

ULTRASCREEN® DISK FILTER PILOT STUDY REPORT

Tertiary Filtration for Phosphorus Removal Reedsburg WWTF 06/10/2022 – 07/21/2022



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1. Executive Summary

Nuove Energie USA, Inc. was contracted by the City of Reedsburg to perform a tertiary filtration study for the City of Reedsburg Wastewater Treatment Facility (WWTF) at their facility located at 802 Division Street.

The pilot arrived at the Reedsburg WWTF on June 6th, 2022 and testing commenced on June 10th after the needed connections to power and water were completed, and the unit was readied for service. The unit was setup and operated per the design conditions provided to follow and a meeting was held with the Reedsburg facility in cooperation with their consulting engineer, Town & Country Engineering, prior to the testing commencement. Follow up meetings were typically held once per week to establish the following weeks testing protocol and strategy.

Kier Ruggerio with Nuove Energie USA operated the pilot over the course of the study and compiled the report to follow. The pilot program was overseen by Cassie Elmer and Ben Heidemann with Town & Country Engineering and Chris Kleinschmit with the facility's operation staff who aided with pilot setup along with his team, as well as addressing day to day needs, and performed regular check-ins for coordination.

The pilot testing went extremely well. With chemical precipitation prior to the Ultrascreen system, the **filter effluent TP over the duration of the study averaged 0.12 mg/L, easily exceeding the 0.25 mg/L TP effluent goal.** Also, it should be noted this 0.12 mg/L TP average included the testing during the high influent TP period at the beginning of the study.

Project Background

The WWTF is subject to Wisconsin River Total Maximum Daily Load (TMDL) effluent phosphorus limits and will be subject to increasingly stringent limits which will become effective in July 2023. Additionally, a new WWTF is being planned due to issues of flooding and overloading at the existing site. Construction for the new site is anticipated to take place beginning in spring of 2024.

The WWTF currently uses chemical phosphorus removal with ferric chloride to comply with their phosphorus limit of 1 mg/L. At the new WWTF, the City intends to utilize biological phosphorus removal followed by tertiary filtration for long-term compliance with phosphorus limits.

Design Conditions Set Forth in the RFQ

The pilot study must show that effluent phosphorus can be removed to the following levels. The study should include sufficient testing to document the required coagulant and flocculent doses for the lowest effluent concentration and the range of additional effluent concentrations presented. It is anticipated that influent phosphorus concentrations to the filter will range between 0.6 mg/L to 1.5 mg/L.

- Anticipated lowest effluent phosphorus concentration: 0.25 mg/L
- Maximum hydraulic loading to the filters shall be 5 gpm/sf.

Given that the WWTF currently utilizes ferric chloride for chemical treatment and will continue to do so at the new WWTF, it is the City's desire to continue using ferric chloride for a coagulant. The manufacturer will be required to provide any chemicals, mixing tanks, or other associated equipment necessary for the pilot test. Mixing tanks shall be sized to have sufficient volumes for detention times needed for range of concentrations above.

The WWTF will be designed for the following flows, which must be treated by the filtration equipment, up to the Design Maximum Day flow. Provisions shall be made for bypassing of the Design Peak Hourly Flow.

- Current Annual Average (2015-2020) – 2.355 MGD
- Design Annual Average – 2.907 MGD
- Design Maximum Month – 4.192 MGD
- Design Maximum Day – 7.098 MGD
- Design Peak Hourly Flow – 10.416 MGD

2. Introduction to the Ultrascreen® Disk Filter Technology

The Ultrascreen® Disk Filter uses Dynamic Tangential Filtration® to physically remove biological and inorganic solids as well as chemically precipitated solids like Phosphorus from wastewater. The filtering disks are constructed using a woven 316 stainless steel mesh as the filtration medium. Dynamic Tangential Filtration® is a unique, patented concept that uses the combination of constant disk rotation and an influent flow pattern where water passes across the disks tangentially, rather than orthogonally. This reduces the effective openings of the stainless-steel mesh and allows for very efficient separation of micro particles contained in the influent water. The efficiency achieved with tangential filtration allows the system to handle total suspended solids (TSS) upsets up to 150 mg/L and leads to a smaller overall footprint for the system and filtration rates of up to 16 gpm per square foot of disk area.

The filtering disks work in pairs. The influent water enters between a pair of disks and water passes outward across the disks. The filtered water then flows by gravity into a common collection well and exits the unit through the outlet pipe.

As water passes across the rotating disks, solids accumulate on the disk surface, which creates headloss. This causes the water level between the pairs of disks to increase. When the water reaches a predetermined level, a level sensor activates an automatic spray wash cleaning sequence. Each disk has its own spray header to ensure efficient disk cleaning. The spray wash wastewater (backwash reject) from each set of disks is collected in a common channel and then purged from the unit through a dedicated drain. The reject water is then typically returned to the headworks of the facility for continued treatment.

The Ultrascreen Disk Filter offers the lowest possible total cost of ownership. The robust, all stainless-steel construction of the filtering disks means less changing of the filtering elements; typically, the filtration media has an average lifespan greater than 10 years. None of the mechanical bearings within the tank are submerged, which drastically increases the bearing's lifespan. The design allows for a simple, "plug and play" startup process and easy access to the unit internals when maintenance is required.

Optimizing the performance of the system is possible because the disk rotation speed, wash cycle timing, and water level in the feed zone are all adjustable. Process adjustments like these are not possible with other static disk filter systems.

The Ultrascreen Disk Filter is simple to integrate, as it comes as a complete filtration package including the backwash system, disk drive system, local control panel, and connecting flanges factory installed (unless specified otherwise.) With the local control panel being factory assembled to the filter, the interconnecting wiring from the local control panel to the associated filter components and sensors is shipped complete and factory tested, meaning installation and startup typically only requires siting/securing the filter in place, bringing power to the local control panel, connecting the associated piping, and connecting to SCADA for remote monitoring and operation capability.

The Ultrascreen Disk Filter's compact footprint, robust stainless steel filtration media, and ease of installation combined with its low total cost of ownership and easy to maintain design make it the right choice for your tertiary filtration needs.

3. Ultrascreen Pilot Unit Description

The Ultrascreen Model UY1001 pilot unit is a self-contained disk filtration system consisting of a filter containing one pair of disks with a total filtration area of 17 square feet, utilizing 316L stainless steel 20-micron woven filtration media. Typical filtration rates of up to 16 gpm/ft² are achievable depending on influent water quality and process requirements for a total peak capacity as high as 272 gpm.



Figure 1. Ultrascreen Pilot Unit

The pilot unit was equipped with a self-priming influent pump as well as the needed hoses for supplying and discharging water from the unit. The influent was drawn from the WWTF clarifier effluent and fed into the Ultrascreen flocculation tank for chemical precipitation/flocculation via ferric chloride and an anionic high molecular weight emulsion polymer (Neo Solutions NS 6350 – 30% Anionicity.) The filter skid was equipped with an influent flow meter, local control panel, and an automated self-contained backwashing system which draws its wash water from the effluent of the unit.

The unit was provided with coagulant & polymer day tanks along with peristaltic chemical dosing pumps for feeding each chemical. The coagulant ferric chloride, when utilized, was dosed to an inline static mixer directly following the influent feed pump and conveyed to a 795-gallon baffled flocculation tank via a 50-foot long 4-inch flexible hose. The polymer was dosed to the first stage of flocculation with carry-water for better floc formation as well as improved TP removals. The flocculation tank was equipped with adjustable dual paddle wheel flocculators to provide the needed chemical mixing.

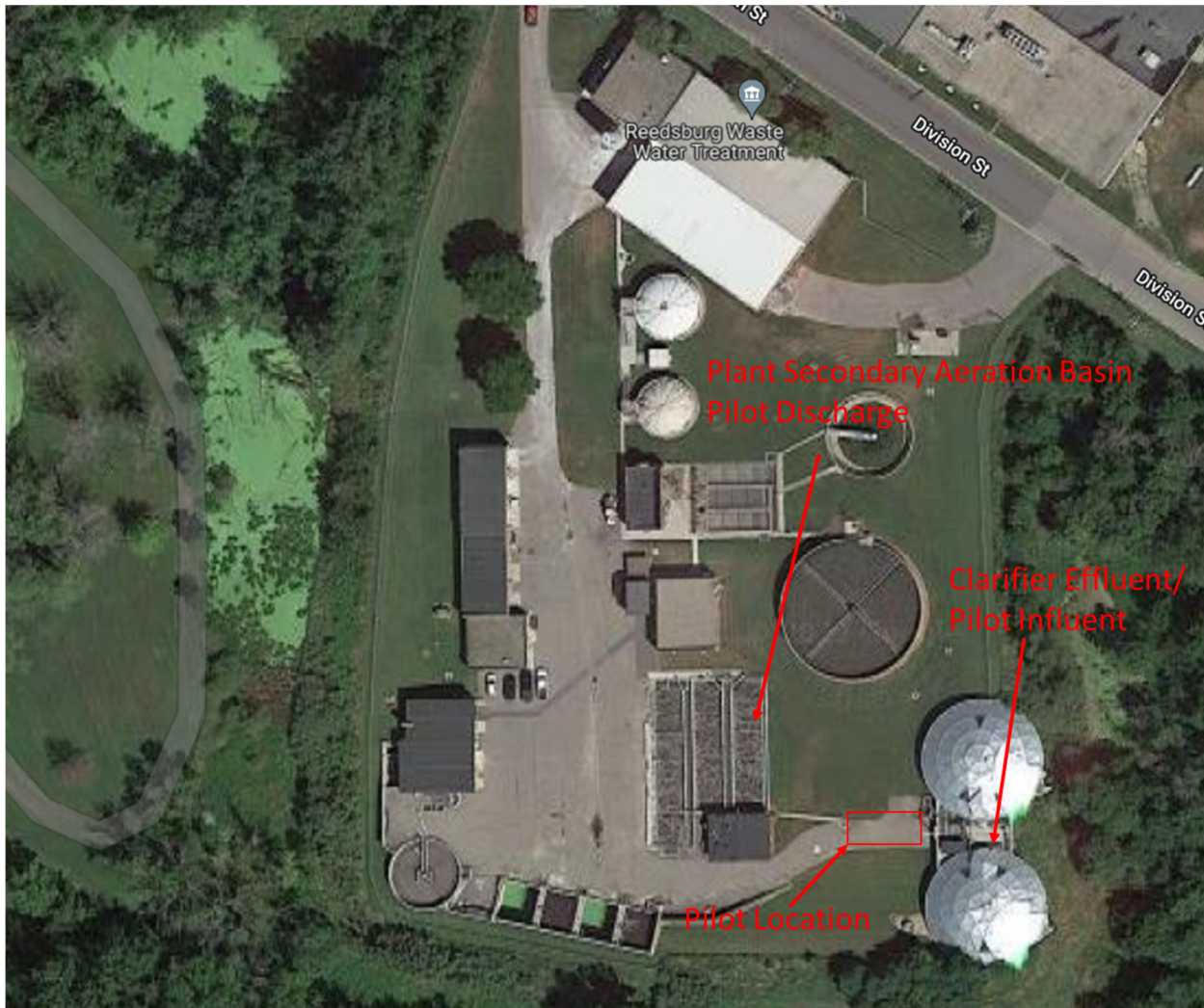


Figure 2. Reedsburg Pilot Site

Data was collected via an operational log which was kept of the pilot's operating parameters and is presented in full in **Appendix A**. Samples were collected as needed for process optimization via grab sampling and supplemented with an influent and effluent refrigerated composite sampler for the eight hour runs per the protocol established.

Samples for process optimization were tested onsite for Total Phosphorus (TP) and Dissolved Total Phosphorus by the Nuove staff member for making process related adjustments and recorded. A Hach DR5000 photospectrometer, DRB200 Batch Reactor were utilized for the Total Phosphorus analysis and a 0.45-micron filtration membrane syringe was provided for filtering the samples for Dissolved Total Phosphorus prior to analysis. Determination of Total Phosphorus and Dissolved Total Phosphorus was by the PhosVer® 3 Ascorbic Acid method with Acid Persulfate Digestion, which is EPA Compliant per Hach Method 8190 with a Range: 0.06 - 3.50 mg/L PO₄.

A duplicate sample from each composite run was given to WWTF for Total Phosphorus testing for confirmation in their onsite lab. The WWTF also ran each of the samples for Total Suspended Solids (TSS.)



Figure 3. Pilot Setup: a.) Pilot Unit with Clarifier in the background, b.) Two-Stage Flocculation Tankage, c.) Internal View of Flocculation Tank, d.) Ultrascreen Pilot Overall, e.) View of Ultrascreen Disks and Backwash System

4. Results

To follow is a summary of the operating conditions for each of the composite runs completed and the lab results of the 8 hour or greater composite sample per the testing protocol established. The influent Total Phosphorus to the filter system varied quite dramatically during the course of the pilot, reaching levels of over 3 mg/L TP at the start of the study to less than 0.2 mg/L at the midpoint of the study. The study was paused on June 16-22, to allow the facility to optimize their clarified effluent for the design conditions and once again on July 1-18. This resulted in three ranges of influent TP tested, which were established as High Influent TP (approx. 2-3 mg/L), Low Influent TP (approx. 0.2-0.3 mg/L), Moderate Influent TP (approx. 0.4-0.5 mg/L) which was the closest to the intended design parameters.

The results of the pilot testing proved the Ultrascreen disk filter can efficiently and effectively reduce Total Phosphorus at the Reedsburg WWTF to well within the anticipated TMDL's. The Ultrascreen filter removed on average 58% of the particulate Total Phosphorus throughout the duration of the study with a maximum removal of 1.8 mg/L of Total Phosphorus across the filter. With chemical precipitation, the filter effluent TP over the duration of the study averaged 0.12 mg/L, well exceeding the 0.25 mg/L TP effluent goal. Also, it should be noted this 0.12 mg/L TP average included the testing during the high influent TP period at the beginning of the study.

Testing on 6/15/2022 and then on 6/23-24 were conducted at slightly lower filter loading rates vs the remainder of the tests due to hydraulic restrictions between the flocculation tank and the filter unit. This was rectified for the consequent tests conducted by adjusting the piping configuration. The remainder of the tests were performed at 5 gpm/ft² average loading rate and one run was performed at 7 gpm/ft² peak loading rate at the conclusion of the testing.

4.1 Scenario 1 - High Influent Total Phosphorus

The influent Total Phosphorus at the beginning of the study was well above the typical effluent of the WWTF due to some seasonal variation as well as some process equipment issues within the facility. Composite runs were conducted both with and without chemical precipitation prior to the Ultrascreen system and the system chemistry as well as physical parameters were optimized, yielding 70% of particulate phosphorus removal without chemical precipitation and 97% of particulate phosphorus removal with ferric chloride and polymer addition. This represented the highest removal of TP throughout the duration of the study, removing 1.8 mg/L of Total Phosphorus across the filter system.

Table 1 – Optimized Operational Parameters/Results: High TP Influent Without Chemical Precipitation

Date	Flow Rate (gpm)	Ferric Dose/ Anionic Polymer Dose (mg/L)	Filter Loading Rate (gpm/ft ²)	Disk Speed (rpm)	Floc Time (min.)	% Forward Flow to Backwash	Composite Sample Analytical Results	Phosphorus Total as P (mg/L) Nuove Pilot Lab/Facility Lab	Phosphorus Total Dis. P as P (mg/L) Nuove Pilot Lab	TSS (mg/L) Facility Lab
06/13/2022	85	N/A	5	50	N/A	0.38	Influent	2.83 (2.83)	2.16	7.75
							Effluent	2.52 (2.65)	2.39	5.8

Table 2 – Optimized Operational Parameters/Results: High TP Influent With Chemical Precipitation

Date	Flow Rate (gpm)	Ferric Dose/ Anionic Polymer Dose (mg/L)	Filter Loading Rate (gpm/ft ²)	Disk Speed (rpm)	Floc Time (min.)	% Forward Flow to Backwash	Composite Sample Analytical Results	Phosphorus Total as P (mg/L) Nuove Pilot Lab/ (Facility Lab)	Phosphorus Total Dis. P as P (mg/L) Nuove Pilot Lab	TSS (mg/L) Facility Lab
06/15/2022	64	15/1.2	3.75	40	12.46	5.6	Influent	2.22 (2.22)	2.15	2.75
							Effluent	0.42 (0.37)	0.37	-

4.2 Scenario 2 - Low Influent Total Phosphorus

A one week pause in piloting was taken from June 16-22 to allow the WWTF to stabilize and reduce their effluent TP concentrations. When the pilot program was restarted, the influent TP to the filtration system was greatly reduced. The WWTF clarified effluent was in the range of 0.16 mg/L –

0.28 mg/L TP for this phase of testing. Composite runs were conducted both with and without chemical precipitation prior to the Ultrascreen system. The system chemistry as well as physical parameters were optimized, yielding 46% of particulate phosphorus removal without chemical precipitation and an effluent TP of 0.10 mg/L, and an average of 48% of particulate phosphorus removal with ferric chloride and polymer addition and an average of 0.09 mg/L TP.

Table 3 - Operational Parameters/Results: Low TP Influent Without Chemical Precipitation

Date	Flow Rate (gpm)	Ferric Dose/ Anionic Polymer Dose (mg/L)	Filter Loading Rate (gpm/ft ²)	Disk Speed (rpm)	Floc Time (min.)	% Forward Flow to Backwash	Composite Sample Analytical Results	Phosphorus Total as P (mg/L) Nuove Pilot Lab/ Facility Lab		Phosphorus Total Dis. P as P (mg/L) Nuove Pilot Lab	TSS (mg/L) Facility Lab
06/27/2022	85	N/A	5	70	N/A	0.13	Influent	0.16	(0.19)	0.08	3.4
							Effluent	0.10	(0.10)		

Table 4 - Operational Parameters/Results: Low TP Influent with Chemical Precipitation

Date	Flow Rate (gpm)	Ferric Dose/ Anionic Polymer Dose (mg/L)	Filter Loading Rate (gpm/ft ²)	Disk Speed (rpm)	Floc Time (min.)	% Forward Flow to Backwash	Composite Sample Analytical Results	Phosphorus Total as P (mg/L) Nuove Pilot Lab / (Facility Lab)		Phosphorus Total Dis. P as P (mg/L) Nuove Pilot Lab	TSS (mg/L) Facility Lab
06/23/2022	64	5/1	3.75	40	12.46	2.91	Influent	0.24	(0.19)	0.09	2.75
							Effluent	0.11	(0.08)		
06/24/2022	64	15/1	3.75	40	12.46	2.8	Influent	0.24	(0.18)	0.10	-
							Effluent	0.09	(0.03)		
06/25/2022	85	15/.75	5	40	9.36	2.46	Influent	0.20	(0.13)	0.11	-
							Effluent	0.07	(0.02)		
06/26/2022	85	20/.75	5	40	9.36	2.81	Influent	0.15	(0.11)	0.06	1.25
							Effluent	0.04	(0.06)		
06/29/2022	85	10/.75	5	50	9.36	2.49	Influent	0.28	(0.26)	0.17	4.2
							Effluent	0.13	(0.12)		
06/30/2022	85	15/1	5	50	9.36	2.81	Influent	0.22	(0.18)	0.13	4.2
							Effluent	0.10	(0.07)		

4.3 Scenario 3 - Moderate Influent Total Phosphorus (Expected Design Conditions)

At the conclusion of the low influent TP testing, a two week pause in piloting was taken from July 1-18 to allow the WWTF to attempt to slightly increase their effluent TP concentrations to the expected design conditions of 0.6 – 1.5 mg/L TP. When the pilot program was restarted, the WWTF clarified effluent was in the range of 0.41 mg/L – 0.51 mg/L TP for this phase of testing. Composite runs were conducted with chemical precipitation prior to the Ultrascreen system, and two different specific filter

loading rates were tested. The 5 gpm/ft² loading rate, which was utilized throughout the majority of the study, was first tested yielding 62% of particulate phosphorus removal, reducing 0.51 mg/L TP to 0.11 mg/L TP. An increased specific filter loading rate was then tested, to help stress test the Ultrascreen filtration system at 7 gpm/ft² filter loading rate, yielding 75% of particulate phosphorus removal reducing 0.41 mg/L TP to 0.05 mg/L TP. While the increased loading rate did yield slightly higher percentage of the forward flow to backwash waste, the TP removal as well as the TSS removals production were both increased as well, yielding an effluent TP of 0.05 mg/L.

Table 5 - Operational Parameters/Results: Moderate TP Influent with Chemical Precip.

Date	Flow Rate (gpm)	Ferric Dose/ Anionic Polymer Dose (mg/L)	Filter Loading Rate (gpm/ft ²)	Disk Speed (rpm)	Floc Time (min.)	% Forward Flow to Backwash	Composite Sample Analytical Results	Phosphorus Total as P (mg/L)		Phosphorus Total Dis. P as P (mg/L) Nuove Pilot Lab	TSS (mg/L) Facility Lab
								Nuove Pilot Lab	Facility Lab		
07/19/2022	85	20/1	5	50	9.36	2.81	Influent	0.51	(0.69)	0.31	6.6
							Effluent	0.11	(0.14)	0.02	4.2

Table 6 - Operational Parameters/Results: Moderate TP Influent with Chemical Precipitation at Elevated Specific Filter Loading Rate

Date	Flow Rate (gpm)	Ferric Dose/ Anionic Polymer Dose (mg/L)	Filter Loading Rate (gpm/ft ²)	Disk Speed (rpm)	Floc Time (min.)	% Forward Flow to Backwash	Composite Sample Analytical Results	Phosphorus Total as P (mg/L)		Phosphorus Total Dis. P as P (mg/L) Nuove Pilot Lab	TSS (mg/L) Facility Lab
								Nuove Pilot Lab	Facility Lab		
07/20/2022	119	20/0.7	7	40	6.69	4.22	Influent	0.41	(0.53)	-	6.6
							Effluent	0.05	(0.07)	0.02	1.8

5. Conclusions

The results of the pilot testing proved the Ultrascreen disk filter can efficiently and effectively reduce Total Phosphorus at the Reedsburg WWTF to well within the anticipated TMDL’s. Phosphorus precipitation of Soluble Reactive Phosphorus can be accomplished either via increased Ferric Chloride dosing to the main facility system with polishing of the remaining particulate Phosphorus via filtration, or with Ferric Chloride and Anionic Polymer dosing to a flocculation system just prior to the Ultrascreen filters. Even with a system upset and the loss of BNR phosphorus removal, the Ultrascreen filter was able to remove an astounding 1.8 mg/L of particulate phosphorus directly through the filter after chemical precipitation. Throughout the duration of the study, removal of particulate phosphorus averaged 58% for the composite runs recorded. With chemical precipitation over the duration of the study, including the high influent TP period, the Ultrascreen filter averaged 0.12 mg/L, easily exceeding the 0.25 mg/L TP effluent goal set forth in the RFQ.

Based on the pilot operation and data collected, a design filter loading rate of 5 gpm/ft² is appropriate with either direct filtration or with coagulation/flocculation prior to the filter. A peak loading rate of 7 gpm/ft² was also successfully trialed at the conclusion of the study with good results and could be considered for peak flow conditions.

TSS was reduced on average by 26% over the course of the study, but it should be noted this does not take into account the solids generated via chemical precipitation and then consequently removed through the filtration system, as influent samples were taken prior to the tertiary coagulant and polymer addition.

The percent of the flow to waste averaged 2.7% of the total system flow over the study duration. When operating without coagulation/ flocculation throughout the course of the study this value was greatly reduced, averaging only 0.26% of the total system flow. This yields extremely efficient filtration operation in terms of backwash water produced and the consequent electrical consumption for the operation of the system. The Ultrascreen filter also performed very well with the addition of coagulation and flocculation directly preceding the filter, with a flow to waste averaging 3.2% of the total system flow with coagulation/flocculation prior to the filter.

The Ultrascreen filter functioned flawlessly over the course of the study and the conclusion of the study the stainless steel Ultrascreen filtration media was readily cleaned with a simple application of household bleach followed by a commercially available ZEP brand rust and stain remover to remove any residual chemical and biological accumulation.

Once again Nuove Energie would like to thank the City of Reedsburg WWTF and their consulting engineer, Town & Country, for the invitation and support for piloting testing the Ultrascreen filtration technology. The Ultrascreen's robust all stainless steel filtration design is an excellent fit for the planned Reedsburg tertiary improvements to enable the facility to meet the effluent permit requirements, while providing years of trouble free operation and maintenance.

Appendix A – Compiled Operational Log Book for the Pilot Duration

Project Name: Reedsburg, WI P-Removal Pilot

Date	Time (24 hr Format)	Coagulant	Coagulant Dose (mg/L) As FeCl3	Polymer	Polymer Dose (mg/L)	Flowrate (m/hr)	Pilot Operational Parameters							Onsite Lab Samples					Notes/Comments	Official Lab Samples									
							Flowrate (gpm)	Specific Flowrate (gpm/ft2)	Flocculation (1 for Yes 0 for No)	Total Floc Time (minutes)	Stage 1 Floc rpm	Stage 2 Floc Rpm	Filter Rotation % Speed	Filter rpm	Filter Avg BW ON (Seconds)	Filter Avg BW OFF (Seconds)	BW % of Total flow	Sample Time		Type of Sample (Grab/Composite)*	Influent TP (mg/L) Corrected	Influent Diss. TP (mg/L) Corrected	Effluent TP (mg/L) Corrected	Effluent Diss. TP (mg/L) Corrected	Influent TP (mg/L)	Effluent TP (mg/L)	Influent TSS (mg/L)	Effluent TSS (mg/L)	
6/10/2022	7:30	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	-	-	-	-	-	Turned in composite samples	-	-	-	-		
6/10/2022	9:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	-	-	-	-	-	collected grabs	3.15	3.2	6.25	2.95		
6/10/2022	15:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	5.5	87	0.44	-	-	-	-	-	Started composite sample for 14 hr. composite	-	-	-	-		
6/11/2022	8:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	-	-	-	-	-	Turned in filter avg. flow composite	-	-	-	-		
6/11/2022	10:30	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	5	120	0.56	10:00	Grab	3.27	2.96	2.24	3.13	-	5.24	5.08	-	4	
6/11/2022	12:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	-	-	-	-	-	Started composite sample for 20 hr. composite	-	-	-	-		
6/12/2022	19:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	-	-	-	-	-	-	4.31	4.09	-	2.8		
6/13/2022	7:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	-	-	-	-	-	Turned in filter avg. flow composite	-	-	-	-		
6/13/2022	8:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	5	104	0.38	8:00	Grab	2.27	2.07	2.21	2.09	-	2.83	2.65	7.75	5.8	
6/13/2022	8:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	50	6	-	-	-	8:00	Composite	2.83	2.16	2.52	2.39	-	-	-	-	-	
6/13/2022	21:00	FeCl3	10	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	50	6	-	-	-	-	-	-	-	-	Started Flocculation & Filter	-	-	-	-		
6/14/2022	8:00	FeCl3	10	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	50	6	6	15	5.6	8:45	Grab	2.21	2.03	0.64	0.3	-	-	-	-	-	
6/14/2022	8:00	FeCl3	10	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	50	6	6	15	5.6	8:45	Composite	2.71	2.75	1	0.59	-	-	-	-	-	
6/14/2022	8:45	FeCl3	10	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	-	-	-	-	-	Collected grab and composite samples	-	-	-	-	-	
6/14/2022	15:30	FeCl3	15	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	15:30	Grab	2.41	1.67	0.36	0.11	-	-	-	-	-	
6/14/2022	16:00	FeCl3	20	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	16:00	Grab	2.36	1.43	0.31	0.22	-	-	-	-	-	
6/14/2022	21:30	FeCl3	15	NS-6350	1.2	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	-	-	-	-	-	Started composite	-	-	-	-	-	
6/15/2022	7:00	FeCl3	15	NS-6350	1.2	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	7:15	Composite	2.2	1.67	0.42	0.14	-	2.15	0.37	2.75	-	
6/15/2022	7:45	FeCl3	15	NS-6350	1.2	14.5	64	3.75	1	12.46	10	12	40	4.8	5.5	28	-	-	-	-	-	-	Collected composite samples	-	-	-	-	-	
6/23/2022	12:00	-	-	-	-	14.5	64	3.75	0	0.00	-	-	40	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
6/23/2022	14:30	FeCl3	5	NS-6350	0.5	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	15:00	Grab	0.24	0.09	0.11	0.08	-	-	-	-	-	
6/23/2022	15:00	FeCl3	5	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	15:30	Grab	0.24	0.09	0.11	0.06	-	0.19	0.08	2.75	4.4	
6/23/2022	15:30	FeCl3	5	NS-6350	1.5	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	16:00	Grab	0.24	0.09	0.15	0.05	-	-	-	-	-	
6/23/2022	21:30	FeCl3	15	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	6	25	2.91	-	-	-	-	-	-	-	-	-	-	-	
6/24/2022	7:00	FeCl3	15	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
6/24/2022	7:30	FeCl3	15	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	5.5	25	2.8	-	-	-	-	-	-	-	-	-	-	-	
6/24/2022	8:00	FeCl3	15	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	8:00	Grab	0.24	0.1	0.05	0.12	-	-	-	-	-	
6/24/2022	8:00	FeCl3	15	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	8:00	Composite	0.24	0.1	0.09	0.03	-	0.18	0.03	-	3.2	
6/24/2022	8:30	FeCl3	10	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
6/24/2022	8:45	FeCl3	10	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	5.5	33	-	-	-	-	-	-	-	-	-	-	-	-	
6/24/2022	16:00	FeCl3	10	NS-6350	1	14.5	64	3.75	1	12.46	10	12	40	4.8	-	-	-	-	-	-	-	-	-	Started composite sample for 15hr. composite	-	-	-	-	-
6/24/2022	16:15	FeCl3	15	NS-6350	0.75	19.3	85	5.00	1	9.36	11	12	40	4.8	7	14	-	-	-	-	-	-	-	-	-	-	-	-	
6/25/2022	7:00	FeCl3	15	NS-6350	0.75	19.3	85	5.00	1	9.36	11	12	40	4.8	-	-	-	-	-	-	-	-	-	Turned in composites	-	-	-	-	
6/25/2022	14:00	FeCl3	15	NS-6350	0.75	19.3	85	5.00	1	9.36	11	12	40	4.8	-	-	-	14:00	Composite	0.2	0.11	0.7	0.02	-	0.13	0.021	-	4.4	
6/25/2022	18:00	FeCl3	20	NS-6350	0.75	19.3	85	5.00	1	9.36	11	12	40	4.8	7	14	2.81	-	-	-	-	-	-	Collected composites Samples	-	-	-	-	
6/26/2022	7:00	FeCl3	20	NS-6350	0.75	19.3	85	5.00	1	9.36	11	12	40	4.8	-	-	-	-	-	-	-	-	-	Turned in composite	-	-	-	-	
6/26/2022	12:00	FeCl3	20	NS-6350	0.75	19.3	85	5.00	1	9.36	11	12	40	4.8	-	-	-	12:00	Composite	0.15	0.06	0.04	0.02	-	0.11	0.056	1.25	0.8	
6/26/2022	15:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	40	4.8	-	-	-	-	-	-	-	-	Started 15hr. composite w/ no chemicals	-	-	-	-	-	
6/27/2022	7:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	40	4.8	-	-	-	-	-	-	-	-	Turned in composite samples	-	-	-	-	-	
6/27/2022	7:10	-	-	-	-	19.3	85	5.00	0	0.00	-	-	40	4.8	4.5	220	0.13	-	-	-	-	-	-	-	-	-	-	-	
6/27/2022	7:25	-	-	-	-	19.3	85	5.00	0	0.00	-	-	70	8.4	-	-	-	7:30	Composite	0.16	0.08	0.1	0.03	-	0.19	0.098	3.4	0.08	
6/27/2022	12:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	70	8.4	-	-	-	-	-	-	-	-	Started composites for 19hr. composite sample	-	-	-	-	-	
6/28/2022	7:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	70	8.4	-	-	-	-	-	-	-	-	Turned in 20hr. composite sample	-	-	-	-	-	
6/28/2022	8:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	70	8.4	-	-	-	8:00	Composite	0.23	0.17	0.15	0.09	-	-	-	-	-	
6/28/2022	9:00	-	-	-	-	19.3	85	5.00	0	0.00	-	-	70	8.4	3.75	155	0.26	-	-	-	-	-	Collected composite samples	-	-	-	-	-	
6/28/2022	15:00	FeCl3	10	NS-6350	0.5	19.3	85	5.00	1	9.36	11	12	50	6	-	-	-	-	-	-	-	-	Started 14hr. Composites	-	-	-	-	-	
6/29/2022	7:00	FeCl3	10	NS-6350	0.5	19.3	84.92	5.00	1	9.36	11	12	50	6	-	-	-	-	-	-	-	-	Had issue w/sampler, did not turn in sample and ran two on the 06/29	-	-	-	-	-	
6/29/2022	7:30	FeCl3	10	NS-6350	0.5	19.3	84.92	5.00	1	9.36	11	12	50	6	-	-	-	7:30	Grab	0.36	0.25	0.19	0.05	-	-	-	-	-	
6/29/2022	9:30	FeCl3	10	NS-6350	0.75	19.3	84.92	5.00	1	9.36	11	12	50	6	-	-	-	-	-	-	-	-	Started 8hr. Composite	-	-	-	-	-	
6/29/2022	9:45	FeCl3	10	NS-6350	0.																								