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Michael C. Patrick
Executive Director

July 17, 2024

EES Case Management Unit
Environment and Natural Resources Division
U.S. Department of Justice
Box 7611
Washington, D.C. 20044-7611

Re: DJ # 90-5-1-1-11394 Signal Mountain Remediation Plan Deliverable

To whom it may concern:

The Hamilton County WWTA has completed a draft deliverable in accordance with the Consent Decree entered into by the United States District Court for the Eastern District of Tennessee (Southern Division), titled *Signal Mountain Remediation Plan*.

The deliverable has been submitted for public comment to the Public Document Repository (PDR) located on the WWTA's website here: https://wwta.hamiltontn.gov/178/Public-Document-Repository and also as a physical hard copy in a Public Document Repository at the Chattanooga-Hamilton County Library as of **July 16, 2024**. Public comments must be submitted within 45 days of the date entered in the PDR. The public may use the form available in the PDR to provide comments or send comments directly to:

Hamilton County Water & Wastewater Treatment Authority
RE: Consent Decree Public Comments
c/o Natasha Long
1250 Market Street, Suite 3050
Chattanooga, TN 37402

The Hamilton County WWTA will be conducting two Public Meetings to provide information about the deliverable required by the Consent Decree, titled *Signal Mountain Remediation Plan*. Details about each meeting are available below:

Public Meeting 1 will be conducted on August 5, 2024, at 6:00 – 7:00 PM local time at Joseph Glasscock Community Center; 3620 Tom Weathers Drive, Red Bank, TN 37415.

Public Meeting 2 will be conducted on August 6, 2024, at 10:00 – 11:00 AM local time, at the Signal Mountain Town Hall gymnasium; 1111 Ridgeway Avenue, Signal Mountain, TN 37377.

Sincerely,

Michael C. Patrick

Michael C. Patrick, P.E.
WWTA Executive Director

Enclosure

cc:

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Signal Mountain Remediation Plan Draft Submitted for Review by EPA and TDEC

Prepared for

The United States Environmental Protection Agency and Tennessee Department of Environment and Conservation

Case No. 1:23-cv-00225

Prepared by

Hamilton County
Water & Wastewater
Treatment Authority (WWTA)

Submitted by

LJA Engineering, Inc.
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Chattanooga, TN 37402

July 15th, 2024

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1. Summary

1.1. Statement of the Problem

The Hamilton County Water and Wastewater Treatment Authority (WWTA) entered into a consent decree with the United States and the State of Tennessee in the case styled *United States of America et. al. v. Hamilton County Water and Wastewater Treatment Authority, No. 1:23cv-00225* ("CD"), which became effective on July 15th, 2024. Pursuant to Section VII, paragraph 28 of the CD, WWTA is required to submit a Signal Mountain Remediation Plan to the Environmental Protection Agency ("EPA") and Tennessee Department of Environment and Conservation ("TDEC"). The Signal Mountain Wastewater Treatment Plant (WWTP) is the only wastewater treatment plant owned and operated by the HCWWTA and only treats flows from the Signal Mountain area. Other areas of the HCWWTA system discharge into the neighboring City of Chattanooga's Moccasin Bend Environmental Campus for treatment.

The WWTP has experienced multiple permit violations due to excess flow from inflow and infiltration (I/I) within its collection basin. Rehabilitation within the Signal Mountain basin is planned. However, due to the topography of Signal Mountain, reducing flows to meet the permit requirements will require significant time and money. Furthermore, rehabilitation could take up to 20 years to address significant I/I removal due to the extent of I/I flows observed within this basin and the topography of where the collection system assets are located.

During a flow monitoring study performed in 2012-2013, the WWTP received an average daily flow of 0.340 million gallons per day (MGD), with a peak wet weather instantaneous flow of 3.48 MGD. More recent flow monitoring at the plant have recorded observations just over 5 MGD peak wet weather instantaneous flow (15-minute flow reading). The WWTP's current National Pollutant Discharge Elimination System (NPDES) permit allows for a maximum flow of 0.4 MGD, although historical documents indicate the WWTP was designed to be capable of treating 0.8 MGD without violating the permitted end-of-pipe effluent limitations. Flow limitations are summarized in Table 1.1.

Table 1.1: Conditions at Critical Flow Points

Flow	Condition
0.34 MGD	Average Dry Weather Daily Flow
0.40 MGD	NPDES Permit Flow Limit
0.80 MGD	Capable of Treatment Without Violating Permitted End-of-Pipe Conditions
1.30 MGD	Approximate Flow Point Where Bypassing is Initiated
5.00± MGD	Maximum Instantaneous Flow During Wet Weather Events

Large flow fluctuations disrupt the ability of the plant to effectively treat influent and meet permit limits in the days following high-flow events, with each subsequent wet-weather event degrading the performance of the biological treatment system. Since a long-term solution is needed to address I/I flows and reduce disruptive spikes in influent flows, a temporary solution at the plant has been put in place to minimize impacts to the treatment effectiveness of the plant during high flow events. At approximately 1.3 MGD in flow, excess influent is bypassed around the biological treatment process via an overflow weir directly to the Chlorine Contact Chamber (CCC) where it receives disinfection. These events as well as the number of permit violations are shown per month in Figure 1.1. Biological treatment continues to be performed on the base flows below 1.3 MGD. These bypassing events are the current solution for the high flows experienced but are unsustainable in the long-term as the plant will continue to violate its NPDES permit under current operating conditions.

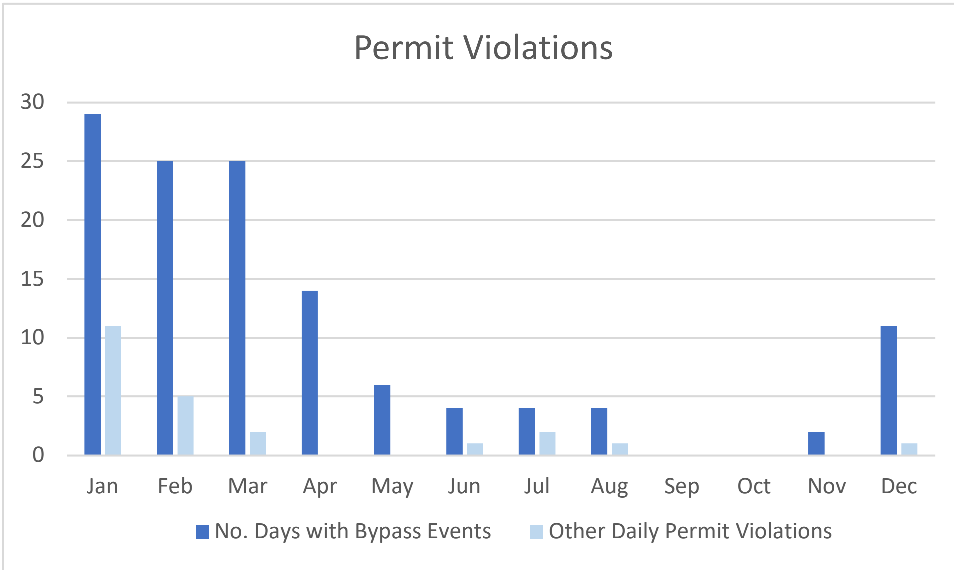


Figure 1.2: Daily Permit Violations by Month, 2023

1.2. Requirements

As detailed in Section VII of the CD, WWTA is required to submit a Signal Mountain Remediation Plan which shall include:

- Analysis of alternative remedial options
- Analysis of the effectiveness of the treatment technologies considered to meet effluent limits in wet weather, including pilot study
- Description of all selected remedial measures
- Schedule for design and construction of selected measures

1.3. Summary of the Alternative Solutions Considered

Prerequisite Action Items - Required Preliminary Work – In conjunction with each alternative below, the following work will be required in order to upgrade and maintain the WWTP while a long term final solution is implemented: an access road will be constructed to recently acquired property adjacent to the WWTP, which will tie into the existing WWTP roadway and provide access to construct new required infrastructure in the future; a waste activated sludge (WAS) tank will be installed to alleviate sludge hauling practices and optimize control of the process treatment system; gravity sewer outside drops will be installed at the beginning of the overall treatment system to slow velocities of wastewater coming down Signal Mountain, which will improve operations of all downstream equipment; a headworks system will be constructed including screening and grit removal to remove solids at a higher rate which will improve the performance of biological treatment system and prevent pump damage from grit and larger solids; incoming flow monitoring equipment improvements will be made to more accurately measure what flows are entering the WWTP; and a backup generator will be installed to maintain operation of equipment during power fluctuations and outages. In either alternative below, the WWTP will continue to be in operation for a period of several years until construction improvement projects can be completed. The required preliminary work is intended to minimize NOVs and allow for better operation and maintenance while a long-term solution is designed and constructed, regardless of the alternative recommended.

Alternative #1 – "No Action" Alternative – This alternative is not viable; the plant will continue to bypass the biological system and violate the NPDES permit limits.

Alternative #2 – Decommission WWTP and Pump to City of Chattanooga – In this alternative, the WWTP would be decommissioned and flow from the Signal Mountain basin would be pumped to the City of Chattanooga's collection system, eventually reaching the Moccasin Bend Environmental Campus for treatment. This alternative would include construction of a new equalization tank and pump station on the current WWTP site. A skid-mounted, three-pump arrangement with variable frequency drives would be utilized with one pump in operation during low flows, two in operation during high flows, and one in spare. Each pump would operate between approximately 800 gallons per minute (GPM) and 2,500 GPM based upon level in the equalization tank. In isolated situations in which a single pump cannot keep up with influent flows, both pumps would operate until the tank level drops below a setpoint. There would be a single force main to send wastewater from the Signal Mountain system to the City of Chattanooga's system. In addition to the smaller EQ basin at the Signal Mountain WWTP site, a larger EQ basin (5 MG) located near the connection point to the City of Chattanooga will be required to attenuate the flows sent to Chattanooga's system. The internal components of the existing treatment basin and clarifier would be removed and be used as extra storage equalization as needed in conjunction with the newly constructed tank; and all non-used structures and basins would be decommissioned and retired in place.

Alternative #3 – Keep Existing WWTP and Meet Permit Limits – In this alternative, the WWTP would remain in operation and a Remediation and Optimization Plan will be enacted to significantly reduce current NOVs and bypasses. The Remediation plan would involve installing a cloth media filtration system acting as a primary treatment process just downstream of the new headworks and upstream of the existing biological system. The filtration system would require a new solids handling system to be installed due to solids produced from screenings and backwash cycles. A new chlorine contact chamber would be added and sized for increased capacity to handle the biological treatment and wet weather bypass flows.

After the filtration system is installed, the Optimization Plan would be initiated allowing the filtration system to treat all flows while meeting current permit limits, then the biological system would be taken offline and investigated for repairs and/or upgrades. These repairs and upgrades are anticipated to increase the biological system's capacity and allow for an ease in operation and maintenance practices.

1.4. Recommended Solution

The recommended solution is **Alternative 3 – Keep Existing WWTP and Meet Permit Limits** – Upgrades including the prerequisite action items will be installed and the Remediation and Optimization Plans will be initiated, allowing the plant to eliminate chronic bypassing and reduce NOVs. This alternative is the most cost-efficient option available to address the issues at the plant in the shortest period.

2. Remediation Alternatives Analysis

2.1. "No Action" Alternative

This alternative would constitute no upgrades or changes at the WWTP. Violations of the plant's NPDES permit would continue under this alternative. Because of this, it is unviable to consider no action.

2.2. Decommission Signal Mountain WWTP and Transfer Flows to Chattanooga

In this alternative, the WWTP would be decommissioned and flow from the Signal Mountain basin would be pumped to the City of Chattanooga's collection system, with flows eventually reaching the Moccasin Bend Environmental Campus for treatment. This alternative consists of the following scope of work beyond the MUST Dos:

- ◊ Installation of a wet well equalization tank at the WWTP to attenuate the fluctuating incoming flows and act as a wet well for the pumping of the flows to Chattanooga. Approximate storage capacity was limited to 0.4 MG due to geotechnical investigations revealing underlying soil conditions which would be problematic for construction and cost prohibitive.
- ◊ Installation of three (3) skid-mounted pumps with one pump in normal operation and two pumps in high flow conditions with one in spare. These pumps would operate with a variable frequency drive given the fluctuation between low and high flows. Approximate operating conditions for the high and low flow pumps are between 800 and 2,500 GPM with a 200 Hp motor. During low-flow conditions, the primary pump would operate on tank level and the frequency ramped up as needed during high-flow, wet-weather conditions. The skid would contain the pumps, suction and discharge piping, valving, controls, and the starter.
- ◊ Installation of approximately 22,000 LF of 14-inch force main would be installed to send the flow to an equalization tank at the tie-in point to the City of Chattanooga's collection system. As part of the conceptual feasibility analysis of this alternative, the material of pipe was assumed to be mostly PVC C900 and with minimal DIP to alleviate costs. Pipeline under roadways, railroad, and other structures would be DIP and the remaining pipeline would be PVC C900. See Figure 2.2 below for the conceptual force main alignment.
- ◊ Installation of concrete storage equalization tank at the discharge point of the force main before the flow enters the City of Chattanooga collection system. Approximate capacity was assumed to be 5 million gallons.
- ◊ Conversion of existing treatment basins (Primary Contact Stabilization Basin and secondary clarifier) to serve as additional storage capacity of approximately 400,000 gallons.
- ◊ Installation of piping to connect the new storage equalization tank and existing converted treatment basins with ancillary piping and valving to control flows from each source.

◊ Decommissioning and retiring in place of the existing equipment and piping not being utilized for storage capacity.

Flow Design Basis

This Alternative was based on the highest recorded peak instantaneous (15-minute) flow of 5.28 MGD since flows will need to be pumped. Two pumps in operation can pump up to 3.60 MGD (2,500 GPM) and the wet well EQ tank can store up to 0.40 MGD, leaving a remainder of 1.68 MGD. This does not factor in the potential of the existing treatment basins to be converted to additional EQ basins, contributing another 0.40 MGD of storage. **Due to I/I overload from the Signal Mountain collection system the equalization basin at Moccasin bend may not be able to handle the flow causing an overflow or bypass at the downstream storage location.** I/I rehabilitation efforts will need to remove approximately 1.68 MGD with the SM collection system for this option to be feasible.

Process Schematic and Layout

See Figure 2.1 below for the overall layout of how the pumping and storage arrangement detailed above would be installed at the WWTP.

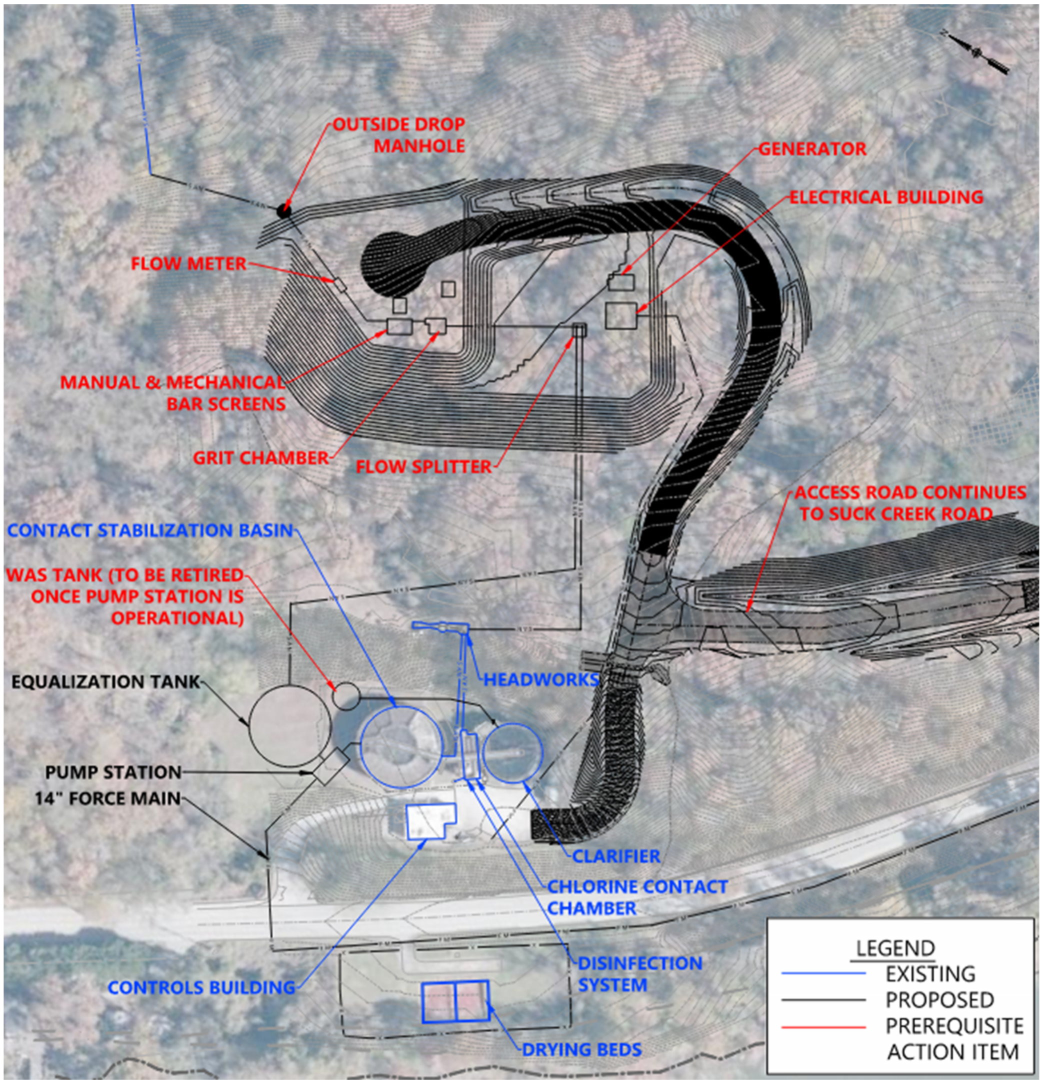


Figure 2.1: Alternative 2 Signal Mountain WWTP Proposed Layout

The following is the scope of work for the MUST Dos specific to this alternative:

- ◊ The access road to newly acquired property upstream of the existing headworks, consists of paving approximately 900 LF with a new entrance off Suck Creek Road and then combining with the existing paving at the WWTP. Drainage improvement along the roadway and across Suck Creek Road will be constructed. This road will allow for larger vehicles to access the existing plant and future expansions of the headworks.
- ◊ The WAS tank will be installed to optimize control of the process treatment system and alleviate sludge hauling practices. The WAS Tank will receive sludge from both existing clarifiers before any future expansions in Alternative 2 are realized. Once Alternative 2 construction is finalized, the WAS Tank will become a solids tank to only handle solids collected from the flow arrestor.
- ◊ Gravity sewer outside drops at the beginning of the overall treatment system will be installed to slow velocities of wastewater coming down Signal Mountain, which will improve operations of all

downstream equipment. Solids will settle at the bottom due to reduced velocity and will be pumped to the WAS tank. The outside drops would remain in place once all construction in Alternative 2 is completed.

- ◊ A new headworks system will be installed consisting of one mechanical multi-rake bar screen with ¼-inch openings to remove solids as they enter the headworks. The grit removal system will have an aerated chamber exposed to medium bubble aeration where floatables rise to the surface are removed by a paddle system. The second chamber of the grit removal system will unaerated and equipped with lamella separator to remove the finer grit. The entire headwork system will be constructed within a concrete structure. All solids will be disposed into nearby dumpsters after washing. The overall goal of the headworks system is to protect downstream equipment and processes from solids and to function with the most optimal performance. The new headworks system will remain in place once all construction in Alternative 2 is completed.
- ◊ New flow monitoring equipment will be installed downstream of the outside drops to accurately measure influent wastewater flow. The flow meter will function by using the Doppler Effect to measure the velocity and both pressure transducer and ultrasonic sensor to measure depth. The new influent flow monitoring equipment will remain in place once all construction in Alternative 2 is completed.

◊ A backup generator will be installed near the Control Operations building specific for this alternative. The generator size will be 1.5 MW to operate the existing WWTP mechanical equipment as well as future loadings from the new mechanical equipment including but not limited to the pumps, blowers and mixers.

The proposed 14" force-main shown in Figure 2.1 was assumed to leave the site and parallel Suck Creek Road for a number of miles before diverting and traveling through proposed easement property along the Tennessee River before connecting to the proposed 5 MG Equalization Tank near the Moccasin Bend Environmental Campus. The Equalization tank would connect before Chattanooga's existing gravity system and final treatment at Moccasin Bend Environmental Campus. The conceptual alignment from the WWTP to the Chattanooga system discharge location is shown in Figure 2.2.

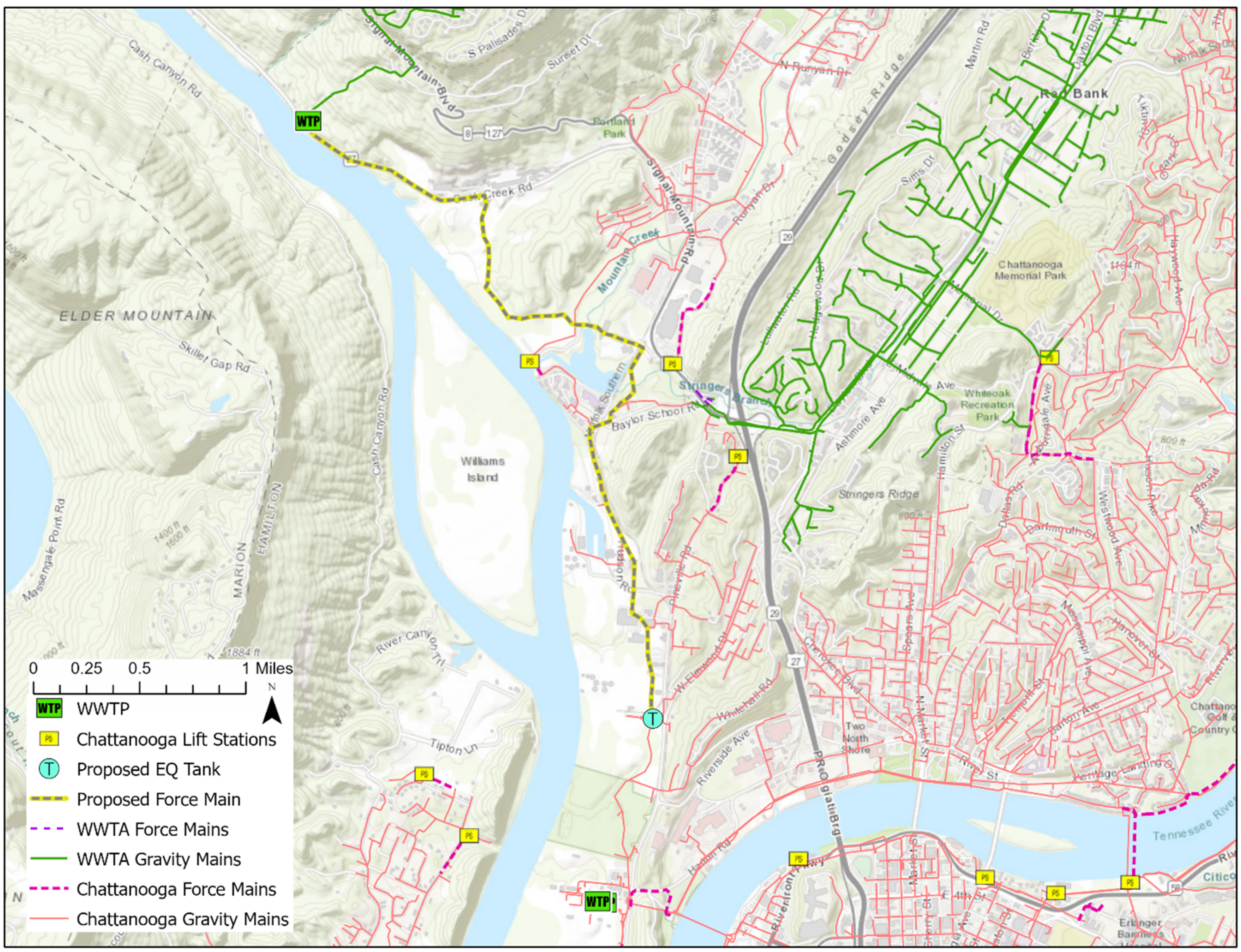


Figure 2.2: Proposed Force Main Route to Send Flows to Moccasin Bend Environmental Campus

Cost Analysis

The capital costs associated with the construction of the Must-Do components, Equalization tanks, pump station and Force-Main are estimated to be **$60,855,350**.

The projected Operation and Maintenance costs associated with this alternative have been developed using the assumptions listed below. A present worth calculation over a twenty-year period was prepared for this alternative using these costs. Specific assumptions made were:

1. Wheelage and treatment is currently $2.863/1000-gal, with rate increases at 6% per annum.
2. Current Estimates of $2.78/gallon stored are derived from client data.
3. Current plant costs are continued in years 1-7 of operation and maintenance costs until the pump station is constructed and operable.
4. Discount Rate is assumed to be 3%.
5. O&M escalation assumed to be 1%.
6. Equipment Replacements would occur every 5 years of operation (approx. $200,000 each).
7. Construction costs are spread out over the first 7 years.

The main issues associated with this alternative are the extensive costs **($82M total present worth over 20 years)** and time to complete. Costs are extensive due to high steel costs, equipment capital and electrical costs, and the wheelage and treatment costs for the flows sent to Chattanooga. The time required to acquire easements along the force main alignment would take approximately 2.5 years and then an additional 4.5 years to complete construction of the force main and pump station. Other alternatives were considered within this option but there is always going to be the scenario where either storage tanks, and or pumps/force mains capital costs and operation make any scenario difficult and cost prohibitive.

2.3. Keep Existing WWTP and Meet Permit Limits

In this alternative, the WWTP would remain in place and a Remediation and Optimization Plan will be enacted to significantly reduce current NOVs and bypasses. Bypassing violations would be eliminated due to construction of a cloth media filtration system capable of treating excessive wet weather flows to meet current NPDES permit limits. By installing this advanced primary treatment system, the issues with meeting dry weather low and average flow conditions and then handling large wet-weather flows can be resolved. The filtration system is ideally suited to remove insoluble wastes that are problematic during low and average flow conditions, as well as handling large flow fluctuations and first flush contaminants and subsequent dilute flows during wet-weather events by acting as an advanced primary treatment system. Studies have shown that this system when placed ahead of traditional biological treatment systems, can increase the efficiency of the biological treatment system by 45% to 60%.

As this advance primary treatment system is not dependent on maintaining and sustaining a bio-mass colony, it provides the opportunity, once installed, to take the existing biological system offline and allowing detailed investigations of the interior of the activated contact stabilization basins to determine additional improvements that could be made to increase the biological treatment capabilities of the existing system. This alternative consists of the following scope of work beyond the MUST Dos:

Remediation Plan (Phase 1)

Two (2) cloth disck filtration units in a concrete basin would be installed to perform advanced primary treatment prior to entering secondary treatment in the existing biological treatment system. This configuration would provide primary treatment during dry weather conditions and provide necessary filtration area to treat storm events up to 5 MGD with both units online. The cloth media disk filtration system can filter high solids waste streams without the use of chemicals. This system is ideal for primary wastewater treatment due to its proven removal efficiencies and high-quality effluent, even under varying influent conditions. Additionally, this system could improve the biological treatment capabilities by 45% to 60% (existing 0.8 MGD capacity increased to 1.16 MGD to 1.28 MGD) by providing a more consistent range of Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD) loadings, rather than the large swings that are currently occurring between dry weather/average flow conditions and wet-weather flows.

A pilot study was performed using an Aqua Aerobic single disk Aqua MiniDisk® cloth media filter (CMF) equipped with OptiFiber PF-14® MicroFiber cloth filtration media, which has a nominal filtration rating of 5 microns. The results of this Pilot Testing can be found in Appendix I. Samples from the pilot testing were collected by a 3rd party laboratory, Microbac.

Included with the filtration system would be a new chlorine contact chamber sized for increased capacity to handle peak flows and a solids waste handling system to dewater/thicken solids. Both solids from the existing clarifiers and the new filtration system would be sent to the WAS Tank where a pump would control the flow of solids into the solids handling facility. The solids handling system would be installed within a building that houses a dewatering belt press, tanks and pumps to thicken solids before they are sent to a sludge holding tank and hauled to the Moccasin Bend Environmental Campus for further treatment.

Biological Treatment Improvements/Optimization (Phase 2)

After installation of the filtration system, an investigation of the existing biological system would be performed while the filtration system acts as the sole treatment process. The effluent from the filtration unit would receive disinfection before discharge to the outfall. While there are unknowns about the current condition of the activated contact stabilization biological treatment system, it is assumed and likely that the internal components of the existing biological system are in poor condition. Necessary repairs could include replacing deficient air piping and diffusers, additional blowers and/or replacement, baffle wall replacement, and removing all wastewater and solids from the system. The former thickener and digester sections, which are currently unused zones with no treatment being performed, are likely to be rehabilitated and would serve as an expanded treatment section with additional aeration. This Optimization Plan (Phase 2) would allow the biological capacity of the SM WWTP to increase by approximately 0.4 MG with an overall capacity of 1.20 MGD. The anticipated estimated costs of these repairs would be approximately $4.5 million.

Process Schematic and Layout

See Figure 2.3 below for the overall layout of how the pumping and storage arrangement detailed above would be installed at the WWTP.

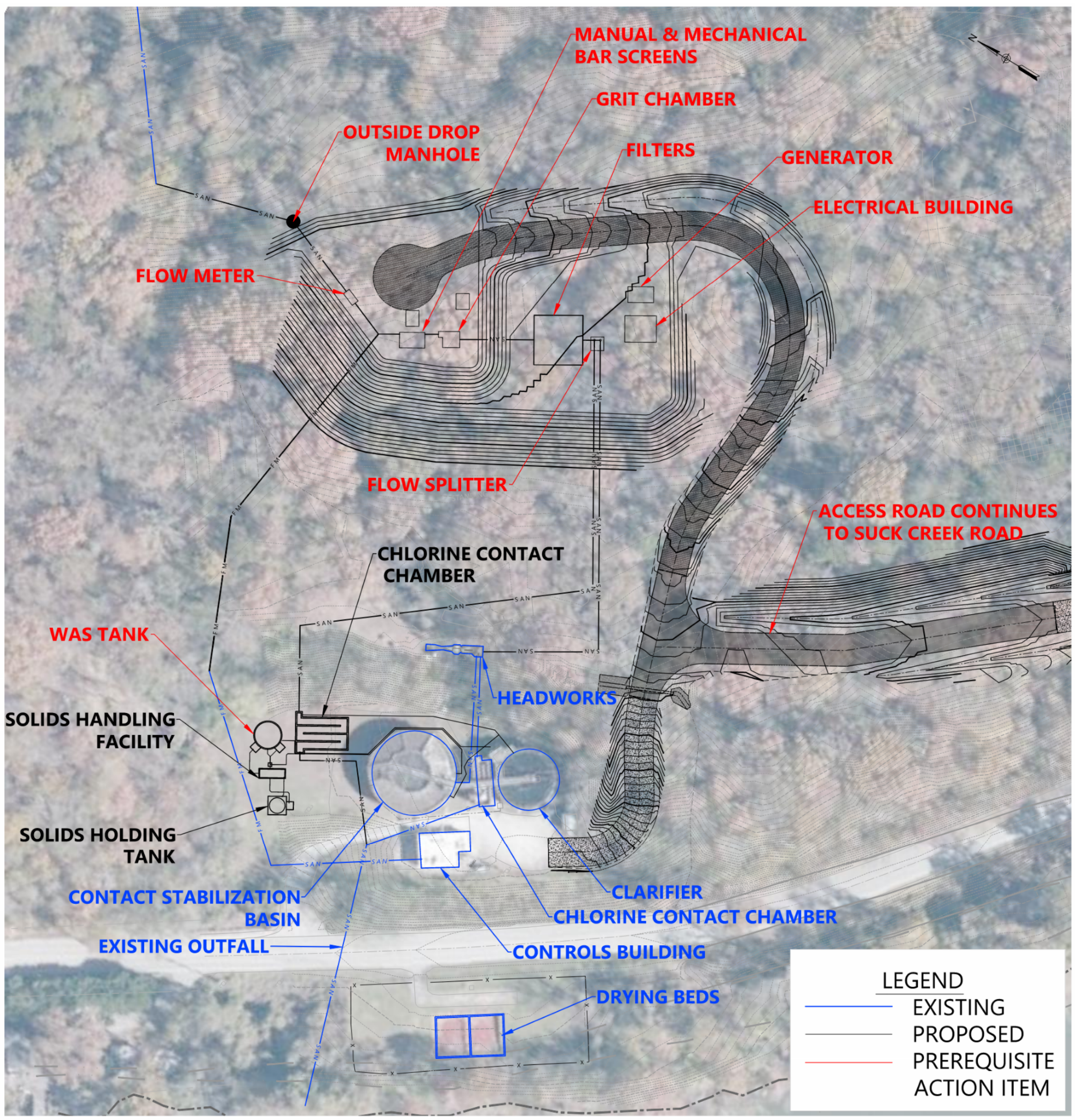


Figure 2.3: Alternative 3 Signal Mountain WWTP Proposed Layout

Flow Design Basis

This Alternative was based on the highest recorded peak hourly flow of 5.11 MGD (5.28 MGD 15-min peak) flow that will need to be treated. The capacity of the SM WWTP is estimated be 0.8 MGD after the filtration system is operation. The Phase 2 Optimization plan will add 0.4 MGD of biological treatment to increase the treatment capacity to approximately 1.20 MGD, leaving a remainder of 3.91 MGD. I/I rehabilitation efforts will need to remove approximately 3.91 MGD within the SM collection system over 20 years before the filtration system is taken offline.

The following is the scope of work for the Required Preliminary Work specific to this alternative:

- ◊ The access road from the newly acquired property of former owner River Gorge Trust, consists of paving approximately 900 linear feet with a new entrance off Suck Creek Rd and then combining with the existing paving at the SM WWTP. Drainage improvement along the roadway and across Suck Creek Road will be constructed. This road will allow for larger vehicles to access the existing plant and future expansions of the headworks.
- ◊ The WAS tank will be installed to optimize control of the process treatment system and alleviate sludge hauling practices. The WAS Tank will receive sludge from both existing clarifiers and from the filtration system.
- ◊ Gravity sewer outside drops at the beginning of the overall treatment system will be installed to slow velocities of wastewater coming down SM, which will improve operations of all downstream equipment. Solids will settle at the bottom due to reduced velocity and will be pumped to the WAS tank.
- ◊ A new headworks system will be installed consisting of one mechanical multi-rake bar screen with ¼-inch openings to remove solids as they enter from the SM basin area. The grit removal system will have an aerated chamber exposed to medium bubble aeration where floatables rise to the surface are removed by a paddle system. The second chamber of the grit removal system is unaerated and equipped with lamella separator to remove the finer grit. The entire headwork system will be constructed within a concrete structure. All solids will be disposed into nearby located dumpsters after washing. The overall goal of the headworks system is to protect downstream equipment and processes from solids, to function with the most optimal performance.
- ◊ A new flow monitoring equipment will be installed downstream of the outside drops to accurately measure influent wastewater flow. The flow meter will function by using the Doppler Effect to measure the velocity and both pressure transducer and ultrasonic sensor to measure depth.
- ◊ An upgrade to the existing disinfection system will be installed at the most downstream portion of the SM WWTP.
- ◊ A backup generator will be installed near the Control Operations building. The generator size is 900 kW (0.9 MW) to operate the existing SM WWTP mechanical equipment as well as future loadings from the new mechanical equipment including but not limited to the filtration system, pumps, blowers and mixers.

Cost Analysis

The capital costs associated with all phases of construction are **$21,906,171**.

The projected Operation and Maintenance costs associated with this alternative have been developed using the assumptions listed below. A present worth calculation over a twenty-year period was prepared for this alternative using these costs. Specific assumptions made were:

1. Discount Rate is assumed to be 3%.
2. O&M escalation assumed to be 1%.
3. O&M Costs are in addition to current O&M costs for the plant per HCWWTA.
4. Filtration system and Required Preliminary Work Construction costs are spread out over the first 6 years.
5. Equipment Replacements would occur every 5 years of operation ($200,000 ea.)
6. Phase 2 Biological Improvements/Optimization, design and permitting would start by Year 8 with Construction Costs beginning by Year 10 and completed by Year 15.

In this alternative, the requirements of the consent order are met on a more cost and time effective basis. The amount of NOVs will be significantly reduced and bypasses eliminated as a result of the upgrades and repairs made to the plant. Total 20-year present worth is noted at **$35,055,322**. Updated equipment at the WWTP comprises the entirety of the capital costs associated with this alternative, negating any wheelage and treatment costs. Construction is assumed to take approximately 6 years to completion with equipment replacements made periodically.

3. Treatment Technologies Considered

3.1. Cloth Media Filtration System

The effectiveness of the cloth media filtration system included with **Alternative 3** was considered in meeting effluent limits for all pollutants controlled by the WWTP's NPDES Permit in a full range of conditions during the wet weather season. Multiple vendors were encouraged to participate including Veolia with their Hydrotech™ Discfilter but they decided to not participate at the last minute due to problems with site conditions and existing wastewater conditions that would enter their filter during the pilot study. Only Aqua Aerobics choose to participate.

From December 2021 through early March 2022, a pilot study was performed using an Aqua Aerobic single disk Aqua MiniDisk® cloth media filter (CMF) equipped with OptiFiber PF-14® MicroFiber cloth filtration media, which has a nominal filtration rating of 5 microns. The results of this Pilot Testing can be found in Appendix I. It is important to note that sampling was purposely performed during the wet season, when dilute influent conditions were consistently present, so that testing results would come from the worst-case scenario conditions to mimic the operation of the filtration system. Samples from the pilot testing were collected by a 3rd party laboratory, Microbac. The sampling protocol morphed over the four (4) month period but in the end, it was settled to take four (4) six (6)-hour composite samples for all dry weather/low flow conditions and wet weather/high flow conditions, with the goal to capture the first flush, when loading concentrations were at their highest during wet weather/high flow conditions.

Of the eleven (11) dry weather/low flow condition sampling events, the average removal rate was 50% for BOD_5 and 71% for TSS. Of the nine (9) wet weather/high flow condition sampling events, the average removal rate was 69% for BOD_5 and 77% for TSS. Comparing the NPDES daily effluent permit limits for all twenty (20) sampling events, only once during the wet weather sampling events did the NPDES daily maximum of 45 mg/L exceed the limit (2/3/22 when the daily influent average was 219.5 mg/L and the daily effluent average was 65.2 mg/L for BOD_5); and only once during the dry weather sampling events did the NPDES daily maximum of 45 mg/L exceed the limit (2/2/22 when the daily influent average was 123 mg/L and the daily effluent average was 49 mg/L for BOD_5). Never was the NPDES weekly nor monthly BOD_5 and TSS concentration of 40 mg/L and 30 mg/L, respectively, exceeded.

The pilot testing results met the performance expectations as realized through the lab data collected and analyzed and would be a feasible solution to address the current NOV's at the WWTP and allow for a timetable to increase the biological treatment capacity and reduce I/I in the upstream collection system. The influent concentration loads were significantly reduced through the cloth disk filtration technology from Aqua Aerobics, especially during "first flush" events which tend to overwhelm the WWTP during operations. During dry weather operations of the pilot unit, data shows that removal percentages were still significant considering the lower load concentrations experienced Figure 3.1 and Figure 3.2 below show the ranges of influent and effluent concentrations, which demonstrate effectiveness during both wet and dry weather events. Additionally, this system could improve the biological treatment capabilities by 45% to 60% (existing 0.8 MGD capacity increased to 1.16 MGD to 1.28 MGD) by providing a more consistent range of Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD) loadings, rather than the large swings that are currently occurring between dry weather/average flow conditions and wet-weather flows.

Aqua-Aerobic Systems Report, Evaluation of AquaStormTM Cloth Media Filtration Technology for Dual Use Advanced Primary and Wet Weather Treatment, can be found in Appendix II.

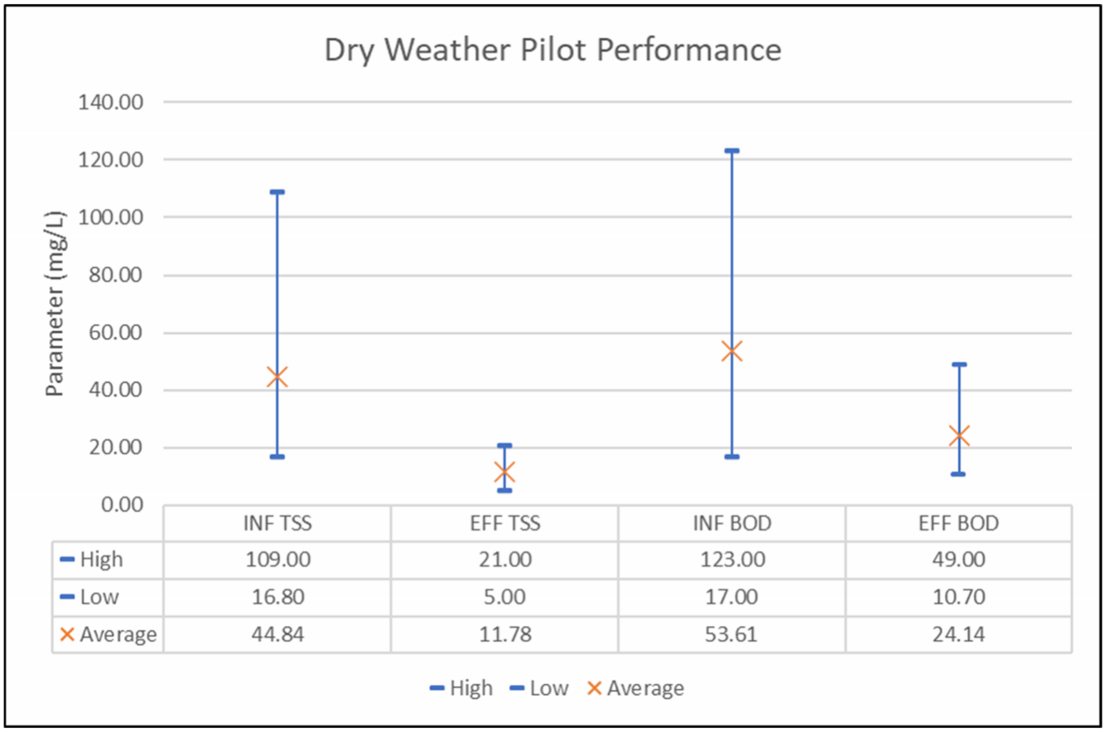


Figure 3.1: Dry Weather Pilot Performance

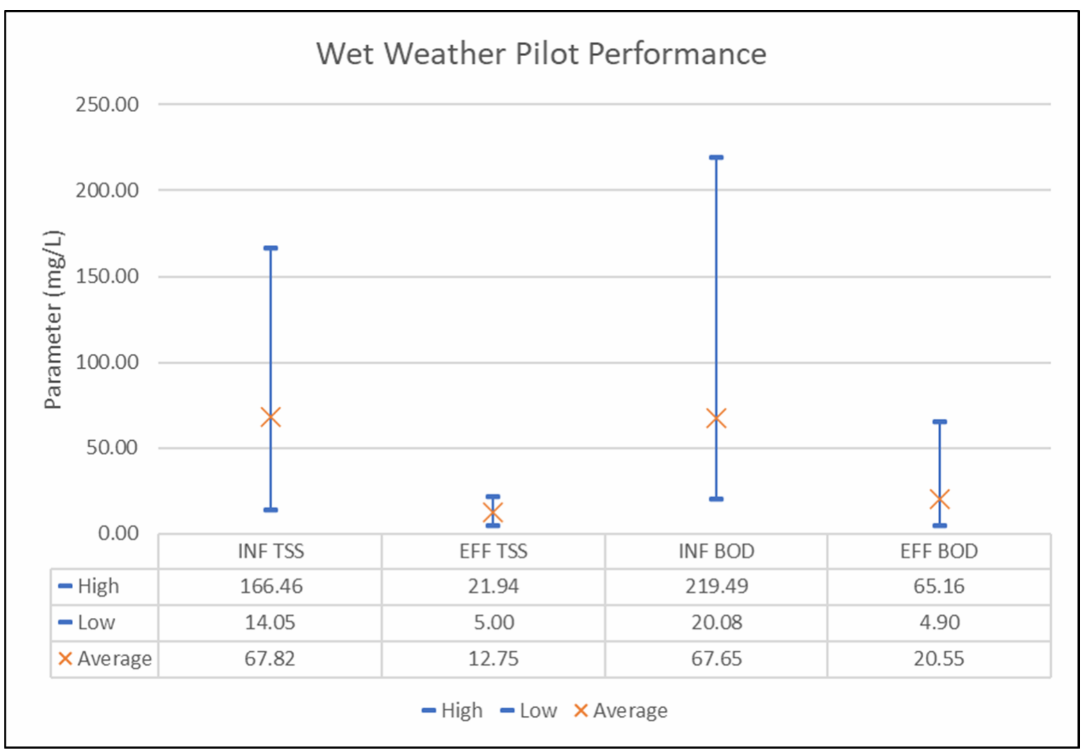


Figure 3.2: Wet Weather Pilot Performance

4. Selected Plan Description

4.1. Detailed Description of Chosen Alternative

The chosen alternative (**Alternative 3**) consists of a Remediation Plan and an Optimization Plan, which satisfies Section VII Paragraph 28.b.1 of the CD. The Remediation Plan will be the installation of the cloth media disc filtration system and solids handling system while the Optimization Plan will entail investigations of each treatment basin to possibly repair/modify the internal structures and equipment to increase treatment capacity and efficiency.

Remediation Plan

Filtration System

Two (2) parallel cloth media disk filter units in a concrete basin will installed to perform primary treatment prior to entering secondary treatment in the existing biological treatment system. This configuration would provide primary treatment under dry weather conditions and provide necessary filtration area to treat storm events up to 5 MGD with both units online. The cloth media disk filtration system can filter high solids waste streams without the use of chemicals. This system is ideal for primary wastewater treatment due to its proven removal efficiencies and high-quality effluent, even under varying influent conditions.

The operating of the filtrating system involves a Filtration mode, Backwash mode, Solids Wasting mode and Floatable Wasting mode. See below for these exact operation modes:

Filtration Mode:

1. Influent wastewater enters the filter by gravity.
2. Stationary cloth media disk are completely submerged.
3. Solids deposit on the outside of the cloth media forming a mat as filtrate flows through the disk into the hollow center tube.
4. Tank liquid level rises as head loss builds due to collection of solids.
5. Filtrate is collected in the hollow center tube and discharges over the effluent weir.
6. Heavier solids settle to the hopper at the bottom of the tank.

Backwash Mode:

1. Solids are backwashed at predetermined liquid level or time.
2. Backwash shoes directly contact the cloth media and solids are removed by vacuum pressure using backwash pump.
3. Disks rotates slowly and two disks are backwashed at a time.
4. Filtration is not interrupted.
5. Backwash solids are directed to the WAS Tank.

Solids Wasting Mode:

1. Heavier solids the from the collection hopper are removed on an intermittent basis.
2. The Backwash/solids pump provides suction to the solids collection manifold to remove the settled solids.
3. Solids are pumped to the WAS Tank.

Floatable Wasting Mode:

1. Floatable scum is allowed to collect on the water surface.
2. After a certain number of backwash cycles, the water level is allowed to rise above the preset high level.
3. As the water level increases, floating scum is removed by overflowing the scum removal weir.
4. The scum is pumped to the WAS Tank.

See Figure 4.1 below for cross section representation of the filtration system.

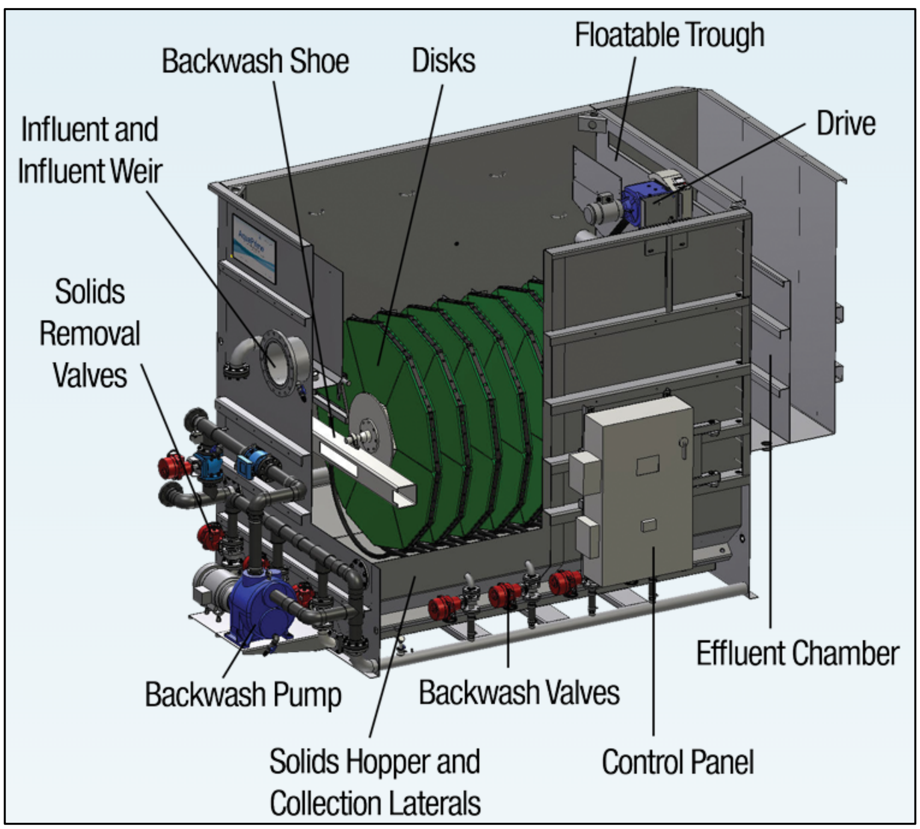


Figure 4.1: Cross Section View of Filtration System

Solids Handling System:

The Sludge Handling Facility will receive solids from the WAS Tank, which collects solids from the new filtration system and both existing clarifiers. These solids will be thickened to a 4-5% solid concentration via a gravity belt thickener. After the solids are thickened, the solids will be pumped to a sludge holding tank, from which the solids will be withdrawn and hauled off via a tanker truck for further treatment at the MB WWTP. The overall process of solids control seen by the thickener will be controlled on the influent side by the pump from the WAS Tank and controlled on the effluent side by the pump to the sludge holding tank.

In a gravity belt thickener, the sludge solids concentration is increased along the length of a porous belt as water drains through it, the sludge solids forming a layer on the belt surface. The belt is continuously recirculated, as with a classical conveyor belt, and the thickened solids are allowed to fall off the end into a collector vessel – often assisted by a scraper. The filtrate is collected in a submersible pump and sent to the sludge holding tank. The gravity belt thickener has the following accessories to aid in the overall thickening process:

- ◊ Center-Pivot alignment design allows for adjustments on both sides reducing potential for blinding and extends the belts life by making corrections faster and smoother.
- ◊ Pneumatic actuator lifts allows the plow assembly to lift for easier cleaning, eliminating manual lift of each plow.
- ◊ Pneumatic controlled rigid tensioning assembly adjusts and maintains belt tension with parallel movement for extended belt life.
- ◊ Individual adjustable UHMW polyethylene plows are free floating but properly weighted to always maintain contact with belt.

See Figure 4.2 representing the overall simplified process of the gravity thickening belt.

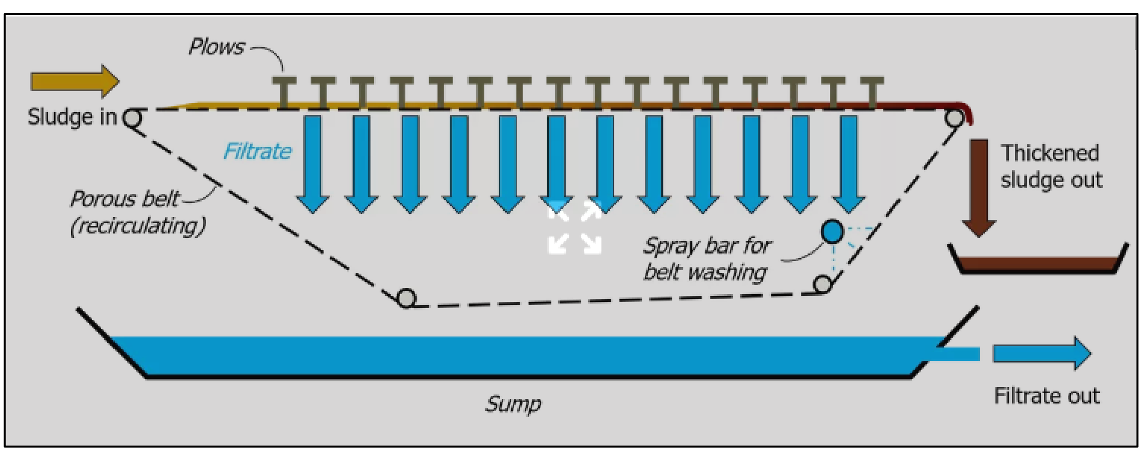


Figure 4.2: Gravity Belt Thickener Schematic

A polymer/conditioner system will be installed as part of the overall solids handling facility prior to the thickener by dosing with inorganic coagulants (such as iron or aluminum) and/or organic flocculants (or polymers). The polymer system will aid to coalesce the smaller sludge particles into larger flocs, and to

reduce the colloidal content of the particulate matter. This then increases both the particle sedimentation rate and the permeability of the cake, the solids sediment formed from the particles. In doing so, the efficiency of the downstream thickening and dewatering processes is increased.

Chlorine Contact Chamber

A new chlorine contact chamber would be added and sized to meet observed influent flow rates. The design will meet TDEC design criteria regarding contact duration required to disinfect. The approximate size is 25-ft by 40-ft with a four baffled wall flow pattern. A 12.5-percent sodium hypochlorite solution will be added at the most upstream location and dechlorination via a 38-percent sodium bisulfite solution will be added at the most downstream location to aid in reduction of chlorine residuals.

Side-Stream Monitoring

When wastewater is bypassed around the biological treatment unit the following parameters will be monitored and information recorded as required by Section VII Paragraph 28.b.5 of the CD:

- ◊ The final outfall will be monitored for permit compliance with 24-hour composite sampling on all controlled parameters.
- ◊ The internal outfall will be monitored for Total Suspended Solids and 5-day Biochemical Oxygen Demand (24-hour composite sampling, as well as precipitation data from when the diversion occurred until the end date.
- ◊ The volume of water diverted during the event.
- ◊ The duration of the diversion including start/end time, flow rate when the diversion commenced, and maximum flow rate during the event.

Information gathered will be included in DMRs as well as Quarterly Reports to the EPA. Additionally, a notice will be posted to the web when wastewater is diverted and testing results will be added to the Public Document Repository, which was created as stipulated by the CD.

As detailed in Section VII, paragraph 28.b.(2) of the CD, WWTA is required to phase out the diversion of water around the bacteriological treatment unit within 20 years of the Effective date of the Consent Decree. Within 10 years the diversion will occur a maximum of 7 days per month, and by year 15 diversion will occur a maximum of 5 days per month.

Optimization Plan

Investigation of the existing biological system will be performed, while the filtration system acts as the sole treatment process in addition to disinfection. While the CSB and secondary clarification basin are down, each basin will be pumped down of all water and cleaned via spray washing. Once clean, each basin will be inspected via three-dimensional laser scanning survey to see the conditions of all internal piping and structures.

While there are unknowns, it is likely to be discovered the internal components of each basin are in poor condition, especially the CSB since it has been in service longer (53 years). Necessary repairs include but are not limited to replacing deficient air piping and diffusers, additional blowers and/or replacement, baffle wall replacement, and removing all wastewater and solids from the system. The former thickener and digester sections, which are currently unused dead zones with no treatment being performed, is likely to be rehabilitated and will serve as an expanded treatment section with additional aeration.

It is expected that with the Remediation Plan in conjunction with this Optimization Plan, would increase the biological capacity of the plant. This alternative eliminates all non-treated bypassing while meeting NPDES end of pipe permit limits.

Sewer Rehabilitation

WWTA is currently working on a long-term sanitary sewer rehabilitation program to reduce I/I entering the system and eliminating sanitary sewer overflows in the collection system. This program will be a phased program to gradually reduce the I/I entering the system to restore hydraulic carrying capacity and reduce the wet weather flows to the Signal Mountain STP. The order of the sub basins to be addressed is currently listed in the preliminary priority Groupings within the Consent Decree and will be further clarified in the Sanitary Sewer Evaluation and Rehabilitation Program. WWTA has received funding through the American Rescue Program and begun the preliminary investigations and engineering studies and designs in the priority basins within the collection system.

5. Schedule and Public Notification

5.1. Schedule

The Remediation Plan will be put into action once it has been submitted to TDEC and the EPA. Construction and implementation of the remediation plan laid out in **Alternative 3** will be completed within 5 years (60 months) of submittal. A detailed schedule for Signal Mountain Remediation and Optimization can be found in Appendix III.

WWTA will submit a WWTP Optimization Plan for Signal Mountain within 13 months of Remediation Plan construction completion. If the EPA and TDEC do not approve of the Optimization Plan WWTA will submit a revised plan within 30 days of receiving comments. Once the EPA and TDEC approve of the WWTA Optimization Plan, work on it will begin and will conclude within 36 months (3 years) of approval. The end date for completion of the Optimization plan shown in Table 5.1 assumes that the EPA and TDEC approved of the optimization plan on the first submittal. If the plan needs to be revised the Optimization Plan time frame will be shifted to allow for 36 months for construction from when the plan is approved.

Within 90 days of Optimization Plan approval WWTA will apply for a modification or reissuance of Signal Mountains NPDES permit to meet the optimized flow capacity.

Starting at the Effective Date work will be conducted to reduce I/I into the system in order to meet Section VII, paragraph 28.b.(2) of the CD and will be completed within 240 months (20 years) of the Effective Date, see Appendix III. Within 10 years of the effective date diversion around the WWTP will be limited to a maximum of 7 days per month and by 15 years after the effective days diversion will only occur a maximum of 5 days per month. Diversion around the biological treatment system will eliminated by 20 years after the Effective Date as shown in Table 5.1 below.

Table 5.1: Consent Decree Deadlines

Item No.	Consent Decree Requirement	CD Required Deadline (Months)
1	Effective Date	0
2	Remediation Plan	2
3	Completion of Construction Remediation Plan	62
4	WWTP Optimization Plan	75
5	NPDES Permit Modification TDEC Submittal	78
6	NPDES Permit Modification TDEC Review	84
7	Completion of Construction Optimization	111
8	Diversion around WWTP	
a	Max of 7 days per month (12-month rolling average)	120
b	Max of 5 days per month (12-month rolling average)	180
c	Eliminate WWTP Diversion around Biological Treatment	240

5.2. Public Investment/ Public meeting

Details regarding the public impact of the work considered in this document will be divested to the public via public forum and through publishing in local newspapers. All meetings and questions will be recorded and released in a timely manner.

WWTA will provide a 45-day comment period to the public, and will consider these comments for 15 days before submitting the Remediation Plan to the EPA and TDEC.

WWTA will hold two meetings for public comment on the Remediation Plan, one in Signal Mountain the other in Red Bank. These meetings will be held within the public comment period no less than 14 days before the comment period closes.

Notice of Public meetings will be:

- Sent to WWTA customers by mail/email
- Placed in the Chattanooga Times Free Press and Chattanooga News Chronical
- Posted on the WWTA website and social media
- Sent to community groups by mail/email

Comments received as well as WWTAs responses to comments can be found in Appendix IV.

Appendix I: LJA Pilot Study Report

Technical Memorandum For HCWWTA Signal Mountain STP Pilot Test Study

Prepared by LJA Engineering, Inc.
Chattanooga, TN
February 2022

we
seek
solutions.

LJA ENGINEERING

Table of Contents

1. Background

1.1. Statement of the Problem

Hamilton County Water and Wastewater Treatment Authority (HCWWTA) is currently in negotiations with multiple parties including the City of Chattanooga, the U.S. Environmental Protection Agency Region 4 (EPA); the U.S. Department of Justice (DOJ); and the Tennessee Department of Environment and Conservation (TDEC) regarding a potential Federal Consent Decree (CD) for the wastewater collection system. In addition to the ongoing Federal CD negotiations, the Owner has received and entered into a Consent Order (CO) with TDEC concerning Notice of Violations (NOVs) at the Signal Mountain Sewage Treatment Plant (STP) on November 2, 2018.

A Corrective Action Plan/Engineering Report (CAP/ER), as required by this Order, was prepared by LJA Engineering (ENGINEER) and submitted to TDEC on April 26, 2019. TDEC reviewed and approved the CAP/ER on October 31, 2019. The CAP/ER specifically addressed the minor NOV's at the plant, with the final disposition of the unpermitted wet weather discharges at the STP to be addressed during the negotiations of the Federal Consent Order and agreements with the City of Chattanooga. During the initial investigations in preparation of the CAP/ER report, it was determined that a Preliminary Engineering Report (PER) for the Signal Mountain STP will be required to determine the most technically feasible and affordable solutions for the long-term disposition of the Signal Mountain service area flows. The STP currently receives an average daily flow of 350,000 gallons per day (gpd). The STP's NPDES permit allows a maximum flow of 400,000 gpd. During certain wet weather events, the STP receives up to 5.035 million gallons per day (MGD) of flow. Currently, the STP has the capacity to treat up to 0.8 MGD of flow. When flows exceeding the treatment plant's capacity are seen at the headworks of the STP, the excess flow is bypassed around the biological treatment process to the chlorine contact chamber where the wastewater receives disinfection before discharge to the Tennessee River.

This report was prepared to summarize efforts made by the ENGINEER to address wet weather flows that exceed the capacity of the STP by utilizing a cloth disk filtration as a viable solution to address current NPDES NOV's while meeting current NPDES permit limitations.

1.2. Summary of the Alternative Solutions Considered

Three manufacturers of the cloth disk filtration technology were considered and engaged to participate in this pilot test study. However due to logistics of providing the equipment to the site and working during the time period given, only one manufacturer, Aqua Aerobics, was able to participate in the pilot test study.

2. Pilot Testing Setup

The Aqua Aerobics AquaPrime® cloth disk filtration pilot unit was placed in the open field space just north of the contact stabilization basin. The open field space was cleared and graded with stone by Higgins Construction. Once the area was stabilized, B&B Erection crane company mobilized on site with a crane and bobcat to help set the units and the ancillary equipment (effluent tanks, pumps, and totes) in place. Higgins Construction also assisted with cleaning out the headworks and setting an influent pump to supply wastewater to the pilot unit during operation. This work was completed in late November and into early December 2021. See Figure 1 below showing the general layout of a traditional AquaPrime® cloth disk filtration unit.

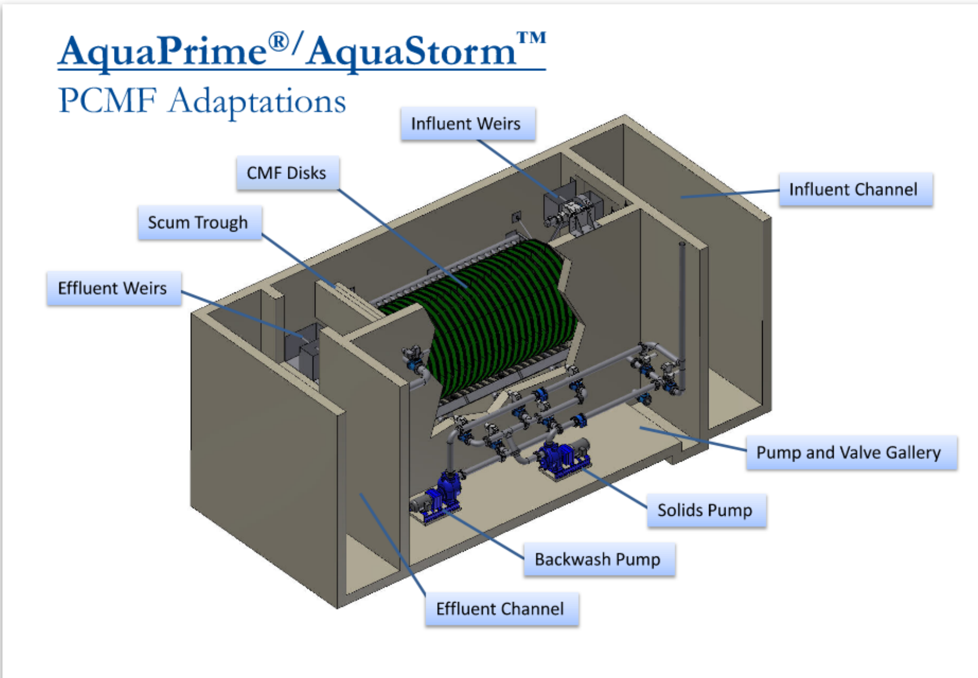


Figure 1 – Traditional AquaPrime® Layout

Piping associated with the pilot unit consisted of an influent line leading from the headworks to the pilot unit. All effluents from the pilot unit, backwash from cycling and cleaning the unit, and solids pumps from the unit were all sent to the effluent tank provided. From the effluent tank, all combined wastewater was pumped (via primary and secondary means) to the start of the primary contact stabilization basin for treatment.

Aqua Aerobics staff then began putting the pilot unit into operation over the next couple of weeks including troubleshooting issues encountered during setup. Higgins Construction remobilized and set a new primary effluent pump in the effluent tank since the required pressure was not being supplied. During setup, Aqua Aerobics staff trained LJA Employees on local and remote sampling operations of the unit and how to observe data in real time. After completing final installation, the unit was ready to collect the first sampling event on December 17, 2021, and last collected on March 1, 2022. See Figures 2 and 3 for setups of the system.

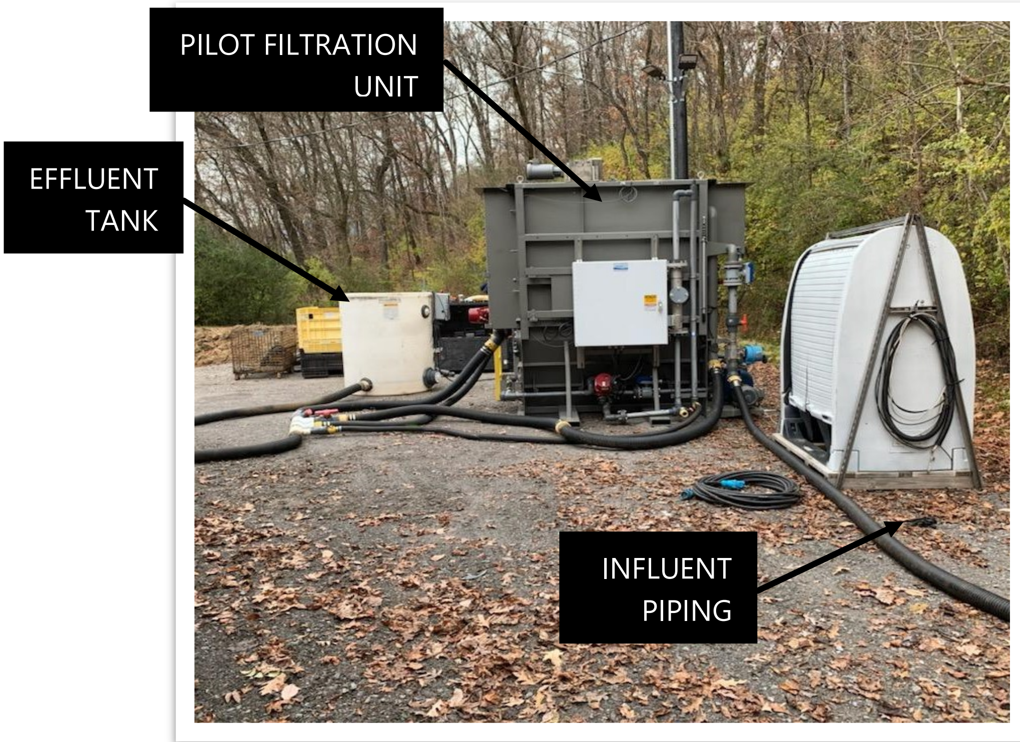


Figure 2 – Pilot Filtration System Setup Picture

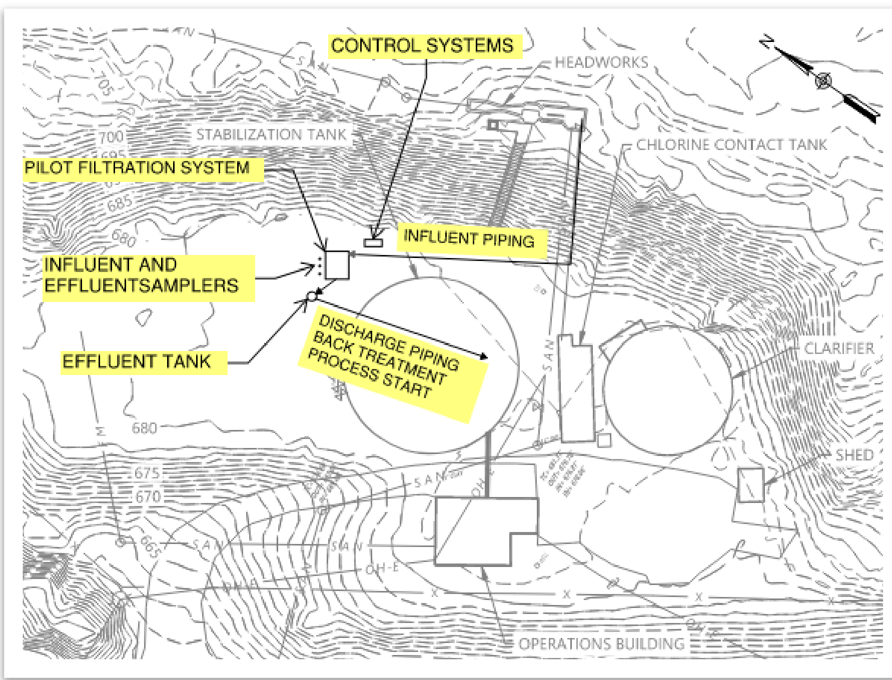


Figure 3 – Pilot Filtration System Setup Schematic

3. Pilot Testing Sampling Protocol

The Testing Protocol was adjusted multiple times throughout sampling as CD negotiations with the EPA and TDEC continued and technical conversation with Aqua Aerobics advanced. Initially, the sampling protocol was designed to test only during wet weather events and sample both influent and effluent hourly over a 24-hour period to capture the first flush resulting from a rain event. More specifically, the "first flush" refers to the sediment resting within sewer pipes that is flushed out of the collection/transmission system and enters the plant after the occurrence of a stand-alone rain event, resulting in higher loading concentrations. After realizing future operation of the unit could occur outside of first flush and wet weather events, the unit was tested during dry weather conditions and/or other periods where high Total Suspended Solid (TSS) and Biological Oxygen Demand (BOD) concentrations were present outside of direct wet weather events.

The protocol then shifted to testing one 24-hour composite sample during dry weather conditions or expected low loading TSS and BOD concentrations. Using the turbidity meter set up in the influent portion of the pilot unit, live data could be tracked to expect these loading concentrations. In the event of wet weather or expected high load TSS and BOD concentrations, the protocol was to continue hourly testing until the high load TSS and BOD concentrations subsided to the base dry weather loadings.

As sampling continued with the revised protocol, troubleshooting solutions for the influent and effluent samplers experiencing malfunctions were undertaken, as both encountered errors in collection. Several occurrences of empty and incomplete sample bottles were recorded. To fix the issue, LJA staff worked with Aqua Aerobics staff in changing mechanical parts as well as changing the configuration of the samplers' programming. With the effluent sampler experiencing the majority of issues, a second effluent sampler was brought onsite to ensure necessary and adequate samples were being taken.

The last revision to the sampling protocol was performed after realizing some of the dry weather conditions or low load TSS/ BOD concentrations, were not giving us the full data spectrum to realize efficiency and removal rates. A change was made for these events to sample four daily sampling composites on a quarterly basis with each quarterly sample consisting of six hourly samples collected during low load concentrations for each day. The wet weather event or high load TSS/BOD sampling protocol did not change from hourly collection for the necessary period. See table 1 below for a summary of the protocol revisions.

Sampling Protocol	Dry Weather & Low Loads Sampling	Wet Weather & High Loads Sampling
Original Plan	No Sampling	Yes, 24 individual hourly samples
Revision 1	Yes, one 24-hour composite sample	Yes, 24 individual hourly samples
Revision 2	Yes, 6-hour quarterly composite samples	Yes, remaining individual hourly samples

Table 1 – Sampling Protocol Revisions

4. Sampling Data Results and Analysis

Lab results were collected by Microbac Laboratories. For each collection date, LJA staff met with a Microbac representative on site to collect the samples and determine what the testing protocol would be for the previous 24-hour collection. Additionally, the influent and effluent sampler bottles were properly emptied, washed, and reset to collect during the next sampling event.

4.1. Dry Weather Conditions/Low Load Concentrations

A total of eleven (11) dry weather days were recorded for analysis. Three (3) days were removed from the analysis due to the influent and/or effluent sampling equipment malfunctioning. While the intention was to collect samples throughout the entire day, errors in collection at times reduced the number of samples analyzed. This is reflected in days with less than 4 quarterly composite samples. The efficiency results for the pilot unit are recorded in table 2 along with the sampling protocol used for each day and the corresponding influent flow rates for the STP.

Date	Sampling Protocol	Average Daily Influent Flow Rate (MGD)	BOD % Removal	TSS % Removal
1/18/2022	1 24-hour composite sample	0.360	37.1	69.0
1/21/2022	4 quarterly composite samples	0.197	45.0	73.7
2/2/2022	2 quarterly composite samples	0.419	60.2	82.1
2/8/2022	4 quarterly composite samples	0.298	40.5	64.3
2/9/2022	4 quarterly composite samples	0.269	57.8	66.3
2/10/2022	4 quarterly composite samples	0.326	50.8	68.9
2/11/2022	2 quarterly composite samples	0.320	33.9	61.7
2/15/2022	4 quarterly composite samples	0.315	52.4	74.3
2/16/2022	3 quarterly composite samples	0.352	71.1	74.1
2/17/2022	4 quarterly composite samples	0.385	54.4	74.2
3/1/2022	4 quarterly composite samples	0.191	46.6	75.9

Table 2 – Dry Weather Sampling Events

The average removal rate during the dry weather days was **50.0%** for BOD and **71.4%** for TSS. Figures 4 and 5 below show the influent and effluent concentration values for BOD and TSS during each event with the average percent removal trendline overlaid.

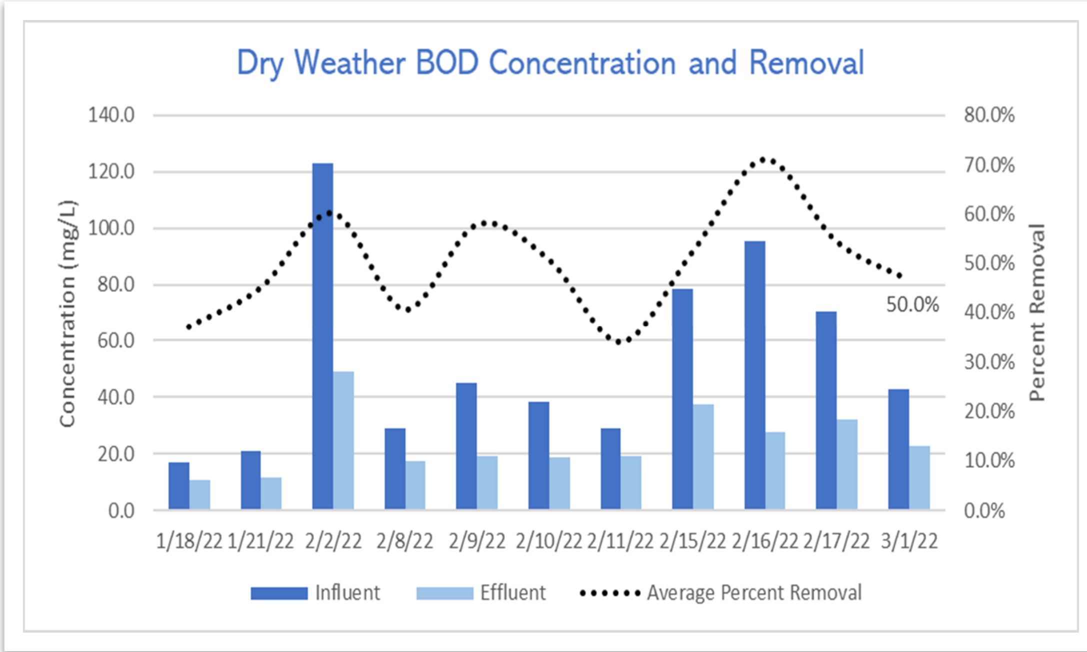


Figure 4 – Dry Weather BOD Percent Removal

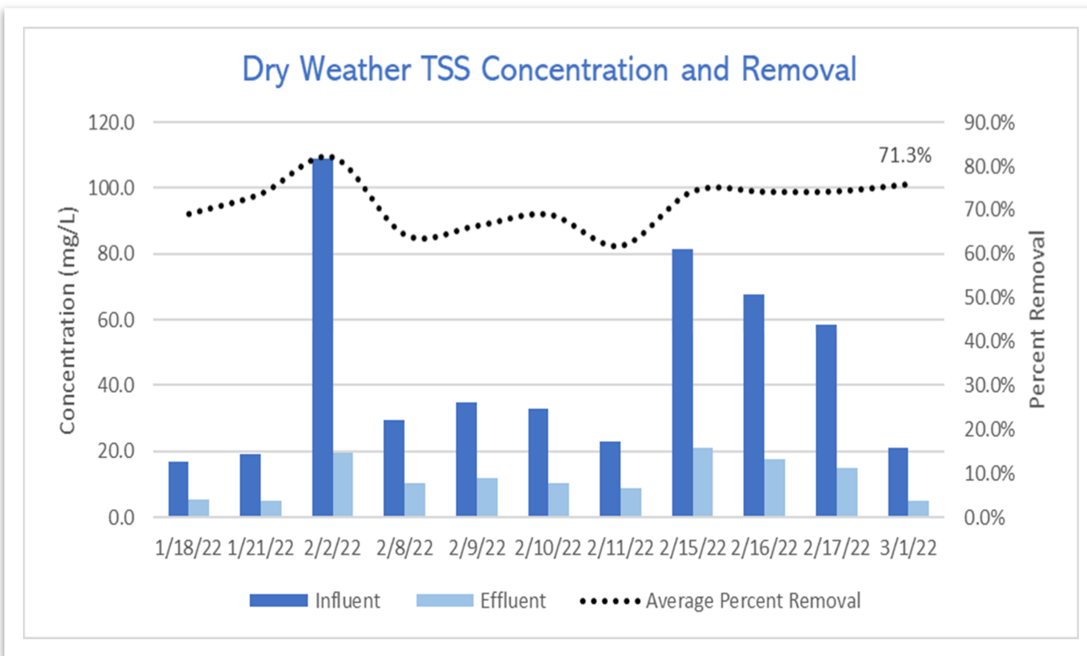


Figure 5 – Dry Weather TSS Percent Removal

4.2. Wet Weather Event/High Load Concentrations

A total of nine (9) wet weather days were recorded for analysis. One (1) day was removed from the analysis due to the effluent sampling equipment malfunctioning. A combination of quarterly and hourly samples was taken on days in which the rain event started much later than the sampling start time. Quarterly samples were also taken for wet weather events that lasted prolonged periods of time, since the “first flush” had already been collected. These 8 days are reflected in table 2 with the sampling protocol used for that day, the precipitation amount, and the average daily influent rate incoming to the STP.

Date	Sampling Protocol	Average Daily Influent Flow Rate (MGD)	Precipitation (in.)	BOD % Removal	TSS % Removal
12/19/2021	24 individual hourly samples	1.052	0.11	65.9	84.6
1/17/2021	24 individual hourly samples	1.781	0.46	80.0	82.2
2/3/2022	24 individual hourly samples	1.114	2.17	70.3	86.8
2/4/2022	2 quarterly composite samples	3.302	1.02	42.7	72.4
2/18/2022	24 individual hourly samples	0.564	1.76	65.4	83.3
2/22/2022	24 individual hourly samples	0.423	0.58	70.3	76.9
2/23/2022	2 quarterly composite samples & 12 hourly samples	1.814	3.00	72.9	74.5
2/24/2022	4 quarterly composite samples	1.868	0.19	86.6	67.2
2/25/2022	4 quarterly composite samples	1.857	0.37	66.8	61.2

Table 2 – Wet Weather Sampling Events

The average removal rate during the wet weather days was **69.0%** for BOD and **76.6%** for TSS. Figures 6 and 7 below show the influent and effluent concentration values for BOD and TSS during each sampling event with the average percent removal trendline overlaid.

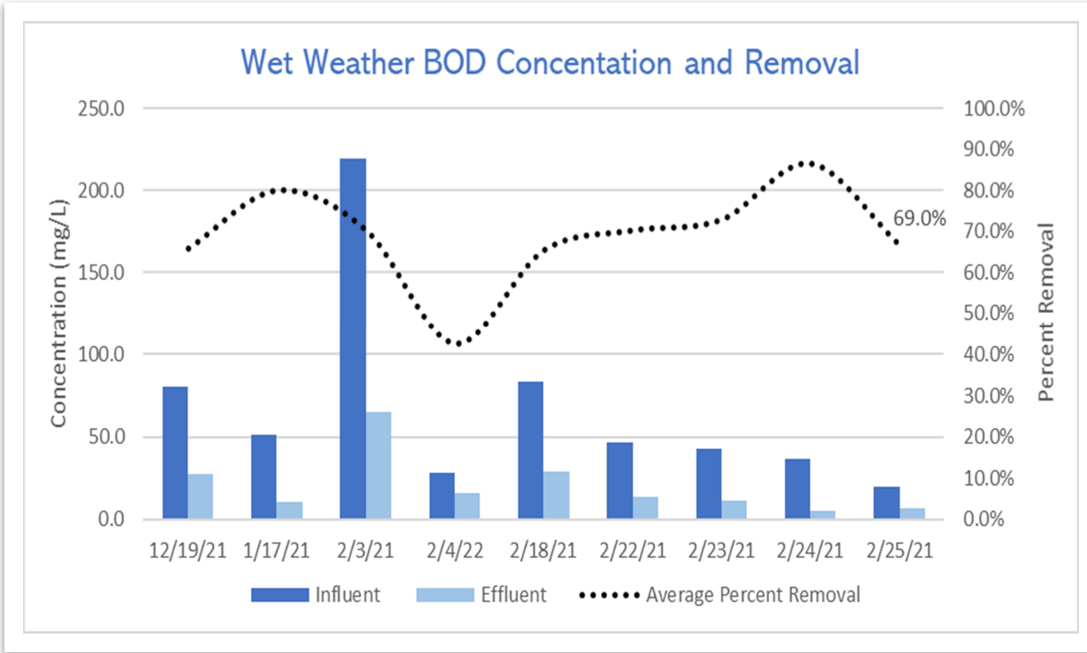


Figure 6 – Wet Weather BOD Percent Removal

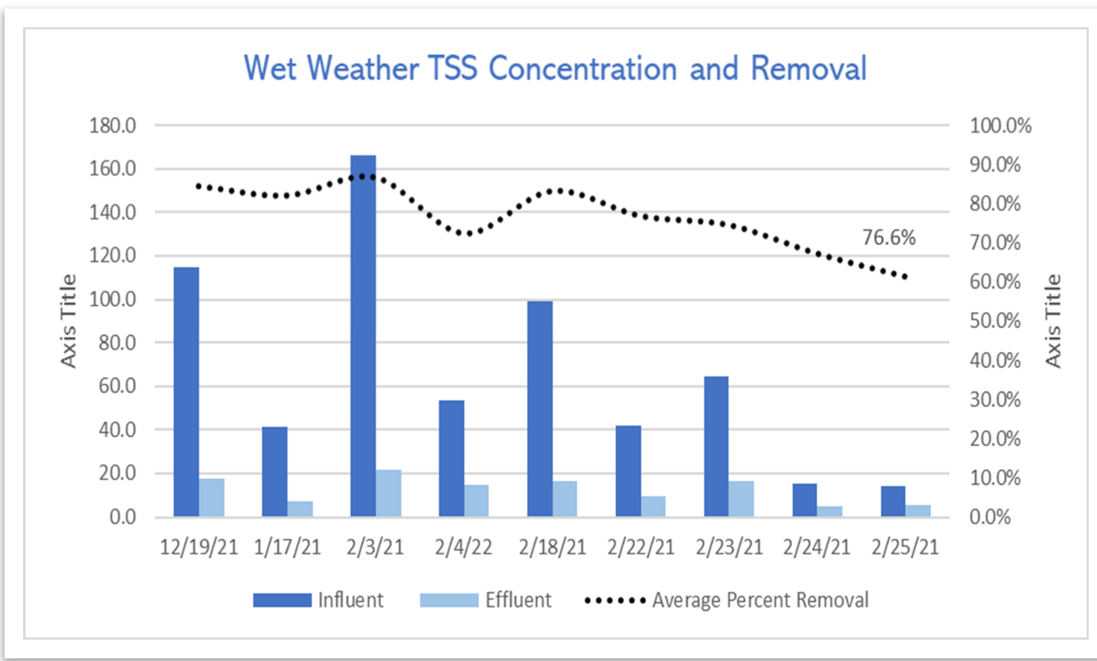


Figure 7 – Wet Weather TSS Percent Removal

5. Conclusion

5.1. Removal Percentage Comparisons

The percent removal averages for the dry weather conditions and wet weather storm events were as expected based on previous studies conducted by Aqua Aerobics, see Figure 8 below.

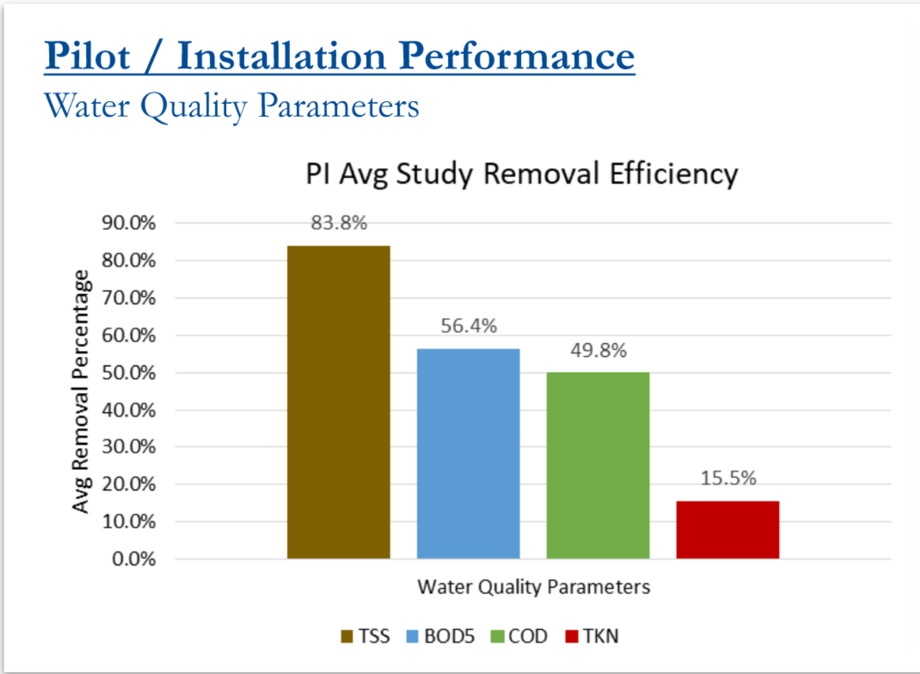


Figure 8 – Aqua Aerobics Pilot Testing Historical Data

From their previous studies, **56.4%** and **83.8%** were the percent removals for BOD and TSS, respectively. It is important to note that Aqua-Aerobics historical data is an average across multiple seasons, weather events, and influent conditions; whereas the scope of this study was limited to winter, the wettest season of the year. As such, dilute influent conditions were consistently present throughout the study, increasing the likelihood for lower removal efficiency. In comparing those historical percentages to our study for dry weather and wet weather for BOD, there is a notable difference in removal percentage for Dry Weather BOD of -14%, Dry Weather TSS of -17%, Wet Weather BOD of 22% and Wet Weather TSS of -9%.

While the removal percentages above are an average of several daily averages, when the "first flush," mentioned earlier, is considered, the removal rates are even more significant. For instance, for the wet weather event occurring on December 19, 2021, the first seven samples analyzed all had high BOD and TSS influent concentrations (over 100 mg/L). The average removal percentages for these samples were **74.1%** for BOD and **90.5%** for TSS, as shown in Table 3 below. Comparing this to the daily average percentage removal of **58.1%** for BOD and **73.2%** for TSS, demonstrates significant effectiveness under "first flush" conditions.

Sample Collect	BOD Influent (mg/L)	BOD Effluent (mg/L)	BOD Removal Percentage	TSS Influent (mg/L)	TSS Effluent (mg/L)	TSS Removal Percentage
1	330.0	84.9	74.3%	547.0	29.5	94.6%
2	136.0	46.7	65.7%	242.0	30.7	87.3%
3	121.0	41.0	66.1%	216.0	21.2	90.2%
4	123.0	38.8	68.5%	203.0	21.0	89.7%
5	114.0	21.6	81.1%	220.0	17.0	92.3%
6	117.0	27.0	76.9%	233.0	20.8	91.1%
7	106.0	14.5	86.3%	152.0	18.0	88.2%
Average			74.1%			90.5%

Table 3 – "First Flush" Removal Percentages

5.2. Permit Limit Comparison

Upon reviewing all 9 wet weather events and high load concentration data points and comparing to the current **NPDES daily maximum** effluent BOD and TSS concentration permit limits of **45 mg/L**, there was only one day on February 3, 2022 where the BOD effluent exceeded this (65.2 mg/L, influent was 219.5 mg/L). The TSS effluent did not exceed the permit limit.

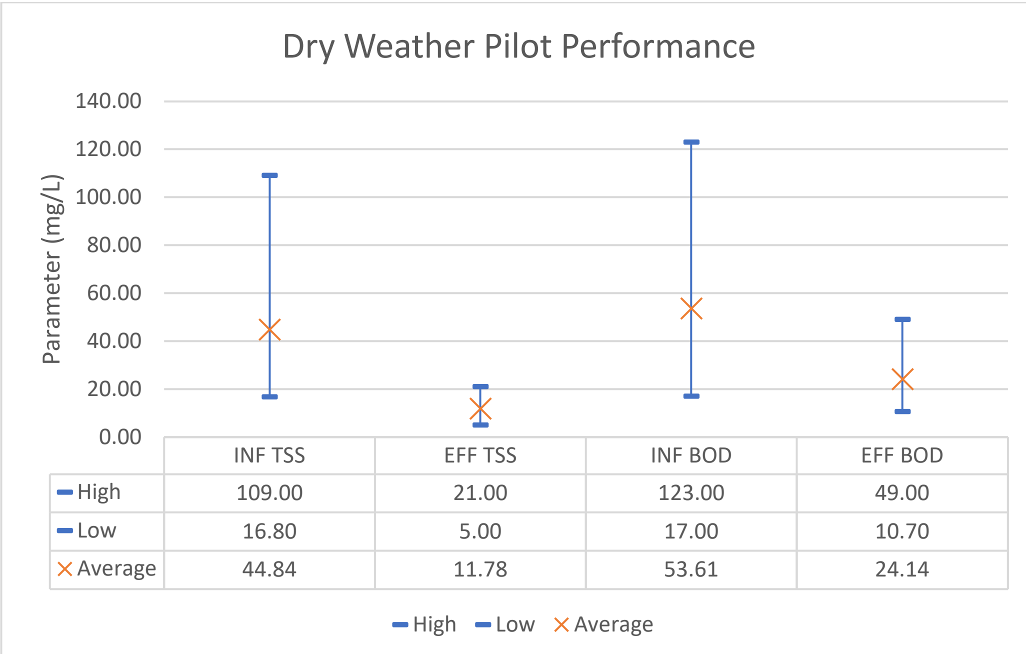
Upon reviewing all 11 dry weather and low load concentration data points and comparing to the current **NPDES daily maximum** effluent BOD and TSS concentration permit limits of **45 mg/L**, there was only one day, February 2, 2022, where the BOD effluent exceeded this limit (49.0 mg/L, influent was 123.0 mg/L). The TSS effluent did not exceed the permit limit.

Reviewing all 9 wet weather and 11 dry weather data points and comparing to the current **NPDES weekly and monthly** effluent BOD and TSS concentration averages permit limits of 40 and 30 mg/L, respectively, there were no weekly/monthly occurrences where neither BOD nor TSS exceeded these average permit limits.

Even in the event of high loading conditions, such as those seen on February 2nd and 3rd, it is still not likely that permit limits will be exceeded since the effluent stream from the AquaPrime unit will be combined with the effluent from the plants established biological processes. As such, TSS and BOD concentrations in the combined effluent streams will likely be lowered below threshold limits even under these rare extreme high load conditions.

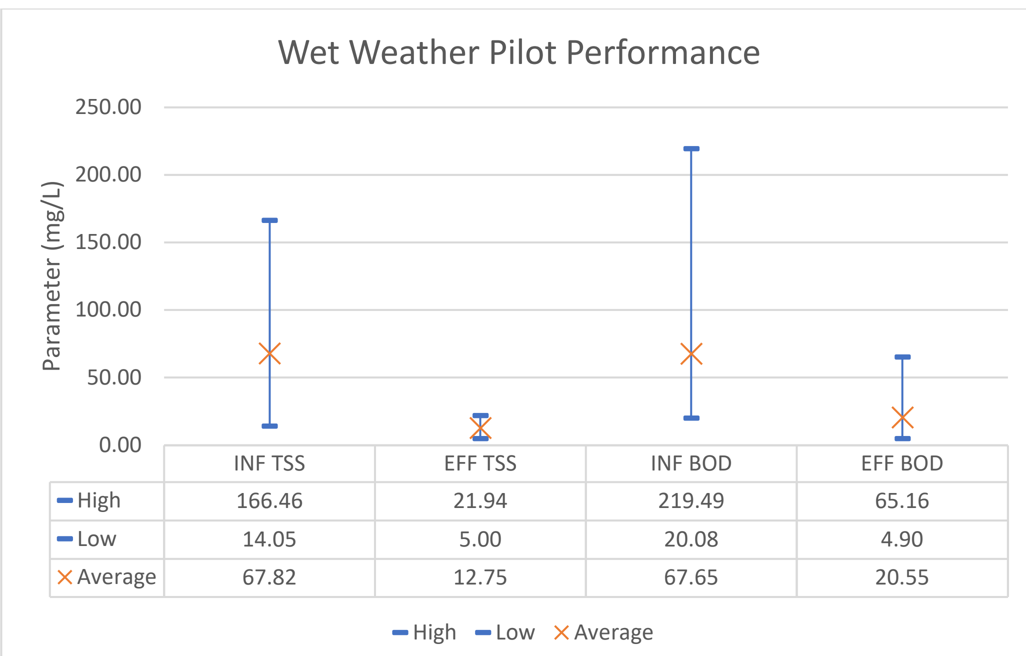
6. Recommendations

The pilot testing results met the performance expectations as realized through the lab data collected and analyzed and would be a feasible solution to address the current NOV's at the STP. The influent concentration loads were significantly reduced through the cloth disk filtration technology from Aqua Aerobics, especially during "first flush" events which tend to overwhelm the STP during operations. During dry weather operations of the pilot unit, data shows that removal percentages were still significant considering the lower load concentrations experienced. Figures 9 and 10 below show the ranges of influent and effluent concentrations, which demonstrate effectiveness during both wet and dry weather events.



	INF TSS	EFF TSS	INF BOD	EFF BOD
High	109.00	21.00	123.00	49.00
Low	16.80	5.00	17.00	10.70
Average	44.84	11.78	53.61	24.14

Figure 9 – Dry Weather Pilot Performance



	INF TSS	EFF TSS	INF BOD	EFF BOD
High	166.46	21.94	219.49	65.16
Low	14.05	5.00	20.08	4.90
Average	67.82	12.75	67.65	20.55

Figure 10 – Wet Weather Pilot Performance

LJA and HCWWTA have discussed potential operations of a permanent cloth disk filtration unit to alleviate the NOVs experienced at the STP. For the most efficient placement of the filtration system, it is recommended to install the unit subsequent to the headworks of the STP to act as both an advanced primary treatment and as a wet weather treatment system. The system would be in operation at all times, alleviating the load on the STP by decreasing load concentrations incoming to the biological treatment process. This would result in less oxygen demand, and thus increased biological STP capacity. If the system were installed only as a wet weather treatment (side stream) and online only intermittently, then the benefits of the alleviating the STP and increasing biological capacity would not be realized. The removal per dollar spent in this scenario would be lower as well, as intermittent operation requires the same initial investments.

The wet weather treatment option is only an interim solution while infiltration and inflow are being reduced within the collection system via rehabilitation and potential storage tank projects, which are currently being evaluated. Furthermore, it is more cost effective for this filtration system to act as an advanced primary treatment as well, compared to a dollar per gallon removed scenario in the rehabilitation and/or storage projects.

It is the intent of the Technical Memorandum to be incorporated into the overall Preliminary Engineering Report (PER) as part of the TDEC SRF Facilities plan submittal. The PER will go into further detail of the filtration system including initial costs and expected operation and maintenance costs through a 20-year life cycle.

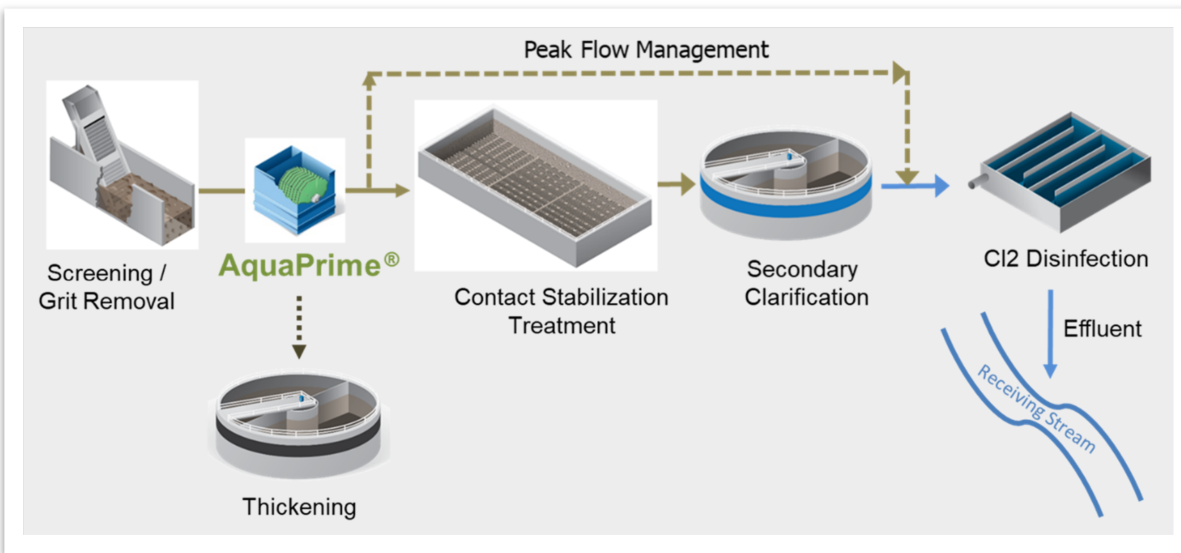


Figure 11 – Cloth Disk Filter Location Schematic

Appendix II: Evaluation of AquaStormTM Cloth Media Filtration Technology for Dual Use Advanced Primary and Wet Weather Treatment – Aqua-Aerobic Systems Report

Evaluation of AquaStorm™ Cloth Media Filtration Technology for Dual Use Advanced Primary and Wet Weather Treatment

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Testing conducted at:

Signal Mountain Wastewater Treatment Plant (SMWWTP)

Testing conducted for:

LJA Engineering, Incorporated

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

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Executive Summary

Aqua-Aerobic Systems Inc. (AASI) conducted a pilot study at the Signal Mountain Wastewater Treatment Plant in Signal Mountain, Tennessee. The purpose of this evaluation was to assess the performance of AquaStorm® pile cloth media filtration with OptiFiber PF-14® cloth media in its ability to handle the influent conditions to achieve advanced primary treatment under dry weather conditions, and wet weather treatment in a dual use application.

To evaluate the performance of the technology under dry weather conditions, the unit was subject to different hydraulic loading conditions ranging up to 6 gpm/sf of cloth media area. Composite samples were collected by auto samplers at discrete 1-hour intervals over a 24 hour period, and these 1 hour composites were combined into a single larger composite sample for TSS and CBOD analysis.

Under wet weather conditions, the hydraulic loading to the pilot was adjusted up to 6 gpm/sf to simulate the peak flow condition that may be seen during these wet weather events. Under these conditions, individual 1 hour influent and effluent composites were collected as with the dry weather scenario. However, these samples were not combined, but rather separately analyzed for TSS and CBOD to track performance of the technology over the course of a wet weather event.

Samples were collected and analyzed by an independent, third party contractor (Microbac Laboratories, Incorporated). This filtration study utilized a single disk Aqua MiniDisk® cloth media filter (CMF) equipped with OptiFiber PF-14® MicroFiber cloth filtration media, which has a nominal filtration rating of 5 microns.

Below is the summary of the removal percentages from lab data collected during the study under both dry weather and wet weather conditions:

Primary Treatment Summary Data (Dry Weather)	
Parameters	**% Removal**
TSS	68%
BOD5	52.1%

Wet Weather Summary Data			
Event	Weighted Average TSS Removal %	Weighted Average CBOD Removal %	HLR (gpm/sf)
1	66.3	55.2	4
2	73.1	61.3	4
3	84.5	66.3	4
4	77.8	60.2	4
5	66.3	55.2	6
6	68.7	67.6	6

FINDINGS

- AquaStorm™ technology with OptiFiber® PF-14 cloth media achieved substantial TSS, CBOD removal rates under both dry weather and wet weather conditions under a variety of solids and hydraulic loading conditions. Average effluent TSS and CBOD values were well below permit requirements of 30/30 mg/L CBOD/TSS. This level of performance was achieved without chemical pretreatment.
- Wasting rates under dry and wet weather conditions were modest, averaging 5.5% of forward flow for dry weather events and between 4-20% for wet weather events.
- Based on the pilot study results, it is recommended that the wet weather AquaStorm™ filter be designed at a maximum peak solids loading rate of less than 15 $lbs/ft^2/day$ for a peak hour flow condition or up to 6.5 gpm/ft^2 for peak hour flow condition as long as the solids concentration is less than 15 $lbs/ft^2/day$. Under dry weather conditions, it is recommended to limit hydraulic flux to 4 gpm/ft^2 and solids loading to less than 10 $lbs/ft^2/day$. By keeping the loading to the recommended maximum design conditions, this will reduce the backwash frequency during the higher solids events.

1. Introduction

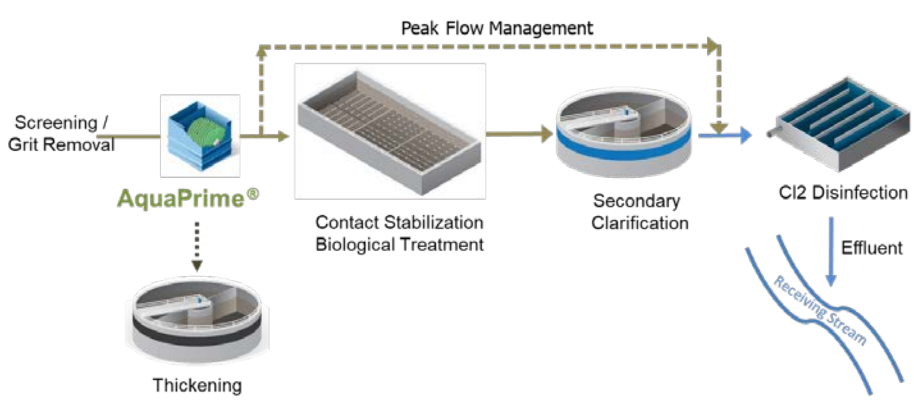
The Signal Mountain Wastewater Treatment Plant (SMWWTP) currently has a permitted capacity of 0.400 MGD but has an assumed design capacity of 1.3 MGD. The SMWWTP experiences large quantities of infiltration and inflow (I/I) during rain events, increasing influent flows to the plant up to a historical peak of 5.0 MGD (15-minute instantaneous peak). Any excess flow over 1.3 MGD has historically been routed around the biological portion of the SMWWTP and through the disinfection process and released into the Tennessee River and reported as a bypass to TDEC.

The Hamilton County Water and Wastewater Treatment Authority (HCWWTA), which owns and operates the plant, wishes to consider the use of pile cloth disk filters to treat wastewater prior to disinfection and discharge. Pilot testing was undertaken to establish the feasibility of this technology in this service. Aqua-Aerobic Systems, Inc. (AASI) conducted a pilot-scale wet weather study using a single AquaStorm™ MiniDisk Pile Cloth Media Filter (PCMF) equipped with OptiFiber® PF-14, a cloth filtration medium designed specifically for wet weather and combined sewer overflow (CSO) / sanitary sewer overflow applications. The PCMF is specifically designed to treat the influent conditions that are seen during wet weather events. This technology has been demonstrated at several facilities including Fox Metro WWTP, IL; Wood Dale, IL; Rushville, IN; Little Rock, AR; and Johnson County, KS. For the purposes of the application of this pilot study, OptiFiber® PF-14 Cloth Filtration Media has been selected due to its nominal 5 µm openings which provide for a high level of solids removal. The fibers in PF-14 media are finer and more densely packed relative to other cloths offered by AASI and can therefore provide a more consistent and higher quality effluent.

A separate party under direct contract with LJA Engineering, Incorporated provided sample collection and sample analysis to demonstrate the pilot's performance and reliability through six (6) storm events in which excess flow over 0.7 MGD are detected. The unit was also tested between rain events to assess their performance on non I/I-diluted wastewater.

2. Objectives

The purpose of the pilot study was to assess the performance of AquaStorm™ Pile Cloth Media Filtration with PF-14 cloth media to demonstrate and achieve advanced primary treatment and wet weather treatment in a dual use application. Below is the proposed flow diagram for the potential application:



Several parameters were examined throughout the pilot study. They are as follows:

- Influent and effluent TSS
- Influent and effluent cBOD
- Influent and effluent turbidity
- Volume of backwash and solids waste

3. Methods and Materials

3.1. Pile Cloth Media Filtration Process Description

The AASI pilot unit used for this study was the MD-12 PCMF pilot system, depicted below in Figure 1. The system is free-standing and consists of a full-scale, single disk, AquaStorm™ MiniDisk® PCMF with 10.8 ft^2 of effective filtration area, chemical feed pumps, flocculation tanks, piping and valves, magnetic flow meters, and effluent, overflow, backwash, and drain lines from the unit.

Figure 1: AASI MD-12 Pilot Unit.

The AquaStorm™ Pile Cloth Media Filter features an outside-in flow path, which allows for three zones of solids removal as shown in Figure 2. These zones are especially critical in primary and wet weather applications due to the high solids typically associated with primarytreatment and the first flush following a wet weather event.

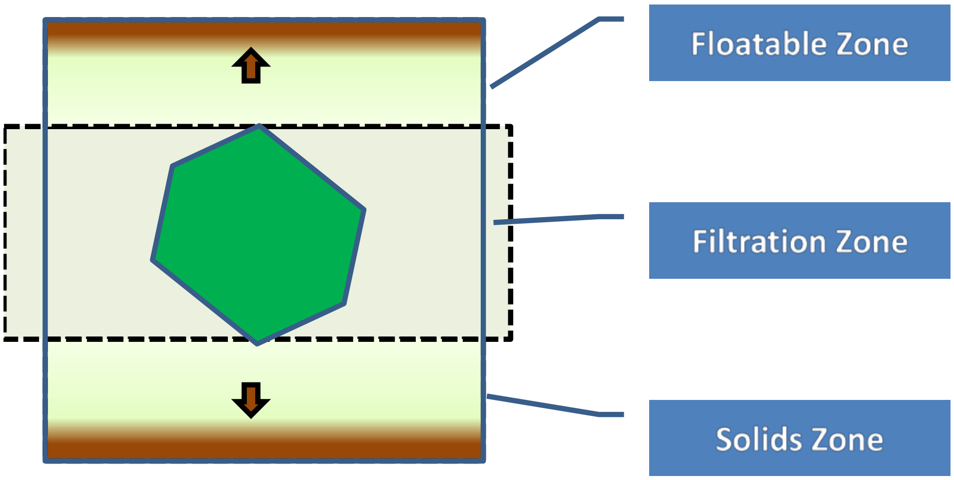


Figure 2: AquaStorm™ Process Diagram.

Floatable Removal Mode

The top zone is the "floatable zone" where surface materials such as fats, oils and grease are allowed to collect on the water surface. Solids are removed from this zone by allowing floating material to overflow a scum weir several times each day. Figure 3 shows the removal of the floatable material.

Figure 3: Floatable Removal Zone.

Filtration Mode

The middle zone is the "filtration zone" where solids are removed through filtration. Here, solids deposit on the outside of the cloth media, forming a mat as filtrate flows through the media. Figure 4 shows the filtration of solids on the cloth media through the outside-in process.

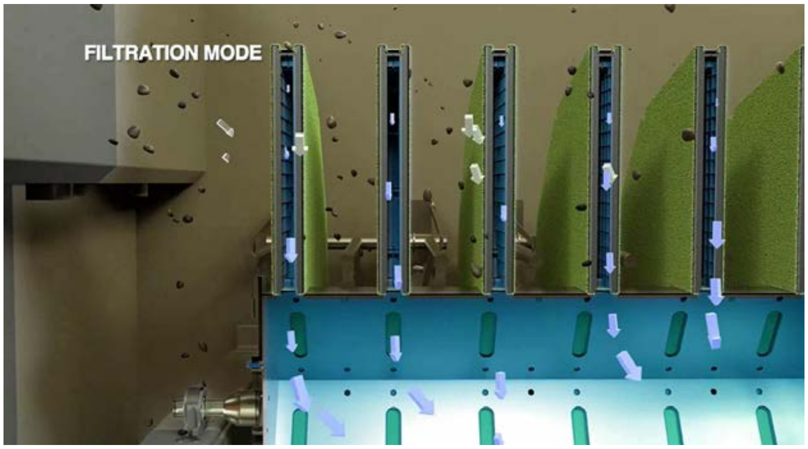


Figure 4: Filtration mode.

Backwash Mode

The buildup of solids on the media creates hydraulic resistance to flow through the media and causes the water level in the tank to rise. Upon reaching a specific basin level or elapsed time period, the disks will begin to rotate and backwash mode will be automatically initiated to clean the pile cloth media. Backwash initiation is shown in Figure 5.

Figure 5: Backwash initiation.

The backwash pump draws filtered water from the inside of the disk through the media and removes solids from the media's surface, as seen in Figure 6. Solids are backwashed from the pile cloth media surface by liquid suction through backwash shoes positioned on both sides of each disk. These spring loaded backwash shoes, depicted in Figure 7, contact the pile cloth media to provide the necessary suction for optimum cleaning efficiency.

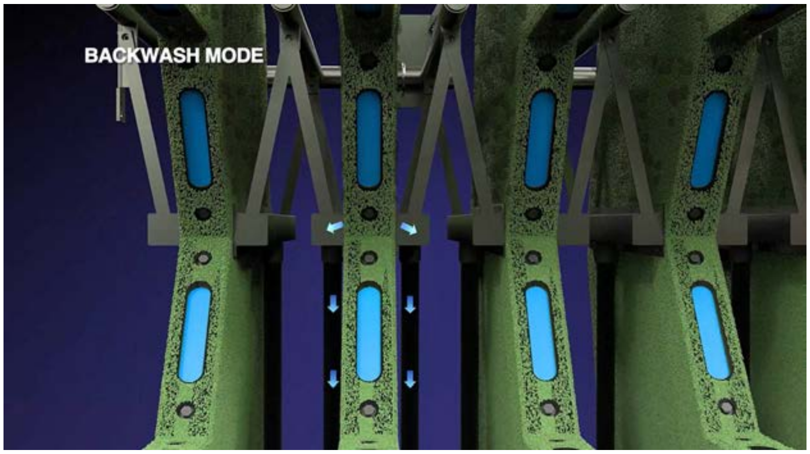


Figure 6: Backwashing from the inside-out.

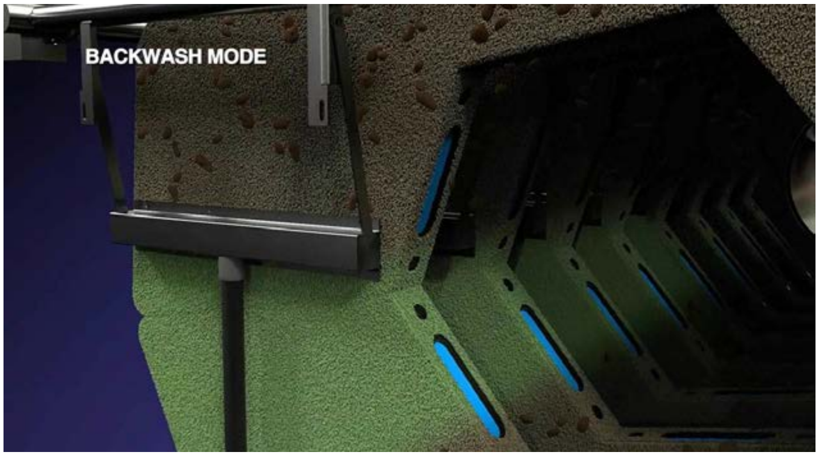


Figure 7: Backwashing and removal of solids.

During backwash disks rotate slowly while a backwash/waste pump (not shown) draws filtered water from the centertube through the pile cloth media on an inside-to-outside, or reversed, flow path. This provides effective cleaning of the pile cloth media over the entire disk. By the end of the backwash cycle, the basin water level returns to its normal operating level.

The backwash process fluidizes fibers to provide an efficient release of stored solids deep within the fiber. An illustration of the backwash mechanism is shown in Figure 8.

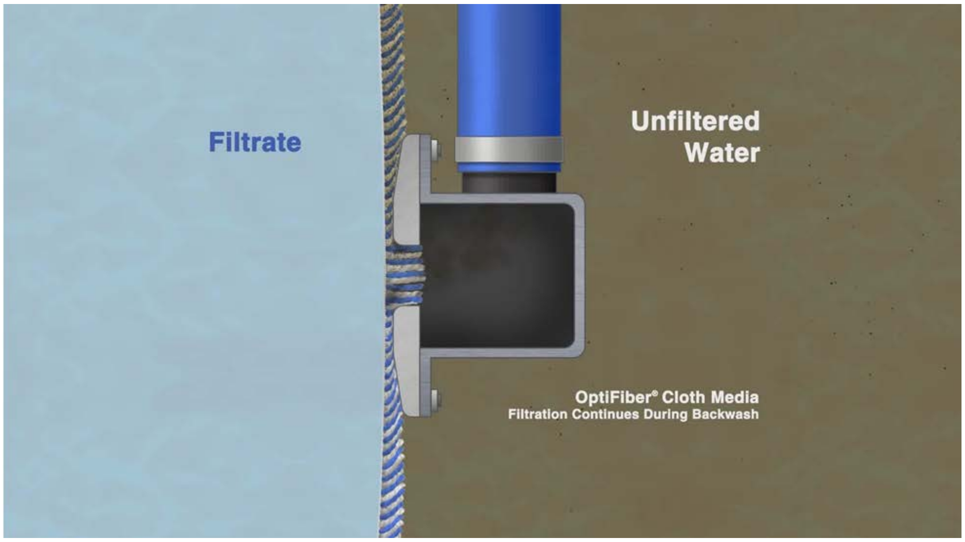


Figure 1: AquaStorm™ backwash illustration.

Settled Solids Removal Mode

The quiescent environment during filtration combined with the outside-in flow path allows heavier particulates to settle to the bottom of the basin. Upon reaching a specific number of backwash cycles performed or an elapsed time period, the solids waste mode will be automatically initiated. This mode utilizes the backwash/waste pump to provide suction of the settled solids through a perforated solids collection manifold in the hoppers. The solids are pumped on an intermittent basis, typically to the thickener or primary clarifiers for solids handling (Figure 9 and Figure 10). Filtration continues during solids waste mode, allowing continuous filtration while maintaining efficient performance.

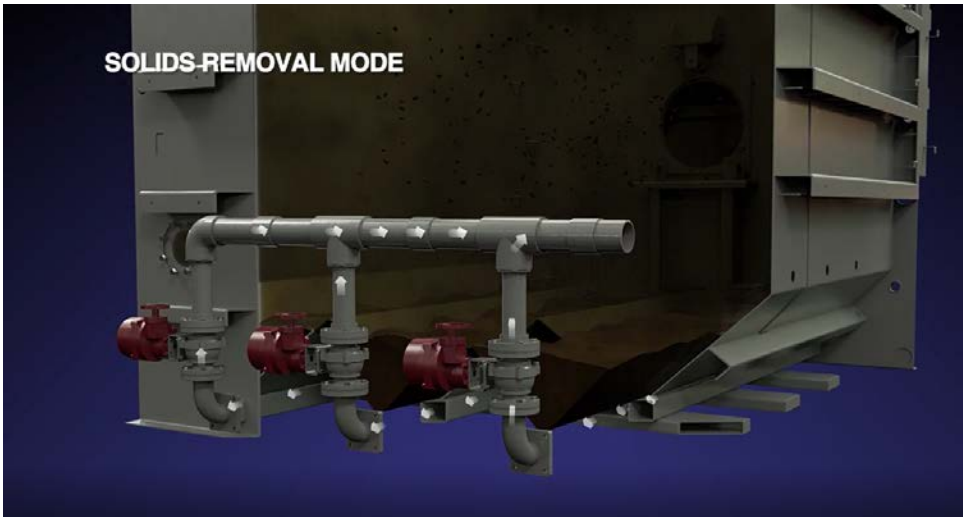


Figure 2: Solids Removal Mode – pumping of solids out of system.

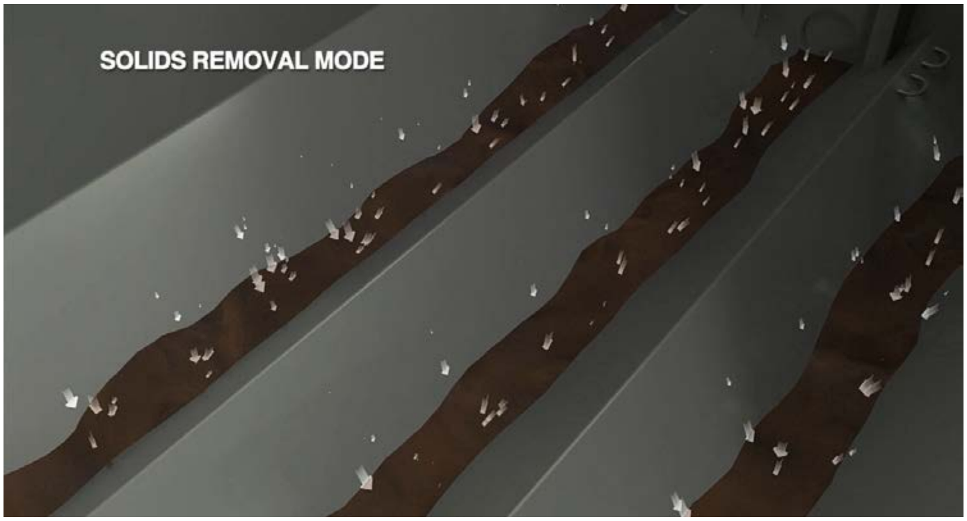


Figure 10: Emptying of hoppers.

Startup & Shut Down/Storage
The AquaStorm PCMF is used for remote sites, side-stream auxiliary or dual treatment for peak wet weather flow treatment. This means that the filter(s) might be offline waiting for a peak flow event to occur. When the filter is offline, the unit is stored dry (without water in the filtration tank). To startup a filter, the influent valve or gate is opened. This control is typical done based on input from the plant SCADA system or AASI provided control system as requested. Once the filter is online, the unit will fill and the automatic operation will occur.

At the end of a peak wet weather flow event, the filter can be taken offline by plant SCADA or AASI control system which involves closing the influent valve or gate. After the flows in the main treatment train(s) have subsided, the operator can shut down the filter for storage until the next event. This achieve by the operator initiating the clean and store operational sequence in the AASI control system. This shutdown/storage sequence automatically will do the following in the order below:

- Open the scum/floatable valve to drain the trough for approximate 60 seconds.
- Start a continuous backwash to clean the cloth and reduce the water level down to an elevation just above the backwash shoe.
- Stop the continuous backwash and transition to settled solids wasting until the water level down to an elevation of about 1 foot in the hoppers.

- If there is an automatic drain valve, the drain valve will be opened to drain out the remaining water. After shutdown/storage, it is recommended when the operation staff have time to wash down the equipment and basin with plant water to remove any materials remaining on the equipment, walls or in basin to prevent odors.

Control System
AquaStorm™ filter operation is automatically controlled by a programmable logic controller (PLC). These PLC based control systems are frequently networked with the plant SCADA system for monitoring or intercommunication purposes.

PLC Equipment Description
The PLC system monitors, regulates and sequences all automatic functions. As a standard, PLC controllers are Allen-Bradley MicroLogix Controllers. PLC inputs are via 16 point (120 VAC) discrete or 8 point (4-20mA) analog input modules, while outputs are via 16 point discrete (Relay) or 4 point (4-20mA) analog output modules. In the case of a power loss, the system will resume operation at the point from where they left off as soon as power is restored. On power-up, any multiple motor starts will commence at 10-second intervals. The PLC processors are equipped with a battery to provide ladder program and data table memory support in case of a power failure.

Automatic Operation

PLC systems allow the AquaStorm™ filter system to perform all the standard functions and provide maximum flexibility for variation in control strategies. Aqua-Aerobic Systems, Inc. provides all standard and customized programs through our in-house Electrical Engineering group. For the AquaStorm™ filter, these systems are level based with time overrides. They also provide a complement of fully adjustable set points in addition to filter system monitoring.

Manual Override

Aqua-Aerobic Systems control panels are equipped with Hand/Off/Auto motor switches that will allow for switching the respective hand switch from auto to the desired position to operate any motor independent of the current PLC command.

Local Operator Interface Panel

Each PLC control panel is equipped with a Panelview Plus Human Machine Interface (HMI) unit manufactured by Allen-Bradley. The operator interface unit features a color LCD touch screen display and communicates directly to the PLC. This HMI unit will allow the changing of counter and timer values to adjust the various plant controls. The ability to monitor basic system status throughout the plant is also provided at this unit.

This display contains various display pages used to provide the operator with filter status and alarm information. There are also pages from which the operator enters changes to process variables and timers to control the automatic sequencing.

Interface Operation

Some of the various screens available through the local operator control panel are listed below:

- System status
- Backwash interval/duration adjust
- Sludge waste interval/duration adjust
- Floatable wasting interval/duration adjust
- Elapsed time meters and totalizers (motors and process)
- Backwash interval history
- Alarm display
- Alarm history

Controls Programming Documentation

As a standard procedure, Aqua-Aerobic Systems will provide a written control strategy with the equipment submittal information. In addition to the control strategy, we can also provide the PLC programming documentation for onsite troubleshooting purposes. Due to the proprietary nature of the program, a confidentially agreement is necessary if this information is provided.

Typical Arrangement

Figure 11 illustrates a typical arrangement of a single AquaStorm™ unit equipped with 24 PCMF disks.

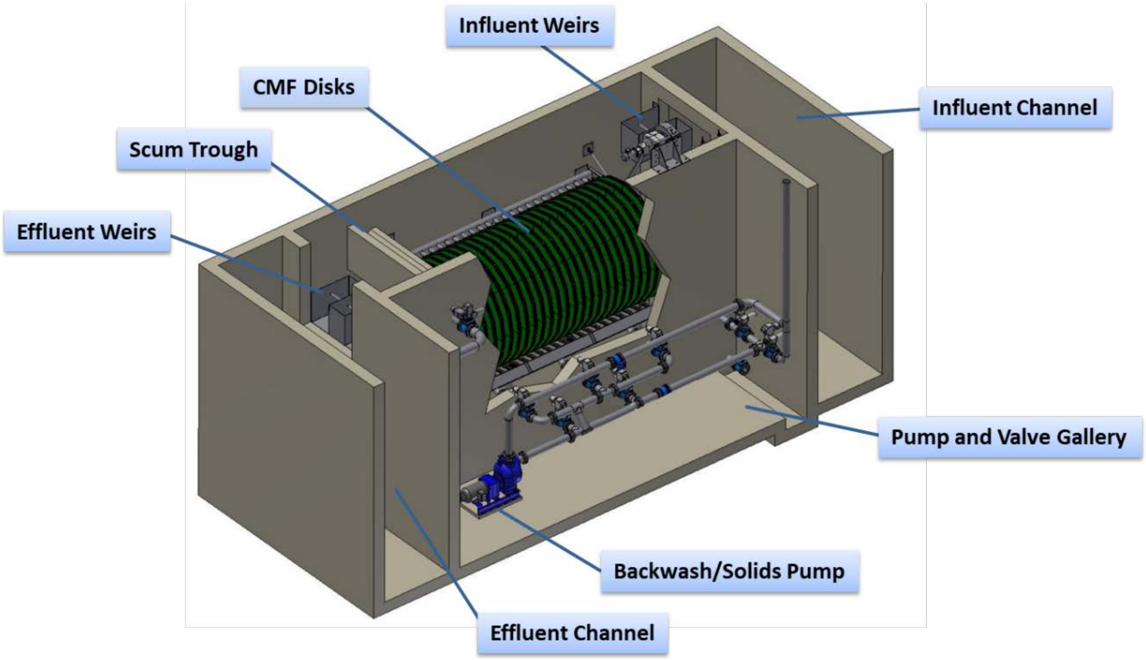


Figure 11: AquaStorm™ 24-disk unit.

AquaStorm™ Advantages for Dual-Use Wet Weather, Primary Treatment

- Utilizes engineered OptiFiber® cloth filtration media
- Produces extremely consistent, high quality effluent
- Designed to handle extreme variation in TSS loadings
- Instant startup and instant high quality effluent
- Low waste volumes
- Simple to operate and maintain
- Unmanned operation at remote sites
- Vertical oriented disks reduce the footprint, resulting in small overall site requirement
- Continuous treatment capacity vs storage or tunnels (limited capacity)
- Easy to maintain and clean as necessary
- Automated shutdown and storage

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3.2. Cloth Media Description

The OptiFiber® PCMF technology by AASI of Rockford, IL is a proven, cost effective technology. AASI offers different cloth types: OptiFiber PA2-13®, OptiFiber PES-13®, OptiFiber PES-14®, and OptiFiber PF-14® PCMF. OptiFiber PF-14® cloth, depicted in Figure 12, has been selected for optimal wet weather and primary filtration performance. This cloth has been specifically designed for primary wastewater and wet weather treatment and provides the highest level of removal. OptiFiber PF-14® cloth contains thin short fibers that are densely packed, allowing it to perform depth filtration and remain easy to clean.

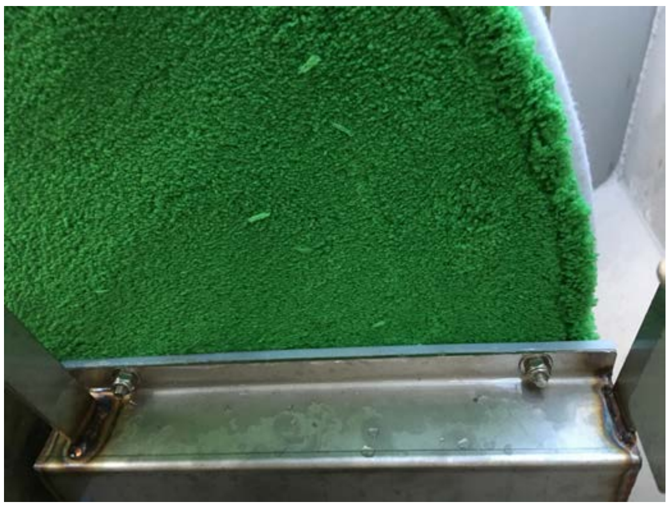

Figure 3: OptiFiber PF-14®, PCMF.

3.3. Final Pilot Setup Details

Influent flow for the Signal Mountain WWTP pilot filter was pulled from the plant's main raw water channel after screening and upstream of the plant's other processes. A submersible pump was placed in the channel, and a float switch was hung from a fabricated mount that was placed in the channel.

Backwash events were automatically initiated at an approximate 300 mm (12 inch) level differential between the water level in the basin and the effluent weir elevation. The backwash mechanism effectively cleaned the cloth by drawing filtrate backwards through the cloth into the backwash shoe assembly. Deposited solids were removed from the tank bottom by using the same backwash pump assembly through a manifold on the bottom of the tank. All outflow from the pilot filter was directed to a downstream lift station, and submersible pumps in that lift station conveyed this outflow to the secondary treatment process on site.

Influent and effluent turbidity values were monitored continuously using two Hach Solitax SC sensors. Influent flow, as well as backwash and solids wasting flows, were monitored using Krohne 2100 C magnetic flow meters. The pilot unit was PLC-controlled and equipped with an electronic supervisory control and data acquisition (SCADA) logging system. The control system also permitted remote access to support monitoring and control of the test conditions.

The sampling protocol was modified between dry weather and wet weather events. For dry weather events, discrete influent and effluent samples (collected 3 times per hour at 20 minute intervals for each bottle) were combined into a single sample for each day of sampling. Later in the pilot, this was revised to (3) smaller composite samples.

For wet-weather events, the sampling protocol was conducted as follows:

- Hours 0-2
    - Composite samples at 15-min intervals
    - Each composite consisting of 3 discrete samples taken at 5-min intervals
    - 8 total composite samples
- Hours 2-4
    - Composite samples at 30-min intervals
    - Each composite consisting of 3 discrete samples taken at 10-min intervals
    - 4 total composite samples
- Hours 4+
    - Composite samples at 1-hour intervals
    - Each composite consisting of 3 discrete samples taken at 20-min intervals.
    - Up to 12 total composite samples or until the event ends
        - consisting of 3 discrete samples taken at 20-min intervals

3.4. Data Collection & Analysis

Auto-samplers were set-up to collect influent and effluent composite samples. In addition, online instrumentation was used to monitor pilot performance, which was continuously logged on the pilot SCADA system. A list of the parameters that were monitored along with the instrumentation used are displayed in Table 1.

Table 1: Instrumentation.

Parameter	Instruments
Influent/effluent turbidity	Hach Solitax® SC Sensor
Influent Flow	3" Krohne 2100 C Flow Meter
Backwash / Solids Waste Flow	2" Krohne 2100 C Flow Meter
Backwash Vacuum Pressure	Pressure Transmitter
Tank Level	Level Transducer

3.5. Testing Schedule and Operating Conditions

The pilot was onsite and online from December, 2021 to early March, 2022 for both dry weather and wet weather conditions. Figures 13-14 and Table 2 summarize the operating conditions of the pilot under dry weather and wet weather conditions, respectively.

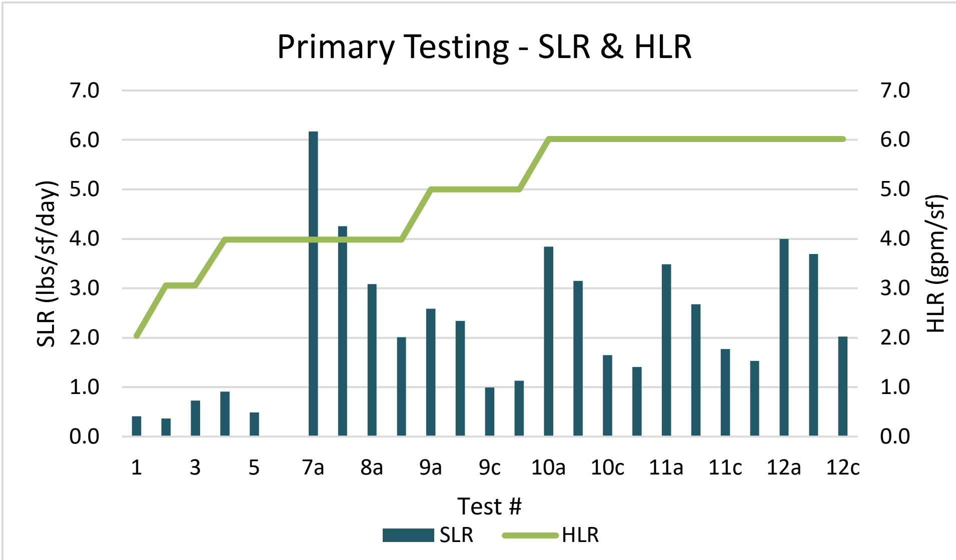

Figure 13: Dry weather HLR and SLR, 1/17 – 2/10.

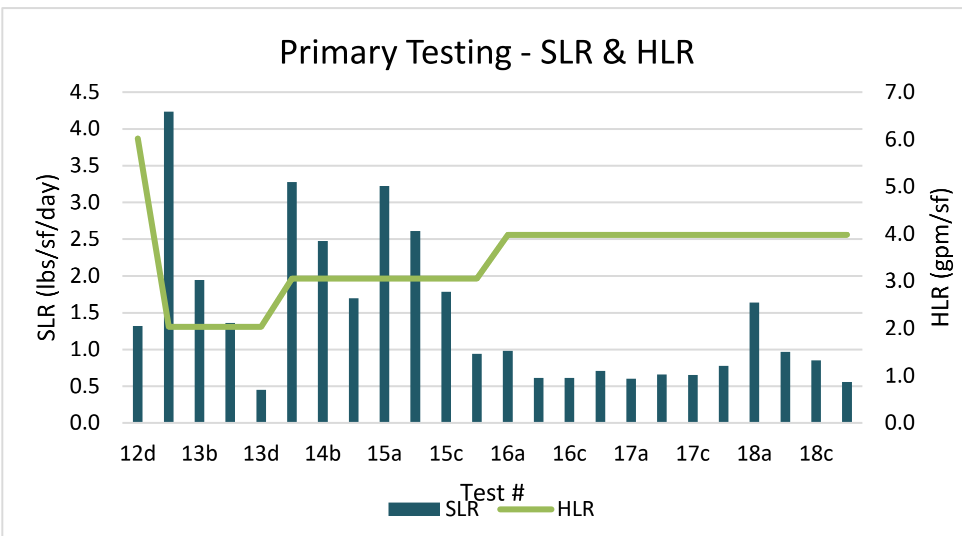

Figure 14: Dry weather HLR and SLR, 2/10 – 2/28.

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Table 2: Wet weather events and operating conditions.

Wet Weather Event	Date and Time (ET)	Avg. HLR (gpm/ft^2)	Samples Tested
1	12/18/2021, 8:30 AM	4.0	TSS, cBOD
2	1/16/2022, 7:00 AM	4.0	TSS, cBOD
3	2/2/2022, 1:30 PM	4.0	TSS, cBOD
4	2/17/2022, 2:30 PM	5.0	TSS, cBOD
5	2/21/2022, 6:45 AM	6.0	TSS, cBOD
6	2/22/2022, 5:00 PM	6.0	TSS, cBOD

4. Dry Weather Event Results

As summarized in Section 2.5, the pilot unit operated under hydraulic fluxes ranging from under 1.5 gpm/ft^2 up to 6 gpm/ft^2, and solids loading rates up to over 6 lbs TSS/ft^2/day. Dry weather results were collected from Monday to Friday, with the unit taken offline during weekends.

4.1. TSS and CBOD Lab Results

The figures below summarize TSS and cBOD removal results under dry weather conditions over the course of the study (as reported by Microbac Laboratories):

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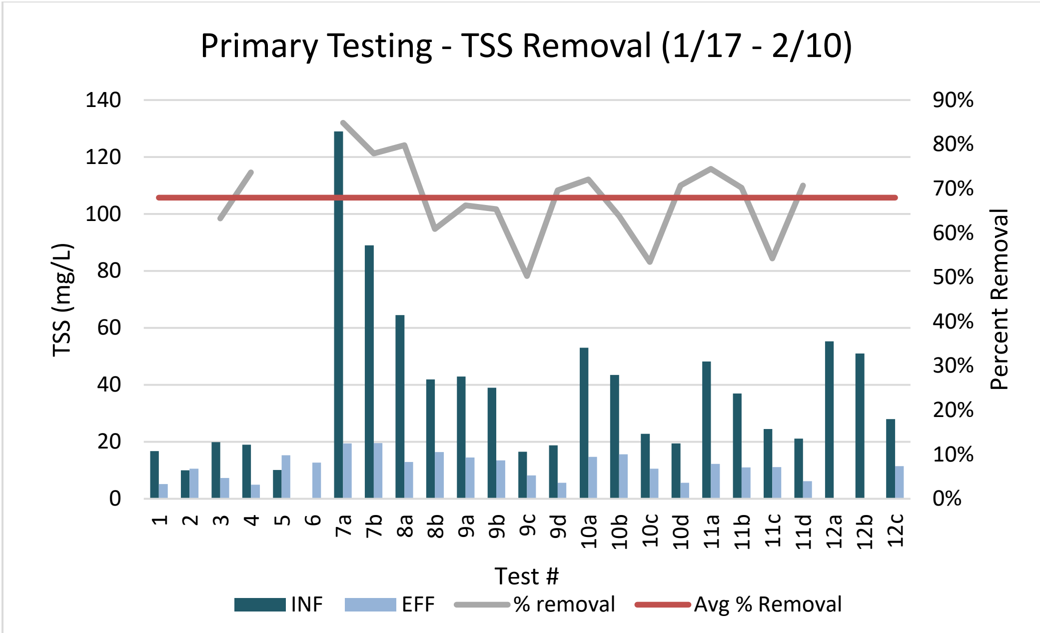

Figure 15: TSS removal, dry weather conditions (1/17 – 2/10).

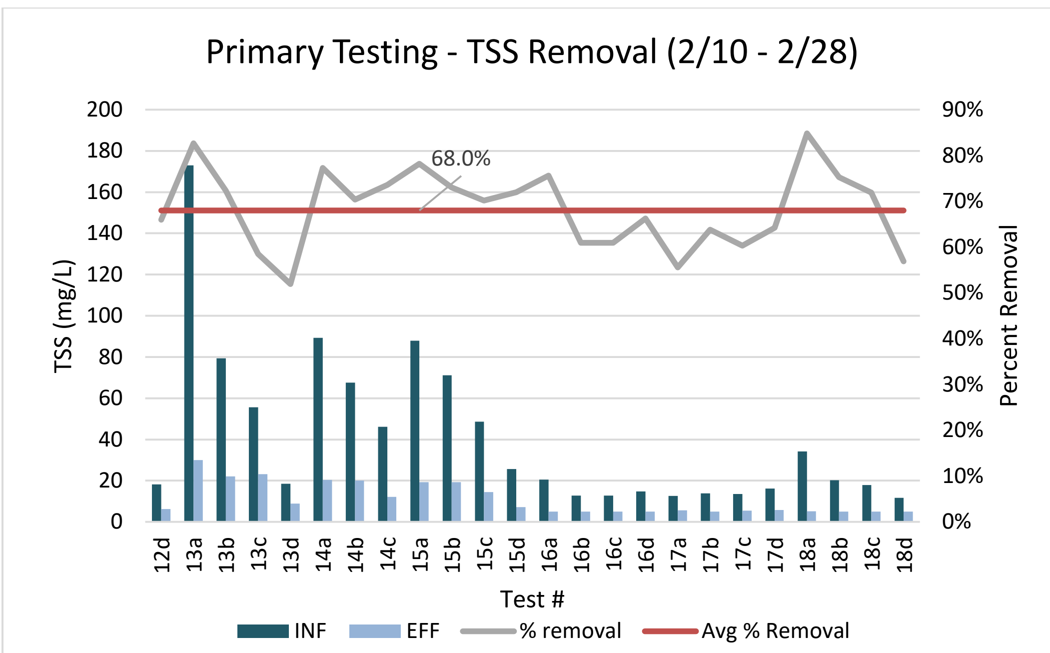

Figure 16: TSS removal, dry weather conditions (2/10 – 2/28).

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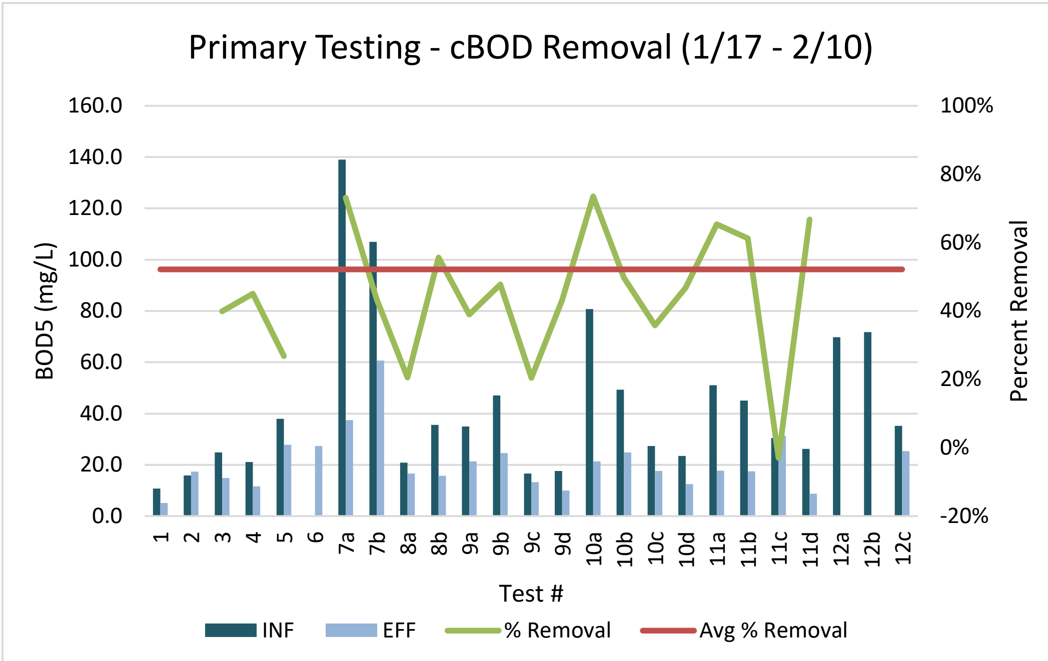

Figure 17: cBOD removal, dry weather conditions (1/17 – 2/10).

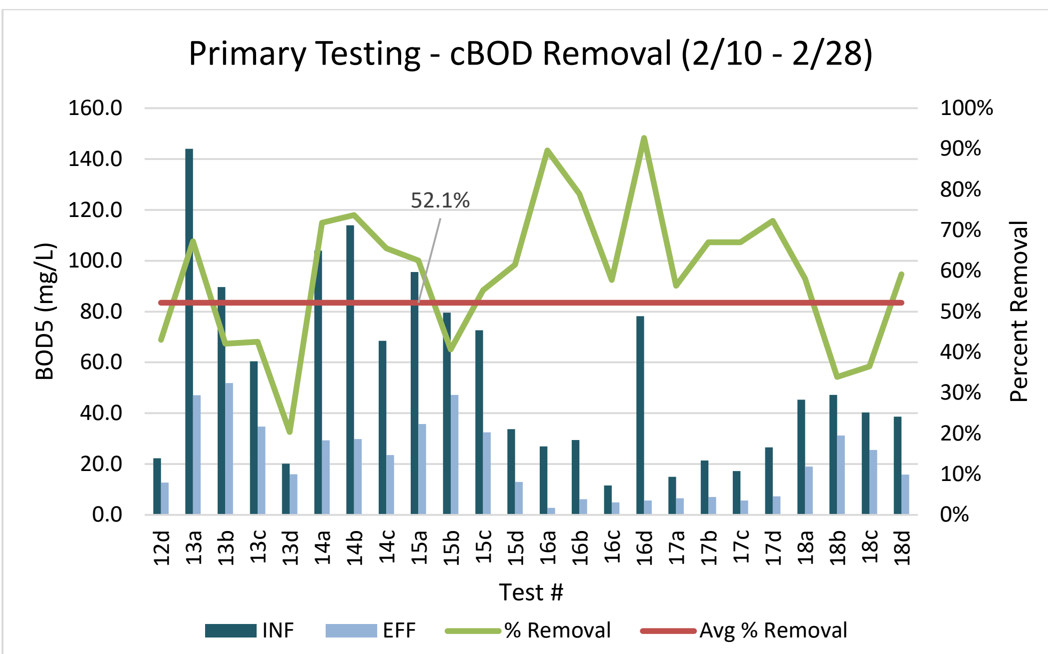

Figure 18: cBOD removal, dry weather conditions (2/10 – 2/28).

Average TSS and CBOD removal over the course of the study was 68% and 52.1%, respectively. These rates of removal were maintained over a range of solids and hydraulic loading rates. Effluent TSS and cBOD averaged 11.3 mg/L and 21.1 mg/L over the course of the study, respectively. These values are well below permit requirements.

4.2. Waste Volumes

Waste volumes over the course of the study were tracked by the SCADA system, and the Krohne flow meter on the backwash and solids waste line (see section 2.4). See the figures below for waste volumes over the course of the study:

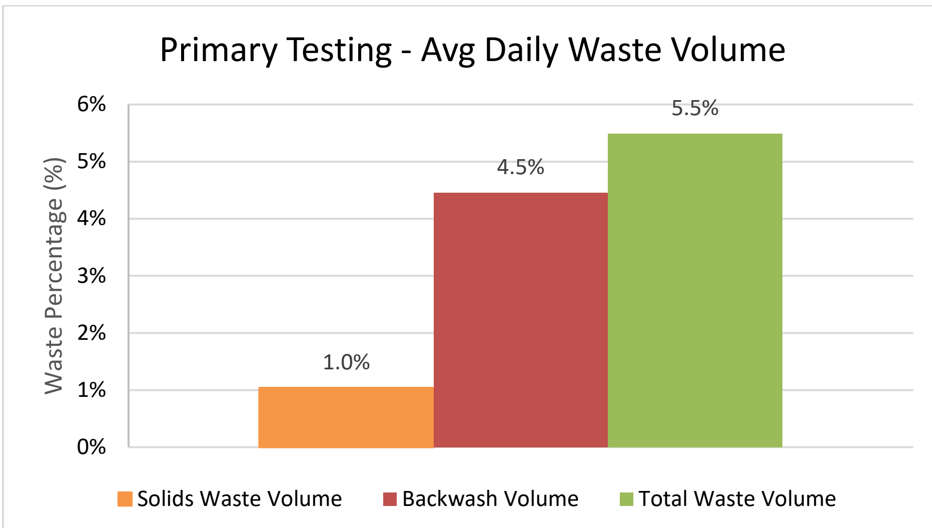

Figure 19: Average waste rates as a percentage of forward flow, dry weather conditions.

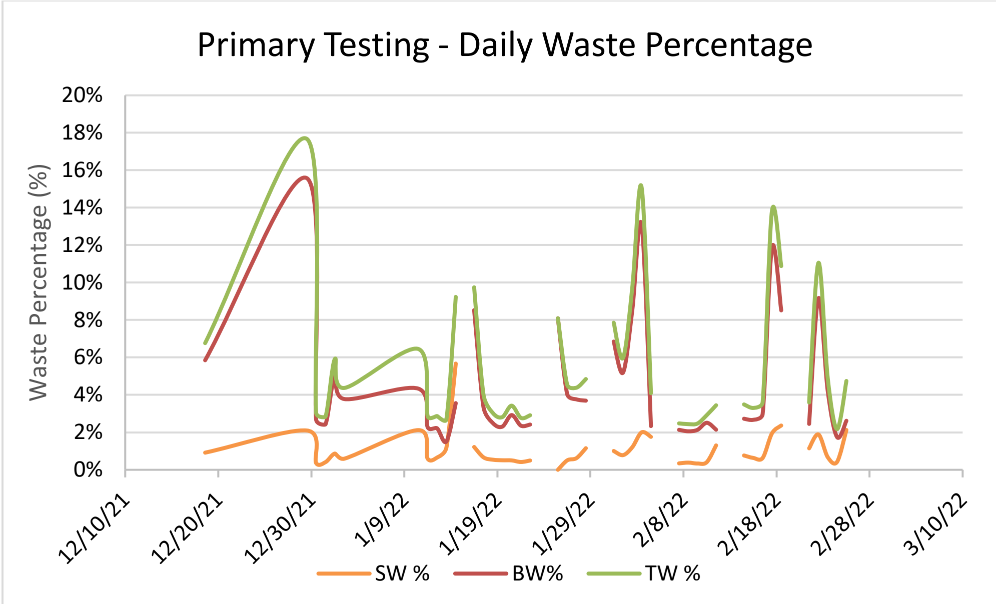

Figure 20: Daily waste percentage under dry weather conditions.

Average daily wasting rates as a percentage of forward flow was 5.5% over the course of the study (4.5% backwash, 1.0% solids waste). Total wasting rates were proportional with solids loading, ranging up to 18% of forward flow.

It is important to note that we used our MD-12 AquaStorm™ pilot unit for this study. In the full scale installation, the hoppers are even deeper than our AquaStorm™ pilot unit by a factor of 2.5 resulting in even more storage capacity for settled solids. This will decrease the solids waste in the full scale unit versus the results seen in the pilot.

Secondly, the pilot unit uses a single disk for testing which provides conservative backwash frequency. When operating the pilot unit as demonstrated during this study, the recovery of level is limited since the ratio of volume (1 foot operating differential) to the filtration area is greatly increased in comparison to a full scale installation. The pilot unit used for the testing has a recovery volume versus filtration area of 1.5 ft^3/ft^2. In a full scale installation, an AquaStorm™ Model 108 unit with 24 disks has a ratio of 0.096 ft^3/ft^2. This is approximately 16 times better, which will allow for the water level to decrease to the original starting level quicker, therefore resulting in a longer time between backwashes.

5. Wet Weather Event Results

5.1. Wet Weather Event #1 (12/18 – 19)

5.1.1. Operating Parameters – Event #1

Table 3: Operating Parameters for Event #1

Operating Parameters	Values
Flow (gpm)	43
HLR (gpm/ft^2)	4

5.1.2. Online Turbidity Data – Event #1

The first flush for event #1 occurred around 8:30 AM local time on 12/18/2021. At this point, influent turbidity was measured up to 223 NTU. Effluent turbidity ranged from 1.6 NTU to 660 NTU over the course of the event. Figure 21 shows the turbidity readings over the course of the event.

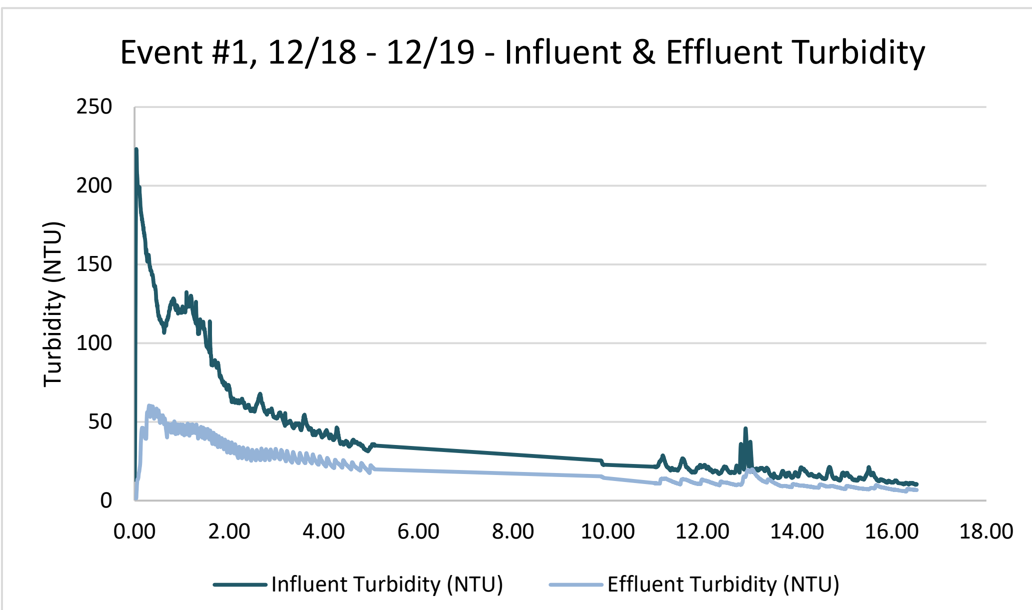

Figure 21: Wet weather event #1 turbidity performance per SCADA data.

5.1.3. TSS and CBOD Laboratory Data – Event #1

TSS and CBOD removal over the course of event #1 was significant. Average TSS and CBOD removal over the course of this event was 66.3% and 55.2%, respectively. Note that immediately after the first flush, TSS removal was at or above 90%. Towards the end of the event (after the first flush), the influent was more dilute and TSS/CBOD removal percentage decreased as expected.

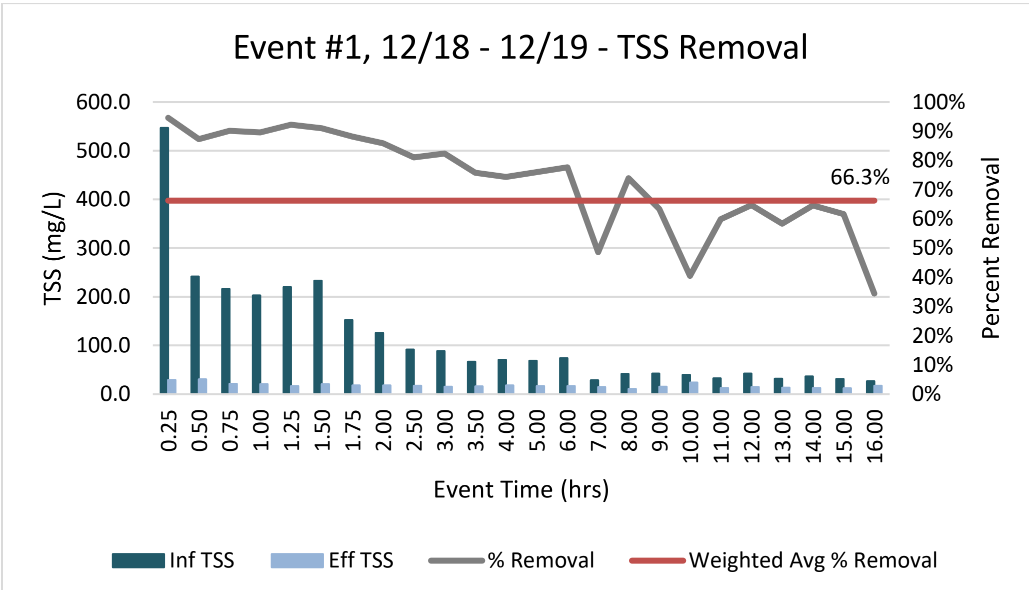

Figure 22: Event #1 influent and effluent TSS lab data.

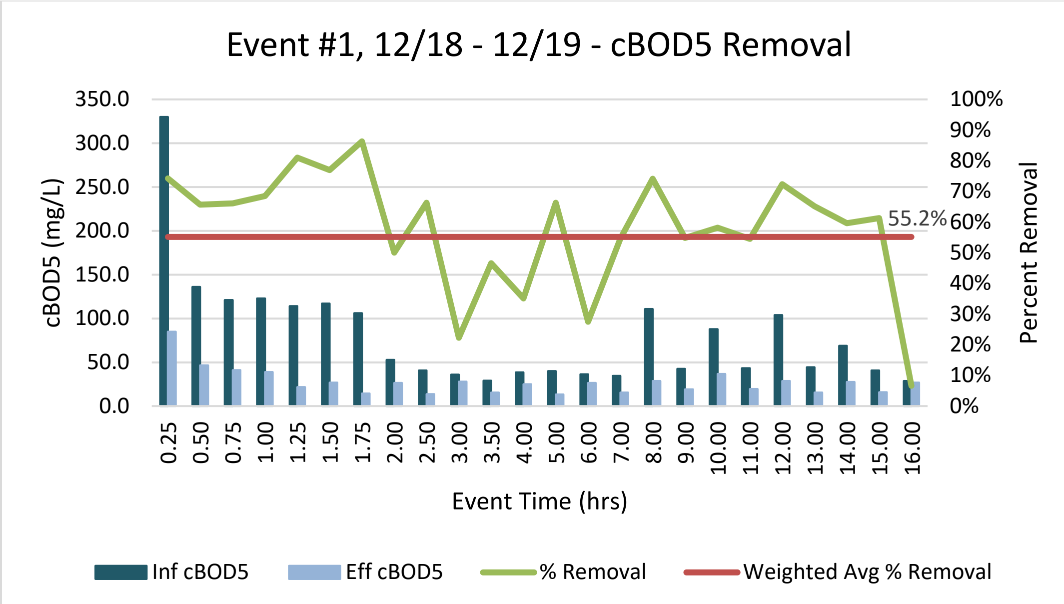

Figure 23: Event #1 influent and effluent CBOD lab data.

5.1.4. Backwash and Solids Waste – Event #1

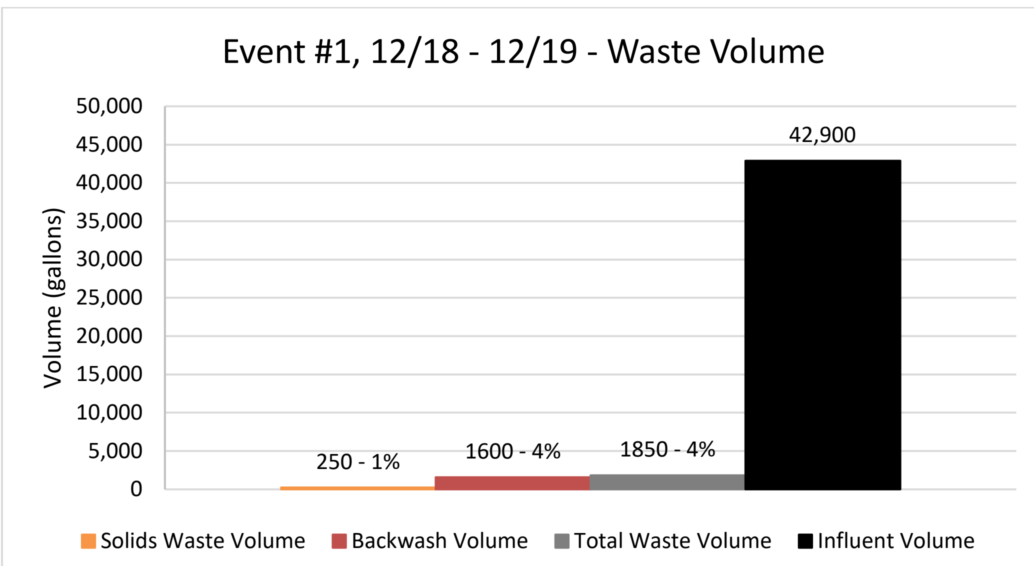

Figure 24: Event #1 waste volumes as a percentage of forward flow.

5.2. Wet Weather Event #2 (1/16 – 17)

5.2.1. Operating Parameters – Event #2

Table 4: Operating Parameters for Event #2

Operating Parameters	Values
Flow (gpm)	43
HLR (gpm/ft^2)	4

5.2.2. Online Turbidity Data – Event #2

The first flush for event #2 occurred around 7:05 AM local time on 1/16/22. As shown below, influent turbidity readings were corrupted by solids build up on the probe. Effluent turbidity readings were never above 30 NTU for the duration of the event.

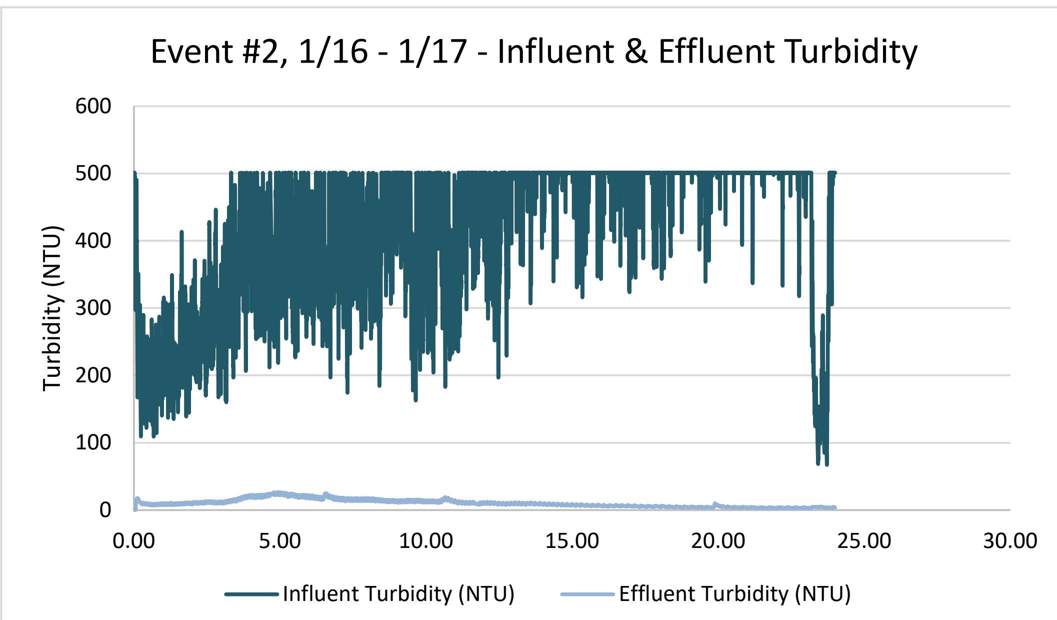

Figure 25: Wet weather event #2 turbidity performance per SCADA data.

5.2.3. TSS and CBOD Laboratory Data – Event #2

TSS and CBOD removal over the course of event #2 was significant. Average TSS and CBOD removal over the course of this event was 73.1% and 61.3%, respectively. Note that immediately after the first flush, TSS removal was at or above 90%. Towards the end of the event (after the first flush), the influent was more dilute and TSS/CBOD removal percentage decreased as expected.

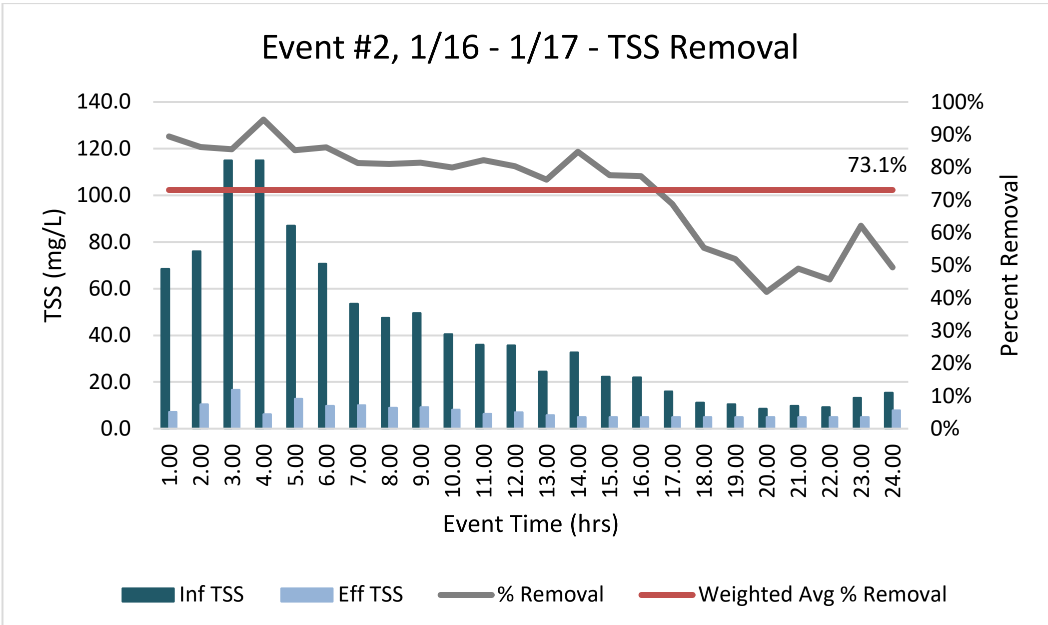

Figure 26: Event #2 influent and effluent TSS lab data.

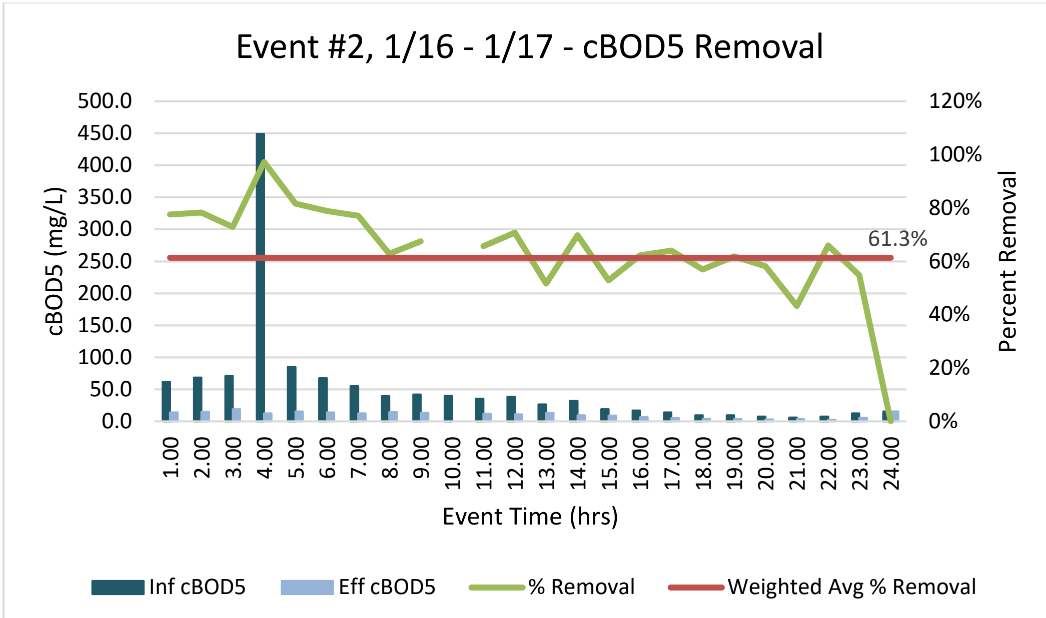

Figure 27: Event #2 influent and effluent CBOD lab data.

5.2.4. Backwash and Solids Waste – Event #2

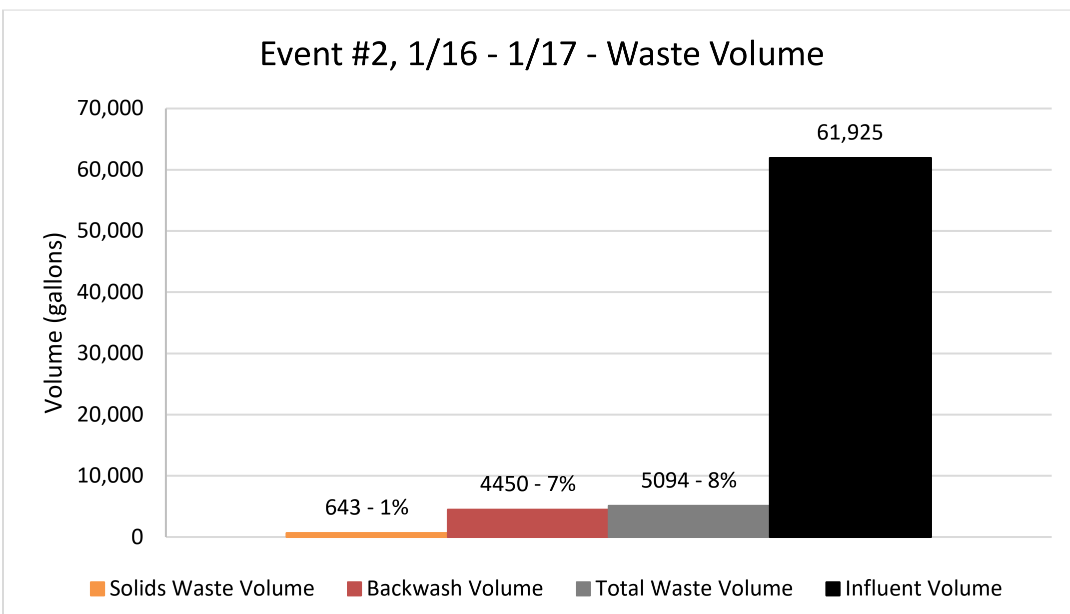

Figure 28: Event #2 waste volumes as a percentage of forward flow.

5.3. Wet Weather Event #3 (2/2 - 3)

5.3.1. Operating Parameters – Event #3

Table 5: Operating Parameters for Event #3

Operating Parameters	Values
Flow (gpm)	43
HLR (gpm/ft^2)	4

5.3.2. Online Turbidity Data – Event #3

The first flush for event #3 occurred around 2:00 AM local time on 2/3/2022. At this point, influent turbidity was measured up to 280 NTU. Effluent turbidity ranged from 15 NTU to 63 NTU over the course of the event. Figure 29 shows the turbidity readings over the course of the event.

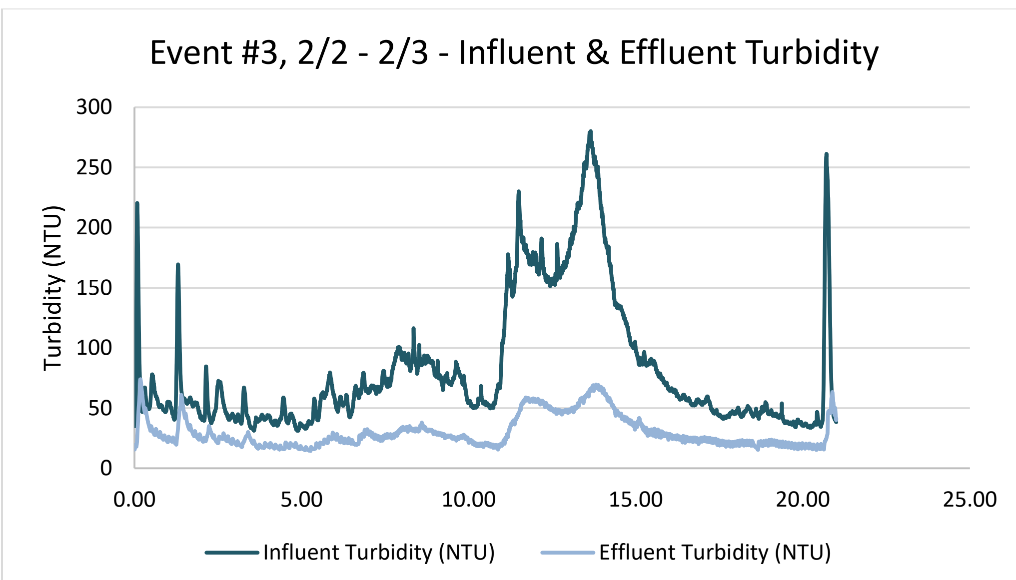

Figure 29: Wet weather event #3 turbidity performance per SCADA data.

5.3.3. TSS and CBOD Laboratory Data – Event #3

TSS and CBOD removal over the course of event #3 was significant. Average TSS and CBOD removal over the course of this event was 84.5% and 66.3%, respectively. Note that immediately after the first flush, TSS removal was at or above 90%. Towards the end of the event (after the first flush), the influent was more dilute and TSS/CBOD removal percentage decreased as expected.

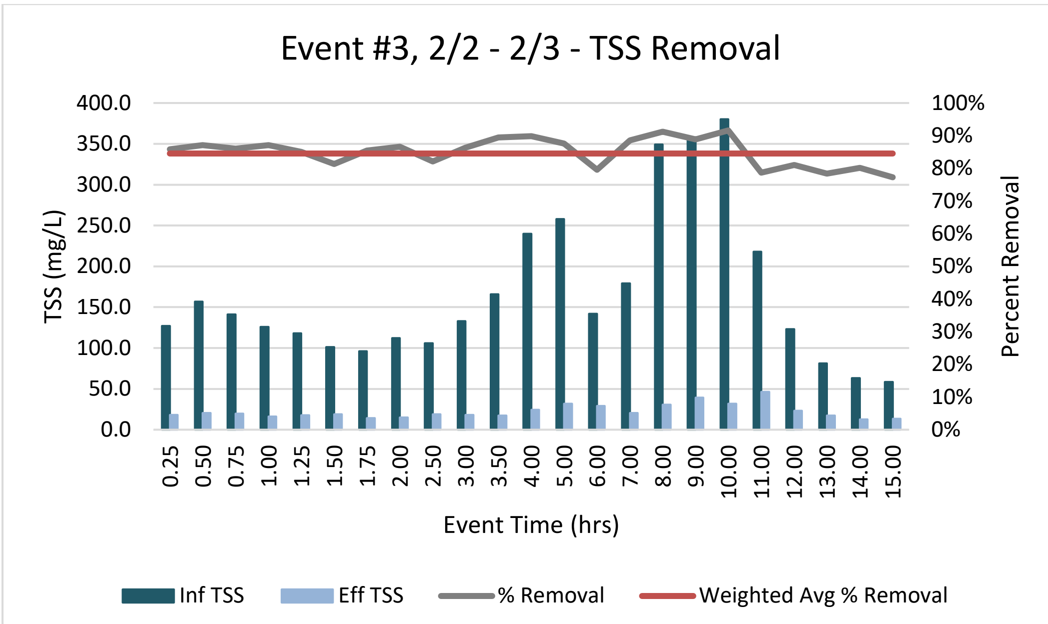

Figure 30: Event #3 influent and effluent TSS lab data.

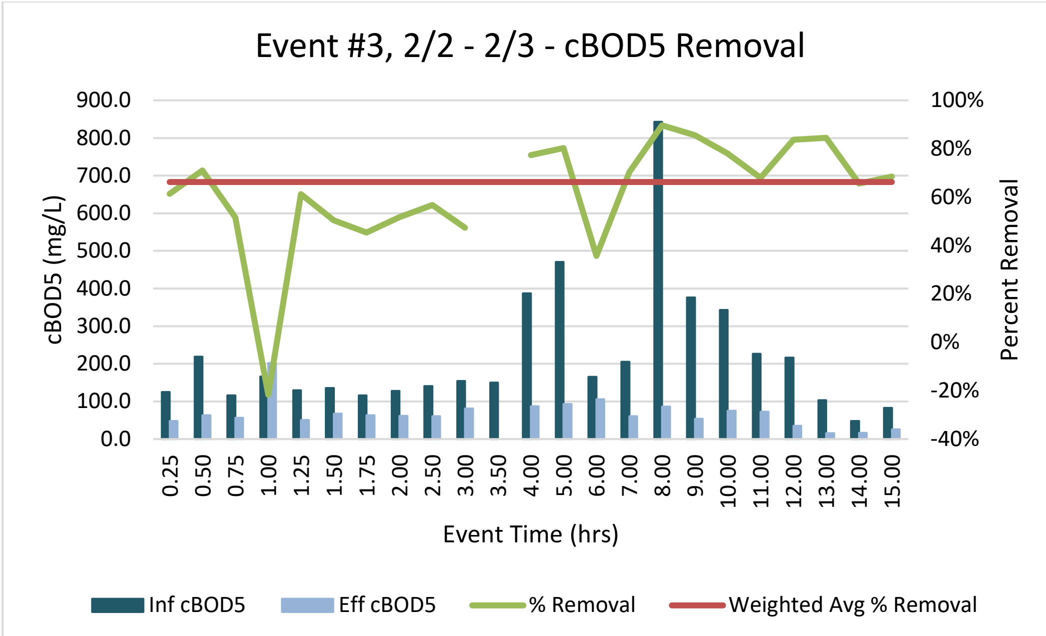

Figure 31: Event #3 influent and effluent CBOD lab data.

5.3.4. Backwash and Solids Waste – Event #3

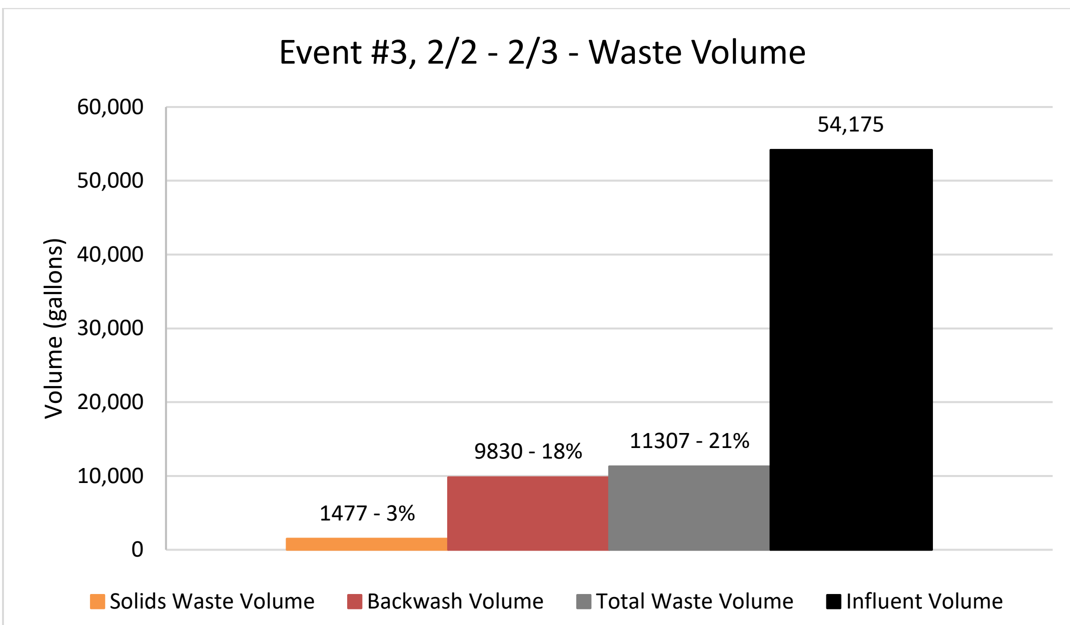

Figure 32: Event #3 waste volumes as a percentage of forward flow.

5.4. Wet Weather Event #4 (2/17 - 18)

5.4.1. Operating Parameters – Event #4

Table 6: Operating Parameters for Event #4

Operating Parameters	Values
Flow (gpm)	43
HLR (gpm/ft^2)	4

5.4.2. Online Turbidity Data – Event #4

The first flush for event #4 occurred around 6:00 PM local time on 2/17/2022. At this point, influent turbidity was measured up to 205 NTU. Effluent turbidity ranged from 8 NTU to 73 NTU over the course of the event. Figure 33 shows the turbidity readings over the course of the event.

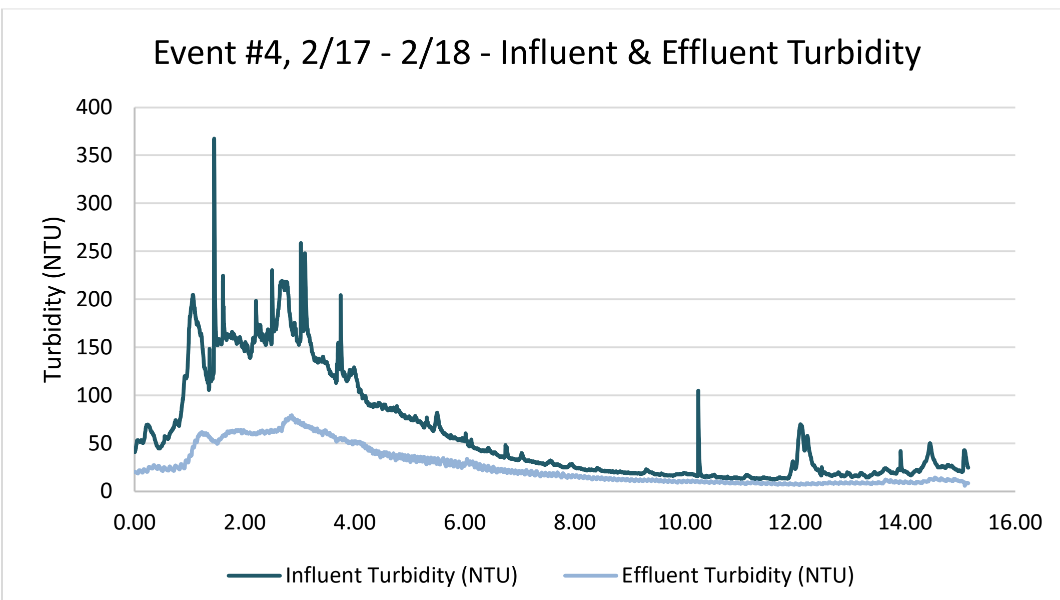

Figure 33: Wet weather event #4 turbidity performance per SCADA data.

5.4.3. TSS and CBOD Laboratory Data – Event #4

TSS and CBOD removal over the course of event #4 was significant. Average TSS and CBOD removal over the course of this event was 77.8% and 60.2%, respectively. Note that immediately after the first flush, TSS removal was at or above 90%. Towards the end of the event (after the first flush), the influent was more dilute and TSS/CBOD removal percentage decreased as expected.

Also note that for this wet weather event, the first 6 sample bottles were composited into a single influent and effluent sample for lab analysis. This change in sampling protocol is reflected in the weighted TSS and CBOD removal averages.

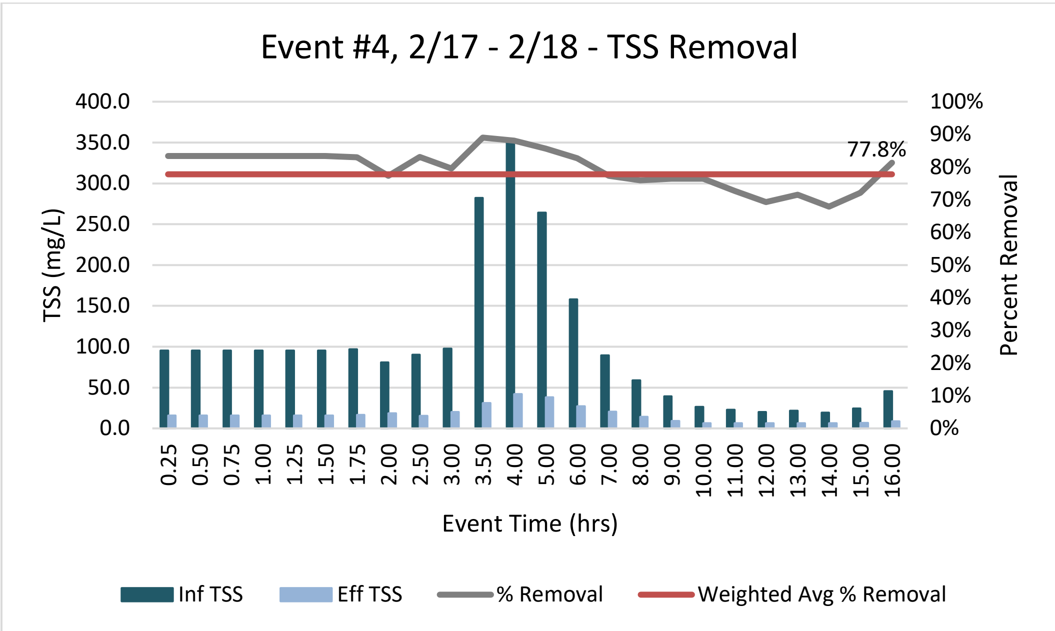

Figure 34: Event #4 influent and effluent TSS lab data.

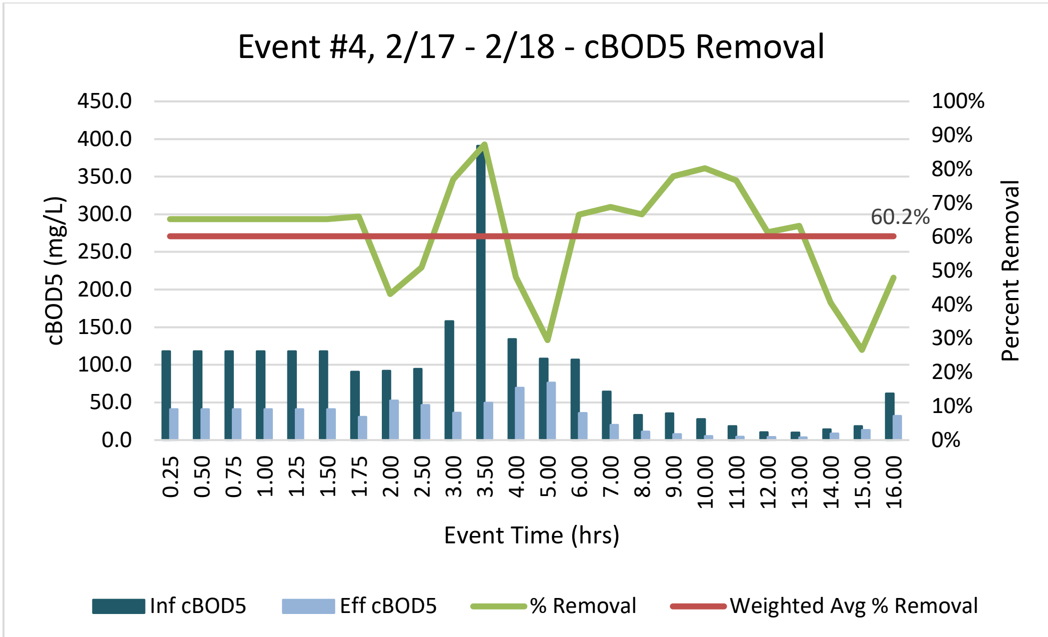

Figure 35: Event #4 influent and effluent CBOD lab data.

5.4.4. Backwash and Solids Waste – Event #4

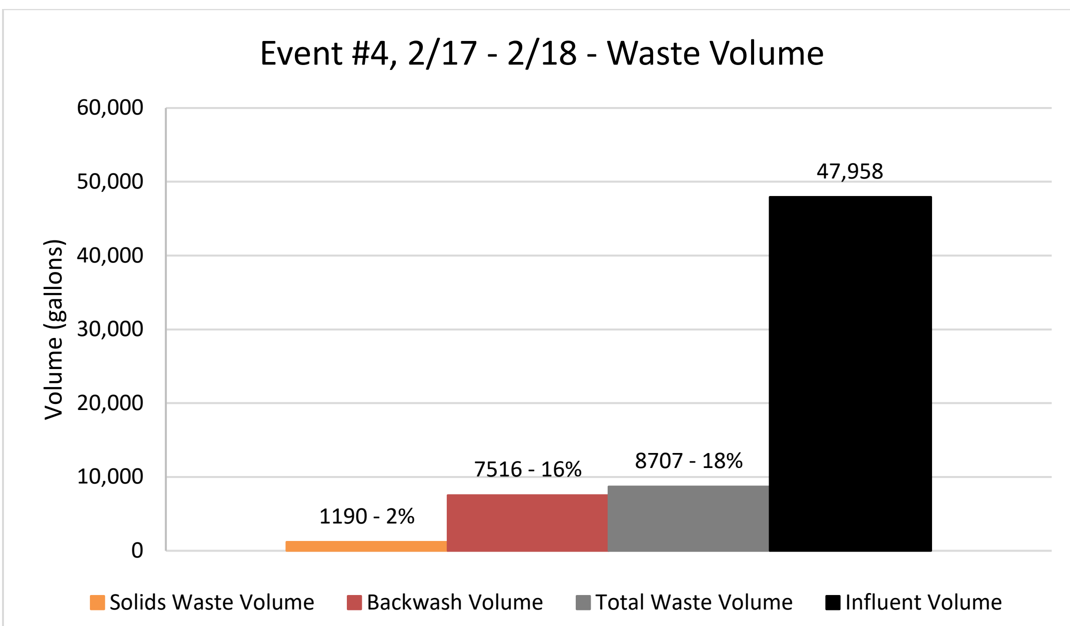

Figure 36: Event #4 waste volumes as a percentage of forward flow.

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5.5. Wet Weather Event #5 (2/21 - 22)

5.5.1. Operating Parameters – Event #5

Table 7: Operating Parameters for Event #5

Operating Parameters	Values
Flow (gpm)	65
HLR (gpm/ft^2)	6

5.5.2. Online Turbidity Data – Event #5

The first flush for event #5 occurred around 10:00 PM local time on 2/21/2022. At this point, influent turbidity was measured up to 100 NTU. Effluent turbidity ranged from 4 NTU to 23 NTU over the course of the event. Figure 37 shows the turbidity readings over the course of the event.

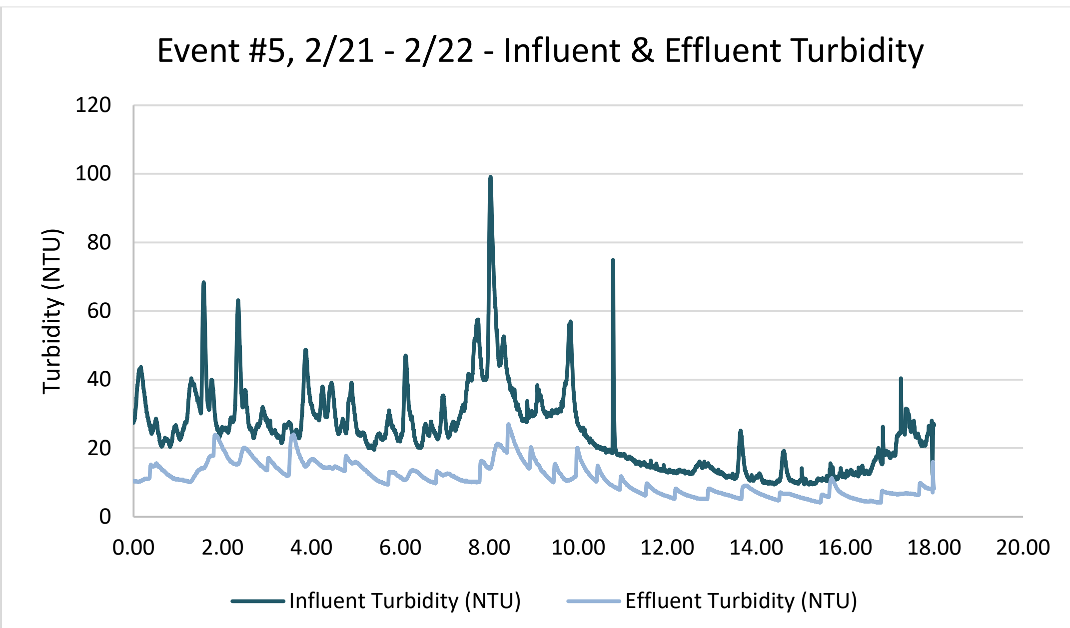

Figure 37: Wet weather event #5 turbidity performance per SCADA data.

5.5.3. TSS and CBOD Laboratory Data – Event #5

TSS and CBOD removal over the course of event #5 was significant. Average TSS and CBOD removal over the course of this event was 77.3% and 70.9%, respectively. Note that immediately after the first flush, TSS removal was at or above 80%. Towards the end of the event (after the first flush), the influent was more dilute and TSS/CBOD removal percentage decreased as expected.

As with wet weather event #4, the first 6 sample bottles were composited into a single influent and effluent sample for lab analysis. This change in sampling protocol is reflected in the weighted TSS and CBOD removal averages.

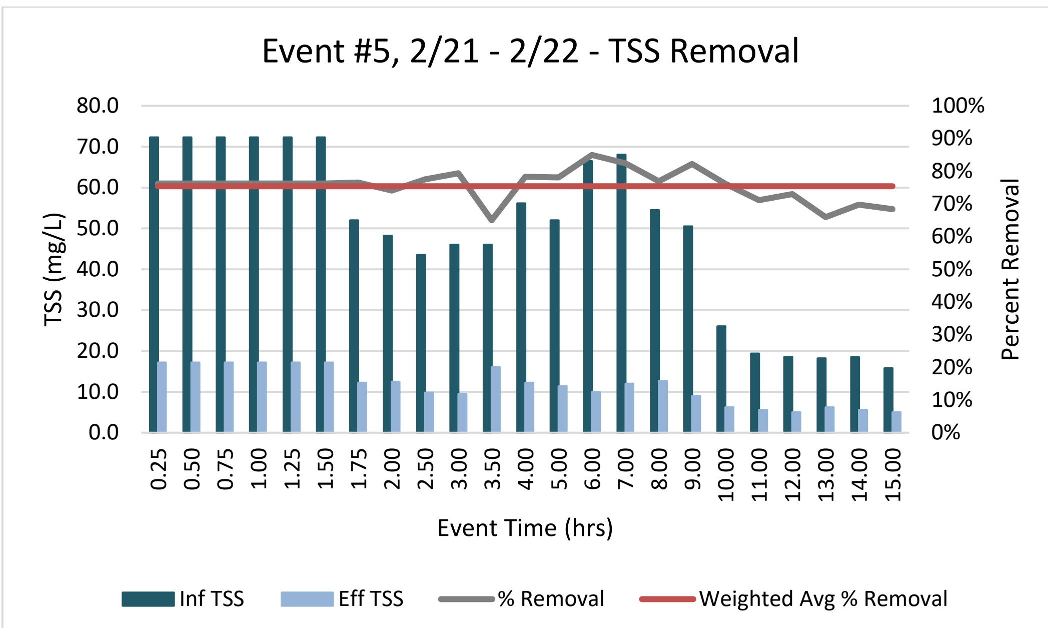

Figure 38: Event #5 influent and effluent TSS lab data.

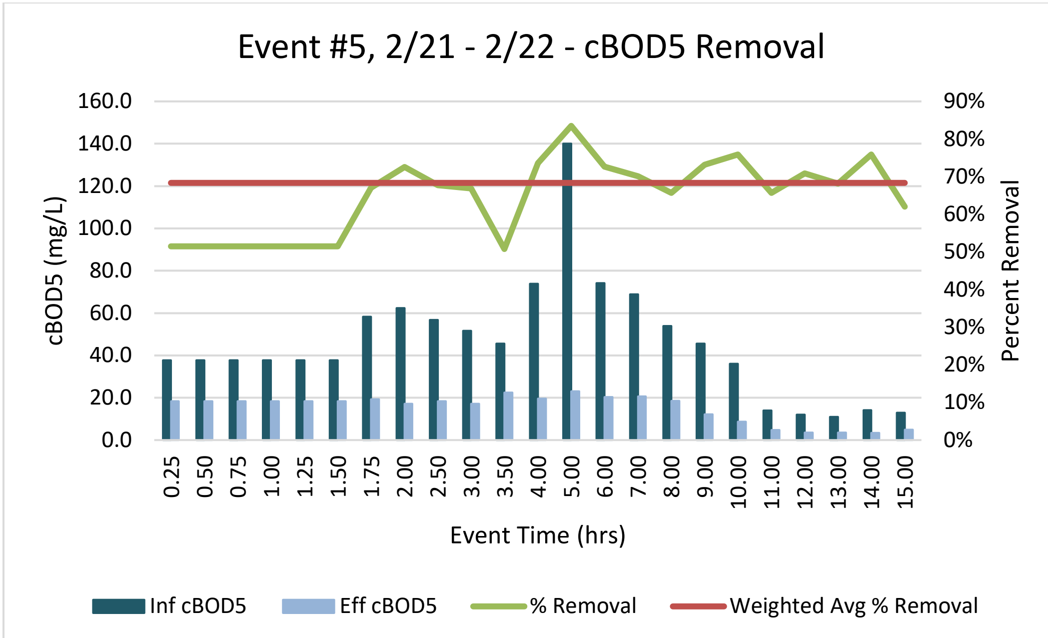

Figure 39: Event #5 influent and effluent CBOD lab data.

5.5.4. Backwash and Solids Waste – Event #5

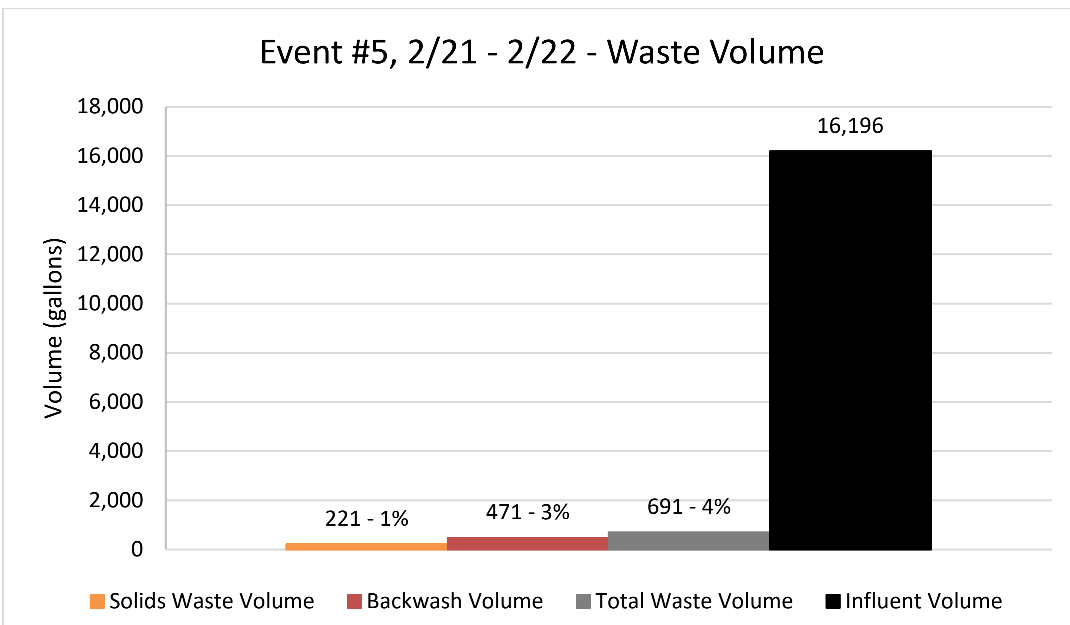

Figure 40: Event #5 waste volumes as a percentage of forward flow.

5.6. Wet Weather Event #6 (2/22 - 23)

5.6.1. Operating Parameters – Event #6

Table 8: Operating Parameters for Event #6

Operating Parameters	Values
Flow (gpm)	65
HLR (gpm/ft^2)	6

5.6.2. Online Turbidity Data – Event #6

The first flush for event #6 occurred around 10:30 PM local time on 2/22/2022. At this point, influent turbidity was measured up to 275 NTU. Effluent turbidity ranged from 7 NTU to 100 NTU over the course of the event. Figure 41 shows the turbidity readings over the course of the event.

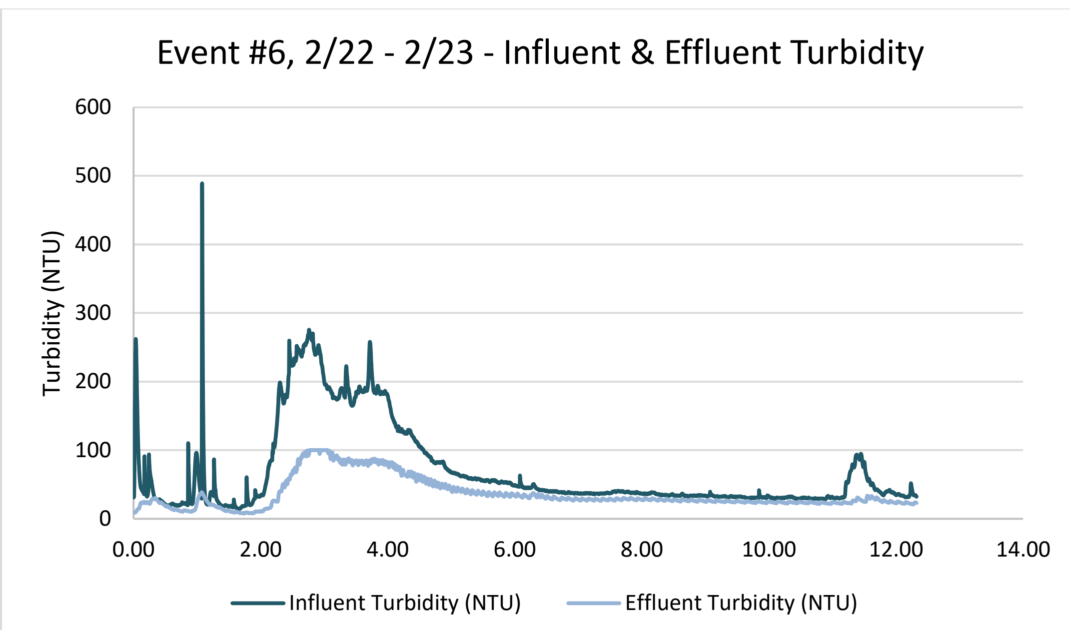

Figure 41: Wet weather event #6 turbidity performance per SCADA data.

5.6.3. TSS and CBOD Laboratory Data – Event #6

TSS and CBOD removal over the course of event #6 was significant. Average TSS and CBOD removal over the course of this event was 68.7% and 67.6%, respectively. Note that immediately after the first flush, TSS removal was at or above 80%. Towards the end of the event (after the first flush), the influent was more dilute and TSS/CBOD removal percentage decreased as expected.

For this wet weather event, the first 12 sample bottles were composited into two larger influent and effluent samples for lab analysis (bottles 1-6 for composite #1, bottles 7-12 for composite #2). This change in sampling protocol is reflected in the weighted TSS and CBOD removal averages.

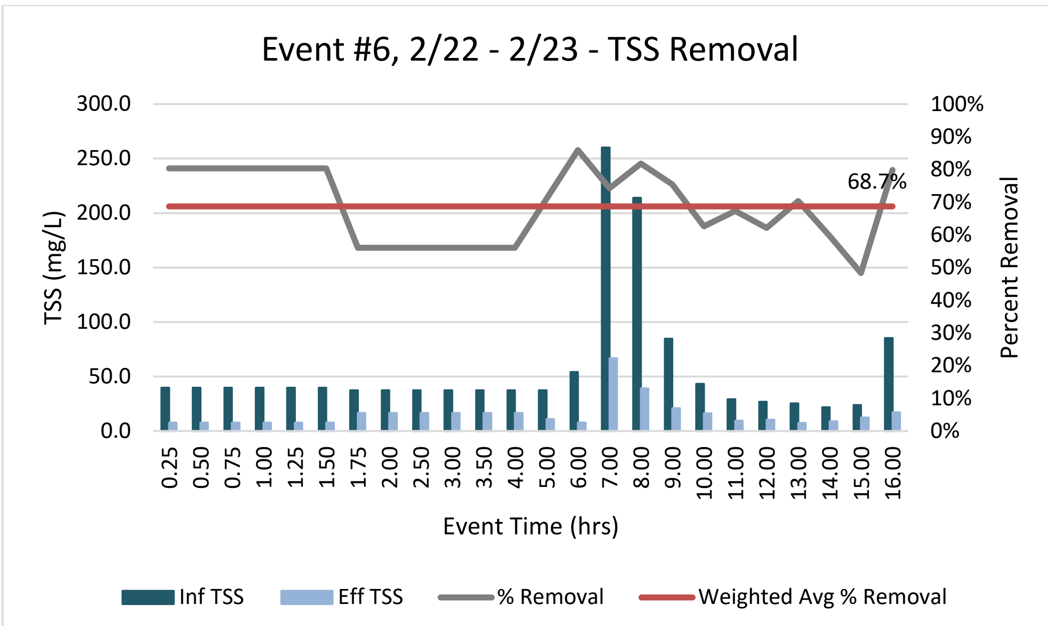

Figure 42: Event #6 influent and effluent TSS lab data.

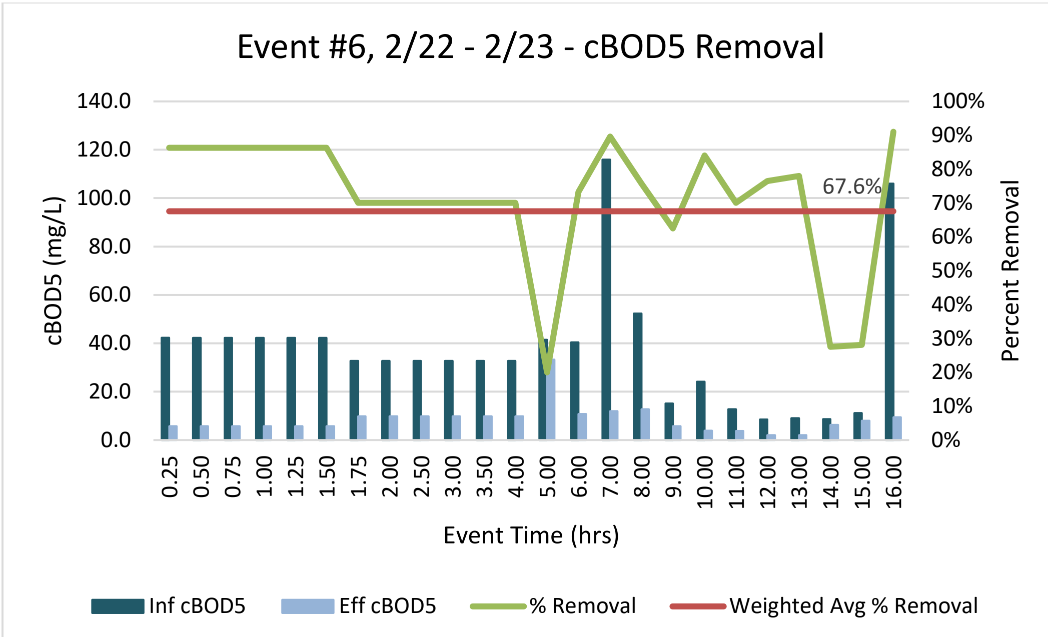

Figure 43: Event #6 influent and effluent CBOD lab data.

5.6.4. Backwash and Solids Waste – Event #6

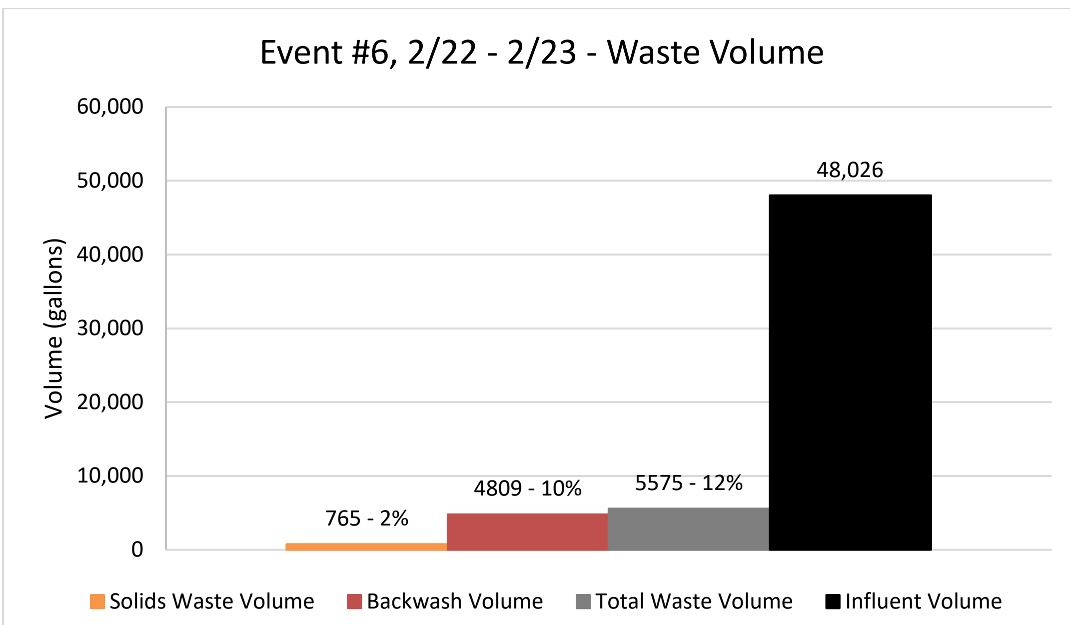

Figure 44: Event #6 waste volumes as a percentage of forward flow.

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5.7. Overall Wet Weather Performance

The following results summarize the performance of the pilot unit during the six (6) wet weather events evaluated during the study. Table 7 displays the pilot unit's average performance over the course of the six events:

Table 9: Average Wet Weather Performance, MD-12.

Event	Weighted Average TSS Removal %	Weighted Average CBOD Removal %	HLR (gpm/sf)
Event #1 (12/18-19)	66.3	55.2	4
Event #2 (1/16-17)	73.1	61.3	4
Event #3 (2/2-3)	84.5	66.3	4
Event #4 (2/17-18)	77.8	60.2	4
Event #5 (2/21-22)	66.3	55.2	6
Event #6 (2/22-23)	68.7	67.6	6

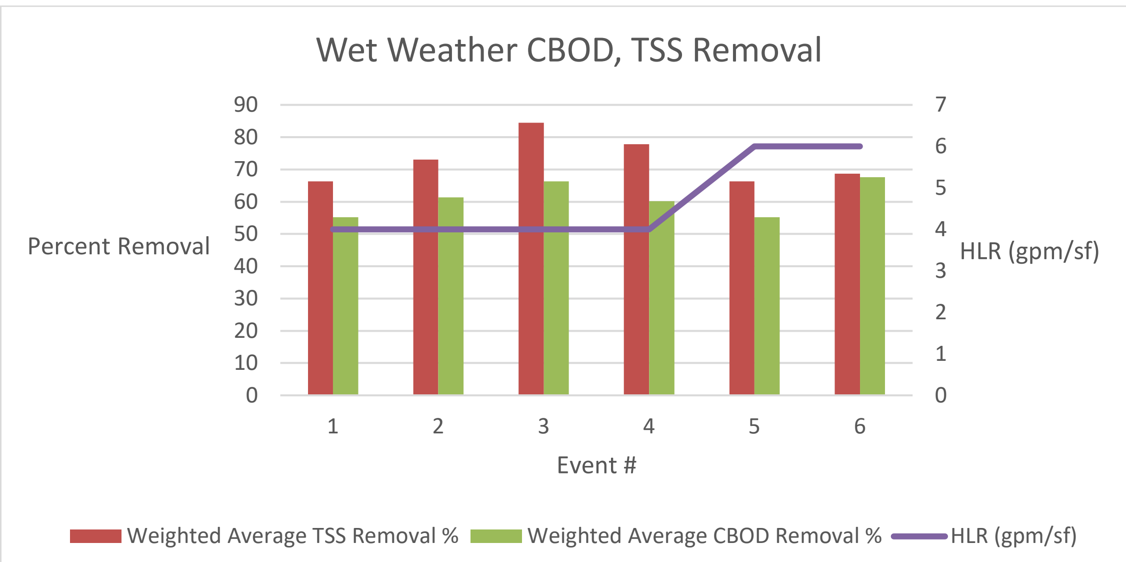

Figure 45: Overall wet weather CBOD, TSS removal for HCWWTA pilot.

The data above shows the pilot unit achieved excellent TSS and CBOD removal across all six wet weather events, and this performance was maintained even for higher hydraulic loadings up to 6 gpm/ft^2 of filtration area.

6. Conclusions

The results of this pilot study indicate that AquaStorm™ PCMF technology, with nominal 5-micron rated OptiFiber PF-14 media, achieved excellent performance for advanced primary and peak wet weather treatment in a dual-use application.

Under dry weather conditions, the filter achieved TSS and cBOD removal rates of 68% and 52.1%, respectively. This was achieved without the use of coagulant for solids precipitation, and was achieved at a range of hydraulic loading rates ranging up to 6 gpm/ft^2. This level of performance was achieved with a modest average total wasting rate of 5.5% of forward flow.

The pilot unit achieved similar levels of TSS and CBOD treatment over six different wet weather events, also without the use of chemical pre-treatment. Discrete sampling showed the filter was able to achieve excellent TSS removal efficiencies (>80%) immediately after the first flush. This level of performance was also achieved with modest wasting rates, although it is worth noting that backwash rates are expected to be lower for a full scale installation compared to the pilot unit.

Based on the pilot study results, it is recommended that the wet weather AquaStorm™ filter be designed at a maximum peak solids loading rate of less than 15 lbs/ft^2/day for a peak hour flow condition or up to 6.5 gpm/ft^2 for peak hour flow condition as long as the solids concentration is less than 15 lbs/ft^2/day. Under dry weather conditions, it is recommended to limit hydraulic flux to 4 gpm/ft^2 and solids loading to less than 10 lbs/ft^2/day. By keeping the loading to the recommended maximum design conditions, this will reduce the backwash frequency during the higher solids events.

Appendix A – Lab Data

Laboratory data from MicroBac Laboratories, Incorporated can be provided upon request for both dry weather and wet weather events.

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Appendix B – SCADA Data

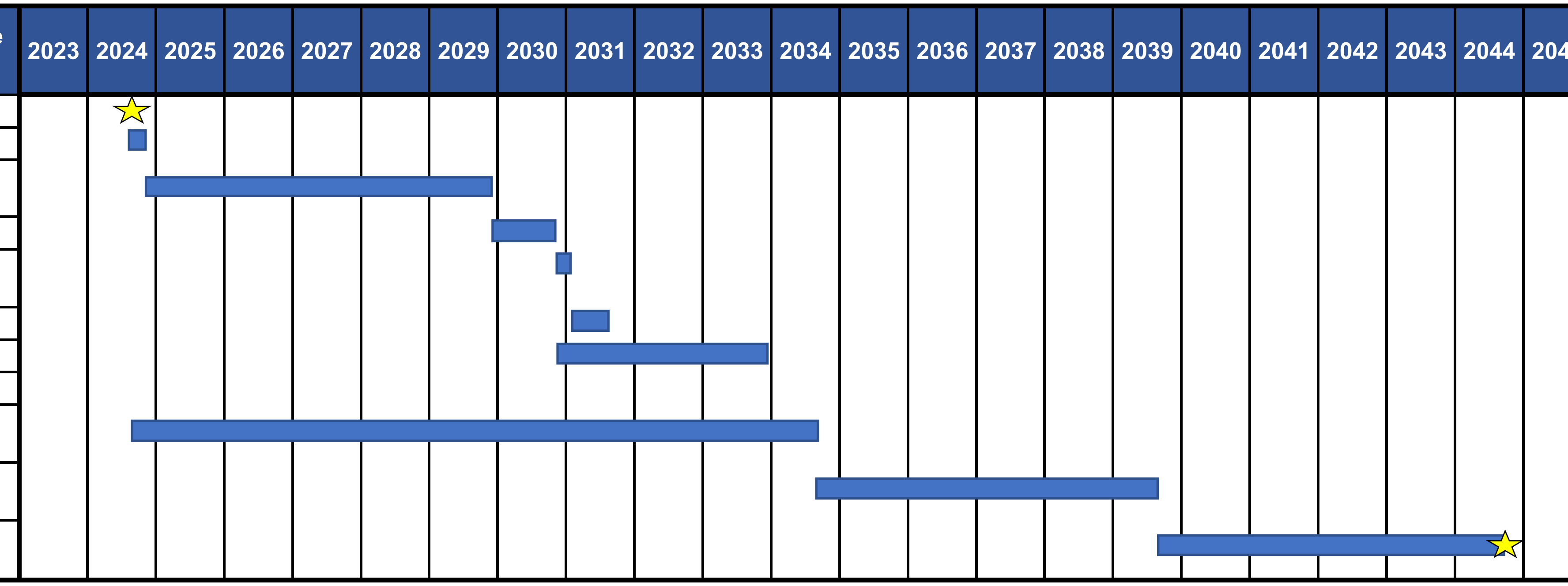
Date	Operational Time (hours)	Average Filter Tank Level (ft)	Median Filter Tank Level (ft)	Minimum Operating Tank Level (ft)	Maximum Operating Tank Level	Typical Recovery (ft)	Ave. Filter pH	Max Filter pH	Min Filter pH	Average Daily Flow Rate (gpm)	Ave. Flow During Operation	Maximum Flow Rate (gpm)	Median Flow Rate (gpm)	Minimum Flow Rate (gpm)	Cumulative Flow Treated (gal)	[HLR] Average Daily Flux (gpm/	Ave. Influent Turbidity (NTU)	Max. Influent Turbidity (NTU)	Min. Influent Turbidity (NTU)	Ave. Effluent Turbidity (NTU)	Max. Effluent Turbidity (NTU	Min. Effluent Turbidity (NTU)	Avg Turbidity Removal (%)	Waste Total (gal)	Wasting Rate (Total)
12/18/2021	10.6	5.64	6.09	2.68	6.98	4.30	6.73	6.92	6.46	35.5	43.0	44.1	42.7	0	27,348	2.00	40.0	124.6	12.6	17.8	46.7	0.3	55.6%	1,850	6.8%
12/29/2021	4.1	3.53	2.09	2.02	6.95	4.92	6.40	6.77	6.27	9.4	54.0	54.6	0.4	0	13,156	2.51	40.3	142.8	10.6	16.8	54.6	0.2	58.4%	2,326	17.7%
12/30/2021	24.0	6.27	6.19	5.81	6.95	1.14	7.01	7.10	6.88	54.0	54.0	55.1	54.0	53	77,761	2.51	21.3	36.8	10.4	11.1	21.2	5.1	48.0%	2,367	3.0%
12/31/2021	24.0	6.47	6.45	5.96	6.95	0.99	6.90	7.04	6.80	54.0	54.0	55.1	54.0	53	77,769	2.51	14.2	26.1	5.1	6.7	12.1	2.9	53.0%	2,207	2.8%
1/1/2022	24.0	6.71	6.69	6.47	7.00	0.53	6.86	7.04	6.69	54.0	54.0	55.2	54.0	#DIV/0!	77,752	2.51	22.4	67.0	4.5	9.6	29.8	2.6	56.9%	4,604	5.9%
1/2/2022	6.0	5.78	5.33	5.28	7.00	1.72	6.68	6.83	6.51	17.9	54.0	54.9	0.7	#DIV/0!	19,538	2.51	122.1	187.0	24.7	9.8	24.4	4.7	92.0%	854	4.4%
1/10/2022	0.4	5.02	5.33	2.05	5.34	3.29	6.11	6.22	6.00	1.0	43.5	1.0	0.1	0	1,010	2.02	387.6	501.1	225.5	12.0	21.4	0.4	96.9%	65	6.5%
1/11/2022	14.6	5.79	5.69	5.32	6.76	1.44	6.47	6.76	6.24	15.5	24.7	34.0	11.2	0	21,656	1.15	306.0	501.2	13.5	11.2	20.1	3.6	96.4%	619	2.9%
1/12/2022	23.2	6.15	6.09	5.51	6.88	1.36	6.76	6.82	6.70	26.6	27.2	34.0	32.4	10	37,826	1.26	76.7	196.4	15.4	5.1	8.7	1.6	93.4%	1,086	2.9%
1/13/2022	19.6	5.83	5.65	5.33	6.73	1.40	6.72	6.78	6.67	10.2	11.2	12.1	10.9	#DIV/0!	13,178	0.52	148.7	250.5	66.0	6.0	11.6	1.8	96.0%	355	2.7%
1/14/2022	12.5	5.81	5.73	5.44	6.71	1.27	6.72	6.85	6.62	6.5	11.1	12.0	10.1	#DIV/0!	8,315	0.52	404.0	501.0	220.7	3.0	8.4	0.2	99.3%	768	9.2%
1/15/2022	0.0	#DIV/0!	#NUM!	5.33	6.77	1.45	6.70	6.82	6.16	0.3	####	33.7	0.0	#DIV/0!	0	####	500.9	501.1	17.7	0.4	20.8	0.3	99.9%	0	####
1/16/2022	17.8	6.63	6.68	6.11	7.04	0.93	6.51	6.72	6.40	32.2	43.0	44.2	42.5	0	46,026	2.00	422.6	501.1	208.7	9.2	21.4	0.3	97.8%	4,486	9.7%
1/17/2022	24.0	6.26	6.21	5.73	6.92	1.19	6.48	6.59	6.38	30.3	30.3	43.9	22.8	21	43,582	1.41	488.5	501.2	441.1	5.3	8.1	3.1	98.9%	1,746	4.0%
1/18/2022	24.0	6.24	6.17	5.72	6.90	1.18	6.48	6.61	6.35	29.1	29.1	34.0	32.3	21	41,846	1.35	355.8	501.2	124.7	5.0	8.6	1.8	98.6%	1,266	3.0%
1/19/2022	24.0	6.31	6.23	5.91	6.92	1.00	6.45	6.53	6.39	33.0	33.0	34.1	33.0	32	47,516	1.53	297.6	501.0	58.4	5.4	8.3	1.9	98.2%	1,337	2.8%
1/20/2022	24.0	6.33	6.27	5.93	6.92	1.00	6.41	6.46	6.34	38.9	38.9	44.0	42.1	#DIV/0!	56,006	1.81	154.1	501.0	18.7	5.8	9.1	3.1	96.2%	1,918	3.4%
1/21/2022	24.0	6.30	6.23	5.91	6.92	1.00	6.39	6.48	6.25	43.0	43.0	44.2	43.0	#DIV/0!	61,914	2.00	52.8	106.2	24.1	5.6	9.8	1.8	89.4%	1,716	2.8%
1/22/2022	12.3	5.88	5.93	5.33	6.90	1.58	6.44	6.54	6.34	22.9	43.0	43.9	41.9	#DIV/0!	31,770	2.00	144.3	501.1	23.6	5.6	9.0	1.9	96.1%	926	2.9%
1/23/2022	0.0	5.32	5.32	5.32	5.33	0.01	6.32	6.36	6.29	0.3	####	1.0	0.0	0	0	####	300.9	350.1	250.5	5.9	7.0	5.2	98.0%	0	####
1/24/2022	0.0	5.32	5.32	5.31	5.32	0.00	6.24	6.27	6.20	0.3	####	1.0	0.0	0	0	####	291.8	501.2	218.1	4.6	4.9	4.4	98.4%	0	####
1/25/2022	0.4	5.35	5.32	5.32	5.34	0.02	6.10	6.19	6.04	1.0	43.9	1.0	0.1	0	1,001	2.04	304.1	442.2	221.8	5.6	8.2	3.2	98.2%	81	8.1%
1/26/2022	15.2	6.00	6.07	5.32	6.92	1.60	6.18	6.38	6.00	27.5	43.0	44.0	42.3	0	39,346	2.00	206.5	501.2	14.4	10.3	16.1	7.0	95.0%	1,787	4.5%
1/27/2022	23.9	6.40	6.35	5.96	6.97	1.01	6.37	6.49	6.21	43.0	43.0	44.2	43.0	42	61,634	2.00	24.6	45.2	5.4	10.0	17.2	2.2	59.4%	2,703	4.4%
1/28/2022	8.8	6.38	6.36	5.95	6.96	1.01	6.59	6.90	6.29	16.0	43.0	43.9	0.8	0	22,758	2.00	14.9	33.2	6.4	2.3	12.3	0.2	84.8%	1,103	4.8%
1/29/2022	0.0	2.29	2.16	2.02	2.78	0.76	6.38	6.46	6.34	0.3	####	1.0	0.0	0	0	####	13.1	16.5	10.9	0.4	0.5	0.3	97.0%	0	####
1/30/2022	0.0	2.12	2.14	2.01	2.20	0.19	6.29	6.35	6.19	0.3	####	1.0	0.0	0	0	####	14.3	15.9	13.1	0.4	0.5	0.4	96.9%	0	####
1/31/2022	16.8	6.52	6.51	6.10	7.02	0.92	6.22	6.37	5.95	30.2	43.0	44.1	42.4	0	43,229	2.00	44.7	80.7	13.7	15.4	30.4	0.4	65.6%	3,396	7.9%
2/1/2022	23.8	6.48	6.45	5.99	7.00	1.01	6.19	6.29	6.11	43.0	43.0	44.1	43.0	42	61,508	2.00	50.2	101.8	25.6	14.4	23.3	3.1	71.4%	3,675	6.0%
2/2/2022	24.0	6.57	6.58	6.04	7.03	0.98	6.23	6.30	6.15	43.0	43.0	44.1	43.0	42	61,833	2.00	47.6	93.1	7.2	18.5	34.0	3.2	61.0%	6,035	9.8%
2/3/2022	23.7	6.60	6.68	5.91	7.06	1.15	6.24	6.33	6.16	43.0	43.0	44.2	43.0	42	61,235	2.00	64.3	191.1	23.3	25.9	56.3	12.4	59.7%	9,234	15.1%
2/4/2022	8.2	6.12	6.06	5.74	6.89	1.15	6.29	6.43	5.97	14.9	43.0	43.9	0.8	0	21,152	2.00	12.1	21.3	6.1	4.0	13.0	0.2	67.3%	866	4.1%
2/5/2022	0.0	2.37	2.28	2.03	2.78	0.75	6.11	6.25	6.01	0.3	####	1.0	0.0	0	0	####	7.9	10.6	5.8	0.4	0.4	0.3	95.4%	0	####
2/6/2022	0.0	2.04	2.04	2.00	2.10	0.10	5.89	5.97	5.82	0.3	####	1.0	0.0	0	0	####	9.1	9.6	8.4	0.7	2.1	0.3	92.2%	0	####
2/7/2022	15.7	6.12	6.06	5.33	6.92	1.59	6.13	6.44	5.71	35.5	53.9	55.0	53.3	#DIV/0!	50,904	2.51	19.1	35.1	9.1	13.8	97.8	0.4	27.8%	1,262	2.5%
2/8/2022	23.4	6.39	6.33	5.89	6.96	1.07	6.51	6.71	6.31	61.5	61.5	66.0	64.4	#DIV/0!	86,260	2.86	30.9	70.8	4.2	9.1	15.2	2.1	70.6%	2,104	2.4%
2/9/2022	24.0	6.50	6.45	6.16	6.97	0.81	6.45	6.63	6.36	65.0	65.0	66.1	65.0	64	93,594	3.02	23.3	38.1	4.7	9.0	15.2	2.4	61.4%	2,312	2.5%
2/10/2022	23.5	6.55	6.51	6.20	6.98	0.78	6.41	6.62	6.25	65.0	65.0	66.1	65.0	64	91,617	3.02	21.4	41.4	4.1	10.7	19.0	2.1	50.1%	2,676	2.9%
2/11/2022	8.1	6.49	6.51	6.23	6.94	0.71	6.40	6.67	6.25	22.1	64.8	65.9	0.8	0	31,465	3.01	16.9	28.4	4.6	2.0	10.8	0.2	88.0%	1,084	3.4%
2/12/2022	0.0	#DIV/0!	#NUM!	#NUM!	#NUM!	#NUM!	5.94	6.20	5.77	0.3	####	1.0	0.0	0	0	####	17.7	18.3	17.1	0.4	0.4	0.3	97.8%	0	####
2/13/2022	0.0	#DIV/0!	#NUM!	#NUM!	#NUM!	#NUM!	5.76	5.78	5.75	0.3	####	1.0	0.0	0	0	####	17.5	17.9	17.1	0.4	0.5	0.3	97.7%	0	####
2/14/2022	16.9	6.07	5.98	5.59	6.87	1.29	5.87	6.11	5.76	15.9	22.3	23.1	21.4	0	22,695	1.04	39.5	75.8	17.2	17.9	50.5	0.4	54.7%	792	3.5%
2/15/2022	24.0	6.20	6.18	5.55	6.90	1.35	6.21	6.34	6.05	28.8	28.8	34.0	32.2	21	41,509	1.34	36.1	80.0	4.8	19.7	43.7	2.5	45.4%	1,371	3.3%
2/16/2022	24.0	6.33	6.29	5.80	6.94	1.14	6.22	6.27	6.18	33.0	33.0	34.1	33.0	32	47,512	1.53	37.5	83.7	5.4	18.6	40.2	2.7	50.4%	1,711	3.6%
2/17/2022	23.9	6.53	6.55	5.85	7.08	1.23	6.26	6.35	6.16	38.8	38.8	53.9	33.6	32	55,485	1.80	58.6	162.8	6.0	27.1	62.7	3.3	53.8%	7,660	13.8%
2/18/2022	8.3	6.66	6.71	6.39	7.01	0.62	6.23	6.33	6.15	18.3	52.6	53.9	0.8	0	26,046	2.44	14.4	29.3	6.5	4.2	15.4	0.2	71.1%	2,834	10.9%
2/19/2022	0.0	#DIV/0!	#NUM!	#NUM!	#NUM!	#NUM!	6.14	6.22	6.03	0.3	####	1.0	0.0	0	0	####	8.8	11.5	6.4	0.4	0.4	0.3	95.9%	0	####
2/20/2022	0.0	#DIV/0!	#NUM!	#NUM!	#NUM!	#NUM!	5.82	5.95	5.69	0.3	####	1.0	0.0	0	0	####	8.0	8.6	7.5	0.4	0.4	0.3	95.2%	0	####
2/21/2022	18.4	5.98	5.87	5.47	6.84	1.38	5.98	6.23	5.75	12.0	15.4	16.2	14.5	0	17,025	0.71	25.5	47.6	8.4	9.6	19.3	0.3	62.3%	612	3.6%
2/22/2022	24.0	6.23	6.16	5.62	7.00	1.38	6.13	6.30	6.02	23.9	23.9	65.6	15.4	14	34,356	1.11	36.5	185.1	10.8	14.9	81.5	5.2	59.1%	3,797	11.1%
2/23/2022	24.0	6.37	6.37	5.84	7.00	1.16	6.22	6.36	6.04	50.3	50.3	65.9	43.7	42	72,459	2.34	29.0	61.7	14.1	18.9	37.4	8.9	35.0%	3,536	4.9%
2/24/2022	23.8	6.28	6.19	5.91	6.90	1.00	6.30	6.38	6.25	43.0	43.0	44.1	43.0	42	61,379	2.00	14.5	22.4	9.5	7.7	10.6	5.4	47.1%	1,330	2.2%
2/25/2022	7.6	6.29	6.27	6.01	6.90	0.90	6.18	6.38	5.99	13.9	43.0	43.9	0.7	0	19,663	2.00	12.4	19.3	8.3	2.7	9.3	0.2	77.9%	933	4.7%
2/26/2022	0.0	#DIV/0!	#NUM!	#NUM!	#NUM!	#NUM!	6.00	6.05	5.96	0.3	####	1.0	0.0	0	0	####	9.2	10.8	7.9	0.4	0.4	0.3	95.9%	0	####
2/27/2022	0.0	#DIV/0!	#NUM!	#NUM!	#NUM!	#NUM!	5.74	5.90	5.7	0.3	####	1.0	0	0	0.00	####	789.4%	9.5	6.8	0.3	0	0	1	0	####
2/28/2022	17.1	6.27	6.20	5.90	6.93	1.02	5.92	6.15	5.6	30.9	43.0	44.1	42	0	#####	2.0	1356.8%	24.9	6.6	4.9	9	0	1	1,196	2.7%

Date	Average BW Flow (gpm)	Median BW Flow (gpm)	BW Count	BW Interval (min)	Cumulative BW Volume (gal)	BW Ratio	Average BW Vacuum (in Hg)	Min BW Vacuum (in Hg)	Median BW Vacuum (in Hg)	High BW Vacuum (in Hg)	Average SW Flow (gpm)	Median SW Flow (gpm)	SW Count	SW Interval (min)	Cumulative SW Volume (gal)	SW Ratio	Solids Conditioning Count	BW/SW Ratio	Cumulative SC Volume (gal)	SC Ratio	Extended BW Waste Rate	BW Duration (min)	Extended BW Duration (min)	SW Duration (min)
12/18/2021	26	31	71	9	1,600	5.8%	0.3	0.1	0.6	2.3	32	34	8	79	250	0.3%	0	6.4	0	0	0.538	53.08	0	6.167
12/29/2021	27	32	86	3	2,049	15.6%	0.7	0.1	0.4	2.2	32	34	9	27	276	2.1%	2	7.4	47.01563	0.003574	0.538	66.83	0	6.167
12/30/2021	26	31	93	15	2,089	2.7%	1.1	0.2	0.8	2.4	29	32	10	144	278	0.4%	2	7.5	46.51042	0.000598	0.538	69.83	0	7.5
12/31/2021	26	31	82	18	1,888	2.4%	3.1	1.2	2.9	5.6	29	30	12	120	319	0.4%	3	5.9	85.36875	0.001098	0.538	64.5	0	9.25
1/1/2022	27	32	135	11	3,330	5.1%	5.1	2.5	5.1	7.0	30	31	24	60	674	0.9%	6	5.8	131.6365	0.001693	0.538	132.6	0	17.5
1/2/2022	27	33	27	13	738	3.8%	5.0	2.4	4.9	8.8	28	30	4	90	116	0.6%	0	6.4	0	0	0.538	63.08	0	2.917
1/10/2022	28	32	2	12	44	4.3%	2.8	1.7	2.8	3.5	29	30	2	12	21	2.1%	2	2.0	33.9375	0.033587	0.538	1.5	0	0.833
1/11/2022	26	32	22	40	491	2.3%	3.3	1.5	3.2	5.3	29	32	5	175	127	0.6%	2	3.9	45.54271	0.002103	0.538	16.42	0	4.083
1/12/2022	25	31	38	37	839	2.2%	4.7	1.8	4.6	7.9	27	30	10	139	247	0.7%	4	3.4	87.3375	0.002309	0.538	28.67	0	8.167
1/13/2022	24	30	10	118	200	1.5%	6.3	3.8	6.3	8.1	25	27	7	168	156	1.2%	2	1.3	42.90313	0.003256	0.538	7.583	0	5.833
1/14/2022	28	32	8	93	236	3.6%	8.0	2.3	8.3	11.3	31	32	8	93	472	5.7%	4	0.6	84.00521	0.010103	0.538	10.25	0	14.75
1/15/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	1.8	#NUM!	9.6	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
1/16/2022	26	32	179	6	3,925	8.5%	4.3	1.8	4.2	6.9	31	33	19	56	561	1.2%	2	7.0	44.91979	0.000976	0.538	135	0	13.92
1/17/2022	26	31	67	21	1,456	3.3%	5.6	1.4	5.4	8.6	29	32	11	131	290	0.7%	4	5.0	86.99062	0.001996	0.538	50.25	0	8.667
1/18/2022	25	31	49	29	1,041	2.5%	8.1	2.1	8.6	10.3	28	31	9	160	225	0.5%	3	4.6	84.65417	0.002023	0.538	36.92	0	7.167
1/19/2022	25	31	52	28	1,095	2.3%	10.0	2.4	10.7	13.4	28	32	10	144	242	0.5%	3	4.5	81.91563	0.001724	0.538	39.08	0	8.167
1/20/2022	25	31	77	19	1,636	2.9%	10.0	1.7	11.2	13.2	28	31	11	131	281	0.5%	4	5.8	82.99375	0.001482	0.538	57.92	0	8.417
1/21/2022	25	32	68	21	1,458	2.4%	10.5	2.0	11.5	14.2	29	32	10	144	257	0.4%	4	5.7	78.03479	0.001261	0.538	51.25	0	7.833
1/22/2022	26	32	36	21	768	2.4%	10.8	1.9	11.9	13.6	28	32	6	123	158	0.5%	2	4.9	39.75208	0.001251	0.538	27.08	0	4.667
1/23/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
1/24/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
1/25/2022	26	34	3	8	81	8.1%	10.7	2.4	11.8	13.5	####	#NUM!	0	####	0	0.0%	0	####	0	#DIV/0!	0.538	2.667	0	0
1/26/2022	27	34	72	13	1,589	4.0%	9.4	2.0	10.1	12.8	30	32	7	131	198	0.5%	1	8.0	43.73542	0.00112	0.538	54.17	0	5.167
1/27/2022	26	32	108	13	2,319	3.8%	10.4	2.4	11.2	12.9	29	32	14	102	384	0.6%	4	6.0	81.78125	0.001327	0.538	81.33	0	10.42
1/28/2022	26	32	35	15	840	3.7%	12.4	3.2	13.0	16.0	30	31	5	106	263	1.2%	0	3.2	0	0	0.538	29.25	0	7.75
1/29/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
1/30/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
1/31/2022	26	32	134	8	2,961	6.8%	7.0	2.2	7.2	10.2	31	33	15	67	435	1.0%	4	6.8	86.70208	0.002006	0.538	100.6	0	11.17
2/1/2022	26	32	149	10	3,193	5.2%	10.4	2.0	11.3	13.9	30	32	17	84	482	0.8%	4	6.6	78.49479	0.001276	0.538	112.1	0	12.83
2/2/2022	26	32	232	6	5,286	8.5%	10.5	1.9	11.2	14.3	30	32	26	55	748	1.2%	4	7.1	82.31146	0.001341	0.538	181	0	18.92
2/3/2022	28	33	276	5	8,009	13.1%	8.0	2.5	7.6	12.6	30	31	43	33	1,225	2.0%	3	6.5	156.1729	0.00255	0.538	266.3	0	31.67
2/4/2022	26	31	19	26	494	2.3%	12.4	3.7	12.2	17.9	31	31	3	164	372	1.8%	0	1.3	0	0	0.538	17.17	0	11.83
2/5/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/6/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/7/2022	25	30	49	19	1,087	2.1%	8.6	2.5	8.7	13.1	31	34	6	157	175	0.3%	2	6.2	41.11354	0.000808	0.538	38.67	0	4.75
2/8/2022	24	30	84	17	1,774	2.1%	11.4	2.5	12.2	15.2	29	32	10	117	330	0.4%	4	5.4	74.64792	0.000865	0.538	67.33	0	9.25
2/9/2022	24	30	94	15	1,998	2.1%	12.7	2.9	13.7	16.7	28	31	12	120	315	0.3%	3	6.4	77.75521	0.000831	0.538	75.67	0	8.917
2/10/2022	25	30	107	13	2,301	2.5%	12.3	2.4	13.4	16.3	28	31	14	101	375	0.4%	3	6.1	76.67083	0.000837	0.538	87.5	0	10.92
2/11/2022	25	30	27	18	674	2.1%	13.6	2.8	14.4	18.5	30	31	5	97	410	1.3%	2	1.6	36.68125	0.001166	0.538	25.42	0	13.25
2/12/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/13/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/14/2022	26	32	26	39	619	2.7%	9.5	2.0	10.1	14.3	31	34	6	169	174	0.8%	2	3.6	40.41042	0.001781	0.538	20.67	0	5.083
2/15/2022	24	30	51	28	1,108	2.7%	12.5	2.1	13.7	17.1	29	32	10	144	263	0.6%	4	4.2	76.90625	0.001853	0.538	41.08	0	8.25
2/16/2022	24	30	67	21	1,413	3.0%	13.3	2.5	14.2	18.1	28	31	11	131	298	0.6%	3	4.7	53.11771	0.001118	0.538	53	0	9
2/17/2022	27	31	190	8	6,582	11.9%	9.2	2.7	7.8	16.3	30	32	38	38	1,078	1.9%	5	6.1	79.97813	0.001441	0.538	229.2	0	28.5
2/18/2022	25	31	91	5	2,218	8.5%	7.3	3.0	6.7	13.8	30	31	12	41	616	2.4%	2	3.6	25.13646	0.000965	0.538	79	0	18.25
2/19/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/20/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/21/2022	26	30	18	61	417	2.5%	3.5	1.2	10.4	13.1	29	34	7	158	135	1.1%	2	2.1	24.85417	0.00146	0.538	14.42	0	5.917
2/22/2022	27	32	90	16	3,148	9.2%	10.3	5.1	10.5	14.4	29	32	23	63	649	1.9%	5	4.9	71.87604	0.002092	0.538	109.3	0	17.75
2/23/2022	26	31	116	12	3,049	4.2%	8.6	3.6	8.4	12.6	29	31	18	80	488	0.7%	4	6.3	47.56042	0.000656	0.538	107.8	0	13.75
2/24/2022	24	29	50	29	1,073	1.7%	11.9	2.7	13.1	15.4	27	31	10	143	257	0.4%	4	4.2	47.32813	0.000771	0.538	39.75	0	8.917
2/25/2022	26	31	18	25	515	2.6%	13.8	5.8	14.6	17.7	30	31	5	91	418	2.1%	1	1.2	23.37917	0.001189	0.538	18.75	0	13.75
2/26/2022	#DIV/0!	####	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/27/2022	#DIV/0!	####	0	#DIV/0!	0.0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	#NUM!	####	#NUM!	0	####	0	####	0	####	0	#DIV/0!	0.538	0	0	0
2/28/2022	24.8	30.8	47.0	21.8	1031.7	0.0	9.0	2.6	9.3	13	29.08	33.18	6	170.8	164.8	0.004	1	6.262	26.57708	0.000603	0.538	37.33	0	5.167

Appendix III: Schedule for CD Compliance - Signal Mountain WWTP

Schedule for CD Compliance - Signal Mountain WWTP

Item No.	Consent Decree Requirement	CD Required Deadline (Months)	Deliverable Dates
1	Effective Date	0	7/15/2024
2	Remediation Plan	2	9/15/2024
3	Completion of Construction Remediation Plan	62	9/15/2029
4	WWTP Optimization Plan	75	10/15/2030
5	NPDES Permit Modification TDEC Submittal	78	1/15/2031
6	NPDES Permit Modification TDEC Review	84	7/15/2031
7	Completion of Construction Optimization	111	10/15/2033
8	Diversion around WWTP		
a	Max of 7 days per month (12-month rolling average)	120	7/15/2034
b	Max of 5 days per month (12-month rolling average)	180	7/15/2039
c	Eliminate WWTP Diversion around Biological Treatment	240	7/15/2044



Appendix IV: Public Comments and Responses