allow the activated sludge to settle to the bottom of the clarifiers, where the activated sludge is collected and pumped

to the RAS reaeration basin before being returned to the aeration basins. The portion of the settled solids returned to the secondary treatment process is called return activated sludge (RAS). This is done to provide adequate levels of microorganisms for continuous treatment of the pollutants in the wastewater after primary treatment.

2. For every pound of BOD entering the secondary treatment process, approximately 0.85 pounds of new microorganisms are produced. Since the quantity of activated sludge is always increasing through the continual reproduction of the microorganisms, excess sludge must be removed, in the form of WAS. WAS is from each clarifier through a sump cast into the floor of the clarifier and is conveyed to the biosolids handling system by the pressure of the RAS pumping system.

The sludge is wasted in sufficient quantities to maintain, preferably, a desired sludge age as indicated by a target Sludge Retention Time (SRT).

Process Parameters

The activated sludge process is affected by many operational parameters. Some of the parameters are fixed by the engineer's design, others are under the direct control of the operator, and some are directly affected by the day-to-day activities of the community. The activated sludge process has been used extensively in the United States since the 1940s. The basic design parameters have been well documented and applied successfully. However, a good design cannot overcome the effects of a poor process control plan. This section presents a discussion of many process parameters, with particular emphasis on those parameters that will provide the means to optimize the treatment process and result in final effluent quality that meets or exceeds permit requirements. It is ultimately the responsibility of the operations staff to track the process and make small, incremental improvements to the process control plan.

- Some parameters that especially affect the degree of overall treatment (BOD/TSS removal) accomplished by the biological (activated sludge) system are:
- Influent Wastewater Quality
- Sludge Retention Time (SRT)
- pH/Alkalinity
- Temperature
- Dissolved Oxygen (DO)
- F/M Ratio

These parameters and other parameters that affect process control are discussed in more detail in the following sub-sections.

Aeration Tank Volume, Number of Tanks, Secondary Clarifier Surface Area, and Sidewall Depth

These four parameters have been designed by the engineer and are beyond the control of the operator. The operator can take some of the treatment units off-line, or add treatment units, if available. Except for maintenance activities, it is expected that all treatment trains, and all secondary clarifiers associated with biological process will be normally on-line and operational. Process control adjustments must take into consideration the number of units on-line at any time.

Raw Wastewater Flow and Organic Loading

Since the raw wastewater flow and the organic loadings will vary based on the contributing domestic and commercial/industrial discharges, the operator must be prepared to treat all wastewaters discharged to the treatment plant. However, the internal plant sidestream flows coming from various unit processes can impact the flow and loadings and are manageable to some degree. Some examples of these sidestream flows would be supernatant and filtrate from the biosolids lagoon system and belt filter presses.

Operational Mode

The aeration basin system is designed for the plug flow mode of operation with the RAS returned to the beginning of the aeration basin to mix with the incoming wastewater (typically, trickling filter effluent). The plug flow mode is the oldest and most common aeration tank design. It is also called "conventional activated sludge" mode. The most notable characteristic of the plug flow mode is that the loading and oxygen demand, is much higher at the influent end of the tank and decreases along the length of the tank to the effluent end.

In general, the oxygen demand in the aeration basin is primarily due to the oxidation of the remaining carbonaceous BOD compounds not removed in the trickling filter process.

The rectangular design also allows for tapered aeration. More air can be diffused into the zones at the influent end of the tank, where the demand is the highest, and incrementally less air can be diffused into the subsequent zones, where the demand is lower. This has the advantage of saving energy, by not over-aerating the wastewater, and keeping the DO at sufficient levels at the end of the basin. The DO of the aeration basin effluent should be kept in the range of 1.5 to 2.0 mg/L to maintain an adequate supply of available oxygen for the aerobic microorganisms.

Lastly, the plug flow mode is less likely to allow the "pass-thru" of BOD or ammonia during periods of higher flows approaching 90 mgd.

Dissolved Oxygen Control

The activated sludge process depends on having sufficient oxygen for the biological degradation (oxidation of organic material to CO_2 and H_2O) of the organic material in the wastewater (Food, F in the F/M ratio) and for the maintenance (cell synthesis and endogenous respiration) of the biological population (Microorganisms, M in the F/M ratio). The aeration system has been designed to provide oxygen for peak oxygen demand periods. However, the system oxygen demand is typically much less than peak during typical diurnal flow periods.

There are two DO probes in each basin. The first is located near the beginning of the aeration basin and the second is located near the end.

The DO meters in each basin are mounted on the walkway railing. The probes are mounted adjacent to the meters and are held at a constant depth by a system that is integral with the probe and clamped to the railing. It is also important to periodically measure DO at various points throughout the basins with a portable DO meter to ensure that the fixed DO probes are accurately reporting the actual conditions of the basins.

The aeration basins are served by six 1,500 horsepower, single stage centrifugal blowers. Air from the blowers discharges through two separate air mains that run through the Pipe Gallery. There are two interconnections between the air headers that normally remain open to balance the air flow and pressure in the system.

In addition to the blowers, the DO control system relies on butterfly-type air flow control valves that are adjusted by the operator to control air to the associated basin and manually operated valves adjusted to control flow to the associated diffuser grid.

The DO probes located in each of the basins continuously measure the dissolved oxygen level in the basin and send their signal back to the plant computer system. When the DO falls below the setpoint, this is an indication that the DO demand has increased due to an increase in the BOD loading.

The plant is a carbon oxidation system. Carbon oxidation (BOD removal) is accomplished by heterotrophic bacteria, which derive their energy from the oxidation of organic carbon compounds (BOD).

A noticeable difference between flows from day to night operation and weekend versus weekday operation can be expected. As flows and loadings increase, the system oxygen demand usually increases. Any changes in flows and loadings are compensated for through the DO control system.

Food-to-Microorganism Ratio (F/M Ratio)

This is a very important variable to track and evaluate the process control plan. The food to microorganism ratio should be relatively stable, if the loading into the facility is not subject to large variations and a good level of microbial activity has been established. Since the operator has little or no control over the loadings coming into the facility, F/M Ratio is not a practical process control method. The results of the BOD analyses take six days to get, the one day of sampling plus the five days for the incubation and analysis. By the time the operator knows what the loading "was," the loading has passed through the facility.

The MLSS is comprised of both organic (volatile) solids and inorganic (non-volatile) solids. Those solids measured as volatile are representative of the microorganisms available to consume food (BOD). A more accurate measurement of the population of microorganisms and organic solids of the aeration basins is made by the Mixed Liquor Volatile Suspended Solids (MLVSS) test, excluding the inert or inorganic solids measured in the MLSS test. For determining F/M, it is more desirable to use the portion of "active" solids in the aeration tank in the calculation. However, many operators use the MLSS concentration for their wasting program and check to make sure that the percent volatile remains stable.

The determination of the F/M Ratio can be determined as follows:

Where:

- VABV = Aeration Basin volume, MG
- QINF = Average Influent Wastewater flow, MGD
- BODPRI = Primary Effluent Wastewater BOD, mg/l
- MLSS = Mixed Liquor Suspended Solids, mg/l
- F/M = Food-to-Microorganism Ratio,
  - F = Food, in lbs of BOD
  - M = Microorganisms, in lbs of MLVSS

To calculate the amount of food (F) available for consumption by the microorganisms, the total amount of BOD (in pounds) must be calculated as follows:

- F (lbs BOD) = QINF, MGD x BODPRI, mg/l x 8.34 lbs/gal

To calculate the total amount of active microorganisms (M) contained within the activated sludge system, the pounds of microorganisms (using MLSS) must be calculated as follows:

- M (lbs MLSS) = VABV, MG x MLSS, mg/l x 8.34 lbs/gal

With the total amount of food and microorganisms calculated in pounds, the F/M ratio is calculated using the formulas below:

- F/M ratio = QINF x BODPRI x 8.34
- VABV x MLSS x 8.34

Typical F/M ratios may range around 0.08 to 0.12.

The MLSS concentration can be maintained by making the appropriate wasting adjustments, supported by sufficient activated sludge return rates. The concentration of MLSS will be affected by the SRT chosen by the operator and the influent flow volume, BOD loading, temperature, and other environmental factors that affect the biological treatment system. If the flows and loadings are less than the design numbers, the biological system may not be able to support the design MLSS concentration. Conversely, if the flows and loadings are higher than the design values, the MLSS concentration could be greater than the design number. Using SRT as the process control methodology and optimization of the process, the operator may find that the effluent quality is better at a slightly different F/M Ratio.

The successful use of F/M Ratio as a control variable (for wasting calculations) would require a large amount of laboratory time to determine both the amount of food added to, and the mass of organisms in, the system. It should be noted that process calculations made based on the five-day Biochemical Oxygen Demand (BOD_5) test may not be representative of actual present plant loadings due to the lag time associated with the test. This makes the F/M determination too slow for adequate process control purposes. The use of the COD (Chemical Oxygen Demand) analysis to replace the BOD test is possible. However, the ratio of COD to BOD frequently has a wide range of values and does not include the nitrogenous oxygen demand present in the raw influent wastewater. F/M ratio, as a control variable, works only in plants that have an influent flow that does not vary greatly in loadings. As the organic loading (F) increases and decreases the mass of microorganisms (M) will also tend to increase or decrease proportionately if the operator does not either over-waste or under-waste.

Nevertheless, F/M is a valuable tool in assessing the ability of the activated sludge system to meet the requirements of BOD removal. A historic database, including F/M Ratios, MLSS and MLVSS concentrations, BOD/TSS/Ammonia concentrations and SRT, should be maintained to help in diagnosing operational problems.

Solids Retention Time (SRT)

Solids Retention Time (SRT) is the amount of time in days biological solids are retained in the activated sludge system. Many times, SRT is used interchangeably with MCRT, or Mean Cell Residence Time. Some facilities include the inventory that is maintained in the aeration tanks and the final clarifiers (sludge blankets) in the calculation for MCRT. The SRT calculation should take into consideration only the inventory in the aeration basins. This calculation is often referred to as aerobic SRT. Shorter SRTs not only preclude maximum nitrification in facilities requiring nitrogen reduction, but also result in a loss of the nitrifiers from the final clarifiers because the underdeveloped nitrifying sludge does not flocculate very well and final clarification captures only a small percentage of the nitrifying bacteria. The Maxson WWTF was designed to operate at an SRT of approximately 1.0 to 1.5 days. Through the year the SRT can range from 0.8 to 2.0 days depending on the wastewater temperatures and is adjusted to optimize treatment.

A minimum SRT is required to ensure that organisms in the activated sludge are not washed out of the system or wasted from the system faster than they can reproduce. An SRT that is too long results in a buildup of inert materials and dead organisms, which are of no benefit to the system.

Since the amount of food (BOD) in the wastewater cannot be controlled and approximately 0.80 pounds of new microorganisms are produced for every 1.0 pound of food and nutrient loading biodegraded. The population (inventory) of microorganisms will tend to increase or decrease as the loading changes as well as, changes in temperature, pH, or any other factors that affect the growth rate. The operator must make process changes that will support the inventory change. This is done by controlling the DO level in the aeration basins and the MLSS concentration in the treatment system.

Return Sludge Control

Selection of a RAS rate that will sustain a desirable MLSS level in the aeration basins is important to the overall operation of the activated sludge system. If the RAS rate is too low, the following undesirable conditions may develop:

- The population of microorganisms in the aeration basins will be insufficient to effectively treat the influent loading during periods of increasing flow, causing deterioration in the effluent quality.
- The longer the detention times in the secondary clarifiers, the greater the potential for anaerobic activity in the sludge, leading to gasification and rising sludge problems.
- Accumulation of sludge in the secondary clarifier will create a deep sludge blanket, which may allow solids to escape over the clarifier weirs into the effluent and increasing effluent solids. Blankets should be kept at a minimum, ideally 1 to 3 feet.
- Too high a return sludge rate must also be avoided because higher return rates allow less time for sludge consolidation in the secondary clarifiers. The recycling of a poorly consolidated (thin) sludge makes it difficult to maintain the desired MLSS concentration in the aeration basins.

Waste Sludge Control

To achieve a balance between the amount of food (BOD) in the wastewater and the amounts and types of microorganisms available to consume the food, a portion of these active organisms must be removed regularly. The amount removed is directly proportional to the number of solids that are growing because of normal reproduction, minus the loss due to natural decay and loss through the secondary clarifier effluent. Natural decay is more commonly known as Endogenous Respiration, which is the use of cellular material as a food source to maintain energy to sustain life. Without adequate solids removal from the treatment process, effluent quality will deteriorate, microorganism growth rate will be slowed, and mixed liquor settleability will be affected to the degree of impacting final clarifier operation. Sludge wasting procedures, more than any other activity, affects the process control of the facility. A poor, inconsistent wasting program will adversely affect the following:

- the growth rate of the activated sludge inventory
- oxygen consumption
- MLSS settleability in the final clarifiers
- the incidence of foaming
- overall effluent quality

The goal of the wasting program should be to remove the quantity of activated sludge equal to the growth of the inventory daily. In other words, the operator should try to operate the activated sludge system in a steady-state condition. A steady-state condition is desirable but not perfectly attainable due to normal variations in flows and loads typically experienced at wastewater treatment plants.

Waste Control by SRT

The use of Solids Retention Time (SRT) is recommended as the operational control method. Normal SRTs vary from system to system, but a range of 1 to 3 days, based on the MLSS inventory in the aeration basins. The inventory contained in the aeration basins used to calculate the portion of the activated sludge inventory to be wasted. The SRT will be used to denote the aerobic SRT using the inventory contained in the aeration basins only and not the inventory contained in the final clarifiers.

To maintain a desired SRT, a fraction of the solids in the aerobic inventory are wasted daily. For example, if an SRT of 2 days is desired, then one half (1/2) of the aerobic inventory solids is wasted daily. Once the quantity of sludge to be wasted has been determined, the rate at which it is wasted must be determined. Refer to ***Section 5 Final Clarification and Pumping*** for more information on the operation and control of the wasting system. The WAS system discharges directly to the sludge lagoon system.

When using SRT as the process control parameter, the operator should avoid making changes too quickly. Ideally, changes should not be more than 10 percent, so the biomass has time to acclimatize.

Evaluating the change in SRT should consist of looking at BOD, TSS, and ammonia in the effluent as well as sludge settleability and DO demand. These parameters, and any others that the operator may find to be valuable, should be plotted on a graph to show a trend toward improving effluent quality or deteriorating effluent quality.

If a change shows improving effluent quality, the operator should consider adding additional time to the target SRT and graph the results. If the effluent quality continues to improve, the operator should continue to add time to the SRT until the effluent quality decreases. The operator should then return to the target SRT that produced the best effluent quality in terms of all the discharge parameters.

If raw influent BOD loading is found to fluctuate drastically on a day-to-day basis, the operator may want to consider using a 5- or 7-day moving average for the wasting calculations. This will eliminate the tendency to over or under waste and will contribute to keeping the biological system in a more steady-state condition.

Although the F/M ratio is used as the operational control method at some facilities, it is not recommended because of the amount of work needed to make it work reliably. When SRT is used as the process control methodology, and it is applied successfully so that the SRT is stable, the operator will find that the F/M ratio will also be stable.

When decisions are made to waste a given quantity of sludge based upon flow and laboratory data, it must be recognized that the activated sludge system dynamics may change shortly after a decision is made. This is where operator experience comes into play.

For instance, if the sludge settling characteristics begin deteriorating it may be found that the depth of the sludge blanket will begin increasing and return sludge solids concentrations will begin decreasing. Consequently, at a given hydraulic wasting rate, the total mass of solids wasted will be reduced. If the RAS rate is increased to compensate for the poorer settling rate, an even lower RAS concentration may result. These overlaying effects must be recognized by the operator and adjustments made, if necessary. In this case, if it is important that a certain mass of solids be wasted, the operator will have to increase the sludge wasting rate proportionally.

The activated sludge wasting process is a continuous operation. Based on the sludge wasting quantity calculated above, the operator can determine the waste activated sludge pumping rate. Wasting rates should be set to remove sludge at a lowest rate over the operation day.

General Considerations

The activated sludge process is complex, with many process variables and interrelationships. As indicated at the beginning of this section, the operator should become familiar with activated sludge theory and process control before making major changes to the operation of the facility. The inter-relationship between SRT, sludge wasting, return sludge flow, and sludge settling characteristics can be complex.

In review, the basic approach outlined in this section suggests that the operator pay close attention (1) to sludge wasting (to develop and maintain a good SRT and F/M ratio, as well as to maintain good settling characteristics, and (2) to dissolved oxygen levels in the aeration basins, as well as the final clarifiers. Sludge wasting should be based on an optimum SRT taking into consideration factors such as pH, alkalinity, and temperature. Dissolved oxygen in the aeration basins should be kept between 2 and 3 mg/L.

4.6.3 Equipment Control

Motorized valves control air flow to each basin. In addition to the motorized valves, manually operated valves are manipulated by the operator to balance flow to each basin grid to meet system demands. The following table identify the local controls associated with the aeration system air flow control valves. The blowers associated with the aeration basins are discussed in *Section 4.7 Aeration Blowers*.

Aeration Basin Air Flow Control Valve (typical)

Manually Operated Aeration Valve (typical per grid)

Table 4.6-2 provides the controls and monitoring located at each motorized air flow control valve.

Table 4.6-2 Main Control Panel – Air Flow Control Valves

Control Name/Location	Features	Function
Remote-Local	Selector switch	When switched to the Remote position, the valve modulates open and closed in response to operator command from SCADA. When in the Local position, the valve position is controlled manually by the operator.
Open-Close	Pushbuttons	When the Open button is pushed, the valve opens. When the Close button is pushed, the valve closes.

4.6.4 Operation

Normal Operation

Generally, the number of basins used should depend on the influent flow and the detention time desired. When ten or fewer basins are needed to provide the required detention time, the larger basins should be used.

The two outer sluice gates at the Flow Control Structure, SG-17 and SG-19, should be opened. The center sluice gate, SG-18, should be closed. Sluice gates at the effluent end of the basins should always be open.

Flow to each basin is varied by influent flow control valves V-181 through V-186 and V-141 through V-148 and measured by flow meters M-135 through M-140 and M-119 through M-126. The operator inputs values to the computer to maintain an equal flow split to all basins in service, and a selectable flow split between north and south basins and to individual basins. The computer compares actual flows measured by the flow meters to flows resulting from selected splitting and modulates control valves to balance the flows. Normally, the flow should be equally divided by volume among all basins in service.

When all basins are used, the total basin volume is 17,397,814 gallons. So, each larger basin should receive 7.35 percent of the flow, and each smaller basin should receive 6.62 percent of the flow as should by the formulas below.

1. 1,279,251 ÷ 17,397,814 x 100 = 7.35 percent
2. 1,151,251 ÷ 17,397,814 x 100 = 6.62 percent

When only the larger basins are in service, the flow to each basin should be 10 percent.

Air flow to each of the aeration basins is independently and automatically controlled as a function of the basin influent flow. As an alternate, air flow may also be controlled by the DO sensed by DO probes in each basin. In this configuration, the air flow control valves modulate to maintain an operator-entered DO setpoint.

Alternate Operation

Alternate operations indicate that one or more components of the aeration basin system will be out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control.

Shutdown Considerations

1. Confirm that there are sufficient aeration basins online to manage the flow from the trickling filters.
2. At the MCP, place control switches for the aeration blowers being taken out of service in the “Off” position.
3. At the LCP for the aeration blowers being taken out of service, place the Hand/Off/Auto selector switch in the “Off” position.
4. If the basin requires draining, manually open the mud valves located on the upper deck of the basin to drain through the drain sumps. The basins drain to the plant influent ahead of the bar screens.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect aeration blowers for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the blower only when it is in good working condition.
3. Ensure that only authorized personnel are allowed in the in the aeration basin area and no one might be injured when equipment is activated.
4. Ensure all motor bearing and gear reducers have been properly lubricated using the manufacturers recommended lubricants.
5. Confirm all maintenance and/or repairs have been completed.
6. Remove any existing lockout devices and follow lockout/tagout procedures for the single-stage blowers.
7. Verify that the local disconnect at the MCP for each blower to be started is in the “Off” position.
8. Verify that the Local/Off/Auto switch at each LCP is in the “Off” position.
9. Check on the readiness of all upstream and downstream equipment such as the trickling filters, intermediate pumps, flow control structure, level controls, etc.
10. Confirm all safety devices are functioning properly.
11. Place the local disconnect and control power switch at the MCP in the “Off” position.

Startup

1. Slowly open the inlet gate to the basin(s) being placed into service to begin introducing flow to the basin.
2. When the diffusers have been submerged, begin introducing air through the diffusers.
3. Once the basin is full, open the inlet gate completely.
4. Adjust air flow as needed to maintain the target DO at the end of the basin.

Routine Checklist

The aeration basin system should be inspected for the following items when in operation:

1. Check the blowers for unusual noise, vibration, misalignment, and/or excess heat.
2. Inspect all switches (blowers, air flow control valves, gates, etc.) for proper positioning.
3. Document any equipment malfunction and the corrective action implemented.
4. Check to see that all safety guards are in place and personnel are clear of the equipment.
5. Check for even air distribution along the surface of the in-service aeration basins.
6. Check DO with a portable analyzer and compare results with the online analyzers.
7. Check MLSS concentration in the basins to ensure it remains within target limits.
8. Check flow through each basin to ensure even flow distribution among the basins that are in service.

Troubleshooting

The following identifies problems that may be encountered during the operation of the activated sludge system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the probable causes and recommendations action.

Table 4.6-3 provides troubleshooting information for operational issues associated with the activated sludge system.

Table 4.6-3 Troubleshooting Guide – Activated Sludge System

Problem	Probable Cause	Recommended Action
Effluent BOD approaching or exceeding permit level	Analytical error.	Review recent system monitoring data. Monitor process performance and operation.
		Review BOD analyses, i.e., probe membrane, reagents. If BOD analyses are thought to be erroneous, confirm with other sample results before taking further action. Confirm any determinations regarding analytical results with laboratory performing test.
	Due to effluent solids.	Determine whether the increase is reflected in other parameters. If the increase is attributed to suspended solids. Similar increase in COD is possible confirmation of BOD value. Confirm correlation with other parameters.
	Inadequate DO.	Review accumulated data regarding aeration basin DO. If low DO has been present since the sample was obtained for BOD test, refer to the section in this table on low DO.
	Reduced performance caused by spill.	Investigate possibility of spill or other abnormal discharge to the WWTF. If DO was abnormally high on the day of the sample BOD test, a supervisor should be notified. If DO has remained high since the day of the sample, refer to the section in this table on low oxygen uptake.
	Low MLSS (low SRT).	Review past influent data including BOD, COD, flow, and pH. If no increase is found in any of the influent parameters, review the past basin MLSS data and sampling procedures. If MLSS level was low on day of BOD sample and has since increased to normal, wait for further indication of problem from BOD data before taking further action. If MLSS level is low and has remained low, refer to the section in this table on low MLSS.
	Excessive flow.	Check flow and SRT. If flow has increased while BOD concentration has remained normal, system retention time may be inadequate.
	Low oxygen uptake.	Review past oxygen data. Refer to section in this table on low oxygen uptake.

Table 4.6-3 Troubleshooting Guide – Activated Sludge System

Problem	Probable Cause	Recommended Action
Excessive foaming in aeration basin	Shocked microorganisms.	Review oxygen uptake data. If oxygen uptake is low, refer to the section in this table on low oxygen uptake.
	Filamentous organism *Nocardia*, manifested by a brown, stable foam.	Check color of foam and examine mixed liquor sample under microscope for filaments. Consider alteration of operation to minimize foaming. Adjust SRT downward by increasing wasting rate to wash out filaments out of the system, change mixing or aeration procedures.
Low DO	Insufficient air	Check DO profile through the aeration basin. Adjust DO setpoints as necessary.
	Instrument failure	Check function of DO meter. Schedule repairs and/or replacement.
	High temperature	Check aeration basin temperature and past monitoring data. Increase in basin temperature results in both increased oxygen utilization and decreased oxygen solubility. Take no further action. Caution: Extremely high temperatures in the basin (above 35° C or 100° F) can have harmful effects on biological activities. Carefully observe temperature during hot period.
	Foaming	Inspect aeration basin for excessive foaming. Verify facility is operating within the target SRT.
	Increased loading	Review past influent data, including BOD. Increased oxygen utilization results from either an increase in organic concentration or increase in flow at the same organic concentration. Take action to reduce organic loading or flow. Determine source of increased organic loading and take necessary measures to eliminate the source. Monitor situation.

Table 4.6-3 Troubleshooting Guide – Activated Sludge System

Problem	Probable Cause	Recommended Action
Low oxygen uptake	Bad sample	Obtain fresh sample and rerun analysis to confirm value. Rerun test.
	Old sludge	Check wasting rate. Increase wasting rate and verify target SRT (1.0 to 1.5 days).
	Cold temperature. Decreased basin temperature can result in decreased oxygen utilization.	Check for decrease aeration basin temperature. Monitor situation.
	Analytical error	Review oxygen uptake analysis probe membrane, sample techniques. Take corrective action and rerun analysis to confirm original value. If the analysis is found to be in error, take no further action.
	Influent toxicity	Review most recent data on influent wastewater parameters (e.g., metals) and/or obtain fresh sample for analysis. Eliminate source of toxins.
	Spill	Check plant and service area for spills and review operation of plant. Take action to reduce effect of spill on activated sludge system. Increase sludge wasting. If uptake improves, sludge was only shocked and could improve within 24 hours if toxic material is eliminated from influent. Run oxygen uptake every 4 hours during that period for confirmation.
Low MLSS in the aeration basin (low SRT)	Inadequate return sludge	Check return sludge flow. Determine new RAS flow.
	Over wasting of sludge	Check WAS flow. Determine new WAS flow.

Table 4.6-3 Troubleshooting Guide – Activated Sludge System

Problem	Probable Cause	Recommended Action
Decreased activated sludge settling rate (greater than 30 percent)	Changes in influent BOD concentration, influent flow, or MLSS concentration	Review plant organic loading data SRT, micro-exam for sudden changes. Maintain target SRT by adjusting sludge wasting.
	Filamentous organisms	Microscopically examine sample of sludge to determine presence of filamentous organisms (long, stringy, intertwined organisms). Make adjustments to wasting and DO, as required. Note: High organic loadings, insufficient nutrients, high SRT, and low DO can lead to filamentous conditions. Define the situation.
	Non-filamentous bulking solids, as evidenced by high clarifier effluent suspended solids	Examine under microscope; look for small disperse growth with low filamentous organisms. Determine sludge wasting needs and adjusted SRT. Decrease SRT by increased sludge wasting.

4.6.5 Maintenance

Process Maintenance

The general maintenance for the fine bubble diffuser equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the fine bubble diffuser consists of keeping the equipment areas clean, inspecting the equipment for proper operation, and ensuring free of leaks.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 4.6-4 provides the manufacturer's contact information for the aeration diffusers.

Table 4.6-4 Contact Information – Aeration Diffusers

Manufacturer	
Name:	Environmental Dynamic International (EDI)
Address:	5601 Paris Road Columbia, MO 65202
Phone:	573-507-5185

Table 4.6-5 presents a series of general maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the aeration diffusers. **Refer to the manufacturer for specific recommendations**.

Table 4.6-5 Maintenance Schedule – Aeration Diffusers

Frequency	Maintenance Task to be Performed
Daily	Perform visual inspections to proper air bubbles distribution across the diffuser grid.
Monthly	Monitor the airflow and pressure drop across the diffusers to ensure they are operating within the specified range
Quarterly	Inspect the diffuser membranes for signs of fouling or clogging
Annually	Perform a detailed performance evaluation to check for any significant changes in oxygen transfer efficiency.
All system components should be inspected for general wear or damage. This includes but not limited to: • Pipe supports including anchor bolts, pipe straps and fasteners. • Pipe connection including fasteners, shifts in alignment of pipes and joints. • Diffuser assembly components including all connections, anchor points and wear at any contact points. • Any worn or damaged components need to be repaired or replaced.	
Refer to manufacturer's guidelines and recommendations for: • In Situ Cleaning of Membrane • In Situ Acid Cleaning	

4.6.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

4.7 Aeration Blowers

4.7.1 Overview

The function of the aeration blowers is to provide oxygen for and mixing of the microorganisms in the aeration basins and in the RAS reaeration basins. The blowers modulate to meet the current air requirements of the aeration and RAS reaeration systems.

The major components of the aeration blowers include:

- 6 – Single-stage aeration basin blowers
- 3 – RAS reaeration basin blowers
- 9 – Local Control Panels
- 1 – Aeration Basin Master Control Panel
- 1 – RAS reaeration basin Master Control Panel

4.7.2 Description

Aeration Basins

There are six electric motor driven, single stage dual-vane geared high-speed centrifugal blowers used to supply air to the aeration basins. The blowers are rated for 26,000 standard cubic feet per minute (scfm) (net delivered flow rate) at 7.8 pounds per square inch gauge (psig), with 1250 horsepower motors.

See ***Figure 4.6-1 Aeration Basins No.1-14*** for schematic of the aeration basins and associated equipment.

Aeration Basin Root Blowers (typical)

The blowers and associated control panels are housed within the Blower Building. The blower system operates to maintain a header pressure in the air headers supplying the aeration basins and the RAS Reaeration Basins.

Each single stage centrifugal blower unit includes a skid-mounted compressor, gearbox, main drive motor, base frame, oil lubrication system, remote skid-mounted Local Control Panel (LCP), termination cabinets, and ancillary equipment. All the blower units are integrated into a Master Control Panel (MCP).

Table 4.7-1 provides the design criteria for the aeration basin single stage blowers.

Table 4.7-1 System Data – Aeration Basins Single Stage Blowers

Component	Value
Singe Stage Blowers	
Quantity:	6
Manufacturer:	Roots® Blower
Tag:	E-159, E-160, E-161, E-162, E-163, E-164
Type:	Centrifugal Compressor
Model	OIB
Inlet Volume, CFM	40,000
Inlet Pressure, PSIA	14.5
Discharge Pressure, PSIA	22.2
Speed, RPM	5140

Table 4.7-1 System Data – Aeration Basins Single Stage Blowers

Component	Value
Motors	
Manufacturer:	General Dynamics
Model	M2813
Frame:	688WZ Y
Horsepower:	1,500
RPM:	1,800
Phase:	3
Volts:	4160
Hertz:	60

RAS Reaeration Basin

There are three blowers to supply air to the RAS reaeration basins. Each blower is rated for 26,000 scfm.

The blowers and associated control panels are housed within the RAS Reaeration Blower Building. The blower system operates to maintain a target DO of 4 to 6 mg/L.

Reaeration Basin Blower and Control Panel (typical)

Each blower unit includes an electric and mechanical oil pump, inlet and discharge guide vanes, drive coupling, oil cooler, oil heater, and associated instruments and controls.

Table 4.7-2 provides the design criteria for the RAS reaeration blowers.

Table 4.7-2 System Data – RAS Reaeration Blowers

Component	Value
Singe Stage Blowers	
Quantity:	3
Manufacturer:	Lone Star Blower
Tag:	TBD
Type:	Geared Turbo Centrifugal
Model	GL20
Motors	
Manufacturer:	GE Industrial Motors
Model:	5KS583EAM122
Enclosure:	WPII
Frame:	5811S
Horsepower:	1,250
RPM:	3,580
Service Factor:	1.15
Phase:	3
Volts:	4,160
Hertz:	60

4.7.3 Equipment Control

The following provides a description of the controls associated with the aeration system for the aeration basins and the RAS reaeration basin. The blowers normally operate in Auto controlled by their associated Master Control Panel. The locations of the controls and indicators and functions for each blower system are listed in the tables below.

Aeration Blowers

Table 4.7-3 provides the controls and monitoring for each aeration blower.

Table 4.7-3 Aeration Blower Locations of Controls

Control or Indicator	Number of Units	At Equipment	At Blower Control Panel	At SCADA
Aeration Basin Blowers				
Remote-Local selector switch	6		X	
Start pushbutton	6		X	
Stop pushbutton	6		X	
Computer control				X
Green indicating light	6		X	
Red indicating light	6		X	
Blower discharge pressure gauge	6		X	
Vibration indicators	18		X	
Motor winding temperature indicators	18		X	
Blower bearing temperature indicator	6		X	
Blower discharge air temperature indicator	6		X	
Speed increaser bearing temperature indicators	24		X	
Motor bearing temperature indicators	12		X	
Motor cooling air, leaving air cooler temperature indicator	6		X	
Lubrication System				
Auxiliary oil pump **Hand-Off-Auto** selector switch	6		X	
Green indicating light	6		X	
Lube oil pressure gauge	6		X	
Lube oil cooler temperature indicators	12		X	
Discharge Valve				
Hand-Auto selector switch	6		X	
Open pushbutton	6		X	
Close pushbutton	6		X	
Green indicating light	6		X	
Red indicating light	6		X	
Bypass Valve				
Hand-Auto selector switch	6		X	
Open pushbutton	6		X	
Close pushbutton	6		X	
Green indicating light	6		X	
Red indicating light	6		X	

Table 4.7-3 Aeration Blower Locations of Controls

Control or Indicator	Number of Units	At Equipment	At Blower Control Panel	At SCADA
Inlet Vanes				
Hand-Auto selector switch	6		X	
Open pushbutton	6		X	
Close pushbutton	6		X	
Inlet vane position indicator	6		X	X
Other				
Green control panel indicating light	6		X	X
Acknowledge pushbutton	6		X	
Test pushbutton	6		X	
Reset pushbutton	6		X	

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

Table 4.7-4 provides the information of the aeration blower system controls function.

Table 4.7-4 Aeration Blower System Functions of Controls

Control or Indicator	Functions
Aeration Basin Blower	
Selector switch	**Remote** – Originally transferred blower control to the computer. Currently, is abandoned.
	Local – Blower control is at the Start and Stop pushbuttons.
Start pushbutton	When pressed while selector switch is in the **Local** position, the blower will start.
Stop pushbutton	When pressed while the blower is operating in the **Local** position, the blower will stop.
Computer control	Blower can be emergency stopped from the computer.
Green indicating light	**Blower On** – Illuminates when the blower is operating.
Red indicating light	**Blower Off** – Illuminates when the blower is not operating.
Gauge	**Blower Discharge Pressure** – Indicates blower discharge pressure is 0 to 15 psi. North and south discharge header pressures are indicated at the computer.
Vibration indicators	Indicators provided for blower, gear, and motor vibration.
Motor winding temperature indicators	Indicators provided for Phase A, Phase B, and Phase C. Indicate motor winding temperature from 0 to 250° F (0 to 121° C).
Blower bearing temperature indicators	Indicators provided for front radial bearing, rear radial bearing, and thrust bearing. Indicate temperature from 0 to 250° F (0 to 121° C). Alarm will sound if either radial bearing heats to 170° F (76.6° C) or if thrust bearing heats to 155° F (68.3° C). Blower will shut down if either radial bearing heats to 180° F (82.1° C) or if thrust bearing heats to 165° F (73.8° C).

Table 4.7-4 Aeration Blower System Functions of Controls

Control or Indicator	Functions
Temperature indicator	**Blower, Discharge Air** – Indicates temperature of air discharged from the blower from 0 to 250° F (0 to 121° C). Alarm will sound if temperature rises to 230° F (110° C) and blower will shut down if discharge air temperature rises to 250° F (121° C). North and south discharge header temperatures are indicated at the computer.
	Speed Increaser Bearing – Indicators provided for high speed, coupling end bearing; high speed, blind end bearing; low speed, coupling end bearing; and low speed, blind end bearing. Indicate temperature from 0 to 250° F (121° C). Alarm will sound if any bearing temperature rises to 170 ° F (76.6° C) and blower will shut down if bearing heats to 180° F (82.1° C).
	Motor Bearing – Indicators provided for front bearing and rear bearing. Indicate temperature from 0 to 250° F (0 to 121° C). Alarm will sound if either bearing heats to 170° F (76.7° C) and blower will shut down if either bearing heats to 180° F (82.1° C).
	Motor Cooling Air, Leaving Air Cooler – Indicates temperature of discharge air from motor cooling system from 0 to 250° F (0 to 121° C). Alarm will sound if air heats to 150° F (65.5° C).
Lubrication System	
Auxiliary Oil Pump selector switch	**Hand** – Pump operates continuously.
	Off – Pump does not operate.
	Auto – Pump starts when Start button is pressed and operates until oil pressure rises to 18 psi. When blower stops, pump will start when oil pressure drops to 14 psi and operates for a predetermined length of time. Any time the oil pressure drops to 14 psi, the auxiliary oil pump will start. If lube oil pressure drops to 10 psi, the blower will shut down and the alarm will sound.
Green indicating light	Illuminates when the auxiliary oil pump is operating.
Lube oil pressure gauge	Indicates pressure of lubrication oil from 0 to 15 psi.
Temperature indicators	**Lube Oil Cooler** – Indicators provided for lube oil entering oil cooler and lube oil leaving oil cooler. Indicate oil temperature from 0 to 250° F (0 to 121° C). Alarm will sound if lube oil leaving oil cooler heats to 130° F (54.4° C) or if lube oil entering oil cooler heats to 155° F (68.3° C). Blower will shut down if lube oil entering oil cooler heats to 165° F (73.8° C).
Discharge Valve	
Selector switch	**Hand** – Valve is positioned with **Open** and **Close** pushbuttons.
	Auto – Valve is positioned by operation of the blower. Valve opens when blower Start button is pressed. It closes when the blower motor is stopped.
Pushbutton	**Open** – Opens valve when pressed, provided **Hand-Auto** selector switch is in the **Hand** position. To completely open the valve, button must be held in until valve is completely open.
	Close – Closes valve when pressed, provided **Hand-Auto** selector switch is in the **Hand** position. To completely close the valve, button must be held in until valve is completely closed.
Green indicating light	Illuminates when valve is not completely closed.
Red indicating light	Illuminates when valve is not completed opened.

Table 4.7-4 Aeration Blower System Functions of Controls

Control or Indicator	Functions
Bypass Valve	
Selector switch	**Hand** – Valve is positioned with **Open** and **Close** pushbuttons.
	Auto – Valve is positioned by operation of the blower. Valve is open until 45 seconds after the blower starts. It remains closed until Stop button is pressed or blower is stopped under alarm conditions.
Pushbutton	**Open** – Opens valve when pressed, provided **Hand-Auto** selector switch is in the **Hand** position. To completely open the valve, button must be held in until valve is completely open.
	Close – Closes valve when pressed, provided **Hand-Auto** selector switch is in the **Hand** position. To completely close the valve, button must be held in until valve is completely closed.
Green indicating light	Illuminates when valve is not completely opened.
Red indicating light	Illuminates when valve is not completed closed.
Inlet Vanes	
Inlet valves selector switch	**Hand** – Vanes are positioned with Open and Close pushbuttons.
	Auto – Vanes are positioned by operation of the blower. Vanes are closed until blower is operating at full speed. Vanes are then adjusted by the computer to provide the required air flow. When the blower shuts down, the vane closes.
Pushbutton	**Open** – When pressed, the inlet vane opens.
	Close – When pressed, the inlet vane closes.
Inlet valve position indicator	Indicated vane position as percent open. Position is also indicated at the computer.
Other	
Green indicating light	**Control Power** – Illuminates when power is available to the control panel. Blower will shut down if power is not available to the control panel.
Pushbutton	**Acknowledge** – Silences horn and extinguishes flashing light or lights on the annunciator panel.
	Test – When pressed, illuminates all annunciator sections.
	Reset – When presses, extinguishes lights of annunciator sections when alarm condition has been cleared.

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

RAS Reaeration Blowers

The RAS reaeration blower system is designed to be controlled through the Blower Master Control Panel. The blowers alternate by runtime and operate to maintain the pressure on the discharge header to the RAS reaeration basins. The table below shows the blower controls available on the individual local control panels (LCP) and the Blower Master Control Panel (BMCP).

Table 4.7-5 provides the controls and monitoring located for each RAS reaeration blower.

Table 4.7-5 RAS Reaeration Blower Locations of Controls

Control or Indicator	Number of Units	At Blower Control Panel	At Blower Main Control Panel	At SCADA
Aeration Basin Blowers				
Disconnect Switch	3	X	X	
Blower Ready/LCP	3	X		
Blower in Remote/LCP	3	X		
Blower Running/LCP	3	X		
Alarm Horn/LCP	3	X		
Horn Silence/LCP	3	X		
Elapsed Time Meter	3	X		
Emergency Stop/LCP	3	X		
Trip/Surge Alarm/LCP	3	X		
Common Alarm/LCP	3	X		
HMI Screen/LCP	3	X		
Emergency Stop/BMCP	3		X	
Common Alarm/BMCP	3		X	
HMI Screen/BMCP	3		X	

Table 4.7-6 provides the information of the RAS reaeration blower system controls function.

Table 4.7-6 RAS Reaeration Basin Blower Functions of Controls

Control Name/Location	Features	Function
Blower Ready/LCP	Green Light	Illuminates when there are no active alarms, and the blower is available to operate.
Blower in Remote/LCP	White Light	Illuminates when the blower Local/Remote selection is in the Remote position.
Blower Running/LCP	Red Light	Illuminates when the blower is running.
Alarm Horn/LCP	Audible Alarm	Sounds when an alarm is activated.
Horn Silence/LCP	Pushbutton	Silences the alarm horn when activated by an alarm.
Elapsed time meter	Display	Displays accumulated hours of operations.
Emergency Stop/LCP	Push/Pull Button	When pushed, stops the blower if it is running. Requires being pulled back out to deactivate before restarting the blower.
Trip/Surge Alarm/LCP	Red Beacon	Illuminates when the blower has surged or has tripped.
Common Alarm/LCP	Amber Beacon	Illuminates when the blower has experienced a common alarm that requires investigation.
HMI Screen/LCP	Control Display	Provides operator access to control functions for the blower.
Emergency Stop/BMCP	Push/Pull Button	When pushed, stops the blowers if they are running. Requires being pulled back out to deactivate before restarting the blowers.

Table 4.7-6 RAS Reaeration Basin Blower Functions of Controls

Control Name/Location	Features	Function
Common Alarm/BMCP	Amber Light	Illuminates when the blower system has experienced a common alarm that requires investigation.
HMI Screen/BMCP	Control Display	Provides operator access to control functions for the blower system.

4.7.4 Operation

Normal Operation

The normal mode of operation for the aeration basin blower system is to have enough aeration basins in service to treat the influent flow and adequate air flow from the blowers to the in-service aeration basins to maintain aerobic treatment. Similarly, the normal mode of operation for the RAS reaeration blowers is to provide a sufficient rate of air to the in-service basins to maintain an adequate DO concentration.

Alternate Operation

Alternate operations indicate that one or more components of the aeration basin system will be out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control.

Shutdown Considerations

1. Confirm backup blowers are available to meet the air demands.
2. If shutting a blower down will result in insufficient air to meet air demands, consider taking a basin offline if plant flow allows without compromising treatment efficiency.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect aeration blowers for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the blower only when it is in good working condition.
3. Ensure that only authorized personnel are allowed in the in the aeration basin/RAS reaeration basin areas and no one might be injured when equipment is activated.
4. Ensure all motor bearing and gear reducers have been properly lubricated using the manufacturers recommended lubricants.
5. Confirm all maintenance and/or repairs have been completed.
6. Remove any existing lockout devices and follow lockout/tagout procedures for the single-stage blowers.

7. Verify that the local disconnect at the MCP for each blower to be started is in the "Off" position.

8. Verify that the Local/Off/Auto switch at each LCP is in the "Off" position.

9. Check on the readiness of all upstream and downstream equipment such as the trickling filters, intermediate pumps, flow control structure, level controls, etc.

10. Confirm all safety devices are functioning properly.

11. Place the local disconnect and control power switch at the MCP in the "Off" position.

Startup

1. At the MCP, place the main breaker for the blowers in the "On" position.

2. At the MCP, place the control power switch in the "On" position.

3. At the LCP for the blower, place the Hand/Off/Auto switch in the "Auto" position.

Routine Checklist

The aeration basin system should be inspected for the following items when in operation:

1. Check the blowers for unusual noise, vibration, misalignment, and/or excess heat.

2. Inspect all control panel switches for proper positioning.

3. Document any equipment malfunction and the corrective action implemented.

4. Check to see that all safety guards are in place and personnel are clear of the equipment.

Troubleshooting

The following identifies problems that may be encountered during the operation of the aeration basin and RAS reaeration basin blower systems. Refer to the manufacturers' O&M manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 4.7-7 provides troubleshooting information for operational issues associated with the aeration basin and RAS reaeration blowers.

Table 4.7-7 Troubleshooting Guide – Aeration Basin and RAS Reaeration Basin Blower Systems

Problem	Probable Cause	Recommended Action
General blower failure.	Blower mechanical failure.	Refer to blower manufacturer's O&M manual.
	Emergency Stop activated.	Clear alarm condition and investigate causes for alarm.
No airflow from blower; no blower failure indicated.	Blower discharge valve closed.	Check position of discharge valves and open correct valves.
	Blower discharge to atmosphere, valves oriented incorrectly.	Trace air piping from blowers to basin and ensure correct orientation of valves.
DO concentration in basins is lower than desired range.	Blower malfunction.	Refer to blower manufacturer's O&M manual.
	Basin air piping malfunction, e.g. leaks, incorrect valve positioning.	Trace air piping from blowers to basin confirming correct orientation of valves. Check discharge pressure to monitor for leaks.
	Online DO probe malfunction.	Check DO manually with hand-held probe to compare with online reading. Clean/calibrate DO analyzer if necessary.
	Insufficient air flow.	Increase air flow to basins.
Air filter(s) differential pressure(s) too high.	Air filter needs replaced.	Replace old filter with a new, clean filter and monitor pressure afterwards.

4.7.5 Maintenance

Process Maintenance

The general maintenance for the aeration blowers can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the aeration blowers consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information.

Table 4.7-8 provides the manufacturer's and service representative's contact information for the aeration blowers.

Table 4.7-8 Contact Information – Aeration Blowers

Manufacturer	
Name:	Roots® Blower
Address:	900 W. Mount Street Connersville, Indiana 47331
Phone:	765.827.9200
Website:	www.rootsblower.com
Service Representative	
Name:	Process System Inc.
Address:	918 Highway 51 South NE Brookhaven, MS
Phone:	601-757-6025
Website:	www.processsystems.us
Email:	ericyoung@processsystems.us

Table 4.7-9 presents a series of general maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the single-stage blowers. Refer to the manufacturer's manual for specific maintenance schedule and guidelines.

Table 4.7-9 Maintenance Schedule – Single-Stage Blowers

Frequency	Maintenance Task to be Performed
Daily	Check for any unusual noise or vibration, inspect for leaks, and verify that the blower is operating within the proper temperature and pressure limits.
Weekly	Inspect the drive belts (if applicable) for tension and wear.
Monthly	Check the lubrication levels and quality of oil; replace if necessary. Verify and clean air silencers.
Every 3 Months	Inspect and clean air filters; replace as needed.
Semi-Annually	Check all fasteners for proper torque and inspect the condition of the seals and gaskets.
Annually	Perform inspection to the entire blower, including the drive system and bearings. Replace parts as required.

Maintenance information for the Reaeration Blowers is included in ***Section 4.8 Return Activated Sludge (RAS) Reaeration Basin***.

4.7.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

4.8 Return Activated Sludge (RAS) Reaeration Basin

4.8.1 Overview

Settled sludge from the final clarifiers is pumped by the RAS pumping system to the RAS Reaeration Basin for oxygen boost by blowers through fine-bubble diffusers prior to being returned to the biological process in the aeration basins.

The major components of the RAS Reaeration Basin system include:

- 1 - 3.5 million gallons reaeration basin
- 1 – 24-inch RAS line from Final Clarifiers 1-N through 4-N and 1-S through 4-S
- 1 – 24-inch RAS line from Final Clarifiers 5-N and 5-S
- 16 – Air drop legs
- 12 – Fine bubble diffuser aeration grids
- 18,172 – Fine bubble diffusers
- 6 – DO probes
- 3 – RAS reaeration blowers (discussed in ***Section 4.7 Aeration Blowers***)

Figure 4.8-1 Process Flow Schematic RAS Reaeration Basin provides a schematic for the RAS reaeration basins and associated equipment.

Figure 4.8-2 Reaeration Blowers Flow Schematic provides the RAS Blowers Flow Schematic.

4.8.2 Description

The major components associated with the RAS Reaeration Basin are summarized below. In addition, the design criteria associated with the reaeration basin equipment is provided in tabular form.

RAS Reaeration Basins

The RAS Reaeration Basins consist of three single-pass rectangular trains. Each train measures approximately 44 feet wide and 258 feet long with a sidewater depth of 13.75 feet. Each basin has a volume of 1.167 million gallons and provide a total volume of 3.5 million gallons.

Reaeration Basin (typical)

Flow to the basins is from a common inlet channel. Equal flow splitting is provided from the inlet channel to the basins by three 20-foot-long motor-actuated weir gates. Three 40-foot weirs are provided to allow flow from each basin and into a common effluent channel. A dropbox is provided on the southeast corner of the effluent channel with a 54-inch RAS pipe from the box to convey flow to the Flow Control Structure before the aeration basins.

Each train has two DO probes situated near the influent and effluent to measure the current DO concentration. The DO measurements are displayed locally and in the SCADA system.

24-Inch RAS Influent Lines

Two 24-inch RAS influent lines convey settled sludge from Final Clarifiers 1-N through 4-N and 1-S through 4-S to the RAS Reaeration Basin. A third 24-inch RAS influent line conveys settled sludge from Final Clarifiers 5-N and 5-S. The first two lines originate in the RAS/WAS Pump

Station associated with Final Clarifiers 1-N through 4-N and 1-S through 4-S and discharges into the reaeration basin inlet channel. A magnetic flow meter measures the flow pumped from the clarifiers to the reaeration basin. The third 24-inch RAS influent line receives flow from the Final Clarifiers 5-N and 5-S RAS Pump Station and discharges into the reaeration basin inlet channel. This line also has a magnetic flow meter that measures the flow pumped from the associated final clarifiers.

RAS Aeration System

The aeration system for the RAS Reaeration Basins consists of blowers and a series of drop legs with aeration grids containing 9-inch fine bubble diffusers. The blowers are discussed in ***Section 4.7 Aeration Blowers***. Air from the blowers in the RAS Reaeration Blower Building is supplied through two 48-inch ductile iron pipes that run from the blower building to the RAS Reaeration Basins. The air mains are each supplied with a manually-operated butterfly valve that may be used to isolate the air main. Manually operated valve to each grid can be positioned by the operator for DO control when necessary.

The main air header pipe diameter varies from 48- to 24-inches. Each basin pass contains four diffuser grids. Each diffuser grid receives air from a 10-inch welded boss connection that provides the drop leg for the diffuser grid. The east and west trains have four drop leg connections (two per grid). The eight drop leg connections for the center train were provided for flexibility in the event an air main is out of service. The other air main can provide air to two of the three trains. During normal operation, only four of the eight drop leg valves should be open to allow for air to the center train to ensure even air flow splitting to all three trains.

The drop legs are stainless steel and transition to PVC at the bottom of the basin. Each drop leg is provided with a manually operated butterfly valve for isolation and air flow adjustment. These butterfly valves were adjusted during plant startup and should be maintained at that position without requiring any adjustment with varying RAS flow rates that may be applied. The air flow split to each of the four diffuser grids can be expected to stay relatively similar and not require any air flow adjustment.

4.8.3 Equipment Control

Air flow to the basins is controlled by the operator manually either locally at the valve or remotely from an operator workstation. All I/O associated with the RAS Reaeration Basins are hardwired to DCU-2 located in the electrical IPA building located south of the RAS Reaeration Basin structure. The IPA building also provides power for all electrical items at the RAS Reaeration Basins.

4.8.4 Operation

Normal Operation

Normal operation of the RAS Reaeration Basin is in the automatic mode with the blowers operating to maintain a header pressure setpoint. The operator can adjust the header setpoint and adjust the position of valves to the basin grids to maintain a target DO within the basins.

Alternate Operation

Alternate operations indicate that one or more components of the RAS Reaeration Basin system will be out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, remote and manual control. For instance, all pieces of equipment associated with the single stage blower system can be operated locally at the LCP or through the Blower Master Control Panel.

Shutdown Considerations

1. Confirm that there are sufficient RAS reaeration basins online to manage the flow to the RAS reaeration system.

2. At the RAS Reaeration Basin inlet channel, raise the weir gate to the basin being taken offline to stop flow to that tank.

3. Close the butterfly valve supplying air to the basin being taken offline.

4. If the basin requires draining, transfer the contents of the basin with a pump. When as many solids as possible have been removed by the pump, manually open the mud valves located on the upper deck of the basin to drain through the drain sumps. The basins drain to the manhole located on the southeast corner of the RAS reaeration basin structure.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.

2. Inspect aeration blowers, fine bubble diffusers, and all related equipment for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the system only when it is in good working condition.

3. Ensure that only authorized personnel are allowed in the in the reaeration basin area and no one might be injured when equipment is activated.

4. Ensure all motor bearing and gear reducers have been properly lubricated using the manufacturers recommended lubricants.

5. Confirm all maintenance and/or repairs have been completed.

6. Remove any existing lockout devices and follow lockout/tagout procedures for the equipment being placed online.

7. Verify that the local disconnect at the MCP for each blower to be started is in the “Off” position.

8. Verify that the Local/Off/Auto switch at each LCP is in the “Off” position.

9. Check on the readiness of all upstream and downstream equipment such as the trickling filters, intermediate pumps, flow control structure, level controls, etc.

10. Confirm all safety devices are functioning properly.

11. Place the local disconnect and control power switch at the MCP in the “Off” position.

Startup

1. At the inlet channel weir gate, slightly lower the gate to slowly allow flow into the empty basin.

2. When the diffusers are submerged, open the butterfly valve on the air line enough to allow air through the drop legs.

3. Observe the air pattern through the diffusers to confirm air distribution.

4. Lower the weir gate completely to continue filling the basin.

5. Set the air supply butterfly valve to the normal position.

Routine Checklist

The reaeration basin system should be inspected for the following items when in operation:

1. Check the blowers for unusual noise, vibration, misalignment, and/or excess heat.

2. Inspect all control panel switches for proper positioning.

3. Document any equipment malfunction and the corrective action implemented.

4. Check to see that all safety guards are in place and personnel are clear of the equipment.

5. Check for sufficient DO concentration throughout the basin (1.5 to 2.5 mg/L).

6. Check for even air distribution throughout the basin.

Troubleshooting

The following identifies problems that may be encountered during the operation of the RAS reaeration basin system. Refer to the manufacturer's O&M Manual for additional information on specific issues with equipment. Listed are operations problems followed by the possible causes and recommendations action.

Table 4.8-1 provides troubleshooting information for operational issues associated with the RAS reaeration basins.

Table 4.8-1 Troubleshooting Guide – RAS Reaeration Basin

Problem	Probable Cause	Recommended Action
Air boiling in one area of the basin surface.	Fine bubble diffuser has failed.	As a temporary measure, close the air valve to the affected dropleg. Basin will need to be taken out of service and drained to allow repair.
	Break in air line.	
Low DO in basin.	Insufficient air flow.	Increase air flow to basin and monitor DO to confirm increase to target level.
High DO in basin.	Too much air flow.	Decrease air flow to basin and monitor DO to confirm decrease to target level.

4.8.5 Maintenance

Process Maintenance

The general maintenance for the RAS aeration blowers can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the RAS aeration blowers consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 4.8-2 provides the manufacturer's contact information for the RAS reaeration blowers.

Table 4.8-2 Contact Information – RAS Reaeration Blowers

Manufacturer	
Name:	Lone Star Blower
Address:	8883 West Monroe Road Houston, TX 77061
Phone:	832-532-3112
Fax:	832-532-3115
Website:	www.lonestarblower.com

Table 4.8-3 presents a series of maintenance inspection and lubrication guidelines and identifies the frequency of theses inspections and the nature of the tasks that need to be performed for the single-stage blowers. In addition to the weekly and monthly tasks shown below, consult the equipment manufacturer's O&M manual for details on oil testing, oil changes, etc.

Table 4.8-3 Maintenance Schedule – RAS Reaeration Blowers

Frequency	Maintenance Task to be Performed
Weekly	Check for any abnormal sounds from the compressor. Check oil level in reservoir. Check that oil pressure and temperature are normal. Review/log all pressures and temperatures displayed on the HMI. Check air filter condition (differential pressure sensor or manometer gauge).
Monthly	Inspect filter/silencer for cleanliness and general condition. Confirm that check valve operates properly. Inspect general condition of the guide vane actuators. Inspect and tighten electrical connections. Check spacer coupling for fatigue cracks.

4.8.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

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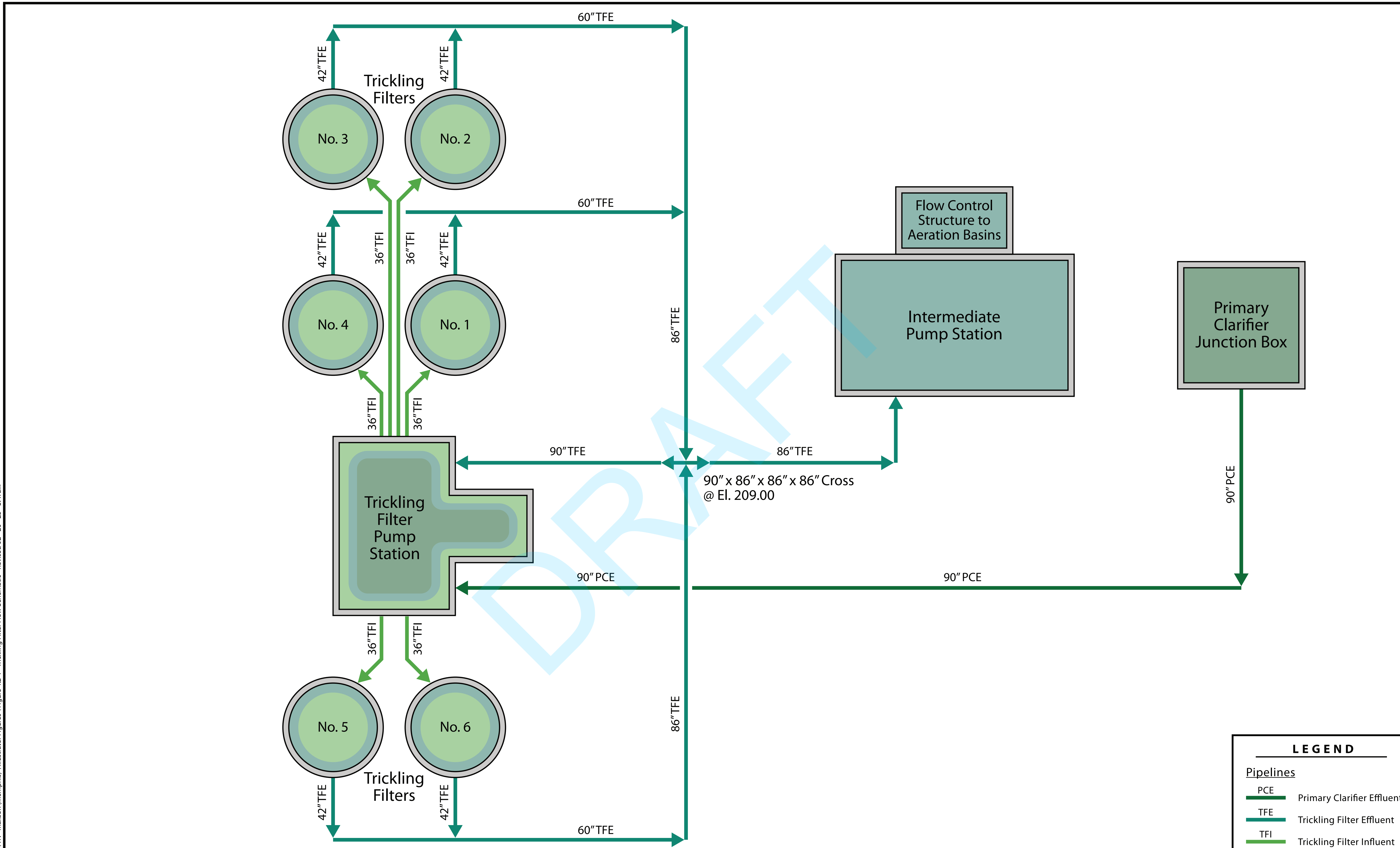
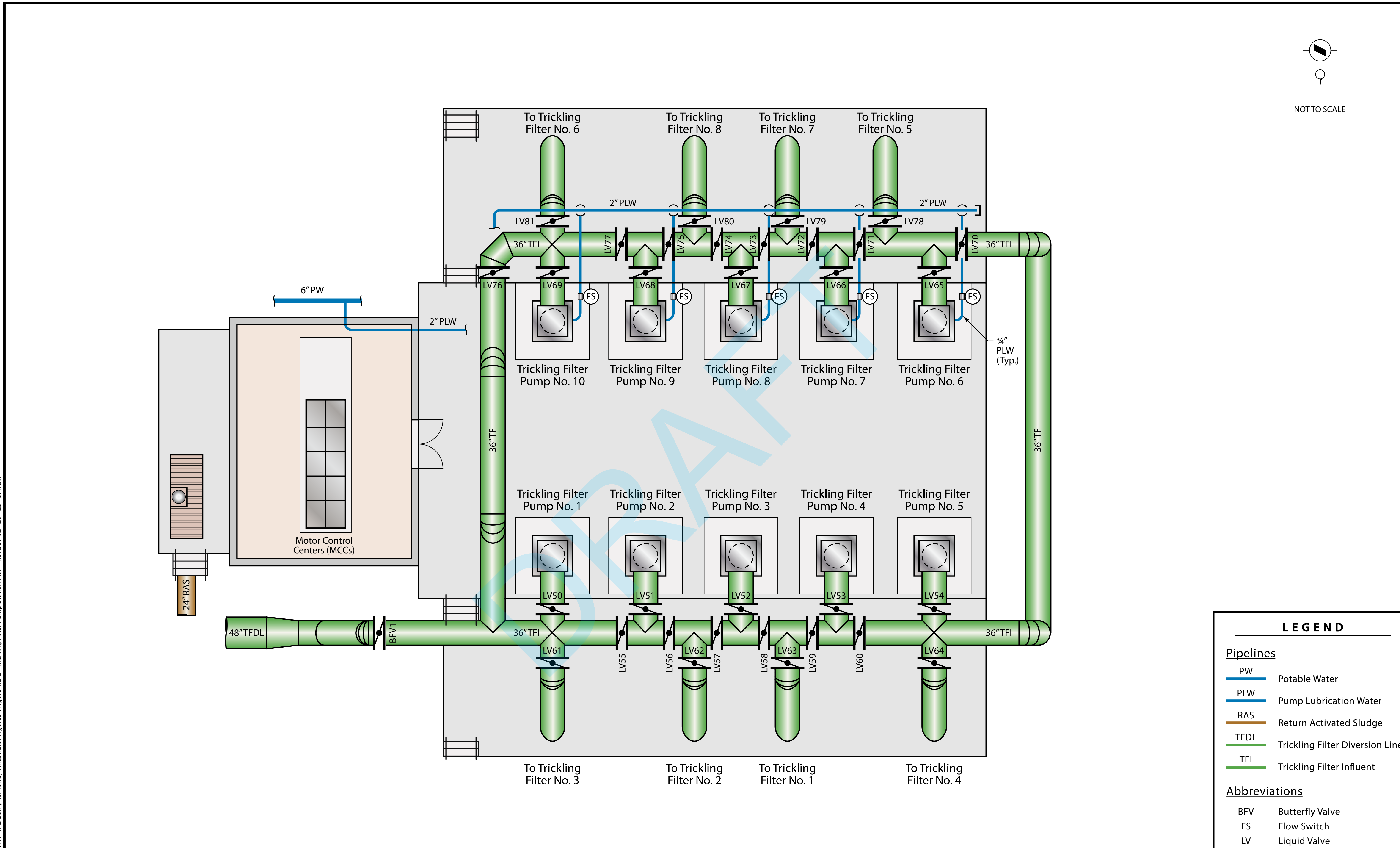


C:\TN - Maxson (Memphis)\ Illustrator Figures \ Figure 4.2-1 - Trickling Filter Flow Schematic - Revised 02 - 20 - 25 - S. Trulli

CDM Smith

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

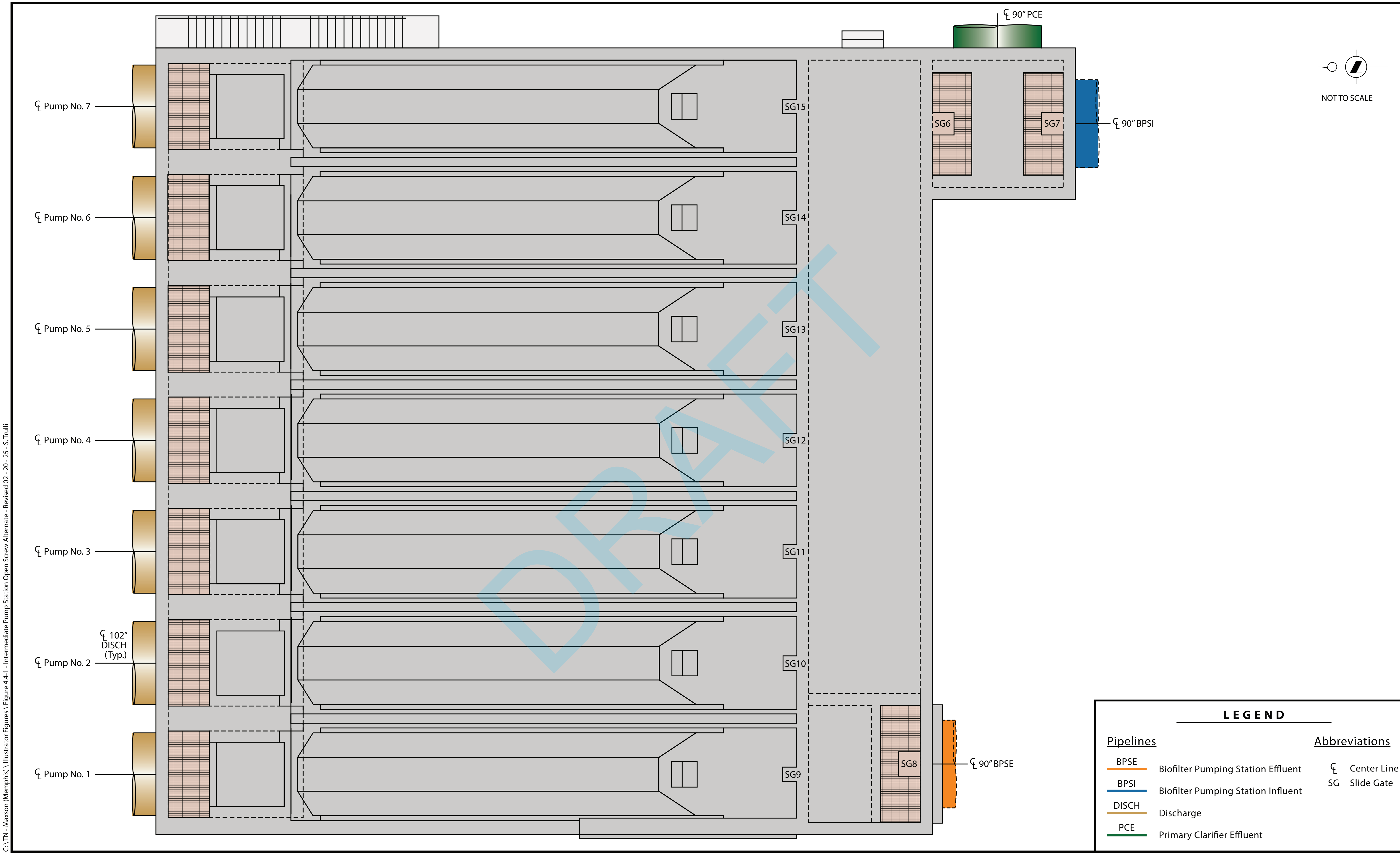
Figure 4.2-1
Trickling Filter Flow Schematic



CDM Smith

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 4.2-2
Trickling Filter Pump Station Plan



LEGEND

Pipelines

BPSE	Biofilter Pumping Station Effluent
BPSI	Biofilter Pumping Station Influent
DISCH	Discharge
PCE	Primary Clarifier Effluent

Abbreviations

℄	Center Line
SG	Slide Gate

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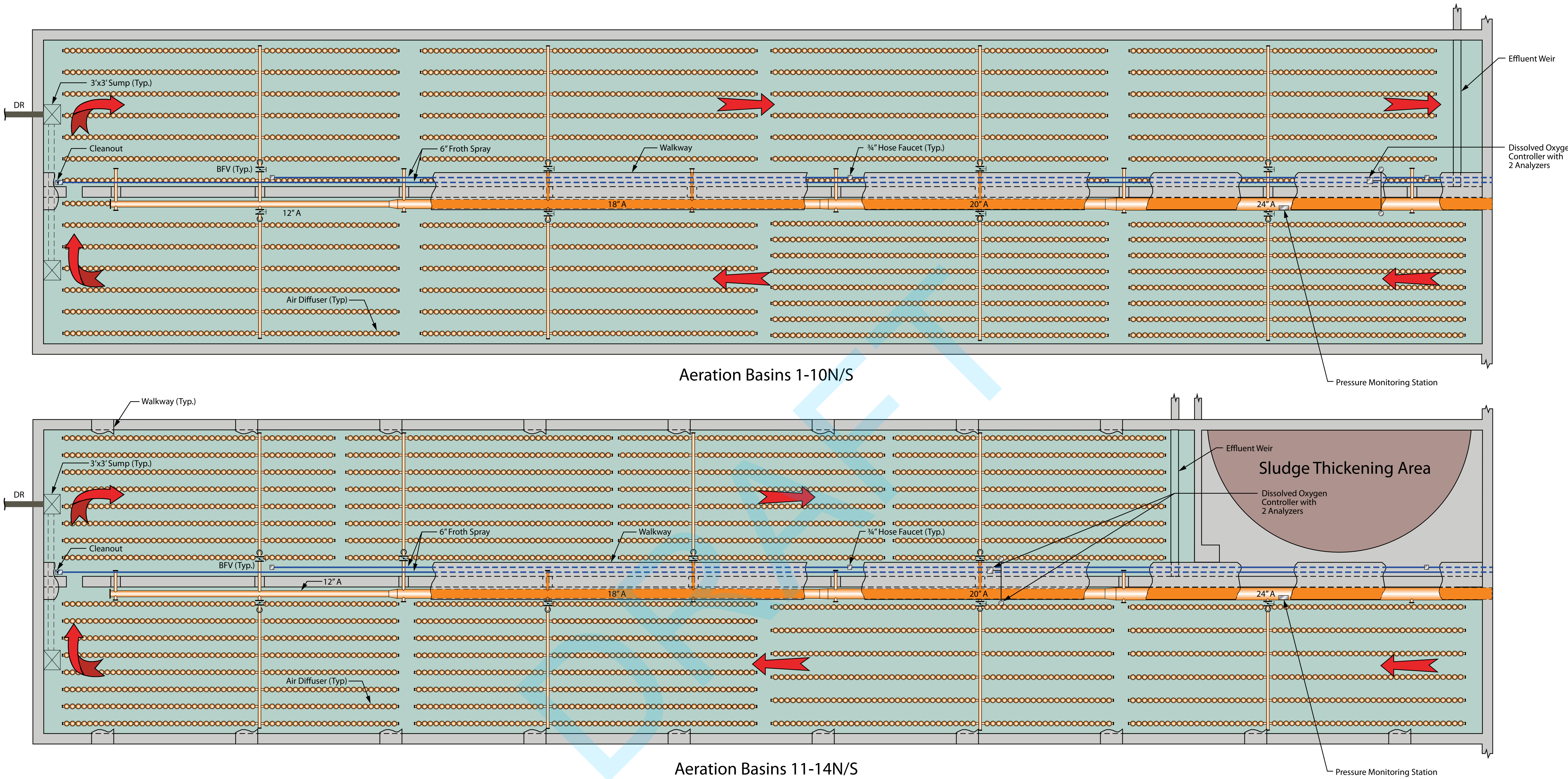
T.E. Maxson WWTF Process Upgrades

Figure 4.4-1
Intermediate Pump Station Open Screw Alternate Plan



LEGEND

Pipelines

A	Air
DR	Drain

Abbreviations

BFV	Butterfly Valve

C:\TN - Maxson (Memphis)\ Illustrator Figures \ Figure 4.6-1 - Aeration Basins No. 1-14 Plan - Revised 03 - 19 - 25 - A. Parker

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Figure 4.6-1
Aeration Basins No. 1-14 Plan

Section 5

Final Clarification and Pumping

5.1 Overview

The purpose of the final clarification system is to allow for separation of the liquid and solid portions of the mixed liquor suspended solids (MLSS) received from the aeration basins. Since the MLSS has a higher specific gravity than water, the quiescent conditions in the secondary clarifiers allow the suspended solids to settle to the bottom of the clarifier by gravity. The clear liquid that is left is called supernatant and/or secondary clarifier effluent which passes over the V-notch weirs and into the clarifier launder to a 54-inch line to the associated Effluent Junction Box, then to the Disinfection Contact Tank for disinfection and use in the non-potable water system or Gravity Outfall. During conditions where the effluent is not able to flow by gravity to the Mississippi River (high river level), the Effluent Discharge Pump Station pumps the effluent to the river.

Scum that floats on the top of the clarifier is removed by a skimming system that rotates with the suction header in a clockwise direction. The skimmer captures the floating scum and directs it to a scum box. When the skimmer passes over the scum box it activates a scum flushing valve that allows the scum to travel to the scum pump system. The scum pump system is described in ***Section 5.4 Scum Collection and Handling***.

The suspended solids that are separated from the liquid in the final clarifier and settle to the clarifier bottom are referred to as activated sludge. The solids are collected from the bottom of the clarifier by the sludge well located in the center of the tank. Most of the activated sludge is returned to the wastewater process as return activated sludge (RAS) to the aeration basins. A portion of the activated sludge is removed from the treatment process (wasted) and sent to the biosolids handling system as waste activated sludge (WAS) to maintain a consistent level of solids in the activated sludge treatment process. The RAS/WAS pumping system is described in ***Section 5.3 RAS and WAS Pumping***.

Maxson WWTF Secondary Clarifiers

5.2 Final Clarifiers

5.2.1 Overview

There are ten final clarifiers: 1 through 4 North (1-N through 4-N), 1 through 4 South (1-S through 4-S), 5 North (5-N), and 5 South (5-S). Clarifiers 1-N through 4-N are labeled counterclockwise with Clarifier 1-N located on the northeast side of the Return Sludge Pump Station and Clarifier 4-N located on the northwest side of the pump station. Clarifier 5-N is located west of Clarifier 4-N. Clarifiers 1-S through 4-S are labeled clockwise with Clarifier 1-S located on the southeast side of the Return Sludge Pump station and Clarifier 4-S located on the southwest of the pump station. Clarifier 5-S is located west of Clarifier 4-S.

Since the MLSS has a higher specific gravity than the wastewater, the low velocity conditions in the final clarifiers allow the activated sludge to settle to the bottom of the tank and the supernatant passes over the v-notch weirs and into the clarifier launder to a 54-inch line to the associated Effluent Junction Box, then to the Disinfection Contact Tank for disinfection and use in the non-potable water system or Gravity Outfall. During conditions where the effluent is not able to flow by gravity to the Mississippi River (high river level), the Effluent Discharge Pump Station pumps the effluent to the river.

Clarifier Effluent Junction Box (Typical)

The effluent from the aeration basins flows through the aeration basin effluent channels and through inlet valves to the associated final clarifiers. Flow travels from a 48-inch MLSS line upward through the center column of each clarifier and exits through energy dissipation ports near the surface of the tank. The velocity of the flow is slowed by the circular feed well or baffle. From the circular feed well, the flow travels radially through the clarifier toward the circular scum baffle, passes under it, and over the v-notch weir, located along the outside edge, or periphery, of the clarifier.

A portion of the settled solids, called return activated sludge (RAS), is pumped to the RAS Reaeration Basin and then returned to the aeration basins. Returning activated sludge to the aeration basins provides sufficient microorganisms for continuous treatment of the pollutants in the wastewater already partially treated in the primary treatment processes. A spiral scraper located near the tank floor directs the settled sludge into a hopper located in the bottom of the clarifier. The sludge from the hopper then flows into the RAS wet well. The RAS pumps, located in the RAS Pump Station, draw RAS through an 18-inch diameter line from the RAS wet well.

For every pound of BOD entering the secondary treatment process, approximately 0.5 pounds of new microorganisms are produced. Since the quantity of activated sludge is always increasing through the continual reproduction of the microorganisms, excess sludge must be removed in the form of waste activated sludge (WAS). WAS is drawn from the RAS pipeline and conveyed by the pressure in the RAS line through the WAS flow control valve to the sludge lagoon system for eventual disposal off site in a landfill.

WAS control is a critical component of the successful operation of the biological process and is discussed in greater detail in ***Subsection 5.2.2 Process Control***.

Substances that are less dense than the MLSS in a clarifier tend to accumulate on the water surface. Scum on the surface of the circular feed well flows out of the feed well through eight scum outlets situated along the perimeter of the feed well. A skimmer arm guides the scum towards a beaching plate and into a scum trough. The scum then flows by gravity through a 6-inch diameter pipe and into the Scum Well. The scum from the well is routinely pumped to the 42-inch WAS/Scum Line to sludge processing by the associated scum pump.

5.2.2 Process Control

The Maxson WWTF utilizes WesTech and Kuster-Water clarifier systems. Details on the clarifier components can be found in the respective O&M manual. The clarifiers consist of the following components:

- Final Clarifier Distribution Box
- Clarifier Tank
- Collector Mechanism and Controls
- Center Influent Column
- Feed Well
- Center Cage
- Sludge Removal Assembly
- Scum Removal Mechanism
- Scum Skimmer Assembly
- Scum Box
- Scum Flushing Valve
- Scum Baffle and V-Notch Weir

Final Clarification Distribution

Flow from the aeration basins to the final clarifiers is from the Pipe Gallery located between the two batteries of aeration basins. Each clarifier receives flow through motor operated butterfly valves as shown in ***Table 5.2-1*** below.

Table 5.2-1 Final Clarifier Inlet Valves

Clarifier	Valve Tag
1-N	V-127
1-S	V-128
2-N	V-129
2-S	V-130
3-N	V-131
3-S	V-132
4-N	V-133
4-S	V-134
5-N	JSB-SG-5
5-S	JSB-SG-4

Clarifier Tank

The final clarifiers measure 135-feet diameter with a sidewater depth of 15-feet. All the clarifiers contain the clarifier collector mechanism and other components.

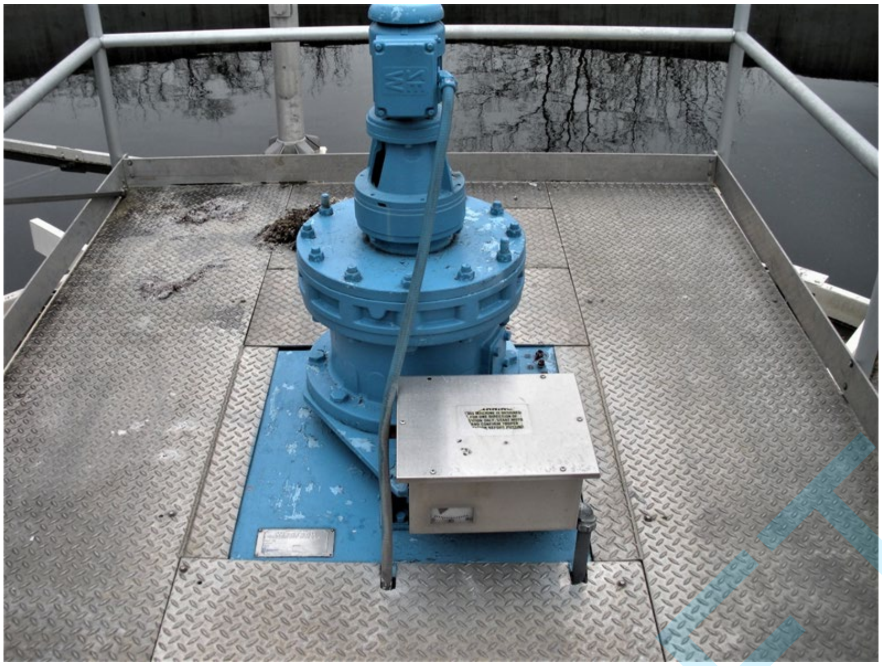
Collector Mechanism

Each collector mechanism is installed in the clarifier tank. Each mechanism performs the following functions:

1. Disperses the MLSS into the tank and controls short-circuiting.
2. Collects and removes settled solids from the secondary effluent.
3. Removes secondary effluent equally from the clarifier to prevent short-circuiting.
4. Collects, moves, and thickens settled sludge.
5. Prevents dilution of the sludge at sludge withdrawal points by continually pushing settled MLSS into the center hopper.
6. Collects floating scum from the clarifier surface and discharges the scum into the scum wet wells.

Each collector is a center-column feed type with peripheral weir overflow to an annular inboard discharge clarifier launder. The center column supports the entire mechanical drive and collector mechanism and the inboard end of the access walkway. This walkway extends from the outside wall of the tank to the drive mechanism in the center of the tank, thus allowing personnel access to the drive mechanism, as well as for the purpose of taking sludge blanket readings.

The photo below shows the drive mechanism of one of the clarification systems.



Typical Final Clarifier Drive Mechanism

Stationary Center Influent Column

Each secondary clarifier has a stationary cylindrical steel influent column that has a diameter of 48-inches. One end has a support flange bolted to the tank floor over the influent line. The other end has a similar flange at the top for supporting the drive unit and walkway. There are openings in the upper portion of the column to allow unrestricted passage of the flow into the energy dissipating inlet chamber.

Feed Well

A flocculating feed well is in the center of the tank to diffuse the liquid into the tank without disturbing solids separation or formation of velocity currents. Baffled openings near the water surface allow scum to exit the feed well.

Center Cage

The top of the cage is attached to the main drive gear to rotate the cage and attached arms and feed well.

Sludge Removal Assembly

The sludge collection equipment consists of a two-arm assembly, supported from the rotating turntable, which sweeps the entire bottom of the tank. The equipment moves activated sludge from the tank floor to the center of the tank where it enters a sump.

Scum Removal

Each clarifier has scum skimming devices as part of the clarifier's mechanism. These skimming mechanisms sweep the surface of each secondary clarifier, moving scum and floating material to a scum box at the periphery of the tank. The scum is then directed into the scum box and drains to the scum pump system.

Scum Skimmer Assembly

A hinged scum skimmer assembly is located on the outer end of each skimmer blade. Each assembly collects the scum and traps the scum against the beach plate of the scum box. A squeegee is mounted at the end of each skimmer assembly to wipe the scum into the scum box. The scum skimmer assembly includes brushes to keep the weirs and trough clean.

The photo below shows the scum skimmer assembly in one of the clarifiers.

Final Clarifier Scum Skimmer Assembly (Typical)

Scum Box

A scum box is located outside of each group of clarifiers that receives scum by gravity.

Scum Flushing Valve

A valve is built into each scum box that automatically opens and allows clarified liquid into the scum box aid in flushing out the sticky scum and settled solids. Every pass of a scum skimmer over a scum box actuates these valves, allowing sufficient delay after deposit of the solids before flushing begins.

Scum Baffle and V-Notch Weir

A scum baffle is provided in curved baffle sections fastened to the launder wall with adjustable fiberglass reinforced plastic (FRP) support brackets, stainless steel fasteners, and anchor bolts. This scum baffle helps to prevent short-circuiting in the secondary clarifier. A V-notched weir is installed just outside of the scum baffles. The weir is set hydraulically to provide even flow around the periphery of the clarifier without short-circuiting. The photo below shows the scum baffle, weir, and effluent launder in a final clarifier.

Typical Final Clarifier Scum Baffle, Effluent Weirs, and Launder

Liquid and Solids Flow Paths

Flow exits the aeration basins through a 48-inch effluent pipe. The MLSS that enters the final clarifiers are separated by gravity. The MLSS settles to the bottom of the clarifier forming a sludge blanket, and the clear liquid, referred to as clarifier supernatant or final clarifier effluent, travels over the clarifier weirs to downstream treatment systems for final treatment through a 48-inch clarifier effluent line.

The settled suspended solids are raked to the center sump of the clarifier and conveyed to the RAS/WAS pump station. Collected solids are conveyed through two 14-inch diameter RAS pipes that combine at the RAS/WAS pump station suction manifold. RAS is then pumped to the RAS Reaeration Basin or wasted to the sludge lagoon system for biosolids handling.

Operation and Control

Each final clarifier collector mechanism has a local On/Off selector switch. When in the On position, the clarifier drive runs continuously. When in the Off position, the drive will not run.

Each clarifier drive is provided with a torque switch. A high torque condition will energize an alarm at the local panel. A high-high torque condition will shut down the drive and energize an alarm at SCADA that the drive failed on High-High torque. In addition, the drive has a relief valve that will open to relieve hydraulic fluid back into the hydraulic tank.

Depth of Sludge Blanket

The depth of sludge blanket test primarily indicates to the operator the sludge settling characteristics, but also may indicate the need for sludge wasting. Low depth of sludge blankets in the final clarifiers results in reduced return sludge solids concentrations, and high depth of sludge blankets may result in anaerobic conditions and the potential for floating sludge. The final clarifiers have been designed for rapid removal of sludge to minimize the chances of anaerobic conditions occurring but cannot compensate for excessive sludge in the settling tanks due to inadequate sludge return and/or wasting procedures. Any DO in the mixed liquor exiting the aeration basins is consumed in the clarifiers within a short time – potentially as little as 10 to 15 minutes. After 30 minutes, gases such as methane (CH_4), carbon dioxide (CO_2), and nitrogen (N_2) start rising, which hinders settling. Therefore, sludge detention time in the final clarifiers should be kept to a minimum compatible with maintaining the desired MLSS in the secondary process.

The depth of the sludge blanket should be routinely measured using a "Sludge Judge" or another similar device. When using the sludge blanket level device, care should be taken to lower the device slowly into the clarifier. In some cases, a fine floc develops above the blanket. The depth of this material is not measured. Measurements should be made at least twice per shift, or more frequently during a process upset. It is a good idea to make sure that all operators take the blanket depth readings and interpret the results using the same procedure to make the data collected meaningful.

Sludge Settling Characteristics

The maintenance of sludge with good settling characteristics is one of the main keys to the successful operation of the activated sludge process. Some of the more frequent causes cited by plant operators of poor settling and compacting sludge are: (1) bulking sludge, (2) rising sludge, (3) foam forming sludge, and (4) poor bio-flocculation. Each condition is described below.

Bulking Sludge

Bulking sludges are those which have poor settling characteristics, poor compaction, and, under a microscope, show a heavy growth of filamentous organisms (either bacteria or fungi). The liquid that does separate from the solids usually produces a crystal-clear, high-quality effluent; but generally, there is not enough time for complete removal of the solids in the final clarifiers. The result is that the sludge blanket in the clarifier becomes deeper, rises to overflow the weirs, and is discharged with the effluent. The causes of bulking cited most often in the literature are: (1) changes in the character of the wastewater (organic, inorganic, and nutrient content, pH, temperature, and degree of freshness); and (2) faulty operation (low DO, inadequate sludge wasting, inadequate return sludge rate, and inadequate distribution of the wastewater feed).

Monitoring - Two methods are in common use to express the degree of bulking. One is the standard settling test, which is usually conducted with a sample of the aeration basin mixed liquor in a settleometer. If, after 30 minutes of settling, the volume of sludge is high (greater than 500 ml/L, and if microscopic evaluation shows a heavy growth of filamentous organisms, a bulking condition exists.

Another method of expressing the degree of sludge bulking involves not only the settled sludge volume, but also the weight of the sludge. Knowing these two items, the sludge volume index (SVI) can be calculated in milliliters per gram:

$$SVI = \text{Volume of SS (ml)} \times 1{,}000 \text{ mg/L of TSS}$$

In general, sludges with an SVI ranging from 50 to 100 have excellent settling characteristics, and as SVI increases, the settleability becomes poorer.

Remedies - Some of the process factors affecting settling characteristics, such as raw wastewater flow and loading, aeration basin and clarifier design, and temperature, cannot be controlled by the operator.

If filamentous organisms have been determined to be the source of the bulking, the operator must take a practical approach to the problem including:

- Identification of the filamentous organisms present
- Determination of the proper remedies available, both short and long term

Short term remedies involve treating the symptoms such as changing RAS rates, adding settling aids, and chlorinating the RAS.

Long term remedies involve treating the causes such as controlling MLSS pH, controlling influent septicity, adding nutrients, changing aeration rates, and changing F/M ratio.

Rising Sludge

Rising sludges normally have good settling properties, but after settling, they have a tendency to rise or float to the surface in a relatively short time, often in large clumps or mats. Only nitrifying sludges possess this characteristic, and the time required for the sludge to float itself is a function of the rate at which the sludge uses oxygen. In the settled sludge, dissolved oxygen is soon consumed (potentially, 10 to 15 minutes) and then oxygen is obtained by the bacteria from nitrites (NO_2) and nitrates (NO_3) in the liquid. Nitrogen gas, formed from this reaction, is trapped in the sludge mass. If enough gas is formed, the sludge mass becomes buoyant and rises to the surface. Rising sludge problems can be overcome by increasing the return sludge rate to retard the formation of nitrogen gas or by aerating the sludge to provide a higher level of residual DO, to prevent the reduction of nitrates during the sedimentation period. At the facility, the BOD levels are expected to be very low in the final clarifiers, which makes the probability of rising sludge from denitrification very unlikely unless the RAS rate is reduced below proper levels.

Foam-Forming Sludge

Foam-forming sludge usually has as SVI in the range of 100 ml/g to 150+ ml/g and produces a turbid supernatant upon settling. Its distinguishing characteristic is that it produces very stable foam on the aeration tank which cannot be broken up by a water spray. The mechanism that produces the foam-forming sludge is an overgrowth of actinomycetes in an activated sludge system with a long sludge age. The actinomycetes colonies are very minute, highly branched filaments. They are actually so small that it requires a microscope with greater magnification and greater resolution than those usually found in wastewater treatment plants to examine them. The actinomycetes produce a lipid metabolic by-product which causes the foaming, and then the minute colonies themselves become incorporated in the foam. The solution to the foam-forming sludge problem is not chemical treatment but reduction in the sludge detention time in the final clarifiers. This is accomplished by adjusting the RAS and WAS rates.

Poor Bio-flocculation

Too low or too high a BOD loading, toxicants in the wastewater, a lack of essential nutrients, or some unknown reason may cause mixed liquor solids to break up into very small particles which settle poorly. The clarifier effluent becomes turbid, resulting in high BOD and TSS levels in the final effluent. Poor bio-flocculation, like rising sludge conditions, should not exist at the facility unless a major failure of a unit process occurs.

Design Criteria and Nameplate Data

Table 5.2-2 provides the design specifications for the final clarifiers.

Table 5.2-2 System Data - Final Clarifiers

Component/Criteria	Value	
Final Clarifiers	***1-N through 4-N and 1-S through 4-S[1]***	***5-N and 5-S***
Number:	8	2
Manufacturer:	WesTech	Kusters Water
Model:	8050	HBPS-S/1
Diameter, feet:	135	135
Sidewater depth, feet:	17.5	15
Unit surface area, square feet:	14,300	14,314
Total surface area, square feet:	85,828	
Flow, mgd (average):	80	18
Flow, mgd (peak hour):	160	34
Surface overflow rate, gpd/square feet (average):	585	629
Surface overflow rate, gpd/square feet (peak hour):	1170	1188
Detention time, hours (annual average):	5.4	
Detention time, hours (peak hour):	2.7	
Motor manufacturer:	Baldor	TECO Westinghouse
Motor horsepower:	0.75	1.5
Volts/phase/hertz:	460/3/60	460/3/60

[1] Information taken from the *Revisions to Operations Manual Part 1* dated September 1997.

5.2.3 Equipment Control

The clarifiers use a local control panel to start and stop the clarifier drive system. The photo below shows a clarifier local control panel.

Clarifier Local Control Panel (typical)

Table 5.2-3 provides the location of controls associated with Clarifiers 1-N through 4-N and 1-S through 4-S.

Table 5.2-3 Final Clarifier Controls

Control or Indicator	Number of Units	At Equipment	MSB-2	At Equipment Control Panel
Sludge/Scum Collectors for Clarifiers 1-N through 4-N and 1-S through 4-S				
On-Off selector switch	8	X		
Alarm horn silence pushbutton	8	X		
Torque overload reset pushbutton	8	X		
Sludge Collecting Equipment for Clarifier 4				
Main disconnect On-Off switch	1	X		
Start pushbutton	1	X		
Stop pushbutton	1	X		
Alarm Test pushbutton	1	X		
Alarm Silence pushbutton	1	X		
Reset pushbutton	1	X		
Torque overload cutout switch	1	X		
Red alarm light	1	X		
Alarm horn	1	X		
Green On indicating light	1	X		
Red Off indicating light	1	X		
Computer monitoring of operating status	1			X

Table 5.2-4 provides descriptions of the functions of controls associated with the clarifiers.

Table 5.2-4 Final Clarifier Control Functions

Control or Indicator	Functions
Sludge/Scum Collectors for Clarifiers 1-N through 4-N and 1-S through 4-S	
Selector switch	On – Collector operates continuously.
	Off – Collector does not operate.
Alarm Horn Silence pushbutton	When collector drive torque reaches 100 percent of the rated torque, the horn sounds. The horn can be silenced by pushing this button.
Torque Overload Reset pushbutton	When collector drive torque reaches 125 percent of the rated torque, the unit will stop. After the overload cause is corrected, this button must be pushed before the unit will operate.

Table 5.2-4 Final Clarifier Control Functions

Control or Indicator	Functions
Sludge/Scum Collectors for Clarifiers 5-N and 5-S	
Power Disconnect Switch	Local disconnect for power to the drive.
Emergency Stop	Pull to reset the e-stop to allow operation of the drive. Push to stop the drive.
Red “Clarifier Running” Light	Illuminates when the clarifier drive is running.
Clarifier Off/On Selector Switch	When in the “Off” position, the drive will not run. When in the “On” position, the drive will run if there are no active interlocks.
Green “Clarifier Stopped” Light	Illuminates when the clarifier drive is not running.
Amber “Torque Shutdown” Light	Illuminates when a high torque condition is active.
Reset Pushbutton	When pressed, will allow operation of the clarifier drive if there are no active interlocks.

5.2.4 Operation

Expected Operating Parameters and Goals

The clarifiers are designed to separate the mixed liquor flow into settled solids (sludge), floatable solids (scum), and clarified effluent. The clarifier influent flow rate is equal to the raw influent flow, recycle flows, and the RAS flow rate combined. The flow enters the center stilling well of the clarifier, where the velocity is reduced to a point that liquid and solid separation can occur. The liquid flows out of the stilling well into the final clarifier and solids settle to the bottom of the clarifier.

The photo below shows the solids and liquids being separated in the stilling well in one of the clarifiers at Maxson WWTF.

Final Clarifier Stilling Well (typical)

The clarified liquid (supernatant) leaves the clarifier by traveling under a baffle plate, over v-notch weirs, then into the clarifier launder. The effluent travels around the launder and out through an effluent box located on the bottom of each secondary clarifier's respective effluent launder.

Scum is removed by the skimmer that pushes the floating scum over into the scum box with a squeegee arm located on the end of the skimmer arm. The scum flows down to the scum pump system by gravity where the scum is collected and pumped to the WAS line and to the sludge lagoon system.

The solids that settle to the bottom of the clarifier are removed at a rate that is controlled either locally or through the SCADA system. The settled solids being removed are pumped to the RAS Reaeration Basin, with a portion of the RAS flow being sent to sludge lagoon system as WAS.

Operating Process Control

The final clarifier process is affected by hydraulic loading rates that are a combination of the influent flow stream and the facility internal flows. The influent and facility internal flow rates can affect how well the clarification process works. These flow rates may also affect the level of the sludge blanket in the clarifier.

The sludge blanket should be measured regularly at the same time each shift and during the higher incoming flow rates. The recommended sludge blanket for each clarifier is between 1 to 3 feet. The sludge blanket depth can be controlled by adjusting the RAS flow rate. Controlling the RAS flow rate is described in ***Section 5.3 RAS and WAS Pumping***.

Process Variables

Final clarifier process variables include:

- Influent Flow Rate
- Return Activated Sludge (RAS) Flow Rate
- Concentration and condition of the MLSS

Process Related Calculations

The following calculations are related to the final clarifier process.

Circular Basin Volume = (0.785) (diameter, ft)^2(side water depth, ft) (7.48 gal/cu. Ft)

Theoretical Detention Time = $\dfrac{\text{(Basin Volume, gal) (24 hr./day)}}{\text{Flow, gal/day}}$

Surface Overflow Rate, GPD/sq. ft = $\dfrac{\text{Flow, Gallons/day}}{\text{Surface Area, sq. ft}}$

Mean Flow Velocity, ft/min = $\dfrac{\text{Flow, GPM}}{\text{(Width, ft) (Depth, ft) (7.48 gal/cu. Ft)}}$

$$\text{Weir Loading, GPM/ft} = \frac{\text{Flow, GPM}}{\text{Weir Length, ft}}$$

$$\text{Solids Loading, lbs./sq. ft} = \frac{\text{(MLSS concentration, mg/L) (flow, gpd) (8.34 gal/lb.)}}{\text{Surface Area, sq. ft}}$$

Process Dependencies

The clarification system requires that the MLSS flowing into the clarification process meets the design criteria of the facility. The system requires that the upstream and downstream systems are operational, and that the RAS system is functional.

Startup

The startup of the clarification system requires both the upstream and downstream process systems to be operational and ready to be placed into operation. Downstream processes must be prepared to be started in conjunction with the clarification system because the system is a flow-through design, meaning that once the influent flow stream enters the clarification system, the clarified effluent will gravity flow through the rest of the downstream process, except for pumped flows from the RAS/WAS system.

1. Verify the final clarification system is ready to be started with the facility's management and associated pertinent personnel.

2. Determine which final clarifier will be started.

3. Verify that all required maintenance has been completed on the system's equipment.

4. Visually inspect the facility for any abnormal conditions that would adversely affect the startup.

5. Fill the tanks with water or process flow from the aeration basins.

6. Activate the final clarification's mechanical drive system by energizing the equipment control panel and switching the equipment into automatic at the equipment control panel. Verify that the mechanical drive system is in operation and no alarms were activated.

7. Activate the scum control system by energizing the equipment control panel and switching the equipment into automatic at the control panel. Verify that the scum system is in operation and no alarms were activated.

8. Activate the RAS pumps by energizing the equipment control panel and switching the equipment to automatic at the control panel. Verify that the RAS pumps are in operation and no alarms were activated.

9. Activate the WAS system by energizing the equipment control panel and switching the equipment to automatic at the equipment control panel. Verify that the WAS system is in operation and no alarms were activated.

10. Open the valves that feed the clarifiers being placed into service.

11. The clarification system is now operational.

12. Notify pertinent personnel that the system is in operation.

Normal Operation

Normal operation of the final clarifiers consists of 10 tanks online. The final clarifiers are operated in the manual mode (local On/Off selector in the On position) from the local control and monitored from the plant computer.

Sludge is continuously withdrawn via the RAS pumps located in the associated RAS Pump Station. These pumps are equipped with VFDs and may be operated at a constant flow rate or flow paced based on a signal from the influent flowmeter.

Alternate Operation

Alternate operation consists of taking one of the clarifiers offline due to low flows, maintenance requirements, or equipment failure. The appropriate clarifier influent valve will be placed in the Closed position, diverting all the flow to the other clarifiers. The operator may need to reset the RAS rate to allow for the shorter hydraulic retention time in the clarifier.

During cold and wet weather conditions, extra precautions in operation must be taken to ensure that equipment is not damaged.

- Do not operate if ice forms on the skimmer assembly or the tank wall.
- Torque control weekly maintenance should be performed daily in extreme cold weather conditions. This is needed to ensure the mechanism does not freeze.
- Inspect daily for ice buildup on and around the drive/torque box and remove.
- The skimmer should be taken out-of-service during freezing conditions.

Shutdown

To take a clarifier out of service, the operator should follow these general guidelines:

1. Close the appropriate clarifier inlet valve. Check to be sure that flow to the remaining final clarifiers is balanced.

2. Remove as much sludge as possible by manually running the associated RAS pump. When the sludge blanket has been removed or the sludge concentration has become sufficiently thin, shut down the pump, close the isolation valve on the suction side of the pump and thoroughly flush the pump.

3. The remainder of the contents will have to be pumped by the tank drainage pumping system to the head of the plant.

4. The walls and floor of the tank should be washed down as the tank is emptied. Care should be taken to ensure that the scum box and its discharge line are thoroughly flushed and pumped dry.

5. The final clarifiers system is now shutdown.

Restart Considerations

To restart a final clarifier, the operator should follow these general guidelines:

1. Check to be sure that all maintenance tasks have been completed.

2. Inspect the entire unit, noting that all fasteners are tight, and inspection ports are closed. Check for and remove any tools, equipment, and supplies that remain from maintenance tasks.

3. Check drive for proper oil levels.

4. Run the sludge collector "dry" for several revolutions using the local On/Off selector switch in the On position.

5. Check for smooth rotation, uniform and correct clearances and correct velocity or tip speed.

6. During operation, the drive unit should be checked for excessive heat, proper oil levels, leakage of oil through the seals, and unusual noises and vibration. If any of these conditions exist, the final clarifier should not be placed back online.

7. Open the appropriate clarifier inlet valve.

8. When the final clarifier is approximately 75 percent full, the sludge collection mechanism should be started, using the local On/Off selector switch in the On position. Observe the operation for a few revolutions to check for smooth operation.

9. Monitor the sludge blanket until sufficient blanket has built up before starting the RAS pump for that final clarifier.

Process Troubleshooting

Table 5.2-5 provides a general process troubleshooting guide for the clarifiers. Refer to the original manufacturer's O&M manual for more specific troubleshooting and maintenance information.

Table 5.2-5 Final Clarification Process Troubleshooting

Problem	Probable Cause	Recommended Action
Overload alarm sound or drive operators at high torque for several days	Torque buildup on drive and mechanism	Reduce solids feed to clarifier and check for operating problem.
		Inspect for grit in sludge.
		Inspect skimmer for possible hang up.
		Inspect for foreign objects in tank. Stop drive if torque indicator is jumping.
Solids in effluent	Overloading of clarifier	Confirm desired flow rate and feed solids content. Reduce sludge blanket level.
	Inadequate flocculation	Inspect for evidence of finely dispersed solids.
	Flow through tank short-circuiting	Adjust weirs for even overflow or convergent leakage. Adjust baffles for convergent leakage.
	Sludge pump not operating	Monitor operation of pump. Refer to pump manufacturer's instructions.
	Manifold seals failed	Refer below to "Low solids content in sludge."
Low content in sludge	Inadequate sludge blanket in tank	Confirm proper flow rate.
	Inadequate flocculation	Inspect for finely dispersed solids in effluent.
	Manifold seals worn	Drain tank and replace seals, as required.
Excessive floating scum	Skimmer malfunction	Adjust skimmer for smooth operation and replace wipers. If needed, adjust hinged skimmer (deflector) to trap solids.
	Scum Box not discharging scum	Clean out Scum Box discharge pipe.
	Septic conditions on bottom of tank (pieces of floating sludge and objectionable odor)	Inspect for possible clogging in discharge line.
		Verify if squeegees need replacement.
		Review sludge removal schedule; may require more frequent intervals of removal.
Excessive growth on weirs	Accumulation of solids enhances algae production	Increase frequency of cleaning. Assess if adjustment of hinged skimmer is required. Also note condition of wipers.

5.2.5 Maintenance

Process Maintenance

The general maintenance required for the clarification systems is in the original equipment manufacturers O&M manuals. It is important to keep the weirs, overflow trough, and baffle plates as clean as possible.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

The original equipment manufacturers O&M manuals can be found in ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 5.2-6 provides the manufacturer's and service representative's contact information for the final clarifiers.

Table 5.2-6 Contact Information – Final Clarifiers

Secondary Clarification, Sludge Collection, and Scum Removal Equipment		
	1-N through 4-N and 1-S through 4-S	***5-N and 5-S***
Manufacturer		
Name:	WesTech	Kusters-Water/A Division of Zima Corporation
Address:	3665 S. West Temple Salt Lake City, UT 84115	101 Zima Park Drive Spartanburg, SC 29301
Phone:	801-265-1000	864-576– 0660
Fax:	801-265-1080	864-587-5761
Website:	***www.westech-inc.com***	***www.kusterswater.com***
Manufacturer's Representative - Driver and Skimmer		
Name:	Gulf States Engineering, Co., Inc.	ETEC
Address:	17961 Painters Row Covington, LA 70435	5865 Ridgeway Center Parkway, Suite 300 Memphis, TN 38120
Phone:	985-893-3631	901-820-4477
Fax:	985-893-9531	901-767-0704
Website:	www.gsengr.com	www.etc-sales.com

5.2.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the water reclamation facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

5.3 RAS and WAS Pumping

5.3.1 Overview

The return activated sludge (RAS) and waste activated sludge (WAS) systems are described in this section. The function of the RAS system is to return activated sludge back to the biological treatment process (aeration basins) and maintain a desired sludge blanket level in the final clarifiers. The suspended solids that settle to the bottom of the secondary clarifiers, referred to as "activated sludge," is removed from the clarifiers and pumped to the RAS Reaeration Basin process by centrifugal pumps. Blowers supply air through fine-bubble diffusers to boost the oxygen level in the RAS before it is returned to the aeration basins. The activated sludge returned by the RAS pumps provides a continual source of microorganisms to treat incoming raw wastewater.

The concentration of the activated sludge increases as the microorganisms in the system reproduce. The activated sludge will eventually increase the MLSS concentration in the biological treatment system above the design operating range resulting in a solids overload condition, and the quality of the effluent will be adversely impacted. Removing activated sludge from the treatment system is referred to as "wasting." The WAS system is used to keep the activated sludge process in balance by wasting excess solids to the sludge lagoons and the sludge dewatering system. The amount of sludge to be wasted to optimize the biological processes is discussed in ***Section 4 Biological Treatment***.

Clarifiers 1-N through 4-N and 1-S through 4-S are supported by a RAS / WAS pump station that is located in the Pipe Gallery. The system has six RAS pumps that are identified as E-151 through E-156. RAS pumps E-151, E-153, and E-155 remove sludge from the north clarifiers and E-152, E-154, and E-156 remove sludge from the south clarifiers.

Clarifiers 5-N and 5-S are connected to pumps RAS-4100, RAS-4200, and RAS-4300 with RAS-4100 and RAS-4200 being duty RAS pumps. RAS-4200 is a standby pump that can be valved to pull from either clarifier.

WAS from Clarifiers 1-N through 4-N and 1-S through 4-S is from the RAS system. A WAS line with a flow meter and flow control valve ties off from the RAS line and pressure from the RAS pumps drives WAS to the sludge lagoon system. All wasting is from these clarifiers as there are no provisions to waste from Clarifier 5-N and 5-S.

Figure 5.3-1 Clarifiers and RAS Pump Station Flow Schematic provides the final clarifiers 5N & 5S and RAS pump station flow schematics.

5.3.2 Process Control

Process Components

RAS Pumping System

The RAS pumps convey settled activated sludge to the RAS Reaeration Basin to maintain a desired mixed liquor concentration for the biological treatment process.

The process components for the RAS pumps consist of the following:

- RAS isolation and flow routing valves
- RAS pumps
- Check valves
- Inlet and discharge piping
- RAS magnetic flow meters
- Local control panels

A description of the RAS system's components is described below:

RAS Isolation and Flow Routing Valves

The RAS isolation valves allow the staff to isolate each RAS pump system for maintenance purposes. The flow routing valves allow the RAS pumps to send activated sludge to the RAS Reaeration Basin.

RAS Pumps

The RAS pumps allow the activated sludge to be withdrawn from the clarifiers and send it to the RAS Reaeration Basin.

Check Valve

The check valve allows liquid to flow in only one direction. The check valve control arm lifts when flow is passing through the valve and is used as a pump monitoring point to ensure that the pump is producing positive flow.

Inlet and Discharge Piping

The inlet piping is designed to transfer the RAS flow from the clarifiers to the pumps and the discharge piping starts the discharge end of the RAS pumps and is designed to transfer the RAS to its destination.

RAS Magnetic Flow Meter

The RAS magnetic flow meter monitors the combined RAS flow being sent to the RAS Reaeration Basin. The flow meter is monitored on the plant computer system. The photo below shows the RAS flow meters.

RAS Flow Meter (typical)

Local Control Panel/Instrumentation/Automation System

The local control panels allow the operations staff to control the speed of the pumps and RAS flow rates through SCADA.

Final Clarifier 1N and S – 4N and S RAS Pump Local Control Panel (typical)

Final Clarifier 5 N and S RAS Pump Local Control Panel (typical)

WAS Removal System

The wasting for the treatment system is accomplished using the 42-inch WAS line that pulls from the RAS system associated with Clarifiers 1N through 4N and 1S through 4S. A flow control valve is used to control the WAS removed from the system. The WAS line and flow control valve are located in the Pipe Gallery on the north side. A crossover line located below grade under grating is normally left open to allow wasting from the north and south clarifiers. There is no wasting associated with Clarifier 5N or 5S.

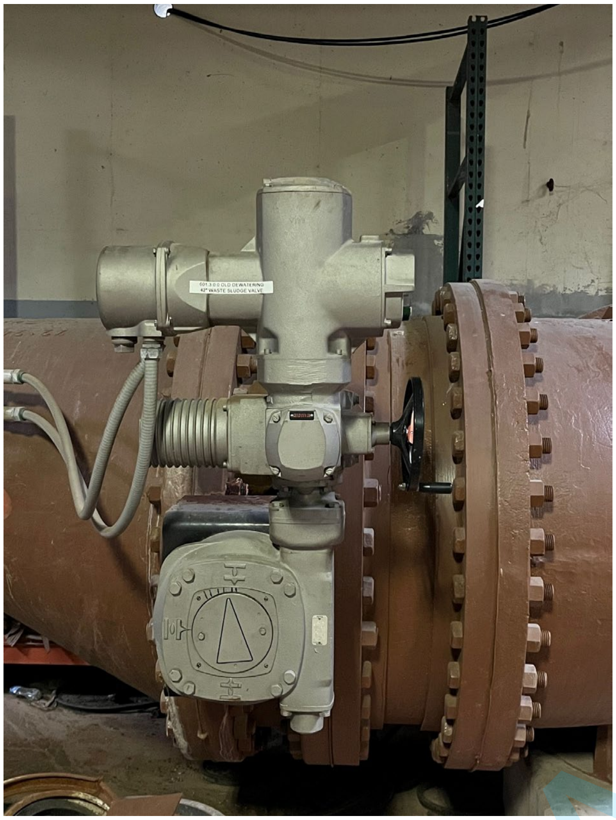
The process components for the WAS consists of the following:

- WAS isolation and flow control valves
- WAS magnetic flow meter
- Local control panel/instrumentation system

A description of the WAS system's components is described below:

WAS Isolation and Flow Control Valves

The WAS isolation valves allow the staff to isolate each WAS system for maintenance purposes.



WAS Flow Control Valve

WAS Magnetic Flow Meter

The WAS magnetic flow meter is in the Pipe Gallery on the north side and is used to monitor the WAS flow rate being sent to the sludge lagoon system through the WAS system.

WAS Flow Meter

Local Control Panel/Instrumentation Automation System

The local control panel / instrumentation / automation system allows the operations staff to control the WAS flow rates through the SCADA system.

Liquid Flow Paths

Mixed liquor settles in the bottom of the final clarifiers when the clarifiers are in operation. The settled mixed liquor flows out of each clarifier through the center hopper and into RAS lines. The RAS lines combine into a single RAS suction manifold at the Pipe Gallery, providing sludge flow from the clarifiers to the operating RAS pumps. When one of these RAS pumps is in service, the unit directs RAS from the RAS suction manifold into the RAS pump volute, and then discharges the RAS into the RAS pump discharge piping to the RAS Reaeration Basin.

Solids Flow Paths

Normal removal of excess biosolids occurs using the 42-inch WAS line and flow control valve. The pressure of the RAS system pushes sludge into the WAS line leading to the sludge lagoon system.

Design Criteria and Nameplate Data

Table 5.3-1 provides the design specifications for the RAS/WAS systems.

Table 5.3-1 System Data - RAS/WAS Systems

Component/Criteria	Value	
	Clarifiers 1-N through 4-N and 1-S through 4-S	***Clarifiers 5-N and 5-S***
Number of units:	6	3
Tag numbers:	E-151 through E-156	RAS-4100, RAS-4200, and RAS-4300
Manufacturer:	Allis-Chalmers	Flygt
Model:	150 F8H	NZ3202.095-614 12”
Type:	Horizontal centrifugal	Dry pit submersible
TDH (ft) maximum/minimum:	28/6	44 (minimum)
Pump Flow rate (gpm) at TDH (maximum/maximum):	3,000/12,000	4,200 (at minimum TDH)
Speed, rpm:	645	1195
Motor manufacturer:	General Electric	Flygt
Motor Model:	5K5G9SN624	30-29-6AA
Speed:	590	1170
Horsepower:	125	60
Voltage/Phase/Hertz:	460/3/60	460/3/60
Service Factor:	1.15	**1.15**

5.3.3 Equipment Control

Table 5.3-2 provides the location of controls associated with RAS/WAS pumping.

Table 5.3-2 RAS/WAS Pump Controls

Control or Indicator	Number of Units	At Equipment	MSB-2	At Equipment Control Panel
Return Sludge Pumps E-151 through E-156				
Man-Auto selector switch	6			X
Manual-Auto selector switch	6	X		
Norm-Emer selector switch	6			X
Normal-Emergency selector switch	6			X
Start pushbutton	12	X		X
Stop pushbutton	12	X		X
Manual speed control knob	6	X		X
Red Power On indicating light	1			X
Red alarm indicating light	1			X
Torque drive disconnect	6			X
Transfer disconnect	6	X		
On red indicator lamp	6	X		
Alarm red indicator lamp	6	X		
Pressure gauge (0 to 30 inches of mercury vacuum)	6	X		
RAS Suction and Discharge Valves				
Hand-Auto selector switch	12	X		
Open pushbutton	12	X		
Close pushbutton	12	X		
Green Open indicating light	12	X		
Red Closed indicator light	12	X		
Disconnect switch	12	X		
Flow meter (0 to 12 mgd)	12	X		
Vacuum system at end of building				
RAS Suction Valve for New Clarifier				
Hand-Off-Auto selector switch	2	X		
Open pushbutton	2	X		
Close pushbutton	2	X		
Stop pushbutton	2	X		
Red Open indicator light	2	X		
Green Close indicator light	2	X		
Computer indicated operating status				

Table 5.3-3 provides descriptions of the functions of controls associated with RAS/WAS pumping.

Table 5.3-3 RAS/WAS Pump Control Functions

Control or Indicator	Functions
RAS Pumps	
Selector switch	**Man** – Pump is controlled by Start and Stop pushbuttons and local rheostat.
	Auto – Pump starting, stopping, and speed is controlled by the computer.
Pushbutton	**Start** – Provided selector switch is in **Man** position, pump starts.
	Stop – Stops pump, provided it is operating in the **Man** position.
Manual speed control rheostat	Controls pump speed when selector switch is in the **Man** position.
Power On indicating light	Illuminates when electrical power is available to variable speed drive control panel.
Alarm indicating light	Illuminates when protection device has stopped the pump.
Tachometer	Indicates pump operating speed.
Computer indicated operating status	Upon operator command, computer will indicate percent of 600 rpm operating speed.

5.3.4 Operation

Expected Operating Parameters and Goals

The RAS pumping system is designed to properly operate at the designated design flow and maintain the proper sludge return rate. The goal of RAS pumping is to maintain the proper sludge level in the operating clarifiers, while returning enough activated sludge to maintain the desired MLSS concentrations in the biological process.

Operating Process Control

The RAS rate that will sustain a desirable MLSS level in the biological treatment process is important to the overall operation of the activated sludge system. If the RAS rate is too low, the following undesirable conditions may develop:

- The organism population in the biological treatment system will be insufficient to treat the influent loading during periods of increasing flow, causing deterioration in the effluent quality.
- The longer the detention times in the final clarifiers, the greater the potential for anaerobic activity in the sludge, leading to gasification and rising sludge problems.
- Accumulation of sludge in the final clarifier will create a deep sludge blanket, which may allow solids to escape over the final clarifier weirs and into the effluent.
- Too high a return sludge rate must also be avoided because higher return rates allow less time for sludge settling in the clarifiers by reducing the hydraulic retention time. The return of a poorly settled sludge makes it difficult to maintain the desired MLSS concentration in the biological process.

Determination of RAS Rate

The RAS rate is established by either of two basic methods:

- Maintain a desired MLSS level in the biological treatment process system for a given food to microorganism (F/M) ratio. This method requires that a given RAS rate be calculated based upon the concentration of settled sludge.
- Maintain a maximum depth to sludge blanket (i.e., maximum depth from water surface to top of sludge blanket) in the final clarifier so that there is, essentially, no sludge buildup above the optimum sludge blanket depth (1 to 3 feet). This is done to minimize the possibility of septic sludge and to return all activated sludge in a more viable condition to the biological treatment process system.

Process Variables

Variables influencing the RAS system can include:

- MLSS settling characteristics
- Influent flow
- WAS flow and solids removal from the process

Process Related Calculations

The process calculation associated with the RAS system is that of the RAS Q to Influent Q ratio, which is:

(RAS Q/Influent Q) x 100

The design criteria found on the mass balance diagram shows the design RAS flow rate of 13.41 mgd with a 16.4 mgd influent. The design ratio is ((13.41/16.4) x 100) = 81.77.

The F/M design ratio from the mass plant balance diagram is:

$$F/M = \frac{\text{(Influent CBOD, mg/L) (Flow, MGD) (8.34 lbs. / gal)}}{\text{(Aeration Tank Cap, MG) (MLVSS, mg/L) (8.34 lbs. / gal)}}$$

= ((212 mg/L *16.4*8.34) / (1.52 MG * 3122 mg/L * 8.34 gal.))

= (28,996.51) / (39,577)

F/M = 0.7

Process Dependencies

The biological process depends on the RAS to return microorganisms to the RAS Reaeration Basin so there is a source of microorganisms available to stabilize the pollutants in the incoming wastewater. The RAS process itself depends upon proper operation of the clarifiers to maintain a sufficient sludge blanket to provide thick activated sludge for return to the biological treatment process.

Operating Modes - RAS

Startup and Restart

The startup of the RAS pumping system requires the related clarification and biological processes to be operational.

This section explains the startup procedures for the RAS pumping system only. The following list is a step-by-step method to start the facility's equipment.

1. Verify the RAS pumping system is ready to be started with the facility's management and associated pertinent personnel.
2. Determine which of the RAS pumps will be started.
3. Verify that all required maintenance has been completed on the RAS pumping system's equipment.
4. Prior to startup, perform a safety meeting that includes emergency procedures for equipment shutdown, communication equipment needed to ensure clear communication between the control room and treatment plant personnel located at the treatment process, and all other related facility safety issues.
5. Visually inspect the RAS pumping system for any abnormal conditions that would adversely affect the startup.
6. Activate the plant computer system and verify the system is working properly.
7. Place the suction and discharge isolation valves and all valves leading to instrumentation, such as pressure gauges, etc., in the Open position.
8. Activate the RAS pumping system by energizing the VFD equipment control panel and switching the equipment in Automatic at the local equipment control panel. Verify that the RAS system is operating, and no alarms were activated.
9. If no alarms were activated, confirm that the local and VFD controls are ready for remote operation from the plant computer system.
10. Select the RAS pump to be started on the plant computer system and start the selected RAS pump.
11. Adjust the RAS flow control setpoint to the desired flow rate.
12. The RAS pumping system is now operational.
13. Notify pertinent personnel that the system is in operation.

Normal Operation

The normal operation for the RAS pumping system is in the automatic mode and functions in conjunction with the clarification and biological treatment processes. Monitor the RAS pumps at least twice per shift, noting discharge pressure, suction pressure, control positions, and RAS flow rate.

Alternate Operation

The alternate operation for the RAS pumping system is in the manual mode. The manual mode can override some of the safety features built into the system. This method of operation is not recommended and must only occur at the approval of facility management.

Shutdown

Shutting down the RAS system may result in solids being transferred to downstream processes from the clarifiers. The RAS system should never be off because it returns the biomass to the biological treatment process. At most, a RAS pump can be taken offline, or RAS flow can be temporarily shut off for maintenance. However, the other RAS pumps should be in service to continue RAS flow while an individual RAS pump is shutdown. The following steps are used to shut down the RAS system.

1. Notify pertinent personnel that the RAS system is being shut down.
2. Follow all the safety protocols related to the RAS system shutdown.
3. Turn the RAS pump to the “OFF” position at the local control panel.
4. Turn the RAS pump quick disconnects to the “OFF” position at the local control panel.
5. Turn the RAS pump local control panel to “OFF” at the MCC.
6. Close the upstream and downstream Isolation valves as required.
7. Notify pertinent personnel that the RAS system is shutdown.

Operating Modes - WAS

Startup and Restart

The startup of the WAS system requires the related clarification and biological processes to be operational.

This section explains the startup procedures for the WAS system only. The following list is a step-by-step method to start the facility’s equipment.

1. Verify the WAS system is ready to be started with the facility's management and associated pertinent personnel.
2. Determine if the crossover line on the WAS line between the north and south clarifiers needs to be opened and position the valve accordingly.
3. Verify that all required maintenance has been completed on the WAS system's equipment.

4. Visually inspect the WAS system for any abnormal conditions that would adversely affect the startup.

5. Adjust the WAS flow control setpoint to the desired flow rate.

6. The WAS system is now operational.

7. Notify pertinent personnel that the system is in operation.

Normal Operation

The normal operation for the WAS system is in the automatic mode and functions in conjunction with the clarification and biological treatment processes. Monitor the WAS system at least twice per shift.

Shutdown

Shutting down the WAS system may result in excessive solids buildup in the treatment process. The following steps are used to shut down the WAS system.

1. Notify pertinent personnel that the WAS system is being shut down.

2. Follow all the safety protocols related to the WAS system shutdown.

3. Close the WAS flow control valve and perform required lockout/tagout if maintenance is to be performed.

4. Notify pertinent personnel that the WAS system is shutdown.

Process Troubleshooting

If there are excessive amounts of scum, examine the upstream process for operational problems including the influent for excessive fats, oils, and grease (FOG).

Table 5.3-4 provides a general outline of process troubleshooting. Refer to the original equipment manufacturers (OEM) O&M manuals troubleshooting section for more information on specific troubleshooting information.

Table 5.3-4 RAS WAS Pumping System Troubleshooting

Problem	Probable Cause	Recommended Action
Pump fails to prime	Low Liquid level inside the pump casing	Add liquid to casing.
	Suction check valve malfunction	Clean or replace check valve.
	Air leaking into suction line	Correct leak
	Internal lining of suction hose separation	Replace suction hose
	Leaking or worn seal or pump Gasket	Check pump vacuum. Replace leaking or worn seal or gasket.
	Discharge head too high	Check piping installation and install bypass line if needed.
	Strainer plugged or blocked	Check strainer and clean if necessary
Pump stops or fails to deliver flow or pressure	Air leaking into suction line.	Correct leak.
	Internal lining of suction hose separation.	Replace suction hose.
	Leaking or worn seal or pump gasket.	Leaking or worn seal or pump gasket. Check pump vacuum. Replace leaking or worn seal or gasket.
	Strainer plugged or blocked.	Check strainer and clean if necessary.
	Suction intake vortexing.	Check installation and correct submergence as needed.
	Impeller/wear plate worn or damaged.	Replace worn or damaged parts. Check that impeller is properly centered and rotates freely.
	Impeller plugged or blocked.	Free impeller of debris.
	Pump speed not running fast enough.	Check driver output; check belts or
	Discharge pressure too high.	Install bypass line.
	Suction lift too high.	Measure lift w/ vacuum gauge. Reduce lift and/or friction losses in suction line.
Pump requires too much power	Pump speed running too fast.	Check driver output: check that sheaves or couplings are correctly sized.
	Discharge head too low.	Adjust discharge valve.
	Liquid is too viscous.	Dilute if possible.
	Bearing(s) seized.	Disassemble pump and check bearings and replace.
Pump clogs frequently	Liquid is too viscous.	Dilute if possible.

5.3.5 Maintenance

Process Maintenance

The general maintenance for the RAS/WAS and pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the RAS/WAS pumping consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 5.3-5 provides the manufacturer's and service representative's contact information for the RAS/WAS systems.

Table 5.3-5 Contact Information – RAS and WAS Systems

RAS System	
Clarifiers 1-N through 4-N and 1-S through 4-S	
Manufacturer	
Name:	[1]Allis-Chalmers
Service Representative	
Name:	JR Stewart
Address:	313 S. Second Street West Memphis, AR 72301
Phone:	870-735-2484
Fax:	870-735-0765
Website:	www.jrspump.com
Email:	hughey@jrspump.com
Clarifiers 5-N and 5-S	
Manufacturer	
Name:	Xylem
Address:	301 Water Street SE, Suite 200 Washington, DC 20003
Phone:	Contact local representative
Fax:	N/A
Website:	www.xylem.com

Table 5.3-5 Contact Information – RAS and WAS Systems

Service Representative	
Name:	Gulf States Engineering, Co., Inc.
Address:	17961 Painters Row Covington, LA 70435
Phone:	985-893-3631
Fax:	985-893-9531
Website:	www.gsengr.com

[1] Allis-Chalmers is no longer in business.

5.3.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the water reclamation facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

5.4 Scum Collection and Handling

5.4.1 Overview

The scum pumping system's purpose is to remove scum and skimmed items collected from the final clarifier surfaces. The scum removal process is dependent on the final clarifier surface skimmer mechanisms to collect scum and move the scum to the beach plate/scum box in each operating final clarifier. The scum system consists of four scum wells, six scum pumps, and associated ancillary equipment. Scum from Clarifiers 1-N through 4-N discharge into a single well containing two scum pumps, Clarifiers 1-S through 4-S discharge into a single well containing two pumps, and Clarifiers 5-N and 5-S each discharge into a dedicated well containing one scum pump. The scum well for Clarifiers 1-N through 4-N is located on the north side of the Pipe Gallery, the scum well for Clarifiers 1-S through 4-S is located on the south side of the Pipe Gallery, the scum well for Final Clarifier 5-N is located on the south side of the clarifier, and the scum well for Final Clarifier 5-S is located on the north side of the clarifier. All scum wells discharge is to a single line that carries scum to the 42-inch WAS pipeline for conveyance to the sludge lagoon system.

The final clarifier's collector/skimming mechanisms rotate and sweep the scum from the surface of the clarifier. The skimmer arm on each clarifier pushes the scum over the scum beach and into a scum box on each clarifier.

Scum Beach and Box (Typical)

The scum holding tanks hydraulic levels are monitored by an ultrasonic level sensor through the SCADA system. There is an additional high level float switch that is set higher than a preset level.

The scum holding tanks continues to receive scum from the clarification system until an adjustable preset hydraulic level is reached in the holding tanks. When the predetermined level is reach, the scum pump system is activated, and scum is pumped to the biosolids processing system. If the scum level continues to rise above the preset level, a high-level float is reached, prompting a "Scum Holding Tank High Level Alarm" and starts all the scum pumps associated with that scum holding tank.

As the scum pumps operate, the scum level in the wet well is pumped down until the scum level reaches the Pump Off position. The pumps will then turn off and will alternate Lead and Lag duty. Two pumps are used to pump scum from the scum wet well through a 4-inch diameter line at the scum pump station. Each scum pump discharges into a 4-inch scum line. These two lines tie together and convey scum to the 42-inch WAS pipeline for conveyance to the sludge lagoon system. Each scum pump has a check valve and an isolation valve on its respective discharge piping. A Local Control Panel (LCP) houses the local controls for these pumps.

5.4.2 Process Control

Process Components

The clarifier scum handling system consists of the following:

- 4 - Scum wells
- 6 - scum pumps
- Discharge piping and valves
- Local control panels
- Instrumentation and related controls

The main treatment goal of the scum removal system is to remove non-soluble floating debris that enter the clarification system and remove these from the treatment process. The process control is to verify that the scum pumps operate properly in the automatic lead / lag sequence as the scum is pumped to the sludge holding tanks. If automatic operation is not available, the treatment goals remain the same and plant staff will have to operate the pumps in the manual mode on an operational basis sufficient to prevent the scum wet well from overflowing.

The scum pump station components are described in greater detail in the following text.

Scum Wells

Four scum wells temporary hold scum skimmed from the associated final clarifiers. One well receives scum from Clarifier 1-N through 4-N. The second well receives scum from Clarifiers 1-S through 4-S. Both scum wells are located near the west end of the Pipe Gallery. Clarifier 5-N and Clarifier 5-S each has its own adjacent scum well.

Scum Pumps

The scum pumps for Clarifiers 1-N through 4-N and Clarifiers 1-S through 4-S are progressing cavity pumps rated for approximately 100 gpm at 85-feet TDH. Each set of clarifiers (north and south) has two scum pumps configured to pull from the associated scum well. Scum Pumps E-183 and E-184 pull from the Clarifiers 1-N through 4-N scum well. Scum Pumps E-181 and E-182 pull from the Clarifiers 1-S through 4-S scum well. The scum pumps associated with Clarifiers 5-N (SCUM-3500-1) and 5-S (SCUM-3500-2) are double-diaphragm rated for approximately 425 gpm situated on a pad located adjacent to their associated scum well.

Clarifier 1N through 4N Scum Pump

Discharge Piping and Valves

Each scum pump discharges into a 4-inch diameter scum line and convey scum to the 42-inch WAS pipeline for conveyance to the sludge lagoon system. Each scum pump has a check valve and isolation valves on its inlet and discharge piping.

Local Control Panel

An LCP houses the local controls for the scum pumps. The control panel contains the pump motor starters, Hand/Off/Automatic selector switches, Pump Run indicating lights, Pump Running elapsed time meters, a thermostatically- (adjustable) controlled condensate heater, phase monitor, and transient voltage surge protection. The panel also houses the alarm horns and indicators used to indicate trouble.

Liquid Flow Paths

Most of the liquid associated with the scum system is removed at the scum well and is sent to the 42-inch WAS pipeline for conveyance to the sludge lagoon system.

Solids Flow Paths

Scum is deposited in each scum box by the action of each final clarifier's collector mechanism. At each clarifier, this scum flows into a 6-inch diameter pipe and into the scum holding well. Each of the scum lines has a cleanout used for maintenance purposes.

The scum pumps for Clarifiers 1-N through 4-N and Clarifiers 1-S and 4-S operate based upon the level in scum levels in the scum holding well as sensed by a bubbler system. As the liquid level rises, one pump starts. When the level drops, the pump stops. After each pumping cycle, the starting sequence of the two pumps is alternated.

The scum pumps for Clarifier 5-N and Clarifier 5-S operate based upon the level in the scum holding wells.

Design Criteria and Nameplate Data

Table 5.4-1 provides the design specifications for the scum pumping system.

Table 5.4-1 System Data - Scum Pumping System

Component/Criteria	Value	
	Clarifiers 1-N through 4-N and 1-S through 4-S	*Clarifiers 5-N and 5-S*
Number of units:	4	1
Tag numbers:	E-181, E-182, E-183, E-184	SCUM-3500-1, SCUM-3500-2
Manufacturer:	Wemco – Trillium Flow Technologies	Penn Valley Pump Co., Inc.
Model number:	Torque-Flow Pump Model E	6DDSX76CN55U-MK2
Type:	Progressing cavity	Double disc diaphragm
Capacity, gpm at TDH:	500	150
TDH:	85-31 feet	72 feet
Motor manufacturer:	General Electric	Toshiba
Model number:	5KE865PFG305	0106XDSB41A-P
Frame:	365T	265T
Horsepower	50	10
Speed, rpm:	1180	2300
Volts/Phase/Frequency:	460/3/60	460/3/60
Service Factor:	1.15	1.15

5.4.3 Equipment Control

Table 5.4-2 provides the location of controls associated with the scum pumps.

Table 5.4-2 Final Clarifier Scum Pump Controls

Control or Indicator	Number of Units	At Equipment	MSB-2	At Equipment Control Panel
Scum Pumps E-181 through E-184				
Disconnect	4		X	
Hand-Off-Remote selector switch	4			X
Hand-Off-Auto selector switch	4		X	
Reset pushbutton	4		X	
Low liquid level cutoff float switch	2	Scum well		
High liquid level alarm float switch	2	Scum well		
Level gauge (0 to 34 feet)	2	Scum well		
Green Running indicating light	4			X
Green On indicating light	4		X	
Red Off indicating light	4		X	

Table 5.4-3 provides descriptions of the functions of controls associated with the scum pumps.

Table 5.4-3 Final Clarifier Scum Pump Control Functions

Control or Indicator	Functions
Scum Pumps	
Selector switch	**Hand** – Pump operates continuously provided liquid level in scum well is above low-level cutoff.
	Off – Pump will not operate.
	Remote – Facilities are available for connection of this control position to the computer for start-stop control at the computer.
Low liquid level cutoff float switch	Prevents pump from operating when scum well liquid level if below the cutoff level.
High liquid level alarm float switch	Provided for future connection at computer to sound alarm when liquid level rises to the high level.
Red indicating light	Illuminates when the pump is operating.
Green indicating light	Illuminates when the pump is not operating.

5.4.4 Operation

Expected Operating Parameters and Goals

The scum pumping system is designed to remove most of the floating scum that is on the surface of the final clarifier. The floating material is guided by a surface skimming arm to a scum trough before flowing to a scum well for pumping to the biosolids handling system.

Operating Process Control

The system requires visual inspection to verify that it is working properly. The system scum well level should be regularly checked by periodic visual inspections. The pumps and system components must be visually checked for proper operation on a regular basis with a recommended frequency of once per shift.

Process Variable

The process variable that can affect this process is the volume of scum and foam the biological treatment process produces. If large amounts of scum and foam are generated, then corrective action will need to be taken to reduce the scum and foam. Close monitoring of the scum pump station will be required during this abnormal event.

Process Dependencies

The clarifiers depend upon regular scum removal to protect effluent quality. The scum pumping equipment must be operating properly to ensure the scum can be constantly removed from the secondary clarifiers.

Operating Modes

Normal Operation

The normal operation for the scum pumping system is in the Automatic mode and functions in conjunction with the clarifier surface skimmers. Staff should inspect each scum well once per shift or more often if problems are occurring.

Alternate Operation

The scum pumping system can be operated in Manual mode. This would require the operations staff to turn the pumps on manually, monitor the pumps and scum well level during this time. This method is not recommended and should be used only under direction of facility management.

Startup and Restart

The startup of the scum pumping system requires the clarification and scum systems equipment are ready to be placed into operation.

This section explains the startup procedures for the scum pumping system only. The following list is a step-by-step method to start the scum pumping equipment.

1. Verify with facility management and associated pertinent personnel that the scum pumping system is ready to be started.

2. Verify that all required maintenance has been completed on the scum pumping system's equipment.

3. Perform a safety meeting that includes emergency procedures for equipment shutdown, how participating personnel will communicate, and all other related facility safety issues that need to be identified prior to startup.

4. Visually inspect the scum pumping system for any abnormal conditions that would adversely affect the startup.

5. Open the associated valves upstream and downstream of the scum pumps.

6. Activate the scum pumping system by energizing the scum pump station control panel and switching the equipment into the “Automatic” mode.

7. Verify that the scum system is in operation and that no alarms were activated.

8. The scum pumping system is now operational.

9. Notify pertinent personnel that the system is in operation. Confirm that the scum pump station is displayed as being fully operational by observing the facility’s operating status on the treatment plant’s SCADA system. If the system appears functional and no alarm conditions exist, normal operation can commence.

Shutdown

Completely shutting down the scum pumping system may result in scum being transferred to downstream processes or the system needing to be unplugged if it remains idle for too long without having first been flushed with water. If the scum pumping system is not being shut down completely, place the Hand/Off/Automatic selector switch for the pump identified for shutdown into the Off position and isolate the pump's discharge line using the discharge isolation valve if required.

Taking the scum pump system completely offline, monitor the scum in the associated secondary clarifiers and physically remove the scum by sending the scum to drain. Use of a vacuum truck or other device capable of removing accumulated scum during the period that the scum pumping system is offline may be necessary.

The following identifies the steps involved in taking the scum pumping system out-of-service:

1. Turn off the scum pumping system by de-energizing the equipment control panel and switching the equipment in the Off position at the respective control panel. Verify that the scum pumping system is off.

2. The scum pumping system is now shutdown.

Process Troubleshooting

If there are excessive amounts of scum, examine the upstream process for operational problems including the influent for excessive fats, oils, and grease (FOG).

Table 5.4-4 provides a general outline of process troubleshooting. Refer to the original equipment manufacturers (OEM) O&M manuals troubleshooting section for more information on specific troubleshooting information.

Table 5.4-4 Scum Pumping System Process Troubleshooting

Problem	Probable Cause	Recommended Action
Low Station Discharge Flow	Gas is binding in the eye of the impeller	Confirm that gas or air has a relief point so the gas or air is not trapped in the volute or impeller.
	There is a vortex developing near the pump suction in scum pit	Raise pump start level to a point where vortexing is not occurring.
	Intake openings are blocked	Clear inlet ports at pump suction.
	Rotation is incorrect. A pump can pump in the wrong direction, just not very efficiently.	Swap motor phases to change direction of rotation.
	Pump discharge blocked	Remove blockage and restart operation.
High Tank Level	Pump intake openings are blocked	Clear inlet ports at pump suction.
	Pump discharge blocked	Remove blockage and restart operation.
	Scum thicker, higher density or viscosity than design concentration	Operate scum system to have thinner scum. Pump more frequently or add spray water to lessen density/viscosity of scum.

Table 5.4-4 Scum Pumping System Process Troubleshooting

Problem	Probable Cause	Recommended Action
Low station level	Scum box pipeline blocked	Clear obstruction and monitor station for proper operation.
	Scum box isolation valve closed	Open isolation valve and monitor station for proper operation.
	Scum pumps operating excessively	Inspect floats to assess if floats are hanging up. Confirm that the pumps are not in Manual mode. Correct condition(s) and return to service in the Automatic mode.

5.4.5 Maintenance

Process Maintenance

The general maintenance for the scum pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the scum pumping consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 5.4-5 provides the manufacturer's and service representative's contact information for the scum pumping.

Table 5.4-5 Contact Information – Scum Pumping System

Clarifiers 1-N through 4-N and 1-S through 4-S	
Manufacturer	
Name:	Moyno, Inc.
Address:	5870 Poe Avenue Dayton, OH 45414
Phone:	937-454-3300
Website:	www.moyno.com
Service Representative	
Name:	D.J. Shubeck Company
Address:	3144 Stage Post Drive, Suite 104 Memphis, TN 38133
Phone:	901-372-2400
Fax:	901-372-4777
Website:	www.djshuceck.com
Clarifiers 5-N and 5-S	
Manufacturer	
Name:	Penn Valley Pump Co., Inc.
Address:	998 Easton Road Warrington, PA 18976
Phone:	215-343-8750
Fax:	215-343-8753
Website:	www.pennvalleypump.com
Service Representative	
Name:	Instrument & Supply, Inc.
Address:	14 Technic Circle, PO Box 1679 Hot Springs, AR 71902
Phone:	501-262-3282
Fax:	501-262-4847
Website:	www.isiequip.com

5.4.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

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Section 6

Effluent Treatment and Pumping

6.1 Overview

The final effluent from the final clarifiers is disinfected with peracetic acid (PAA) solution in the Disinfection Contact Tank. The Disinfection Contact Tank effluent flows to the disinfected effluent channel and then flows over a weir through a 78-inch motorized sluice gate, DIS-SG-5, to the Levee Gate Structure to a 78-inch line to the Cooling Channel to the Mississippi River. Alternately, when the locally measured river stage at Memphis elevation 34 is above 221.5, Disinfection Contact Tank effluent is pumped by the Effluent Discharge Pumps to the Mississippi River through a 90-inch line to the Head Dissipator Gate Structure to a head dissipator and flows to the Cooling Channel to the Mississippi River.

Final effluent from the Disinfection Contact Tank supplies the Effluent Water System. There are four Disinfected Effluent Water Pumps located at the south end, (east and west sides), of the Disinfection Contact Tank. The Disinfected Effluent Water Pumps convey disinfected effluent to the Effluent Water Wet Well. A 24-inch line from the Effluent Water Wet Well supplies the Non-Potable Effluent Water Pumps in the Pipe Gallery. The Non-Potable Effluent Water Pumps supply reclaimed water to the on-site water reuse loop that provides reuse water for various process equipment, on-site hoses, pipeline flushing, and other systems that support the Maxson WWTF.

6.2 Disinfection Contact Tank

6.2.1 Overview

The T.E. Maxson WWTF uses bulk peracetic acid (PAA) solution as the disinfection agent for treated wastewater. The objective of the disinfection system is to inactivate pathogenic organisms in the wastewater prior to discharge to the Mississippi River. Bulk PAA is supplied to the T.E. Maxson WWTF by PeroxyChem (now a subsidiary of Evonik) from their production facility adjacent to the City of Memphis's M.C. Stiles WWTF on the north side of Memphis. The PAA system is operated and maintained by PeroxyChem.

The overall disinfection system consists of two main components: the PAA Storage and Feed System and the Disinfection Contact Tank. The PAA Storage and Feed System includes PAA bulk storage tanks, flow meters, flow control valves, piping, unloading pumps, electrical equipment, control panels, and other miscellaneous equipment used to deliver PAA to the feed points in the Disinfection Tank. All equipment within the PAA Equipment Pad, as well as some piping, platforms, and analyzers within the Disinfection Contact Tank, is owned and operated by PeroxyChem.

All questions about the PAA Storage and Feed System should be direct to PeroxyChem. The City Staff is not to enter the PAA Storage and Feed Area or touch any of the equipment, valves, instruments, or controls associated with the system.

Peracetic Acid Storage Tanks

6.2.2 Description

A plan view drawing of the Disinfection Contact Tank is presented as ***Figure 6.2-1 Disinfection Tank Plan*** and a conceptual process and instrumentation diagram is presented as ***Figure 6.2-2 Disinfection Tank P&ID.*** Key properties of the Disinfection Contact Tank are presented in ***Table 6.2-1***.

Table 6.2-1 Disinfection Contact Tank – Properties

Design Flows through Disinfection Contact Tank	
Minimum Daily Flow (mgd):	50
Permitted Average Daily Flow (mgd):	70
Maximum Daily Flow (mgd):	155
Peak Hour Flow (mgd):	170
Disinfection Contact Tank	
Tank Configuration:	Parallel Basins
Overall Tank Length:	360'-0"
Overall Tank Width:	7
Number of Passes on Each Basin of the Contact Tank:	3
Side Water Depth at Peak Hour Flow (ft) (1 foot of water over effluent weirs):	13.5
Width of Each Pass (ft):	22
Bottom Slab Elevation (ft):	208.00
Effluent Weir Elevation:	22050
Weir Length: Per Basin of Tank (ft) Total (ft)	 30 60
Total Tank Volume (ft^3):	784,404
PAA Detention Time	
Minimum Daily Flow (minutes):	105
Permitted Average Daily Flow (minutes):	75
Maximum Daily Flow (minutes):	34
Peak Hour Flow (minutes):	31

The Disinfection Contact Tank was constructed with two parallel basins, east and west, with each basin configured in a serpentine pattern to maximize contact time. Both the east and west basins are provided with three PAA feed points. The primary application point A is located at the influent end of the tank immediately downstream of the influent chamber and upstream of the first pair of L-shaped stainless-steel baffles. The secondary dose point B is located at approximately the halfway point of the tank, immediately upstream of the second pair of L-shaped stainless-steel baffles. The tertiary feed point C is located approximately two-thirds through each basin of the tank. PeroxyChem operators can adjust valves to select which feed point is in operation dependent upon PAA demand and effluent flow from the Disinfection Contact Tank.

Flow from the final clarifiers enters the Disinfection Contact Tank influent chamber from the 8' x 8' concrete box conduit downstream of the Clarifier 5-N and 5-S Junction Box. During normal operation, flow splits from the influent chamber to the east (DIS-SG-2) and west (DIS-SG-3) basins of the Disinfection Contact Tank.

The Disinfection Contact Tank is equipped with six motorized slide gates, DIS-SG-1 through -6, and a set of stop logs. These can be adjusted to modify the flow configuration of the tank. Each basin of the tank can be isolated and shut down for maintenance, and the entire tank can be bypassed. The slide gates in the Effluent Chamber can be adjusted to divert effluent flow through the Levee Gate Structure Gravity Outfall (DIS-SG-5) or to the Effluent Discharge Pump Station (DIS-SG-6).

Each basin of the Disinfection Contact Tank includes a 30-foot effluent weir, with two ultrasonic level elements installed upstream. The level elements are installed in a duty/standby configuration for each basin of the tank. These instruments measure the depth of water over the effluent weir, which is converted into the effluent flow rate for the disinfection tank. A signal is provided from these instruments to DCU-1 in the Disinfection IPA Building, where the duty flow signals are combined to a single flow value that is sent to the control panels in the PAA Equipment Pad. This allows PeroxyChem to use flow pacing in the PAA dose control algorithm.

The Effluent Water Pump Station is located just upstream of the effluent weirs. Two submersible pumps are installed in each basin of the disinfection tank, (east and west), total of four, to supply effluent water to the Effluent Water Wet Well and ultimately the plant's Non-Potable Effluent Water System. Additional information on the Effluent Water Pump Station is provided in ***Section 6.3 Effluent Water System*.**

The effluent channel downstream of the weirs combines flow from both basins of the Disinfection Contact Tank and directs flow to the Effluent Chamber. The effluent channel also provides supplemental storage volume for the Effluent Water Pump Station wet well. An ultrasonic level instrument is installed to monitor the level in the effluent channel. From the Effluent Chamber, flow can be diverted out to the Levee Gate Structure Gravity Outfall or to the Effluent Discharge Pump Station.

The Disinfection Contact Tank was designed to provide a minimum of 31 minutes contact time with both basins online for the peak hour flow of 170 mgd. The entire Disinfection Contact Tank, or each basin of the tank separately, can be drained for maintenance and inspection (**when the groundwater level is not too high**) by adjusting the position of slide gates and mud valves installed throughout the tank. The Disinfection Contact Tank drains to the Drain Pump Station, which is discussed in ***Section 6.5 Drain Pump Station***.

WARNING: The Disinfection Contact Tank shall not be drained when groundwater levels exceed 208.00’ as measured at the monitoring wells in the vicinity of the disinfection tank. Warning signs are posted near the Disinfection Contact Tank and at the Drain Pump Station to remind operators of this requirement. The groundwater level should be monitored hourly while a tank is drained.

Tank Draining Warning Sign

6.2.3 Equipment Control

Slide Gates

Flow into, through and around the Disinfection Contact Tank is controlled by a series of motorized slide gates and a set of manually installed stop logs. All six slide gates are provided with AUMA multi-turn electric actuators. The same model actuator is used for gates DIS-SG-1, DIS-SG-5, and DIS-SG-6, and a different model is used for DIS-SG-2, DIS-SG-3, and DIS-SG-4. Properties of the slide gate actuators is provided in ***Table 6.2-2.***

Table 6.2-2 Slide Gate Electrical Actuators – Properties

Parameter	Value	Value
Gates:	DIS-SG-1, DIS-SG-5, DIS-SG-6	DIS-SG-2, DIS-SG-3, DIS-SG-4
Model Number:	SA10.2/GK14.6/AM02.1	SA14.2/GK16.2/AM02.1
Rated output torque:	317 ft-lb	665 ft-lb
Max. Thrust:	36,000 lbs	56,000 lbs
Overall output speed:	27 rpm	19.3 rpm
Approximate Weight:	123 lbs	207 lbs
Operation mode:	Open-Close	
Enclosure:	NEMA 4X	
Voltage:	480 V	
Phase:	3-Ph	
Frequency:	60 Hz	
Nominal Motor Speed:	3,360 rpm	
Nominal Motor Power:	1 hp	1-1/2 hp
Nominal current:	3.0 FLA	4.0 FLA

The actuators are provided with mechanical position indicators, torque switches, limit switches, and position transmission via a 4-20 mA signal. Each actuator is provided with a removable handwheel for manual operation. The slide gates can be controlled at individual local control stations or remotely from an HMI associated with DCU-1 in the Disinfection Electrical IPA Building.

Flow and Level Measurement

Flow measurement is achieved for each basin of the Disinfection Contact Tank by pairs of ultrasonic level sensors mounted upstream of the effluent weirs. The instruments operate in a duty/standby configuration for each basin of the tank. A summary of the level sensors and transmitters is provided in ***Table 6.2-3***.

Table 6.2-3 Disinfection Contact Tank – Level Sensors and Transmitters

Parameter	Value
Level Sensors	
Tags:	FE-7065, FE-7070, FE-7075, FE-7080
Manufacturer:	Pulsar
Model:	dBMach3
Part Number:	dBM3010400000-NP
Type:	Ultrasonic Transducer
Signal Cable Length:	20 m
Measurement Range:	0 – 7.95 ft
Accuracy:	+/- 0.039 in.

Table 6.2-3 Disinfection Contact Tank – Level Sensors and Transmitters

Parameter	Value
Transmitters	
Tags:	FIT-7065, FIT-7070, FIT-7075, FIT-7080
Manufacturer:	Pulsar
Model:	FlowCERT
Part Number:	15211115211X4-X0P
Enclosure Rating:	NEMA 4X

The ultrasonic transducers measure the level in the Disinfection Contact Tank by timing the echo received from a pulse of sound in air. This level is measurement is converted to a flow rate using a weir equation developed specifically for the Disinfection Contact Tank effluent weirs. The level and flow rate can be displayed on each transmitter. The FlowCERT transmitters can be programmed either by the built-in keypad or by PC via the RS 232 Serial Interface. All parameters are stored in non-volatile memory and are retained in the event of a power interruption.

Signals from the level instruments are wired to DCU-1 where the duty signals from each basin of the tank are combined into an overall flow value. This value is sent to the PeroxyChem system control panels to allow them to adjust PAA Dose in response to changes in effluent flow rate.

The level in the effluent channel is measured by a single ultrasonic transducer mounted downstream of the effluent weirs. A signal from this instrument is provided to DCU-1 for real-time monitoring of the effluent channel level, along with a high-level alarm. This signal is used to control the number of pumps operating in the Effluent Discharge Pump Station. Information for this instrument is provided in ***Table 6.2-4***.

Table 6.2-4 Disinfection Contact Tank – Effluent Channel Level Instrument

Parameter	Value
Level Sensors	
Tags:	LE-7085
Manufacturer:	Pulsar
Model:	dB3
Part Number:	dB03005100000-NP
Type:	Ultrasonic Transducer
Signal Cable Length:	20 m
Measurement Range:	0.41 – 10 ft
Accuracy:	0.25% or 0.24 in., whichever is greater
Transmitters	
Tags:	LIT-7085
Manufacturer:	Pulsar
Model	Blackbox 130
Part Number:	130D11000X4-X0P

Analytical Instruments

PeroxyChem has installed four on-line PAA residual analyzers and two COD analyzers. For each basin of the Disinfection Contact Tank, one PAA analyzer is installed downstream of the second injection point, and one is installed near the end of the tank. Signals from these analyzers are used to display PAA residuals at the PeroxyChem system control panels, and they are used as inputs to the dose control algorithms to determine the PAA feed rate.

PeroxyChem has a sample pump installed in the influent chamber that sends a continuous sample to the COD analyzer shed. The COD analyzers operate in a duty/standby configuration. The signal from the COD analyzers is used to display COD at the PeroxyChem system control panels and as an input to the PAA dose control algorithms. The COD value is used in the algorithms to adjust PAA dose in response to changes in the effluent PAA demand.

6.2.4 Operation

Slide Gates

Provided in ***Table 6.2-5*** is a summary of the dimensions of each slide gate, along with its location and function. All gates are supplied by R.W. Gate and constructed of Type 316 stainless steel.

Table 6.2-5 Disinfection Contact Tank – Slide Gates

Gate Number	Width (ft)	Height (ft)	Seating Head (ft)	Location	Purpose
DIS-SP-1	96	72	11.07	Influent Chamber	Controls flow to Disinfection Contact Tank bypass
DIS-SP-2	120	120	10.86	Influent Chamber	Controls flow to east basin of Disinfection Contact Tank
DIS-SP-3	120	120	10.86	Influent Chamber	Controls flow to west basin of Disinfection Contact Tank
DIS-SP-4	120	120	10.79	Influent Chamber	Controls flow from effluent channel of Disinfection Contact Tank
DIS-SP-5	78	78	6.17	Effluent Chamber	Controls flow to gravity outfall
DIS-SP-6	84	84	13.79	Effluent Chamber	Controls flow to Effluent Discharge Pump Station

To bypass the Disinfection Contact Tank, the following steps should be performed:

1. Open DIS-SG-1 to allow flow to enter the bypass channel.
2. Install stop logs DIS-SP-1 (discussed in following subsection).
3. Close DIS-SG-2 and DIS-SG-3 after allowing the Influent Chamber to drain.
4. Close DIS-SG-4 to shut off flow from the Disinfection Contact Tank to the Effluent Chamber.

To bring the tank back into service after bypassing, the following steps should be performed:

1. Open DIS-SG-4 to allow flow from the Disinfection Contact Tank to the Effluent Chamber.
2. Open DIS-SG-2 and DIS-SG-3.
3. Remove the stop logs DIS-SP-1 from installed location to the stop log storage rack.
4. Close DIS-SG-1 to cut off flow into the bypass channel.

Slide Gate DIS-SG-5 can be raised and lowered to isolate flow to the Gravity Outfall, and slide gate DIS-SG-6 is raised and lowered to send flow to the Effluent Discharge Pump Station. These are isolation gates that are not intended for throttling or flow control. The Disinfection Contact Tank effluent flows through DIS-SG-5 to the disinfected effluent channel and then flows over a weir through a 78-inch motorized sluice gate to the Levee Gate Structure to a 78-inch line to the Cooling Channel to the Mississippi River. Alternately, when the locally measured river stage at Memphis elevation 34 is above 221.5, Disinfection Contact Tank effluent is pumped by the Effluent Discharge Pumps to the Mississippi River through a 90-inch line to the Head Dissipator Gate Structure to a head dissipator and flows to the Cooling Channel to the Mississippi River.

The operation of the Effluent Discharge Pump Station is discussed in ***Section 6.4 Effluent Discharge Pump Station***.

The following steps should be taken prior to operating a slide gate:

1. Check that both sides of the slide, frame, seals, and stem are free of all grout, sand, paint, and other debris. Pay close attention the seals, stem threads, and slides.
2. Verify that the stem is centered and straight.
3. Verify that stem guides are positioned correctly and are securely fastened.
4. Make sure that all anchor nuts have been tightened.
5. Apply tension to stem and check stem guides for proper alignment. There must be uniform clearance between the operating stem and all stem guides.
6. If necessary, clean the stem threads with only a wire brush with stainless steel or brass bristles. Do NOT use a grinder or similar rotary device with brush type wheel to clean the stem threads as damage will occur to the stem threads.
7. Lubricate the stem threads with an appropriate lubricant. Operating effort will be greatly increased if the stem threads have not been cleaned and properly lubricated.
8. Re-install stem cover.

Stop Logs

The stop logs that comprise DIS-SP-1 are summarized below in ***Table 6.2-6.*** These stop logs are used to stop flow to both basins of the Disinfection Contact Tank, and they are installed by use of the jib crane installed above the influent junction structure.

Table 6.2-6 Disinfection Contact Tank – Stop Logs

Parameter	Value
Tag:	DIS-SP-1
Manufacturer:	R.W. Gate
Material:	Grade 316 Stainless Steel
Dimensions per Stop Log: Width Height	 144” 19-13/16”
Weight per Stop Log:	610 lbs
Seating Head:	8.65’
Total Quantity of Stop Logs:	7

When installing the stop logs in the Disinfection Contact Tank, make sure to install the logs in the correct “upstream to downstream” position. Ensure that the frame and seals are free of grout and debris before they are installed. Use the jib crane, hoist, and lifting device to slowly lower the stop logs into the frame to prevent damage to the seals. The lifting device is equipped with a spring-loaded lanyard release and hooks that engage into the top of each stop log. Once a stop log is in the correct position, pull the lanyard release to disengage the hooks from the lifting holes. All seven stop logs must be installed to completely shut off flow to both basins of the Disinfection Contact Tank.

When removing the stop logs from the installed position, the hooks will automatically engage the lifting holes once the lifting device is lowered into place. Occasionally, the lanyard will need to be pulled to engage the stop log. All seven stop logs should be removed from the frame to return the Disinfection Contact Tank to service.

Jib Crane and Hoist

A jib crane is installed on the top slab of the Disinfection Contact Tank for moving the stop logs from the stop log storage rack to their installed location in the influent chamber. The stop log storage rack is located adjacent to the disinfection tank northeast of the Influent Junction Box. Information for the jib crane and electric hoist is provided below in ***Table 6.2-7***.

Table 6.2-7 Disinfection Contact Tank – Jib Crane and Hoist

Parameter	Value
Jib Crane	
Manufacturer:	Gorbel
Type:	Free Standing
Model Number:	WSJ360-1000-10-10
Capacity:	1000 lbs
Height Under Boom (HUB):	10’
Span:	10’
Mast Diameter:	12-3/4”
Hoist	
Manufacturer:	Harrington
Type:	Electric Chain Hoist
Model Number:	SNER005S
Capacity:	1000 lbs
Lifting Speed:	15 ft/min
Output:	0.6 hp

Before using the jib crane, the operator should be sure the hook is high enough to clear any obstruction. Before a load is handled by the crane, the jib boom should be brought into position so that it is directly over the load. The jib boom should be moved gradually toward the desired location. Before lifting any of the stop logs, the hoist should be positioned directly over the storage rack or frame within the disinfection tank. Failure to center the hoist over the stop log may cause it to swing upon lifting. Always start the trolley motion slowly and reduce the trolley speed gradually. A list of recommended operational practices from Gorbel is provided below:

1. The crane should be moved smoothly and gradually to avoid abrupt, jerky movements of the load. Slack must be removed from the sling and hoisting ropes before the load is lifted.
2. Center the crane over the load before starting the hoist to avoid swinging the load as the lift is started. Loads should not be swung by the crane to reach areas not under the crane.
3. Crane-hoisting ropes should be kept vertical. Cranes shall not be used for side pulls.
4. Be sure everyone in the immediate area is clear of the load and aware that a load is being moved.
5. Do not make lifts beyond the rated load capacity (1000 lbs,) of the crane, sling chains, rope slings, etc.
6. Make certain that before moving the load, load slings, load chains, or other lifting devices are fully seated in the saddle of the hook with the hook latch closed.
7. Check that the load is lifted high enough to clear all obstructions when moving boom or trolley.

8. At no time should a load be left suspended from the crane unless the operator has the push button with the power on. Under this condition, keep the load as close as possible to the ground to minimize the possibility of an injury if the load should drop. When the crane is holding a load, the operator should always remain at the push button.

9. Do not lift loads with sling hooks hanging loose. If all sling hooks are not needed, they should be stored properly or use a different sling.

10. All slings or cables should be removed from the crane hooks when not in use.

11. Operators shall not carry loads or empty blocks over personnel.

12. Whenever the operator leaves the crane, the following procedure should be followed:

    a. Raise all hooks to an intermediate position.

    b. Spot the crane at an approved designated location.

    c. Place all controls in the "off" position.

    d. Open the main switch to the "off" position.

    e. Make visual check before leaving the crane.

13. In case of emergency or during inspection, repair, cleaning, or lubrication, a warning sign should be displayed, and the main switch should be locked in the "off" position. This should be done whether the work is being performed by the crane operator or by others.

14. Contact with rotation stops and trolley end stops shall be made with extreme caution. The operator should do so with particular care for the safety of persons near the crane.

Mud Valves

A series of mud valves can be used to drain each basin or the entire Disinfection Contact Tank. The effluent channel can be drained separately from the main compartments of the tank. A summary of these mud valves is provided in ***Table 6.2-8.***

Table 6.2-8 Disinfection Contact Tank – Mud Valves

Valve Number	Diameter, inches	Location	Operator
DIS-MV-1	8	East Basin of Disinfection Contact Tank	Stem w/ 2" Nut
DIS-MV-2	8	East Basin of Disinfection Contact Tank	Stem w/ 2" Nut
DIS-MV-3	8	East Basin of Disinfection Contact Tank	Stem w/ 2" Nut
DIS-MV-4	8	West Basin of Disinfection Contact Tank	Stem w/ 2" Nut
DIS-MV-5	8	West Basin of Disinfection Contact Tank	Stem w/ 2" Nut
DIS-MV-6	8	West Basin of Disinfection Contact Tank	Stem w/ 2" Nut
DIS-MV-7	8	Disinfection Contact Tank effluent channel	Stem w/ 2" Nut

The mud valves are manufactured by Troy Valve and are constructed of Grade 316 stainless steel. Each valve can be operated from the operating level above the tank with a 2" square nut connected to the mud valve by a stainless-steel extension stem. When accessible after a tank draining operation is performed, the stem and lifting nut within the plug of each valve should be lubricated with a quality grease.

Each 8" drain line connects to a 12" drain header underneath the Disinfection Contact Tank. The drain headers combine into a single 12" pipe that conveys drain flow to the Drain Pump Station, which is discussed in further detail in ***Section 6.5 Drain Pump Station***. This pump station accepts flow from the underdrains of the Disinfection Contact Tank and Clarifiers 5N/5S.

WARNING: The Disinfection Contact Tank shall not be drained when groundwater levels exceed 208.00' as measured at the monitoring wells in the vicinity of the disinfection tank. Warning signs are posted near the Disinfection Contact Tank and at the Drain Pump Station to remind operators of this requirement. The groundwater level should be monitored hourly while a tank is drained.

Tank Draining Warning Sign

Sampling

Samples are taken from both the influent and effluent chambers of the Disinfection Contact Tank to provide pre-disinfection and post-disinfection data. A stainless-steel well pump is installed within a 6-inch casing at each sample point. A lifting cable is provided at each sample point to remove the pumps. Flow discharges from each pump through tubing and Schedule 80 PVC piping to the Sampler Building, located immediately north of the Disinfection Contact Tank. Two automatic samplers are installed in the Sampler Building on top of refrigerators. Information on the sample pumps and automatic samplers is provided in ***Table 6.2-9***.

Table 6.2-9 Disinfection Contact Tank – Sampling Equipment

Parameter	Value
Sample Pumps	
Quantity:	2
Manufacturer:	Sta-Rite
Model:	HS Series Signature 2000
Part Number:	S15P4HS05121
Type:	Well Pump
Shell Material of Construction:	Grade 300 Stainless Steel
Diameter:	3-7/8”
Discharge Bearing:	Self-lubricating Nylatron
Discharge Connection:	1-1/4” NPT
Nominal Capacity:	15 gpm
Motor:	½ hp
Automatic Samplers	
Quantity:	2
Manufacturer:	N-CON
Model:	Sentinel M96
Inlet Connection:	2” NPT
Discharge Connection:	3” NPT
Weight:	60 lbs (excluding refrigerator)
Programmer Rating:	NEMA 4X

The samplers are used to automatically collect, composite, and refrigerate samples from the Disinfection Contact Tank. Liquid to be sampled flows into the sampling chamber and is mixed. An oscillating, constant volume dipper collects samples from the sampling chamber, and any flow not captured by the dipper exits the sampling chamber through a 3” line that drains back to the disinfection tank. The dipper periodically enters the liquid and removes a 24 mL sample then returns to the raised position. Collected sample flows from the dipper through tubing to the sample storage container, which is kept in the stainless-steel refrigerator beneath the sampler.

An on-board PLC on the samplers can be programmed for time cycle sampling or proportional sampling. An operator can also initiate a manual sample from the PLC. The sample count must be reset each time a composite sample is picked up. Pressing the return key on the PLC or the Reset button will reset the count. A rotameter is installed upstream of each sampler to provide visual flow measurement, and globe valves are installed to adjust the flow rate delivered to each sampler.

6.2.5 Maintenance

Process Maintenance

The general maintenance for the disinfection contact tanks equipment can be found in the original manufacturer’s operations and maintenance manuals. The process maintenance for the disinfection contact tanks consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Slide Gates and Stop Logs

Materials of construction for the slide gates are summarized in ***Table 6.2-10*** below.

Table 6.2-10 Slide Gates – Materials of Construction

Component	Material	Standard
Wall Thimble	316L Stainless Steel	ASTM A240
Frame	316L Stainless Steel	ASTM A240
Slide	316L Stainless Steel	ASTM A240
Stem	316 Stainless Steel	ASTM A240
Stop Collar	Bronze C95400	ASTM B505
Guide Seals and Top Seal	UHMWPE	ASTM D4020
Invert Seal	EPDM	ASTM D2000
Stem Guide Bracket	316L Stainless Steel	ASTM A240
Stem Guide Bushing	UHMWPE	ASTM D4020
Stem Cover	Clear Butyrate	n/a
Gearbox Lift Nut	Bronze C95800	ASTM B505
Fasteners	316 Stainless Steel	ASTM A240
Anchor Studs	316 Stainless Steel	ASTM A240

The slide gates should be visually inspected at regular intervals (at least every six months) for signs of misalignment or damage. The stem should be regularly inspected to ensure it is free of debris and properly lubricated. Operating stems should be cleaned and greased at least once every six months. This is especially important due to the large size of these gates. Stems should be cleaned with a brush with stainless steel or brass bristles. Steel bristles should not be used. A grinder with circular bristle wheels should not be used as this will damage the threads. Recommended lubricants include Mobil Unirex EP2, PetroCanada Precision XL3 Moly EP2, and PetroCanada Precision XL5 Moly EP2.

To ensure that the electric actuators are ready to operate when needed, a test run should be performed on each gate at least every six months. The bolts between the actuator and gearbox should be checked for tightness annually. The gear housings for the actuators are filled with lubricant in the factory. A grease change is recommended every 10 – 12 years, or sooner if the gates are operated frequently. The recommended lubricant for the actuators is F15 – Shell ALVANIA 1029 grease.

The stop logs and lifting device should be visually inspected annually for signs of damage to seals and for obstructions inside the frame or other damage. Functionality of the lanyard release on the lifting device should be checked annually. The stop log storage rack should be covered when the stop logs are not installed in the disinfection tank to avoid direct exposure to sunlight.

Contact information for the service representative for the slide gates and stop logs is listed below in ***Table 6.2-11***.

Table 6.2-11 Contact Information – Slide Gates and Stop Logs

Service Representative	
Name:	Gulf States Engineering Co.
Address:	8381 Industrial Drive Olive Branch, MS 38654
Phone:	662-890-4768
Fax:	662-890-4769
Website:	www.gsengr.com

Jib Crane and Hoist

An inspection and maintenance schedule for the jib crane components is provided below in ***Table 6.2-12***.

Table 6.2-12 Jib Crane – Inspection and Maintenance Schedule

Component	Maintenance	Frequency
Hoist Trolley	Check clevis pin for wear. Cotter pin should be fully wrapped around clevis. Replace cotter pin if cracked or fatigued.	Every 2000 hours or yearly
End Stop	Check for full compression of lock washer.	Every 2000 hours or yearly
Wheels	Check for cracks, pits, and/or grooves. All these increase pull forces. If any of these conditions exist, wheels should be replaced.	Every 2000 hours or yearly
Trunnion Rollers or Cam Followers	Check to make sure both rollers have full face contact with pipe and lock washers are compressed. Check to see that cam guard is installed.	Every 1000 hours or 6 months
Pivot Pin(s)	Check that cotter pin or retaining pin and O-rings are properly installed so that boom cannot dislodge.	Every 2000 hours or yearly
Anchor Bolts	Check that lock washers are compressed, and nuts tightened to full compression.	Every 500 hours or 3 months
Accessory Items	Conduct a general inspection of all accessory items.	Every 1000 hours or 6 months

It is not necessary to lubricate the track or bearings, as lubricating may attract airborne particles and may increase the rolling resistance. Do not use substances such as WD40, silicone sprays, oil, or grease.

The operation of a motorized hoist involves more than simply activating the hoist controls. The use of an overhead hoist is subject to certain hazards that cannot be mitigated by engineered features, but only by the exercise of intelligence, care, common sense, and experience in anticipating the effects and results of activating the hoist controls. All hoist operators should be required to read the operations section of the Harrington manual prior to operating the crane.

Methods and criteria for inspection of the electric hoist are presented below in ***Table 6.2-13***. Since it is likely that the hoist will be used infrequently, these inspections should be performed prior to each usage of the hoist.

Table 6.2-13 Electric Hoist – Inspection and Maintenance Schedule

Component	Inspection Criteria	Action
Functional Operating Mechanisms.	Mechanisms should be properly adjusted and should not produce unusual sounds when operated.	Repair or replace as required.
Limit Switch	Proper operation. Actuation of limit switch should stop hoist.	Repair or replace as required.
Limit Lever Assembly	Lever should not be bent or significantly worn and should be able to move freely.	Replace.
Braking System Operation	Braking distance with rated capacity should not exceed 3% of the lifting speed (approximately two chain links)	Repair or replace as required.
Hooks – Surface Condition	Hooks should be fee of significant rust, weld splatter, deep nicks, or gouges.	Replace.
Hooks – Fretting Wear	The hook dimensions should not be less than the discard value listed in the manufacturer manual.	Replace.
Hooks – Bent Shank or Neck	Shank and neck portions of hook should be free of deformations.	Replace.
Hooks – Yoke Assembly	The yoke assembly should be free of significant rust, weld splatter, nicks, and gouges. Hose should not be elongated, fasteners should not be loose, and there should be no gap between mating parts.	Tighten or replace as required.
Hooks – Swivel Bearing	The swivel bearing parts and surfaces should not show significant wear, and should be free of dirt, grime, and deformations. Hook should rotate freely with no roughness.	Clean/lubricate or replace as required.
Hooks – Idle Sheave and Axle	Pockets of Idle Sheave should be free of significant wear. Idle Sheave surfaces should be free of nicks, gouges, dirt, and grime. Bearing parts and surfaces of Idle Sheave and Axle should not show significant wear. Idle Sheave should rotate freely with no roughness or significant free play.	Clean/lubricate or replace as required.
Hooks – Hook Latches	Latch should not be deformed. Attachment of latch to hook should not be loose. Latch spring should not be missing and should not be weak. Latch movement should not be stiff. When depressed and released latch should snap smartly to its closed position.	Replace.
Load Chain – Surface Condition	Should be free of rust, nicks, gouges, dents, and weld splatter. Links should not be deformed and should not show signs of abrasion. Surfaces where links bear on one another should be free of significant wear.	Replace.

Table 6.2-13 Electric Hoist – Inspection and Maintenance Schedule

Component	Inspection Criteria	Action
Load Chain – Pitch and Wire Diameter	Dimensions should within ranges listed in Harrington manual.	Replace. Inspect Load Sheave
Load Chain – Lubrication	Entire surface of each chain link should be coated with lubricant and should be free of dirt and grim. Chain should not emit cracking noise when hoisting a load.	Clean/lubricate
Load Chain – Reeving	Chain should be reeved properly through Load Sheave. Chain, chain springs, cushion rubbers, striker plates, and stoppers should be installed properly.	Reeve/install chain properly.
Housing and Mechanical Components	Hoist components, including load blocks, suspension housing, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins, and rollers should be free of cracks, distortion, significant wear, and corrosion. Evidence can be detected visually or via detection of unusual sounds of vibration during operation.	Replace.
Gaskets and Sealing Enclosures	Gaskets and sealing enclosures must be in good condition and installed properly to preserve the rating of the hoist.	Replace.
Bolts, Nuts and Rivets	Bolts, nuts, and rivets should not be loose.	Tighten or replace as required.
Motor Brake	Motor brake gap should be adjusted before measuring the brake wear. Brake lining dimension should not be less than dimension listed in Harrington manual. Braking surfaces should be clean, free of grease/oil and should not be glazed.	Adjust, repair, or replace as required.
Contractor Contacts	Contacts should be free of significant pitting or deterioration. Check the contactor cycles for Count/Hour meter.	Replace.
Load Sheave	Pockets of Load Sheave should be free of significant wear.	Replace.
Cushion Rubber	Should be free of significant deformation.	Replace.
Chain Springs	Chain springs should not be deformed or compressed.	Replace.
Pendant – Switches	Depressing and releasing pushbuttons should make and break contacts in switch contact block and result in corresponding electrical continuity or open circuit. Pushbuttons should be interlocked either mechanically or electrically to prevent simultaneous energization of circuits for both up and down motion.	Repair or replace, as necessary.
Pendant – Housing	Housing should be free of cracks and mating surfaces of parts should seal without gaps.	Replace.
Pendant – Wiring	Wire connections to switches in pendant should not be loose or damaged.	Tighten or repair.
Pendant – Cord	Surface of cord should be free from nicks, gouges, and abrasions. Each conductor in cord should have 100% electrical continuity even when cord is flexed back and forth. Pendant Cord Strain Relief Cable should absorb all load associated with forces applied to the pendant.	Replace.
Pendant – Labels	Labels denoting functions should be legible.	Replace.
Warning Labels	Warning labels should be affixed to the hoist, and they should be legible.	Replace.
Hoist Capacity Label	The label that indicates the capacity of the hoist should be legible and securely attached.	Replace.

The bearing surfaces of the load chain should be lubricated with Harrington lubricating grease (Part No. ER1BS1951) or an equivalent to industrial general lithium grease. The chain should be lubricated every three months. Bearings and hooks should be cleaned and lubricated at least once per year, and suspension pins at least twice per year.

The oil level in the gear box can be checked using the oil check hole on the side of the hoist body. With the hoist level, the oil level should be at least ½" below bottom edge of check hole and at most even with the bottom edge of the check hole. Gear oil should be changed at least once every 5 years. To change the oil, remove both fill, drain plugs, and allow the old oil to drain completely. Replace the drain plug and refill the gear case with new oil until the level is within the correct range.

A troubleshooting guide for the electric hoist is included below in ***Table 6.2-14.***

Table 6.2-14 Troubleshooting Guide – Electric Hoist

Problem	Probable Cause	Recommended Action
Hoist moving in wrong direction.	Power supply reversed phased	Switch the 2 power supply cord wires at the power source.
	Improper electrical connections	Refer to wiring diagram and check all connections.
Hoist will not operate.	Loss of power	Check circuit breakers, switches, fuses, and connections on power lines/cable.
	Wrong voltage or frequency	Check voltage and frequency of power supply against the rating on the nameplate of the motor.
	Hoist overload	Reduce load to within rated capacity of hoist.
	Motor overheated and optional thermal overload protector has tripped.	
	Improper, loose, or broken wire in hoist electrical system	Shut off power supply, check wiring connections on hoist control panel and inside push-button pendant.
	Brake does not release	Check motor brake adjustment for proper clearance.
	Faulty magnetic contactor	Check coil for open or short circuit. Check all connections in the control circuit. Check for open contactors. Replace as needed.
	Defect in control transformer	Check transformer coil for signs of overheating. Disconnect transformer and check for open winding.
	Motor burned out	Replace motor frame/stator, shaft/rotor, and any other damaged parts.
	Faulty start switch	Disconnect start switch from motor. The resistance between the start switch terminals 2 and 3 should be greater than 500 ohms. If not, consult factory.
	Faulty start capacitors	Check capacitors for open or short circuit. Check connections. Replace as needed.

Table 6.2-14 Troubleshooting Guide – Electric Hoist

Problem	Probable Cause	Recommended Action
Hoist lifts but will not lower	Down circuit open	Check circuit for loose connections. Check downside of limit switch for malfunction.
	Broken conductor in pendant cord	Check the continuity for each conductor in the cable. If one is broken, replace entire cable.
	Faulty magnetic contactors	Check coils for open or short circuit. Check all connections on motor circuit. Check for burned contacts. Replace as needed.
	Faulty switch in pendant	Check electrical continuity. Check electrical connections. Replace or repair as needed.
Hoist lowers but will not lift	Hoist overloaded	Reduce load to within rated capacity of hoist.
	Low voltage in hoist power supply	Determine cause of low voltage and bring to within +/- 10% of the voltage on the motor nameplate. The voltage should be measured at the hoist contactor.
	Up circuit open	Check circuit for loose connections. Check upside of limit switch for malfunction.
	Broken conductor in pendant cord	Check the continuity of each conductor in the cable. If one is broken replace entire cable.
	Faulty magnetic contactor	Check coil for open or short circuit. Check all connections in the control circuit. Check for open contactors. Replace as needed.
	Faulty switch in pendant	Check electrical continuity. Check electrical connections. Replace or repair as needed.
	Faulty friction clutch	If abnormal operation or slippage occurs do NOT attempt to disassemble or adjust the Friction Clutch. Replace the worn or malfunctioning Friction Clutch as an assembly with a new, factory adjusted part.
Hoist will not lift rated load or does not have the proper lifting speed	Hoist overloaded	Reduce load to within rated capacity of hoist.
	Low voltage in hoist power supply	Determine cause of low voltage and bring to within +/- 10% of the voltage on the motor nameplate. The voltage should be measured at the hoist contactor.
	Brake drags	Check motor brake adjustment for proper clearance.
	Faulty friction clutch	If abnormal operation or slippage occurs do NOT attempt to disassemble or adjust the Friction Clutch. Replace the worn or malfunctioning Friction Clutch as an assembly with a new, factory adjusted part.
Load drifts excessively when hoist is stopped	Motor brake not holding	Clean and inspect brake lining. Check brake adjustment for proper clearance.
Motor or brake overheating	Excessive load.	Reduce load to within rated capacity of hoist.
	Excessive duty cycle	Reduce frequency of lifts.
	Wrong voltage or frequency	Check voltage and frequency of power supply against the rating on the nameplate on the motor.
	Brake drags	Check motor brake adjustment for proper clearance.
	Extreme external heating	Above an ambient temperature of 140°F, the frequency of hoist operation must be reduced to avoid overheating of the motor. Special provisions should be made to ventilate the hoist or otherwise shield it from the heat.

Table 6.2-14 Troubleshooting Guide – Electric Hoist

Problem	Probable Cause	Recommended Action
Hoist operates intermittently	Collectors making poor contact	Check movement of spring-loaded arm, weak spring, connections, and shoe. Replace as needed.
	Contactor contacts arcing	Check for burned contacts. Replace as needed.
	Loose connection in circuit	Check all wires and terminals for bad connections. Replace as needed.
	Broken conductor in pendant cord	Check for intermittent continuity in each conductor in the pendant cord. Replace entire pendant cord if continuity is not constant.

The service representative for the jib crane and hoist is listed below in ***Table 6.2-15.***

Table 6.2-15 Contact Information – Jib Crane and Hoist

Service Representative	
Name:	Jeff Goodwin – LK Goodwin Company
Address:	20 Technology Way West Greenwich, RI 02817
Phone:	(800) 343-2478
Fax:	(401) 781-2880
E-mail:	jgoodwin@lkgoodwin.com

Mud Valves

Each mud valve is provided with a mechanical position indicator. When the mud valves are in the closed position, the position indicator should read 0000.0 turns. A sticker provided on each position indicator displays the number of turns required to fully open each valve. The stem that passes through each indicator should be routinely lubricated with dielectric, food-grade, clear grease to prevent damage to the silicone sleeve during actuation. The bronze bushing and stainless stem should be periodically checked for excessive wear. If excessive wear is observed, the plumbness of the stem should be verified before replacing any parts. The silicone enclosure sleeve may take on a yellowish tint after several years, especially since these valves are exposed to direct sunlight.

Replacement parts are available from Troy Valve upon request. The service representative for the mud valves is listed below in ***Table 6.2-16.***

Table 6.2-16 Contact Information – Mud Valve

Service Representative	
Name:	Josh Wilburn – Consolidated Pipe & Supply Co.
Address:	190 Mann Dr Collierville, TN 38017
Phone:	(901) 850-3200
Fax:	(901) 850-3201
E-mail:	josh.wilburn@cpspipe.com

Level Instruments

A troubleshooting guide for the dBMach3 transmitters is provided below in ***Table 6.2-17***. PeroxyChem is responsible for calibrating these instruments annually, and City staff shall not perform any calibration work on them.

Table 6.2-17 Troubleshooting Guide – dBMach 3 Transmitters

Symptom	Remedy
Display blank, transducer not firing.	Check power supply, voltage selector switch and fuse.
Displays "No Xducer"	Check wiring to transducer.
Displays "Xducer Flt"	There is a fault with the transducer wiring, so check wiring to transducer.
Incorrect reading being displayed for current level.	Measure actual distance from transducer head to surface of material. Enter Program Mode and directly access P21 (Set Distance) type in the measured distance, ENTER, ENTER again when prompted, wait until SET displayed and return to Run Mode, display should now update to correct reading.
Material level is consistently incorrect by the same amount.	Check empty level (P15), display offset (P802), and measurement offset (P851).
LED's change color at relevant relay switch points but relays do not change state.	Check supply to unit and ensure voltage selector set to correct position.

Samplers

A recommended maintenance schedule for the samplers is provided in ***Table 6.2-18.*** The sampler requires no lubrication.

Table 6.2-18 Maintenance Schedule – Automatic Samplers

Frequency	Activity
Daily	Clean up any spills.
	Check sample dipper and clean with paper towel, as necessary.
	Check sample delivery tube. Clean, as necessary.
	Check operating temperature of refrigerator and adjust, as necessary.
	Check sampler operation by pressing yellow +/- TEST button. Be sure to have a container in the refrigerator to collect sample.
	Reset the counter by pressing on the external reset button.
	Replace filled sample container with a clean, empty container.
Weekly	Defrost refrigerator as needed. NEVER use a sharp tool to remove ice from the evaporator.
	Clean condensate or any spills from the refrigerator.
Monthly	Clean entire sampler with FANTASTIC, 409, or another non-abrasive cleaner.

A troubleshooting guide for the automatic samplers is provided in ***Table 6.2-19***. Always disconnect the sampler from power before attempting service.

Table 6.2-19 Troubleshooting Guide – Automatic Samplers

Problem	Possible Cause	Check	Required Action
Sampler totally inoperative	Unit disconnected from power source	Fuse or circuit breaker	Reconnect
	Programmer disconnected	Check connection	Reconnect
	Open circuit to control	Check wire and connection continuities	Repair/reconnect, as necessary
Sampler shuts down prematurely	PLC was not reset when the sample picked up	PLC reads “Finished”	Reset PLC
Timer operates but dipper does not return	Relay 1CR inoperative	Observe relay operation or replace	Replace relay if defective
	Open circuit in motor operator	Check for resistance across motor operator circuits	Replace motor operator if defective
	Open circuit in wiring	Check wiring	Reconnect where necessary
Sample storage temperature too hot	Refrigerator unplugged	Check refrigerator plug	Connect plug
	Thermostat set too high, or thermostat contacts open	Test by setting temperature as cold as it can go and see if compressor comes on	Have refrigeration repair service check
Sample storage temperature too cold	Thermostat contacts stuck closed Slow leak of gas from refrigerator		Have refrigeration repair service check

Contact information for the service representative for the automatic samplers is provided in ***Table 6.2-20.***

Table 6.2-20 Contact Information – Automatic Samplers

Service Representative	
Name:	N-Con Systems Co., Inc. Bly Hartley)
Address:	130 Old Edwards Rd Arnoldsville, GA 30619
Phone:	706 389-9600
E-mail:	bly@n-con.com nconsystems@gmail.com
Website:	www.n-con.com

6.2.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

6.3 Effluent Water System

6.3.1 Overview

The Disinfection Contact Tank has four Disinfected Effluent Water Pumps to supply disinfected effluent water to the Effluent Water System Wet Well. The disinfected effluent water is then fed by gravity through a 24-inch line to the Non-Potable Effluent Water Pumps in the Pipe Gallery to be distributed across the Maxson WWTF for washdown and other non-potable water needs.

Four submersible Disinfected Effluent Water Pumps are located at the south end of the Disinfection Contact Tank, two pumps in each basin, east and west sides, directly upstream of the flow measurement weir and upstream of the Disinfection Contact Tank Effluent Channel. Each Disinfected Effluent Water Pump conveys disinfected effluent water across the Disinfection Tank Effluent Channel through a pressure switch/gauge assembly and a check valve before going underground to the Effluent Water Wet Well, which is directly south of the Clarifier Junction Box.

The Effluent Water Wet Well can receive effluent water from either the Disinfected Effluent Water Pumps or by opening a 24" slide gate to provide flow from the Clarifier Effluent Junction Box. The Effluent Water Wet Well is equipped with an ultrasonic level sensor and a level switch to monitor the wet well level.

From the Effluent Water Wet Well, effluent water goes to the Non-Potable Effluent Water Pumps, located in the Pipe Gallery, to be distributed across the Maxson WWTF as needed.

Effluent Water Pumps

The four submersible non-clog wastewater pumps are tagged using the following nomenclature:

East Side

- Disinfected Effluent Water Pump 1 (DIS-P-1)
- Disinfected Effluent Water Pump 2 (DIS-P-2)

West Side

- Disinfected Effluent Water Pump 3 (DIS-P-3)
- Disinfected Effluent Water Pump 4 (DIS-P-4)

The photograph below shows two of the Disinfected Effluent Water Pumps.

Disinfected Effluent Water Pumps (Typical)

Figure 6.3-1 Effluent Pump Station General Layout provides a plan view of the Effluent Pump Station and surrounding structures.

Figure 6.3-2 Effluent Pump Station Plans provides plan views of the Effluent Pump Station at three different elevations.

The photograph below shows the four Non-Potable Effluent Water Pumps located in the Pipe Gallery.

Non-Potable Effluent Water Pumps

The major components for the Effluent Water System include the following:

- Disinfection Contact Tank
- 4- Disinfected Effluent Water Pumps
- 2- Davit Crane System and Pump Guide Rails
- Level Sensing Instrumentation
- Valves, Piping, and Other Appurtenances
  - Pressure Switch and Pressure Gauge Assembly
  - Check Valves with Limit Switches
  - Plug Valves
  - Air Vacuum Valves
- Motor Controls with VFDs
- Buried Effluent Water Bypass Valve
- Non-Potable Effluent Water Pumps

6.3.2 Process Control

Process Components

The major components associated with the Effluent Water Pump System are summarized below. In addition, the design criteria associated with the effluent water pumps is provided in tabular form.

Disinfection Contact Tank

The Disinfection Contact Tank was constructed to provide the necessary Peracetic Acid (PAA) contact time. The Disinfection Contact Tank is separated into two parallel basins. Each basin of the tank includes an effluent weir. The tank includes an effluent channel downstream of the tank effluent weirs to convey out of the Disinfection Contact Tank. The Effluent Water Pumps are located at the end of the Disinfection Contact Tank east and west sides and upstream of the effluent weir.

Disinfected Effluent Water Pumps

The four Disinfected Effluent Water Pumps are submersible non-clog wastewater pumps, each equipped with a 20hp submersible electric motor and controlled by a variable frequency drive (VFD) that allows the pump to vary the volume of liquid it pumps to the Effluent Water Wet Well.

The operation of the Disinfected Effluent Water Pumps is based on the need to maintain effluent water to the downstream Effluent Water System Wet Well that supplies the Non-Potable Effluent Water Pumps. The Disinfected Effluent Water Pumps maintain the hydraulic level of the Effluent Water System Wet Well and are controlled through VFDs to allow variations in the pump speeds to meet the changing downstream flow conditions required. The disinfected effluent water is pumped to the Effluent Water System Wet Well based on a pre-set level in the wet well. The pumps are setup in a Lead/Lag/Standby-1/Standby-2 configuration that changes daily.

Non-Potable Effluent Water Pumps

The operation of the four Non-Potable Effluent Water Pumps is based on effluent water demand at the plant. The motor controls are in the Motor Control Center (MCC) MSB-2 in the Return Sludge Pumping Station in the Pipe Gallery. Local controls for the pumps are at the pumps. Remote control of the pumps is accomplished through automatic programming logic at the Emerson Ovation Process Control System (PCS) that is accessed through the various Workstations of the Maxson plant. These components must all function properly to provide the flow of disinfected effluent water to Non-Potable Effluent Water system throughout the plant.

Davit Crane System and Pump Guide Rails

The two davit cranes serve to lift and remove the disinfected effluent water pumps as well as lower the pumps into place to automatically and firmly connect to the discharge connection.

Level Sensing Instrumentation

The Disinfected Effluent Water Pumps use a non-contact ultrasonic level sensor to monitor the hydraulic level of the Effluent Wet Well. The system sends a 4-20mA output that is used to control the Disinfected Effluent Water Pumps. The backup level system is a level float switch that is activated on a high-high water level and will send a signal to the Emerson Ovation control system to stop any running Disinfected Effluent Water pump.

Disinfected Effluent Water Pump Valves, Piping, and Other Appurtenances

Each of the Disinfected Effluent Water Pumps has a 6-inch diameter discharge connection that increases to an 8-inch diameter discharge pipe while rising vertically before travelling through the tank wall, over the Disinfection Contact Tank Effluent Channel. The pipe continues above ground past a pressure gauge/switch assembly and air vacuum valve, and then through a check valve and plug valve. These individual 8-inch diameter pipes from each pumps' respective discharge point combine into a single 12-inch diameter header that sends the flow to the Effluent Water Wet Well.

Motor Controls with VFDs

The motor controls for the Disinfected Effluent Water Pumps are in the Disinfection IPA Electrical Building. The electrical room houses all the low and high voltage system for the Disinfected Effluent Water Pumps.

The photograph below shows a typical VFD keypad for the Disinfected Effluent Water Pumps at the motor control center (MCC).

Typical VFD Keypad for Disinfected Effluent Water Pumps at the MCC

Buried Effluent Water Bypass Valve

A buried 24-inch valve between the Clarifier Effluent Junction Box and the Effluent Water Wet Well can be used to bypass the disinfected effluent water flow to the Non-Potable Effluent Water Pumps. Opening this valve allows for non-disinfected effluent water to be used for the effluent water system instead of the disinfected effluent water from the Disinfected Effluent Water Pumps.

24-Inch Effluent Water Bypass Valve

Non-Potable Effluent Water Pumps

The four Non-Potable Effluent Water Pumps, located in the Pipe Gallery, are horizontal centrifugal wastewater pumps tagged using the following nomenclature:

- E-188
- E-189
- E-190
- E-191

The Non-Potable Effluent Water Pumps supply reclaimed water to the on-site water reuse loop that provides reuse water for various process equipment, on-site hoses, pipeline flushing, and other systems that support the Maxson WWTF.

Major Process Valves

Table ***6.3-1*** describes the process valves that are integral to the operation of the effluent water pumps.

Table 6.3-1 Disinfected Effluent and Non-Potable Water Pump Process Valves

Valve Tag	Size	Normal Operating Position	Purpose
Disinfected Effluent Water Pump Process Valves			
DIS-AVV-1	2-inch	Closed	Vent Air
DIS-AVV-2	2-inch	Closed	Vent Air
DIS-AVV-3	2-inch	Closed	Vent Air
DIS-AVV-4	2-inch	Closed	Vent Air
DIS-RFCV-3	8-inch	Open	Check Valve
DIS-RSCV-4	8-inch	Open	Check Valve
DIS-RSCV-5	8-inch	Open	Check Valve
DIS-RSCV-6	8-inch	Open	Check Valve
DIS-PV-4	8-inch	Open	Plug Valve
DIS-PV-5	8-inch	Open	Plug Valve
DIS-PV-6	8-inch	Open	Plug Valve
DIS-PV-7	8-inch	Open	Plug Valve
Non-Potable Water Pumps Process Valves			
DIS-BFV-1	24-inch	Closed	Effluent Water Bypass
V-324	10-inch	Open	Suction Plug Valve
V-325	10-inch	Open	Suction Plug Valve
V-326	10-inch	Open	Suction Plug Valve
V-327	10-inch	Open	Suction Plug Valve
V-328	8-inch	Open	Check Valve
V-329	8-inch	Open	Check Valve
V-330	8-inch	Open	Check Valve
V-331	8-inch	Open	Check Valve
V-332	8-inch	Open	Discharge Plug Valve
V-333	8-inch	Open	Discharge Plug Valve
V-334	8-inch	Open	Discharge Plug Valve
V-335	8-inch	Open	Discharge Plug Valve

Design Criteria and Nameplate Data

Table 6.3-2 provides the design specifications for the Disinfected Effluent Water Pumps.

Table 6.3-2 System Data – Disinfected Effluent Water Pumps

Component/Criteria	Value
Effluent Water Pumps	
Manufacturer:	Flygt
Model Number:	NP 3153 MT 3 (435)
Number of Units:	4
Rated HP:	20
Minimum Motor Full Load Speed (rpm):	1760
Maximum Allowed Motor (FLA):	26
Motor Design Voltage/Phase/Hertz:	460/3/60
Suction Size (inch):	5-7/8
Discharge Size (inch):	5-7/8
Minimum Pump Shut-Off Head at Design Speed (feet):	42.3
Design Capacity (design) (gpm):	1030
TDH at Design Capacity (feet):	42.3
Primary Capacity (design) (gpm):	1980
TDH at Primary Capacity (feet):	10.9
Secondary Capacity (gpm):	750
Minimum TDH at Secondary Capacity (feet):	50
Maximum NPSH Required @ Secondary TDH (feet):	23.3
Impeller Dia. (inch):	8-9/16
Pump Weight (lbs):	485
Non-Potable Effluent Water Pumps	
Manufacturer:	WDM Worthington
Model Number:	HSR 5x6x16
Number of Units:	4
Rated HP:	50
Motor Design Voltage/Phase/Hertz:	460/3/60
Rated Power (KW):	37.3
Suction Size (inch):	8”
Discharge Size (inch):	5”
Primary Capacity (design) (gpm):	1000
TDH at Primary Capacity (feet):	160

6.3.3 Equipment Control

General

The four Effluent Water Pumps pump disinfected effluent water to the Effluent Water Wet Well, which supplies the Non-Potable Effluent Water Pumps. The Non-Potable Effluent Water Pumps distribute the disinfected effluent water across the site as required.

The Effluent Water Pump system normally operates in automatic, and the pumps are activated by an adjustable hydraulic level control setpoint based of the Disinfected Effluent Channel effluent water wet well.

The Non-Potable Effluent Water Pumps are controlled locally at the motor control center located in the Disinfection IPA Building or remotely using the Emerson Ovation system. Non-Potable Effluent Water Flow is monitored by flow meter M-164 (0-4000 gpm). Each Non-Potable Effluent Water Pump has the following:

- Inlet pressure gauge 0 – 30 psig
- Discharge pressure gauge 0 – 100 psig
- Oil reservoir

Disinfection IPA Motor Control Center

Table 6.3-3 provides the local controls and monitoring located at the motor control center (MCC) for the Disinfected Effluent Water Pumps.

Table 6.3-3 Motor Control Center – Disinfected Effluent Water Pumps

Control Name/Location	Features	Function
On-Trip-Off	Main Breaker	"On" position allows electrical power from the MCC to the local disconnect to the equipment controls. "Off" position stops all power from the electrical panel to the equipment controls. "Reset" allows breaker to be reset after circuit overload has been corrected.
On-Off	Control Power	In the "On" position, the panel is energized. In the "Off" position, the panel is not energized.
Hand-Off-Auto	Three-way Switch	The "Hand" position allows the pump to be controlled locally. The "Off" position will prevent the pump from operating. The "Auto" position allows the actuator to be controlled through the plant's control system.
Pump Speed	Potentiometer Knob	Speed percentage for variable drive motor speed. Minimum speed is 50% for the effluent water pumps.
Start	Black Pushbutton	Depressing the pushbutton will start the pump.
Stop	Red Pushbutton	Depressing the pushbutton will stop the pump
Press Alarm Reset	Black Pushbutton	Depressing the pushbutton will clear the pump alarm once the alarm condition has been corrected.
Emergency Stop	Emergency Stop Red Mushroom	Depressing the pushbutton will immediately stop operation of the pump. The E-Stop pushbutton must be pulled out to allow for pump operation.
On Light	Red Light	Activation of the light indicates the pump is running
Off Light	Green Light	Activation of the light indicates the pump is not running
Auto Light	Yellow Light	Activation of the light indicates the selector switch is turned to 'Auto'

Table 6.3-3 Motor Control Center – Disinfected Effluent Water Pumps

Control Name/Location	Features	Function
Leak Light	Yellow Light	Activation of the light indicates that a leak alarm inside the pump has been detected
High Temp Light	Yellow Light	Activation of the light indicates a high temperature is detected inside the motor
VFD Fault Light	Yellow Light	Activation of the light indicates
High Pressure Light	Yellow Light	Activation of the light indicates
Valve Fault Light	Yellow Light	Activation of the light indicates
VFD Keypad	Schneider Keypad	The VFD Keypad can be used to configure the VFD and monitor the various electrical settings for the pump motor

The Non-Potable Effluent Water Pumps are controlled locally at the motor control center located in the Pipe Gallery or remotely using the Emerson Ovation system.

Pipe Gallery Motor Control Center MSB

Table 6.3-4 provides the local controls and monitoring located at the motor control center (MCC) MSB-2 for the Effluent Water Pumps.

Table 6.3-4 Motor Control Center –Effluent Water Pumps

Control Name/Location MCC MSB	Features	Function
On-Trip-Off	Main Disconnect Breaker	“On” position allows electrical power from the MCC MSB to the local disconnect to the equipment controls. “Off” position stops all power from the electrical panel to the equipment controls. “Reset” allows breaker to be reset after circuit overload has been corrected.
Reset	Pushbutton	Depressing the pushbutton will reset the pump overload.
Hand-Off-Auto	Three-way Switch	The “Hand” position allows the pump to be controlled locally. The "Off” position will prevent the pump from operating. The “Auto” position allows the actuator to be controlled through the plant’s control system.
On Light	Green Light	Activation of the light indicates the pump is running
Off Light	Red Light	Activation of the light indicates the pump is not running

Table 6.3-5 provides the local controls and monitoring located at the Non-Potable Effluent Water Pumps.

Table 6.3-5 Motor Control Center – Non-Potable Effluent Water Pumps

Control Name/ at each Pump	Features	Function
On-Off	Local Power Disconnect	"On" position allows electrical power from the local power disconnect to the to the equipment. "Off" position stops all power from the electrical panel to the equipment controls
Hand-Off-Auto	Selector Switch	When in the Hand position, the pump operates continuously. When in the Auto position, the pump operates based on controls and system demand.
Start	Pushbutton	Depressing the pushbutton will start the pump overload.
Stop	Pushbutton	Depressing the pushbutton will start the pump overload.

The photograph below shows a typical Non-Potable Effluent Water Pump and local controls.

Non-Potable Effluent Water Pump (Typical)

6.3.4 Operation

Normal Operations

Effluent Water Pumps

The normal mode of operation for the Effluent Water Pumps is in automatic mode through the Emerson Ovation System. In the automatic mode of operation, the effluent water wet well level starts and stops the pumps. The effluent water wet well level will also increase/decrease the pump speed to maintain a specific level in the wet well.

The Effluent Water Pumps maintain a constant water level in the effluent water wet well. Each basin of the Disinfection Contact Tank has two Effluent Water Pumps. The lead and lag pumps are in separate sections of the Disinfection Contact Tank, one in the east and one in the west. In addition, one standby pump will be in each section of the Disinfection Contact Tank.

The lead pump is called to run when the water level in effluent water wet well reaches elevation 223'. Once called to run, the pump automatically ramps up and down to maintain the level setpoint of 223'. The lag pump is called to run if the elevation reaches 222'. The lead and lag pump initially run at minimum speed when the lag pump is called to run and ramp up and down synchronously to maintain target level of 223'. If the lead and lag pump reach minimum speed the lag pump is called to stop. If the lead pump reaches minimum speed, the pump maintains minimum speed until the level reaches 226' and is then called to stop. The designated lead and lag pump should never be in the same basin of the disinfection tank unless two pumps in the other basin are unavailable. The lead, lag, standby 1, and standby 2 designations automatically alternate daily.

Alternate Operations

Alternate operations indicate that one or more components of the effluent water pumps are out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, as well as remote and manual control. For instance, all pieces of equipment associated with effluent water system can be operated locally at the MCC.

Shutdown Considerations

1. At the MCC for each pump, place the Hand/Off/Auto selector switch in the "Off" position.
2. At the MCC for each pump, pull the disconnect switch to the "Off" position.
3. At the local disconnect for each pump, place the switch for each pump in the "Off" position.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect the effluent water equipment for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the effluent water equipment only when it is in good working condition.

3. Ensure that only authorized personnel are allowed in the in the effluent water area and no one might be injured when equipment is activated.

4. Ensure all motors and equipment have been properly lubricated using the manufacturers recommended lubricant.

5. Confirm all maintenance and/or repairs have been completed.

6. Remove any existing lockout devices and follow lockout/tagout procedures for each pump and electrical equipment.

7. Verify that the local disconnect at the local pump disconnect and MCC for each pump to be started are in the "Off" position.

8. Verify that the Hand/Off/Auto switch at the MCC is in the "Off" position.

9. Check on the readiness of all upstream and downstream equipment such as the pumps, level controls, etc.

10. Confirm the influent level transducer is functioning properly for the pump system to be restarted.

11. Visually inspect the disinfection tank water level to ensure safe operating conditions.

12. Energize the effluent water pump disconnect and MCC disconnect by placing each disconnect in the "On" position.

13. Place the "Hand/Off/Auto" switch to the "On" position.

14. At the MCC, momentarily place the Hand/Off/Auto selector switch in "Hand."

15. Observe the pump discharge and discharge pressure to confirm proper pump impeller rotation.

16. After confirming rotation, return the Hand/Off/Auto selector switch to "Auto" position and allow the level to control the pump.

17. After confirming proper rotation, stop the machine by returning the Hand/Off/Auto switch to the "Off" position.

18. Confirm all safety devices are functioning properly.

Startup

1. At the MCC in the Disinfection IPA Building, place the main breaker for each pump in the "On" position.

2. At the pump VFD panel, place the control power switch in the "On" position.

3. At the MCC, place the Hand/Off/Auto switch to the "Auto" position.

4. At the local disconnect for the pump, place the disconnect switch in the "On" position.

5. Ensure the effluent water pumps are in "Auto" at the Emerson Ovation System.

6. Confirm that the Emergency Stop at the MCC and at the pump are both pulled out to allow for operation.

7. Each operating pump will be started remotely, controlled by the Emerson Ovation System and the effluent wet well level.

Routine Checklist

The effluent water pump system should be inspected for the following items when in operation:

1. Monitor the pumps discharge pressure at the pressure switch to be sure the pump is pumping properly.

2. Monitor the pump discharge flow at the effluent wet well to ensure the pump is pumping properly.

3. Monitor the effluent wet well level and ensure the proper levels are maintained.

Troubleshooting

The following identifies problems that may be encountered during the operation of the effluent water pump system. Refer to the manufacturer's O&M manual for additional information on specific issues with equipment. Listed are operations problems followed by the probable causes and recommendations action.

Table 6.3-6 provides troubleshooting information for operational issues associated with the Effluent Water Pumps.

Table 6.3-6 Troubleshooting Guide – Effluent Water Pumps

Problem	Probable Cause	Recommended Action
The pump does not start.	An alarm signal is active at the control panel.	Check that the impeller rotates freely, the sensors do not indicate an alarm, and the overload protection is not tripped. If problem persists, contact local sales and service representative.
	The pump does not start automatically but can be started manually.	Check the start level regulator is functioning. Clean or replace if necessary.
		Confirm all connections are intact.
		Confirm the relay and contactor coils are intact.
		Check the control selector switch and confirm it makes contact in all positions.
		Check the control circuit and functions.
	No power to pump.	Make sure the main power switch is on.
		Confirm there is control voltage to start the pump.
		Check the fuses and secure or replace if necessary.
		Confirm voltage on all phases
		Confirm the overload protection is not tripped.
		Inspect the motor cable for damage.
	Impeller is stuck/binding.	Clean the impeller and replace if necessary.

Table 6.3-6 Troubleshooting Guide – Effluent Water Pumps

Problem	Probable Cause	Recommended Action
The pump does not stop when level sensor is at shutoff level.	Level sensor malfunction.	Check the level regulators and clean if necessary.
		Check level regulators for correct operation.
		Check the contactors and control circuit.
The pump repeatedly starts and stops.	The self-holding function of the contactor malfunctions.	Check the contactor connections.
		Check the voltage in the control circuit in relation to the rated voltages on the coil.
		Check the functioning of the stop-level regulator.
		Check whether the voltage drop in the line at the starting surge causes the contactor's self-holding malfunction.

Non-Potable Effluent Water Pumps

The normal mode of operation for the Non-Potable Effluent Water Pumps is in automatic mode through the Emerson Ovation System. In the automatic mode of operation. The number of pumps operating depends on the demand on the Non-Potable Effluent Water System. As the demand increases, additional pumps are started. The pumps are stopped when the demand drops off. The flow measured by M-164 is recorded in the Emerson Ovation System in mgd.

The Non-Potable Effluent Water Pumps are powered through motor control center MCC-2 in the electrical room in the Pipe Gallery. They are automatically controlled by the computer in response to flow demand. One pump operates continuously. The second pump operates when the demand exceeds 1000 gpm (63 1/s), the third when the demand exceeds 2000 gpm (126 1/s), and the fourth when the demand exceeds 4,000 gpm (252 1/s). These starting and stopping flow rate set points can be adjusted at the computer to provide optimum performance of the system. When the computer determines that an additional pump is required, it sounds an alarm and displays a message indicating which pump is about to start. If the operator desires, the operator then has from 1 to 5 minutes (the specific length of time is preset and adjustable) to enter an inhibit command, delaying the pump starting up to 60 minutes (this length of time is also preset and adjustable). If the operator inhibits the start, the computer goes through the same sequence when the inhibit time elapses, provided the pump operating is still required. The flow measured by M-164 is recorded by the computer.

Alternate Operations

Alternate operations indicate that one or more components of the Effluent Non-Potable Water Pumps are out of service or cannot be automatically controlled. Provisions have been made to operate the system during abnormal conditions through redundancy of equipment, as well as remote and manual control. For instance, all pieces of equipment associated with Non-potable Effluent Water System can be operated locally at the MCC MSB-2. **Note that operation local in the Hand mode requires continuous attention.**

Shutdown Considerations

1. At the MCC MSB-2 for each pump, place the Hand/Off/Auto selector switch in the "Off" position.
2. At the MCC MSB-2 for each pump, place the disconnect switch to the "Off" position.
3. At the MCC MSB-2 for each pump, place the main disconnect switch in the "Off" position.

Restart Considerations

Pre-Start Checklist

1. Check and ensure that all safety devices are attached and functioning.
2. Inspect the Non-Potable Effluent Water equipment for visible damage. Immediately rectify defects or report them to supervising personnel. Operate the effluent non-potable water equipment only when it is in good working condition.
3. Ensure that only authorized personnel are allowed in the in the Non-Potable Effluent Water area and no one might be injured when equipment is activated.
4. Ensure all motors and equipment have been properly lubricated using the manufacturers recommended lubricant.
5. Confirm all maintenance and/or repairs have been completed.
6. Remove any existing lockout devices and follow lockout/tagout procedures for each pump and electrical equipment.
7. Verify that the local disconnect at the local pump disconnect and MCC MSB-2 for each pump to be started are in the "Off" position.
8. Verify that the Hand/Off/Auto switch at the MCC MSB-2 is in the "Off" position.
9. Check on the readiness of all upstream and downstream equipment such as the pumps, level controls, etc.
10. Energize the Non-Potable Effluent Water pump disconnect and MCC MSB-2 disconnect by placing each disconnect in the "On" position.
11. Place the "Hand/Off/Auto" switch to the "On" position.
12. At the MCC MSB-2, momentarily place the Hand/Off/Auto selector switch in "Hand."
13. Observe the pump discharge and discharge pressure to confirm proper pump impeller rotation.
14. After confirming rotation, return the Hand/Off/Auto selector switch to "Auto" position and allow the level to control the pump.

15. After confirming proper rotation, stop the machine by returning the Hand/Off/Auto switch to the “Off” position.

16. Confirm all safety devices are functioning properly.

Startup

1. At the MCC MSB-2 in the Pipe Gallery, place the main breaker for each pump in the “On” position.

2. At the MCC MSB, place the Hand/Off/Auto switch to the “Auto” position.

3. At the local disconnect for the pump, place the disconnect switch in the “On” position.

4. Ensure the effluent water pumps are in “Auto” at the Emerson Ovation System.

5. Each operating pump will be started remotely, controlled by the Emerson Ovation System based on the Non-Potable Effluent Water System demand.

Routine Checklist

1. The Non-Potable Effluent Water Pump system should be inspected for the following items when in operation:

2. Monitor the individual pumps inlet (suction) pressure and the discharge pressure to be sure the pump is pumping properly.

3. Monitor the individual pumps oil reservoir level for proper level, (middle of sight glass).

4. Monitor the Non-Potable Effluent Water system flow at the FM-??

5. Monitor the Non-Potable Effluent Water system pressure and ensure the proper pressure is maintained.

Troubleshooting

The following identifies problems that may be encountered during the operation of the Non-Potable Effluent Water Pump system. Refer to the manufacturer's O&M manual for additional information on specific issues with equipment. Listed are operations problems followed by the probable causes and recommendations action.

Table 6.3-7 provides troubleshooting information for operational issues associated with the Non-Potable Effluent Water Pumps.

Table 6.3-7 Troubleshooting Guide – Non-Potable Effluent Water Pumps

Problem	Probable Cause	Recommended Action
Motor fails to start	Loose or poor connections in control circuits.	Visually inspect all connections in control switch.
	Motor overload.	Reset motor overload at MCC MSB.
Motor fails to come up to speed	Low or incorrect voltage.	Check voltage in control panel and at motor leads.
	Mechanical overload.	Check impeller setting, check for tight or locked shaft.
Motor noisy	Worn thrust bearing.	Remove dust cover and rotate rotor by hand, visually examine balls and races.
Failure to deliver water or insufficient capacity	Pump not primed.	Prime pump.
	Rotation incorrect.	Reverse two leads.
	Upstream/downstream valves not open.	Check valve positions and open appropriately.
	Impeller damaged.	Repair or replace impeller.
	Packing gland too tight.	Loosen packing gland.
Bearings overheat or have reduced operating life	Internal misalignment due to pipe strain or improper foundation.	Confirm piping and foundation are aligned properly.
	Shaft bent or damaged.	Replace shaft.
	Excessive lubrication of bearings.	Remove excessive grease.
	Insufficient lubrication of bearings.	Lubricate bearings properly.
	Incorrect type of lubricant used.	Use only manufacturer recommended lubricants.
	Lubricant contaminated.	Remove contaminated lubricant and replace with recommended lubricant.
	Bearings rusted due to water present in bearing frame.	Locate and prevent water intrusion in bearing frame, replace bearings.
	Pump vibrating excessively.	Correct excessive vibration.
	Worn bearings.	Replace bearings.
	Rotating assembly not balanced.	Balance rotating assembly.

6.3.5 Maintenance

Process Maintenance

The general maintenance for the effluent pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the effluent pumping consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Contact Information

Table 6.3-8 provides the manufacturer's and service representative's contact information for the effluent pumping equipment.

Table 6.3-8 Contact Information – Effluent Water Pumps

Manufacturer	
Name:	Xylem, Inc.
Address:	14125 South Bridge Circle Charlotte, NC 28273
Phone:	704-409-9700
Fax:	704-295-9080
Website:	***Xyleminc.com***
Service Representative	
Name:	Gulf State Engineering Company, Inc.
Address:	7007 Channel 16 Way Jackson, MS 39209
Phone:	601-922-1364
Fax:	601-922-1774
Website:	***Gsengr.com***
Email:	info@gsengr.com

6.3.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

6.4 Effluent Discharge Pump Station

6.4.1 Overview

Plant effluent is discharged to the Mississippi River through a Cooling Channel west of the plant in two different ways, gravity discharge or pumped discharge from the Effluent Discharge Pump Station. The method chosen depends on the locally measured river stage Memphis elevation 34.

At river elevations below 221.5, the plant effluent flows by gravity from the Disinfection Contact Tank Effluent Chamber out the sluice gate DIS-SG-5 to a 78-inch line to the Levee Gate Structure Gate V-424.

The Disinfection Contact Tank effluent flows to the disinfected effluent channel to the Effluent Chamber and then flows through a 78-inch motorized sluice gate V-424 to the Normal Effluent Discharge Levee Gate Structure to the Cooling Channel to Mississippi River outfall. The 78-inch motorized sluice gate V-424 is normally in the open position, except when the river elevation is above 221.5. Then the plant discharge must be pumped over the levee by the Effluent Discharge Pumps.

The Effluent Pump Station automatically pumps effluent from the junction box, at the end of the Disinfection Contact Tank, over the levee west of the plant. the Effluent Discharge Pumping Station wet well receives flow from the from the Disinfection Contact Tank Effluent Chamber through motorized slide gate DIS-SG-6 and automatically pumps effluent out the High-Water Discharge Head Dissipator Gate Structure gate SG-24 and flows through the Cooling Channel to Mississippi River. SG-24 is always in the open position.

Effluent Discharge Pump Station

Aerial View of the T.E. Maxson WWTF Effluent Water Discharge Location

Gate SG-24 at High Water Discharge Head Dissipator Gate Structure is in the permanently open position. A head dissipator is located at the discharge to prevent dislodging the riprap while discharging at low river stages. Note that the Disinfection Contact Tank serves as a storage supply to the Effluent Discharge Pumping Station wet well.

Normal Effluent Discharge Levee Gate and High-Water Discharge Head Dissipator Gate

The gate in the foreground, V-424, is the Normal Effluent Discharge Levee Gate Structure. The walkway to the gate (SG-24) structure in the background is the High-Water Discharge Head Dissipator Gate Structure. During high river elevation, the normal gate is closed.

There are two other gates in the Effluent Chamber of the Disinfection Contact Tank, DIS-SG-5, and DIS-SG-6, which must change position to operate the Effluent Discharge Pumps for High River elevation.

Effluent Chamber

Effluent Discharge Pumps

Number	4
Designation	No. 1, No. 2, No. 3, No. 4
Type	Vertical diffusion vane, constant speed
Rated total head, ft	25
Capacity of rated head, gpm	36,000
Model	52 PMR VCT 1, Single-stage
RPM	505
Manufacturer	Byron Jackson

Motor

Size, hp (kW)	350 (261)
Speed, rpm	600
Frame	680BP
Manufacturer	U.S. Electrical Motors

Grease Pumps

Number	4
Type	Positive displacement
Lubricant reservoir capacity, lbs (kg)	10 (4.5)
Quantity of lubricant per stroke, cu in (cm)	0.03 (0.5)
Pressure, psi (kN/m2)	1000 (6895)
Model	DC-10
Manufacturer	Farval

Sump Pump

Number		1
Head, ft	(m)	32 (9.8)
Capacity, gpm	(l/s)	150 (9.5)
Model		CS-3102
Manufacturer		Flygt

6.4.2 Process Control

Process Components

The process components for the Effluent Discharge Pump Station system are:

- Four Effluent Discharge Pumps
- Grease Pumps
- Sump Pump
- Controls and Instrumentation

6.4.3 Equipment Control

The Effluent Discharge Pumps are powered through Motor Control Center No. 6 located at the south wall of the Effluent Discharge Pumping Station Control Room. Equipment associated with the pumps is powered through Panel "B" located on the east wall of the control room. The sluice gates at the head dissipator, and the sump pump are powered through Panel "A" on the east end of the south wall in the control room. The gate control panel is on the north wall of the control room. The locations of controls associated with discharging plant effluent are listed in ***Table 6.4-1***. The function of each control is listed in ***Table 6.4-2***.

Table 6.4-1 Effluent Discharge Pump Station – Location of Controls

Control or Indicator	Number of Units	At Equipment	At Gate Control Panel	At MCC-6
Effluent Flow Control				
Pushbutton				
Effluent to Pump Station	1	X		
Effluent to Levee	1	X		
Effluent Pumps				
Main Disconnect Switch	5			X
Selector Switch				
Hand-Off-Auto	4			X
Pushbutton				
Start	4			X
Off	4			X
Test	4	X		
Pump Control Float Switches	8	Effluent Discharge Pump Station Wet Well		
Low Water Cutoff Float Switch	1	Effluent Discharge Pump Station Wet Well		
High Water Level Alarm Float Switch	1	Effluent Discharge Pump Station Wet Well		
Time Delay Relay	4			X
Ammeter – Off/1/2/3	5			X
Ammeter Gauge (0 to 100)	4			X
Elapsed Time Meter				
Ammeter Gauge (0 to 50,000)	4			X
Green Indicating Light				
Power	4	X		
Off	4			X
Amber Indicating Light				
Cycle	4	X		
Red Indicating Light				
Fault	4	X		
Reservoir Low Level	4	X		
Pressure Gauge (0 to 35 psi)	8	X		
White Indicating Light				
Motor Fault	4			X
Effluent to Levee	1		X	
Effluent to Pump Station	1		X	
Grease Pumps				
Circuit Breaker	4	Panel B		
Selector Switch				
Hand-Off-Auto	4	X		
Repeat Cycle Timer	4	X		
Sump Pump				
Pushbutton				
Start	1	Control station on east wall		
Stop	1	Control station on east wall		
Float Switch	1	Sump wet well		

Table 6.4-2 Effluent Discharge Pump Station – Function of Controls

Control or Indicator	Functions
Effluent Flow Control	
Pushbutton	**Effluent to Pump Station** – Initiate opening and closing sluice gate to divert flow to the effluent discharge pumping station. Button illuminates white when effluent is directed to pump station. **Effluent to Levee** – Initiate opening and closing sluice gate to divert flow to gravity line to river. Button illuminates white when effluent is directed to pump station.
Effluent Pumps	
Selector Switch	**Hand** – Pump is controlled by **Start** and **Off** pushbuttons. **Off** – Pump will not function. **Automatic** – Pump is automatically controlled by wet well liquid level.
Pushbutton	**Start** – Starts pump, provided selector switch is in the **Hand** position. **Off** – Stops pump, provided selector switch is in the **Hand** position.
Pump Control Float Switches	Start and stop pump when selector switch is in the **Automatic** position.
Low Water Cutoff Float Switch	Stops pumps when wet well level drops to approximately 5.3 ft (1.6 m).
High Water Level Alarm Float Switch, Distribution Box	Sounds alarm at the computer when liquid depth in distribution box rises to 14 feet.
High Water Level Alarm Float Switch, Wet Well	Sounds alarm at the computer when liquid depth in wet well rises to approximately 20.3 feet.
Red Indicating Light	**On** – Pump is operating. **Off** – Pump is not running.
Green Indicating Light	**On** – Pump is not running. **Off** – Pump is running.
White Indicating Light	**On** – Alarm condition existed for a preset length of time (1.5 – 15 seconds). **Off** – Alarm condition not present.
Grease Pumps	
Selector Switch	**Hand** – Pump operates continuously. **Off** – Pump does not operate. **Auto** – Pump will operate on a minimum 24-hour cycle when corresponding effluent pump **Start** button is pressed or wet well liquid level requests operation of corresponding effluent pump. Pump will not operate if corresponding effluent pump is not required to operate.
Repeat Cycle Timer	Controls duration and frequency of pump operation as required when selector switch is in the **Auto** position.
Sump Pump	
Pushbutton	**Start** – Starts pump. **Off** – Stops pump.

6.4.4 Operation

Operating Modes

Normal Operations

Normally, the river level is low enough to discharge through the Levee Gate Structure by gravity to the Cooling Channel to the river. Sluice gate, effluent pump, and grease pump selector switches should be in the Off position. Sluice gate positions are as shown in ***Table 6.4-3***.

Table 6.4-3 Normal Operation – Sluice Gate Positions

Sluice Gate Number	Opened	Closed
V-424 at Normal Levee Discharge Gate	X	
SG-24 at Head Dissipator Gate	X	
DIS-SG-4 Controls flow from effluent channel of Disinfection Contact Tank	X	
DIS-SG-5 Controls Flow to Gravity Outfall	X	
DIS-SG-6 Controls Flow to Effluent Discharge Pump Station		X

Sluice gates which are not in the appropriate position can be adjusted by pushing the Effluent to Levee button or manually changed at the control panel or sluice gate.

Frequency and duration of pump motor exercising should be in accordance with the manufacturer's recommendations. Because City policy is to discharge through the Effluent Pumping Station only during high river stages, the pump motor must be disconnected from the pump while exercising. Before disconnecting the pump from the motor, the equipment should be isolated from the power source. When disconnecting and connecting the coupling, manufacturer's instructions should be closely followed to avoid costly damage to the equipment.

Alternate Operations

When the locally measured river stage at Memphis elevation 34 is 209 feet, 200 MGD (757,000 m^3/d) can be discharged by gravity. As the river stage rises to 221.9 feet, the amount of effluent that can be discharged by gravity is reduced to zero. This is why the activation level is above 221.5 feet. When effluent cannot discharge by gravity, liquid level in the downstream side of the distribution box will rise. When it reaches a depth of 14 feet, an alarm is sounded at the computer. The Disinfection Contact Tank should be operated as an extension of the Effluent Discharge Pump Station wet well by keeping it online supplying water through DIS-SG-4 from the effluent channel to the wet well.

The Effluent Discharge Pump selector switches at the pumping station should be placed in the Auto position and the Effluent to Pump Station button should be pressed to adjust the sluice gates appropriately for effluent pumping. Flow will enter the pumping station wet well and start the pumps. Sluice gates should be in the positions shown in ***Table 6.4-4***.

Table 6.4-4 Alternate Operation – Sluice Gate Positions

Sluice Gate Number	Opened	Closed
V-424 at Normal Levee Discharge Gate		X
SG-24 at Head Dissipator Gate	X	
DIS-SG-4 Controls flow from effluent channel of Disinfection Contact Tank	X	
DIS-SG-5 Controls Flow to Gravity Outfall		X
DIS-SG-6 Controls Flow to Effluent Discharge Pump Station	X	

Sluice gates which are not positioned automatically appropriately should be positioned manually at the control panel or sluice gate. The Effluent Discharge Pumps will operate according to ***Table 6.4-5***.

Table 6.4-5 Alternate Operation – Effluent Discharge Pump Operation

Depth of Liquid in Wet Well, ft (m)	Increasing Liquid Level	Decreasing Liquid Level
20.3 (6.2)	High water alarm sounds at computer	
16.7 (5.1)	Pump 4 starts	
15.7 (4.8)	Pump 3 starts	
14.7 (4.5)	Pump 2 starts	Pump 4 stops
13.8 (4.2)	Pump 1 starts	Pump 3 stops
12.8 (3.9)		Pump 2 stops
11.8 (3.6)		Pump 1 stops
5.3 (1.6)		Low water cutoff stops and sounds alarm at computer

If the effluent flow rate exceeds the capacity of the Effluent Discharge Pumps, the wet well liquid level will not drop when all four pumps are running. Eventually, the high-water alarm will sound.

When the river elevation drops low enough so that the entire effluent flow can be discharged by gravity, the **Effluent to Levee** button should be pressed. Sluice gates should be in the positions listed under Normal Operation. Sluice gates which are not automatically positioned appropriately should be manually positioned. Pump selector switches should be placed in the **Off** position. The discharge channel should be drained by opening the valve at the northeast corner of the channel. After the channel drains, the valve should be closed. Effluent which remains in the pumping station wet well should be removed by the sump pump to avoid stagnant conditions from developing.

Abnormal Operation

If sluice gates do not automatically operate, they should be operated manually with the pushbuttons at the control panel or at the specific sluice gate. Electric operator failure requires manual operation using the local handwheel.

Failure of automatic pump controls can be overcome by manually operating the pumps from the control panel. Care should be taken to avoid starting a pump more than once every 40 minutes.

6.4.5 Maintenance

Process Maintenance

The general maintenance for the Effluent Discharge Pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the effluent pumping consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Data

Table 6.4-6 provides the manufacturer's contact information for the effluent discharge system.

Table 6.4-6 Contact Information – Effluent Discharge Pumps

Manufacturer	
Name:	Flowserve - Byron Jackson
Address:	5212 North O'Connor Boulevard, Suite 700 Irving, Texas 75039
Phone:	972-443-6500
Website:	www.flowserve.com
Service Representative	
Name:	Flowserve MFG Memphis Pumps
Address:	1790 Dock Street Memphis, TN 38106
Phone:	901-948-4880
Website:	www.flowerve.com

6.4.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

Follow all safety requirements for City, County, State, and Federal Guidelines. Review the original manufacturer's equipment manual for specific safety related to the equipment. Consult your supervisor for safety instructions prior to working on or around the wastewater treatment facility. Only qualified personnel should operate or perform maintenance on equipment. If you have any safety concerns, consult your immediate supervisor or the safety department.

6.5 Drain Pump Station

6.5.1 Overview

The Drain Pump Station consists of a 10-ft x 10-ft concrete wet well with two submersible Drain Pumps. Inflow to the station is from an 18-inch line from the adjacent 8-ft x 8-ft Drain Pump Station Manhole. The Drain Pump Station has two submersible that convey to the existing 12" drain South of the Pipe Gallery.

The Drain Pump Station receives drainage from:

- Disinfection Contact Tank mud valves
- Bulk Peracetic Acid Storage drainage trench
- Clarifiers 5N and 5S Drains
- RAS Pump Station drainage trench

Drain Pump Station

6.5.2 Process Control

Process Components

The process components for the Drain Pump Station system are:

- Drain Pump Station Manhole
- Drain Pump Station Wet Well
- Drain Pump Station Pumps
- Controls and Instrumentation

Drain Pump Station Manhole

Inflow to the station is from an 18-inch line from the adjacent 8-ft x 8-ft Drain Pump Station Manhole.

The Drain Pump Station Manhole receives drainage flow from the following areas:

- Disinfection Contact Tank from the mud valves and underdrains flow into the MH wet well through their respective 12-inch drain and underdrain lines entering on the West side of the manhole. Both have duck bill check valves. There is also a 12-inch valve on the underdrain just West of the Drain Pump Station manhole.
- Clarifiers 5N and 5S from their respective drain valves and underdrains through 12-inch drain and underdrain lines entering on the North side of the manhole. Both have duck bill check valves.

- Precipitation from the PAA Chemical Tanker Truck Offloading Area Containment Trench Drain through a 3-inch trench drain valve that sizes to a 6-inch that ties into the 12-inch drain line from Clarifiers 5N and 5S. There is also a line from the sump pump in the PAA Storage Tank containment that feeds to the 12-inch drain line from 5N.
- Clarifiers 5N and 5S RAS Pump Station Trench Drain through a 4-inch valve that ties into the 12-inch drain line from Clarifiers 5N and 5S. The valve for the Drain Line is normally closed because the Clarifiers 5N and 5S RAS Pump Station Trench Drain could backfill the station if the Drain Pump Station is at a high level.

The drain yard valves (plug valve) have two-inch operator nuts.

WARNING: The Disinfection Contact Tank shall not be drained when groundwater levels exceed 208.00' as measured at the monitoring wells in the vicinity of the disinfection tank. Warning signs are posted near the Disinfection Contact Tank and at the Underdrain Pump Station to remind operators of this requirement. The groundwater level should be monitored hourly while a tank is drained.

Tank Draining Warning Sign

Table 6.5-1 describes valves associated with the Drain Pump Station system.

Table 6.5-1 Drain Pump Station Process Valves

Valve Tag	Normal Operating Position	Purpose
DIS-PV-2	Open	Isolates DIS-P-5 discharge when closed.
DIS-PV-3	Open	Isolates DIS-P-6 discharge when closed.

6.5.3 Equipment Control

Power

The Drainage Pump Station Control Panel, CP-1705, is powered from a disconnect in the Disinfection Electrical IPA near the Drain Pump Station.

Disconnect for CP-1705 in the Disinfection Electrical IPA

The pumps are controlled from the Drain Pump Station local control panel CP-1705 based on float level switches.

CP-1705 has an amber high level alarm light on it and a local power disconnect switch.

The Drain Pumps each have the following:

- HAND/OFF/AUTO Selector Switch
- Pump Elapsed Time Meter
- Pump Running Green Indicator Light
- Pump Overtemp Red Indicator Light
- Pump High Pressure Red Indicator Light
- Pump Seal Fail Red Indicator Light
- Pump Fault Red Indicator Light
- Pump Fault Reset Pushbutton
- MiniCAS Pump Monitor
- Pump Power Breaker
- Pump Overload Reset Pushbutton

CP-1705 Drain Pump Station Control Panel

CP-1705 Drain Pump Station Control Panel Interior

Alarms

Table 6.5-2 provides alarms associated with the Drain Pump Station system.

Table 6.5-2 Alarms - Drain Pump Station System

Alarm Name	Cause
High Level	1 ft below PAA Trench 5 ft below RAS Trench

6.5.4 Operation

Operating Modes

Normal Operations

The normal operation of the Drain Pump Station system is in the Automatic mode. The inflow to the station should be regulated by adjusting the opening of the respective drainage valves of the area being drained to not hydraulically overload the station. Operate the Drain Pumps to pump down the wet well using the pump HAND/OFF/AUTO control switches from OFF to AUTO. The float switches will control the pump starting/stopping.

Maintenance/repairs of the RAS Pumps for Clarifier 5N and 5S would require that the RAS Pump Station Trench Drain yard valve be opened, and the Drain Pump Station pumps be place in Automatic mode. When done, the RAS Pump Station Trench Drain yard valve must be closed to prevent flooding the RAS Pump Station when draining the Disinfection Contact Tank, PAA Trench, or Clarifiers 5N or 5S.

For draining of the Disinfection Contact Tank, PAA Trench, or Clarifiers 5N or 5S, before Drain Pumps are started, the Clarifier 5N and 5S RAS Pump Station Trench drain valve should be confirmed to be closed. Tanks not being drain should have their drain valves confirmed closed.

Alternate Operations

The alternate operation of the Drain Pump Station system is in the Manual mode. Operating the system in the Manual mode will require the system staff start and stop the pumps manually, in addition to regulating the inflow to the station by adjusting the opening of the respective drainage valves of the area being drained to not hydraulically overload the station.

Shutdown Considerations

Shut off the Drain Pumps by turning the pump HAND/OFF/AUTO control switches to OFF.

Restart Considerations

If recent work has been done on the Drain Pump Station pumps or equipment, ensure that station is ready for use, discharge valves are open, and Drain Pump Station local control panel CP-1705 is powered.

1. **Do not drain Disinfection Contact Tank without confirming groundwater elevations. Groundwater elevation in vicinity of Disinfection Contact Tank shall not exceed 208.0' at any time within two weeks prior to draining.**

2. If recent work has been done on the Drain Pump Station pumps or equipment, ensure that station is ready for use, discharge valves are open, and Drain Pump Station local control panel CP-1705 is powered.

3. Coordinate the roles and responsibilities of the project being executed with all entities involved, what areas are being drained, and by opening valves so that the Drain Pump Station is not overloaded hydraulically.

4. The Drain Pump Station receives flow from the following areas:

   - Precipitation from the PAA Chemical Tanker Truck Offloading Area Containment Trench Drain. Normally the Containment Trench Drain valve is closed. The Containment Trench requires routine draining of precipitation to the Drain Pump Station. The yard valve is normally closed and should only be opened to allow drainage to the Drain Pump Station This area should be observed for ponding. The liquid should always be assessed for PAA contamination that may require neutralization. If a PAA Tanker Truck spill occurs, do not drain to the Drain Pump Station, until the contents are assessed and properly neutralized.

   - Clarifiers 5N and 5S RAS Pump Station Trench Drain, this area should be monitored so that liquid does not build up and could potentially submerge equipment. The yard valve (2-inch nut plug valve) is normally closed and should only be opened to allow drainage to the Drain Pump Station when work that requires draining and washing is being performed at the RAS Pump Station. During work the pumps at the Drain Pump Station should be in AUTO. After work is completed, this valve should be closed or there is a risk of flooding the station.

   - Disinfection Contact Tank (PAA Contact Tank) from the mud valves and underdrains. The Disinfection Contact Tank draining and cleaning is addressed in SOP – 6.2.5 Disinfection Tank Draining Cleaning and Inspection.

   - Clarifiers 5N and 5S from their respective drain valves and underdrains. Clarifiers 5N and 5S require routine draining for cleaning, inspection, and maintenance activities. The drain valves are 2-inch nut plug valve.

5. Operate the Drain Pumps to pump down the wet well using the pump HAND/OFF/AUTO control switches from OFF to AUTO. The float switches will control the pump starting/stopping.

6. Monitor the effluent being discharged while pumping for permit requirements as directed by operations.

7. Shut off the Drain Pumps by turning the pump HAND/OFF/AUTO control switches to OFF.

6.5.5 Maintenance

Process Maintenance

The general maintenance for the Drain Pump Station pumping equipment can be found in the original manufacturer's operations and maintenance manuals. The process maintenance for the effluent pumping consists of keeping the equipment areas clean, inspecting the pumping equipment for proper operation, and ensuring pumps are properly lubricated.

Specific preventative maintenance tasks are contained within the plant's computerized maintenance management system (CMMS).

Equipment O&M Manuals

Consult the manufacturer's O&M manual(s) for more detailed information on required and recommended maintenance and detailed operations information.

Refer to ***Appendix XX Vendor Manuals.***

Equipment Data

Table 6.5-3 provides the manufacturer's contact information for the surface water discharge system.

Table 6.5-3 Contact Information – Drain Pump Station System

Manufacturer	
Name:	xylem
Address:	301 Water Street, Suite 200 Washington, DC 20003
Phone:	Contact local representative
Website:	www.xylem.com
Service Representative	
Name:	Gulf States Engineering Co., Inc.
Address:	8381 Industrial Drive Olive Branch, MS 38654
Phone:	662-890-4768
Fax:	662-890-4769
Website:	www.gsengr.com

6.5.6 Safety References

Please note that this section on safety is for informational purposes only and is designed solely to serve as a guide towards the development of a detailed safety program that is specifically tailored for the use of personnel at the Maxson WWTF. The development of a safety program that completely and adequately addresses the safety requirements of the staff is beyond the scope of the information provided in this document.

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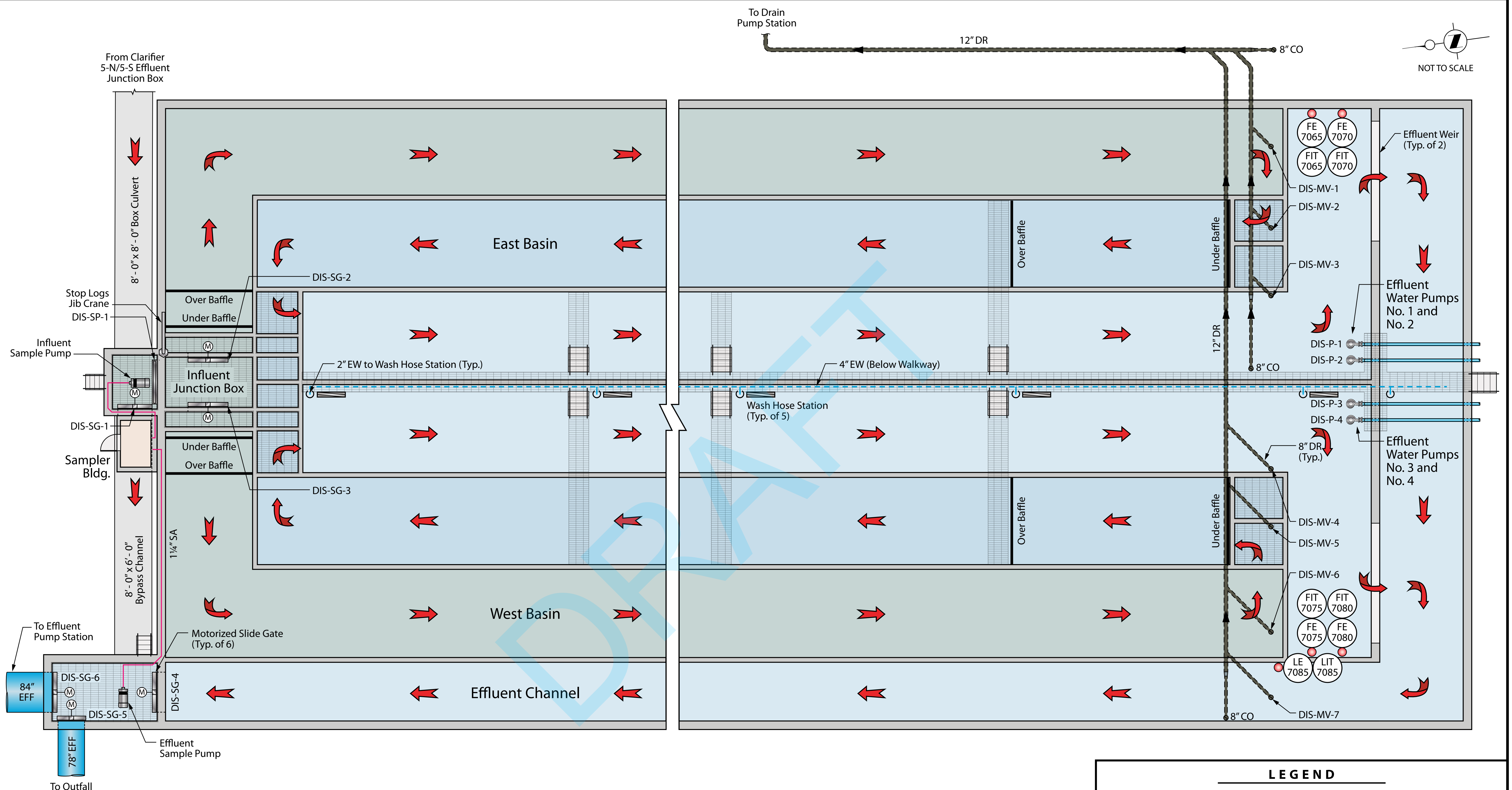


C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 6.2-1 - Disinfection Tank Plan - Revised 09-08-21 - S.Trulli

LEGEND

Pipelines

DR	Drain
EFF	Effluent
EW	Effluent Water
SA	Sample Water

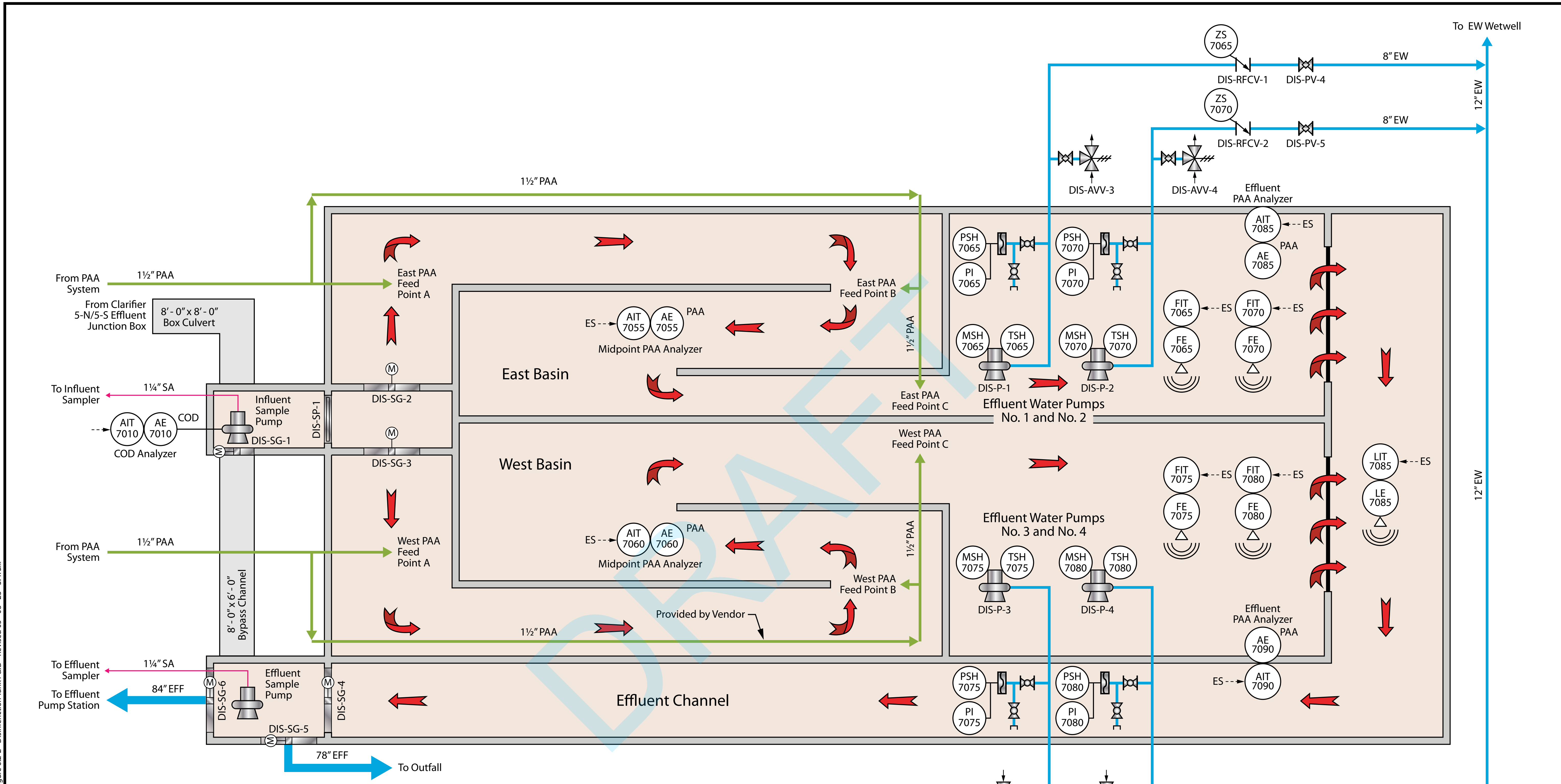
Abbreviations

FE	Flow Element	SG	Slide Gate
FIT	Flow Indicating Transmitter	SP	Stop Log
LE	Level Element		
LIT	Level Indicating Transmitter		
MV	Mud Valve		
P	Pump		

CDM Smith

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 6.2-1
Disinfection Tank Plan



LEGEND

Pipelines

EFF	Effluent
EW	Effluent Water
PAA	Peracetic Acid
SA	Sample Water

Abbreviations (Valves and Equipment)

AVV	Air Vacuum Valve
PV	Plug Valve
P	Pump
RFCV	Rubber Flapper Check Valve
SG	Slide Gate
SP	Stop Log

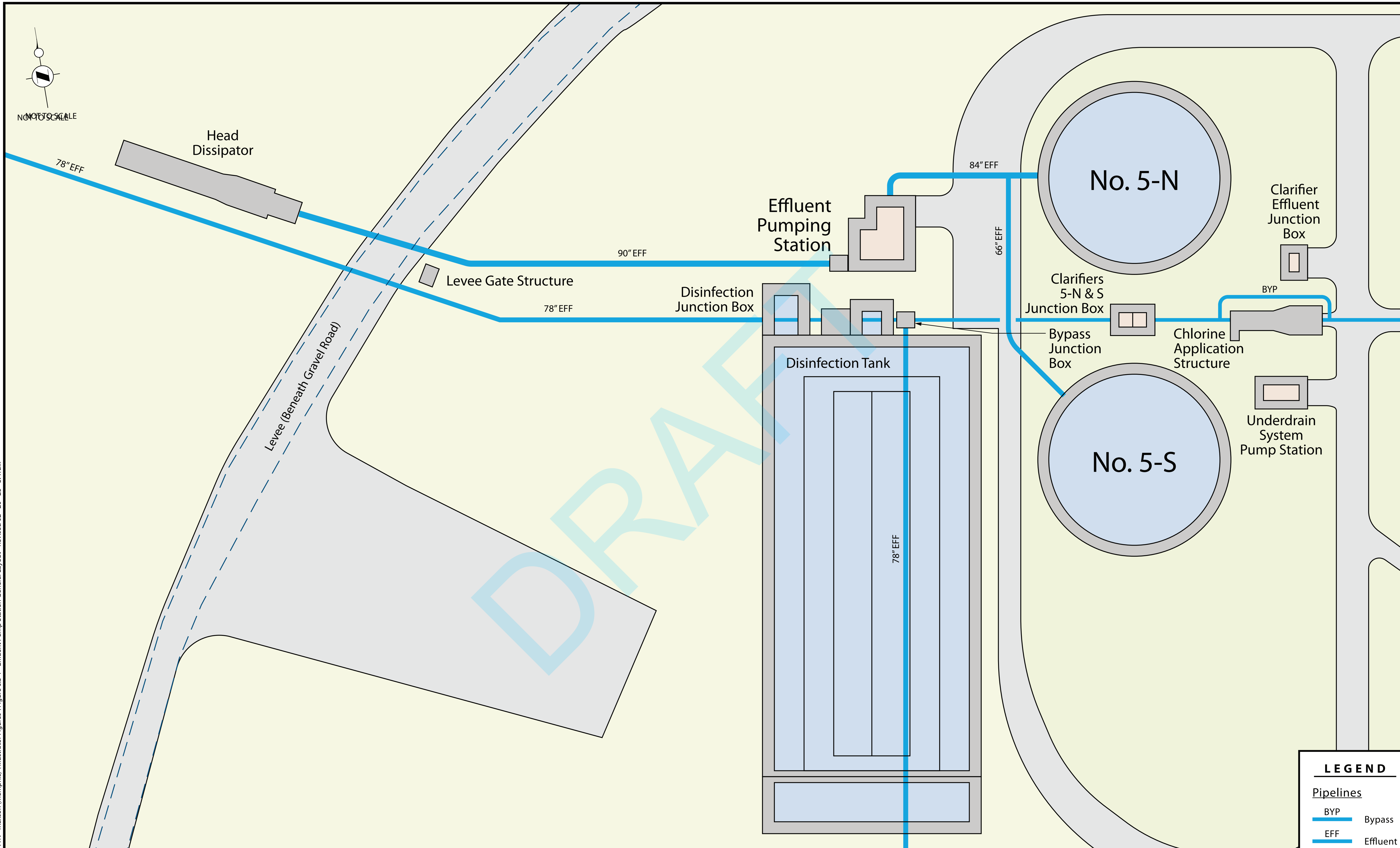
Abbreviations (Automation)

AE	Analyzer Element
AIT	Analyzer Indicating Transmitter
FE	Flow Element
FIT	Flow Indicating Transmitter
LE	Level Element
LIT	Level Indicating Transmitter
MSH	Moisture Switch High
PI	Pressure Indicator
ZS	Position Switch
PSH	Position Switch High
TSH	Temperature Switch High

C:\ TN - Maxson (Memphis) \ Illustrator Figures \ Figure 6.2-2 - Disinfection Tank P&ID - Revised 05 - 08 - 23 - S. Trulli

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

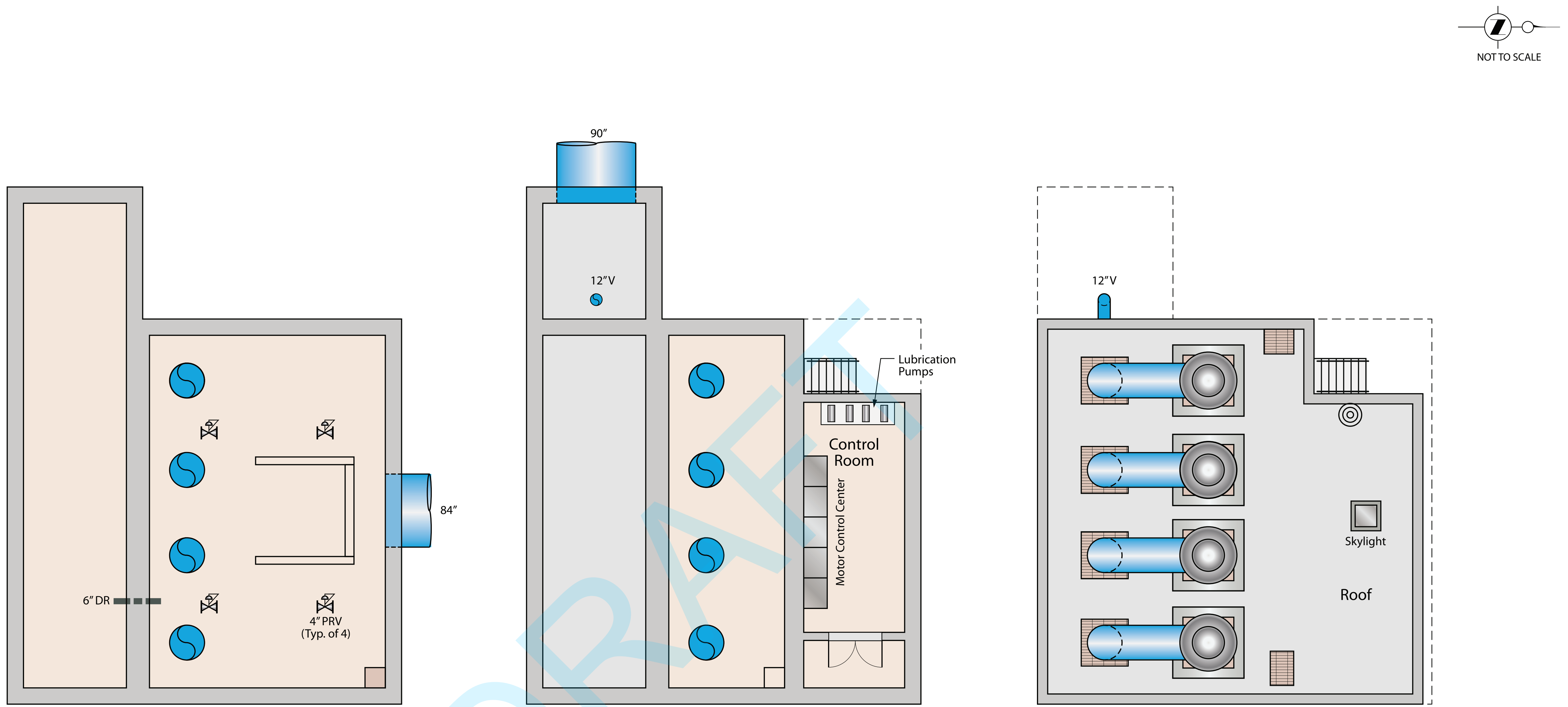
Figure 6.2-2
Disinfection Tank P&ID



C:\TN - Maxson (Memphis)\Illustrator Figures\Figure 6.3-1 - Effluent Pump Station General Layout - Revised 02 - 20 - 25 - S. Trulli

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 6.3-1
Effluent Pump Station General Layout



Plan at Elevation 218.00

Plan at Elevation 230.00

Plan at Elevation 238.50

LEGEND

Pipelines

DR	Drain
EFF	Effluent
V	Vent

Abbreviations

PRV	Pressure Relief Valve

City of Memphis, Tennessee
T.E. Maxson WWTF Process Upgrades

Figure 6.3-2
Effluent Pump Station Plans