DUCK ISLAND WASTEWATER TREATMENT FACILITY
CITY OF LOWELL, MASSACHUSETTS

APRIL 2023

High Flow Management Plan

WRIGHT-PIERCE
Engineering a Better Environment

High Flow Management Plan
Duck Island Wastewater Treatment Facility
City of Lowell, Massachusetts

April 2023

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Section 1 Introduction

The Lowell Regional Wastewater Utility (LRWWU) owns and operates a combined sewer system (CSS) and the Duck Island Wastewater Treatment Facility (DIWWTF or "Duck Island"). The sewer system consists of approximately 220 miles of gravity sewers and fourteen sewer pumping stations. Ten miles of large-diameter interceptors (48-inches to 120-inches in diameter), along the banks of the Merrimack and Concord Rivers collect wastewater from the sewer system and convey it to Duck Island. The system serves the City of Lowell and the Towns of Tewksbury, Dracut, Chelmsford, and Tyngsborough in Massachusetts. Duck Island, located in Lowell, began operations in 1978 and discharges treated effluent to the Merrimack River. It was designed for an average daily flow of 32 MGD and a peak hourly flow of 112 MGD. Duck Island uses a secondary treatment bypass designed to direct a portion of the primary treatment effluent around the secondary process to prevent loss of solids from the secondary process when needed during high flow events. The bypassed flows are blended with the secondary treatment effluent before the chlorine contact tanks, where the blended flow is disinfected.

Wet weather flow in excess of Duck Island's capacity is stored in the large diameter interceptor sewer system on each side of the Merrimack River using automated controls. When wet weather flow exceeds the storage capacity of the combined sewer system, discharges to local waterways may occur via diversion stations to permitted combined sewer overflow (CSO) outfalls to minimize excessive system surcharging. The City owns nine permitted CSO diversion stations, under the National Pollutant Discharge Elimination System (NPDES) program, with outfalls to the Merrimack River, Concord River, and Beaver Brook. The City manages several programs to meet the NPDES permit objectives including the following:

- Capital Improvement Projects Program
- Collection System Capacity, Management, Operations and Maintenance Program (CMOM)
- Infiltration and Inflow (I/I) Control Program
- High-Flow Management (HFM) Program

The programs play an important role in the City's wet weather management procedures and should be referenced as needed. This document covers the HFM program and is intended to be updated as the City continues to optimize and maximize combined sewer flows to Duck Island.

1.1 Purpose of Report

This report documents the City's efforts to optimize HFM procedures into a comprehensive High Flow Management Plan (HFMP). The key components of the HFMP as outlined in the draft 2023 Consent Decree are summarized as follows:

A. Standard operating procedures to prepare for and process excess wet weather flow generated and collected by the combined sewer system during wet weather, snow melt, and high river flow events to avoid excess untreated CSO discharges.
B. High flow management procedures, including for the LRWU, collection system, and CSO outfalls, to maximize the flow reaching Duck Island, maximize the in-line storage within the collection system, and minimize the volume of discharges through CSO outfalls.
C. Evaluation of the effective capacity of Duck Island during wet weather or high flow periods with the objective to maximize total and secondary treatment capacity for flow received at the influent pump station to comply with NPDES permit conditions.

D. Reporting procedures for high flow conditions that require a secondary bypass at the Duck Island WWTF or at the CSO Diversion Stations, including the system or plant operating conditions that may impair achieving the full capacity of the combined sewer system and Duck Island, identified in items A, B, and C above, and in compliance with any reporting requirements under this HFMP, NPDES permit, or *314 CMR §16.00*.

1.2 History

The City's collection system dates to the 1800s, where sewer and stormwater systems were constructed as a combined system and discharged to local waterways. Today, approximately 7,600 acres or 90% of the City's total land area is served by the wastewater collection system. Approximately 56% of land area (3,600 acres) continues to be served by combined sewers. In 1975 construction of the original Duck Island began, and the facility came on-line in 1978. The original facility consisted of influent screw pumping, automatic mechanical bar screening, six primary clarifiers, secondary treatment bypass, eight aeration tanks, four secondary clarifiers, chlorine disinfection, effluent pumping, and sludge handling facilities. The secondary treatment process has evolved over time to include advanced treatment, but the layout of the facility remains largely unchanged. A brief history of the City's infrastructure and regulatory milestones is provided below.

- 1800-1900s – Collection system constructed as a combined system
- 1970s – Interceptors constructed to direct combined flows to Duck Island
- 1978 – Duck Island brought online
- 1988 – Consent decree to develop and implement a long-term control plan (LTCP) for CSO mitigation
- 1990 – First CSO Facilities Plan developed
- 2011 – Original HFMP submitted
- 2019 – Phase 3 CSO Control program and Integrated Planning Framework submitted
- 2019 – SCADA system upgraded including optimized controls for remote diversion stations
- 2019 – NPDES permit issued with new CSO notification requirements
- 2019 – HFM Protocol Automation comprehensively updated (Appendix A)
- 2022 – Updated CSO notification requirements contained within NPDES permit

1.3 High Flow Management Plan Development

Initially, the HFM program considered maximizing storage first, then initiating secondary bypass when necessary and then diverting as a last resort. This was referred to as the storage-bypass-diversion approach, which intended to minimize unnecessary secondary treatment bypass during less severe storms. After this approach was tested during several storms, it was concluded that it was not effective because stations upstream of Duck Island are more likely to divert when the upstream interceptors of Merrimack and West Station are at capacity and less flow reaches the facility so the maximum treatment capacity may not be reached. This original operational approach often resulted in diversions in the system while Duck Island was not operating at peak capacity, thereby not maximizing treatment.

To maximize treatment, a secondary bypass-storage-diversion approach was developed independently of the severity of the rain event. This approach involved first maximizing flow through Duck Island, including secondary bypass, before initiating storage in the interceptor system. The change in approach was initially hindered by the difficulty of balancing flows between the North and South Bank Interceptors by means of the flow control gates at the North Bank Flow Control Station and Merrimack Diversion Station. Improvements were made based on evaluating how the separate interceptor systems reacted when storing flows.

Following several iterations, the protocol for balancing flows from both North and South interceptors and minimizing diversions was automated to optimize the storage within the interceptors. The flow control gates are programmed to balance flows to Duck Island from each station while maintaining maximum plant influent flow and using the interceptor system for storage during wet weather conditions. This process is described in Section 4 and depicted as a flowchart in Appendix A.

After evaluating the revised HFM program under several different storms, it was determined that maximizing flow to Duck Island provides the most consistent results considering varying conditions and multiple operators. The most important characteristics of the bypass-storage-diversion approach are its simplicity and the ability to avoid diversions while Duck Island influent flow is not maximized. This approach optimizes the treatment capacity and maintains available storage in the interceptor system for subsequent wet weather flows resulting from prolonged storm events.

Section 2 Existing LRWWU Capacity

This section of the HFMP summarizes the Lowell Regional Wastewater Utility's (LRWWU) capacity for the collection system and Duck Island. As discussed in Section 1, the City uses a secondary bypass-storage-diversion approach to manage the overall capacity of the utility. Under this approach, the collection system is limited by treatment capacity at Duck Island and localized hydraulic capacities when storing flows. Duck Island is limited by hydraulic and treatment capacities to maintain NPDES permit compliance.

2.1 NPDES Permit

Duck Island is authorized to discharge treated effluent through its outfall to the Merrimack River based on the standards set forth in its NPDES permit (MA0100633). The Utility's overall capacity is driven by the ability to meet NPDES permit limits, which includes an effluent flow limit along with pollutant limits. The most recent permit was issued in September 2019. Most provisions of the permit became effective in December 2019. However, the City contested the proposed effluent phosphorus limit and the permit in whole was only final and effective on December 1, 2020, for the appealed items. The permit also includes nine permitted CSO outfalls which discharge to the Merrimack River, Beaver Brook, and Concord River.

The limits for Duck Island's effluent discharge include an effluent flow limit of 32 MGD calculated as an arithmetic mean of the monthly average flow for the reporting month and the monthly average flows of the previous eleven months. The permit also includes limits for $CBOD_5$, TSS, pH, total residual chlorine, and e. coli. The total phosphorous limit becomes effective May 31st, 2025. The City submits an annual NPDES report outlining the facility's performance for the previous year, including CSO activity.

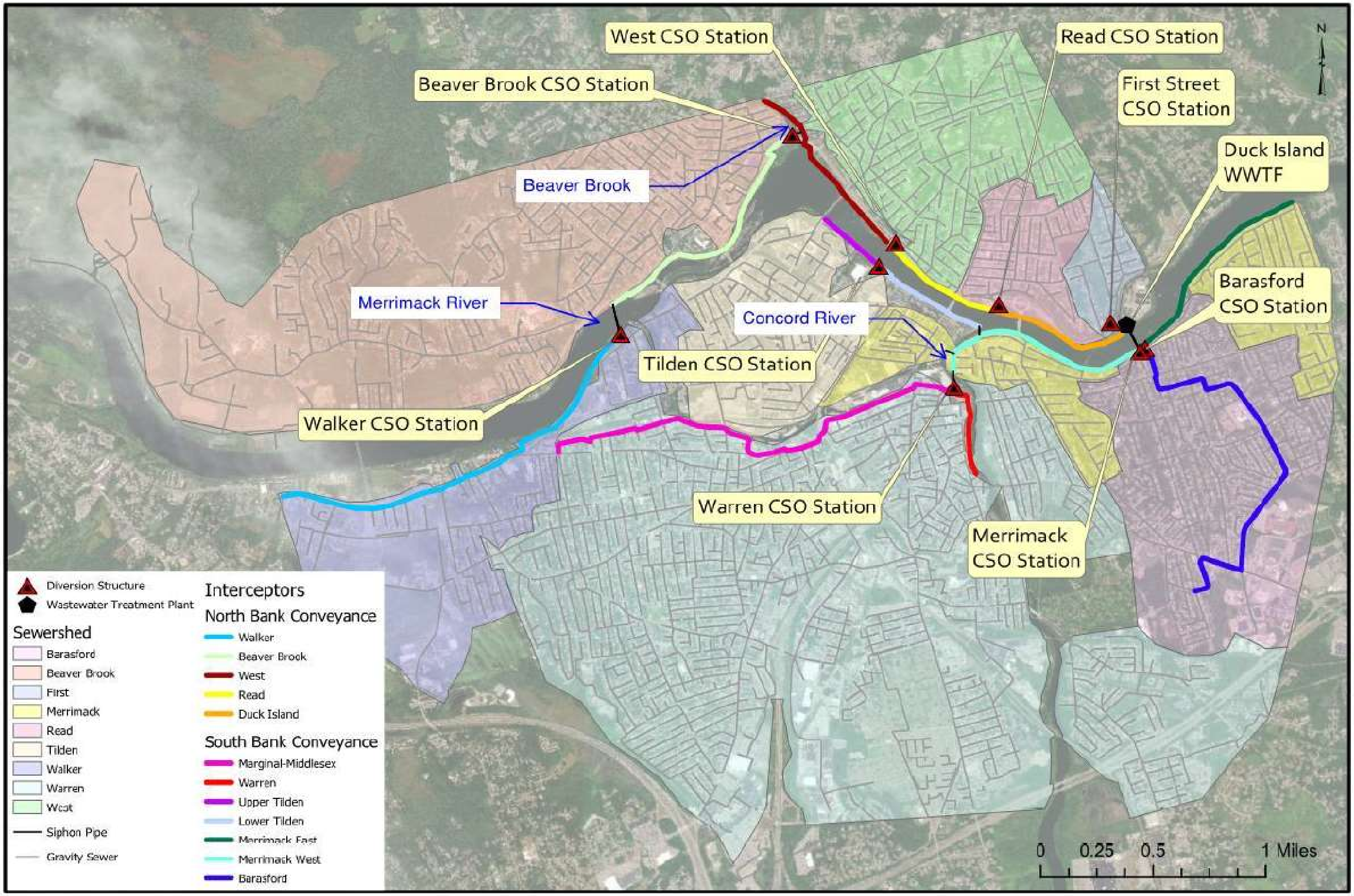
2.2 Collection System

The CSO diversion stations can discharge flow via gravity and/or pumping, if needed, for surcharge relief and to protect upstream infrastructure. All stations, except Read Station, have multiple gates and at least one gravity or pump diversion gate. Most stations include a flow control gate within the structure or upstream collection system to control the flow through the station and enable interceptor storage. Levels in the influent channel and interceptor are measured with a level instrument for monitoring and control. The flow control gate(s) and gravity diversion gate(s) are programmed to open and close when certain levels are reached to maximize storage while also protecting upstream properties. The Beaver Brook station diverts to Beaver Brook, Warren station diverts to Concord River, and the other diversion stations divert to the Merrimack River. Diversion stations which may be impacted by local waterway flooding were designed to include back-up pumping systems when flow cannot be safely diverted by gravity.

Since implementation of the system wide SCADA system as well as installation of programmable logic controllers (PLC) and water depth monitoring at each diversion station, the City is able to safely automate wet weather storage in the interceptor system. The remote control of diversion gates and pumps allows operators to start and stop diversions based on real-time water levels if needed. Normal operation is to leave the system in automatic and allow the system to regulate the storage and diversions based upon operator input settings for each station which are based upon past experience to maximize interceptor storage and flow to Duck Island. Remote gate control enables wet weather storage in the interceptors upstream of the stations, resulting in significant reduction of CSO volume and frequency. The SCADA system is also used to acquire operational data and to monitor equipment at each station. Alarms are generated at each remote station to help operators react quickly if there are any equipment failures that might otherwise go unnoticed. This helps minimize CSO discharges. The alarms are also used to indicate a discharge is pending or has begun and is used for notification and reporting purposes.

Each station calculates diverted flow using one or multiple methods. Flow diverted via gravity is calculated based on the style of diversion gate. For weir gates, the calculation is calculated by the PLC using flow over the sharp crested weir. The head on the weir is measured using a level instrument. For stations with open-up gates, the flow is calculated using the equation for an orifice. The PLC uses the gate position to determine the size of the opening and uses level instruments to measure the water depth on each side of the gate to determine the differential head. This calculation requires a specific discharge coefficient selected for each station. For more information, refer to Appendix B which includes the ladder logic for each diversion station PLC. Refer to Appendix C for example screenshots of the SCADA screens. Each diversion station is described in the following sections. Appendix D includes an overall view of the City's collection system and drawings of each diversion station. Note these drawings reflect the station's original design intent and some features or elevations may not be current. Figure 2-1 shows where each station is located, and Table 2-1 provides an overview of key details for each Diversion Station. The approximated flow capacity through each station is provided in Table 2-2. The following subsections provide a brief description of each Diversion Station.

Figure 2-1 CSO Diversion Station Locations



2.2.1 North Bank Interceptor

2.2.1.1 Beaver Brook

The Beaver Brook Diversion Station is located along Beaver Brook, just after it becomes a tributary of the Merrimack River. This station is located NE of UMass Lowell's North Campus and next to the VFW highway. The Beaver Brook Interceptor collects combined wastewater flow from the northwest portions of the City's collection system on the north side of the Merrimack River in addition to flow collected and conveyed from Walker Station. The Beaver Brook Diversion Station conveys flow to the West Street Diversion Station via three siphons. The structure includes a 96-inch influent line, which splits into two parallel channels and a third bypass channel, if required. Influent flow is automatically controlled via influent gates to allow flow storage in the upstream collection system. Non-diverted flow passes through an automated flow control sluice gate and Parshall flume for flow measurement and level monitoring. There is a 40-foot-long gravity flow CSO discharge weir. Diverted flow is automatically calculated using the height of the water passing over the diversion weir.

2.2.1.2 First Street

The First Street Diversion Station is located on First Street, directly across from Duck Island and includes a building with below grade levels. The First Street Diversion Station conveys flow to the North Bank Interceptor via a 96-inch effluent line. The structure includes an 18-inch influent line and a CSO diversion gate.

2.2.1.3 Read Street

The Read Street Diversion Station is a below-grade structure located along the Merrimack River near the Hunts Falls Bridge rotary and across the VFW Highway. The Read Street Interceptor receives combined flow from the area near Bridge Street. The Read Street Diversion Station conveys flow to the North Bank Interceptor via a 30-inch effluent line. The structure includes a 60-inch influent line and 60-inch CSO discharge line with a gravity diversion weir gate. Diverted flow is automatically calculated using the height of the water passing over the diversion gate weir once flow depth in the influent channel exceeds 9.81 feet.

2.2.1.3.1 North Bank Flow Control Station

The North Bank Flow Control station came online in 2018 and is located upstream of Read Street Station in the 96-inch interceptor and downstream of the West Street Diversion Station. This location allowed the utility to take advantage of the upstream interceptor storage where the interceptor drops 7 feet. The structure includes a flow control gate for upstream storage that will modulate during high flow events to maximize wet weather storage in the interceptor and maximize flow through Duck Island. Gate operations can be found in the High Flow Management Protocol (Section 4 and Appendix A).

2.2.1.4 Walker Street

The Walker Street Diversion Station is located on Pawtucket Street, which runs along the south side of the Merrimack River, upstream of the Black Brook and Pawtucket Dam. The station is located just North of the UMass Lowell Library. The Walker Street Interceptor receives combined flow from several small branches of the collection system in the southeast area of the city and sanitary flow from the North Chelmsford regional connection. There is also a cross-connection in the Marginal/Middlesex Interceptor which allows for flow from that interceptor to enter the Walker Street Interceptor during surcharge conditions. The Walker Street Diversion Station conveys flow to Beaver Brook Diversion Station via siphons. The structure includes a 48-inch influent line which splits into two parallel channels. Influent flow is automatically controlled via the flow control gate to allow flow storage in the upstream collection system. Non-diverted flow passes through a flow control sluice gate and Parshall flume for flow measurement and level monitoring. There is a 13-foot CSO discharge weir to divert flow to a wet well with an ultrasonic level element and three diversion pumps, which discharge to a 54-inch CSO outfall line. Diverted flow is automatically calculated using the height of the water passing over the diversion gate weir. One pump will start pumping when the wet well reaches 8.5 feet; two pumps will run at 9.1 feet; and all three pumps will run at 11.1 feet. Pump operations will stop when the wet well reaches 1.8 feet. Diverted flow is automatically calculated using the height of the water passing over the diversion weir.

2.2.1.5 West Street

The West Street Diversion Station is located along the Merrimack River on the median of the VFW Highway in Centralville. The station is located across the Merrimack River from the Tsongas Arena and Tilden CSO Station. The West Street Interceptor collects sanitary flow from Dracut and combined flow from the Beaver Brook Station. The West Street Diversion Station conveys flow to the North Bank Interceptor via a 96-inch effluent line. The structure includes 96-inch, 48-inch, and 72-inch influent lines which converge upstream of a CSO diversion gate and effluent flow control gate. The West Street Station is used as a backup flow control station for the interceptor and the flow control gate only modulates if the North Bank Flow Control Station, located at the Read Station site, has a failure. The start diversion set point is 9.00 feet and once a diversion has started, the gate will modulate to maintain a storage level of 7.5 feet. Diverted flow is automatically calculated using the equation for flow through an orifice based upon the gate position and water depth measurements on each side of the gate.

In 2018 the station was rehabilitated to supplement Lowell's Flood Damage Reduction (FDR) system in the area. This included the rehabilitation of two pumps for when the river level is elevated above action level 3 (>54.0 Water Service elevation based on USGS Gage 01100000 datum). This would typically be required in the event of a coincidental high river level and high wet weather flow scenario. The pumps are engine driven and must be started locally but can be operated remotely via PLC after starting. Normal operation is for the pumps to be controlled automatically using the wet well level transducer or the pump back-up float control panel. This station includes a standard operating procedure (SOP) for operation included in the Lowell Flood Damage Reduction System Operations & Maintenance Manual which is summarized in Section 4.2.2. The SOP is included in Appendix A.

2.2.2 South Bank Interceptor

2.2.2.1 Barasford Avenue

The Barasford Avenue Diversion Station is located below ground adjacent to the Merrimack Diversion Station. The Barasford Avenue Interceptor receives combined flow from Wentworth Avenue, Douglas Road, and the Belvidere neighborhood. The Barasford Avenue Diversion Station conveys flow to the Merrimack River Diversion station via a 48-inch effluent line. The structure includes an 84-inch influent line and an 84-inch CSO discharge line with an automated weir diversion gate. Flow to the South Bank Interceptor is measured with a Parshall flume while diverted flow is automatically calculated using the height of the water passing over the diversion gate weir. The diversion gate opens when the influent channel level reaches 4.5 feet and closes at 3.0 feet. The flow control gate will close when the influent channel level reaches 9.4 feet and open back up at 8.8 feet. The station also includes an effluent flow control gate which is modulated based on the Merrimack Interceptor level to avoid diversion at Merrimack station. The Barasford and Merrimack stations share a PLC and level instrumentation.

2.2.2.2 Merrimack

The Merrimack Diversion Station is located across the Merrimack River from Duck Island on East Merrimack Street. It consists of a building with a below grade level located in the neighborhood adjacent to the Barasford Avenue Diversion Station. The Merrimack Interceptor consists of an East and West section. The Merrimack West Interceptor receives combined flow from the Warren siphons, East Merrimack Street siphons, and the Lower Tilden

Interceptor siphon. The Merrimack East Interceptor receives combined flow from several sewer tributary areas on the southeastern bank of the Merrimack River and sanitary flow from Tewksbury. The interceptor also receives combined flow directly from the Barasford Avenue Diversion Station. The Merrimack Diversion Station conveys flow to Duck Island from the South Bank Interceptor. The structure includes a 120-inch influent line from the west and an 84-inch line from the east which transitions to 120-inch at the station. Influent flow converges in the influent channel to three siphons which convey flow to Duck Island. Influent flow is automatically controlled via a flow control gate to allow flow storage in the upstream interceptor. There are four 48-inch CSO discharge gates that open upward to divert flow. The diversion gates will open when the interceptor reaches 9.2 feet and modulate to maintain 9.2 feet. All four diversion gates will modulate at the same rate. The diversion gates will close when the influent interceptor level reaches 8.5 feet. The diverted flow is automatically calculated using the equation for flow through an orifice based upon the gate position and flow depth on each side of the gates. In the event that the river elevation impacts gravity diversion flow, the river level exceeds the interceptor level, or the gravity diversion gates cannot maintain the modulation set points, there are two diversion pumps. The pumps are controlled via an ultrasonic level element monitoring the wet well level. The lead pump will start when the wet well level reaches 15.0 feet and the lag pump will start at 15.5 feet. Both pumps will stop running at 14.0 feet. Pumped flow discharges to a 48-inch pump diversion line and measured based off the pump max flow rate on the pump curve.

2.2.2.3 Tilden Street

The Tilden Street Diversion Station is located near the Tsongas Arena, along the Merrimack River and includes a building with below grade levels. It is set in the back of the parking lot which serves the arena. The Tilden Street Interceptor consists of two interceptors named the Upper and Lower Tilden Interceptor, which are separated by the Tilden Street Diversion Station. The Tilden Street Diversion Station conveys flow to the South Bank Interceptor via a 36-inch effluent line. The structure includes a 72-inch influent line and 48-inch CSO discharge line for the gravity diversion gate. Influent flow is automatically controlled via an influent gate just upstream of the station's Parshall flume to allow flow storage in the upstream collection system. The Parshall flume is used for non-diverted flow measurement and level monitoring. The diversion gate opens when the influent channel level reaches 5.0 feet and will modulate at 4.5 feet. The diversion gate will close when the influent channel level reaches 4.0 feet. Diverted flow is automatically calculated using the equation for flow through an orifice using the gate position and flow depth on each side of the gate.

2.2.2.4 Warren Street

The Warren Street Diversion Station is located along the Concord River in a populated downtown area, adjacent to a parking garage and the Concord River. The station includes a building with below grade levels. The Warren Street Interceptor receives combined flow from most of the city's collection system in the southern and central areas of the city. The Warren Street Diversion Station also receives flow from the Marginal/Middlesex Interceptor. This interceptor includes a cross-connection to the Walker Street Interceptor during surcharge events within the Marginal/Middlesex Interceptor.

The Warren Street Diversion Station conveys flow to the South Bank Interceptor (Merrimack Diversion Station) via three siphons. The structure includes a 90-inch and 48-inch influent line. Influent flow is automatically controlled via a flow control gate to allow flow storage in the upstream collection system. There are two automated, downward opening, CSO discharge gates to control diverted flow to a 90-inch CSO outfall line. The diversion gates open, modulating at the same rate, when the influent level reaches 7.5 feet and will modulate to maintain a level of 6.5 feet. The diversion gates will close when the level reaches 4.0 feet. The diverted flow is automatically calculated using the height of the water passing over the diversion gate weirs using the gate position.

Table 2-1 CSO Diversion Station Overview

Diversion Station	Outfall No.	Receiving Stream	CSO Measurement	Upstream Acres	Downstream Connection
North Bank Interceptor					
Beaver Brook	007	Beaver Brook	Weir	570	North Interceptor to West Station
First	012	Merrimack River	Port	90	Duck Island
Read	011	Merrimack River	Weir	175	North Interceptor to Duck Island
Walker	002	Merrimack River	Weir	140	North Interceptor to Beaver Brook Station
West	008	Merrimack River	Port	1,100 (and Dracut)	North Interceptor to Read Station
South Bank Interceptor					
Barasford	030(1)	Merrimack River	Weir	600	South Interceptor to Merrimack Station
Merrimack	030(2)	Merrimack River	Port (gravity) Flowmeter (pumped)	2,941	Duck Island
Tilden	027	Merrimack River	Port	350	South Interceptor to Merrimack Station
Warren	020	Concord River	Weir (2)	1,626	South Interceptor to Merrimack Station

Table 2-2 CSO Diversion Station Physical Features

Diversion Station	Interceptor Length (ft)[1]	Influent Pipe (in.)	Influent Capacity (MGD)	Effluent Pipe (in.)	Effluent Capacity[2] (MGD)	Pump Capacity (MGD)	Effluent Flow Constraint[3] (MGD)
North Bank Interceptor							
Beaver Brook	6,800	96	170	Siphons: 16, 20, & 24	25	-	145
First	3,475	48	37	18	3	-	34
Read	3,280	60	53	30	16	-	37
Walker	9,850	48	32	Siphons: 14, 16, & 20	8	18 per pump, 3 total	24
West	5,050	96, 72, & 48	280	96	93	68 per pump, 2 total	187
South Bank Interceptor							
Barasford	10,200	84	277	48	21	-	256
Merrimack	10,800	84 & 120	204	Siphons: 30, 36, & 48	63	32 per pump, 2 total	141
Tilden	5,695	72	72	36	28	-	44
Warren	15,175	90 & 48	348	Siphons: 30, 30, & 30	45	-	303

1. Interceptor length is the total length of influent interceptors directly connected to each Diversion Station.
2. Effluent Capacity is the approximate conveyance capacity of the station to the downstream connection.
3. The flow constraint is the theoretical flow limitation at the station calculated by subtracting the effluent capacity from the influent capacity. It should be noted that these values are theoretical and may be higher or lower than real world results based on local conditions.

2.3 Duck Island Wastewater Treatment Facility

The purpose of this section is to summarize the maximum flow Duck Island can hydraulically convey in various segments as discussed in Section 2.3.1 and the theoretical treatment capacity of the various processes at the treatment facility as discussed in Section 2.3.2. Values presented in these sections are from the Capacity Evaluation pending completion in 2023.

2.3.1 Hydraulic Capacity

Duck Island was designed for an average daily flow of 32 MGD and a peak hourly flow of 112 MGD with a secondary treatment bypass during high flows. Bypass is accomplished via secondary bypass weirs and gates upstream of the aeration tanks. Secondary bypass flows are conveyed to the chlorine contact tank influent channel via a single 60-inch pipe where it is blended with secondary treatment effluent for disinfection. The total hydraulic capacity of the facility is dependent upon the hydraulic capacity of each process as summarized in the following sections.

2.3.1.1 Preliminary and Primary Treatment Flow Capacity

Influent pumping consists of four screw pumps rated for 43 MGD each. The potential capacity with one pump offline is 129 MGD but is dependent on a free discharge and is reduced when the hydraulic grade results in backflow at the screw pump discharge. Hydraulic modeling and field observations suggest that the hydraulic grade increases to the point that backflow occurs in the off-line pump at about 100-MGD, which requires 3 pumps on-line. Three pumps have been able to maintain a forward flow of at least 117 MGD despite backflow at an off-line pump. Thus, the influent pumping capacity is not a hydraulic flow capacity constraint.

Downstream of the influent pumps are two mechanical screens to remove large debris from the influent wastewater. The screens are rated for 64 MGD each and experience operational issues depending on the volume of debris in the influent during high flow conditions. Furthermore, the lack of redundancy or bypass capability is a potential hydraulic bottleneck. When a screen is offline due to maintenance needs, there is no way to remove screenings from the screen field, thereby restricting flow as the screen blinds. Facility operators would need to manually rake or remove the screen from the channel to maintain full hydraulic flow capacity. Although the screens can operate at variable speed, they are operated at full speed regardless of the influent flow to maximize how quickly the screen field is cleared. With both screens functional they are not considered a bottleneck.

Normal operation is to operate all six primary clarifiers to maximize treatment capabilities during high flow periods. The 2018 Phase 2B upgrades at Duck Island made several improvements to improve hydraulic capacity at the facility, including removing the cone valves on the influent to each primary clarifier. Although the facility sometimes operates with flooded primary clarifier effluent weirs due to downstream constraints, this does not appear to impact the primary clarifiers’ hydraulic capacity. At flows greater than 112 MGD, headloss within the influent piping to each clarifier increases and restricts the feasibility of conveying significantly higher flows. As noted, the facility has processed instantaneous peak flows up to about 117 MGD, and about 120 MGD was assessed to be the current maximum feasible instantaneous peak flow through primary treatment.

2.3.1.2 Secondary Treatment Flow Capacity

In 2002, the aeration trains were modified to provide advanced secondary treatment by modifying the aeration tank layout and changing from an eight-aeration tank process to a four-aeration tank process with multiple zones. These modifications improved treatment but resulted in additional hydraulic bottlenecks from the addition of effluent weirs and ports between zones. Additionally, new flow control valves were installed to automatically control and maintain balanced flow into each train. Based on the current secondary treatment system configuration (four trains with three treatment cells each and four secondary clarifiers), the peak secondary hydraulic capacity is about 48 MGD of primary effluent flow (70 MGD including return activated sludge (RAS) flow) with all unit processes online. Taking one secondary clarifier or aeration train offline results in a hydraulic capacity of 36 MGD of primary effluent flow.

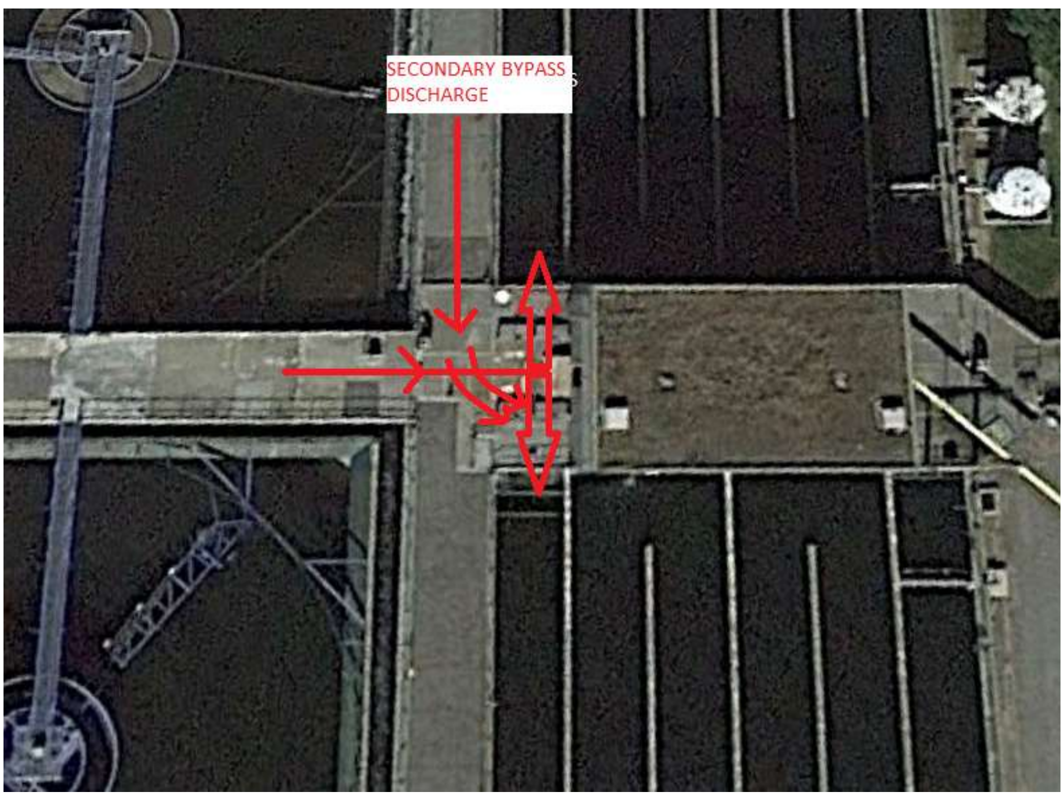
2.3.1.3 Secondary Bypass Flow Capacity

The secondary bypass consists of two overflow weirs and modulating gates to control bypass flow. The bypass weirs allow flow to enter a 60-inch FRP bypass pipe which conveys flow around the secondary treatment process. This system has a maximum hydraulic capacity of about 80 MGD based on the diameter and length of the bypass piping before the hydraulic grade backs up and floods the bypass weirs, which could impact primary treatment. The bypass system does not normally convey this full capacity due to impacts to the disinfection treatment capacity as discussed in Section 2.3.2.3. Since the secondary treatment hydraulic capacity is approximately 48 MGD, the current peak hourly flow to the bypass line is approximately 64 MGD, for a total peak hour capacity of 112 MGD.

2.3.1.4 Disinfection Flow Capacity

The Chlorine Contact Tank (CCT) inlet channel is an area with high turbulence and flow split issues during bypass events. The channel splits at a tee from a single 8-foot channel into two 14-foot channels as shown in Figure 2-2. The 8-foot section of channel is where the secondary bypass discharges at a 90-degree angle. During secondary bypass events, the momentum from the bypass discharge causes more flow to enter the south CCT channel. This short section of 8-foot channel acts as an overall bottleneck, impacting both the secondary treatment capacity and total flow capacity, where increasing flow through one process may reduce the capacity of the other.

Figure 2-2 Secondary Bypass Discharge Upstream of CCT



2.3.2 Treatment Capacity

This section of the report serves to evaluate and characterize the capacity and performance of the primary, secondary, and disinfection systems as it relates to Duck Island's ability to meet NPDES permit requirements.

2.3.2.1 Primary Clarification

Primary clarification is provided by six primary clarifiers. Current design guidelines, including TR-16 which is a design guideline document referenced by MassDEP for technical standards, recommend a maximum surface overflow rate (SOR) of 1,200 gpd/sf for sustained flows (maximum monthly or 12-month moving average) and a peak hourly SOR of 3,000 gpd/sf. Based on these values, the primary clarifiers can treat average flows of 46 MGD with six units online and 39 MGD with five units online, if one is down for maintenance. This exceeds the current 12-month moving average flows.

The TR-16 recommended maximum peak hourly overflow rate of 3,000 gpd/sf corresponds to a peak flow of approximately 96 MGD with 5 tanks online and 115 MGD with 6 tanks online. The design peak hour flow is 112 MGD and the primary clarifiers have performed well in the past at flows up to 117 MGD based on historical removal rates. The 2018 Phase 2B upgrades at Duck Island made several improvements to the primary clarifiers to improve operation during high flow, including raising the scum ring height, flushing capabilities for scum lines, and increased center ring diameter.

Overall, the primary clarifiers perform exceptionally well with an above average total suspended solids (TSS) removal rate of 60% and carbonaceous biochemical oxygen demand (cBOD) removal rate of 30%. Primary treatment is not considered a limiting factor for capacity at the Duck Island based on current average conditions. At peak hourly flows during wet weather events, the removal efficiency is typically reduced, but this is also related to the diluted nature of the wastewater. Lowell has a long track record of typically meeting the effluent criteria in the NPDES permit in the blended effluent (combined secondary effluent and secondary bypass). When violations have occurred, it is often related to upset conditions in the secondary treatment system or difficulties with disinfection.

2.3.2.2 Secondary Treatment

The secondary treatment process at the facility consists of activated sludge treatment in four aeration trains followed by four secondary clarifiers. Normal operation consists of three to four aeration trains, depending on the season, and four clarifiers online. Each aeration train consists of three cells. The first cell is the anaerobic selector which is divided into two zones. The second cell is an aerobic zone followed by the third cell which is a swing zone that operates as a continuous or cyclic aeration zone. Air to cell 3 is cycled as needed to prevent full nitrification and promote denitrification to remove nitrate. In general, cBOD removal is not a limiting factor for capacity. The secondary treatment capacity is limited by total phosphorus (TP) and TSS limits. The secondary treatment process can treat up to 48 MGD of primary effluent with four aeration tanks and four secondary clarifiers online. Taking an aeration tank offline reduces capacity to approximately 40 MGD while taking a secondary clarifier offline reduces capacity to 36 MGD depending on solids settling characteristics.

A BioWin® model was developed as part of the Capacity Evaluation to assess the facility's phosphorous removal capabilities to meet the total phosphorous NPDES permit limit with the existing enhanced biological phosphorous removal (EBPR) treatment process. The model indicates that the facility is able to consistently meet an effluent TP less than 1.08 mg/L at current average flows and water quality conditions as long as nitrate and nitrite are near zero in the return sludge. Nitrification is inhibited during the colder periods of the year due to the average water temperature and short SRT (< 3 day), which favors biological phosphorus removal. However, during warmer periods, the use of cyclic aeration is critical to limiting nitrate/nitrite in the return sludge. The set points for cyclic aeration are critical. The unaerated portion needs to be long enough to promote denitrification, but not so long that conditions become anaerobic, which promotes the release of phosphorus.

As temperatures increase and flows vary, particularly during wet weather flow when the maximum hydraulic capacity of the secondary system (48 MGD) occurs, the model indicates that the addition of a metal salt may be needed to meet the permit limits for TP. At peak hour flow conditions, metal salt addition may not be needed due to the dilute nature of the flows. The City intends to install a chemical phosphorus removal system as part of the Phase 3 Upgrade project scheduled for construction in 2024-2025. The system will provide redundancy for the enhanced biological phosphorous removal process and allow the facility to effectively remove TP at the projected design average flow (32 MGD) and maximum secondary capacity (48 MGD), even if the EBPR process experiences upset. The system also allows the facility to compensate for wet weather by increasing TP removal from the secondary process during secondary bypass events.

To assess the treatment capacity of the secondary clarifiers for total suspended solids removal, two state point analyses (SPA) were conducted. The first (Figure 2-3) uses the Härtel and Pöpel (1992) model. The second (Figure 2-4) uses the Daigger correlation. The State Point of a well operated clarifier should be located below the settling flux curve and the underflow rate line operating below the descending limb of the settling flux curve. If the State Point is located above the settling flux curve in any condition, the mixed liquor solids will not fully settle in the clarifier, and a portion will flow out of the clarifier via the effluent weir. Similarly, if the underflow rate operating line is shown above the settling flux curve in any condition, the sludge blanket is projected to rise and exit the clarifier via the effluent weir.

Figure 2-3 shows two settling flux curves, one using the results from field testing performed at Duck Island on August 30, 2021, and another using the empirical correlation between the SVI of the sludge and the settling constants of the sludge from Härtel and Pöpel (1992). The settling flux curve from the field testing was determined on a day that the SVI was 110 mL/g at a water temperature of 20°C. The field results were adjusted to the average water temperature of 15°C. The settling velocity in the empirical equation from Härtel and Pöpel was developed for an SVI value of 150 mL/g and an average water temperature of 15°C.

The SPA indicates that the secondary clarifiers should typically operate well within their capacity. The overflow solid fluxes are contained under the settling flux curves whenever the SVI is 150 ml/g or less, representing a good operating condition with low effluent suspended solids. It is important to note that the empirical correlation from Härtel and Pöpel was used as guidance to evaluate the secondary clarifier performance for an SVI of 150 mL/g. The initial field testing of the sludge settling velocity was conducted at an SVI of 110 mL/g. This testing showed the need for higher return sludge rates than the Härtel and Pöpel equation suggests, but all of the results are still well within the normal operation of the secondary clarifiers. It's also worth noting that SVI's less than 80 are typically undesirable because the sludge settles too rapidly, often leaving behind lighter pin floc.

To model a worst-case scenario (poor settling characteristics) a SPA was conducted with an SVI of 200 and wastewater temperature of 10°C. Results of this SPA are presented in Figure 2-4. As seen in this SPA, during periods with an elevated SVI of 200 ml/g, secondary treatment flows over 40 MGD would be challenging. Once peak secondary flows reach 40 MGD, it would be recommended to use a 10% to 20% safety factor for the sustained flow. This would correspond to allowable flows of 32 to 36 MGD, with higher flows directed to the secondary bypass. Fortunately, SVIs greater than 150 ml/g should not occur, except on rare occasions of process upset, for example periods with excess solids inventory in the secondary clarifiers.

Based on this analysis, the secondary clarifiers provide adequate settling capacity even at flowrates over 48 MGD through secondary treatment if SVI is around 150 ml/g or less. Current conditions at the time of a wet weather event and experience will dictate how much flow can be sustained for long periods of time through the facility. The facility has an SPA spreadsheet and ability to measure suspended solids in the clarifier effluent to help assess capacity during occasions when the SVI and/or sustained flows are high.

Figure 2-3 State Point Analysis (Härtel and Pöpel)

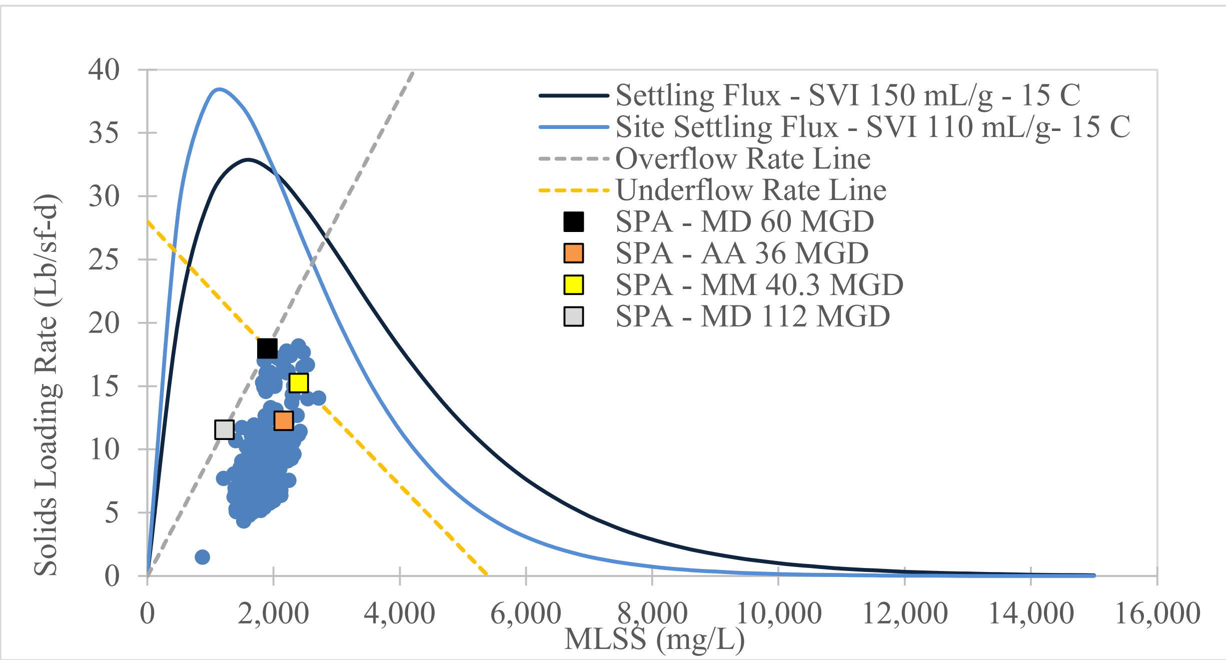
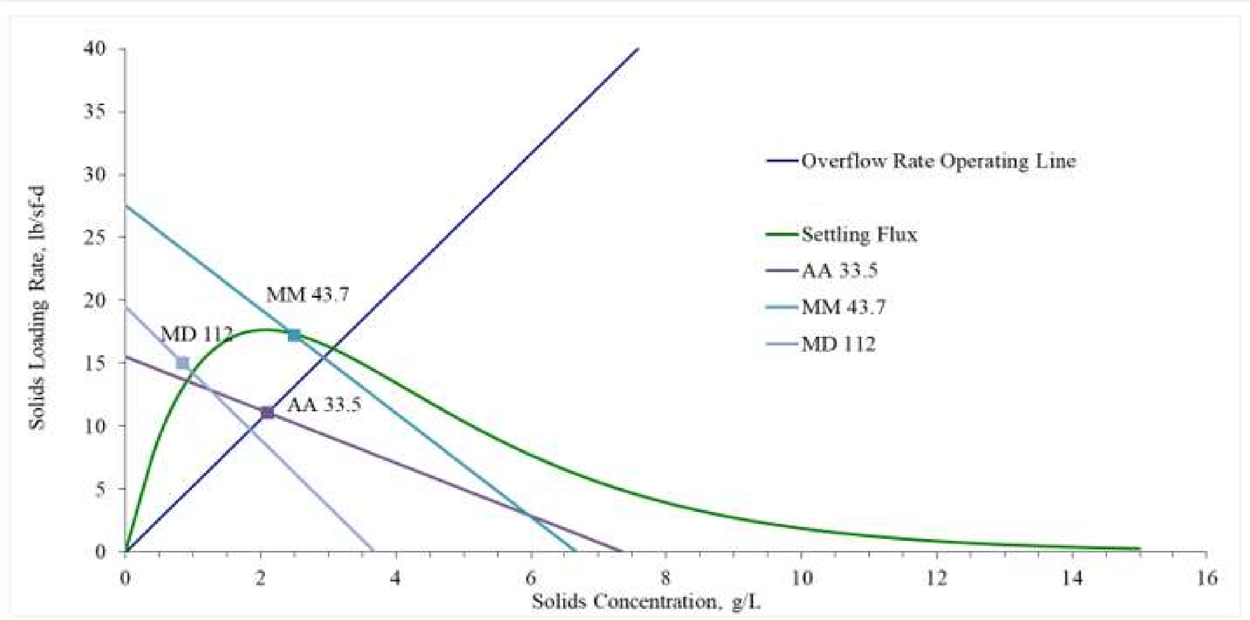


Figure 2-4 State-Point Analysis with SVI of 200 (Daigger)



2.3.2.3 Disinfection

Based on TR-16 guidelines, 30 minutes of contact time should be provided for peak hour flows, which can be decreased if it can be proven that adequate disinfection is occurring with less contact time. Based on the CCTs alone, to provide 30 minutes of contact time, total flow through disinfection must stay below 60 MGD. The bypass conduit has a volume of 650,000 gallons. For bypass flows ranging from 10 to 64 MGD, the contact time in the bypass conduit ranges from 90 to 15 minutes. Additionally, hydraulic conveyance issues as discussed in Section 2.3.1.4 exist where the bypassed flows enter the CCT influent chamber, which results in more flow being conveyed to the south CCT. This reduces the overall contact time in the southern CCT train. The facility compensates for this by basing their dose rate on the analyzers and sample points within the southern CCT train. This can result in high chlorine residual in the north train.

In general, it appears there is adequate chlorine contact time for existing flows with adequate hypochlorite pump capacity and response time for dose control at both the secondary bypass and the CCT. However, disinfection performance is also impacted by solids and nitrite presence, wastewater temperature, mixing, and chlorine concentration. These factors require higher dosing of chlorine solution to compensate. During a wet weather event, higher TSS is more likely to be present, so a high initial dose is likely to be required at the secondary bypass and CCT locations. Experience will dictate what the required dose may be. As part of the Phase 3 Upgrade project, improved monitoring and control of the bypass chlorine dosing will be provided to help the facility take advantage of the contact time within the bypass pipe. The project will also include new sodium hypochlorite pumps with capacity to provide higher dosages during wet weather events. Chlorine dosing of the secondary bypass is discussed in more detail in Section 4 and a SOP flow chart is included in Appendix A.

2.3.3 Overall Capacity

Based on the current hydraulic and treatment capacities at Duck Island, the original design peak hourly flowrate of 112 MGD continues to reflect the actual capacity of the facility, which is dictated primarily by hydraulic constraints. The limiting condition in this case is maintaining free-flow effluent weirs within secondary treatment, which may impact treatment performance.

For both the aeration tank effluent and the secondary clarifier effluent, it is preferred to keep both sets of weirs from being submerged to maintain equal flow splits. However, under high flow conditions it is acceptable to submerge the weirs depending on the expected frequency and duration of occurrence. The potential for impacting secondary clarifier performance is more significant in terms of effluent quality than impacts on the aeration basins. The primary concern with flooding the aeration tank effluent weirs is the resulting unbalanced flow distribution to the influent of the aeration tanks, forcing the motor operated influent valves to actuate more, potentially incurring additional headloss and restricting overall flow capacity of the facility. Currently, total influent flows over 112 MGD (secondary treatment flow of 48-50 MGD and bypass flows of 62-64 MGD) are predicted to result in flooded Secondary Clarifier effluent weirs due to the turbulence in the disinfection area. This flow capacity represents a reasonable balance between treatment and flow capacity with the existing facility layout.

The peak hourly flow capacity at Duck Island is summarized as follows:

- Primary effluent flow: 48 MGD
- Total flow through secondary: 70 MGD (primary effluent + RAS flow)
- Secondary bypass: 64 MGD
- Total influent flow: 112 MGD

The overall peak hourly capacity of 112 MGD at Duck Island dictates when collection system flow storage begins. As influent flow at Duck Island exceeds 112 MGD or is sustained above 100 MGD, flow must be stored or redirected within the collection system to prevent permit violations or unpermitted discharges at Duck Island. The City automatically maintains flow through Duck Island using the High Flow Management Protocol discussed in Section 4. Flow is typically held at or above 103 MGD through Duck Island to provide a safety of factor and allow the control system to adjust to account for sudden changes in the system. The setpoints and conditions dictating the High Flow Management Protocol are continually reviewed by the Head Operator based on current conditions at Duck Island and the collection system.

Section 3 Operation and Maintenance

The City maintains a comprehensive Operation and Maintenance program for both the Duck Island Wastewater Treatment Facility and the Collection System (CMOM). These programs are comprised of standard operating procedures to ensure the utility is able to reliably meet permit requirements. Duck Island is staffed year-round, 24 hours a day, by a minimum Grade 6 Certified Head Operator and another experienced Operator who are responsible for implementing these procedures.

3.1 Information Systems

The City uses electronic instruments at all CSO stations and Duck Island for the direct measurement, control, and recording of all processes. The SCADA system provides real-time alerts for CSO discharges which are continuously monitored by the Head Operator, who confirms the overflow discharge prior to initiating public notification. The SCADA system is also used to monitor and control the major treatment processes and equipment at Duck Island. This integrated data management approach for the collection system and treatment facility provides effective high flow management for the City.

Multiple SCADA screens were developed to support the HFM program as shown in Appendix C. The screens were designed to provide the operators with an overview of the diversion stations, the interceptor system, Duck Island secondary bypass, and all treatment process flows. The CSO Overview Screen provides a graphical representation of the system that allows the operator to quickly assess the current system conditions, thereby reducing time spent interpreting data during high flow events. The CSO Overview Screen acts as a simplified navigation tool, allowing operators to move from one screen to another by clicking on different areas of the screen.

The SCADA system includes a “Diversion Pending” alarm for all CSO diversion stations. If the Duck Island influent flow is less than the allowed maximum influent flow rate, then the flow control gate at the station with the pending diversion is incrementally opened to increase flow to Duck Island. Diversion station gates are precisely controlled via hydraulic actuators with valve position feedback and control down to 0.1% accuracy. Overflow duration and volumes are automatically calculated for each diversion station and stored in the SCADA historian. This information is stored electronically and backed up via the SCADA iFix historian system. In conjunction with the SCADA system, Hach Water Information Management Solution (Hach WIMS) is used to aid in data validation, provide user-friendly data output, and generate custom reports. This allows for post-event evaluation of any issues experienced or to look for ways to improve system operation.

In addition to operational data, the City maintains a comprehensive set of drawings, schematics, and figures associated with their collection system, diversion stations, and Duck Island. This information is used alongside a comprehensive GIS system of the collection system, which allows for location-based data storage for all sewer and stormwater piping and structures. The system is also used to document flood protection mapping and water quality monitoring data.

3.2 Collection System Inspection and Maintenance

The City's infiltration and inflow (I/I) monitoring program was most recently updated in 2022. The purpose of this program is to determine cost effective ways to assess and monitor the City's collection system to determine areas of I/I concern which may impact the capacity of the system during wet weather events. For additional information reference the most recent I/I monitoring program documentation. Some of the assessment efforts include the following:

- Video inspection of the sewer system to identify physical defect or areas of I/I using City owned video inspection trucks operated by full-time City employees with National Association of Sewer Service Companies (NASSCO) certifications.
- Scheduled cleaning of the collection system using City owned and operated vacuum trucks.
- Flow-monitoring programs and engineering studies in support of collection system model development
- Conductance surveys throughout the collection system to identify and further investigate parts of the system with low conductance suggestive of high I/I
- Property inspections to identify sources of inflow
- Coordination between Duck Island and Department of Planning and Development (DPD) to ensure adequate review of all new sewer connections to the collection system and reduce private inflow to the combined system

Review of data collected from these activities as part of high flow management occurs at HFM meetings conducted periodically. When the HFM program was first developed, these meetings occurred bi-weekly, but after several years of optimizing the HFM program the meetings occur as needed, typically quarterly. These meetings are to ascertain system capacity in the context of wet-weather events, areas that may need improvement, and areas that require a more detailed flow assessment to identify issues.

Section 4 High Flow Management Protocol

The original HFM plan, finalized in 2011, summarized the improvements plant personnel made managing remote diversion stations, influent flow to Duck Island, and operation of the secondary bypass. The implemented program was developed through monthly team meetings, daily assessments of system responses to wet-weather conditions, data and chart analysis, familiarization with the interceptor system, and development of a written HFM protocol. The HFM protocol is a critical component of the High Flow Management Program to optimize LRWWU treatment capacity and follows the following logic:

1. Maximize flow to the Duck Island treatment facility including flow through the secondary bypass
2. Maximize use of available storage in the collection system's interceptors upstream of flow-control gates
3. Prevent sewer surcharging by diverting flow through CSO stations

The North Bank and South Bank interceptors are controlled primarily by gates at the North Bank Flow Control Station located near Read Street Station and at Merrimack Station (on the South Bank). These gates are kept open to levels that do not restrict flow under normal (dry) conditions. These gates are set to allow free gravity flow to the facility until Duck Island has reached the maximum allowable influent flow rate as dictated by the High Flow Management Protocol.

Upon maximization of flow to the biological secondary treatment system (48-50 MGD), the secondary bypass gates are opened to allow excess primary treatment capacity to be conveyed through the bypass channel. Flows in excess of the peak hourly flow limit of 112 MGD are not allowed due to the capacity restraints discussed in Section 2. The collection system diversion station control gates automatically modulate to maintain the maximum flow rate to Duck Island. As these gates modulate, levels in the North and South Bank interceptors rise until the diversion set point is reached for each diversion station. Upon crossing this threshold, excess flows are diverted through CSO stations to prevent sewer surcharging. The location where a CSO diversion occurs varies between storms. Each diversion station gate or pump is controlled by a PLC to maximize storage in their respective interceptors.

4.1 Preparation

The City typically maintains the same level of preparedness regardless of weather predictions. The exception being if a major storm with river flooding is anticipated (e.g. above a 25-year storm event). Since the facility is operated 24/7, operators are available to manage situations around the clock. During extreme events, on-call personnel are able to be brought to the facility as needed. In general, the City strives to ensure the following preparatory measures are maintained at all times:

- Maintain generator fuel storage tank at Duck Island and remote stations above 50% full
- Conduct maintenance and confirm available fuel for the portable generators to be deployed to pump stations, if needed
- Maintain sodium hypochlorite and sodium bisulfite chemical storage levels above 50% full
- Visit diversion stations at least once a week to ensure the facility is in good working order
- Ensure all treatment tanks are available to bring online to maximize treatment capacity, if needed
- Ensure bypass sampling and chlorine dosing equipment is ready

In addition to these activities the City maintains an inventory of critical supplies and spare parts to keep equipment in operation.

4.2 High Flow Operations

Overall system operation and activation of the automated Diversion Stations during wet weather events is a complex series of decisions made by the local PLC and Head Operators based on river levels, incoming storm characteristics, time of day, and Duck Island operations.

The High Flow Management plan is based on the following operational protocol:

- All remote gates with “Auto” functionality are programmed to safely maximize storage and minimize CSO diversions. The remote gates and pumps are left in “Auto” unless maintenance issues are ongoing.
- Chlorine dosing at the Duck Island chlorine contact tank is adjusted as needed to compensate for higher chlorine demand due to the secondary bypass flow. Chlorine dosing to the secondary bypass is implemented at the start of the secondary bypass event and adjusted based on bypassed flow.
- The local weather forecast is continuously monitored to anticipate the storm arrival time, duration, and amount of potential precipitation. Until the total flow through Aeration reaches 70 MGD setpoint, the North Bank Flow Control Gate is left at 5% open and the Merrimack Flow Control Gate left at 37% open. This is the standard position for these gates and allows for wet-weather flow to pass through the stations.
- The instantaneous Primary Influent Flow at Duck Island is maximized to 112 MGD with all primary clarifiers online. Sustained flows may require the allowable forward flow to be reduced based upon treatment conditions.
  - It is important that the Primary Influent Flow is maintained at or above 100 MGD (67-inches in the Primary Influent channel) before adjusting the Flow Control Gates at Merrimack and West.
  - Secondary Bypass is activated when the combined secondary influent flow is around 70 MGD (primary effluent plus RAS).
- Flow through secondary treatment is maximized by allowing the influent flow control valves on the aeration tank and secondary clarifier inlet piping to balance approximately 10-12 MGD of influent flow through each aeration tank and clarifier with four of each online. Return sludge pumping is reduced, but typically held around 30% of the secondary influent flow during wet weather conditions.
- Once flow into the treatment plant has been maximized, the North Bank and South Bank Interceptors are utilized for wet weather storage by adjusting the Flow Control Gates at North Bank and Merrimack. These gates are adjusted to balance the flow stored in each interceptor system.
  - The effects on the Primary Influent Flow Rate are observed and a Primary Influent Flow setpoint determined by the Head Operator is maintained throughout the wet weather event to maintain maximum flow reaching Duck Island while still providing a safety factor for sudden changes in the system. The default setpoint is 103 MGD.
- After both the Primary Influent Flow and Interceptor Storage have been maximized, the Diversion Stations will initiate CSO diversions if interceptor levels rise above the gate-open set points at these locations based on local conditions at these stations.
- Immediately following the start of a secondary bypass or a CSO Diversion, all parties listed on the Downstream Notification List are contacted in accordance with the City’s notification plan described in Section 5 and Appendix E.
- The Merrimack and North Bank Flow Control Gates are continually adjusted throughout the storm event in order to first maintain maximum flow to the treatment plant and then maintain maximum storage within the interceptors.
  - The Merrimack Flow Control Gate is adjusted in 3% increments, with a 3-minute observation time between adjustments. The maximum gate open position is 47%.

  - The North Bank Flow Control Gate is adjusted in 1% increments, with a 4-minute observation time between adjustments. The maximum gate open position is 15%.
  - Once the Primary Influent Flow is maximized, storage must be maintained in both interceptors throughout the storm event.
  - When the Duck Island Influent Flow Rate drops below 103 MGD, the interceptor levels are compared, and the Flow Control Gate associated with the higher interceptor level is incrementally opened.
  - When the Plant Influent Flow Rate rises above 103 MGD, the interceptor levels are compared, and the Flow Control Gate associated with the lower interceptor level is incrementally closed.
- The maximum Primary Influent Flow of 103 MGD is maintained until the interceptors have returned to normal levels and all CSO diversions have ceased.
- Immediately following the end of a secondary bypass or a CSO Diversion, all parties listed on the Downstream Notification List are contacted in accordance with the City's notification plan described in Section 5 and Appendix E.
- The Diversion or Bypass Log and the Head Operator's Log are updated with diversion data regarding the high flow event.

These reactions are predominantly automated through control rules established in SCADA but are continually reviewed and assessed by Head Operators throughout any given event. At any time, operators may change the automated system response based on their professional experience to avoid undesirable outcomes or to increase flow through Duck Island when conditions allow.

Flow is maximized through the secondary treatment process via motor operated valves (MOV) on the inlet side of each aeration tank. Once flow through the system is maximized, the secondary bypass gates are allowed to modulate to divert flow around the secondary treatment process in conjunction with the aeration tank MOVs. Flow through the plant is maximized and then the system begins controlling the high flow conditions using the collection system controls.

Based on historical data analysis, the City sets open and close set points for diversion and flow control gates to maximize interceptor storage. For example, raising the diversion gate open set point as high as possible allows for maximum storage in the upstream interceptor. Experience suggests that interceptor storage is safely maximized at approximately one foot below the crown of the pipe. When an influent channel reaches the diversion setpoint the diversion gates are programmed to automatically open and divert flow as a CSO.

The flow control gates automatically modulate to minimize flow that is diverted to outfalls by monitoring the levels within the interceptors and diversion stations and maintaining a set water depth that maximizes storage and flow to Duck Island. This complex system of controls has allowed the City to optimize their high flow management procedures to reduce CSO frequency and volume.

4.2.1 Secondary Bypass Chlorination Procedure

Hypochlorite Pump No. 3 is normally dedicated to chlorinating the secondary bypass. Several hours prior to an expected secondary bypass event, Hypochlorite Pump No. 3 is confirmed to be in Auto and the Primary Tunnel chlorination line and RAS chlorination line manual isolation valves are confirmed to be closed. In the Sodium Hypochlorite Building, the Upper Plant Water gate valve is slowly opened (refer to Appendix A – Secondary Bypass Chlorination SOP for visual). The Hypo Bypass Valve is then opened remotely using SCADA. Hypochlorite Pump No. 3 will turn on in Auto and dose based on a setpoint once the Secondary Bypass has been activated. The dose can be adjusted based on the residual measured by the Pre-Chlorine Residual analyzer in the chlorine contact tank. Once the secondary bypass event has ended, Hypochlorite Pump No. 3 will shut off automatically, the plant water gate valve in the Sodium Hypochlorite Building can be manually shut, and the Hypo Bypass Valve is closed using SCADA.

4.2.2 West Flood Pump Station

The West Flood Pump Station is controlled in a similar manner as the other diversion stations, except during river flooding scenarios where additional measures are required. The area where the pump station is located is within the Merrimack River 100-year flood plain. As a result, the area around the pump station includes a Flood Damage Reduction (FDR) System along the left overbanks of Beaver Brook (FEMA segment 3) and the Merrimack River, extending from Bachman Street to Bridge Street. The FDR protects the Centralville Neighborhood from inundation during the 1% annual chance or greater flood. The system is composed of two parts: a levee system and a pump station. The pump station is located on the left overbank of the Merrimack River at West Street, in the roadway median of the Veterans of Foreign Wars Highway. The levee system is split into two sections: the Rosemont Levee along Beaver Brook and the Lakeview Levee, located along the Merrimack River. The levees are constructed of earthen berms and concrete I-walls. A portion of the FDR system requires active closures at Beaver Street to be installed by the City as part of a flood response. The West Flood Pump Station is required to convey wastewater flows to either Duck Island or the diversion structure during high river flood stage events. Control is similar to the other diversion stations in that conveying flow to Duck Island is prioritized unless it is at capacity. This pump station is a critical component of the FDR system because it prevents CSO flows impacted by the river elevation from surcharging upstream infrastructure. Operation of this system is based on the Lowell Flood Damage Reduction System Operations & Maintenance Manual which is maintained by LRWWU and should be referenced for additional information. Pumping operations are described in more detail in Appendix A – West Pump Station SOP.

4.3 Post-High Flow Operations

Following high flow events, the City conducts the following activities:

- Continue to follow the City's notification plan described in Section 5 and Appendix E to indicate when a diversion has stopped and prepare a detailed report
- Adjust chlorine dosing if being operated manually to prevent overdosing
- Drain secondary bypass to the Duck Island influent
- Collect data from event(s) and analyze to determine any issues in need of investigation

Section 5 Public Notification and Outreach

Notification of CSO events follows the regulations as outlined within 314 CMR 16.00. The City provides real-time notification of CSO events via emails. Detailed reports of each CSO event and high flow treatment performance are made available to all parties after proper validation of instrument and communication records. The City has also worked with downstream communities to develop user friendly notification reports based on their feedback.

Interested individuals may request admission to the City's CSO notification list at any time by filling out a CSO Notification Request web form that is accessible from the Wastewater Utility's page on the City's website (www.lowellma.gov/1287). The website includes a widget to translate the page contents to over a hundred other languages for ease of access. Individuals may also provide their phone number as a preferred means of notification via text messages, but the detailed reports are only sent directly via email. Details on CSO activities are also available on the website. The full CSO Notification Plan accepted by regulatory agencies is also available on the website:

https://www.lowellma.gov/DocumentCenter/View/21016

Wastewater staff have been actively involved in communication and collaboration with special interest groups like the Massachusetts Coalition for Water Resources Stewardship, Massachusetts Rivers Alliance, the Merrimack River Watershed Council, downstream communities, Boards of Health, and others to identify the primary objectives of public notifications that may be delivered in a timeframe manageable from a utility perspective while still meaningful to the general public.

5.1 Notification Plan

Many of the voluntary standard procedures which the City had previously conducted were stated as requirements in the City's 2019 NPDES permit (Part I.F.3(g)) as part of a public notification plan. In general, the CSO Public Notification Plan is as follows:

- Continuous monitoring of CSO discharges at all permitted CSO outfalls through the SCADA network.
- Initial notification to all subscribers via email and/or text message at the start of a CSO discharge. The notification list includes local news outlets including news outlets that serve the Environmental Justice communities.
- Supplemental notification is provided at the termination of CSO discharges to all subscribers. This message includes the date and time at which the CSO discharges ceased.
- Annual summary of all wet-weather events is posted online by March 31 and included in Duck Island's Annual Wastewater Report. This includes the number of CSO activations and volume of each, status and progress of CSO abatement work, and contacts for additional information on CSOs and water quality impacts on a website.

A list of all of the information that is required to be in the public advisory notification in accordance with 314 CMR 16.04 (10) and how the City meets those requirements is described in the City's CSO Notification Plan included in Appendix E. Several key features of the notification include the following:

- Identity of the permittee and description of discharge or overflow location(s), and outfall number(s)
- Approximate date and time the discharge or overflow began, and its duration

- Estimated volume of the discharge or overflow is determined based on the average discharge or overflow data reported to the Department and/or EPA for the prior three calendar years.
- Whether, at the time of notification, the discharge or overflow has ceased, and if so, the approximate time and date that the discharge or overflow ended
- Waters and land areas, including names of water bodies and municipalities, affected, or potentially affected by the discharge or overflow
- Precautionary measures to be taken by the public, including the following language: “Avoid contact with these water bodies for 48 hours after the discharge or overflow ceases due to increased health risks from bacteria and other pollutants. See website for more information”
- Link to the City's website for additional information on discharges and overflows, and its CSO and/or SSO abatement program(s)
- A statement that the discharge or overflow consists, or likely consists, of untreated or partially treated sewage and waste.

Section 6 Conclusions

The High Flow Management Plan is a working document intended to be updated based on improvements to the City's utilities and experiences managing high flow conditions. The goal of the HFMP is to reduce CSOs and maximize flow treated at Duck Island. There are numerous features in the collection system and at Duck Island which are integral to this process, including nine CSO Diversion Stations, two major interceptors on each bank of the Merrimack River, and the individual treatment processes at Duck Island.

Duck Island's hydraulic and treatment capacity are critical for mitigating CSO diversions. Since its original construction in the 1970's, the capacity has remained relatively the same at a peak hourly flow capacity of about 112 MGD and sustained peak flows around 100 MGD due to secondary treatment impacts. The secondary treatment capacity is 48 MGD (70 MGD including RAS flow) with all treatment processes online. Remaining primary treatment effluent is diverted to the facility's secondary bypass, which discharges to the chlorine contact tank influent channel where it is blended with secondary effluent.

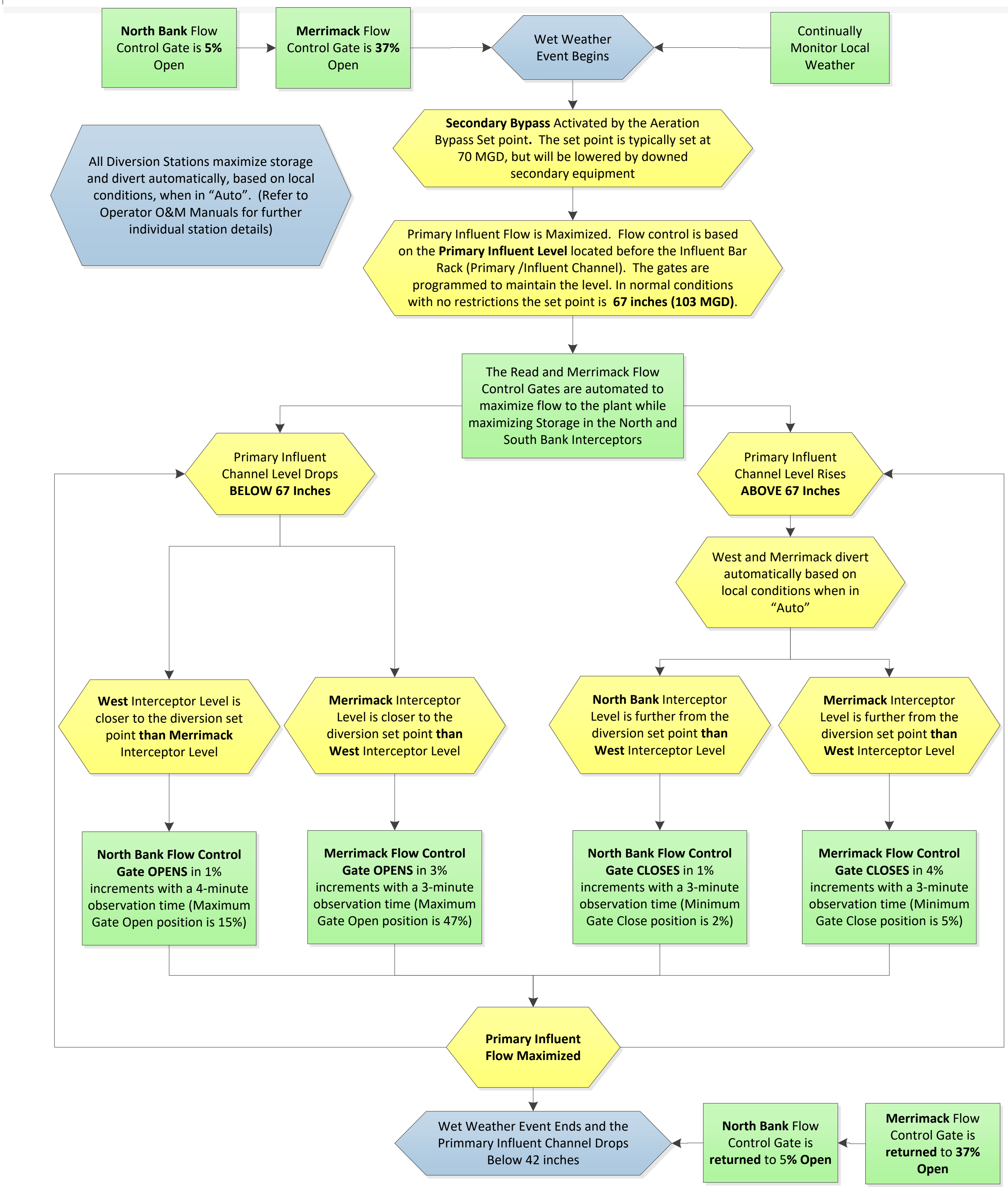
The City has effectively balanced the needs between the collection system and Duck Island to ensure efficient use of capital funding. Prior to Duck Island's construction, a majority of the collection and storm water systems were combined sewer systems. Today, about 56% of the City's land area is served by a combined sewer system and the City continues to work on separation efforts, where economical. At Duck Island, the City has balanced capital improvement projects between capacity, maintenance, and treatment. These efforts help reduce the frequency and volume of CSOs while maintaining treatment efficacy for permit compliance.

One of the most important improvements for CSO reduction was implementation and optimization of the High Flow Management Protocol, which is the foundation of the HFMP. The protocol uses control logic through the SCADA System to maximize flow to and through Duck Island and once maximized, uses available storage in the collection system's large diameter interceptors. Once there is a risk of surcharging upstream sewers with potential for property damage or unpermitted discharges, a CSO diversion is initiated. Following initiation of a CSO diversion, the City has a comprehensive notification plan to meet MassDEP requirements and ensure proper communication is provided to the public and interested parties.

Appendix A
High Flow Management SOPs

Automated High Flow Management Protocol

March 27, 2023



LRWWU Standard Operating Procedure – Secondary Bypass Chlorination

May 28, 2021

4 Hours before a predicted rain bypass event.

↓

Verify Hypochlorite Pump No.3 is in Auto. (Fig 4)

↓

Verify the Primary Tunnel Chlorination Line Butterfly Control Valve is closed (Located in the Aeration Tunnel at the beginning of the Bypass Channel - Fig.1)

↓

Verify the RAS Chlorination Line Control Valve is closed (Located in the Secondary Tunnel at the four way intersection - Fig.2)

↓

Open (¾-1 Turn) the Upper Plant Water Gate Valve that controls flow into the Influent Chlorination Line (Located in the Chlorination Building - Fig.3)

↓

Plant water is being fed into the Secondary Bypass Line

↓

Visually confirm that plant water is now being fed into the Secondary Bypass Line

↓

Secondary Bypass Begins

↓

Hypochlorite Pump will turn on in Auto and dose according to the "Auto Dosage" setpoint (Fig 5)

↓

Secondary Bypass is being chlorinated

↓

Monitor the Pre-Chlorine Residual and adjust the bypass dosage/ interval as needed. (Fig 5)

↓

Secondary Bypass Ends

↓

Hypochlorite Pump No.3 will turn off automatically.

↓

The **Secondary Bypass Pending Warning** is no longer in alarm

↓

Close the Upper Plant Water Gate Valve that controls flow into the Influent Chlorination Line (Fig.3)

↓

Close the Hypo Bypass Valve through SCADA after the Plant Water is shut off. Note the Valve will not close automatically. (Fig.4)

↓

Resume Normal Operation

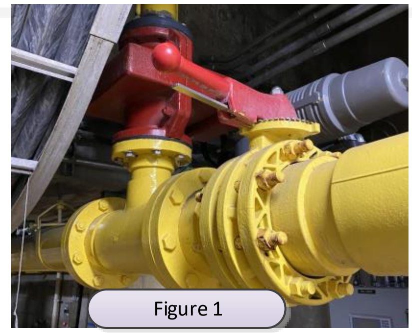


Figure 1

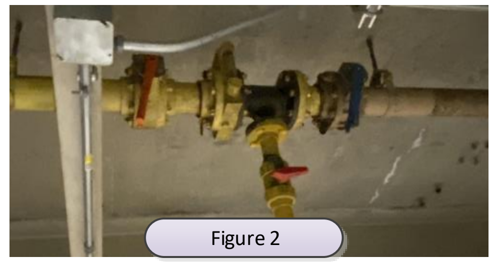


Figure 2

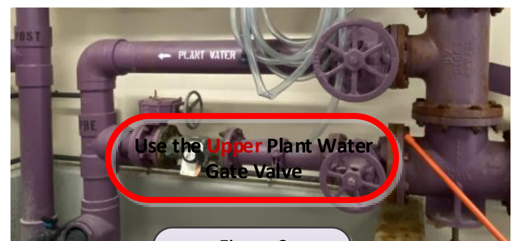


Figure 3

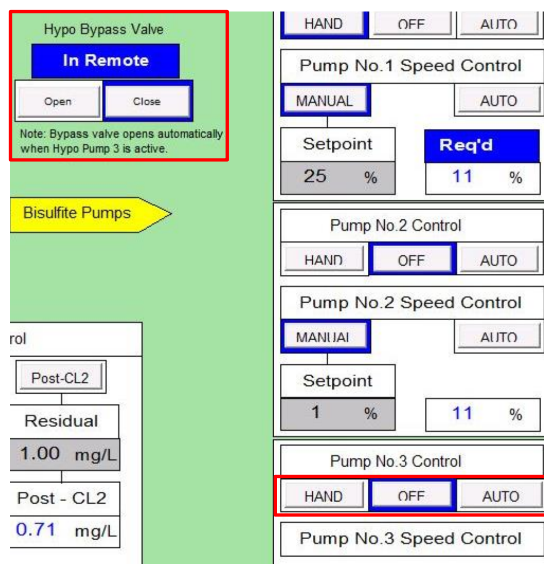


Figure 4

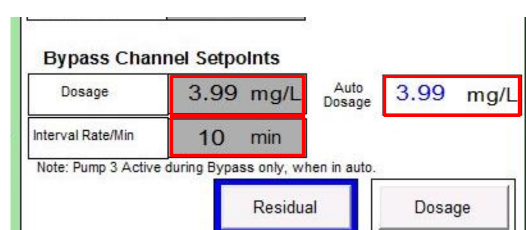
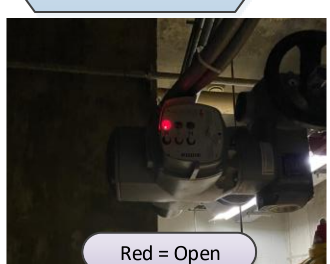


Figure 5

Proper Valving in the Hypochlorite Building for Pump 3



Red = Open

Green = Closed

West Flood Pump Station SOP

Has river reached Action Level 3 AND the Influent Chamber Water Level has reached 13'?

YES

1. Open Pump Diversion Slide Gate (SG-140)
2. Fully Close Pump Exercising Gate Valve (GV-130)
3. Fully Open Pump Discharge Gate Valve (GV-110, GV-120)
4. Ensure City Water fill line closed at solenoid
5. Ensure PLC and Wet Well Transducer Are Operational
6. Ensure Backup Float Control Panel Set to OFF

Has Influent Chamber Water Level reached 15'?

NO

Continue to Monitor Influent Chamber Water Level

YES

1. Open Wet Well Slide Gate (SG-130)
2. Close Gravity Diversion Slide Gate (SG-120)
3. Look for Green Light on Engine Local Control Panel to Confirm Engine in AUTO Mode. If Red Light is On, Press AUTO Button and Confirm Red Light Turns Off, and Green Light Turns On. When in AUTO, PLC will control engines.
4. Pump the Right-Angle Gear Oil Hand Pump (Lever with Red Handle) 20 Times.
5. Press Green Engine Start Button at Engine No. 1 Panel
6. Manually Clutch Engine
7. Confirm Wet Well Water Level Has Dropped Below 11', and Turn Backup Float Control Panel ON.
8. Monitor Engine and Panels for Alarms

Is there an alarm due to high wet well level?

Continue to Monitor Engine and Panels for Alarms

NO

Is there an alarm due to low wet well level?

NO

YES

YES

1. Press Green Engine Start Button at Engine No. 2 Panel
2. Manually Clutch Engine Slowly
3. Monitor Engine and Panels for Alarms
4. Notify Incident Manager and System Manager
5. Check Pump Discharge Flap Valves to Ensure They Are Not Stuck in Open Position

1. Confirm Low Level Condition in Wet Well via level transducer and Low Level Float Switch indicator light on Backup Float Control Panel
2. Notify System Manager and wait for confirmation to shut down Engine.
3. Upon confirmation for shut down by System Manager, manually de-clutch Engine.
4. Press Red Engine Stop Button at Engine No. 1 Panel.
5. Notify System Manager

Are wet well levels continuing to rise?

Continue to Monitor Engine and Panels for Alarms

NO

YES

Alert Incident Manager and System Manager

NO

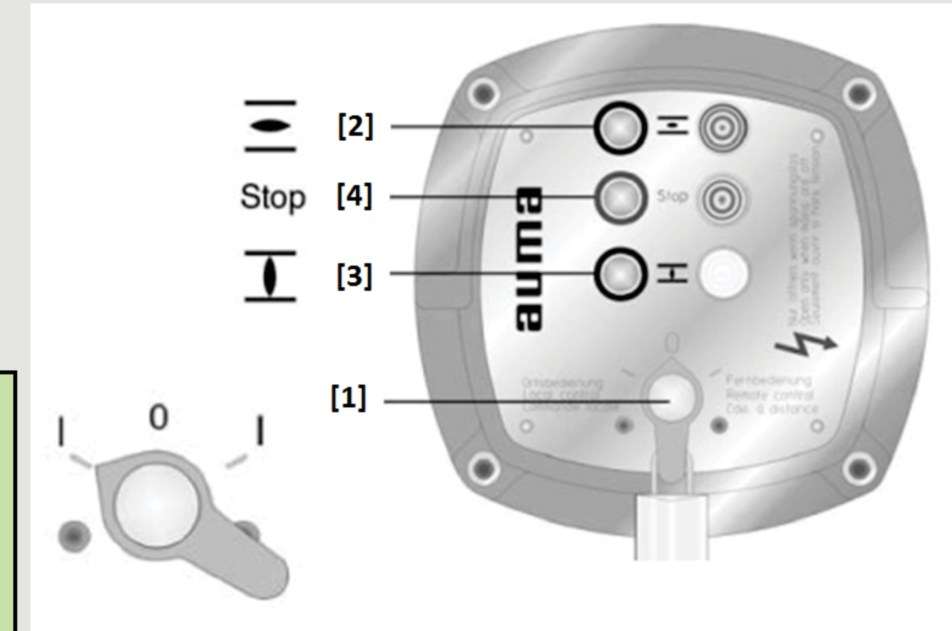
Is there an alarm due to low wet well level (with two engines active)?

YES

1. Confirm Low Level Condition in Wet Well via level transducer and Low Level Float Switch indicator light on Backup Float Control Panel.
2. Manually de-clutch Engine.
3. Press Red Engine Stop Button at Engine No. 2 Panel.
4. Notify Incident Manager and System Manager

Instructions on Slide Gate Operation (SG-120, SG-130, SG-140)

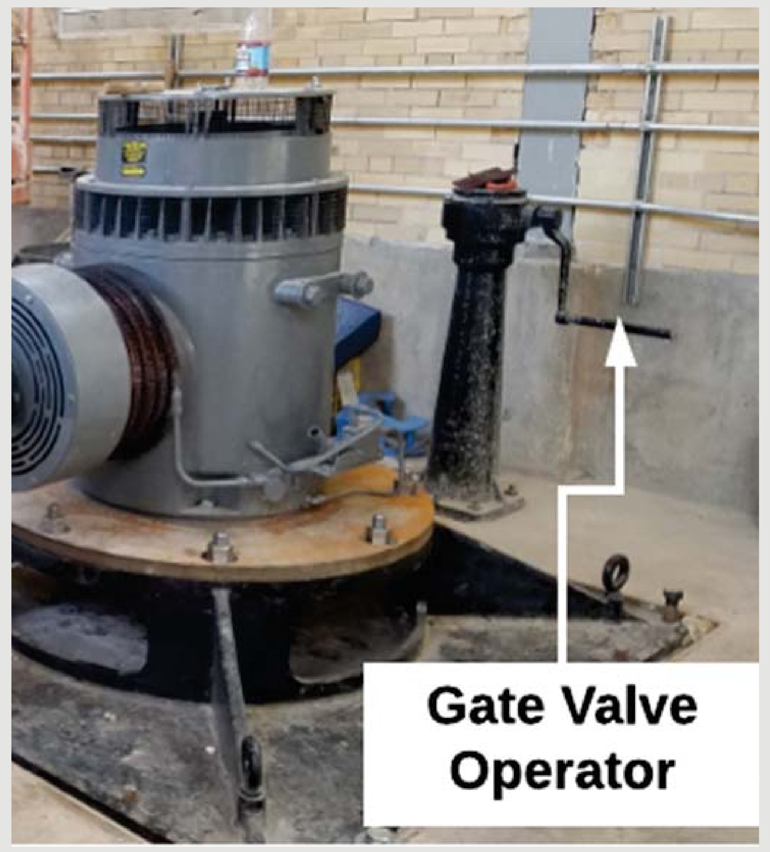
1. Set Selector Switch (Component 1 on Diagram) to Local Control
2. Push Top Button (Component 2 on Diagram) to Open Gate
3. Push Bottom Button (Component 3 on Diagram) to Close Gate
4. Push Middle Button (Component 4 on Diagram) to Stop Motor



AUMA Slide Gate Actuator Local Panel Diagram

Gate Valve Operation

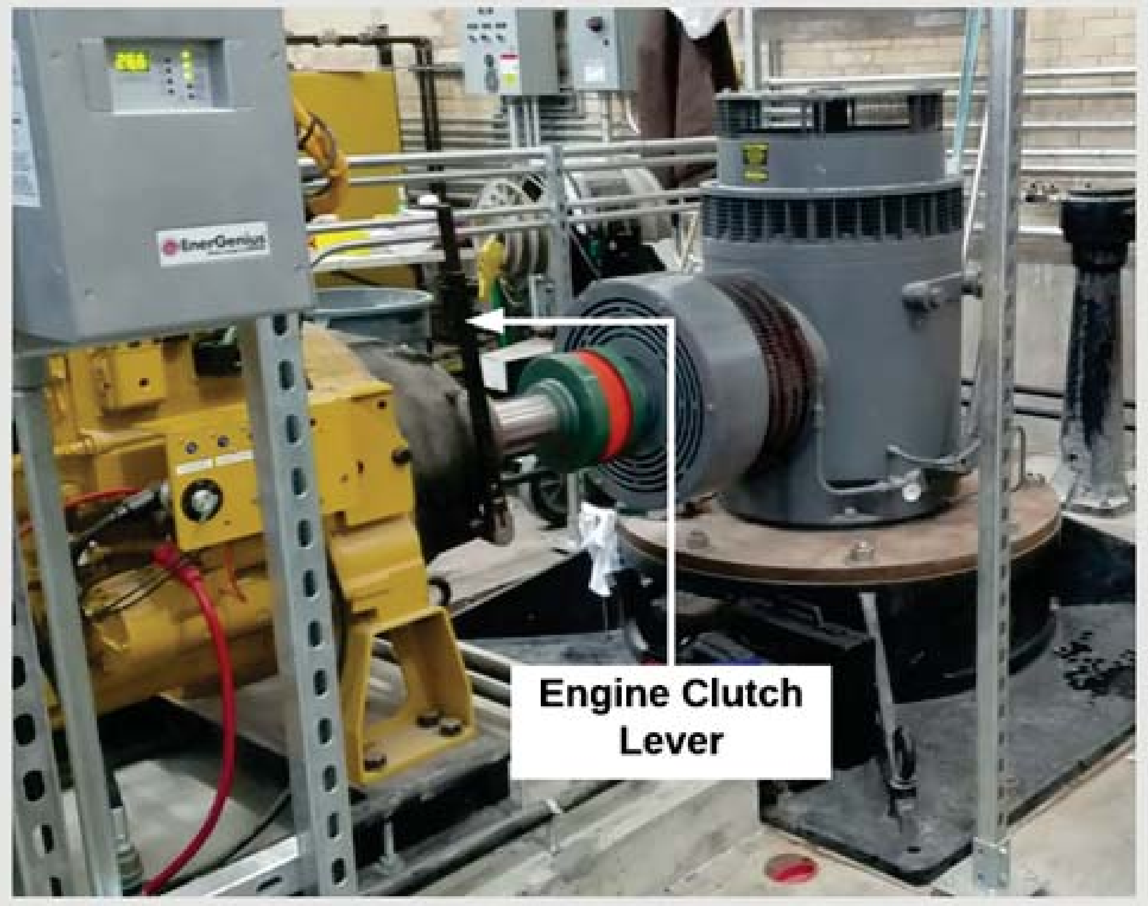
Turn crank CLOCKWISE to open (typical of GV-110, GV-120, GV-130)



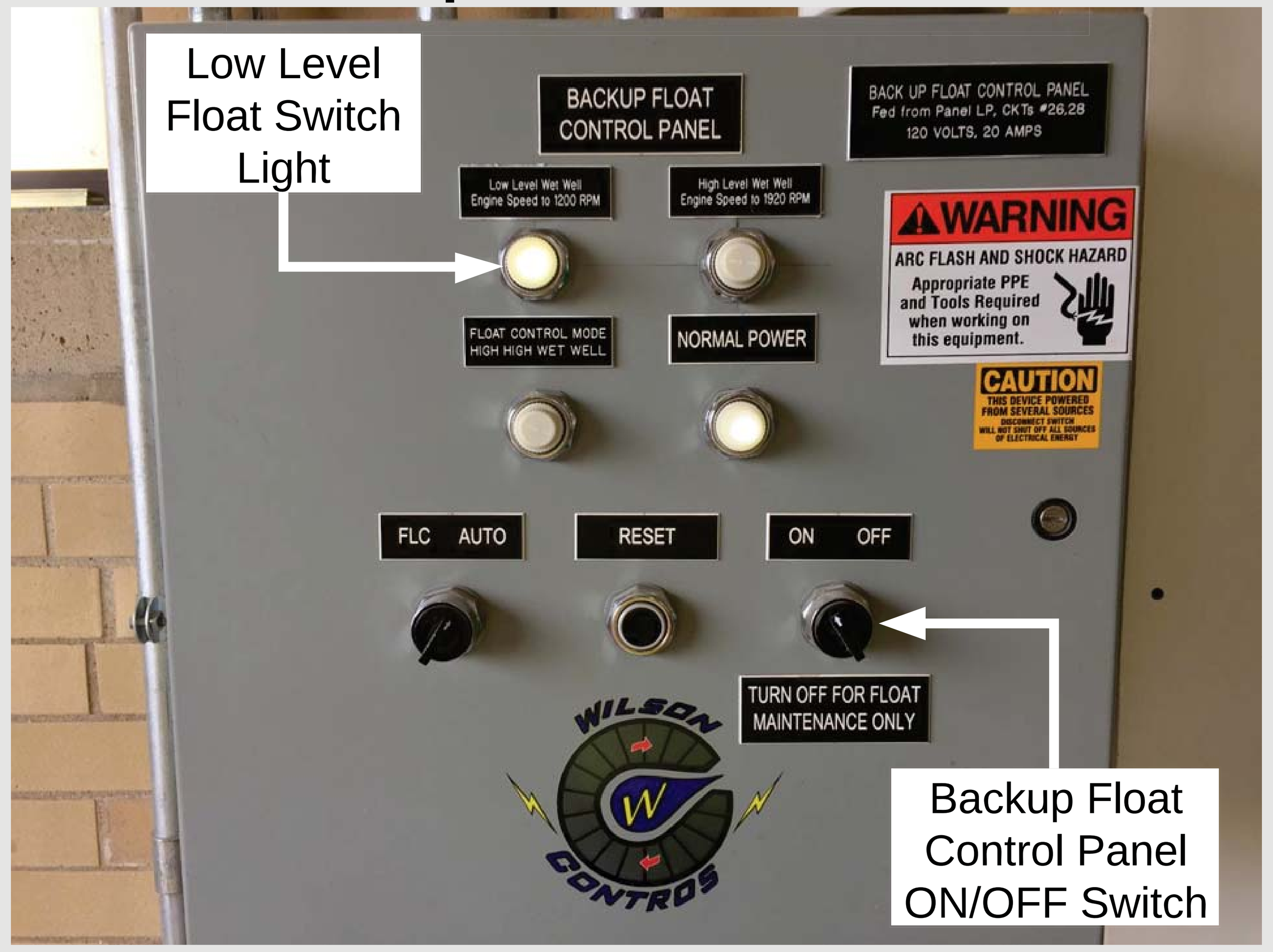
Gate Valve Operator. Picture Typical of Pump Discharge Gate Valves (GV-110, GV-120).

Engine Local Control Panel

Engine Clutch



Backup Float Control Panel



West Flood Pump Station Monthly Maintenance and Pump Exercise SOP

Perform Monthly Visual Inspection and Maintenance

1. Confirm Pump Diversion Slide Gate Closed (SG-140)
2. Confirm Wet Well Slide Gate Closed (SG-130, Normally Closed)

3. Confirm Wet Well water level at least 10.8'. If not, turn on City water until level reaches 10.8'. The solenoid valve will shut off the City water at this level. Solenoid panel located to right of sink.

4. Fully Open Pump Exercising Gate Valve (GV-130)
5. Fully Open Pump Discharge Gate Valve (GV-110, GV-120)

Instructions on Slide Gate Operation (SG-120, SG-130, SG-140)

1. Set Selector Switch (Component 1 on Diagram) to Local Control
2. Push Top Button (Component 2 on Diagram) to Open Gate
3. Push Bottom Button (Component 3 on Diagram) to Close Gate
4. Push Middle Button (Component 4 on Diagram) to Stop Motor

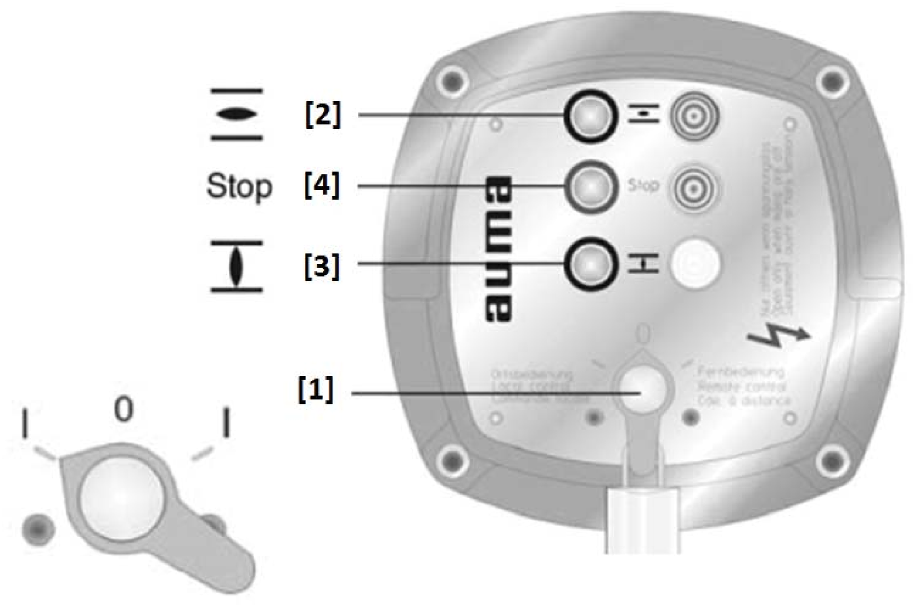


Figure 1
AUMA Slide Gate Actuator Local Panel Diagram

Siemens Hydroranger

Figure 2
Siemens Hydroranger 200. Confirm Wet Well level at least 10.8'. The solenoid switch will fill the wet well to this elevation.

Gate Valve Operation

Turn crank **CLOCKWISE** to open
(typical of GV-110, GV-120, GV-130)

Figure 3
Gate Valve Operator. Picture Typical of Pump Discharge Gate Valves (GV-110, GV-120).

6. Look for Red Light on Engine Local Control Panel to Confirm Engine in Manual Mode. If Green Light is On, Hold Red Button Down Until Green Light Turns Off, and Red Light Turns On.
7. Press Green Engine Start Button at Engine No. 1 Panel
8. Pump the Right-Angle Gear Oil Hand Pump (Lever with Red Handle) 20 Times.
9. Manually Clutch Engine (Push Clutch Lever Towards Engine)
10. Increase Engine Speed at Engine Control Panel to 1,920 RPM (Rabbit Button)
11. Run Pump/Engine No. 1 for 30 Minutes

Engine Local Control Panel

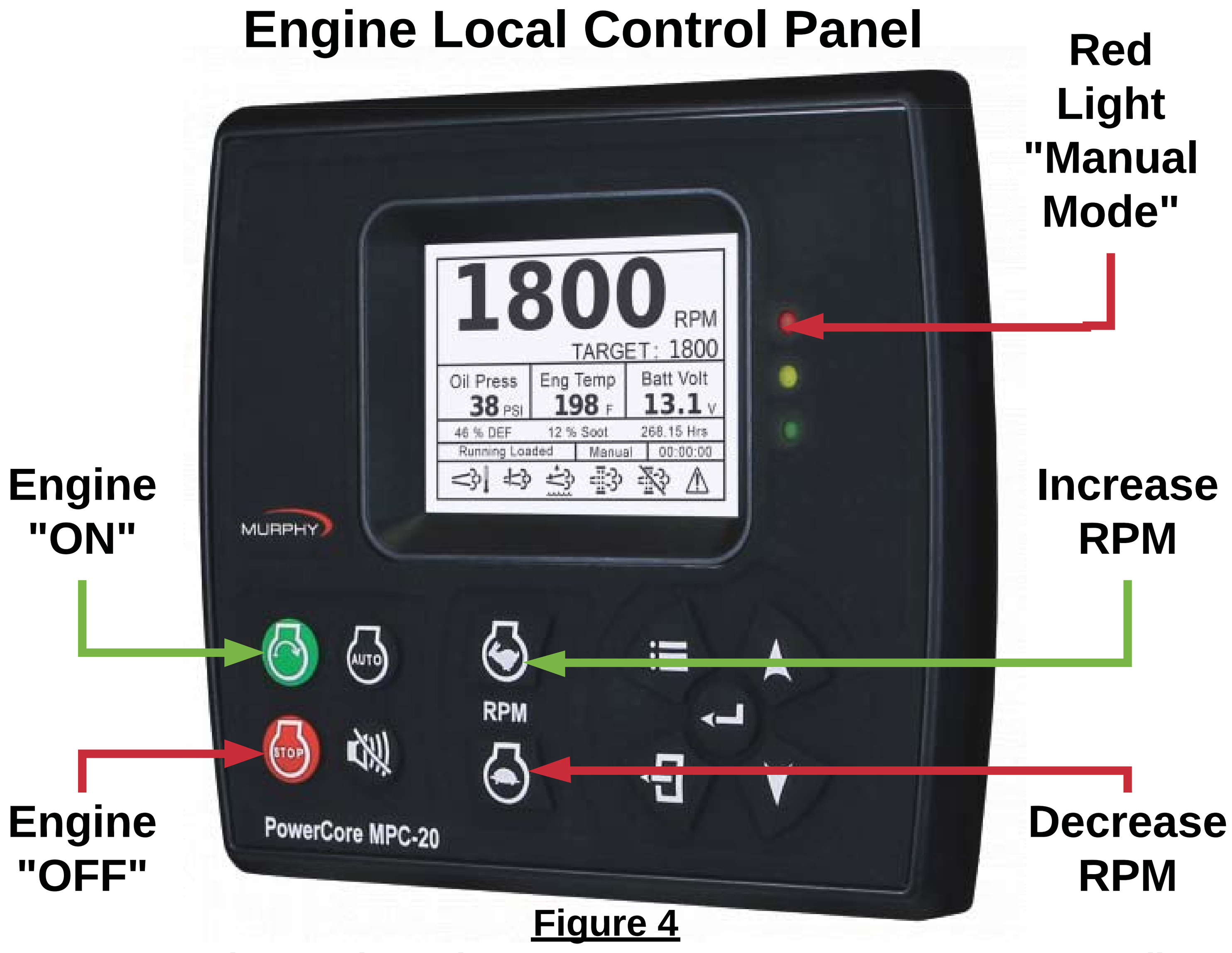


Figure 4
Engine Local Control Panel FIgure, used to turn on the engine, manually control engine/pump, and monitor engine condition/alarms.

Engine Clutch

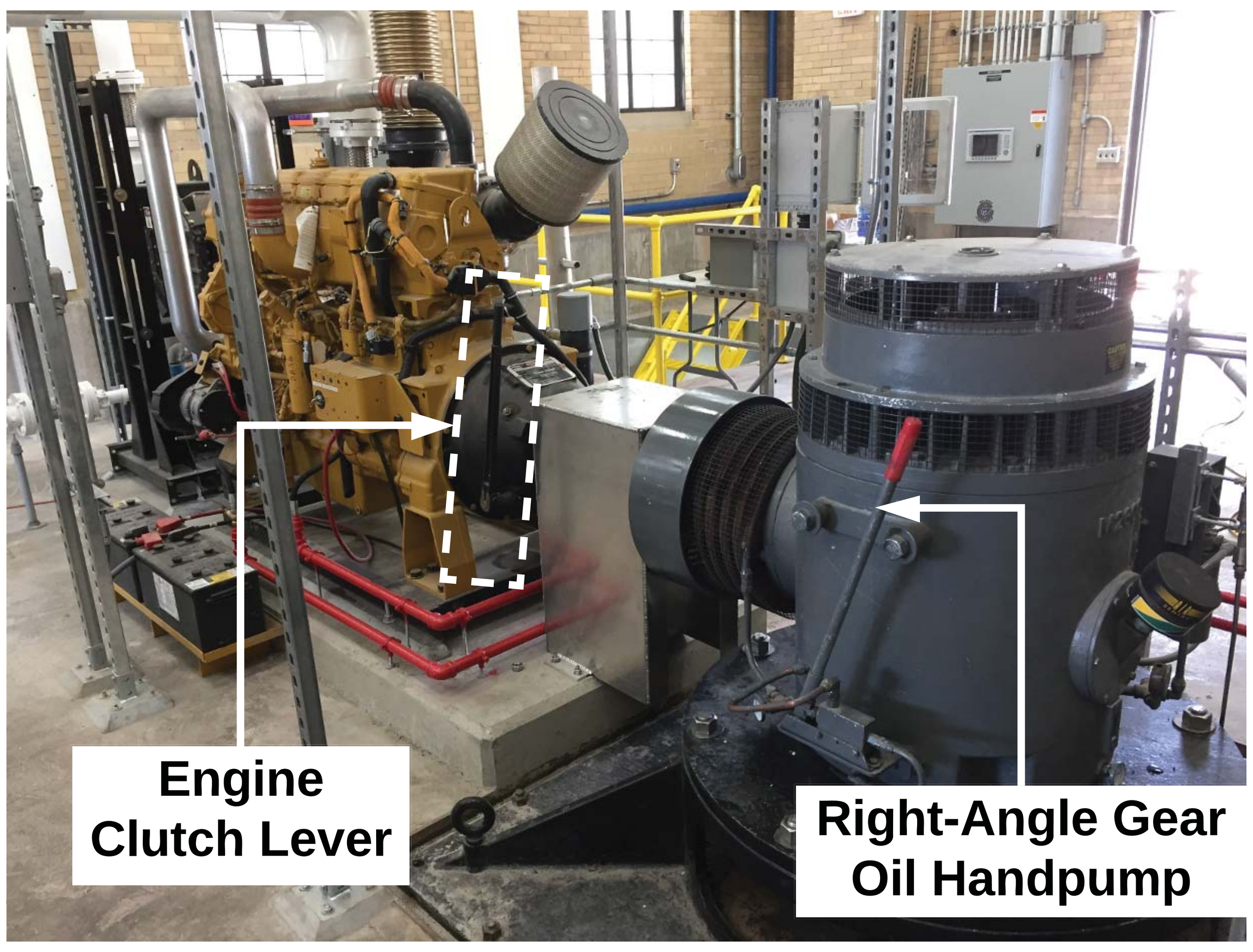


Figure 5
Engine and RIght-Angle Drive, with Engine Clutch Lever Highlighted.

12.Check Pump Discharge Channel to Ensure Channel not Surcharging

Pump Discharge Channel

Figure 6
Flap gate condition in pump discharge chamber during pump exercise. Ensure water is not surcharging channel. If surcharging to within 3 feet of top of structure, begin engine shutdown procedure (starting at Step 12) and investigate for blockages.

Pump Exercise Gate Valve (from Wet Well)

Figure 7
Pump exercise gate valve, as seen from inside wet well.

13.Reduce Engine Speed to 1,200 RPM (Turtle Button) (See Engine Control Panel Above)
14. Manually Declutch Engine (See Photo Above, Push Clutch Lever Away from Engine)
15. Press Red Engine Stop Button at Engine #1 Panel (See Engine Control Panel Above)
16. Repeat for Pump/Engine No. 2

Appendix B
Diversion Station PLC Logic

0

BARASFORD BYPASS
GATE POSITION
POSTSCALE

Barasford Ladder Logic

GRT
Greater Than (A>B)
Source A BARBYPSGTEPOS
<F8[0]>
0.06875038
Source B 10.0

DIV
Divide
Source A F8[34]
100.0
Source B 695.0
Dest F11[133]
0.0

1

BARASFORD BYPASS
GATE POSITION
POSTSCALE

LEQ
Less Than or Eql (A<=B)
Source A BARBYPSGTEPOS
<F8[0]>
0.06875038
Source B 10.0

MOV
Move
Source 0.0
Dest F11[133]
0.0

2

BARASFORD BYPASS
GATE POSITION
POSTSCALE

GRT
Greater Than (A>B)
Source A BARBYPSGTEPOS
<F8[0]>
0.06875038
Source B 2.0

Scale with
Parameters

SCP_Real
Scale with Parameters
SCP_Real Brrsfrd_Div_Gte_Elv_SCP ...
Input BARBYPSGTEPOS
<F8[0]>
0.06875038
Input_Min 0
Input_Max 100
Scale_Min 4.61
Scale_Max 0.9
Output 0.9

Barrasford Diversion
Gate Elevation
(.9-4.6 ft)

MOV
Move
Source Brrsfrd_Div_Gte_Elv_SCP.Output
0.9
Dest F11[130]
4.61

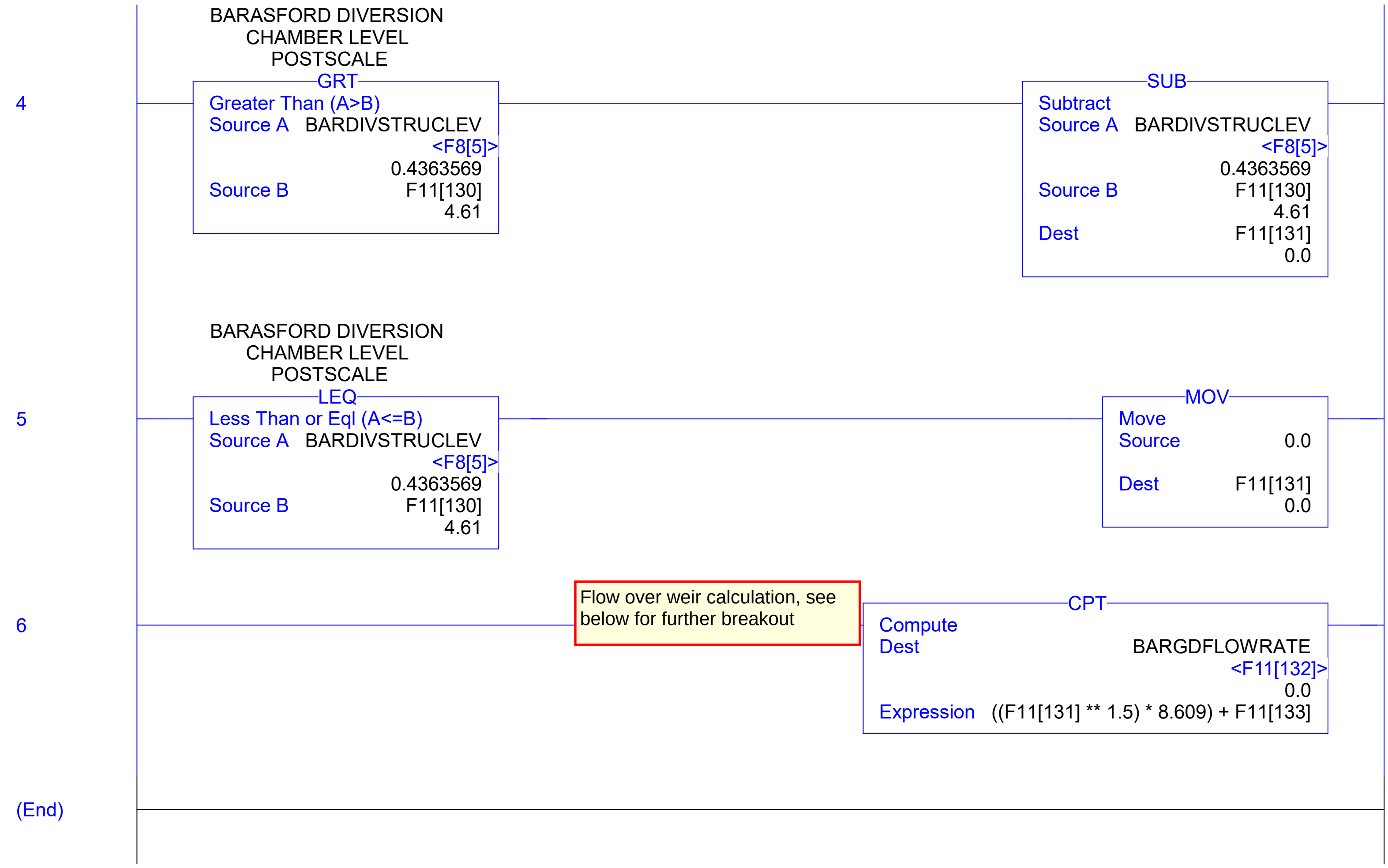
3

BARASFORD BYPASS
GATE POSITION
POSTSCALE

LEQ
Less Than or Eql (A<=B)
Source A BARBYPSGTEPOS
<F8[0]>
0.06875038
Source B 2.0

Barrasford Diversion
Gate Elevation
(.9-4.6 ft)

MOV
Move
Source 4.61
Dest F11[130]
4.61



Barasford Gravity Diversion flow rate = ((F11[131] ** 1.5) * 8.609) + F11[133]

- F11[131] = Barasford Diversion Structure Elevation - F11[130]

- F11[130] = Barrasford Diversion Gate Elevation 9 - 4.6 ft

- Beaver Brook
    - Diversion Flow (GPM) calculates when the influent channel level is greater than 4.5 ft
        - F8[3] = Influent channel level
        - F8[40] = Diversion flow height = F8[3] - 4.5 ft

        - Diversion Flow (GPM) = 3.33*(40.0*SQR(F8[40]*F8[40]*F8[40]))/1.547

- Pumped Diversion Flow (GPM), when influent channel level is greater than 6ft
    - F8[3] = Influent channel level
    - F8[43] = Elevation over pumped diversion weir = F8[3] - 6 ft
    - F8[44] = Pumped Diversion flow =

      3.33*(40.0*SQR(F8[43]*F8[43]*F8[43]))/1.547

Merrimack Ladder Logic

Merrimack Diversion Station includes four diversion gates, each is controlled using similar logic as shown below. The flow through each is calculated separately and summed for a total flow diverted value.

0

SUB
Subtract
Source A MERRIVERLEVEL
<F8[9]>
2.2859373
Source B 1.01
Dest F11[0]
1.2759373

1

MOV
Move
Source INTERCEPTORLEVEL
<F8[35]>
1.5000122
Dest F11[1]
1.5006988

2

MOV
Move
Source 4.0
Dest F11[2]
4.0

MOV
Move
Source 5.89
Dest F11[3]
5.89

3

Scale with Parameters
SCP_Real
Scale with Parameters
SCP_Real GATE_1_SCP ...
Input SLIDEGATE1POSITION
<F8[11]>
1.4750004
Input_Min 0.0
Input_Max 100.0
Scale_Min 5.96
Scale_Max 9.96
Output 6.019

MOV
Move
Source GATE_1_SCP.Output
6.019
Dest F11[4]
6.019

4

GEQ
Grtr Than or Eql (A>=B)
Source A F11[4]
6.019
Source B 9.88

MOV
Move
Source 9.88
Dest F11[4]
6.019

5

SUB
Subtract
Source A F11[4]
6.019
Source B F11[3]
5.89
Dest F11[5]
0.12900019

6
GEQ
Grtr Than or Eql (A>=B)
Source A F11[5]
0.12900019
Source B 0.0001

MOV
Move
Source F11[5]
0.12900019
Dest F11[6]
0.12900019

7
LES
Less Than (A<B)
Source A F11[5]
0.12900019
Source B 0.0001

MOV
Move
Source 0.0001
Dest F11[6]
0.12900019

8
DIV
Divide
Source A F11[2]
4.0
Source B 2.0
Dest F11[7]
2.0

9
CPT
Compute
Dest F11[8]
0.70665383
Expression SQR (((F11[7] ** 2.0) - ((F11[7] - F11[6]) ** 2.0)))

10
CPT
Compute
Dest F11[9]
0.3611238
Expression (F11[12] / 2.0) - (ASN (((F11[7] - F11[6]) / F11[7])))

11
CPT
Compute
Dest F11[10]
1.3221492
Expression (F11[7] - F11[6]) * F11[8]

12
CPT
Compute
Dest F11[11]
0.12234604
Expression ((F11[7] ** 2.0) * F11[9]) - F11[10]

13
CPT
Compute
Dest F11[13]
0.4993596
Expression (F11[7] ** 2.0) - ((F11[7] - F11[6]) ** 2.0)

14
CPT
Compute
Dest F11[14]
0.077178836
Expression F11[7] - ((2.0 * (F11[13] ** 1.5)) / (3.0 * F11[11]))

15 ADD
Add
Source A F11[3] 5.89
Source B F11[14] 0.077178836
Dest F11[15] 5.967179

16 GRT
Greater Than (A>B)
Source A F11[0] 1.2759373
Source B F11[15] 5.967179

MOV
Move
Source F11[0] 1.2759373
Dest F11[17] 5.967179

17 LEQ
Less Than or Eql (A<=B)
Source A F11[0] 1.2759373
Source B F11[15] 5.967179

MOV
Move
Source F11[15] 5.967179
Dest F11[17] 5.967179

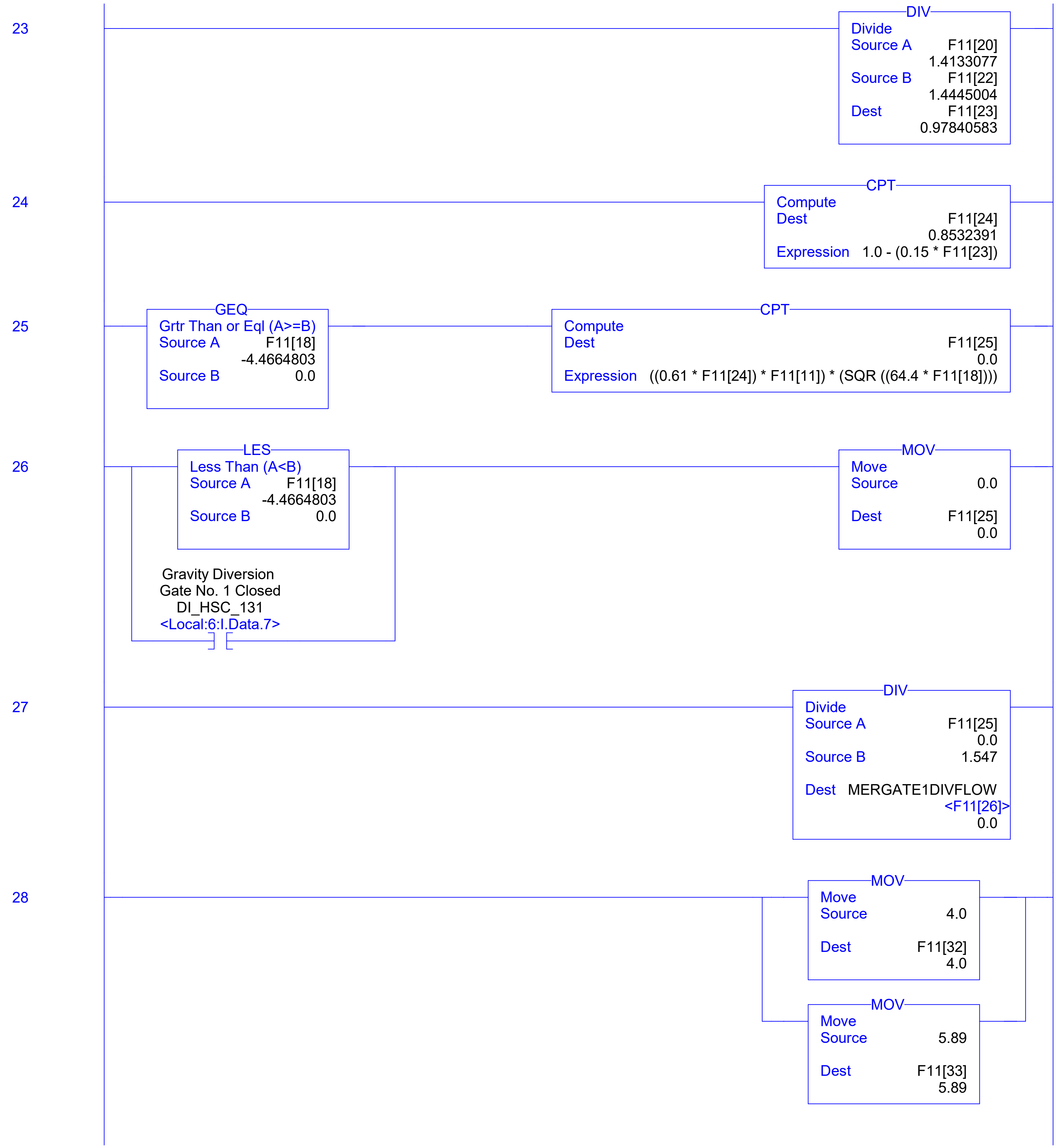
18 SUB
Subtract
Source A F11[1] 1.5006988
Source B F11[17] 5.967179
Dest F11[18] -4.4664803

19 SUB
Subtract
Source A F11[7] 2.0
Source B F11[6] 0.12900019
Dest F11[19] 1.8709998

20 CPT
Compute
Dest F11[20] 1.4133077
Expression 2.0 * (SQR (((F11[7] ** 2.0) - (F11[19] ** 2.0))))

21 CPT
Compute
Dest F11[21] 0.7222502
Expression 2.0 * (ACS ((F11[19] / F11[7])))

22 CPT
Compute
Dest F11[22] 1.4445004
Expression F11[7] * F11[21]


23
DIV
Divide
Source A F11[20]
1.4133077
Source B F11[22]
1.4445004
Dest F11[23]
0.97840583
24
CPT
Compute
Dest F11[24]
0.8532391
Expression 1.0 - (0.15 * F11[23])
25
GEQ
Grtr Than or Eql (A>=B)
Source A F11[18]
-4.4664803
Source B 0.0
CPT
Compute
Dest F11[25]
0.0
Expression ((0.61 * F11[24]) * F11[11]) * (SQR ((64.4 * F11[18])))
26
LES
Less Than (A<B)
Source A F11[18]
-4.4664803
Source B 0.0
Gravity Diversion
Gate No. 1 Closed
DI_HSC_131
<Local:6:I.Data.7>
MOV
Move
Source 0.0
Dest F11[25]
0.0
27
DIV
Divide
Source A F11[25]
0.0
Source B 1.547
Dest MERGATE1DIVFLOW
<F11[26]>
0.0
28
MOV
Move
Source 4.0
Dest F11[32]
4.0
MOV
Move
Source 5.89
Dest F11[33]
5.89

29

Scale with Parameters
SCP_Real
Scale with Parameters
SCP_Real GATE_2_SCP ...
Input SLIDEGATE2POSITION
<F8[12]>
6.25038147e-003
Input_Min 0.0
Input_Max 100.0
Scale_Min 5.93
Scale_Max 9.93
Output 5.9302497

MOV
Move
Source GATE_2_SCP.Output
5.9302497
Dest F11[34]
5.9302497

30

GEQ
Grtr Than or Eql (A>=B)
Source A F11[34]
5.9302497
Source B 9.88

MOV
Move
Source 9.88
Dest F11[34]
5.9302497

31

SUB
Subtract
Source A F11[34]
5.9302497
Source B F11[33]
5.89
Dest F11[35]
0.040249825

32

GEQ
Grtr Than or Eql (A>=B)
Source A F11[35]
0.040249825
Source B 0.0001

MOV
Move
Source F11[35]
0.040249825
Dest F11[36]
0.040249825

33

LES
Less Than (A<B)
Source A F11[35]
0.040249825
Source B 0.0001

MOV
Move
Source 0.0001
Dest F11[36]
0.040249825

34

DIV
Divide
Source A F11[32]
4.0
Source B 2.0
Dest F11[37]
2.0

35

CPT
Compute
Dest F11[38]
0.3992233
Expression SQR (((F11[37] ** 2.0) - ((F11[37] - F11[36]) ** 2.0)))

36
CPT
Compute
Dest F11[39]
0.20096028
Expression (F11[12] / 2.0) - (ASN (((F11[37] - F11[36]) / F11[37])))

37
CPT
Compute
Dest F11[40]
0.7823779
Expression (F11[37] - F11[36]) * F11[38]

38
CPT
Compute
Dest F11[41]
0.021463215
Expression ((F11[37] ** 2.0) * F11[39]) - F11[40]

39
CPT
Compute
Dest F11[43]
0.15937924
Expression (F11[37] ** 2.0) - ((F11[37] - F11[36]) ** 2.0)

40
CPT
Compute
Dest F11[44]
0.023660064
Expression F11[37] - ((2.0 * (F11[43] ** 1.5)) / (3.0 * F11[41]))

41
ADD
Add
Source A F11[33]
5.89
Source B F11[44]
0.023660064
Dest F11[45]
5.91366

42
GRT
Greater Than (A>B)
Source A F11[0]
1.2759373
Source B F11[45]
5.91366

MOV
Move
Source F11[0]
1.2759373
Dest F11[47]
5.91366

43
LEQ
Less Than or Eql (A<=B)
Source A F11[0]
1.2759373
Source B F11[45]
5.91366

MOV
Move
Source F11[45]
5.91366
Dest F11[47]
5.91366

44
SUB
Subtract
Source A F11[1]
1.5006988
Source B F11[47]
5.91366
Dest F11[48]
-4.412961

45

SUB
Subtract
Source A F11[37]
2.0
Source B F11[36]
0.040249825
Dest F11[49]
1.9597502

46

CPT
Compute
Dest F11[50]
0.7984466
Expression 2.0 * (SQR (((F11[37] ** 2.0) - (F11[49] ** 2.0))))

47

CPT
Compute
Dest F11[51]
0.40192318
Expression 2.0 * (ACS ((F11[49] / F11[37])))

48

CPT
Compute
Dest F11[52]
0.80384636
Expression F11[37] * F11[51]

49

DIV
Divide
Source A F11[50]
0.7984466
Source B F11[52]
0.80384636
Dest F11[53]
0.9932826

50

CPT
Compute
Dest F11[54]
0.8510076
Expression 1.0 - (0.15 * F11[53])

51

GEQ
Grtr Than or Eql (A>=B)
Source A F11[48]
-4.412961
Source B 0.0

CPT
Compute
Dest F11[55]
0.0
Expression ((0.61 * F11[54]) * F11[41]) * (SQR ((64.4 * F11[48])))

52

LES
Less Than (A<B)
Source A F11[48]
-4.412961
Source B 0.0

Gravity Diversion
Gate No. 2 Closed
DI_HSC_132
<Local:6:I.Data.10>

MOV
Move
Source 0.0
Dest F11[55]
0.0

53
DIV
Divide
Source A F11[55]
0.0
Source B 1.547
Dest MERGATE2DIVFLOW
<F11[56]>
0.0

54
MOV
Move
Source 4.0
Dest F11[62]
4.0

MOV
Move
Source 5.89
Dest F11[63]
5.89

55
Scale with
Parameters
SCP_Real
Scale with Parameters
SCP_Real GATE_3_SCP ...
Input SLIDEGATE3POSITION
<F8[13]>
0.16250038
Input_Min 0.0
Input_Max 100.0
Scale_Min 6.0
Scale_Max 10.0
Output 6.0065002

MOV
Move
Source GATE_3_SCP.Output
6.0065002
Dest F11[64]
6.0065002

56
GEQ
Grtr Than or Eql (A>=B)
Source A F11[64]
6.0065002
Source B 9.88

MOV
Move
Source 9.88
Dest F11[64]
6.0065002

57
SUB
Subtract
Source A F11[64]
6.0065002
Source B F11[63]
5.89
Dest F11[65]
0.11650038

58
GEQ
Grtr Than or Eql (A>=B)
Source A F11[65]
0.11650038
Source B 0.0001

MOV
Move
Source F11[65]
0.11650038
Dest F11[66]
0.11650038

59
LES
Less Than (A<B)
Source A F11[65]
0.11650038
Source B 0.0001

MOV
Move
Source 0.0001
Dest F11[66]
0.11650038

60
DIV
Divide
Source A F11[62]
4.0
Source B 2.0
Dest F11[67]
2.0

61
CPT
Compute
Dest F11[68]
0.6726283
Expression SQR (((F11[67] ** 2.0) - ((F11[67] - F11[66]) ** 2.0)))

62
CPT
Compute
Dest F11[69]
0.34299922
Expression (F11[12] / 2.0) - (ASN (((F11[67] - F11[66]) / F11[67])))

63
CPT
Compute
Dest F11[70]
1.2668952
Expression (F11[67] - F11[66]) * F11[68]

64
CPT
Compute
Dest F11[71]
0.105101705
Expression ((F11[67] ** 2.0) * F11[69]) - F11[70]

65
CPT
Compute
Dest F11[73]
0.45242882
Expression (F11[67] ** 2.0) - ((F11[67] - F11[66]) ** 2.0)

66
CPT
Compute
Dest F11[74]
0.06970203
Expression F11[67] - ((2.0 * (F11[73] ** 1.5)) / (3.0 * F11[71]))

67
ADD
Add
Source A F11[63]
5.89
Source B F11[74]
0.06970203
Dest F11[75]
5.959702

68
GRT
Greater Than (A>B)
Source A F11[0]
1.2759373
Source B F11[75]
5.959702

MOV
Move
Source F11[0]
1.2759373
Dest F11[77]
5.959702

69
LEQ
Less Than or Eql (A<=B)
Source A F11[0]
1.2759373
Source B F11[75]
5.959702

MOV
Move
Source F11[75]
5.959702
Dest F11[77]
5.959702

70
SUB
Subtract
Source A F11[1]
1.5006988
Source B F11[77]
5.959702
Dest F11[78]
-4.4590034

71
SUB
Subtract
Source A F11[67]
2.0
Source B F11[66]
0.11650038
Dest F11[79]
1.8834996

72
CPT
Compute
Dest F11[80]
1.3452566
Expression 2.0 * (SQR (((F11[67] ** 2.0) - (F11[79] ** 2.0))))

73
CPT
Compute
Dest F11[81]
0.68600106
Expression 2.0 * (ACS ((F11[79] / F11[67])))

74
CPT
Compute
Dest F11[82]
1.3720021
Expression F11[67] * F11[81]

75
DIV
Divide
Source A F11[80]
1.3452566
Source B F11[82]
1.3720021
Dest F11[83]
0.9805062

76
CPT
Compute
Dest F11[84]
0.85292405
Expression 1.0 - (0.15 * F11[83])

77
GEQ
Grtr Than or Eql (A>=B)
Source A F11[78]
-4.4590034
Source B 0.0

CPT
Compute
Dest F11[85]
0.0
Expression ((0.61 * F11[84]) * F11[71]) * (SQR ((64.4 * F11[78])))

78
LES
Less Than (A<B)
Source A F11[78]
-4.4590034
Source B 0.0

Gravity Diversion
Gate No. 3 Closed
DI_HSC_133
<Local:6:I.Data.13>

MOV
Move
Source 0.0
Dest F11[85]
0.0

79
DIV
Divide
Source A F11[85]
0.0
Source B 1.547
Dest MERGATE3DIVFLOW
<F11[86]>
0.0

80
MOV
Move
Source 4.0
Dest F11[92]
4.0

MOV
Move
Source 5.89
Dest F11[93]
5.89

81
Scale with
Parameters
SCP_Real
Scale with Parameters
SCP_Real GATE_4_SCP ...
Input SLIDEGATE3POSITION
<F8[13]>
0.16250038
Input_Min 0.0
Input_Max 100.0
Scale_Min 6.1
Scale_Max 10.1
Output 6.1065

MOV
Move
Source GATE_4_SCP.Output
6.1065
Dest F11[94]
6.1065

82
GEQ
Grtr Than or Eql (A>=B)
Source A F11[94]
6.1065
Source B 9.88

MOV
Move
Source 9.88
Dest F11[94]
6.1065

83
SUB
Subtract
Source A F11[94]
6.1065
Source B F11[93]
5.89
Dest F11[95]
0.21650028

84
GEQ
Grtr Than or Eql (A>=B)
Source A F11[95]
0.21650028
Source B 0.0001

MOV
Move
Source F11[95]
0.21650028
Dest F11[96]
0.21650028

85
LES
Less Than (A<B)
Source A F11[95]
0.21650028
Source B 0.0001

MOV
Move
Source 0.0001
Dest F11[96]
0.21650028

86
DIV
Divide
Source A F11[92]
4.0
Source B 2.0
Dest F11[97]
2.0

87
CPT
Compute
Dest F11[98]
0.9050572
Expression SQR (((F11[97] ** 2.0) - ((F11[97] - F11[96]) ** 2.0)))

88
CPT
Compute
Dest F11[99]
0.46959758
Expression (F11[12] / 2.0) - (ASN (((F11[97] - F11[96]) / F11[97])))

89
CPT
Compute
Dest F11[100]
1.6141692
Expression (F11[97] - F11[96]) * F11[98]

90
CPT
Compute
Dest F11[101]
0.26422107
Expression ((F11[97] ** 2.0) * F11[99]) - F11[100]

91
CPT
Compute
Dest F11[103]
0.8191285
Expression (F11[97] ** 2.0) - ((F11[97] - F11[96]) ** 2.0)

92
CPT
Compute
Dest F11[104]
0.12944996
Expression F11[97] - ((2.0 * (F11[103] ** 1.5)) / (3.0 * F11[101]))

93
ADD
Add
Source A F11[93]
5.89
Source B F11[104]
0.12944996
Dest F11[105]
6.0194497

94
GRT
Greater Than (A>B)
Source A F11[0]
1.2759373
Source B F11[105]
6.0194497

MOV
Move
Source F11[0]
1.2759373
Dest F11[107]
6.0194497

95
LEQ
Less Than or Eql (A<=B)
Source A F11[0]
1.2759373
Source B F11[105]
6.0194497

MOV
Move
Source F11[105]
6.0194497
Dest F11[107]
6.0194497

96
SUB
Subtract
Source A F11[1]
1.5006988
Source B F11[107]
6.0194497
Dest F11[108]
-4.518751

97
SUB
Subtract
Source A F11[97]
2.0
Source B F11[96]
0.21650028
Dest F11[109]
1.7834997

98
CPT
Compute
Dest F11[110]
1.8101144
Expression 2.0 * (SQR (((F11[97] ** 2.0) - (F11[109] ** 2.0))))

99

CPT
Compute
Dest F11[111]
0.9391978
Expression 2.0 * (ACS ((F11[109] / F11[97])))

100

CPT
Compute
Dest F11[112]
1.8783956
Expression F11[97] * F11[111]

101

DIV
Divide
Source A F11[110]
1.8101144
Source B F11[112]
1.8783956
Dest F11[113]
0.9636492

102

CPT
Compute
Dest F11[114]
0.8554526
Expression 1.0 - (0.15 * F11[113])

103

GEQ
Grtr Than or Eql (A>=B)
Source A F11[108]
-4.518751
Source B 0.0

CPT
Compute
Dest F11[115]
0.0
Expression ((0.61 * F11[114]) * F11[101]) * (SQR ((64.4 * F11[108])))

104

LES
Less Than (A<B)
Source A F11[108]
-4.518751
Source B 0.0

Gravity Diversion
Gate No. 4 Closed
DI_HSC_134
<Local:7:I.Data.0>

MOV
Move
Source 0.0
Dest F11[115]
0.0

105

DIV
Divide
Source A F11[115]
0.0
Source B 1.547
Dest MERGATE4DIVFLOW
<F11[116]>
0.0

106

Merrimack Gravity Diversion In Progress
FAULT_20
<N120[1].4>

CPT
Compute
Dest MERGDFLOWRATE
<F11[120]>
0.0
Expression ((MERGATE1DIVFLOW + MERGATE2DIVFLOW) + MERGATE3DIVFLOW) + MERGATE4DIVFLOW

107

Merrimack Gravity Diversion In Progress
FAULT_20
<N120[1].4>
/

MOV
Move
Source 0.0

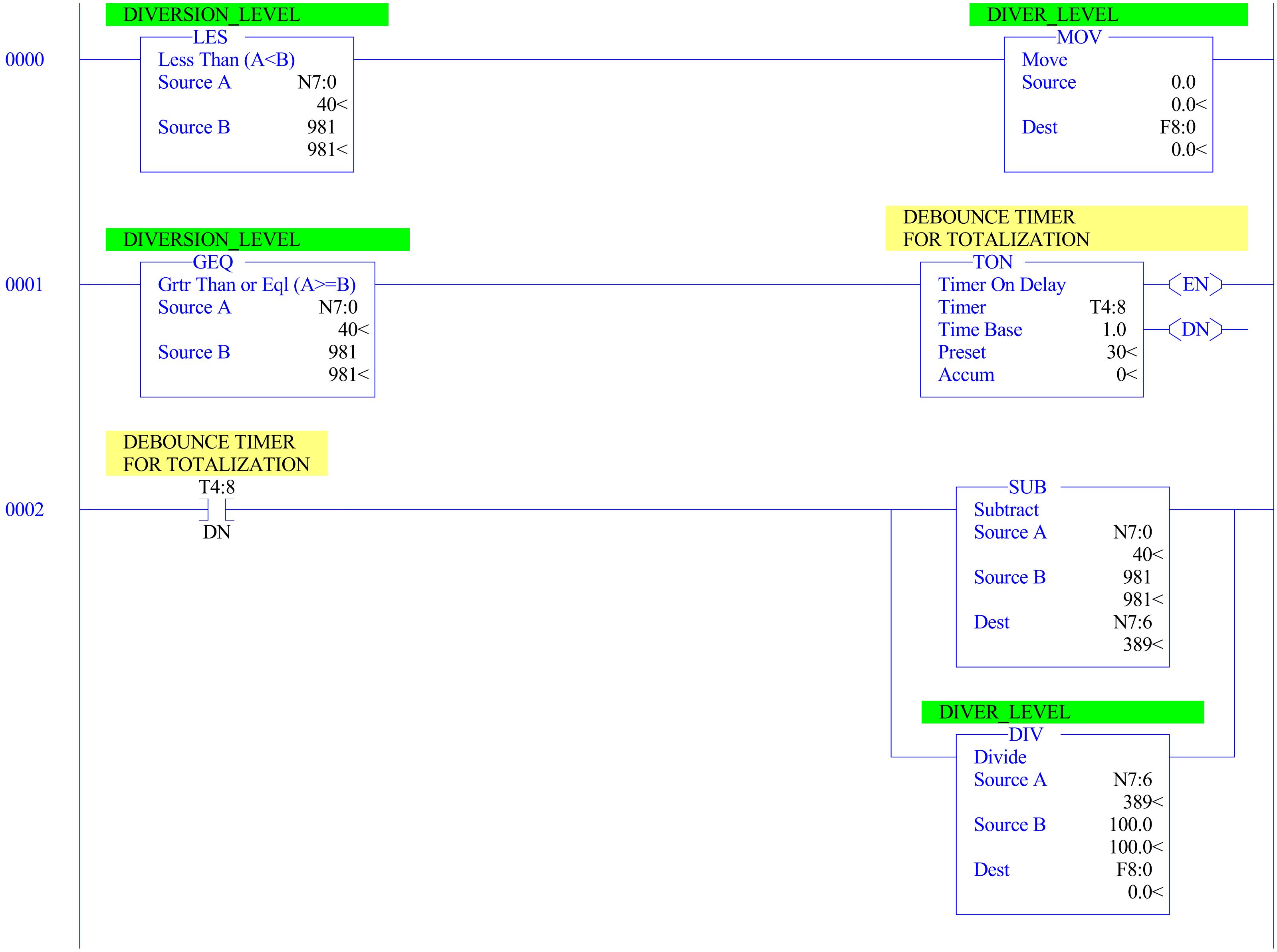
Dest MERGDFLOWRATE
<F11[120]>
0.0

(End)

Gate diversion flow calculation for 1 gate
Merrimack Gate 1 Diversion flow
- F11[26] = F11[25]/1.547
- F11[25] = ((0.61 * F11[24]) * F11[11]) * (SQR ((64.4 * F11[18])))
- F11[24] = 1.0 - (0.15 * F11[23])
- F11[23] = F11[20]/F11[22]
- F11[20] = 2.0 * (SQR (((F11[7] ** 2.0) - (F11[19] ** 2.0))))
- F11[7] = F11[2]/2
- F11[2] = 4.0
- F11[19] = F11[7] - F11[6]
- F11[7] = F11[2]/2
- F11[2] = 4.0
- F11[6] = F11[5]
- F11[5] = F11[4] - F11[3]
- F11[4] = Slide gate 1 position
- F11[3] = 5.89
- F11[22] = F11[7] * F11[21]
- F11[7] = F11[2]/2
- F11[2] = 4.0
- F11[21] = 2.0 * (ACS ((F11[19] / F11[7])))
- F11[19] = F11[7] - F11[6]
- F11[7] = F11[2]/2
- F11[2] = 4.0
- F11[6] = F11[5]
- F11[5] = F11[4] - F11[3]
- F11[4] = Slide gate 1 position
- F11[3] = 5.89

- Merrimack Total Gravity Diversion FlowRate = ((MERGATE1DIVFLOW + MERGATE2DIVFLOW) + MERGATE3DIVFLOW) + MERGATE4DIVFLOW

- F8[10] = Merrimack Pumped Diversion Flow from FI-129


0000
DIVERSION_LEVEL
LES
Less Than (A<B)
Source A N7:0
40<
Source B 981
981<
DIVER_LEVEL
MOV
Move
Source 0.0
0.0<
Dest F8:0
0.0<
0001
DIVERSION_LEVEL
GEQ
Grtr Than or Eql (A>=B)
Source A N7:0
40<
Source B 981
981<
DEBOUNCE TIMER
FOR TOTALIZATION
TON
Timer On Delay
Timer T4:8
Time Base 1.0
Preset 30<
Accum 0<
EN
DN
0002
DEBOUNCE TIMER
FOR TOTALIZATION
T4:8
DN
SUB
Subtract
Source A N7:0
40<
Source B 981
981<
Dest N7:6
389<
DIVER_LEVEL
DIV
Divide
Source A N7:6
389<
Source B 100.0
100.0<
Dest F8:0
0.0<

FLOW CALCULATION

Q=KLH(1.5)
Q= FLOW RATE
H=HEAD ON THE WEIR
L=CREST LENGTH OF WEIR (8.9 FT FOR REED STREET WEIR) (8.9 X 2.152 = 19.1528)
K=CONSTANT BASED ON UNITS (CFS=3.330, GPM=1495, MGD=2.152)

0003

HEIGHT_SQUARED

MUL
Multiply
Source A F8:0
0.0<
Source B F8:0
0.0<
Dest F8:1
0.0<

0004

HEIGHT_CUBED

MUL
Multiply
Source A F8:0
0.0<
Source B F8:1
0.0<
Dest F8:2
0.0<

0005

HEAD ON THE WEIR
RESULT
HEIGHT_RAISED_3HLVS

SQR
Square Root
Source F8:2
0.0<
Dest F8:3
0.0<

0006

FLOW_MGD

MUL
Multiply
Source A F8:3
0.0<
Source B 19.1528
19.1528<
Dest F8:5
0.0<

0007

FLOW_TOTAL_TMR

TON
Timer On Delay
Timer T4:0
Time Base 1.0
Preset 6<
Accum 1<

(EN)
(DN)

 Tuesday, November 23, 2021 - 14:26:05

0008

FLOW_KGALS_PER_DAY
DIV
Divide
Source A F8:5
0.0<
Source B 14400.0
14400.0<
Dest F8:6
0.0<

0009

FLOW_TOTAL_TMR/DN
T4:0
DN

FLOW_TOTAL_TODAY
ADD
Add
Source A F8:6
0.0<
Source B F8:8
0.0<
Dest F8:8
0.0<

0010

FLOW_TOTAL_TMR/DN
T4:0
DN

FLOW_TOTAL_TMR
T4:0
RES

0011

FLOW_MGD_MUL_100
MUL
Multiply
Source A F8:5
0.0<
Source B 100.0
100.0<
Dest N7:10
0<

FLOW_TOTAL_MUL_100
MOV
Move
Source F8:8
0.0<
Dest N7:11
0<

FLOWTOTYESMUL100
MUL
Multiply
Source A F8:10
0.0<
Source B 100.0
100.0<
Dest N7:14
0<

0012

TODAY'S TOTAL
HIGH WORD

MOV
Move
Source F8:8
0.0<
Dest N20:5
0<

ABS BUFFER

SUB
Subtract
Source A F8:8
0.0<
Source B N20:5
0<
Dest F8:20
0.0<

TODAY'S TOTAL
LOW WORD

MUL
Multiply
Source A F8:20
0.0<
Source B 1000.0
1000.0<
Dest N20:6
0<

0013

YESTERDAY'S TOTAL
HIGH WORD

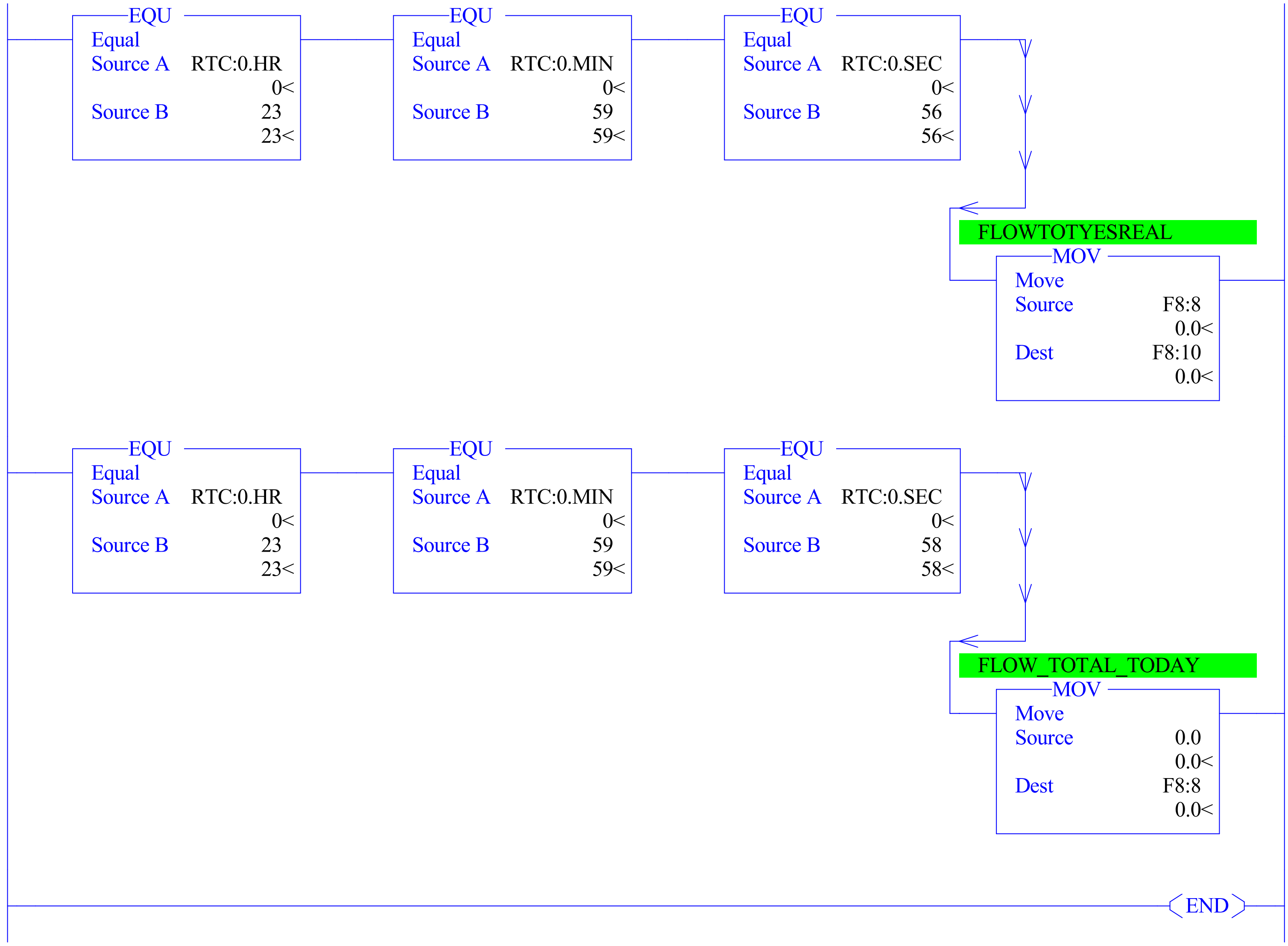
MOV
Move
Source F8:10
0.0<
Dest N20:7
0<

ABS BUFFER 2

SUB
Subtract
Source A F8:10
0.0<
Source B N20:7
0<
Dest F8:21
0.0<

YESTERDAY'S TOTAL
LOW WORD

MUL
Multiply
Source A F8:21
0.0<
Source B 1000.0
1000.0<
Dest N20:8
0<



Read Street
Q=KLH(1.5)
Q= FLOW RATE
H=HEAD ON THE WEIR
L=CREST LENGTH OF WEIR (8.9 FT FOR REED STREET WEIR) (8.9 X 2.152 = 19.1528)
K=CONSTANT BASED ON UNITS (CFS=3.330, GPM=1495, MGD=2.152)
- Flow in MGD = F8:5
F8:5 = F8:3 * 19.1528
- F8:3 = F8:2^2, Head on Weir
- F8:2 = F8:0^3, Height cubed
- F8:0 = diversion channel level

```
- Tilden Street
        - Diversion Pump Flow = F8[9]
                - F8[9] = Flow meter 0-62 MGD
        - Gravity Diversion Flow Rate = F11[26]
                - F11[26] = F11[25]/1.547
 - F11[25] = ((0.61 * F11[24]) * F11[11]) * (SQR ((64.4 * F11[18])))
                                - F11[24] = 1.0 - (0.15 * F11[23])
                                        - F11[23] = F11[20]/F11[22]
                                        - F11[20] =
                                        - F11[22] = F11[7] * F11[21]
                                        - F11[7] = F11[2]/2.0
                                        - F11[2] = 4.0
                                        - F11[21] = 2.0 * (ACS((F11[19] / F11[7])))
                                        - F11[19] = F11[7] - F11[6]
                                        - F11[7] = F11[2]/2.0
                                        - F11[2] = 4.0
                                        - F11[6] = F11[5] = F11[4] - F11[3]

                                                                                -
F11[4] = ((5.65 - 1.72) / (100.0 - 0.0))*DIVERSIONGATEPOS + (1.72 - (0.0*((5.65 -1.72)
/ (100.0 - 0.0))))
                                                                                -
F11[3] = 1.72

                                        - F11[7] =F11[2]/2.0

                                        - F11[2] = 4.0

                                - F11[11] = ((F11[7] ** 2.0) * F11[9]) - F11[10]
                                        - F11[7] = F11[2]/2.0
                                                - F11[2] = 4.0
                                - F11[18] = F11[1] - F11[17]
                                        - F11[1] = Influent channel flow
                                        - F11[17] = F11[0]
                                                - F11[0] = River level - 4.27
```

Walker Street

-

- Pumped Diversion Flow Rate = F8[41], calculates when influent channel is over 4.25 ft

- F8[41] = 3.33*(14.0*SQR(DIVERIONHEIGTH*DIVERIONHEIGTH*DIVERIONHEIGTH))/1.547

- DIVERIONHEIGTH = INFLUENTCHANELLEVEL - 4.25

0000

DIVER_GATE_1_POS
GEQ
Grtr Than or Eql (A>=B)
Source A N7:11
8<
Source B 100
100<

DIVERGTE1LKBY
DIV
Divide
Source A F8:13
100.0<
Source B 695.0
695.0<
Dest F9:25
0.0<

0001

DIVER_GATE_1_POS
LES
Less Than (A<B)
Source A N7:11
8<
Source B 100
100<

DIVERGTE1LKBY
MOV
Move
Source 0.0
0.0<
Dest F9:25
0.0<

0002

INFCNLLVLFORGTECNTRL
LES
Less Than (A<B)
Source A F8:7
4.43<
Source B F8:18
7.53<

DVRGTE1FLOWMGD
MOV
Move
Source 0.0
0.0<
Dest F9:0
0.0<

DIVERGTE1HGTOVERWEIR
MOV
Move
Source 0.0
0.0<
Dest F9:1
0.0<

0003

INFCNLLVLFORGTECNTRL
GEQ
Grtr Than or Eql (A>=B)
Source A F8:7
4.43<
Source B F8:18
7.53<

DIVERGTE1HGTOVERWEIR
SUB
Subtract
Source A F8:7
4.43<
Source B F8:18
7.53<
Dest F9:1
0.0<

0004

DIVERGTE1HGTSQRD
MUL
Multiply
Source A F9:1
0.0<
Source B F9:1
0.0<
Dest F9:2
0.0<

0005

DIVERGTE1HGTCBD

MUL
Multiply

Source A	F9:1	0.0<
Source B	F9:2	0.0<
Dest	F9:3	0.0<

0006

SQRRTDIVER1HGTCBD

SQR
Square Root

Source	F9:3	0.0<
Dest	F9:4	0.0<

0007

GTE1WEIRCNSTNTCFS

MUL
Multiply

Source A	3.33	3.33<
Source B	F9:5	8.0<
Dest	F9:6	26.64<

0008

GTE1WEIRCNSTNMGD

MUL
Multiply

Source A	F9:6	26.64<
Source B	0.6463	0.6463<
Dest	F9:7	17.21743<

0009

DIVER_GTE_1_FLOW_

MUL
Multiply

Source A	F9:7	17.21743<
Source B	F9:4	0.0<
Dest	F9:8	0.0<

0010

DVRGTE1FLOWMGD

ADD
Add

Source A	F9:8	0.0<
Source B	F9:25	0.0<
Dest	F9:0	0.0<

0011

DIVER_GATE_2_POS
GEQ
Grtr Than or Eql (A>=B)
Source A N7:12
4<
Source B 100
100<

DIVERGTE2LKBY
DIV
Divide
Source A F8:13
100.0<
Source B 695.0
695.0<
Dest F9:26
0.0<

0012

DIVER_GATE_2_POS
LES
Less Than (A<B)
Source A N7:12
4<
Source B 100
100<

DIVERGTE2LKBY
MOV
Move
Source 0.0
0.0<
Dest F9:26
0.0<

0013

INFCNLLVLFORGTECNTRL
LES
Less Than (A<B)
Source A F8:7
4.43<
Source B F8:19
7.56<

DIVERGTE2FLOWMGD
MOV
Move
Source 0.0
0.0<
Dest F9:10
0.0<

DIVERGTE2HGTOVERWEIR
MOV
Move
Source 0.0
0.0<
Dest F9:11
0.0<

0014

INFCNLLVLFORGTECNTRL
GEQ
Grtr Than or Eql (A>=B)
Source A F8:7
4.43<
Source B F8:19
7.56<

DIVERGTE2HGTOVERWEIR
SUB
Subtract
Source A F8:7
4.43<
Source B F8:19
7.56<
Dest F9:11
0.0<

0015

DVRGTE2HGTSQRD
MUL
Multiply
Source A F9:11
0.0<
Source B F9:11
0.0<
Dest F9:12
0.0<

0016

DIVERGTE2HGTCUBED
MUL
Multiply
Source A F9:11
0.0<
Source B F9:12
0.0<
Dest F9:13
0.0<

0017

SQRRTDIVER2HGTCUBED
SQR
Square Root
Source F9:13
0.0<
Dest F9:14
0.0<

0018

DVRGTE2WEIRCNSTNTCFS
MUL
Multiply
Source A 3.33
3.33<
Source B F9:15
8.0<
Dest F9:16
26.64<

0019

DVRGTE2WEIRCNSTNTMGD
MUL
Multiply
Source A F9:16
26.64<
Source B 0.6463
0.6463<
Dest F9:17
17.21743<

0020

DIVER_GTE_2_FLOW
MUL
Multiply
Source A F9:17
17.21743<
Source B F9:14
0.0<
Dest F9:18
0.0<

0021

DIVERGTEOPENSTEPNUM
GEQ
Grtr Than or Eql (A>=B)
Source A N7:24
0<
Source B 1
1<

DIVER_GATE_2_POS
GRT
Greater Than (A>B)
Source A N7:12
4<
Source B 100
100<

DIVERGTE2FLOWMGD
ADD
Add
Source A F9:18
0.0<
Source B F9:26
0.0<
Dest F9:10
0.0<

0022

DIVERSIONFLOWMGD
ADD
Add
Source A F9:0
0.0<
Source B F9:10
0.0<
Dest F8:15
0.0<

DIVERFLOWMGDDIV10000
DIV
Divide
Source A F8:15
0.0<
Source B F9:19
14400.0<
Dest F8:16
0.0<

0023

MOV
Move
Source S:5
0<
Dest N7:40
0<

0024

DIVERFLOWTOTTMR
TON
Timer On Delay
Timer T4:7
Time Base 1.0
Preset 6<
Accum 4<
EN
DN

0025

DIVERFLOWTOTTMR/DN
T4:7
DN

Today's Total
Diversoin Flow
Buffer
TODAYSFLOWTOTALMG
ADD
Add
Source A F8:16
0.0<
Source B F8:20
0.0<
Dest F8:20
0.0<

0026

DIVERFLOWTOTTMR/DN
T4:7
DN

DIVERFLOWTOTTMR
T4:7
RES

0027

EQU
Equal
Source A RTC:0.HR
0<
Source B N7:200
23<

EQU
Equal
Source A RTC:0.MIN
0<
Source B N7:201
59<

EQU
Equal
Source A RTC:0.SEC
0<
Source B 56
56<

YESTERTOTALMG
MOV
Move
Source F8:20
0.0<
Dest F8:21
0.0<

0028

EQU
Equal
Source A RTC:0.HR
0<
Source B N7:200
23<

EQU
Equal
Source A RTC:0.MIN
0<
Source B N7:201
59<

EQU
Equal
Source A RTC:0.SEC
0<
Source B 58
58<

Today's Total
Diversoin Flow
Buffer
TODAYSFLOWTOTALMG
MOV
Move
Source 0.0
0.0<
Dest F8:20
0.0<

0029

DIVERFLOWTOTTDY
MUL
Multiply
Source A F8:20
0.0<
Source B 10.0
10.0<
Dest N7:27
0<

DIVERFLOWTOTYES
MUL
Multiply
Source A F8:21
0.0<
Source B 10.0
10.0<
Dest N7:28
0<

DIVERFLOWMATEMGD
MUL
Multiply
Source A F8:15
0.0<
Source B 10.0
10.0<
Dest N7:29
0<

0030

Today's Total
Diversion Flow High
Word

MOV
Move
Source F8:20
0.0<
Dest N20:50
0<

Yesterday's Total
Diversoin Flow
Buffer

SUB
Subtract
Source A F8:20
0.0<
Source B N20:50
0<
Dest F8:25
0.0<

Today's Total
Diversion FLow Low
Word

MUL
Multiply
Source A F8:25
0.0<
Source B 1000.0
1000.0<
Dest N20:51
0<

0031

Yesterday's Total Diversion Flow High Word

MOV
Move
Source F8:21
0.0<
Dest N20:52
0<

Yesterday's Total Diversoin Flow Buffer

SUB
Subtract
Source A F8:21
0.0<
Source B N20:52
0<
Dest F8:26
0.0<

YesterDay's Total Diversion FLow Low Word

MUL
Multiply
Source A F8:26
0.0<
Source B 1000.0
1000.0<
Dest N20:53
0<

0032

END

Warren
- N7:29 = F8:15 * 10
    - F8:15 = F9:0 + F9:10
        - F9:0 = F9:8 + F9:25
            - F9:8 = F9:7 * F9:4 ;Diversion Gate 1 Flow
                - F9:7 = F9:6 * 0.6463 ;GTE1WEIRCNSTNMGD
                    - F9:6 = 3.33 * F9:5 ;GTE1WEIRCNSTNTCFS
                        - F9:5 = 8.0
                - F9:4 = SQRT(F9:3)
                    - F9:3 = F9:1 * F9:2 ;DIVERGTE1HGTCBD
                        - F9:1 = F8:7 - F8:18 ;DIVERGTE1HGTOVERWEIR
                            - F8:7 = N7:30/100 ;INFCNLLVLFORGTECNTRL
                                - N7:30 = N7:13 when influent chamber level > N7:15 INFLUENT CHANNEL LEVEL 2
                                - N7:30 = N7:15 INFLUENT CHANNEL LEVEL 2 > N7:13 INFLUENT CHANNEL LEVEL 1
                            - F8:18 = N7:22/100 ;Height over gate 1
                                - N7:22 = Diversion gate elevation scaled from min 757 to max 277
                        - F9:2 = (F9:1)^2
            - F9:25 = F8:13/695 ;DIVERGTE1LKBY
                - F8:13 = 100
        - F9:10 = F8:1 - 4.78 ;DIVCNLLVLWITHOFSET
            - F8:1 = N7:14/100 ;DIVCHNLLVLREAL
                - N7:14 = DIVERSION CHANNEL LEVEL

West Street PLC Ladder Logic

0

Influent Channel
Level
Scaled to Elevation
SUB
Subtract
Source A LIT_DIV113_AI10
49.06975
Source B 51.92
Dest LIT_113_AI7
-2.8502464

Diversion Structure
Elevation
SUB
Subtract
Source A LIT_120_AI3
52.52
Source B 51.92
Dest LIT_DIV120_AI4
0.6000023

Diversion Gate
Scaled to Elevation
SUB
Subtract
Source A ZI_SG112_AI3
51.923412
Source B 51.92
Dest SG112_AI1
-2.8502464

DIVERSION GATE ELEVATION

1

Influent Channel
Level
Scaled to Elevation
LES
Less Than (A<B)
Source A LIT_113_AI7
-2.8502464
Source B SG112_AI1
-2.8502464

Diversion Gate
Scaled to Elevation
MOV
Move
Source LIT_113_AI7
-2.8502464
Dest SG112_AI1
-2.8502464

CALCULATE AREA OF DIVERSION GATE OPENING

2

Gravity Diversion
Gate Opening
Area Calculated
MUL
Multiply
Source A SG112_AI1
-2.8502464
Source B 8.0
Dest SG112_AI2
-22.801971

3

Calculate Head across the Gate
Influent Channel
Level
Scaled to Elevation
LEQ
Less Than or Eql (A<=B)
Source A LIT_113_AI7
-2.8502464
Source B 0.0

Gravity Diversion
No Measureable
Flow
NO_FLOW

Diversion Gate
Scaled to Elevation
GRT
Greater Than (A>B)
Source A SG112_AI1
-2.8502464
Source B 0.0

Diversion Gate
Elevation
Divided by 2
DIV
Divide
Source A SG112_AI1
-2.8502464
Source B 2
Dest SG112_AI3
0.0

Diversion Gate
Scaled to Elevation
LEQ
Less Than or Eql (A<=B)
Source A SG112_AI1
-2.8502464
Source B 0.0

Diversion Gate
Elevation
Divided by 2
MOV
Move
Source 0
Dest SG112_AI3
0.0

Diversion Structure
Elevation
GRT
Greater Than (A>B)
Source A LIT_DIV120_AI4
0.6000023
Source B 0

Diversion Gate
Water Level
Calculated
SUB
Subtract
Source A LIT_DIV120_AI4
0.6000023
Source B SG112_AI3
0.0
Dest SG112_AI5
0.6000023

Diversion Structure
Elevation
LES
Less Than (A<B)
Source A LIT_DIV120_AI4
0.6000023
Source B 0

Diversion Gate
Water Level
Calculated
MOV
Move
Source 0.0
Dest SG112_AI5
0.6000023

Diversion Structure
Elevation
LEQ
Less Than or Eql (A<=B)
Source A LIT_DIV120_AI4
0.6000023
Source B SG112_AI3
0.0

Diversion Gate
Water Level
Calculated
MOV
Move
Source 0.0
Dest SG112_AI5
0.6000023

Influent Channel
Water Level
Calculated
SUB
Subtract
Source A LIT_113_AI7
-2.8502464
Source B SG112_AI3
0.0
Dest LIT_113_AI8

-2.8502464

Diversion Gate
Head Across Gate
Calculated
SUB
Subtract
Source A LIT_113_AI8
-2.8502464
Source B SG112_AI5
0.6000023
Dest SG112_AI6
-3.4502487

SQUARE ROOT OF HEAD

4

Diversion Gate
Square root
of Head
MUL
Multiply
Source A SG112_AI6
-3.4502487
Source B 64.4

Dest SG112_AI7
14.906241

Diversion Gate
Square root
of Head
SQR
Square Root
Source SG112_AI7
14.906241
Dest SG112_AI7
14.906241

5

Diversion Structure Flow Calculated
MUL
Multiply
Source A SG112_AI7
14.906241
Source B SG112_AI2
-22.801971
Dest LIT_113_AI9
0.0

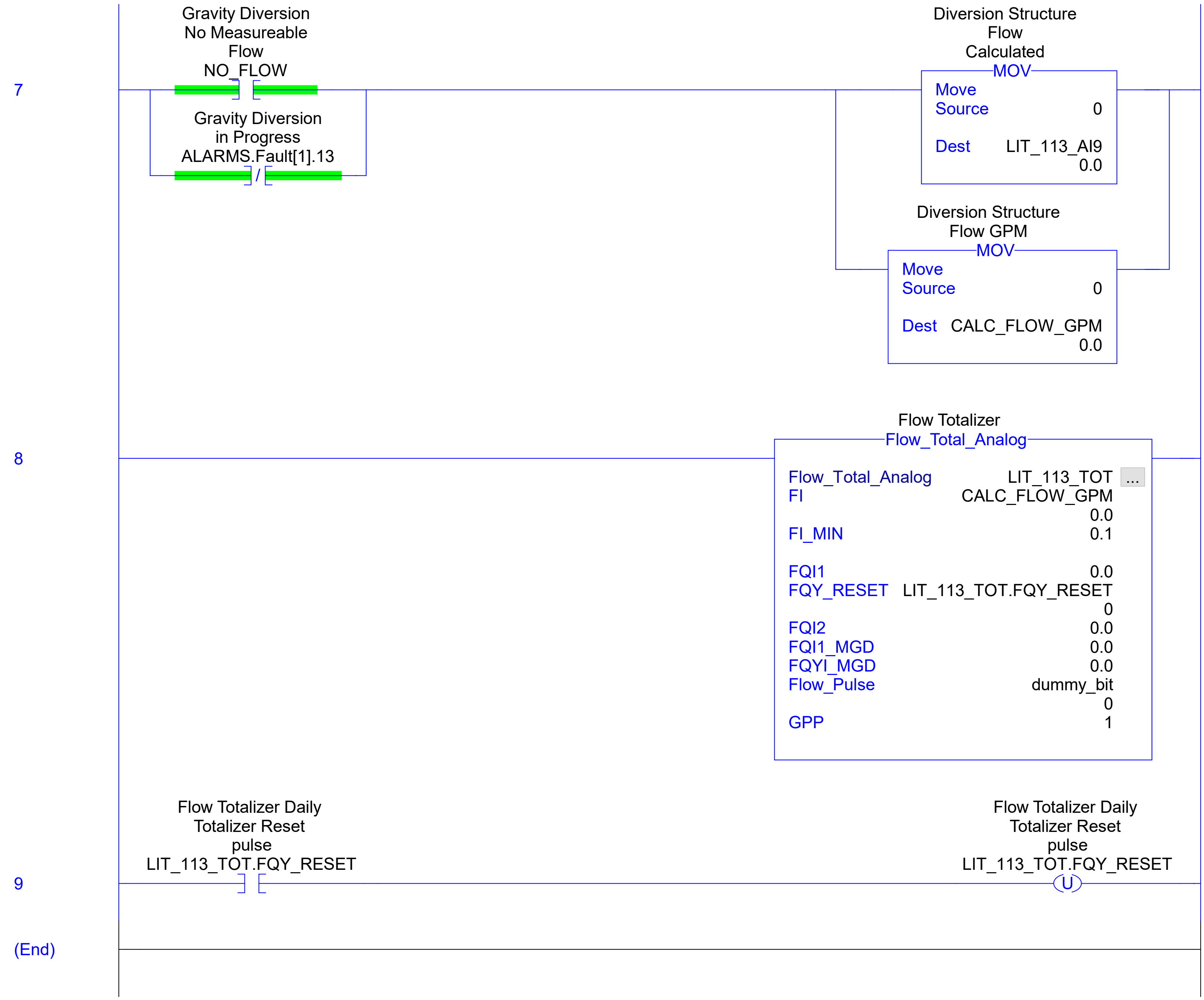
Diversion Structure Flow Calculated
MUL
Multiply
Source A LIT_113_AI9
0.0
Source B 0.8
Dest LIT_113_AI9
0.0

Diversion Structure Flow Calculated
MUL
Multiply
Source A LIT_113_AI9
0.0
Source B 0.6464
Dest LIT_113_AI9
0.0

6

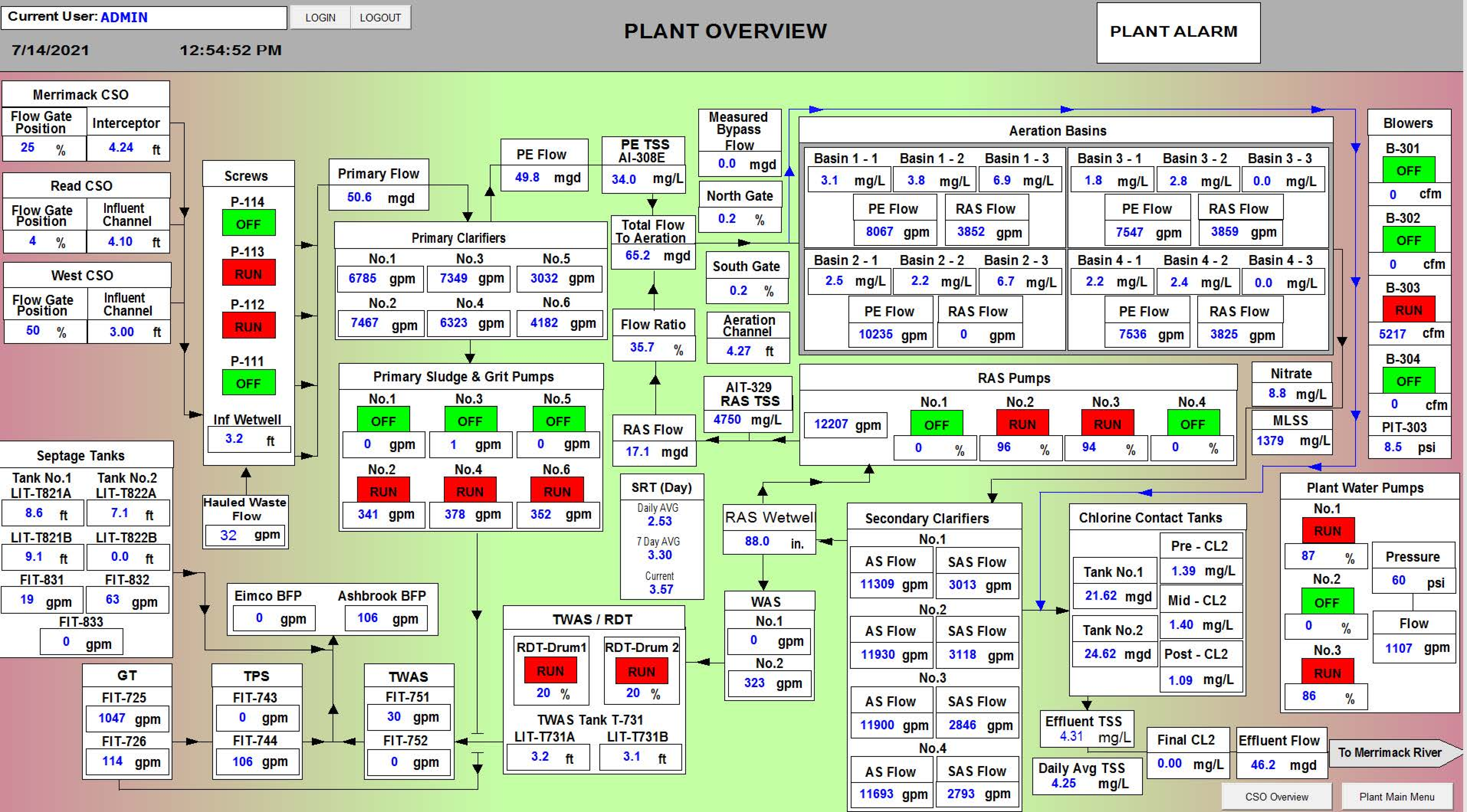
Diversion Structure Flow Calculated
MUL
Multiply
Source A LIT_113_AI9
0.0
Source B 1000000
Dest CALC_GALLONS
-175764784.0

Diversion Structure Flow GPM
DIV
Divide
Source A CALC_GALLONS
-175764784.0
Source B 1440
Dest CALC_FLOW_GPM
0.0



West Street
- Diversion flow
  - CALC_FLOW_GPM = CALC_GALLONS/1440
    - CALC_GALLONS = LIT_113_AI9 * 1,000,000
      - LIT_113_AI9 = SG112_AI7 * SG112_AI2 * 0.8 * 0.6464
        - SG112_AI7 = (SG112_AI6 * 64.4)^2
          - SG112_AI6 = LIT_113_AI8 - SG112_AI5
            - LIT_113_AI8 = LIT_113_AI7 - SG112_AI3
              - LIT_113_AI7 = LIT_DIV113_AI10 - 51.92 ;Influent Channel Level Scaled to Elevation
              - SG112_AI3 = SG112_AI1/2
                - SG112_AI1 = ZI_SG112_AI3 - 51.92 ;Diversion Gate Scaled to Elevation
            - SG112_AI5 = SG112_AI5 - LIT_DIV120_AI4
              - LIT_DIV120_AI4 = LIT_120_AI3 - 51.92 ;Diversion Structure Elevation
                - LIT_120_AI3 = Local:6:Ch4Data Scaled between 49.7 and 69.7

Appendix C
SCADA Screens


Current User: ADMIN
LOGIN
LOGOUT
PLANT OVERVIEW
PLANT ALARM
7/14/2021
12:54:52 PM
Merrimack CSO
Flow Gate Position 25 %
Interceptor 4.24 ft
Read CSO
Flow Gate Position 4 %
Influent Channel 4.10 ft
West CSO
Flow Gate Position 50 %
Influent Channel 3.00 ft
Screws
P-114 OFF
P-113 RUN
P-112 RUN
P-111 OFF
Inf Wetwell 3.2 ft
Hauled Waste Flow 32 gpm
Primary Flow 50.6 mgd
PE Flow 49.8 mgd
PE TSS AI-308E 34.0 mg/L
Measured Bypass Flow 0.0 mgd
North Gate 0.2 %
Total Flow To Aeration 65.2 mgd
South Gate 0.2 %
Flow Ratio 35.7 %
Aeration Channel 4.27 ft
Primary Clarifiers
No.1 6785 gpm
No.3 7349 gpm
No.5 3032 gpm
No.2 7467 gpm
No.4 6323 gpm
No.6 4182 gpm
Primary Sludge & Grit Pumps
No.1 OFF 0 gpm
No.3 OFF 1 gpm
No.5 OFF 0 gpm
No.2 RUN 341 gpm
No.4 RUN 378 gpm
No.6 RUN 352 gpm
Aeration Basins
Basin 1 - 1 3.1 mg/L
Basin 1 - 2 3.8 mg/L
Basin 1 - 3 6.9 mg/L
PE Flow 8067 gpm
RAS Flow 3852 gpm
Basin 3 - 1 1.8 mg/L
Basin 3 - 2 2.8 mg/L
Basin 3 - 3 0.0 mg/L
PE Flow 7547 gpm
RAS Flow 3859 gpm
Basin 2 - 1 2.5 mg/L
Basin 2 - 2 2.2 mg/L
Basin 2 - 3 6.7 mg/L
PE Flow 10235 gpm
RAS Flow 0 gpm
Basin 4 - 1 2.2 mg/L
Basin 4 - 2 2.4 mg/L
Basin 4 - 3 0.0 mg/L
PE Flow 7536 gpm
RAS Flow 3825 gpm
Blowers
B-301 OFF 0 cfm
B-302 OFF 0 cfm
B-303 RUN 5217 cfm
B-304 OFF 0 cfm
PIT-303 8.5 psi
Nitrate 8.8 mg/L
MLSS 1379 mg/L
AIT-329 RAS TSS 4750 mg/L
RAS Flow 17.1 mgd
RAS Pumps
12207 gpm
No.1 OFF 0 %
No.2 RUN 96 %
No.3 RUN 94 %
No.4 OFF 0 %
SRT (Day)
Daily AVG 2.53
7 Day AVG 3.30
Current 3.57
RAS Wetwell 88.0 in.
WAS
No.1 0 gpm
No.2 323 gpm
Secondary Clarifiers
No.1 AS Flow 11309 gpm SAS Flow 3013 gpm
No.2 AS Flow 11930 gpm SAS Flow 3118 gpm
No.3 AS Flow 11900 gpm SAS Flow 2846 gpm
No.4 AS Flow 11693 gpm SAS Flow 2793 gpm
Chlorine Contact Tanks
Tank No.1 21.62 mgd
Tank No.2 24.62 mgd
Pre - CL2 1.39 mg/L
Mid - CL2 1.40 mg/L
Post - CL2 1.09 mg/L
Plant Water Pumps
No.1 RUN 87 %
No.2 OFF 0 %
No.3 RUN 86 %
Pressure 60 psi
Flow 1107 gpm
Effluent TSS 4.31 mg/L
Daily Avg TSS 4.25 mg/L
Final CL2 0.00 mg/L
Effluent Flow 46.2 mgd
To Merrimack River
Septage Tanks
Tank No.1 LIT-T821A 8.6 ft
Tank No.2 LIT-T822A 7.1 ft
LIT-T821B 9.1 ft
LIT-T822B 0.0 ft
FIT-831 19 gpm
FIT-832 63 gpm
FIT-833 0 gpm
Eimco BFP 0 gpm
Ashbrook BFP 106 gpm
TWAS / RDT
RDT-Drum1 RUN 20 %
RDT-Drum 2 RUN 20 %
TWAS Tank T-731
LIT-T731A 3.2 ft
LIT-T731B 3.1 ft
GT
FIT-725 1047 gpm
FIT-726 114 gpm
TPS
FIT-743 0 gpm
FIT-744 106 gpm
TWAS
FIT-751 30 gpm
FIT-752 0 gpm
CSO Overview
Plant Main Menu

Current User: ADMIN | LOGIN | LOGOUT

LOWELL REGIONAL WASTE WATER UTILITY
REMOTE STATIONS MAIN MENU

7/14/2021 1:45:21 PM

CSO Stations

- CSO Overview
- **North Bank CSO**
  - Read Street CSO — Control | Alarms
  - West CSO — Control | Alarms
  - Beaver Brook CSO — Control | Overview
    - Alarms 1 | Alarms 2
  - Walker CSO — Control | Alarms
  - First CSO — Control | Alarms
- **South Bank CSO**
  - Merrimack CSO — Control | Overview
    - Alarms 1 | Alarms 2
  - Barasford CSO — Control | Alarms
  - Warren CSO — Control | Alarms
  - Tilden CSO — Control | Alarms

Pump Stations

- School — Control | Alarms
- Appleton Mills — Control | Alarms
- Freda — Control | Alarms
- Trotting Park — Control | Alarms
- Cannington — Control | Alarms
- Varnum — Control | Alarms
- Pawtucket — Control | Alarms
- Princeton — Control | Alarms
- Rosemont — Control | Alarms
- Lawrence Mills — Control | Alarms
- Chelmsford — Control | Alarms
- Pyne — Control | Alarms
- Rivers Edge — Control | Alarms
- Hamilton Canal District — Control | Alarms

Station Notes (2/18/2018):

- West Street Generator Runs Every Wednesday at 9 AM.

Plant Main Menu

Recent Diversion
Start: 7 / 12 13 : 8
End: 7 / 12 13 : 9

Recent Bypass
Start: 7 / 13 6 : 16
End: 7 / 13 10 : 5

Radio Repeaters

Communications

Alarm Summary

Historical Trends

Current User: **ADMIN** LOGIN LOGOUT

7/14/2021 1:46:38 PM

REMOTE STATION COMMUNICATIONS

Remote Node No.	Station Name	Polling Order	Read Status	Write Status	Comm Status	Comm Percentage
Node No.1					NORMAL	100 %
Node No.2	Merrimack CSO		Done	Done	NORMAL	100 %
Node No.3	Tilden CSO		Done	Done	NORMAL	100 %
Node No.4	Warren CSO		Done	Done	NORMAL	100 %
Node No.5	West CSO		Done	Done	NORMAL	100 %
Node No.6	Beaver Brook CSO		Done	Done	NORMAL	100 %
Node No.7	Walker CSO		Done	Done	NORMAL	98 %
Node No.8	Read Street CSO		Done	Done	NORMAL	100 %
Node No.9	Varnum		Done	Done	NORMAL	100 %
Node No.10	Wedge Street Repeater		Done	Done	NORMAL	100 %
Node No.11	Chelmsford		Done	Done	NORMAL	100 %
Node No.12	Pawtucket		Done	Done	NORMAL	97 %
Node No.13	Princeton		Done	Done	NORMAL	100 %
Node No.14	School St. Pump Sta.		Done	Done	NORMAL	100 %
Node No.15	Appleton Mills		Done	Done	NORMAL	100 %
Node No.16	10th Street Tank Repeater		Done	Done	NORMAL	100 %
Node No.17	Rivers Edge		Done	Done	NORMAL	100 %
Node No.18	Cannington	←	Done	Done	NORMAL	100 %
Node No.19	Feda Lane		Done	Done	NORMAL	99 %
Node No.20	Lawrence Mills		Done	Done	NORMAL	100 %
Node No.21	Pyne School		Done	Done	NORMAL	100 %
Node No.22	Rosemont Ave		Done	Done	NORMAL	100 %
Node No.23	Trotting Park		Done	Done	NORMAL	100 %
Node No.24	HCD		Done	Done	NORMAL	100 %

Polling Sequencer Control

START PAUSE

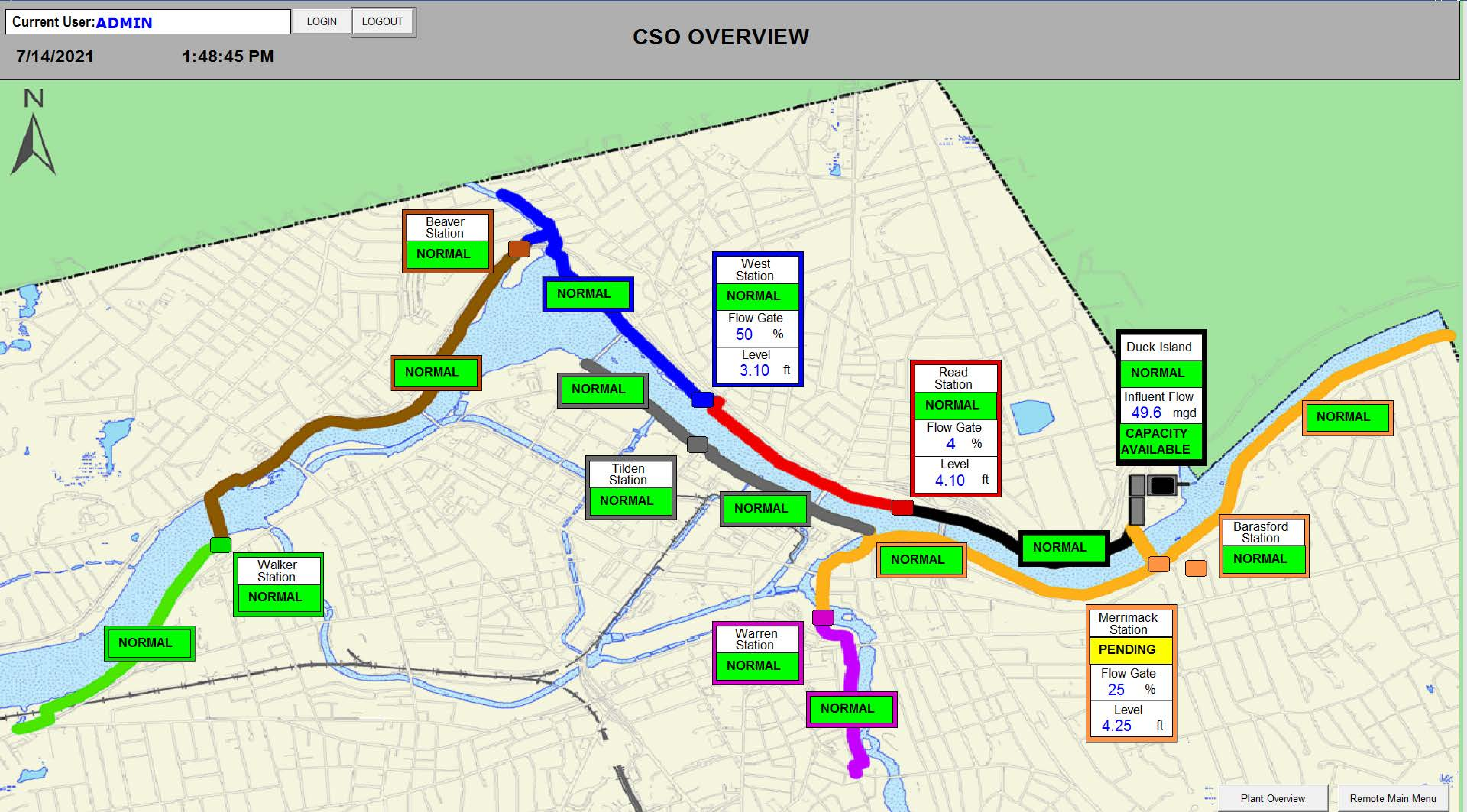
INCREMENT STEP DECREMENT STEP

Current Step
17

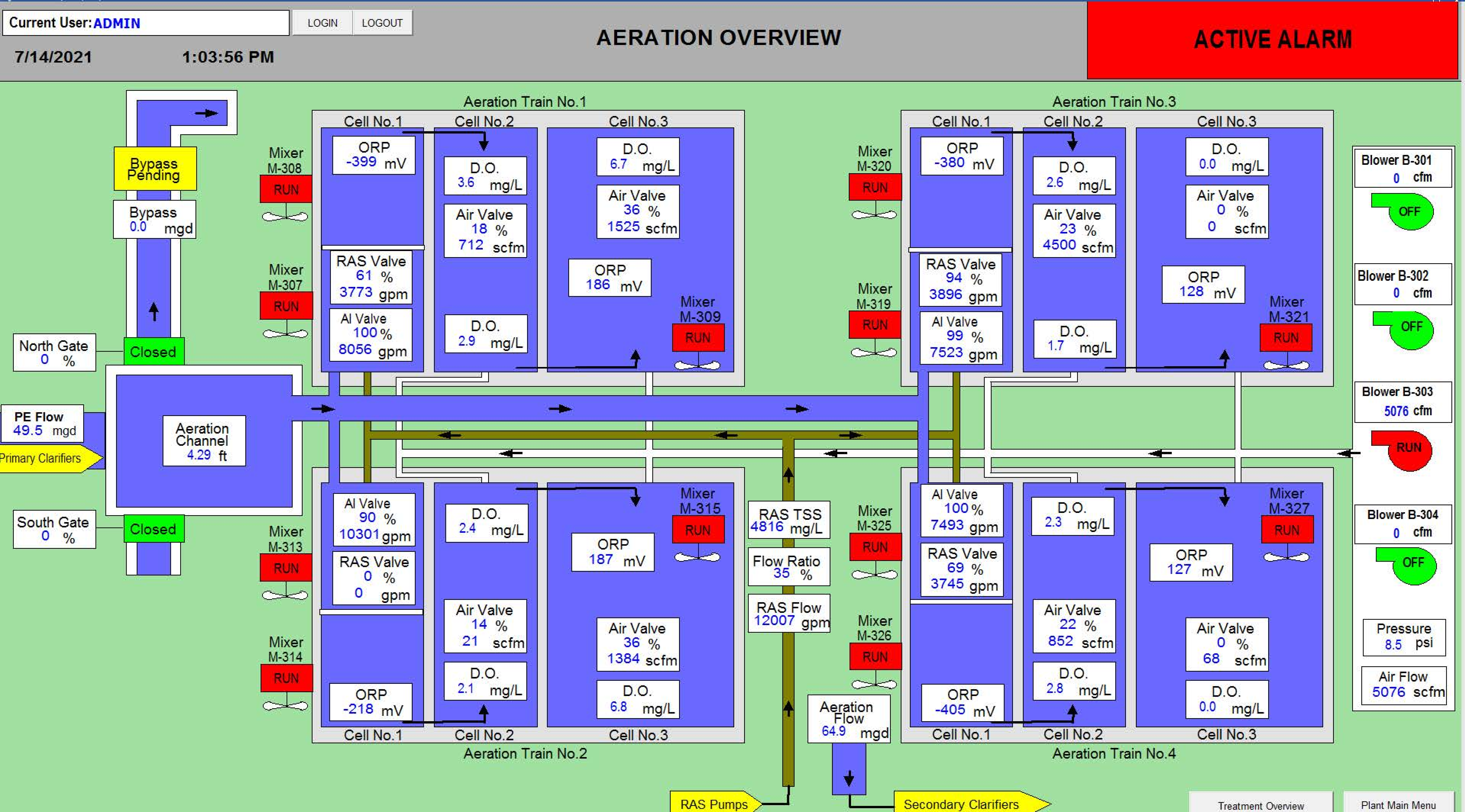
PRE - LOAD POLLING ORDER

Step Order	New Polling Order	Polling Order
Step No.1	2	2
Step No.2	3	3
Step No.3	4	4
Step No.4	5	5
Step No.5	6	6
Step No.6	7	7
Step No.7	8	8
Step No.8	9	9
Step No.9	10	10
Step No.10	11	11
Step No.11	12	12
Step No.12	13	13
Step No.13	14	14
Step No.14	15	15
Step No.15	16	16
Step No.16	17	17
Step No.17	18	18
Step No.18	19	19
Step No.19	20	20
Step No.20	21	21
Step No.21	22	22
Step No.22	23	23
Step No.23	24	24

Remote Main Menu Plant Main Menu



Current User: ADMIN
LOGIN
LOGOUT
CSO OVERVIEW
7/14/2021
1:48:45 PM
N
Beaver Station
NORMAL
NORMAL
West Station
NORMAL
Flow Gate
50 %
Level
3.10 ft
NORMAL
NORMAL
Read Station
NORMAL
Flow Gate
4 %
Level
4.10 ft
Duck Island
NORMAL
Influent Flow
49.6 mgd
CAPACITY AVAILABLE
NORMAL
Tilden Station
NORMAL
NORMAL
NORMAL
Barasford Station
NORMAL
Walker Station
NORMAL
NORMAL
Warren Station
NORMAL
NORMAL
Merrimack Station
PENDING
Flow Gate
25 %
Level
4.25 ft
Plant Overview
Remote Main Menu



Current User: ADMIN
LOGIN
LOGOUT
7/14/2021
1:03:56 PM
AERATION OVERVIEW
ACTIVE ALARM
Bypass Pending
Bypass 0.0 mgd
North Gate 0 %
Closed
South Gate 0 %
Closed
PE Flow 49.5 mgd
Primary Clarifiers
Aeration Channel 4.29 ft
Aeration Train No.1
Cell No.1
Cell No.2
Cell No.3
Mixer M-308 RUN
Mixer M-307 RUN
ORP -399 mV
RAS Valve 61 % 3773 gpm
Al Valve 100 % 8056 gpm
D.O. 3.6 mg/L
Air Valve 18 % 712 scfm
D.O. 2.9 mg/L
D.O. 6.7 mg/L
Air Valve 36 % 1525 scfm
ORP 186 mV
Mixer M-309 RUN
Aeration Train No.2
Mixer M-313 RUN
Mixer M-314 RUN
Al Valve 90 % 10301 gpm
RAS Valve 0 % 0 gpm
ORP -218 mV
D.O. 2.4 mg/L
Air Valve 14 % 21 scfm
D.O. 2.1 mg/L
Mixer M-315 RUN
ORP 187 mV
Air Valve 36 % 1384 scfm
D.O. 6.8 mg/L
RAS TSS 4816 mg/L
Flow Ratio 35 %
RAS Flow 12007 gpm
Aeration Flow 64.9 mgd
RAS Pumps
Secondary Clarifiers
Aeration Train No.3
Mixer M-320 RUN
Mixer M-319 RUN
ORP -380 mV
RAS Valve 94 % 3896 gpm
Al Valve 99 % 7523 gpm
D.O. 2.6 mg/L
Air Valve 23 % 4500 scfm
D.O. 1.7 mg/L
D.O. 0.0 mg/L
Air Valve 0 % 0 scfm
ORP 128 mV
Mixer M-321 RUN
Aeration Train No.4
Mixer M-325 RUN
Mixer M-326 RUN
Al Valve 100 % 7493 gpm
RAS Valve 69 % 3745 gpm
ORP -405 mV
D.O. 2.3 mg/L
Air Valve 22 % 852 scfm
D.O. 2.8 mg/L
Mixer M-327 RUN
ORP 127 mV
Air Valve 0 % 68 scfm
D.O. 0.0 mg/L
Blower B-301 0 cfm OFF
Blower B-302 0 cfm OFF
Blower B-303 5076 cfm RUN
Blower B-304 0 cfm OFF
Pressure 8.5 psi
Air Flow 5076 scfm
Treatment Overview
Plant Main Menu

Current User: ADMIN | LOGIN | LOGOUT

POLLING ACTIVE

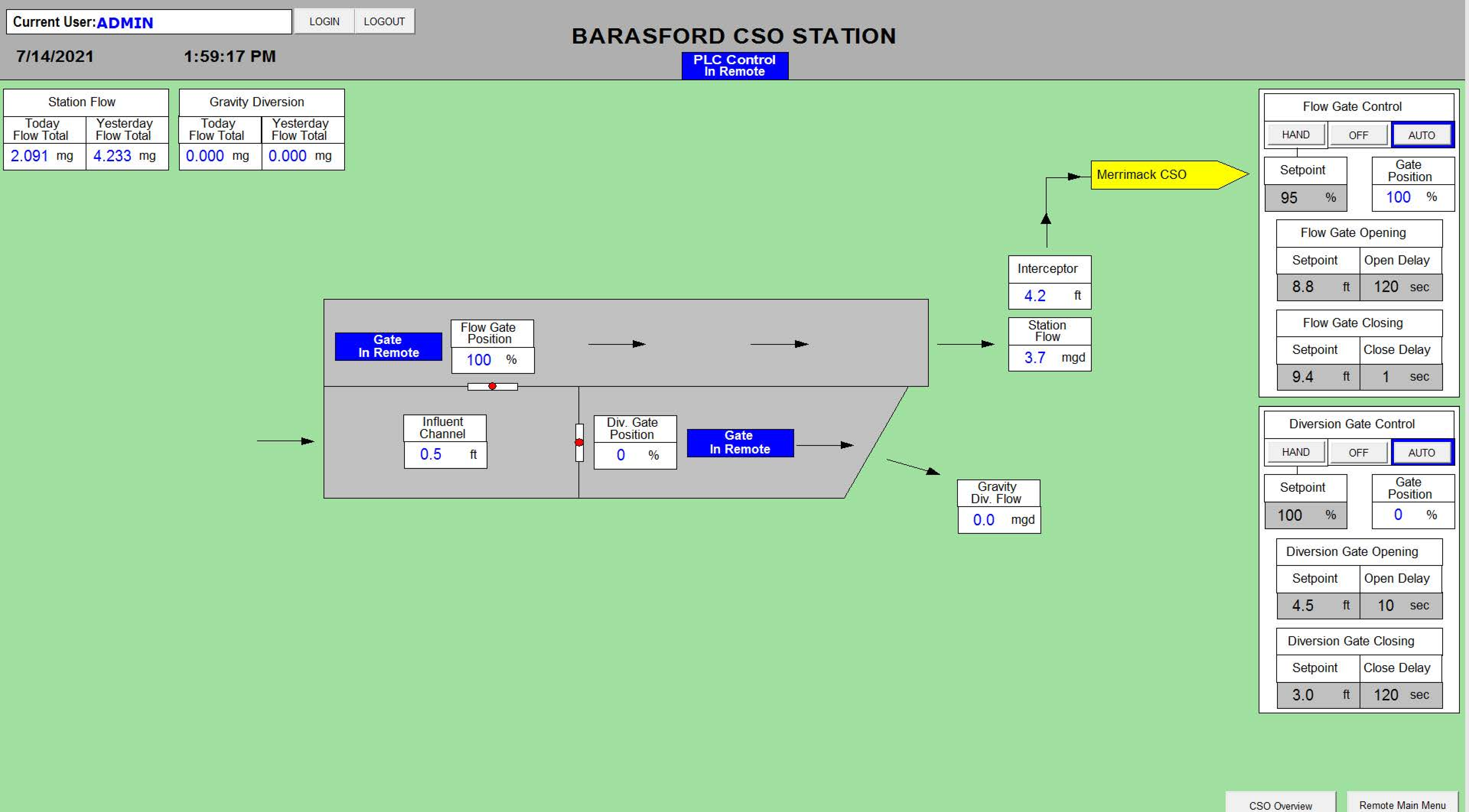
BARASFORD ALARM SETUP

PLC Control In Remote

7/14/2021 1:59:49 PM

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT	
Communications Failure	NORMAL						
Influent Channel High level	NORMAL	ENABLE	DISABLE	Active	Stnby	5.5	ft
Diversion Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.6	%
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.5	%
Flow Control Gate Closed	NORMAL	ENABLE	DISABLE	Active	Stnby		
Diversion Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby		
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby		
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby		
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby		
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5	min

Remote Main Menu


Current User: ADMIN
LOGIN
LOGOUT
7/14/2021
1:59:17 PM
BARASFORD CSO STATION
PLC Control In Remote
Station Flow
Today Flow Total
2.091 mg
Yesterday Flow Total
4.233 mg
Gravity Diversion
Today Flow Total
0.000 mg
Yesterday Flow Total
0.000 mg
Gate In Remote
Flow Gate Position
100 %
Influent Channel
0.5 ft
Div. Gate Position
0 %
Gate In Remote
Interceptor
4.2 ft
Station Flow
3.7 mgd
Merrimack CSO
Gravity Div. Flow
0.0 mgd
Flow Gate Control
HAND
OFF
AUTO
Setpoint
95 %
Gate Position
100 %
Flow Gate Opening
Setpoint
8.8 ft
Open Delay
120 sec
Flow Gate Closing
Setpoint
9.4 ft
Close Delay
1 sec
Diversion Gate Control
HAND
OFF
AUTO
Setpoint
100 %
Gate Position
0 %
Diversion Gate Opening
Setpoint
4.5 ft
Open Delay
10 sec
Diversion Gate Closing
Setpoint
3.0 ft
Close Delay
120 sec
CSO Overview
Remote Main Menu

Current User: JPORTILLO | LOGIN | LOGOUT

4/21/2023 12:05:53 PM

BEAVER BROOK ALARM SETUP

PLC Control In Remote

ACTIVE ALARM

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Processor Fault	NORMAL					
PLC Run Error	NORMAL					
Rosemount Power Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Rosemount Station Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
Power Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Generator Running	NORMAL	ENABLE	DISABLE	Active	Stnby	
High Influent Channel Level	NORMAL	ENABLE	DISABLE	Active	Stnby	6.00 ft
High Intercecptor Level	NORMAL	ENABLE	DISABLE	Active	Stnby	9.80 ft
High Diversion Channel Level	NORMAL	ENABLE	DISABLE	Active	Stnby	4.50 ft
High River Level	NORMAL	ENABLE	DISABLE	Active	Stnby	

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		DELAY
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Influent Gate No.1 Failed To Open	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Gate No.1 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Gate No.2 Failed To Open	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Gate No.2 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.5 %
Bypass Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.5 %
Gravity Gate No.1 Failed To Open	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Gate No.1 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Gate No.2 Failed To Open	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Gate No.2 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Gate No.3 Failed To Open	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Gate No.3 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Gate No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Gate No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	

Current User: JPORTILLO | LOGIN | LOGOUT

4/21/2023 12:10:47 PM

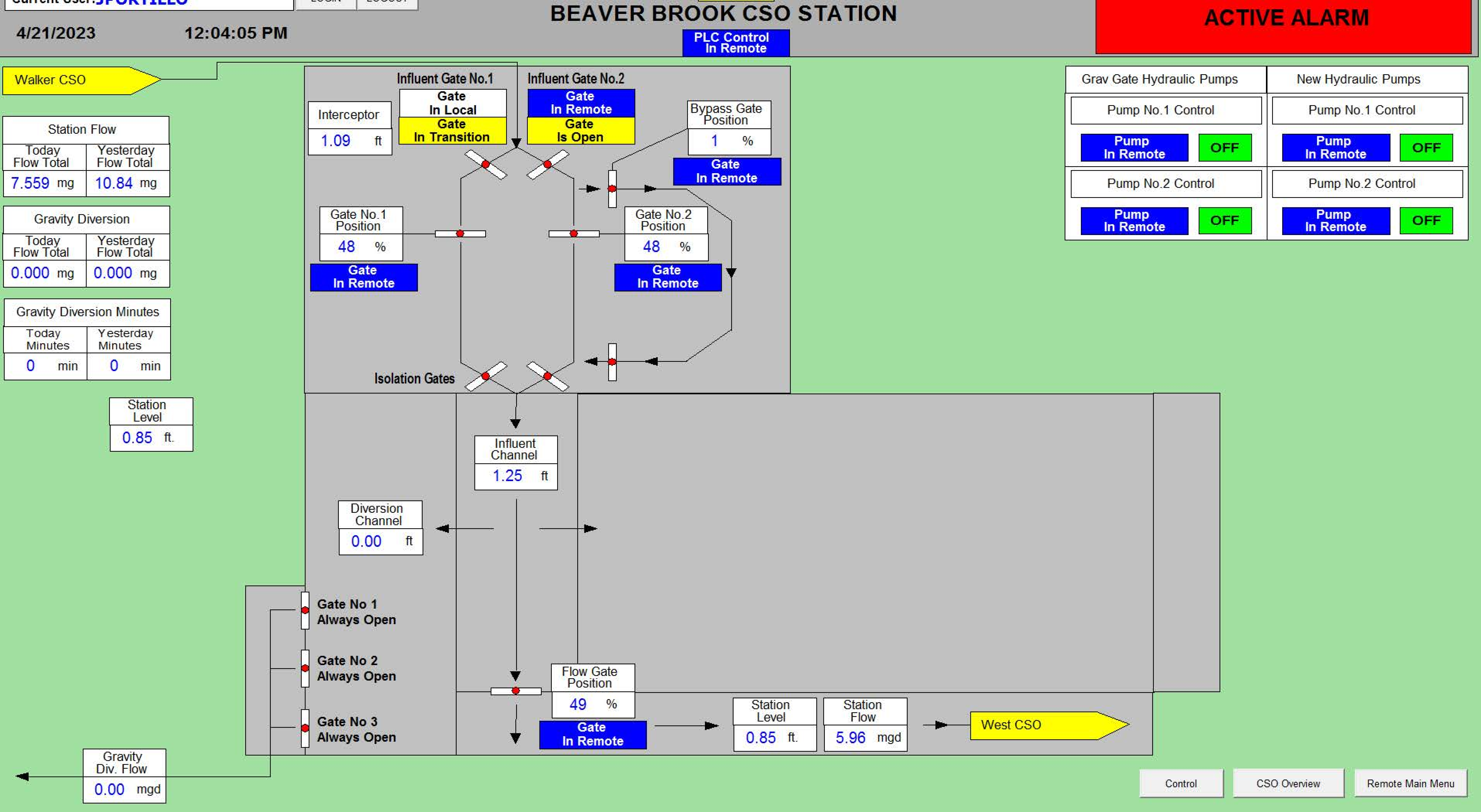
BEAVER BROOK ALARM SETUP

PLC Control In Remote

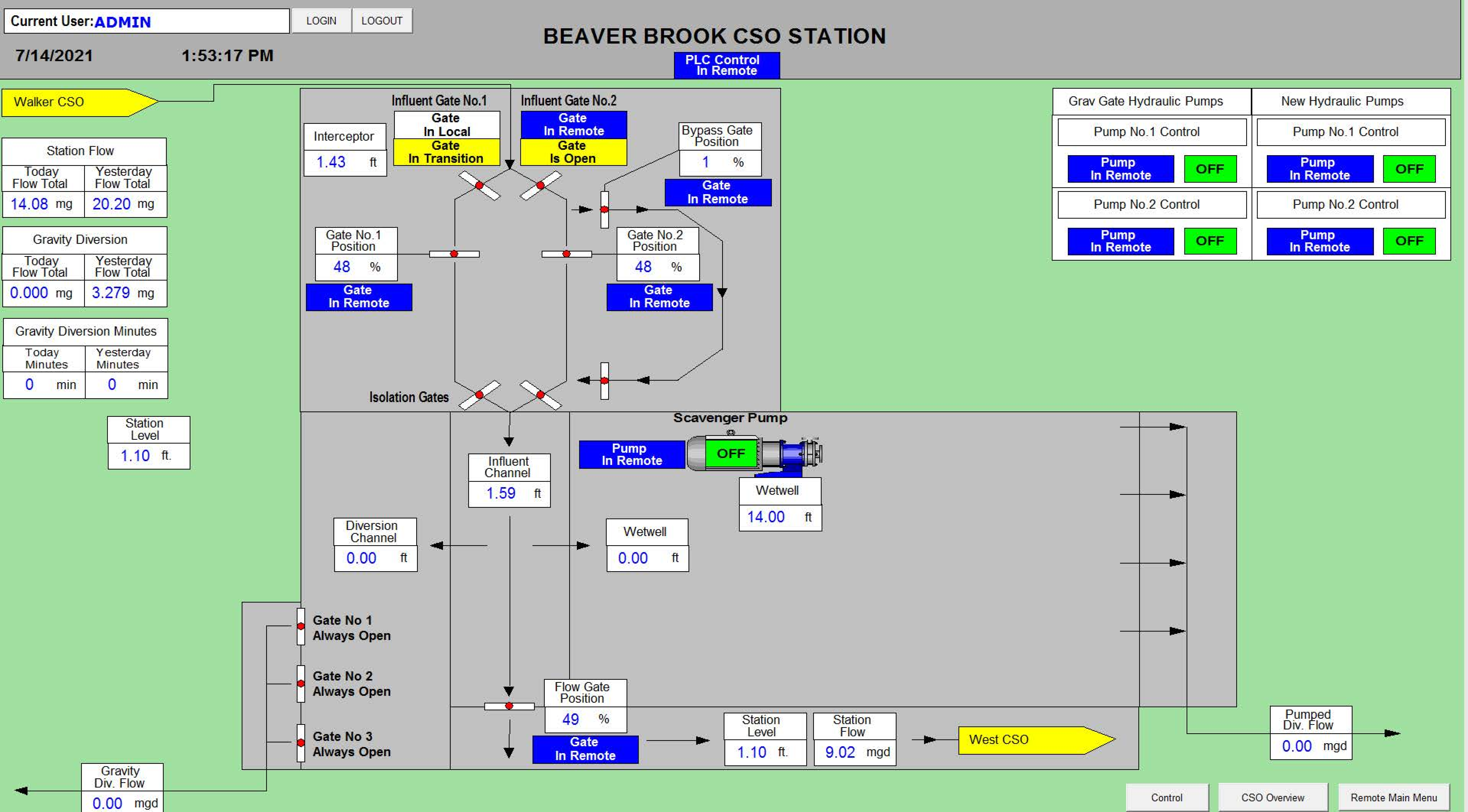
ACTIVE ALARM

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Bypass Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Gate No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Gate No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Gate No.3 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Bypass Gate Opened	NORMAL	ENABLE	DISABLE	Active	Stnby	5 %
Hydraulic System Low Oil Level	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.1 Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.2 Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	

Gravity Gate Hydraulic Unit Alarms						
ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Hydraulic System Low Oil Level	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Oil Level Shutdown	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Nitrogen Shutdown	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Oil Pressure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System High Temp Shutdown	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.1 Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.2 Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System PLC Low Battery	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System PLC Comm Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	



BEAVER BROOK CSO STATION
4/21/2023
12:04:05 PM
PLC Control In Remote
ACTIVE ALARM
Walker CSO
Station Flow
Today Flow Total
7.559 mg
Yesterday Flow Total
10.84 mg
Gravity Diversion
Today Flow Total
0.000 mg
Yesterday Flow Total
0.000 mg
Gravity Diversion Minutes
Today Minutes
0 min
Yesterday Minutes
0 min
Station Level
0.85 ft.
Interceptor
1.09 ft
Influent Gate No.1
Gate In Local
Gate In Transition
Influent Gate No.2
Gate In Remote
Gate Is Open
Bypass Gate Position
1 %
Gate In Remote
Gate No.1 Position
48 %
Gate In Remote
Gate No.2 Position
48 %
Gate In Remote
Isolation Gates
Grav Gate Hydraulic Pumps
Pump No.1 Control
Pump In Remote
OFF
Pump No.2 Control
Pump In Remote
OFF
New Hydraulic Pumps
Pump No.1 Control
Pump In Remote
OFF
Pump No.2 Control
Pump In Remote
OFF
Influent Channel
1.25 ft
Diversion Channel
0.00 ft
Gate No 1 Always Open
Gate No 2 Always Open
Gate No 3 Always Open
Flow Gate Position
49 %
Gate In Remote
Station Level
0.85 ft.
Station Flow
5.96 mgd
West CSO
Gravity Div. Flow
0.00 mgd
Control
CSO Overview
Remote Main Menu



Current User: ADMIN
LOGIN
LOGOUT
BEAVER BROOK CSO STATION
7/14/2021
1:53:17 PM
PLC Control In Remote
Walker CSO
Station Flow
Today Flow Total 14.08 mg
Yesterday Flow Total 20.20 mg
Gravity Diversion
Today Flow Total 0.000 mg
Yesterday Flow Total 3.279 mg
Gravity Diversion Minutes
Today Minutes 0 min
Yesterday Minutes 0 min
Station Level 1.10 ft.
Influent Gate No.1
Gate In Local
Gate In Transition
Influent Gate No.2
Gate In Remote
Gate Is Open
Interceptor 1.43 ft
Bypass Gate Position 1 %
Gate In Remote
Gate No.1 Position 48 %
Gate In Remote
Gate No.2 Position 48 %
Gate In Remote
Isolation Gates
Grav Gate Hydraulic Pumps
Pump No.1 Control
Pump In Remote
OFF
Pump No.2 Control
Pump In Remote
OFF
New Hydraulic Pumps
Pump No.1 Control
Pump In Remote
OFF
Pump No.2 Control
Pump In Remote
OFF
Scavenger Pump
Pump In Remote
OFF
Wetwell 14.00 ft
Influent Channel 1.59 ft
Diversion Channel 0.00 ft
Wetwell 0.00 ft
Gate No 1 Always Open
Gate No 2 Always Open
Gate No 3 Always Open
Flow Gate Position 49 %
Gate In Remote
Station Level 1.10 ft.
Station Flow 9.02 mgd
West CSO
Pumped Div. Flow 0.00 mgd
Gravity Div. Flow 0.00 mgd
Control
CSO Overview
Remote Main Menu

Current User: JPORTILLO LOGIN LOGOUT

MERRIMACK ALARM SETUP

4/21/2023 12:13:53 PM

PLC Control In Remote

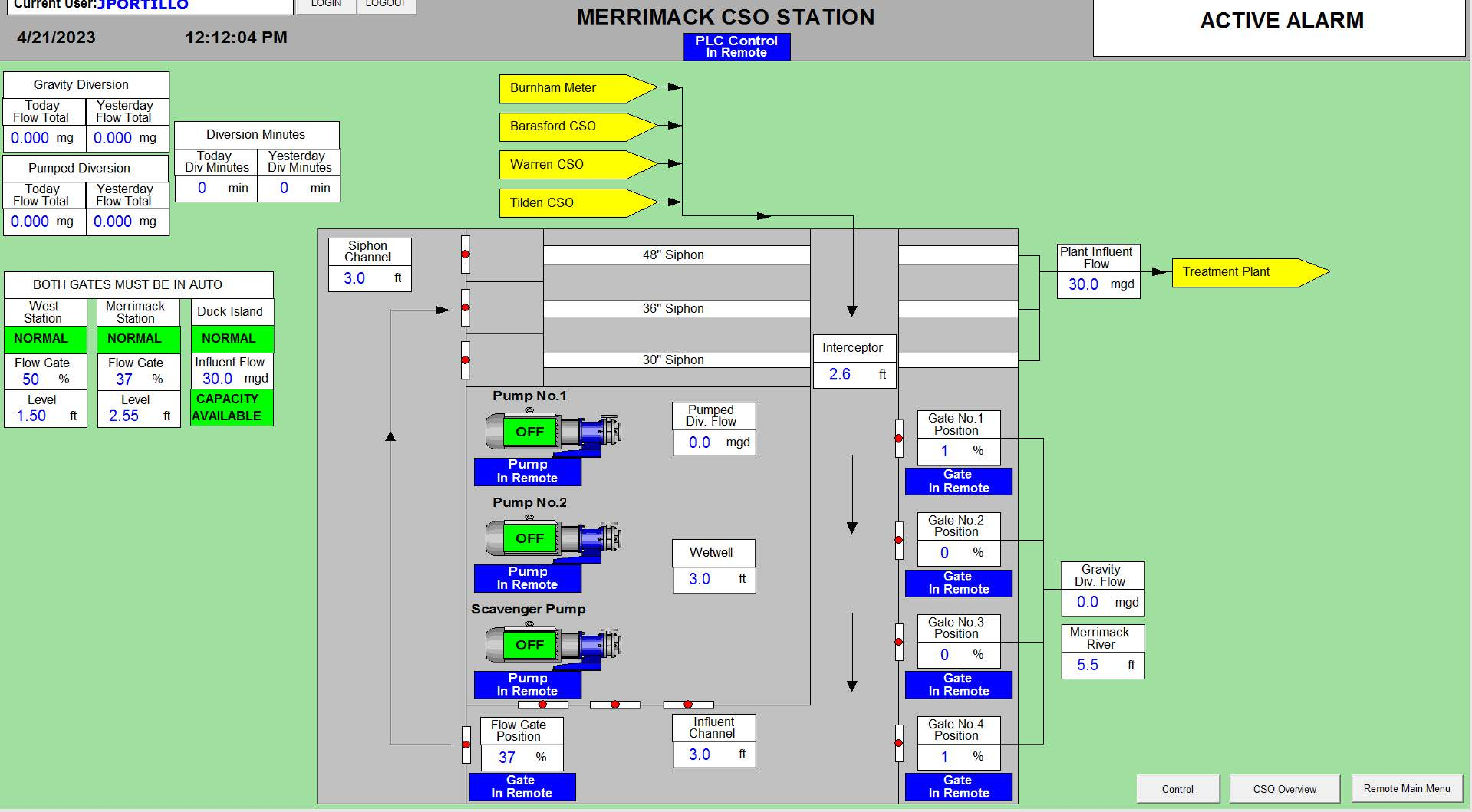
ACTIVE ALARM

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Processor Fault	NORMAL					
PLC Run Error	NORMAL					
River High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Channel High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	10.0 ft
Siphon Channel High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	9.0 ft
Wet Well High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	17.0 ft
Wet Well Low Level	NORMAL	ENABLE	DISABLE	Active	Stnby	1.0 ft
Diversion Gate No.1 Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	2.0 %
Diversion Gate No.2 Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	2.0 %
Diversion Gate No.3 Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	2.0 %
Diversion Gate No.4 Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	2.0 %
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.5 %
Diversion Pump No.1 Start Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.2 Start Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.1 No Flow	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.2 No Flow	NORMAL	ENABLE	DISABLE	Active	Stnby	
Scavenger Pump Start Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Building Power Failure	ALARM	ENABLE	DISABLE	Active	Stnby	
Generator Running	NORMAL	ENABLE	DISABLE	Active	Stnby	
Generator Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Seal Water Fault Div Pump 1	NORMAL	ENABLE	DISABLE	Active	Stnby	
Seal Water Fault Div Pump 2	NORMAL	ENABLE	DISABLE	Active	Stnby	

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Diversion Gate No.1 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.2 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.3 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.4 Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Scavenger Pump Continuous Running	NORMAL	ENABLE	DISABLE	Active	Stnby	24 hrs
Diversion Gate No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.3 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.4 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		DELAY
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min
Pump Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min

Next Alarm Page Remote Main Menu



Current User: JPORTILLO
LOGIN
LOGOUT
4/21/2023
12:12:04 PM
MERRIMACK CSO STATION
PLC Control In Remote
ACTIVE ALARM
Gravity Diversion
Today Flow Total 0.000 mg
Yesterday Flow Total 0.000 mg
Pumped Diversion
Today Flow Total 0.000 mg
Yesterday Flow Total 0.000 mg
Diversion Minutes
Today Div Minutes 0 min
Yesterday Div Minutes 0 min
BOTH GATES MUST BE IN AUTO
West Station NORMAL
Flow Gate 50 %
Level 1.50 ft
Merrimack Station NORMAL
Flow Gate 37 %
Level 2.55 ft
Duck Island NORMAL
Influent Flow 30.0 mgd
CAPACITY AVAILABLE
Burnham Meter
Barasford CSO
Warren CSO
Tilden CSO
Siphon Channel 3.0 ft
48" Siphon
36" Siphon
30" Siphon
Interceptor 2.6 ft
Plant Influent Flow 30.0 mgd
Treatment Plant
Pump No.1
OFF
Pump In Remote
Pumped Div. Flow 0.0 mgd
Pump No.2
OFF
Pump In Remote
Wetwell 3.0 ft
Scavenger Pump
OFF
Pump In Remote
Flow Gate Position 37 %
Gate In Remote
Influent Channel 3.0 ft
Gate No.1 Position 1 %
Gate In Remote
Gate No.2 Position 0 %
Gate In Remote
Gate No.3 Position 0 %
Gate In Remote
Gate No.4 Position 1 %
Gate In Remote
Gravity Div. Flow 0.0 mgd
Merrimack River 5.5 ft
Control
CSO Overview
Remote Main Menu

Current User: JPORTILLO | LOGIN | LOGOUT

4/21/2023 12:12:50 PM

MERRIMACK CSO STATION

PLC Control In Remote

ACTIVE ALARM

BOTH GATES MUST BE IN AUTO

Read Station	Merrimack Station	Duck Island
Gate In Auto	Gate In Auto	NORMAL
NORMAL	NORMAL	Influent Flow 31.0 mgd
Flow Gate 6 %	Flow Gate 37 %	CAPACITY AVAILABLE
Level 1.90 ft	Level 2.55 ft	

Storage Mode In Level Control

Select	Control	Storage Setpoint	Reset Setpoint	Reset Delay Setpoint
Flow	31.0 mgd	102.0 mgd		
Level	35 inches	67 inches		

Diversion Minutes

Today Div Minutes	Yesterday Div Minutes
0 min	0 min

Gravity Diversion Gates Control

	Gate No.1 Control	Gate No.2 Control	Gate No.3 Control	Gate No.4 Control
Mode	HAND / OFF / AUTO	HAND / OFF / AUTO	HAND / OFF / AUTO	HAND / OFF / AUTO
Setpoint	0 %	0 %	0 %	0 %
Gate Position	1 %	0 %	0 %	1 %

Flow Gate Control

HAND / OFF / AUTO

Setpoint 38 %

Ref Setpoint 37 %

Ref Position 37 %

Gate Position 37 %

Gravity Diversions Gates Control Setpoints

Modulation Setpoint	Close Setpoint	Gate Deadband		
9.2 ft	8.5 ft	1.5 %		
Gate 1 Start Setpoint	Gate 2 Start Setpoint	Gate 3 Start Setpoint	Gate 4 Start Setpoint	
9.2 ft	9.2 ft	9.2 ft	9.2 ft	

Diversion Pumps

Pump No.1 Control	Pump No.2 Control
HAND / OFF / AUTO	HAND / OFF / AUTO

Lead On Setpoint	Lead Off Setpoint	Lag On Setpoint	Lag Off Setpoint
15.0 ft	14.0 ft	15.5 ft	14.4 ft

Scavenger Pump

Pump Control

HAND / OFF / AUTO

On Setpoint	Off Setpoint
6.0 ft	3.0 ft

Start Delay Setpoint 480 min

Hydraulic Pumps

Pump No.1 Control

Pump In Remote | OFF

Pump No.2 Control

Pump In Remote | OFF

CSO Sation | CSO Overview | Remote Main Menu

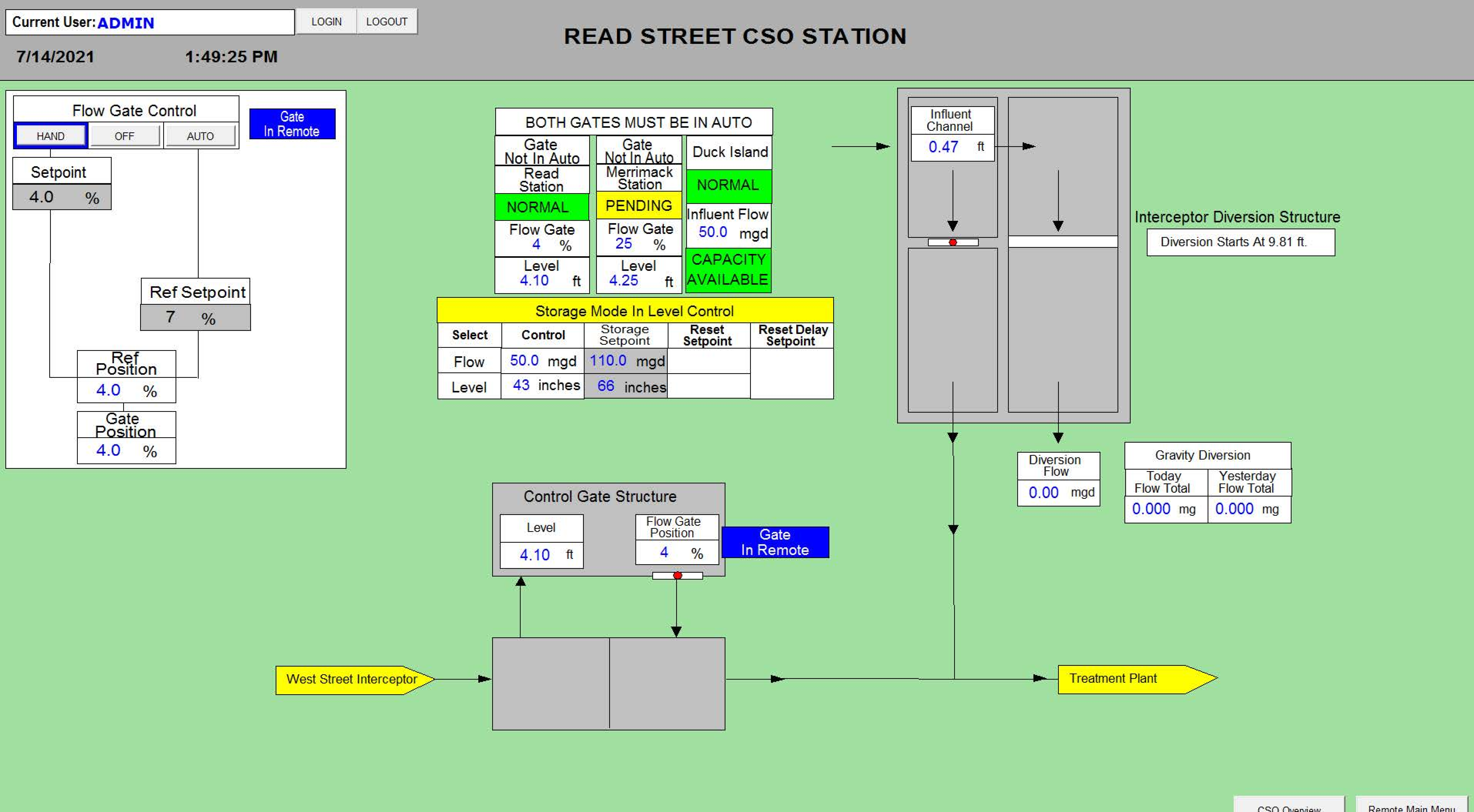
Current User: ADMIN	LOGIN	LOGOUT

7/14/2021 1:50:02 PM

READ STREET ALARM SETUP

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Processor Fault	NORMAL					
PLC Run Error	NORMAL					
UPS Low Battery	NORMAL	ENABLE	DISABLE	Active	Stnby	
UPS Power Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
High Diversion Level	NORMAL	ENABLE	DISABLE	Active	Stnby	7.00 ft
High High Diversion Level	NORMAL	ENABLE	DISABLE	Active	Stnby	7.00 ft
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	5 %
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Warning	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Closed	ALARM	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate High Water Level	NORMAL	ENABLE	DISABLE	Active	Stnby	19.00 ft

Remote Main Menu


Current User: ADMIN
LOGIN
LOGOUT
7/14/2021
1:49:25 PM
READ STREET CSO STATION
Flow Gate Control
HAND
OFF
AUTO
Gate In Remote
Setpoint
4.0 %
Ref Setpoint
7 %
Ref Position
4.0 %
Gate Position
4.0 %
BOTH GATES MUST BE IN AUTO
Gate Not In Auto
Read Station
NORMAL
Flow Gate
4 %
Level
4.10 ft
Gate Not In Auto
Merrimack Station
PENDING
Flow Gate
25 %
Level
4.25 ft
Duck Island
NORMAL
Influent Flow
50.0 mgd
CAPACITY AVAILABLE
Storage Mode In Level Control
Select
Control
Storage Setpoint
Reset Setpoint
Reset Delay Setpoint
Flow
50.0 mgd
110.0 mgd
Level
43 inches
66 inches
Influent Channel
0.47 ft
Interceptor Diversion Structure
Diversion Starts At 9.81 ft.
Diversion Flow
0.00 mgd
Gravity Diversion
Today Flow Total
0.000 mg
Yesterday Flow Total
0.000 mg
Control Gate Structure
Level
4.10 ft
Flow Gate Position
4 %
Gate In Remote
West Street Interceptor
Treatment Plant
CSO Overview
Remote Main Menu

Current User: JPORTILLO

LOGIN LOGOUT

4/21/2023 1:20:21 PM

TILDEN ALARM SETUP

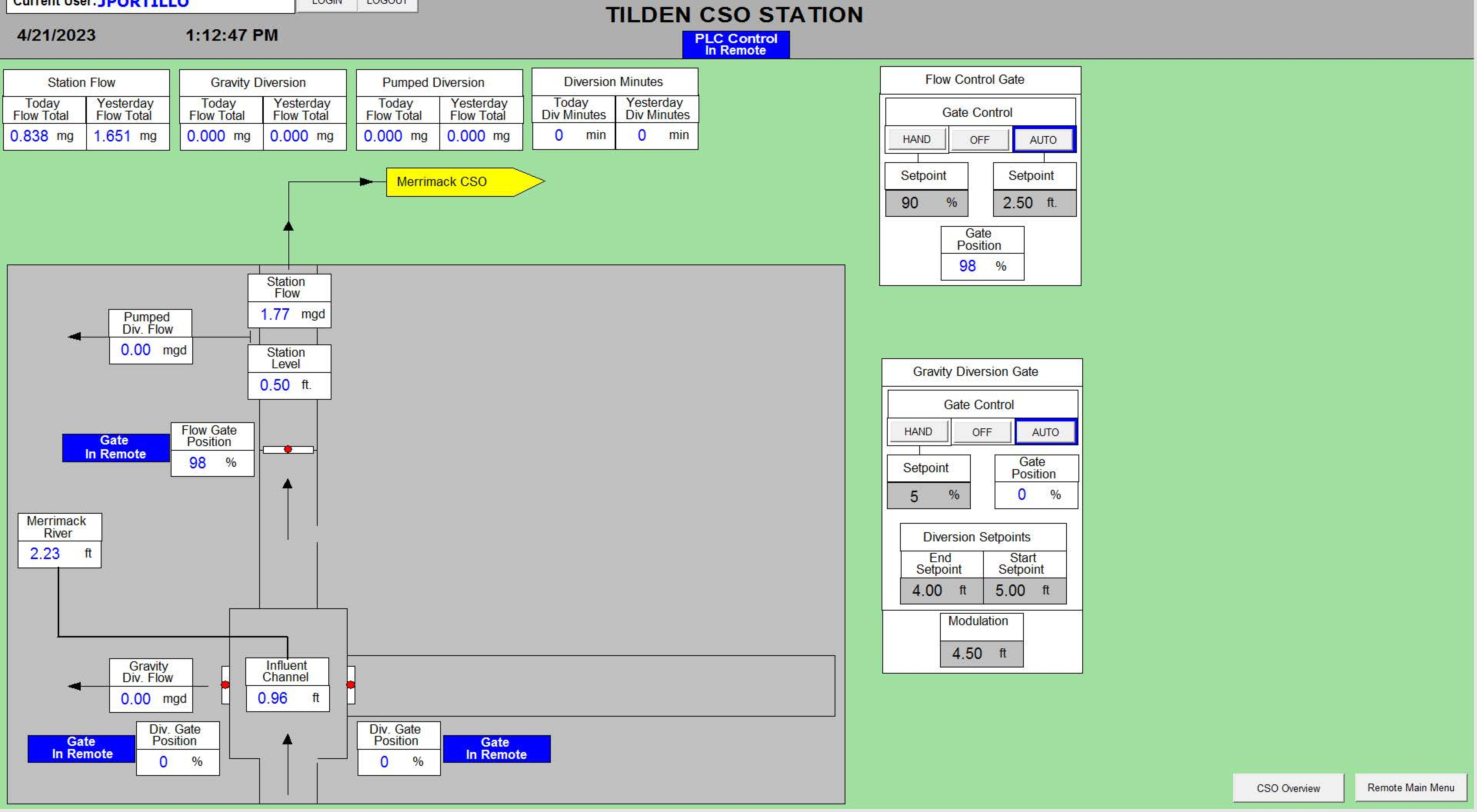
PLC Control In Remote

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Processor Fault	NORMAL					
PLC Run Error	NORMAL					
High River Level	ALARM	ENABLE	DISABLE	Active	Stnby	
High Influent Channel Level	NORMAL	ENABLE	DISABLE	Active	Stnby	5.5 ft
High Wet Well Level	NORMAL	ENABLE	DISABLE	Active	Stnby	14.5 ft
Low Wet Well Level	NORMAL	ENABLE	DISABLE	Active	Stnby	1.0 ft
Gravity Diversion Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	5.0 %
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	10.0 %
Flow Control Gate Closed	NORMAL	ENABLE	DISABLE	Active	Stnby	
Power Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Generator Running	NORMAL	ENABLE	DISABLE	Active	Stnby	
Generator Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Bio System Trouble	NORMAL	ENABLE	DISABLE	Active	Stnby	
Bio Tank High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Pump No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Pump No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System E-Stop	NORMAL	ENABLE	DISABLE	Active	Stnby	

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Gravity Diversion Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Oil Level	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Oil Level Shutdown	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Nitrogen Shutdown	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Oil Pressure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System High Temp Shutdown	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.1 Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.2 Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System PLC Low Battery	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System PLC Comm Fail	NORMAL	ENABLE	DISABLE	Active	Stnby	

Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min

Remote Main Menu


Current User: JPORTILLO
LOGIN
LOGOUT
TILDEN CSO STATION
4/21/2023
1:12:47 PM
PLC Control
In Remote
Station Flow
Today Flow Total
0.838 mg
Yesterday Flow Total
1.651 mg
Gravity Diversion
Today Flow Total
0.000 mg
Yesterday Flow Total
0.000 mg
Pumped Diversion
Today Flow Total
0.000 mg
Yesterday Flow Total
0.000 mg
Diversion Minutes
Today Div Minutes
0 min
Yesterday Div Minutes
0 min
Merrimack CSO
Station Flow
1.77 mgd
Pumped Div. Flow
0.00 mgd
Station Level
0.50 ft.
Gate In Remote
Flow Gate Position
98 %
Merrimack River
2.23 ft
Gravity Div. Flow
0.00 mgd
Influent Channel
0.96 ft
Gate In Remote
Div. Gate Position
0 %
Div. Gate Position
0 %
Gate In Remote
Flow Control Gate
Gate Control
HAND
OFF
AUTO
Setpoint
90 %
Setpoint
2.50 ft.
Gate Position
98 %
Gravity Diversion Gate
Gate Control
HAND
OFF
AUTO
Setpoint
5 %
Gate Position
0 %
Diversion Setpoints
End Setpoint
4.00 ft
Start Setpoint
5.00 ft
Modulation
4.50 ft
CSO Overview
Remote Main Menu

Current User: ADMIN LOGIN LOGOUT

7/14/2021 1:55:52 PM

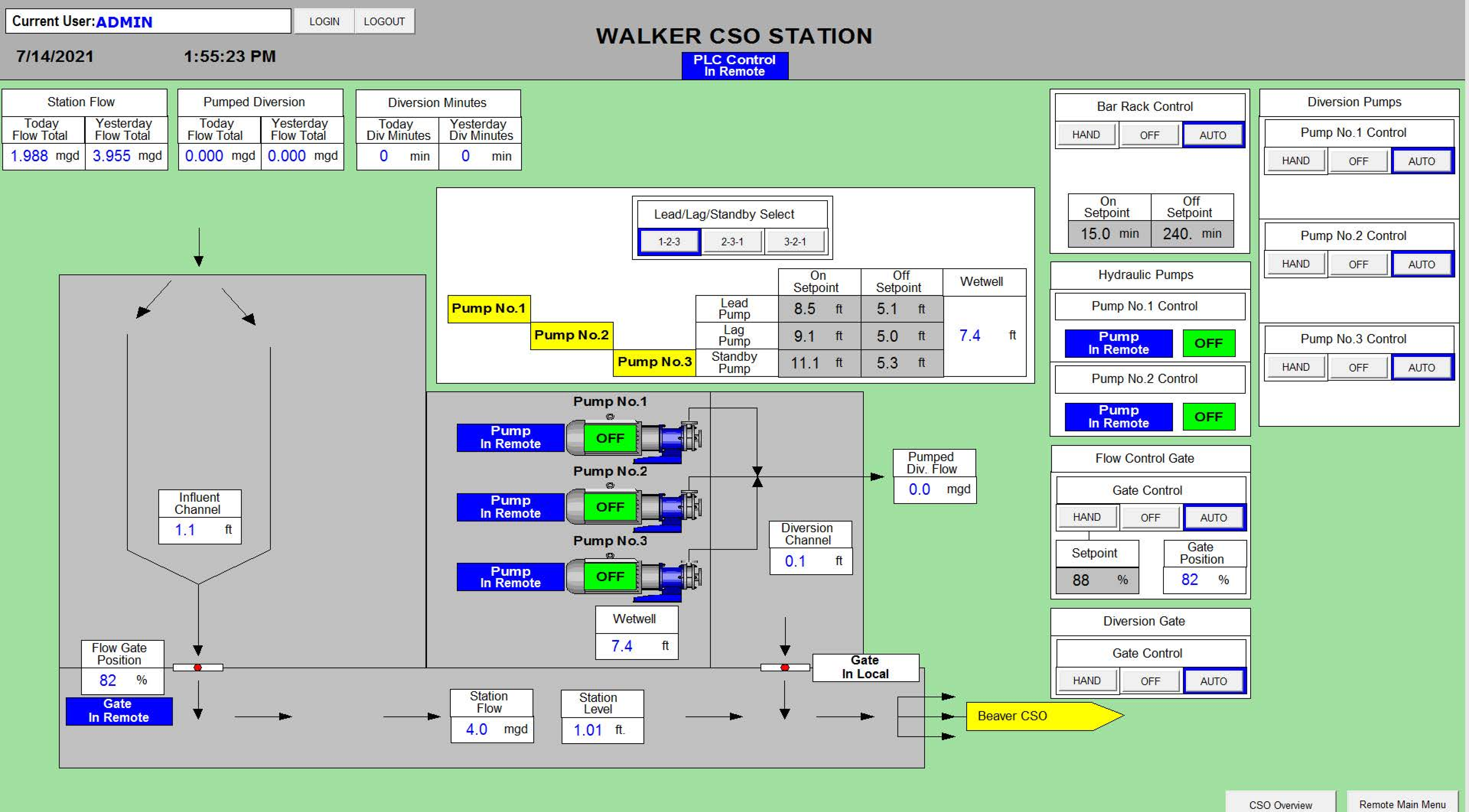
WALKER ALARM SETUP

PLC Control In Remote

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Processor Fault	NORMAL					
PLC Run Error	NORMAL					
High Influent Channel Level	NORMAL	ENABLE	DISABLE	Active	Stnby	4.0 ft
High Wet Well Level	NORMAL	ENABLE	DISABLE	Active	Stnby	13.0 ft
Low Wet Well Level	NORMAL	ENABLE	DISABLE	Active	Stnby	0.1 ft
Flow Control Gate Failed To Open	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Failed To Close	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.1 Start Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.2 Start Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.3 Start Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Pump No.3 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Low Oil Level	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic System Accumulator Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Hydraulic Motor Pump No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		DELAY
Pump Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	15 min

Remote Main Menu



Current User: ADMIN
LOGIN
LOGOUT
WALKER CSO STATION
PLC Control In Remote
7/14/2021
1:55:23 PM
Station Flow
Today Flow Total 1.988 mgd
Yesterday Flow Total 3.955 mgd
Pumped Diversion
Today Flow Total 0.000 mgd
Yesterday Flow Total 0.000 mgd
Diversion Minutes
Today Div Minutes 0 min
Yesterday Div Minutes 0 min
Lead/Lag/Standby Select
1-2-3
2-3-1
3-2-1
Pump No.1
Pump No.2
Pump No.3
On Setpoint
Off Setpoint
Wetwell
Lead Pump 8.5 ft 5.1 ft
Lag Pump 9.1 ft 5.0 ft
Standby Pump 11.1 ft 5.3 ft
7.4 ft
Bar Rack Control
HAND
OFF
AUTO
On Setpoint 15.0 min
Off Setpoint 240. min
Diversion Pumps
Pump No.1 Control
HAND
OFF
AUTO
Pump No.2 Control
HAND
OFF
AUTO
Pump No.3 Control
HAND
OFF
AUTO
Hydraulic Pumps
Pump No.1 Control
Pump In Remote
OFF
Pump No.2 Control
Pump In Remote
OFF
Pump No.1
Pump In Remote
OFF
Pump No.2
Pump In Remote
OFF
Pump No.3
Pump In Remote
OFF
Influent Channel 1.1 ft
Pumped Div. Flow 0.0 mgd
Diversion Channel 0.1 ft
Wetwell 7.4 ft
Flow Control Gate
Gate Control
HAND
OFF
AUTO
Setpoint 88 %
Gate Position 82 %
Diversion Gate
Gate Control
HAND
OFF
AUTO
Flow Gate Position 82 %
Gate In Remote
Gate In Local
Station Flow 4.0 mgd
Station Level 1.01 ft.
Beaver CSO
CSO Overview
Remote Main Menu

Current User: ADMIN LOGIN LOGOUT

7/14/2021 2:00:32 PM

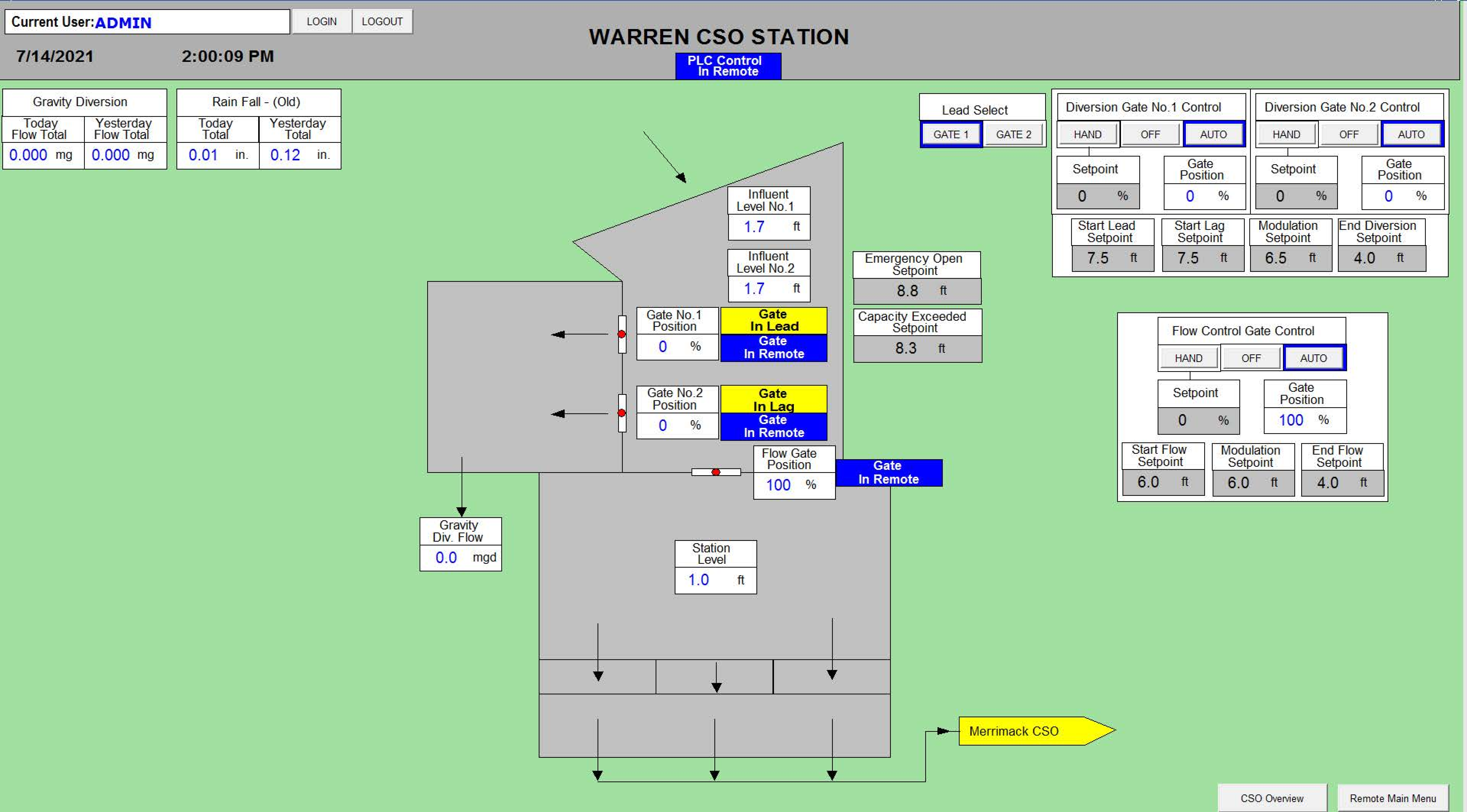
WARREN ALARM SETUP

PLC Control In Remote

ALARM	STATUS	ENABLE / DISABLE		ACTIVE/ STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Processor Fault	NORMAL					
PLC Run Error	NORMAL					
Power Failure	NORMAL	ENABLE	DISABLE	Active	Stnby	
Influent Channel High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	7.0 ft
Diversion Channel High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	9.0 ft
Siphon Channel High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	6.0 ft
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	5.0 %
Diversion Gate No.1 Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	5.0 %
Diversion Gate No.2 Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	5.0 %
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.1 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate No.2 Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min
Channel Level Differential	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Capacity Exceeded	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Closed	NORMAL	ENABLE	DISABLE	Active	Stnby	

ALARM	STATUS	ENABLE / DISABLE		ACTIVE/ STANDBY		SETPOINT
Influent Gate Controller Fault	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate 1 Controller Fault	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate 2 Controller Fault	NORMAL	ENABLE	DISABLE	Active	Stnby	
Combustable Gas Warning	NORMAL	ENABLE	DISABLE	Active	Stnby	
Combustable Gas Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
H2S Warning	NORMAL	ENABLE	DISABLE	Active	Stnby	
H2S Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
O2 Warning	NORMAL	ENABLE	DISABLE	Active	Stnby	
O2 Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	

Remote Main Menu



Current User: ADMIN
LOGIN
LOGOUT
WARREN CSO STATION
7/14/2021
2:00:09 PM
PLC Control In Remote
Gravity Diversion
Today Flow Total 0.000 mg
Yesterday Flow Total 0.000 mg
Rain Fall - (Old)
Today Total 0.01 in.
Yesterday Total 0.12 in.
Lead Select
GATE 1
GATE 2
Diversion Gate No.1 Control
HAND OFF AUTO
Setpoint 0 %
Gate Position 0 %
Diversion Gate No.2 Control
HAND OFF AUTO
Setpoint 0 %
Gate Position 0 %
Start Lead Setpoint 7.5 ft
Start Lag Setpoint 7.5 ft
Modulation Setpoint 6.5 ft
End Diversion Setpoint 4.0 ft
Influent Level No.1 1.7 ft
Influent Level No.2 1.7 ft
Emergency Open Setpoint 8.8 ft
Capacity Exceeded Setpoint 8.3 ft
Gate No.1 Position 0 %
Gate In Lead
Gate In Remote
Gate No.2 Position 0 %
Gate In Lag
Gate In Remote
Flow Gate Position 100 %
Gate In Remote
Flow Control Gate Control
HAND OFF AUTO
Setpoint 0 %
Gate Position 100 %
Start Flow Setpoint 6.0 ft
Modulation Setpoint 6.0 ft
End Flow Setpoint 4.0 ft
Gravity Div. Flow 0.0 mgd
Station Level 1.0 ft
Merrimack CSO
CSO Overview
Remote Main Menu

Current User: ADMIN | LOGIN | LOGOUT

7/14/2021 1:52:04 PM

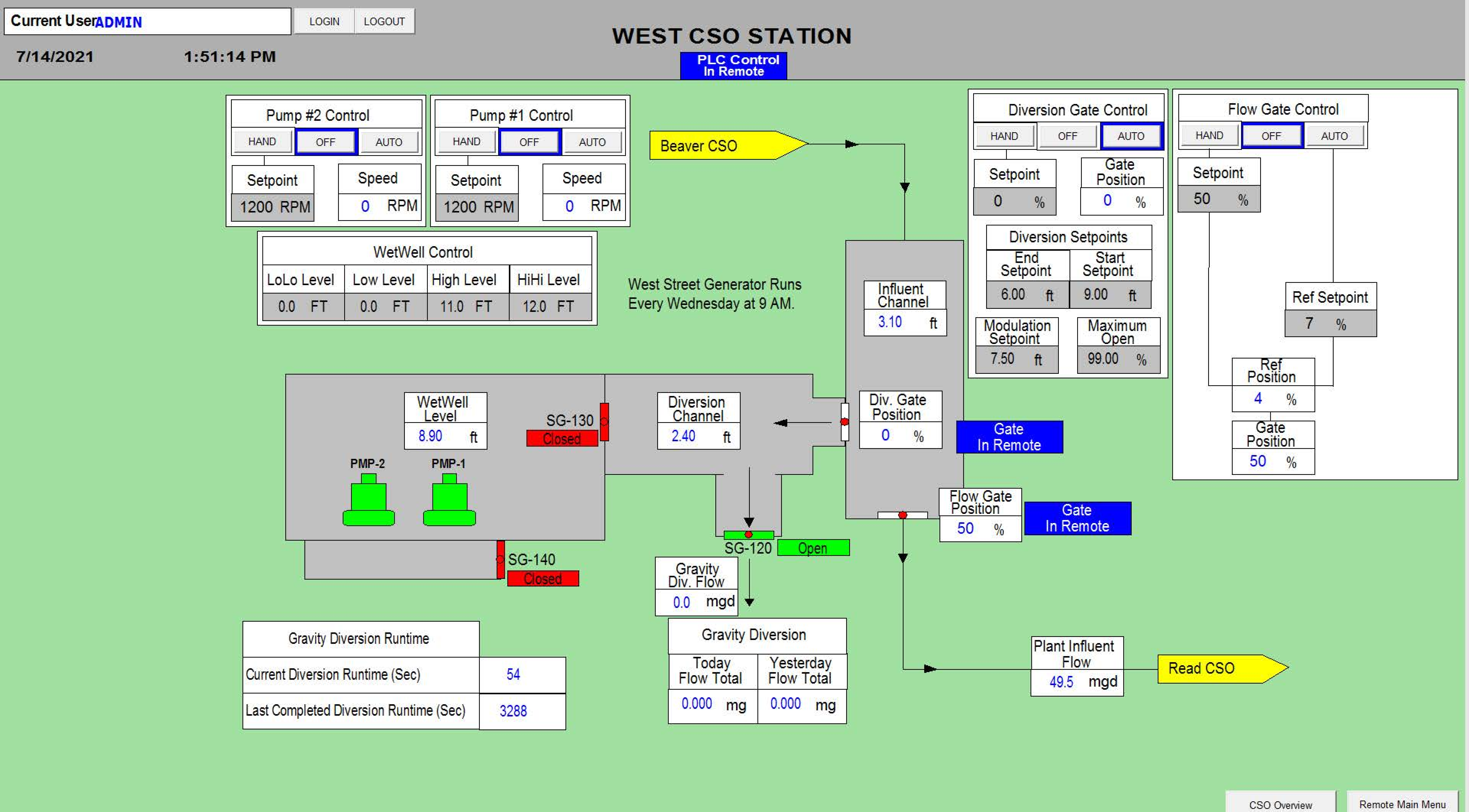
WEST ALARM SETUP

PLC Control In Remote

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
PLC Run Error	NORMAL					
PLC Processor Fault	NORMAL					
PLC Battery Fail	NORMAL					
SCADA Panel Surge Supp. Fail	NORMAL					
SCADA Panel Power Fail	NORMAL					
SCADA Panel UPS Battery Fail	NORMAL					
SCADA Panel UPS Buffering	NORMAL					
Float Control Panel Loss of Power	NORMAL					
Float Control Mode Active	NORMAL					
Building Intrusion	NORMAL					
Sump Pump Running	NORMAL					
Pump #1 Running	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump #1 Ready to Run	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump #1 Common Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump #1 Engine Fault	NORMAL					
Wet Well High Float	ALARM	ENABLE	DISABLE	Active	Stnby	
Pump #2 Running	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump #2 Ready to Run	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump #2 Common Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
Pump #2 Engine Fault	NORMAL					
Diversion Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Utility Power Fail	NORMAL					
Generator Run	NORMAL					
Generator Fail	NORMAL					
Diesel Day Tank Common Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	

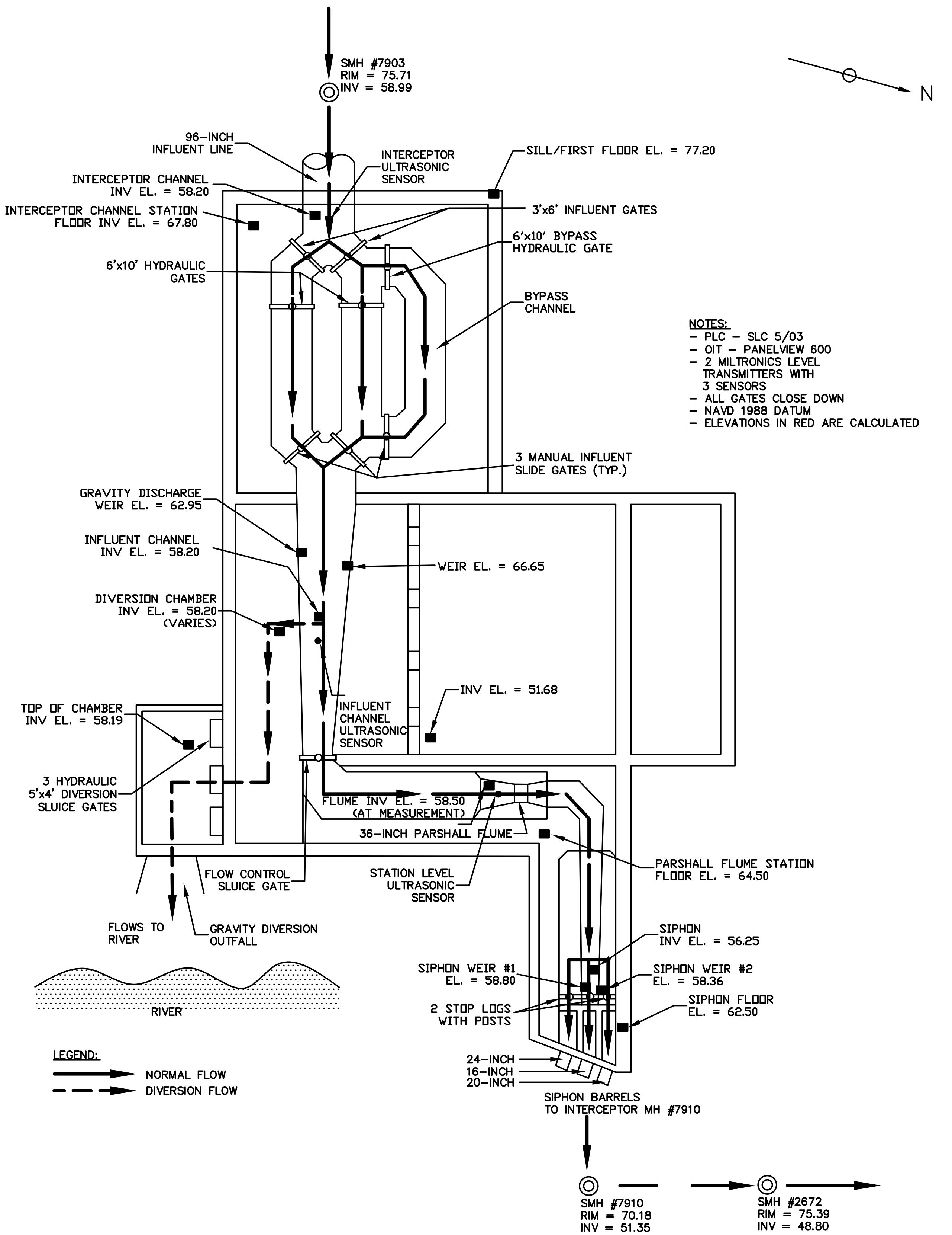
ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Flow Control Gate Controller Alarm	NORMAL					
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	2.0 %
Diversion Gate Controller Alarm	NORMAL					
Diversion Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	2.0 %
Slide Gate SG120 Faulted	NORMAL					
Flow Control Gate Closed	NORMAL	ENABLE	DISABLE	Active	Stnby	0.3 %
Slide Gate SG130 Faulted	NORMAL					
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Slide Gate SG140 Faulted	NORMAL					
Influent Channel High level	NORMAL	ENABLE	DISABLE	Active	Stnby	9.0 ft
Building High Temperature	NORMAL	ENABLE	DISABLE	Active	Stnby	
Building Smoke Alarm	NORMAL	ENABLE	DISABLE	Active	Stnby	
WetWell Lo-Lo Level	NORMAL	ENABLE	DISABLE	Active	Stnby	0.0 ft
WetWell Low Level	NORMAL	ENABLE	DISABLE	Active	Stnby	0.0 ft
WetWell High Level	NORMAL	ENABLE	DISABLE	Active	Stnby	11.0 ft
WetWell Hi-Hi Level	NORMAL	ENABLE	DISABLE	Active	Stnby	12.0 ft
Station in Local Control	NORMAL					
Flow Control Gate Warning	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate Warning	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min
Diversion Channel High level	NORMAL	ENABLE	DISABLE	Active	Stnby	6.0 ft

Remote Main Menu

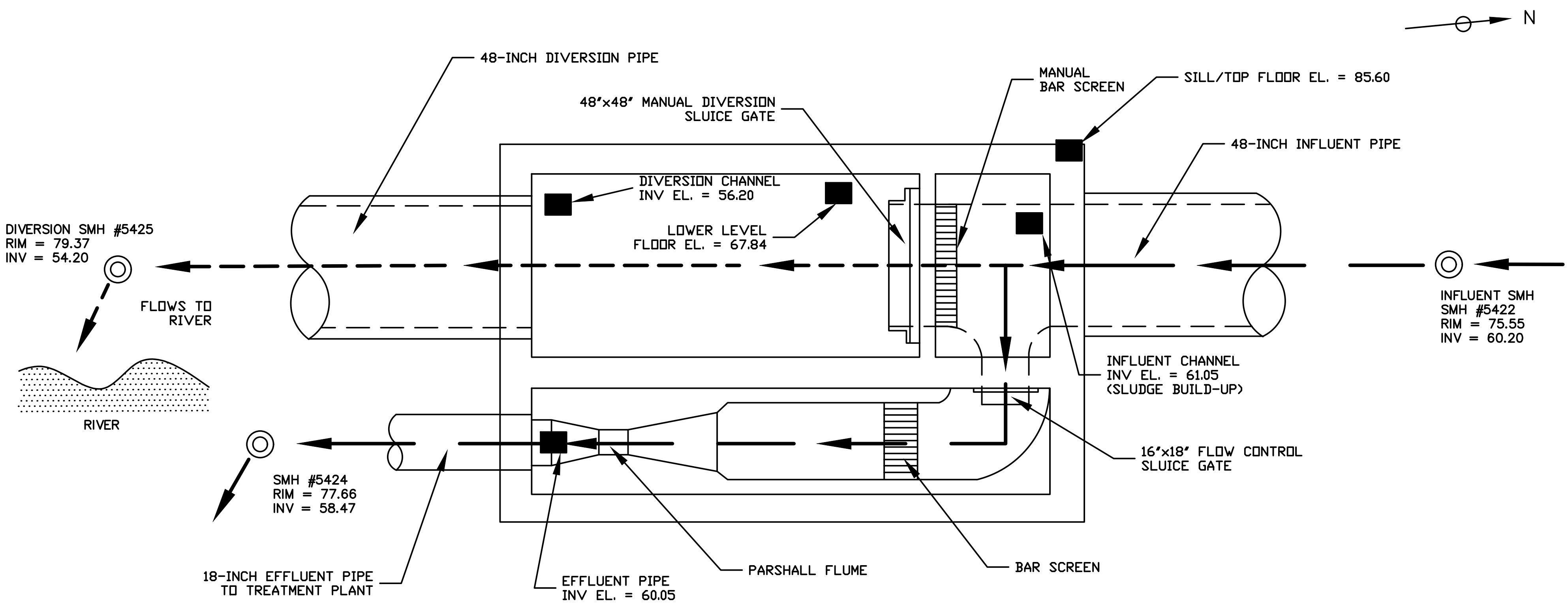


Current User ADMIN
LOGIN
LOGOUT
7/14/2021
1:51:14 PM
WEST CSO STATION
PLC Control In Remote
Pump #2 Control
HAND OFF AUTO
Setpoint 1200 RPM
Speed 0 RPM
Pump #1 Control
HAND OFF AUTO
Setpoint 1200 RPM
Speed 0 RPM
WetWell Control
LoLo Level 0.0 FT
Low Level 0.0 FT
High Level 11.0 FT
HiHi Level 12.0 FT
Beaver CSO
West Street Generator Runs Every Wednesday at 9 AM.
Influent Channel 3.10 ft
Diversion Gate Control
HAND OFF AUTO
Setpoint 0 %
Gate Position 0 %
Diversion Setpoints
End Setpoint 6.00 ft
Start Setpoint 9.00 ft
Modulation Setpoint 7.50 ft
Maximum Open 99.00 %
Flow Gate Control
HAND OFF AUTO
Setpoint 50 %
Ref Setpoint 7 %
Ref Position 4 %
Gate Position 50 %
WetWell Level 8.90 ft
SG-130 Closed
Diversion Channel 2.40 ft
Div. Gate Position 0 %
Gate In Remote
PMP-2
PMP-1
Flow Gate Position 50 %
Gate In Remote
SG-120 Open
SG-140 Closed
Gravity Div. Flow 0.0 mgd
Gravity Diversion Runtime
Current Diversion Runtime (Sec) 54
Last Completed Diversion Runtime (Sec) 3288
Gravity Diversion
Today Flow Total 0.000 mg
Yesterday Flow Total 0.000 mg
Plant Influent Flow 49.5 mgd
Read CSO
CSO Overview
Remote Main Menu

Appendix D
Diversion Station Drawings



LOWELL REGIONAL WASTEWATER UTILITY	REV	DESCRIPTION	DATE	BEAVER BROOK DIVERSION STATION	JOB NO.:
	REV-2	UPDATED FOR HFMP	APR 25, 2023		DATE: 4/25/2023
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009		SCALE: NOT TO SCALE
	DESIGNED BY: AF, CH	APPROVED BY:			
	DRAWN BY: DP	REVIEWED BY:			SHEET: 1 of 1

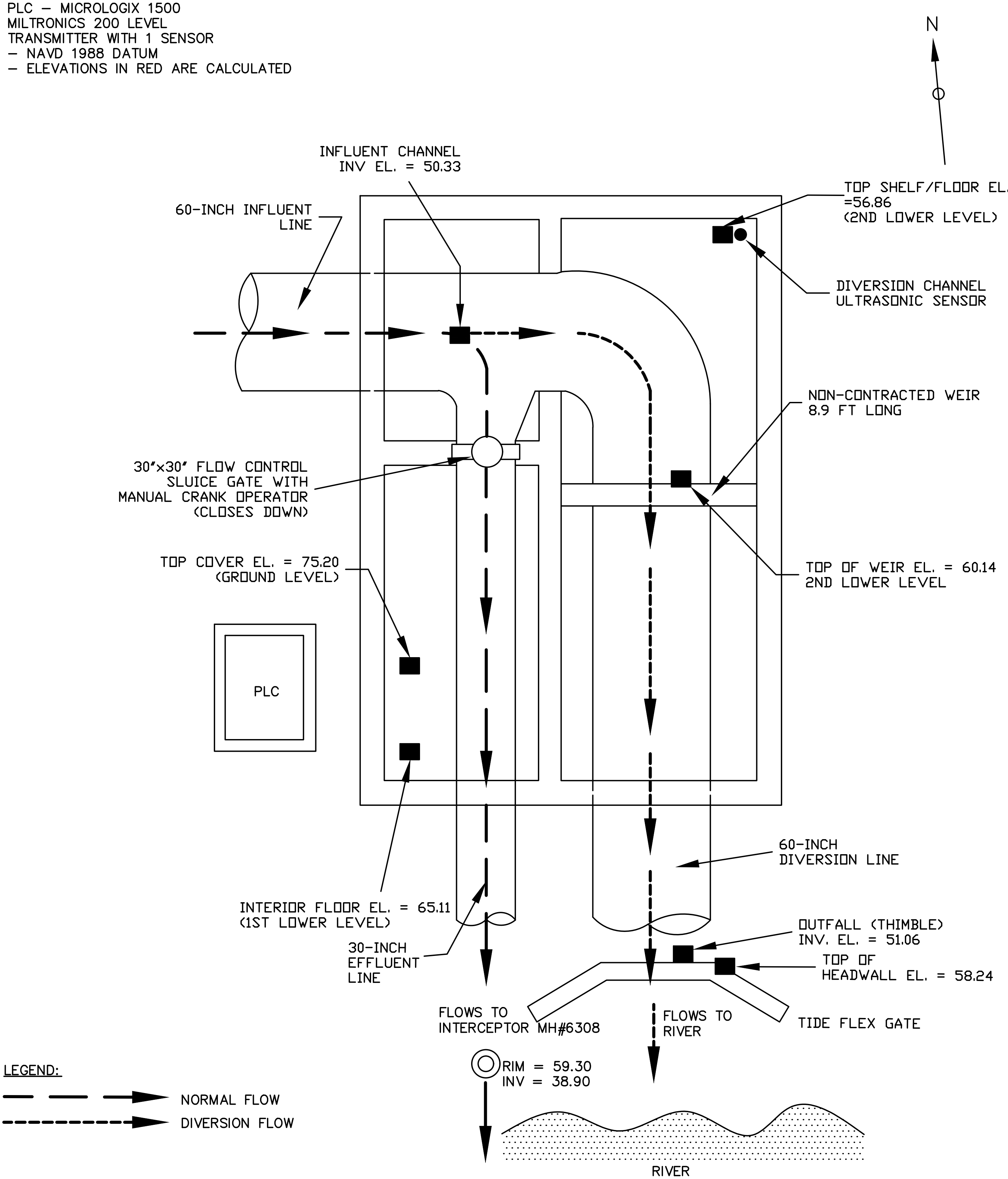


NOTES:
- FISHER PORTER FLOW CHART
- LEVEL SENSOR
- NO PLC
- ALL GATES CLOSE DOWN
- NAVD 1988 DATUM
- ELEVATIONS IN RED ARE CALCULATED

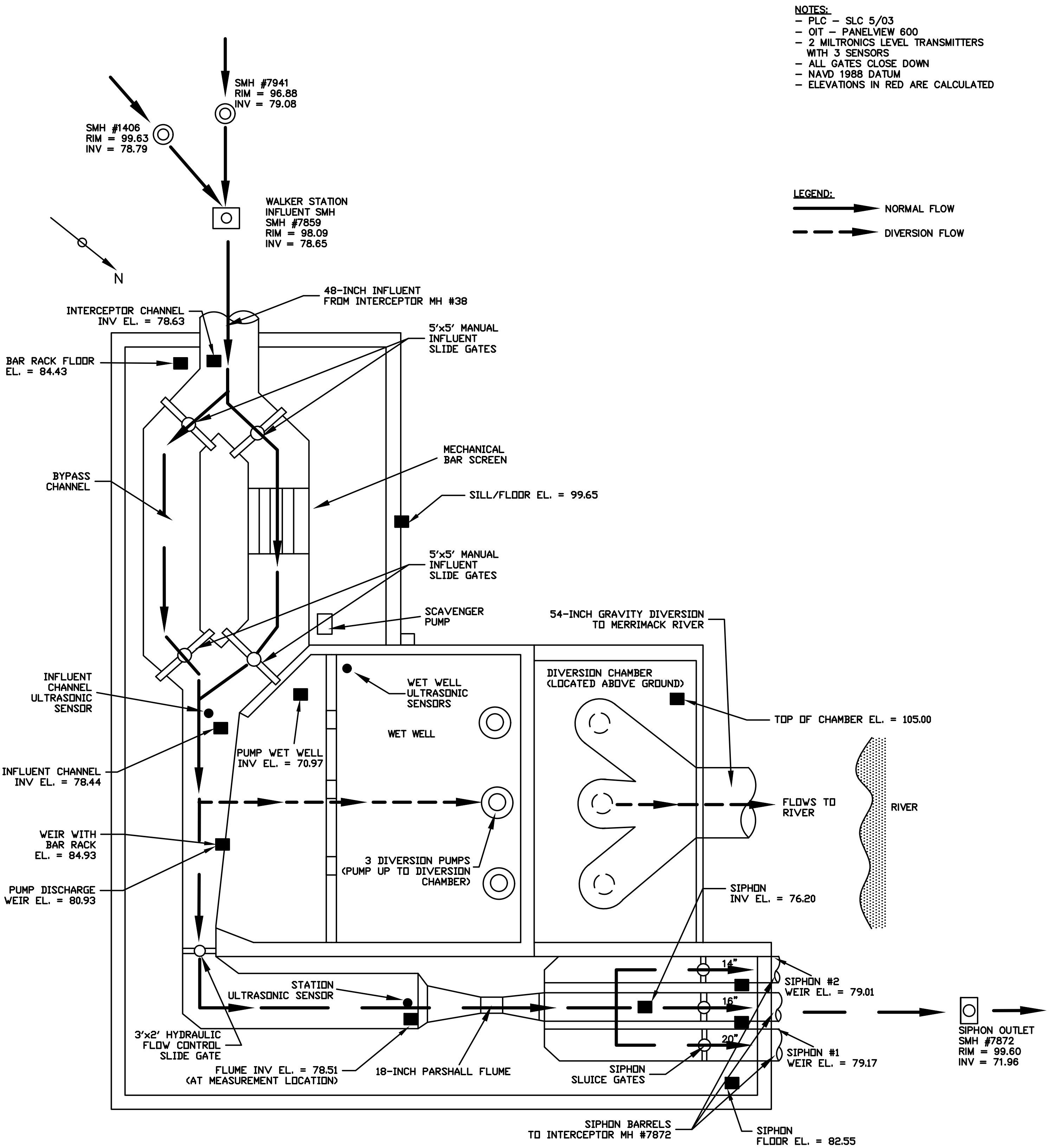
LEGEND:
NORMAL FLOW
DIVERSION FLOW

LOWELL REGIONAL WASTEWATER UTILITY	REV	DESCRIPTION	DATE	**FIRST STREET DIVERSION STATION**
	REV-2	UPDATED FOR HFMP	APR 25, 2023	JOB NO.:
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009	DATE: 4/25/2023
	DESIGNED BY: AF, CH	APPROVED BY:		SCALE: NOT TO SCALE
	DRAWN BY: DP	REVIEWED BY: EW		SHEET: 1 of 1

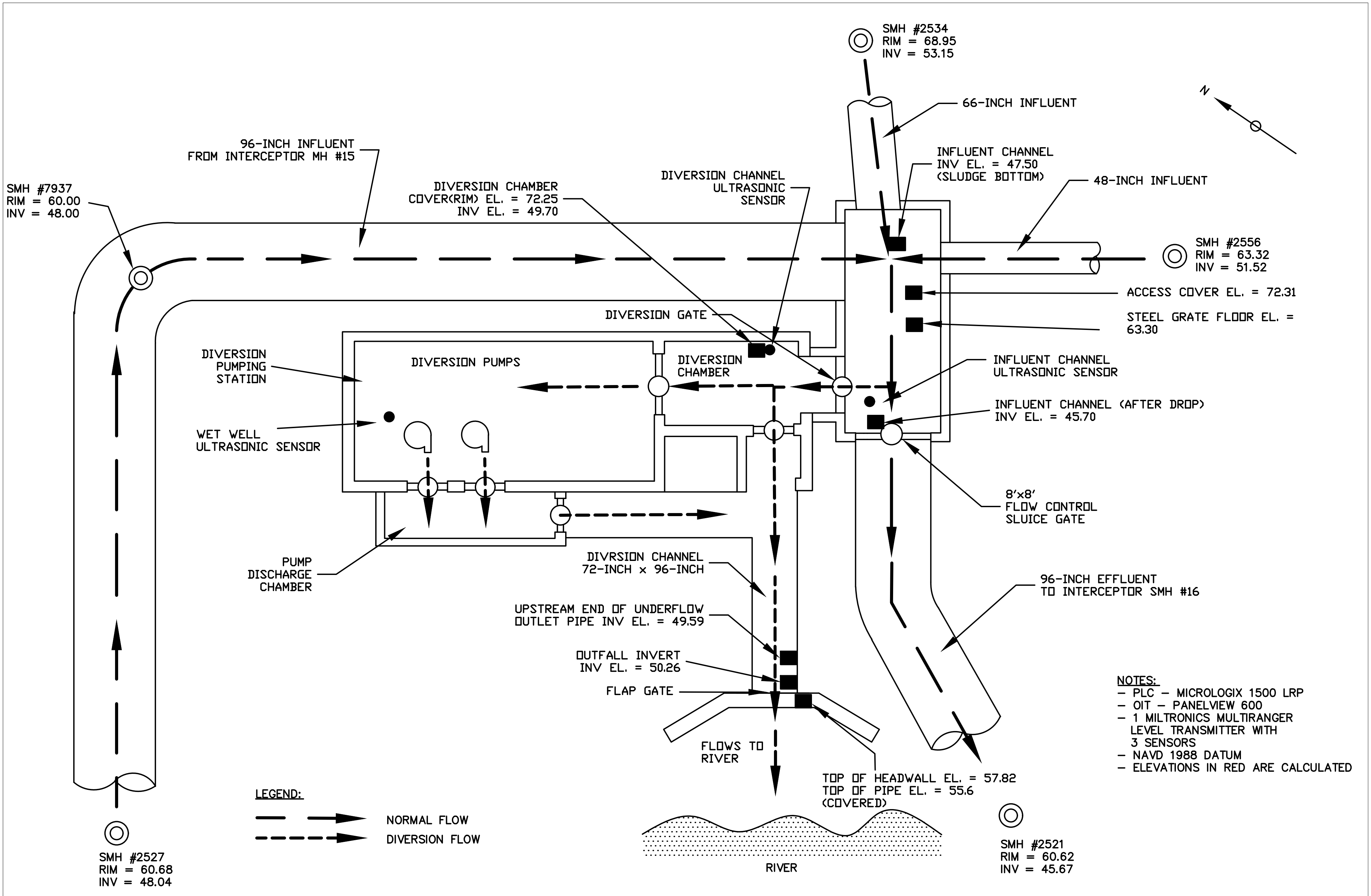
NOTES:
PLC LOCATED ABOVE GROUND
PLC – MICROLOGIX 1500
MILTRONICS 200 LEVEL
TRANSMITTER WITH 1 SENSOR
– NAVD 1988 DATUM
– ELEVATIONS IN RED ARE CALCULATED



	REV	DESCRIPTION	DATE		
LOWELL REGIONAL WASTEWATER UTILITY	REV-2	UPDATED FOR HFMP	APR 25, 2023	READ STREET DIVERSION STATION	JOB NO.:
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009		DATE: 4/25/2023
	DESIGNED BY: AF, CH	APPROVED BY:			SCALE: NOT TO SCALE
	DRAWN BY: DP	REVIEWED BY: EW			SHEET: 1 of 1



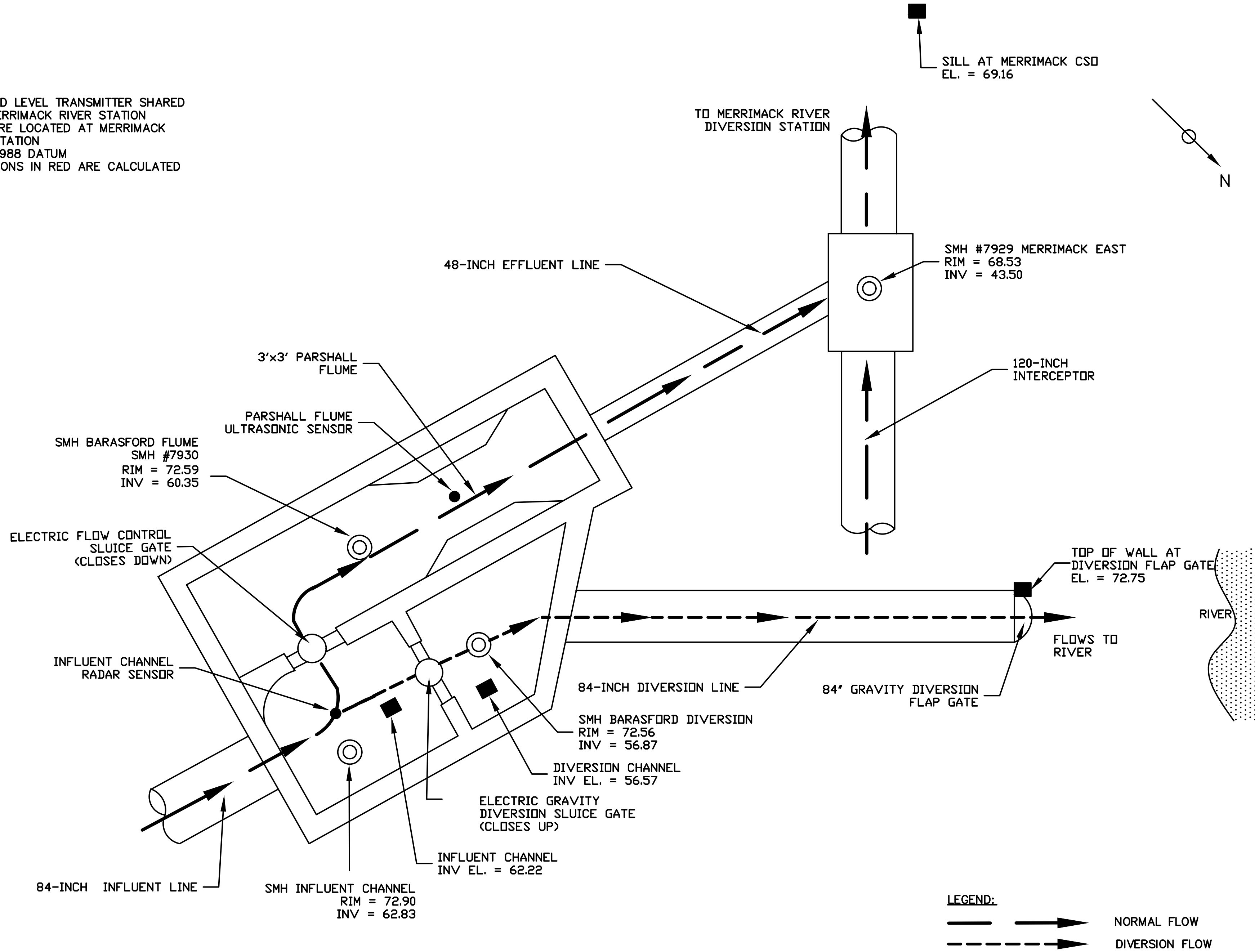
LOWELL REGIONAL WASTEWATER UTILITY	REV	DESCRIPTION	DATE	WALKER STREET DIVERSION STATION	JOB NO.:
	REV-2	UPDATED FOR HFMP	APR 25, 2023		DATE: 4/25/2023
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009		SCALE: NOT TO SCALE
	DESIGNED BY: AF, CH	APPROVED BY:			
	DRAWN BY: DP	REVIEWED BY: EW			SHEET: 1 of 1



LOWELL REGIONAL WASTEWATER UTILITY	REV	DESCRIPTION	DATE	**WEST STREET DIVERSION STATION**	JOB NO.:
	REV-2	UPDATED FOR HFMP	APR 25, 2023		DATE: 4/25/2023
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009		SCALE: NOT TO SCALE
	DESIGNED BY: AF, CH		APPROVED BY:		
	DRAWN BY: DP		REVIEWED BY: EW		SHEET: 1 of 1

NOTES:

- PLC AND LEVEL TRANSMITTER SHARED WITH MERRIMACK RIVER STATION BOTH ARE LOCATED AT MERRIMACK RIVER STATION
- NAVD 1988 DATUM
- ELEVATIONS IN RED ARE CALCULATED



LOWELL REGIONAL WASTEWATER UTILITY

REV	DESCRIPTION	DATE
REV-2	UPDATED FOR HFMP	APR 25, 2023
REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009

DESIGNED BY: AF, CH | APPROVED BY:

DRAWN BY: DP | REVIEWED BY: EW

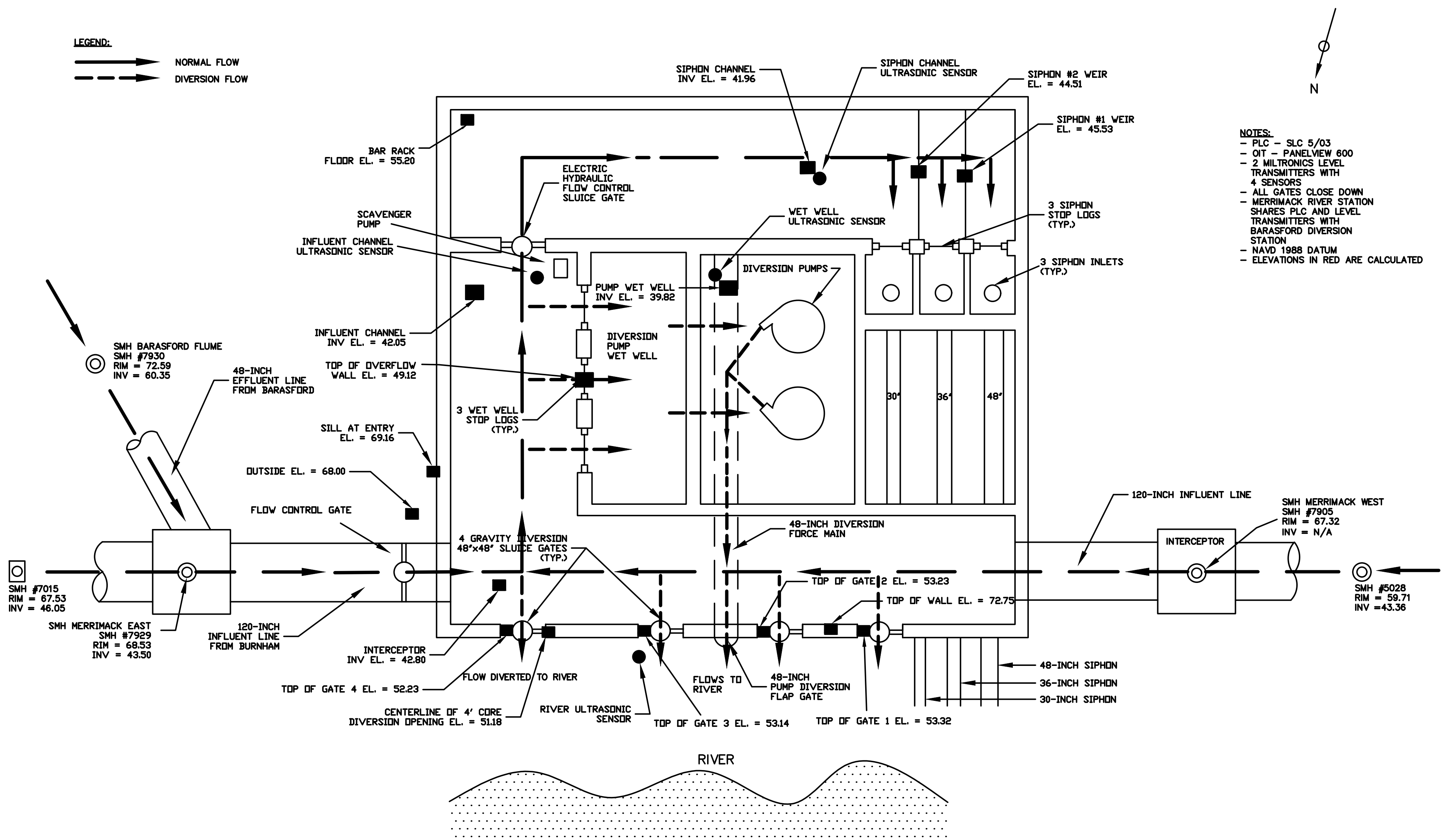
BARASFORD AVENUE DIVERSION STATION

JOB NO.:

DATE: 4/25/2023

SCALE: NOT TO SCALE

SHEET: 1 of 1



LOWELL REGIONAL WASTEWATER UTILITY

REV	DESCRIPTION	DATE
REV-2	UPDATED FOR HFMP	APR 25, 2023
REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009

DESIGNED BY: AF, CH | APPROVED BY:

DRAWN BY: DP | REVIEWED BY: EW

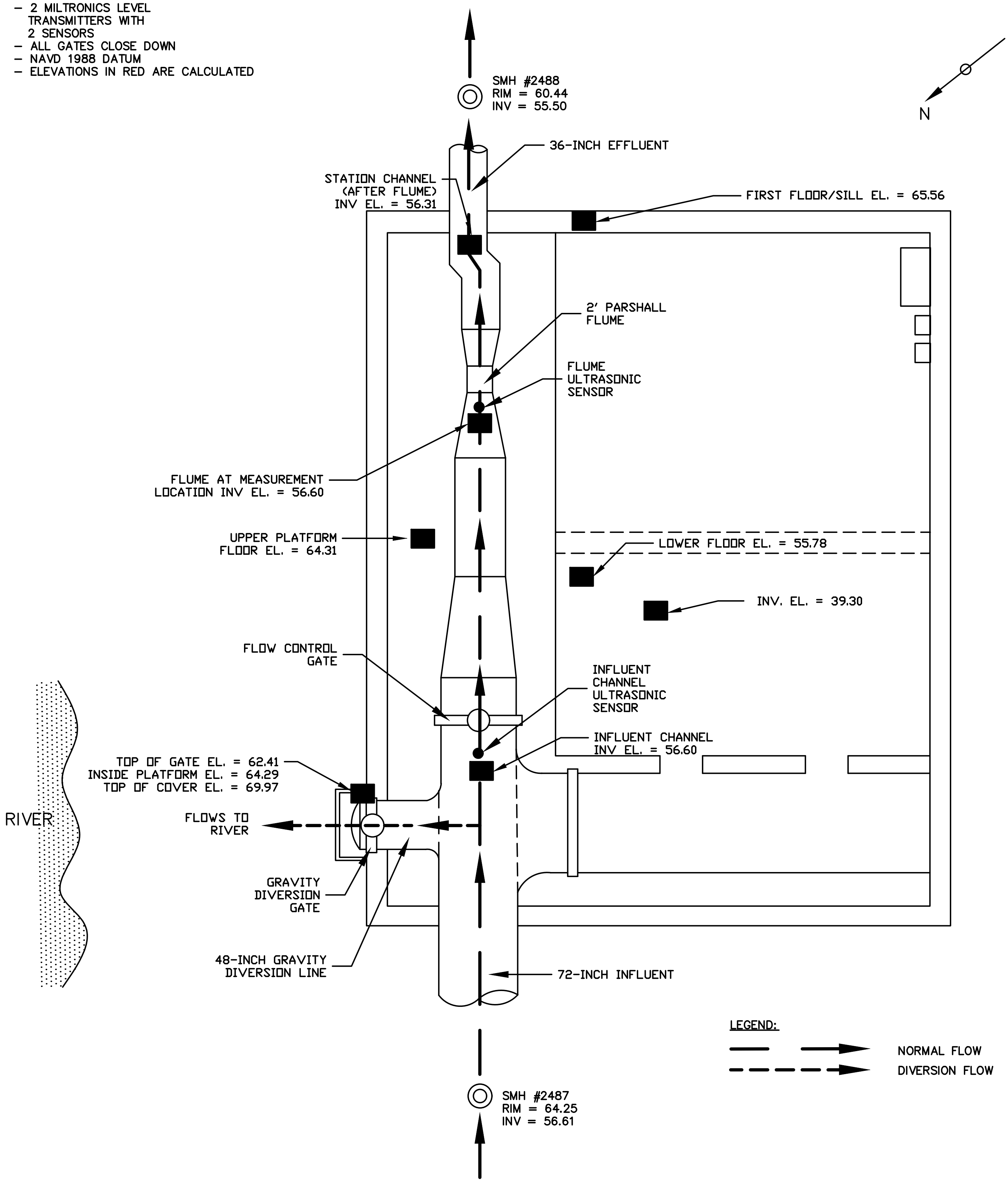
MERRIMACK RIVER DIVERSION STATION

JOB NO.:

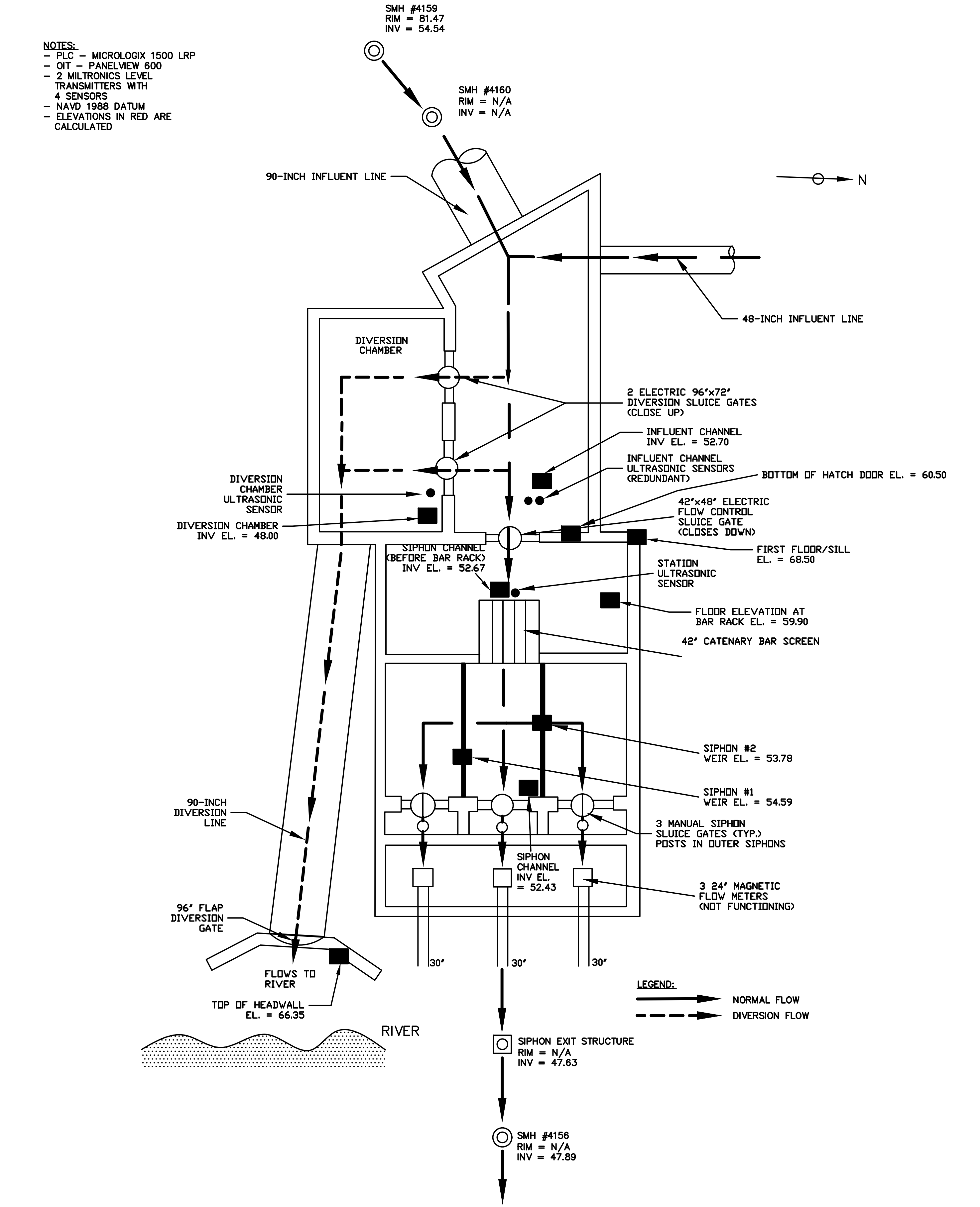
DATE: 4/25/2023

SCALE: NOT TO SCALE

NOTES:
- PLC – SLC 5/03
- OIT – PANELVIEW 600
- 2 MILTRONICS LEVEL TRANSMITTERS WITH 2 SENSORS
- ALL GATES CLOSE DOWN
- NAVD 1988 DATUM
- ELEVATIONS IN RED ARE CALCULATED



LOWELL REGIONAL WASTEWATER UTILITY	REV	DESCRIPTION	DATE	**TILDEN STREET DIVERSION STATION**	JOB NO.:
	REV-2	UPDATED FOR HFMP	APR 25, 2023		DATE: 4/25/2023
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009		SCALE: NOT TO SCALE
	DESIGNED BY: AF, CH		APPROVED BY:		SHEET: 1 of 1
	DRAWN BY: DP		REVIEWED BY: EW		



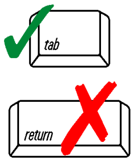
LOWELL REGIONAL WASTEWATER UTILITY	REV	DESCRIPTION	DATE	WARREN STREET DIVERSION STATION	JOB NO.:
	REV-2	UPDATED FOR HFMP	APR 25, 2023		DATE: 4/25/2023
	REV-1	SUBMITTED FOR REVIEW	SEPT 9, 2009		SCALE: NOT TO SCALE
	DESIGNED BY: AF, CH	APPROVED BY:			
	DRAWN BY: DP	REVIEWED BY: EW			SHEET: 1 of 1

Appendix E
CSO Notification Plan

Massachusetts Department of Environmental Protection
Bureau of Water Resources – Wastewater Management Program
Combined Sewer Overflow Final Public Notification Plan

1. Facility Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



Lowell Regional Wastewater Utility
Name of Permittee (Facility or System)

Aaron Fox	afox@lowellma.gov	978-674-1604
Permittee Contact Name	Email Address	Phone number

451 First Street Blvd, Lowell, MA 01850
Permittee Mailing Address

MA0100633
NPDES Permit #

System contains (check all that apply):

☒ Collection system ☒ Pump station(s) above 1MGD ☒ Wastewater treatment plant

Location of WWTP discharge, if applicable: See attached plan

☒ **Attach** a map with locations of discharges and affected waterbodies. Include other supporting information as needed.

2. Identification of Environmental Justice Populations

Are there Environmental Justice (EJ) populations that would potentially be affected by your wastewater treatment plant discharge(s) or a combined sewer overflow? See the Instructions file for more detail. ☒ Yes ☐ No

If there are EJ populations that would potentially be affected, do 25% or more of households lack English-language proficiency, and at least 5% of the population self-identify as "do not speak English very well"? See the Instructions file for more detail. ☒ Yes ☐ No

Provide a list of all languages that notifications will be translated into:

Spanish, Portuguese, Cambodian

Attach a description of how translations of public advisory notification and signage required by these regulations will be provided to EJ populations in the languages listed above. Include:

- ☒ A description of the third party or internal resource used to produce the translations
- ☒ A description of how the translation will be accessed by a public advisory notification recipient
- ☒ A description of how the translation will be accessed by someone reading the signage at CSO outfalls and public access points

3. Discharges, Overflows, and Public Notification Content

When public notification is required: (check box to affirm)

☒ Permittee is aware that all events covered under 314 CMR 16.03(1)(a-e) require a public notification.

Required content of public notification: (check box to affirm)

☒ Permittee is aware of all required information for public notifications under 314 CMR 16.04(10)

Attach a description of how the permittee will meet the requirements under 314 CMR 16.04(10), including the following:

- ☒ How the permittee will determine or discover that an event has occurred
- ☒ How the permittee will estimate the volume of discharges or overflows
- ☒ How the permittee will estimate the commencement times, cessation times, and duration of discharges or overflows
- ☒ A list of the waters and land areas affected by the permittee's discharges or overflows

Permittee can meet all requirements of 314 CMR 16.04(10) ☒ Yes ☐ No

If no, please describe in detail which components the permittee is not able to meet and the measures needed to comply. Include a schedule for compliance.

Components that cannot be met

Schedule for compliance

4. Discovery and Required Timeline for Notification Following Discharge or Overflow

Requesting approval of an alternative method:

Is the permittee requesting approval to use a method other than metering to detect a discharge? (Requires approval of MassDEP Commissioner) ☐ Yes ☒ No

- ☐ If yes, **attach** additional information on the method to detect a discharge
- ☐ If yes, **attach** a letter to the Commissioner with the approval request

Discovery of a Discharge or Overflow:

☒ **Attach** a description of the steps the permittee will take to determine or discover that a discharge or overflow from its outfall or sewer system is occurring

Can the permittee discover an event under 314 CMR 16.04(5)(a), (b) & (c) within the required timeline? ☒ Yes ☐ No

- ☐ If no, **attach** a description specifying the limitations to meeting these requirements and potential remedies. Include and a schedule for implementing potential remedies.

Issuance of Public Notification:

Permittee can meet the notification requirements in 314 CMR 16.04(4) to notify as soon as possible, but no later than two hours after discovery. ☒ Yes ☐ No

- ☐ If no, **attach** a description specifying the limitations, potential remedies, and a schedule for implementing potential remedies.
- ☐ If no, **attach** a letter to the Commissioner requesting approval for a longer time period for notification.

Continuation of Public Notification:

Permittee can meet the notification requirements in 314 CMR 16.04(7) to issue an update 8 hours after the public advisory notification, if the initial notification does not indicate that the event has ceased. ☒ Yes ☐ No

☐ If no, **attach** a description of which requirement cannot be met, what measures are needed for compliance, and a schedule for compliance.

Cessation of Public Notification:

Permittee can meet the notification requirements in 314 CMR 16.04(8) to continue issuing 8 hour updates for ongoing events, and notify within 2 hours of when the event ceases or is projected to cease. ☒ Yes ☐ No

☐ If no, **attach** a description of which requirement cannot be met, what measures are needed for compliance, and a schedule for compliance.

Retraction of Public Notification:

Permittee can meet the notification requirements in 314 CMR 16.04(9) to issue a retraction if the permittee becomes aware within 48 hours of issuing the public advisory notification that no discharge or overflow actually occurred. ☒ Yes ☐ No

☐ If no, **attach** a description of which requirement cannot be met, what measures are needed for compliance, and a schedule for compliance.

5. CSO Permittee Website

Does the permittee/sewer authority have an existing website or web page where relevant information is posted? ☒ Yes ☐ No

If yes, provide the URL:

https://www.lowellma.gov/637/Wastewater-Utility

Describe the subscriber-based system where the public can sign up to receive your notifications.

See attached plan

Permittee's website is able to meet the requirements under 314 CMR 16.04(3) ☒ Yes ☐ No

Permittee's website is able to meet the requirements under 314 CMR 16.05(1)(a-e) ☒ Yes ☐ No

If any website requirements can not be met, specify limitations to meeting these requirements, potential remedies, and a schedule for compliance:

☒ **Attach** a description of how the Permittee will update the website with requirements under 314 CMR 16.04(3) and 314 CMR 16.05(1)(a-e)

6. Signage

Permittee has consulted with the Board of Health/Health Departments in municipalities affected by their discharges for public access sign location points as required by 314 CMR 16.05(3)? ☒ Yes ☐ No

☒ **Attach** a list of locations where signs will be installed and dates when signs will be installed.

Permittee is able to meet the signage requirements under 314 CMR 16.05(2)? ☒ Yes ☐ No

If no, specify limitations to meeting these requirements, potential remedies, and a schedule for compliance:

Permittee is able to meet the signage requirements under 314 CMR 16.05(3)? ☒ Yes ☐ No

If no, specify limitations to meeting these requirements, potential remedies, and a schedule for compliance:

7. Public Notification Recipients

Media Outlets

List the two media outlets serving the area near the discharge or outfall that the permittee will contact to provide a public notification. Include name of organization, name of contact, and contact's email address or fax number.

The Lowell Sun: Alana Melanson amelanson@lowellsun.com

Name of media outlet #1

Boston Herald: Meghan Ottolini Meghan.Ottolini@bostonherald.com

Name of media outlet #2

If permittee has determined that an EJ population could potentially be affected by a discharge or overflow, which of these media outlets serves the EJ population? If neither does, then provide at least one additional news organization that primarily serves the EJ population(s) within the impacted municipalities. (Include name of organization, name of contact, and contact's email address or fax number.)

Spanish: El Planeta, editor@elplaneta.com; Portuguese: Brazilian Times, Liliane Paiva lilianenyc@gmail.com; Cambodian: TBD

Name of additional media outlet serving EJ population if neither media outlet above serves EJ population

☒ **Attach** a description explaining how the identified media outlets serve potentially affected EJ populations.

See Instructions for list of **Required Public Notification Recipients** (314 CMR 16.04(4)(a)).

☒ **Attach** a list of your required contacts.

8. Detection method maintenance

If metering is used, will the Permittee perform the requirements in 314 CMR 16.06(2)(b) below?

Calibrate metering equipment on an annual basis, at minimum ☒ Yes ☐ No

Properly maintain metering equipment ☒ Yes ☐ No

If models are used and approved, will the Permittee perform the following requirements in 314 CMR 16.06(2)(d) below?

Review and update the model input data as needed	☐ Yes	☐ No
Maintain any data collection equipment providing critical input to the model	☐ Yes	☐ No
Assess model predictions annually, at a minimum	☐ Yes	☐ No
Provide a description of actions taken in writing on or before March 1st of each year	☐ Yes	☐ No

9. Public Notice

Submit a public notice to the Environmental Monitor at the same time this plan is submitted to MassDEP. Indicate below that the permittee will submit the public notice as follows:

■ Email the public notice to MEPA@mass.gov at the same time the plan is submitted to MassDEP

■ Include in the body of the email, "Please publish the attached public notice as 'Notice of Combined Sewer Overflow (CSO) Final Public Notification Plan.'"

■ Attach the public notice to the email as a PDF

■ Permittee will place a public notice in at least one media outlet that serves the EJ population(s) in the municipalities impacted by the discharge. Indicate media outlet(s) below:

The Lowell Sun

Include the following in the Public Notice, required under 314 CMR 16.06(2):

■ A statement that a CSO Public Notification Plan has been prepared and submitted to the Department

■ A link to a website where an interested party can review the plan

■ A statement that written comments on the plan can be submitted to MassDEP and the permittee for a period of 30 days after the date of publication in the Environmental Monitor or media outlet, whichever date is later. Explicitly list the end date for submission of public comments

■ Translations of the Public Notice in languages most appropriate for neighborhoods within the impacted municipalities that are identified as environmental justice populations due to lacking English language proficiency

Certification

I attest that I have examined and am familiar with the information contained in this submittal, including any and all documents accompanying this certifying statement. The information contained in this submittal is, to the best of my knowledge, true, accurate, and complete. I am fully authorized to make this attestation on behalf of the facility.

Aaron Fox	Operations Manager
Print Name	Title
	1/11/2023
Signature	Date

January 12, 2023

Lowell Preliminary Public Notification Plan

Executive Summary

The City of Lowell (Lowell) has developed this Public Notification Plan pursuant to the requirements stated in Massachusetts Regulation 314 CMR 16. As a city that historically contained a Combined Sewer infrastructure, Lowell has made concerted efforts over the years to mitigate and control Combined Sewer Overflows (CSOs) and continues to do so as investments are made in its wastewater and stormwater infrastructure. This Plan outlines public notification protocols which will comply with the regulatory requirements.

Lowell is collaborating with various stakeholders on the Merrimack including: downstream municipalities, regional organizations, Boards of Health, and other wastewater utilities. Lowell's plan was created to meet the requirements of the CMR while ensuring consistent messaging from and to all parties on the Merrimack. Lowell has also engaged with an engineering consultant to support both the draft submission in May 2022, as well as the final submission due in January 2023.

Section 1: Permittee and System Information

Lowell Wastewater's sewer system consists of approximately 220 miles of gravity sewers and 14 sewage pumping stations. Ten miles of large-diameter (48-inch to 120-inch) interceptors located along the banks of the Merrimack and Concord Rivers collect wastewater from the sewer system and convey it to the Wastewater Treatment Plant. The treatment plant was designed to provide biological treatment for an average flow of 32 million gallons per day (MGD), with a short-term peak full treatment capacity of 62 MGD.

Lowell Wastewater manages a Supervisory Control and Data Acquisition (SCADA) network, which allows operators to remotely monitor and control gates, valves, and pumps directly from the Operations Center at Duck Island. In addition to equipment at Duck Island, remote monitoring and control was enabled at nine active CSO diversion stations along the interceptor system that discharge into the Merrimack River, Concord River, and Beaver Brook (See Table 1 & Figure 1).

Table 1: Permitted Outfall Locations

Outfall #	Name	Latitude	Longitude	Receiving Water
002-SDS#1	Walker Station	42.64621	-71.33407	Merrimack River
007-SDS#2	Beaver Brook	42.65933	-71.31925	Beaver Brook
008-SDS#3	West Station	42.65254	-71.31032	Merrimack River
011-SDS#4	Read Station	42.64822	-71.30111	Merrimack River
012-SDS#5	First Street	42.64756	-71.29086	Merrimack River
020-SDS#6	Warren Station	42.64277	-71.30502	Concord River
027-SDS#7	Tilden Station	42.65072	-71.31152	Merrimack River
030(1)-SDS#8	Barasford Station	42.64531	-71.28841	Merrimack River
030(2)	Merrimack Station	42.64518	-71.28881	Merrimack River

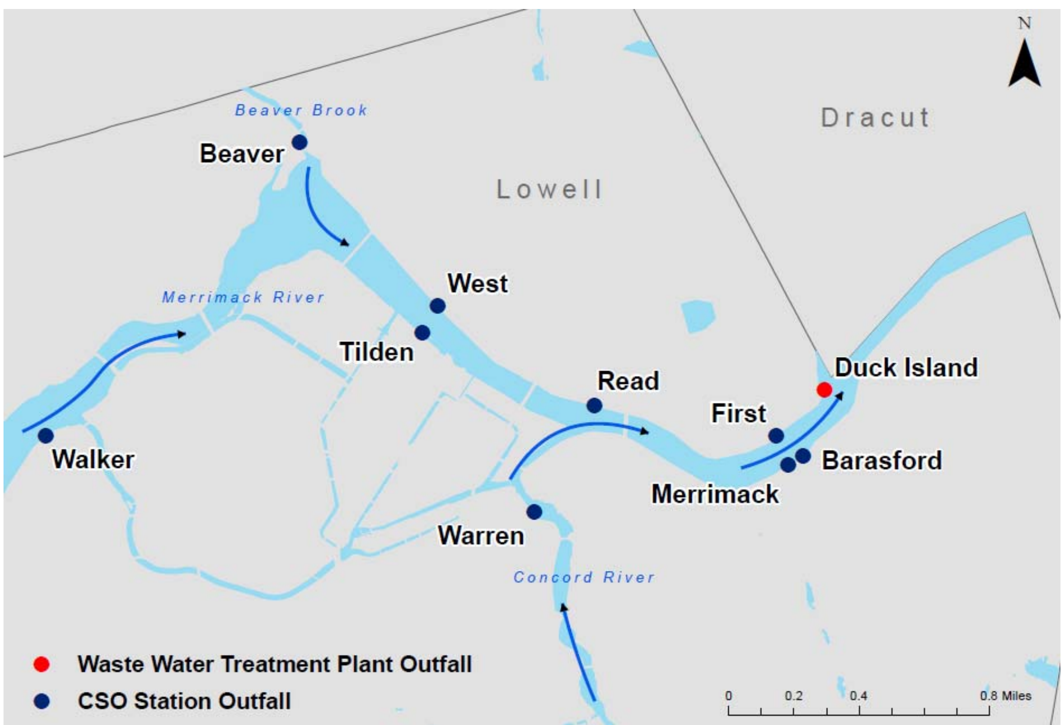


Figure 1: Lowell CSO Diversion Locations

Section 2: Identification of Environmental Justice Populations

Identification of Environmental Justice Populations

Lowell is engaged with a consultant to determine the affected area from a CSO discharge event. The affected area was determined by an analysis of river flow during wet weather, CSO discharge and pathogen concentrations. Historical flow and rainfall data were used to determine the typical river flow conditions during CSO activation to estimate the extent of downstream impact. The affected area for combined sewer overflows was determined to extend to approximately 12.3 miles beyond the Lowell Regional Wastewater Utility outfall to Wingate Avenue in Methuen, MA. This includes the following municipalities downstream of Lowell: Dracut, Tewksbury, Andover, Lawrence, and Methuen (Figure 2). Affected area for blended wastewater and SSO events was determined to be 591 feet and 222 feet beyond the outfall respectively. An explanation of the calculation of the affected area is included in Attachment A.

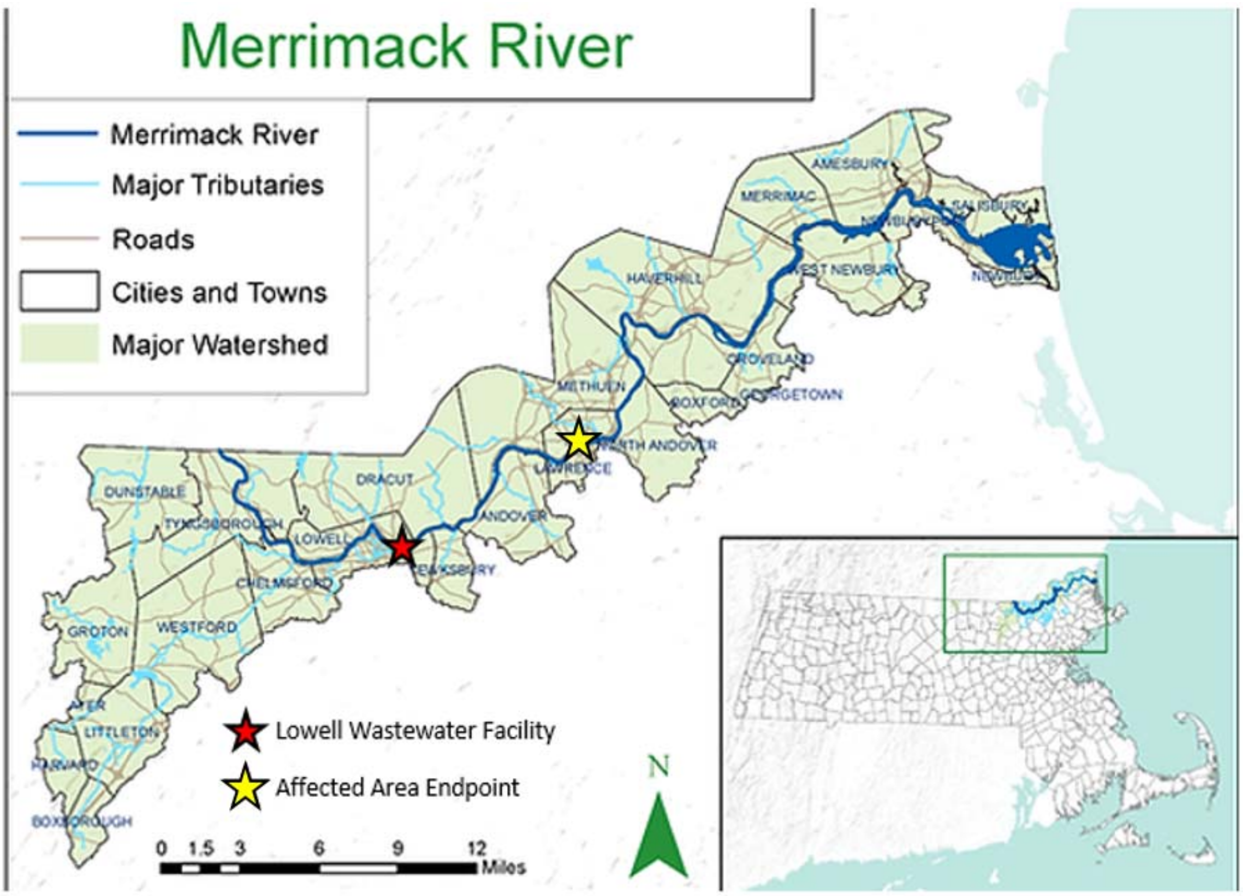


Figure 2: Communities on the Merrimack River (Source: Massachusetts River Alliance)

Downstream municipalities that have 25 percent or more households that lack English language proficiency were identified using the list of 2020 Environmental Justice populations from mass.gov. Municipalities that are designated as meeting the above threshold were denoted with an "E" on that list and include Lowell, Lawrence, and Methuen. Data from the 2015 census depicting languages spoken by 5% or more of the population that self-identify as "do not speak English very well" was provided through the Massachusetts Executive Office of Energy and Environment Affairs (EOEEA). Using the map shown in Figure 3, Lowell identified the following languages meeting that criteria in the three identified communities: Spanish or Spanish Creole, Portuguese or Portuguese Creole, and MonKhmer/Cambodian

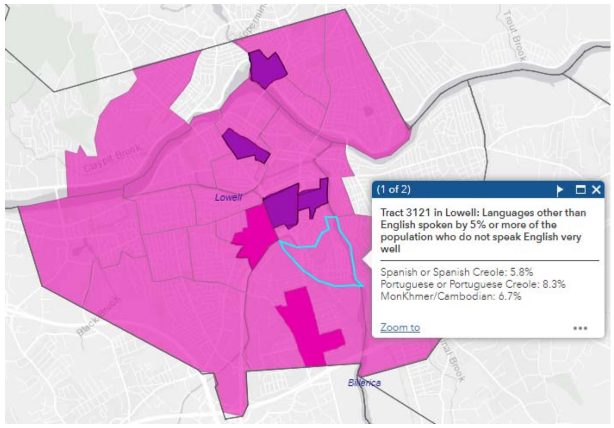


Figure 3: Languages identified in Lowell where 5% of the population has speakers who self-identify as "do not speak English well"

Required Translation: Public Advisory Notification Translation

Lowell will be distributing public notifications through a third party vendor. The vendor software allows for the public to choose their preferred language for public advisory notifications.

Required Translation: Signage Translation

Permanent signage posted will include a QR code which will link to Lowell's website providing translations through Google Translate. The translation widget covers all three languages identified above, in addition to over 100 other languages. The Google Translate widget is located on the bottom right of the website, and works when viewing the website through a mobile device or desktop computer (Figure 4).

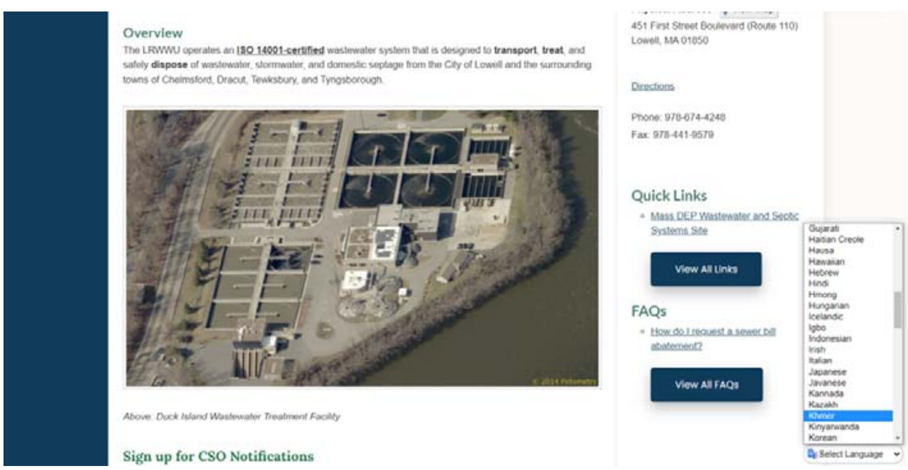


Figure 4: Lowell website translation through Google Translate

Required Translation: News organization that primarily serves the environmental justice population

The two largest news organizations in the area, the Boston Herald and Lowell Sun, do not serve the Environmental Justice populations stated above. Lowell has identified alternative news organizations that serve the Portuguese (Brazilian Times) and Spanish (El Planeta) population. These two new originations will be included in the distribution list for notifications. As of now, a Cambodian news organization has not been identified. As part of the “Frequently Asked Questions on 314 CMR 16.00” MassDEP stated they will share a list of alternative media outlets once complete. When an official news outlet for this Environmental Justice population is found, Lowell will update and add the Cambodian news outlet to the distribution list.

Section 3: Discharges, Overflows, and Public Notification

Lowell is aware of all requirements covered under 314 CMR 16.03(1)(a-e) that necessitate a public advisory notification, and of the required information to be included in the public notifications under 314 CMR 16.04(10). Lowell can meet all the requirements listed in 16.04(10).

The Lowell Wastewater Treatment Plant (Duck Island) is staffed year round 24-hours a day by both a Grade 6 Certified Head Operator and an operator, at a minimum. Lowell utilizes electronic instruments at all CSO stations for the direct measurement/metering of CSO information. The calculations are automated via Lowell’s SCADA system. Lowell’s SCADA system provides real-time alerts for discharges, which are continuously monitored by a Head Operator who confirms the overflow prior to initiating public notification. Lowell utilizes Hach Water Information Management Solution (Hach WIMS) as well as additional reporting technologies to aid in data validation of recent high flow events.

In addition to a 24-hour operation staff, the Collection System Supervisor is on call 24 hours a day with multiple employees designated as backups. When Lowell is notified of a possible sanitary sewer overflow (SSO), an employee visits the site to inspect the incident and determine if the overflow impacted a public waterway. If a public waterway is impacted, a public advisory notification will be issued.

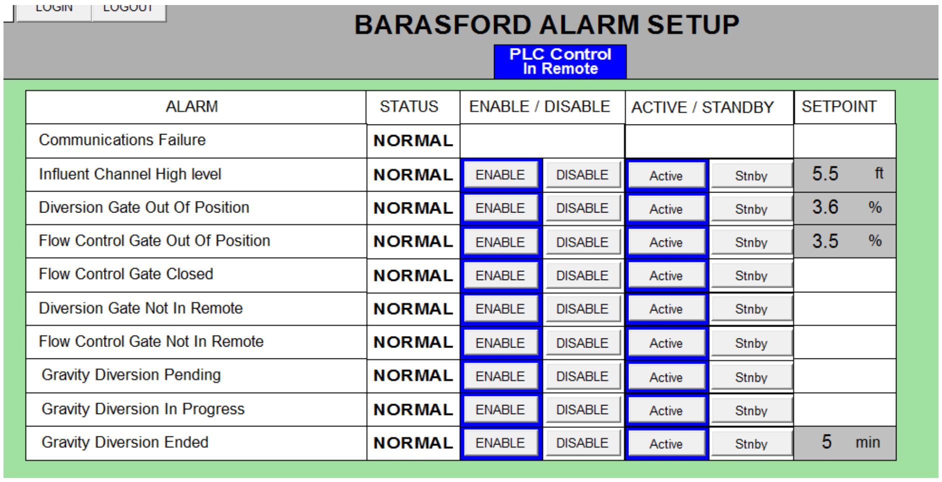
Below is a list of all of the information that is required to be in the public advisory notification in accordance with 314 CMR 16.04 (10), followed by the Lowell’s plan to meet each of the regulations:

(a) Description of discharge or overflow location(s), and outfall number(s), if applicable

- Active discharge locations are determined using direct monitoring at the CSO stations and instantaneously communicated to the Head Operator on duty by a SCADA alarm. The public notification will include Table 1 with an additional column indicating if the station is active or inactive.
- Partially treated events are discharged through Duck Island’s permitted outfall, serial number 035.
- A description of all reportable SSOs will include the closest street address as well as name and location of any body of water that the SSO impacts.

(b) Approximate date and time the discharge or overflow began, and its duration

- Active discharge locations are determined using direct monitoring at each CSO station and instantaneously communicated to the Head Operator on duty by a SCADA alarm. See Figure 5 for an example of alarms for a diversion station. The SCADA system will timestamp when the “…Diversion in Progress” alarm begins and when the “….Diversion Ended” alarm triggers for each CSO station (See Figure 6). The SCADA system will then calculate the duration based on time between these alarms and display it for the Head Operators to record.



LOGIN LOGOUT

BARASFORD ALARM SETUP

PLC Control In Remote

ALARM	STATUS	ENABLE / DISABLE		ACTIVE / STANDBY		SETPOINT
Communications Failure	NORMAL					
Influent Channel High level	NORMAL	ENABLE	DISABLE	Active	Stnby	5.5 ft
Diversion Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.6 %
Flow Control Gate Out Of Position	NORMAL	ENABLE	DISABLE	Active	Stnby	3.5 %
Flow Control Gate Closed	NORMAL	ENABLE	DISABLE	Active	Stnby	
Diversion Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Flow Control Gate Not In Remote	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Pending	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion In Progress	NORMAL	ENABLE	DISABLE	Active	Stnby	
Gravity Diversion Ended	NORMAL	ENABLE	DISABLE	Active	Stnby	5 min

Figure 5: Barasford Alarm Screen

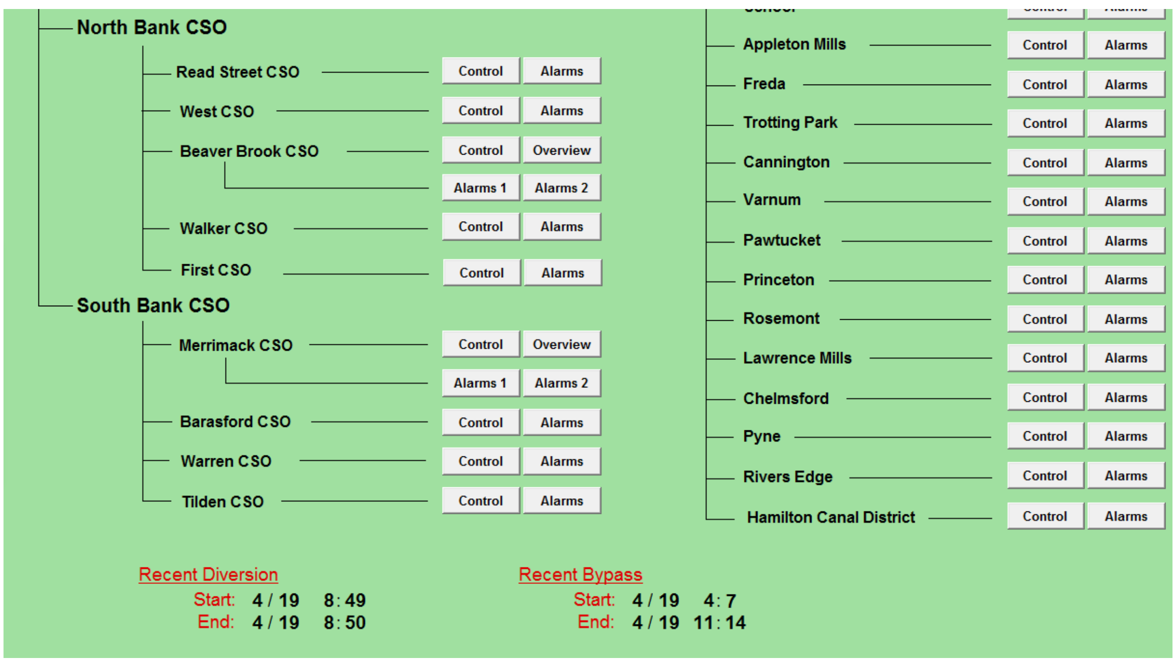


Figure 6: Diversion and Bypass Timestamps

- Partially treated status is determined via SCADA alarms as described in 16.04(10)(b) for CSO alarms.
- Lowell actively maintains six level sensors deployed at areas with reported reoccurring overflows. These level sensors measure and collect level profiles over user-specified time intervals across an established deployment period. In the event that an SSO occurs in one of the deployed areas these level sensors can be used to get an estimate of time, duration and volume of the SSO. Sensors are moved to additional areas when investigation is required. At the time of plan development the sensors are located in the marked areas in the following picture (Figure 7).

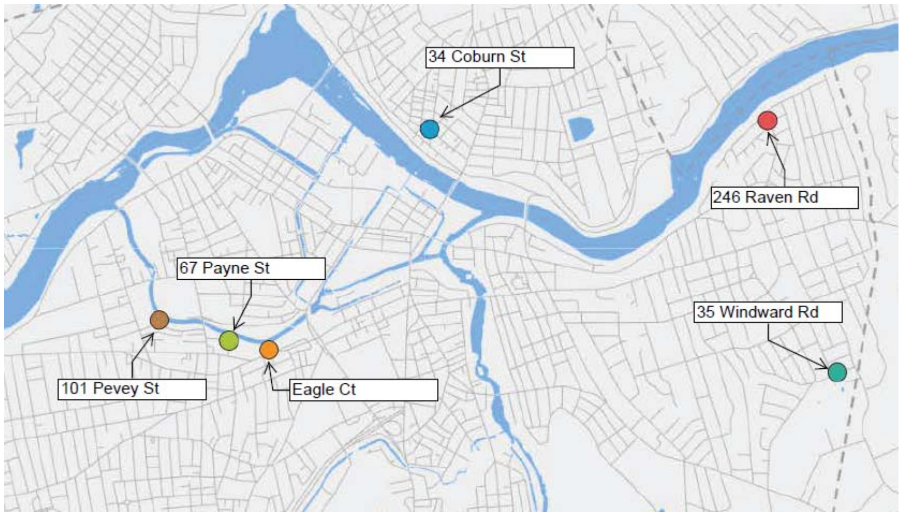


Figure 7: Collection system level sensor locations

- In the event that an SSO occurs where a level sensors is not deployed, notification of an SSO would rely on citizen or employee notification. This notification can occur via a phone call to the facility or through an online citizen reporting portal on the Lowell website. Lowell will follow up with a site visit to the location within 4 hours to confirm the event and determine the impact of the overflow. The employee responding to the event will notify the Head Operator on duty if a public advisory notification needs to be sent with the relevant information.

(c) Estimated volume of the discharge or overflow will be determined based on the average discharge or overflow from data reported to the Department and/or EPA for the prior three calendar years, taking into consideration historical information for the projected rainfall event, if possible.

- Estimated volume of the discharge for each discharge is determined by taking the median discharge volume for each discharge event that occurred in the three previous calendar years. See Attachment B for an example calculation.

(d) Identity of the permittee

- Lowell Wastewater will identify itself by name and permit number, MA0100633, in all public notifications.

(e) Whether, at the time of notification, the discharge or overflow has ceased, and if so, the approximate time and date that the discharge or overflow ended

- Lowell Wastewater continuously monitors all permitted CSO stations and outfalls through the SCADA network. A "…Diversion Ended" alarm will trigger for each CSO station when the gates have fully closed or the level is below the weir. The time of the event has ceased for each CSO station will be timestamped for the Head Operator to record on the public advisory notification. (Figure 6)
- Partially treated status is determined via SCADA alarms as described in 16.04(10)(e) for CSO alarms.
- SSO discharges cessation are determined using the best available resources. If a location has level sensors, that data is utilized to determine when the discharge ended. If no level sensor is present, employee investigation will be used.

(f) Waters and land areas, including names of water bodies and municipalities, affected or potentially affected by the discharge or overflow

- All CSO outfalls discharge to either the Merrimack River, Concord River, or Beaver Brook. Affected area calculation determines that the discharge is affective to Wingate Avenue in Methuen, MA.
- Table 1 will be included in the CSO discharge public advisory notifications which show water bodies that are impacted by the event.

(g) Precautionary measures to be taken by the public, including the following language: “Avoid contact with these water bodies for 48 hours after the discharge or overflow ceases due to increased health risks from bacteria and other pollutants. See website for more information on whether specific resource areas, such as bathing beaches, are affected.”

- All public notifications will include the required precautionary language noted in 16.04(10)(g).

(h) Link to the permittee's website for additional information on discharges and overflows, and its CSO and/or SSO abatement program(s)

- A link to Lowell Wastewater’s website will be provided as part of all notification emails.

(i) A statement that the discharge or overflow consists, or likely consists, of untreated or partially treated sewage and waste.

- A notification for partially treated events will be issued for all notifications from Outfall Serial Number 035. All other events, needing notification, will be considered untreated.

Section 4: Discovery and Required Timeline for Notification

Discovery and Notification of CSO Discharges

As mentioned in previous sections, an advanced SCADA network was established throughout Lowell's collection system, providing operating personnel at Duck Island with an active and continuous view of the flow and capacity within the system. Active flow and level depth monitoring is gathered through direct metering at Lowell's regulated CSO Stations. Programmed to follow Lowell's High Flow Management (HFM) Protocol logic, when the SCADA network detects insufficient available capacity based on set points within the collection system, automated commands to discharge at one or more of these relief points are performed, triggering an alarm notification in the process.

The CSO alarm notification serves as the official notice for the Head Operator to confirm that an active discharge is occurring within the collection system. Upon discovery, the Head Operator will send out a public notification within two hours. While the SCADA alarm serves as an accurate and reliable discovery method of a CSO discharge, in the event of any uncertainty regarding the legitimacy of a discharge alarm, the Head Operator will review station level and CSO measurement trends to verify the event prior to sending out CSO notification.

Within two hours of discovery of a CSO discharge, appropriate Lowell personnel shall issue a public advisory notification that meets the information specified within 314 CMR 16.04(10). Public advisory notifications shall be issued electronically to the appropriate entities specified within 314 CMR 16.04(4). In the event that CSO discharges occur at multiple CSO outfalls, Lowell will issue a combined public advisory notification.

Lowell is equipped to send out additional public notifications eight hours later. An alarm will trigger seven hours after the start of the event alerting the Head Operator to send an eight hour updated public advisory notification. The following information will be included:

- *Indication as to whether a discharge or overflow is ongoing or has ceased.*
  - Lowell will follow the same method described in Section 3 under the response for 314 CMR 16.04 (10)(b).
- *If it has ceased, indication of the approximate time of cessation*
  - Lowell will follow the same method described in Section 3 under the response for 314 CMR 16.04 (10)(b).
- *Any updated information that has changed since the initial public advisory notification.*
  - The Head Operator will note any corrections/errors in the notification.
- *Shall be issued to all parties required to receive notifications under 314 CMR 16.04(4).*
  - The public advisory notification will be sent to all required recipients and all members that are signed up for notifications.

Lowell is capable of updating the city website with information on high flow events by the end of the next business day after the event has ceased. Prior to posting to the website all volumes, durations, and start times are reviewed by the engineering team and thus Lowell does not have the staff on site to post to the website 24 hours a day. Permission to delay posting to website until next business day was noted in MassDEP documentation accompanying the 314 CMR 16.00 regulation. Lowell's business hours are 7 am to 3 pm, Monday through Friday.

Discovery and Notification of SSO Discharges or Overflows

Sanitary Sewer Overflows (SSOs) occur infrequently in Lowell's collection system, and are predominantly constrained to known problem areas. SSOs are typically discovered in one of two ways: through citizen reporting and level monitoring.

Citizens are able to notify the Utility and report observed issues by using the CivicReady electronic messaging system, hosted on Lowell Wastewater's website, and/or calling the Utility. Areas with known reoccurring SSOs are actively monitored via the deployment of a collection of six level sensors just upstream of the areas of concern. These level sensors measure and collect level profiles over user-specified time intervals across an established deployment period. Data collected from these sensors is transmitted to an online viewing portal. Text and email alerts are set such that an alert notification is sent out in real time when a level threshold is breached.

The alert notification will be relayed to an on-call staff, who will visit the area of concern to inspect the reported overflow. The staff member shall determine whether the overflow occurred based on the results of the inspection. Any confirmed SSO shall be considered "discovered" upon completion of this inspection.

In the event that an SSO discharge or overflow has been determined to flow into a surface water, the staff member onsite will relay the information to the Head Operator on duty. The Head Operator will send a notification with the relevant information specified by 314 CMR 16.03(1)(c) through (e). The public advisory notification shall be issued within four hours of discovery.

Discovery and Notification of Partially Treated Wastewater

During high flow events, Lowell maximizes flow through the facility through a secondary bypass. Lowell utilizes a SCADA network which notifies operators of increased flows and the need for secondary treatment bypass. The bypass gates open once the flow exceeds the bypass start set point, starting the bypass event. When flows reach this point, the Head Operator receives an alarm. The SCADA system controls the bypass gates to maximize flow. The bypass gates close once the flow can be fully treated ending the event. (See Figure 8). The times the bypass started and ended are timestamped on a SCADA screen (See Figure 4).

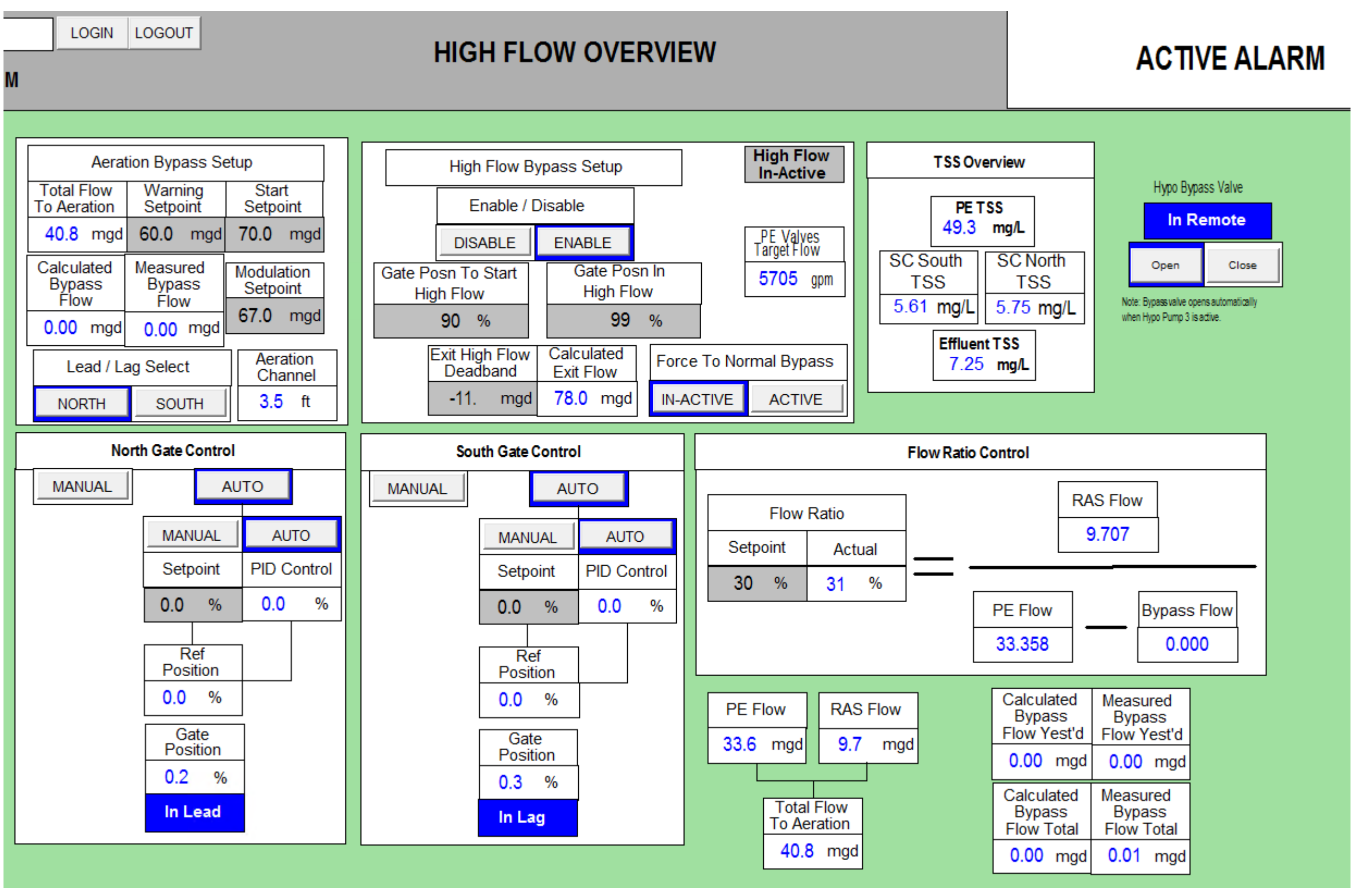


Figure 8: Lowell's High Flow Overview SCADA Screen

Lowell uses a combination of SCADA and Hach WIMS to determine and record the duration and volume of bypass; additional reporting technologies are used to initiate public notification within two hours.

See the "Discovery and Notification of CSO Discharges" in Section 4 for eight hour notification details.

Cessation of Public Notification

Once an event is complete, whether it be a CSO or partially treated event, the Head Operator is notified of the cessation of the event by SCADA alarms. After receiving an alarm that the discharge has ended, the Head Operator will verify the event has ceased. Approximate time that the discharge ceases is recorded in SCADA and can be reported in the eight hour public advisory notification.

Retraction of Public Notification

If at any time after the public notification is sent a staff member determines that the discharge did not occur, then a retraction email will be sent to the full distribution list. Operations staff utilize the SCADA system to determine active discharges by utilizing alarms and data trends. Lowell engineering staff will review the data from the most recent discharge to determine the validity of the data. This review process involves comparing data from multiple different flow meters, rain gages, and SCADA set points to determine if the discharge followed standard protocols and if the data aligns with what would be expected for that high flow event. In the event that previously reported discharge data is inaccurate a retraction notification will be issued.

Section 5:CSO Permittee Website

In accordance with 314 CMR 16.04(3) Lowell shall establish and maintain a public website to post public advisory notifications. Notifications will be uploaded to the website as discussed in Section 4. Along with the notifications, information on CSO and high flow treatment can be found on the Lowell's website. Records from past high flow treatment events, dating back three calendar years, can be found on the Lowell's website uploaded on a monthly basis. Lowell's website includes pages explaining the treatment process as well as high flow treatment procedures.

The website will include links to websites providing information on the closure or advisory status of shellfish growing areas, bathing beaches, or other water resource areas potentially affected by the discharge or overflow.

In accordance with 314 CMR 16.05(1) Lowell's High Flow management webpage will include the following pieces of information:

(a) A map showing Lowell's nine permitted CSO outfall locations as well as a table noting the corresponding outfall numbers
- Table 1 and Figure 1 are located on the website under the wastewater combined sewer overflow page (www.lowellma.gov/1287/Combined-Sewer-Overflows-CSO).

(b) A summary of the Lowell's Long-term CSO Control Plan, and status of its implementation
- Lowell will add a Long Term Control Plan to the website when it has been approved. The website will include a summary of the approved plan, with updates to this section of the website done on a yearly basis and/or when a major milestone occurs.
- Once approve, the Long Term Control Plan can be found in the following location: www.lowellma.gov/1076

(c) Instructions on how an interested person can subscribe to receive public advisory notifications
- Interested individuals may subscribe to Lowell's notification list by filling out a Notification Request on Lowell's website (www.lowellma.gov/1287/Combined-Sewer-Overflows-CSO). Users will be redirected to a webpage to provide their primary contact information which will then be automatically added to the distribution list for all notifications.

(d) Links to any CSO Reports required to be developed in a NPDES for at least the preceding three calendar years
- CSO Reports are included within Lowell's Annual Report which will be posted to the website.

(e) A compilation of discharge data for each public advisory notification event, updated so that data for each month is posted within 15 days of the last day of the month. Data posted shall include updated information on the estimated duration, frequency and volume of the discharge, rainfall data, and treatment provided for any CSO discharges. The website shall include data for at least the preceding three calendar years, if applicable.
- All data in 16.05(1)(e) will be uploaded to the website by the 15th day of the month.
- Lowell Wastewater utilizes a SCADA system and Hach WIMS program to collect and analyze data on high flow, as well as other aspects of the treatment process. Reported discharges are reviewed prior to publishing to the website.

Section 6: Signage

In accordance with 314 CMR 16.05 (2), each CSO station and outfall will have at minimum one sign on or outside the station and one sign visible from the river or waterway in the vicinity of the CSO outfall. Signs will state the name of the station, the SDS number, and identify it as a diversion station and outfall for Lowell. These signs will be in English, but will also include universal symbols that express no fishing, boating, or swimming in the vicinity of the outfall. (Figure 9)

Figure 9: Outfall Sign for Walker Station

To accommodate regulation 314 CMR 16.05 (3), Lowell developed a sign utilizing MassDEP's template. The sign states that the location is downstream of a combined sewer outfall, and includes warning text and explains the dangers to the waterway during high flow events, as well as universal pictograms. A QR code and a URL are included to link to the Lowell's website for additional information and translations. Signs include a section that allows the Boards of Health to post temporary notices. Below is an example of the template design for the public access point sign (Figure 10).

Figure 10: Sign template for public access points

Once the plan and sign are approved, Lowell will ensure the signs are deployed to all required locations within three months of approval. Lowell will work with downstream communities on the deployment of signs not within the city of Lowell.

Lowell used the MassDEP CSOs and Beach/Boat Access map provided on their website as a base list in the determination of public access points within the affected area. Lowell contacted municipalities and boards of health members in all downstream communities within the affected area to confirm contact information and public access points. Table 2 depicts locations along the Merrimack River within the affected area.

Table 2: Public Access Locations

Municipality	Access Type	Access Name/Address	BOH Contact
Lowell	None	No Public Access Points	Lisa Golden lgolden@lowellma.gov
Dracut	None	No Public Access Points	Dave Ouellete douellette@dracutma.gov
Tewksbury	None	No Public Access Points	Shannon Gillis sgillis@tewksbury-ma.gov
Methuen	Fishing & Boating	Riverside Conservation Area 1110 Riverside Drive	Felix Zemel fzemel@ci.methuen.ma.us
Andover	Public Access	53 River Road (Behind Greater Lawrence Technical School)	Thomas Carbone Thomas.Carbone@andoverma.us
Lawrence	Fishing & Boating	Riley Park 57 Wolcott Avenue	Michael Armano MArmano@cityoflawrence.com

Section 7: Public Notification Recipients

In accordance with 314 CMR 16.04 the public advisory notification, and any updates required by 314 CMR 16.04(7) and (8), shall also be issued to at least the two largest news organizations which are The Lowell Sun and the Boston Herald for Lowell. Lowell will also serve the Environmental Justice populations through the news organizations mentioned in Section 2.

Lowell's public advisory notification, and any required updated notifications shall be issued electronically to the parties listed below. Additional recipients will be added to the distribution list upon request. All addresses noted below are based on active contact information at the time of publishing and are subject to change.

- Massachusetts Department of Environmental Protection; massdep.sewagenotification@mass.gov
- the U.S. Environmental Protection Agency; R1.EPANotifications@epa.gov; koopman.douglas@epa.gov
- the Massachusetts Department of Public Health; DPHToxicology@mass.gov
- the municipal board of health or the health department where the outfall or overflow is located; Lisa Golden, the director of Health and Human Services for the City of Lowell
- the board of health or the health department and shellfish constables (if applicable) for any municipality directly impacted by the discharge or overflow;
    - Lowell has reached out to all Boards of Health downstream of Lowell to update the contact list. All boards of health contacts, noted in Table 2, that have public access points along the Merrimack River, will be included in the distribution list.
- any person who subscribed to receive such public advisory notifications by email or text messaging;
    - Anyone from the public can be added to the distribution list via the Lowell Website: www.lowellma.gov/1287
- the public water supplier(s) where drinking water supplies may be affected;
    - Lowell has contact information for all drinking water suppliers that source their water from the Merrimack River and are downstream of Lowell. All drinking water facilities that fall within the affected area are included in the distribution list.
- the Massachusetts Division of Marine Fisheries where shellfish growing areas may be affected; jeff.kennedy@mass.gov
- the Massachusetts Department of Conservation and Recreation when its water recreation properties may be affected; MEMA.StateControl@mass.gov
- the Massachusetts Division of Fisheries and Wildlife when its boat ramps and fishing piers may be affected; doug.cameron@mass.gov
- Operators of any potentially affected bathing beaches, as defined in 105 CMR
    - There are no known bathing beach within the affected area of the Merrimack River.

Attachment A

MEMORANDUM

TO: Evan Walsh, Engineering Supervisor
City of Lowell

FROM: Peter Varga, Kleinfelder

DATE : 01/12/23

SUBJECT: Lowell Affected Area Calculation Methodology

CC: Aaron Fox, Gorden Bergeron
City of Lowell

BACKGROUND

The City of Lowell has submitted a Preliminary Public Notification Plan pursuant to the requirements stated in Massachusetts Law 314 CMR 16.06(1). As part of that Plan, the intent of this memorandum is to describe the methodology applied to calculating the affected area caused by Combined Sewer Overflow (CSO), treatment plant bypass, and Sanitary Sewer Overflow (SSO) discharges from the combined sewer system to the receiving water bodies, including the Merrimack River, the Concord River and Beaver Brook. The affected area can be defined as the downstream extent of contamination in pathogen concentrations still above the State water quality limit. The CSO Public Notification Plan for the City of Lowell requires that populations within any affected area downstream of a discharge be notified of the risks associated with the contaminant release into the receiving waters.

The Merrimack River is 117 miles long, has its headwaters in New Hampshire and flows southward into Massachusetts before traveling northeast, emptying into the Gulf of Maine at Newburyport, MA. Major communities that exist along the Merrimack River downstream of Lowell include Lawrence, Methuen, Haverhill, West Newbury, and Newburyport. For discharges to the Concord River and Beaver Brook, there are no downstream communities prior to the convergence of those water bodies to the Merrimack River. Using the methodology described below, estimates of affected area, particularly in reference to the communities along its length, can be made.

DATA COLLECTION

Grab Sampling. Grab sampling is used to characterize the pathogen concentration in the CSO discharge during overflow events, because of the short holding time requirement (6 hours) for pathogen samples. A grab sample is a discrete, individual sample collected over a maximum of 15 minutes. Grab samples represent the conditions at the time the sample is taken, and do not account for variations in quality throughout a storm event. Sampling is conducted using standard QA/QC protocols and procedures. Due to the large quantity of grab sample data from the

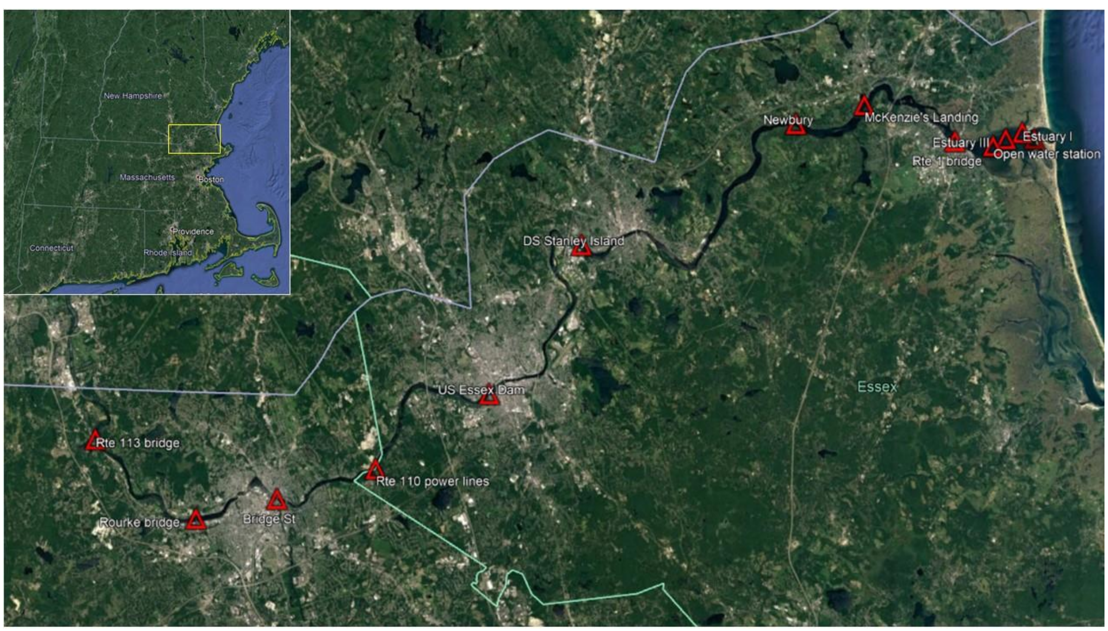
Massachusetts Water Resources Authority's (MWRA) CSOs, and the similarities between the two sewer systems, MWRA data is used in this affected area calculation. As Lowell collects more data on its CSOs it will eventually replace MWRA's data with its own to estimate concentrations in subsequent storm events. The table below summarizes Class B water statistical threshold values which is not to be exceeded by more than 10% of grab samples.

EPA bacteria standard for Class B Water – Statistical Threshold Value (STV)

E. Coli STV	410	cfu/100mL
Entero STV	130	cfu/100mL

Precipitation. Rainfall data is necessary to analyze the Combined Sewer System (CSS), calibrate and validate CSO models, and develop design conditions for predicting current and future CSOs. Rainfall data includes long-term rainfall records and data gathered at specific sites near the CSS. To ensure that data collection efforts are representative and conservative, events are selected for the affected area determination that displayed the highest ratio of CSO discharge volume to rainfall quantities.

Streamflow. Several U.S. Geological Survey (USGS) gaging stations exist along the Merrimack River. For determining the flow in the Merrimack River during each storm event, CSO release, and discharge, applicable published USGS gaging station data is used. Specifically, stream gages that are located at Manchester, Lowell, and Newburyport are analyzed as part of the affected area calculations.



[Location map of the Massachusetts section of the Merrimack River | U.S. Geological Survey (usgs.gov)]

CSO Discharge Data Collection. To measure discharge volumes, Lowell utilizes direct measurement/metering methodologies, in which electronic instruments are installed at all CSO locations. The calculations are automated via Lowell's Supervisory Control and Data Acquisitions (SCADA) system. Lowell's SCADA system provides real-time alerts for discharges which are continuously monitored by a Head Operator, who confirms the overflow prior to initiating public notification. Lowell utilizes HACH WIMS programming, as well as additional reporting technologies, to aid in the creation of reports of recent high flow events.

List of Key Parameters:

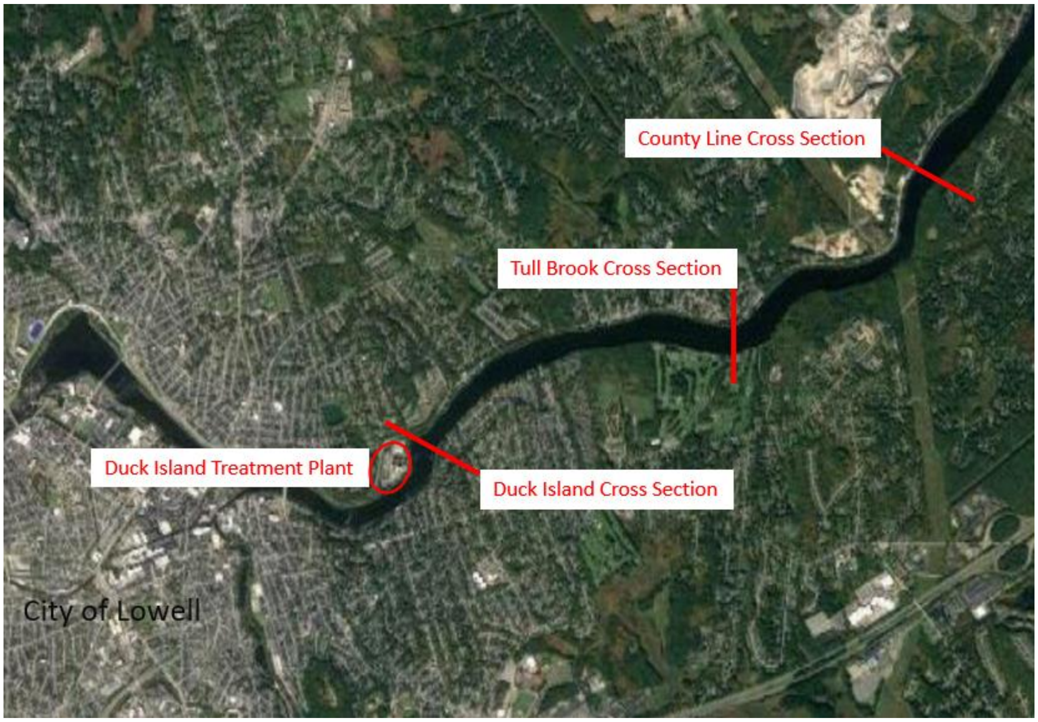
Parameter	Application
USGS stream gaging data	Instantaneous volume at time of discharge and over time and distance downstream.
Tributary drainage area for stream gage	Incremental flow contribution as the release moves downstream
Local precipitation data	Correlating event with CSO discharge quantity
CSO discharge data	Volume of discharged combined sewage
Actual and correlated pathogen concentration data	Determine initial concentrations at discharge
Regulatory Limits of *E. Coli* and *Enterococci*	Point at which parameters are met determines extent of affected area.

DETERMINING AFFECTED AREA

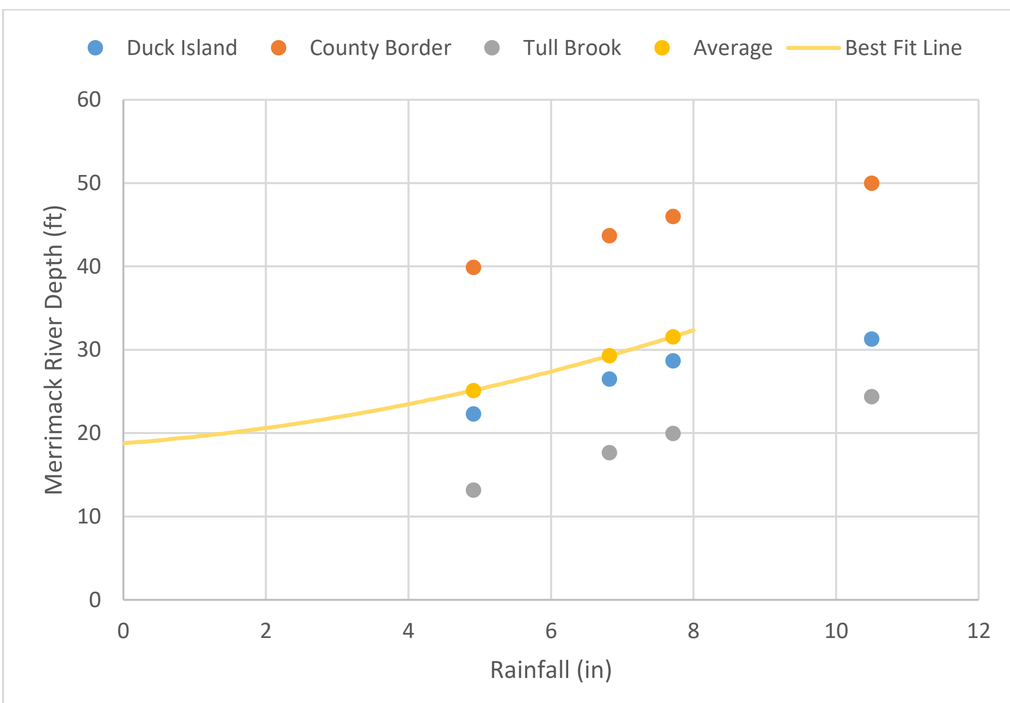
The affected area is determined by an analysis of river flow during wet weather, CSO discharge volumes, and pathogen concentrations. Historical and real time USGS stream gaging data and rainfall data are used to determine the typical river flow conditions during CSO activation to estimate the extent of downstream impact.

Streamflow is determined both upstream and downstream of Lowell from published real-time USGS river gage data. Tributary land area for each USGS stream gage is an additional important factor in the analysis. River flow during the weather event is correlated to the tributary area of the USGS gage to determine contribution of flow per square mile of tributary area (cfs/mi^2) during the event. Each square mile of tributary area aggregated between USGS stream gages generates an incremental increase of additional flow; this factor was used to calculate the increase in volume and velocity moving downstream along the river from Lowell to Newburyport (additional cfs/ft of river travelled).

Average river width and depth (700ft and 20ft respectively) were applied to calculate the volume in a theoretical 1-foot-wide cross section of the river. Characteristic river dimensions were determined using the average dimensions of three cross-sections up to 3 miles downstream of the Duck Island Wastewater Treatment Facility. Cross sections were taken from the FEMA Flood Insurance Study for the Merrimack River, with the water surface elevation representing the average depth over the cross-sections during a 1.5-inch storm event. An overview of the cross-section locations used, and their respective interpolated stage curves, are shown in the figures below.



Location of Merrimack River Cross-Sections used for Characteristic Dimensions



Interpolated Merrimack River Stage for Representative Cross-Sections (Source: FEMA Flood Insurance Study for Middlesex County, MA[1])

A dilution factor based on standard methodologies published by EPA[2] and on the pathogen grab sample concentration data from the CSO is applied both to the cross-section, and as volume increases as it moves in the downstream direction.

Using the USGS discharge data (cfs) applied to this theoretical cross section results in an estimate of average river velocity (fps). River velocity is required to determine the hydraulic retention time from the discharge to travel a given distance: this is important because a pathogen die off rate is applied, which in addition to the incremental increase in flow and resulting dilution, will contribute to further dilution of pathogens in the water. This pathogen die off rate is calculated based on a data report from MWRA[3], EPA methodologies[4] and principles of Chick's and Watson's Law[5], which is a standard method that describes the deactivation of microbes over time. The point in time the pathogen concentration reaches the Massachusetts State standard can be correlated with a distance downstream of the discharge by factoring the velocity of the river; this distance defines the extent of the affected area.

Affected Area Calculation Tool. An Excel-based tool has been developed that provides a simple means to determine the affected area with minimal input of variables. The tool will be updated on a regular basis as data is collected over time.

Using the methodology described in this memorandum, an estimate of the Affected Area due to a CSO release from Lowell regulator(s)extends approximately 12.3 miles, which corresponds to the area of Wingate Avenue in Methuen, MA. The City of Lowell is currently collecting data on pathogen concentrations from its CSOs which will be used in future calculations; data sampled directly from Lowell CSOs will be continuously collected and incorporated into the tool to ensure that the estimate is accurate and up to date.

Bypass Events. While this memorandum focuses on downstream impacts of CSO discharges, the methodology can also be used for determining the downstream impacts of a SSO or a bypass event at the Duck Island facility. To conservatively estimate the affected area of a bypass event at the Duck Island facility, historic E. Coli concentration data from past bypass events since 2020 were used, and the highest reported concentration (2,420 MPN/100mL occurring in January 2021) was used for the calculation. To conservatively estimate Enterococci data, a ratio of 3.5:1 (E. Coli/Enterococci) was applied, resulting in an Enterococci concentration of 691 MPN/100mL. To apply a conservative estimate of bypass flow, total flow from the treatment facility outfall during the reported bypass event was used (21.75 MG) and corresponding flows in the Merrimack River (13,263 cfs) during this event were determined using USGS data and incorporated into the calculations. The resulting affected area from a bypass event is 591 feet. There are no public access points to the Merrimack River within this distance from the Duck Island Treatment facility, and impacts are limited to the City of Lowell.

Sanitary Sewer Overflow (SSO) Events. In general, most SSOs that occur in the City of Lowell tend to be of lower volume and tend to be isolated incidents. To conservatively estimate the affected area of an SSO event, event log data since 2014 was used, and the highest reported estimated volume due to system capacity issues (50,000 gallons) was incorporated into the calculation. Additionally, a conservative concentration estimate for E. Coli was used based on historic (2017-2020) MWRA data for raw sewage (400,000 MPN/100mL) and similarly, a 3.5:1

ratio was applied to determine the associated Enterococci concentration (114,286 MPN/100mL). Flows in the Merrimack River on the day the SSO was reported were obtained from online USGS records (1,714 cfs). Using these conservative estimates, the calculated affected area from an SSO event is 222 feet. Based on this information, it is extremely unlikely that an SSO event would cause a discharge that would require notification to any downstream community along the Merrimack River. For high-volume SSOs occurring at outfalls immediately adjacent to neighboring communities, the City of Lowell will utilize the Excel-based tool and the above methodology to confirm whether those communities are impacted and issue a public notification as required per 314 CMR 16.00.

References:

1. *FEMA Flood Insurance Study for Middlesex County, MA*
2. *Tech_notes_9_dec 2013_pathogens.pdf (epa.gov)*
3. *MWRA; Task 4: Semiannual CSO Discharge Report No. 6 July 1, 2020 – December 31, 2020*; *https://www.mwra.com/cso/pcmpa-reports/06_070120-123120.pdf*
4. *2004 EPA CSO SSO Report to Congress: Appendix H Estimation of SSO Impacts in Streams and Rivers*
5. *Chick's law and Watson's law - law for disinfection (brainkart.com)*

Attachment B

In accordance with 314 CMR 16.04 (10) the estimated volume of the discharge or overflow will be determined based on the average discharge or overflow from data reported to the MassDEP and/or EPA for the prior three calendar years. The estimated volume of the discharge for each diversion station is determined by taking the median discharge volume for each discharge event that occurred in the three previous calendar years.

An example is provided below for Walker Station. From 2020 through 2022 Walker station had 23 CSO diversion events, as shown in table B-1. The volumes of the discharge ranged from 0.02 million gallons (MG) to 9.54 MG. The median volume for the 23 events is 0.65 MG.

Table B-1: Walker Station Diversion Events 2020-2022

Date	Walker Station CSO Volume (MG)
4/19/2022	0.02
7/8/2021	0.05
5/28/2022	0.13
10/17/2022	0.21
7/28/2022	0.24
7/18/2021	0.33
7/30/2021	0.35
10/18/2022	0.42
9/13/2021	0.44
1/17/2022	0.54
9/19/2022	0.6
7/19/2022	0.65

Date	Walker Station CSO Volume (MG)
1/25/2020	1.07
10/17/2020	1.86
7/22/2020	2.73
7/12/2021	3.24
11/12/2021	3.68
8/19/2021	4.16
4/29/2021	4.22
9/5/2022	5.06
9/2/2021	5.14
9/10/2020	5.31
7/9/2021	9.54

The table below displays Table 1 with additional columns for Active/Inactive and estimated volume. In this example the estimated volumes are calculated as the median CSO volume for each station for 2020 to 2022. These are the values that will display in notification for the 2023 calendar year. Values will be updated at the beginning of each calendar year.

Outfall #	Name	Latitude	Longitude	Receiving Water	Active/ Inactive	Estimated Volume (MG)
035	Lowell Wastewater	42.64521	-71.28881	Merrimack River	Active	3.22
002-SDS#1	Walker Station	42.64621	-71.33407	Merrimack River	Active	0.65
007-SDS#2	Beaver Brook	42.65933	-71.31925	Beaver Brook	Active	0.47
008-SDS#3	West Station	42.65254	-71.31032	Merrimack River	Active	3.50
011-SDS#4	Read Station	42.64822	-71.30111	Merrimack River	Active	0.02
012-SDS#5	First Street	42.64756	-71.29086	Merrimack River	Inactive	N/A
020-SDS#6	Warren Station	42.64277	-71.30502	Concord River	Active	1.90
027-SDS#7	Tilden Station	42.65072	-71.31152	Merrimack River	Active	0.48
030(1)-SDS#8	Barasford Station	42.64531	-71.28841	Merrimack River	Active	1.55
030(2)	Merrimack Station	42.64518	-71.28881	Merrimack River	Active	2.25

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