LAKE WHATCOM WATER AND SEWER DISTRICT

WHATCOM COUNTY **WASHINGTON**

SUDDEN VALLEY WATER TREATMENT PLANT ALTERNATIVES ANALYSIS

G&O #20434
SEPTEMBER 2022

Gray & Osborne, Inc.
CONSULTING ENGINEERS

LAKE WHATCOM WATER AND SEWER DISTRICT

WHATCOM COUNTY **WASHINGTON**

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lake whatcom

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TABLE OF CONTENTS

CHAPTER 1 - INTRODUCTION

CHAPTER 2 - PROJECT BACKGROUND

CHAPTER 3 - PLANNING AND OTHER DESIGN CONSIDERATIONS

CHAPTER 4 - ALTERNATIVES ANALYSIS

CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 6 - FUNDING OPPORTUNITIES

LIST OF TABLES

LIST OF FIGURES

APPENDICES

CHAPTER 1

INTRODUCTION

INTRODUCTION AND PURPOSE

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project were used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost effectively provide clean, potable water for the existing and projected service areas.

This report is meant to highlight work completed, summarize alternatives for improvements to the Sudden Valley WTP, and to provide recommendations for selected improvements that will ensure high finished water quality, reliable water service, capacity for future demands, and provide operational flexibility for District staff with regards to water service for all current and future customers.

The report is organized as follows:

- Chapter 2 includes a description of background information, the existing facilities, and a summary of previously completed work.

- Chapter 3 provides information on planning considerations for the project including population/demand projections and regulatory / permitting considerations.

- Chapter 4 provides a description and analysis of the improvement alternatives considered, and a set of recommendations based on critical factors.

- Chapter 5 provides a summary of funding opportunities that may be of interest in order to help finance the recommended improvements.

CHAPTER 2

PROJECT BACKGROUND

INTRODUCTION

The District operates three Group A water systems – South Shore (DOH #95910), Eagleridge (DOH #08118), and Agate Heights (DOH #52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and serves both the Sudden Valley area as well as the Geneva area. These two areas are supplied wholly by water treated at the Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. Figure 2-1 shows a map of the District's service area and highlights the location of major facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 MG of storage in five reservoirs.

The District also maintains a secondary intertie with the City of Bellingham Water System (DOH #50600) that is used only during emergency situations.

EXISTING FACILITIES

GENEVA

The Geneva area is completely served by the Sudden Valley WTP via the Sudden Valley area. The facilities located within the Geneva area are as follows:

- Fifteen miles of water distribution mains;
- 0.5 MG distribution reservoir;
- One mile long intertie with the Sudden Valley water system;
- A transmission pump station (Beecher at Columbus Street);
- Seven pressure reducing valve (PRV) stations;
- Two distribution pressure booster stations; and
- An emergency intertie with the City of Bellingham.

The current number of equivalent residential units (ERUs) in Geneva is 1,136, which is important because the Sudden Valley WTP must be sized to accommodate demand from both the Sudden Valley and Geneva areas. With approved reduced source criteria and further decreases in demands documented in the *2021 Water Use Efficiency Update*

(Wilson Engineering), the water supply source from Sudden Valley is adequate to supply the estimated full build-out of 1,239 connections for Geneva.

A Developer Extension Agreement project, completed in 2010, added a booster pump station and approximately 2,230 feet of 8-inch HDPE water main to serve existing and future development. The booster pump station is located on Lake Louise Road and serves the area in the vicinity of Beecher Avenue and 10th Street. At that time, future plans included construction of a reservoir at the top of the highest pressure zone and conversion of the booster pump station to a transmission pump station to feed the future reservoir.

Additional information on this system is provided in the District's most recent *Water System Plan* (Wilson Engineering, 2018).

EAGLERIDGE

Water provided by the District in the Eagleridge water system is supplied from an intertie with the City of Bellingham (City) water system. Eagleridge includes approximately 5,000 feet of water distribution mains and one pressure booster station capable of providing 750 gpm fire flow under peak hourly demand conditions. The system currently serves 71 connections and build-out for this area would consist of 85 equivalent residential connections. The remaining District customers in the area are sewer only customers who either draw water directly from Lake Whatcom or own and operate their own private wells.

Additional information on this system is provided in the District's most recent *Water System Plan* (Wilson Engineering, 2018).

AGATE HEIGHTS

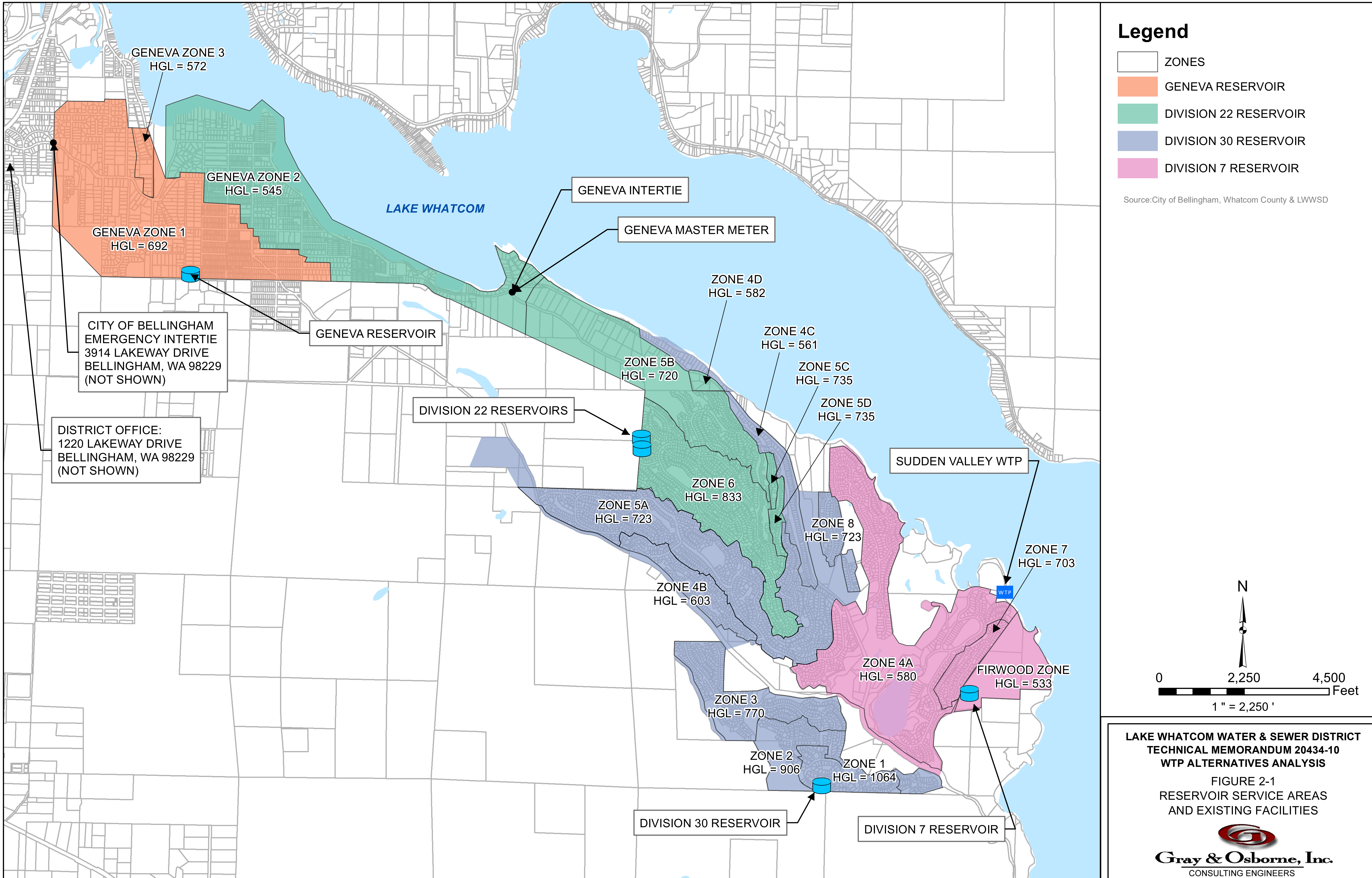
The Agate Heights water system includes the 10-inch Agate Heights Well, a package water treatment package to chlorinate the groundwater, remove manganese, and pump water to the 79,300 gallon concrete reservoir. The system also includes a second transmission pump station to fill the 105,700 gallon reservoir, two PRV stations, and over 5,000 feet of transmission and distribution mains.

Additional information on this system is provided in the District's most recent *Water System Plan* (Wilson Engineering, 2018).

SUDDEN VALLEY

The Sudden Valley water system includes:

- Fifty-three miles of water distribution and transmission mains;
- Four distribution reservoirs (1.0 MG, 0.5 MG, 0.63 MG and 0.15 MG);



LAKE WHATCOM WATER & SEWER DISTRICT
TECHNICAL MEMORANDUM 20434-10
WTP ALTERNATIVES ANALYSIS

FIGURE 2-1
RESERVOIR SERVICE AREAS
AND EXISTING FACILITIES

Gray & Osborne, Inc.
CONSULTING ENGINEERS

L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\GIS\1-1 RESERVOIR SERVICE AREAS.mxd

- Three transmission pump installations;
- Forty-seven PRV stations;
- One 2 million gallons per day (mgd) water treatment plant; and
- >5,000-foot long intertie with the Geneva water system described above.

The current number of ERU connections in Sudden Valley is 2,685. With approved reduced source criteria and further decreases in demands documented in the *2021 Water Use Efficiency Update* (Wilson Engineering), the District's water rights and source supply equipment are sufficient to serve the estimated full build-out number of Sudden Valley and Geneva residential connections. Estimated full residential build-out for Sudden Valley is 3,267 ERUs based on the number of vacant lots that could be developed. There is one intertie from the Sudden Valley water system to the Geneva water system. With this intertie the District supplies water to Geneva from its water treatment plant in Sudden Valley.

It is important to note that the Sudden Valley Water Treatment Plant described below provides potable water for both the Sudden Valley and Geneva systems. The combined number of current ERU connections for these combined systems is 3,935 ERUs while the estimated full residential buildout for these combined systems is 4,506 ERUs. It is critical that these combined numbers be considered when planning for future WTP demands.

Additional information on this system is provided in the District's most recent Water System Plan, which was approved in 2018.

SUDDEN VALLEY WATER TREATMENT PLANT

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 mgd but currently operates at approximately 1.0 mgd (700 gpm). The WTP is housed in a partially below grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The WTP is located within an easement on property owned by the Sudden Valley Community Association. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before treated water is pumped to the distribution system and storage reservoirs.

PREVIOUSLY COMPLETED WORK

WATER SYSTEM PLAN

The District's most recent Water System Plan (2018 WSP) was completed by Wilson Engineering and was approved in 2018. The plan provides a description of existing facilities, reviews historical water demand, and provides projected water system demands necessary to supply the full build-out population. The Plan highlights several capital improvement projects that are recommended in order to provide additional water service, and to keep the existing facilities in good condition.

SUDDEN VALLEY WTP ASSESSMENT

In February of 2020, engineers from Gray & Osborne visited the Sudden Valley WTP and performed a condition assessment of the existing facilities. During the visit, Gray & Osborne process, mechanical, structural, and electrical engineers discussed the current operations, perceived deficiencies, and desired needs for the WTP with operations staff, and also assessed the condition of the existing facilities at the WTP Main Building, Finished Water Pump Building, and Chlorine Contact Basin.

The assessment report highlighted several improvements and recommendations, and divided these items into high priority improvements and recommended improvements. These improvements were evaluated in nine technical memoranda provided to the District. High priority improvements were designed to ensure successful, efficient, and cost-effective water treatment for many years while recommended improvements were provided to improve treatment efficiency, improve staff safety, and improve reliability of the overall treatment process.

Cost estimates for the high priority improvements and the recommended improvements were not provided in the report, largely because many of the project costs could be combined to provide additional value to the District, and because the scope of the improvements could not be defined at that time without subsequent analysis and discussion.

TECHNICAL MEMORANDUM 20434-1, SUDDEN VALLEY WTP PUMP PERFORMANCE TESTING

This memorandum documents the results of the pump performance testing performed on the existing raw water, clearwell transfer, and finished water pumps located at the WTP. The memorandum describes the testing process, summarizes the testing results, and provides recommendations for modifications to the existing pumps and motor control equipment. Cost estimates are also provided for planning purposes.

The memorandum had the following recommendations:

- Replace the existing raw water pumps, clearwell transfer pumps, and finished water pumps along with their respective motor starters and coordinate the proposed starters with the District's desire to upgrade motor starter equipment to variable frequency drive (VFD) technology.

The recommendations listed above are estimated to cost $1.317 million including contingency (20 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent). Cost estimates are listed in 2020 dollars and this technical memorandum is provided in Appendix C.

TECHNICAL MEMORANDUM 20434-2, SUDDEN VALLEY WTP CHLORINE CONTACT BASIN COATING ASSESSMENT

This memorandum highlights the assessment performed on the existing Chlorine Contact Basin (CCB) coating system. The CCB coating system was inspected by Lance Stevens P.E. of Evergreen Coating Engineers. The memorandum describes the testing process, summarizes the test results, and provides recommendations and cost estimates for modifications.

The memorandum had the following recommendations:

- Replace both interior and exterior coating systems within 5 years;
- Provide seal welding on the tank interior; and
- Furnish and install new appurtenances to improve tank functionality, access, and safety.

The recommendations listed above are estimated to cost $680,000 including contingency (20 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent). Cost estimates are listed in 2020 dollars and this technical memorandum is provided in Appendix D.

TECHNICAL MEMORANDUM 20434-3, SUDDEN VALLEY WTP TIER 2-TIER 3 SEISMIC EVALUATION

This memorandum highlights an analysis completed on the WTP's Main Building and Finished Water Pump Building according to the American Society of Civil Engineers (ASCE) 41 *Seismic Evaluation and Retrofit of Existing Buildings* protocols. The memorandum highlighted the criteria used for the evaluation and identified both structural and non-structural deficiencies for both buildings.

No structural deficiencies were identified for the Main Building; however, several non-structural deficiencies were identified. The cost to address these non-structural deficiencies was $118,000 including contingency (20 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent).

The analysis identified both structural and non-structural deficiencies for the Finished Water Pump Building. The cost to address both these types of deficiencies was $291,000 including contingency (20 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent).

Cost estimates are in 2020 dollars and this technical memorandum is provided in Appendix E.

TECHNICAL MEMORANDUM 20434-4, SUDDEN VALLEY WTP CHEMICAL SYSTEMS ANALYSIS

This memorandum highlights the assessment performed on the existing chemical injection systems utilized at the WTP. This includes both potassium aluminum sulfate (alum) used for coagulation as well as soda ash used for pH control. The memorandum describes the existing system components, highlights the difficulties experienced by WTP staff, identifies various alternatives for chemical delivery, storage, pumping, and injection, and provides recommendations and cost estimates for modifications.

The memorandum had the following recommendations:

- Continue use of alum as coagulant, but replace the existing alum storage tank and metering pump equipment; and
- Continue use of soda ash for pH control, rehabilitate the existing loading platform, but replace the existing tank mixer and metering pump equipment.

The memorandum also recommended construction of a new chemical storage building which would house the alum and soda ash equipment. A new building would provide separation between the chemicals and electrical equipment, provide additional space within the Main Building for other uses, and would better optimize the chemical delivery and storage process.

The recommendations listed above are estimated to cost $1.186 million including contingency (25 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent). Cost estimates are listed in 2020 dollars and this technical memorandum is provided in Appendix F.

TECHNICAL MEMORANDUM 20434-5, SUDDEN VALLEY WTP FILTRATION SYSTEMS ANALYSIS

This memorandum highlights the assessment performed on the existing rapid rate multi-media filter units in use at the WTP. The existing filter units were inspected and the overall performance of the units and the associated backwash components was analyzed. Additionally, the capacity of the existing filters was analyzed for their ability to handle projected system demands. The memorandum describes the existing filter components, highlights performance issues, and identifies various alternatives for filtration. As the District cannot replace the existing filters without significant impact to WTP operation, and whether or not new filters are provided may depend on the availability of space as a result from other treatment process modifications, a specific recommendation was not provided in this memo.

The memorandum reviewed the following alternatives:

- Rehabilitation of the existing filter units;
- Installation of new pretreatment equipment and rehabilitation of existing filter units;
- Replacement of existing filter units with new package filtration systems, including contact adsorption clarifier pretreatment technology; and
- Replacement of existing filter units with new membrane filtration technology.

Cost estimates for each alternative ranged from $90,000 to $5,876,000 including contingency (25 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent). Cost estimates are listed in 2020 dollars and this technical memorandum is provided in Appendix G.

TECHNICAL MEMORANDUM 20434-6, SUDDEN VALLEY WTP DISINFECTION SYSTEMS ANALYSIS

This memorandum highlights the assessment performed on the existing WTP disinfection systems. The analysis was broken into two components: chlorine disinfection and contact time and each component were analyzed separately. The memorandum describes the existing components, current deficiencies, safety, system control, analyzed alternatives for both chlorine gas and other disinfectants, and provided recommendations with cost estimates.

The following chlorine disinfection alternatives were analyzed:

- Continued use of chlorine gas with no modifications;
- Continued use of chlorine gas with modifications to bring the system into compliance with current building codes;
- Continued use of chlorine gas within a new building;
- Use of on-site generation of sodium hypochlorite; and
- Use of commercially delivered sodium hypochlorite.

For contact time, the memorandum identified deficiencies with the existing chlorine contact basin, analyzed methods for improving contact time or providing additional contact time, and provided recommendations and cost estimates.

The memorandum analyzed the following contact time alternatives:

- Rehabilitation of the existing chlorine contact basin;
- Construction of a new, larger chlorine contact basin; and
- Construction of a new, supplemental chlorine contact basin.

The memorandum did not provide a recommendation for the chlorine disinfection system because the decision on which method to employ will be significantly impacted by other treatment process decisions. With regards to contact time, the memorandum recommended construction of a new, larger chlorine contact basin that can provide the necessary contact time for finished water. The existing chlorine contact basin would either remain available as a redundant tank in the event the new proposed tank must be taken offline for maintenance and/or coating, or be utilized as a filter backwash storage/recycle tank.

Costs for new disinfection equipment ranged from $271,000 to $1,511,000 while a new replacement chlorine contact basin is estimated to cost $1.671 million. All cost estimates includes contingency (25 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent). Cost estimates are listed in 2020 dollars and this technical memorandum is provided in Appendix H.

TECHNICAL MEMORANDUM 20434-7, SUDDEN VALLEY WTP BACKWASH SYSTEMS ANALYSIS

This memorandum highlights the assessment performed on the existing rapid rate multi-media filter backwash process. The backwash system removes trapped particulates from the filter media and the assessment included an analysis of both liquid and solids process streams, backwash performance, operations, maintenance, and temporary storage. Because the backwash requirements and subsequent waste stream management are highly dependent on the type of filter utilized, and because the District cannot replace/modify the existing filters without significant impact to WTP operation, a specific recommendation was not provided in this memo.

The memorandum reviewed the following alternatives, each of which had two options for both above- and below-grade storage facilities:

- Continued discharge to the municipal sewer;
- Discharge to lake Whatcom; and
- Backwash recycle.

Cost estimates for each alternative ranged from $1,022,000 to $2,126,000 including contingency (25 percent), Washington State Sales Tax (9.0 percent), and Project design/administration (25 percent). Cost estimates are listed in 2020 dollars and this technical memorandum is provided in Appendix I.

TECHNICAL MEMORANDUM 20434-8, SUDDEN VALLEY WTP STRUCTURAL AND ARCHITECTURAL SYSTEMS ANALYSIS

This memorandum highlights the assessment performed on the existing Main Building and Finished Water Pump buildings at the WTP. In an effort to maximize the available space, provide separation between the chemicals and electrical equipment, and provide a better, more efficient workspace for District staff, the memorandum analyzed the existing buildings with regards to code adherence, constructability, property and land acquisition, access, and capacity for expansion. Because building expansion is highly dependent on whether or not additional treatment system modifications are desired/required, and the fact that the space required for treatment components will drive the space requirements for each building, a specific recommendation was not provided in this memo.

The memorandum reviewed the following alternatives:

- WTP Main Building expansion upwards;
- WTP Main Building expansion horizontally; and
- Construction of a new, separate building.

Cost estimates were not provided for these alternatives. Instead costs per square foot for various expansion components and/or construction types were provided for planning and estimating purposes. This technical memorandum is provided in Appendix J.

TECHNICAL MEMORANDUM 20434-9, SUDDEN VALLEY WTP EQUIPMENT RISK ASSESSMENT

This memorandum highlights the risk assessment that was performed for the equipment associated with each treatment component in use at the WTP. The District quantified the level of risk for each treatment component in an attempt to establish an objective level of risk which could be used to prioritize WTP modifications. Each treatment component was assessed according to two methods and the results were categorized (high, moderate, low, and minimal) with regards to the cost to the District resulting from taking the equipment offline as well as the health and safety risk to District staff and water system customers from each component. The results from this analysis were summarized; however, no recommendations and/or cost estimates were provided.

CHAPTER 3

PLANNING AND OTHER DESIGN CONSIDERATIONS

INTRODUCTION

This Chapter summarizes the projected water demands for the South Shore water system serving the Sudden Valley and Geneva communities and highlights other planning and design considerations used to develop the alternatives described in Chapter 4.

PROJECTED SYSTEM DEMANDS

Projected system demands are fully detailed in the 2018 WSP but are briefly summarized herein. Since the Sudden Valley WTP serves only the South Shore water system (Sudden Valley and Geneva), Eagleridge and Agate Heights service demands will not be considered further.

Table 3-1 summarizes the projected water system demands for the South Shore water system.

TABLE 3-1

Projected Water Demand Summary

Year	ERUs(1)	Average Day Demand (gpd)(2)	Maximum Day Demand (gpd)(3)
2016	3,812	600,200	1,089,320
2017	3,819	601,150	1,090,590
2018	3,826	602,275	1,092,700
2019	3,833	603,400	1,094,810
2020	3,840	604,525	1,096,620
2021	3,847	605,650	1,099,030
2022	3,854	606,775	1,101,140
2023	3,861	607,900	1,103,250
2024	3,868	609,025	1,105,360
2025	3,875	610,150	1,107,470
2026	3,882	611,275	1,109,580
2036	3,952	622,525	1,130,680
Buildout	4,506	706,875	1,275,180
Water Rights	1,607,178 gpd (annual daily average) 2,197,472 gpd (instantaneous)		

(1) Based on growth and buildout assumptions described in the 2018 WSP.
(2) Based on an ERU value of 157 gpd/ERU per the 2018 WSP.
(3) Based on an ERU value of 285 gpd/ERU per the 2018 WSP.

Table 3-1 shows a maximum day demand of 1,275,180 gallons per day, which assumes that the water conservation efforts highlighted in the 2018 WSP are fully mature. Because the treatment capacity of the Sudden Valley WTP (2.0 mgd) is greater than the projected maximum day demand at buildout, the existing WTP has sufficient capacity to serve the projected water demands for the South Shore water system. As such, a design value of 2.0 mgd (1,400 gpm) will be used to develop alternatives described later in this report.

STORAGE

This project assumes that no modifications to the existing water system storage facilities are required to meet full-buildout demands. Additional information on the District's existing storage facilities is provided in the 2018 WSP. Note that there is an active District project (District Project #C2111) to replace the existing 1 MG Division 7 Reservoir with a pair of smaller concrete reservoirs that will provide a combined storage of 0.475 MG. The design and sizing of the Division 7 Reservoir Project #C2111 is outside the scope of this alternatives analysis.

Planning is ongoing for a project to replace the existing 1 MG Division 7 Reservoir with a pair of smaller concrete reservoirs that will provide a combined storage of 0.475 MG.

SOURCE CAPACITY

No modifications to the existing source facilities are proposed as part of this project. Additional information on the District's sources is provided in the 2018 WSP.

WATER RIGHTS

A complete discussion of current and pending water rights is provided in the District's 2018 WSP. The components within this project will not affect existing or proposed water rights.

CHAPTER 4

ALTERNATIVES ANALYSIS

INTRODUCTION

This Chapter highlights four alternatives developed to accomplish the treatment and service goals outlined by the District in 2021. The goals and alternatives are described fully below. Then, the alternatives are summarized and analyzed in order to provide a recommendation to the District for modifications.

ALTERNATIVES ANALYSIS

ALTERNATIVE GOALS

To help guide the project as well as the selection of any specific treatment alternative, the District identified goals that would be used to analyze each alternative. By determining how successfully each treatment alternative accomplished the District's goals, the alternatives could be quantitatively and qualitatively compared. This type of analysis can help the District select the best, most cost-effective alternative to meet both short- and long-term treatment needs.

Through interactive discussion sessions between District administrative staff, operational staff, and District commissioners, the following treatment goals were identified:

1. Maintain Exceptional Water Quality Performance Record

    - The District received recognition for their compliance with Washington State Department of Health's Treatment Optimization Performance Program in 2010, 2016, and 2021. Additionally, the District provides exceptionally high-quality water to its service area and any modifications to the treatment system must not negatively impact water quality.

2. Accommodate Immediate Need for Space and Separation Between Chemicals and Process/Electrical Equipment

    - The Sudden Valley WTP is very cramped and utilizes a common space for treatment process equipment, material storage, chemical storage, workspace, laboratory work, and electrical components. Sharing this space has created issues with workflow as well as contributed to premature corrosion of critical electrical infrastructure. Any alternative considered should address the need for additional space and the desire to separate chemicals and chemical storage from the required electrical equipment.

3. Provide Adequate Equipment and Process Redundancy

    - For some treatment components, the District does not maintain adequate redundant equipment that would allow them to continue treatment operations should a piece of equipment be offline for maintenance. Furthermore, select equipment is beyond typical service life – making securing replacement parts a difficult, costly, and often lengthy process. Alternatives should improve the redundancy of the WTP such that treatment can be maintained (even at a lower treatment capacity) if specific components need to be taken offline.

4. Improve Access and Flexibility for Equipment Repair/Rehabilitation and/or Future Expansion

    - To maximize value of funds spent on improving the treatment process, all alternatives must consider construction phasing so that the work does not need to be modified to accommodate future projects. Furthermore, alternatives should provide free and open access for rehabilitation to the maximum extent possible.

5. Provide Capacity for the Design Flow of 1,400 gpm (2.0 mgd)

    - As discussed in Chapter 3, any alternatives should be sized to meet the projected buildout maximum day demand of 1,275 mgd (900 gpm).

        - The selected treatment plant design capacity of 2.0 mgd (1,400 gpm) provides additional system resiliency and capacity contingencies.

6. Provide Equipment with a Design Life of 30-50 years

    - Any alternative considered should be robust and designed to last 30-50 years where possible to ensure that the District can maintain successful treatment operations while minimizing capital improvement projects.

How successfully each of the alternatives described below accomplishes these six goals will help determine the District’s path forward with regard to modifications at the WTP.

TREATMENT ALTERNATIVES

As discussed previously, each of the technical memoranda described in Chapter 2 highlighted a unique portion of the water treatment process. For a majority of these memoranda, various component alternatives were described, ranked, and analyzed. For example, for the chemical systems discussion in Technical Memorandum 20434-4, various pH adjustment chemicals were considered (soda ash, sodium hydroxide, etc.), and for each of these chemicals considered, various delivery methods were presented (manual loading, automated loading, etc.). This same process was completed for the WTP coagulant system. In total, 12 alternatives were considered within the technical memorandum.

Given that several specific alternatives were presented within each of the eight technical memoranda, the number of permutations for combinations of equipment is daunting and would make combining the various component alternatives into a cohesive project alternative very cumbersome. To address this issue and minimize the number of permutations for consideration, the District and Gray & Osborne developed four alternatives for analysis representing four levels of cost and effort including minimum, adjusted minimum, medium, and maximum alternatives.

The modifications within each project were then sequenced and prioritized based on their capital cost, impact to remaining WTP processes, risk assessment level, and how well each modification accomplished the six goals outlined above.

For consistency, each portion of the alternatives described below will follow the designations utilized within the technical memorandum developed previously. A description of each alternative component is provided, and costs for each component are summarized at the end of each section.

Alternative 1A – Minimum Alternative

The Minimum Alternative has the lowest capital cost and requires the lowest level of effort and modifications to the existing facilities. The alternative provides some improved redundancy, but the primary goal of this alternative is to extend the existing service life of the current treatment processes and to replace equipment only if it is faulty or beyond its service life. Briefly, this alternative includes the following components, each of which is described further below:

- Replace the existing finished water, clearwell transfer, and raw water pumps with new pumps, motors, and motor starters;

- Complete structural seismic improvements to the Finished Water Pump Building;

- Complete non-structural seismic improvements to the Finished Water Pump Building and WTP Main Building;
- Replace the existing alum storage and dosing system with new equipment;
- Rehabilitate existing Filter 1/2 vessel;
- Complete minor, non-process related improvements to the chlorine disinfection system;
- Construct a new 300,000-gallon chlorine contact basin; and
- Complete a variety of non-process related improvements to include site security fencing and surveillance installation, restroom improvements, and SCADA system improvements.

Pumping Equipment

This alternative includes replacement of the existing finished water, clearwell transfer, and raw water pumping equipment with new components. Equipment to be replaced includes pumps, motors, and motor starters for each pump unit (8 total). To provide additional operational flexibility, all of the existing motor starters will be replaced with new variable frequency drive (VFD) motor starters. For the purposes of this analysis, it is assumed that the new motor starters will be installed into the existing MCCs. As VFD starter technology is typically larger than non-VFD technology, the District should complete a predesign study to confirm unit sizes with regard to the available space. Additional MCC columns will be added to the existing array as necessary to house the new equipment. Additionally, special consideration should be given to construction sequencing so that at least one pump unit can remain operational at all times during replacement. It is important to note that during each of these replacement projects there will be no pump redundancy unless the District procures/utilizes a temporary pump.

Prior to replacing the finished water pumping equipment, the District should review water demand for the South Shore system and revise pump and storage capacity as required to optimize service flexibility, operational costs, and redundancy.

Lastly, replacement of each set of pumps should be accompanied by installation of additional instrumentation and completion of SCADA system programming modifications. Additional instrumentation, especially with regard to the clearwell transfer pumps, as well as the inclusion of new VFD motor starter equipment into the overall programming scheme can help optimize system functionality, reduce pump cycling, and minimize operational costs.

<u>Seismic Considerations</u>

Main Building

This alternative includes completion of the recommended seismic retrofits to the existing WTP Main Building. Specifically, the alternative includes the following non-structural improvements:

- Installation of additional bracing for the restroom wall framing;
- Installation of additional bracing for the wall-mounted electrical transformer;
- Installation of additional bracing for the ceiling mounted air handling unit;
- Installation of additional bracing and flexible connections for fluid piping; and
- Installation of seismic anchorage for existing motor control centers and electrical panels.

Completion of the above items will bring the Main Building up to the "Operational" performance level highlighted in Technical Memorandum 20434-2.

Finished Water Pump Building

This alternative includes completion of the recommended seismic retrofits to the Finished Water Pump Building. Specifically, the alternative includes both structural and non-structural elements. Structural modifications include:

- Modifications to the existing roof/wall diaphragm to allow for shear forces in the roof diaphragm to be deflected to the shear walls; and
- Modifications to the existing roof sheathing to improve shear strength.

Additionally, non-structural modifications include:

- Replacement of existing CMU bathroom/pump room partition walls with wood-framed walls;
- Installation of additional bracing for the generator exhaust piping;
- Installation of additional bracing for the gas heating unit;
- Installation of additional bracing and flexible connections for fluid piping;
- Installation of additional bracing and flexible connections for natural gas piping and meters;
- Installation of seismic anchorage for existing motor control centers and electrical panels;
- Installation of additional bracing for the wall-mounted electrical transformer;
- Installation of additional bracing for the water heater; and

- Installation of additional bracing for the existing conduit runs.

Completion of the above items will bring the Finished Water Pump Building up to the "Operational" performance level highlighted in Technical Memorandum 20434-2.

CCB

This alternative does not include any seismic modifications to the existing CCB.

Chemical Systems

This alternative includes replacement of the existing alum storage tank and chemical delivery systems with new equipment. New equipment would include a new 2,500-gallon high-density polyethylene storage tank, new duplex chemical metering pump panel, and new chemical delivery piping. This alternative does not include any modifications to the existing soda ash storage and/or delivery equipment.

To provide additional operational flexibility, this component also includes modifications to the WTP control scheme to accommodate the new metering pumps.

This alternative also includes modifications to the existing WTP Main Building required for installation of a new motorized coiling door. The existing access door is not large enough to accommodate removal of the existing tank or installation of a new tank. As such, the existing storefront windows at the north wall of the Main Building will be removed and a new coiling door will be installed that will allow for access, delivery, and installation of large items. The new door will be 10 – 12 feet wide, full height, and will include a motorized operator with wall mounted controls.

Filtration Systems

This alternative includes rehabilitation of the existing filter vessels. Rehabilitation will include installation of one additional access ladder per vessel, spot repairs to the existing Filter 1/2 exterior coating system, spot repairs to the existing flocculation tank coating system (interior and exterior), and inspection of the Filter 1/2 underdrain equipment and interior coating system. Spot repairs to the coating system will include localized surface preparation and application of new NSF61 compliant coatings. New ladders will be welded or hooked to the existing filter vessels opposite the existing ladders as feasible. Lastly, inspection of the existing filter underdrain will include removing the existing media and underdrain, inspection, and replacement of damaged components with new equipment.

Special construction sequencing would be required in order to remove Filter 1/2 and the flocculation tank from service during repairs. This work should take place during the winter months when demand is lowest. The District may also wish to explore securing additional temporary water sources from neighboring water systems during the construction period to provide additional redundancy.

Disinfection Systems

Alternative 1A includes continued use of the existing gas chlorine system without significant modifications. Minor items such as paint and spot corrosion will be addressed by WTP staff; however, no changes will be made to type of disinfection, system control, or system operation.

This alternative also includes construction of a new 300,000 gallon CCB. The proposed new CCB will replace the existing CCB and will provide contact time for the filtered, chlorinated water prior to introduction to the distribution system. The proposed CCB will be sized to provide adequate contact time for the full WTP design flow of 1,400 gpm. A new CCB will provide a suitably sized vessel for adequate chlorine contact time, will allow the existing CCB to be repurposed if desired or provide a redundant tank should maintenance be required on the new tank, and maximizes the overall capital value of modifications to the disinfection system when compared to the costs for seismic improvements, non-seismic improvements, and recoating the tank. At this point in time, the alternative includes construction of a 44-foot diameter welded steel tank with an overflow height of 27 feet. The tank will include internal, HDPE baffles, access hatches, and other appurtenances to support tank maintenance.

Backwash Systems

This alternative does not include any modifications to the backwash systems. Filter backwash and solids handling will continue to utilize the existing facilities and operating procedures.

Non-Process Equipment

Non-Process Equipment includes items such as site security and SCADA improvements. This alternative includes new security fencing, new security cameras, upgrades to the existing restroom facilities, and installation of a new coiling door to the WTP Main Building.

Table 4-1 provides a summary of the components included for Alternative 1A, their estimated capital costs, and their time frame for completion.

TABLE 4-1

Alternative 1A – Minimum Alternative Cost Summary

Project	Capital Cost	Short- or Long-Term(1)
Finished Water Pump, Motor, and Motor Starter Replacement	$455,000	Short
Clearwell Transfer Pump, Motor, and Motor Starter Replacement	$210,000	Short
Raw Water Pump, Motor, and Motor Starter Replacement	$150,000	Short
Main Building Seismic Improvements	$75,000	Long
Finished Water Pump Building Seismic Improvements	$180,000	Long
Alum Storage and Delivery Equipment Replacement	$40,000	Short
Existing Media Filter Rehabilitation	$100,000	Long
Construct new 0.3 MG Steel CCB	$990,000	Long
Non-Process Improvements	$75,000	Short
Subtotal	**$2,275,000**	-
Contingency (40%)	$910,000	-
Washington State Sales Tax (9.0%)	$287,000	-
Total Construction Cost	**$3,472,000**	-
Design and Project Administration (25%)	$868,000	-
Total Project Cost	**$4,340,000**	-

(1) Short term improvement are proposed to be completed within the next 10 years. Long-term improvements are proposed to be completed in more than 10 years.

Alternative 1B – Adjusted Minimum Alternative

The Adjusted Minimum Alternative has the second lowest capital cost and requires the second lowest level of effort and modifications to the existing facilities. It is very similar to Alternative 1A, in that it provides some improved redundancy, but the primary benefit of this alternative is that it provides separation between the chemical systems and electrical equipment through construction of a new, stand-alone building. Briefly, this alternative includes the following components, each of which is described further below:

- Replace the existing finished water, clearwell transfer, and raw water pumps with new pumps, motors, and motor control starters;
- Complete structural seismic improvements to the Finished Water Pump Building;
- Complete non-structural seismic improvements to the Finished Water Pump Building and WTP Main Building;

- Replace the existing alum storage and dosing system with new equipment;
- Construct a new, 1,800 sf stand-alone CMU building to house chemical storage and dosing equipment;
- Rehabilitate existing Filter 1/2 vessel;
- Complete minor, non-process related improvements to the chlorine disinfection system;
- Construct a new 300,000-gallon chlorine contact basin; and
- Complete a variety of non-process related improvements to include site security fencing and surveillance installation, restroom improvements, and SCADA system improvements.

<u>Pumping Equipment</u>

This alternative includes replacement of the finished water, clearwell transfer, and raw water pumps, and motor starters, as described above for Alternative 1A.

<u>Seismic Considerations</u>

This alternative includes completion of the non-structural seismic improvements to the WTP Main Building and Finished Water Pump Building, as well as the structural seismic improvements to the Finished Water Pump Building as described in Alternative 1A. No seismic modification to the CCB is included in this alternative.

<u>Chemical Systems</u>

Alternative 1B includes replacement of the existing alum storage tank and chemical delivery systems with new equipment. New equipment would include a new 2,500-gallon high-density polyethylene storage tank, new duplex chemical metering pump panel, and new chemical delivery piping.

This alternative also includes modifications to the soda ash system. Modifications include refurbishing and recoating the existing soda ash storage tank and loading platform, installation of new chemical mixers, installation of new duplex chemical metering pump equipment, and relocation of all of this equipment to the new chemical building described below. Some examples of typical duplex chemical metering skids are shown in Figure 4-1.

To provide additional operational flexibility, this alternative also includes modifications to the WTP control scheme to accommodate the new metering pumps.

Instead of locating the chemical storage and delivery systems within the WTP Main Building, the equipment described above will be located within a new, standalone building located just north of the Main Building as shown in Figure 4-2. The new building will provide the desired separation between chemical system/storage and the electrical equipment – which will improve longevity for the electrical systems, will provide greater flexibility for chemical storage and delivery, and will also improve access for operations staff. The proposed building will include the following:

- 1,800 – 1,900 square feet (57' x 33');
- Concrete slab;
- CMU wall construction;
- Metal roofing panels;
- Three coiling doors for large deliveries and equipment removal;
- Two, 6-foot double doors for foot traffic; and
- Lighting, heating, and ventilation equipment.

The building footprint listed above is larger than necessary for the chemical equipment; however, this will provide space for expansion, installation of additional treatment equipment, chemical storage, or general use by WTP operations staff.

<u>Filtration Systems</u>

Alternative 1B includes rehabilitation of the existing filter 1/2 vessel identical to Alternative 1A.

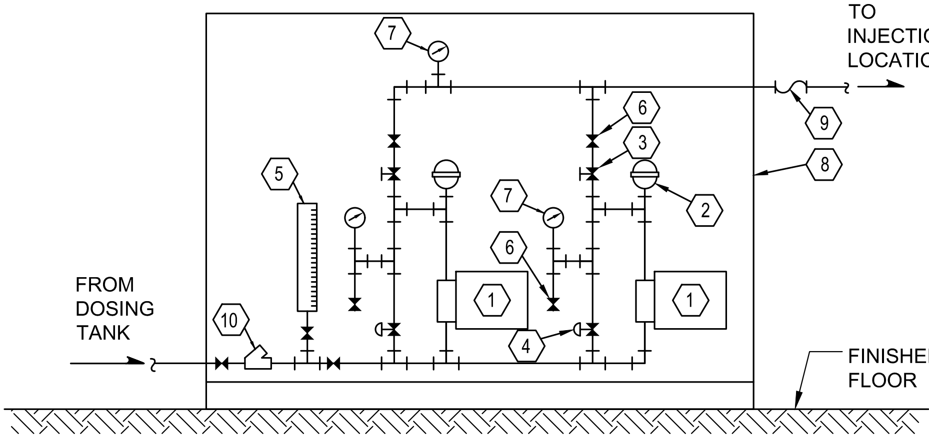
<u>Disinfection Systems</u>

Alternative 1B also includes continued use of the existing gas chlorine system without significant modifications. Minor items such as paint and spot corrosion will be addressed by WTP staff; however, no changes will be made to type of disinfection, system control, or system operation.

Alternative 1B also includes construction of a new 300,000 gallon CCB identical to the tank proposed in Alternative 1A. The exact location of the proposed new tank will be determined prior to construction; however, one potential location for the tank is shown in Figure 4-2.

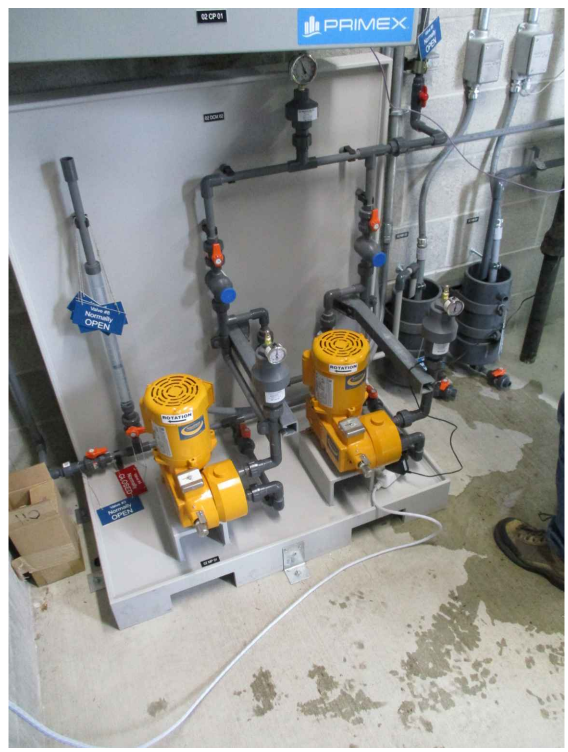
<u>Backwash Systems</u>

This alternative does not include any modifications to the backwash systems. Filter backwash and solids handling will continue to utilize the existing facilities and operating procedures.



LEGEND:

1. CHEMICAL FEED PUMP
2. PULSATION DAMPENER, TYP
3. BACK PRESSURE VALVE, TYP
4. PRESSURE RELIEF VALVE, TYP
5. CALIBRATION COLUMN
6. ISOLATION VALVE, TYP
7. PRESSURE GAUGE, TYP
8. FREE STANDING PVC/HDPE SKID & BACKPLATE
9. FLEXIBLE CONNECTION
10. WYE STRAINER



0 1"

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-10
WTP ALTERNATIVES ANALYSIS

FIGURE 4-1

CHEMICAL PUMP SKID SCHEMATIC

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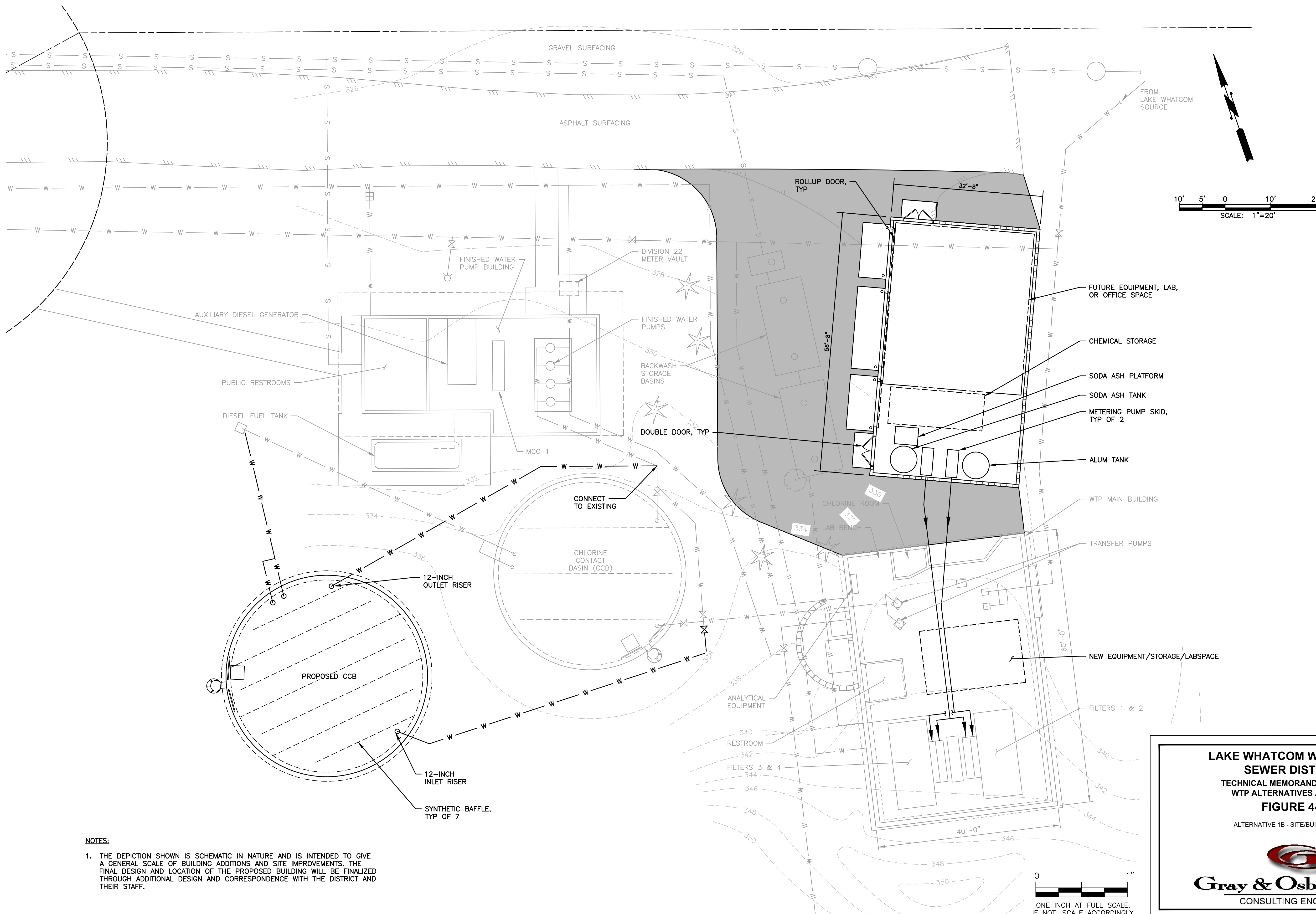
L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\Figures 2022-04-18\FIGURE 4-1.dwg, 4/24/2022 10:03 PM, PHILIP MARSHALL



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-10

WTP ALTERNATIVES ANALYSIS

FIGURE 4-2

ALTERNATIVE 1B - SITE/BUILDING PLAN

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Non-Process Equipment

Non-Process Equipment includes items such as site security and SCADA improvements. This alternative includes new security fencing, new security cameras, upgrades to the existing restroom facilities, and installation of a new coiling door to the WTP Main Building.

Table 4-2 provides a summary of the components included for Alternative 1B, their estimated capital costs, and their time frame for completion.

TABLE 4-2

Alternative 1B – Adjusted Minimum Alternative Cost Summary

Project	Capital Cost	Short- or Long-Term(1)
Finished Water Pump Replacement	$455,000	Short
Clearwell Transfer Pump Replacement	$210,000	Short
Raw Water Pump Replacement	$150,000	Short
Main Building Seismic Improvements	$75,000	Long
Finished Water Pump Building Seismic Improvements	$180,000	Long
Chemical Systems Modifications	$2,104,000	Long
Existing Media Filter Rehabilitation	$100,000	Long
Construct new 0.3 MG Steel CCB	$990,000	Long
Non-Process Improvements	$75,000	Short
Subtotal	**$4,339,000**	-
Contingency (40%)	$1,735,000	-
Washington State Sales Tax (9.0%)	$547,000	-
Total Construction Cost	**$6,621,000**	-
Design and Project Administration (25%)	$1,655,000	-
Total Project Cost	**$8,276,000**	-

(1) Short term improvement are proposed to be completed within the next 10 years. Long-term improvements are proposed to be completed in more than 10 years.

Alternative 2 – Medium Alternative

The Medium Alternative has the third-lowest capital cost and requires a higher level of effort and modifications to the existing facilities than either of the Minimum Alternatives. Alternative 2 provides improved redundancy and achieves the goal of separating the chemical storage and delivery equipment from the electrical components. It also makes more significant operational improvements to the treatment equipment to help ensure longevity and operational flexibility. Briefly, this alternative includes the following components, each of which is described further below:

- Replace the existing finished water, clearwell transfer, and raw water pumps with new pumps, motors, and motor control centers;
- Complete structural seismic improvements to the Finished Water Pump Building and CCB;
- Complete non-structural seismic improvements to the Finished Water Pump Building and WTP Main Building;
- Replace the existing alum storage and dosing system with new equipment;
- Rehabilitate the existing soda ash storage and dosing system with new equipment;
- Construct a new, 1,800 sf stand-alone CMU building to house chemical storage and dosing equipment;
- Rehabilitate existing Filter 1/2 vessel;
- Install and utilize new, stand-alone pretreatment equipment to be located within the new chemical systems building;
- Complete modifications to the existing gas-chlorine disinfection system that will bring the room into conformance with current building and chemical use codes;
- Construct a new 300,000-gallon chlorine contact basin;
- Convert the existing CCB into a backwash storage/settling basin and implement backwash recycle at the WTP; and
- Complete a variety of non-process related improvements to include site security fencing and surveillance installation, restroom improvements, and SCADA system improvements.

Pumping Equipment

This alternative includes replacement of the finished water, clearwell transfer, and raw water pumps, motor starters, and MCCs as described above for Alternatives 1A and 1B.

Seismic Considerations

Main Building

This alternative includes completion of the non-structural seismic improvements to the WTP Main Building as described in Alternatives 1A and 1B.

Finished Water Pump Building

This alternative includes completion of both the structural and non-structural seismic improvements to the WTP Finished Water Pump Building as described in Alternatives 1A and 1B.

CCB

Unlike Alternatives 1A and 1B, this alternative includes modifications to the existing CCB. The CCB provides contact time for the finished water prior to the distribution system and if this tank needed to be removed from service due to damage sustained during a seismic event, the District's ability to provide potable water would be significantly impacted.

In the December 2016 report "*Lake Whatcom Water and Sewer District Reservoir Seismic Vulnerability Assessment Technical Report*" by BHC Consultants, a seismic evaluation of the WTP Reservoir was performed. The evaluation found the shell, foundation, and anchorage to be adequate for the predicted seismic forces; however, there were two deficiencies identified:

- Inadequate uplift resistance of the foundation; and
- Lack of piping flexibility.

This alternative includes construction of a widened foundation ring wall to provide additional uplift resistance, and installation of force-balanced FLEX-TEND® couplings to the inlet and discharge piping/tank connections to provide seismic resiliency.

Chemical Systems

Similar to Alternatives 1A and 1B, Alternative 2 includes replacement of the existing alum storage tank and chemical delivery systems with new equipment. New equipment would include a new 2,500-gallon high-density polyethylene storage tank, new duplex chemical metering pump panel, and new chemical delivery piping.

This alternative also includes modifications to the soda ash system. Modifications include refurbishing and recoating the existing soda ash storage tank and loading platform, installation of new chemical mixers, installation of new duplex chemical metering pump equipment, and relocation all of this equipment to the new chemical building described below. Some examples of typical duplex chemical metering skids are shown in Figure 4-1.

To provide additional operational flexibility, this alternative also includes modifications to the WTP control scheme to accommodate the new metering pumps.

Instead of locating the chemical storage and delivery systems within the WTP Main Building, the equipment described above will be located within a new, standalone building located just north of the Main Building as shown in Figure 4-3. The new building will provide the desired separation between chemical system/storage and the electrical equipment – which will improve longevity for the electrical systems, will provide greater flexibility for chemical storage and delivery, and will also improve access to chemical and pretreatment equipment for operations staff. The proposed building will include the following:

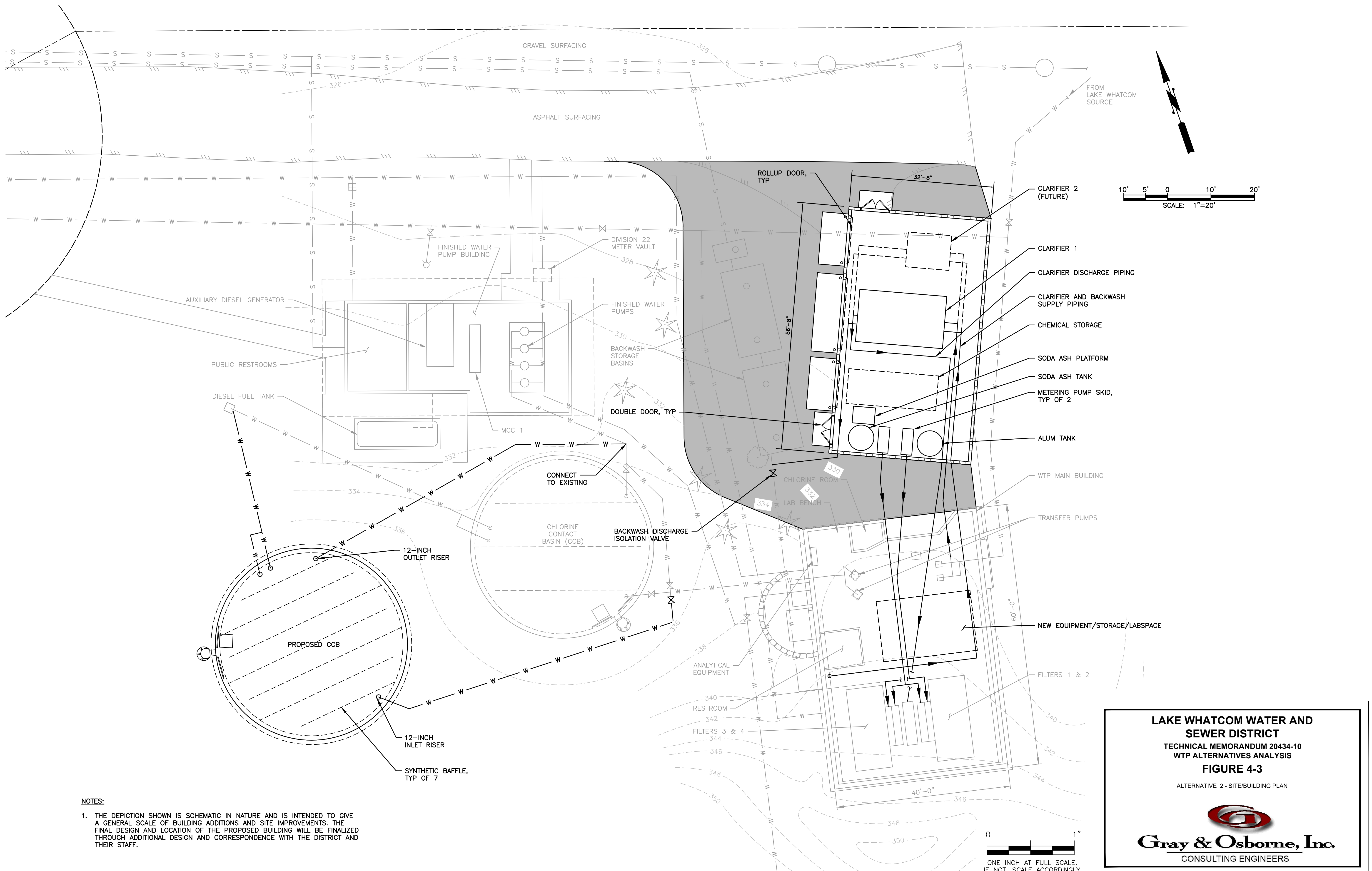
- 1,800 – 1,900 square feet (57' x 33');
- Concrete slab;
- CMU wall construction;
- Metal roofing panels;
- Three coiling doors for large deliveries and equipment removal;
- Two, 6-foot double doors for foot traffic; and
- Lighting, heating, and ventilation equipment.

The building footprint listed above is larger than necessary for the chemical equipment; however, this alternative also includes modifications to the existing filter pretreatment equipment. The proposed pretreatment equipment is also located in a new building, and making the building large enough to contain both pretreatment and chemical system equipment provides distinct economic advantages to the District.

<u>Filtration Systems</u>

In addition to the rehabilitation of existing filter vessels as described in Alternatives 1A and 1B, Alternative 2 includes utilization of new pretreatment equipment within a new building.

This alternative includes removing the existing flocculation tank and supporting equipment from service and installing a new, stand-alone contact adsorption clarifier within the new, stand-alone building described in the Chemical Systems section above.



NOTES:

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LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-10
WTP ALTERNATIVES ANALYSIS

FIGURE 4-3

ALTERNATIVE 2 - SITE/BUILDING PLAN

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A new building is required because installing the proposed pretreatment equipment within the Main Building is not feasible, and also because installing the proposed equipment within a new building will allow the existing WTP to remain in operation for as long as possible during construction. Furthermore, construction of a new building will allow the District to separate the chemical storage and dosing systems from the electrical gear within the WTP Main Building, which was one of the District's primary alternative goals. The proposed clarifier will accept water from the raw water pumps and provide preliminary filtration prior to water being pumped to the existing filter vessels. The clarifier will be constructed from stainless steel materials and will include various controls and alarms to provide sufficient safeguards against failures.

With the installation of new pretreatment equipment, the existing flocculation tank will be removed from service and removed from the Main Building. As a result of its removal, as well as the relocation of the existing alum storage tank and soda-ash storage tank to the proposed building, additional open space within the Main Building will be available for use. For the alternative, the new, open space will be reutilized for additional storage, laboratory, and office space. Reorganization of the existing space will provide better work flow, separation of wet laboratory activities and office space/recordkeeping, and provide a better working environment for WTP staff.

<u>Disinfection Systems</u>

This alternative includes modifications to the existing chlorine gas injection system in order to allow the system to meet current building codes. Modifications are subject to change based on changes in the code, but generally include the following:

- Replace existing mechanical ventilation unit and connect it to auxiliary power;
- Replace existing fire alarm system and install fire suppression within the chlorine room;
- Replace the chlorine gas detection and alarm system components;
- Install a spare gas cylinder storage cabinet;
- Reconfigure existing space to allow for improve canister anchorage to the wall; and
- Investigate existing power distribution equipment (conduit, outlets, etc.) and provide additional safeguards to protect against escape of potentially harmful and corrosive gases from the chlorine room.

The District will continue to utilize gas chlorine injection to create an aqueous hypochlorite solution which is then used to provide disinfection to filtered water.

Similar to Alternatives 1A and 1B, Alternative 2 also includes construction of a new 300,000 gallon CCB. One proposed location for this tank is shown in Figure 4-3.

<u>Backwash Systems</u>

This alternative includes significant modifications to the existing WTP backwash system. During backwash of the media filters, water is pumped upwards (reverse direction) through the media, which removes trapped particles and "cleans" the filter bed. Water generated during this backwash process is deposited to a temporary below-grade basin, allowed to settle, then is conveyed by gravity to a wastewater lift station located within Morning Beach Park just northwest of the WTP Main Building. This process is expensive and cumbersome for WTP staff as the existing lift station does not have large enough capacity to pump both backwash water and residential wastewater during the wet winter months.

To provide better operational flexibility and to minimize backwash flow to the City of Bellingham wastewater collection system, this alternative includes repurposing the existing CCB to provide backwash water storage, settling, and distribution. It also includes the necessary improvements to allow the District to recycle backwash supernatant to the treatment process. Recycling of backwash water is allowed by DOH provided that various parameters are monitored and that the backwash flow does not exceed 10 percent of the overall flow to the filters.

To allow the CCB to be used for backwash recycling, the following improvements are included with this alternative:

- Completion of previously mentioned CCB seismic retrofits;
- Completion of CCB coating and appurtenance improvements;
- Installation of two new 700 gpm backwash water pumps within the existing backwash storage tank;
- Installation of two new 100 gpm backwash recycle pumps in a stand-alone enclosure adjacent to the existing CCB; and
- Installation of additional water quality monitoring equipment and flow meters to allow for full and complete system optimization.

Additional electrical and ancillary improvements will be required to support the items listed above. Additionally, this alternative will allow the repurposed CCB to remain in service, where it can provide redundancy in the event the primary CCB must be taken offline for maintenance or recoating.

Non-Process Equipment

Non-Process Equipment includes items such as site security and SCADA improvements. This alternative includes new security fencing, new security cameras, upgrades to the existing restroom facilities, and installation of a new coiling door to the WTP Main Building. This alternative also includes restructuring and modifications to the existing lab/office space within the Main Building, and installation of new davit crane lifting equipment for the raw water pump vault.

Table 4-3 provides a summary of the components included for Alternative 2, their estimated capital costs, and their time frame for completion.

TABLE 4-3

Alternative 2 – Medium Alternative Cost Summary

Project	Capital Cost	Short- or Long-Term(1)
Finished Water Pump Replacement	$455,000	Short
Clearwell Transfer Pump Replacement	$210,000	Short
Raw Water Pump Replacement	$150,000	Short
Main Building Seismic Improvements	$75,000	Long
Finished Water Pump Building Seismic Improvements	$180,000	Long
CCB Seismic Improvements	$200,000	Long
Filtration and Chemical Systems Modifications	$2,104,000	Long
Existing Media Filter Rehabilitation	$100,000	Long
Chlorine Gas System Modifications	$153,000	Short
Construct new 0.3MG Steel CCB	$990,000	Long
Rehabilitate Existing CCB	$620,000	Long
Backwash Recycle Conversion	$630,000	Long
Non-Process Improvements	$75,000	Short
Subtotal	**$5,942,000**	-
Contingency (40%)	$2,377,000	-
Washington State Sales Tax (9.0%)	$749,000	-
Total Construction Cost	**$9,066,000**	
Design and Project Administration (25%)	$2,267,000	-
Total Project Cost	**$11,335,000**	-

(1) Short term improvement are proposed to be completed within the next 10 years. Long-term improvements are proposed to be completed in more than 10 years.

Alternative 3 – Maximum Alternative

The Maximum Alternative has the highest capital cost and requires the most effort and greatest number of modifications to the existing facilities of all four alternatives. This alternative provides improved redundancy, achieves the goal of separating the chemical storage and delivery equipment from the electrical components, improves access to critical filtration equipment, optimizes the treatment process to the maximum extent possible, and improves workspace within the WTP Main Building. It also makes more significant operational improvements to the treatment equipment to help ensure longevity and operational flexibility. Briefly, this alternative includes the following components, each of which is described further below:

- Replace the existing finished water, clearwell transfer, and raw water pumps with new pumps, motors, and motor control centers;
- Complete structural seismic improvements to the Finished Water Pump Building and CCB;
- Complete non-structural seismic improvements to the Finished Water Pump Building and WTP Main Building;
- Replace the existing alum storage and dosing system with new equipment;
- Rehabilitate the existing soda ash storage and dosing system with new equipment;
- Construct a new, 3,200 sf stand-alone CMU building to house chemical storage and dosing equipment;
- Install and utilize new rapid rate, mixed media, direct filtration equipment to be located within the new chemical systems building;
- Install and utilize new onsite hypochlorite generation equipment to provide chemical disinfectant for the filtered water;
- Construct a new 300,000-gallon chlorine contact basin,
- Convert the existing CCB into a backwash storage/settling basin and implement backwash recycle at the WTP; and
- Complete a variety of non-process related improvements to include site security fencing and surveillance installation, restroom improvements, and SCADA system improvements.

Pumping Equipment

This alternative includes replacement of the finished water, clearwell transfer, and raw water pumps, motor starters, and MCCs as described above for Alternatives 1A, 1B, and 2.

Seismic Considerations

Main Building

This alternative includes completion of the non-structural seismic improvements to the WTP Main Building as described in Alternatives 1A, 1B, and 2.

Finished Water Pump Building

This alternative includes completion of both the structural and non-structural seismic improvements to the WTP Finished Water Pump Building as described in Alternatives 1A, 1B, and 2.

CCB

This alternative includes completion of seismic retrofits to the existing CCB as described in Alternative 2.

Chemical Systems

Similar to Alternatives 1A, 1B, and 2, Alternative 3 includes replacement of the existing alum storage tank and chemical delivery systems with new equipment. New equipment would include a new 2,500-gallon high-density polyethylene storage tank, new duplex chemical metering pump panel, and new chemical delivery piping.

This alternative also includes modifications to the soda ash system. Modifications include refurbishing and recoating the existing soda ash storage tank and loading platform, installation of new chemical mixers, installation of new duplex chemical metering pump equipment, and relocation all of this equipment to the new chemical building described below. Some examples of typical duplex chemical metering skids are shown in Figure 4-1.

To provide additional operational flexibility, this alternative also includes modifications to the WTP control scheme to accommodate the new metering pumps.

Instead of locating the chemical storage and delivery systems within the WTP Main Building, the equipment described above will be located within a new, standalone building located just north of the Main Building as shown in Figure 4-4. The new building will provide the desired separation between chemical system/storage and the electrical equipment – which will improve longevity for the electrical systems, will provide greater flexibility for chemical storage and delivery, and will improve access for operations staff. Additional information on the proposed building is provided under the Filtration Systems heading below.

<u>Filtration Systems</u>

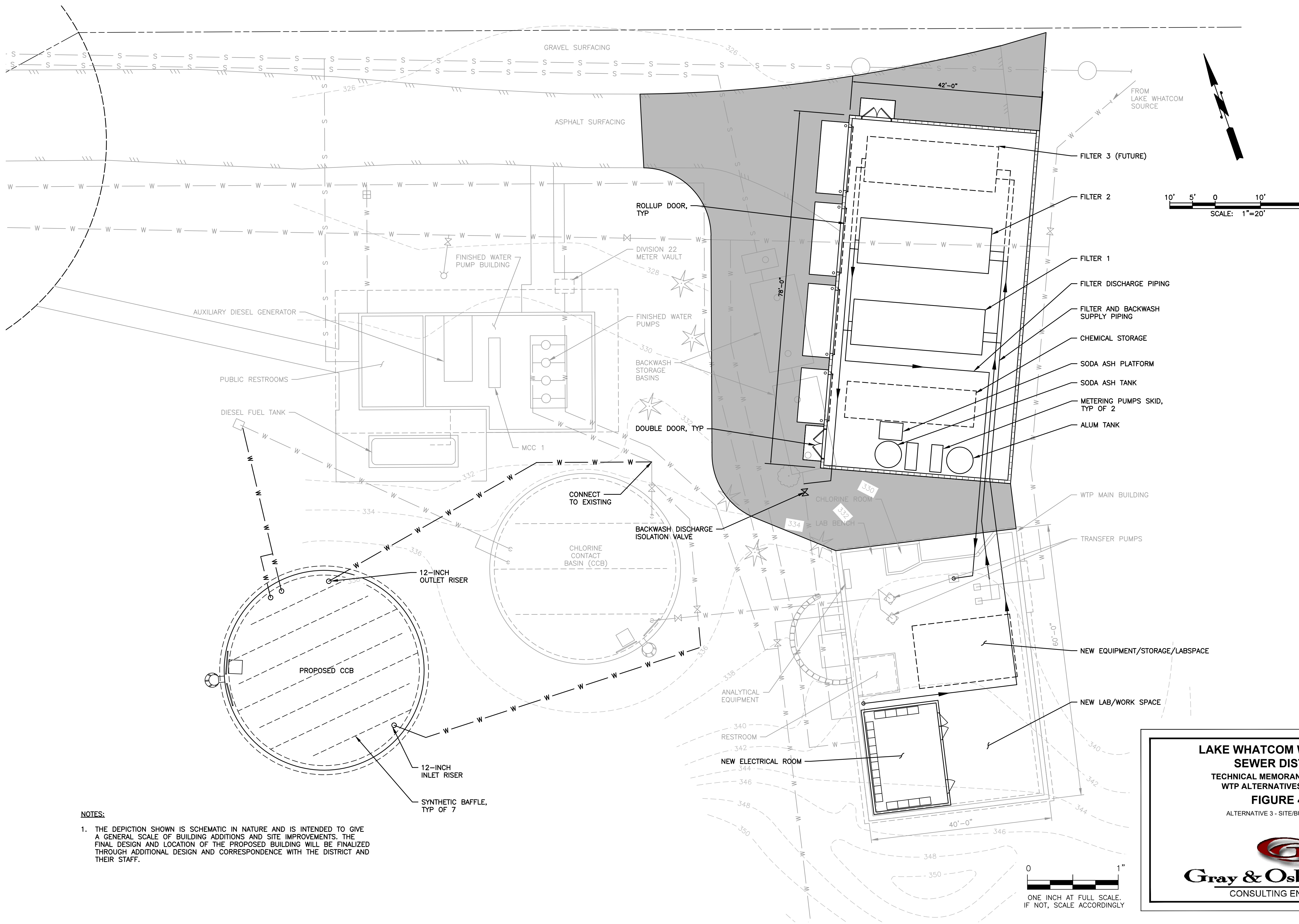
This alternative includes removing the existing mixed media filter vessels from service and installing two new rapid-rate mixed media filters with adjoining contact adsorption clarifiers within a new, stand-alone building just north of the existing Main Building as shown in Figure 4-4. Even though the existing filters are functional, they were installed in 1974 and are nearly 50 years old. Additionally, they are located at the back of the Main Building, which makes modification and/or replacement impossible without significant disruptions in service and major modifications to the existing Main Building facade. Relocating them to a new building will improve access to the filters and maximizes the capital value of providing a standalone building to separate the chemical system components from the electrical equipment. The building will be sized to accommodate two new filter units, space and piping for a future third filter unit, chemical storage space, chemical delivery and metering pump equipment, and space for electrical and control components.

The proposed building will include the following:

- 3,200 – 3,300 square feet (42' x 78');
- Concrete slab;
- CMU wall construction;
- Metal roofing panels;
- Four coiling doors for large deliveries and equipment removal;
- Two, 6-foot double doors for foot traffic; and
- Lighting, heating, and ventilation equipment.

The building footprint listed above is larger than necessary for the filtration equipment; however, this alternative also includes inclusion of new chemical delivery and storage equipment, as well as space for a future third filter unit or filter pretreatment equipment as required.

With the installation of new filters equipped with pretreatment equipment, the existing flocculation tank will be removed from service and removed from the Main Building. As a result of its removal, as well as the relocation of the existing alum storage tank and soda-ash storage tank to the proposed building, additional open space within the Main Building will be available for use. To utilize this space, this alternative includes construction of a new electrical room and relocation of electrical gear to this new space. This will provide separation between the electrical equipment and the remaining treatment plant environment.



NOTES:

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ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

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TECHNICAL MEMORANDUM 20434-10
WTP ALTERNATIVES ANALYSIS

FIGURE 4-4

ALTERNATIVE 3 - SITE/BUILDING PLAN

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Disinfection Systems

This alternative includes abandoning the existing gas chlorine equipment and utilizing new, onsite hypochlorite generation. Utilizing onsite hypochlorite generation equipment reduces reliance on outside vendors for disinfectant chemicals and provide more control to District staff over the disinfection process. The equipment would be located within the WTP Main Building, and would include brine equipment, a commercial onsite hypochlorite generation skid, water softening equipment, and all associated electrical and control/monitoring devices. For the purposes of this analysis, the proposed hypochlorite generation system will be capable of providing up to 20 pounds per day which is suitable for the ultimate design flow of 1,400 gpm.

This alternative also includes modifications to the WTP control scheme to accommodate the new hypochlorite generation equipment and associated instrumentation, devices, and metering pumps.

This alternative also includes construction of a new 300,000 gallon chlorine contact basin to provide sufficient contact time prior to introduction to the distribution system. The new CCB will be as described in Alternatives 1A, 1B and 2. One proposed location for this tank is shown in Figure 4-4.

Backwash Systems

Alternative 3 includes modifications as described in Alternative 2 to allow for recycling the media filter backwash water back through the treatment cycle and on to the distribution system.

Non-Process Equipment

Non-Process Equipment includes items such as site security and SCADA improvements. This alternative includes new security fencing, new security cameras, upgrades to the existing restroom facilities, and installation of a new coiling door to the WTP Main Building. This alternative also includes restructuring and modifications to the existing lab/office space within the Main Building, installation of new davit crane lifting equipment for the raw water pump vault, and construction of a new electrical room for electrical equipment.

Table 4-4 provides a summary of the components included for Alternative 3, their estimated capital costs, and their time frame for completion.

TABLE 4-4

Alternative 3 – Maximum Alternative Cost Summary

Project	Capital Cost	Short- or Long-Term(1)
Finished Water Pump Replacement	$455,000	Short
Clearwell Transfer Pump Replacement	$210,000	Short
Raw Water Pump Replacement	$150,000	Short
Main Building Seismic Improvements	$75,000	Long
Finished Water Pump Building Seismic Improvements	$180,000	Long
CCB Seismic Improvements	$200,000	Long
Filtration & Chemical Systems Modifications	$3,450,000	Long
Chlorine System Modifications	$887,000	Short
Construct new 0.3 MG Steel CCB	$990,000	Long
Rehabilitate Existing CCB	$620,000	Long
Backwash Recycle Conversion	$630,000	Long
Non-Process Improvements	$75,000	Short
Subtotal	**$7,922,000**	-
Contingency (40%)	$3,169,000	-
Washington State Sales Tax (9.0%)	$998,000	-
Total Construction Cost	**$12,088,000**	
Design and Project Administration (25%)	$3,022,000	-
Total Project Cost	**$15,111,000**	-

(1) Short term improvement are proposed to be completed within the next 10 years. Long-term improvements are proposed to be completed in more than 10 years.

ALTERNATIVE SUMMARY

To help summarize each alternative and allow for a more direct comparison, Table 4-5 provides a listing of the alternative components discussed and whether or not they are included within each alternative.

TABLE 4-5

Alternative Comparison Summary

Modification	Alternative 1A – Minimum	Alternative 1B - Adjusted Minimum	Alternative 2 - Medium	Alternative 3 - Maximum
Finished Water Pump Replacement	X	X	X	X
Clearwell Transfer Pump Replacement	X	X	X	X
Raw Water Pump Replacement	X	X	X	X
Main Building Seismic Improvements	X	X	X	X
Finished Water Pump Building Seismic Improvements	X	X	X	X
CCB Seismic Improvements			X	X
Alum System Improvements	X	X	X	X
Soda Ash System Improvements		X	X	X
Existing Filter System Rehabilitation	X	X	X	
New Filter System Equipment				X
New CCB	X	X	X	X
Gas Chlorine Utilization	X	X	X	
New On-Site Hypochlorite Generation Equipment				X
Pretreatment Equipment Improvements			X	X
New, Standalone Building		X	X	X
Backwash Recycle Implementation			X	X
Site Security Improvements	X	X	X	X
Lab/Office Space Improvements			X	X
Main Building Coiling Door	X	X	X	X
Main Building Restroom Improvements	X	X	X	X
Estimated Construction Costs	**$3,472,000**	**$6,621,000**	**$9,066,000**	**$12,088,000**
Estimated Project Costs	**$4,340,000**	**$8,276,000**	**$11,332,000**	**$15,110,000**

Each of the alternatives introduced above have various advantages and disadvantages, and each has varying levels of success at accomplishing the six goals outlined by the District.

Table 4-6 provides a summary of each alternative and provides a quantitative analysis for each with respect to individual goals 1-6. The values have been assigned between 0 – 10 such that a higher score means that a particular alternative more successfully addresses the defined goal. As a reminder, the six goals identified by the District are as follows:

1. Maintain exceptional water quality performance record.
2. Accommodate immediate need for space and separation between chemicals and process/electrical equipment.
3. Provide adequate equipment and process redundancy.
4. Improve access and flexibility for equipment repair/rehabilitation and/or future expansion.
5. Provide capacity for the design flow of 1,400 gpm.
6. Provide equipment with a design life of 30-50 years.

Additionally, the District has identified that the overall project cost/value (and subsequent impact to rate payers) is of paramount importance. To that end, an overall project cost and value line has been added to the list of goals in Table 4-6. Furthermore, Table 4-6 also includes a weighted scale factor for each goal. The weight value indicates the relative level of importance for each goal such that a higher weight value indicates that a particular goal is more important.

TABLE 4-6

Alternative Comparison Summary

Parameter	Weight	Alternative							
		1A – Minimum		1B – Adjusted Minimum		2 – Medium		3 – Maximum	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Goal 1	0.1	10	1.00	10	1	10	1	10	1
Goal 2	0.25	0	0.00	6	1.5	5	1.25	7	1.75
Goal 3	0.1	5	0.50	5	0.5	7	0.7	9	0.9
Goal 4	0.1	2	0.20	2	0.2	5	0.5	8	0.8
Goal 5	0.05	10	0.50	10	0.5	10	0.5	10	0.5
Goal 6	0.05	5	0.25	5	0.25	7	0.35	8	0.4
Cost/Value	0.35	7	2.45	9	3.15	5	1.75	3	1.05
Total	**1**	**39**	**4.90**	**47**	**7.10**	**49**	**6.05**	**55**	**6.40**
Construction Cost	-	$3,472,000		$6,621,000		$9,066,000		$12,088,000	
Project Cost	-	$4,340,000		$8,276,000		$11,332,000		$15,110,000	

The scoring in Table 4-6 indicates that Alternative 1B has the highest weighted score, and as such, most cost effectively and successfully accomplishes the District's six goals for WTP modifications. It is noteworthy that Alternative 3 was the highest scoring alternative, but when these scores are weighted according to the District's priorities, the high capital cost negatively impacts its scoring.

Alternative 1B does accomplish several key goals - most notably the need for additional space, to separate the chemical systems from the electrical equipment, and to provide redundancy for the CCB. While Alternatives 1B, 2, and 3 all accomplish these goals, Alternative 1B accomplishes these feats with the lowest capital and project costs.

We recommend that the District pursue Alternative 1B as described above and in Chapter 5. While District funds may be used for any/all of these projects, it may also be possible to apply for, and receive grants or low-interest loans to reduce the overall project costs for these improvements. Information on potential funding opportunities for these projects is provided in Chapter 6.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

This chapter provides additional information on the recommended alternative, Alternative 1B.

PUMPING EQUIPMENT

Finished water pumps and associated motor control equipment will be replaced. New pumps will be installed and will be controlled by new VFD motor starters. The new pumps and new VFDs will continue to be located within the Finished Water Pump Building.

Clearwell transfer pumps and associated motor control equipment will be replaced. New pumps will be installed and will be controlled by new VFD motor starters. The new pumps and new VFDs will continue to be located within the Main Building. A flow meter will be installed on the discharge side of the proposed pumps so that flow can be monitored and matched to the flow from the CCB. Lastly, the control scheme for clearwell transfer pump operation will be changed to eliminate the fill/draw cycle for the clearwell to the maximum extent possible.

Raw water pumps and associated motor control equipment will be replaced. New pumps will be installed and will be controlled by new VFD motor starters. The new pumps and new VFDs will continue to be located within the Main Building.

Prior to replacement of the Finished Water Pumps, the District should complete an investigation into the design points for each pump with regards to current and projected system demands for both the Division 7 and Division 22 reservoirs. Pump and motor size will be optimized based on the ultimate demand for each area which will provide the staff with more operational flexibility and control.

For all three pump types, it is assumed that the new motor starters will be installed into the existing MCCs. As VFD starter technology is typically larger than non-VFD technology, the District should complete a project pre-design study to confirm unit sizes with regard to the available space. Additional MCC columns may be necessary to house the new equipment if the existing MCC columns cannot accommodate the new equipment.

SEISMIC CONSIDERATIONS

MAIN BUILDING

Non-structural retrofits to the existing WTP Main Building will be completed, including, but not limited to, the following:

- Installation of additional bracing for the restroom wall framing;
- Installation of additional bracing for the wall-mounted electrical transformer;
- Installation of additional bracing for the ceiling mounted air handling unit;
- Installation of additional bracing and flexible connections for fluid piping; and
- Installation of seismic anchorage for existing motor control centers and electrical panels.

FINISHED WATER PUMP BUILDING

Structural retrofits to the existing Finished Water Pump Building will be completed, including, but not limited to, the following:

- Modifications to the existing roof/wall diaphragm to allow for shear forces in the roof diaphragm to be deflected to the shear walls; and
- Modifications to the existing roof sheathing to improve shear strength.

Additionally, non-structural retrofits to the existing Finished Water Pump Building will be completed, including, but not limited to, the following:

- Replacement of existing CMU bathroom/pump room partition walls with wood-framed walls;
- Installation of additional bracing for the generator exhaust piping;
- Installation of additional bracing for the gas heating unit;
- Installation of additional bracing and flexible connections for fluid piping;
- Installation of additional bracing and flexible connections for natural gas piping and meters;

- Installation of seismic anchorage for existing motor control centers and electrical panels;
- Installation of additional bracing for the wall-mounted electrical transformer;
- Installation of additional bracing for the water heater; and
- Installation of additional bracing for the existing conduit runs.

SITE AND SECURITY IMPROVEMENTS

Site security improvements will be completed. Improvements will include, at a minimum, the following:

- Installation of approximately 600 LF of chain link security fencing, gates, and access control equipment;
- Installation of security cameras and other monitoring equipment; and
- Upgrades to the telemetry/SCADA/electrical system to accommodate the proposed new cameras and monitoring equipment.

Additionally, site improvements will be as required to complete the remaining improvements noted below. This will include installation of new access roadway, landscaping, clearing and grubbing, and new grading to accommodate changes to the CCB, Finished Water Pump Building, and proposed new chemical building.

STORMWATER IMPROVEMENTS

Stormwater improvements will be based on each specific project slated for completion and in accordance with Whatcom County stormwater regulations. Of the projects described herein, only two are likely to require significant stormwater system improvements: construction of a new CCB, and construction of a new chemical systems building. A new CCB will increase the impervious area of the parcel and will remove a portion of the natural vegetation that currently remains onsite. Although a new chemical systems building will not likely increase the overall impervious area, there are likely to be significant stormwater requirements for the proposed new chemical building. It should be noted that Whatcom County stormwater permitting requirements are particularly strict, and include many additional restrictions based on the WTP's proximity to Lake Whatcom. These requirements will require extra planning/design/permitting efforts, and should be coordinated prior to development of the individual project design schedules.

We also recommend that the District contact the Washington State Department of Ecology (Ecology) to determine if Ecology review will be required as the level of agency review will largely depend on the full scope of the project.

PROCESS EQUIPMENT

PRETREATMENT

Modifications will include minor rehabilitation (i.e., spot repair) of the flocculation tank coating system.

FILTRATION

Modifications to the filter equipment will include installation of one additional ladder (for a total of two) per filter vessel, rehabilitation of the existing coating system for Filter 1/2, investigation of the existing Filter 1/2 underdrain system, and completion of any repairs/rehabilitation required based on this investigation.

DISINFECTION

Minor aesthetic improvements will be completed by District staff within the existing chlorine room. This will include at least new paint, addressing any corrosion to existing HVAC equipment, and addressing power distribution equipment to ensure that chlorine gas cannot travel via these pathways to the WTP Main Building space.

Additionally, a new 300,000-gallon CCB will be constructed adjacent to the Finished Water Pump Building. Preliminary design criteria for the new CCB are as follows and one potential location for the proposed tank is shown in Figure 4-2.

TABLE 5-1

Preliminary CCB Design Criteria

Parameter	Value
Type	Circular, Welded Steel
Diameter (ft)	44
Base Elevation (ft)	345.0
Overflow Elevation (ft)	372.0
Volume (gal)	307,000
Gallons per Foot	11,373
Inlet	12-inch perforated riser
Outlet	12-inch perforated riser
Baffles	7, Hypalon or HDPE
Baffling Efficiency	0.5
Instrumentation	Radar Level Sensor (1x); Float Switch (2x); Intrusion Switch (1x)

CHEMICAL SYSTEMS

The existing alum tank will be replaced with a new 2,500-gallon HDPE storage tank. Additionally, a duplex chemical pumping system will be provided. Both of these units will be installed within the new, stand-alone chemical systems building described below and shown in Figure 4-2.

The proposed building design will be finalized based on District needs identified during design, but the building will generally include the following:

- 1,800 – 1,900 square feet (57' x 33');
- Concrete slab;
- CMU wall construction;
- Metal roofing panels;
- Three coiling doors for large deliveries and equipment removal;
- Two, 6-foot double door for foot traffic; and
- Lighting, heating, and ventilation equipment.

ELECTRICAL/HVAC

Improvements to the electrical and HVAC equipment will be on an individual basis as required to meet current electrical and mechanical codes enforced at the time of project completion. In general, replacement of the existing raw water, clearwell transfer, and finished water pumps will require significant upgrades to the existing electrical equipment within the Finished Water Pump Building and WTP Main Buildings.

TELEMETRY AND CONTROLS

Improvements to the telemetry and controls system employed at the WTP will be on an individual basis and will be based on the specific equipment installed as part of a project. In general, modifications will include only changes necessary to incorporate additional instrumentation such as level sensors, flow meters, pumps, and security equipment. For each project, the SCADA system will be upgraded as required to accommodate the new equipment, and programming will be completed to allow for full control of the new equipment by WTP staff.

OTHER OPERATIONAL CONDITIONS

STARTUP AND TESTING

A startup and testing plan will be required as part of any construction document package that affects treatment equipment modifications. The general contractor awarded the project must provide a plan for component and system startup and will be required to demonstrate that each component will meet the design requirements once put into service.

The startup plan will include key information such as contact information for the equipment representatives, contingency plan in the event of failures such as leaks, power failures, etc., design flows and operational parameters. Furthermore, the technical performance specifications for each critical piece of equipment will require that a trained representative is present during system startup.

OPERATION AND MAINTENANCE

The proposed equipment will be operated and maintained in accordance with District standards and best practices. Any new equipment associated with a specific project will be incorporated into the District's existing Operations & Maintenance Manual.

STAFFING

The District currently maintains a full staff of employees and water system specialists that will operate and maintain the facility. No additional staff members are anticipated at this point in time.

SAFETY

No significant additional safety risks will result from construction of the proposed project.

SAMPLING AND MONITORING

The proposed project will not modify the District's existing sampling and monitoring schedule or procedures.

PERMITTING AND REGULATORY CONSIDERATIONS

As with any project that affects the equipment used to provide potable water to a municipal water system, regulatory and permitting concerns must be addressed. The section below summarizes the regulatory efforts needed to complete any of the proposed projects.

WASHINGTON STATE DEPARTMENT OF HEALTH PROJECT REPORT

Per WAC 246-290-110, a Project Report must be submitted to the Washington State Department of Health (DOH) for any modification or addition to a water system.

It is anticipated that Project Reports will be required for construction of a new CCB, relocation of the existing chemical systems, and replacement of the raw water, clearwell transfer, and finished water pumping equipment.

Site work, seismic improvements, and other structural modifications do not require project reports and/or review by DOH prior to execution.

CONSTRUCTION DOCUMENTS

Per WAC 246-290-120, Construction Documents (Plans and Specifications) must be submitted to DOH for review and approval prior to constructing modifications or additions to a water system.

Once approved by DOH, construction documents will be provided by the District via a public forum for bidding by responsive, responsible contractors. If awarded, the project will then be constructed as shown on these Plans and as defined by the Contract Specifications.

STATE ENVIRONMENTAL POLICY ACT (SEPA)

Per RCW 43.21C and WAC 197-111, all government agencies must consider the environmental impacts of a proposed project. For the projects listed herein, it is assumed that the District will act as lead agency for the SEPA review and notification process.

WHATCOM COUNTY PERMITTING

The projects discussed herein are located within Whatcom County, and as such, would be subject to requirements listed in County ordinances/codes. Construction of a new CCB as well as a new chemical systems building will require Whatcom County Building Permits. The County building permit may have other accessory permits such as grading, critical areas, and stormwater permits - the full breadth of which can only be identified after development of a preliminary building and site plan.

It is noteworthy that County building permits can typically take between 6-12 months to procure, depending on project conditions. The time required for permit procurement should be incorporated into the project schedule. Additionally, prior to design of any project, we recommend that the District communicate with county building officials to discuss permit requirements, submittals, and deadlines.

CITY PERMITTING

The WTP is not located within the City limits for the City of Bellingham, and as such, would not be subject to city codes or requirements.

EASEMENTS

It is the District's intent that any and all projects requiring construction of new facilities be completed within existing District easements wherever possible. Consideration will be given to each project on a case-by-case basis with regard to location, existing easements, potential easements, property ownership, and access to the facility.

ELECTRICAL PERMIT

For many of the projects proposed above, electrical permits will be required prior to completion of the work. These permits will be procured by the contractor who is awarded the construction project as needed. Additional Department of Labor & Industries electrical permits and inspections will be required, but these applications and coordination will be provided by the general contractor awarded the project and their chosen electrical subcontractors as part of the construction.

CHAPTER 6

FUNDING OPPORTUNITIES

INTRODUCTION

This Chapter provides a brief summary of various funding opportunities that may be available for project design and/or construction funding. The list below is not exhaustive and other opportunities may become available, but the list below represents the most commonly used funding sources for public utility infrastructure projects in Washington State.

It is important to note that prior to pursuit of project funding, it is recommended that the District or their representative consult with agency managers to determine if the District is eligible for funding, how much funding is available, whether a specific project would be eligible for funding and which type (predesign, design, construction, etc.), specific application requirements, as well as other project/funding parameters.

PUBLIC WORKS BOARD

The Public Works Trust Fund (PWTF) is a revolving loan fund designed to help local governments finance public works projects through low-interest loans and technical assistance. The PWTF, established in 1985 by legislative action, offers loans substantially below market rates, payable over periods ranging up to 20 years. To be eligible for the PWTF programs, an applicant must be a local government such as a city, county, or utility district. PWTF has four loan programs including construction, preconstruction, planning, and emergency.

PWB-funded projects must be completed within 5 years of funding. Periodically, the Public Works Board also has funding for Pre-Construction and Planning activities; however, preconstruction funding is generally limited to $1 million per jurisdiction per biennium.

Additional information on this funding source is provided at https://www.commerce.wa.gov/building-infrastructure/pwb-financing/. The new Program Director at the Public Works Board is Mark Rentfrow and he can be reached at (360) 529-6432 or by email at mark.rentfrow@commerce.wa.gov.

DRINKING WATER STATE REVOLVING FUND (DWSRF)

In 1996, Congress established the DWSRF through the reauthorization of the federal Safe Drinking Water Act. The program is managed by both DOH and the Washington State Public Works Board. The purpose of the program is to provide low-interest loans to assist publicly- and privately-owned water systems improve drinking water and protect public health, with a limited amount of principal forgiveness for communities with high affordability index scores. Additionally, water system restructuring and consolidation projects are program priorities.

Eligible public-owned water systems include city and county governments, public utility districts, and special purpose districts. Privately owned systems are eligible as long as they are Group A systems. Maximum award per single water system is $12,000,000 and for combined systems an award of $24,000,000 is available. DWSRF loans require a 1 percent loan fee and a 1.75 percent interest rate; however, no local match is required. Loan terms are generally 20 years or the life of the project, whichever is less. These loans are often allowed a high level of forgiveness if the system is consolidated due to water quality issues.

DWSRF puts its greatest emphasis on communities and projects with significant water quality issues. Applications are generally available in September and due at the end of November.

Additional information on this funding source is provided at https://www.doh.wa.gov/DWSRF. Corina Hayes is the organization contact for this program and can be reached at (360) 236-3153 or by email at corina.hayes@doh.wa.gov.

COMMUNITY DEVELOPMENT BLOCK GENERAL PURPOSE GRANTS (CDBG)

The CDBG program is a competitive source of federal funding for a broad range of community development projects and is funded by the Federal Housing and Urban Development Program. It is a state-wide program for low-income communities with a total budget of around $11 million each year, focusing on cities and towns with populations less than 50,000 and counties with less than 200,000 population that are not participating in a CDBG Entitlement Urban County Consortium. A primary requirement of the CDBG program is that the project must principally benefit at least 51 percent of the low-to-moderate income residents of the project area. CDBG has two programs including General Purpose and Planning Only. The General Purpose program provides grant funds for the design, construction, or reconstruction of water and sewer systems up to the amount of $1,000,000 and can be used for water, wastewater, utility side-connections, stormwater, streets and community facilities. The Planning Only program includes projects such as comprehensive plans and capital improvement plans and has an upper limit of $30,000 for a single applicant or $50,000 for a joint applicant. Eligible applicants for the CDBG programs include cities, towns, and special purpose districts; however, special purposed districts must partner with an eligible local jurisdiction to apply.

Applications for general purpose grants from this fund are currently open and applications are due on or around June 1 of each year.

Additional information on this funding source is provided at https://www.commerce.wa.gov/serving-communities/community-development-block-grants/. The agency contact for the CDBG program is Jacquie Andresen. Ms. Andresen can be reached at (360) 688-0822 or by email at jacquie.andresen@commerce.wa.gov.

USDA RURAL DEVELOPMENT WATER AND WASTEWATER LOAN FUNDING (USDARD)

The USDA Rural Development Administration provides loan (and some grant) funding for water and wastewater infrastructure projects for communities with a population under 10,000 and who are unable to obtain funding from other sources at reasonable rates. Projects can include both residential and commercial activities. Applications are accepted year-round and interest rates vary quarterly with the federal prime rate depending upon the financial status of the borrower. RD provides three loan rates for water infrastructure projects: 2.5 percent market rate, 2.0 percent intermediate rate, and 1.5 percent poverty rate.

Loan terms can be as long as 40 years or for the life of the facility, and a limited amount of grant funding is available for low-income communities to reduce rate impacts for large projects. As this program provides funds on a reimbursement basis, interim financing is often required. Interim funding can be obtained from another funding agency. Evergreen Rural Water Association and the Rural Community Assistance Corporation (RCAC) provide short-term interim finance loans and frequently work with USDARD.

Additional information on this funding source is provided at https://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program/wa. Darla O'Connor is the USDARD project manager for Whatcom County with an office in Mount Vernon. She can be reached at (360) 488-4835 or by email at darlaoconnor@usda.gov.

INFRASTRUCTURE ASSISTANCE COORDINATING COUNCIL (IACC)

While not a funding agency, the IACC represents a valuable resource for local governments within Washington State. The IACC is a nonprofit organization dedicated to helping Washington communities and tribes identify and obtain resources they need to develop, improve, and maintain infrastructure. It consists of staff from state and federal agencies, local government associations, and nonprofit technical assistance organizations. IACC's purpose is to improve the delivery of infrastructure assistance, both financial and technical, to local governments and tribes in Washington State. It does this by keeping its members informed of changes in infrastructure programs or services and in providing opportunities to network and gain information. IACC sponsors an annual statewide conference in October of each year where state and federal programs assisting local governments and tribes with infrastructure needs convene to share information about their programs with local government representatives. IACC also provides technical assistance to communities and tribes by bringing together the appropriate funding and technical assistance representatives with community members to collaborate on specific projects.

Additional information on this funding source is provided at http://www.infrafunding.wa.gov/. The program contact for the IACC in Washington is program is Valerie Smith. Ms. Smith can be reached at (360) 725-3062, Ext. 143 or by email at valeri.smith@commerce.wa.gov.

FEMA HAZARD MITIGATION GRANT

While the Federal Emergency Management Agency (FEMA) does not fund infrastructure construction projects directly, the Stafford Act allows this agency to set aside between 14 percent and 20 percent of the amount of public assistance and individual assistance grant funding expended in disaster impacted communities following federally-declared disaster for purposes of hazard mitigation. FEMA Hazard Mitigation Grants generally cover 75 percent of eligible project costs, which must be justified based on benefit-cost analysis prepared on FEMA benefit-cost software. The Washington Military Department Emergency Management Division provides 12.5 percent of eligible project costs and the applicant's eligible project cost share is generally 12.5 percent. The Hazard Mitigation Grant Program generally accepts applications statewide; however, preference is given to applications from jurisdictions within the counties included in the subject federally-declared disaster. Potentially eligible Hazard Mitigation Grant applications include seismic retrofit of water storage and transmission infrastructure.

Additional information is available at https://www.fema.gov/grants/mitigation. The Washington State contact for HMG information is Tim Cook. Tim can be reached at (253) 512-7072, or by email at tim.cook@mil.wa.gov.

BUILDING RESILIENT INFRASTRUCTURE AND COMMUNITIES

Recently, FEMA initiated the Building Resilient Infrastructure and Communities (BRIC) Program to improve disaster preparedness and response. The BRIC program funds 75 percent of eligible project costs with no input from the state leaving the applicant with a 25 percent applicant cost-share. BRIC is a nationwide program and has a limited amount of advance assistance funding available to assist communities with potentially eligible projects with development of the benefit-cost analysis and associated planning and permitting. Hazard Mitigation Grant funding rounds generally follow the disaster declaration timeline. Applications for the BRIC Program funding are submitted during the annual fall application period. The funding for Hazard Mitigation Grant and BRIC-funded projects often takes more than a year from application submittal to project funding. HMGP and BRIC grant funds are managed by the Washington Military Department Division of Emergency Management. Potential applicants should contact their local emergency management agency to learn more regarding open federally-declared disasters and potential HMGP and BRIC application requirements and timelines.

OTHER FUNDING OPPORTUNITIES

Other funding opportunities may become available on a year-to-year basis. It is also important to note that project funding availability changes annually based on funds allocated by local, state, and federal governments.

APPENDIX A

PROJECT COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
ALTERNATIVE 1A - MINIMUM IMPROVEMENTS COST ESTIMATE SUMMARY

April 25, 2022
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Finished Water Pump Replacement	1	LS	$ 455,000	$ 455,000
2	Liquid Alum System Replacement	1	LS	$ 40,000	$ 40,000
3	Clearwell Transfer Pump Replacement	1	LS	$ 210,000	$ 210,000
4	Raw Water Pump Replacement	1	LS	$ 150,000	$ 150,000
5	Non-Process Improvements	1	LS	$ 75,000	$ 75,000
6	WTP Main Building Seismic Retrofits	1	LS	$ 75,000	$ 75,000
7	Finished Water Pump Building Seismic Retrofits	1	LS	$ 180,000	$ 180,000
8	New 0.3 MG Steel Chlorine Contact Basin (CCB)	1	LS	$ 990,000	$ 990,000
9	Rehabilitate Existing Filter Vessel 1/2	1	LS	$ 100,000	$ 100,000
				Subtotal (1)	**$ 2,275,000**
				Contingency (40%)	$ 910,000
				Washington State Sales Tax (9.0%) (2)	$ 287,000
				TOTAL ALTERNATIVE CONSTRUCTION COST	**$ 3,472,000**
				Design and Project Administration (25%) (3)	$ 868,000
				TOTAL ALTERNATIVE PROJECT COST	**$ 4,340,000**

1) Costs listed are in 2021 dollars
2) Current sales tax rate is 8.7%.
3) Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
ALTERNATIVE 1B - ADJUSTED MINIMUM IMPROVEMENTS COST ESTIMATE SUMMARY

April 25, 2022
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Finished Water Pump Replacement	1	LS	$ 455,000	$ 455,000
2	Clearwell Transfer Pump Replacement	1	LS	$ 210,000	$ 210,000
3	Raw Water Pump Replacement	1	LS	$ 150,000	$ 150,000
4	Chemical Addition System Improvements	1	LS	$ 2,104,000	$ 2,104,000
5	Non-Process Improvements	1	LS	$ 75,000	$ 75,000
6	WTP Main Building Seismic Retrofits	1	LS	$ 75,000	$ 75,000
7	Finished Water Pump Building Seismic Retrofits	1	LS	$ 180,000	$ 180,000
8	New 0.3 MG Steel Chlorine Contact Basin (CCB)	1	LS	$ 990,000	$ 990,000
9	Rehabilitate Existing Filter Vessel 1/2	1	LS	$ 100,000	$ 100,000
				Subtotal (1)	**$ 4,339,000**
				Contingency (40%)	$ 1,735,600
				Washington State Sales Tax (9.0%) (2)	$ 547,000
				TOTAL ALTERNATIVE CONSTRUCTION COST	**$ 6,621,600**
				Design and Project Administration (25%) (3)	$ 1,655,000
				TOTAL ALTERNATIVE PROJECT COST	**$ 8,276,600**

1) Costs listed are in 2021 dollars
2) Current sales tax rate is 8.7%.
3) Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
ALTERNATIVE 2 - MEDIUM IMPROVEMENTS COST ESTIMATE SUMMARY

April 25, 2022
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Finished Water Pump Replacement	1	LS	$ 455,000	$ 455,000
2	Clearwell Transfer Pump Replacement	1	LS	$ 210,000	$ 210,000
3	Raw Water Pump Replacement	1	LS	$ 150,000	$ 150,000
4	WTP Main Building Seismic Retrofits	1	LS	$ 75,000	$ 75,000
5	Finished Water Pump Building Seismic Retrofits	1	LS	$ 180,000	$ 180,000
6	Existing CCB Seismic Improvements	1	LS	$ 200,000	$ 200,000
7	Existing Chlorine Gas System Modifications	1	LS	$ 153,000	$ 153,000
8	Site Security Improvements	1	LS	$ 75,000	$ 75,000
9	Chemical Addition System Improvements	1	LS	$ 2,104,000	$ 2,104,000
10	New 0.3 MG Steel Chlorine Contact Basin (CCB)	1	LS	$ 990,000	$ 990,000
11	Existing Filter Rehabilitation	1	LS	$ 100,000	$ 100,000
12	Existing CCB Rehabilitation / Repurposing	1	LS	$ 620,000	$ 620,000
13	Backwash Recycle Implementation	1	LS	$ 630,000	$ 630,000
				Subtotal [1]	**$ 5,942,000**
				Contingency (40%)	$ 2,377,000
				Washington State Sales Tax (9.0%) [2]	$ 749,000
				TOTAL ALTERNATIVE CONSTRUCTION COST	**$ 9,068,000**
				Design and Project Administration (25%) [3]	$ 2,267,000
				TOTAL ALTERNATIVE PROJECT COST	**$ 11,335,000**

1) Costs listed are in 2021 dollars
2) Current sales tax rate is 8.7%.
3) Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
ALTERNATIVE 3 - MAXIMUM IMPROVEMENTS COST ESTIMATE SUMMARY

April 25, 2022
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Finished Water Pump Replacement	1	LS	$ 455,000	$ 455,000
2	Clearwell Transfer Pump Replacement	1	LS	$ 210,000	$ 210,000
3	Raw Water Pump Replacement	1	LS	$ 150,000	$ 150,000
4	WTP Main Building Seismic Retrofits	1	LS	$ 75,000	$ 75,000
5	Finished Water Pump Building Seismic Retrofits	1	LS	$ 180,000	$ 180,000
6	Non-Process Improvements	1	LS	$ 75,000	$ 75,000
7	Existing CCB Seismic Improvements	1	LS	$ 200,000	$ 200,000
8	New Mixed Media Filters & Associated Building	1	LS	$ 3,450,000	$ 3,450,000
9	OSHG Disinfection Implementation	1	LS	$ 887,000	$ 887,000
10	New 0.3 MG Steel Chlorine Contact Basin (CCB)	1	LS	$ 990,000	$ 990,000
11	Existing CCB Rehabilitation	1	LS	$ 620,000	$ 620,000
12	Backwash Recycle Implementation	1	LS	$ 630,000	$ 630,000
				Subtotal (1)	**$ 7,922,000**
				Contingency (40%)	$ 3,169,000
				Washington State Sales Tax (9.0%) (2)	$ 998,000
				TOTAL ALTERNATIVE CONSTRUCTION COST	**$ 12,089,000**
				Design and Project Administration (25%) (3)	$ 3,022,000
				TOTAL ALTERNATIVE PROJECT COST	**$ 15,111,000**

1) Costs listed are in 2021 dollars
2) Current sales tax rate is 8.7%.
3) Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

APPENDIX B

SUDDEN VALLEY WATER TREATMENT PLANT ASSESSMENT REPORT

LAKE WHATCOM WATER AND SEWER DISTRICT

WHATCOM COUNTY **WASHINGTON**

SUDDEN VALLEY WATER TREATMENT PLANT ASSESSMENT REPORT

G&O #20434
JULY 2020

Gray & Osborne, Inc.
CONSULTING ENGINEERS

LAKE WHATCOM WATER AND SEWER DISTRICT

WHATCOM COUNTY WASHINGTON

SUDDEN VALLEY WATER TREATMENT PLANT ASSESSMENT REPORT

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35688
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7/6/2020

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7/6/2020

G&O #20434
JULY 2020

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

CHAPTER 1 – INTRODUCTION AND EXISTING FACILITIES

CHAPTER 2 – WTP CONDITION ASSESSMENT

CHAPTER 3 – TREATMENT IMPROVEMENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The Lake Whatcom Water and Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP). This assessment is part of a larger project that includes a holistic analysis of the South Shore Water System and its components, including treatment, distribution systems, and water sources. The first step in this process is to complete a condition assessment of the existing treatment plant system. The purpose of the assessment is to investigate the integrity of the existing WTP facilities from a structural, electrical, mechanical, architectural, and process perspective in order to guide the District's decisions on use and/or modifications at the WTP. Following this assessment, the District along with Gray & Osborne will complete an alternatives analysis based on the findings and recommendations within the assessment report. Using this alternatives analysis report, the District can then select the most cost-effective alternative(s) and proceed with selected modifications.

The existing WTP is a rapid rate direct filtration plant that uses chlorine gas for disinfection. The plant was originally constructed in 1972 and has a rated capacity of 2.0 million gallons per day (mgd). The WTP has been upgraded several times since its construction, most recently in 1992. The WTP treats surface water from Lake Whatcom and is located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive.

A site visit was completed on February 12, 2020 by Gray & Osborne process, mechanical, electrical, and structural engineers. During the visit, Gray & Osborne discussed the current operations, perceived deficiencies, and desired needs for the WTP with operations staff, and also assessed the condition of the existing facilities at both the WTP Main Building, Finished Water Pump Building, and Chlorine Contact Basin.

The condition assessment found several items for improvement, but did not find any significant structural, electrical, mechanical, or operational issues that would prevent the WTP from successful operation for the foreseeable future. In general, the facilities are in good condition and only require minor repairs and the completion of regular maintenance items in order to maintain their current function.

The report below does make some recommendations for alternatives that, if enacted, may improve the operational efficiency of the WTP. In addition to these recommendations and the listed repairs, this assessment has identified a number of high-priority improvements that should be addressed to ensure the successful operation of the facility in the future. Table ES-1 provides a summary of the high priority repairs and improvements to the facility.

TABLE ES-1

Sudden Valley WTP High Priority Modifications Summary

Modification	Location[1]	Discipline[2]
Conduct chlorine disinfection system alternatives analysis	MB	P
Chlorine gas system modifications	MB	P
Alum storage and metering pump system modifications	MB	P
Soda Ash storage and metering pump system modifications	MB	P
Conduct backwash system alternatives analysis	MB	P
Replace existing clearwell and CCB level switches	MB	P
Replace corroded steel supports	MB	S
Prepare and coat steel tanks (Floc, Soda Ash, and Filters 1/2)	MB	S
Install seismic bracing for electrical conduit, electrical equipment, and treatment equipment	MB/FPB	S
Complete detailed structural evaluation	MB/FPB	S
Relocate existing laboratory electrical equipment	MB	A
Remove soil cover, vegetation growth, and organic debris from building exterior and roof	MB	A
Provide water upgrades to safety shower and eyewash	MB	A
Add fire and smoke alarm system	MB/FPB	A
Investigate current heating schedule	MB/FPB	M
Combine all existing plant records into a single as-built planset	MB/FPB	E
Complete a comprehensive electrical system audit	MB/FPB	E
Remove chemicals and metering equipment away from MCCs	MB	E
Review historical peak demand electrical consumption	MB/FPB	E
Replace MCC1 and MCC2 with new, current technology	MB/FPB	E
Replace MCC3 to address panel and interior component corrosion	MB	E

(1) MB = WTP Main Building. FPB = Finished Water Pump Building. CCB = Chlorine Contact Basin.

(2) P = Process, S = Structural, A = Architectural, M = Mechanical, and E = Electrical.

If the recommendations listed in Table ES-1 are addressed, the WTP appears capable of successfully, effectively, and efficiently meeting the District’s water treatment needs for at least the next 10 to 20 years. Although the original facility is nearly 50 years old, the structures are in good overall condition and do not appear to need significant structural, electrical, mechanical or process modifications.

Based on the findings listed in table ES-1, the District along with Gray & Osborne will complete the second phase of the project. This second phase will include a more thorough analysis of treatment alternatives that will help fully identify the desired scope of modifications to the WTP. This analysis will also help define key design parameters, system requirements, and permitting issues. Lastly, defining the full and complete scope of modifications will also allow the District to develop accurate cost estimates that can be used for budgeting and planning purposes.

CHAPTER 1

INTRODUCTION AND EXISTING FACILITIES

INTRODUCTION

The Lake Whatcom Water and Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for the existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment is to identify potential improvements for the existing structures and current treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The report can also be used to guide selection of feasible water treatment alternatives for longer term treatment of the Lake Whatcom source.

This report summarizes the findings of the WTP condition assessment, which was conducted on February 12, 2020. During this assessment Gray & Osborne personnel investigated the process, operations, structural, architectural, mechanical, and electrical components for the WTP.

Chapter 1 of this report provides a brief background on the District's South Shore Water System and description of water rights for the system. It also includes a description of each of the components utilized for water intake and treatment at the WTP.

Chapter 2 of this report summarizes the findings of the assessment with regards to process, structural, architectural, mechanical, and electrical disciplines.

Finally, Chapter 3 of this report provides a summary of the improvements that would be required for these facilities to meet current structural, mechanical, and electrical codes. This chapter also summarizes the modifications that may help to optimize the treatment process and provide a more efficient workspace for operations staff.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems ‑ South Shore (DOH #95910), Eagleridge (DOH #08118), and Agate Heights (DOH #52957) ‑ all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley Water Treatment Plant. In addition to the WTP, the

District also owns and maintains surface water source, storage, and distribution system facilities. Figure 1-1 shows a map of the District's service area and highlights the location of major facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 MG of storage in five reservoirs.

The District also maintains a secondary intertie with the City of Bellingham Water System (DOH #50600) that is used only during emergency situations.

WATER RIGHTS AND PROJECTED DEMAND

The District's Sudden Valley water rights are summarized in Table 1-1. A more detailed discussion of the District's water rights is included in the current Water System Plan (*Wilson Engineering, 2018*). According to the Water System Plan, the District maintains adequate water rights for their existing demands as well as projected maximum day demands.

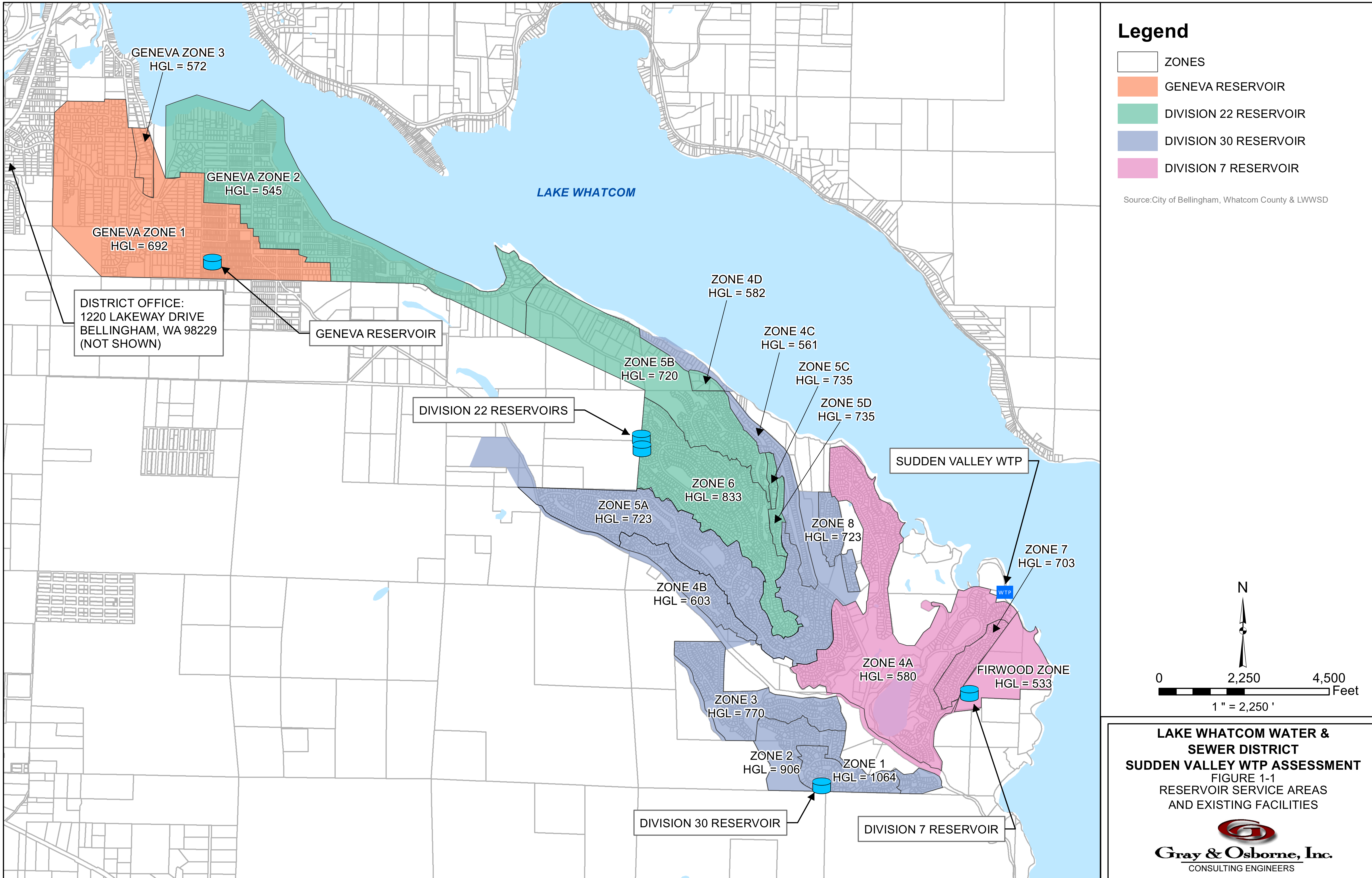
TABLE 1-1

Water Rights Summary

Location	Type	Number	Instantaneous Flow (gpm)	Maximum Annual Withdrawal (acre-feet)
South Shore (Sudden Valley and Geneva)	Surface Water	S1-00736C S1-00734C R1-25120C S1-25121P	1,526	1,800
Eagle Ridge	Intertie(1)	N/A	150	-
Agate Heights	Groundwater	G1-22681P CG1-22763P CG1-23449C	438	506.9
Total			**1,964(2)**	**1,800**

(1) With City of Bellingham, who maintains a large surface water source from Lake Whatcom.
(2) Does not include Eagleridge Intertie water rights.

The District's average day demand (ADD) and maximum day demand (MDD) are summarized in Table 1-2. A more detailed discussion of the District's historical, current, and projected system demands is included in the current Water System Plan (*Wilson Engineering, 2018*). According to the Water System Plan, the District's existing water rights are sufficient to meet projected ADD and MDD for the South Shore system. While the District may possess sufficient water rights to meet projected demands, the data in Table 1-2 suggest that the existing WTP cannot meet these projected demands with its current operational flow of 700 gallons per minute (gpm). The assessments below will address capacity limitations for the individual components of the treatment process. Additionally, Appendix B contains a summary of the District's monthly treatment reports for 2018 and 2019.



LAKE WHATCOM WATER & SEWER DISTRICT
SUDDEN VALLEY WTP ASSESSMENT
FIGURE 1-1
RESERVOIR SERVICE AREAS AND EXISTING FACILITIES

Gray & Osborne, Inc.
CONSULTING ENGINEERS

L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\GIS\1-1 RESERVOIR SERVICE AREAS.mxd

TABLE 1-2

Water Demand Summary

Parameter	2020	2036	Buildout
Sudden Valley ADD (gpd)(1)	405,000	415,500	490,000
Geneva ADD (gpd)	200,000	208,000	217,000
Combined ADD (gpd)	***605,000***	***623,500***	***707,000***
Sudden Valley MDD (gpd)(2)	675,000	691,000	817,000
Geneva MDD (gpd)	422,000	440,000	458,500
Combined MDD (gpd)	***1,097,000***	***1,131,000***	***1,275,500***
8-Hour Filter Capacity (gallons @ 700 gpm/1,000 gpm)	336,000/480,000		
16-Hour Filter Capacity (gallons @ 700 gpm/1,000 gpm)	672,000/960,000		
WTP Rated Capacity (gpd)(3)	2,000,000		

(1) ADD values taken from 2018 WSP and based on consumption of 150 gpd/ERU.
(2) MDD values taken from 2018 WSP and based on consumption of 250 gpd/ERU.
(3) Based on a current filter surface area of 252 sf and a maximum allowable filtration rate of 6.0 gpm/sf.

WATER TREATMENT PLANT (WTP)

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (mgd) but currently operates at approximately 1.01 mgd (700 gpm). The WTP is housed in a partially below grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before treated water is pumped to the distribution system and storage reservoirs. Each of the individual components of the treatment process is described below. Photographs of the components listed below are provided in Appendix A.

Raw Water Intake

The raw water intake draws from within Lake Whatcom, the shoreline of which is approximately 300 feet from the WTP. The intake structure is located approximately 300 feet from the shoreline at a depth of approximately 70 feet below the water surface. The intake structure consists of a 36-inch diameter tee fitting, intake screens, and transition fittings to connect to the 24-inch ductile iron pipe that proceeds from the intake structure to the shoreline. Near the shoreline, the piping transitions from 24-inch to 10-inch diameter. Approximately 100 feet inland from shore, the incoming piping includes valves for system isolation, check valves to maintain a flooded pipe, overflow/pressure relief appurtenances, and fittings necessary to direct the pipe to the WTP. From this valve assembly, the 10-inch diameter ductile iron pipe continues an additional 200 feet to the entrance at the WTP.

Raw water quality is typically good throughout the year at this location. Annually, raw water temperature ranges between 5.0 - 10.0 degrees C, pH ranges between 6.9 - 7.5, and turbidity ranges between 0.1 - 1.4 NTU. Turbidity fluctuates seasonally and tends to increase during the spring and fall stormy season, or during periods of extended wet weather. A summary of daily water quality information for 2018 and 2019 is provided in Appendix B.

The intake piping is inspected every 5 years, was most recently inspected in 2017 by H_2O Solutions, LLC.

Raw Water Pumps

Inside the WTP, two raw water pumps move raw water from the intake piping, past the chemical injection point, and up to the flocculation tank. Both raw water pumps are located below grade level in a pit adjacent to the flocculation tank. The pumps are accessed by a single, vertical, ladder. The pump pit is covered with aluminum grating and clear plastic sheeting to prevent small objects from falling into the pit.

Both Raw Water Pump 1 and Raw Water Pump 2 are horizontal, centrifugal pumps. The pumps are driven by 20 hp, 3-phase, 1,180 rpm, totally enclosed, fan cooled (TEFC) variable speed motors. Each pump is capable of providing up to 1,400 gpm at 25 feet total dynamic head (TDH). The pumps are operated on an alternating lead/lag schedule and their operational motor speed is controlled by their variable frequency drive (VFD) motor starter which is currently set to deliver approximately 700 gpm each. Both Raw Water Pumps were installed in 1992. In 2002, the District replaced the motor on Raw Water Pump 1. Both pumps are maintained regularly according to the manufacturer's recommended schedule, and performance issues with the pumps are addressed as required.

Raw Water Flow Meter

The raw water flow meter is located at grade level downstream from the raw water pumps. The flow meter is a 10-inch diameter Toshiba LF400 Series magnetic flow meter with an integral transmitter, local display, and flanged connections. The display shows both the instantaneous flow as well as the cumulative total flow through the meter. The flow values are also displayed on the WTP Supervisory Control and Data Acquisition (SCADA) system and are recorded for trending and tracking purposes. In 2020, the District purchased a replacement raw water flow meter, which is stored onsite and can be installed quickly if the existing raw water meter should fail.

Flocculation

Once through the raw water pumps, water proceeds through approximately 30 feet of piping before entering the flocculation tank. The flocculation tank is a painted, welded steel tank with a diameter of 13.5 feet, a height of 8.6 feet, and a nominal volume of 9,000 gallons. The tank is divided into three equal sections and water flows through the tank in an over-under-over pattern. The tank contains one access ladder welded to the outer sidewall. The tank is coated on both the interior and exterior surfaces; however, the specific coating system components are not known.

The flocculation tank is equipped with a high level float. As the water level rises within the flocculation tank, the float activates and de-energizes the raw water pumps, thus stopping flow to the tank and preventing an overflow condition. This high alarm signal is also relayed to the WTP SCADA system which alerts the WTP staff that the system requires inspection.

The flocculation tank can also provide priming water for the raw water pumps should the intake check valve fail or leak. If needed, water is piped from the flocculation tank down to the intake side of the raw water pump to ensure that the intake piping remains full prior to raw water pump startup. Without this piping connection, the intake piping could empty; and the raw water pumps would lose prime, which will lead to excessive wear and in-rush electrical currents during startup. The WTP staff recently replaced the intake check valve and no longer uses this priming piping; however, the piping is maintained so that it is available for future use.

Rapid Rate Filters

Water leaves the flocculation tank via 12-inch diameter ductile iron piping and is conveyed by gravity to the equalization trough. At the trough, water is evenly distributed among the four filter units. Each filter unit consists of an inlet trough, filter media, an underdrain system, surface wash and backwashing equipment, and filtered water piping.

Filter media includes anthracite, sand, and garnet (Table 1-3). Each filter has a surface area of approximately 63 square feet, a depth of 10 feet, and a nominal media volume of 273 cubic feet. At a typical operational flow of 700 gpm (~1 mgd), the surface loading rate for all four filters is 2.8 gpm/sf, which is well within the maximum allowable rate listed by the Washington State Department of Health (DOH) for a multi-media filter (6 gpm/sf). The surface loading rate using only two filters is 5.55 gpm/sf (700 gpm/126 sf), which suggests that the WTP can operate at the typical flow rate with only two filters in service.

Filters 1 and 2 are contained within a common welded and coated steel tank that rests on a concrete equipment pad. Filters 3 and 4 are contained within a marine grade aluminum tank that rests on a concrete equipment pad.

Typically, the WTP operates for 10 to 16 hours each day, and longer during warm summer months when water demand is high.

TABLE 1-3

Sudden Valley WTP Media Filter Summary

Parameter	Value
Type	Gravity, Direct Filtration
Filter area (sf, total)	252 (4 each at 63 sf)
Rate of Filtration @ 700 gpm (gpm/sf)	2.8
Rate of Filtration @ 1,000 gpm (gpm/sf)	4.0
Rate of Filtration @ 1,390 gpm (gpm/sf)(1)	5.5
Rate of Filtration @ 1,526 gpm (gpm/sf)(2)	6.0
Rate of Backwash (gpm/sf)	20.6
Design Media Depth (inches)	
#1A Anthracite (1.0 mm - 1.1 mm)	18"
F16 Sand (0.45 mm - 0.55 mm)	9"
#50 Garnet Sand (0.28 mm - 0.38 mm)	4.5"
#12 Garnet Gravel (1.46 mm - 1.56 mm)	4.5"
#3 Gravel (0.375" - 0.1875")	3"
#2 Gravel (0.75" - 0.375")	3"
#1 Gravel (1.50" - 0.75")	10"

(1) Value is based on WTP rated capacity of 2.0 mgd.
(2) Value is based on current South Shore Water System Water Right (Table 1-1).

During normal filter operation, water is distributed evenly to all four cells and flows through the filter media and into the respective underdrain chambers. As it passes through the filter media, flocculated sediment and small particles are trapped by the media. As additional particles are trapped on the surface of the filter, both the headloss through the filter media and the turbidity of the filtered water increases. Per the District's normal operating procedures, each filter bed is backwashed each day prior to operating the filters.

Once through the filters, water flows through the filter discharge piping to the clearwell. The discharge piping at each filter consists of isolation valves, flow control valves, chemical injection fittings, and flow meters in order to ensure consistent operation.

During the backwash of a filter cell, water from the distribution system served by the District 7 Reservoir flows *upward* by gravity through the filter at approximately 1,300 gpm (20.6 gpm/sf). The backwash flowrate is measured by a magnetic flow meter on the backwash line located on the south wall of the WTP. At this flowrate, the media bed is fluidized to remove the accumulated sediment particles and the particle laden backwash water flows into the filter cell waste trough and into the backwash storage basin. Each filter also includes a surface wash system that consists of two supply arms with up to nine nozzles on each side (18 total nozzles). The pressure and flow of backwash water through these nozzles causes the arms to rotate and disperse spray that agitates the media surface. Spray from these nozzles only occurs during backwash and helps to prevent the formation of mudballs on the media bed. The complete backwash sequence includes the following steps:

- 4.0 minutes of surface wash only;
- 2.5 minutes of surface wash and filter backwash;
- 5 minutes of filter backwash;
- up to 20 minutes settling, equalization, and drainage; and
- 15 minutes of filter to waste.

After this backwash sequence, the filters return to normal operation and water flows through the filters and into the clearwell. According to WTP staff, the entire backwash process for all four filters typically takes 120 to 160 minutes.

The backwash storage basin is located underground between the WTP building and the finished water pump building. The basin has a volume of approximately 16,000 to 17,000 gallons and provides an opportunity for settling of the removed particles. Backwash water within the basin is pumped via one of two submersible pumps several times as part of each backwash sequence. The backwash water is pumped to the residential sewer system where water proceeds to the City of Bellingham's Post Point Wastewater Treatment Plan (WWTP) for treatment. Overflow from the backwash basin is directed back to Lake Whatcom.

Clearwell

Once through the media filters, water flows through 6-, 8-, and 10-inch diameter piping to the clearwell. The clearwell is a concrete basin below the floor slab of the WTP and is accessed via a 24-inch access hatch in the clearwell's northwest corner. The access hatch is located very near the entrance to the WTP and contains a gasketed lid designed to prevent intrusion of liquids or debris.

Based on record drawings, the footprint of the clearwell is 439 square feet, which at the maximum operating depth of 6.25 feet results in a volume of 20,520 gallons.

The WTP utilizes two identical transfer pumps to move water from the clearwell to the chorine contact basin and pump operation is rotated for each pumping cycle. Each transfer pump is a 20 hp, 60 Hz, 1,760 rpm, Peerless vertical turbine pump with a listed capacity of 1,400 gpm at 43 feet TDH. The pumps operate at full speed and flow (1,400 gpm), and cycle on and off depending on the water level within the clearwell.

The clearwell contains a pressure transducer that reads and records the water level. When the water level within the clearwell rises to the upper setpoint, one transfer pump will energize. There is a 3-foot operating range within the clearwell based on the upper water level setpoint of 6'-3" and the lower water level setpoint of 3'-3". If the high alarm water level setpoint (7'-2") in the clearwell is reached, the filter system will shut down to avoid additional filling of the clearwell. High level indication/alarm is provided by an Autocon Selectrol 3500 mercury switch. The clearwell also contains an overflow pipe with an elevation of 8'-0" above the floor. This overflow pipe will deliver water by gravity back to Lake Whatcom.

Chlorine Disinfectant Injection System

The WTP utilizes a gas chlorine injection system to provide disinfectant chemicals to the filtered water. This disinfectant provides the necessary chlorine residual to meet the concentration and contact time (CT) requirements set forth by DOH. Commercially prepared chlorine gas is delivered to the WTP in 150-pound cylinders and stored within a separate room inside the WTP. Two active cylinders and two spare cylinders are maintained onsite at all times. The active cylinders are stored on a scale, and specialized gas regulators and flow meters provide the desired gas flow. The chlorine supply to Filters 1 and 2, Filters 3 and 4, and the flocculation tank are all controlled separately using individual flow regulators and meters.

Chlorine gas is mixed with a sidestream of filtered water creating a hypochlorite solution that is then injected to the piping between the filter units and the clearwell. Additionally, a small amount of chlorine solution is injected to the first chamber of the flocculation tank, which helps prevent algal growth on the filter media. Because the WTP operates at a single flow rate, the chlorine system is adjusted manually as needed and does not include automated flow control.

The chlorine room at the WTP contains two chlorine gas sensors, which will warn operations staff of a potential leak so that appropriate ventilation and safety procedures can be followed.

Chlorine Contact Basin

Filtered water is pumped from the clearwell via the transfer pumps to the chlorine contact basin (CCB). The CCB was constructed in 1994 and is a circular, baffled, welded steel reservoir located adjacent to the Finished Water Pump Building. Design information for the CCB is summarized in Table 1-4.

TABLE 1-4

Sudden Valley WTP Chlorine Contact Basin Design Criteria Summary

Parameter	Value
Year Constructed	1994
Type	Welded steel
Shape	Circular
Height (ft)	25
Diameter (ft)	40
Base elevation (ft)	336.0
Overflow elevation (ft)	360.0
Volume (gal)	225,000
Gallons per foot	9,400
Inlet/Outlet	10-inch Perforated Riser

Water enters the CCB via a diffuser riser at one end and flows in a serpentine fashion between three steel baffles to the outlet diffuser. The inlet diffuser consists of a 10-inch diameter PVC pipe with 25, 2-inch diameter holes drilled at approximately 9.25-inches on center. The outlet diffuser riser consists of a 10-inch diameter PVC pipe with 50, 2-inch diameter holes drilled at approximately 9.25-inches on center. These risers act to promote consistent flow throughout the full depth of the water column from the inlet to the outlet. The CCB has both exterior and interior coatings. The CCB is inspected every 5 years, was most recently inspected in 2017 by H_2O Solutions, LLC.

The CCB utilizes a single, mercury level switch for high level alarm within the tank; however, the District plans to install a redundant alarm sometime in 2020. The switch communicates the alarm signal to the WTP PLC, which relays the alarm to WTP staff. Water level (depth) is measured using a pressure transmitter. Access to the CCB is provided by two 36-inch diameter manways located on opposite sides of the tank at ground level, as well as a 24-inch access hatch on the roof of the tank.

In 2016, Gray & Osborne conducted a formal tracer analysis on the District's CT system, which included the chlorine gas injection system and CCB. Surface water systems in Washington must provide a minimum level of CT to protect water quality and ensure disinfection of treated water. CT is the product of the chlorine residual (C) and the residence time within the contact basin (T). The residence time used for calculating CT is a function of the flow through the basin, minimum volume within the contact basin, and the baffling efficiency of the basin. The study conducted on the CCB at the WTP in 2016 showed a baffling efficiency of 0.3, which is less than the theoretical value of 0.7 that the WTP had previously been using. As a result of the tracer study, the WTP staff have made several operational changes in order to ensure that they consistently provide suitable disinfection of treated water leaving the WTP. One of these operational changes was to maintain a maximum allowable flow through the plant of 1,000 gpm while a second operational change was to increase the target chlorine residual dose from 0.8 to a minimum of 1.0 mg/L.

Finished Water Pumping

Four finished water pumps pump water from the CCB to either the Division 7 or the Division 22 Reservoirs. These pumps are energized and/or de-energized based on the water levels within these reservoirs. The pumps are located in the Finished Water Pump Building adjacent to the CCB. This building also contains electrical equipment for the pumps, a small laundry facility, network and surveillance equipment, as well as the auxiliary generator for the WTP. The building also contains two adjoining public restrooms (mens and womens) available for use by beach/park patrons. At the time of our onsite assessment, the restrooms had been closed for the winter and were inaccessible.

The four pumps are served by a common 10-inch intake header with two pumps providing flow to the Division 7 Reservoir and two pumps providing flow to the Division 22 Reservoirs. The Division 7 Reservoir pumps are 100 hp, 60 Hz, 1,780 rpm, vertical centrifugal pumps with a design point of 700 gpm at 445 feet TDH. The Division 22 Reservoir pumps are 150 hp, 60 Hz, 1,780 rpm, vertical centrifugal pumps with a design point of 700 gpm at 608 TDH. Each pump is connected to a discharge flow control valve that regulates the discharge flow and pressure to the distribution system. Flow from each set of pumps is monitored by a flow meter. Instantaneous and total flow are measured by the meter and displayed and recorded on the WTP's SCADA system.

Chemical Dosing Systems

The WTP utilizes two chemicals in its treatment system in addition to chlorine disinfectant. The first is potassium aluminum sulfate (alum), which is a common coagulant used in water treatment processes. Alum is stored within a 1,900-gallon polyethylene storage tank with a diameter of 6.2 feet and a height of 8.5 feet. The storage tank supplies a diaphragm chemical metering pump, which injects the alum in to the raw water piping upstream of the flocculation tank. The alum chemical feed pump is a Pulsatron E Series with a listed capacity of 44 gpd and a maximum pressure of 100 psi.

Alum is delivered by a commercial vendor approximately every 3 months. The vendor connects a hose from the delivery vehicle to the tank inlet camlock fitting and pumps the alum solution into the tank.

The second chemical utilized at the WTP is soda ash for pH control. Soda ash is mixed and stored in a 1,200-gallon, open top, welded steel tank with a diameter of 5.6 feet and a height of 6 feet. The tank includes a shaft driven mixer as well as a polycarbonate hinged access lid. WTP staff must prepare the soda ash solution as needed by manually adding 50-pound bags of dry soda ash to the tank. Bags of dry soda ash are delivered to the WTP where staff transfer the bags to a rolling cart which is used to transport them to their various temporary storage locations within the WTP. When ready to use, the staff haul the bags up a small platform and manually dump them into the soda ash storage tank. Filtered water is then added to the tank in the appropriate volume to create the working solution. This filtered water supply includes a totalizing flow meter used to track the flow. Approximately 16 to 20 bags of soda ash are mixed approximately every 11 to 12 days to create the dosing solution. Soda ash is injected to the filtered water between the filters and the clearwell.

Soda ash solution is delivered from the storage tank to the injection location via a Pulsatron E Series diaphragm metering pump with a listed capacity of 600 gpd and a maximum pressure of 30 psi. The chemical metering pump is located near the top level of the soda ash storage tank in order to reduce potential for crystallization within the check valve and to reduce the risk of siphoning.

Both the soda ash and alum feed pumps are manually calibrated on a daily basis using a graduated cylinder near the injection location. Based on the daily calibration, the dose rate from the pumps is modified and/or the WTP staff performs maintenance on the pumps/piping to address flow issues.

Auxiliary Power Systems

The WTP utilizes a 450-kW diesel-powered auxiliary generator to provide standby power in the event of a loss of power to the WTP. This generator also provides auxiliary power to the Afternoon Beach Sewer Pump Station, which is located approximately 300 feet northwest of the Finished Water Pump Building. The generator, installed in 2014, is located inside the Finished Water Pump Building and diesel fuel is provided to the tank via an above grade diesel storage tank located between the Finished Water Pump Building and the CCB. The generator can provide power for the complete WTP facility and sewer pump station for up to 96 hours.

Instrumentation

The WTP uses various instruments and equipment to monitor and control the overall treatment process. A description of the key components used by the WTP is provided below.

<u>Flow Meters</u>

Information on the flow meters utilized at the WTP are summarized in Table 1-5.

TABLE 1-5

Sudden Valley WTP Flow Meter Summary

Meter Name	Location	Type[(1)]	Make/Model
Raw Water	Grade level near WTP entrance	Magnetic, FL	Toshiba LF400
Filter Outlet	Downstream of each filter outlet	Magnetic, FL	Badger Primo
Backwash	Vertical pipe on south wall of WTP	Magnetic, FL	Badger Primo
Division 7 Finished Water	Finished water pump building	Magnetic, FL	Endress & Hauser Promag 500
Division 22 Finished Water	Finished water pump building	Magnetic, FL	Badger Primo Advanced U

(1) FL = flanged connections, MJ = mechanical joint connections, TD = threaded connections.

<u>Turbidimeters</u>

The WTP staff recently replaced all of their existing HACH 1720E inline turbidimeters with new HACH 5300 laser turbidimeters in 2018 and 2019. As required by DOH, turbidity is measured for the raw water, at each filter, and for the combined filter effluent. These data are displayed at the SCADA system and are also tracked and logged for reporting purposes.

<u>Chlorine Analyzers</u>

The WTP staff replaced their previous chlorine analyzers with HACH CL17 analytical equipment in 2018.

<u>Temperature/pH Analyzers</u>

pH and temperature are measured using standard probes procured from HACH. Both raw and finished water pH and temperature are measured via a flow-cell and probe assembly. The equipment is calibrated and maintained on a regular basis.

<u>Streaming Current Monitors</u>

The WTP maintains a streaming current monitor which is designed to assist with determining the coagulant dose prior to flocculation. WTP staff use the streaming current monitor to identify large scale changes in water chemistry that may impact coagulant dose, but they do not use the equipment to optimize their coagulant dose on a daily or weekly basis. The system collects a sample of raw water after coagulant addition and typically, the streaming current monitor is used only to identify an overfeed condition.

<u>Pressure Transducers</u>

The WTP utilizes a Keller Level Rat pressure transducer sensor within the clearwell.

The CCB also utilizes a pressure transducer to measure the water level (depth) within the tank.

<u>Float Switches</u>

The WTP utilizes float switches within the flocculation tank and mercury based level switches within the clearwell and the CCB. These switches provide a high alarm in the event that the water levels in the tanks rise above the high level setpoint. These switches were installed in 1994 with construction of the WTP.

CHAPTER 2

WTP CONDITION ASSESSMENT

INTRODUCTION

On, February 12, 2020, engineers from Gray & Osborne visited the Sudden Valley WTP to perform a condition assessment of the existing facilities. Russell Porter P.E., Aaron Pease P.E., Myron Basden P.E./S.E., Keith Stewart P.E., and Perry McKay from Gray and Osborne met District WTP operator Kevin Cook and electrician Ken Zangari onsite at the WTP.

Mr. Cook described the treatment equipment and provided operations and technical information on all facets of the treatment plant. After becoming familiar with the WTP facilities, the assessment team split up and performed assessments on all of the facilities with a specific focus on their area of expertise. The following sections include a summary of the issues identified by each discipline at our condition assessment.

TREATMENT/PROCESS CONDITION ASSESSMENT

The process condition assessment included all of the components and processes used to generate potable water at the WTP including equipment, operations, maintenance, chemicals, and monitoring and controls. Information was collected from on-site observations, discussions with operations staff regarding system performance, and previous experience at the WTP through the completion of other projects. The treatment equipment was described previously, and the assessments below correlate to the areas described in these previous sections.

WTP MAIN BUILDING

Intake Piping

- The intake piping is inspected every 5 years and was most recently inspected in 2017 by H_2O Solutions, LLC. The inspection revealed no significant damage or deterioration of intake structure and piping between the intake and the shoreline. Furthermore, the report had no recommendations for additional modifications.

- Check valves between the shoreline and the WTP have recently been modified/replaced and are in good condition.

- Inspection of the below grade raw water intake piping between the shoreline and the WTP was not included in this assessment; however, WTP staff believe that the piping is in good condition.

- Within the WTP Main Building, raw water piping is coated 10-inch diameter ductile iron materials and overall is in good condition.

  While the total installed raw water pump capacity is 2,800 gpm (1,400 gpm per pump), the typical and maximum flow rate through the filters is 700 gpm, and 1,000 gpm, respectively. The fluid velocities within the 10-inch raw water piping at 700 gpm and 1,000 gpm are 2.9 feet per second (fps) and 4.0 fps, respectively. Both of these values are within the recommended velocity range for municipal treatment systems (2 to 8 fps) and, as such, appear to maintain sufficient capacity. To maintain fluid velocities below the recommended maximum value of 8.0 fps, flow through the intake piping should not exceed 1,950 gpm. This value is above the Sudden Valley water right value of 1,526 gpm and as such, it is doubtful that the raw water intake piping would ever need to be upsized to serve the current facility.

Raw Water Pumps

- Both raw water pumps were installed in 1992 and although the pumps are in good condition, function as designed, and the motor for Raw Water Pump 1 was replaced in 2002, the pumps are approaching the end of their useful life.

- The floor in the raw water pump pit does not slope to the sump in all directions and allows for localized ponding and sediment accumulation. The presence of these sediments, especially when wet, creates slippery and dirty conditions within the pit.

- Although a supplementary raw water connection is available at grade level downstream of the existing raw water pumps, the WTP does not possess a suitable auxiliary raw water pump in the event that both raw water pumps are out of service.

- Signage indicating that the raw water pump pit is considered a confined space is not currently provided.

  Because of the potential for entrapment and the single ingress/egress ladder, the raw water pump pit should be considered a confined space and confined space entry procedures should be followed whenever entering.

- Lowering piping, fittings, or equipment into the pump pit is difficult due to restricted access in that area. No portable hoist was observed, and access for a mobile hoist is restricted by existing piping and chemical storage. The lack of a hoist will make lowering heavy piping and fittings into the raw water pit difficult.

Raw Water Flow Meter

- The existing raw water flow meter has a listed range between 100 to 2,000 gpm and has sufficient capacity to operate under the maximum allowable flows through the WTP.

- The raw water flow meter is different from the remaining flow meters utilized in the WTP, which increases the number of spare and replacement parts required for maintenance.

- The meter is old and no longer supported by Toshiba nor is this meter commonly used in the municipal surface water treatment industry.

Flocculation

- The flocculation tank contains piping directly above the tank walls and interior space which will make removal/modifications to this piping and/or the flocculation tank difficult. Corrosion was noted on this piping and its current location may promote corrosion on the upper lip of the flocculation tank wall.

  One of these items is a tube-style high level alarm and sensor. This style of equipment is old and prone to sticking.

- Access to the full circumference of the flocculation tank is poor and restricted by the chemical dosing systems, raw water inlet pipe, and overhead water piping and electrical conduit.

- The flocculation tank appears to be undersized for the typical operational flow.

  Flocculation basins are typically designed using two criteria: hydraulic retention time and mixing energy. Assuming a sidewater depth of 7.5 feet, the operational volume of the flocculation basin is approximately 8,000 gallons. Given the typical flow through the WTP of 700 gpm, this results in a hydraulic retention time of 11.4 minutes (8,000 gallons/700 gpm), which is significantly lower than the design recommendation of 30 to 45 minutes for baffled channel contact flocculation basins (*Integrated Design and Operation of Water Treatment Facilities, S. Kawamura, 2000*). To achieve the recommended retention time of 30 minutes, flow through the flocculation tank should be reduced to 270 gpm or the flocculation tank volume should be increased to 21,000 gallons.

The mixing energy is calculated using the hydraulic retention time and the headloss through the basin. Assuming a range of headlosses between 0.5 to 2.0 feet, the mixing energy is between 37 - 74 s^{-1}, respectively. The recommendation for mixing energy in baffled channel contact flocculation basins is 55 - 10 s^{-1} (*Kawamura, 2000*). As such, it appears that the existing flocculation tank at the WTP provides more mixing energy than recommended for ideal flocculation of entrained particles. Providing extra mixing energy will reduce the effectiveness of floc creation prior to filtration.

Rapid Rate Media Filters

- Discussions with the WTP staff suggest that the backwash sequence is successful at cleaning the filters. There is no apparent long-term decrease in filter run times, and the filtration performance appears to be consistent immediately following a backwash. During our site visit, two backwash sequences were observed and our observations agree with WTP's description of the backwash system and its performance.

- Access to the filter discharge piping and fittings is limited and restricted due to the presence and the location of the equalization trough.

- Access to each filter platform is provided by only a single, vertical ladder. This represents a safety risk in the event that the existing ladder becomes obstructed or blocked.

- Media depth, consistency, and particle size breakdown were not investigated during the assessment. Discussions with WTP staff indicate that the filter media performance is good. WTP staff add additional anthracite on an annual basis to bring the total depth of anthracite (top layer) back up to the original design depth (Table 1-3).

- The underdrain system was not accessible during the WTP assessment; however, WTP staff believe that the underdrain system is in good condition.

- Discussions with WTP operations staff indicate that typical filter run times have remained stable for several years.

  Backwash flow and volume appears to be within the design range identified in the O&M manual. The backwash cycle appears to sufficiently remove trapped sediments.

Typical mixed media backwash flows are between 10 to 20 gpm/sf (*Integrated Design and Operation of Water Treatment Facilities, S. Kawamura, 2000*). At the WTP, current backwash flow is approximately 1,300 gpm, or 20.6 gpm/sf (1,300 gpm/63 sf), which is at the maximum recommended range noted above.

The backwash water is currently stored in a wastewater holding tank adjacent to the WTP. When the tank is full, the wastewater is pumped to the gravity sewer by up to two submersible pumps and then is conveyed to the City of Bellingham Post Point WWTF for treatment. This process is expensive and cumbersome for the District and their staff. The District has indicated that costs for backwash disposal to the WWTF have increased in recent years and has expressed a desire to modify this system if possible to minimize the volume of water sent to the City's municipal sewer system.

- The maximum allowable filter rate for multi-media direct filtration units is 6.0 gpm/sf. Given the total filter area for all four filters of 252 sf, and a typical flow rate of 700 gpm, the current filtration rate at the WTP is approximately 2.8 gpm/sf, which is below the maximum allowable value. Using the existing filter units, the WTP could filter up to 1,510 gpm – which is very nearly the current Sudden Valley instantaneous water right of 1,526 gpm (Table 1-1) – and still meet the maximum filtration rate requirement.

  WTP staff have indicated that they are interested in investigating the possibility of utilizing a mono-media filtration system in an attempt to improve filter run times. This may be feasible; however, it should be noted that the maximum allowable filtration rate (6.0 gpm/sf) would be reduced to 3.0 gpm/sf per Washington Administrative Code (WAC) 246-290-654. Given the current filter surface area, this would reduce the maximum filtration flow through the WTP to 755 gpm, which is above the current typical operational flow, but below the historical maximum operational flow of 1,000 gpm. This reduced flow rate also does not appear to be large enough to meet projected ADD and MDD for the South Shore System as shown in Table 1-2.

Clearwell

- The clearwell appears to be in good condition, although a thorough investigation was not possible as part of this assessment since the WTP was in operation during the site visit.

- The existing transfer pumps appear to be in good condition. However, the pumps were installed in 1992, are nearly 30 years old, and are approaching the end of their useful life.

- There is staining on the concrete walls within the clearwell. The presence of stains can hide other, more serious defects and detracts from the aesthetic appearance of the clearwell.

- The single access hatch represents a source of contamination to the filtered water. The hatch is adjacent to the path travelled by soda ash chemicals and is a potential source of contamination for spilled liquids.

- The hatch represents a trip hazard for WTP staff and is not highlighted or indicated by high visibility colors.

- The clearwell is considered a confined space; however, no signage or other information noting the access restrictions was noted in the vicinity or on the lid.

- Confined space entry equipment was not noted onsite.

Chlorine Disinfectant Injection System

- The chlorine disinfection system appears to be functioning as desired. Piping, tubing, and equipment appear to be in good condition.

- Gaseous chlorine presents some level of risk to WTP operations staff in the event of a leak, and a significant safety risk in the event of a fire or explosion.

  While the existing chlorine gas disinfection facilities likely meet building code requirements in place at the time of their construction, the current chlorine gas storage facilities do not appear to meet current building code requirements.

  The 2015 International Building Code defines the Maximum Allowable Quantities of hazardous materials that can be stored or used within a facility without triggering specific design and construction criteria. Gaseous chlorine is considered both an oxidizing gas (a physical hazard) and a toxic gas (a health hazard) and as such, the maximum allowable quantity is 150 pounds as a liquefied gas, or 810 cubic feet at NTP as a gas (both of which correspond to a single 150-pound cylinder). Several exceptions allow this maximum allowable quantity to be increased by 100 percent in buildings equipped with an approved automatic sprinkler system and by an additional 100 percent when approved storage cabinets are used. Therefore, in a building with a sprinkler system and if all the chlorine gas is stored within approved cabinets, a total of 600 pounds of chlorine gas, or four 150-pound cylinders can be used before triggering a hazardous, H-3 occupancy. A building with an H-3 occupancy is required to have several additional safety and building protection systems including additional planning documents, ventilation system requirements, gas cabinets, smoke detection and alarm systems, emergency power supplies, and emergency alarm systems, among other requirements.

Any significant modifications to the chlorine disinfectant injection system would require that the system be modified to meet current building code requirements for the use and storage of chlorine gas.

Additional code requirements regarding chlorine use and storage are provided in Appendix E.

- Flow directions and labels for chlorine flow meters are not sufficiently labeled which may cause confusion for staff.
- Spare chlorine cylinders are not labeled sufficiently as spares, or as empty/full which may cause confusion for staff and insufficient gas redundancy.
- The coating system in the chlorine room has failed in areas and shows signs of significant fatigue in other areas.
- The spare gaseous chlorine cylinders have only one safety restraint chain near the top of the cylinder. Two chains, one near the top and another near the bottom should be provided for cylinder storage and security.
- Active gaseous chlorine cylinders are secured with a single, loose chain to the scale stanchion, which is bolted to the scale, which in turn is bolted to the floor. This arrangement will not sufficiently secure the active cylinders during a seismic event.

Chemical Dosing Systems

- Material Safety Data Sheets (MSDS) files were not inspected during this assessment. MSDS files were recently updated and are located above the existing laboratory workspace.
- The existing chemical storage facilities for alum and soda ash do not appear to violate the maximum allowable chemical quantities identified by International Building, Fire, or Mechanical Codes.

- The alum storage tank is old, beyond its useful life of 15 to 17 years, and shows signs of degradation.

- Alum is provided by a commercial vendor, and WTP staff have noted that this process is cumbersome and requires two individuals to prevent overflow since there is no direct line of sight between the parking lot and storage tank.

- Alum tank does not contain electronic level sensing equipment which can help staff identify when additional solution is needed.

- Alum dosing is manually calibrated on a daily basis, which is cumbersome and messy for WTP staff. Calibration is performed at the injection location requiring fittings to be loosened and reconnected each time a calibration is performed.

- The WTP maintains sufficient spare pumps/parts for the alum diaphragm metering pump.

- The soda ash storage tank is mislabeled as "Caustic Soda" (Sodium Hydroxide).

- The soda ash storage tank appears to be in good condition and does not show significant signs of coating damage or fatigue.

- The soda ash mixer appears to be in poor condition, is highly corroded, and is likely beyond its useful life.

- Soda ash solution must be prepared manually by WTP staff, and bags of soda ash must be moved at least three times between delivery and mixing. This process is cumbersome and exposes the staff to chemicals and heavy lifting requirements.

- The soda ash tank can only be accessed via a single, small access platform. This platform and its coating system show signs of fatigue. The platform limits access to the soda ash tank and other facilities due to its size and location.

- The location of the soda ash system likely contributes to corrosion and degradation of the electrical equipment within the WTP building.

Instrumentation

- The WTP utilizes several various flow meters for flow measurement. This makes maintaining spare parts more difficult and requires specialized knowledge for each type of meter.

- The WTP does not maintain spare flow meters for each type of unit utilized, which reduces the overall WTP reliability in the event that one of the meters fails.

- The WTP recently upgraded to HACH TC5300 turbidity meters units for measurement of raw, filtered, and finished water turbidity. The staff is pleased with the level of performance and the ease of maintenance associated with this equipment and the equipment is in good condition.

- The WTP recently upgraded to HACH CL17 chlorine analyzers. The staff is pleased with the level of performance and the ease of maintenance associated with this equipment and the equipment is in good condition.

- The WTP utilizes HACH equipment for temperature and pH monitors. The WTP monitors the temperature and pH of raw water, filtered water, and finished water. The staff is pleased with the level of performance and the ease of maintenance associated with this equipment and the equipment is in good condition.

- The WTP maintains streaming current monitoring equipment but does not currently utilize this equipment for coagulant/flocculant optimization. The staff is pleased with the level of performance and the ease of maintenance associated with this equipment and the equipment is in good condition.

- The existing clearwell level switch is out of date and utilizes mercury, which is not suitable for use with potable water.

FINISHED WATER PUMP BUILDING

Finished Water Pumping

- The finished water pumps appear to be in good condition. However, the pumps were installed in 1992, are nearly 30 years old, and are approaching the end of their useful life.

- The District does not currently maintain spare finished water pumps and/or motors, which reduces the overall level of redundancy if one or more of the pumps or motors should fail.

- The WTP cannot run more than two finished water pumps concurrently. Discussions with the WTP staff suggest that this is due to the high in-rush and amperage draw for the finished water pumps.

- The finished water pumps have not been flow tested within the last 10 years to verify their performance.

- Access to all sides of each finished water pump is somewhat restricted by the piping arrangement within the building.

- Pressure gauges have not been tested or certified within the last 5 years, which reduces the confidence in their ability to accurately read the system pressure.

CHLORINE CONTACT BASIN

- A full and complete investigation of the CCB was not conducted as part of this assessment because the WTP was in operation during the site visit.

  The tank was most recently inspected by certified divers in 2017 by H_2O Solutions, LLC. The inspection revealed no significant damage or deterioration for the suction and its components. Furthermore, the report had no recommendations for additional modifications.

- As mentioned previously, the District recently completed a tracer study investigation on its CT system – which included the CCB. The results of this investigation found that the theoretical baffling efficiency (0.7) used to estimate the CT for the system was higher than the empirically determined baffling efficiency of 0.3.

  As a result of that study, DOH set the maximum allowable flow through the WTP at 1,000 gpm. Since that directive, WTP staff have reduced the flow through the WTP to 700 gpm and increased the target chlorine residual value to a minimum of 1.0 mg/L. These changes have worked well and help ensure that the WTP provides sufficient disinfection for its treated water; however, this reduced operational flow will inhibit the WTP's ability to meet projected ADD and MDD demands for the South Shore water system

STRUCTURAL CONDITION ASSESSMENT

The structural assessment included the WTP Main Building, the Finished Water Pump Building, items within these two buildings, and the CCB. Information was collected from on-site observations as well as available original drawings for the existing structures. The structural assessment included a review of the condition of structural members, notes of any items not complying with current building code, preliminary seismic review, and potential structural modifications that may provide benefit for operation of the plant. The building code used for this evaluation is the 2015 International Building Code (IBC). The preliminary seismic evaluation was completed using Tier 1 checklists from ASCE 41 *Seismic Evaluation and Retrofit of Existing Buildings*.

WTP MAIN BUILDING

The WTP Main Building is a one-story building consists of precast concrete tee beams overlain by 4-inch concrete topping slab at the roof. The tee beams are supported at the perimeter of the building by cast-in-place concrete walls. The building is built into a hillside so its walls are partially to fully buried below grade except at the entrance on the north side of the building. The north wall with the entrance is a glass and metal framed "storefront" façade. According to record drawings, the roof structure has 3-ply built up roofing, overlain by 2 inches of sand, overlain by up to 18 inches of soil fill. Below are specific items noted during the assessment.

- In general, the concrete structure is in good condition. No major cracks or spalling were found. In isolated locations, reinforcement on the underside of the precast concrete tee beams is exposed and shows signs of minor corrosion that does not appear to have impacted the strength of the beams.

- According to record drawings, the topping slab over the tee beams is only 2-inches thick at the perimeter. It increases to 4-inches thick at the center of the roof to provide an external slope to promote drainage. The flanges of the tee beams are also relatively thin, tapering down to 1.5-inches thick at the ends of the flange. While the flanges and topping slab could not be directly observed in the field due to the presence of plant matter and soil cover, it appears all components of the structure conform with the record drawings. According to the original record drawings, the roof was designed for 40 pounds per square foot (psf) live load and a maximum soil depth of 18 inches. Based on our investigation of the record drawings, the roof is not expected to be capable of supporting loads from added items such as equipment or tanks without installing structural retrofits.

- Miscellaneous structural steel supports such as pipe, conduit, and equipment supports are corroded. In some cases, the corrosion is severe enough that the strength of the support has been reduced.

- There are several steel tanks inside the building. The steel is coated with paint and in some areas the paint has failed leading to corrosion of the steel. Specifically, corrosion was noted on the flocculation tank, the distribution trough, and Filters 1 and 2. There is also some minor signs of corrosion on the roof of the clearwell. The corrosion does not appear to be advanced enough to affect the structural integrity of the tanks.

- Various segments of piping and its associated fittings show minor signs of corrosion. This corrosion tends to be located at joints, fasteners, or edges which is typical for piping within a moist environment. The observed level of corrosion does not appear to have affected the integrity of the piping and/or fittings.

- A preliminary Tier 1 seismic evaluation was performed for the building. The Tier 1 evaluation is a checklist that allows quick screening of the building for significant seismic deficiencies. For the purpose of this evaluation, the building is categorized as a Type C2 with concrete shear walls and stiff diaphragm. The checklist did not find any major seismic deficiencies in the building, with only one minor item flagged by the checklist, namely the vertical rebar anchoring connection at the perimeter walls. A copy of the checklist is provided in Appendix C.

- Many of the interior tanks and miscellaneous items supported from the building structure do not appear to have adequate seismic anchorage and/or bracing. These items are at risk of experiencing excessive movement and damage during a design-level earthquake. Interior tanks appear to be unanchored to the floor. Piping connections to the tanks do not appear to have flexible connections, which puts them at risk of damage if tanks move laterally during a design-level earthquake.

FINISHED WATER PUMP BUILDING

This one story building was constructed in 1992 and consists of prefabricated wood trusses at the roof supported by CMU walls at the perimeter of the building. Below are specific items noted during the assessment.

- In general, the prefabricated wood trusses and CMU walls were found to be in good condition. No water damage was found.

- Electrical conduit in the attic had only occasional bracing that did not appear to be adequate for the design-level earthquake. Insufficient bracing increases the risk of electrical failures after a design-level earthquake.

- A preliminary Tier 1 seismic evaluation was performed for this building. For the purpose of this evaluation, the building is categorized as a Type RM1 with reinforced masonry bearing walls and flexible diaphragm. The checklist found two seismic deficiencies of concern. The first deficiency concerns the transfer of horizontal shear forces from the roof diaphragm to the CMU wall at the south side of the building. The cantilevered roof over the exterior porch on the south side of the building does not appear to have a load path to transfer forces from the roof diaphragm to the CMU wall. There is a risk of damage or partial roof collapse in the design-level earthquake. The second deficiency is insufficient out-of-plane anchorage of the top of CMU walls to the roof diaphragm which results in some risk of damage to the wall and roof if the top of the wall moves away from the intended bearing point of the roof trusses during a design-level earthquake.

CHLORINE CONTACT BASIN

The CCB was described previously, but is a welded, coated, steel tank located just south of the Finished Water Pump Building that provides contact time for chlorinated filtered water from the clearwell.

- The exterior coating system on the CCB shows many localized areas of damage and/or failure. Corrosion of the steel wall is evident at these locations. Previous areas of corrosion have been addressed by WTP staff through surface preparation and spot coating repair.

- The interior coating system of the CCB appears to be in fair condition and shows only minor signs of corrosion at select areas (edges) within the tank.

- A seismic vulnerability assessment was completed in 2016 and had two significant recommendations for the CCB. First, the report stated that the concrete ringwall foundation should be retrofitted to increase uplift resistance during the design-level earthquake. Secondly, flexible piping connections were recommended to reduce the risk of damage that would result in emptying of the reservoir. Otherwise the report did not find deficiencies regarding the steel shell or anchorages to the foundation.

ARCHITECTURAL CONDITION ASSESSMENT

The architectural assessment included the WTP Main Building and the Finished Water Pump Building. Information was collected from on-site observations as well as original drawings for the existing structures. The assessment included a review of the condition of non-mechanical building systems and workspaces and compliance with current codes. The code used for this evaluation is the 2015 International Building Code (IMC).

GENERAL ARCHITECTURAL

The WTP has sufficient building access restrictions, but the property has minimal site security measures. Both the WTP Building and Finished Water Pump Building are secured with door locks. The CCB is secured with a padlocked ladder guard to prevent access to the tank. The generator fuel tank is secured behind a wood slat fence and gate secured with a padlock. The WTP does not contain any site fencing.

Camera surveillance is provided at the WTP Building and the CCB; however, this system is not used for alarming due to the high volume of nuisance alarms caused by wildlife and visitors to the adjacent Afternoon Beach Park.

WTP MAIN BUILDING

- This building includes a small water quality lab area that is comprised of approximately 10 linear feet of base cabinets and countertop. Within the countertop is a 24-inch sample sink that receives flow streams of filtered water and finished water for water quality sampling and analysis. The remainder of the available countertop area is utilized for water quality analysis instruments and as the plant operator's work station for computer access and required monthly reporting. The WTP's Human Machine Interface (HMI) computer is located here and is housed within one of the base cabinets with a shelf above the countertop holding two monitors.

  The location of this work station near the sink and lab area places the computer equipment and necessary paperwork/files at greater risk for damage.

- This building includes a small bathroom along the west wall. The bathroom includes a toilet and a utility sink along with some open wall shelving for storage of janitorial supplies. Hot water is supplied to the utility sink via a mini-tank style Bosch water heater located within the closet adjacent to the bathroom. The water heater appears to be less than 5 years old.

  The bathroom is functional but shows typical signs of deterioration associated with use and age including some light moisture damage, paint deterioration, staining, and poor lighting.

- Additional filter media is currently stored south of Filters 3 and 4 between the filter tank and the building wall. While neat and organized, this location significantly restricts access to all sides of the filters for inspection and/or maintenance. This location also makes access to the filter media bags cumbersome for WTP staff.

- The facility includes an emergency eye and face wash station located on a wall adjacent to the lab area and an emergency drench shower located on the northeast corner of the Filter 3 and 4 vessel. Emergency eyewash and shower equipment is now regulated through the plumbing code by ANSI/ISEA Z358.1 - American National Standard for Emergency

Eyewash and Shower Equipment. This standard not only includes requirements for the fixtures, but also water supply to the fixtures and access to the fixtures within a facility. Eye and face wash stations should be located to be accessed in no more than 10 seconds by a user and should provide uninterrupted flow of 3.0 gpm for 15 minutes. Drench showers should also be located to be reached within 10 seconds and should provide uninterrupted flow of 20 gpm for 15 minutes. The access pathways to both types of emergency fixtures should be free and clear of obstructions and the water supply should be tempered to a temperature between 60 degrees F and 100 degrees F. In addition, emergency fixtures should also be activated weekly to ensure flow and should be tested and certified annually.

Given the location of the existing equipment within the Main Building, neither the eyewash or drench shower is in compliance with the access requirements of ANSI Z358.1. Flow and temperature for these units were not tested during the site visit, but given the date of their installation, they may not meet current flow or temperature requirements. In addition, the supply to both of these fixtures is not tempered and therefore does not meet the temperature requirements.

- There is evidence of moisture weeping through the east wall directly above the electrical gear for the raw water pumps as indicated by some rust staining down the wall at the beam-to-wall interface. It does not appear this location has leaked in the recent past and there was no apparent direct water damage to the electrical gear.

- There is evidence of moisture weeping through the east wall near the second beam to the south of the raw water pump electrical gear (MCC 3). This location had some shiny or reflective spots, indicative of a wet surface during this assessment.

- There is evidence of moisture weeping through the aluminum storefront entrance area predominantly at the easterly interface where the aluminum framing meets the concrete wall. There is staining down this wall, down the vertical framing along the wall, at the floor, and on the adjacent wall around the corner to the east. This moisture appears to be coming from outside within the entrance alcove.

- The existing aluminum storefront window entrance alcove restricts the ability to move supplies and equipment in and out. The existing aluminum-framed, glass door is 42-inches wide; however, for deliveries of chemicals on pallets and other supplies for the WTP, a double door or an overhead coiling door would be preferred.

In addition, any major work to the facility to replace or repair equipment, tanks, etc. would require that the storefront system be disassembled.

- At the concrete slab roof overhang above the alcove there was moisture staining coming in from the leading edge as well as at several locations along the joint between the concrete walls and slab extending above. In addition, it appears an attempt to seal some of these joints may have been done in the past as evidenced by some seams of white caulk.

- Some of portions of the facility's floors appear to be continually wet, particularly between the tanks and filters. The concrete floor is painted and is in good condition; however, the standing water on portions of this makes the flooring slippery and represents a potential safety hazard.

- The front and side exterior faces of the structure are covered with significant growth. This growth appears to be English Ivy and overhangs the building roof on three sides. While it is apparent this growth allows for significant camouflaging of the structure from the roadway, it does impede inspections of the structure, waterproofing systems, and roof drainage. In addition, roots from organic growth can be tenacious, can deteriorate waterproofing systems, and can work their way into structural joints potentially causing damage.

- Similar to the exterior wall faces, the roof is overgrown with plant life and also includes some large woody debris that has blown and/or fallen down on to the roof from the adjacent woods.

- Chlorine room access door and frame show signs of corrosion and the coating system is showing signs of fatigue.

- The building does not currently utilize an effective smoke or fire alarm system.

FINISHED WATER PUMP BUILDING

- The downspout on the northeast corner of the building has a leak in a joint near the soffit causing enough of a splash at grade that the cedar siding appeared to be constantly wet. The continuous presence of moisture will deteriorate the siding in this area.

- The roof and siding appear to be in good condition.

- Each end of this building includes a light well (skylight) framed through the attic with domed skylights. These areas are subject to water damage if not maintained, cleaned, and inspected on a regular basis.

- The building does not currently utilize an effective smoke or fire alarm system.

MECHANICAL CONDITION ASSESSMENT

The mechanical/HVAC assessment included the WTP Main Building and the Finished Water Pump Building. Information was collected from on-site observations as well as original drawings for the existing structures. The assessment included review of the condition of mechanical heating/cooling equipment, dehumidifiers, ventilation equipment, and compliance with current mechanical codes, namely, the 2015 International Mechanical Code (IMC).

WTP MAIN BUILDING

- This building includes a single, ceiling-hung, electric air handling unit that supplies the space with ventilation and heating and is controlled by a programmable Honeywell thermostat located within a ventilated lockbox. The internal fan has a capacity of up to 1,900 cubic feet per minute (cfm) at approximately 0.3 inches of water column (in-WC) and the heating coil has a capacity of 16 kW. This unit has a mixing box with a fixed bypass damper that allows control of the amount of outside air that is brought in and the amount of inside air that is recirculated. This unit is over 10 years old and was rebuilt in 2018 due to corrosion of the electric heating coils. In its current conditions, this unit appears to have many years of service life remaining. The unit includes a filter box with 2-inch pleated filters; however, the filters were not accessible at the time of the assessment.

  When outside air ventilation is being provided, a discharge relief louver ducted through the Chlorine Gas Room allows exhaust air to leave the space. Plant operators indicate that there are no issues or concerns with heat capacity or ventilation; however, it was noted the electric heat is expensive to operate during winter months.

  Heating and ventilating equipment is in good condition with years of service life remaining.

- This building also includes two, stand-alone industrial dehumidifiers. Each has a rated capacity of 195 pints of water removal per day at 80 degrees F and 60-percent humidity. These units include 2-inch MERV 8 pleated filters. Plant operators note that since the installation of these dehumidifiers, interior moisture control has significantly improved and has not posed an issue in recent years.

  The dehumidifiers are in good condition with years of service life remaining.

- Air flow through the Chlorine Gas Room is provided via an intake louver installed within the door and an exhaust fan with a 12" x 12" louvered gravity backdraft damper. The operable louvers of the gravity backdraft damper are partially restricted by plant growth on the building exterior.

FINISHED WATER PUMP BUILDING

- This facility includes a 40,000 btu/hr, natural gas unit heater in the southeast corner, and generator louvers which remain closed unless the generator is in operation. These components are in excellent condition with years of service life remaining.

- There appears to be a small exhaust leak in a pipe joint where the generator exhaust connects into the underside of the silencer. A portion of the insulation blanketing was stained with black soot.

ELECTRICAL CONDITION ASSESSMENT

The electrical assessment included the WTP Main Building and Finished Water Pump Building. Information was collected from on-site observations, discussions with WTP treatment staff, as well as original drawings for the existing structures. The electrical assessment included a review of the condition of existing equipment, use of the existing equipment, compliance with current electrical codes (NEC 2020), and potential modifications that may benefit the operation of the plant.

The existing utility service includes a pad mounted 300 kVA, 480/277 VAC (360 full load amps) three phase electrical transformer. This transformer is owned and managed by Puget Sound Energy and has PSE identification number 462999-164283. This service feeds a 480 VAC motor control center (MCC 1) located in the Finished Water Pump Building through a 600-amp main circuit breaker, also located in the Finished Water Pump Building. MCC 1 is generator-backed by a 600-amp rated automatic transfer switch and 450kW (~680 amp) generator. MCC 1 also provides a 150-amp 480/277 VAC feed to the treatment building, which distributes power from its own MCCs (MCC 2 and MCC 3). The generator in the Finished Water Pump Building also serves the nearby Afternoon Beach Sewer Pump Station which has its own utility feed.

GENERAL ELECTRICAL

- An overarching concern is the size of the utility transformer and its ability to provide power to the WTP. As stated above the transformer has the capacity to provide 360 amps but the facility is designed to distribute 600 amps. The load study from the 1992 WTP Upgrade Improvements Project indicates a peak requirement of 449 amps, suggesting that the existing transformer is not sized to fully power the complete operation of the WTP for an extended period of time.

- Occupational Health and Safety Association (OSHA) mandates that electrical distribution equipment, that is likely to require service while energized, be labeled with arc flash protection labels indicating the safe working distances and the correct personal protective equipment (PPE) required. The existing electrical distribution equipment in both the WTP Main Building and Finished Water Pump Building does not currently have these labels.

- The auxiliary power generation system is new and is in excellent condition. The system is tested for approximately 30 minutes each week in accordance with the manufacturer's recommendations.

- Based on previous observations by District staff, buried conduits and/or conductors show signs of corrosion and are likely in fair/poor condition.

WTP MAIN BUILDING

At the WTP Main Building, the power enters MCC 2 which is located on the west wall and contains the clearwell transfer pumps, a panelboard, and HVAC power. MCC 2 feeds MCC 3, which is located on the east side of the WTP Main Building and contains the motor starters for the raw water pumps.

- MCC 2 is in fair/poor condition and is a GE 8000 series product which is no longer manufactured or supported with spare components.

- The original circuit breakers in MCC 2 are approaching the end of their recommended service life.

- There is a concrete pad for a previously utilized transmission pump in front of MCC 2, which violates the NEC clear space requirement for this MCC. According to the NEC, at least 42 inches of clear space are required.

- MCC 3 is a Square D Series 6 MCC which is a currently supported product line. The unit is in fair/poor condition, most likely due to its proximity to bags of soda ash. This close proximity to chemicals and water metering equipment makes the equipment more susceptible to corrosion, degradation, and places the equipment at a greater risk for failure. The panel cover shows signs of corrosion. Although the MCC interior was not inspected as part of this assessment because the WTP was in operation, WTP staff have noted that the interior components of MCC 3 exhibit signs of corrosion.

- The electrical equipment in the chorine room includes outlets and conduit and is in excellent condition primarily due to the use of PVC-RGS conduit within the space. Several existing conduits in this room are uncapped, allowing chlorine gas fumes to enter the associated panelboard, and subsequently, the WTP Main Building.

- In several locations, electrical conduit is mounted to the floor of the building. This installation location creates a tripping hazard and makes transportation of heavy items using wheeled carts or hand trucks more difficult.

- On the wall immediately south of MCC 2 there are two panels leftover from the control panel improvements project. These panels are not labeled but are a blue panel manufactured by S&B with several unused level displays, and a grey panel manufactured by QCC immediately to its right. These two panels contain field wiring that run to the main control panel for the WTP, which is designated as MCP 1. Using a control panel as a pulling point and/or junction box is not allowed by the NEC.

- There are several additional panelboards and control panels not currently used for their original design function. These panels take up valuable wall space, create confusion and difficulty in tracing wires and cables, and provide the opportunity for additional violations of current and future electrical code requirements.

- MCC 2 and the panelboards immediately following the existing 208/240V transformer do not utilize surge protection devices (SPD). SPD's help protect the electrical equipment from damage due to in-rush currents and inconsistencies in the electrical service during both normal operation and when starting up after a loss of power.

FINISHED WATER PUMP BUILDING

- MCC 1 is old and has reached the end of its recommended service life. The motor control center's product line (GE 8000 series) is no longer manufactured and in 2017 GE sold this portion of its business to Allen Bradley (ABB). ABB does offer support but the availability of new components is questionable and will continue to become more difficult with each passing year.

- The existing motor starters for the finished water pumps are auto-transformers which is an outdated technology.

- The original circuit breakers are near the end of their recommended service life.

- The generator is approximately 6 years old; however, the adjacent washing machine infringes upon the minimum required clear space around the generator. Per the NEC Article 110, a minimum of 42 inches is required in front of equipment operating at 600 V or less which is likely to require examination, adjustment, servicing, or maintenance while energized.

- The external fuel tank is less than 5 horizontal feet from the eave of the building. The 2015 International Fire Code (IFC) #5704 stipulates that diesel fuel tanks of that size must be at least 5 feet from building eaves.

- This building utilizes fluorescent light fixtures, which are outdated and inefficient.

- MCC 1 and the panelboards immediately following the existing 208/240V transformer do not utilize surge protection devices (SPD). SPD's help protect the electrical equipment from damage due to inrush currents and inconsistencies in the electrical service during both normal operation and when starting up after a loss of power.

- All of the conduits between the Main Building and the Finished Water Pump Building are routed through a common 3-foot hand hole. This hand hole contains low voltage conductors, high voltage conductors, 24VDC signal cables, and ethernet cables. Current NEC does not permit both low and high voltage cables to occupy the same space.

TELEMETRY/SCADA

The existing supervisory control and data accusation (SCADA) system consists of a computer-based HMI that communicates with a programmable logic controller (PLC) in the WTP. HMI software is the iFIX platform. In addition to monitoring and controlling activities at the WTP, the PLC also communicates with, and monitors the Division 7 and Division 22 Reservoirs directly via leased phone lines. Discussions with operations staff indicate that the Comcast broadband connection from the WTP to the internet for remote monitoring is generally reliable; however, there is already work in progress to add a local copy of the alarming software (WIN 911) across the water system in case of the loss of communication at the site. The existing SCADA system allows the operations staff to operate the WTP automatically based on the real time water system demand.

- In general, the District is pleased with both the reliability and performance of the SCADA system. Typically, WTP staff have a monthly call with their integrator (QCC Inc.) to discuss any issues and possible improvements. This proactive approach helps to ensure that the system is maintained in good working order.

- The process control panels in the water treatment building were updated in 2012 to an Allen Bradley CompactLogix PLC based system and have had very few modifications since that time. MCP-1 (located on the west wall of the WTP Main Building) acts as the master while MCP-2 (east wall of the WTP Main Building) acts as a remote I/O base. Both these panels are in good condition. MCP-2 does not appear to have suffered from the corrosive environment despite being adjacent to the MCC 3.

CHAPTER 3

TREATMENT IMPROVEMENTS

INTRODUCTION

This chapter presents recommendations for modifications or actions based on the assessment observations noted in Chapter 2 for each discipline. The recommendations are divided into high-priority and recommended improvements. For each discipline as well as each building at the WTP, high-priority improvements are listed first, followed by recommended improvements.

In addition to the improvements recommended as a result of our assessment, the lists of recommendations below also include items noted during preparation of the most recent Water System Plan completed by Wilson Engineering in 2018 as well as the WTP Sanitary Survey completed by DOH in March 2020.

High priority improvements should be addressed within 5 years in order to help ensure the integrity of the existing facilities as well as WTP operations. Recommended improvements should be addressed within 5 to 15 years and would provide additional convenience and efficiency to the WTP operations staff and would help ensure the long-term longevity of the WTP structure and components.

TREATMENT/PROCESS RECOMMENDATIONS

HIGH PRIORITY IMPROVEMENTS

WTP Main Building

- Replace the existing clearwell level alarm switch to one that does not utilize mercury.
- Replace the existing CCB level alarm switch to one that does not utilize mercury.
- Address issues with existing chlorine disinfection system.
    - In addition to the condition assessment provided as part of this project, perform an alternatives analysis to determine whether disinfection with chorine gas continues to be the best alternative for use at the WTP. While gaseous chlorine is a viable method for disinfection of potable water – especially for small-scale water treatment facilities – many municipalities choose to disinfect using liquid sodium hypochlorite or other liquid based chemicals due to

the inherent safety risks of chlorine gas. The alternatives analysis should investigate options such as continuing gas chlorination, disinfection with bulk sodium hypochlorite, and disinfection through onsite hypochlorite generation, and should evaluate these alternatives in the context of other process improvements that may be desired.

  - If an alternative technology is desired, then proceed with the design and implementation of the desired technology.

  - If continued use of gas chlorination is desired, then complete the following modifications and any recommendations provided in the alternatives analysis:

    1. Assess ventilation system and air exchange.

    2. Revise labels for chlorine solution tubing.

    3. Remove existing coatings, prepare surfaces, and provide new coating system for interior walls.

    4. Add additional chain restraint system for spare cylinders approximately 18-inches from the floor.

    5. Revise scale orientation to allow for an additional chain restraint to active cylinders approximately 18 inches from the floor.

    6. Remove existing coatings, prepare surfaces, and provide new coating system for existing door (interior and exterior sides).

    7. Address existing chlorination system issues such as safety systems (fire, sprinkler, alarming, etc.), maximum storage allowances through the installation of Chlortainers and removal of spare cylinders, indicators and alarms, and storage containers in accordance with the codes listed in Appendix E.

- Address shortcomings with the existing alum system.

  - If modifications to other systems at the WTP will allow for relocation of the alum tank, we recommend that the following modifications be completed at the final tank location. Otherwise, the following recommendations could be completed for the existing alum tank location.

1. Replace existing alum storage tank with new HDPE full draining tank. New tank should be double containment style for safety against leaks/spills.

2. Provide relocated alum fill connection to allow for easier delivery of chemical and easier observation of tank level during filling.

3. Provide level sensing equipment and/or external sight gauge for alum tank.

4. Install alum duplex chemical metering pump skid.

5. Compile and update MSDS files for all chemicals used at the WTP and store this information at the existing laboratory workspace.

6. As recommended by the DOH Sanitary Survey (Appendix D), prepare and file standard alum chemical quality specifications and standard delivery procedures for review prior to/during chemical delivery.

- Address shortcomings with the existing soda ash system.

  - For continued use of the existing soda ash mixing/storage tank, we recommend that the following modifications be completed at the final tank location.

1. Drain, clean, remove the existing coating, prepare and recoat the existing alum tank.

2. Install level markings on the interior of the tank to facilitate easier chemical addition and filling.

3. Revise tank and platform orientation to provide for easier access by staff with chemicals.

4. Replace existing soda ash mixer.

5. Provide common soda ash duplex chemical metering pump skid.

    - If modifications to the other chemical systems, equipment, or layout of the WTP Main Building will allow for relocation of the soda ash tank, we recommend that a new, similarly sized, HDPE soda ash tank be provided in the desired location.

- Address shortcomings with existing backwash system.

    - In addition to the condition assessment provided as part of this project, perform an alternatives analysis for the existing backwash storage and pumping system. While the current backwash method and settling tank is sufficient for WTP operation, the process is expensive due to costs associated with pumping large volumes of water to the City of Bellingham municipal sewer system. The alternatives analysis should investigate methods to optimize the backwash process and reduce operating costs such as discharging backwash supernatant back to Lake Whatcom, installing a larger settling tank, or utilizing backwash recycle storage and pumping equipment. These alternatives should be evaluated in the context of other process improvements that may be desired.

RECOMMENDED IMPROVEMENTS

WTP Main Building

- Address shortcomings with raw water pumping area and equipment.

    - Complete raw water pump performance testing.

      Depending on the results of this performance test, repair, rehabilitate, replace, or procure spare equipment for each pump and/or pump motor as required.

    - Purchase/procure an auxiliary/portable raw water pump for connection to the auxiliary WTP inlet. Alternatively, a spare raw water pump may be purchased to replace one of the existing raw water pumps in the event that it fails.

- Procure a spare backwash flow meter.

    - In conjunction with this recommendation, it may be useful to centralize the flow meters using a common manufacturer or model number. This will provide commonality of operation and will allow a common supply of spare parts to be used for all of the meters.

- Address shortcomings with the existing flocculation tank.

    - For continued use of the existing flocculation tank, the existing coating system should be addressed as described in the structural recommendations section.

    - If a larger tank that will provide the minimum recommended residence time of 30 minutes is desired, the above modifications can be omitted and the tank can be replaced with a new, 21,000-gallon tank.

      A tank with the same footprint as the existing tank would need to be approximately 21 feet tall (including 1-foot of freboard), which is taller than the existing 13-foot ceiling in the WTP Main Building. Given the maximum tank height of 10.5 feet (to allow for access) including 1-foot of freeboard, a 21,000-gallon tank would have a diameter of approximately 19.5 feet. This size tank will not fit within the existing WTP Main Building footprint without significant other modifications. As such, it is anticipated that modifications to the flocculation tank will be done in conjunction with a larger WTP modifications project and/or remodel effort.

      It should be noted that although a new, larger tank would bring the residence time and mixing energy values closer to theoretical design values, the current flocculation tank does not inhibit the WTP from meeting the current performance requirements.

- Regrade and resurface the raw water pump pit floor to promote good drainage to the sump area and prevent the accumulation of sediments.

- Procure confined space access equipment dedicated to the WTP.

- Relocate existing small diameter piping at the flocculation tank so that piping and conduit located within the tank footprint is minimized.

- Furnish and install additional ladder access to the east side of Filter 1 and 2 and to the west side of Filter 3 and 4.

- Revise CT calculations to include the clearwell volume and an assumed baffling efficiency of 0.1.

- Provide high visibility painting or indicators for the clearwell access hatch.

- Complete transfer pump performance testing.

  Depending on the results of this performance test, repair, rehabilitate, replace, or procure spare equipment for each pump and/or pump motor as required.

- Drain and clean the clearwell.

- Provide additional "Operator in Trouble" motion sensors and alarm systems.

- Replace existing tube-style high level alarm in the flocculation tank.

Finished Water Pump Building

- Replace/test existing finished water pressure gauges.

- Complete finished water pump performance testing.

  Depending on the results of this performance test, repair, rehabilitate, replace, or procure spare equipment for each pump and/or pump motor as required.

- Procure spare finished water pump motor.

- Provide additional “Operator in Trouble” motion sensors and alarm systems.

STRUCTURAL RECOMMENDATIONS

HIGH PRIORITY IMPROVEMENTS

WTP Main Building

- Replace corroded steel supports for miscellaneous items such as conduit, piping, and equipment.

- If the existing floc tank is to be reused, prepare and coat both the interior and exterior of these tanks to prevent additional loss of metal. Preparation should be a minimum of SSPC-SP10 and coatings should be NSF61 approved for use with potable water. Fill the existing void space below the tank with high-strength grout.

- If the existing Filter 1 and 2 is to be reused, prepare and coat the lower 2 feet of the vessel to prevent additional loss of metal. Preparation should be a minimum of SSPC-SP3 or SSPC-SP11 and coatings should be NSF61 approved for use with potable water.

- Perform a detailed structural evaluation of seismic anchorage and bracing of interior components including, but not limited to, anchorage of interior tanks, flexible connections of piping, bracing of piping and conduit, wall-mounted electrical transformers, anchorage and bracing of miscellaneous equipment. A detailed structural evaluation was completed for the District's reservoirs in 2016, but was not completed for the WTP Main Building or Finished Water Pump Building.

- Furnish and install seismic bracing and flexible connections for tanks and other key equipment as identified by the seismic evaluation.

Finished Water Pump Building

- Add additional seismic bracing to electrical conduit in the attic to meet the demands of the design-level earthquake.

- Perform a detailed structural analysis and develop seismic retrofit design to address the deficiencies identified by the Tier 1 evaluation regarding the connection between the roof diaphragm and top of CMU wall. Implement the modifications to the Finished Water Pump Building structure as recommended from the detailed structural seismic evaluation.

RECOMMENDED IMPROVEMENTS

WTP Main Building

- Prepare existing exposed rebar on concrete ceiling to SSPC-11 Standards and coat the exposed metal with appropriate, high quality commercial primer/paint system.

Chlorine Contact Basin

- Perform a formal coating inspection on the interior and exterior of the CCB.

  This inspection should be conducted by a consultant specializing in the testing and inspection of potable water storage facility coating systems. The inspector should be NACE Certified and the coating assessment should include pull tests, metal thickness inspection, a formal visual assessment of the coating system, and any other recommended testing that will assess the viability of the coating system and/or integrity of the steel tank.

- Develop a plan for treatment and disinfection operations during the time period that the CCB is offline for maintenance.

  Pending the results of the coating inspection recommended above, the CCB will require both interior and exterior coating system improvements. During this time period, which can last up to 3 months, the CCB will be unavailable for use and a system should be devised for how disinfection of filtered water will be provided.

ARCHITECTURAL RECOMMENDATIONS

HIGH PRIORITY IMPROVEMENTS

WTP Main Building

- Address the risk for corruption of the electronic equipment at the existing work counter by relocating the electrical equipment to another area of the WTP.

  One alternative to complete this recommendation is to convert the totality of the existing counter space to laboratory and wet-work (sampling, analysis, etc.) and relocate the computer work station. It is anticipated this will be done in conjunction with a larger WTP modifications project and/or remodel effort.

- Remove the soil cover and associated plant growth down to the cast concrete curb that is likely at the base of the existing chain link fence. In addition, heavy, woody debris should be removed from the roof on an annual basis.

- Remove ivy and other plant vegetative growth from building exterior.

- Replace and/or revise the existing safety shower and eyewash systems to be in compliance with ANSI Z358.1.

- Add an effective smoke and fire alarm system. The system should be in accordance with IFC requirements and should include heat/rise and smoke detection systems, and egress pull stations should be linked to the existing SCADA system to notify District staff that an alarm has been activated.

Finished Water Pump Building

- Remove any debris and clean existing roof on an annual basis.

- Add an effective smoke and fire alarm system. The system should be in accordance with IFC requirements and should include heat/rise and smoke detection systems, and egress pull stations should be linked to the existing SCADA system to notify District staff that an alarm has been activated.

RECOMMENDED IMPROVEMENTS

General Architecture

- Investigate alternatives to provide additional site security measures such as fencing, restricted access gates, and cameras. The investigation should address the District's tolerance for risk, public safety, park access, and desired level of security, all in conjunction with other measures and large-scale modifications proposed for the WTP.

WTP Main Building

- Address deteriorating conditions in the restroom. Modifications should include replacement of damaged drywall, new paint, and new fixtures.

- Remove heavy, woody debris from the roof on an annual basis.

- Address wall weeping on the east wall above MCC 3.

- Address leakage at existing storefront windows and above the windows on concrete alcove. This may be addressed by removing damaged or deficient seals and replacing with new materials.

- Address pooling of water on WTP floor to avoid potential hazards. This may be addressed by grinding or grooving the floor to promote drainage to the existing trench, and then recoating the modifications.

- Revise the existing storefront window arrangement to allow for a new, wider door that will facilitate easier delivery of pallets or other large items. It is anticipated this is done in conjunction with a larger plant modifications project and/or remodel effort.

- Relocate stored filter media to another area of the facility, or a new facility in order to provide unhindered access to all sides of Filters 3 and 4. It is anticipated this is done in conjunction with a larger plant modifications project and/or remodel effort.

- Relocate stored/extra/damaged materials in the SE corner of the building to another area of the facility, or to a new facility in order to provide unhindered access to all sides of Filters 1 and 2. It is anticipated this is done in conjunction with a larger plant modifications project and/or remodel effort.

MECHANICAL RECOMMENDATIONS

HIGH PRIORITY IMPROVEMENTS

WTP Main Building

- Investigate current heating schedule and equipment to optimize it for plant operation, staff comfort, protection of equipment, energy efficiency, and cost.

RECOMMENDED IMPROVEMENTS

General Mechanical

- Perform an energy audit to identify the primary source of energy consumption and heat loss.

  This audit should be conducted by Puget Sound Energy or another subconsultant familiar with the function and use of a treatment facility and experienced in providing comprehensive energy audit assessments. The audit should include all components of both the WTP Main Building and Finished Water Pump Building and should identify ways the WTP can reduce its energy footprint and operational costs.

Finished Water Pump Building

- Complete repairs to leak in the generator exhaust piping.

ELECTRICAL RECOMMENDATIONS

HIGH PRIORITY IMPROVEMENTS

General Electrical

- Combine all plant records into a new and complete electrical record set that incorporates all the changes made into a single current as-built for power distribution and controls.

- Perform a complete audit of the electrical system to focus on the electrical reliability of the circuit breakers and fuses in the MCCs as well as safety and code compliance.

  This work is typically completed by a consultant specializing in electrical analysis and various companies perform this work including Vertiv, Eaton's electrical engineering services group, and Siemen's electrical services group.

  This audit should accomplish the following tasks:

  - Identify any deficiencies with the physical condition or operation of electrical distribution equipment that could not be investigated as part of this assessment. This would include buried conduits and/or conductors. Coordinated outages to portions of the WTP facility will be required.

  - Coordinate the circuit breakers and/or list the modifications required to selectively coordinate the system,

  - Provide OSHA compliant labeling for arc and shock hazards, and

  - Identify available fault current at key points in the system and identify which devices to not have sufficient withstand ratings,

  - Recommend a schedule for the replacement of the original circuit breakers.

- Perform an electrical analysis to review the peak demand usage from historical utility bills to evaluate how well the PSE installed transformer is able to meet the facility's needs.

WTP Main Building

- Remove all chemical storage and metering pump equipment from the vicinity of MCC 2 and MCC 3. While the NEC requires at least 42-inches of clear space, 8 to 10 feet is often provided as "good practice" to help protect electrical equipment.

- Install surge protection devices (SPDs) at the first panelboards after the transformer.

- Replace MCC 2 with new equipment including motor starters, circuit breakers, surge protection devices, and VFD load filters.

- Replace MCC 3 with new equipment to address existing component corrosion.

Finished Water Pump Building

- Replace MCC 1 with new equipment including motor starters, circuit breakers, surge protection devices, and VFD load filters.

- Install surge protection devices (SPDs) at the first panelboard downstream of the wall mounted transformer.

RECOMMENDED IMPROVEMENTS

WTP Main Building

- Replace florescent lighting with LED lighting. This replacement should provide a small reduction in energy consumption but will require significantly less maintenance than current light fixtures.

- Replace AC UPS backed systems with DC UPS backed systems for increased reliability.

- Consolidate small panelboards and/or panelboards that are not currently used for their original design intent into fewer panels to provide a simpler, more streamlined distribution system. Address any open conduits to these panels through removal of capping.

- Reroute floor mounted electrical conduits to the walls and/or ceiling in order to eliminate tripping hazard.

- Reroute field wiring within the blue / grey panels manufactured by S&B and QCC through a different pathway, then remove the panel(s) if possible. Alternatively, the panels could be made into junction boxes by removing any remaining control apparatus as well as any connections associated with door mounted devices.

- Assess the likelihood of installing a third transfer pump at the WTP. If a third pump is not likely, remove the existing transfer pump pad and anchors to provide code-compliant clear space in front of MCC 2.

Finished Water Pump Building

- Replace florescent lighting with LED lighting. This replacement should provide a small reduction in energy consumption but will require significantly less maintenance than current light fixtures.

- Continue to test the auxiliary generator under load on a regular basis to ensure that it will successfully provide the necessary power to operate the entire facility. On an annual basis provide a full loading test on the generator using a load bank.

- Investigate options for relocation of existing generator fuel tank.

SUMMARY

Table 3-1 below provides a modification summary, discipline, and location for the High Priority Improvements. Table 3-2 provides this information for the Recommended Improvements. It is important to note that while the recommended improvements are not explicitly and immediately required, they are recommended in order to ensure the longevity of the existing facilities and their ability to provide the desired level of filtration and output.

TABLE 3-1

Sudden Valley WTP High Priority Modifications Summary

Modification	Location(1)	Discipline(2)
Conduct chlorine disinfection system alternatives analysis	MB	P
Chlorine gas system modifications	MB	P
Alum storage and metering pump system modifications	MB	P
Soda Ash storage and metering pump system modifications	MB	P
Conduct backwash system alternatives analysis	MB	P
Replace existing clearwell and CCB level switches	MB	P
Replace corroded steel supports	MB	S
Prepare and coat steel tanks (Floc, Soda Ash, and Filters 1/2)	MB	S
Install seismic bracing for electrical conduit, electrical equipment, and treatment equipment	MB/FPB	S
Complete detailed structural evaluation	MB/FPB	S
Relocate existing laboratory electrical equipment	MB	A
Remove soil cover, vegetation growth, and organic debris from building exterior and roof	MB	A
Provide water upgrades to safety shower and eyewash	MB	A
Add fire and smoke alarm system	MB/FPB	A
Investigate current heating schedule	MB/FPB	M
Combine all existing plant records into a single as-built planset	MB/FPB	E
Complete a comprehensive electrical system audit	MB/FPB	E
Remove chemicals and metering equipment away from MCCs	MB	E
Review historical peak demand electrical consumption	MB/FPB	E
Replace MCC1 and MCC2 with new, current technology	MB/FPB	E
Replace MCC3 to address panel and interior component corrosion	MB	E

(1) MB = WTP Main Building. FPB = Finished Water Pump Building. CCB = Chlorine Contact Basin.

(2) P = Process, S = Structural, A = Architectural, M = Mechanical, and E = Electrical.

TABLE 3-2

Sudden Valley WTP Recommended Modifications Summary

Modification	Location[(1)]	Discipline[(2)]
Modify/repair existing flocculation tank	MB	P
Provide new grout floor within raw water pump pit	MB	P
Drain and clean the clearwell	MB	P
Procure spare backwash flow meter	MB	P
Procure dedicated confined space equipment for the WTP	MB	P
Install additional access ladder to Filters 1 and 2 and Filters 3 and 4	MB	P
Revise CT calculations to include clearwell and BE of 0.1	MB	P
Revise piping and conduit above flocculation tank	MB	P
Provide additional Operator In Trouble alarming equipment	MB/FPB	P
Replacing existing tube-style level alarm at flocculation tank	MB	P
Procure a spare finished water pump motor	FPB	P
Replace existing pressure gauges	FPB	P
Improve the visibility of the existing clearwell hatch	MB	P
Complete a performance test of the raw water, transfer, and finished water pumps	MB/FPB	P
Prepare and coat exposed ceiling rebar	MB	S
Address deficiencies found in 2016 seismic report	CCB	S
Perform formal CCB coating inspection	CCB	S
Address deteriorating conditions in restroom	MB	A
Investigate additional site security measures	MB/FPB	A
Remove heavy organic debris from roof	FPB	A
Repair wall seepage above MCC3	MB	A
Repair seepage/leaks at storefront window assemblies	MB	A
Modify floor to promote drainage to existing trench drain	MB	A
Revise existing storefront window to provide larger door opening	MB	A
Relocate stored filter media and other supplies equipment	MB	A
Conduct energy and heat audit	MB/FPB	M
Repair crack in generator exhaust piping	FPB	M
Conduct annual load testing for existing generator	FPB	E
Replace existing fluorescent light fixtures with LED equipment	MB/FPB	E
Replace AC backed system with DC backed systems	MB/FPB	E
Consolidate existing electrical panelboards	MB/FPB	E
Reroute floor mounted electrical conduit	MB/FPB	E
Reroute field wiring within grey/blue wall mounted panels	MB	E
Modify transfer pump pad based on long-term operations strategy	MB	E
Fuel tank relocation investigation	FPB	E

(1) MB = WTP Main Building. FPB = Finished Water Pump Building. CCB = Chlorine Contact Basin.

(2) P = Process, S = Structural, A = Architectural, M = Mechanical, and E = Electrical.

APPENDIX A

EXISTING FACILITY PHOTOGRAPHS

A1: Sudden Valley WTP

From Left to Right:
East WTP façade. WTP façade. West WTP façade.

A2: Raw Water Pumps

Clockwise from Upper Left:
Raw Water Pump 1 (gold) and 2 (blue). Sediment accumulation on the floor. Raw Water Pump suction piping.

A3: Raw Water Flow Meter and Piping

From Left to Right:

Raw Water Pump discharge piping including Raw Water Flow Meter and Alum injection. Flocculation tank inlet.

A4: Flocculation Tank

Clockwise from Top:
Flocculation Tank corrosion. Flocculation Tank outlet and access ladder. Flocculation Tank priming piping.

A5: Filter Equalization Trough

From Left to Right:
Filters 1 and 2 (foreground), Equalization Trough, and Filters 3 and 4 (background). Equalization trough.

A6: Filters 1 and 2

Clockwise from Left:
Filters 1 and 2 with backwash waste trough. Filters 1 and 2. Filters 1 and 2 backwash waste trough and handrail.

A7: Filters 3 and 4

Clockwise from Left:
Filters 3 and 4. Filters 3 and 4 tank and connecting piping. Filters 3 and 4 backwash waste trough.

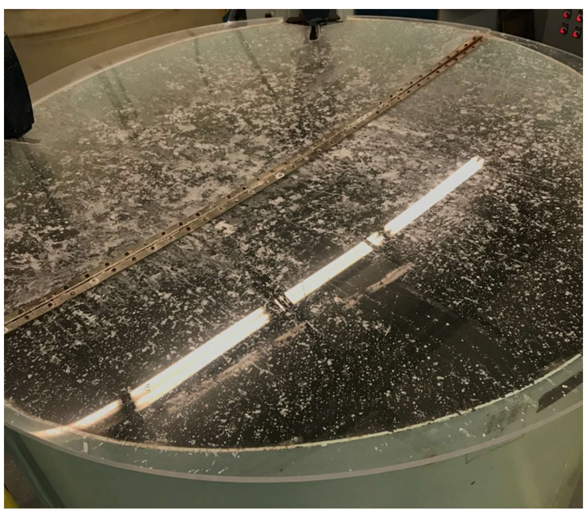
<u>**A8: Filtered Water Piping**</u>

From Left to Right:
Filters 1 and 2 connecting piping.
Filters 3 and 4 connecting piping.

A9: Alum Dosing Equipment

From Left to Right:
Existing Alum tank. Existing soda ash (left) and alum (right) chemical metering pumps.

A10: Soda Ash Dosing Equipment



Clockwise from Upper Left:
Soda Ash tank and loading platform. Soda ash (left) and alum (right) chemical metering pumps. Soda ash tank hinged access lid.

A11: Clearwell

From Left to Right:
Clearwell interior with staining. Clearwell access lid and ladder.

A12: Clearwell Transfer Pumps

From Left to Right:
Clearwell transfer pumps and connecting piping. Clearwell transfer pumps and discharge piping.

A13: Instrumentation

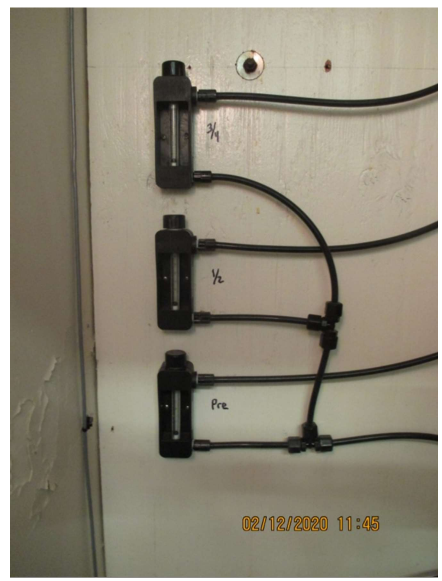
Clockwise from Upper Left:

Raw water quality instrumentation. Finished water quality instrumentation. Raw water flow meter. Finished water quality instrumentation.

A14: Existing Workstation

From Left to Right:
West side of workstation – electrical equipment. East side of workstation – water quality sampling and analysis.

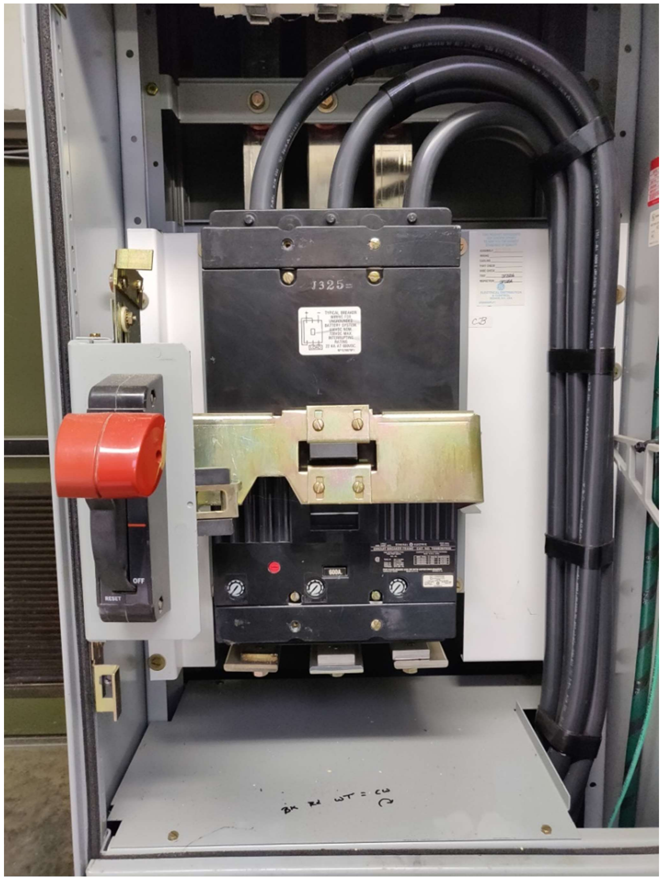
A15: Chlorine Gas Equipment



Clockwise from Upper Left:

Active chlorine gas cylinders and scale. Scale assembly. Gas disinfection flow meters. Chlorine Gas Room exhaust louver

A16: Motor Control Center 1 (MCC1)



From Left to Right:
Finished Water Pump Building MCC 1. Service disconnect.

A17: Motor Control Center 2 (MCC2)

From Left to Right:
WTP Main Building MCC 2. MCC 2.

A18: Motor Control Center 3 (MCC3)

Photographed:
WTP Main Building MCC 3.

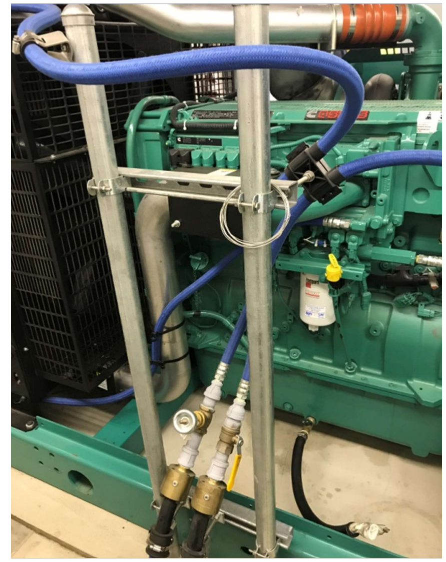
A19: Finished Water Pump Building

Photographed:
Finished Water Pump Building north façade.

A20: Finished Water Pumps

From Left to Right:
Finished water pumps and suction piping. Finished water pumps and discharge piping.

A21: Auxiliary Generator



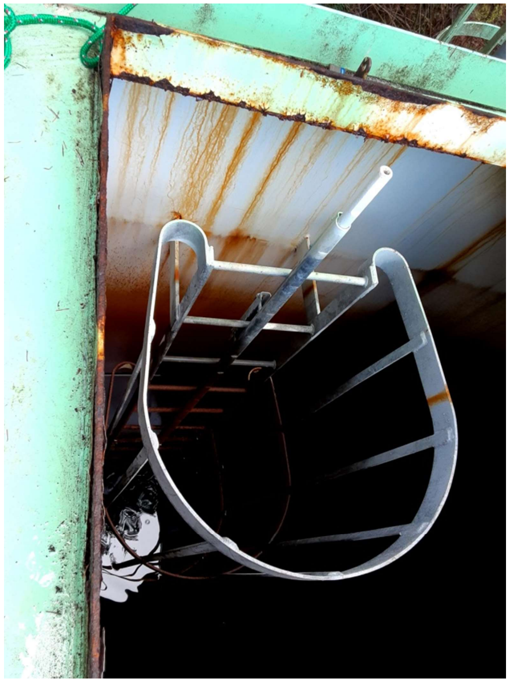
Clockwise from Left:
Auxiliary generator with washing machine and intake louver (background). Auxiliary generator. Auxiliary generator.

A22: External Generator Diesel Fuel Tank

From Left to Right:

Auxiliary generator diesel fuel tank. Auxiliary genitor diesel fuel tank and Finished Water Pump Building south façade.

A23: Chlorine Contact Basin (CCB)



Clockwise from Upper Left:

CCB algae and corrosion. CCB with west manway. CCB interior access ladder. CCB external sight gauge. CCB east wall.

APPENDIX B

DAILY MONITORING REPORT INFORMATION

Health

Water Treatment Plant Monthly Report Form

Month: 1 Year: 2018

PWS ID	959101	PWS Name	Lake Whatcom Water & Sewer Dist
Source ID	S01	Source Name	Lake Whatcom
County	Whatcom	Plant ID	Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs): Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU: Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU: 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	494.0	11.87	39.9	6.0	54.9	n/a	n/a	63.9	n/a	n/a	n/a	0.48	n/a	0.04				0.05	0.04	0.04	0	0.05	91.0	6.4	7.6	7.4	n/a	n/a	n/a
2	595.0	14.36	39.7	9.0	66.4	n/a	n/a	77.4	n/a	n/a	n/a	0.39	n/a	0.05			0.05	0.04	0.04	0.05	0	0.05	88.3	6.4	7.6	7.4	n/a	n/a	n/a
3	470.9	11.26	40.2	7.0	52.1	n/a	n/a	60.7	n/a	n/a	n/a	0.47	n/a				0.05	0.04	0.04	0.04	0	0.05	90.7	6.3	7.6	7.4	n/a	n/a	n/a
4	498.9	11.99	39.3	8.0	55.4	n/a	n/a	64.6	n/a	n/a	n/a	0.47	n/a				0.05	0.04	0.04	0.04	0	0.05	90.8	6.2	7.6	7.4	n/a	n/a	n/a
5	488.6	11.65	39.5	6.0	53.9	n/a	n/a	62.8	n/a	n/a	n/a	0.53	n/a				0.06	0.04	0.05	0.05	0	0.06	90.5	6.3	7.5	7.3	n/a	n/a	n/a
6	518.1	12.40	39.4	8.0	57.3	n/a	n/a	66.8	n/a	n/a	n/a	0.56	n/a	0.05			0.05	0.04	0.05	0.05	0	0.05	91.6	6.3	7.5	7.3	n/a	n/a	n/a
7	501.7	11.99	39.8	6.0	55.4	n/a	n/a	64.6	n/a	n/a	n/a	0.57	n/a				0.05	0.04	0.04	0.04	0	0.05	92.5	6.3	7.5	7.3	n/a	n/a	n/a
8	519.9	12.55	39.3	9.0	58.0	n/a	n/a	67.6	n/a	n/a	n/a	0.50	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	91.4	6.3	7.5	7.3	n/a	n/a	n/a
9	527.5	12.61	39.3	5.0	58.3	n/a	n/a	68.0	n/a	n/a	n/a	0.59	n/a	0.05			0.05	0.04	0.04	0.05	0	0.05	92.4	6.3	7.5	7.3	n/a	n/a	n/a
10	436.0	10.47	39.2	8.0	48.4	n/a	n/a	56.4	n/a	n/a	n/a	0.62	n/a				0.05	0.03	0.04	0.04	0	0.05	93.6	6.2	7.6	7.3	n/a	n/a	n/a
11	478.6	11.42	39.1	6.0	52.8	n/a	n/a	61.5	n/a	n/a	n/a	0.53	n/a				0.05	0.04	0.04	0.04	0	0.05	91.9	6.1	7.6	7.2	n/a	n/a	n/a
12	483.0	11.57	40.1	7.0	53.5	n/a	n/a	62.3	n/a	n/a	n/a	0.56	n/a				0.05	0.04	0.04	0.04	0	0.05	92.3	6.2	7.5	7.3	n/a	n/a	n/a
13	477.0	11.38	39.2	8.0	52.6	n/a	n/a	61.3	n/a	n/a	n/a	0.57	n/a				0.05	0.04	0.04	0.04	0	0.05	92.4	6.2	7.5	7.3	n/a	n/a	n/a
14	564.7	13.53	39.5	9.0	62.5	n/a	n/a	72.9	n/a	n/a	n/a	0.63	n/a	0.05			0.05	0.04	0.04	0.05	0	0.05	92.8	6.2	7.5	7.4	n/a	n/a	n/a
15	423.9	10.12	38.7	9.0	46.8	n/a	n/a	54.5	n/a	n/a	n/a	0.57	n/a				0.05	0.04	0.05	0.05	0	0.05	91.8	6.3	7.5	7.4	n/a	n/a	n/a
16	545.5	13.08	39.4	8.0	60.5	n/a	n/a	70.5	n/a	n/a	n/a	0.49	n/a	0.05			0.05	0.03	0.04	0.04	0	0.05	91.3	6.3	7.5	7.4	n/a	n/a	n/a
17	458.1	10.94	39.3	8.0	50.6	n/a	n/a	59.0	n/a	n/a	n/a	0.55	n/a				0.06	0.04	0.04	0.05	0	0.06	91.5	6.3	7.5	7.3	n/a	n/a	n/a
18	522.6	12.49	38.8	5.0	57.8	n/a	n/a	67.3	n/a	n/a	n/a	0.38	n/a	0.04			0.05	0.04	0.05	0.05	0	0.05	88.2	6.3	7.5	7.4	n/a	n/a	n/a
19	470.4	11.24	39.1	7.0	51.9	n/a	n/a	60.5	n/a	n/a	n/a	0.43	n/a				0.06	0.04	0.05	0.05	0	0.06	88.2	6.3	7.5	7.3	n/a	n/a	n/a
20	433.8	10.36	39.1	8.0	47.9	n/a	n/a	55.8	n/a	n/a	n/a	0.41	n/a				0.05	0.03	0.04	0.04	0	0.05	90.3	6.3	7.5	7.3	n/a	n/a	n/a
21	531.7	12.70	39.3	7.0	58.7	n/a	n/a	68.4	n/a	n/a	n/a	0.60	n/a	0.04			0.06	0.04	0.04	0.05	0	0.06	92.5	6.2	7.5	7.3	n/a	n/a	n/a
22	506.2	12.12	39.0	8.0	56.0	n/a	n/a	65.3	n/a	n/a	n/a	0.58	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	93.1	6.2	7.5	7.3	n/a	n/a	n/a
23	493.3	11.79	39.2	7.0	54.5	n/a	n/a	63.5	n/a	n/a	n/a	0.58	n/a				0.05	0.04	0.04	0.04	0	0.05	92.6	6.1	7.5	7.3	n/a	n/a	n/a
24	459.5	10.99	39.1	7.0	50.8	n/a	n/a	59.2	n/a	n/a	n/a	0.67	n/a				0.05	0.04	0.05	0.05	0	0.05	93.0	6.1	7.5	7.3	n/a	n/a	n/a
25	471.7	11.28	39.1	8.0	52.1	n/a	n/a	60.8	n/a	n/a	n/a	0.55	n/a				0.05	0.04	0.04	0.04	0	0.05	92.0	6.0	7.6	7.3	n/a	n/a	n/a
26	502.7	12.01	40.2	6.0	55.5	n/a	n/a	64.7	n/a	n/a	n/a	0.50	n/a	0.03			0.05	0.04	0.04	0.04	0	0.05	92.0	0.0	7.6	7.3	n/a	n/a	n/a
27	463.9	11.09	38.9	7.0	51.3	n/a	n/a	59.8	n/a	n/a	n/a	0.66	n/a				0.05	0.04	0.05	0.05	0	0.05	92.9	6.1	7.6	7.4	n/a	n/a	n/a
28	532.9	12.74	39.2	8.0	58.9	n/a	n/a	68.6	n/a	n/a	n/a	0.57	n/a	0.05			0.06	0.04	0.04	0.05	0	0.06	91.7	6.1	7.6	7.5	n/a	n/a	n/a
29	493.7	11.79	38.8	10.0	54.5	n/a	n/a	63.5	n/a	n/a	n/a	0.60	n/a				0.06	0.04	0.04	0.05	0	0.06	92.2	6.1	7.6	7.4	n/a	n/a	n/a
30	491.0	11.74	38.7	6.0	54.3	n/a	n/a	63.3	n/a	n/a	n/a	0.63	n/a	0.04			0.06	0.03	0.04	0.04	0	0.06	93.2	6.1	7.6	7.4	n/a	n/a	n/a
31	499.5	11.9	39.0	8.0	55.2	n/a	n/a	64.3	n/a	n/a	n/a	0.64	n/a				0.05	0.03	0.03	0.04	0	0.05	94.3	6.1	7.6	7.4	n/a	n/a	n/a
Total	15354	367.5	1,218	229.0	1,698.6	0.0	0.0	1,980.1	0.0	0.0	0.0										0								
Avg	495	11.9	39.30	7.4	54.8			63.9				0.54								0.04			91.7	6.0	7.5	7.3			

Total number of CFE samples analyzed for month: N = 105

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.03

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Health

Water Treatment Plant Monthly Report Form

Month: 2 Year: 2018

PWS ID: 959101 PWS Name: Lake Whatcom Water & Sewer Dist County: Whatcom
Source ID: S01 Source Name: Lake Whatcom Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	432.1	10.34	38.9	8.0	47.8	n/a	n/a	55.7	n/a	n/a	n/a	0.74	n/a				0.05	0.03	0.04	0.04	0	0.05	94.6	6.1	7.5	7.4	n/a	n/a	n/a
2	515.1	12.33	39.0	10.0	57.0	n/a	n/a	66.4	n/a	n/a	n/a	0.70	n/a	0.04			0.06	0.04	0.04	0.05	0	0.06	93.6	6.1	7.5	7.3	n/a	n/a	n/a
3	502.6	12.01	38.6	6.0	55.5	n/a	n/a	64.7	n/a	n/a	n/a	0.72	n/a	0.04			0.06	0.03	0.04	0.04	0	0.06	94.1	6.1	7.5	7.0	n/a	n/a	n/a
4	531.1	12.71	39.2	7.0	58.8	n/a	n/a	68.5	n/a	n/a	n/a	0.63	n/a	0.04			0.06	0.04	0.04	0.05	0	0.06	92.9	6.2	7.5	7.4	n/a	n/a	n/a
5	545.0	13.09	39.2	7.0	60.5	n/a	n/a	70.5	n/a	n/a	n/a	1.36	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	96.9	6.1	7.6	7.4	n/a	n/a	n/a
6	496.9	11.89	39.0	10.0	54.9	n/a	n/a	64.0	n/a	n/a	n/a	1.01	n/a				0.05	0.04	0.04	0.04	0	0.05	95.7	6.2	7.5	7.3	n/a	n/a	n/a
7	418.8	10.09	38.7	8.0	46.7	n/a	n/a	54.4	n/a	n/a	n/a	1.36	n/a				0.05	0.04	0.04	0.04	0	0.05	96.8	6.2	7.4	7.3	n/a	n/a	n/a
8	541.6	13.06	39.8	7.0	60.4	n/a	n/a	70.4	n/a	n/a	n/a	0.86	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	95.1	6.1	7.5	7.3	n/a	n/a	n/a
9	532.6	12.73	39.1	5.0	58.9	n/a	n/a	68.6	n/a	n/a	n/a	0.84	n/a			0.05	0.03	0.03	0.03	0.04	0	0.05	95.8	6.1	7.6	7.4	n/a	n/a	n/a
10	524.2	12.69	38.8	8.0	58.7	n/a	n/a	68.4	n/a	n/a	n/a	1.00	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	95.7	6.2	7.6	7.4	n/a	n/a	n/a
11	510.3	12.27	39.2	6.0	56.7	n/a	n/a	66.1	n/a	n/a	n/a	1.01	n/a			0.06	0.04	0.03	0.03	0.04	0	0.06	96.0	6.2	7.6	7.4	n/a	n/a	n/a
12	565.1	13.78	40.0	8.0	63.7	n/a	n/a	74.3	n/a	n/a	n/a	1.11	n/a	0.04			0.05	0.04	0.05	0.05	0	0.05	96.0	6.1	7.6	7.4	n/a	n/a	n/a
13	530.0	12.71	39.7	7.0	58.7	n/a	n/a	68.5	n/a	n/a	n/a	0.84	n/a	0.03			0.05	0.05	0.05	0.05	0	0.05	94.7	6.0	7.6	7.4	n/a	n/a	n/a
14	517.9	12.41	39.5	7.0	57.3	n/a	n/a	66.8	n/a	n/a	n/a	0.71	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	94.7	6.0	7.6	7.3	n/a	n/a	n/a
15	484.8	11.63	39.7	7.0	53.7	n/a	n/a	62.6	n/a	n/a	n/a	0.78	n/a				0.05	0.04	0.04	0.04	0	0.05	94.5	6.0	7.6	7.3	n/a	n/a	n/a
16	512.6	12.26	39.4	9.0	56.7	n/a	n/a	66.0	n/a	n/a	n/a	0.66	n/a	0.05			0.05	0.04	0.04	0.05	0	0.05	93.2	5.9	7.6	7.4	n/a	n/a	n/a
17	532.1	12.73	39.4	7.0	58.8	n/a	n/a	68.6	n/a	n/a	n/a	0.70	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	93.9	5.9	7.6	7.4	n/a	n/a	n/a
18	515.7	12.36	39.5	8.0	57.1	n/a	n/a	66.6	n/a	n/a	n/a	0.72	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	94.8	5.8	7.7	7.5	n/a	n/a	n/a
19	615.2	14.81	39.1	9.0	68.5	n/a	n/a	79.8	n/a	n/a	n/a	0.67	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	93.6	5.8	7.7	7.5	n/a	n/a	n/a
20	477.3	11.41	39.4	7.0	52.7	n/a	n/a	61.5	n/a	n/a	n/a	0.80	n/a				0.05	0.03	0.03	0.04	0	0.05	95.4	5.7	7.7	7.5	n/a	n/a	n/a
21	440.4	10.55	40.5	6.0	48.8	n/a	n/a	56.8	n/a	n/a	n/a	0.96	n/a					0.05	0.04	0.05	0	0.05	95.3	5.4	7.8	7.5	n/a	n/a	n/a
22	472.2	11.29	39.5	6.0	52.2	n/a	n/a	60.8	n/a	n/a	n/a	0.90	n/a	0.05				0.05	0.04	0.05	0	0.05	94.8	5.7	7.3	7.5	n/a	n/a	n/a
23	492.9	11.79	40.2	8.0	54.5	n/a	n/a	63.5	n/a	n/a	n/a	0.55	n/a				0.05	0.03	0.04	0.04	0	0.05	92.7	5.6	7.3	7.5	n/a	n/a	n/a
24	424.5	10.14	39.7	5.0	46.9	n/a	n/a	54.6	n/a	n/a	n/a	0.59	n/a				0.05	0.04	0.05	0.05	0	0.05	92.1	5.6	7.3	7.5	n/a	n/a	n/a
25	522.2	12.51	40.2	7.0	57.8	n/a	n/a	67.4	n/a	n/a	n/a	0.51	n/a	0.05			0.05	0.04	0.04	0.05	0	0.05	91.1	5.6	7.3	7.5	n/a	n/a	n/a
26	507.4	12.15	39.9	6.0	56.2	n/a	n/a	65.5	n/a	n/a	n/a	0.51	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	91.6	5.6	7.3	7.5	n/a	n/a	n/a
27	468.4	11.20	39.8	6.0	51.8	n/a	n/a	60.4	n/a	n/a	n/a	0.87	n/a	0.05				0.05	0.03	0.04	0	0.05	95.0	5.6	7.3	7.4	n/a	n/a	n/a
28	472.6	11.41	39.9	6.0	52.7	n/a	n/a	61.5	n/a	n/a	n/a	0.56	n/a	0.04				0.05	0.04	0.04	0	0.05	92.3	5.4	7.6	7.3	n/a	n/a	n/a
29						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a
30						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a
31						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a
Total	14102	338.3	1,105	201.0	1,564.0	0.0	0.0	1,823.1	0.0	0.0	0.0										0								
Avg	504	12.1	39.46	7.2	55.9			65.1				0.81								0.04			94.4	5.9	7.5	7.4			

Total number of CFE samples analyzed for month: N = 100

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.03

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Health

Water Treatment Plant Monthly Report Form

Month: 3 Year: 2018

PWS ID: 959101 | PWS Name: Lake Whatcom Water & Sewer Dist | County: Whatcom
Source ID: S01 | Source Name: Lake Whatcom | Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	504.5	12.06	39.6	6.0	55.7	n/a	n/a	65.0	n/a	n/a	n/a	0.59	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	93.6	5.4	7.5	7.2	n/a	n/a	n/a
2	491.1	11.79	40.0	6.0	54.5	n/a	n/a	63.5	n/a	n/a	n/a	0.54	n/a				0.05	0.04	0.04	0.04	0	0.05	92.0	5.4	7.5	7.3	n/a	n/a	n/a
3	464.9	11.10	39.4	8.0	51.3	n/a	n/a	59.8	n/a	n/a	n/a	0.54	n/a				0.05	0.03	0.03	0.04	0	0.05	93.1	5.5	7.4	7.3	n/a	n/a	n/a
4	442.1	10.67	39.5	8.0	49.3	n/a	n/a	57.5	n/a	n/a	n/a	0.56	n/a				0.05	0.03	0.03	0.04	0	0.05	93.5	5.4	7.4	7.3	n/a	n/a	n/a
5	608.7	14.88	39.8	9.0	68.8	n/a	n/a	80.2	n/a	n/a	n/a	0.53	n/a	0.04			0.05	0.04	0.04	0.04	0	0.05	92.0	5.5	7.4	7.2	n/a	n/a	n/a
6	481.7	11.53	39.7	6.0	53.3	n/a	n/a	62.1	n/a	n/a	n/a	0.53	n/a				0.05	0.04	0.04	0.04	0	0.05	91.7	5.5	7.4	7.1	n/a	n/a	n/a
7	481.0	11.51	39.5	7.0	53.2	n/a	n/a	62.0	n/a	n/a	n/a	0.57	n/a				0.05	0.04	0.04	0.04	0	0.05	92.4	5.5	7.4	7.2	n/a	n/a	n/a
8	447.3	10.73	44.6	7.0	49.6	n/a	n/a	57.8	n/a	n/a	n/a	0.53	n/a				0.05	0.04	0.04	0.04	0	0.05	91.8	5.5	7.4	7.2	n/a	n/a	n/a
9	507.6	12.13	40.0	7.0	56.1	n/a	n/a	65.4	n/a	n/a	n/a	0.52	n/a	0.05			0.05	0.03	0.04	0.04	0	0.05	91.8	5.5	7.4	7.2	n/a	n/a	n/a
10	500.4	11.98	39.0	8.0	55.4	n/a	n/a	64.5	n/a	n/a	n/a	0.48	n/a				0.05	0.04	0.05	0.05	0	0.05	90.3	5.5	7.4	7.2	n/a	n/a	n/a
11	511.8	12.25	39.1	8.0	56.6	n/a	n/a	66.0	n/a	n/a	n/a	0.49	n/a	0.05			0.05	0.03	0.04	0.04	0	0.05	91.4	5.5	7.4	7.2	n/a	n/a	n/a
12	538.3	12.95	43.0	9.0	59.9	n/a	n/a	69.8	n/a	n/a	n/a	0.51	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	92.7	5.6	7.4	7.2	n/a	n/a	n/a
13	477.6	11.46	39.3	8.0	53.0	n/a	n/a	61.8	n/a	n/a	n/a	0.48	n/a				0.05	0.04	0.03	0.04	0	0.05	91.6	5.7	7.4	7.4	n/a	n/a	n/a
14	462.1	11.10	39.2	7.0	51.3	n/a	n/a	59.8	n/a	n/a	n/a	0.53	n/a				0.04	0.04	0.04	0.04	0	0.04	92.4	5.6	7.3	7.4	n/a	n/a	n/a
15	475.4	11.39	38.9	8.0	52.6	n/a	n/a	61.4	n/a	n/a	n/a	0.48	n/a				0.04	0.06	0.05	0.05	0	0.06	89.6	5.7	7.4	7.4	n/a	n/a	n/a
16	454.7	10.89	39.1	7.0	50.3	n/a	n/a	58.7	n/a	n/a	n/a	0.53	n/a				0.04	0.04	0.03	0.04	0	0.04	93.0	5.7	7.4	7.4	n/a	n/a	n/a
17	490.6	11.73	38.9	7.0	54.2	n/a	n/a	63.2	n/a	n/a	n/a	0.49	n/a				0.04	0.04	0.03	0.04	0	0.04	92.5	5.6	7.3	7.4	n/a	n/a	n/a
18	504.7	12.10	39.1	8.0	55.9	n/a	n/a	65.2	n/a	n/a	n/a	0.49	n/a	0.03			0.04	0.04	0.04	0.04	0	0.04	92.3	5.8	7.3	7.5	n/a	n/a	n/a
19	578.2	13.87	38.8	8.0	64.1	n/a	n/a	74.7	n/a	n/a	n/a	0.48	n/a	0.05			0.04	0.03	0.02	0.04	0	0.05	92.7	5.7	7.4	7.4	n/a	n/a	n/a
20	482.0	11.51	39.0	8.0	53.2	n/a	n/a	62.0	n/a	n/a	n/a	0.48	n/a				0.04	0.03	0.03	0.03	0	0.04	93.0	5.7	7.3	7.3	n/a	n/a	n/a
21	474.0	11.34	38.9	6.0	52.4	n/a	n/a	61.1	n/a	n/a	n/a	0.45	n/a				0.04	0.04	0.04	0.04	0	0.04	91.1	5.8	7.3	7.3	n/a	n/a	n/a
22	478.7	11.45	39.1	7.0	52.9	n/a	n/a	61.7	n/a	n/a	n/a	0.52	n/a				0.04	0.04	0.04	0.04	0	0.04	92.3	5.6	7.3	7.4	n/a	n/a	n/a
23	457.3	10.92	39.9	5.0	50.5	n/a	n/a	58.8	n/a	n/a	n/a	0.89	n/a				0.03	0.03	0.04	0.03	0	0.04	96.3	5.7	7.3	7.4	n/a	n/a	n/a
24	474.9	11.34	39.8	7.0	52.4	n/a	n/a	61.1	n/a	n/a	n/a	0.87	n/a				0.04	0.03	0.04	0.04	0	0.04	95.8	5.8	7.3	7.3	n/a	n/a	n/a
25	522.5	12.50	38.9	8.0	57.8	n/a	n/a	67.4	n/a	n/a	n/a	0.91	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	95.9	6.0	7.3	7.3	n/a	n/a	n/a
26	528.5	12.68	39.1	7.0	58.6	n/a	n/a	68.3	n/a	n/a	n/a	0.42	n/a				0.05	0.03	0.03	0.04	0	0.05	91.4	5.7	7.2	7.3	n/a	n/a	n/a
27	465.2	11.11	39.0	6.0	51.4	n/a	n/a	59.9	n/a	n/a	n/a	0.44	n/a				0.04	0.03	0.03	0.03	0	0.04	92.4	5.8	7.2	7.3	n/a	n/a	n/a
28	494.4	11.85	38.8	8.0	54.8	n/a	n/a	63.9	n/a	n/a	n/a	0.61	n/a				0.05	0.03	0.02	0.03	0	0.05	94.5	6.0	7.2	7.3	n/a	n/a	n/a
29	442.6	10.56	39.2	7.0	48.8	n/a	n/a	56.9	n/a	n/a	n/a	0.49	n/a				0.06	0.03	0.03	0.04	0	0.06	91.9	6.0	7.2	7.3	n/a	n/a	n/a
30	470.4	11.27	38.7	5.0	52.1	n/a	n/a	60.7	n/a	n/a	n/a	0.46	n/a				0.06	0.04	0.04	0.05	0	0.06	89.9	6.1	7.2	7.3	n/a	n/a	n/a
31	423.4	10.1	38.8	7.0	46.8	n/a	n/a	54.6	n/a	n/a	n/a	0.40	n/a				0.06	0.03	0.04	0.04	0	0.06	89.1	6.2	7.2	7.1	n/a	n/a	n/a
Total	15137	362.8	1,226	223.0	1,676.9	0.0	0.0	1,954.7	0.0	0.0	0.0										0								
Avg	488	11.7	39.54	7.2	54.1			63.1				0.54								0.04			92.4	5.7	7.3	7.3			

Total number of CFE samples analyzed for month: N = 101

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.04

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Health

Water Treatment Plant Monthly Report Form

Month: 4 Year: 2018

PWS ID: 959101 PWS Name: Lake Whatcom Water & Sewer Dist County: Whatcom
Source ID: S01 Source Name: Lake Whatcom Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs)								Turbidity NTU		Combined Filter Effluent Turbidity 4 hour sample NTU							No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C	pH		Total Alkalinity mg/L as CaCO3		Calcium Hardness mg/L as CaCO3 Fin
				Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Raw	Settled	1st	2nd	3rd	4th	5th	6th	Avg				Raw	Raw	Final	Raw	Fin	
1	544.2	13.13	39.5	9.0	60.7	n/a	n/a	70.8	n/a	n/a	n/a	0.43	n/a	0.04			0.06	0.03	0.03	0.04	0	0.06	90.8	6.0	7.1	7.2	n/a	n/a	n/a
2	517.3	12.43	38.8	11.0	57.4	n/a	n/a	67.0	n/a	n/a	n/a	0.50	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	92.5	6.0	7.2	7.3	n/a	n/a	n/a
3	446.9	10.69	38.8	6.0	49.4	n/a	n/a	57.6	n/a	n/a	n/a	0.45	n/a				0.04	0.03	0.03	0.03	0	0.04	92.5	5.9	7.1	7.3	n/a	n/a	n/a
4	503.8	12.02	38.8	5.0	55.6	n/a	n/a	64.8	n/a	n/a	n/a	0.38	n/a				0.05	0.04	0.04	0.04	0	0.05	88.6	6.3	7.1	7.2	n/a	n/a	n/a
5	489.5	11.70	39.0	8.0	54.1	n/a	n/a	63.0	n/a	n/a	n/a	0.41	n/a				0.05	0.03	0.03	0.04	0	0.05	91.0	6.2	7.1	7.1	n/a	n/a	n/a
6	443.5	10.62	38.7	6.0	49.1	n/a	n/a	57.2	n/a	n/a	n/a	0.40	n/a				0.04	0.02	0.03	0.03	0	0.04	92.5	6.3	7.1	7.1	n/a	n/a	n/a
7	481.9	11.49	38.9	5.0	53.1	n/a	n/a	61.9	n/a	n/a	n/a	0.41	n/a				0.03	0.03	0.03	0.03	0	0.03	92.6	5.9	7.0	7.3	n/a	n/a	n/a
8	484.6	11.57	38.6	7.0	53.5	n/a	n/a	62.3	n/a	n/a	n/a	0.43	n/a				0.05	0.03	0.03	0.04	0	0.05	91.4	6.0	7.0	7.3	n/a	n/a	n/a
9	527.8	12.61	39.0	8.0	58.3	n/a	n/a	67.9	n/a	n/a	n/a	0.41	n/a	0.03			0.05	0.02	0.03	0.03	0	0.05	92.1	6.4	7.0	7.2	n/a	n/a	n/a
10	540.9	12.93	39.5	7.0	59.8	n/a	n/a	69.7	n/a	n/a	n/a	0.45	n/a	0.03			0.05	0.03	0.02	0.03	0	0.05	92.7	6.3	6.9	7.3	n/a	n/a	n/a
11	416.6	9.96	38.8	7.0	46.1	n/a	n/a	53.7	n/a	n/a	n/a	0.50	n/a				0.04	0.03	0.03	0.03	0	0.04	93.3	6.1	7.0	7.3	n/a	n/a	n/a
12	547.6	13.09	38.5	8.0	60.5	n/a	n/a	70.5	n/a	n/a	n/a	0.53	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	93.9	6.4	7.0	7.4	n/a	n/a	n/a
13	484.5	11.58	39.0	8.0	53.5	n/a	n/a	62.4	n/a	n/a	n/a	0.55	n/a				0.05	0.03	0.03	0.04	0	0.05	93.3	6.2	7.0	7.4	n/a	n/a	n/a
14	499.7	12.05	39.1	7.0	55.7	n/a	n/a	64.9	n/a	n/a	n/a	0.50	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	93.5	6.4	7.1	7.3	n/a	n/a	n/a
15	481.0	11.49	38.7	6.0	53.1	n/a	n/a	61.9	n/a	n/a	n/a	0.52	n/a				0.05	0.04	0.04	0.04	0	0.05	91.6	6.6	7.1	7.2	n/a	n/a	n/a
16	555.8	13.28	39.1	8.0	61.4	n/a	n/a	71.6	n/a	n/a	n/a	0.40	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	90.0	6.1	7.1	7.2	n/a	n/a	n/a
17	580.8	13.90	38.9	7.0	64.2	n/a	n/a	74.9	n/a	n/a	n/a	0.42	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	90.5	6.2	7.0	7.3	n/a	n/a	n/a
18	530.4	12.68	38.8	9.0	58.6	n/a	n/a	68.3	n/a	n/a	n/a	0.44	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	91.5	6.6	7.1	7.3	n/a	n/a	n/a
19	473.0	11.29	38.6	8.0	52.2	n/a	n/a	60.8	n/a	n/a	n/a	0.47	n/a				0.05	0.03	0.03	0.04	0	0.05	92.3	6.8	7.1	7.3	n/a	n/a	n/a
20	462.5	11.04	38.6	6.0	51.0	n/a	n/a	59.5	n/a	n/a	n/a	0.46	n/a				0.05	0.03	0.04	0.04	0	0.05	91.3	6.4	7.1	7.3	n/a	n/a	n/a
21	495.1	11.81	49.5	7.0	54.6	n/a	n/a	63.6	n/a	n/a	n/a	0.44	n/a				0.05	0.03	0.03	0.04	0	0.05	91.7	6.4	7.1	7.3	n/a	n/a	n/a
22	562.7	13.43	40.3	9.0	62.1	n/a	n/a	72.4	n/a	n/a	n/a	0.47	n/a	0.03			0.05	0.02	0.03	0.03	0	0.05	93.1	6.8	7.1	7.4	n/a	n/a	n/a
23	494.6	11.81	39.5	9.0	54.6	n/a	n/a	63.6	n/a	n/a	n/a	0.52	n/a				0.05	0.03	0.03	0.04	0	0.05	92.9	6.6	7.1	7.4	n/a	n/a	n/a
24	508.4	12.14	38.4	7.0	56.1	n/a	n/a	65.4	n/a	n/a	n/a	0.64	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	94.9	6.4	7.0	7.3	n/a	n/a	n/a
25	492.5	11.76	38.5	7.0	54.4	n/a	n/a	63.4	n/a	n/a	n/a	0.79	n/a				0.04	0.03	0.03	0.03	0	0.04	95.8	6.4	7.0	7.3	n/a	n/a	n/a
26	495.3	11.82	38.6	8.0	54.6	n/a	n/a	63.7	n/a	n/a	n/a	0.95	n/a				0.04	0.03	0.04	0.04	0	0.04	96.1	6.7	7.0	7.3	n/a	n/a	n/a
27	474.5	11.33	38.7	8.0	52.4	n/a	n/a	61.1	n/a	n/a	n/a	0.97	n/a				0.04	0.03	0.04	0.04	0	0.04	96.2	6.4	7.0	7.3	n/a	n/a	n/a
28	488.6	11.66	38.7	7.0	53.9	n/a	n/a	62.8	n/a	n/a	n/a	1.19	n/a				0.04	0.03	0.02	0.03	0	0.04	97.5	6.5	6.9	7.3	n/a	n/a	n/a
29	493.4	11.78	38.7	7.0	54.4	n/a	n/a	63.4	n/a	n/a	n/a	1.17	n/a				0.04	0.02	0.03	0.03	0	0.04	97.4	6.7	6.9	7.3	n/a	n/a	n/a
30	571.1	13.63	38.7	8.0	63.0	n/a	n/a	73.5	n/a	n/a	n/a	0.38	n/a	0.04			0.05	0.02	0.02	0.03	0	0.05	91.4	6.5	6.9	7.3	n/a	n/a	n/a
31						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a
Total	15089	360.7	1,177	223.0	1,667.3	0.0	0.0	1,943.5	0.0	0.0	0.0										0								
Avg	503	12.0	39.24	7.4	55.6			64.8				0.55								0.04			92.8	6.3	7.0	7.3			

Total number of CFE samples analyzed for month: N = 102
Total number of CFE samples exceeding 0.3 NTU: E = 0
NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)
Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%
Number of days CFE exceeded 1.0 NTU this month: 0
Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"
Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N
Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0
Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y
Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.04
Report Submitted By: Kevin Cook Signature:

DOH Form #331-023-F (Excel version)

Washington State Department of Health

Water Treatment Plant Monthly Report Form

Month: 5 Year: 2018

PWS ID: | PWS Name: Lake Whatcom Water & Sewer Dist | County: Whatcom
Source ID: S01 | Source Name: Lake Whatcom | Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs)								Turbidity NTU		Combined Filter Effluent Turbidity 4 hour sample NTU							No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C	pH		Total Alkalinity mg/L as CaCO3		Calcium Hardness mg/L as CaCO3 Fin
				Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Raw	Settled	1st	2nd	3rd	4th	5th	6th	Avg				Raw	Raw	Final	Raw	Fin	
1	473.0	11.29	37.7	7.0	52.2	n/a	n/a	60.8	n/a	n/a	n/a	0.338	n/a				0.05	0.02	0.02	0.03	0	0.05	91.1	6.6	6.9	7.3	n/a	n/a	n/a
2	484.7	11.57	36.9	6.0	53.5	n/a	n/a	62.4	n/a	n/a	n/a	0.331	n/a				0.05	0.02	0.02	0.03	0	0.05	90.9	6.6	6.8	7.3	n/a	n/a	n/a
3	528.5	12.61	40.6	7.0	58.3	n/a	n/a	68.0	n/a	n/a	n/a	0.316	n/a	0.02			0.05	0.03	0.03	0.03	0	0.05	89.7	6.6	6.7	7.2	n/a	n/a	n/a
4	457.4	10.92	38.7	7.0	50.5	n/a	n/a	58.8	n/a	n/a	n/a	0.353	n/a				0.04	0.03	0.04	0.04	0	0.04	89.6	6.9	6.7	7.2	n/a	n/a	n/a
5	379.3	9.06	39.0	7.0	41.9	n/a	n/a	48.8	n/a	n/a	n/a	0.407	n/a				0.04	0.03	0.03	0.03	0	0.04	91.8	6.7	6.7	7.2	n/a	n/a	n/a
6	702.1	16.74	39.1	8.0	77.4	n/a	n/a	90.2	n/a	n/a	n/a	0.481	n/a	0.02	0.04		0.04	0.03	0.03	0.03	0	0.04	93.3	6.6	6.7	7.2	n/a	n/a	n/a
7	548.6	13.10	38.6	9.0	60.5	n/a	n/a	70.6	n/a	n/a	n/a	0.342	n/a	0.03			0.05	0.02	0.02	0.03	0	0.05	91.2	7.0	6.7	7.2	n/a	n/a	n/a
8	456.5	10.89	39.8	8.0	50.4	n/a	n/a	58.7	n/a	n/a	n/a	0.305	n/a				0.05	0.03	0.03	0.04	0	0.05	88.0	6.6	6.7	7.2	n/a	n/a	n/a
9	556.3	13.27	38.6	8.0	61.4	n/a	n/a	71.5	n/a	n/a	n/a	0.368	n/a	0.03			0.04	0.04	0.04	0.04	0	0.04	89.8	6.6	6.8	7.2	n/a	n/a	n/a
10	510.4	12.18	38.5	9.0	56.3	n/a	n/a	65.6	n/a	n/a	n/a	0.305	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	89.3	6.8	6.7	7.3	n/a	n/a	n/a
11	487.1	11.63	38.6	6.0	53.8	n/a	n/a	62.7	n/a	n/a	n/a	0.361	n/a				0.04	0.03	0.03	0.03	0	0.04	90.8	6.8	6.6	7.2	n/a	n/a	n/a
12	527.3	12.58	38.4	6.0	58.2	n/a	n/a	67.8	n/a	n/a	n/a	0.338	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	89.6	6.8	6.6	7.2	n/a	n/a	n/a
13	581.8	13.89	38.9	8.0	64.2	n/a	n/a	74.8	n/a	n/a	n/a	0.329	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	89.4	7.1	6.6	7.2	n/a	n/a	n/a
14	572.8	13.67	38.7	9.0	63.2	n/a	n/a	73.6	n/a	n/a	n/a	0.315	n/a	0.03			0.03	0.02	0.03	0.03	0	0.03	91.3	7.0	6.6	7.2	n/a	n/a	n/a
15	580.1	13.84	38.5	9.0	64.0	n/a	n/a	74.6	n/a	n/a	n/a	0.389	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	91.6	7.1	6.6	7.2	n/a	n/a	n/a
16	562.7	13.43	38.6	7.0	62.1	n/a	n/a	72.3	n/a	n/a	n/a	0.3	n/a	0.03			0.05	0.02	0.02	0.03	0	0.05	89.1	6.7	7.1	7.0	n/a	n/a	n/a
17	578.2	13.81	38.5	7.0	63.8	n/a	n/a	74.4	n/a	n/a	n/a	0.31	n/a	0.03			0.05	0.02	0.02	0.03	0	0.05	90.2	6.8	7.2	7.0	n/a	n/a	n/a
18	492.5	11.74	38.3	7.0	54.3	n/a	n/a	63.3	n/a	n/a	n/a	0.27	n/a				0.05	0.03	0.04	0.04	0	0.05	85.3	6.8	7.1	7.3	n/a	n/a	n/a
19	537.2	12.82	38.2	7.0	59.3	n/a	n/a	69.1	n/a	n/a	n/a	0.30	n/a	0.05			0.05	0.03	0.04	0.04	0	0.05	85.9	6.8	7.2	7.3	n/a	n/a	n/a
20	569.8	13.60	39.0	9.0	62.9	n/a	n/a	73.3	n/a	n/a	n/a	0.36	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	88.8	7.1	7.1	7.3	n/a	n/a	n/a
21	592.4	14.13	38.6	9.0	65.3	n/a	n/a	76.2	n/a	n/a	n/a	0.39	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	90.4	7.1	7.1	7.2	n/a	n/a	n/a
22	591.5	14.11	38.4	9.0	65.2	n/a	n/a	76.0	n/a	n/a	n/a	0.39	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	90.5	6.8	7.2	7.3	n/a	n/a	n/a
23	603.6	14.40	38.4	8.0	66.6	n/a	n/a	77.6	n/a	n/a	n/a	0.24	n/a	0.03			0.05	0.04	0.04	0.04	0	0.05	83.4	6.9	7.1	7.3	n/a	n/a	n/a
24	546.0	13.03	38.2	9.0	60.2	n/a	n/a	70.2	n/a	n/a	n/a	0.28	n/a	0.05			0.05	0.04	0.04	0.05	0	0.05	83.8	6.8	7.1	7.3	n/a	n/a	n/a
25	539.0	12.86	38.2	8.0	59.5	n/a	n/a	69.3	n/a	n/a	n/a	0.30	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	87.6	6.7	7.1	7.3	n/a	n/a	n/a
26	545.0	13.00	38.5	8.0	60.1	n/a	n/a	70.0	n/a	n/a	n/a	0.44	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	91.4	6.9	7.1	7.3	n/a	n/a	n/a
27	590.4	14.09	38.5	10.0	65.1	n/a	n/a	75.9	n/a	n/a	n/a	0.42	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	91.2	6.7	7.1	7.3	n/a	n/a	n/a
28	639.5	15.26	38.4	10.0	70.5	n/a	n/a	82.2	n/a	n/a	n/a	0.43	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	91.9	6.9	7.1	7.4	n/a	n/a	n/a
29	644.3	15.41	38.7	8.0	71.2	n/a	n/a	83.0	n/a	n/a	n/a	0.24	n/a	0.04			0.05	0.04	0.05	0.05	0	0.05	81.4	7.0	7.3	7.4	n/a	n/a	n/a
30	545.8	13.03	38.6	7.0	60.2	n/a	n/a	70.2	n/a	n/a	n/a	0.30	n/a	0.05			0.05	0.03	0.03	0.04	0	0.05	86.7	6.7	7.3	7.3	n/a	n/a	n/a
31	573.2	13.7	38.8	7.0	63.2	n/a	n/a	73.7	n/a	n/a	n/a	0.29	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	87.8	6.8	7.3	7.3	n/a	n/a	n/a
Total	16997	405.6	1,197	244.0	1,875.0	0.0	0.0	2,185.6	0.0	0.0	0.0										0								
Avg	548	13.1	38.60	7.9	60.5			70.5				0.34								0.04			89.1	6.8	6.9	7.3			

Total number of CFE samples analyzed for month: N = 118

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.03

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 6 Year: 2018

PWS ID:
Source ID: S01
PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom
County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs): Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU: Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU: 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C: Raw	pH: Raw	pH: Final	Total Alkalinity mg/L as CaCO3: Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	570.7	13.62	38.7	8.0	62.9	n/a	n/a	73.4	n/a	n/a	n/a	0.326	n/a	0.02			0.05	0.04	0.04	0.04	0	0.05	88.5	6.8	7.3	7.3	n/a	n/a	n/a
2	570.6	13.61	38.9	8.0	62.9	n/a	n/a	73.3	n/a	n/a	n/a	0.333	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	88.7	6.7	7.2	7.3	n/a	n/a	n/a
3	537.6	12.83	38.7	9.0	59.3	n/a	n/a	69.1	n/a	n/a	n/a	0.441	n/a	0.03			0.04	0.04	0.04	0.04	0	0.04	91.5	6.7	7.3	7.2	n/a	n/a	n/a
4	592.3	14.19	39.6	8.0	65.6	n/a	n/a	76.5	n/a	n/a	n/a	0.289	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	87.0	7.0	7.3	7.2	n/a	n/a	n/a
5	530.1	12.64	39.0	8.0	58.4	n/a	n/a	68.1	n/a	n/a	n/a	0.261	n/a	0.05			0.04	0.04	0.04	0.04	0	0.05	83.7	7.0	7.2	7.4	n/a	n/a	n/a
6	546.5	13.04	39.0	7.0	60.3	n/a	n/a	70.3	n/a	n/a	n/a	0.263	n/a	0.02			0.04	0.03	0.03	0.03	0	0.04	88.6	6.7	7.2	7.4	n/a	n/a	n/a
7	575.3	13.73	38.9	8.0	63.5	n/a	n/a	74.0	n/a	n/a	n/a	0.226	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	84.5	7.1	7.2	7.3	n/a	n/a	n/a
8	474.4	11.33	38.8	7.0	52.4	n/a	n/a	61.0	n/a	n/a	n/a	0.242	n/a				0.04	0.02	0.02	0.03	0	0.04	89.0	6.8	7.2	7.3	n/a	n/a	n/a
9	561.5	13.40	38.4	8.0	61.9	n/a	n/a	72.2	n/a	n/a	n/a	0.255	n/a	0.02			0.04	0.02	0.02	0.03	0	0.04	90.2	6.7	7.3	7.4	n/a	n/a	n/a
10	589.6	14.06	38.6	7.0	65.0	n/a	n/a	75.8	n/a	n/a	n/a	0.276	n/a	0.02			0.05	0.02	0.02	0.03	0	0.05	90.0	6.7	7.3	7.4	n/a	n/a	n/a
11	497.6	11.88	37.2	10.0	54.9	n/a	n/a	64.0	n/a	n/a	n/a	0.305	n/a	0.02			0.05	0.03	0.03	0.03	0	0.05	89.3	6.8	7.2	7.4	n/a	n/a	n/a
12	546.0	13.03	38.5	8.0	60.2	n/a	n/a	70.2	n/a	n/a	n/a	0.218	n/a	0.02			0.05	0.02	0.03	0.03	0	0.05	86.2	7.0	7.3	7.4	n/a	n/a	n/a
13	484.3	11.56	38.3	6.0	53.4	n/a	n/a	62.3	n/a	n/a	n/a	0.241	n/a				0.03	0.03	0.03	0.03	0	0.03	87.6	7.0	7.3	7.4	n/a	n/a	n/a
14	475.6	11.35	38.3	6.0	52.5	n/a	n/a	61.1	n/a	n/a	n/a	0.253	n/a				0.04	0.03	0.03	0.03	0	0.04	86.8	6.9	7.2	7.4	n/a	n/a	n/a
15	517.2	12.35	38.7	7.0	57.1	n/a	n/a	66.5	n/a	n/a	n/a	0.492	n/a	0.03			0.04	0.03	0.02	0.03	0	0.04	93.9	6.7	7.3	7.4	n/a	n/a	n/a
16	583.4	13.92	37.8	9.0	64.4	n/a	n/a	75.0	n/a	n/a	n/a	0.229	n/a	0.02			0.04	0.03	0.04	0.03	0	0.04	85.8	6.9	7.3	7.4	n/a	n/a	n/a
17	614.1	14.64	39.2	11.0	67.7	n/a	n/a	78.9	n/a	n/a	n/a	0.198	n/a	0.04			0.04	0.03	0.02	0.03	0	0.04	83.6	6.9	7.3	7.4	n/a	n/a	n/a
18	714.4	17.06	38.2	10.0	78.9	n/a	n/a	91.9	n/a	n/a	n/a	0.231	n/a	0.02			0.04	0.03	0.03	0.03	0	0.04	87.0	6.9	7.3	7.4	n/a	n/a	n/a
19	633.0	15.09	37.9	9.0	69.8	n/a	n/a	81.3	n/a	n/a	n/a	0.198	n/a	0.03			0.04	0.03	0.02	0.03	0	0.04	84.8	7.0	7.3	7.4	n/a	n/a	n/a
20	629.4	15.00	37.8	9.0	69.3	n/a	n/a	80.8	n/a	n/a	n/a	0.201	n/a	0.03			0.04	0.03	0.02	0.03	0	0.04	85.1	6.9	7.2	7.3	n/a	n/a	n/a
21	618.0	14.73	37.7	8.0	68.1	n/a	n/a	79.4	n/a	n/a	n/a	0.192	n/a	0.03			0.04	0.03	0.02	0.03	0	0.04	84.4	6.9	7.2	7.3	n/a	n/a	n/a
22	603.2	14.38	38.1	9.0	66.4	n/a	n/a	77.5	n/a	n/a	n/a	0.333	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	89.5	6.8	7.2	7.3	n/a	n/a	n/a
23	552.7	13.18	37.7	8.0	60.9	n/a	n/a	71.0	n/a	n/a	n/a	0.207	n/a	0.03			0.05	0.02	0.03	0.03	0	0.05	84.3	7.0	7.2	7.4	n/a	n/a	n/a
24	646.5	15.41	38.0	7.0	71.2	n/a	n/a	83.0	n/a	n/a	n/a	0.202	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	82.7	7.1	7.3	7.4	n/a	n/a	n/a
25	661.5	15.77	38.0	8.0	72.9	n/a	n/a	85.0	n/a	n/a	n/a	0.215	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	83.7	7.3	7.2	7.4	n/a	n/a	n/a
26	538.1	12.83	38.0	8.0	59.3	n/a	n/a	69.1	n/a	n/a	n/a	0.226	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	83.4	7.3	7.2	7.3	n/a	n/a	n/a
27	538.1	12.83	38.1	8.0	59.3	n/a	n/a	69.1	n/a	n/a	n/a	0.212	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	84.7	7.2	7.4	7.3	n/a	n/a	n/a
28	588.6	14.04	38.0	9.0	64.9	n/a	n/a	75.6	n/a	n/a	n/a	0.186	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	81.2	6.9	7.3	7.3	n/a	n/a	n/a
29	550.6	13.13	39.2	9.0	60.7	n/a	n/a	70.7	n/a	n/a	n/a	0.309	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	87.9	7.1	7.2	7.3	n/a	n/a	n/a
30	539.0	12.85	38.3	8.0	59.4	n/a	n/a	69.2	n/a	n/a	n/a	0.312	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	88.0	7.1	7.1	7.3	n/a	n/a	n/a
31						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a
Total	17080	407.5	1,152	245.0	1,883.4	0.0	0.0	2,195.4	0.0	0.0	n/a										0								
Avg	569	13.6	38.40	8.2	62.8			73.2				0.26								0.03			86.7	6.9	7.2	7.3			

Total number of CFE samples analyzed for month: N = 117

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in): Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection: 5/3/2017

\# filters with more than 10 percent media loss: 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU): 0.03

Report Submitted By: Kevin Cook

Signature:

DOH Form #331-023-F (Excel version)

Water Treatment Plant Monthly Report Form

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Month: 7 Year: 2018

PWS ID:
PWS Name: Lake Whatcom Water & Sewer Dist
County: Whatcom
Source ID: S01
Source Name: Lake Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	508.1	12.11	38.2	6.0	56.0			65.2				0.224		0.06			0.04	0.03	0.03	0.04	0	0.06	82.1	7.3	7.1	7.2			
2	628.3	14.99	38.6	9.0	69.3			80.7				0.189		0.04			0.05	0.04	0.03	0.04	0	0.05	78.8	6.7	7.1	7.2			
3	535.8	12.78	38.7	8.0	59.1			68.8				0.291		0.04			0.04	0.03	0.03	0.04	0	0.04	88.0	6.8	7.1	7.2			
4	613.8	14.64	38.7	8.0	67.7			78.9				0.187		0.05			0.04	0.03	0.03	0.04	0	0.05	79.9	7.1	7.0	7.2			
5	631.3	15.05	38.6	9.0	69.6			81.1				0.233		0.06			0.04	0.03	0.03	0.04	0	0.06	82.8	6.9	7.0	7.2			
6	646.1	15.40	38.4	8.0	71.2			83.0				0.390		0.05			0.05	0.03	0.03	0.04	0	0.05	89.7	7.0	7.0	7.2			
7	544.9	13.00	38.4	8.0	60.1			70.0				0.178		0.06			0.06	0.05	0.03	0.05	0	0.06	71.9	7.0	7.2	7.2			
8	620.6	14.80	38.7	8.0	68.4			79.7				0.170		0.06			0.06	0.05	0.04	0.05	0	0.06	69.1	7.4	7.6	7.2			
9	676.3	16.12	38.3	8.0	74.5			86.9				0.157		0.03	0.06		0.04	0.03	0.04	0.04	0	0.06	74.5	7.1	7.6	7.2			
10	540.5	12.89	38.2	7.0	59.6			69.4				0.149		0.04			0.03	0.03	0.03	0.03	0	0.04	78.2	7.2	7.4	7.2			
11	615.1	14.66	39.7	7.0	67.8			79.0				0.309		0.03			0.04	0.03	0.03	0.03	0	0.04	89.5	7.1	7.2	7.2			
12	625.2	14.91	38.2	8.0	68.9			80.3				0.340		0.03			0.04	0.02	0.03	0.03	0	0.04	91.2	7.5	7.0	7.3			
13	641.0	15.29	38.6	9.0	70.7			82.4				0.272		0.03			0.04	0.02	0.04	0.03	0	0.04	88.1	6.8	7.0	7.3			
14	691.2	16.48	37.8	8.0	76.2			88.8				0.170		0.05		0.04	0.02	0.03	0.03	0.03	0	0.05	80.0	7.0	7.0	7.2			
15	699.4	16.69	38.0	10.0	77.1			89.9				0.176		0.03		0.04	0.02	0.02	0.02	0.03	0	0.04	85.2	7.2	6.9	7.2			
16	819.7	19.81	38.6	11.0	91.6			106.8				0.185		0.02		0.03	0.04	0.04	0.04	0.03	0	0.04	81.6	7.2	7.4	7.2			
17	691.9	16.51	38.8	10.0	76.3			89.0				0.256		0.04		0.04	0.03	0.03	0.04	0.04	0	0.04	85.9	7.2	7.2	7.2			
18	753.8	18.08	38.4	10.0	83.6			97.4				0.211		0.05	0.03		0.03	0.05	0.05	0.04	0	0.05	80.1	6.9	7.3	7.2			
19	639.4	15.25	38.6	9.0	70.5			82.2				0.167		0.06			0.04	0.02	0.03	0.04	0	0.06	77.5	7.1	7.1	7.2			
20	642.9	15.33	38.4	9.0	70.9			82.6				0.176		0.03			0.03	0.02	0.02	0.03	0	0.03	85.8	7.0	7.1	7.2			
21	698.9	16.66	39.0	10.0	77.0			89.8				0.194		0.03		0.03	0.02	0.02	0.02	0.02	0	0.03	87.6	7.3	7.1	7.2			
22	869.2	21.14	39.2	12.0	97.7			113.9				0.242		0.03	0.03	0.04	0.02	0.03	0.03	0.03	0	0.04	87.6	6.7	7.3	7.2			
23	735.8	17.95	38.9	10.0	83.0			96.7				0.164		0.04	0.04		0.03	0.03	0.03	0.03	0	0.04	79.3	7.0	7.3	7.2			
24	708.6	16.94	38.6	10.0	78.3			91.3				0.174		0.04	0.04		0.03	0.03	0.03	0.03	0	0.04	80.5	7.1	7.2	7.2			
25	749.8	17.92	39.0	10.0	82.8			96.6				0.226		0.04	0.04		0.03	0.03	0.03	0.03	0	0.04	85.0	7.2	7.1	7.1			
26	774.6	18.54	38.8	11.0	85.7			99.9				0.207		0.03	0.04		0.03	0.02	0.03	0.03	0	0.04	85.5	7.1	7.1	7.1			
27	771.5	18.42	38.7	10.0	85.1			99.2				0.213		0.03	0.03		0.03	0.03	0.04	0.03	0	0.04	85.0	7.2	7.1	7.1			
28	755.7	18.02	38.7	11.0	83.3			97.1				0.220		0.04		0.03	0.03	0.03	0.03	0.03	0	0.04	85.5	7.0	6.9	7.2			
29	815.9	19.56	38.6	10.0	90.4			105.4				0.211		0.03		0.04	0.03	0.03	0.03	0.03	0	0.04	84.8	6.7	7.0	7.1			
30	734.6	17.86	38.2	12.0	82.5			96.2				0.208		0.03		0.03	0.02	0.03	0.03	0.03	0	0.03	86.5	7.3	7.1	7.2			
31	743.4	18.0	38.2	11.0	83.4			97.2				0.32		0:03		0.03	0.02	0.02	0.02	0.02	0	0.03	92.4	7.2	7.1	7.2			
Total	21123	505.8	1,196	287.0	2,338.1			2,725.4													0								
Avg	681	16.3	38.58	9.3	75.4			87.9				0.22								0.03			83.2	7.1	7.2	7.2			

Total number of CFE samples analyzed for month: N = 142

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.04

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 8 | Year: 2018

PWS ID: | PWS Name: Lake Whatcom Water & Sewer Dist | County: Whatcom

Source ID: S01 | Source Name: Lake Whatcom | Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

				Chemicals Used (lbs)								Turbidity NTU		Combined Filter Effluent Turbidity 4 hour sample NTU										Temp C	pH		Total Alkalinity mg/L as CaCO3		
Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Raw	Settled	1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Raw	Raw	Final	Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	687.6	16.40	39.5	9.0	75.8	n/a	n/a	88.4	n/a	n/a	n/a	0.163	n/a	0.05		0.03	0.04	0.04	0.04	0.04	0	0.05	75.5	7.3	6.8	7.2	n/a	n/a	n/a
2	626.2	14.93	38.2	9.0	69.0	n/a	n/a	80.4	n/a	n/a	n/a	0.167	n/a	0.04			0.03	0.04	0.04	0.04	0	0.04	77.5	7.4	7.1	7.2	n/a	n/a	n/a
3	663.7	15.84	38.3	9.0	73.2	n/a	n/a	85.4	n/a	n/a	n/a	0.113	n/a	0.04			0.04	0.05	0.05	0.05	0	0.05	60.2	7.4	7.2	7.2	n/a	n/a	n/a
4	649.4	15.53	38.4	10.0	71.8	n/a	n/a	83.7	n/a	n/a	n/a	0.239	n/a	0.05			0.05	0.05	0.05	0.05	0	0.05	79.1	7.3	7.3	7.2	n/a	n/a	n/a
5	734.4	17.51	38.7	11.0	80.9	n/a	n/a	94.4	n/a	n/a	n/a	0.163	n/a	0.05	0.06		0.05	0.04	0.04	0.05	0	0.06	70.6	7.2	7.1	7.2	n/a	n/a	n/a
6	874.2	21.00	38.8	11.0	97.1	n/a	n/a	113.2	n/a	n/a	n/a	0.139	n/a	0.04	0.04	0.05	0.02	0.03	0.03	0.04	0	0.05	74.8	7.2	7.3	7.2	n/a	n/a	n/a
7	738.1	17.71	38.6	10.0	81.9	n/a	n/a	95.4	n/a	n/a	n/a	0.360	n/a	0.04		0.04	0.02	0.03	0.03	0.03	0	0.04	91.1	7.3	7.1	7.2	n/a	n/a	n/a
8	757.9	18.17	38.3	10.0	84.0	n/a	n/a	97.9	n/a	n/a	n/a	0.157	n/a	0.04		0.04	0.02	0.02	0.02	0.03	0	0.04	82.2	7.1	7.3	7.2	n/a	n/a	n/a
9	680.6	16.27	38.4	10.0	75.2	n/a	n/a	87.7	n/a	n/a	n/a	0.181	n/a	0.03		0.04	0.04	0.02	0.03	0.03	0	0.04	82.3	7.2	7.1	7.2	n/a	n/a	n/a
10	784.7	18.94	38.6	10.0	87.5	n/a	n/a	102.0	n/a	n/a	n/a	0.189	n/a	0.03	0.03		0.04	0.03	0.03	0.03	0	0.04	83.1	7.2	7.2	7.2	n/a	n/a	n/a
11	665.0	15.89	39.3	10.0	73.4	n/a	n/a	85.6	n/a	n/a	n/a	0.206	n/a	0.03			0.04	0.02	0.03	0.03	0	0.04	85.4	7.1	7.1	7.2	n/a	n/a	n/a
12	672.9	16.07	37.9	10.0	74.3	n/a	n/a	86.6	n/a	n/a	n/a	0.187	n/a	0.03		0.04	0.02	0.02	0.02	0.03	0	0.04	86.1	7.4	7.1	7.3	n/a	n/a	n/a
13	671.2	16.05	38.7	10.0	74.2	n/a	n/a	86.5	n/a	n/a	n/a	0.215	n/a	0.02	0.02		0.04	0.02	0.02	0.02	0	0.04	88.8	7.4	7.1	7.2	n/a	n/a	n/a
14	729.6	17.44	38.2	10.0	80.6	n/a	n/a	94.0	n/a	n/a	n/a	0.284	n/a	0.04	0.04		0.04	0.03	0.04	0.04	0	0.04	86.6	6.9	7.2	7.2	n/a	n/a	n/a
15	698.9	16.73	38.7	10.0	77.3	n/a	n/a	90.2	n/a	n/a	n/a	0.265	n/a	0.05		0.04	0.02	0.03	0.04	0.04	0	0.05	86.4	7.3	7.1	7.2	n/a	n/a	n/a
16	684.0	16.32	38.4	9.0	75.4	n/a	n/a	87.9	n/a	n/a	n/a	0.139	n/a	0.06		0.04	0.06	0.04	0.04	0.05	0	0.06	65.5	7.2	7.1	7.2	n/a	n/a	n/a
17	636.6	15.24	38.6	10.0	70.4	n/a	n/a	82.1	n/a	n/a	n/a	0.107	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	62.6	7.3	7.1	7.2	n/a	n/a	n/a
18	775.0	18.64	38.2	10.0	86.2	n/a	n/a	100.4	n/a	n/a	n/a	0.168	n/a	0.04	0.04		0.04	0.04	0.04	0.04	0	0.04	76.2	7.3	7.2	7.2	n/a	n/a	n/a
19	781.3	18.90	39.1	11.0	87.4	n/a	n/a	101.8	n/a	n/a	n/a	0.174	n/a	0.04	0.04		0.04	0.04	0.04	0.04	0	0.04	77.0	7.3	7.1	7.2	n/a	n/a	n/a
20	803.5	19.37	40.0	10.0	89.5	n/a	n/a	104.4	n/a	n/a	n/a	0.165	n/a	0.03	0.03		0.04	0.03	0.03	0.03	0	0.04	80.6	7.2	7.1	7.2	n/a	n/a	n/a
21	676.3	16.18	38.5	10.0	74.8	n/a	n/a	87.2	n/a	n/a	n/a	0.179	n/a	0.03	0.03		0.04	0.02	0.02	0.03	0	0.04	84.4	7.1	7.1	7.3	n/a	n/a	n/a
22	731.3	17.54	38.5	11.0	81.1	n/a	n/a	94.5	n/a	n/a	n/a	0.174	n/a	0.02	0.03		0.04	0.04	0.04	0.03	0	0.04	80.5	7.5	7.0	7.3	n/a	n/a	n/a
23	624.4	14.89	38.6	10.0	68.8	n/a	n/a	80.2	n/a	n/a	n/a	0.146	n/a	0.04			0.04	0.05	0.05	0.05	0	0.05	69.2	7.3	7.1	7.3	n/a	n/a	n/a
24	678.3	16.18	39.1	9.0	74.8	n/a	n/a	87.2	n/a	n/a	n/a	0.152	n/a	0.06	0.06		0.04	0.03	0.03	0.04	0	0.06	71.1	7.2	7.1	7.3	n/a	n/a	n/a
25	613.2	14.62	39.1	9.0	67.6	n/a	n/a	78.8	n/a	n/a	n/a	0.215	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	84.9	7.5	7.0	7.3	n/a	n/a	n/a
26	607.3	14.48	38.5	9.0	66.9	n/a	n/a	78.0	n/a	n/a	n/a	0.213	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	82.4	7.4	7.1	7.2	n/a	n/a	n/a
27	651.9	15.55	39.2	9.0	71.9	n/a	n/a	83.8	n/a	n/a	n/a	0.142	n/a	0.04			0.04	0.05	0.06	0.05	0	0.06	66.5	7.3	7.1	7.2	n/a	n/a	n/a
28	591.7	14.11	38.5	8.0	65.2	n/a	n/a	76.0	n/a	n/a	n/a	0.136	n/a	0.06			0.04	0.02	0.03	0.04	0	0.06	72.4	7.2	7.1	7.2	n/a	n/a	n/a
29	613.5	14.63	38.6	9.0	67.6	n/a	n/a	78.8	n/a	n/a	n/a	0.202	n/a	0.04			0.04	0.02	0.02	0.03	0	0.04	85.1	7.5	7.0	7.2	n/a	n/a	n/a
30	588.2	14.02	39.2	7.0	64.8	n/a	n/a	75.6	n/a	n/a	n/a	0.186	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	82.5	7.5	7.1	7.2	n/a	n/a	n/a
31	564.4	13.5	38.5	6.0	62.2	n/a	n/a	72.5	n/a	n/a	n/a	0.19	n/a	0.03			0.03	0.03	0.03	0.03	0	0.03	84.3	7.4	7.2	7.2	n/a	n/a	n/a
Total	21255	508.6	1,199	296.0	2,351.0	0.0	0.0	2,740.4	0.0	0.0	0.0										0								
Avg	686	16.4	38.67	9.5	75.8			88.4				0.18								0.04			78.5	7.3	7.1	7.2			

Total number of CFE samples analyzed for month: N = 143

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.04

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 9 Year: 2018

PWS ID:
Source ID: S01
PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom
County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs)								Turbidity NTU		Combined Filter Effluent Turbidity 4 hour sample NTU							No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C	pH		Total Alkalinity mg/L as CaCO3		Calcium Hardness mg/L as CaCO3 Fin
				Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Raw	Settled	1st	2nd	3rd	4th	5th	6th	Avg				Raw	Raw	Final	Raw	Fin	
1	607.7	14.49	38.3	8.0	67.0			78.1				0.185		0.03			0.04	0.03	0.07	0.04	0	0.07	77.0	7.2	7.3	7.2			
2	633.5	15.13	38.3	8.0	69.9			81.5				0.157		0.06			0.03	0.04	0.07	0.05	0	0.07	68.2	7.4	7.3	7.2			
3	648.6	15.47	38.3	9.0	71.5			83.4				0.185		0.04			0.04	0.03	0.03	0.04	0	0.04	81.1	7.0	7.3	7.2			
4	712.2	17.08	38.5	8.0	78.9			92.0				0.201		0.03	0.03		0.04	0.02	0.02	0.03	0	0.04	86.1	7.1	7.3	7.2			
5	697.8	16.75	38.6	9.0	77.4			90.3				0.222		0.02	0.02		0.04	0.02	0.02	0.02	0	0.04	89.2	7.5	7.2	7.2			
6	593.3	14.15	38.3	8.0	65.4			76.2				0.225		0.02			0.04	0.03	0.02	0.03	0	0.04	87.8	7.4	7.2	7.2			
7	506.4	12.09	38.3	8.0	55.9			65.1				0.155		0.03			0.04	0.04	0.06	0.04	0	0.06	72.6	7.4	7.2	7.2			
8	547.0	13.04	38.3	6.0	60.3			70.2				0.216					0.05	0.04	0.03	0.04	0	0.05	81.5	7.6	7.1	7.2			
9	610.3	14.69	38.4	9.0	67.9			79.1				0.237		0.03			0.04	0.06	0.03	0.04	0	0.06	83.1	7.6	7.1	7.2			
10	640.5	15.28	39.8	8.0	70.6			82.3				0.254		0.04			0.04	0.03	0.03	0.04	0	0.04	86.2	7.3	7.1	7.1			
11	525.1	12.52	38.1	8.0	57.9			67.5				0.178		0.04			0.04	0.03	0.03	0.04	0	0.04	80.3	7.3	7.1	7.2			
12	509.5	12.15	52.0	8.0	56.2			65.5				0.207		0.06			0.04	0.03	0.03	0.04	0	0.06	80.7	7.5	7.1	7.2			
13	525.2	12.53	40.2	8.0	57.9			67.5				0.306		0.03			0.04	0.02	0.02	0.03	0	0.04	91.0	7.5	7.1	7.2			
14	499.2	11.90	39.8	8.0	55.0			64.1				0.196					0.04	0.03	0.03	0.03	0	0.04	83.0	7.5	7.0	7.2			
15	564.2	13.46	40.0	7.0	62.2			72.5				0.172		0.03			0.04	0.03	0.03	0.03	0	0.04	81.1	7.4	7.1	7.2			
16	490.5	11.69	39.7	7.0	54.1			63.0				0.178					0.04	0.02	0.02	0.03	0	0.04	85.0	7.5	7.0	7.2			
17	604.4	14.42	40.3	9.0	66.6			77.7				0.244		0.03			0.04	0.06	0.03	0.04	0	0.06	83.6	7.0	7.1	7.2			
18	515.3	12.29	39.3	9.0	56.8			66.2				0.252		0.04			0.04	0.03	0.03	0.04	0	0.04	86.1	7.2	7.1	7.2			
19	496.7	11.84	39.0	7.0	54.7			63.8				0.268					0.04	0.03	0.03	0.03	0	0.04	87.6	7.7	7.0	7.2			
20	495.0	11.81	39.4	7.0	54.6			63.6				0.322					0.04	0.03	0.03	0.03	0	0.04	89.6	7.6	7.0	7.2			
21	503.7	12.01	40.1	8.0	55.5			64.7				0.161		0.03			0.04	0.02	0.02	0.03	0	0.04	82.9	7.4	7.0	7.2			
22	475.3	11.34	39.2	8.0	52.4			61.1				0.167					0.04	0.02	0.02	0.03	0	0.04	84.0	7.3	7.0	7.2			
23	617.0	14.71	39.4	9.0	68.0			79.3				0.168		0.03			0.04	0.03	0.04	0.04	0	0.04	79.2	7.0	7.0	7.2			
24	696.4	16.61	39.4	10.0	76.8			89.5				0.202		0.04		0.04	0.03	0.03	0.03	0.03	0	0.04	83.2	7.1	7.0	7.2			
25	685.6	16.35	39.5	9.0	75.6			88.1				0.191		0.03		0.04	0.03	0.03	0.04	0.03	0	0.04	82.2	7.7	6.9	7.2			
26	499.4	11.92	39.9	8.0	55.1			64.2				0.214					0.04	0.03	0.04	0.04	0	0.04	82.9	7.4	7.0	7.2			
27	490.9	11.70	39.8	7.0	54.1			63.0				0.222					0.04	0.02	0.02	0.03	0	0.04	88.0	7.4	6.9	7.2			
28	538.8	12.85	39.9	9.0	59.4			69.3				0.192		0.02			0.04	0.03	0.03	0.03	0	0.04	84.4	7.4	6.9	7.2			
29	472.7	11.27	39.7	6.0	52.1			60.7				0.207		0.03			0.04	0.02	0.02	0.03	0	0.04	86.7	7.7	6.9	7.2			
30	522.4	12.47	39.4	8.0	67.7			67.2				0.235		0.02			0.04	0.03	0.03	0.03	0	0.04	87.2	7.5	6.9	7.2			
31																						0.00							
Total	16925	404.0	1,189	241.0	1,867.4			2,176.8													0								
Avg	564	13.5	39.64	8.0	62.2			72.6				0.21								0.03			83.4	7.4	7.1	7.2			

Total number of CFE samples analyzed for month: N = 116

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection: 5/3/2017 # filters with more than 10 percent media loss: 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.05

Report Submitted By: Kevin Cook

Signature:

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 10 Year: 2018

PWS ID: PWS Name: Lake Whatcom Water & Sewer Dist County: Whatcom

Source ID: S01 Source Name: Lake Whatcom Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	497.7	11.88	39.8	8.0	54.9	n/a	n/a	64.0	n/a	n/a	n/a	0.278	n/a	0.03				0.04	0.03	0.03	0	0.04	88.0	7.4	6.9	7.2	n/a	n/a	n/a	
2	580.8	13.85	39.4	6.0	64.0	n/a	n/a	74.6	n/a	n/a	n/a	0.196	n/a	0.03			0.03	0.02	0.03	0.03	0	0.03	86.0	7.0	6.9	7.2	n/a	n/a	n/a	
3	523.3	12.48	39.5	6.0	57.7	n/a	n/a	67.3	n/a	n/a	n/a	0.187	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	81.3	7.2	7.1	7.2	n/a	n/a	n/a	
4	532.9	12.71	40.4	7.0	58.7	n/a	n/a	68.5	n/a	n/a	n/a	0.181	n/a	0.04			0.04	0.02	0.02	0.03	0	0.04	83.4	7.6	7.1	7.1	n/a	n/a	n/a	
5	455.2	10.86	39.4	7.0	50.2	n/a	n/a	58.5	n/a	n/a	n/a	0.249	n/a				0.04	0.02	0.02	0.03	0	0.04	89.3	7.6	7.1	7.1	n/a	n/a	n/a	
6	483.9	11.54	39.7	7.0	53.3	n/a	n/a	62.2	n/a	n/a	n/a	0.198	n/a				0.04	0.03	0.03	0.03	0	0.04	83.2	7.2	7.2	7.2	n/a	n/a	n/a	
7	549.3	13.10	40.1	8.0	60.6	n/a	n/a	70.6	n/a	n/a	n/a	0.278	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	88.3	7.5	7.1	7.1	n/a	n/a	n/a	
8	613.8	14.64	40.1	8.0	67.7	n/a	n/a	78.9	n/a	n/a	n/a	0.218	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	83.9	7.5	7.1	7.1	n/a	n/a	n/a	
9	515.9	12.31	39.3	7.0	56.9	n/a	n/a	66.3	n/a	n/a	n/a	0.179	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	81.8	7.2	7.1	7.1	n/a	n/a	n/a	
10	517.6	12.34	40.2	7.0	57.1	n/a	n/a	66.5	n/a	n/a	n/a	0.232	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	86.0	7.3	7.0	7.1	n/a	n/a	n/a	
11	506.9	12.09	39.6	7.0	55.9	n/a	n/a	65.1	n/a	n/a	n/a	0.221	n/a	0.03			0.04	0.02	0.03	0.03	0	0.04	86.4	7.3	7.1	7.2	n/a	n/a	n/a	
12	498.9	11.90	39.6	7.0	55.0	n/a	n/a	64.1	n/a	n/a	n/a	0.222	n/a				0.04	0.03	0.03	0.03	0	0.04	85.0	7.3	7.1	7.2	n/a	n/a	n/a	
13	466.8	11.13	39.7	6.0	51.4	n/a	n/a	60.0	n/a	n/a	n/a	0.318	n/a				0.04	0.03	0.03	0.03	0	0.04	89.5	7.1	7.1	7.2	n/a	n/a	n/a	
14	587.0	14.00	40.8	9.0	64.7	n/a	n/a	75.5	n/a	n/a	n/a	0.268	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	87.9	7.1	7.2	7.2	n/a	n/a	n/a	
15	534.6	12.75	39.8	8.0	58.9	n/a	n/a	68.7	n/a	n/a	n/a	0.185	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	81.1	7.4	7.1	7.2	n/a	n/a	n/a	
16	507.2	12.10	40.0	8.0	55.9	n/a	n/a	65.2	n/a	n/a	n/a	0.189	n/a	0.03			0.04	0.04	0.04	0.04	0	0.04	80.2	7.3	7.1	7.2	n/a	n/a	n/a	
17	509.7	12.15	39.6	7.0	56.2	n/a	n/a	65.5	n/a	n/a	n/a	0.209	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	83.3	7.4	7.1	7.2	n/a	n/a	n/a	
18	472.8	11.28	39.4	7.0	52.1	n/a	n/a	60.8	n/a	n/a	n/a	0.221	n/a				0.04	0.03	0.03	0.03	0	0.04	84.9	7.4	7.1	7.2	n/a	n/a	n/a	
19	497.8	11.87	39.7	7.0	54.9	n/a	n/a	64.0	n/a	n/a	n/a	0.243	n/a				0.05	0.03	0.03	0.04	0	0.05	84.9	7.4	7.1	7.2	n/a	n/a	n/a	
20	523.9	12.49	39.5	7.0	57.7	n/a	n/a	67.3	n/a	n/a	n/a	0.256	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	86.3	7.3	7.1	7.1	n/a	n/a	n/a	
21	536.9	12.80	39.8	7.0	59.2	n/a	n/a	69.0	n/a	n/a	n/a	0.259	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	86.5	7.3	7.1	7.1	n/a	n/a	n/a	
22	527.4	12.58	40.4	9.0	58.2	n/a	n/a	67.8	n/a	n/a	n/a	0.231	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	84.8	7.3	7.1	7.1	n/a	n/a	n/a	
23	478.7	11.42	39.4	6.0	52.8	n/a	n/a	61.5	n/a	n/a	n/a	0.241	n/a				0.05	0.03	0.03	0.04	0	0.05	84.8	7.3	7.1	7.1	n/a	n/a	n/a	
24	496.1	11.83	40.2	6.0	54.7	n/a	n/a	63.7	n/a	n/a	n/a	0.201	n/a				0.05	0.03	0.03	0.04	0	0.05	81.8	7.4	7.1	7.1	n/a	n/a	n/a	
25	425.2	10.14	39.5	8.0	46.9	n/a	n/a	54.6	n/a	n/a	n/a	0.236	n/a				0.05	0.03	0.04	0.04	0	0.05	83.1	7.3	7.1	7.1	n/a	n/a	n/a	
26	471.7	11.25	40.2	5.0	52.0	n/a	n/a	60.6	n/a	n/a	n/a	0.170	n/a				0.04	0.03	0.03	0.03	0	0.04	80.4	7.1	7.0	7.1	n/a	n/a	n/a	
27	595.8	14.26	39.5	8.0	65.9	n/a	n/a	76.8	n/a	n/a	n/a	0.204	n/a	0.03			0.05	0.02	0.03	0.03	0	0.05	84.1	7.0	7.1	7.1	n/a	n/a	n/a	
28	492.4	11.74	39.5	7.0	54.3	n/a	n/a	63.3	n/a	n/a	n/a	0.422	n/a				0.04	0.02	0.02	0.03	0	0.04	93.7	7.3	7.1	7.1	n/a	n/a	n/a	
29	560.0	13.36	39.9	8.0	61.8	n/a	n/a	72.0	n/a	n/a	n/a	0.289	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	87.0	7.3	7.0	7.1	n/a	n/a	n/a	
30	492.0	11.73	39.9	7.0	54.2	n/a	n/a	63.2	n/a	n/a	n/a	0.278	n/a				0.04	0.03	0.03	0.03	0	0.04	88.0	7.7	7.0	7.1	n/a	n/a	n/a	
31	499.2	11.9	39.8	6.0	55.1	n/a	n/a	64.2	n/a	n/a	n/a	0.27	n/a				0.04	0.04	0.04	0.04	0	0.04	85.2	7.3	7.1	7.1	n/a	n/a	n/a	
Total	15951	380.5	1,234	221.0	1,758.9	0.0	0.0	2,050.2	0.0	0.0	0.0										0									
Avg	515	12.3	39.80	7.1	56.7			66.1				0.24								0.03			85.2	7.3	7.1	7.1				

Total number of CFE samples analyzed for month: N = 110

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.03

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 11 Year: 2018

PWS ID:
PWS Name: Lake Whatcom Water & Sewer Dist
County: Whatcom
Source ID: S01
Source Name: Lake Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs): Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU: Raw	Settled
1	464.5	11.08	40.1	6.0	51.2	n/a	n/a	59.7	n/a	n/a	n/a	0.211	n/a
2	480.0	11.46	39.1	6.0	53.0	n/a	n/a	61.7	n/a	n/a	n/a	0.091	n/a
3	467.0	11.13	39.1	7.0	51.5	n/a	n/a	60.0	n/a	n/a	n/a	0.313	n/a
4	491.5	11.73	39.4	8.0	58.8	n/a	n/a	68.6	n/a	n/a	n/a	0.481	n/a
5	468.8	11.23	39.2	9.0	51.9	n/a	n/a	60.5	n/a	n/a	n/a	0.642	n/a
6	440.7	10.52	39.4	6.0	48.6	n/a	n/a	56.7	n/a	n/a	n/a	0.562	n/a
7	540.7	12.90	79.8	8.0	59.6	n/a	n/a	69.5	n/a	n/a	n/a	0.324	n/a
8	582.6	13.89	40.3	8.0	64.2	n/a	n/a	74.9	n/a	n/a	n/a	0.220	n/a
9	479.5	11.45	39.7	5.0	52.9	n/a	n/a	61.7	n/a	n/a	n/a	0.216	n/a
10	449.4	10.71	40.5	8.0	49.5	n/a	n/a	57.7	n/a	n/a	n/a	0.242	n/a
11	588.6	14.06	39.7	9.0	65.0	n/a	n/a	75.7	n/a	n/a	n/a	0.405	n/a
12	557.4	13.33	39.9	7.0	61.6	n/a	n/a	71.8	n/a	n/a	n/a	0.494	n/a
13	498.2	11.99	39.8	5.0	55.4	n/a	n/a	64.6	n/a	n/a	n/a	0.307	n/a
14	398.4	9.72	39.8	7.0	44.9	n/a	n/a	52.4	n/a	n/a	n/a	0.303	n/a
15	399.0	9.53	39.7	5.0	44.0	n/a	n/a	51.3	n/a	n/a	n/a	0.274	n/a
16	431.7	10.33	40.2	6.0	47.7	n/a	n/a	55.6	n/a	n/a	n/a	0.224	n/a
17	803.8	19.50	80.7	13.0	90.2	n/a	n/a	105.1	n/a	n/a	n/a	0.466	n/a
18	743.9	17.79	121.5	12.0	82.2	n/a	n/a	95.9	n/a	n/a	n/a	0.464	n/a
19	648.0	15.70	82.3	8.0	72.6	n/a	n/a	84.6	n/a	n/a	n/a	0.494	n/a
20	761.8	18.72	82.4	11.0	86.5	n/a	n/a	100.8	n/a	n/a	n/a	0.535	n/a
21	748.4	17.90	40.3	12.0	82.7	n/a	n/a	96.4	n/a	n/a	n/a	0.500	n/a
22	476.2	11.76	40.0	6.0	54.4	n/a	n/a	63.4	n/a	n/a	n/a	0.437	n/a
23	408.1	10.06	41.1	5.0	46.5	n/a	n/a	54.2	n/a	n/a	n/a	0.327	n/a
24	381.7	9.25	80.8	11.0	42.7	n/a	n/a	49.8	n/a	n/a	n/a	0.572	n/a
25	784.3	19.21	81.5	11.0	88.8	n/a	n/a	103.5	n/a	n/a	n/a	0.520	n/a
26	828.1	20.21	41.9	6.0	93.4	n/a	n/a	108.9	n/a	n/a	n/a	0.283	n/a
27	379.6	9.28	40.0	7.0	42.9	n/a	n/a	50.0	n/a	n/a	n/a	0.444	n/a
28	450.3	11.32	46.3	6.0	52.3	n/a	n/a	61.0	n/a	n/a	n/a	0.431	n/a
29	404.2	9.99	41.2	6.0	46.2	n/a	n/a	53.8	n/a	n/a	n/a	0.512	n/a
30	592.5	14.19	81.2	12.0	65.6	n/a	n/a	76.4	n/a	n/a	n/a	0.464	n/a
31						n/a	n/a		n/a	n/a	n/a		n/a
Total	16149	389.9	1,577	236.0	1,807.1	0.0	0.0	2,106.4	0.0	0.0	0.0		
Avg	538	13.0	52.56	7.9	60.2			70.2				0.39	

Date	Combined Filter Effluent Turbidity 4 hour sample NTU: 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C: Raw	pH: Raw	pH: Final	Total Alkalinity mg/L as CaCO3: Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1				0.04	0.03	0.03	0.03	0	0.04	84.2	7.0	7.1	7.1	n/a	n/a	n/a
2				0.04	0.04	0.05	0.04	0	0.05	52.4	6.9	7.1	7.1	n/a	n/a	n/a
3				0.05	0.03	0.04	0.04	0	0.05	87.2	6.8	7.1	7.1	n/a	n/a	n/a
4				0.05	0.02	0.02	0.03	0	0.05	93.8	7.0	7.2	7.1	n/a	n/a	n/a
5				0.05	0.03	0.03	0.04	0	0.05	94.3	7.1	7.1	7.1	n/a	n/a	n/a
6				0.05	0.02	0.03	0.03	0	0.05	94.1	7.4	7.0	7.1	n/a	n/a	n/a
7	0.03			0.04	0.03	0.03	0.03	0	0.04	90.0	7.2	7.1	7.1	n/a	n/a	n/a
8	0.02			0.05	0.03	0.03	0.03	0	0.05	85.2	7.6	7.1	7.1	n/a	n/a	n/a
9				0.05	0.03	0.03	0.04	0	0.05	83.0	8.0	7.1	7.1	n/a	n/a	n/a
10				0.06	0.03	0.03	0.04	0	0.06	83.5	7.4	7.1	7.1	n/a	n/a	n/a
11	0.04			0.06	0.03	0.03	0.04	0	0.06	90.1	7.6	7.1	7.1	n/a	n/a	n/a
12	0.03			0.06	0.03	0.04	0.04	0	0.06	91.9	7.7	7.2	7.2	n/a	n/a	n/a
13	0.03			0.05	0.03	0.04	0.04	0	0.05	87.8	7.4	7.2	7.1	n/a	n/a	n/a
14				0.05	0.03	0.03	0.04	0	0.05	87.9	8.5	7.1	7.1	n/a	n/a	n/a
15				0.04	0.02	0.03	0.03	0	0.04	89.1	7.2	7.4	7.1	n/a	n/a	n/a
16				0.03	0.03	0.05	0.04	0	0.05	83.6	7.3	7.1	7.1	n/a	n/a	n/a
17		0.04	0.03	0.05	0.04	0.05	0.04	0	0.05	91.0	7.5	7.1	7.1	n/a	n/a	n/a
18		0.05	0.04	0.04	0.05	0.06	0.05	0	0.06	89.7	7.1	7.1	7.1	n/a	n/a	n/a
19	0.04			0.04	0.04	0.05	0.04	0	0.05	91.4	9.4	7.2	7.2	n/a	n/a	n/a
20	0.03	0.02		0.05	0.05	0.05	0.04	0	0.05	92.5	9.1	7.3	7.2	n/a	n/a	n/a
21	0.06	0.04		0.05	0.04	0.04	0.05	0	0.06	90.8	7.4	7.1	7.1	n/a	n/a	n/a
22				0.05	0.04	0.04	0.04	0	0.05	90.1	8.3	7.2	7.1	n/a	n/a	n/a
23				0.05	0.04	0.04	0.04	0	0.05	86.7	8.3	7.2	7.1	n/a	n/a	n/a
24				0.06	0.05	0.05	0.05	0	0.06	90.7	9.0	7.2	7.2	n/a	n/a	n/a
25	0.05	0.04		0.06	0.04	0.04	0.05	0	0.06	91.2	8.9	7.3	7.2	n/a	n/a	n/a
26	0.05	0.06	0.07	0.06	0.03	0.04	0.05	0	0.07	81.7	6.4	7.3	7.1	n/a	n/a	n/a
27				0.05	0.03	0.03	0.04	0	0.05	91.7	9.1	7.2	7.1	n/a	n/a	n/a
28				0.06	0.03	0.04	0.04	0	0.06	89.9	8.6	7.3	7.2	n/a	n/a	n/a
29				0.06	0.03	0.03	0.04	0	0.06	92.2	9.4	7.3	7.2	n/a	n/a	n/a
30			0.05	0.05	0.03	0.03	0.04	0	0.05	91.4	8.9	7.2	7.3	n/a	n/a	n/a
31									0.00					n/a	n/a	n/a
Total								0								
Avg							0.04			88.0	7.9	7.2	7.1			

Total number of CFE samples analyzed for month: N = 110

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet [illegible]

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection 5/3/2017

filters with more than 10 percent media loss 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verfication of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU) 0.05

Report Submitted By Kevin Cook

Signature

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 12 Year: 2018

PWS ID:
Source ID: S01
PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom
County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled
1	616.8	15.41	41.0	6.0	71.2	n/a	n/a	83.0	n/a	n/a	n/a	0.508	n/a
2	418.0	10.36	41.3	6.0	47.9	n/a	n/a	55.8	n/a	n/a	n/a	0.477	n/a
3	604.5	14.49	80.9	11.0	67.0	n/a	n/a	78.1	n/a	n/a	n/a	0.494	n/a
4	491.5	11.73	41.5	7.0	67.5	n/a	n/a	78.7	n/a	n/a	n/a	0.429	n/a
5	428.0	10.61	40.5	7.0	49.0	n/a	n/a	57.2	n/a	n/a	n/a	0.446	n/a
6	447.0	11.05	40.9	6.0	51.1	n/a	n/a	59.5	n/a	n/a	n/a	0.418	n/a
7	438.6	10.90	40.9	7.0	50.4	n/a	n/a	58.7	n/a	n/a	n/a	0.424	n/a
8	441.3	10.91	41.3	7.0	50.4	n/a	n/a	58.8	n/a	n/a	n/a	0.400	n/a
9	621.8	15.09	83.4	14.0	69.8	n/a	n/a	81.3	n/a	n/a	n/a	0.437	n/a
10	766.2	19.08	41.9	9.0	88.2	n/a	n/a	102.8	n/a	n/a	n/a	0.485	n/a
11	494.7	12.11	41.1	8.0	56.0	n/a	n/a	65.2	n/a	n/a	n/a	0.359	n/a
12	462.3	11.58	41.4	8.0	53.5	n/a	n/a	62.4	n/a	n/a	n/a	0.431	n/a
13	507.4	12.54	41.2	7.0	58.0	n/a	n/a	67.6	n/a	n/a	n/a	0.392	n/a
14	382.2	9.33	41.8	7.0	43.1	n/a	n/a	50.2	n/a	n/a	n/a	0.427	n/a
15	535.7	13.40	41.3	7.0	62.0	n/a	n/a	72.2	n/a	n/a	n/a	0.409	n/a
16	484.3	11.87	41.1	6.0	54.9	n/a	n/a	64.0	n/a	n/a	n/a	0.435	n/a
17	694.3	16.80	82.3	13.0	77.6	n/a	n/a	90.5	n/a	n/a	n/a	0.466	n/a
18	456.7	10.98	40.3	6.0	50.7	n/a	n/a	59.1	n/a	n/a	n/a	0.472	n/a
19	480.5	11.63	40.3	7.0	53.8	n/a	n/a	62.7	n/a	n/a	n/a	0.377	n/a
20	428.7	10.33	41.1	8.0	47.8	n/a	n/a	55.7	n/a	n/a	n/a	0.370	n/a
21	477.7	11.58	40.2	7.0	53.5	n/a	n/a	62.4	n/a	n/a	n/a	0.407	n/a
22	475.1	11.55	39.9	7.0	53.4	n/a	n/a	62.2	n/a	n/a	n/a	0.366	n/a
23	548.8	13.51	40.5	10.0	62.5	n/a	n/a	72.8	n/a	n/a	n/a	0.429	n/a
24	492.8	11.92	40.8	8.0	55.1	n/a	n/a	64.2	n/a	n/a	n/a	0.387	n/a
25	544.6	13.58	40.8	9.0	62.8	n/a	n/a	73.2	n/a	n/a	n/a	0.442	n/a
26	525.3	12.93	41.2	9.0	59.8	n/a	n/a	69.7	n/a	n/a	n/a	0.375	n/a
27	542.8	13.26	41.0	8.0	61.3	n/a	n/a	71.5	n/a	n/a	n/a	0.368	n/a
28	508.1	12.21	40.9	7.0	56.4	n/a	n/a	65.8	n/a	n/a	n/a	0.370	n/a
29	484.7	11.62	40.6	8.0	53.7	n/a	n/a	62.6	n/a	n/a	n/a	0.488	n/a
30	578.1	13.90	41.2	8.0	64.2	n/a	n/a	74.9	n/a	n/a	n/a	0.385	n/a
31	487.3	11.7	40.5	6.0	54.0	n/a	n/a	63.0	n/a	n/a	n/a	0.36	n/a
Total	15866	387.9	1,393	244.0	1,806.5	0.0	0.0	2,105.8	0.0	0.0	0.0		
Avg	512	12.5	44.94	7.9	58.3			67.9				0.42	

Date	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin
1	0.04			0.05	0.04	0.03	0.04	0	0.05	92.1	8.5	7.2	7.2	n/a	n/a	n/a
2				0.06	0.04	0.03	0.04	0	0.06	90.9	8.9	7.4	7.2	n/a	n/a	n/a
3			0.03	0.04	0.06	0.04	0.04	0	0.06	91.4	8.0	7.6	7.3	n/a	n/a	n/a
4	0.04			0.06	0.03	0.03	0.04	0	0.06	90.7	7.4	7.5	7.3	n/a	n/a	n/a
5			0.07	0.03	0.03		0.04	0	0.07	90.3	6.8	7.3	7.3	n/a	n/a	n/a
6			0.07	0.03	0.03		0.04	0	0.07	89.6	6.3	7.7	7.3	n/a	n/a	n/a
7				0.07	0.03	0.03	0.04	0	0.07	89.8	6.4	7.6	7.3	n/a	n/a	n/a
8				0.07	0.04	0.04	0.05	0	0.07	87.5	7.2	7.4	7.3	n/a	n/a	n/a
9			0.04	0.04	0.07	0.04	0.05	0	0.07	89.1	7.5	7.3	7.2	n/a	n/a	n/a
10	0.04	0.04		0.07	0.04	0.04	0.05	0	0.07	90.5	7.9	7.4	7.2	n/a	n/a	n/a
11			0.07	0.04	0.04	0.04	0.05	0	0.07	86.8	6.5	7.4	7.1	n/a	n/a	n/a
12				0.07	0.03	0.04	0.05	0	0.07	89.2	6.3	7.4	7.2	n/a	n/a	n/a
13			0.05	0.04	0.04	0.04	0.04	0	0.05	89.2	6.4	7.3	7.2	n/a	n/a	n/a
14				0.05	0.03	0.03	0.04	0	0.05	91.4	7.5	7.4	7.2	n/a	n/a	n/a
15	0.03			0.05	0.03	0.03	0.04	0	0.05	91.4	7.6	7.4	7.2	n/a	n/a	n/a
16	0.04				0.05	0.04	0.04	0	0.05	90.0	7.3	7.4	7.3	n/a	n/a	n/a
17	0.04			0.06	0.03	0.04	0.04	0	0.06	90.9	7.2	7.3	7.3	n/a	n/a	n/a
18				0.06	0.03	0.03	0.04	0	0.06	91.5	7.4	7.4	7.3	n/a	n/a	n/a
19				0.05	0.03	0.03	0.04	0	0.05	90.3	7.3	7.4	7.3	n/a	n/a	n/a
20				0.05	0.03	0.03	0.04	0	0.05	90.1	6.9	7.5	7.2	n/a	n/a	n/a
21				0.06	0.03	0.04	0.04	0	0.06	89.4	7.2	7.4	7.2	n/a	n/a	n/a
22				0.06	0.03	0.03	0.04	0	0.06	89.1	7.0	7.4	7.3	n/a	n/a	n/a
23	0.03			0.06	0.03	0.04	0.04	0	0.06	90.7	6.9	7.3	7.3	n/a	n/a	n/a
24				0.06	0.03	0.04	0.04	0	0.06	88.8	7.0	7.4	7.3	n/a	n/a	n/a
25	0.04			0.06	0.03	0.03	0.04	0	0.06	91.0	7.0	7.5	7.4	n/a	n/a	n/a
26	0.03			0.06	0.03	0.04	0.04	0	0.06	89.3	6.9	7.5	7.3	n/a	n/a	n/a
27	0.04			0.06	0.03	0.03	0.04	0	0.06	89.1	6.8	7.4	7.3	n/a	n/a	n/a
28	0.03			0.05	0.03	0.03	0.04	0	0.05	90.5	6.8	7.5	7.3	n/a	n/a	n/a
29				0.05	0.03	0.04	0.04	0	0.05	91.8	6.7	7.4	7.3	n/a	n/a	n/a
30	0.04			0.05	0.04	0.04	0.04	0	0.05	89.0	6.7	7.5	7.3	n/a	n/a	n/a
31				0.05	0.04	0.04	0.04	0	0.05	87.9	6.7	7.5	7.3	n/a	n/a	n/a
Total								0								
Avg							0.04			90.0	7.1	7.4	7.3			

Total number of CFE samples analyzed for month: N = 109
Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection 5/3/2017 # filters with more than 10 percent media loss 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.04

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 1 Year: 2019

PWS II
Source ID: S01

PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom

County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	539.2	13.05	40.4	7.0	60.3			70.3				0.281		0.03			0.05	0.03	0.03	0.04	0	0.05	87.5	6.6	7.5	7.4				
2	538.0	12.99	40.8	9.0	60.1			70.0				0.315		0.03			0.04	0.03	0.03	0.03	0	0.04	89.7	6.5	7.5	7.4				
3	500.3	11.95	40.6	7.0	55.3			64.4				0.394					0.06	0.03	0.03	0.04	0	0.06	89.8	6.5	7.5	7.3				
4	492.2	11.76	40.7	7.0	54.3			63.3				0.370					0.06	0.03	0.03	0.04	0	0.06	89.2	6.6	7.4	7.3				
5	483.6	11.54	40.8	7.0	53.4			62.2				0.405					0.05	0.03	0.03	0.04	0	0.05	90.9	6.6	7.4	7.4				
6	611.0	14.71	40.4	9.0	68.0			79.3				0.455		0.04			0.06	0.03	0.03	0.04	0	0.06	91.2	[illegible]	7.4	7.4				
7	499.7	11.95	40.6	6.0	55.2			64.4				0.440					0.05	0.03	0.03	0.04	0	0.05	91.7	6.4	7.5	7.4				
8	496.9	11.90	40.3	6.0	55.0			64.1				0.403					0.06	0.03	0.03	0.04	0	0.06	90.1	6.4	7.5	7.4				
9	479.6	11.44	40.3	6.0	52.8			61.6				0.274					0.05	0.03	0.03	0.04	0	0.05	86.6	6.4	7.4	7.4				
10	455.7	10.89	40.2	7.0	50.3			58.7				0.396					0.06	0.03	0.03	0.04	0	0.06	89.9	6.4	7.4	7.4				
11	515.9	12.31	41.1	7.0	56.9			66.3				0.362					0.05	0.03	0.03	0.04	0	0.05	89.9	6.4	7.6	7.4				
12	493.1	11.80	40.7	8.0	54.5			63.6				0.350					0.06	0.03	0.04	0.04	0	0.06	87.6	6.4	7.7	7.4				
13	543.9	12.98	40.3	7.0	60.0			69.9				0.352				0.06	0.03	0.03	0.03	0.04	0	0.06	89.3	6.4	7.6	7.4				
14	474.1	11.34	40.2	7.0	52.4			61.1				0.327					0.04	0.02	0.02	0.03	0	0.04	91.8	6.3	7.6	7.4				
15	441.2	10.54	40.6	6.0	48.7			56.8				0.341					0.05	0.03	0.03	0.04	0	0.05	89.2	6.4	7.5	7.3				
16	516.5	12.32	40.9	8.0	57.0			66.4				0.222		0.04			0.05	0.04	0.05	0.05	0	0.05	79.7	6.3	7.4	7.4				
17	458.2	10.94	40.1	6.0	50.6			59.0				0.312					0.05	0.03	0.04	0.04	0	0.05	87.2	6.4	7.4	7.3				
18	483.2	11.54	40.5	6.0	53.3			62.2				0.331					0.06	0.03	0.03	0.04	0	0.06	87.9	6.3	7.4	7.3				
19	462.5	11.04	40.8	8.0	51.0			59.5				0.181					0.06	0.03	0.03	0.04	0	0.06	77.9	6.4	7.4	7.3				
20	445.1	10.64	40.9	7.0	49.2			57.3				0.364					0.06	0.03	0.03	0.04	0	0.06	89.0	6.3	7.5	7.3				
21	539.5	12.91	40.4	6.0	59.7			69.5				0.290				0.05	0.04	0.05	0.05	0.05	0	0.05	83.6	6.3	7.4	7.3				
22	523.7	12.61	40.8	9.0	58.3			67.9				0.324		0.06			0.05	0.03	0.03	0.04	0	0.06	86.9	6.2	7.4	7.3				
23	463.1	11.06	40.6	7.0	51.1			59.6				0.307					0.05	0.03	0.03	0.04	0	0.05	88.1	6.2	7.4	7.3				
24	469.3	11.20	40.2	7.0	51.8			60.3				0.366					0.05	0.03	0.03	0.04	0	0.05	90.0	6.3	7.3	7.3				
25	467.5	11.16	40.9	6.0	51.6			60.1				0.408					0.05	0.03	0.03	0.04	0	0.05	91.0	6.3	7.3	7.3				
26	510.3	12.19	40.3	7.0	56.3			65.7				0.398		0.03			0.05	0.03	0.03	0.04	0	0.05	91.2	6.3	7.3	7.3				
27	513.9	12.28	40.6	7.0	56.7			66.1				0.400		0.03			0.05	0.03	0.03	0.04	0	0.05	91.3	6.3	7.3	7.4				
28	504.3	12.04	40.4	9.0	55.7			64.9				0.311		0.03			0.05	0.03	0.04	0.04	0	0.05	87.9	6.3	7.3	7.4				
29	486.7	11.61	41.2	8.0	53.7			62.6				0.325					0.05	0.03	0.03	0.04	0	0.05	88.7	6.1	7.3	7.4				
30	454.3	10.85	40.1	6.0	50.2			58.5				0.315					0.05	0.03	0.03	0.04	0	0.05	88.4	6.2	7.3	7.3				
31	475.5	11.4	40.2	8.0	52.5			61.2				0.33					0.05	0.02	0.03	0.03	0	0.05	90.0	6.2	7.3	7.3				
Total	15338	366.9	1,256	221.0	1,695.9			1,976.8													0									
Avg	495	11.8	40.52	7.1	54.7			63.8				0.34								0.04			88.5	6.4	7.4	7.4				

Total number of CFE samples analyzed for month: N = 103

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU): 0.04

Filter media design specs (in) Anthracite: 18" Sand: 9" Garnet: 9"

Date of last filter inspection: 5/3/2017

filters with more than 10 percent media loss: 0

Report Submitted By: Kevin Cook

Signature: [signature]

2-4-19

DOH Form #331-023-F (Excel version)

Date Printed: 2/1/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 2 Year: 2019

PWS ID:
PWS Name: Lake Whatcom Water & Sewer Dist
County: Whatcom
Source ID: S01
Source Name: Lake Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	484.2	11.56	40.5	9.0	53.5			62.3				0.314					0.05	0.03	0.03	0.04	0	0.05	88.3	6.2	7.3	7.3				
2	493.5	11.78	40.3	8.0	54.5			63.5				0.426					0.05	0.03	0.04	0.04	0	0.05	90.6	6.2	7.3	7.3				
3	501.1	11.96	40.4	9.0	55.3			64.4				0.194					0.04	0.03	0.04	0.04	0	0.04	81.1	6.0	7.4	7.4				
4	497.9	11.89	40.4	7.0	55.0			64.1				0.200					0.05	0.03	0.04	0.04	0	0.05	80.0	5.2	7.7	7.4				
5	416.6	9.96	40.1	7.0	46.1			53.7				0.221					0.05	0.04	0.06	0.05	0	0.06	77.4	5.0	7.7	7.4				
6	520.5	12.43	40.7	7.0	57.4			66.9				0.259		0.03			0.05	0.03	0.03	0.04	0	0.05	86.5	5.8	7.5	7.3				
7	505.8	12.09	41.1	10.0	55.9			65.2				0.206		0.03			0.04	0.03	0.03	0.03	0	0.04	84.2	5.7	7.5	7.3				
8	517.0	12.35	41.8	6.0	57.1			66.6				0.283		0.04			0.05	0.03	0.03	0.04	0	0.05	86.7	5.8	7.4	7.3				
9	539.2	12.87	41.2	6.0	59.5			69.4				0.215		0.04			0.05	0.03	0.03	0.04	0	0.05	82.6	5.7	7.5	7.4				
10	518.0	12.38	41.6	8.0	57.2			66.7				0.224		0.04			0.05	0.03	0.03	0.04	0	0.05	83.3	5.6	7.5	7.4				
11	529.9	12.66	41.0	9.0	58.5			68.2				0.255		0.03			0.06	0.03	0.04	0.04	0	0.06	84.3	5.6	7.5	7.4				
12	478.3	11.43	41.4	7.0	52.8			61.6				0.274					0.05	0.03	0.03	0.04	0	0.05	86.6	5.5	7.5	7.4				
13	513.7	12.27	41.1	8.0	56.7			66.1				0.234		0.04			0.04	0.03	0.03	0.04	0	0.04	85.0	4.8	7.7	7.4				
14	522.2	12.47	41.2	8.0	57.6			67.2				0.246		0.03			0.05	0.03	0.03	0.04	0	0.05	85.8	4.8	7.7	7.4				
15	507.1	12.11	41.4	8.0	56.0			65.3				0.240		0.03			0.05	0.03	0.03	0.04	0	0.05	85.4	5.4	7.3	7.3				
16	527.9	12.61	41.5	9.0	58.3			68.0				0.221		0.03			0.05	0.03	0.04	0.04	0	0.05	83.0	5.4	7.3	7.3				
17	523.7	12.51	41.1	7.0	57.8			67.4				0.298		0.04			0.05	0.02	0.02	0.03	0	0.05	89.1	5.4	7.4	7.3				
18	522.7	12.48	41.1	7.0	57.7			67.3				0.239		0.02			0.04	0.02	0.02	0.03	0	0.04	89.5	5.2	7.5	7.3				
19	532.6	12.73	41.6	10.0	58.8			68.6				0.231		0.03			0.04	0.02	0.02	0.03	0	0.04	88.1	5.4	7.4	7.3				
20	342.4	8.23	42.3	9.0	38.1			44.4				0.237		0.02			0.05		0.02	0.03	0	0.05	87.3	5.5	7.4	7.3				
21	616.3	14.72	52.4	9.0	68.0			79.3				0.314		0.02			0.05	0.02	0.02	0.03	0	0.05	91.2	4.7	7.5	7.3				
22	486.8	11.62	41.1	6.0	53.7			62.6				0.375					0.04	0.03	0.03	0.03	0	0.04	91.1	5.7	7.1	7.4				
23	447.3	10.67	41.6	6.0	49.3			57.5				0.311					0.04	0.03	0.03	0.03	0	0.04	89.3	5.7	7.1	7.4				
24	541.8	12.94	41.4	8.0	59.8			69.7				0.337		0.03			0.04	0.03	0.03	0.03	0	0.04	90.4	5.7	7.1	7.4				
25	522.1	12.48	41.0	7.0	57.7			67.2				0.360		0.03			0.04	0.03	0.03	0.03	0	0.04	91.0	5.3	7.3	7.3				
26	532.2	12.70	41.1	7.0	58.7			68.4				0.231		0.04			0.05	0.03	0.03	0.04	0	0.05	83.8	5.3	7.3	7.4				
27	446.7	10.67	41.2	7.0	49.3			57.5				0.219					0.05	0.03	0.03	0.04	0	0.05	83.3	5.1	7.3	7.2				
28	486.9	11.64	41.3	7.0	53.8			62.7				0.201					0.05	0.03	0.04	0.04	0	0.05	80.1	5.3	7.3	7.3				
29																						0.00								
30																						0.00								
31																						0.00								
Total	14074	336.2	1,163	216.0	1,554.2			1,811.7													0									
Avg	503	12.0	41.52	7.7	55.5			64.7				0.26								0.04			85.9	5.5	7.4	7.3				

Total number of CFE samples analyzed for month: N = 101
Total number of CFE samples exceeding 0.3 NTU: E = 0
Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%
Number of days CFE exceeded 1.0 NTU this month: 0
Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N
Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y
Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y
Max variation (NTU) 0.04

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"
Date of last filter inspection 5/3/2017
\# filters with more than 10 percent media loss 0
Report Submitted By Kevin Cook
Signature

DOH Form #331-023-F (Excel version)

Date Printed: 3/4/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 3 Year: 2019

PWS ID:
Source ID: S01

PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom

County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs): Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU: Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU: 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C: Raw	pH: Raw	pH: Final	Total Alkalinity mg/L as CaCO3: Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	486.1	11.60	41.2	7.0	53.6			62.5				0.15					0.05	0.03	0.04	0.04	0	0.05	73.3	4.7	7.5	7.4				
2	492.4	11.77	41.0	7.0	54.4			63.4				0.20					0.05	0.03	0.03	0.04	0	0.05	81.7	5.2	7.3	7.4				
3	502.6	11.99	41.0	7.0	55.4			64.6				0.16					0.05	0.03	0.04	0.04	0	0.05	75.0	5.2	7.3	7.4				
4	533.5	12.77	41.4	8.0	59.0			68.8				0.14		0.04			0.05	0.03	0.03	0.04	0	0.05	73.2	5.1	7.4	7.4				
5	442.6	10.56	41.1	8.0	48.8			56.9				0.14					0.05	0.04	0.03	0.04	0	0.05	71.4	5.2	7.4	7.4				
6	507.4	12.11	41.0	5.0	56.0			65.3				0.16		0.04			0.05	0.03	0.03	0.04	0	0.05	76.6	5.0	7.4	7.4				
7	445.6	10.64	42.5	5.0	49.2			57.3				0.19					0.05	0.03	0.04	0.04	0	0.05	78.9	5.0	7.5	7.3				
8	468.5	11.19	41.5	7.0	51.7			60.3				0.21					0.05	0.04	0.05	0.05	0	0.05	77.8	5.0	7.5	7.1				
9	482.1	11.51	41.8	8.0	53.2			62.0				0.23					0.05	0.03	0.03	0.04	0	0.05	84.1	5.0	7.5	7.3				
10	512.7	12.25	41.5	6.0	56.6			66.0				0.22		0.05			0.05	0.03	0.03	0.04	0	0.05	81.8	5.0	7.5	7.3				
11	505.7	12.09	40.9	6.0	55.9			65.1				0.24		0.03			0.05	0.03	0.04	0.04	0	0.05	84.4	5.1	7.5	7.4				
12	445.7	10.65	40.6	8.0	49.2			57.4				0.34					0.05	0.03	0.03	0.04	0	0.05	89.2	5.0	7.5	7.4				
13	520.9	12.43	49.8	7.0	57.5			67.0				0.21		0.04			0.05	0.03	0.04	0.04	0	0.05	81.0	5.0	7.5	7.4				
14	476.4	11.38	41.3	5.0	52.6			61.3				0.23					0.05	0.03	0.04	0.04	0	0.05	82.6	5.0	7.5	7.4				
15	469.6	11.21	40.9	7.0	51.8			60.4				0.32					0.05	0.03	0.04	0.04	0	0.05	87.5	5.1	7.5	7.4				
16	547.9	13.09	41.0	7.0	60.5			70.6				0.32		0.04			0.05	0.03	0.04	0.04	0	0.05	87.5	5.2	7.5	7.4				
17	488.9	11.68	40.9	6.0	54.0			62.9				0.33					0.05	0.03	0.03	0.04	0	0.05	88.9	5.1	7.4	7.3				
18	535.4	12.79	40.7	8.0	59.1			68.9				0.34		0.04			0.04	0.03	0.03	0.04	0	0.04	89.7	5.2	7.4	7.3				
19	503.5	12.02	40.7	8.0	55.5			64.7				0.31		0.03			0.04	0.03	0.03	0.03	0	0.04	89.5	5.2	7.4	7.3				
20	467.0	11.16	40.9	8.0	51.6			60.2				0.31					0.05	0.03	0.03	0.04	0	0.05	88.2	5.2	7.5	7.3				
21	490.4	11.70	40.7	7.0	54.1			63.0				0.27					0.05	0.04	0.04	0.04	0	0.05	84.0	5.2	7.4	7.3				
22	461.4	11.02	40.7	7.0	50.9			59.4				0.30					0.05	0.03	0.03	0.04	0	0.05	87.8	5.3	7.4	7.3				
23	484.4	11.56	40.6	7.0	53.4			62.3				0.32					0.04	0.03	0.03	0.03	0	0.04	89.6	5.2	7.4	7.3				
24	537.8	12.84	41.2	8.0	59.4			69.2				0.32		0.03			0.05	0.04	0.04	0.04	0	0.05	87.5	5.4	7.4	7.3				
25	530.1	12.65	40.3	7.0	58.5			68.2				0.29		0.04			0.05	0.03	0.03	0.04	0	0.05	87.1	5.2	7.4	7.3				
26	444.1	10.61	40.5	7.0	49.1			57.2				0.31					0.05	0.04	0.04	0.04	0	0.05	86.0	5.2	7.4	7.3				
27	460.9	10.99	44.3	8.0	50.8			59.2				0.31					0.04	0.03	0.03	0.03	0	0.04	89.2	5.6	7.3	7.3				
28	507.7	12.14	40.3	7.0	56.1			65.4				0.29		0.04			0.05	0.03	0.03	0.04	0	0.05	87.1	5.3	7.3	7.3				
29	435.8	10.39	40.7	6.0	48.0			56.0				0.30					0.05	0.03	0.03	0.04	0	0.05	87.8	5.3	7.3	7.3				
30	507.4	12.11	40.4	8.0	56.0			65.2				0.28		0.03			0.05	0.03	0.03	0.04	0	0.05	87.5	5.3	7.3	7.3				
31	493.6	11.8	40.1	9.0	54.5			63.5				0.29					0.04	0.03	0.03	0.03	0	0.04	88.7	5.4	7.3	7.3				
Total	15188	362.7	1,272	219.0	1,676.5			1,954.3													0									
Avg	490	11.7	41.04	7.1	54.1			63.0				0.26								0.04			84.0	5.2	7.4	7.3				

Total number of CFE samples analyzed for month: N = 105

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU): 0.02

Filter media design specs (in): Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection: 3/27/2019

filters with more than 10 percent media loss: 0

Report Submitted By: Kevin Cook

Signature:

DOH Form #331-023-F (Excel version)

Date Printed: 4/1/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 4 Year: 2019

PWS ID: | PWS Name: Lake Whatcom Water & Sewer Dist | County: Whatcom
Source ID: S01 | Source Name: Lake Whatcom | Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	479.2	11.48	40.2	9.0	53.1			61.8				0.31					0.05	0.03	0.03	0.04	0	0.05	88.2	5.4	7.3	7.3				
2	494.2	11.78	39.4	6.0	54.5			63.5				0.29					0.05	0.03	0.03	0.04	0	0.05	87.1	5.8	7.1	7.3				
3	448.6	10.71	39.9	6.0	49.5			57.7				0.31					0.05	0.03	0.03	0.04	0	0.05	88.0	5.7	7.2	7.2				
4	408.4	9.74	39.6	7.0	45.0			52.5				0.31					0.05	0.03	0.03	0.04	0	0.05	88.3	6.1	7.2	2.4				
5	483.2	11.53	40.1	6.0	53.3			62.1				0.28					0.05	0.03	0.04	0.04	0	0.05	85.8	5.7	6.9	7.9				
6	457.5	10.94	40.0	7.0	50.6			58.9				0.34					0.05	0.03	0.03	0.04	0	0.05	89.3	5.9	6.9	7.2				
7	494.4	11.79	39.7	6.0	54.5			63.5				0.29					0.04	0.03	0.03	0.03	0	0.04	88.4	6.1	6.9	7.2				
8	509.1	12.17	39.8	8.0	56.3			65.6				0.29		0.03			0.04	0.03	0.03	0.03	0	0.04	88.6	5.9	6.9	7.2				
9	454.3	10.84	39.8	5.0	50.[illegible]			58.4				0.27					0.04	0.03	0.03	0.03	0	0.04	87.5	5.6	10.1	7.2				
10	480.1	11.46	40.9	7.0	53.0			61.8				0.30					0.04	0.04	0.05	0.04	0	0.05	85.7	6.1	10.0	7.2				
11	535.2	12.75	40.1	6.0	58.9			68.7				0.30				0.04	0.03	0.04	0.04	0.04	0	0.04	87.6	6.2	7.3	7.2				
12	509.4	12.18	40.1	8.0	56.3			65.6				0.29		0.04			0.03	0.04	0.04	0.04	0	0.04	87.0	5.9	7.3	7.3				
13	468.8	11.18	40.5	9.0	51.7			60.2				0.28					0.04	0.03	0.04	0.04	0	0.04	86.9	5.6	7.3	7.2				
14	571.0	13.65	40.2	8.0	63.1			73.6				0.33		0.04			0.05	0.04	0.04	0.04	0	0.05	87.2	6.2	7.2	7.2				
15	496.0	11.88	40.2	5.0	54.9			64.0				0.29					0.05	0.03	0.04	0.04	0	0.05	86.0	5.8	7.2	7.2				
16	449.2	10.73	40.2	7.0	49.6			57.8				0.30					0.04	0.03	0.04	0.04	0	0.04	87.9	5.7	7.3	7.2				
17	463.4	11.07	40.3	10.0	51.2			59.6				0.33					0.04	0.03	0.04	0.04	0	0.04	88.7	5.8	7.3	7.2				
18	459.2	10.99	40.2	6.0	50.8			59.2				0.29					0.04	0.03	0.03	0.03	0	0.04	88.5	6.2	7.4	7.3				
19	419.2	9.99	66.8	5.0	46.2			53.8				0.30					0.04	0.03	0.04	0.04	0	0.04	87.7	6.2	7.2	7.2				
20	581.6	13.91	39.7	9.0	64.3			75.0				0.28		0.04			0.05	0.03	0.04	0.04	0	0.05	85.8	6.1	7.3	7.2				
21	546.6	13.03	39.8	8.0	60.2			70.2				0.32		0.05			0.04	0.04	0.05	0.05	0	0.05	85.7	5.9	7.2	7.2				
22	544.2	12.98	39.8	7.0	60.0			70.0				0.30		0.05			0.04	0.03	0.03	0.04	0	0.05	87.5	6.0	7.6	7.1				
23	446.3	10.65	40.4	5.0	49.2			57.4				0.30					0.04	0.03	0.04	0.04	0	0.04	87.8	6.2	7.1	7.2				
24	475.1	11.33	39.9	7.0	52.4			61.1				0.28					0.04	0.03	0.03	0.03	0	0.04	88.2	6.5	7.1	7.1				
25	493.6	11.77	40.9	6.0	54.4			63.4				0.35					0.03	0.03	0.04	0.03	0	0.04	90.5	6.1	7.0	7.2				
26	480.8	11.48	40.1	10.0	53.0			61.8				0.45					0.04	0.03	0.04	0.04	0	0.04	91.8	6.2	7.1	7.2				
27	452.0	10.78	40.0	6.0	49.8			58.1				0.29					0.03	0.03	0.03	0.03	0	0.03	89.8	6.3	7.2	7.2				
28	539.4	12.87	40.0	8.0	59.5			69.4				0.31		0.04			0.04	0.03	0.03	0.04	0	0.04	88.9	6.2	7.0	7.2				
29	523.3	12.48	40.0	7.0	57.7			67.2				0.30		0.05			0.04	0.04	0.04	0.04	~~0~~	0.05	86.0	6.4	7.1	7.2				
30	489.3	11.68	42.1	6.0	54.0			62.9									0.04	0.03	0.04	0.04	0	0.00		6.5	7.1	(3.50				
31																						0.00								
Total	14652	349.8	1,231	210.0	1,617.0			1,884.9													0									
Avg	488	11.7	41.02	7.0	53.9			62.8				0.31								0.04			87.8	6.0	7.4	6.7				

Total number of CFE samples analyzed for month: N = 99 120

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection: 3/27/2019 # filters with more than 10 percent media loss: 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.02

Report Submitted By: Kevin Cook Signature: [signature]

DOH Form #331-023-F (Excel version)

Revised on 5/20/19

Water Treatment Plant Monthly Report Form

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Month: 5 Year: 2019

PWS #:
PWS Name: Lake Whatcom Water & Sewer Dist
County: Whatcom
Source ID: S01
Source Name: Lake Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs): Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU: Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU: 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C: Raw	pH: Raw	Final	Total Alkalinity mg/L as CaCO3: Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	538.7	12.85	43.4	9.0	59.4	n/a	n/a	69.2	n/a	n/a	n/a	0.307	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	87.0	6.6	7.2	7.3	n/a	n/a	n/a	
2	475.8	11.34	40.0	9.0	52.4	n/a	n/a	61.1	n/a	n/a	n/a	0.313	n/a				0.04	0.03	0.03	0.03	0	0.04	89.4	6.6	7.1	7.3	n/a	n/a	n/a	
3	515.5	12.32	39.6	8.0	57.0	n/a	n/a	66.4	n/a	n/a	n/a	0.306	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	86.9	6.2	7.1	7.2	n/a	n/a	n/a	
4	473.3	11.28	39.8	7.0	52.1	n/a	n/a	60.8	n/a	n/a	n/a	0.303	n/a				0.05	0.04	0.04	0.04	0	0.05	85.7	6.0	6.9	7.2	n/a	n/a	n/a	
5	520.1	12.41	40.2	9.0	57.4	n/a	n/a	66.9	n/a	n/a	n/a	0.300	n/a	0.05			0.04	0.03	0.04	0.04	0	0.05	86.7	6.1	7.0	7.2	n/a	n/a	n/a	
6	606.2	14.49	39.9	10.0	67.0	n/a	n/a	78.1	n/a	n/a	n/a	0.303	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	87.6	6.8	7.3	7.2	n/a	n/a	n/a	
7	530.8	12.66	40.1	8.0	58.5	n/a	n/a	68.2	n/a	n/a	n/a	0.299	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	87.5	6.8	7.3	7.2	n/a	n/a	n/a	
8	527.2	12.58	39.9	7.0	58.2	n/a	n/a	67.8	n/a	n/a	n/a	0.303	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	88.4	6.3	7.3	7.2	n/a	n/a	n/a	
9	560.6	13.38	39.8	8.0	61.8	n/a	n/a	72.1	n/a	n/a	n/a	0.281	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	87.5	6.4	7.2	7.2	n/a	n/a	n/a	
10	551.3	13.15	40.9	10.0	60.8	n/a	n/a	70.9	n/a	n/a	n/a	0.294	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	87.2	6.2	7.2	7.2	n/a	n/a	n/a	
11	603.9	14.40	39.6	9.0	66.6	n/a	n/a	77.6	n/a	n/a	n/a	0.304	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	88.5	6.5	7.2	7.2	n/a	n/a	n/a	
12	626.0	14.99	39.8	9.0	69.3	n/a	n/a	80.7	n/a	n/a	n/a	0.316	n/a	0.04			0.04	0.04	0.05	0.04	0	0.05	86.6	6.5	7.3	7.2	n/a	n/a	n/a	
13	568.3	13.62	52.4	9.0	62.9	n/a	n/a	73.4	n/a	n/a	n/a	0.268	n/a	0.05			0.04	0.04	0.04	0.04	0	0.05	84.1	6.3	7.2	7.2	n/a	n/a	n/a	
14	524.2	12.51	39.8	7.0	57.8	n/a	n/a	67.4	n/a	n/a	n/a	0.269	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	86.1	6.3	7.1	7.2	n/a	n/a	n/a	
15	515.5	12.30	39.6	6.0	56.8	n/a	n/a	66.3	n/a	n/a	n/a	0.259	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	84.6	6.7	7.0	7.1	n/a	n/a	n/a	
16	521.8	12.45	39.8	7.0	57.5	n/a	n/a	67.1	n/a	n/a	n/a	0.36	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	88.8	6.6	7.1	7.2	n/a	n/a	n/a	
17	549.4	13.16	39.9	8.0	60.8	n/a	n/a	70.9	n/a	n/a	n/a	0.36	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	90.2	6.4	7.1	7.2	n/a	n/a	n/a	
18	542.2	12.94	39.9	7.0	59.8	n/a	n/a	69.7	n/a	n/a	n/a	0.32	n/a	0.03			0.04	0.04	0.04	0.04	0	0.04	88.2	6.4	7.0	7.2	n/a	n/a	n/a	
19	539.1	12.87	40.2	8.0	59.5	n/a	n/a	69.4	n/a	n/a	n/a	0.49	n/a	0.05			0.04	0.04	0.04	0.04	0	0.05	91.3	6.5	7.0	7.2	n/a	n/a	n/a	
20	646.9	15.63	40.2	9.0	72.3	n/a	n/a	84.2	n/a	n/a	n/a	0.30	n/a	0.05			0.04	0.03	0.04	0.04	0	0.05	86.7	6.4	7.2	7.2	n/a	n/a	n/a	
21	534.9	12.80	39.9	8.0	59.2	n/a	n/a	69.0	n/a	n/a	n/a	0.26	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	84.7	6.4	7.2	7.1	n/a	n/a	n/a	
22	476.6	11.37	39.7	6.0	52.6	n/a	n/a	61.3	n/a	n/a	n/a	0.23	n/a				0.04	0.03	0.04	0.04	0	0.04	84.0	6.9	7.1	7.1	n/a	n/a	n/a	
23	538.8	12.86	40.8	8.0	59.4	n/a	n/a	69.3	n/a	n/a	n/a	0.27	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	85.1	6.6	7.0	7.1	n/a	n/a	n/a	
24	475.2	11.34	40.4	8.0	52.4	n/a	n/a	61.1	n/a	n/a	n/a	0.23	n/a				0.04	0.03	0.04	0.04	0	0.04	84.3	6.6	7.1	7.2	n/a	n/a	n/a	
25	646.9	15.53	40.2	10.0	71.8	n/a	n/a	83.7	n/a	n/a	n/a	0.25	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	84.9	6.3	7.2	7.2	n/a	n/a	n/a	
26	496.6	11.86	40.0	7.0	54.8	n/a	n/a	63.9	n/a	n/a	n/a	0.23	n/a				0.04	0.04	0.05	0.04	0	0.05	80.8	6.0	7.1	7.1	n/a	n/a	n/a	
27	583.6	13.93	40.3	8.0	64.4	n/a	n/a	75.1	n/a	n/a	n/a	0.21	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	82.5	6.5	7.2	7.1	n/a	n/a	n/a	
28	609.8	14.63	40.1	8.0	67.6	n/a	n/a	78.8	n/a	n/a	n/a	0.24	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	85.2	6.4	7.2	7.3	n/a	n/a	n/a	
29	517.3	12.36	39.8	6.0	57.1	n/a	n/a	66.6	n/a	n/a	n/a	0.22	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	82.7	6.4	7.1	7.2	n/a	n/a	n/a	
30	540.4	12.97	39.9	8.0	60.0	n/a	n/a	69.9	n/a	n/a	n/a	0.22	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	83.3	6.8	7.2	7.2	n/a	n/a	n/a	
31	590.7	14.1	40.0	9.0	65.3	n/a	n/a	76.1	n/a	n/a	n/a	0.24	n/a	0.04			0.03	0.03	0.04	0.04	0	0.04	85.4	6.5	7.1	7.2	n/a	n/a	n/a	
Total	16948	405.1	1,256	250.0	1,872.5	0.0	0.0	2,182.7	0.0	0.0	0.0										0									
Avg	547	13.1	40.51	8.1	60.4			70.4				0.29								0.04			86.2	6.5	7.1	7.2				

Total number of CFE samples analyzed for month: N = 119
Total number of CFE samples exceeding 0.3 NTU: E = 0
NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection: 3/27/2019 # filters with more than 10 percent media loss: 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.02

Report Submitted By: Kevin Cook Signature:

DOH Form #331-023-F (Excel version)

Date Printed: 6/3/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 6 Year: 2019

PWS ID:
Source ID: S01

PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom

County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs)								Turbidity NTU		Combined Filter Effluent Turbidity 4 hour sample NTU							No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C	pH		Total Alkalinity mg/L as CaCO3		Calcium Hardness mg/L as CaCO3 Fin	Remarks
				Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Raw	Settled	1st	2nd	3rd	4th	5th	6th	Avg				Raw	Raw	Final	Raw	Fin		
1	555.5	13.25	40.3	7.0	61.2	n/a	n/a	71.4	n/a	n/a	n/a	0.224	n/a	0.06			0.04	0.03	0.03	0.04	0	0.06	82.1	6.5	7.0	7.2	n/a	n/a	n/a	
2	673.4	16.20	39.9	9.0	74.9	n/a	n/a	87.3	n/a	n/a	n/a	0.215	n/a	0.04	0.04		0.03	0.04	0.04	0.04	0	0.04	82.3	6.3	7.0	7.3	n/a	n/a	n/a	
3	692.2	16.75	39.8	9.0	77.4	n/a	n/a	90.3	n/a	n/a	n/a	0.209	n/a	0.05	0.05		0.04	0.04	0.04	0.04	0	0.05	78.9	6.3	7.2	7.3	n/a	n/a	n/a	
4	587.4	14.08	40.9	9.0	65.1	n/a	n/a	75.9	n/a	n/a	n/a	0.200	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	82.5	6.5	7.0	7.3	n/a	n/a	n/a	
5	616.7	14.77	40.1	7.0	68.3	n/a	n/a	79.6	n/a	n/a	n/a	0.228	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	84.6	6.5	7.0	7.2	n/a	n/a	n/a	
6	520.4	12.40	39.6	10.0	57.3	n/a	n/a	66.8	n/a	n/a	n/a	0.218	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	83.9	6.8	7.2	7.2	n/a	n/a	n/a	
7	599.0	14.30	39.2	8.0	66.1	n/a	n/a	77.1	n/a	n/a	n/a	0.301	n/a	0.03			0.03	0.03	0.04	0.03	0	0.04	89.2	6.8	7.2	7.2	n/a	n/a	n/a	
8	534.7	12.75	39.2	7.0	58.9	n/a	n/a	68.7	n/a	n/a	n/a	0.259	n/a	0.05			0.04	0.04	0.04	0.04	0	0.05	83.6	6.7	7.2	7.2	n/a	n/a	n/a	
9	642.6	15.36	39.7	10.0	71.0	n/a	n/a	82.8	n/a	n/a	n/a	0.246	n/a	0.05			0.04	0.04	0.04	0.04	0	0.05	82.7	6.5	7.2	7.2	n/a	n/a	n/a	
10	673.0	16.10	39.6	11.0	74.4	n/a	n/a	86.7	n/a	n/a	n/a	0.267	n/a	0.05	0.05		0.04	0.03	0.03	0.04	0	0.05	85.0	6.6	7.3	7.2	n/a	n/a	n/a	
11	640.8	15.38	39.5	11.0	71.1	n/a	n/a	82.9	n/a	n/a	n/a	0.266	n/a	0.03			0.04	0.02	0.02	0.03	0	0.04	89.7	6.8	7.2	7.2	n/a	n/a	n/a	
12	675.4	16.19	39.6	11.0	74.8	n/a	n/a	87.2	n/a	n/a	n/a	0.308	n/a	0.03	0.03		0.04	0.02	0.03	0.03	0	0.04	90.3	6.6	7.3	7.2	n/a	n/a	n/a	
13	609.9	14.63	39.5	10.0	67.6	n/a	n/a	78.8	n/a	n/a	n/a	0.362	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	90.3	6.7	7.2	7.2	n/a	n/a	n/a	
14	668.3	16.04	39.2	9.0	74.2	n/a	n/a	86.4	n/a	n/a	n/a	0.242	n/a	0.04	0.04		0.04	0.03	0.04	0.04	0	0.04	84.3	6.8	7.3	7.2	n/a	n/a	n/a	
15	560.2	13.35	40.2	7.0	61.7	n/a	n/a	71.9	n/a	n/a	n/a	0.278	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	87.4	6.6	7.2	7.0	n/a	n/a	n/a	
16	716.6	17.16	39.5	10.0	79.3	n/a	n/a	92.4	n/a	n/a	n/a	0.216	n/a	0.04	0.04		0.04	0.03	0.03	0.04	0	0.04	83.3	6.4	7.3	7.1	n/a	n/a	n/a	
17	662.8	16.04	39.3	8.0	74.2	n/a	n/a	86.4	n/a	n/a	n/a	0.253	n/a	0.04	0.05		0.04	0.04	0.05	0.04	0	0.05	82.6	6.3	7.3	7.1	n/a	n/a	n/a	
18	605.8	14.48	38.9	8.0	66.9	n/a	n/a	78.0	n/a	n/a	n/a	0.248	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	84.9	6.7	7.2	7.0	n/a	n/a	n/a	
19	627.1	14.98	39.9	7.0	69.2	n/a	n/a	80.7	n/a	n/a	n/a	0.264	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	86.7	6.9	7.2	7.0	n/a	n/a	n/a	
20	585.5	14.01	40.2	8.0	64.8	n/a	n/a	75.5	n/a	n/a	n/a	0.235	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	85.1	6.8	7.2	7.2	n/a	n/a	n/a	
21	571.3	13.63	40.1	10.0	63.0	n/a	n/a	73.4	n/a	n/a	n/a	0.216	n/a	0.04			0.04	0.02	0.03	0.03	0	0.04	85.0	6.9	7.1	7.3	n/a	n/a	n/a	
22	630.5	15.08	40.3	9.0	69.7	n/a	n/a	81.3	n/a	n/a	n/a	0.216	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	85.0	6.7	7.0	7.2	n/a	n/a	n/a	
23	548.6	13.09	39.8	9.0	60.5	n/a	n/a	70.6	n/a	n/a	n/a	0.194	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	82.0	6.8	7.0	7.2	n/a	n/a	n/a	
24	647.0	15.47	40.2	8.0	71.5	n/a	n/a	83.4	n/a	n/a	n/a	0.196	n/a	0.04			0.04	0.02	0.03	0.03	0	0.04	83.4	6.9	7.0	7.2	n/a	n/a	n/a	
25	550.9	13.13	40.9	8.0	60.7	n/a	n/a	70.8	n/a	n/a	n/a	0.202	n/a	0.03			0.04	0.02	0.03	0.03	0	0.04	85.1	6.5	7.0	7.2	n/a	n/a	n/a	
26	648.7	15.49	41.4	9.0	71.6	n/a	n/a	83.5	n/a	n/a	n/a	0.250	n/a	0.03			0.04	0.04	0.04	0.04	0	0.04	85.0	7.2	7.0	7.2	n/a	n/a	n/a	
27	566.9	13.51	40.2	8.0	62.5	n/a	n/a	72.8	n/a	n/a	n/a	0.216	n/a	0.05			0.04	0.03	0.04	0.04	0	0.05	81.5	7.0	7.0	7.2	n/a	n/a	n/a	
28	560.7	13.37	40.4	8.0	61.8	n/a	n/a	72.0	n/a	n/a	n/a	0.207	n/a	0.04			0.04	0.02	0.02	0.03	0	0.04	85.5	7.0	6.9	7.2	n/a	n/a	n/a	
29	501.8	11.96	40.3	6.0	55.3	n/a	n/a	64.4	n/a	n/a	n/a	0.261	n/a				0.04	0.03	0.04	0.04	0	0.04	86.0	7.3	6.9	7.2	n/a	n/a	n/a	
30	627.2	14.98	40.2	8.0	69.3	n/a	n/a	80.7	n/a	n/a	n/a	0.242	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	84.5	6.9	6.9	7.2	n/a	n/a	n/a	
31						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a	
Total	18301	437.9	1,198	259.0	2,024.4	0.0	0.0	2,359.7	0.0	0.0	0.0										0									
Avg	610	14.6	39.94	8.6	67.5			78.7				0.24								0.04			84.8	6.7	7.1	7.2				

Total number of CFE samples analyzed for month: N = 126
Total number of CFE samples exceeding 0.3 NTU: E = 0
Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%
Number of days CFE exceeded 1.0 NTU this month: 0
Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N
Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y
Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y
Max variation (NTU) 0.04

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"
Date of last filter inspection 3/27/2019
filters with more than 10 percent media loss 0
Report Submitted By Kevin Cook
Signature

DOH Form #331-023-F (Excel version)

Date Printed: 7/2/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month 7 Year 2019

PWS ID | PWS Name: Lake Whatcom Water & Sewer Dist | County: Whatcom

Source ID: S01 | Source Name: Lake Whatcom | Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	688.8	16.58	40.2	8.0	76.6	n/a	n/a	89.3	n/a	n/a	n/a	0.264	n/a	0.04	0.04		0.04	0.03	0.02	0.03	0	0.04	87.1	6.8	7.0	7.2	n/a	n/a	n/a	
2	581.6	13.90	39.9	10.0	64.3	n/a	n/a	74.9	n/a	n/a	n/a	0.266	n/a	0.02			0.04	0.03	0.03	0.03	0	0.04	88.7	6.8	7.0	7.2	n/a	n/a	n/a	
3	595.6	14.19	39.8	9.0	65.6	n/a	n/a	76.5	n/a	n/a	n/a	0.287	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	86.1	7.0	6.9	7.2	n/a	n/a	n/a	
4	568.5	13.56	39.7	8.0	62.7	n/a	n/a	73.0	n/a	n/a	n/a	0.318	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	87.4	7.1	6.9	7.2	n/a	n/a	n/a	
5	603.8	14.42	40.4	9.0	66.7	n/a	n/a	77.7	n/a	n/a	n/a	0.300	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	87.5	6.8	6.9	7.2	n/a	n/a	n/a	
6	589.1	14.04	40.1	8.0	64.9	n/a	n/a	75.7	n/a	n/a	n/a	0.327	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	89.3	6.9	6.9	7.2	n/a	n/a	n/a	
7	573.8	13.68	40.4	8.0	63.2	n/a	n/a	73.7	n/a	n/a	n/a	0.348	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	88.5	7.1	6.9	7.1	n/a	n/a	n/a	
8	625.8	14.96	40.3	9.0	69.1	n/a	n/a	80.6	n/a	n/a	n/a	0.242	n/a	0.05			0.04	0.03	0.04	0.04	0	0.05	83.5	6.9	7.0	7.2	n/a	n/a	n/a	
9	589.3	14.05	40.2	9.0	64.9	n/a	n/a	75.7	n/a	n/a	n/a	0.261	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	85.6	7.1	7.1	7.2	n/a	n/a	n/a	
10	574.6	13.69	40.8	10.0	63.3	n/a	n/a	73.8	n/a	n/a	n/a	0.204	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	84.1	7.0	7.2	7.2	n/a	n/a	n/a	
11	524.9	12.51	40.3	8.0	57.8	n/a	n/a	67.4	n/a	n/a	n/a	0.215	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	82.6	6.7	7.1	7.1	n/a	n/a	n/a	
12	516.5	12.31	40.3	9.0	56.9	n/a	n/a	66.3	n/a	n/a	n/a	0.228	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	83.6	6.9	7.0	7.1	n/a	n/a	n/a	
13	557.5	13.29	39.8	8.0	61.4	n/a	n/a	71.6	n/a	n/a	n/a	0.209	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	82.1	6.9	7.0	7.2	n/a	n/a	n/a	
14	570.6	13.60	40.1	10.0	62.9	n/a	n/a	73.3	n/a	n/a	n/a	0.225	n/a	0.04			0.03	0.03	0.03	0.03	0	0.04	85.6	6.9	6.9	7.1	n/a	n/a	n/a	
15	622.5	14.85	40.0	9.0	68.7	n/a	n/a	80.0	n/a	n/a	n/a	0.205	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	82.9	7.1	6.9	7.1	n/a	n/a	n/a	
16	828.4	20.10	41.2		92.9	n/a	n/a	108.3	n/a	n/a	n/a	0.220	n/a	0.04	0.05	0.04	0.03	0.03	0.04	0.04	0	0.05	82.6	6.9	7.3	7.1	n/a	n/a	n/a	
17	580.8	13.87	40.3	8.0	64.1	n/a	n/a	74.7	n/a	n/a	n/a	0.234	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	85.0	6.9	7.2	7.1	n/a	n/a	n/a	
18	544.3	12.98	39.9	9.0	60.0	n/a	n/a	69.9	n/a	n/a	n/a	0.224	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	83.3	6.8	7.1	7.1	n/a	n/a	n/a	
19	485.5	11.57	40.2	8.0	53.5	n/a	n/a	62.3	n/a	n/a	n/a	0.206	n/a				0.04	0.02	0.03	0.03	0	0.04	85.4	6.9	7.1	7.1	n/a	n/a	n/a	
20	676.3	16.12	40.0	7.0	74.5	n/a	n/a	86.8	n/a	n/a	n/a	0.228	n/a	0.04	0.04		0.04	0.03	0.04	0.04	0	0.04	83.3	7.1	7.1	7.1	n/a	n/a	n/a	
21	599.2	14.29	39.8	8.0	66.0	n/a	n/a	77.0	n/a	n/a	n/a	0.263	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	85.7	7.0	7.1	7.1	n/a	n/a	n/a	
22	678.6	16.29	41.0	9.0	75.3	n/a	n/a	87.8	n/a	n/a	n/a	0.262	n/a	0.04	0.05		0.04	0.03	0.04	0.04	0	0.05	84.7	6.8	7.0	7.1	n/a	n/a	n/a	
23	599.5	14.29	40.3	10.0	66.1	n/a	n/a	77.0	n/a	n/a	n/a	0.207	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	81.9	6.8	7.1	7.2	n/a	n/a	n/a	
24	601.9	14.43	40.0	9.0	66.7	n/a	n/a	77.8	n/a	n/a	n/a	0.228	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	84.6	7.1	7.0	7.1	n/a	n/a	n/a	
25	619.8	14.77	40.3	9.0	68.3	n/a	n/a	79.6	n/a	n/a	n/a	0.229	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	85.8	7.0	6.9	7.0	n/a	n/a	n/a	
26	760.1	18.30	40.9	10.0	84.6	n/a	n/a	98.6	n/a	n/a	n/a	0.263	n/a	0.04	0.05		0.04	0.04	0.05	0.04	0	0.05	83.3	7.0	6.9	7.0	n/a	n/a	n/a	
27	683.4	16.33	40.2	7.0	75.5	n/a	n/a	88.0	n/a	n/a	n/a	0.294	n/a	0.05			0.04	0.03	0.03	0.04	0	0.05	87.2	7.0	7.0	7.2	n/a	n/a	n/a	
28	549.1	13.09	40.0	8.0	60.5	n/a	n/a	70.5	n/a	n/a	n/a	0.412	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	90.3	7.0	6.9	7.2	n/a	n/a	n/a	
29	636.4	15.26	40.1	11.0	70.5	n/a	n/a	82.2	n/a	n/a	n/a	0.222	n/a	0.05			0.04	0.04	0.04	0.04	0	0.05	80.9	7.4	7.6	7.2	n/a	n/a	n/a	
30	643.9	15.43	40.6	9.0	71.3	n/a	n/a	83.1	n/a	n/a	n/a	0.205	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	82.9	7.0	6.8	6.8	n/a	n/a	n/a	
31	622.7	14.9	40.1	10.0	69.0	n/a	n/a	80.4	n/a	n/a	n/a	0.194	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	79.4	7.2	7.3	7.1	n/a	n/a	n/a	
Total	18893	451.7	1,247	264.0	2,087.7	0.0	0.0	2,433.6	0.0	0.0	0.0										0									
Avg	609	14.6	40.23	8.8	67.3			78.5				0.25								0.04			84.9	7.0	7.0	7.1				

Total number of CFE samples analyzed for month: N = 129

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection 3/27/2019 # filters with more than 10 percent media loss 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.03

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Date Printed: 8/8/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 8 Year: 2019

PWS ID:
Source ID: S01
PWS Name: Lake Whatcom Water & Sewer Dist
Source Name: Lake Whatcom
County: Whatcom
Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	620.9	14.86	40.7	9.0	68.7			80.1				0.234		0.05			0.04	0.03	0.03	0.04	0	0.05	84.0	7.4	7.5	7.2				
2	596.9	14.36	39.8	7.0	66.4			77.4				0.366		0.03			0.03	0.03	0.03	0.03	0	0.03	91.8	7.1	7.4	7.2				
3	515.5	12.38	39.7	9.0	57.2			66.7				0.244		0.04			0.03	0.03	0.03	0.03	0	0.04	86.7	7.5	7.2	7.3				
4	638.7	15.27	39.7	8.0	70.6			82.3				0.359		0.04			0.04	0.04	0.04	0.04	0	0.04	88.9	7.6	7.1	7.3				
5	664.1	15.98	40.1	10.0	73.9			86.1				0.296		0.05			0.04	0.03	0.03	0.04	0	0.05	87.3	7.0	7.6	7.3				
6	599.5	14.49	40.2	10.0	67.0			78.1				0.279		0.04			0.04	0.03	0.04	0.04	0	0.04	86.6	[illegible]	7.0	7.3				
7	679.7	16.42	39.9	10.0	75.9			88.5				0.327		0.04		0.04	0.04	0.03	0.03	0.04	0	0.04	89.0	6.9	6.9	7.4				
8	510.4	12.35	39.9	8.0	57.1			66.5				0.379		0.03			0.04	0.04	0.05	0.04	0	0.05	89.4	7.1	6.9	7.4				
9	675.6	16.23	40.1	9.0	75.0			87.5				0.292		0.06	0.06		0.04	0.03	0.03	0.04	0	0.06	84.9	7.2	6.7	7.4				
10	581.6	13.92	40.9	9.0	64.3			75.0				0.322		0.03			0.04	0.03	0.04	0.04	0	0.04	89.1	7.3	6.8	7.3				
11	561.4	13.44	39.8	9.0	62.1			72.4				0.318		0.03			0.04	0.02	0.02	0.03	0	0.04	91.4	7.4	6.7	7.4				
12	546.1	13.08	39.5	9.0	60.5			70.5				0.246		0.03			0.04	0.03	0.04	0.04	0	0.04	85.8	7.3	6.7	7.3				
13	573.3	13.71	40.4	8.0	63.4			73.8				0.250		0.04			0.04	0.03	0.03	0.04	0	0.04	86.0	7.8	6.7	7.1				
14	622.9	14.89	40.3	7.0	68.8			80.2				0.304		0.03			0.04	0.04	0.04	0.04	0	0.04	87.7	7.6	6.6	7.1				
15	586.2	14.07	40.2	10.0	65.0			75.8				0.313		0.05			0.04	0.03	0.04	0.04	0	0.05	87.2	7.2	6.8	7.5				
16	634.5	15.18	50.1	10.0	70.2			81.8				0.301		0.05			0.04	0.03	0.04	0.04	0	0.05	86.7	7.2	6.7	7.4				
17	602.3	14.45	39.8	9.0	66.8			77.8				0.333		0.04			0.04	0.03	0.04	0.04	0	0.04	88.7	7.1	6.6	7.4				
18	607.9	14.59	40.0	10.0	67.4			78.6				0.318		0.04			0.04	0.02	0.03	0.03	0	0.04	89.8	7.8	6.7	7.4				
19	628.6	15.14	41.3	8.0	70.0			81.6				0.259		0.03			0.04	0.03	0.03	0.03	0	0.04	87.5	5.9	8.4	7.4				
20	618.5	14.79	39.8	6.0	68.4			79.7				0.268		0.03			0.04	0.03	0.03	0.03	0	0.04	87.9	7.1	6.9	7.4				
21	575.5	13.82	39.9	9.0	63.9			74.5				0.311		0.04			0.04	0.03	0.03	0.04	0	0.04	88.7	6.5	7.7	7.4				
22	476.6	11.43	40.0	8.0	52.8			61.6				0.253					0.04	0.03	0.03	0.03	0	0.04	86.8	6.6	7.3	7.1				
23	610.0	14.60	39.7	8.0	67.5			78.7				0.364		0.05			0.04	0.03	0.03	0.04	0	0.05	89.7	7.1	7.2	7.1				
24	489.0	11.74	39.7	8.0	54.3			63.3				0.283					0.04	0.03	0.03	0.03	0	0.04	88.2	6.9	7.1	7.4				
25	598.4	14.35	39.8	10.0	66.3			77.3				0.244		0.04			0.04	0.02	0.03	0.03	0	0.04	86.7	7.0	7.2	7.4				
26	595.2	14.24	40.2	8.0	65.8			76.7				0.285		0.03			0.04	0.03	0.03	0.03	0	0.04	88.6	6.9	7.3	7.4				
27	601.5	14.47	39.9	9.0	66.9			77.9				0.294		0.04			0.04	0.03	0.03	0.04	0	0.04	88.1	7.0	7.3	7.4				
28	646.8	15.51	40.2	9.0	71.7			83.6				0.318		0.03			0.04	0.03	0.04	0.04	0	0.04	89.0	6.8	7.2	7.4				
29	559.7	13.45	41.6	10.0	62.2			72.5				0.292		0.04			0.04	0.03	0.03	0.04	0	0.04	88.0	6.6	7.2	7.4				
30	655.2	15.70	40.6	10.0	72.6			84.6				0.031		0.03			0.05	0.06	0.06	0.05	0	0.06	(61,290	6.6	7.1	7.4				
31	539.0	12.9	40.1	8.0	59.7			69.6				0.303		0.06			0.05	0.03	0.03	0.04	0	0.06	86.0	6.7	7.0	7.5				
Total	18412	441.8	1,254	272.0	2,042.2			2,380.6													0									
Avg	594	14.3	40.45	8.8	65.9			76.8				0.29								0.04			83.1	7.1	7.1	7.3				

Total number of CFE samples analyzed for month: N = 124
Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection: 3/27/2019

\# filters with more than 10 percent media loss: 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU) 0.04

Report Submitted By: Kevin Cook

Signature:

DOH Form #331-023-F (Excel version)

Date Printed: 9/3/2019

Water Treatment Plant Monthly Report Form

Washington State Department of Health

PWS ID		PWS Name	Lake Whatcom Water & Sewer Dist	County	Whatcom
Source ID	S01	Source Name	Lake Whatcom	Plant ID	Southshore

Month: 9 Year: 2019

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	626.5	15.06	40.3	8.0	69.6	n/a	n/a	81.1	n/a	n/a	n/a	0.294	n/a	0.04			0.05	0.04	0.06	0.05	0	0.06	83.8	6.8	7.1	7.5	n/a	n/a	n/a	
2	616.0	14.83	40.2	8.0	68.5	n/a	n/a	79.9	n/a	n/a	n/a	0.331	n/a	0.06			0.05	0.03	0.04	0.05	0	0.06	86.4	6.7	7.1	7.3	n/a	n/a	n/a	
3	626.5	15.09	57.2	10.0	69.8	n/a	n/a	81.3	n/a	n/a	n/a	0.285	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	86.0	6.8	7.1	7.2	n/a	n/a	n/a	
4	595.4	14.50	45.1	9.0	67.0	n/a	n/a	78.1	n/a	n/a	n/a	0.274	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	87.2	6.6	7.1	7.2	n/a	n/a	n/a	
5	561.6	13.49	56.7	7.0	62.4	n/a	n/a	72.7	n/a	n/a	n/a	0.278	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	86.5	6.8	7.0	7.3	n/a	n/a	n/a	
6	630.7	15.46	40.4	13.0	71.5	n/a	n/a	83.3	n/a	n/a	n/a	0.253	n/a	0.04			0.04	0.02	0.02	0.03	0	0.04	88.1	6.6	7.1	7.4	n/a	n/a	n/a	
7	547.3	13.15	40.1	7.0	60.8	n/a	n/a	70.8	n/a	n/a	n/a	0.287	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	86.9	6.4	7.1	7.4	n/a	n/a	n/a	
8	549.8	13.33	40.2	10.0	61.6	n/a	n/a	71.8	n/a	n/a	n/a	0.274	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	85.4	6.4	7.1	7.4	n/a	n/a	n/a	
9	620.7	14.92	41.3	7.0	69.0	n/a	n/a	80.4	n/a	n/a	n/a	0.290	n/a	0.04			0.03	0.03	0.03	0.03	0	0.04	88.8	6.8	7.1	7.4	n/a	n/a	n/a	
10	417.8	10.05	40.2	8.0	46.5	n/a	n/a	54.2	n/a	n/a	n/a	0.315	n/a				0.04	0.03	0.03	0.03	0	0.04	89.4	6.8	7.1	7.3	n/a	n/a	n/a	
11	579.4	13.93	40.6	9.0	64.4	n/a	n/a	75.0	n/a	n/a	n/a	0.414	n/a	0.06			0.04	0.03	0.04	0.04	0	0.06	89.7	7.0	7.0	7.3	n/a	n/a	n/a	
12	550.6	13.23	45.7	8.0	61.2	n/a	n/a	71.3	n/a	n/a	n/a	0.286	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	88.6	6.9	7.0	7.3	n/a	n/a	n/a	
13	504.8	12.10	40.9	7.0	55.9	n/a	n/a	65.2	n/a	n/a	n/a	0.361	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	90.3	6.7	7.0	7.3	n/a	n/a	n/a	
14	492.3	11.81	42.5	8.0	54.6	n/a	n/a	63.6	n/a	n/a	n/a	0.281	n/a				0.04	0.03	0.03	0.03	0	0.04	88.1	7.2	7.0	7.3	n/a	n/a	n/a	
15	567.7	13.64	41.2	9.0	63.1	n/a	n/a	73.5	n/a	n/a	n/a	0.404	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	91.3	6.8	6.9	7.3	n/a	n/a	n/a	
16	488.0	11.73	41.4	7.0	54.2	n/a	n/a	63.2	n/a	n/a	n/a	0.444	n/a				0.05	0.02	0.02	0.03	0	0.05	93.2	6.6	6.8	7.3	n/a	n/a	n/a	
17	505.0	12.11	41.5	6.0	56.0	n/a	n/a	65.3	n/a	n/a	n/a	0.296	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	89.0	0.0	8.1	7.2	n/a	n/a	n/a	
18	522.0	12.51	41.4	7.0	57.8	n/a	n/a	67.4	n/a	n/a	n/a	0.272	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	87.1	6.6	8.1	7.2	n/a	n/a	n/a	
19	501.1	12.01	41.4	6.0	55.5	n/a	n/a	64.7	n/a	n/a	n/a	0.268	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	86.0	7.3	7.4	7.4	n/a	n/a	n/a	
20	470.6	11.29	41.6	6.0	52.2	n/a	n/a	60.8	n/a	n/a	n/a	0.259	n/a				0.05	0.06	0.03	0.05	0	0.06	82.0	7.7	7.2	7.4	n/a	n/a	n/a	
21	502.0	12.03	41.5	6.0	55.6	n/a	n/a	64.8	n/a	n/a	n/a	0.263	n/a	0.03			0.04	0.02	0.03	0.03	0	0.04	88.6	7.8	7.1	7.4	n/a	n/a	n/a	
22	539.5	12.92	41.4	7.0	59.7	n/a	n/a	69.6	n/a	n/a	n/a	0.261	n/a	0.03			0.05	0.04	0.04	0.04	0	0.05	84.7	8.1	6.9	7.4	n/a	n/a	n/a	
23	529.6	12.70	41.1	8.0	58.7	n/a	n/a	68.4	n/a	n/a	n/a	0.259	n/a	0.04			0.04	0.03	0.04	0.04	0	0.04	85.5	7.9	6.7	7.4	n/a	n/a	n/a	
24	481.1	11.54	42.4	8.0	53.4	n/a	n/a	62.2	n/a	n/a	n/a	0.252	n/a				0.04	0.02	0.03	0.03	0	0.04	88.1	7.9	6.7	7.3	n/a	n/a	n/a	
25	485.2	11.64	41.2	8.0	53.8	n/a	n/a	62.7	n/a	n/a	n/a	0.226	n/a				0.04	0.03	0.03	0.03	0	0.04	85.3	7.9	6.6	7.3	n/a	n/a	n/a	
26	482.1	11.56	41.5	6.0	53.5	n/a	n/a	62.3	n/a	n/a	n/a	0.308	n/a				0.04	0.03	0.04	0.04	0	0.04	88.1	7.5	6.9	7.3	n/a	n/a	n/a	
27	471.0	11.30	41.4	6.0	52.2	n/a	n/a	60.9	n/a	n/a	n/a	0.241	n/a				0.04	0.03	0.03	0.03	0	0.04	86.2	8.1	6.9	7.3	n/a	n/a	n/a	
28	477.4	11.45	41.5	7.0	52.9	n/a	n/a	61.7	n/a	n/a	n/a	0.294	n/a				0.04	0.03	0.03	0.03	0	0.04	88.7	7.5	6.9	7.4	n/a	n/a	n/a	
29	533.5	12.79	41.6	8.0	59.1	n/a	n/a	68.9	n/a	n/a	n/a	0.244	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	84.6	7.7	6.7	7.4	n/a	n/a	n/a	
30	643.8	15.77	41.7	10.0	72.9	n/a	n/a	85.0	n/a	n/a	n/a	0.242	n/a	0.04			0.04	0.02	0.04	0.04	0	0.04	85.5	7.9	7.3	7.4	n/a	n/a	n/a	
31						n/a	n/a		n/a	n/a	n/a		n/a									0.00					n/a	n/a	n/a	
Total	16119	387.9	1,275	234.0	1,793.2	0.0	0.0	2,090.2	0.0	0.0	0.0										0									
Avg	537	12.9	42.51	7.8	59.8			69.7				0.29								0.04			87.3	6.9	7.1	7.3				

Total number of CFE samples analyzed for month: N = 111

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.04

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 3/27/2019 # filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook Signature

DOH Form #331-023-F (Excel version)

Water Treatment Plant Monthly Report Form

Washington State Department of Health

Month: 10 Year: 2019

PWS ID: | PWS Name: Lake Whatcom Water & Sewer Dist | County: Whatcom
Source ID: S01 | Source Name: Lake Whatcom | Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	561.7	13.54	41.9	7.0	62.6	n/a	n/a	72.9	n/a	n/a	n/a	0.253	n/a	0.03			0.04	0.03	0.03	0.03	0	0.04	87.2	8.0	6.9	7.4	n/a	n/a	n/a	
2	579.9	13.92	41.9	9.0	64.4	n/a	n/a	75.0	n/a	n/a	n/a	0.243	n/a	0.03			0.04	0.03	0.04	0.04	0	0.04	85.6	7.9	6.9	7.4	n/a	n/a	n/a	
3	548.4	13.17	42.7	10.0	60.9	n/a	n/a	71.0	n/a	n/a	n/a	0.242	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	83.5	7.9	7.0	7.4	n/a	n/a	n/a	
4	601.6	14.68	42.0	8.0	67.8	n/a	n/a	79.1	n/a	n/a	n/a	0.233	n/a	0.05			0.05	0.02	0.02	0.04	0	0.05	85.0	7.9	6.9	7.4	n/a	n/a	n/a	
5	583.3	14.10	42.1	8.0	65.2	n/a	n/a	76.0	n/a	n/a	n/a	0.224	n/a	0.02			0.05	0.03	0.04	0.04	0	0.05	84.4	7.7	6.9	7.4	n/a	n/a	n/a	
6	644.3	15.57	41.8	8.0	72.0	n/a	n/a	83.9	n/a	n/a	n/a	0.255	n/a	0.04			0.05	0.04	0.02	0.04	0	0.05	85.3	7.8	6.8	7.3	n/a	n/a	n/a	
7	651.7	15.90	41.6	10.0	73.5	n/a	n/a	85.7	n/a	n/a	n/a	0.301	n/a	0.02			0.05	0.03	0.04	0.04	0	0.05	88.4	8.1	7.0	7.1	n/a	n/a	n/a	
8	603.1	14.78	42.0	8.0	68.3	n/a	n/a	79.6	n/a	n/a	n/a	0.252	n/a	0.04			0.05	0.04	0.03	0.04	0	0.05	84.1	7.9	7.0	7.1	n/a	n/a	n/a	
9	578.5	14.01	41.9	10.0	64.7	n/a	n/a	75.5	n/a	n/a	n/a	0.241	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	83.4	7.5	6.9	7.3	n/a	n/a	n/a	
10	519.9	12.46	41.9	8.0	57.6	n/a	n/a	67.1	n/a	n/a	n/a	0.246	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	84.8	7.5	6.9	7.3	n/a	n/a	n/a	
11	465.2	11.16	41.9	7.0	51.6	n/a	n/a	60.1	n/a	n/a	n/a	0.298	n/a				0.04	0.03	0.04	0.04	0	0.04	87.7	8.2	6.9	7.3	n/a	n/a	n/a	
12	472.8	11.35	42.7	8.0	52.5	n/a	n/a	61.2	n/a	n/a	n/a	0.239	n/a				0.04	0.03	0.04	0.04	0	0.04	84.7	8.0	6.9	7.3	n/a	n/a	n/a	
13	529.0	12.69	41.4	8.0	58.6	n/a	n/a	68.4	n/a	n/a	n/a	0.246	n/a	0.04			0.04	0.04	0.04	0.04	0	0.04	83.7	7.7	6.9	7.3	n/a	n/a	n/a	
14	719.5	17.63	42.4	9.0	81.5	n/a	n/a	95.0	n/a	n/a	n/a	0.261	n/a	0.05	0.06		0.04	0.03	0.04	0.04	0	0.06	83.1	7.7	7.0	7.4	n/a	n/a	n/a	
15	471.8	11.32	42.0	7.0	52.3	n/a	n/a	61.0	n/a	n/a	n/a	0.250	n/a				0.04	0.03	0.03	0.03	0	0.04	86.7	7.9	7.0	7.4	n/a	n/a	n/a	
16	481.7	11.56	41.8	7.0	53.4	n/a	n/a	62.3	n/a	n/a	n/a	0.237	n/a				0.04	0.03	0.04	0.04	0	0.04	84.5	7.7	7.4	7.3	n/a	n/a	n/a	
17	464.5	11.21	42.0	7.0	51.8	n/a	n/a	60.4	n/a	n/a	n/a	0.301	n/a				0.04	0.03	0.04	0.04	0	0.04	87.8	8.0	7.3	7.3	n/a	n/a	n/a	
18	466.0	11.20	41.7	6.0	51.8	n/a	n/a	60.3	n/a	n/a	n/a	0.269	n/a				0.05	0.03	0.04	0.04	0	0.05	85.1	7.3	7.2	7.4	n/a	n/a	n/a	
19	497.0	11.91	41.9	7.0	55.1	n/a	n/a	64.2	n/a	n/a	n/a	0.287	n/a				0.04	0.03	0.03	0.03	0	0.04	88.4	7.6	7.2	7.3	n/a	n/a	n/a	
20	530.0	12.69	41.9	9.0	58.7	n/a	n/a	68.4	n/a	n/a	n/a	0.276	n/a	0.02			0.04	0.04	0.05	0.04	0	0.05	86.4	7.6	7.0	7.3	n/a	n/a	n/a	
21	392.0	9.46	41.9	6.0	43.7	n/a	n/a	51.0	n/a	n/a	n/a	0.292	n/a				0.04	0.03	0.04	0.04	0	0.04	87.4	8.3	7.2	7.3	n/a	n/a	n/a	
22	455.7	11.22	41.7	7.0	51.9	n/a	n/a	60.5	n/a	n/a	n/a	0.571	n/a	0.05				0.05	0.03	0.04	0	0.05	92.4	8.2	7.3	7.3	n/a	n/a	n/a	
23	599.9	14.33	42.0	8.0	66.2	n/a	n/a	77.2	n/a	n/a	n/a	0.808	n/a	0.03			0.04	0.02	0.02	0.03	0	0.04	96.6	7.8	7.0	7.3	n/a	n/a	n/a	
24	507.2	12.09	42.7	8.0	55.9	n/a	n/a	65.1	n/a	n/a	n/a	0.761	n/a	0.04			0.04	0.03	0.03	0.04	0	0.04	95.4	8.3	7.1	7.2	n/a	n/a	n/a	
25	447.2	10.70	42.3	9.0	49.5	n/a	n/a	57.7	n/a	n/a	n/a	1.800	n/a				0.05	0.03	0.03	0.04	0	0.05	98.0	8.1	7.2	7.3	n/a	n/a	n/a	
26	436.6	10.41	41.8	6.0	48.1	n/a	n/a	56.1	n/a	n/a	n/a	0.686	n/a				0.05	0.03	0.03	0.04	0	0.05	94.7	7.2	7.4	7.3	n/a	n/a	n/a	
27	523.3	12.73	42.0	7.0	58.9	n/a	n/a	68.6	n/a	n/a	n/a	0.707	n/a	0.03			0.05	0.03	0.03	0.04	0	0.05	95.0	7.9	7.6	7.3	n/a	n/a	n/a	
28	539.8	13.26	42.2	8.0	61.3	n/a	n/a	71.5	n/a	n/a	n/a	0.657	n/a	0.03			0.05	0.03	0.04	0.04	0	0.05	94.3	7.8	7.4	7.1	n/a	n/a	n/a	
29	456.5	11.00	42.0	7.0	50.8	n/a	n/a	59.3	n/a	n/a	n/a	0.688	n/a				0.05	0.03	0.03	0.04	0	0.05	94.7	7.7	7.4	7.1	n/a	n/a	n/a	
30	427.2	10.19	42.1	6.0	47.1	n/a	n/a	54.9	n/a	n/a	n/a	0.707	n/a				0.05	0.03	0.03	0.04	0	0.05	94.8	10.2	6.5	7.3	n/a	n/a	n/a	
31	427.1	10.20	42.2	6.0	47.1	n/a	n/a	55.0	n/a	n/a	n/a	0.565	n/a				0.05	0.04	0.04	0.04	0	0.05	92.3	10.9	6.9	7.3	n/a	n/a	n/a	
Total	16182	390.4	1,302	239.0	1,804.7	0.0	0.0	2,103.7	0.0	0.0	0.0										0									
Avg	522	12.6	42.01	7.7	58.2			67.9				0.43								0.04			88.6	8.0	7.1	7.3				

Total number of CFE samples analyzed for month: N = 111

Total number of CFE samples exceeding 0.3 NTU: E = 0

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Date of last filter inspection: 3/27/2019

filters with more than 10 percent media loss: 0

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU): 0.04

Report Submitted By: Kevin Cook

Signature:

DOH Form #331-023-F (Excel version)

Date Printed: 11/6/2019

Water Treatment Plant Monthly Report Form

Washington State Department of Health — Environmental Public Health, Office of Drinking Water

Month: 11 Year: 2019

PWS ID:

Source ID: S01

PWS Name: Lake Whatcom Water & Sewer Dist

Source Name: Lake Whatcom

County: Whatcom

Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs) Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone		
1	455.3	10.87	42.3	6.0	[illegible]	n/a	n/a	58.6	n/a	n/a	n/a
2	451.0	10.81	42.4	7.0	[illegible]	n/a	n/a	58.2	n/a	n/a	n/a
3	535.2	13.17	42.2	8.0	60.9	n/a	n/a	70.9	n/a	n/a	n/a
4	483.4	11.96	45.2	9.0	55.3	n/a	n/a	64.4	n/a	n/a	n/a
5	471.4	11.53	43.4	7.0	53.3	n/a	n/a	62.1	n/a	n/a	n/a
6	428.8	10.27	41.5	7.0	47.5	n/a	n/a	55.3	n/a	n/a	n/a
7	432.7	10.33	40.1	8.0	47.8	n/a	n/a	55.7	n/a	n/a	n/a
8	377.7	9.00	40.5	8.0	41.6	n/a	n/a	48.5	n/a	n/a	n/a
9	505.1	12.43	41.0	8.0	57.5	n/a	n/a	67.0	n/a	n/a	n/a
10	487.8	12.11	41.1	6.0	56.0	n/a	n/a	65.2	n/a	n/a	n/a
11	439.1	10.74	40.9	8.0	49.6	n/a	n/a	57.8	n/a	n/a	n/a
12	525.3	12.68	41.0	8.0	58.6	n/a	n/a	68.3	n/a	n/a	n/a
13	475.4	11.42	40.9	8.0	[illegible]	n/a	n/a	61.5	n/a	n/a	n/a
14	398.0	9.58	42.1	7.0	[illegible]	n/a	n/a	51.6	n/a	n/a	n/a
15	504.9	12.28	41.7	6.0	56.8	n/a	n/a	66.2	n/a	n/a	n/a
16	494.4	11.81	42.8	7.0	54.6	n/a	n/a	63.6	n/a	n/a	n/a
17	490.3	12.03	41.1	7.0	[illegible]	n/a	n/a	64.8	n/a	n/a	n/a
18	465.2	11.43	41.3	8.0	[illegible]	n/a	n/a	61.6	n/a	n/a	n/a
19	442.8	10.92	41.0	9.0	50.5	n/a	n/a	58.8	n/a	n/a	n/a
20	477.6	11.62	41.8	8.0	53.7	n/a	n/a	62.6	n/a	n/a	n/a
21	429.8	10.49	40.9	7.0	[illegible]	n/a	n/a	56.5	n/a	n/a	n/a
22	478.1	11.81	41.3	6.0	[illegible]	n/a	n/a	63.7	n/a	n/a	n/a
23	408.8	9.78	41.4	6.0	45.2	n/a	n/a	52.7	n/a	n/a	n/a
24	497.1	12.10	41.5	6.0	55.9	n/a	n/a	65.2	n/a	n/a	n/a
25	515.8	12.81	41.0	10.0	[illegible]	n/a	n/a	69.0	n/a	n/a	n/a
26	449.3	11.06	41.4	9.0	[illegible]	n/a	n/a	59.6	n/a	n/a	n/a
27	462.2	11.44	42.4	8.0	52.9	n/a	n/a	61.6	n/a	n/a	n/a
28	441.3	10.86	40.2	7.0	50.2	n/a	n/a	58.5	n/a	n/a	n/a
29	753.1	17.99	77.7	13.0	[illegible]	n/a	n/a	96.9	n/a	n/a	n/a
30	446.4	10.67	39.2	9.0	[illegible]	n/a	n/a	57.5	n/a	n/a	n/a
31						n/a	n/a		n/a	n/a	n/a
Total	14223	346.0	1,281	231.0	1,599.3	0.0	0.0	1,864.2	0.0	0.0	0.0
Avg	474	11.5	42.72	7.7	53.3			62.1			

Date	Turbidity NTU Raw	Settled	Combined Filter Effluent Turbidity 4 hour sample NTU 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C Raw	pH Raw	pH Final	Total Alkalinity mg/L as CaCO3 Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	0.542	n/a				0.05	0.02	0.03	0.03	0	0.05	93.8	8.1	7.5	7.3	n/a	n/a	n/a	
2	0.660	n/a				0.05	0.03	0.04	0.04	0	0.05	93.9	8.3	7.6	7.3	n/a	n/a	n/a	
3	0.533	n/a	0.04			0.05	0.03	0.03	0.04	0	0.05	93.0	8.2	7.5	7.4	n/a	n/a	n/a	
4	0.536	n/a				0.04	0.03	0.03	0.03	0	0.04	93.8	8.5	7.5	7.4	n/a	n/a	n/a	
5	0.494	n/a				0.04	0.04	0.04	0.04	0	0.04	91.9	8.6	7.5	7.4	n/a	n/a	n/a	
6	0.435	n/a				0.05	0.03	0.04	0.04	0	0.05	90.8	8.3	7.3	7.4	n/a	n/a	n/a	
7	0.703	n/a				0.06	0.03	0.03	0.04	0	0.06	94.3	8.4	7.4	7.4	n/a	n/a	n/a	
8	0.481	n/a				0.06	0.03	0.03	0.04	0	0.06	91.7	8.6	7.3	7.5	n/a	n/a	n/a	
9	0.464	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	91.4	8.2	7.3	7.5	n/a	n/a	n/a	
10	0.431	n/a				0.06	0.04	0.04	0.05	0	0.06	89.2	8.0	7.4	7.5	n/a	n/a	n/a	
11	0.501	n/a				0.05	0.04	0.04	0.04	0	0.05	91.4	9.0	7.5	7.5	n/a	n/a	n/a	
12	0.363	n/a	0.04			0.05	0.03	0.04	0.04	0	0.05	89.0	7.7	7.6	7.3	n/a	n/a	n/a	
13	0.462	n/a				0.06	0.03	0.03	0.04	0	0.06	91.3	8.0	7.5	7.3	n/a	n/a	n/a	
14	0.377	n/a				0.05	0.03	0.03	0.04	0	0.05	90.3	9.1	7.4	7.3	n/a	n/a	n/a	
15	0.333	n/a	0.04			0.05	0.04	0.05	0.05	0	0.05	86.5	7.9	7.4	7.4	n/a	n/a	n/a	
16	0.387	n/a				0.05	0.03	0.04	0.04	0	0.05	89.7	7.4	7.2	7.3	n/a	n/a	n/a	
17	0.389	n/a	0.04			0.05	0.05	0.03	0.04	0	0.05	89.1	8.9	7.3	7.3	n/a	n/a	n/a	
18	0.381	n/a				0.05	0.03	0.04	0.04	0	0.05	89.5	8.5	7.3	7.5	n/a	n/a	n/a	
19	0.377	n/a				0.05	0.03	0.03	0.04	0	0.05	90.3	8.5	7.5	0.0	n/a	n/a	n/a	
20	0.307	n/a				0.06	0.03	0.04	0.04	0	0.06	85.9	8.3	7.4	7.2	n/a	n/a	n/a	
21	0.344	n/a				0.06	0.03	0.03	0.04	0	0.06	88.4	8.9	7.3	7.2	n/a	n/a	n/a	
22	0.370	n/a				0.06	0.04	0.03	0.04	0	0.06	88.3	9.5	7.7	7.5	n/a	n/a	n/a	
23	0.572	n/a			0.07	0.06	0.04	0.04	0.05	0	0.07	90.8	9.2	7.3	7.5	n/a	n/a	n/a	
24	0.307	n/a			0.06	0.06	0.04	0.04	0.05	0	0.06	83.7	9.8	7.4	7.5	n/a	n/a	n/a	
25	0.319	n/a			0.06	0.04	0.03	0.03	0.04	0	0.06	87.5	9.4	7.5	7.3	n/a	n/a	n/a	
26	0.311	n/a				0.06	0.05	0.03	0.05	0	0.06	85.0	9.6	7.6	7.6	n/a	n/a	n/a	
27	0.346	n/a				0.06	0.05	0.04	0.05	0	0.06	85.5	8.6	8.1	7.6	n/a	n/a	n/a	
28	0.390	n/a				0.06	0.03	0.03	0.04	0	0.06	89.7	9.3	7.4	7.6	n/a	n/a	n/a	
29	1.012	n/a		0.05	0.04	0.05	0.04	0.04	0.04	0	0.05	95.7	9.0	7.3	7.5	n/a	n/a	n/a	
30	0.984	n/a				0.06	0.06	0.04	0.05	0	0.06	94.6	9.2	7.4	7.5	n/a	n/a	n/a	
31		n/a									0.00					n/a	n/a	n/a	
Total										0									
Avg	0.47								0.04			90.2	8.6	7.5	7.2				

Total number of CFE samples analyzed for month: N = 100

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y

Max variation (NTU) 0.05

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 3/27/2019

filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook

Signature

DOH Form #331-023-F (Excel version)

Date Printed: 12/3/2019

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

Water Treatment Plant Monthly Report Form

Month: 12 Year: 2019

PWS ID: PWS Name: Lake Whatcom Water & Sewer Dist County: Whatcom

Source ID: S01 Source Name: Lake Whatcom Plant ID: Southshore

Cells and Columns with Blue Headings are intended for data provided by user

Date	Water Treated in 1000 gals	Total Hours of Operation	Filter Backwash Total in 1000 gal	Chemicals Used (lbs): Chlorine	Alum	Polymer	Filter Aid	Soda Ash	Ozone			Turbidity NTU: Raw	Settled
1	537.5	13.17	39.3	8.0	60.9	n/a	n/a	71.0	n/a	n/a	n/a	0.381	n/a
2	480.8	11.69	39.9	5.0	54.0	n/a	n/a	63.0	n/a	n/a	n/a	0.322	n/a
3	432.8	10.41	40.4	7.0	48.1	n/a	n/a	56.1	n/a	n/a	n/a	0.324	n/a
4	477.3	11.51	40.2	5.0	53.2	n/a	n/a	62.0	n/a	n/a	n/a	0.297	n/a
5	437.3	10.61	40.2	8.0	49.0	n/a	n/a	57.2	n/a	n/a	n/a	0.318	n/a
6	447.7	10.78	40.1	7.0	49.8	n/a	n/a	58.1	n/a	n/a	n/a	0.694	n/a
7	460.0	11.02	40.2	7.0	50.9	n/a	n/a	59.4	n/a	n/a	n/a	0.483	n/a
8	490.5	11.80	40.6	7.0	54.5	n/a	n/a	63.6	n/a	n/a	n/a	0.514	n/a
9	455.4	11.00	40.2	11.0	50.8	n/a	n/a	59.3	n/a	n/a	n/a	0.279	n/a
10	456.0	10.90	40.1	6.0	50.4	n/a	n/a	58.7	n/a	n/a	n/a	0.320	n/a
11	398.2	9.50	41.3	6.0	43.9	n/a	n/a	51.2	n/a	n/a	n/a	0.326	n/a
12	488.2	11.71	40.1	5.0	54.1	n/a	n/a	63.1	n/a	n/a	n/a	0.350	n/a
13	445.9	10.69	40.5	7.0	49.4	n/a	n/a	57.6	n/a	n/a	n/a	0.331	n/a
14	449.7	10.73	39.9	7.0	49.6	n/a	n/a	57.8	n/a	n/a	n/a	0.354	n/a
15	511.5	12.23	39.9	7.0	56.5	n/a	n/a	65.9	n/a	n/a	n/a	0.392	n/a
16	443.0	10.59	40.5	9.0	49.0	n/a	n/a	57.1	n/a	n/a	n/a	0.399	n/a
17	434.7	10.37	39.9	6.0	47.9	n/a	n/a	55.9	n/a	n/a	n/a	0.300	n/a
18	446.3	10.66	40.1	7.0	49.3	n/a	n/a	57.4	n/a	n/a	n/a	0.301	n/a
19	481.4	11.56	40.3	8.0	53.4	n/a	n/a	62.3	n/a	n/a	n/a	0.313	n/a
20	497.0	12.09	40.4	7.0	55.9	n/a	n/a	65.1	n/a	n/a	n/a	0.324	n/a
21	480.4	11.61	40.3	8.0	53.7	n/a	n/a	62.6	n/a	n/a	n/a	0.338	n/a
22	576.8	14.14	39.8	9.0	65.4	n/a	n/a	76.2	n/a	n/a	n/a	0.620	n/a
23	559.9	13.71	40.3	9.0	63.4	n/a	n/a	73.8	n/a	n/a	n/a	0.365	n/a
24	507.8	12.25	40.8	8.0	56.6	n/a	n/a	66.0	n/a	n/a	n/a	0.333	n/a
25	451.4	10.80	55.2	7.0	49.9	n/a	n/a	58.2	n/a	n/a	n/a	0.327	n/a
26	490.8	11.74	38.6	7.0	54.3	n/a	n/a	63.3	n/a	n/a	n/a	0.357	n/a
27	453.9	10.88	40.0	8.0	50.3	n/a	n/a	58.6	n/a	n/a	n/a	0.350	n/a
28	483.6	11.56	40.3	7.0	53.4	n/a	n/a	62.3	n/a	n/a	n/a	0.335	n/a
29	521.2	12.58	39.9	9.0	58.2	n/a	n/a	67.8	n/a	n/a	n/a	0.350	n/a
30	412.4	9.83	40.3	7.0	45.4	n/a	n/a	53.0	n/a	n/a	n/a	0.389	n/a
31	524.6	12.56	40.7	8.0	58.1	n/a	n/a	67.7	n/a	n/a	n/a	0.338	n/a
Total	14734	354.7	1,260	227.0	1,639.4	0.0	0.0	1,911.0	0.0	0.0	0.0		
Avg	475	11.4	40.65	7.3	52.9			61.6				0.37	

Date	Combined Filter Effluent Turbidity 4 hour sample NTU: 1st	2nd	3rd	4th	5th	6th	Avg	No of Samples > 0.3 NTU	Max CFE Turbidity NTU	% NTU Reduction (See Note 1)	Temp C: Raw	pH: Raw	pH: Final	Total Alkalinity mg/L as CaCO3: Raw	Fin	Calcium Hardness mg/L as CaCO3 Fin	Remarks
1	0.04			0.06	0.06	0.04	0.05	0	0.06	86.9	9.0	7.4	7.5	n/a	n/a	n/a	
2				0.06	0.04	0.04	0.05	0	0.06	85.5	8.8	7.3	7.5	n/a	n/a	n/a	
3				0.06	0.03	0.04	0.04	0	0.06	86.6	8.7	7.4	7.5	n/a	n/a	n/a	
4				0.06	0.04	0.04	0.05	0	0.06	84.3	8.8	7.5	7.5	n/a	n/a	n/a	
5				0.06	0.03	0.04	0.04	0	0.06	86.4	8.4	8.3	7.5	n/a	n/a	n/a	
6				0.06	0.04	0.05	0.05	0	0.06	92.8	8.4	8.2	7.5	n/a	n/a	n/a	
7				0.06	0.04	0.04	0.05	0	0.06	90.3	8.7	7.5	7.5	n/a	n/a	n/a	
8				0.06	0.03	0.03	0.04	0	0.06	92.2	8.8	7.3	7.4	n/a	n/a	n/a	
9				0.06	0.04	0.04	0.05	0	0.06	83.3	8.8	7.6	7.4	n/a	n/a	n/a	
10				0.06	0.04	0.08	0.06	0	0.08	81.3	8.5	7.7	7.4	n/a	n/a	n/a	
11				0.06	0.04	0.05	0.05	0	0.06	84.7	8.6	7.5	7.4	n/a	n/a	n/a	
12				0.06	0.04	0.05	0.05	0	0.06	85.7	8.5	7.4	7.4	n/a	n/a	n/a	
13				0.06	0.04	0.04	0.05	0	0.06	85.9	8.4	7.5	7.4	n/a	n/a	n/a	
14				0.06	0.03	0.04	0.04	0	0.06	87.8	8.5	7.3	7.4	n/a	n/a	n/a	
15	0.04			0.06	0.03	0.04	0.04	0	0.06	89.2	8.3	7.4	7.4	n/a	n/a	n/a	
16				0.06	0.04	0.04	0.05	0	0.06	88.3	8.3	7.0	7.3	n/a	n/a	n/a	
17				0.06	0.04	0.05	0.05	0	0.06	83.3	8.0	7.9	7.3	n/a	n/a	n/a	
18				0.06	0.05	0.04	0.05	0	0.06	83.4	7.7	7.3	7.3	n/a	n/a	n/a	
19				0.06	0.04	0.04	0.05	0	0.06	85.1	7.6	7.1	7.2	n/a	n/a	n/a	
20			0.06	0.03	0.04	0.04	0.04	0	0.06	86.9	8.2	7.2	7.5	n/a	n/a	n/a	
21				0.07	0.06	0.04	0.06	0	0.07	83.2	8.0	7.1	7.4	n/a	n/a	n/a	
22	0.04			0.05	0.06	0.03	0.05	0	0.06	92.7	8.0	7.2	7.4	n/a	n/a	n/a	
23	0.03			0.06	0.03	0.04	0.04	0	0.06	89.0	7.9	7.3	7.4	n/a	n/a	n/a	
24	0.04			0.05	0.04	0.04	0.04	0	0.05	87.2	8.1	7.1	7.3	n/a	n/a	n/a	
25				0.05	0.03	0.03	0.04	0	0.05	88.8	8.1	6.9	7.3	n/a	n/a	n/a	
26				0.06	0.04	0.04	0.05	0	0.06	86.9	7.6	7.4	7.3	n/a	n/a	n/a	
27				0.05	0.04	0.04	0.04	0	0.05	87.6	7.6	6.9	7.3	n/a	n/a	n/a	
28				0.05	0.05	0.04	0.05	0	0.05	86.1	7.6	7.2	7.3	n/a	n/a	n/a	
29	0.05			0.05	0.04	0.04	0.05	0	0.05	87.1	7.6	7.1	7.4	n/a	n/a	n/a	
30				0.05	0.05	0.03	0.04	0	0.05	88.9	7.3	6.8	7.3	n/a	n/a	n/a	
31	0.04			0.06	0.03	0.03	0.04	0	0.06	88.2	7.3	6.6	7.3	n/a	n/a	n/a	
Total								0									
Avg							0.05			87.0	8.2	7.3	7.4				

Total number of CFE samples analyzed for month: N = 101

Total number of CFE samples exceeding 0.3 NTU: E = 0

Satisfactory turbidity performance is 95% or greater. Performance determination: [1-(E/N)]x100 = 100.0%

Number of days CFE exceeded 1.0 NTU this month: 0

Did the CFE continuous monitoring fail to operate for more than five (5) consecutive days during this month? Y/N: N

Did you monitor the effluent turbidity of each individual filter on a continuous basis? Y/N: Y

Weekly grab sample verification of on-line turbidimeters per WAC 246-290-638 (4)? Y/N: Y Max variation (NTU) 0.05

DOH Form #331-023-F (Excel version)

NOTE 1: Percent turbidity reduction for each day of operation: PTR = [(Raw NTU)-(Avg CFE NTU)]x(100)/(Raw NTU)

Filter media design specs (in) Anthracite 18" Sand 9" Garnet 9"

Date of last filter inspection 3/27/2019 # filters with more than 10 percent media loss 0

Report Submitted By Kevin Cook Signature

Date Printed: 1/3/2020

APPENDIX C

TIER 1 SEISMIC ANALYSIS CHECKLIST

APPENDIX C
SUMMARY DATA SHEET

BUILDING DATA

Building Name: Treatment Plant Bldg Date: 2/12/2020
Building Address: LWSD - Sudden Valley
Latitude: ______ Longitude: ______ By: MJB
Year Built: ______ Year(s) Remodeled: ______ Original Design Code: ______
Area (sf): ______ Length (ft): ______ Width (ft): ______
No. of Stories: ______ Story Height: ______ Total Height: ______

USE ☐ Industrial ☐ Office ☐ Warehouse ☐ Hospital ☐ Residential ☐ Educational ☐ Other: ______

CONSTRUCTION DATA

Gravity Load Structural System: Conc walls @ perimeter
Exterior Transverse Walls: conc walls Openings? ______
Exterior Longitudinal Walls: Conc walls Openings? ______
Roof Materials/Framing: precast conc "T" girders
Intermediate Floors/Framing: conc slab over clear well
Ground Floor: conc slab on grade
Columns: N/A Foundation: ______
General Condition of Structure: good
Levels Below Grade? clear well
Special Features and Comments: ______

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
System:	shear wall	(see long'tudinal)
Vertical Elements:	conc wall	
Diaphragms:	conc slab	
Connections:	rebar	

EVALUATION DATA

BSE-1N Spectral Response Accelerations: S_{DS} = ______ S_{D1} = ______
Soil Factors: Class = ______ F_a = ______ F_v = ______
BSE-1E Spectral Response Accelerations: S_{XS} = ______ S_{X1} = ______
Level of Seismicity: ______ Performance Level: ______
Building Period: T = ______
Spectral Acceleration: S_a = ______
Modification Factor: $C_mC_1C_2$ = ______ Building Weight: W = ______
Pseudo Lateral Force: V= $C_mC_1C_2S_aW$= ______

BUILDING CLASSIFICATION: ______

REQUIRED TIER 1 CHECKLISTS	**Yes**	**No**
Basic Configuration Checklist	☐	☐
Building Type ______ Structural Checklist	☐	☐
Nonstructural Component Checklist	☐	☐

FURTHER EVALUATION REQUIREMENT: ______

Project: LWSD Location: Treatment Plant BLDG

Completed by: MJB Date: 2/12/20

16.10IO IMMEDIATE OCCUPANCY STRUCTURAL CHECKLIST FOR BUILDING TYPES C2: CONCRETE SHEAR WALLS WITH STIFF DIAPHRAGMS AND C2A: CONCRETE SHEAR WALLS WITH FLEXIBLE DIAPHRAGMS

Very Low Seismicity

Seismic-Force-Resisting System

C NC N/A U COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1)

C NC N/A U REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)

C NC N/A U SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than the greater of 100 lb/in.^{2} or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1)

C NC N/A U REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. The spacing of reinforcing steel is equal to or less than 18 in. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3)

Connections

C NC N/A U WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)

C NC N/A U TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of loads to the shear walls, and the connections are able to develop the lesser of the shear strength of the walls or diaphragms. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)

C NC N/A U FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation, and the dowels are able to develop the lesser of the strength of the walls or the uplift capacity of the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4)

Foundation System

C NC N/A U DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil. (Commentary: Sec. A.6.2.3)

C NC N/A U SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story high. (Commentary: Sec. A.6.2.4)

Low, Moderate, and High Seismicity: Complete the Following Items in Addition to the Items for Very Low Seismicity.

Seismic-Force-Resisting System

C NC N/A U DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components and are compliant with the following items: COLUMN-BAR SPLICES, BEAM-BAR SPLICES, COLUMN-TIE SPACING, STIRRUP SPACING, and STIRRUP AND TIE HOOK in the Immediate Occupancy Structural Checklist for Building Type C1. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2)

C NC N/A U FLAT SLABS: Flat slabs or plates not part of seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3)

C NC N/A U COUPLING BEAMS: The stirrups in coupling beams over means of egress are spaced at or less than *d*/2 and are anchored into the confined core of the beam with hooks of 135 degrees or more. The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads caused by overturning. Coupling beams have the capacity in shear to develop the uplift capacity of the adjacent wall. (Commentary: Sec.A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1)

C NC N/A U OVERTURNING: All shear walls have aspect ratios less than 4-to-1. Wall piers need not be considered. (Commentary: Sec. A.3.2.2.4. Tier 2: Sec. 5.5.3.1.4)

C NC N/A U CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements are confined with spirals or ties with spacing less than $8d_b$. (Commentary: Sec. A.3.2.2.5. Tier 2: Sec. 5.5.3.2.2) # 4 CONT @ 33" OC

C NC N/A U WALL REINFORCING AT OPENINGS: There is added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. (Commentary: Sec. A.3.2.2.6. Tier 2: Sec. 5.5.3.1.5)

C NC N/A U WALL THICKNESS: Thicknesses of bearing walls are not less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 in. (Commentary: Sec. A.3.2.2.7. Tier 2: Sec. 5.5.3.1.2)

Connections

C NC N/A U UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement, and piles are anchored to the pile caps; the pile cap reinforcement and pile anchorage are able to develop the tensile capacity of the piles. (Commentary: Sec. A.5.3.8.Tier 2: Sec. 5.7.3.5)

Diaphragms (Flexible or Stiff)

C NC N/A U DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)

C NC N/A U OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 15% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)

C NC N/A U PLAN IRREGULARITIES: There is tensile capacity to develop the strength of the diaphragm at reentrant corners or other locations of plan irregularities. (Commentary: Sec. A.4.1.7. Tier 2: Sec. 5.6.1.4)

C NC N/A U DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. (Commentary: Sec. A.4.1.8. Tier 2: Sec. 5.6.1.5)

Flexible Diaphragms

C NC N/A U CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)

C NC N/A U STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 1-to-1 in the direction being considered. (Commentary: Sec.A.4.2.1. Tier 2: Sec. 5.6.2)

C NC N/A U SPANS: All wood diaphragms with spans greater than 12 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)

C NC N/A U DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 30 ft and aspect ratios less than or equal to 3-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)

C NC N/A U NONCONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete consist of horizontal spans of less than 40 ft and have aspect ratios less than 4-to-1. (Commentary: Sec. A.4.3.1. Tier 2: Sec. 5.6.3)

C NC N/A U OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

APPENDIX C
SUMMARY DATA SHEET

BUILDING DATA

Building Name: LWSD – Pump Building Date: 2/12/20
Building Address: Sudden Valley
Latitude: ______ Longitude: ______ By: ______
Year Built: ______ Year(s) Remodeled: ______ Original Design Code: ______
Area (sf): ______ Length (ft): ______ Width (ft): ______
No. of Stories: ______ Story Height: ______ Total Height: ______

USE ☐ Industrial ☐ Office ☐ Warehouse ☐ Hospital ☐ Residential ☐ Educational ☐ Other: ______

CONSTRUCTION DATA

Gravity Load Structural System: Prefab wood truss
Exterior Transverse Walls: cmu Openings? ______
Exterior Longitudinal Walls: cmu Openings? ______
Roof Materials/Framing: ______
Intermediate Floors/Framing: N/A
Ground Floor: slab on grade
Columns: N/A Foundation: ______
General Condition of Structure: good
Levels Below Grade? no
Special Features and Comments: ______

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
System:	Reinf. cmu	
Vertical Elements:	Cmu walls	
Diaphragms:	wood sheathing	
Connections:	anchor bolts	

EVALUATION DATA

BSE-1N Spectral Response Accelerations: S_{DS} = ______ S_{D1} = ______
Soil Factors: Class = ______ F_a = ______ F_v = ______
BSE-1E Spectral Response Accelerations: S_{XS} = ______ S_{X1} = ______
Level of Seismicity: ______ Performance Level: ______
Building Period: T = ______
Spectral Acceleration: S_a = ______
Modification Factor: $C_mC_1C_2$ = ______ Building Weight: W = ______
Pseudo Lateral Force: $V = C_mC_1C_2S_aW$ = ______

BUILDING CLASSIFICATION: ______

REQUIRED TIER 1 CHECKLISTS	**Yes**	**No**
Basic Configuration Checklist	☐	☐
Building Type ______ Structural Checklist	☐	☐
Nonstructural Component Checklist	☐	☐

FURTHER EVALUATION REQUIREMENT: ______

Project: Lw5D Location: Pump Building

Completed by: MJB Date: 2/12/20

16.15IO IMMEDIATE OCCUPANCY STRUCTURAL CHECKLIST FOR BUILDING TYPES RM1: REINFORCED MASONRY BEARING WALLS AND RM1A: REINFORCED MASONRY BEARING WALLS WITH STIFF DIAPHRAGMS

Very Low Seismicity

Seismic-Force-Resisting System

C NC N/A U REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)

C NC N/A U SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than 70 lb/in.^{2}. (Commentary: Sec. A.3.2.4.1. Tier 2: Sec. 5.5.3.1.1)

C NC N/A U REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls is greater than 0.002 of the wall with the minimum of 0.0007 in either of the two directions; the spacing of reinforcing steel is less than 48 in., and all vertical bars extend to the top of the walls. (Commentary: Sec. A.3.2.4.2. Tier 2: Sec. 5.5.3.1.3)

Connections

C NC N/A U WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.3)

C NC N/A U TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls, and the connections are able to develop the lesser of the shear strength of the walls or diaphragms. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)

C NC N/A U FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation, and the dowels are able to develop the lesser of the strength of the walls or the uplift capacity of the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4)

C NC N/A U GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)

C NC N/A U WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)

Stiff Diaphragms

C NC N/A U TOPPING SLAB: Precast concrete diaphragm elements are interconnected by a continuous reinforced concrete topping slab. (Commentary: Sec. A.4.5.1. Tier 2: Sec. 5.6.4)

C NC N/A U TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled for transfer of forces into the shear wall or frame elements. (Commentary: Sec. A.5.2.3. Tier 2: Sec. 5.7.2)

Foundation System

C NC N/A U DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil. (Commentary: Sec. A.6.2.3)

C NC N/A U SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story high. (Commentary: Sec. A.6.2.4)

Low, Moderate, and High Seismicity: Complete the Following Items in Addition to the Items for Very Low Seismicity.

Seismic-Force-Resisting System

C NC N/A U REINFORCING AT WALL OPENINGS: All wall openings that interrupt rebar have trim reinforcing on all sides. (Commentary: Sec. A.3.2.4.3. Tier 2: Sec. 5.5.3.1.5)

C NC N/A U PROPORTIONS: The height-to-thickness ratio of the shear walls at each story is less than 30. (Commentary: Sec. A.3.2.4.4. Tier 2: Sec. 5.5.3.1.2)

Diaphragms (Stiff or Flexible)

C NC N/A U OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 15% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)

C NC N/A U OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 4 ft long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)

C NC N/A U PLAN IRREGULARITIES: There is tensile capacity to develop the strength of the diaphragm at reentrant corners or other locations of plan irregularities. (Commentary: Sec. A.4.1.7. Tier 2: Sec. 5.6.1.4)

C NC N/A U DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. (Commentary: Sec. A.4.1.8. Tier 2: Sec. 5.6.1.5)

Flexible Diaphragms

C NC N/A U CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)

C NC N/A U STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 1-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)

C NC N/A U SPANS: All wood diaphragms with spans greater than 12 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)

C NC ~~N/A~~ U DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 30 ft and aspect ratios less than or equal to 3-to-1. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) X

C NC N/A U NONCONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete consist of horizontal spans of less than 40 ft and have aspect ratios less than 4-to-1. (Commentary: Sec. A.4.3.1. Tier 2: Sec. 5.6.3)

C NC N/A U OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

Connections

C NC N/A U STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2)

APPENDIX D

WSDOH 2020 SANITARY SURVEY

State of Washington
DEPARTMENT OF HEALTH
NORTHWEST DRINKING WATER REGIONAL OPERATIONS
20425 72nd Avenue South, Suite 310 • Kent Washington 98032-2388

March 31, 2020

KEVIN COOK - OPERATOR
LWWSD – SOUTH SHORE WS
1220 LAKEWAY DRIVE
BELLINGHAM WA 98229

Subject: LWWSD – South Shore (ID #95910)
Whatcom County
Surface Water Treatment Plant Survey

Dear Mr. Cook:

This letter is written in follow up to our distribution and treatment plant surveys of the LWWSD – South Shore water system. We carried out both surveys on March 2, 2020. I would like to thank you, Jason, and Brent for taking the time to meet and show Jolyn and me around the plant.

The purpose of the sanitary survey program is to improve and strengthen department and utility communication, as well as to help improve and ensure the reliability and sanitary integrity of water system facilities and programs.

LWWSD South Shore is clearly a well-managed and operated plant. There are eight treatment plant operators at varying points in their careers, with well over a hundred cumulative years of experience at LWWSD. All operators are certified and trained as WTPO2s, above and beyond the DOH minimum requirement for South Shore. The operators know the plant well and answered all of our questions either by memory or by looking them up in easily accessible documentation. One result of this strong operations and management is LWWSD's 19 years of turbidity optimization, an impressive accomplishment that we hope the District is proud of. Great work!

In addition, the District has several planning efforts that go well beyond DOH's requirements. Some of the plans that we discussed at the survey included emergency planning, succession planning, a 20-year technical review, and a level of service plan. Steve Hulsman and I were participated in your emergency response table top exercise a couple of years ago. The event was professionally run by an outside consultant, and included a transparent look into the District's goals, strengths, and weaknesses in emergency response. You examined your emergency procedures and how they interfaced with government agencies. At the survey you mentioned a follow up emergency planning event. These efforts show LWWSD's interest in the future of the water system and its ability to provide outstanding service to customers.

I enclosed a copy of the Field Data Sheet and the Distribution Survey Report that we used during the survey to organize our findings. Please review these reports and let me know if anything is inaccurate.

Treatment Plant Findings and recommendations

We did not identify any significant deficiencies or findings in the treatment plant.

Please consider the following recommendations for follow-up action:

1. **Please follow up with me to update your CT assumptions.** Our past analysis concluded that the outflow from the CT tanks was 600-780 GPM (on average each hour). I understand that you now have

the ability to measure the flows from the transmission pumps out of the CT tank and that the average hourly flow is 700 GPM (not 600 to 780 GPM). I will need to see your flow data and update our CT assumptions to more accurately reflect the flow coming out of the tank.

2. **I recommend developing specifications for bulk chemical deliveries and verifying that all bulk deliveries of liquid alum meet your specifications.** I sent an electronic copy of a presentation on chemical receiving SOPs and strategy.

3. While the operators measure the anthracite level in the filters every week or two, they don't currently record this data. Recording your tasks as an operator makes them real, gives you the ability to look back at them, and turns your actions into data that may be useful at some point. **Please log these measurements to document that you are doing them, and to capture any unexpected changes.** It is feasible to measure and record anthracite levels quarterly at a minimum, but if you're doing it every two weeks record it. More frequent anthracite level measurements would align with the high quality operations at LWWSD. Write it down and keep a record of it.

4. **I recommend that LWWSD do routine (weekly) field alkalinity tests to detect corrosion control issues resulting from alum use.** If this cannot be done with your existing equipment, you can purchase the simplified field test kit from Hach (model AL-AP) or a similar device.

5. **Determine if the 'black stuff' that we saw in the bottom of the clearwell is filter media.**

6. I sent an electronic copy of the EPA filter surveillance manual. **Consider including this in the District's filter maintenance program.**

7. While your raw water quality has been very good for a long time, we have seen raw water turbidities change rapidly and unexpectedly. It this case, it is helpful to be prepared to troubleshoot and investigate potential solutions. **I recommend purchasing jar test equipment and learning how to use it, in case of an emergency raw water quality change.**

8. Evergreen Rural Water of Washington (ERWOW) has an apprenticeship program that may be helpful if you are interested in getting new operators certified. It's a two year program that combines experience and coursework. To learn more about the program: https://www.erwow.org/ApprenticeshipProgram/ABOUTTHEPROGRAM.aspx.

Distribution Findings and Recommendations:

Significant findings and deficiencies must be addressed (either fixed or provide a schedule) within 30 days of the date of the report.

Significant Deficiencies:

9. All of LWWSD's tanks need a cap on the travel wire casing. Please install caps on all 5 travel wire casings and send photos. **3-18-20 COMPLETE**

Significant Findings:

10. Please send photos of the hatch, intact gasket, vent and intact 24 mesh screen taken on the top of each tank within the last year. **3-18-20 COMPLETE**

Observations and Recommendations:

11. While all of your tank photos look good and I did not observe any direct openings, the Geneva Tank's gasket on the hatch appears to be separating at the corner and **will likely to be fixed/replaced in the near future.**

12. We discussed the requirement to have an air gap or a minimum of 34 Feet of vertical distance between the invert of the tank's overflow pipe outlet and the top of the vault where the overflow drains. This eliminates the potential for a cross connection. In a letter from Bill Hunter in May, 2016, he verifies >34 feet of vertical distance between the overflow outlet and the rim of the flap valve. The 34 feet of vertical distance needs to be from the overflow outlet to the top of the vault that the overflow drains into. Please verify that there is a minimum of 34 feet between the overflow outlet (invert) and the top of the vault on the Division 7 and Division 30 tanks. **3-18-2020 EMAIL, COMPLETE**
    "The measurement from the top of the vault to the top of the reservoir overflow at division 7 reservoir and division 30 reservoir are 34'8" and 41'6" respectively, both of the reservoirs do exceed the 34' elevation requirement."

The Drinking Water Regulations require that all Group A public water systems have a sanitary survey every 3-5 years. In order to receive credit for the survey, a sanitary survey fee must be paid, as provided by WAC 246-290-990 (3)(iv). Enclosed is an invoice for $1122.00. Please remit your complete payment in the form of a check or money order within thirty days of the date of this letter in the enclosed envelope to: **DOH, Revenue Section, P.O. Box 1099, Olympia, WA 98507-1099.**

Please give me a call at 253/395-6761 if you have any questions or concerns.

Sincerely,

Laura McLaughlin, PE
Regional Engineer
NW Drinking Water Operations

Enclosures: sent electronically to Kevin Cook

- Main Break fact sheet
- USEPA Filter Surveillance Manual
- Chemical Receiving Procedures

cc: Laurette Rasmussen – Whatcom County Health Department
Justin Clary – LWWSD General Manager
Bill Hunter – LWWSD District Engineer
Brent Winters – LWWSD O&M Manager
Jolyn Leslie, Brian Boye - DOH

State of Washington
DEPARTMENT OF HEALTH
NORTHWEST DRINKING WATER REGIONAL OPERATIONS
20425 72nd Avenue South, Suite 310 • Kent Washington 98032-2388

DISTRIBUITON SYSTEM INSPECTION / SANITARY SURVEY REPORT

Date: March 2, 2020

LWWSD – SOUTH SHORE Whatcom County (ID #95910)

Persons Attending:
Kevin Cook, Justin Clary, Jason Dahlstrom, Brent Winters – LWWSD
Jolyn Leslie, Laura McLaughlin – DOH

Purpose: Routine Sanitary Survey of Distribution System

SYSTEM SUMMARY / FINDINGS

Last distribution survey: March 30, 2016

Issues from last survey (distribution related only):

- The CT calculation is based on actual tank level and a maximum flow through the plant of 700 gpm. However, peak flow for CT should be based on the maximum flow either into or out of the contact tank, whichever is greater. Since you currently do not have flow meters on the booster pump stations out of the contact tank, you may want to consider adding flow meters. This could be included/considered in your next WSP update. **2020 UPDATE:** The inflow to the WTP is consistently throttled to 700 GPM (instantaneous). The outflow from the WTP (inflow to the CT tank) has an *hourly average* flow of 700 GPM (to match the inflow to the plant). If either the inflow or outflow from the WTP malfunctioned the filter high or low alarms would sound. The WTP provides the buffer needed to prevent surcharging or draining the filters. The outflow of the CT tank is pumped by two transmission pumps with a combined instantaneous flow of 1570 GPM. They run these transmission pumps for 25 to 26 minutes each hour, which translates to 700 GPM.
- Consider testing for alkalinity to get an idea of baseline (once/month for a year) levels. This sampling is not required by the regulations, but may provide some useful operational information. **2020 UPDATE: Still needed. See comments.**
- With the target finished water pH now set at 7.2 – 7.4, this should help decrease total trihalomethanes (TTHM). Higher pH generally corresponds to higher TTHM levels. It will be interesting to see this year's sample results. **2020 UPDATE:** Currently targeting 7.2-7.4 pH.

Approval status:	Existing Connects	=	3884
	Eng Capacity	=	3935
	Total Lots	=	
System Type:	Group A – Community		

WATER QUALITY HISTORY:

Bacteriological	:	10 samples/month, satisfactory for past 2+ years
Nitrate	:	ND – 0.7 mg/l
Exceed MCL?	:	None

GENERAL SYSTEM DESCRIPTION

The Lake Whatcom Water and Sewer District holds a large service area that completely surrounds Lake Whatcom except for an area at the northwest end that is served by the City of Bellingham. The South Shore system is made up of the District's Geneva and Sudden Valley service areas and sits on the south shore of the lake. All source water comes from Lake Whatcom and is treated in the Sudden Valley WTP. A connection to the Bellingham distribution system, which used to supply the Geneva service area, is maintained as an emergency back-up source. The system currently serves just under 3884 total connections with a full-time residential population of 10,028.

Four distribution storage reservoirs serve the combined Geneva – Sudden Valley service area and each tank has separate inlet/outlet piping. There are eight separate pressure zones plus four sub-zones in the Sudden Valley area while the Geneva area is divided into two pressure zones. The various pressure zones are interconnected by 4 sets of booster pumps and many PRV stations.

SOURCES:

S01 – Lake Whatcom (surface water source) Source not inspected/included as part of this survey.

TREATMENT:

Purpose: Surface Water Treatment (filtration and disinfection)
Treatment plant not inspected/included as part of this survey.

STORAGE:

There are currently 5 storage reservoirs, including the new tank at the Division 22 site. The only reservoirs that can be bypassed for maintenance are the Geneva reservoir (by using our emergency source with the city of Bellingham) and either of the two reservoirs located at the division 22 reservoir site. The other storage reservoirs do not have a bypass and cannot be easily removed from service without potentially causing some areas of the system to be without water.

They are all cleaned/inspected every 5 years by divers, and were last inspected in 2017.

The overflow outlets are also currently under consideration for modification to bring the outlets above ground with the appropriate air gap as the Sudden Valley reservoirs all drain directly to sewer manholes. Tanks had cameras and intrusion alarms. **The operators provided pictures of the hatches and vents on all reservoirs by email.**

During the survey we inspected/visited these reservoirs:

- 500,000 gallon Division 22 Reservoir A - has air gap on overflow, reconfigured since last survey.
- 626,000 gallon Division 22 Reservoir B – new tank since last survey, has air gap on overflow.
- 1,000,000 gallon Division 7 Reservoir
- 500,000 gal Geneva Reservoir – installed air gap on overflow since last survey.

During the survey we did not inspect/visit these reservoirs:

- 150,000 gal Division 30 Reservoir

DISTRIBUTION:

There are eight separate pressure zones plus four sub-zones in the Sudden Valley area while the Geneva area is divided into two pressure zones. The various pressure zones are interconnected by 4 sets of booster pumps and about 50 PRVs. The system schematic shows the complexity and variability of the zones with many able to serve and be served by a number of different zones.

MANAGEMENT & OPERATIONS:

Water System Plan	Approved 10-3-2018, valid through 10-3-2028
WFI Update	Updated in 1/2020, No changes needed
Water Quality Monitoring Schedule	20 Lead/copper samples due in 2022 (standard 3-year)
Coliform Monitoring Plan	10 samples/month; use coliform monitoring plan – generally sample 2/week every week
DBP Monitoring Plan	Reduced annual monitoring
Consumer Confidence Report	Kevin pulls this information together
Operating Permit	Green
Overall Design Approval	Yes
Capital Improvements Planned?	Following annual CIP plan and priorities. Plan to demo their old, unused tank, install telemetry and meter from Sudden Valley to Geneva.
Certified Operator	Kevin Cook, WTPO2, WDM2 – treatment plant Jason Dahlstrom, WTPO1 – distribution Plus 4-5 other operators that can step in. The district-wide succession plan is scheduled to be updated this year.
O&M Manual	Use Cartegraph and have invested in the program in the past year to include asset management. They also use it to help schedule O&M tasks.
Flushing Program	Annual, rolling system so that part of system is flushed every year – don't use unidirectional flushing
Valve Exercise/PRV Maint.	Valve exercise every other year; district performs maintenance on all 50 PRVs every year – check pressures and clean any PRVs with problems.
Routine practice for main repair	Use industry standard – maintain positive pressure, have their own vactor truck. See attached publication that describes language and response for each type of main break.
Water Use Efficiency Program	Yes
Individual Customer Meters	Yes
Distribution System Leakage	2015 3-yr ave = 5.3% , 2014 3-yr ave = 10.3% Leakage improved a lot in 2019.
Cross Connect Program	Rich Munson is the program coordinator; all district-owned devices are tested by contractor. They also have 8 certified CCS's on staff as well.
Watershed Protection Program	Participate in Lake Whatcom area/County efforts of protection/study of the lake and watershed. They are currently carrying out a study on the effects of septic systems on Lake Whatcom's quality, partially funded by DOH. They will be able to compare results to a past study.
Emergency Response Plan	Yes, operators take turns being on-call during weekends

E.coli Response Plan	Yes. They are starting to implement Shake Alert, and have partial living quarters for operators to stay onsite in an emergency.
Power/water outages	Dedicated generators at some sites, most have automatic transfer switches, also 5 portable generators. The treatment plant has a generator that is exercised weekly.
Financial Viability Program	Yes, annual budget approved by commissioners; good reserve account; full rate study is conducted every 5 years, partial study every 2.5 years. The board sets the rates.
Management Structure	Special purpose district; 5 commissioners, elected to 6-year terms
Complaints	None on file since last survey; have tracking system

Washington State Department of **Health**
Environmental Health Programs
Office of Drinking Water

Sanitary Survey of Rapid Rate Filter Plant
Field Data Sheet

System Name	I.D. Number	Date	Evaluation By
LWWSD – South Shore	**95910**	**3/2/2020**	**Laura McLaughlin** **Jolyn Leslie**

Operator(s) Present	WTPO#	Certification Level	Title	Phone Number
Kevin Cook **Jason Dahlstrom, Brent Winters**	**007626**	**WTPO2**	**WTP Lead Operator**	**360.296.4574**

Identify lead operator/WTP supervisor above.
Is lead operator new since the last survey? ☐ Yes ☒ No
Does this person sign the reports? ☒ Yes ☐ No Present during the survey? ☒ Yes ☐ No

Source Water & Watershed Information *(Review Watershed Risk Report from Surface Water Database (SWDB); Gather information needed if incomplete) Intake: Protection provided to Intake facilities; adequate screening; adjustable levels of withdrawal; pumped or gravity (reliability concerns)? Frequency and location of raw water turbidity and fecal coliform samples.*

All source water comes from Lake Whatcom and is treated at the Sudden Valley WTP, which is located on the southern half of Lake Whatcom on the southwest shore. Lake Whatcom has pockets of moderate to high density residential development (generally on the north end of the lake), as well as areas that are not developed (generally on the south end of the lake). The lake is used for recreational purposes with swimming and motor boat usage. The peak capacity of the WTP is 1000 gpm and it currently operates 7 days per week at 700 gpm. The plant is started manually by operators each day and runs until the tanks are filled.

S01 – Lake Whatcom:

- **The intake is located in the upper basin of Lake Whatcom approximately 315 feet off shore and 70 feet deep. The intake is a 4-foot diameter pipe approximately 1-2 feet off the lake bottom with screened openings on both ends. The screen openings are ¼"-⅜". The intake is routinely inspected by divers.**
- **The raw water pumps have variable speed drives, which allow the filter plant to run continuously with only one or two starts per day.**

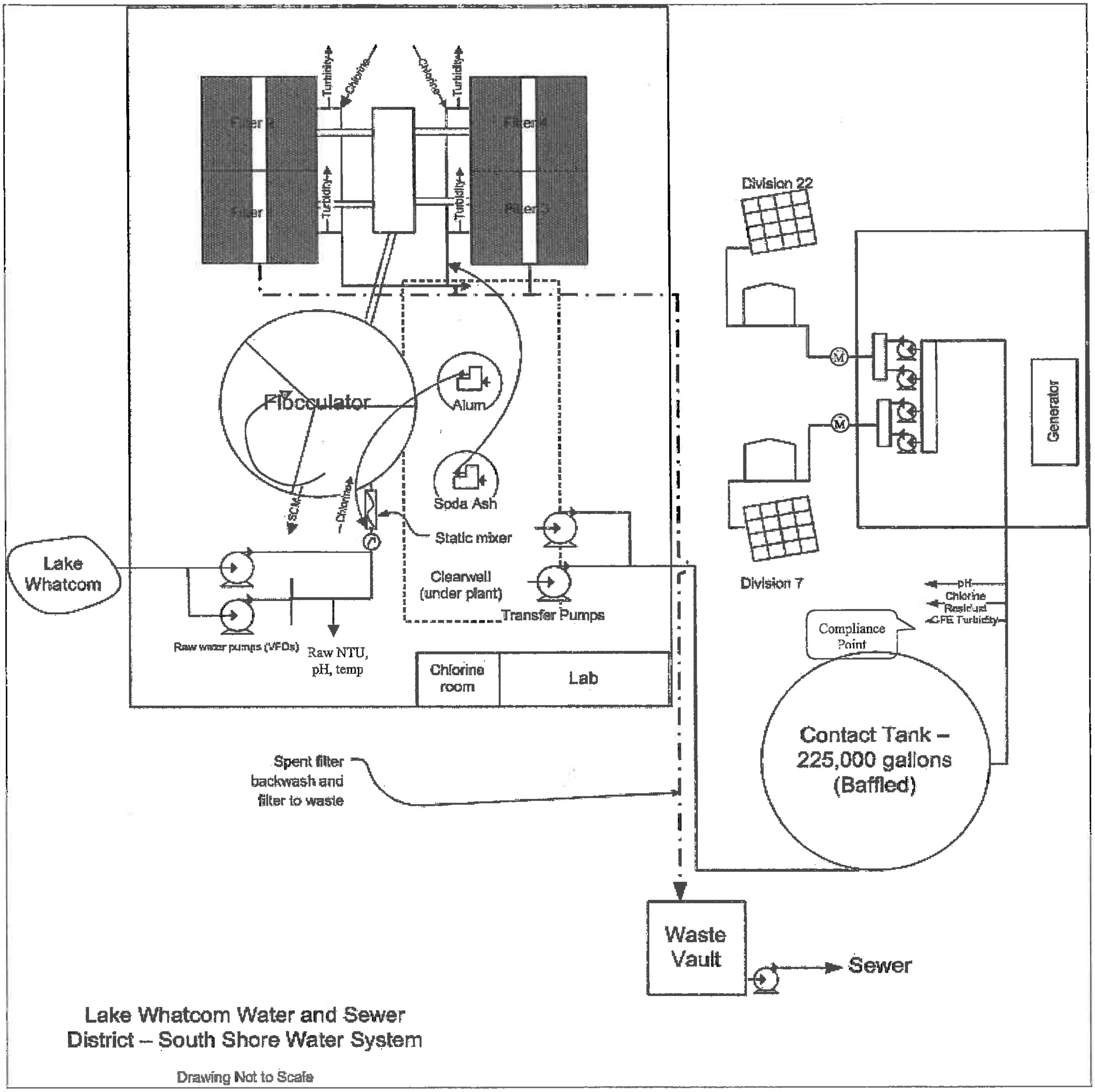
Raw Water Testing:

- **Raw water turbidity is sampled at the treatment plant inlet (after raw water pumps) and uses a Hach TU5300 – see schematic for location.**
- **Raw water fecal coliform samples are collected at treatment plant inlet on a monthly basis. Mean <1/100 ml; Max 1.1/100 ml; only 4 detections in last 24 months at 1.1 CFUs/100 mL. LT2 monitoring is complete and the system remains classified in bin 1 – no additional treatment required for *Cryptosporidium*.**
- **The raw water quality generally has very low turbidities (less than 1 NTU).**

Susceptibility

- **Reviewed the Watershed Microbial Risk Rating Form – this source has a score of 13 and is rated at Moderate risk.**

Plant Schematic *– Use schematic from Comprehensive Performance Evaluation (CPE) report, if available; Show actual compliance monitoring locations for Combined Filter Effluent (CFE) turbidity, Concentration of Residual x Time of Contact (CT), and residuals at entry point to Distribution System (DS); Place arrow and letter at chemical addition points and identify in tables below.*



Chemical Addition - Coagulant(s), Filter Aid(s), pH Adjustment, Pre-Cl_2 /Rapid Mix:

Chemical		Location	Dose	Chemical		Location	Dose
Alum	☒	Before floc basin	27.3 ppm	Soda Ash	☐		
Ferric Cl/SO_4	☐			Caustic Soda	☐		
PACl	☐			Lime	☐		
CAPolymer:	☐			Pre Chlorine	☒	Into floc basin	0.15-0.22 ppm
CAPolymer:	☐			Potassium Perm	☐		
FAPolymer:	☐			Other:	☐		

All chemical used in the WTP NSF Standard 60 Approved: ☒ Yes ☐ No If not, which ones?__________

Note: PACl = Polyaluminum Chloride; CAP = Coagulant Aid Polymer; FAP = Filter Aid Polymer; Insert name(s).
Liquid alum is delivered in bulk. Recommend to verify that deliveries are within system-established specifications.

Operations program complete & up-to-date per WAC 246-290-654(5)? ☒ Yes ☐ No
How are dosages determined; how are they controlled? (Jar tests, Visual floc formation, streaming current monitor, historical, monitoring data, etc.); what turbidity variation triggers a change? (Compare monthly chemical usage to dosage.) Bulk storage? Day tanks?

They use a combination of tools to determine chemical dosages including raw water turbidity readings, individual filter turbidity reading, combined filter turbidity readings, bench top turbidity reading verification, visual floc analysis, steaming current meter readings as well as historical data. The water treatment plant is equipped with a 1700 gallon alum storage tank. The alum meets the AWWA standard B403-93. The water treatment plant has a 1500 gallon soda ash storage tank. The soda ash meets the AWWA standard B201-92. The water treatment plant has a dual automatic switchover 150# chlorine gas feed system (150# cylinder online that if it was to empty a backup tank will automatically open to supply chlorine) with 2 full 150# chlorine cylinders stored for back up in case of a supply chain issue. Since their raw water is extremely stable, (pH, temperature, and very low turbidity levels), their chemical dosages rarely need adjustments.

A streaming current monitor (pulls sample from first floc chamber) is read, but not used for alum dosing, SCM readings vary widely from -180 to -1000 – optimal range from ~0 to -30.

For all plants that use alum, we recommend testing finished water alkalinity at least weekly. Alkalinity in the Pacific Northwest is generally very low in surface water and alum can reduce the levels to a point where it can be problematic for corrosion control. We recommend that alkalinity be at least 20 mg/l as $CaCO_3$. This can be done onsite along with a paired lab sample on a quarterly basis.

Rapid Mix Type: Static Mixer ☒ Mechanical Mixers ☐ Injection Mixers ☐ In-line Blender Mixers ☐

Mixing Energy (G or GT): Undetermined

Operational?

In-line static mixer after alum injection and prior to flocculator. The system does not use, nor does it have the equipment on hand for jar testing. We recommend purchasing equipment and learning how to use it. Calibrate it to your plant. A number of other plants recently have needed to use jar testing to help make plant adjustments due to changes in raw water quality.

Flocculation:
Flocculator Type: **NONE** ☐ Hydraulic ☒ Mechanical ☐ Number of basins: ______

Target Mixing Energy (G or GT): Undetermined

Appearance of floc; tapered energy input?

Circular basin with 3 compartments.

Sedimentation/Clarification:

NONE (Direct Filtration) ☒ Horizontal-flow rectangular ☐ Tube Settlers ☐ Dissolved Air Flotation ☐
Adsorption Clarifier ☐ Horizontal-flow round ☐ Inclined-plate ☐ Other ________ ☐

Filtration:

Single Media ☐ Dual Media ☐ Mixed Media ☒ Pressure Filter ☐ Deep Bed Mono-media ☐
Media Type: Sand ☒ Anthracite ☒ Garnet ☒ Other: ________ ☐
Media Design Depth: 9" Sand, 9" Garnet (two sizes, 4.5" each), 18" anthracite

Filter Dimensions: Length: 8'-0" Width: 9'-2" Total Area: 293.2 sq ft
Max. plant flow rate: 1,000 gpm (typically operates @700 gpm max) Filter Rate: 3.4 gpm/sq ft (2.4 gpm/sf @700 gpm)

Filter #	Current Media Depth/s (in)	Last Measured (Date)	Replenished (Date)
1	17-18 inches	3/23/20	March, 2019
2	17-18 inches	3/23/20	March, 2019
3	17-18 inches	3/23/20	March, 2019
4	17-18 inches	3/23/20	March, 2019

Filter maintenance program? Yes; *Describe program and any filter maintenance activities.*

Their annual filter maintenance program includes changing the surface washer nozzles, inspecting the top of the filters, scraping the top layer of fines off of the filters, and adding 2-6 bags of anthracite so that there are 2.5 inches between the water surface and anthracite. Filter media is also measured regularly throughout the year after backwashes by taking a measurement from the bottom of the surface washers to the top of the anthracite in the filter bed. Kevin measures this every week or two, but does not log it because it changes very little (see recommendation). The last filter rebuild/media change was in the late-2000s and is targeted for approximately every 10 years, so is likely due soon.

Individual Filter Turbidimeters Calibration Date: 2/5/20
Combined Filter Effluent Turbidimeter Calibration Date: 2/5/20

Backwash criteria: manual/time – once/run (typically 10-15 hours, daily) Rate: 17.8 gpm/sq ft

Backwash to: Lagoon ☐ Lagoon To Raw Water ☐ Plant intake ☐ Sanitary Sewer ☒

Filter-to-waste: ☒ Yes ☐ No Time: 15 min Stopped at: (Manually controlled) typically @0.05 ntu

Condition of media (mounding, cracking, mudballs); when replaced; Control of filter rate and backwash rate; Variability of filter rate; Turbidimeters properly operating? Numbers reported when plant is running? Models of turbidimeters: continuous and benchtop; filter to waste (FTW) at all start-ups or after backwash (BW)? Recycle backwash water, thickener supernatant, or sludge dewatering process liquid? Where to? Request to see required records.

The media appeared to be in good condition, no mounding, cracking or mudballs present. The filter rate is controlled by the inlet flow rate and typically operates at a constant rate of 700 gpm.
The plant is shut-down during backwash so there is no risk of surging the other active filters and filters are backwashed sequentially. Backwash rate throughout is constant (1,300 gpm/filter). Backwash sequence is:

- **Surface wash (4 minutes)**
- **Backwash with surface wash (2.5 minutes)**
- **Backwash only (5 minutes)**
- **Filter to waste until turbidity is less than 0.05 NTU and declining**

Each filter has a Hach TU5300 turbidimeter and SC200 controller (shared between two filters). The combined filter effluent turbidimeter is also a Hach TU5300 and SC200 controller – the sample point is from the pipe leaving the contact tank (the piping going in to the clearwell under the plant makes it difficult to get a true CFE reading).

All chemical standards were within the expiration dates. Feed pump calibrations are performed daily using a graduated cylinder. Online chlorine analyzers and pH probes are calibrated/verified daily, all online turbidimeters are verified weekly.

Chemical Addition – Disinfection:

Chemical		Location	Dose	Chemical		Location	Dose
Gas Chlorine	☒	Combined after filters 1/2 & 3/4	1.2 ppm	UV	☐		
NaOCl	☐			Ozone	☐		
$Ca(OCl)_2$	☐			Chloramines	☐		
ClO_2	☐			Other:	☐		

Contact Tank Dimensions: Diameter: 40' Depth: 16.5 Minimum (24' total)

Parameter Monitored	Location	When/ Frequency
pH	Out of contact tank	Continuous
Temperature	Out of contact tank	Continuous
Disinfectant Residual	Out of contact tank	Continuous
Peak Hourly Flow (PHF)	*Currently reading raw flow entering plant as peak hourly flow	Continuous
Other:		

Redundancy of equipment; Contact time (T) evaluation – how derived, variable or constant; How is Peak Hourly Flow (PHF) determined – compare to value used for T in CT calcs; Check CT Summary Report in database, complete as necessary (If CT summary Report is not available, review CT determination in system files); Clearwell vents and screens; Calibration of pH meters and disinfectant residual monitors

There are two tanks at the plant – the clearwell (25,000 gal) is located underneath the plant building but is not used for CT; the contact tank (225,000 gal) is adjacent to the treatment building and is a welded steel tank with baffles.

***The CT calculation is based on the peak flow to the plant, which the operator reported is equal to the flow leaving the contact tank. CT calculation was updated as a result of the tracer study by Gray & Osborne as part of our state-wide contract. Minimum contact tank level is measured/recorded on a daily basis. For the CT calculation, the contact tank level should never go below 16.5', though tank level rarely goes below 17.0'**

Contact time is variable and is based on tank level, 0.3 baffling factor, and peak hour flow of 700 gpm (they no longer use a constant time of 108 minutes). Two booster pump stations pump out of the contact basin (up to Division 7 and Division 22) at ~720 gpm and 850 gpm, but they run simultaneously once every hour for 25-26 minutes, so PHF (spread out over a full hour) out of the tank averages to 700 GPM and is no longer 600-785 gpm. This average 700 GPM flow needs to be verified by the new flowmeters installed on the transmission pumps leaving the CT tank.

It should also be noted that the clearwell under the treatment building is not included in the calculations for CT. There is also no 'CT credit' for flow through the plant (even though pre-chlorination is practiced with chlorine being injected in the flocculator). We also noted that there may be a small mound of filter media in the bottom of the clearwell. This should be investigated.

There is a separate chlorine room with the gas cylinders and feed regulators. The door has a glass window so that the equipment can be viewed without opening the door. Safety procedures/equipment are in place.

Chemical Addition – Corrosion Control/Stability/Other:

Chemical		Location	Dose	Chemical		Location	Dose
Soda Ash	☒	After filter/before clearwell	17.1 ppm	Orthophosphate	☐		
Caustic Soda	☐			Polyphosphate	☐		
Lime	☐			Other:	☐		

Target finished optimal water quality parameters:

pH: 7.2-7.4 Alk: ____ Phosphorus: ____ Other: ____

Fluoridation: None ☒ Hydrofluosilicic Acid ☐ Sodium Fluoride (Saturator) ☐ Sodium Silicofluoride (Dry Feed) ☐

Typical dosage is around 15-20 mg/l. pH has also been lowered slightly since the last survey to be more in line with the target pH of 7.2-7.4.

General Plant Operations/ Cross-Connection Protection (CCP)

Has purveyor had plant hazard evaluation by Cross Connection Control Specialist (CCS)? If so, when? ☐ Yes ☐ No

Internal CCP – chemical makeup; use of day tanks; chemical feed/ makeup interconnections; split chemical feeds? Submerged inlets in chemical feed tanks? Surface washers? FTW connections? Protection from overfeed? Connections to pumps? Hoses/ hose bibs? Any other treatment provided?

All of the plants RP's were tested on 2/24/2020 and all filter to waste, over flows and backwash outlets are double the diameter air gaps to atmosphere. The plant currently uses large bulk tanks to feed chemicals. They considered switching to day tanks, but determined that the tank size would not be much smaller.

Is plant staffed during all times of operation? ☐ Yes ☒ No Full SCADA monitoring/controls

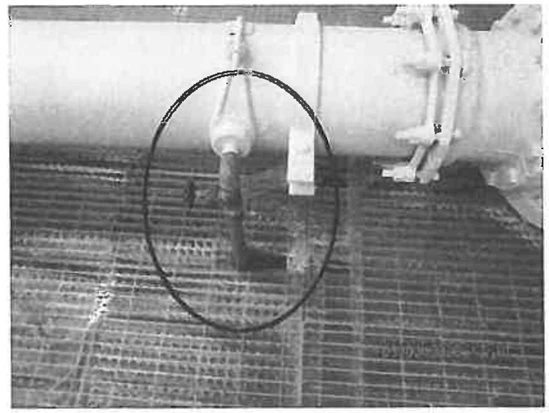
Hours of operation: Start: ~7:30 am Stop: ~3:00 pm Number of Shifts: 1

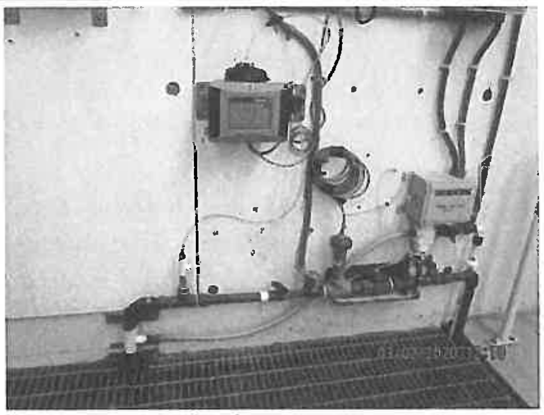
Kevin generally works at the plant from 7:30 am – 3:00 pm. When he arrives in the morning, he starts a backwash cycle, then puts the plant into production for the day and takes all necessary tests for the day. There is an after-hours/weekend person who monitors and responds to SCADA alarms. The plant has motion detectors throughout the building that, when the operator is present, can tell if he has stopped moving for an extended period of time and will trigger an alarm/alert if there is no movement.

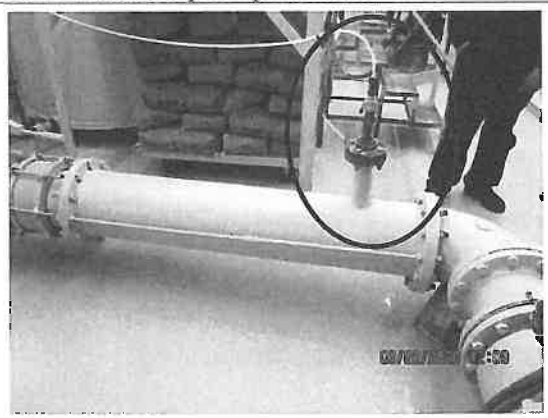
Critical Water Quality Alarms: **Alarms are tested on a routine basis.**

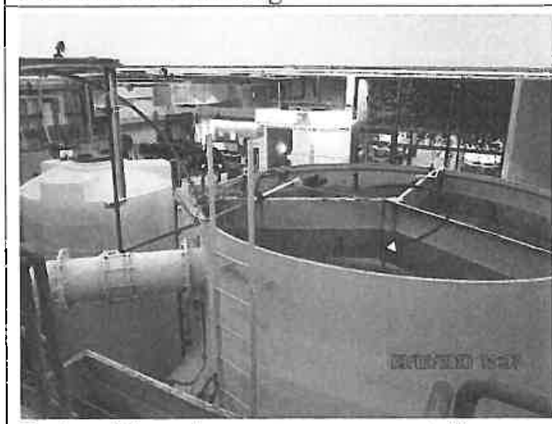
Parameter	Monitoring Point	Alarm Level	Shutdown Level	Response
Turbidity - Raw	Inlet to plant	5.0 NTU	None	Call operator
Turbidity - IFE	At each filter	0.07 NTU	None	Call operator
Chlorine Residual	After contact tank	0.7 low/1.5 high	None	Call operator- remote shutdown
pH - Finished	After contact tank	6.8 low/8.0 high	None	Call operator- remote shutdown
Turbidity - Finished	After contact tank	0.05		Call operator- remote shutdown
Other: Excessive starts			3 times	Shut down plant/call operator
Other: low flow @ intake				Shut down plant/call operator
Other: Clearwell level		3' low/8' high	3' low/8' high	Shut down plant/call operator
Other: Contact tank		17.5' low/21.8'high	21.8' high	Call operator/shut down plant for high level only
Other: Division 7 tank		Low = 28'	High = 33.5	Look at trend, how steep? Look at SCADA, if real, come in and find leak.
Other: Division 22 tanks		Low = 24' on both, auto turn on = 20'on both	High = 31.5'	Look at trend, how steep? Look at SCADA, if real, come in and find leak.


Inlet to plant

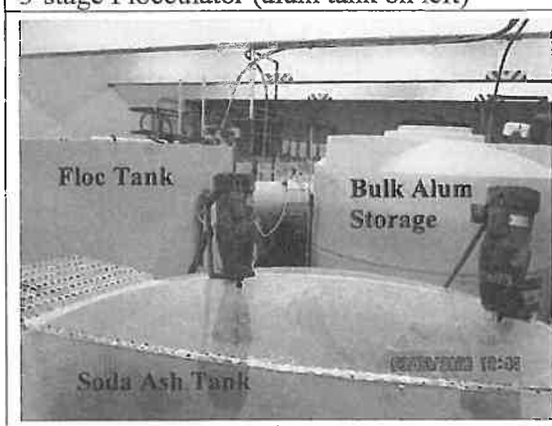

Raw water sample tap location


Raw water monitoring


Alum injection

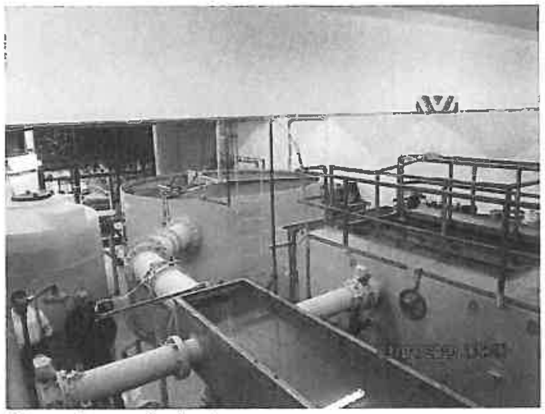

3-stage Flocculator (alum tank on left)

3-stage Flocculator

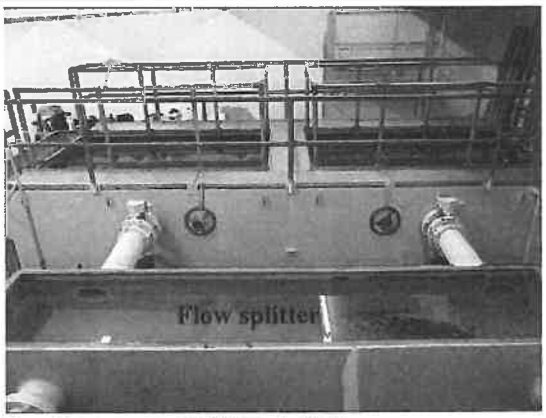


Soda ash tank with mixers

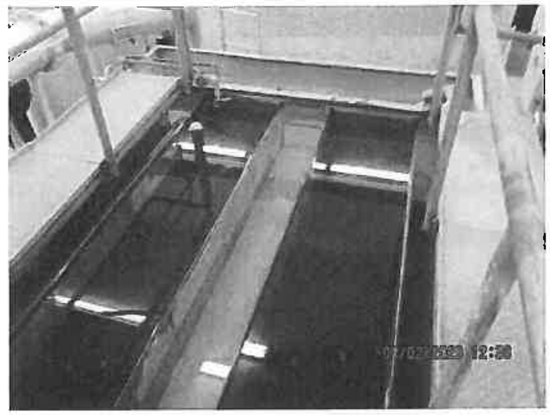
Soda ash – NSF approval


Overview of plant


Filter gallery

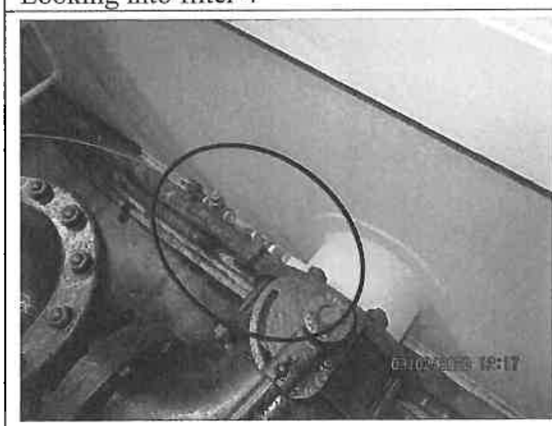


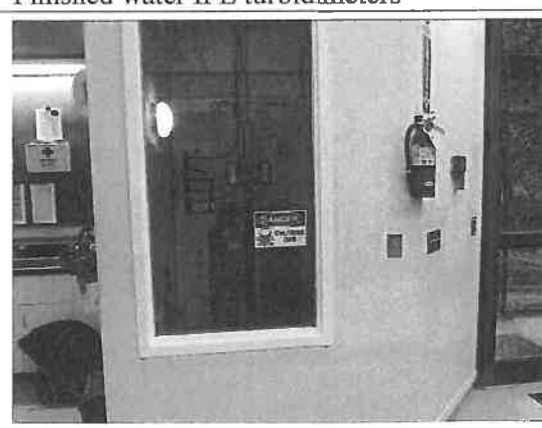
Looking over at filters 1 & 2

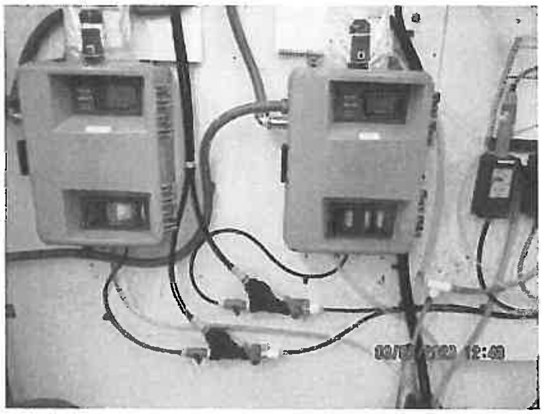

Filters 1 & 2

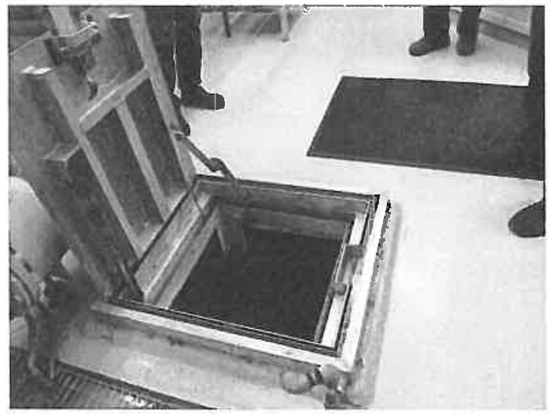

Looking into filter 4


Finished water IFE turbidimeters


IFE sample point (typical)

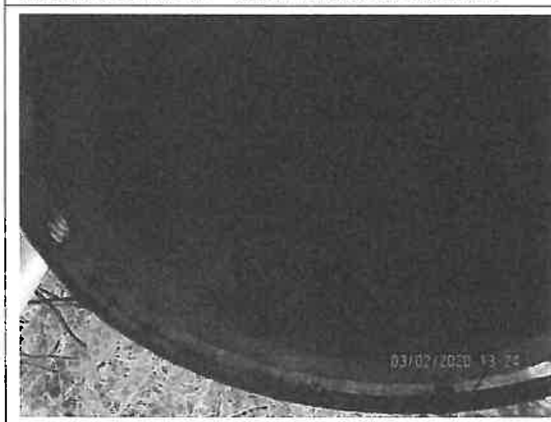

Chlorine gas – enclosed room


Finished water chlorine analyzers


Clearwell access hatch – well sealed

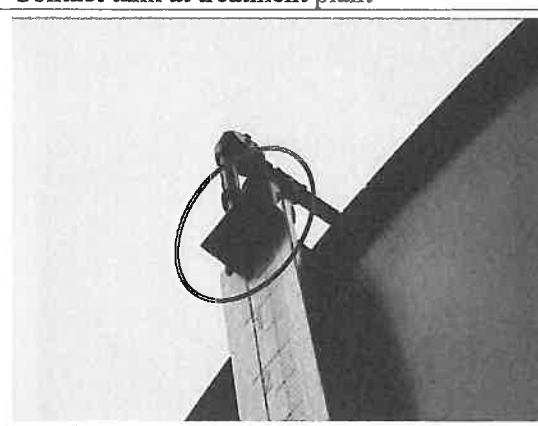

Inside clearwell – filter media in bottom?


Screened overflow on clearwell

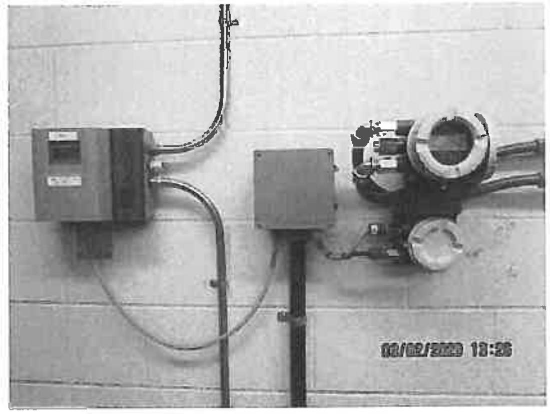

Screened overflow on clearwell

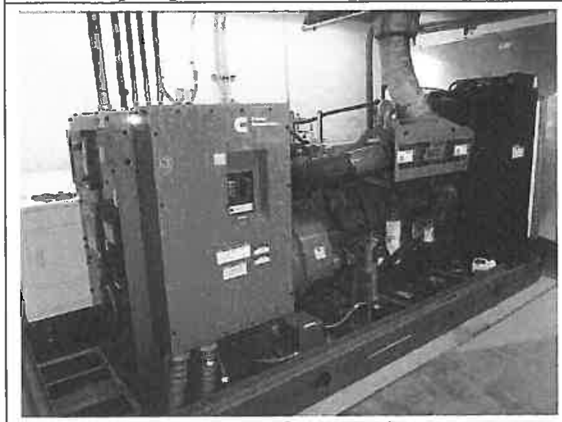
Contact tank at treatment plant


Screened overflow on contact tank

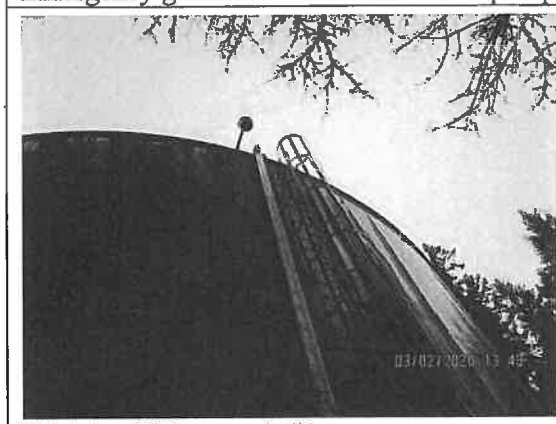

Level gauge travel wire (open end, typical)


Booster pumps from WTP to Division 7 & 22


Flow meters for Division 7 & 22


Emergency generator for WTP/Booster pumps

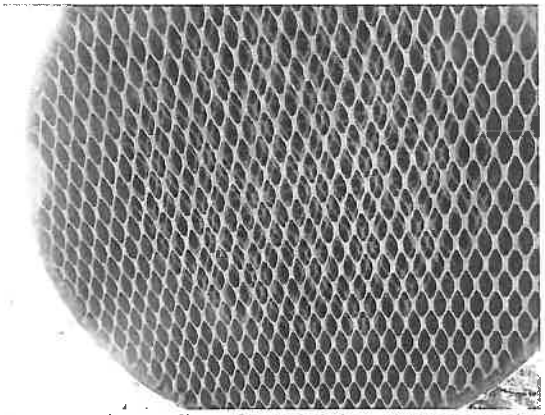

Division 22 tank site (#2, newer tank behind)


Division 22 Reservoir #1

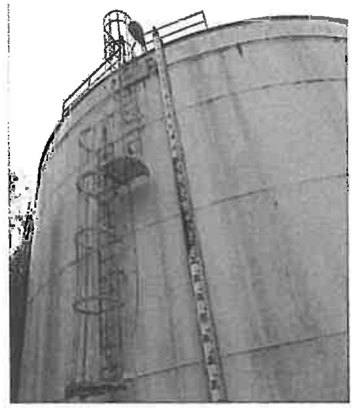

Overflow for Division 22 Reservoir #1


Division 22 Reservoir #2


Division 22 Reservoir #2 – meter and EQ valve

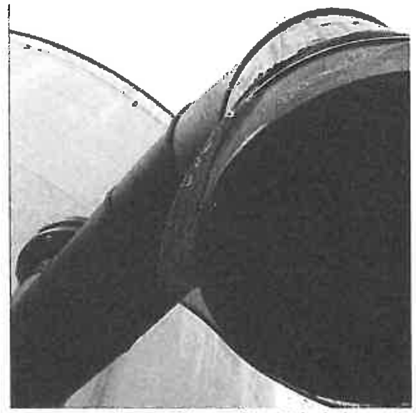


Screened overflow for Division 22 Reservoir #2



Division 30 Reservoir

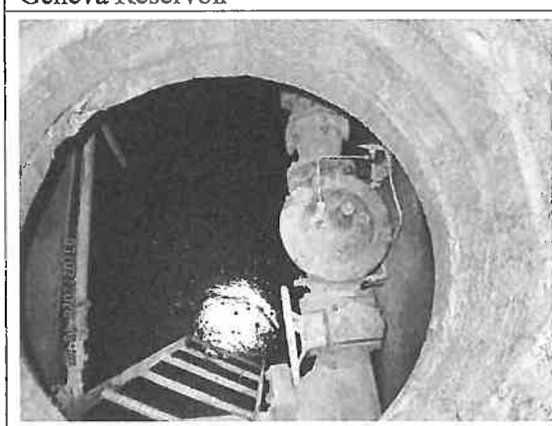
Screened overflow for Division 30 Reservoir



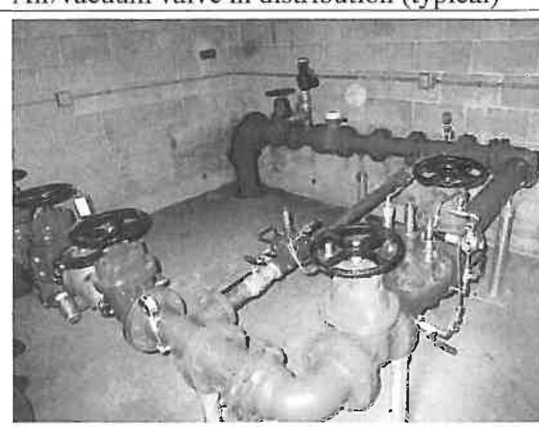
Screened overflow for Division 30 Reservoir

Geneva Reservoir

Air/vacuum valve in distribution (typical)



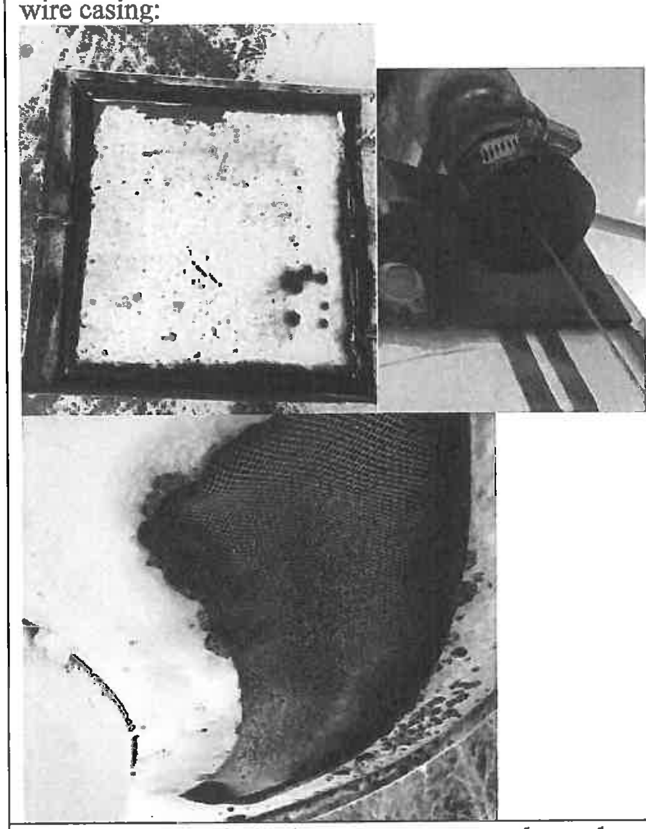
Older PRV station (typical)



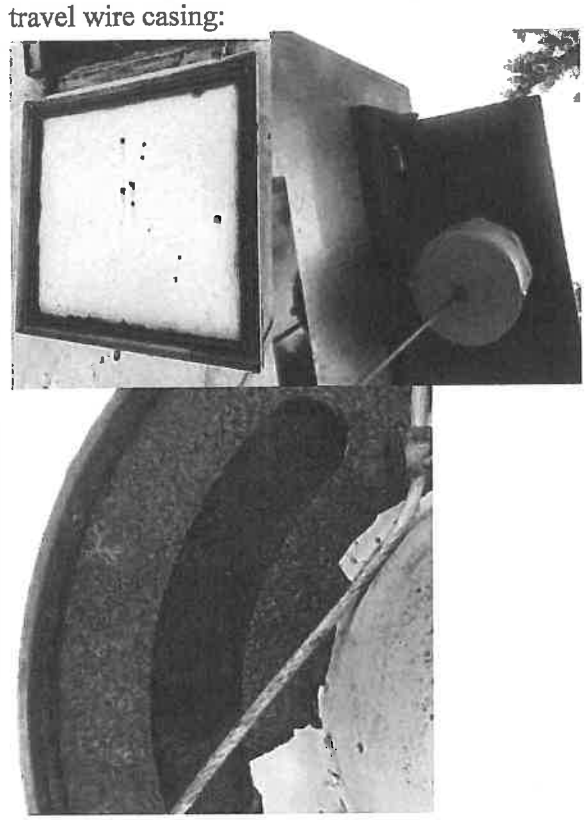
New PRV at Bellingham Scenic St Intertie

Operator Tank Photos: Sent 3/18/2020:

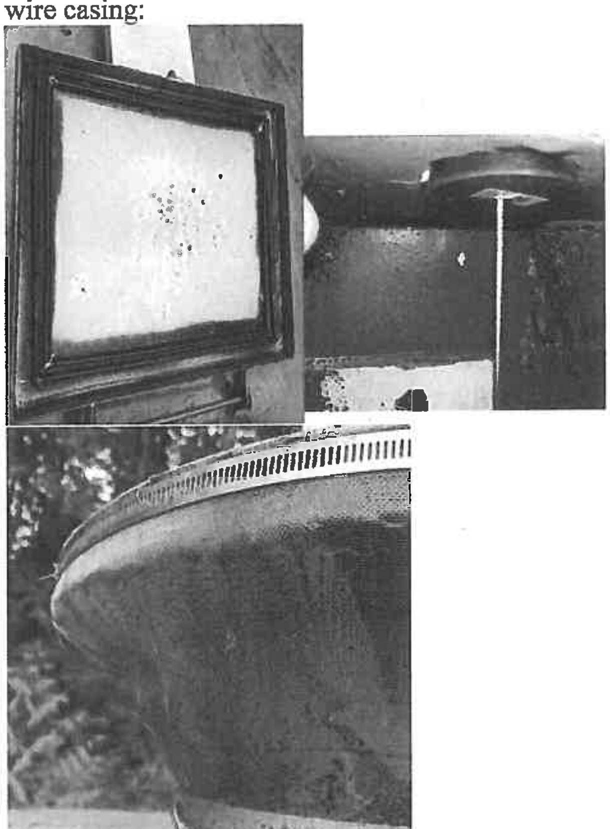
Geneva Roof Hatch Gasket, vent screen, and travel wire casing:



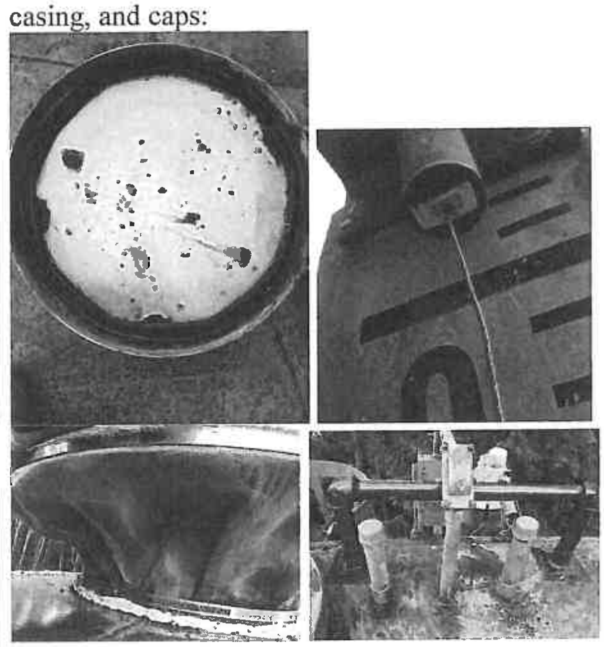
Sudden Valley Roof Hatch Gasket, vent screen, and travel wire casing:

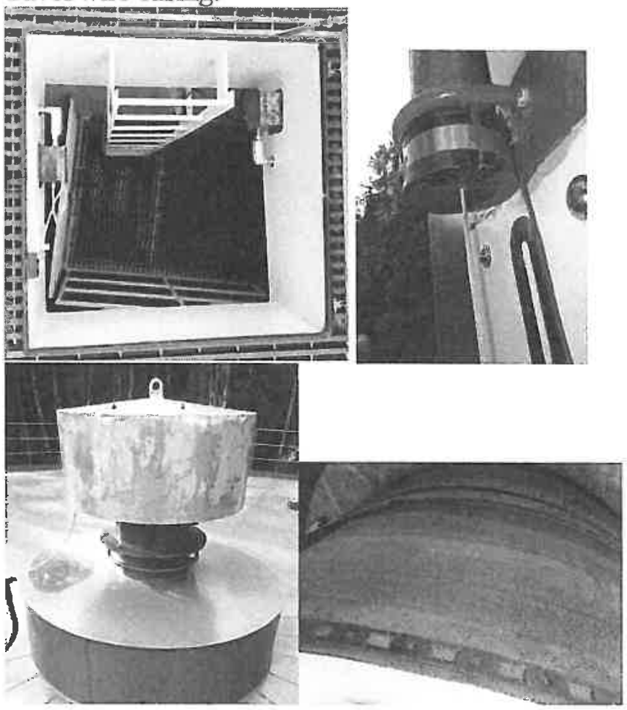
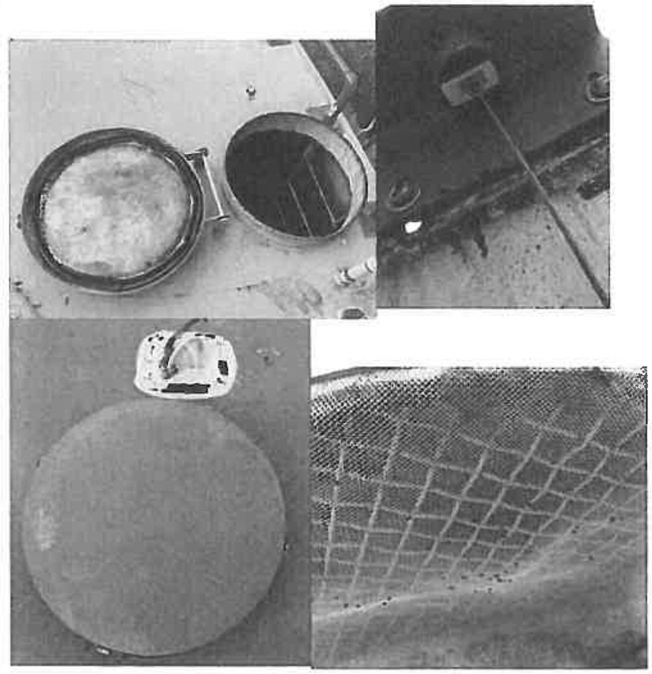


Division 30 Hatch Gasket, vent screen, and travel wire casing:



Division 22 old Hatch Gasket, vent screen, travel wire casing, and caps:



Division 22 New Hatch Gasket, vent screen, and travel wire casing:	Division 7 New Hatch Gasket, vent screen, travel wire casing, and caps:
	

APPENDIX E

CHLORINE GAS STORAGE INFORMATION

CHLORINE GAS STORAGE INFORMATION

MAXIMUM ALLOWABLE QUANTITIES

The hazardous materials provisions of the building codes begin with Tables 307.1(1) and 307.1(2) of the *2015 International Building Code*. These tables set the Maximum Allowable Quantities (per control area) of hazardous materials that pose either physical or health hazards. Gaseous chlorine is considered both an oxidizing gas (physical hazard) and a toxic gas (health hazard) and as such is regulated under the stricter of the requirements of either table. As a physical hazard, the maximum allowable quantity for liquefied oxidizing gases is 150 pounds. As a health hazard, the maximum allowable quantity for corrosive or toxic materials is 150 pounds as a liquefied gas, or 810 cubic feet at NTP as a gas (which is equivalent to a standard 150-pound cylinder). There are some exceptions to these quantities allowing two- to four-times to quantity to be stored or used. However, for the quantities in storage and use at the Sudden Valley WTP these exceptions would not have an effect on the code limits.

HAZARDOUS OCCUPANCY AND CODE REQUIREMENTS

When the quantity of chlorine gas exceeds the maximum allowable, the Occupancy of the Building or Control Area is typically upgraded to H-3. A summary of the building code requirements for H-3 occupancies is outlined below. The list below is not a complete and thorough list of code requirements, but rather a summarized listing of the many requirements.

International Building Code Requirements

- Provide a technical information report identifying the maximum expected quantities of hazardous materials and the methods of protection. This may include a Hazardous Materials Management Plan and a Hazardous Materials Inventory Statement as required by the local fire code official. [IBC 414.1.3, IFC 5001.5.1, IFC 5001.5.2]

- Provide mechanical ventilation where required by IBC, IFC, and IMC. [IBC 414.3]

- Provide an emergency power supply for mechanical ventilation, treatment systems, temperature control, fire and emergency alarm systems, gas and smoke detection systems, or other electrically operated systems. [IBC 414.5.2, IBC 2702.2.8, IFC 6004.2.2.8]

- Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an approved fail-safe engineered system is installed. [IBC 414.5.2.2, IFC 6004.2.2.8.1]

- Provide an automatic fire detection system in accordance with IBC 907.2. [IBC 415.3]

- Provide an automatic sprinkler system in accordance with IBC 903.2.5. [IBC 415.4]

- Provide an approved manual emergency alarm system for storage areas. The alarm-initiating device should be installed outside each access door and should sound a local alarm. [IBC 415.5.1]

- If hazardous materials are transported through corridors or exit passageways, there shall be an emergency telephone system, a local manual alarm station or an approved alarm-initiating device at not more than 150-foot intervals and at each exit and exit access doorway throughout the transport route. [IBC 415.5.2]

- Alarm systems should be monitored at an approved central location. [IBC 415.5.3]

- At least 25 percent of perimeter walls be exterior walls. [IBC 415.6]

- Hazardous occupancies shall be in detached buildings. [IBC 415.8]

- Detached buildings for hazardous occupancies shall be set back not less than 50 feet from lot lines.

- Floors should be liquid tight and non-combustible. [IBC 415.8.4]

- Storage and use cylinders of toxic gas shall be located within gas cabinets, exhausted enclosures, or gas rooms. [IFC 6004.2.2.1]

- Gas rooms shall be separated from other areas by not less than 1-hour fire barriers. [IBC 415.10.2

International Fire Code Requirements

- Provide a readily accessible manual valve or automatic remotely activated fail-safe emergency shut-off valve on all piping at the point of use and at the storage cylinder. [IFC 5003.2.2.1]

- Provide safeguards to prevent the backflow of hazardous materials. [IFC 5003.2.2.1]

- Any gas piping greater than 15 psi require an approved means of leak detection and automatic shut-off. [IFC 5003.2.2.1]

- Equipment using hazardous materials shall be braced and anchored to resist seismic forces per IBC. [IFC 5003.2.8]

- An automatic sprinkler system shall be installed in all Group H occupancies. [IFC 903.2.5, IFC 5004.5] The sprinkler system shall be designed per NFPA 13. [IFC 903.3.1.1]

- Indoor rooms or areas in which hazardous materials are dispensed or used shall be protected by an automatic fire-extinguishing system. [IFC 5005.1.8]

- One or more gas cabinets or exhausted enclosures shall be provided to handle leaking cylinders. [IFC 6004.2.2.3]

  Exemption:

  - Gas cabinets or exhausted enclosure are not required if:

    1. Approved containment vessels or systems capable of fully containing a release;

    2. Trained staff are at an approved location;

    3. Containment vessels or systems are capable of being transported to the leaking cylinder, container, or tank.

- The ventilation exhaust from a Gas Room shall be directed to a treatment system, which shall be utilized to handle the accidental release of gas. The treatment system shall be capable of neutralizing the contents of the largest single vessel. [IFC 6004.2.2.7]

  Treatment System Exemptions:

  - Storage of Toxic Gas ‐ A treatment system is not required to protect a storage area if:

    1. Valve outlets are equipped with gas-tight plugs or caps;

    2. Handwheel operated valves are secured to prevent movement; and

3. Approved containment vessels are provided for leaking cylinders, as noted below.

- Use of Toxic Gas ‑ A treatment system is not required to protect a use area for toxic gases supplied in cylinders not exceeding 1,700 pounds water capacity and if:

    1. An approved gas detection system with a sensing interval of less than 5 minutes is provided; and

    2. An approved automatic closing fail safe valve is located immediately adjacent to cylinder valves.

- Provide a gas detection system capable of detecting the presence of gas at or below the Permissible Exposure Limit and also capable of monitoring the discharge of an exhaust treatment system at or below one-half of the Immediately Dangerous to Life and Health limit. [IFC 6004.2.2.10]

- The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended location. [IFC 6004.2.2.10.2]

- The gas detection system shall automatically close the shut-off valve at the source. [IFC 6004.2.2.10.3]

International Mechanical Code Requirements

- Provide either natural ventilation or a mechanical exhaust ventilation system. [IMC 502.8.1]

- Mechanical ventilation shall pre provided at a rate of not less than 1 cfm per square foot of floor area. [IMC 502.8.1.1]

- Mechanical ventilation shall be continuous. [IMC 502.8.1.1]

- Provide a labeled emergency manual shutoff for the ventilation system. Shutoff should be located outside of the room adjacent to the main access door. [IMC 502.8.1.1]

- Ventilation system for Gas Rooms shall operate under negative pressures within the room. [IMC 502.8.1.2, IFC 5003.8.4.2]

APPENDIX C

TECHNICAL MEMORANDUM 20434-1, SUDDEN VALLEY WTP PUMP PERFORMANCE TESTING

TECHNICAL MEMORANDUM 20434-1

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	SEPTEMBER 19, 2022
SUBJECT:	SUDDEN VALLEY WTP PUMP PERFORMANCE TESTING LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively provide clean, potable water for the existing and projected service areas.

This report summarizes the findings of the pump performance analysis conducted on August 18, 2020.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

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The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD) but currently operates at approximately 1.0 MGD (700 gallons per minute (gpm)). The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before treated water is pumped to the distribution system and storage reservoirs.

In February 2019, engineers from Gray & Osborne visited the WTP to conduct the condition assessment mentioned previously. As part of this assessment, Gray & Osborne evaluated the treatment components from electrical, mechanical, process, and structural perspectives and documented issues found during the visit that did not meet current codes or could be modified to optimize treatment efficiency. The assessment's findings and subsequent recommendations were documented in the *Sudden Valley Water Treatment Plant Assessment Report* (Assessment Report) produced by Gray & Osborne in July 2020. This report provides the basis for the analysis below as well as analysis for additional components at the WTP.

The WTP utilizes raw water pumps to move water from the Lake Whatcom source to the media filters, clearwell transfer pumps to move water from the clearwell to the chlorine contact basin, and finished water pumps to move water from the chlorine contact basin to the District's Division 7 Reservoir, Division 22 Reservoir, and the distribution system. Technical information for these pumps is provided in Table 1.

TABLE 1

WTP Pump Summary

Parameter	Value
Raw Water Pumps	
Type	Horizontal, Centrifugal
Quantity	2
Location	WTP Main Building
Year Installed	1992
Make	GS Aurora
Model	3PC-134075
Impeller (in.)	12
Suction/Discharge Size (in.)	6/6
Design Flow (gpm)	1,400
Design Head (ft)	40
Electrical	20 hp, 3 ph, 60 Hz, 1,180 rpm
Clearwell Transfer Pumps	
Type	Vertical Turbine Lineshaft
Quantity	2
Location	WTP Main Building
Year Installed	1992
Make	Peerless
Model	12HXB
Impeller (serial number, size)	2608379, 7-27/32″ x 8-5/16″
Suction/Discharge Size (in.)	10/10
Design Flow (gpm)	1,400
Design Head (ft)	43
Electrical	20 hp, 3 ph, 60 Hz, 1,760 rpm

TABLE 1 – (continued)

WTP Pump Summary

Parameter	Value
Finished Water Pumps – Division 7	
Type	Vertical Turbine
Quantity	2
Location	Finished Water Pump Building
Year Installed	1992
Make	Peerless
Model	12LD
Impeller (serial number, size)	2649365, 8-5/8″ x 9-7/16″
Number of Stages	6
Suction/Discharge Size (in.)	6/6
Design Flow (gpm)	700
Design Head (ft)	445
Electrical	100 hp, 3 ph, 60 Hz, 1,760 rpm
Finished Water Pumps – Division 22	
Type	Vertical Turbine
Quantity	2
Location	Finished Water Pump Building
Year Installed	1992
Make	Peerless
Model	12LD
Impeller (serial number, size)	2649365, 8-3/4″ x 9-19/32″
Number of Stages	8
Suction/Discharge Size (in.)	6/6
Design Flow (gpm)	700
Design Head (ft)	608
Electrical	150 hp, 3 ph, 60 Hz, 1,760 rpm

Raw Water Pumps

Both raw water pumps are located within the WTP Main Building in a below-grade pit adjacent to the flocculation tank. The pumps are accessed by a single vertical ladder. Although each pump is capable of pumping 1,400 gpm, WTP staff have adjusted the pump output to 700 gpm in order to maximize treatment efficiency and comply with previous directives from the Washington State Department of Health (DOH). The pumps are operated on a lead/lag schedule and are maintained in accordance with the manufacturers' recommendations. The raw water pumps are controlled by two variable frequency drive (VFD) motor starters, both of which were installed in 1992 and are located in Motor Control Center 3 (MCC3) in the WTP Main Building. MCC3 is located in the northeast corner of the building adjacent to the soda ash storage area. Photos of MCC3 are provided in Exhibit A.

The Assessment Report noted that both pumps were installed in 1992 and are in fair condition. The motor for Raw Water Pump 2 was replaced in 2008. The Assessment Report also noted that both of these pumps are likely nearing the end of their reliable useful life and recommended that the District conduct a performance test for these pumps, and depending on the results of that testing, replace both raw water pumps. The Assessment Report also noted that MCC3 and the raw water pump VFDs located therein are in fair/poor condition due to its proximity to soda ash chemicals as well as moisture. MCC3 exhibits a moderate level of corrosion and the Assessment Report recommended that the District replace MCC3 and the raw water pump VFDs located therein as part of any modifications to the raw water pumps and that they consider chemical storage and exposure to moisture before selecting a final installation location for these components.

Clearwell Transfer Pumps

Both clearwell transfer pumps are located within the WTP Main Building near the entrance to the WTP, above the below-grade clearwell. The pumps alternately operate based on the water level within the clearwell and cycle on and off to move water from the clearwell to the chlorine contact basin. The chlorine contact basin is a 225,000-gallon cylindrical welded steel tank with baffles and is located between the WTP Main Building and the Finished Water Pump Building. The clearwell transfer pumps are alternated on a lead/lag schedule and are maintained in accordance with the manufacturer's recommendations. The pumps are critical for supplying the chlorine contact basin, which is a vital component of the treatment process and is used to provide contact time (CT) for disinfection. The transfer pumps are controlled by two across-the-line motor starters, both of which are located in Motor Control Center 2 (MCC2) in the WTP Main Building. MCC2 is located along the south wall of the WTP Main Building. Photos of MCC2 are provided in Exhibit A.

The Assessment Report noted that both clearwell transfer pumps were installed in 1992, are in fair condition, but are likely nearing the end of their reliable useful life. The Assessment Report recommended that the District conduct a performance test for these pumps, and depending on the results of that testing, repair, rehabilitate, or replace both clearwell transfer pumps. The Assessment Report also noted that MCC2 was in good/fair condition, but because of its age is no longer supported by the equipment manufacturer. As such, acquiring spare parts has become increasingly difficult and expensive. MCC2 exhibits a moderate level of corrosion and the Assessment Report recommended that the District replace MCC2 as part of any modifications to the clearwell transfer pumps and that they consider chemical storage and exposure to moisture before selecting a final installation location for these components. Lastly, the District has expressed interest in controlling these pumps using VFD motor starters, which will provide additional operational flexibility for the treatment process, equipment, and staff.

Finished Water Pumps

All four finished water pumps are located in the Finished Water Pump Building. The pumps are fed from a common 10-inch diameter header that provides water from the chorine contact basin. Each set of pumps alternately operate based on the water level within the controlling reservoirs (Division 7 or 22). When the water level within the controlling reservoir reaches the pump off set point, the finished water pumps de-energize and remain offline until the water level in the controlling reservoir reaches the pump on set point. The finished water pumps are alternated on a lead/lag schedule and are maintained in accordance with the manufacturer's recommendations. The pumps are controlled by across-the-line motor starters, all of which are located in Motor Control Center 1 (MCC1) in the Finished Water Pump Building. MCC1 is located south of the finished water pumps in the middle of the Finished Water Pump Building. Photos of MCC1 are provided in Exhibit A.

The Assessment Report noted that all four pumps were originally installed in 1992, but are in good condition. The Assessment Report also noted that all of these pumps may be nearing the end of their reliable useful life and recommended that the District conduct a performance test for these pumps, and depending on the results of that testing, repair, rehabilitate, or replace the finished water pumps. The Assessment Report also noted that MCC1 was in good condition, but given its age is no longer supported by the equipment manufacturer. As such, acquiring spare parts has become increasingly difficult and expensive. The Assessment Report recommended that the District replace MCC1 as part of any modifications to the finished water pumps and that they consider the location of other electrical equipment before selecting a final installation location for these components. Lastly, the District has expressed interest in controlling these pumps using VFD motor starters, which will provide additional operational flexibility for the treatment process, equipment, and staff.

PUMP PERFORMANCE TESTING

On August 18, 2020, Keith Stewart from Gray & Osborne travelled to the Sudden Valley WTP to conduct a performance test of the pumps in use at the facility. WTP Lead

Operator Kevin Cook and District Electrician Ken Zangari were also present and assisted with the testing.

The specific testing protocols are highlighted below, but generally, each pump was energized and allowed to equilibrate at its typical operating flow and conditions. From there, the discharge isolation valve associated with each pump was partially closed and the flow, discharge pressure, inlet pressure, and motor amperage were measured and recorded. This process was repeated for several additional flows. Once the test was completed, the discharge valve was fully opened and the pump was de-energized. All four finished water pumps were analyzed in a similar fashion.

Finished Water Pumps

The finished water pumps and MCC1 are shown as Figures A-1, A-2, and A-3 (Exhibit A). Each pump is equipped with manual isolation valves, hydraulic control valves, and inlet/discharge pressure gauges. The discharge piping from each pump connects to a common header, which exits the building below grade. Isolation valves are 6-inch butterfly valves and typically operate in the fully open position. Control valves for all four pumps are 6-inch Cla-Val Model 60-11BY. Pressure gauges are standard glycerin-filled units suitable for potable water service. The existing pressure gauges are at least 8 years old and have not recently been calibrated. Flow for Division 22 pumps is measured by an 8-inch Endress & Hauser magnetic flow meter located in a buried vault on the north side of the Finished Water Pump Building. This meter was installed in 2019 and the flow value for this meter is displayed on a remote display located on the east wall within the Finished Water Pump Building. Flow for Division 7 pumps is measured by an 8-inch Badger magnetic flow meter located in a buried vault southeast of the chlorine contact basin. This meter was installed in 2006 and the flow value for this meter is displayed on a remote display located on the east wall within the Finished Water Pump Building. Amperage across the motor was measured by an ammeter placed around the load wire within the motor control center cabinet as shown on Figure A-2.

For this analysis, finished water flow, motor amperage, discharge header pressure, and discharge piping pressure were measured at various discharge isolation valve positions. The data collected for the Division 7 Finished Water Pumps and the Division 22 Finished Water Pumps are listed in Tables 2 and 3, respectively. These data are also shown graphically on Figures 1 and 2.

TABLE 2

Division 7 Finished Water Pump Testing Summary

Valve Closure (no. of turns)	Flow (gpm)	Discharge Pressure (psi)	Header Pressure (psi)	Inlet Pressure (psi)	Net Pumping Head (psi)	Amperage (amps)
Finished Water Pump 7-1						
20	807	183	170	6.4	176.6	116.8
10	803	183	170	6.5	176.6	116.6
8	799	184	170	6.5	177.6	116.4
6	793	185	170	6.5	178.5	116.5
4	775	188	169	6.5	181.5	115.8
3	749	194	168	6.5	187.5	114.8
2.25	696	204	165	6.6	197.4	112.4
Finished Water Pump 7-2						
20	820	179	168	6.8	172.2	117.9
10	815	180	169	6.8	173.2	117.6
8	809	180	168	6.8	173.2	117.3
6	807	181	168	6.8	174.2	117.3
4	786	184	168	6.9	177.1	116.7
3	754	190	168	6.9	183.1	115.3
2.5	660	206	165	7.0	199.0	111.6

TABLE 3

Division 22 Finished Water Pump Testing Summary

Valve Closure (no. of turns)	Flow (gpm)	Discharge Pressure (psi)	Header Pressure (psi)	Inlet Pressure (psi)	Net Pumping Head (psi)	Amperage (amps)
Finished Water Pump 22-1						
20	730	254	262	7.3	246.7	150.2
10	730	254	258	7.3	246.7	150.2
8	740	256	258	7.3	246.7	149.8
6	739	259	256	7.3	251.7	149.4
4	697	264	252	7.4	256.6	147.5
3	633	277	250	7.4	269.6	143.1
2.25	430	310	234	7.6	302.4	120.6
Finished Water Pump 22-2						
20	730	252	260	7.7	244.3	158.0
10	724	252	258	7.8	244.3	157.5
8	718	254	260	7.8	246.2	157.0
6	706	258	260	7.8	250.2	157.0
4	700	263	258	7.8	255.2	155.9
3	440	279	250	8.0	271.0	132.8
2.75	306	310	238	8.1	301.9	123.8

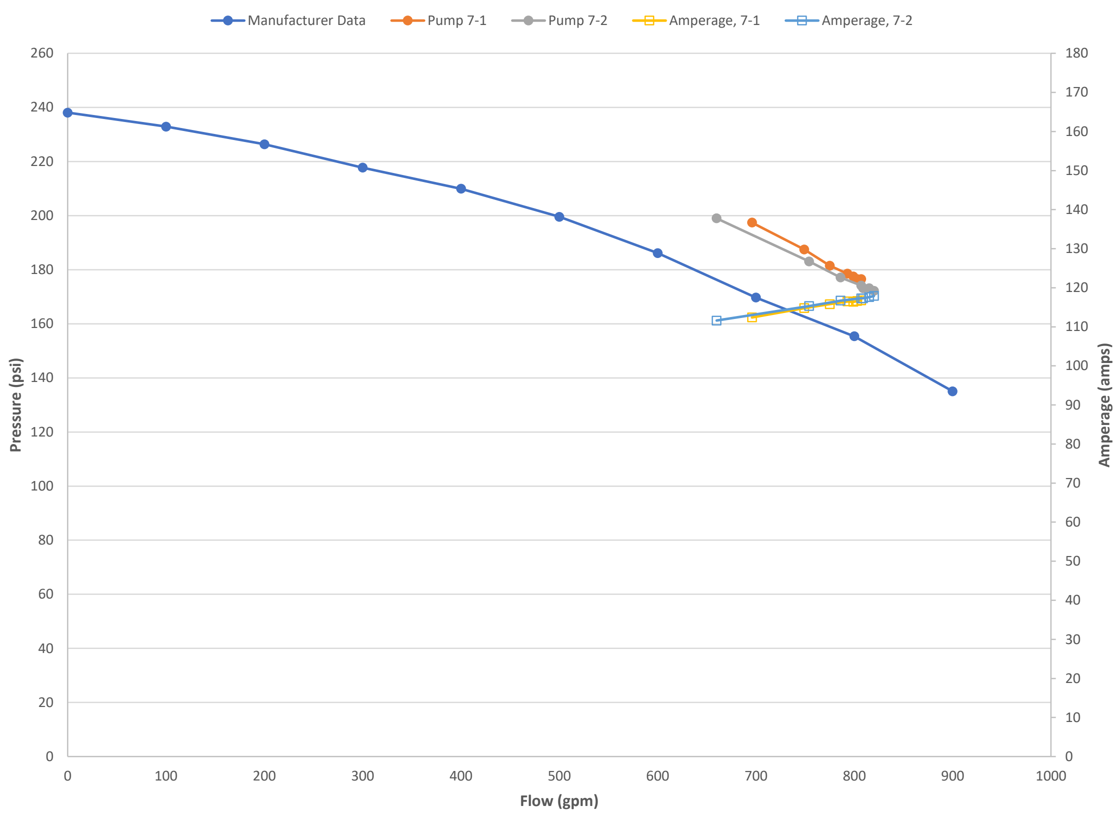


FIGURE 1

Division 7 Finished Water Pump Testing Analysis

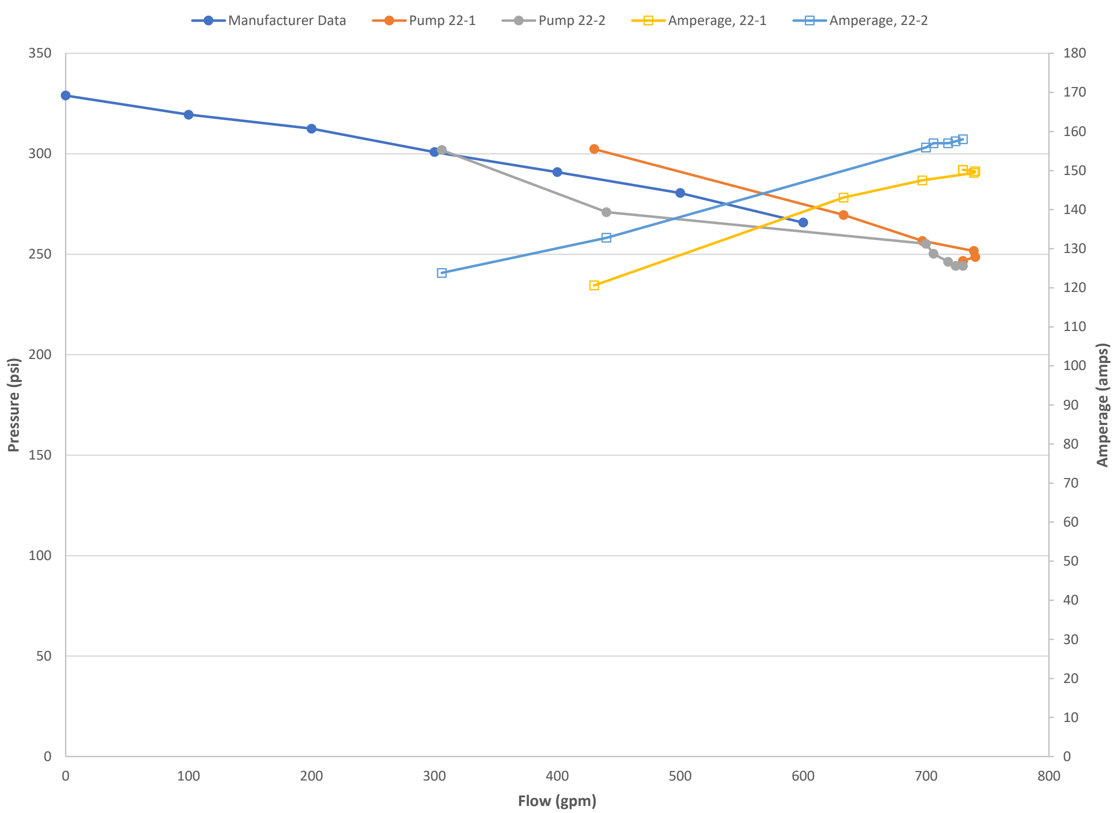


FIGURE 2

Division 22 Finished Water Pump Testing Analysis

The data on Figures 1 and 2 show that the existing finished water pumps are performing at or above the manufacturer's curve. It is unclear why the performance curves for the Division 7 finished water pumps are so far above the manufacturer's performance curve. This could be due to inaccuracies with the pressure gauges or could be related to inherent inaccuracies in recording the flow. During testing – and presumably during normal operation – the flow reading on the display was very jumpy and had a total reading range of approximately 40 to 45 gpm. For the final reading, the values were observed for 30 to 60 seconds and the "average" value was recorded.

The amperage during performance is below the listed maximum load amperage of 119 and 173 amps for Divisions 7 and 22 pumps, respectively.

Given the age of the pumps, if the District continues to utilize these pumps, we recommend that the District complete pump performance testing every 2 to 4 years to ensure functionality of the equipment and to proactively identify potential points of failure. We also recommend that the District replace the existing pressure gauge assemblies with new calibrated pressure gauges to ensure accurate measurements. Additional recommendations are discussed in subsequent sections of this memorandum.

Clearwell Transfer Pumps

The clearwell transfer pumps and MCC2 are shown as Figures A-4 and A-5 (Exhibit A). Each pump is equipped with a check valve, isolation valve, and pressure gauge assembly. The discharge from each pump connects to a common header, which then proceeds to the chlorine contact basin. Prior to the pipe exiting the building, various filtered water samples are extracted through small fitting connections. Check valves, isolation valves, and piping within the WTP Main Building are 10-inch diameter ductile iron materials. There is no flow meter on the transfer pump discharge line.

The testing team experienced several significant difficulties while trying to complete the performance test. First was the absence of a flow meter on the discharge line from the transfer pumps making direct measurement of the flow during the testing impossible. Although flow cannot be directly measured, it is possible to estimate the flow by dividing the volume of water pumped by the time for each run. The volume of water can be estimated by using information from the existing clearwell level sensor. This sensor measures water height in 0.1-foot increments, and using the known footprint and geometry of the clearwell, the volume of water within the clearwell can be estimated for any given water level. We attempted to measure the flow in this manner, but quickly determined that the water surface measurement was too inconsistent and not sensitive enough for the purposes of testing at small increments of flow.

Secondly, the pressure gauge assemblies on the discharge elbow for each pump were not operational. The isolation valves for these valve assemblies were closed and could not be opened without potentially damaging the threaded fittings. We did investigate other installation locations for these pressure gauge assemblies, but all available locations were downstream of the isolation valve and would not provide useful data.

Due to these issues, the transfer pumps were not tested as part of this analysis. We recommend that the District replace the existing pressure gauge assemblies with new equipment so that performance testing could be attempted in the future. Additional recommendations are discussed in subsequent sections of this memorandum.

New pressure gauge assemblies could be installed by replacing the existing components or by drilling a new threaded tap hole in the existing pump discharge elbow. It is important to note that even with new pressure gauge assemblies, performance testing will be difficult because the discharge piping does not contain a flow meter. Even though the pumps were installed in 1992, they appear to be functioning well; given their age, they are likely nearing the end of their reliable useful life.

Raw Water Pumps

The raw water pumps and MCC3 are shown as Figures A-6 and A-7 (Exhibit A). Each pump is equipped with a 4 x 10 reducer, 10-inch check valve, and 10-inch isolation valve. Ductile iron discharge piping from each pump connects to a common header and this header proceeds above grade and to the flocculation basin.

Similar to the transfer pumps, the existing pressure gauge assemblies were locked in the closed position. Even if these gauges were available for use, the equipment was installed in 1992 and is likely no longer accurate. Spare gauges could not be found and as such, the raw water pumps were not tested as part of this analysis. The discharge piping for the raw water pumps does contain a flow meter, so pump performance testing could be completed when new gauge assemblies are installed.

Given the age of the pumps, if the District continues to utilize these pumps, we recommend that the District complete pump performance testing every 2 to 4 years to ensure functionality of the equipment and to proactively identify potential points of failure. We also recommend that the District replace the existing pressure gauge assemblies with new calibrated pressure gauges to ensure accurate measurements. Additional recommendations are discussed in subsequent sections of this memorandum.

SUMMARY OF RECOMMENDATIONS AND COST ESTIMATES

As previously mentioned, the pumps tested as part of this work are controlled by individual across-the-line motor starters. These starters are located within separate MCCs located at various locations in the WTP Main Building and the Finished Water Pump Building. As mentioned previously, MCC1 and MCC2 are old and no longer supported by the manufacturer, while MCC3 is in poor condition due to its exposure to chemicals and moisture. The Assessment Report recommended that MCC1, MCC2, and MCC3 be replaced in order to bring the equipment up to current standards, to ensure that suitable replacement parts are available, and to ensure consistent and reliable functionality to the pumps they control. In addition to this, the District has expressed a desire to increase the flexibility of plant operations by utilizing VFD motor starters for these pumps. VFD motor starters will allow the operational staff to vary the flow based on instantaneous demands, to maintain consistent water levels within either the clearwell or chlorine contact basin, and to optimize functionality of the filtration equipment, among other benefits. Modern VFD motor starters are too large to fit within the existing MCCs, so retrofitting the existing units with new motor starters is not feasible. Furthermore, the existing motors for the raw water pumps, transfer pumps, and finished water pumps are not rated for use with VFDs and as such, would need to be replaced if VFD motor starters were installed.

Because the replacement of MCC1, MCC2, and MCC3 will necessitate the replacement of the associated motor starters and subsequently the pump motors and the District has expressed a desire to both upgrade the equipment to ensure functionality of the pumps and to improve the overall performance capabilities of the treatment plant, we recommend that the District complete the following items for each set of pumps investigated as part of this work.

Finished Water Pumps

Even though pump testing described herein suggests that the finished water pumps are performing very near their original design conditions, we recommend that the District replace the pumps, motors, and motor starters. The MCCs should be replaced and sized to accommodate the desired VFD motor starters and the pumping equipment, including the motor, should be replaced so that it is compatible with the desired VFD controllers. The location of the proposed MCCs should be coordinated with any other modifications to the WTP with regard to exposure to chemicals, water, or other planned improvements. We also recommend that the District replace the discharge pressure gauge assemblies for each pump and procure one spare pressure gauge for each type so that failures can be addressed quickly.

The recommendations listed above are estimated to cost $740,000, which includes materials and installation based on our current understanding of the project scope, contingency (20 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). An itemized cost estimate for these recommendations is provided in Exhibit B.

Clearwell Transfer Pumps

Even though the clearwell transfer pumps appear to be performing adequately, we recommend that the District replace the pumps, motors, and motor starters. The MCCs should be replaced and sized to accommodate the desired VFD motor starters and the pumping equipment, including the motor, should be replaced so that it is compatible with the desired VFD controllers. The location of the proposed MCCs should be coordinated with any other modifications to the WTP with regard to exposure to chemicals, water, or other planned improvements. We also recommend that the District replace the discharge pressure gauge assemblies for each pump and procure one spare pressure gauge for each type so that failures can be addressed quickly.

The recommendations listed above are estimated to cost $338,000, which includes materials and installation based on our current understanding of the project scope, contingency (20 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). An itemized cost estimate for these recommendations is provided in Exhibit B.

Raw Water Pumps

Even though the raw water pumps appear to be performing adequately, we recommend that the District replace the pumps, motors, and motor starters. The location of the proposed MCCs should be coordinated with any other modifications to the WTP with regard to exposure to chemicals, water, or other planned improvements. We also recommend that the District replace the discharge pressure gauge assemblies for each pump and procure one spare pressure gauge for each type so that failures can be addressed quickly.

The recommendations listed above are estimated to cost $239,000, which includes materials and installation based on our current understanding of the project scope, contingency (20 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). An itemized cost estimate for these recommendations is provided in Exhibit B.

EXHIBIT A

PHOTOGRAPHS OF EXISTING PUMPS

FIGURE A-1

Existing Finished Water Pumps
(Division 22 Pumps Are in the Foreground While Division 7 Pumps Are in the Background)

FIGURE A-2

Location Where Motor Amperage Was Measured
(An Ammeter Was Placed Around the Motor Load Conductor and the Value Was Read from the Digital Display)

FIGURE A-3

MCC1
(Shown Is Old and No Longer Supported by the Manufacturer)

FIGURE A-4

Clearwell Transfer Pumps
(The Pumps Move Water from the Below-Grade Clearwell to the Chlorine Contact Basin)

FIGURE A-5

MCC2
(Shows Slight Signs of Corrosion from Exposure to Chemicals and Moisture, Is Old, and Is No Longer Supported by the Manufacturer)

FIGURE A-6

Raw Water Pumps
(The Pumps Move Water from the Lake Whatcom Source to the Flocculation Basin and Are Located Below Grade in the Raw Water Pump Pit)

FIGURE A-7

MCC3
(Shows Signs of Corrosion – Interior and Exterior – from Exposure to Chemicals and Moisture)

EXHIBIT B

PUMP REPLACEMENT COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY PUMP IMPROVEMENTS COST ESTIMATE

Raw Water Pump Modifications
September 23, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Pressure Gauge Assembly	2	EA	$ 600	$ 1,200
2	Spare Pressure Gauge	1	EA	$ 200	$ 200
3	Raw Water Pump VFD	2	EA	$ 15,000	$ 30,000
4	Raw Water Pump/Motor	2	EA	$ 20,000	$ 40,000
5	Pump Removal & Wastehauling	2	EA	$ 5,000	$ 10,000
6	MCC 3 Replacement	1	LS	$ 40,000	$ 40,000
7	Electrical	1	LS	$ 25,000	$ 25,000

Subtotal*	**$ 146,400**
Contingency (20%)	$ 29,300
Subtotal	**$ 175,700**
Washington State Sales Tax (9.0%)**	$ 15,800
Subtotal	**$ 191,500**
Design and Project Administration (25.0%)***	$ 47,900
TOTAL CONSTRUCTION COST	**$ 239,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY PUMP IMPROVEMENTS COST ESTIMATE

Clearwell Transfer Pump Modifications
September 23, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Pressure Gauge Assembly	2	EA	$ 600	$ 1,200
2	Spare Pressure Gauge	1	EA	$ 200	$ 200
3	Transfer Pump VFD	2	EA	$ 25,000	$ 50,000
4	Transfer Pump/Motor	2	EA	$ 30,000	$ 60,000
5	Pump Removal & Wastehauling	2	EA	$ 5,000	$ 10,000
6	MCC 2 Replacement	1	LS	$ 55,000	$ 55,000
7	Electrical	1	LS	$ 30,000	$ 30,000

Subtotal*	**$ 206,400**
Contingency (20%)	$ 41,300
Subtotal	**$ 247,700**
Washington State Sales Tax (9.0%)**	$ 22,300
Subtotal	**$ 270,000**
Design and Project Administration (25.0%)***	$ 67,500
TOTAL CONSTRUCTION COST	**$ 338,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT & ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY PUMP IMPROVEMENTS COST ESTIMATE

Finished Water Pump Modifications
September 23, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Pressure Gauge Assembly	4	EA	$ 600	$ 2,400
2	Spare Pressure Gauge	2	EA	$ 200	$ 400
3	Division 7 Pump VFD	2	EA	$ 30,000	$ 60,000
4	Division 7 Pump/Motor	2	EA	$ 35,000	$ 70,000
5	Division 22 Pump VFD	2	EA	$ 35,000	$ 70,000
6	Division 22 Pump/Motor	2	EA	$ 50,000	$ 100,000
7	Pump Removal & Wastehauling	4	EA	$ 10,000	$ 40,000
8	MCC 1 Replacement	1	LS	$ 75,000	$ 75,000
9	Electrical	1	LS	$ 35,000	$ 35,000

Subtotal*	**$ 452,800**
Contingency (20%)	$ 90,600
Subtotal	**$ 543,400**
Washington State Sales Tax (9.0%)**	$ 48,900
Subtotal	**$ 592,300**
Design and Project Administration (25.0%)***	$ 148,100
TOTAL CONSTRUCTION COST	**$ 740,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

APPENDIX D

TECHNICAL MEMORANDUM 20434-2, SUDDEN VALLEY WTP CHLORINE CONTACT BASIN COATING ASSESSMENT

TECHNICAL MEMORANDUM 20434-2

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	SEPTEMBER 10, 2021
SUBJECT:	SUDDEN VALLEY WTP CHLORINE CONTACT BASIN COATING ASSESSMENT LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost effectively provide clean, potable water for the existing and projected service areas.

This report summarizes the assessment of the interior and exterior coating systems on the existing chlorine contact basin.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

1130 Rainier Avenue South, Suite 300 Seattle, Washington 98144 (206) 284-0860 Fax (206) 283-3206

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD) but currently operates at approximately 1.0 MGD (700 gallons per minute (gpm)). The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before treated water is pumped to the distribution system and storage reservoirs.

The WTP utilizes a chlorine contact basin (CCB) to provide chlorine contact time for filtered water prior to introduction to the distribution system. Technical information for the CCB is provided in Table 1. Figure 1 shows a plan view of the CCB while Figure 2 shows a section view of the CCB.

TABLE 1

WTP CCB Summary

Parameter	Value
Year Constructed	1994
Type	Circular, Welded Steel
Diameter (ft)	40
Base Elevation (ft)	336.0
Overflow Elevation (ft)	360.0
Volume (gal)	225,000
Gallons per Foot	9,400
Inlet	10-inch Perforated Riser
Outlet	10-inch Perforated Riser
Instrumentation	Pressure Switch (High Alarm)

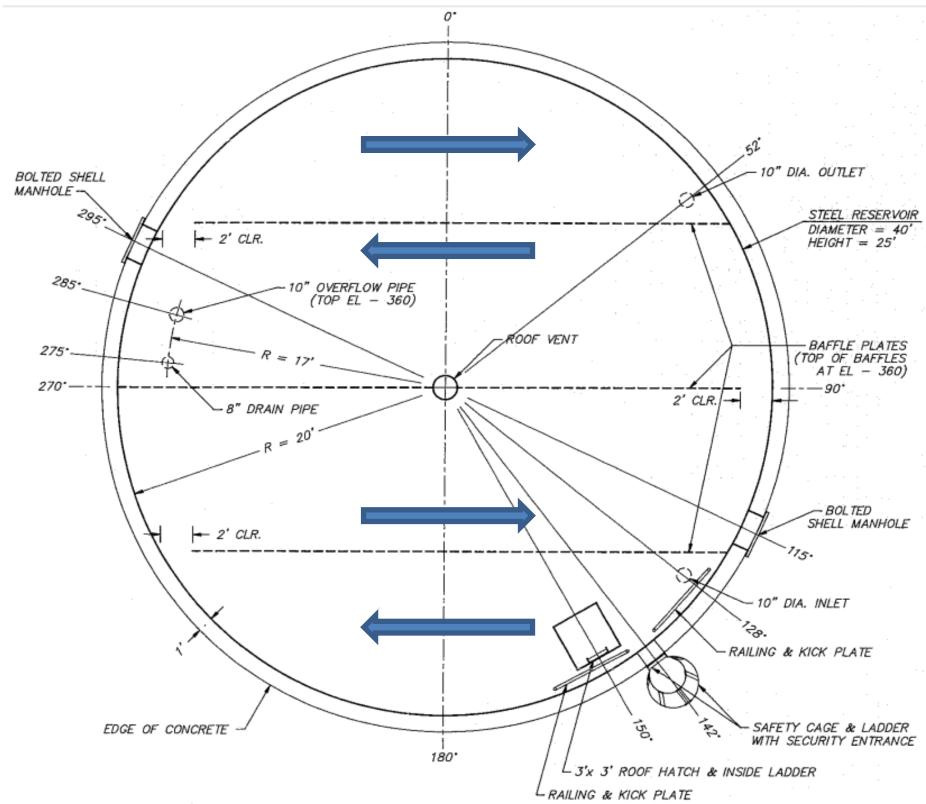


FIGURE 1

WTP CCB Plan View

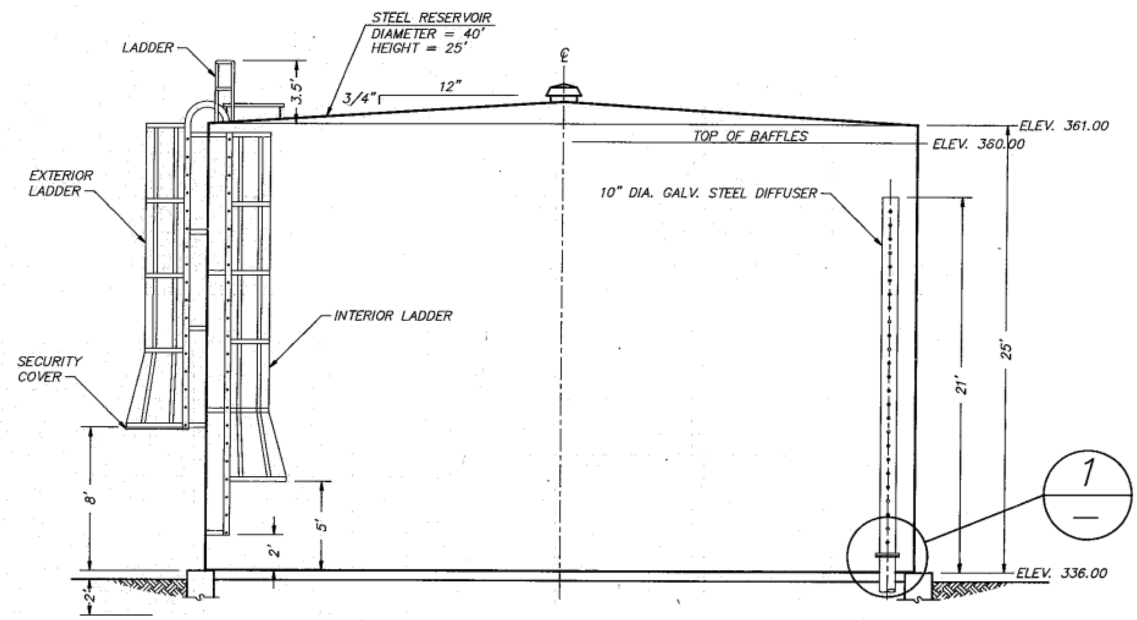


FIGURE 2

WTP CCB Section View

Water enters the CCB via a diffuser riser at one end and flows in a serpentine fashion between three steel baffles to the outlet diffuser. The inlet diffuser consists of a 10-inch diameter PVC pipe with 25 2-inch diameter holes drilled at approximately 9.25 inches on center. The outlet diffuser riser consists of a 10-inch diameter PVC pipe with 50 2-inch diameter holes drilled at approximately 9.25 inches on center. These risers act to promote consistent flow throughout the full depth of the water column from the inlet to the outlet.

The CCB provides chlorine contact time (CT) for filtered water, which is a function of the chlorine concentration of water entering the tank, the hydraulic residence time within the tank, and the baffling efficiency of the tank. As directed by DOH, the District must maintain a minimum of 16.5 feet of water within the tank in order to meet their minimum CT requirement. As such, the CCB represents a critical component of the overall treatment system and must remain functional anytime the WTP is in operation.

CCB INVESTIGATION

Gray & Osborne utilized a subcontractor, Evergreen Coating Engineers, LLC (ECE), to perform the formal investigation. The investigation was conducted by

Lance Stevens P.E., NACE CIP Level 3 on August 19, 2020, and included the following components:

- Visual inspection of the interior and exterior coatings.
- Measurement of coating thickness.
- Measurement of coating adhesion from six testing dollies.
- Collection of coating samples for RCRA 8 metal analysis.
- General assessment of safety equipment, site/tank access, and available appurtenances.

On August 18, representatives from Gray & Osborne traveled to the WTP and affixed six coating adhesion test dollies to the tank surface. Two dollies were placed on the roof of the tank, and four dollies were affixed to the sidewall. Figure 3 shows some of the testing dollies in place.

FIGURE 3

Coating Adhesion Testing Dollies

On August 19, ECE travelled to the WTP to complete the investigation. ECE provided a complete assessment report for their investigation and this report is provided in Exhibit A. A summary of the report’s findings and recommendations is provided in the section below.

SUMMARY OF RECOMMENDATIONS AND COST ESTIMATES

The report provided by ECE had the following observations:

- Interior Coating System:
  - Likely consists of two or three coats of epoxy and is in moderate condition above the waterline and in good condition below the waterline.
  - Interior exhibits staining and rust corrosion, most likely from not having seal welds and not having been stripe-coated.
  - There is likely a section of peeling paint near the center of the tank. This section was difficult to see due to the location of the hatch.
  - Coating samples collected from the tank showed no significant concentrations of lead or other RCRA 8 metals (Exhibit B).
  - The interior of the tank has not been seal welded.
  - Previous corrosion/coating investigations completed by H_2O Solutions, LLC (2018) noted local areas of coating failure and light to moderate corrosion both on the interior and exterior of the tank. This report is provided in Exhibit D.

- Exterior Coating System:
  - Overall, the coating system on the sidewalls is in good condition, while the coating system on the roof is in moderate condition.
  - The roof exhibits algae and lichen growth, which will accelerate the deterioration of the coating system.
  - Existing coating patches have helped extend the service life, but show evidence of failure below the patch.

- Adhesion testing was performed and the results were favorable with a minimum pull strength of 1,089 pounds per square inch (psi) for the six samples tested.

- The tank is equipped with safety features; however, the tank could easily be accessed and/or vandalized in its current condition.

- The roof vent is in poor condition.

- Access to all portions of the tank for inspection is not provided via the single entry hatch.

To address the observations listed above, the report provided by ECE listed the following recommendations, which assume that the District will maintain use of the existing tank:

- Remove the existing interior coating system and replace it with new fluoropolymer coating within 5 years. The new interior coating system should include zinc primer and plural component epoxy topcoat. Sharp edges within the tank interior surface should be stripe coated as part of this coating process. The CCB will be unavailable for use during this process, which is anticipated to require 4 to 6 weeks to fully complete.

- Remove the existing exterior coating system and replace it with a new coating system within 5 years. The new coating system should include zinc primer, polyurethane intermediate coat, and fluoropolymer topcoat after surface preparation. The tank can be coated while in use, but it is desirable to prepare and coat the tank when not in use if feasible. Preparation and coating of the exterior is anticipated to take 2 to 4 weeks if completed with the interior coating work, and 4 to 6 weeks if completed separate from the interior coating work. Containment of the blast material and removed coating is recommended.

- The interior of the tank should receive seal welding to reduce potential for additional corrosion. Seal welding should extend the lifespan of the existing tank structure as well as any coating systems that are applied.

- Replace the existing roof vent, which shows signs of corrosion and damage.

- Install one additional access hatch that will allow for easier and more thorough tank inspection and maintenance.

- Remove both the interior and exterior ladder cages. The exterior ladder should be equipped with a ladder guard set at least 4 feet above grade to provide a protected height of at least 12 feet.

- Provide a cover for the existing access hatch padlock and replace the existing handhole screws with tamperproof devices.

The recommendations listed in the report are estimated to cost $680,000 which includes materials, labor, contingency (20 percent), Washington State sales tax (9.0 percent), and design and project administration (25 percent). If the optional items including the seal welding, additional roof hatch, and new roof vent/tie-offs are removed from the project, the estimated project cost decreases to $500,000. It should be noted that these cost estimates do not include the costs for temporary CT tankage during rehabilitation. The WTP cannot operate in compliance with DOH requirements without providing CT and as such, additional CT facilities are required if the existing tank is removed from service for cleaning, preparation, and coating. A permanent CT tank, a temporary CT tank, or temporary CT piping are all feasible solutions to provide CT during tank rehabilitation.

For comparison, a new 250,000-gallon, 40-foot diameter, 25-foot high welded steel tank with interior baffles and safety appurtenances is estimated to cost between $1.0 million and $1.25 million. This would include new piping and fittings to connect the new tank to the existing finished water pump building but does not include costs such as land acquisition or permitting.

Cost estimates for all three of these alternatives are included in Exhibit C.

EXHIBIT A

EVERGREEN COATING ENGINEERS COATING ASSESSMENT REPORT

LAKE WHATCOM WATER & SEWER DISTRICT

Sudden Valley Water Treatment Plant

Chlorine Contact Basin Tank Evaluation

September 2021 - Draft Report – Rev 2

EVERGREEN
COATING ENGINEERS

Seattle, WA

EXECUTIVE SUMMARY

Gray & Osborne (G&O) contacted Evergreen Coating Engineers (ECE) to complete an evaluation of the Sudden Valley Chlorine Contact Basin Tank (CCB Tank or Tank) for Lake Whatcom Water & Sewer District (District) and provide recommendations for recoating and improvements. The evaluation consisted of the interior and exterior coating systems as well as the tank access features and site. The evaluation was performed by Lance Stevens, P.E., NACE CIP Level 3 of Evergreen Coating Engineers, LLC. The results of that evaluation are contained in this report.

The evaluation found that the coating system on the exterior of the tank is in relatively good condition. The coatings are still protecting the tank except in a few areas on the roof where corrosion has begun. Patches in the coating system on the side shell of the tank are beginning to fail as well. The interior coating system is of more significant concern as it is failing around the edges of the roof plates and structural steel members. The cathodic protection system appears to be working well beneath the water line where it is designed to work. It should be noted that due to the baffles within the tank and only having one access hatch, we could not inspect approximately 2/3 of the interior coating system. It is our opinion that the coatings will protect the tank for another five years but the tank could start to have more problematic metal loss after that.

In addition to the coating system replacement, there are several improvements which could be made to the tank to facilitate access and use. Seal welding, as described within the report, could help to extend the life of the tank as well as extend the length of each coating life cycle. The tank roof vent should be replaced and another access hatch added to the opposite side of the roof to allow for better inspection of the tank.

The improvements should be performed within the next 3 to 5 years and the estimated total project cost of the recommended project in 2020 is $519,000 including a 20 percent contingency and 8.5% sales tax.

INTRODUCTION

BACKGROUND

Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne (G&O) who teamed with Evergreen Coating Engineers (ECE) to evaluate the interior and exterior coating systems as well as the tank access and site features on the District's CCB Tank (Tank). The District's goal was to determine the condition of the tank and the options that are available to maintain the tank in the future. The Tank did not have a nameplate on the exterior so the actual dimensions and size are unknown from the field, however, the District provided data that the Tank is 24 feet in height to the overflow (25 feet overall) and 40 feet in diameter with a usable volume of 225,000 gallons. The Tank was constructed in 1994.

The field data collection was performed by Lance Stevens, P.E. of Evergreen Coating Engineers, LLC (ECE) on August 19, 2020 while the dollies for the adhesion testing were set by Keith Stewart, P.E. of Gray & Osborne, Inc. (G&O) on August 18, 2020. The scope of work was developed to provide the District with an evaluation of the existing coating systems on the interior and exterior of the tank along with a general evaluation of the tank access features and site. The interior was inspected by leaning into the roof hatch. Although it aids in chlorine contact time within the tank, the interior baffle prevented access or the ability to view approximately 2/3 of the tank that is opposite of the existing roof hatch. The exterior was inspected by climbing the tank and by walking around the exterior. No lifts were provided for detailed inspection of the upper shell wall.

It is unknown if the tank has been recoated at some point since construction. Staff that was onsite at the time had not recalled the tank being taken out of service for recoating. Given the appearance of the coating system and that the tank serves as the chlorine contact basin for system CT requirements, it is likely that this is the original coating system.

The safety features of the tank were not evaluated as the District believes that all of the features are in compliance with current codes. A general evaluation of the site and access features is included within this report. Recommendations regarding railings and the ladders on the tank do not imply that an analysis was performed for their compliance with safety codes. The recommendations are based only upon ease of use and access of the facility by District personnel. If any of the recommended improvements are included in future design work, the improvements should be evaluated at that time for compliance with current safety codes.

The coating systems were graded utilizing The Society for Protective Coatings (SSPC)-VIS 2 Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces. In general, the values range from 1-10 with 10 being practically no corrosion evident and 1 being greater than 50 percent corroded. The areas are also categorized by the type of corrosion observed with an S = Spot Rusting, G = General Rusting, P = Pinpoint Rusting, O = Other Rusting which is a combination of types of rusting. As an example, a rust grade of 5-S would represent approximately 1-3 percent spot rusting on a surface.

INTERIOR COATING SYSTEM

The interior coating system likely consists of two or three coats of epoxy, a common coating system in 1994. The coatings were assessed by taking photos and visually observing what could be seen through the roof hatch. Since the tank is utilized for chlorine contact time and has interior baffles, the ability to assess the coatings within all of the tank was hindered and therefore issues could exist which are not included within this report. (See Figure 1).

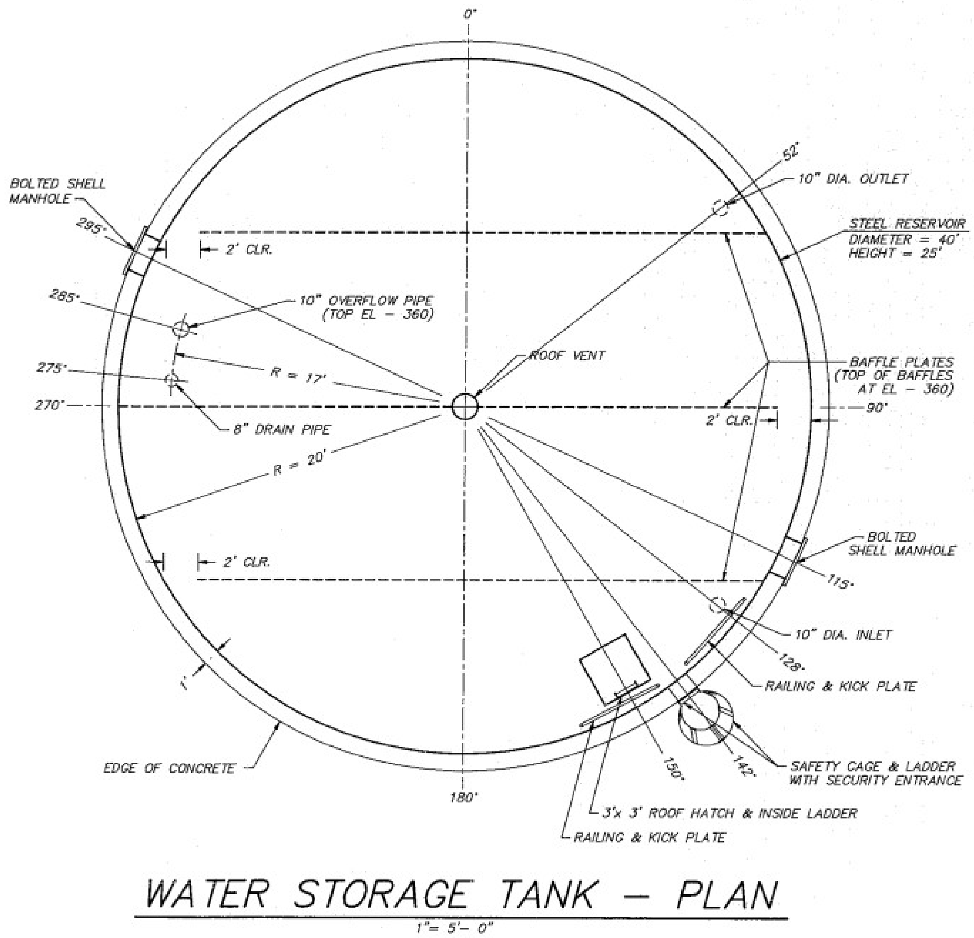


FIGURE 1: CCB Tank Plan

Overall, the interior coating system appeared to be in moderate condition. Beneath the waterline, the coatings appeared to be in good condition. Given the age of the tank, this is most likely due to the cathodic protection system that was observed on the roof of the tank. There was significant rust staining within the interior of the tank mostly from within the lap joints of the roof plates or on edges of angle supports, rafters, and plates (Photos 29-35). The lap joints are where the roof plates overlap each other and the painters can no longer prepare or paint the area within the lap so the area within corrodes and streaks out onto the coated steel. Corrosion within the lap joints can only be prevented by seal welding which is discussed later in this report. Corrosion on the edges of plates and angles can be significantly reduced during recoating by stripe coating these areas. Stripe coating is the application of an additional coat of paint in these areas to build thickness and to prevent the coatings from pulling away from the sharp edges. The corrosion in the overhead area is not designed to be protected by the cathodic protection system.

It was very difficult to see but something which most likely was paint, was peeling from the roof about 10 feet west of the hatch (Photo 35). The observable walls and center portions of the roof plates of the tank typically corresponded to an SSPC-VIS 2 Rust Grade 9- or 10-G representing less than 0.03 percent of the surface rusted. However, the edges of the roof plates, angle supports, and rafters typically corresponded to an SSPC-VIS 2 Rust Grade 4- to 5-G representing approximately 3 to 5 percent rusting.

A coating sample was taken of the interior coating system for Total Metals testing. The results of that test are included at the end of this report. The test results that there is a small amount of lead present in the interior coatings as well as other metals. It is not anticipated that the amount of metals present will require handling measures that will impact project costs. However, the contractors should be made aware of the test results so that they can handle the removal and disposal of the waste materials appropriately.

EXTERIOR COATING SYSTEM

The exterior coating system is likely the original coating system and may consist of a variety of different styles of coatings as that era was a transition period in coating systems. Overall, the coating system has protected the tank well for 26 years in a very damp environment. There are multiple places around the exterior of the tank where coatings have been patched however these are failing underneath the patch as evidenced by the rust staining coming from them (Photo 9). There was a patch of mildew remaining on the side shell on the west side of the tank that hadn't been cleaned the last time that the tank was cleaned (Photo 3). The side shell appears to be in moderate condition with chalking and loss of gloss evident in the coating system. Overall, the exterior side shell appears to be an SSPC-VIS 2 Rust Grade 7-S.

The coatings on the roof of the tank appear to be in moderate condition. The roof had a layer of algae on it which made it very slippery (Photos 21 and 25). While most of the coatings are intact, the top coat could be seen delaminating from the intermediate coat in some areas (Photos 27 and 28). The roof is also suffering from corrosion in areas around the roof hatch and vent. Overall, the roof area around the ladder appears to be an SSPC-VIS 2 Rust Grade 3-S while the rest of the roof is a 10-S.

A coating sample was taken of the exterior coating system for Total Metals testing. The results of that test are included at the end of this report. The test results indicate that there is a negligible amount of barium present in the exterior coating system but no other metal of concern was detected.

COATING ADHESION TESTING

There are two options for recoating a tank. Either all of the coatings can be removed to bare steel and a new coating system applied or the existing coatings can be top coated where they are cleaned and a new system applied over the old system. Not removing the existing system lowers project cost by eliminating the containment that must be constructed if the existing coatings are blasted off. From experience, the cost to blast clean a structure versus pressure wash and hand clean every rusted spot are about equal. It must be understood that applying a new system over an existing system, or top coating, does carry risk to the owner. Any issue that occurs with the existing coating system after top coating will not be warranted by the Contractor as that is an existing condition outside of his control. The issues can be delamination from stresses that are imparted to the existing system by the new system or sometimes from the solvents used in the new system which can attack the old coating system causing failures. There are two ways to help lessen these risks, but some risk does remain. The first way is adhesion testing and the second is to paint a 10 foot by 10 foot patch of the new coating system on the existing system and give it approximately six months to field test the effects.

Adhesion testing is utilized to determine how tight the existing coating system is held to itself and to the structure. The purpose of the testing is to determine whether the existing coating system can withstand the weight of the new coatings as well as the stresses that will be imparted as the new coatings dry. The test is conducted by utilizing an epoxy adhesive to glue an aluminum dolly to the coating. Once the epoxy is cured, either a manual or automatic adhesion tester is attached to the dolly and pressure is applied until the dolly is pulled from the surface or 3,500 psi is reached. If the coatings fail, they will fail in some combination of cohesive failure which is within the same layer of paint, or adhesive failure which is failure between layers of paint or between the paint and the substrate. The glue can also fail adhesively or cohesively but in either event it is noted as a percentage of glue failure. For this test, a Defelsko PosiTest AT-A Automatic S/N 17275 was utilized which has a hydraulic pump that automatically applies a smooth and continuous pull-off pressure which will provide the best result.

Six dollies were set on the tank and their location is shown in Figure 1 above and the pdf results are attached at the end of this report. The results are provided in Table 1: Adhesion Test Results below. The test layers are:

TABLE 1: Adhesion Test Results

A = Substrate; B= Primer coat; C= Intermediate coat; D= Top Coat; Y= Adhesive; Z= Dolly

Dolly	Max: 3,500	Failure %			Location
No.	PSI	Adhesion %	Cohesive %	Glue %	Of Failure
1	1,215		20		D
				80	Y
2	1,089		15		D
				85	Y
3	1,496			100	Y
4	1,622		5		D
				95	Y
5 (Roof)	2,298		50		D
				50	Y
6 (Roof)	1,273		95		C
			5		D

Overall the results were very good. Typically, results over 1,000 psi are acceptable and over 1,400 psi are preferred. It should be noted that these are values that Evergreen Coating Engineers recommends and industry values, depending upon the source, can be as low as 600-700 psi. We believe that the risk that the Owner carries in opting to top coat versus the savings involved should meet a higher standard than the industry minimums.

While the adhesion results are good, one concerning issue is the delamination of the top coat from the intermediate coat on the roof (Photos 27 and 28). From the dolly pull, it may be delaminating cohesively from within itself. It could also be due standing water or to biological attack from what appear to be lichens (Photo 26) that are growing on the roof. Mildew, lichens, and moss grow roots into the coatings which can physically break the coatings apart.

SITE AND ACCESS

The tank site is adjacent to a heavily used parking space that provides resident access to recreation areas and is open to access by the public The site is heavily treed and is very damp but is on a hillside and appears to be well drained. The height of the ring wall of the tank varies in relation to the ground elevation. In some places it is at or below grade and others it sits above grade. On the northeast side of the tank at the sample lines, the ringwall appears to be above the ground (Photo 8). The sill grout is in good condition. The tank is anchored to the ringwall by 13 anchor chairs. Two 36-inch manways are located on the north and south sides of the tank. A fence has been built very close to the tank in order to fence off what is assumed to be a fuel tank for the plant generator.

The roof of the tank is accessed via a ladder system that starts 8 feet from the ground and has a ladder cage and Saf-T-Climb for fall protection. The Saf-T-Climb rail has been painted which may interfere with operation of the device (Photo 22). The ladder cage has a cage guard that swings down vertically. These can be problematic as they can swing down quickly when a lock is removed and hit a worker utilizing a ladder to access the guard. These can be replaced with a horizontal swinging guard. A run of three 1-inch conduit run up the right side of the ladder cage.

Once on the roof, the immediate area is protected by railings. Within this area is the rooftop access hatch. A cable is attached to an anchor point near the roof vent that a worker can attach to a D Ring on his climbing harness. It should also be noted that the #24 mesh screen that protects the vent from insects appears to have a significant amount of corrosion on it from the interior and should be cleaned. While this wouldn't harm the tank in a vacuum situation, in a pressure situation where the pumps fail to shut off, the vent could be significantly blocked. A cathodic protection junction box is also on the roof of the tank.

ANALYSIS

Interior

The interior and exterior coating systems need to be addressed within the next five years depending upon the District's tolerance for steel loss to corrosion on the interior of the tank. One issue is that the majority of coatings in the interior of the tank could not be observed during this assessment so the condition of those areas at this time is unknown. In 2017, the District contracted with H2O Solutions to provide an in-situ inspection of the tank and the degree of corrosion. Additional information on the conditions of the interior components is available in that report.

It is highly recommended that the tank be seal welded as this will prevent a lot of corrosion in the future. If the corrosion damage goes too far, edges of plates and rafters which are typically welded in the seal welding process could get too thin to weld and require additional work or materials to weld. Seal welding is discussed later in this report. The full interior coating system should be removed and replaced. One issue that will likely increase costs on the interior of the tank are the baffles. While these are extra steel to coat, they will likely hinder the work being performed. The two foot gaps between the baffles and the shell wall should be enough room to move most workers and materials around but they will slow the work. A door sheet could be cut into the side of the tank to help improve the ability to complete the recoating or other work inside of the tank. A door sheet is an opening that the contractor cuts into the side of the tank and then welds it back into place once the job is complete. Often the option to cut a door sheet is left up to the contractor to determine which they believe is more cost efficient versus working through the manways. The baffles are also at the same height as the overflow pipe which could allow water to short circuit the baffles once it gets high enough to enter the overflow.

Although the interior ladder that was present during this assessment was found to be in good condition above the water surface, the District removed the ladder and associated safety cage on August 31, 2020. The ladder showed significant signs of corrosion below the water surface and was thought to be taxing the existing passive cathodic anodes that serve to inhibit/slow the rate of corrosion of the tank. The ladder and safety cage was removed by H2O Solutions and additional information on this work is provided in their report. It should be noted that while this action helps improve protection from corrosion, it does leave the District without stable and convenient access to the tank interior.

The interior can only be observed from the one access hatch and as noted above, provides only a limited view of the interior of the tank. The addition of another access hatch on the opposite side of the tank would make inspecting the interior much easier. This could be added for minimal cost as a ladder would not be necessary to include with the hatch.

Exterior

The exterior of the tank is largely protected by the existing coating system but it is beginning to fail. The coating repair patches on the side of the tank are corroding underneath the patches as evidenced by the rust staining leaking from them. The coatings showed strong adhesion as demonstrated in the adhesion tests, however there are some issues with the coatings as they are delaminating in places on the roof. The rooftop areas could likely be pressure washed and prepared via hand tools to remove the loose coatings but some risk could remain that there is a problem that will continue to spread after topcoating if that option was selected. One other problem that was noted while onsite is the moisture in that area. The inspection was conducted in late August which is typically the driest time of the year and the tank was still very wet at noon. This type of moisture would require the use of containment and dehumidification equipment in order to paint the tank and cure the coatings properly. If containment is used, there is no point in top coating the existing system as the costs at that point to remove and replace the coating system would be approximately the same as top coating. The heavy algal growth on the roof and on the sides of the tank show that this moisture is an ongoing issue.

The roof also has some significantly corroded areas in and around the access hatch area and roof vent. The vent is an older styled vent and is showing significant corrosion on the exterior. The interior of the vent is likely much more corroded than the exterior due to the steam that will leave the vent during the summertime. At a minimum the vent should be removed so that the riser can be inspected but should probably be replaced with a vent utilizing pressure and vacuum relief pallets.

Fall Protection

Although an evaluation of fall protection on this reservoir was not part of the scope of work, there is one option that the District may want to consider. Fall protection from the tank roof appears to be provided via an existing structural tie-off anchor. Another option would be for the District to add a circumferential guard rail around the perimeter of the tank and enclose the entire top of the tank for approximately $11,000. This eliminates the need for the static and safety lines and allow multiple personnel on the rooftop at any given time.

Although the District does have a structural tie-off point attached to the tank roof (Photo 18), utilization of this anchor will result in workers' safety cables dragging across the roof surface which will damage the coating system over time. Another option is to install an elevated anchor point approximately 12-inches above the surface of the roof. This style of anchor minimizes contact between the roof surface and the safety lines, thus reducing dragging, scratching, and damage to the coating system.

Security

No evidence of vandalism or security issues were noted onsite. If security is a concern, the interior of this tank could be accessed very easily. Although the ladder is approximately eight feet off of the ground, the ladder guard would likely be ineffective in deterring an intruder. The outside of the cage could be ascended to the roof of the tank (Photo 7). Once on the rooftop, the camera is in an obvious and easily accessible area and could be bagged or dismantled (Photo 16), the padlock on the access hatch is easily accessible to be cut and removed (Photo 23), and the handhole covers could be removed to insert a contaminant into the tank (Photo 17).

While a determined intruder is very difficult to stop, there are multiple ways to improve the security of the tank. A ladder cage is not required since the tank has a Saf-T-Climb fall protection device so that could be eliminated and replaced with an eight foot high full ladder guard set four feet off of the ground to give a protected height of twelve feet. Intrusion switches could be added to the access hatch and included in the SCADA system which likely exists at the treatment plant. This way even if the camera is disabled, District personnel would know if the tank had been breached. The handholes should have the phillips head screws removed and should utilize a security bolt. The padlock could be protected by the addition of a small piece of plate steel over the top of the padlock to prevent accessing it with bolt cutters or a reciprocating saw. Finally, the District could consider the installation of a seismic valve. While these valves are typically used to protect the contents of the tank from being lost after a seismic event, they can also be utilized to isolate the tank until District personnel can verify what has occurred in the event that an intruder sets off an alarm.

Rehabilitation Schedule

In discussions with staff while onsite, it was confirmed that this tank is critical to the operation of the treatment plant and for providing chlorine CT for the system. This tank will be out of service for a minimum of 4-6 weeks in order to recoat the interior and place back into service if the contractor used plural component coatings with a 48 hour cure time. The exterior of the tank will need to be contained in order to paint it. Although precautions would need to be taken, the exterior could be painted with the tank full of water and in operation.

There are two ways to proceed with taking the tank out of service. First, a temporary water tank could be purchased and utilized while the tank is down. Given that this tank provides CT storage, the temporary tank would likely need to include baffles. The chlorine dose could be increased but that could result in complaints and not likely reduce the size of the tank considerably. The second option is to build a new tank. The new tank could range significantly in cost from a Mt. Baker Silo style tank to another welded steel tank. The addition of a second tank would allow for more operational flexibility in the future.

One final issue that was noted is that the bottom of ring wall foundation is exposed next to the sample lines. The District should continue to monitor this area and take action if additional exposure, erosion, or undercutting is observed.

Seal Welding

If the tank is not seal welded, much of the staining that is visible within the roof of the tank will reappear within a couple of years of the interior recoating. This staining is due to ongoing corrosion occurring between the overlaps of the roof plates and the space between the roof plates and rafters. These areas are usually very tight and cannot be cleaned and painted. Eventually the roof plates and rafters will suffer significant corrosion, although the amount of time this takes varies greatly from tank to tank. The only way to prevent this ongoing corrosion is by seal welding the interior of the tank to eliminate these gaps.

As can be seen in Photo 36 from another reservoir, the flange on a rafter can be severely corroded. Photo 38 shows the seal welded tank that the rafter in Photo 37 was taken from. You can see that the corrosion in the ¼-inch thick roof plate above that rafter was significant with degradation of up to a third of the thickness of that plate having occurred. With the seal welding complete, you can see the rafter to roof plate gap has been welded shut. Photo 38 shows the roof plate lap welded shut. The coatings can now be applied as a complete film across those areas and the amount of corrosion that the tank will undergo from this point forward has been significantly reduced, thereby extending the lifespan of the tank. Seal welding the tank during the next recoating project will extend the service life of the structure and will also extend the maximum life that can be obtained from a coating system. The corrosion seen on the edges of the roof plates and the vast majority of the staining seen in the roof of the tank are all issues that are eliminated by seal welding and stripe coating and all things being equal, will typically extend the life of a recoating project by five or more years. The cost to seal weld the interior of Tank 1 is approximately $75,000.

RECOMMENDATIONS

Both the interior and exterior coatings should be removed and replaced. If the work is done after January of 2023, the interior coating system will most likely be a plural component epoxy coating as NSF 61/600 regulations are changing and eliminating most of the coatings that are NSF 61 compliant today. We still recommend the application of a zinc primer to hold the blast before application of a plural component epoxy. This will allow the tank to be fully blasted and cleaned prior to the application of the epoxy and result in a much cleaner and better end product.

On the exterior, we recommend removing and replacing the existing coating system with a zinc primer, polyurethane intermediate coat, and a fluoropolymer top coat. The fluoropolymers are a newer type of coating but have been in widespread use for the last 15 years nationwide. This tank is readily visible by the public and the fluoropolymer coatings will look better at 15 years than a traditional polyurethane coating will look in 4-5 years. The fluoropolymers are also proving that they will last 20+ years and they may last up to 30 years. The fluoropolymer system on this tank would be about $8,500 more than the typical polyurethane system. We also recommend including the containment system so that the environmental conditions can be controlled.

We highly recommend seal welding as it will extend the lifespan of the tank as well as each coating system applied to the tank for the rest of its service life.

We recommend replacing the roof vent, adding an additional access hatch, and installing a padlock guard on the existing hatch. The remaining items mentioned throughout the report would provide additional benefit and could be installed if desired by the District.

COSTS

The Estimated Total Construction Cost for this project is $519,000. This value includes the cost to:

- Remove the existing interior and exterior coatings and recoat the interior and exterior;
- Seal weld the interior:
- Replace the roof vent;
- Add the access hatch and security plate over the existing padlock;

The following are options that should be considered but are not specifically included:

- Circumferential railing could be added for approximately $11,000.
- The exterior ladder guard could be added for approximately $7,500.

Photo 1: East side of tank.

Photo 2: North side of tank with Dolly #4 in the photo.

Photo 3: North side of the tank.

Photo 4: South side of tank with vertical swinging ladder guard.

Photo 5: Overflow with air gap.

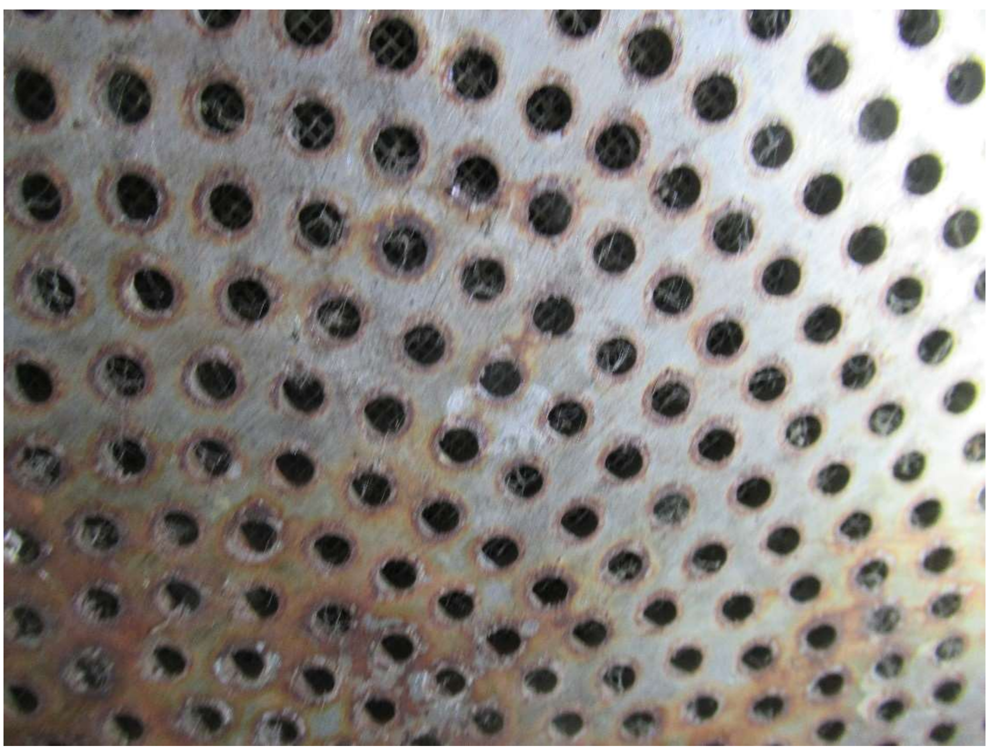


Photo 6: #24 mesh screen protecting the overflow pipe.

Photo 7: Southeast side of the tank with level gauge.

Photo 8: Exposed ring wall on east side by sample lines.

Photo 9: Rust stains from underneath coating patches.

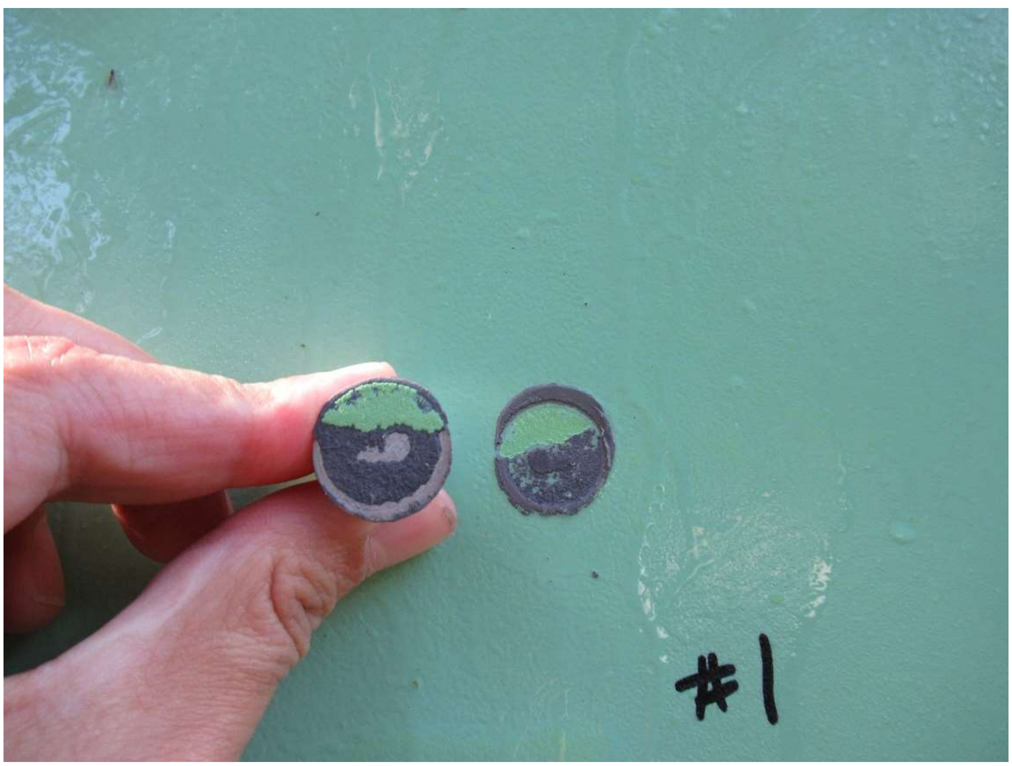


Photo 10: Dolly #1 on the side shell.

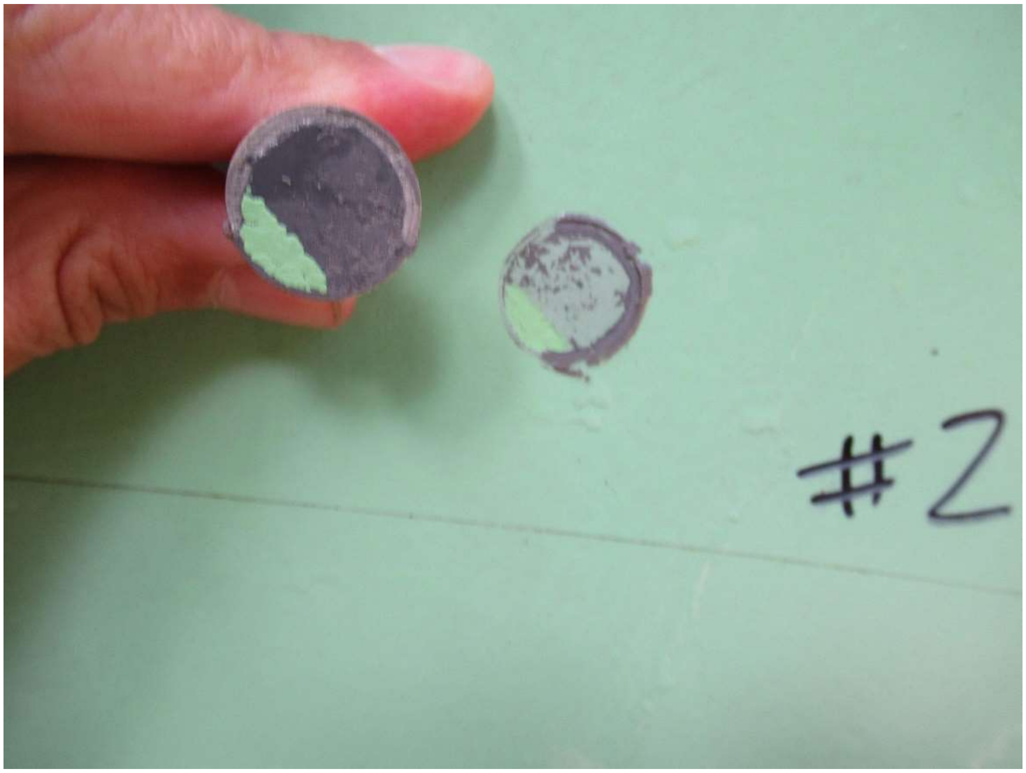


Photo 11: Dolly #2 on the side shell.

Photo 12: Dolly #3 on the side shell.

Photo 13: Dolly #4 on the side shell.

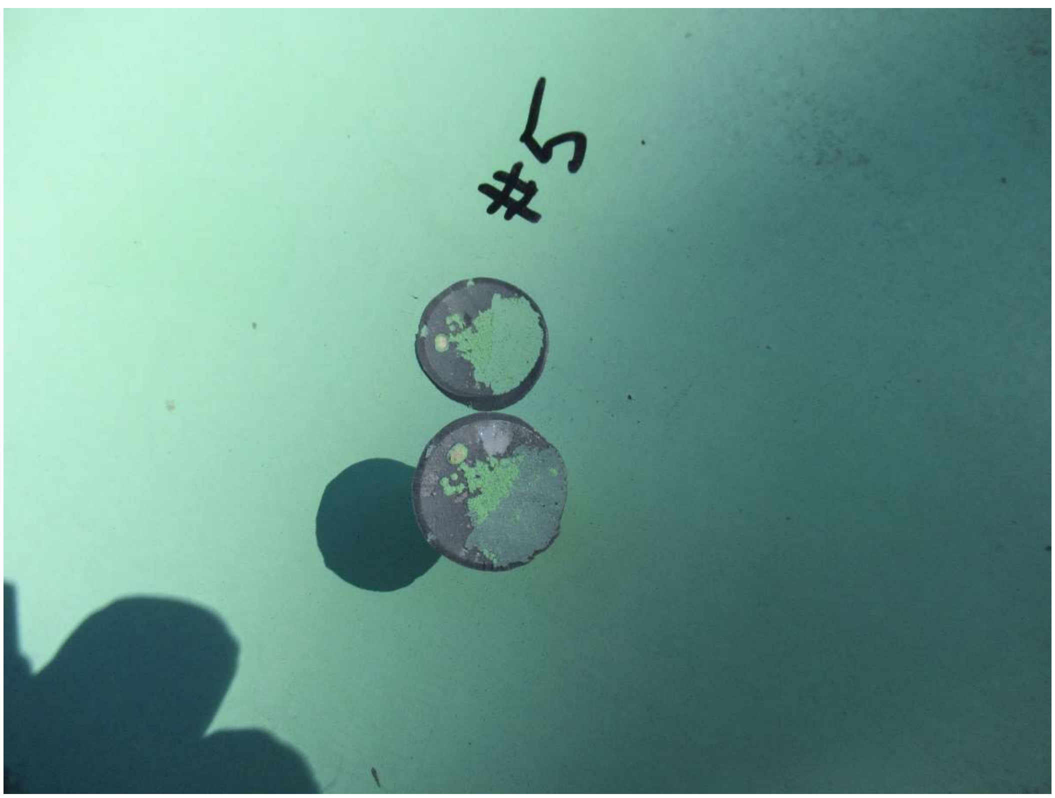


Photo 14: Dolly #5 on the roof.

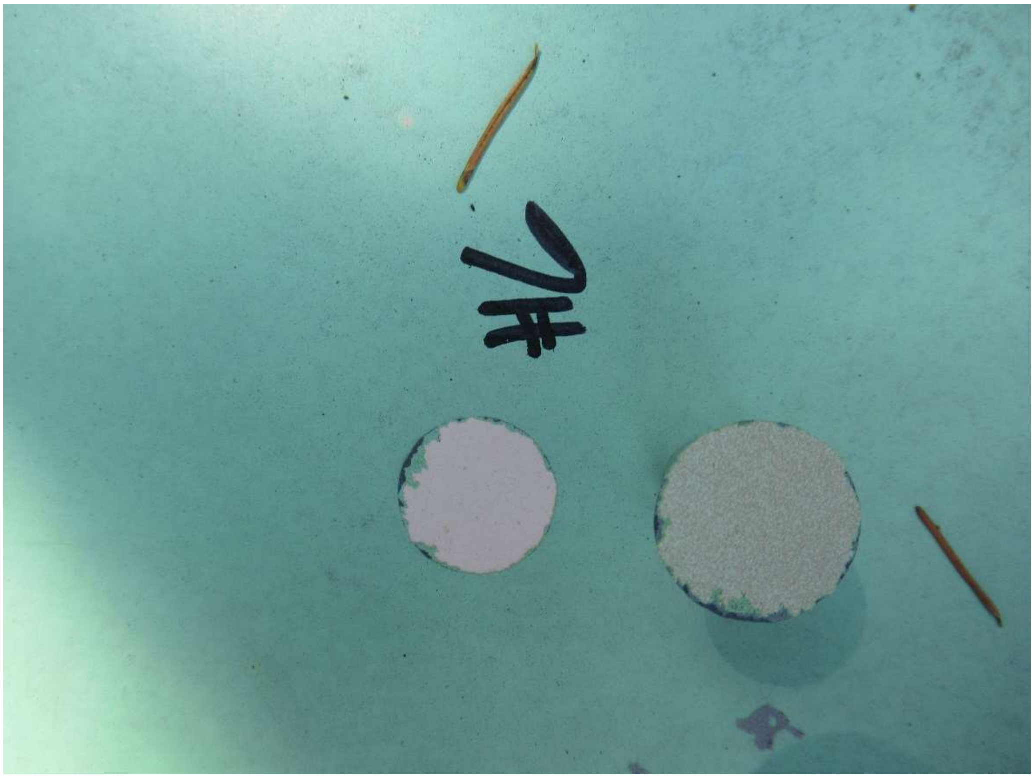


Photo 15: Dolly #6 on the roof.

Photo 16: Ladder, railings, camera, and access hatch.

Photo 17: Level gauge.

Photo 18: Anchorage, roof vent, and cathodic protection box.

Photo 19: Roof vent with rust on the interior of screen.

Photo 20: Cathodic protection box.

Photo 21: Looking north. Note the algae in the right side of the photo.

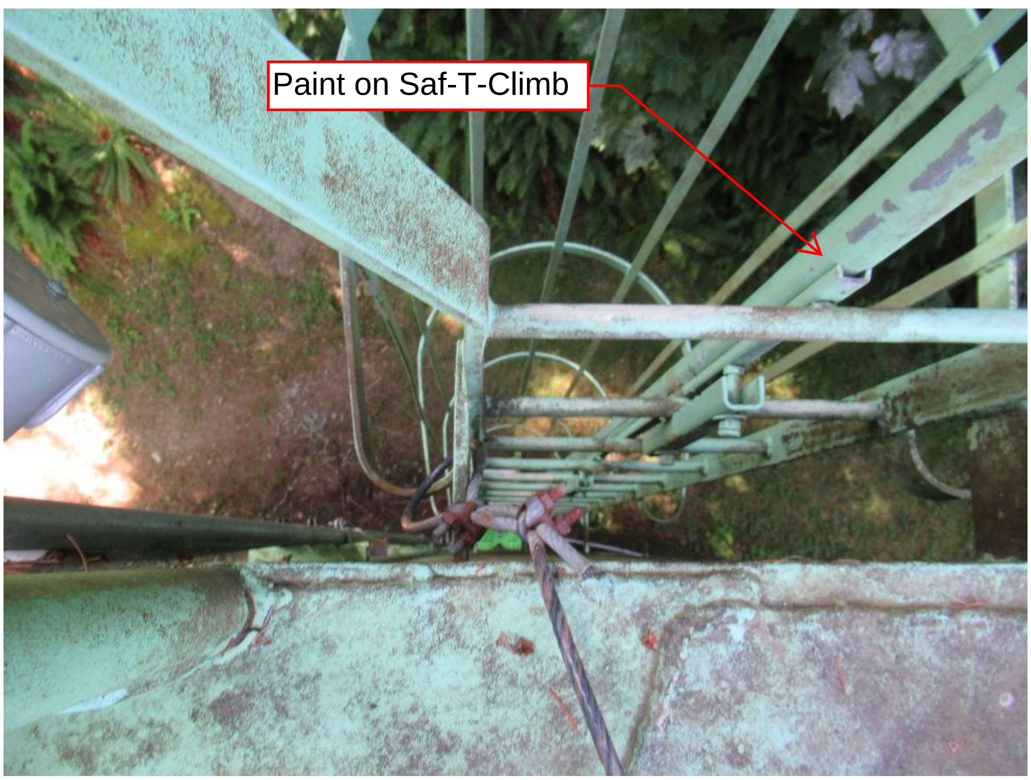


Photo 22: Safety line tied to ladder standoff. Note the Saf-T-Climb is painted.

Photo 23: Access hatch lock.

Photo 24: Corrosion adjacent to the access hatch.

Photo 25: Closeup of the algae on the roof.

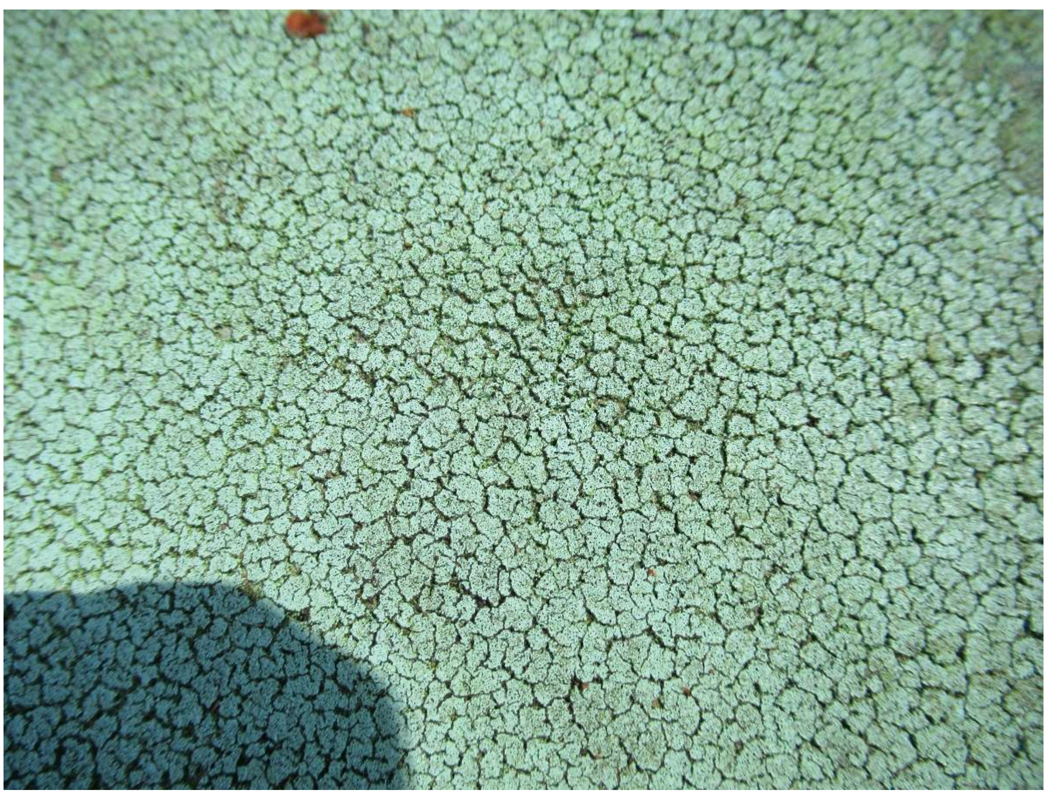


Photo 26: Most likely lichens growing on the roof.

Photo 27: Coating delamination on the roof.

Photo 28: Coating delamination on the roof.

Photo 29: Inside of the access hatch.

Photo 30: Inlet pipe diffuser.

Photo 31: Interior baffle walls.

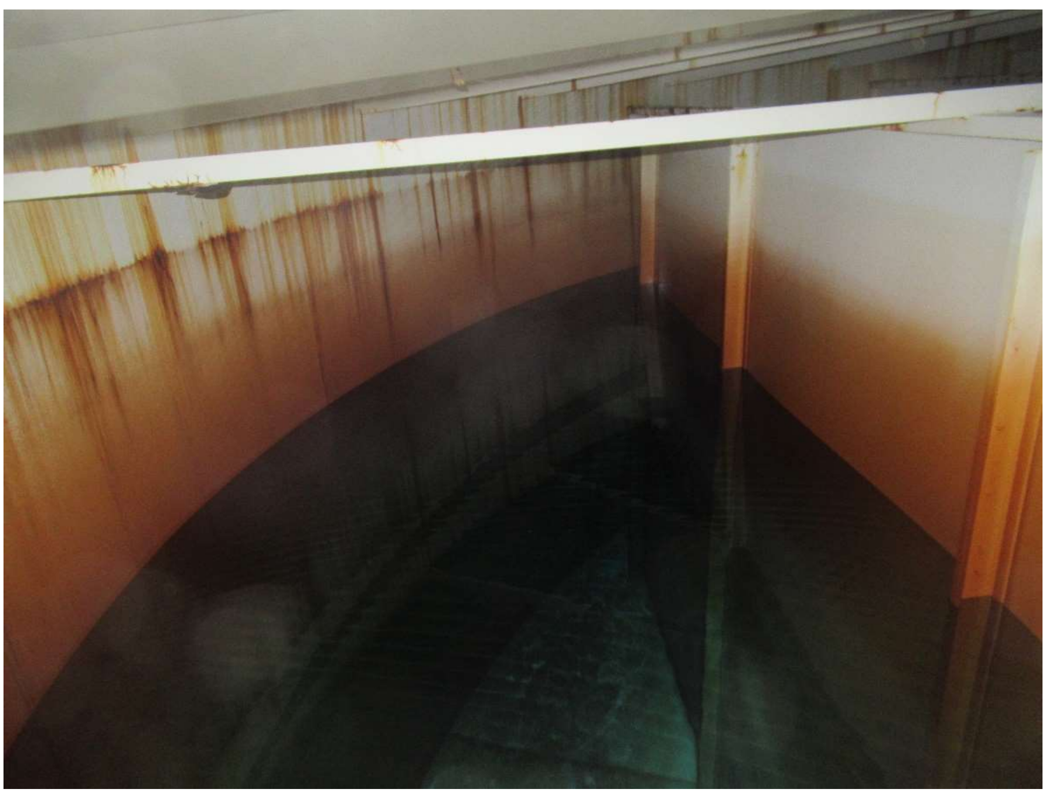


Photo 32: Interior condition.

Photo 33: Interior condition.

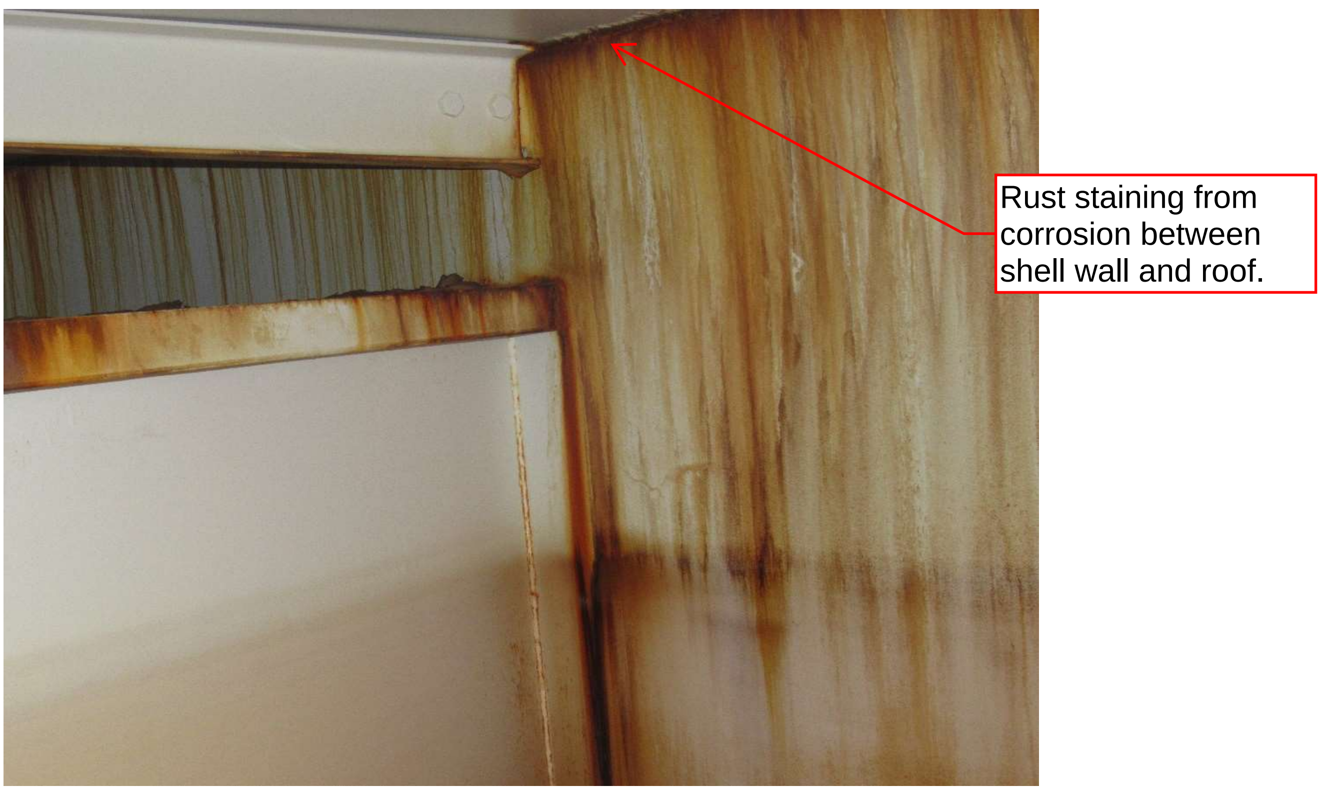


Photo 34: Interior condition.

Photo 35: Interior condition. Note delamination in roof.

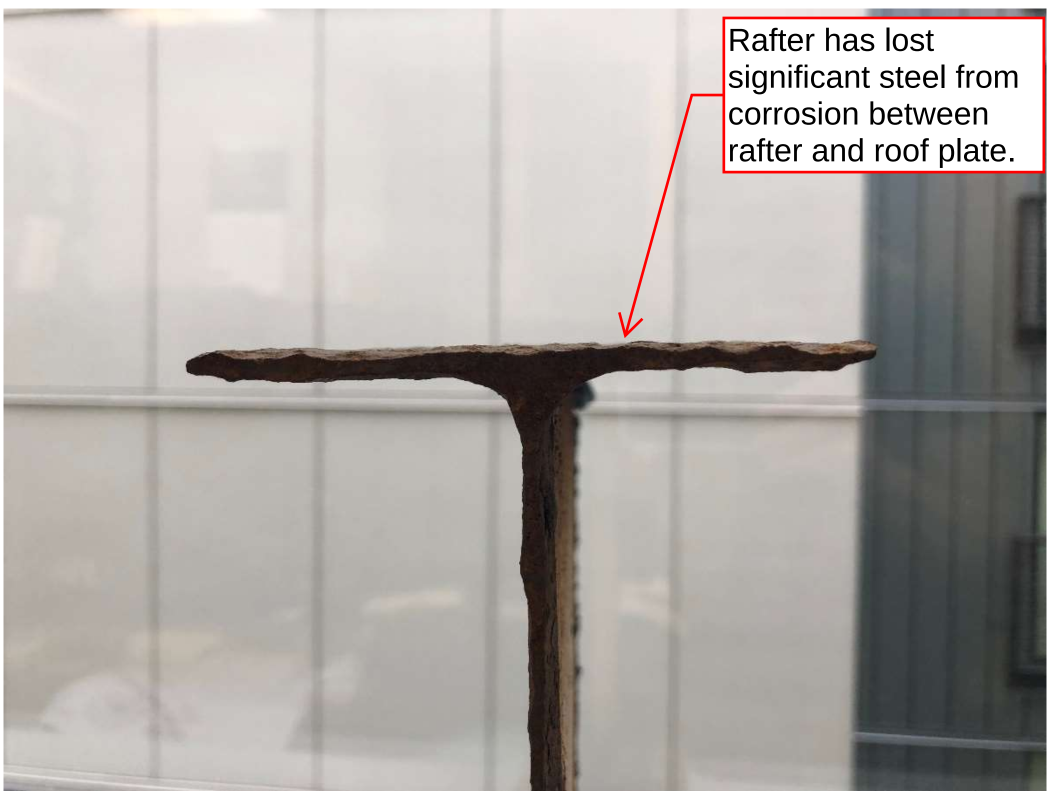


Photo 36: Corroded Rafter

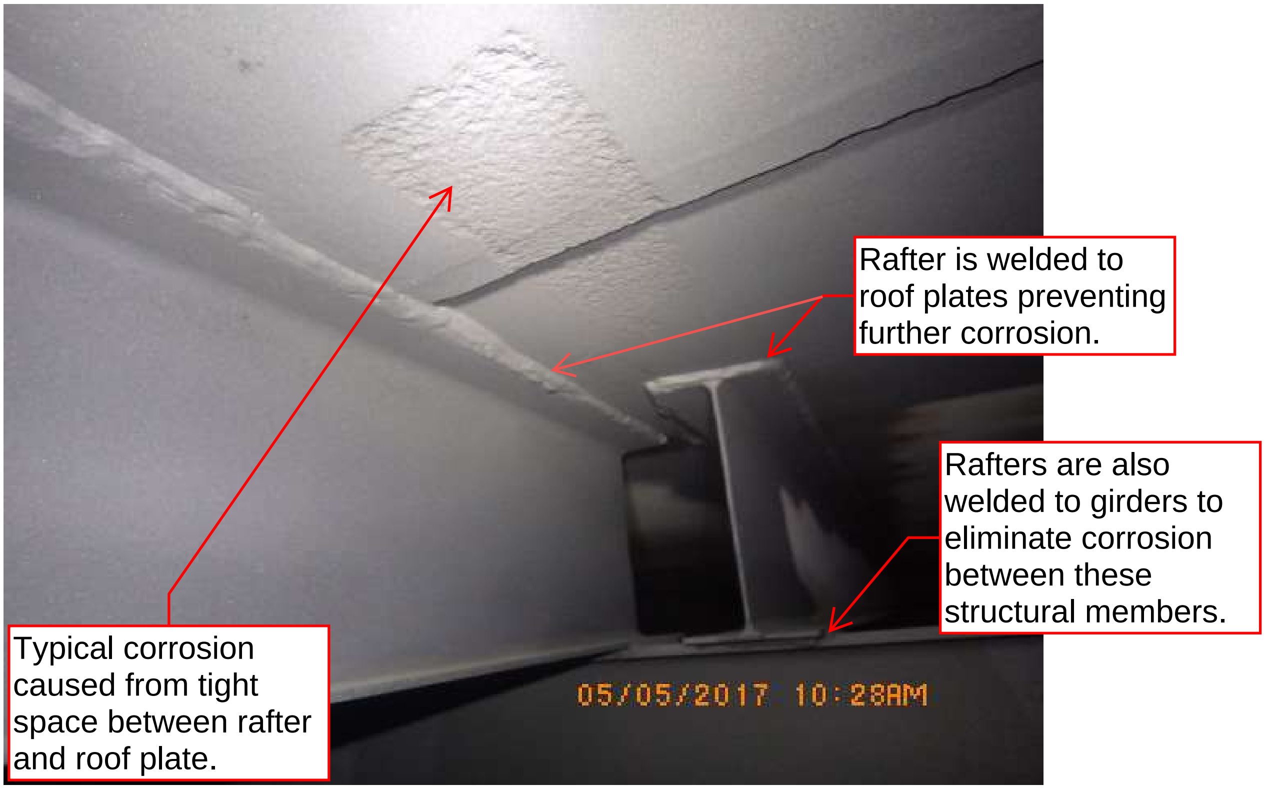


Photo 37: Seal welded rafter cut back from original location.

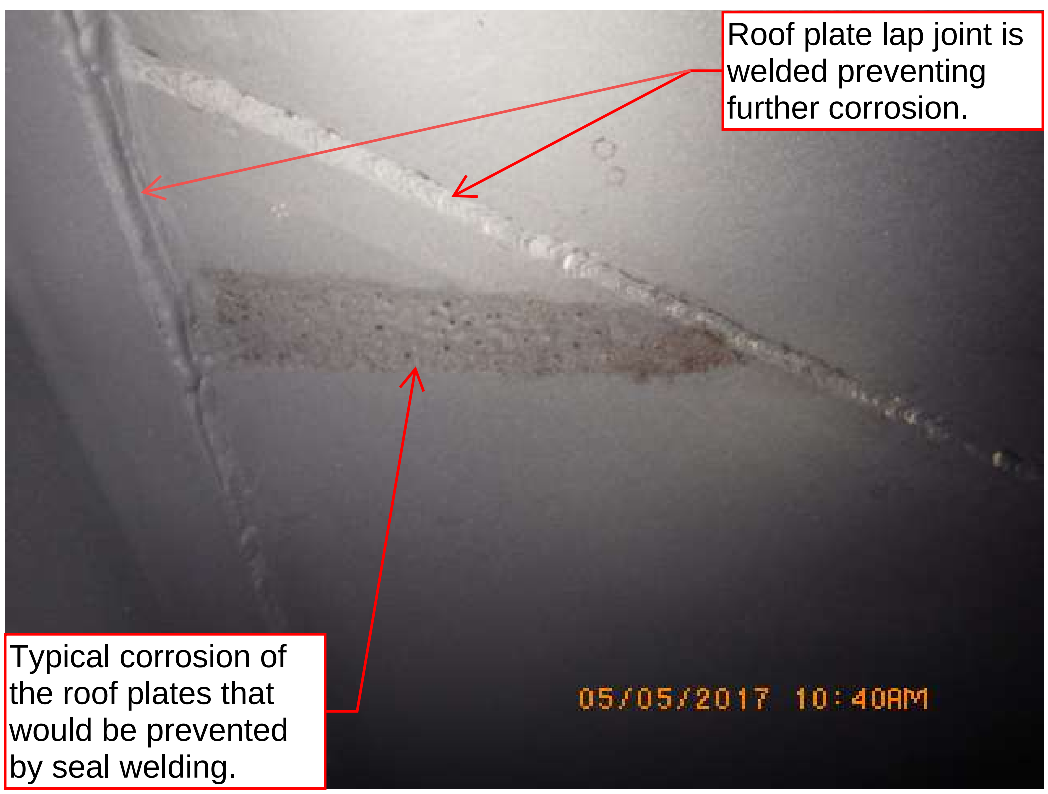


Photo 38: Seal welded roof lap joints. Note the corrosion from the previous rafter location.

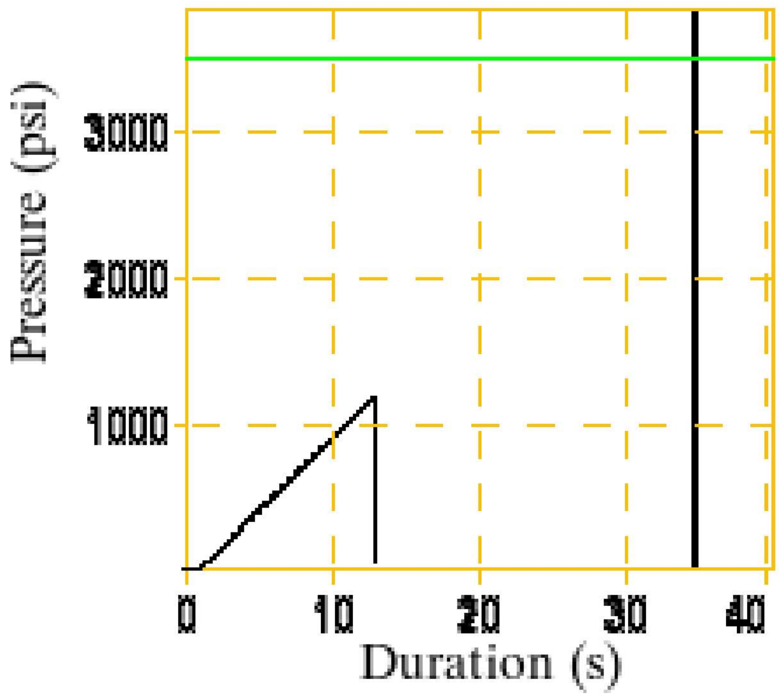
B7

Created: 2020-08-19 12:56:36
PosiTest AT-A S/N: 17275

Readings

#	Pressure Limit (psi)	Duration Hold Time (s)	Dolly Size (mm)	Rate (psi/s)	Result	Pass/Fail Time
1	1214 3500	12.9 0.0/0.0	20	100	Pulled	X 2020-08-19 12:57:28

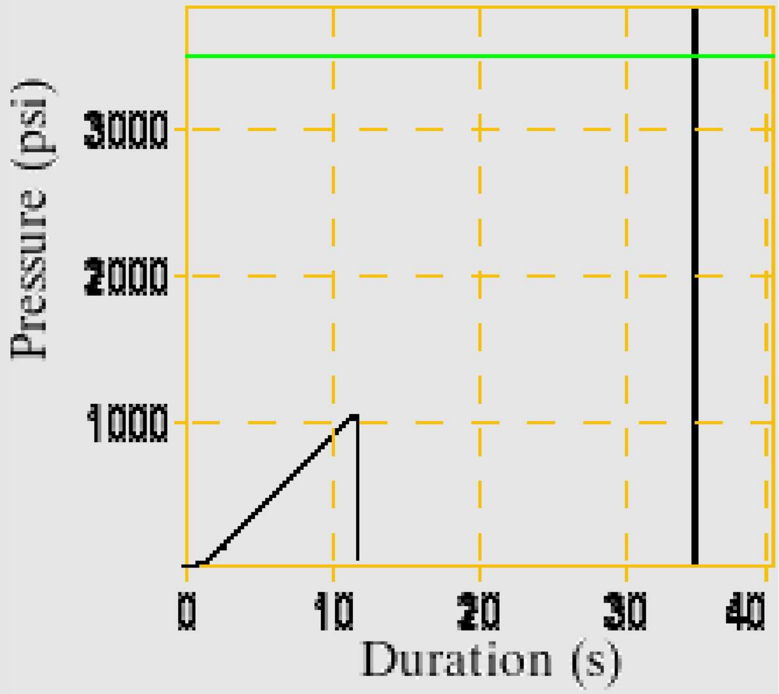
Glue Y:	0	Y/Z Interface:	0
Layer 1: B	0	B/Y Interface:	0
Substrate: A	0	A/B Interface:	0



B7 Readings

#	Pressure Limit (psi)	Duration Hold Time (s)	Dolly Size (mm)	Rate (psi/s)	Result	Pass/Fail Time
2	1089 3500	11.8 0.0/0.0	20	100	Pulled	X 12:59:25

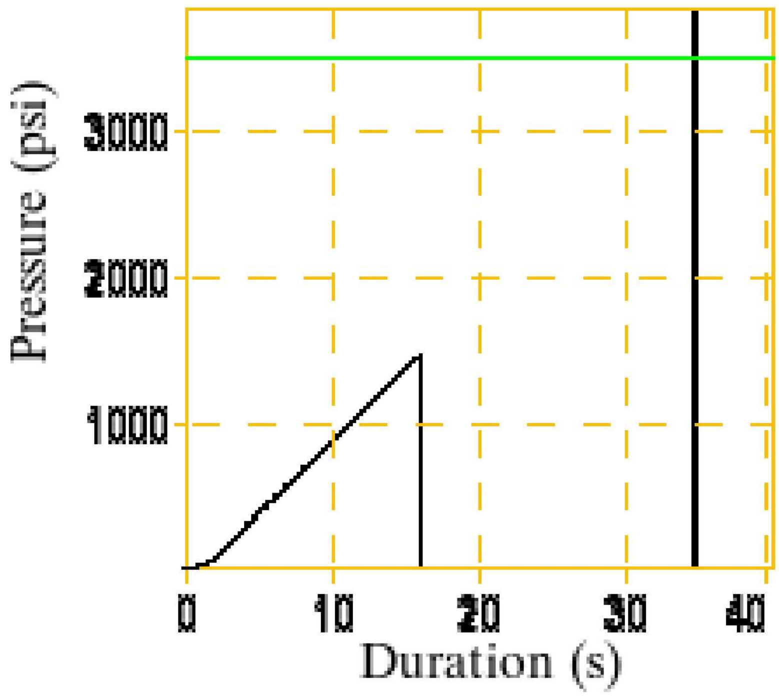
Glue Y:	0	Y/Z Interface:	0
Layer 1: B	0	B/Y Interface:	0
Substrate: A	0	A/B Interface:	0



B7 Readings

#	Pressure Limit (psi)	Duration Hold Time (s)	Dolly Size (mm)	Rate (psi/s)	Result	Pass/Fail Time
3	1496 3500	16.1 0.0/0.0	20	100	Pulled	X 13:01:21

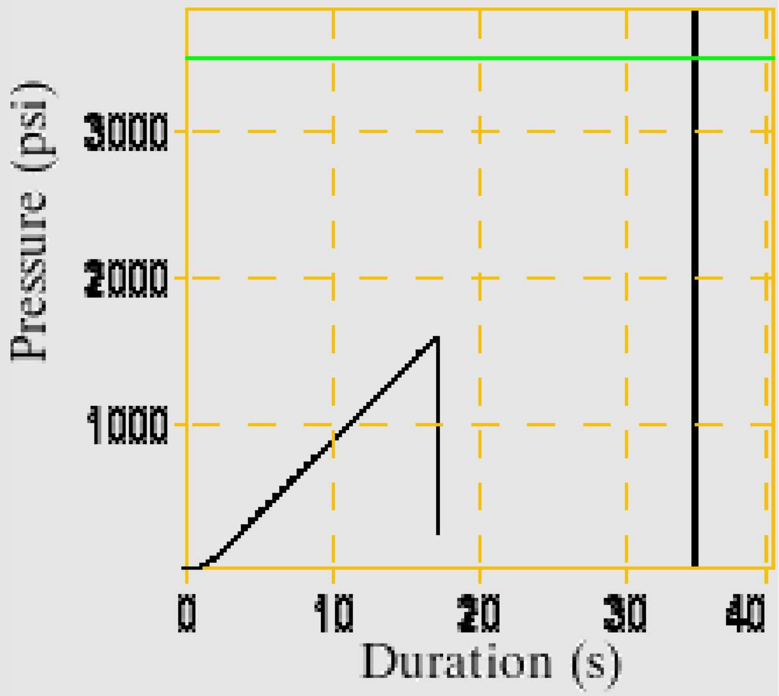
Glue Y:	0	Y/Z Interface:	0
Layer 1: B	0	B/Y Interface:	0
Substrate: A	0	A/B Interface:	0



B7 Readings

#	Pressure Limit (psi)	Duration Hold Time (s)	Dolly Size (mm)	Rate (psi/s)	Result	Pass/Fail Time
4	1622 3500	17.2 0.0/0.0	20	100	Pulled	X 13:04:38

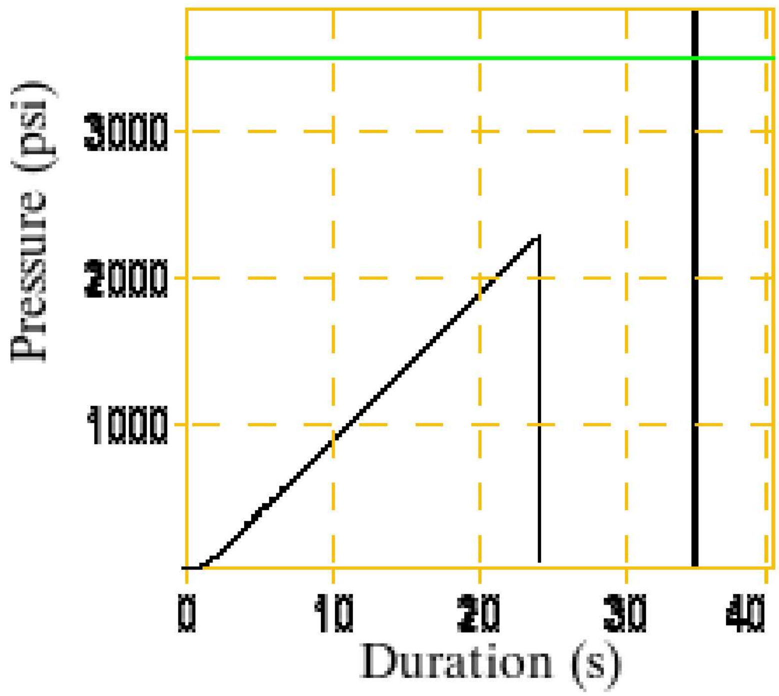
Glue Y:	0	Y/Z Interface:	0
Layer 1: B	0	B/Y Interface:	0
Substrate: A	0	A/B Interface:	0



B7 Readings

#	Pressure Limit (psi)	Duration Hold Time (s)	Dolly Size (mm)	Rate (psi/s)	Result	Pass/Fail Time
5	2298 3500	24.0 0.0/0.0	20	100	Pulled	X 13:29:03

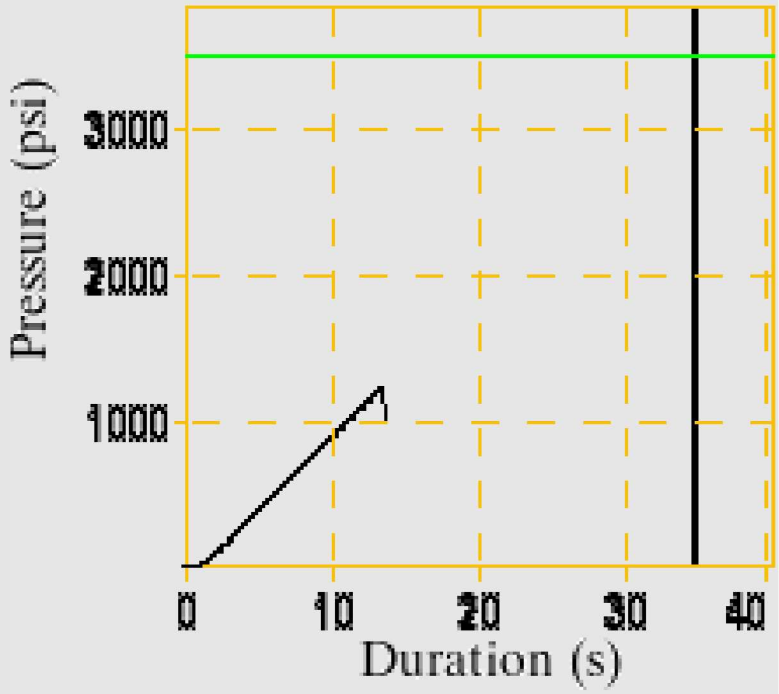
Glue Y:	0	Y/Z Interface:	0
Layer 1: B	0	B/Y Interface:	0
Substrate: A	0	A/B Interface:	0

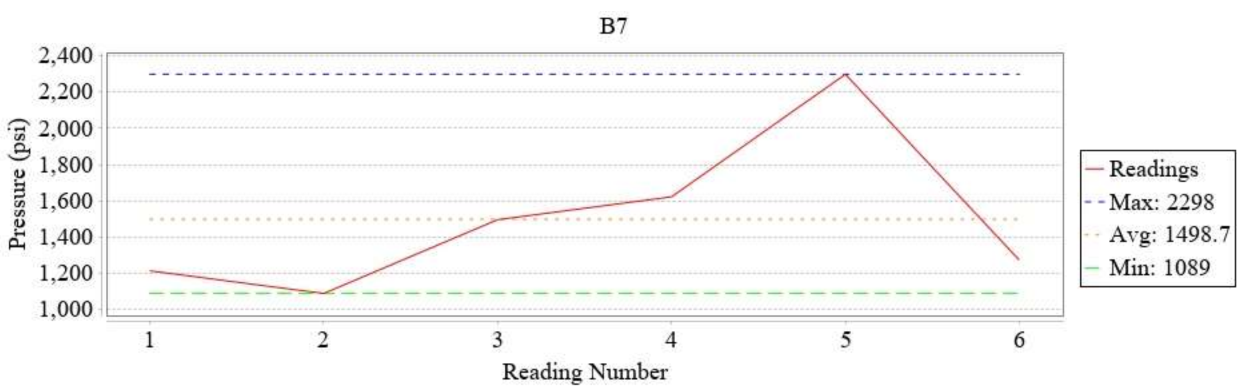


B7 Readings

#	Pressure Limit (psi)	Duration Hold Time (s)	Dolly Size (mm)	Rate (psi/s)	Result	Pass/Fail Time
6	1273 3500	13.6 0.0/0.0	20	100	Pulled	X 13:36:11

Glue Y: 0 Y/Z Interface: 0
Layer 1: B 0 B/Y Interface: 0
Substrate: A 0 A/B Interface: 0





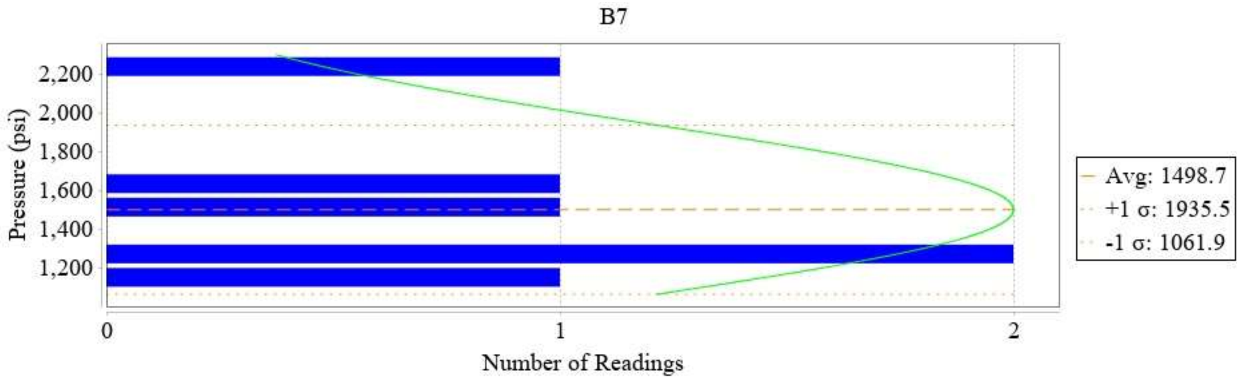

B7
Pressure (psi)
2,200
2,000
1,800
1,600
1,400
1,200
0
1
2
Number of Readings
Avg: 1498.7
+1 σ: 1935.5
-1 σ: 1061.9

EXHIBIT B

COATING SYSTEM SAMPLE ANALYSIS

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

Laboratory Job ID: 580-98505-1
Client Project/Site: Sudden Valley CCB Tank

For:
Evergreen Coating Engineers
6925 37th Ave SW
Seattle, Washington 98126

Attn: Lance Stevens

Authorized for release by:
11/5/2020 1:19:43 PM

Ashley Worthy, Project Manager I
(253)248-4965
Ashley.Worthy@Eurofinset.com

LINKS

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www.eurofinsus.com/Env

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

1 2 3 4 5 6 7 8 9 10 11

Job ID: 580-98505-1

Laboratory: Eurofins TestAmerica, Seattle

Narrative

Job Narrative
580-98505-1

Comments
No additional comments.

Receipt
The samples were received on 10/26/2020 12:45 PM; the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 17.8º C.

Receipt Exceptions

The Field Sampler was not listed on the Chain of Custody.

The Chain-of-Custody (COC) was incomplete as received and/or improperly completed. The COC was not relinquished by the client. The requested analyses are not in the customary place(so the box is not checked) but rather in the lower left of the COC in the 'special instructions' field.

The client did not submit enough sample volume to perform the tests (metals & mercury) requested. The manager of the metals department was consulted regarding the sample volumes. The project manager will need to inform the client that lab can only perform one of those analyses.

Metals
Method 3050B: The following sample did not contain sufficient amount for 3050B method analysis. Amount sample use is recorded in worksheet method and proceeded usual otherwise. CCB INT (580-98505-1) and CCB EXT (580-98505-2)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Client: Evergreen Coating Engineers
Project/Site: Sudden Valley CCB Tank

Job ID: 580-98505-1

Qualifiers

Metals

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Client Sample Results

Client: Evergreen Coating Engineers
Job ID: 580-98505-1
Project/Site: Sudden Valley CCB Tank

Client Sample ID: CCB INT
Lab Sample ID: 580-98505-1
Date Collected: 10/14/20 11:30
Matrix: Solid
Date Received: 10/26/20 12:45

Method: 6010D - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	79		28	2.3	mg/Kg		10/31/20 09:10	11/03/20 20:49	1
Barium	14000		4.6	0.73	mg/Kg		10/31/20 09:10	11/03/20 20:49	1
Cadmium	640		9.2	0.45	mg/Kg		10/31/20 09:10	11/03/20 20:49	1
Chromium	39	B	12	2.0	mg/Kg		10/31/20 09:10	11/04/20 19:53	1
Lead	270		14	2.0	mg/Kg		10/31/20 09:10	11/03/20 20:49	1
Selenium	9.5	J B	46	3.6	mg/Kg		10/31/20 09:10	11/03/20 20:49	1
Silver	62		23	5.1	mg/Kg		10/31/20 09:10	11/03/20 20:49	1

Client Sample Results

Client: Evergreen Coating Engineers
Project/Site: Sudden Valley CCB Tank

Job ID: 580-98505-1

Client Sample ID: CCB EXT
Date Collected: 10/14/20 11:30
Date Received: 10/26/20 12:45

Lab Sample ID: 580-98505-2
Matrix: Solid

Method: 6010D - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		38	3.1	mg/Kg		10/31/20 09:10	11/03/20 20:54	1
Barium	**16**		6.3	0.99	mg/Kg		10/31/20 09:10	11/03/20 20:54	1
Cadmium	ND		13	0.62	mg/Kg		10/31/20 09:10	11/03/20 20:54	1
Chromium	ND		16	2.7	mg/Kg		10/31/20 09:10	11/03/20 20:54	1
Lead	ND		19	2.8	mg/Kg		10/31/20 09:10	11/03/20 20:54	1
Selenium	ND		63	5.0	mg/Kg		10/31/20 09:10	11/03/20 20:54	1
Silver	ND		31	7.0	mg/Kg		10/31/20 09:10	11/03/20 20:54	1

Client: Evergreen Coating Engineers
Project/Site: Sudden Valley CCB Tank

Job ID: 580-98505-1

Method: 6010D - Metals (ICP)

Lab Sample ID: MB 580-342143/23-A
Matrix: Solid
Analysis Batch: 342376

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 342143

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		3.0	0.25	mg/Kg		10/31/20 09:10	11/03/20 18:39	1
Barium	ND		0.50	0.079	mg/Kg		10/31/20 09:10	11/03/20 18:39	1
Cadmium	ND		1.0	0.049	mg/Kg		10/31/20 09:10	11/03/20 18:39	1
Chromium	ND		1.3	0.22	mg/Kg		10/31/20 09:10	11/03/20 18:39	1
Lead	ND		1.5	0.22	mg/Kg		10/31/20 09:10	11/03/20 18:39	1
Selenium	0.460	J	5.0	0.40	mg/Kg		10/31/20 09:10	11/03/20 18:39	1
Silver	ND		2.5	0.56	mg/Kg		10/31/20 09:10	11/03/20 18:39	1

Lab Sample ID: MB 580-342143/23-A
Matrix: Solid
Analysis Batch: 342506

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 342143

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		3.0	0.25	mg/Kg		10/31/20 09:10	11/04/20 18:17	1
Barium	0.130	J	0.50	0.079	mg/Kg		10/31/20 09:10	11/04/20 18:17	1
Cadmium	ND		1.0	0.049	mg/Kg		10/31/20 09:10	11/04/20 18:17	1
Chromium	0.645	J	1.3	0.22	mg/Kg		10/31/20 09:10	11/04/20 18:17	1
Lead	ND		1.5	0.22	mg/Kg		10/31/20 09:10	11/04/20 18:17	1
Selenium	ND		5.0	0.40	mg/Kg		10/31/20 09:10	11/04/20 18:17	1
Silver	ND		2.5	0.56	mg/Kg		10/31/20 09:10	11/04/20 18:17	1

Lab Sample ID: LCS 580-342143/24-A
Matrix: Solid
Analysis Batch: 342376

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 342143

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	50.0	49.4		mg/Kg		99	80 - 120
Barium	50.0	53.5		mg/Kg		107	80 - 120
Cadmium	50.0	52.8		mg/Kg		106	80 - 120
Chromium	50.0	51.0		mg/Kg		102	80 - 120
Lead	50.0	53.9		mg/Kg		108	80 - 120
Selenium	50.0	49.1		mg/Kg		98	80 - 120
Silver	50.0	52.4		mg/Kg		105	80 - 120

Lab Sample ID: LCS 580-342143/24-A
Matrix: Solid
Analysis Batch: 342506

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 342143

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	50.0	50.6		mg/Kg		101	80 - 120
Barium	50.0	55.1		mg/Kg		110	80 - 120
Cadmium	50.0	51.9		mg/Kg		104	80 - 120
Chromium	50.0	49.0		mg/Kg		98	80 - 120
Lead	50.0	51.7		mg/Kg		103	80 - 120
Selenium	50.0	49.8		mg/Kg		100	80 - 120
Silver	50.0	52.0		mg/Kg		104	80 - 120

Client: Evergreen Coating Engineers
Project/Site: Sudden Valley CCB Tank

Job ID: 580-98505-1

Method: 6010D - Metals (ICP) (Continued)

Lab Sample ID: LCSD 580-342143/25-A
Matrix: Solid
Analysis Batch: 342376

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 342143

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	50.0	49.4		mg/Kg		99	80 - 120	0	20
Barium	50.0	50.6		mg/Kg		101	80 - 120	6	20
Cadmium	50.0	53.3		mg/Kg		107	80 - 120	1	20
Chromium	50.0	49.3		mg/Kg		99	80 - 120	3	20
Lead	50.0	53.4		mg/Kg		107	80 - 120	1	20
Selenium	50.0	49.0		mg/Kg		98	80 - 120	0	20
Silver	50.0	52.6		mg/Kg		105	80 - 120	0	20

Lab Sample ID: LCSD 580-342143/25-A
Matrix: Solid
Analysis Batch: 342506

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 342143

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	50.0	52.5		mg/Kg		105	80 - 120	4	20
Barium	50.0	56.2		mg/Kg		112	80 - 120	2	20
Cadmium	50.0	54.9		mg/Kg		110	80 - 120	6	20
Chromium	50.0	54.8		mg/Kg		110	80 - 120	11	20
Lead	50.0	54.0		mg/Kg		108	80 - 120	4	20
Selenium	50.0	52.2		mg/Kg		104	80 - 120	5	20
Silver	50.0	52.5		mg/Kg		105	80 - 120	1	20

Lab Chronicle

Client: Evergreen Coating Engineers
Project/Site: Sudden Valley CCB Tank

Job ID: 580-98505-1

Client Sample ID: CCB INT

Lab Sample ID: 580-98505-1

Date Collected: 10/14/20 11:30
Date Received: 10/26/20 12:45

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			342143	10/31/20 09:10	JCP	TAL SEA
Total/NA	Analysis	6010D		1	342376	11/03/20 20:49	TMH	TAL SEA
Total/NA	Prep	3050B			342143	10/31/20 09:10	JCP	TAL SEA
Total/NA	Analysis	6010D		1	342506	11/04/20 19:53	TMH	TAL SEA

Client Sample ID: CCB EXT

Lab Sample ID: 580-98505-2

Date Collected: 10/14/20 11:30
Date Received: 10/26/20 12:45

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			342143	10/31/20 09:10	JCP	TAL SEA
Total/NA	Analysis	6010D		1	342376	11/03/20 20:54	TMH	TAL SEA

Laboratory References:

TAL SEA = Eurofins TestAmerica, Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Accreditation/Certification Summary

Client: Evergreen Coating Engineers
Job ID: 580-98505-1
Project/Site: Sudden Valley CCB Tank

Laboratory: Eurofins TestAmerica, Seattle

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	17-024	02-19-22
ANAB	Dept. of Defense ELAP	L2236	01-19-22
ANAB	ISO/IEC 17025	L2236	01-19-22
California	State	2901	11-05-20
Montana (UST)	State	NA	04-13-21
Oregon	NELAP	WA100007	11-06-20
US Fish & Wildlife	US Federal Programs	058448	07-31-21
USDA	US Federal Programs	P330-20-00031	02-10-23
Washington	State	C553	02-18-21

Sample Summary

Client: Evergreen Coating Engineers
Project/Site: Sudden Valley CCB Tank

Job ID: 580-98505-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
580-98505-1	CCB INT	Solid	10/14/20 11:30	10/26/20 12:45	
580-98505-2	CCB EXT	Solid	10/14/20 11:30	10/26/20 12:45	

Eurofins TestAmerica, Seattle
5755 8th Street East
Tacoma, WA 98424

Chain of Custody Record

98505 eurofins Environment Testing TestAmerica

Regulatory Program: ☐ DW ☐ NPDES ☑ RCRA ☐ Other:

TestAmerica Laboratories, Inc. d/b/a Eurofins TestAmerica

Client Contact	**Project Manager: Lance Stevens**	**Site Contact:**	**Date:**
Evergreen Coating Engineers	Email: lance@coating-engineers.com	**Lab Contact:**	**Carrier:**
6925 37th Ave SW	**Tel/Fax: 206.450.6243**		
Seattle, WA 98126	**Analysis Turnaround Time**		
(206) 450-6243 Phone	☐ CALENDAR DAYS ☐ WORKING DAYS		
N/A FAX	TAT if different from Below ______		
Project Name: Sudden Valley CCB Tank	☐ 2 weeks		
Site:	☐ 1 week		
P O #	☐ 2 days		
	☐ 1 day		

COC No:
_____ of _____ COCs
TALS Project #:
Sampler:
For Lab Use Only:
Walk-in Client:
Lab Sampling:
Job / SDG No.:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	Sample Specific Notes:
CCB INT	14-Oct	11:30			1			
CCB-EXT	10/14/20	11:30			1			

580-98505 Chain of Custody

Therm. ID: R6 Cor: 17.8° Unc: 18.3°
Cooler Dsc: Envelope
Packing: ____
Cust. Seal: Yes ___ No X
Blue Ice, Wet, Dry, None
FedEx: ____
UPS: ____
Lab Cour: ____
Other: US Mail

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ______

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☐ Disposal by Lab ☐ Archive for ______ Months

Special Instructions/QC Requirements & Comments: Please test for RCRA 8 metals

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd: ____ Corr'd: ____ Therm ID No.: ____

Relinquished by:	Company:	Date/Time:	Received by: Tom Slack	Company: TA-Sea	Date/Time: 10/26/20 1245
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.33, dated 5/4/2020

Login Sample Receipt Checklist

Client: Evergreen Coating Engineers

Job Number: 580-98505-1

Login Number: 98505
List Number: 1
Creator: Blankinship, Tom X

List Source: Eurofins TestAmerica, Seattle

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	False	Thermal preservation not required.
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	False	COC not relinquished.
Is the Field Sampler's name present on COC?	False	Refer to Job Narrative for details.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	False	Refer to Job Narrative for details.
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

1 2 3 4 5 6 7 8 9 10 11

EXHIBIT C

COATING ALTERNATIVE COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-2 - Recommended Modifications to CCB
September 11, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 30,000	$ 30,000
2	Removal of Mill Scale	4000	SF	$ 4	$ 16,000
3	Tank Exterior - Preparation & Recoating	1	LS	$ 105,000	$ 105,000
4	Tank Interior - Preparation & Recoating	1	LS	$ 115,000	$ 115,000
5	Tank Containment	1	LS	$ 35,000	$ 35,000
6	Interior Seal Welding, Complete	1	LS	$ 75,000	$ 75,000
7	Access Hatch	1	LS	$ 10,000	$ 10,000
8	Roof Vent & Additional Tie-offs	1	LS	$ 25,000	$ 25,000
9	Surface Restoration	1	LS	$ 5,000	$ 5,000
				Subtotal*	**$ 416,000**
				Contingency (20%)	$ 83,200
				Subtotal	**$ 499,200**
				Washington State Sales Tax (9.0%)**	$ 44,900
				Subtotal	**$ 544,100**
				Design and Project Administration (25.0%)***	$ 136,000
				TOTAL CONSTRUCTION COST	**$ 680,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-2 - Reduced Modifications to CCB
September 11, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 30,000	$ 30,000
2	Removal of Mill Scale	4000	SF	$ 4	$ 16,000
3	Tank Exterior - Preparation & Recoating	1	LS	$ 105,000	$ 105,000
4	Tank Interior - Preparation & Recoating	1	LS	$ 115,000	$ 115,000
5	Tank Containment	1	LS	$ 35,000	$ 35,000
6	Interior Seal Welding, Complete	1	LS	$ -	$ -
7	Access Hatch	1	LS	$ -	$ -
8	Roof Vent & Additional Tie-offs	1	LS	$ -	$ -
9	Surface Restoration	1	LS	$ 5,000	$ 5,000
				Subtotal*	**$ 306,000**
				Contingency (20%)	$ 61,200
				Subtotal	**$ 367,200**
				Washington State Sales Tax (9.0%)**	$ 33,000
				Subtotal	**$ 400,200**
				Design and Project Administration (25.0%)***	$ 100,100
				TOTAL CONSTRUCTION COST	**$ 500,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-2 - New Welded Steel Tank
September 11, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 30,000	$ 30,000
2	Earthwork & TESC	1	LS	$ 20,000	$ 20,000
3	Excavation Safety Systems	1	LS	$ 5,000	$ 5,000
4	Unsuitable Excavation	25	CY	$ 250	$ 6,250
5	Welded Steel Tank	1	LS	$ 275,000	$ 275,000
6	Safety Appurtenances	1	LS	$ 50,000	$ 50,000
7	Piping, Fittings, and Appurtenances	1	LS	$ 100,000	$ 100,000
8	Connection to Existing System	1	LS	$ 20,000	$ 20,000
9	Interior and Exerior Coating	1	LS	$ 200,000	$ 200,000
				Subtotal*	**$ 706,250**
				Contingency (20%)	$ 141,300
				Subtotal	**$ 847,550**
				Washington State Sales Tax (9.0%)**	$ 76,300
				Subtotal	**$ 923,850**
				Design and Project Administration (25.0%)***	$ 231,000
				TOTAL CONSTRUCTION COST	**$ 1,155,000**

* Costs listed are in 2020 dollars

** Current sales tax rate is 8.7%.

*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

EXHIBIT D

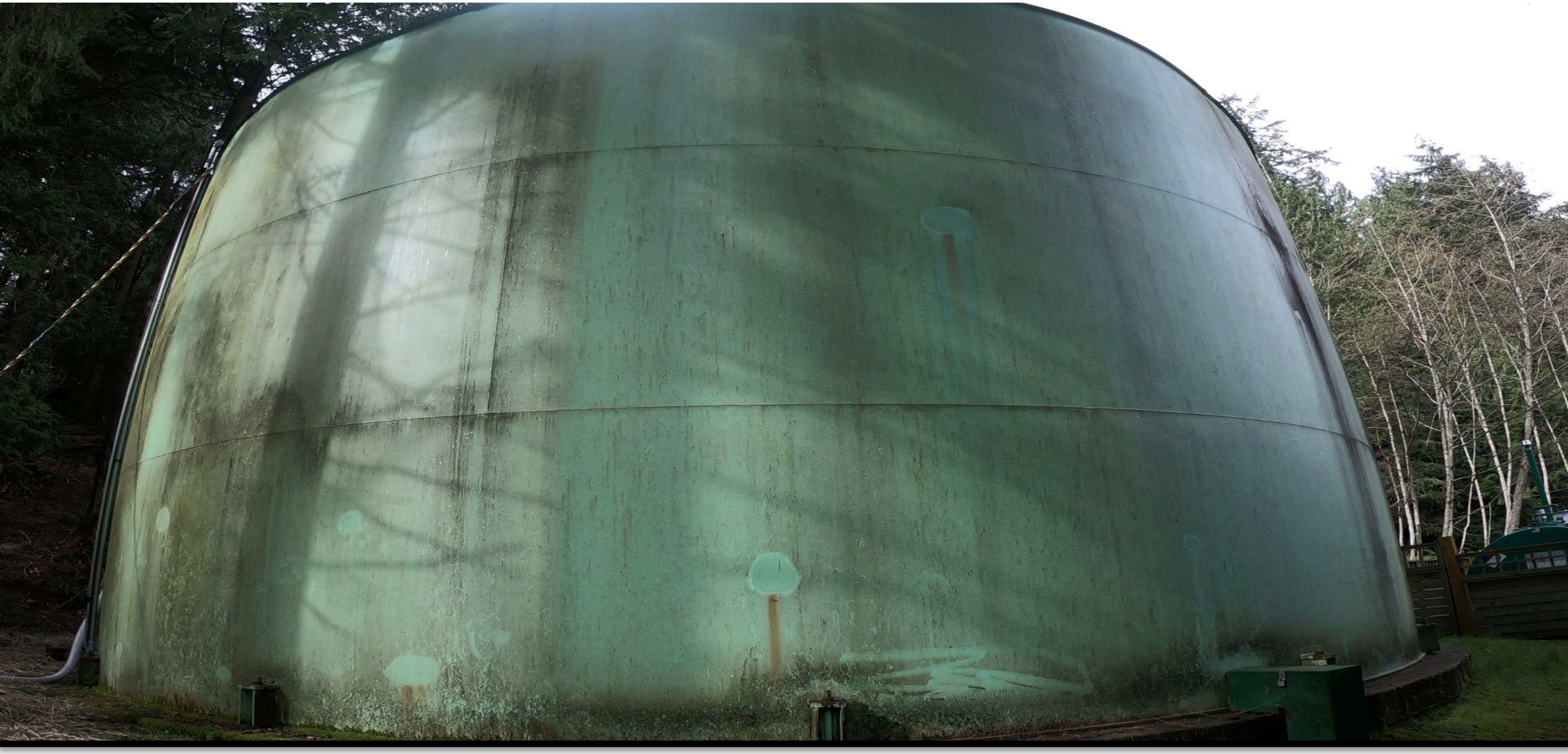
2018 COATINGS AND CORROSION INSPECTION BY H_2O SOLUTIONS

LAKE WHATCOM WATER & SEWER DISTRICT

Treatment Plant Reservoir

April 11, 2018

H2O SOLUTIONS, LLC



Date of Cleaning & Inspection :	April 11, 2018	Tank Name :	Treatment Plant
Water Loss from Cleaning:	12,000 Gallons	Height :	40′
Construction Type:	Steel	Diameter or L x W :	25′
Capacity(gal):	235,000	Year Built :	1992

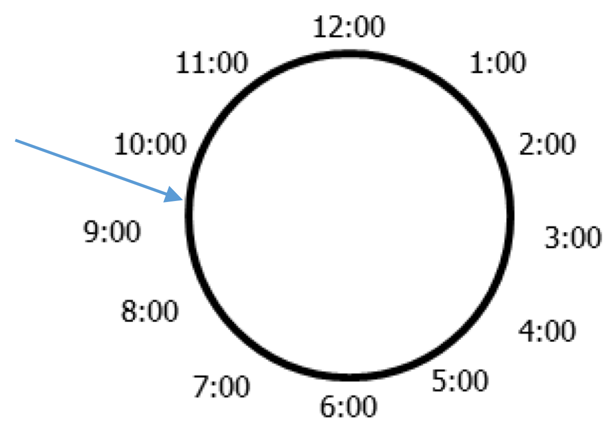
Exterior Wall

Description

Appeared to be in good condition with areas of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4



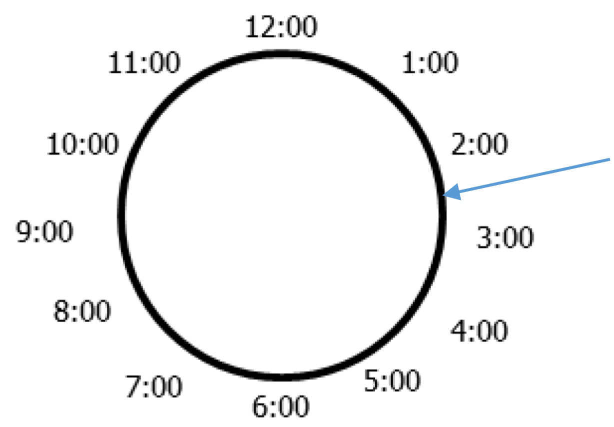
Coating System

Appeared to be in good condition with chalking and delamination. Overall 10% coating failure.

Recommendations

None at this time

Exterior Wall



Description

Appeared to be in good condition with areas of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4

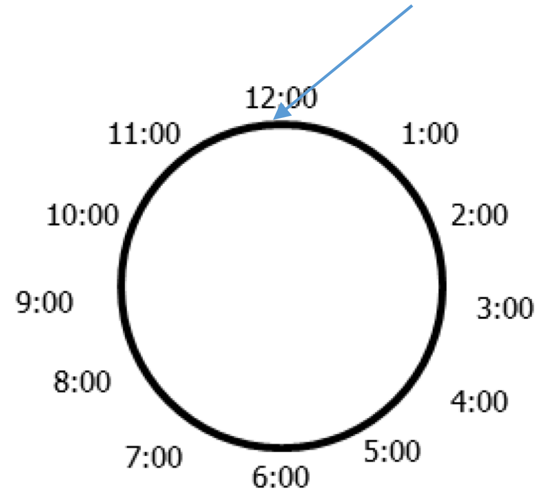
Coating System

Appeared to be in good condition with chalking and delamination. Overall 10% coating failure.

Recommendations

None at this time

Exterior Ladder



Description

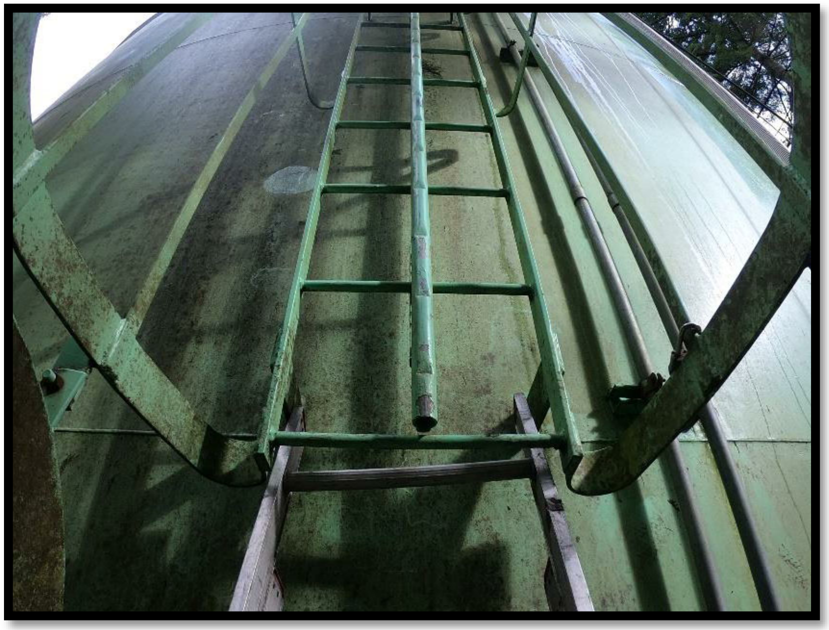
Structurally sound and in good condition. A few isolated spots of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4

Coating System

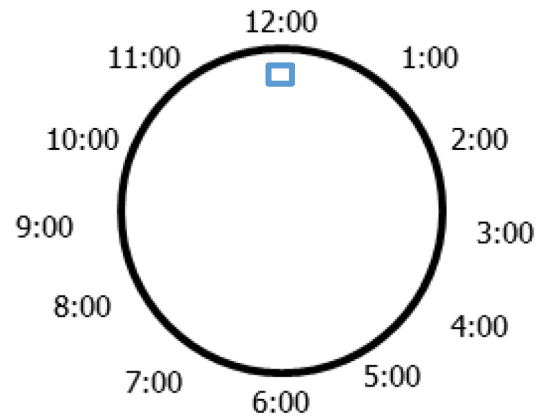
Appeared to be in good condition with minor chalking. Overall less than 5% coating failure.



Recommendations

None at this time.

Exterior Hatch Lid



Description

Appeared to be in good working condition with a few spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

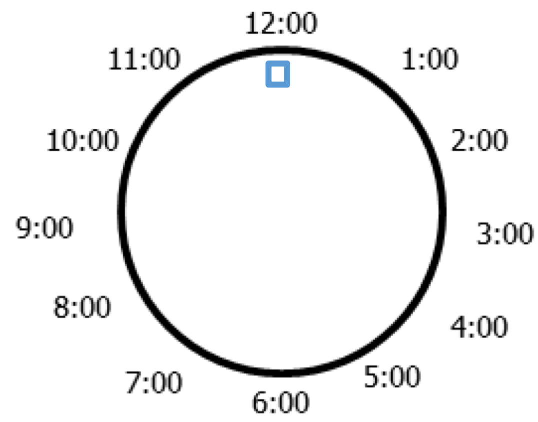
Coating System

Appeared to be in good condition with minor chalking. Overall less than 5% coating failure.

Recommendations

None at this time.

Exterior Hatch



Description

Appeared to be in good working condition with areas of surface corrosion. Overall 20% corrosion present.

Rust Grade

3

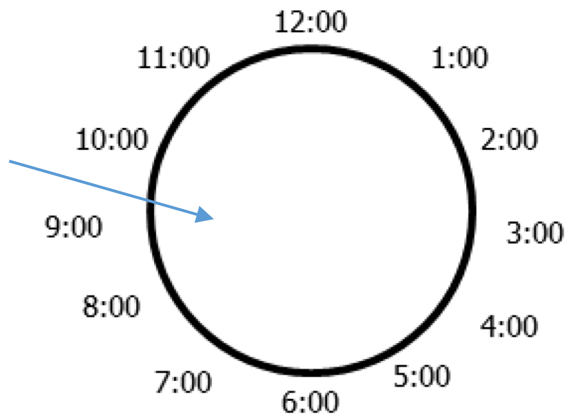
Coating System

Appeared to be in good condition with chalking, delamination and fading. Overall 25% coating failure.

Recommendations

None at this time

Exterior Roof



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4

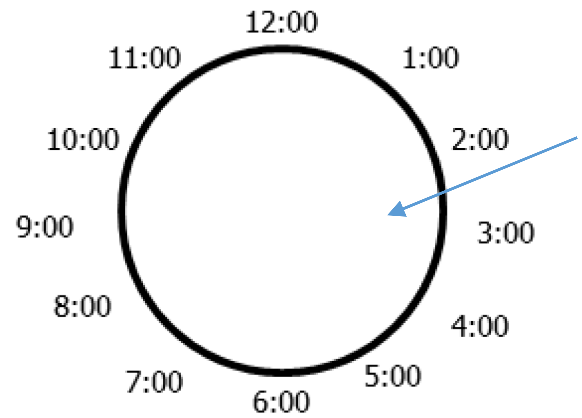
Coating System

Appeared to be in good condition with minor chalking and organic growth build up. Overall 5% coating failure.

Recommendations

None at this time

Exterior Roof



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4

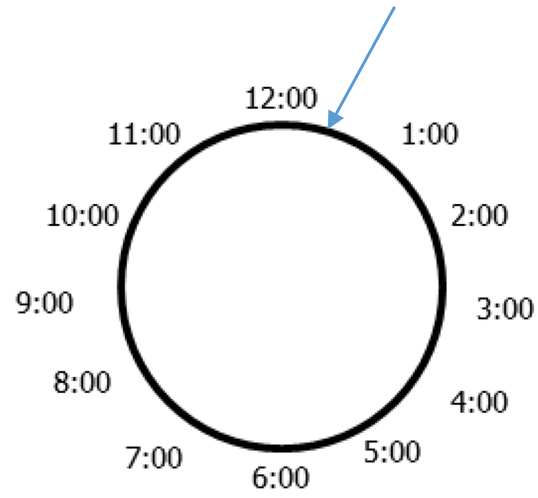
Coating System

Appeared to be in good condition with minor chalking and organic growth build up. Overall 5% coating failure.

Recommendations

None at this time

Exterior Railing



Description

Appeared to be in good condition with areas of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

Coating System

Appeared to be in good condition with chalking and delamination. Overall 5% coating failure.

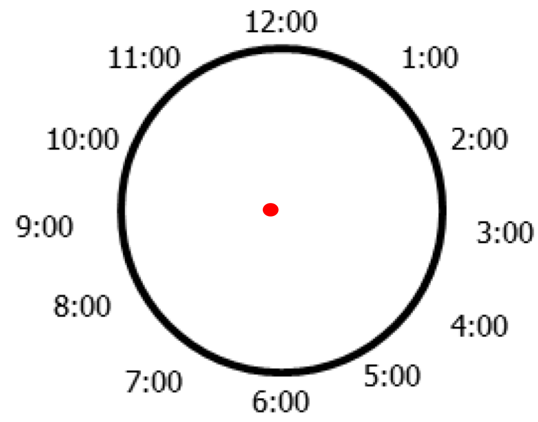
Recommendations

None at this time

Exterior Vent

Description

Appeared to be in good working condition with a few spots of minor surface corrosion. Overall less than 5% corrosion present. Fine mesh screen present and in good condition.



Rust Grade

5

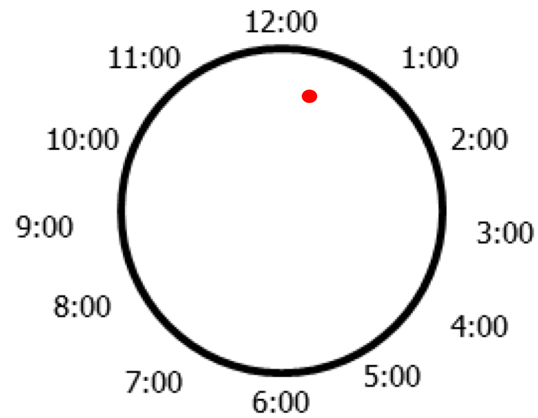
Coating System

Appeared to be in good condition with chalking and delamination. Overall 5% coating failure.

Recommendations

None at this time.

Exterior Telemetry



Description

Appeared to be in good working condition.

Rust Grade

N/A

Coating System

N/A

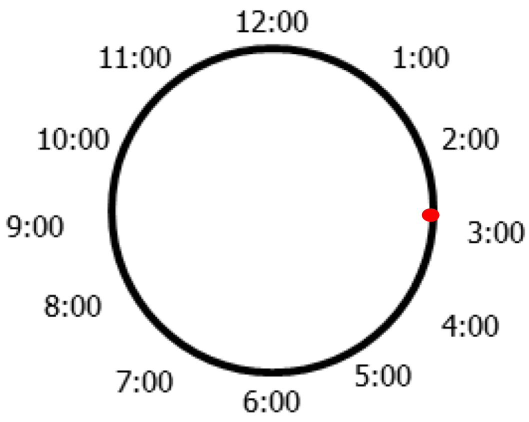
Recommendations

None at this time

Exterior Manway

Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.



Rust Grade

6

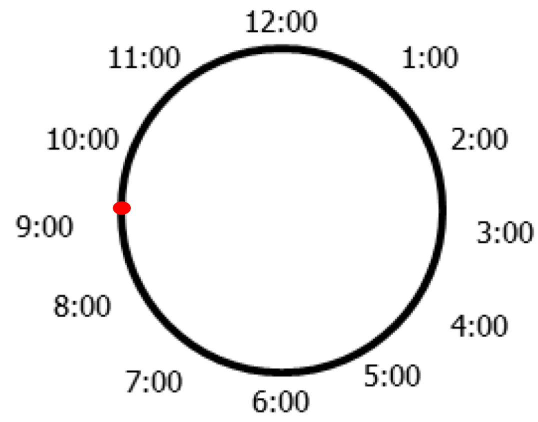
Coating System

Appeared to be in good condition with minor chalking and delamination. Overall 5% coating failure.

Recommendations

None at this time

Exterior Manway



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

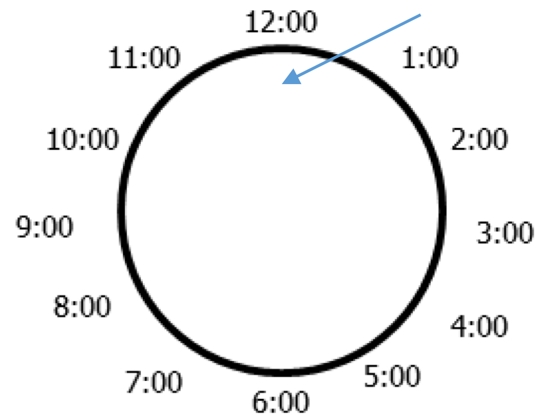
Coating System

Appeared to be in good condition with minor chalking and delamination. Overall 5% coating failure.

Recommendations

None at this time

Interior Ladder



Description

Structurally sound and in fair condition. Areas of moderate to heavy surface corrosion on the rungs. Overall 50% corrosion present.

Rust Grade

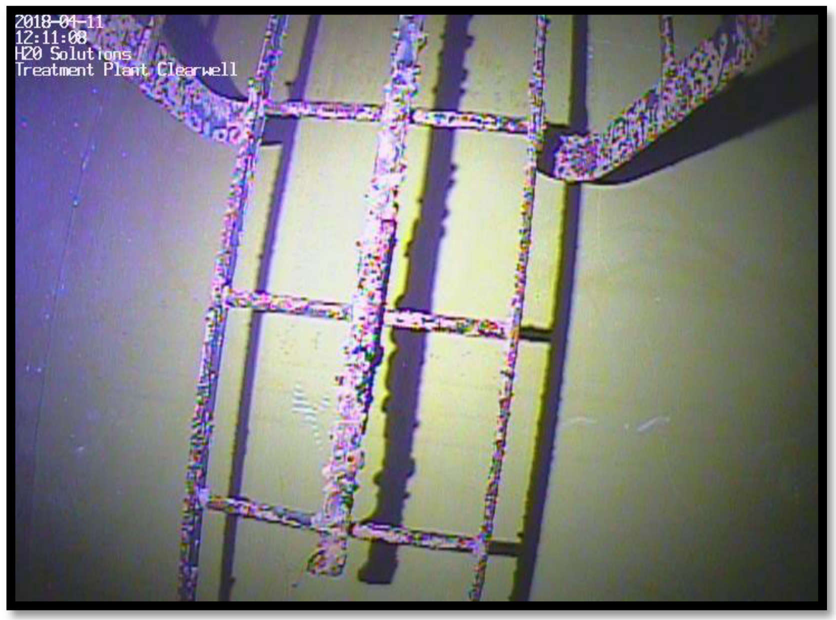
1

Coating System

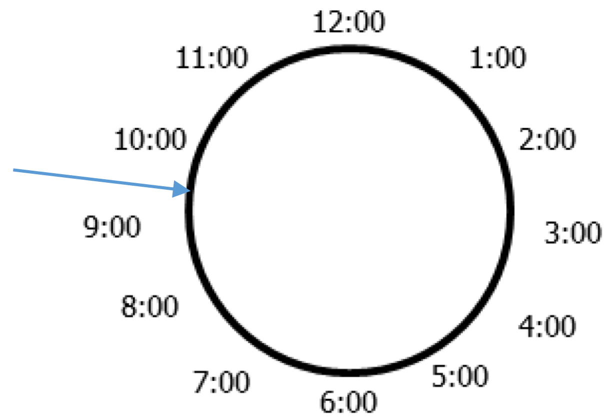
Appeared to be in poor condition with chalking and delamination. Overall 75% coating failure.

Recommendations

None at this time.



Interior Wall



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

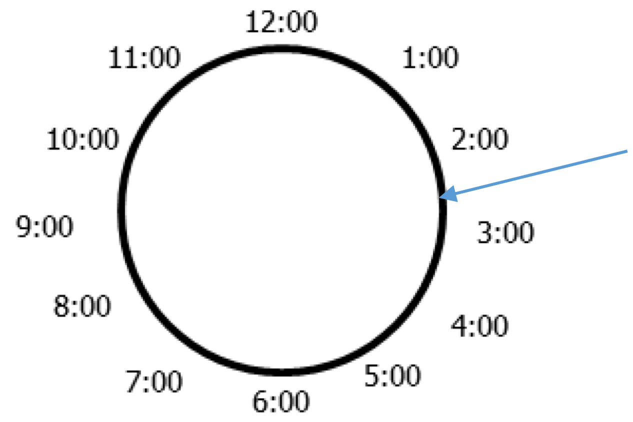
Coating System

Appeared to be in good condition with chalking, delamination, fading and blistering. Overall 5% coating failure.

Recommendations

None at this time

Interior Wall



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

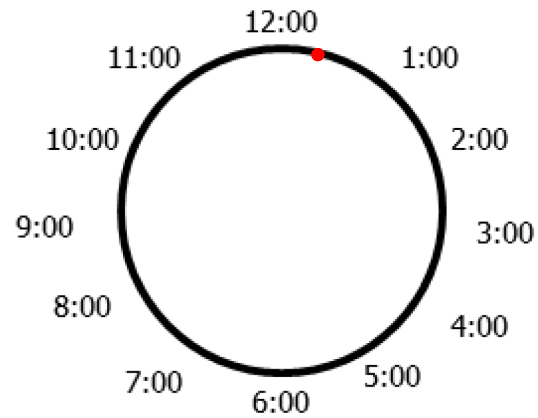
Coating System

Appeared to be in good condition with chalking, delamination, fading and blistering. Overall 5% coating failure.

Recommendations

None at this time

Interior Telemetry



Description

Appeared to be in good working condition.

Rust Grade

N/A

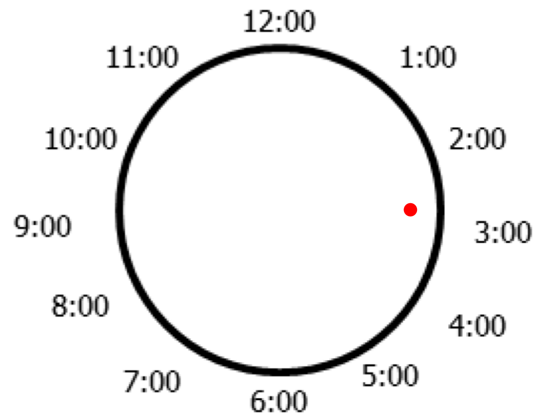
Coating System

N/A

Recommendations

None at this time

Interior Overflow



Description

Appeared to be in good working condition with a few isolated spots of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4

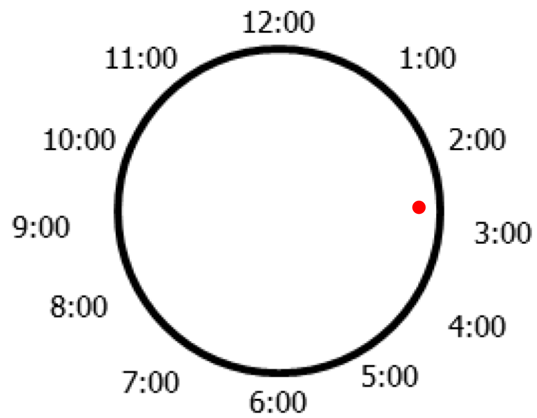
Coating System

Appeared to be in good condition with chalking and blistering. Overall 5% coating failure.

Recommendations

None at this time

Interior Overflow Base



Description

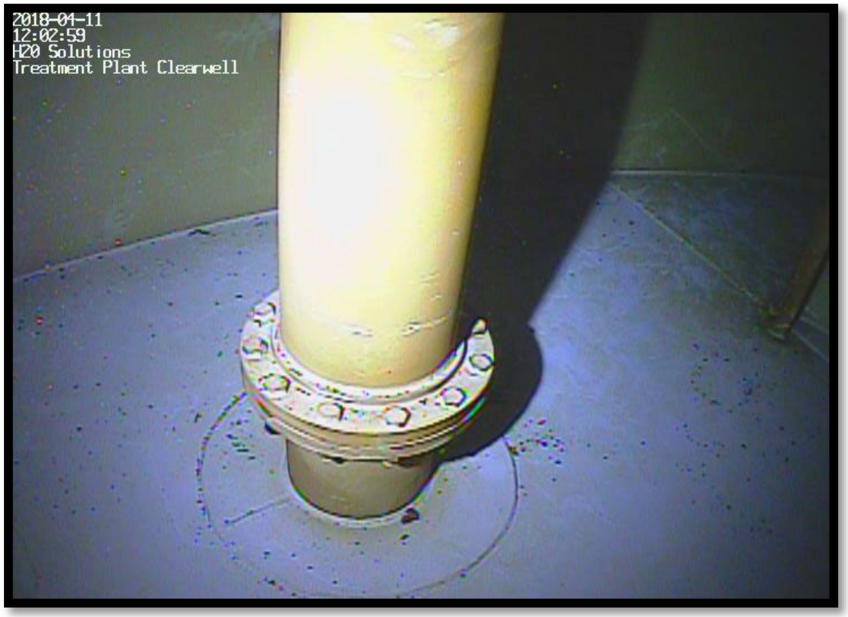
Appeared to be in good working condition with a few isolated spots of minor surface corrosion. Overall 5% corrosion present.

Rust Grade

4

Coating System

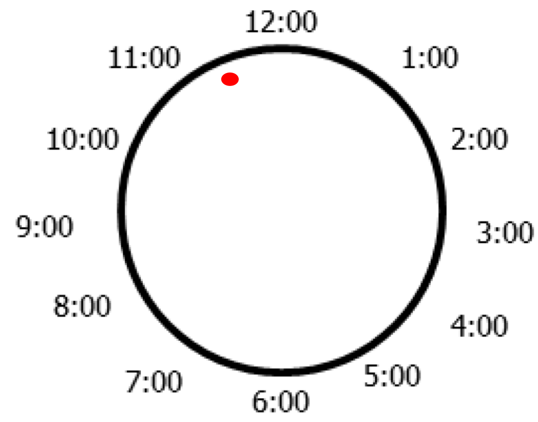
Appeared to be in good condition with chalking and blistering. Overall 5% coating failure.



Recommendations

None at this time

Interior Inlet Base



Description

Appeared to be in good working condition with areas of moderate surface corrosion. Overall 25% corrosion present.

Rust Grade

2

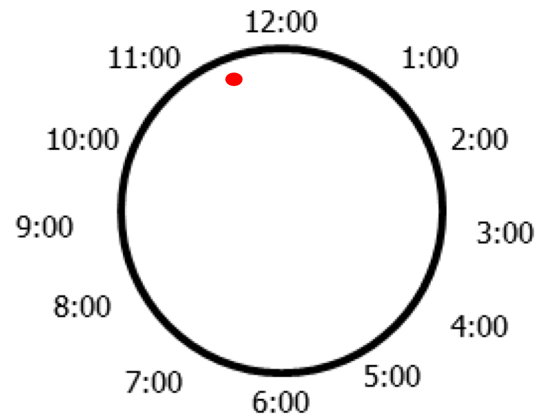
Coating System

Appeared to be in fair condition with delamination. Overall 50% coating failure.

Recommendations

None at this time

Interior Inlet



Description

Appeared to be in good working condition with areas of moderate surface corrosion. Overall 25% corrosion present.

Rust Grade

2

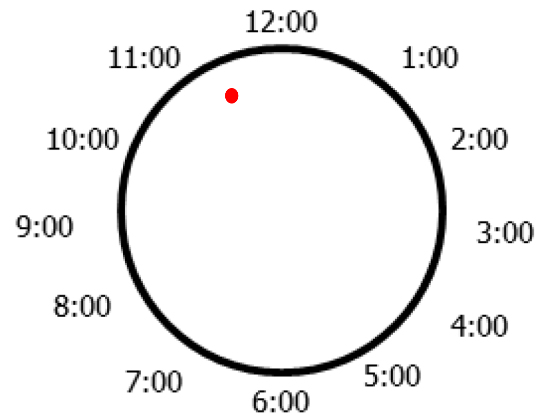
Coating System

Appeared to be in fair condition with delamination. Overall 50% coating failure.

Recommendations

None at this time

Interior Outlet



Description

Appeared to be in good working condition with areas of moderate surface corrosion. Overall 25% corrosion present.

Rust Grade

2

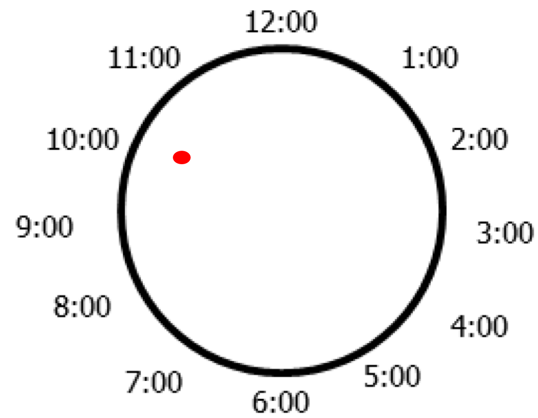
Coating System

Appeared to be in fair condition with delamination. Overall 50% coating failure.

Recommendations

None at this time

Interior Drain



Description

Appeared to be in good working condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

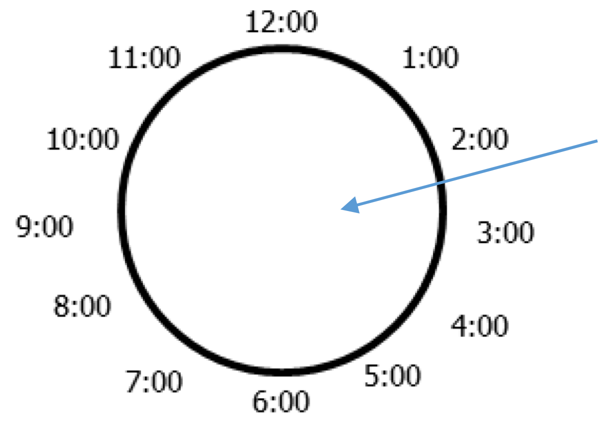
Coating System

Appeared to be in good condition with minor chalking. Overall less than 5% coating failure.

Recommendations

None at this time

Interior Ceiling



Description

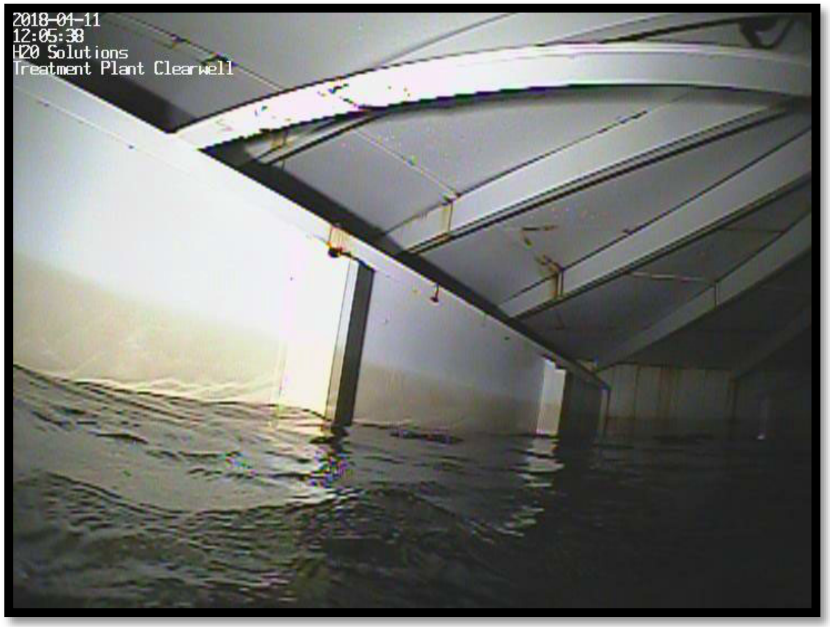
Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

Coating System

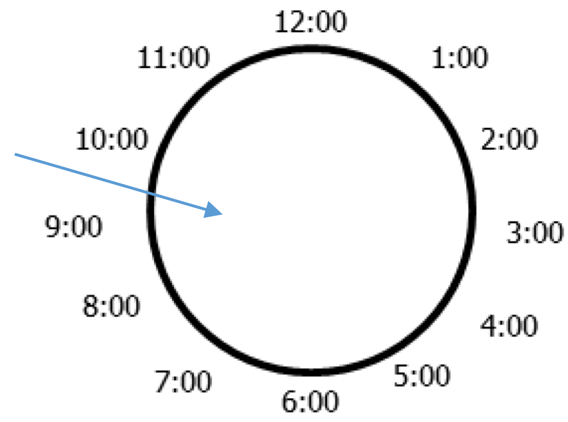
Appeared to be in good condition with chalking. Overall 5% coating failure.



Recommendations

None at this time

Interior Ceiling



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

Coating System

Appeared to be in good condition with chalking. Overall 5% coating failure.

Recommendations

None at this time

Interior Ceiling

Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

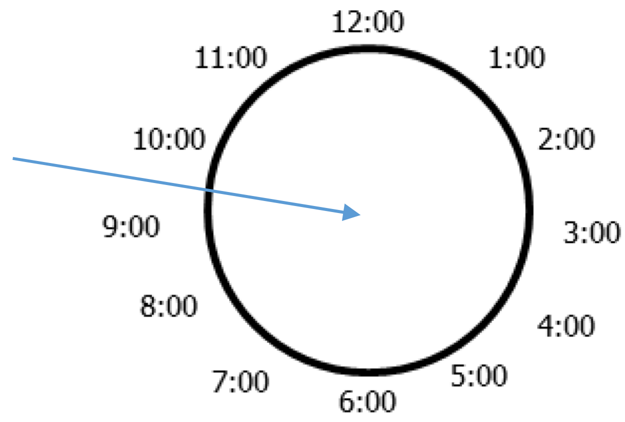
6

Coating System

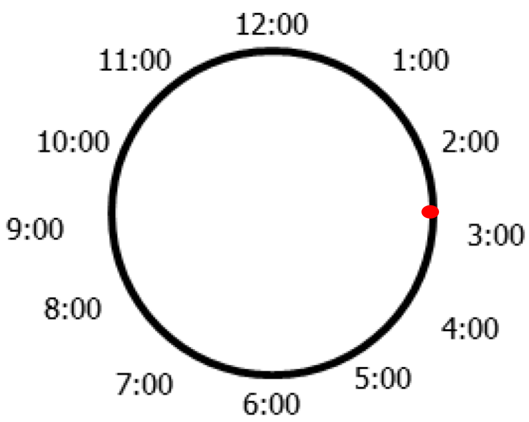
Appeared to be in good condition with chalking. Overall 5% coating failure.

Recommendations

None at this time



Interior Manway



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall 10% corrosion present. Gasket is in good condition.

Rust Grade:

3

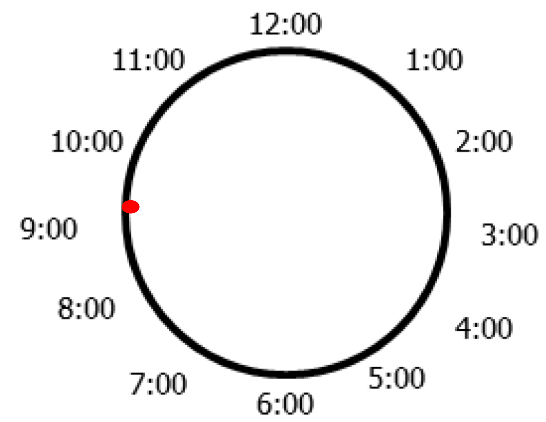
Coating System

Appeared to be in good condition with chalking and blistering. Overall 5% coating failure.

Recommendations

None at this time

Interior Manway



Description

Appeared to be in good condition with a few isolated spots of minor surface corrosion. Overall 10% corrosion present. Gasket is in good condition.

Rust Grade:

3

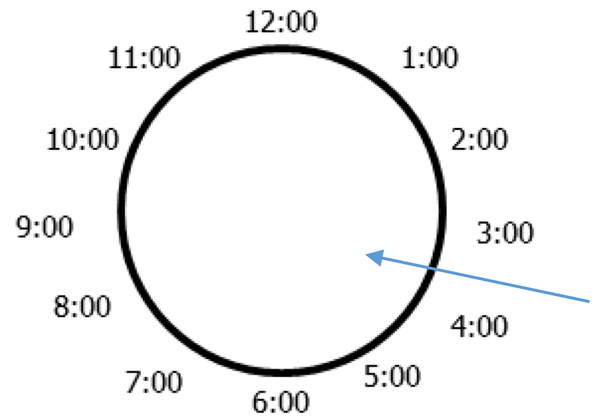
Coating System

Appeared to be in good condition with chalking and blistering. Overall 5% coating failure.

Recommendations

None at this time

Interior Floor



Description

Appeared to be in good working condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

6

Coating System

Appeared to be in good condition with chalking, blistering and staining. Overall 10% coating failure.

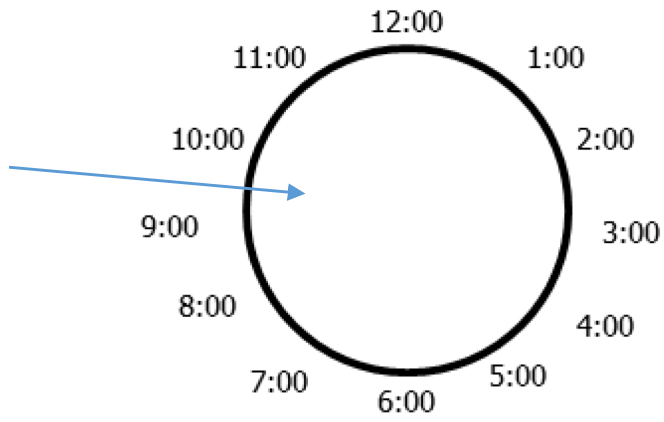
Recommendations

None at this time

Interior Floor

Description

Appeared to be in good working condition with a few isolated spots of minor surface corrosion. Overall les than 5% corrosion present.



Rust Grade

6

Coating System

Appeared to be in good condition with chalking, blistering and staining. Overall 10% coating failure.

Recommendations

None at this time

Interior Floor

Description

Appeared to be in good working condition with a few isolated spots of minor surface corrosion. Overall less than 5% corrosion present.

Rust Grade

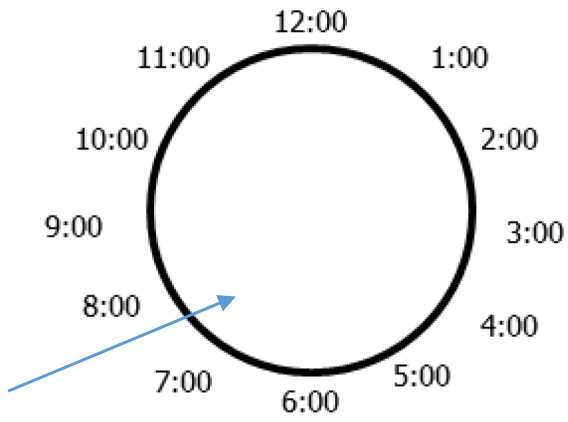
6

Coating System

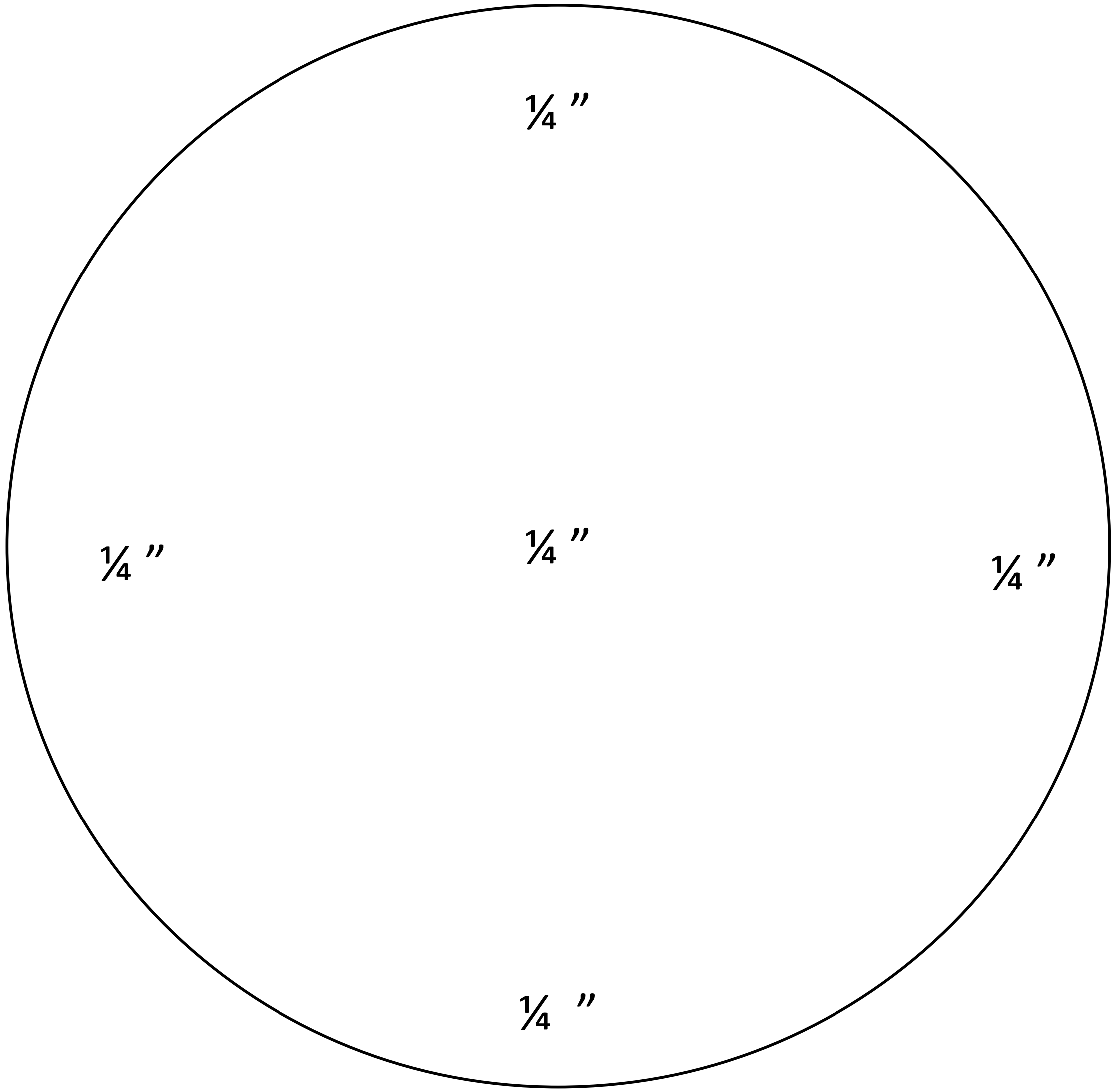
Appeared to be in good condition with chalking, blistering and staining. Overall 10% coating failure.

Recommendations

None at this time



Sediment Depth



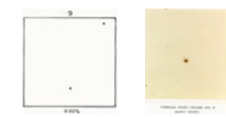
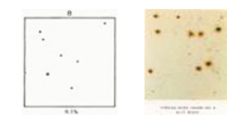
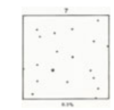
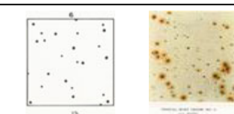
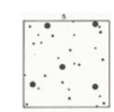
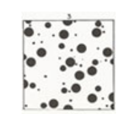
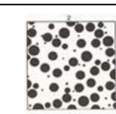
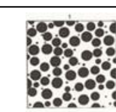
References

Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographical reference standards requires the following precautions:

- Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
- Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
- Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
- It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
- In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
- The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

A	Similar to European Scale of Degree of rusting for Anti-Corrosive Paints (1961) (Black & White)
B	Corresponds to SSPC Initial Surface Conditions E (0 - 0.1%) and BISRA (British Iron and Steel Research Association) 0.1%
C	Corresponds to SSPC Initial Surface Conditions F (0.1%-1%) and BISRA 1%
D	Corresponds to SSPC Initial Surface Conditions G (1 - 10%)
E	Rust grades below 4 are of no practical importance in grading performance of paints
F	Corresponds to SSPC Initial Surface Condition H (50 - 100%)

Rust Grades [A]	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting less than 0.03% of surface rusted	
8[B]	Few isolated rust spots less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6[C]	Extensive rust spots but less than 1% of surface rusted	
5	Rusting to the extent of 3% of surface rusted	
4[D]	Rusting to the extent of 10% of surface rusted	
3[E]	Approximately on sixth of the surface rusted 16%	
2	Approximately one third of the surface rusted 33%	
1	Approximately one half of the surface rusted 50%	

APPENDIX E

TECHNICAL MEMORANDUM 20434-3, SUDDEN VALLEY WTP TIER 2-TIER 3 SEISMIC EVALUATION

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-3

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E. MYRON BASDEN, P.E., S.E. ALEX QUINN, P.E.
DATE:	SEPTEMBER 16, 2021
SUBJECT:	SUDDEN VALLEY WTP TIER 2/TIER 3 SEISMIC EVALUATION LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

STRUCTURAL SCOPE OF WORK

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively provide clean, potable water for the existing and projected service areas.

This memorandum includes a seismic evaluation of two buildings at the WTP and provides recommendations for improvements. These buildings are the Main Water Treatment Plant Building (Main Building) and the Finished Water Pump Building (Pump Building). Items evaluated include the structural systems of the buildings as well as nonstructural components that affect building functionality. This memorandum provides the basis and results of the seismic evaluation. The memorandum also summarizes the finding of another seismic evaluation for the Sudden Valley WTP (SVWTP) Reservoir at the WTP site.

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EXECUTIVE SUMMARY

The Main Building and Pump Building were seismically evaluated using the Tier 3 procedure of American Society of Civil Engineers (ASCE) 41 *Seismic Evaluation and Retrofit of Existing Buildings*. This procedure highlights the four seismic hazard levels and four building performance levels for building function after a seismic event, ranging from BSE-1E Collapse Prevention (least stringent) to BSE-2N Operational (most stringent). A seismic hazard level of BSE-1N and a building performance level of Operational were used as seismic design criteria for both the Main Building and the Pump Building because these levels most closely approximate the seismic requirements that would apply for these buildings if they were built under today's building code. The intent of the building performance level of Operational is very minor damage to the building structure after the design-level earthquake and no required structural repairs before reoccupancy.

Deficiencies and retrofits for the buildings are separated into two categories: structural and nonstructural. Structural refers to any part of the main structure of the building while nonstructural refers to any item that is supported from the main structure.

For the Main Building, no structural deficiencies were found so no structural retrofits are recommended. Nonstructural retrofits with an estimated construction cost of $118,000 are recommended based on seismic deficiencies identified.

For the Pump Building, structural and nonstructural retrofits with an estimated construction cost of $291,000 are recommended based on seismic deficiencies that were identified.

The SVWTP reservoir was seismically evaluated in 2016 and found to have foundation and piping flexibility deficiencies. The estimated construction cost for addressing these deficiencies is $200,000 after adjusting to 2020 dollars.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at the District's Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD) but currently operates at approximately 1.0 MGD (700 gallons per minute (gpm)). The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before treated water is pumped to the distribution system and storage reservoirs.

OVERVIEW OF SEISMIC HAZARDS IN THE PUGET SOUND REGION

Seismic events in the Puget Sound region can generally be categorized into three types. The first is a subduction zone mega-thrust earthquake occurring along the coastline. This type of earthquake can have the largest magnitude with Richter scale magnitudes up to and beyond M9.0 and could affect a large area of the Pacific Northwest. While this event would result in significant and destructive ground shaking in the central Puget Sound region, the highest ground shaking levels would be near the epicenter, which is located along the state's coastline. The frequency of this type of earthquake varies from approximately every 300 to 1,000 years.

The second type is a deep subduction zone earthquake. The epicenter of this type is farther inland and much deeper than the coastal mega-thrust earthquake, and Richter scale magnitudes are typically M6.0 to M7.0. The Nisqually earthquake of 2001 is an example of a deep subduction zone earthquake. These earthquakes happen approximately every 50 years.

The third type is a shallow crustal earthquake. These can happen along a variety of faults in the central Puget Sound region and can have magnitudes up to M7.5. Because the epicenters of these events are much shallower than mega-thrust and deep subduction zone earthquakes, they can cause the highest levels of ground shaking despite not having the greatest Richter scale magnitude. However, shallow crustal earthquakes affect a relatively small area as compared to subduction zone earthquakes. The Seattle Fault and

Whidbey Island Fault are examples of faults prone to shallow crustal earthquakes. The frequency of these types of events is approximately every 5,000 to 7,000 years.

Under the International Building Code (IBC) 2015, seismic design of buildings is based on a level of ground shaking that is not expected to be exceeded during a designated return interval. The return interval refers to the frequency a seismic event of a certain magnitude is expected to occur, expressed in years. The likelihood and magnitude of ground shaking from any of the three types of earthquakes previously described is used to develop maps of ground shaking parameters. To recognize the relative importance of different types of structures, an importance factor of 1.0, 1.25, or 1.50 is assigned which approximately correlate with event return intervals of 500, 1,000, and 2,500 years, respectively. Per current IBC requirements, buildings that provide essential operations and must remain in service after an earthquake are designed to the “Operational” level, with a corresponding importance factor of 1.5 and earthquake design forces correlated to the 2,500-year earthquake event.[1] This corresponds to design-level ground shaking that has a 2 percent chance of occurrence in the next 50 years, which is generally assumed to be the useful life of a building. In contrast, IBC specifies that common buildings that are not essential after an earthquake are designated to the “Life Safety” level and correspond to an importance factor of 1.0, correlating to a 500-year earthquake event. Under the Life Safety level, the building experiences damage due to the design-level earthquake, but maintains a safety factor against collapse. Repairs likely will be required before reoccupancy of the building. Life Safety is the standard for most residential and commercial structures designed today. Both the Main Building and Pump Building are evaluated to the Operational level as they are essential for continued operation of the WTP.

TIER 3 EVALUATION

After collecting information regarding the structural and nonstructural systems and components of the buildings during a site visit, Gray & Osborne performed a Tier 3 seismic analysis of the Main Building and Pump Building for the Operational performance level in accordance with ASCE 41-13 *Seismic Evaluation and Retrofit of Existing Buildings*. The Tier 3 analysis provides the most accurate results of any seismic analysis procedure stated in ASCE 41. This is due to the rigorous and in-depth calculations performed to evaluate each potential seismic deficiency. The goal of the Operational performance level is to allow occupants to survive the design-level earthquake and remain in the building safely. Continued use of the buildings should not be limited to the structural condition but may be limited by disruption of nonstructural

[1] Implied in the IBC seismic design criteria are the following two simultaneous design criteria: a Life Safety building performance level for the 2,500-year earthquake event and Operational performance level for the 500-year earthquake event.

items or processes outside of the buildings. It is important to note that the Operational performance level is approximately equivalent to the current design criteria required by the building code for new buildings designated as critical structures (Risk Category IV). In other words, if these buildings were being designed as new today, they would be designed to the Operational performance level as they are essential for continued operation of the WTP.

SEISMIC ANALYSIS CRITERIA

The Main Building and Pump Building were analyzed in accordance with the Operational performance level of ASCE 41-13 for the BSE-1N seismic hazard level. The BSE-1N seismic hazard level was chosen as the design acceleration is identical to that required by IBC 2015 for new structures. The Tier 3 analysis was used which includes detailed calculations to evaluate the adequacy of both structural and nonstructural components critical to building safety.

MAIN BUILDING SEISMIC ANALYSIS

The Main Building is constructed of cast-in-place concrete foundations, shear walls, and floors. The roof consists of prestressed concrete "T" girders with a cast-in-place topping slab. The existing components of the building were evaluated for the seismic forces determined from the accelerations for the selected seismic hazard level. Table 1 summarizes the results for each critical structural component of the Main Building. The demand/capacity ratio shown is for the most critical of each type of component. For example, all shear walls were analyzed but only reported for the most critical location. In addition, a demand/capacity ratio greater than 1.0 means the component is overstressed at the design-level forces and is likely to fail. The nonstructural elements were evaluated as well and are summarized later in the memorandum.

TABLE 1

Main Building Structural Analysis Summary

Component	Demand/Capacity Ratio
Shear Wall In-Plane Shear	0.36
Shear Wall In-Plane Flexure	0.69
Concrete Wall Out-of-Plane	0.43
Shear Wall Anchorage to Foundation	0.83
Diaphragm Shear	0.47

The results of the Tier 3 seismic analysis of the Main Building indicate that all components of the lateral force resisting system are adequate for the seismic forces corresponding to the Operational performance level. The original Tier 1 analysis identified the small embedment length of the dowels that anchor the shear walls to the foundation as a potential issue. The in-depth calculations performed as part of the Tier 3 evaluation found that the long shear walls and rigid concrete diaphragm were able to provide sufficient force distribution as to not overstress the dowels. Therefore, no structural retrofits are recommended for the Main Building.

PUMP BUILDING SEISMIC ANALYSIS

The Pump Building is constructed of masonry shear walls with wood trusses and a plywood roof topped with asphalt shingles. The existing components of the Pump Building were evaluated for the seismic forces determined from the acceleration for the selected seismic hazard level. Table 2 summarizes the results for each structural component and the demand/capacity ratio shown is for the most critical of each type of component. In addition, a demand/capacity ratio greater than 1.0 means the component is overstressed at the design-level forces and is likely to fail; these items are colored red. Table 2 shows that the diaphragm has inadequate shear capacity and that no apparent connection exists between the diaphragm and the shear walls. Each of the deficient items and associated retrofit options are discussed below.

TABLE 2

Pump Building Structural Analysis Summary

Component	Demand/Capacity Ratio
Shear Wall In-Plane Shear	0.21
Shear Wall In-Plane Flexure	0.62
CMU Wall Out-of-Plane	0.45
Shear Wall Connection to Diaphragm	— (1)
Shear Wall Anchorage to Foundation	0.30
Diaphragm Shear	**1.63**

(1) No apparent connection exists.

Shear Wall Connection to Diaphragm

Based on the record drawings provided by the District, there is not proper detailing to transmit shear forces in the roof diaphragm to the shear wall. Observations made during the site visit confirmed this condition. This issue poses a threat of significant damage and roof collapse during an earthquake as the diaphragm is not adequately braced by the

CMU shear walls to resist horizontal movements during an earthquake. One retrofit option to address this deficiency involves removing the existing soffit at the long overhangs and replacing it with a structural diaphragm. New blocking could be installed at the fascia and new clips added at the shear walls to anchor the diaphragm. This would allow a load path for the roof diaphragm force to transfer through the soffit to the shear walls. In this option, the existing continuous vent located at the underside of the roof overhangs could be replaced with regularly spaced drilled holes to preserve continuity of sheathing between the edge of the roof and the bearing wall. At the north side of the building where there is very little overhang, the existing blocking would be removed and new vented blocking could be installed that would fasten to both the top of the wall and the underside of the roof sheathing. This would require the removal of a small area of roof sheathing in this location.

Diaphragm Shear

The record drawings did not contain complete information regarding the attachment of the roof sheathing; therefore, the diaphragm was analyzed using assumed values commonly found in this type of construction. Based on these assumptions, the existing diaphragm does not have sufficient shear strength to resist the calculated seismic forces. One option to address this issue is to remove the existing roofing down to the sheathing and install additional nails to increase the shear capacity. A new roofing system would then need to be installed. It should be noted that this retrofit is based on assumed design values. The actual construction of the diaphragm should be verified in the field and checked for consistency with the assumptions. Depending on what is discovered in the field, the diaphragm could require a more robust retrofit or possibly no retrofit at all.

NONSTRUCTURAL ANALYSIS

In addition to the seismic evaluation of the structural system, the nonstructural components were evaluated for the requirements of the Operational performance level. The goal of the nonstructural Operational performance level is for nonstructural components to be able to provide the same function post-earthquake as they provided before the earthquake. This nonstructural performance level provides a design approach for nonstructural items consistent with the design and forces of the selected structural performance level. One consideration is the potential disruption of utilities outside of the structures. If power or communications to the structures are lost, these nonstructural components may not operate. Analysis of utilities outside of the structures is beyond the scope of this evaluation. The list below contains the items covered by the nonstructural evaluation:

1. Architectural:
   a. Cladding and Glazing
   b. Partitions
   c. Ceiling Finishes
   d. Appendages and Marquees
   e. Doors and Windows

2. Mechanical Equipment:
   a. Storage Vessels
   b. Fluid Piping
   c. Fire Suppression Systems
   d. Hazardous Materials
   e. HVAC Equipment

3. Electrical and Communications Equipment:
   a. Emergency Power
   b. Light Fixtures

4. Furnishings and Interior Equipment:
   a. Storage Racks
   b. Fall-Prone Contents
   c. Computers and Communication Racks

MAIN BUILDING NONSTRUCTURAL ANALYSIS

Several nonstructural items within the Main Building were found to be noncompliant with the Operational nonstructural performance level. These items are as follows:

- Wall Framing at Restroom – Seismic bracing required.
- Wall-Mounted Transformer – Seismic bracing required.
- HVAC Unit – Seismic bracing required.
- Fluid Piping – Seismic bracing and flexible connections required.
- Electrical Panels – Seismic anchorage required.

The following retrofits are recommended to address the nonstructural deficiencies identified by the seismic evaluation:

- The wall framing at the restroom area has equipment attached to it that may result in failure of the wall during seismic shaking (Figure A-1). The proposed retrofit involves bracing the tops of the walls against the concrete ceiling of the building.

- The transformer mounted to the west wall (Figure A-2) requires seismic bracing in each lateral direction fastening back to the concrete wall in order to provide proper restraint.

- The suspended HVAC unit (Figure A-3) requires bracing in each lateral direction running back to the ceiling. These braces could consist of tension cables in all four directions or steel struts in two lateral directions.

- The fluid piping (Figure A-4) requires seismic bracing at regular spacing throughout the structure along the runs of each pipe.

- The piping from the various fluid-filled tanks (filters, flocculation tank, soda ash tank, and alum tank) that are supported from the floor of the building require flexible connections in order to mitigate any damage caused by differential movement between the tanks and the building during an earthquake. This applies to all tanks where differential movement poses a risk of significant damage.

- The electrical panels (Figure A-5) require additional seismic anchorage in order to comply with the selected performance level. This involves installing additional anchorage dowels that fasten each panel to the supporting slab to prevent any panels from overturning due to ground shaking.

These nonstructural retrofits are essential in order for the Main Building to conform to the Operational performance level. Figures A-1 through A-5 in Exhibit A show the nonstructural items that require retrofit. Estimated order-of-magnitude construction costs for these nonstructural items are provided in Exhibit C.

PUMP BUILDING NONSTRUCTURAL ANALYSIS

Several nonstructural items within the Pump Building were found to be noncompliant with the Operational nonstructural performance level. These items are as follows:

- Masonry Partition Walls – Remove and replace with wood-framed walls.
- Generator Exhaust – Seismic bracing required.
- Gas Heating Unit – Seismic bracing required.
- Natural Gas Piping – Seismic bracing required.
- Fluid Piping – Flexible connection and seismic bracing required.
- Gas Meter – Flexible connection required.

- Wall-Mounted Transformer – Seismic bracing required.
- Water Heater – Seismic restraint required.
- Conduit Runs – Seismic bracing required.
- Electrical Panels – Seismic anchorage required.

The following retrofits are recommended to address the nonstructural deficiencies identified by the seismic evaluation:

- Masonry partition walls separate the restrooms and the stalls within the restrooms. The masonry appears to be minimally reinforced, creating a high risk of collapse during an earthquake. The most efficient option to address the masonry partition walls is to remove the existing partition walls and replace them with wood-framed walls with a durable finish.

- The generator exhaust (Figure B-1) is unbraced and could become disconnected from the unit during an earthquake. The proposed retrofit is to install a brace in each lateral direction that brace it against the wall.

- The gas heating unit (Figure B-2) is unbraced and new seismic bracing should be installed in each lateral direction and attached to the ceiling.

- The natural gas piping, fluid piping, and conduit runs (Figures B-3, B-4, and B-8) require seismic bracing at regular spacing installed throughout the structure along the runs to each component.

- The gas meter (Figure B-5) just outside the structure has piping that runs from the ground through the wall of the building. Differential movement could cause this line to rupture during an earthquake. It is recommended to install a flexible coupling in the line to accommodate any movement.

- The transformer mounted on the north interior wall (Figure B-6) may shake loose during an earthquake. The proposed retrofit is to install lateral bracing back to the walls.

- The water heater (Figure B-7) does not appear to be properly restrained. It is recommended that the water heater be strapped to the adjacent wall.

- The electrical panels in the building (Figure B-9) require additional seismic anchorage in order to comply with the selected performance level. This involves installing additional dowels that fasten each panel to the supporting slab to prevent the panels from overturning.

These nonstructural retrofits are essential in order for the Pump Building to conform to the Operational performance level. Figures B-1 through B-9 in Exhibit B show the nonstructural items that require retrofit. Estimated order-of-magnitude construction costs for these nonstructural items are provided in Exhibit C.

SEISMIC RETROFIT SUMMARY

We recommend that the District complete the seismic retrofits described in order to ensure that the Main Building and Pump Building meet criteria listed for the Operational performance level. Some items for which seismic retrofits are recommended may be slated for replacement in the next 5 to 10 years. For these items, the District may consider not installing the recommended seismic retrofits and accepting a relatively small risk of a design-level earthquake occurring prior to the planned replacement of the item.

The recommended modifications for the Main Building are estimated to cost $118,000, which includes materials, installation, contingency (20 percent), Washington State sales tax (9.0 percent), and design and project administration (25 percent). A complete budgetary cost estimate is provided in Exhibit C.

The recommended modifications for the Pump Building are estimated to cost $291,000, which includes materials, installation, contingency (20 percent), Washington State sales tax (9.0 percent), and design and project administration (25 percent). A complete budgetary cost estimate is provided in Exhibit C.

SVWTP RESERVOIR SUMMARY

In the December 2016 report "Lake Whatcom Water and Sewer District Reservoir Seismic Vulnerability Assessment Technical Report" by BHC Consultants, a seismic evaluation of the WTP Reservoir was performed. The evaluation found the shell, foundation, and anchorage to be adequate for the predicted seismic forces. The two deficiencies identified were inadequate uplift resistance of the foundation and lack of piping flexibility. The retrofit recommended in the report to address the foundation uplift deficiency is to construct a widened foundation ring wall. To address the lack of flexible piping, it is recommended in the report that force-balanced FLEX-TEND® couplings be installed. The report estimates the cost of these retrofits to be $156,000. After applying 4 years of construction cost escalation, the estimate increases to $200,000 which includes materials, contingency, Washington State sales tax, and design/project administration.

EXHIBIT A

MAIN BUILDING PHOTOS

FIGURE A-1

Restroom Wall Framing

FIGURE A-2

Wall-Mounted Transformer

FIGURE A-3

HVAC Unit

FIGURE A-4

Fluid Piping

FIGURE A-5

Electrical Panels

EXHIBIT B

PUMP BUILDING PHOTOS

FIGURE B-1

Generator Exhaust

FIGURE B-2

Gas Heating Unit

FIGURE B-3

Natural Gas Piping

FIGURE B-4

Fluid Piping

FIGURE B-5

Gas Meter

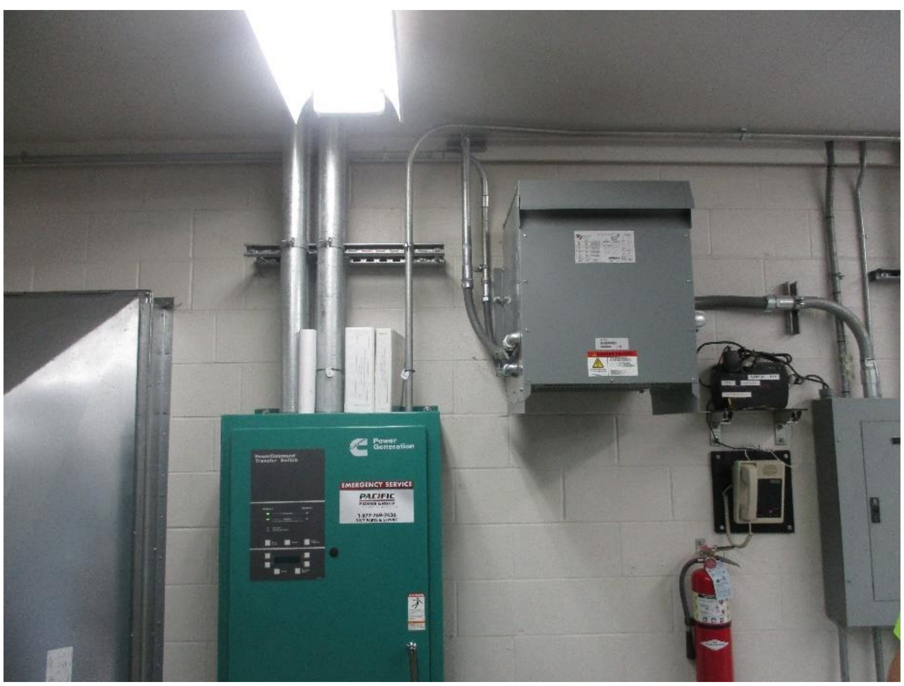

FIGURE B-6

Wall-Mounted Transformer

FIGURE B-7

Water Heater

FIGURE B-8

Conduit Runs

FIGURE B-9

Electrical Panels

EXHIBIT C

SEISMIC RETROFIT COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-3 - Recommended Main Building Seismic Retrofits
October 6, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Restroom wall framing - Bracing	1	LS	$ 7,000	$ 7,000
2	Wall mounted transformer – Bracing	1	LS	$ 4,000	$ 4,000
3	HVAC unit – Bracing	1	LS	$ 4,000	$ 4,000
4	Fluid piping – Bracing	1	LS	$ 20,000	$ 20,000
5	Fluid piping – Flexible connections	1	LS	$ 30,000	$ 30,000
6	Electrical panels - Anchorage	1	LS	$ 7,000	$ 7,000

Subtotal*	**$ 72,000**
Contingency (20%)	$ 14,400
Subtotal	**$ 86,400**
Washington State Sales Tax (9.0%)**	$ 7,800
Subtotal	**$ 94,200**
Design and Project Administration (25.0%)***	$ 23,600
TOTAL CONSTRUCTION COST	**$ 118,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-3 - Recommended Pump Building Seismic Retrofits
October 6, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Shear wall – Connection to diaphragm	1	LS	$ 18,000	$ 18,000
2	Diaphragm – Shear nailing	1	LS	$ 25,000	$ 25,000
3	Roof replacement	1	LS	$ 60,000	$ 60,000
4	Masonry partition walls – Replace	1	LS	$ 20,000	$ 20,000
5	Generator exhaust - Bracing	1	LS	$ 3,000	$ 3,000
6	Gas heater – Bracing	1	LS	$ 3,000	$ 3,000
7	Natural gas piping – Bracing	1	LS	$ 6,000	$ 6,000
8	Wall mounted transformer – Bracing	1	LS	$ 3,000	$ 3,000
9	Fluid piping – Bracing	1	LS	$ 7,000	$ 7,000
10	Fluid piping – Flexible connections	1	LS	$ 15,000	$ 15,000
10	Gas meter – Flexible connection	1	LS	$ 5,000	$ 5,000
11	Water heater – Add restraint	1	LS	$ 2,000	$ 2,000
11	Conduit – Bracing	1	LS	$ 5,000	$ 5,000
12	Electrical panels - Anchorage	1	LS	$ 6,000	$ 6,000
				Subtotal*	**$ 178,000**
				Contingency (20%)	$ 35,600
				Subtotal	**$ 213,600**
				Washington State Sales Tax (9.0%)**	$ 19,200
				Subtotal	**$ 232,800**
				Design and Project Administration (25.0%)***	$ 58,200
				TOTAL CONSTRUCTION COST	**$ 291,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax

APPENDIX F

TECHNICAL MEMORANDUM 20434-4, SUDDEN VALLEY WTP CHEMICAL SYSTEMS ANALYSIS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-4

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	SEPTEMBER 19, 2022
SUBJECT:	SUDDEN VALLEY WTP CHEMICAL SYSTEMS ANALYSIS LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively provide clean potable water for the existing and projected service areas.

This memorandum summarizes the assessment of the existing chemical systems at the WTP, provides alternatives for chemical delivery, and makes recommendations for modifications to the chemical systems. Cost estimates for the alternatives and recommended modifications are also provided.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and

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commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains source, treatment, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that can be used during emergency situations.

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD) but currently operates at approximately 1.0 MGD (700 gallons per minute [gpm]). The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before finished water is pumped to the distribution system and storage reservoirs.

Historically, the plant has performed well and provides high-quality finished water with turbidities of less than 0.1 nephelometric turbidity units (NTU). Raw water is collected from the adjacent Lake Whatcom from an outfall located at a depth of approximately 80 feet and approximately 200 feet from the typical shoreline. Lake Whatcom is a large lake that is moderately developed on the northern and western shores but is largely undeveloped on its eastern shore. Raw water quality from the Lake Whatcom source is fairly consistent with turbidities below 1.0 NTU for most of the year. Turbidity increases during the spring and fall runoff seasons, but typically remains below 5.0 NTU during these periods. Raw water pH is typically between 7.5 and 7.7 and raw water temperature varies between 6 and 8 degrees Celsius.

As mentioned above, the District is interested in investigating all of the treatment systems in place at the WTP and assessing whether improvements/modifications are recommended or required, a timeframe to complete any modifications, and how the modifications might fit into the larger picture of improving the overall treatment performance. There are two primary chemical systems in place at the WTP. The District adds potassium aluminum sulfate to the raw water to aid with coagulation of suspended solids, and adds soda ash to the filtered water for pH control. A description of the equipment associated with each of these systems is provided below.

Coagulant

The District adds potassium aluminum sulfate (alum) to raw water upstream of the existing flocculation tank to optimize the coagulation of particles prior to direct filtration. Alum is commonly used as a coagulant aid in water treatment, especially in plants utilizing a surface water source. The District purchases alum from a commercial vendor and has it delivered to the WTP. The vendor connects a hose from the delivery vehicle to a 3-inch diameter tank inlet camlock fitting and pumps the alum solution into a storage tank located within the WTP Main Building approximately once every 3 months. The strength of the alum solution delivered to the WTP is approximately 49 percent and the operations staff target a dose of 27 milligrams per liter (mg/L) (parts per million [ppm]) to the raw water prior to flocculation. Given that the WTP often operates for up to 16 hours during the summer months, this results in an average daily alum solution consumption of approximately 17 to 20 gallons.

The existing storage tank has a capacity of 1,900 gallons, a diameter of 6.2 feet, and an overall height of 8.5 feet. The tank is fully molded and was originally installed in 1992. The existing tank is equipped with a 12-inch threaded manway on top of the tank, a 3-inch diameter vent fitting connected at the top of the sidewall, and a 3-inch drain fitting near the floor. The tank does not contain any seismic bracing or restraints.

The storage tank feeds a single diaphragm metering pump which moves alum solution from the tank to the injection location on the raw water piping upstream of the flocculation tank. The metering pump is a PULSAtron Series E with a capacity of 44 gallons per day (gpd) at a maximum pressure of 100 pounds per square inch (psi). The alum feed pump is manually calibrated daily using a graduated cylinder near the injection location. Based on the daily calibration, the dose rate from the pump is modified and/or the WTP staff performs maintenance on the pump/piping to address flow issues.

The WTP utilizes a current streaming monitor to monitor the dose of alum. It is important to note that the alum dose is manually controlled; however, the operations staff use the current streaming monitor to note abrupt changes in the dosing system and/or raw water quality.

The alum chemical system components are shown on Figures A-1, A-2, and A-3 in Exhibit A.

With regard to the alum chemical dosing system, the Sudden Valley WTP Assessment Report (Assessment Report) completed by Gray & Osborne in July 2020 noted that the existing alum storage tank is in fair/poor condition, is beyond its recommended useful life, lacks seismic restraints or tie-downs, does not have direct line of sight from the parking lot during filling, does not contain level sensing equipment, is adjacent to electrical equipment including MCC 2, and that the chemical metering pump must be calibrated on a daily basis by removing the injection fittings from the raw water piping. Addressing these shortcomings is one of the District's primary goals for improving the chemical delivery system.

Soda Ash

The second chemical utilized at the WTP is soda ash for pH control. Soda ash is mixed and stored in a 1,200-gallon, open-top, welded steel tank with a diameter of 5.6 feet and a height of 6 feet. The tank includes two rim-mounted shaft-driven mixers as well as a polycarbonate hinged access lid. The tank does not contain any seismic restraints, but does contain a 2-inch PVC process water connection where water is added to the tank. The tank is accessed by a set of four steps and a loading platform located adjacent to the tank.

Bags of dry soda ash are delivered to the WTP by a commercial vendor where staff transfer the bags to a rolling cart, which is used to transport them to their various temporary storage locations within the WTP. WTP staff must prepare the soda ash solution as needed by manually adding 50-pound bags of dry soda ash to the tank. When additional soda ash solution is required, the staff haul the bags up a small platform and manually dump them into the soda ash storage tank. Filtered water is then added to the tank in the appropriate volume to create the dosing solution. Approximately 16 to 20 bags of soda ash are mixed approximately every 11 to 12 days to create the dosing solution, which is equivalent to approximately 80 pounds per day (lb/d). Given the delivery and offloading sequence described above, creating one batch of dosing solution requires three separate lifting sessions of 800 to 1,000 pounds each for WTP staff.

Soda ash solution is delivered from the storage tank to the injection location via a PULSAtron Series E diaphragm metering pump with a listed capacity of 600 gpd and a maximum pressure of 30 psi. The chemical metering pump is located at an elevation near the top level of the soda ash storage tank in order to reduce potential for crystallization within the check valve and to reduce the risk of siphoning. The soda ash feed pump is manually calibrated daily using a graduated cylinder near the injection location. Based on the daily calibration, the dose rate from the pump is modified and/or the WTP staff performs maintenance on the pump/piping to address flow issues. Soda ash solution is injected to the filtered water piping immediately downstream of the filters, just before the water enters the below-grade clearwell.

The soda ash chemical system components are shown on Figures A-4, A-5, and A-6 in Exhibit A.

The Assessment Report noted that the tank is in good condition, the associated rim-mounted mixer is in poor condition, and that the access platform for adding soda ash is in fair condition but occupies a large amount of floor space at the entrance to the WTP. The tank and platform do not contain seismic restraints, and the chemical metering pump system is prone to siphoning and must be manually calibrated on a daily basis by removing the injection fittings. Furthermore, the Assessment Report noted that the storage of large volumes of soda ash, both dry and wet, may be contributing to corrosion and/or degradation of electrical or mechanical equipment within the WTP Main Building. Lastly, it was noted that the current system required staff to move 50-pound bags of soda ash at least three times in order to create the dosing solution.

The District is interested in replacing the alum tank since the existing tank has reached the end of its useful life, providing seismic bracing for the tank, and installing a more reliable, user-friendly metering pump system. The District is also interested in optimizing their soda ash delivery system, providing seismic bracing for the dosing tank, and separating the chemicals from the electrical components to preserve and/or extend their service life. The section below provides alternatives to the current chemical delivery system equipment and locations as a means of achieving these goals.

ALTERNATIVES ANALYSIS

The alternatives listed below are provided to help the District determine the best course of action for their chemical dosing systems. Any modifications to these systems should be considered in the context of other changes that are recommended or desired for the WTP. First, we will discuss alternatives for coagulant addition.

Coagulant

Alternative C1 – Liquid Alum Coagulant

This alternative includes continued use of liquid alum coagulant prior to flocculation. Alum would continue to be delivered by a commercial vendor and transferred from the delivery vessel to a temporary storage tank. A new chemical metering pump skid would then pump the solution from the storage tank to the injection location.

Because the existing alum storage tank is beyond its recommended useful life of 15 to 17 years, the tank should be replaced. The new alum storage tank should be between 1,800 and 2,300 gallons (existing alum storage tank is 1,900 gallons) to provide sufficient storage for alum, minimize frequency for deliveries, and minimize potential for chemical stagnation and/or breakdown of the alum solution. The new tank should include the following components:

- Large (>16-inch diameter) top-side lid for tank access.
- Multiple (two to three) 2- or 3-inch top-side bulkhead fittings to accommodate items such as level sensors, mixers, cables, vent piping, etc.
- Seismic anchors or brace-plates with cables to secure the tank during a seismic event.
- A 3-inch fill connection that is routed to the WTP exterior to provide easy connection for delivery vehicles. This piping should be equipped with a check valve, camlock fitting connection, and should be located in an area where spills or leaks are easily cleaned or can be directed to the municipal sewer system.
- Molded graduated markings to allow for manual estimation of volume of liquid within the tank.
- Level sensor that will relay the liquid level within the tank to the WTP SCADA system.
- A 2- or 3-inch drain fitting that will allow for full and complete drainage of the tank.
- HDPE tank base or concrete equipment pad to accommodate the flange width of the drain connection.

Although the existing storage tank is located in the WTP Main Building, alum is classified as corrosive and its use within the WTP Main Building may expedite degradation of the other mechanical and electrical equipment. Given its corrosivity, it may be beneficial to relocate the alum storage tank to a location outside the WTP Main Building. This could be accomplished by constructing an unenclosed covered area for the storage tank, extending the existing WTP to the north to include a chemical storage room, or constructing a separate Chemical Storage Building.

An unenclosed covered area does not provide protection from moisture or cold temperatures, which would restrict the storage of any dry chemicals and would necessitate the need for insulation and/or heat-trace on any chemical storage tanks or piping. As such, a covered exterior storage space will not be considered further. Additional storage space could be created by extending the existing WTP to the north and enclosing the space which would provide area suitable for chemical storage and any other components as desired. An additional 20 to 25 linear feet should provide suitable space to accommodate alum storage, additional chemical storage, access for deliveries, and isolation from existing treatment equipment and electrical components. A third option is to construct a stand-alone building to house treatment chemicals. The building would include access doors as well as heating and ventilation equipment and should be approximately 500 square feet.

Because of the various uncertainties and unknowns associated with extending an existing building structure, we recommend that if the District wishes to relocate the existing coagulant system in order to provide separation from the existing electrical equipment, a new separate building should be constructed.

For comparison purposes, two installation alternatives are provided here. One is to continue to use liquid alum as a coagulant, to replace the existing storage tank and metering pump system, but continue to store and pump the alum solution within the existing WTP Main Building. This alternative would provide new alum handling equipment but would not address its proximity to electrical equipment, which may be contributing to deterioration and/or corrosion of the electrical components. This alternative is estimated to cost $64,000 which includes construction, contingency (25 percent), Washington State sales tax (9.0 percent), and project design/administration (25 percent). A preliminary cost estimate is included in Exhibit B.

A second installation alternative includes continued use of liquid alum as a coagulant and replacing the existing storage tank and metering pump system, but relocating the new alum handling equipment to a new separate building. This alternative addresses both shortcomings noted with the alum handling equipment as well as the proximity to existing electrical equipment. This alternative is estimated to cost $1,139,000 which includes construction, contingency (25 percent), Washington State sales tax (9.0 percent), and project design/administration (25 percent). A preliminary cost estimate is included in Exhibit B. If a new building is constructed, it would be provided with HVAC equipment to provide heating for the new space. This new heating equipment will increase the electrical load for the WTP. To accommodate this new load, new electrical supply will be sub-fed from the existing electrical service to the Finished Water Pump Building. For the purposes of this investigation, it is assumed that the existing electrical supply is able to accommodate the additional electrical loads for new HVAC equipment. The cost estimate also includes some moderate site improvements including new storm collection equipment and new asphalt paving.

Alternative C2 – Use of Dry Alum Coagulant

This alternative includes utilizing dry alum chemical and installing a dry chemical handling system. The District would then make up their own alum solution as needed, provide temporary storage in a new dosing tank, and meter the alum solution into the raw water via a new metering pump skid.

Dry alum is available in 25-/50-pound bags and as such, must be manually added to a hopper or directly to the solution tank. Dry chemical handling systems are available and allow owners to handle/store large volumes of dry chemical, add various amounts of this chemical to a container to create a dosing solution, then inject that solution into the media of interest. Specialized offloading, handling, storage, and mixing equipment that is very expensive and requires a large footprint can also be used to assist WTP staff with creating the dosing solution.

Very few municipal water treatment facilities utilize dry alum, mostly because it requires additional expensive handling equipment, requires interaction by WTP personnel in which they are exposed to chemical dust, and requires large areas for dry chemical storage. The existing WTP Main Building does not currently have the space required to accommodate this mechanized equipment or the required chemical storage and as such, a new Chemical Storage Building would be required.

For these reasons as well as the fact that the WTP only requires alum delivery approximately every 3 months, this option will not be considered further.

Alternative C3 – Investigate Alternative Coagulants/Polymers

This alternative includes utilization of alternative coagulants which may optimize the flocculation process.

Various coagulant chemicals are used in water treatment, including alum, ferric chloride, polyaluminum chloride (PAC), cationic polymers, and aluminum chlorohydrate, among others. The primary purpose of coagulants is to destabilize the electrical charge for various colloids and suspended particles found in a raw water source in order to promote the creation of larger particles that are more easily removed through filtration. Coagulants are commonly used in water treatment, especially for facilities that utilize a surface water source.

It may be possible to further optimize the coagulation/flocculation process through the use of alternative coagulants. Some considerations for the use of alternative coagulants are summarized in Table 1.

TABLE 1

Coagulant Chemical Summary

Coagulant	Relative Cost	Advantages	Disadvantages
Aluminum Sulfate (Alum)	$	• Most commonly used coagulant • Readily available • Documented success for District	• Can generate large volumes of solids for highly turbid sources
Ferric Chloride	$$	• Excellent for high TOC source water • Readily available • Use is typically 2/3 that of alum	• Highly corrosive
PAC	$$	• Many customized varieties available	• Use is typically 1.3–1.5 that of alum
Cationic Polymers	$$$$$	• Commonly used for low-turbidity water • Typically generates fewer solids when compared to alum • Can reduce alum dose for certain source waters	• Should be optimized regularly • Not as readily available • Often used in *conjunction* with alum
Aluminum Chlorohydrate	$$$$		• Rarely used, except for membrane facilities

Table 1 highlights the relative cost and some of the advantages and disadvantages for each type of coagulant. Alum and ferric chloride are available in large volumes from commercial vendors while PAC, cationic polymers, and aluminum chlorohydrate are typically provided in 55-gallon drums. Because the District has documented success using alum coagulant, alum is the most inexpensive coagulant, is readily available, and is the most commonly used coagulant when compared to other alternatives, we recommend that the District continue to utilize liquid alum for coagulation at the WTP. Additional recommendations on further modifications to the location of the storage tank and method of alum injection are provided later in this memorandum.

Chemical Metering

Regardless of which alternative is selected or whether chemical storage equipment is relocated to a new building, additional chemical metering equipment is recommended. New metering equipment will provide the WTP operations staff with increased flexibility and accuracy for determining the dose of chemicals as well as provide for safeguards against failure or malfunction of the system components.

We recommend that the District provide space and equipment for a chemical delivery skid that includes the piping, appurtenances, and pumps required for chemical injection. These skids can be preassembled and can include pumps provided by a specific manufacturer, or can be left open for pump selection by the District. Figure A-7 shows a schematic diagram for a typical metering pump skid while Figure A-8 shows some photographs of duplex delivery skids used for chemical delivery in a drinking water application. The metering pump skid would include the following components:

- Chemical metering pump(s)
- Isolation valves
- Pressure relief valves
- Backpressure valves
- Pressure gauges
- Pulsation dampener
- Calibration column
- Flexible connections for inlet and outlet
- HDPE backplate of skid for wall/floor mounting

Providing a metering pump skid with a calibration column would allow the WTP operations staff to calibrate the metering pumps daily without having to remove piping connections, which can lead to deterioration of the fittings and chemical leaks or spills. Only one metering pump is proposed as part of this alternative. A second metering pump would provide redundancy and could be provided as a spare if desired or could be integrated to the metering pump skid along with the required valves and controls. A skid that includes two pumping units is typically called a duplex metering skid and examples of these are shown on Figure A-8. The metering pump flow would be flow paced and based off of the raw water flow as measured by the raw water flow meter. The cost for a prefabricated metering skid is between $8,000 (single pump) and $14,000 (duplex) depending on the pump size, type, and features.

Soda Ash

Similar to the alternatives for coagulant listed above, three soda ash addition alternatives are described below. Although there are several methods for pH adjustment of potable water including caustic soda, lime, soda ash, and aeration, these methods utilize chemicals that are more dangerous, expensive, or utilize large, specialized equipment for injection/handling. Furthermore, the District has successfully utilized soda ash for many years to meet their treatment goals. Because other chemicals are more costly, require additional equipment, and because the District has developed a level of familiarity and comfort with using soda ash, they are interested in continuing to utilize soda ash for finished water pH control. As such, only delivery methods and metering pump alternatives are explored in this section.

<u>Alternative S1 – Manual Addition of Dry Soda Ash</u>

This alternative includes manual addition of soda ash to a temporary storage tank where it will be diluted with water to create the dosing solution – identical to the current method of soda ash injection used at the WTP.

Currently, WTP staff carry 50-pound bags of dry soda ash up four steps to the loading platform, where the bags are emptied into the soda ash dosing tank. This process requires that staff move each soda ash bag at least three times – from the delivery truck to a cart, from the cart to the temporary storage location, and from this temporary location to the dosing tank – prior to use. This process is cumbersome, difficult for operations staff, and requires that the soda ash chemical be stored within the WTP Main Building where it is in close proximity to electrical and mechanical equipment.

Based on findings from the Assessment Report, the existing soda ash storage tank is in good condition and could be reused. The loading platform shows signs of corrosion and should be prepared and coated to prevent additional corrosion. The existing rim-mounted mixer is in poor condition, is highly corroded, and should be replaced with a similar size unit. Because soda ash is a corrosive chemical and can contribute to degradation of the electrical and/or mechanical equipment, it may be beneficial to relocate the soda ash storage tank to a location outside the WTP Main Building. This could be accomplished by extending the existing WTP to the north to include a chemical storage room or constructing a separate building as discussed for the coagulant alternative analysis.

Given the difficulties and uncertainties of adding on to an existing building, if the District wishes to provide separation between the soda ash delivery equipment and the electrical equipment, we recommend that the soda ash chemical equipment be relocated to a new building. This building can be CMU/wood truss construction and can be located adjacent (north) to the existing WTP. While approximately 500 square feet is needed for the chemical systems discussed in this memorandum, we recommend that the District construct a building suitable to accommodate other equipment and/or modifications recommended in other supporting technical memoranda prepared as part of this project. If a new building is constructed, the soda ash and coagulant systems should be relocated to the new building in order to provide separation between the chemicals and electrical equipment and to free up space in the existing WTP Main Building.

This alternative includes relocating the existing storage tank to a new separate building, providing the tank with seismic bracing, installing a new chemical metering pump skid, and refurbishing the existing loading platform and access steps for installation in the proposed building. This alternative is estimated to cost $1,128,000 which includes construction, contingency (25 percent), Washington State sales tax (9.0 percent), and project design/administration (25 percent). A budgetary project estimate is provided in Exhibit B. The proposed building would be as described in Alternative C1 and would include HVAC modifications, electrical modifications, and site improvements.

Alternative S2 – Mini-Bulk Addition of Dry Soda Ash

This alternative includes delivery of dry soda ash within a mini-bulk, or super sack storage vessel, offloading the chemical from the delivery vehicle, and staging it onto the loading and distribution equipment where it is delivered to the storage tank via a shaftless screw conveyor or a pneumatic blower.

For this alternative, the District would accept deliveries of dry chemical via super sacks. Super sacks are large, woven bags used to transport various chemicals or other items and are commonly used to transport and/or deliver chemicals to treatment facilities because of their large capacity (~2,000 pounds) and small footprint (4-foot square pallet). Super sacks are filled using specialized equipment by a chemical manufacturer, shipped to a local distribution center, and then delivered to the end user. Because of their large size and weight, super sacks require specialized equipment for offloading and handling. For offloading, the end user is required to provide a forklift to remove the chemical from the delivery vehicle and stage it onto the loading and distribution equipment. One example of loading and distribution equipment is shown on Figure A-9. The equipment includes a steel frame, vibrating hopper, regulation valves, and a shaftless screw conveyor. This structure is typically freestanding and has a footprint of 36 square feet and a height of 15 feet. This equipment will not fit within the existing WTP Main Building and as such, the existing WTP would need to be extended or a separate building must be constructed as described in the discussion on coagulant alternatives.

Super sack or mini-bulk applications are designed to minimize manual handling of chemicals and would minimize the number of chemical additions to the soda ash solution storage tank. Given the current average annual consumption of approximately 80 lb/d, the District would need to procure approximately 15 super sacks each year for their operations.

This alternative includes relocating the existing soda ash storage tank to a new building, providing the tank with seismic bracing, installing a new chemical metering pump skid, and refurbishing the existing loading platform and access steps for installation in the proposed building. It also includes a new super sack handling and dry chemical delivery system with a freestanding frame, vibrating hopper, and shaftless screw conveyor. This alternative is estimated to cost $1,246,000 which includes contingency (25 percent), Washington State sales tax (9.0 percent), and project design/administration (25 percent). A preliminary project cost estimate is provided in Exhibit B.

<u>Alternative S3 – Liquid Soda Ash Delivery</u>

This alternative includes delivery of liquid soda ash solution via a commercial vendor and injection using a new chemical metering pump system.

Liquid soda ash solution would be delivered to the WTP that is ready for immediate use. The solution is typically provided in 55-gallon drums or 300-gallon totes, and the chemical metering pumps can pump directly from these containers to the injection location. The current cost for 10 percent soda ash solution is approximately $0.22 per pound, which is nearly 2.5 times more expensive than dry soda ash delivered in 25-/50-pound bags as described in Alternative C2 above.

Given the current average consumption of approximately 20 gallons of 10 to 11 percent solution each day (80 pounds of soda ash per day), it is estimated that a 55-gallon drum or a 300-gallon tote would last approximately 2.5 and 15 days, respectively. To provide sufficient redundancy and to accommodate temporary delays in chemical supply, the District should have at least five drums and three totes on site at any time. This will create logistical difficulties for storage of sufficient volume of solution, delivery of new solution, and coordination for removal of used barrels.

Bulk storage of liquid soda ash is also possible, but is uncommon in the Pacific Northwest and vendors are reluctant to deliver partial tankers of chemical due to the high cost of transportation and restocking. Alternatively, vendors charge a premium price for bulk delivery, which makes this form of soda ash not cost effective. To avoid these logistical and coordination challenges and because of the low solubility of soda ash and the cost for preparation and delivery from a commercial vendor, this alternative is not cost effective and will not be considered further.

Chemical Delivery

Regardless of which alternative is selected or whether chemical storage equipment is relocated to a new building, additional chemical delivery equipment is recommended. This additional delivery equipment will provide the WTP operations staff with increased flexibility and accuracy for determining the dose of chemicals as well as provide for safeguards against failure or malfunction of the system components.

The recommended chemical injection system is identical to that described above for the coagulant chemical system.

SUMMARY OF RECOMMENDATIONS AND COST ESTIMATES

As noted above, the District has had good success utilizing liquid alum delivered via a commercial vendor as a coagulant for their water treatment process. However, it was noted that the existing alum storage tank is beyond its recommended useful life, does not contain seismic restraints, is cumbersome to fill and lacks direct line of sight between the parking lot and the tank, and the chemical metering pump equipment requires manual calibration on a daily basis. Furthermore, the proximity of chemicals and moisture to electrical and mechanical equipment may be accelerating the corrosion exhibited on this equipment.

Because liquid alum is a cost-effective coagulant with a proven track record of success for the Lake Whatcom source, we recommend that the District continue to utilize liquid alum coagulant delivered by a commercial vendor. Furthermore, we recommend that the WTP relocate the chemical systems to a new building in order to provide separation from the electrical components, additional chemical storage capacity, and line of sight for chemical deliveries. Lastly, we recommend that the chemical metering systems be upgraded to include metering pump skids that include calibration columns and various valves/piping to reduce the level of effort required to calibrate the chemical dosing equipment.

The proposed building would accommodate the new alum storage tank and chemical metering skid. The tank would have the design criteria listed in Table 2.

TABLE 2

Proposed Alum Storage Tank Design Criteria [(1)]

Parameter	Value
Material	HDPE
Capacity (gallons)	2,500
Diameter (inches)	90–96
Height (inches)	98–107
Access Port Diameter (inches)	18
Accessories Included	3-inch full drain fitting 3-inch topside vent fitting 3-inch topside fill fitting 2-inch topside NPT bulkhead fittings (2x) Ultrasonic level sensor Seismic tiedown package Seismic calculation package Ladder lugs Molded graduated markings

(1) Tank based on Snider 5090000N-(L) and 5090300N–.

We also recommend that the District utilize a chemical metering pump skid to move alum from the storage tank described above to the injection location in the WTP Main Building. The metering pump skid would include a single pump as well as the components listed previously.

For soda ash, we recommend that the existing tank be relocated to the proposed chemical building and provided with seismic bracing. The existing mixer should be replaced with a new, similarly sized unit, and the existing platform should be sandblasted and recoated to prevent additional corrosion. Additionally, we recommend that a custom shelf be fabricated and rest on the wall of the soda ash tank. This will allow WTP staff to rest the soda ash bags on the shelf, cut the soda ash bags, and dump them to the tank with minimal lifting and hoisting, thus reducing the physical load on the staff during soda ash addition.

The proposed building should be at least 500 square feet and would include two double doors and one 10-foot wide manually operated coiling door. This will allow for suitable access to the building and easy chemical delivery. The building should be large enough to accommodate the chemical delivery and storage equipment, additional dry chemical storage, and still be expandable as required based on future needs. The building will be provided with electrical service, and this service will be sub-fed provided from the existing WTP Finished Water Pump Building supply. New heating and ventilation equipment will be provided for the building, which will increase the overall electrical load. The additional load will be relatively small and as such, it is assumed that the existing electrical service has sufficient capacity. The Assessment Report did note several potential issues with both the capacity of the electrical service for accommodating additional load as well as with the existing utility transformer size. If a new building is constructed as recommended, a formal electrical analysis should be provided once preliminary sizing of the HVAC equipment is available to determine the full scope of electrical modifications required.

The proposed additions are shown on Figure A-10 and a budgetary cost estimate for the recommended modifications including contingency (25 percent), Washington State sales tax (9.0 percent), and project design and administration (25 percent is provided in Exhibit B.

EXHIBIT A

PHOTOGRAPHS OF EXISTING EQUIPMENT

FIGURE A-1

Existing Alum Storage Tank

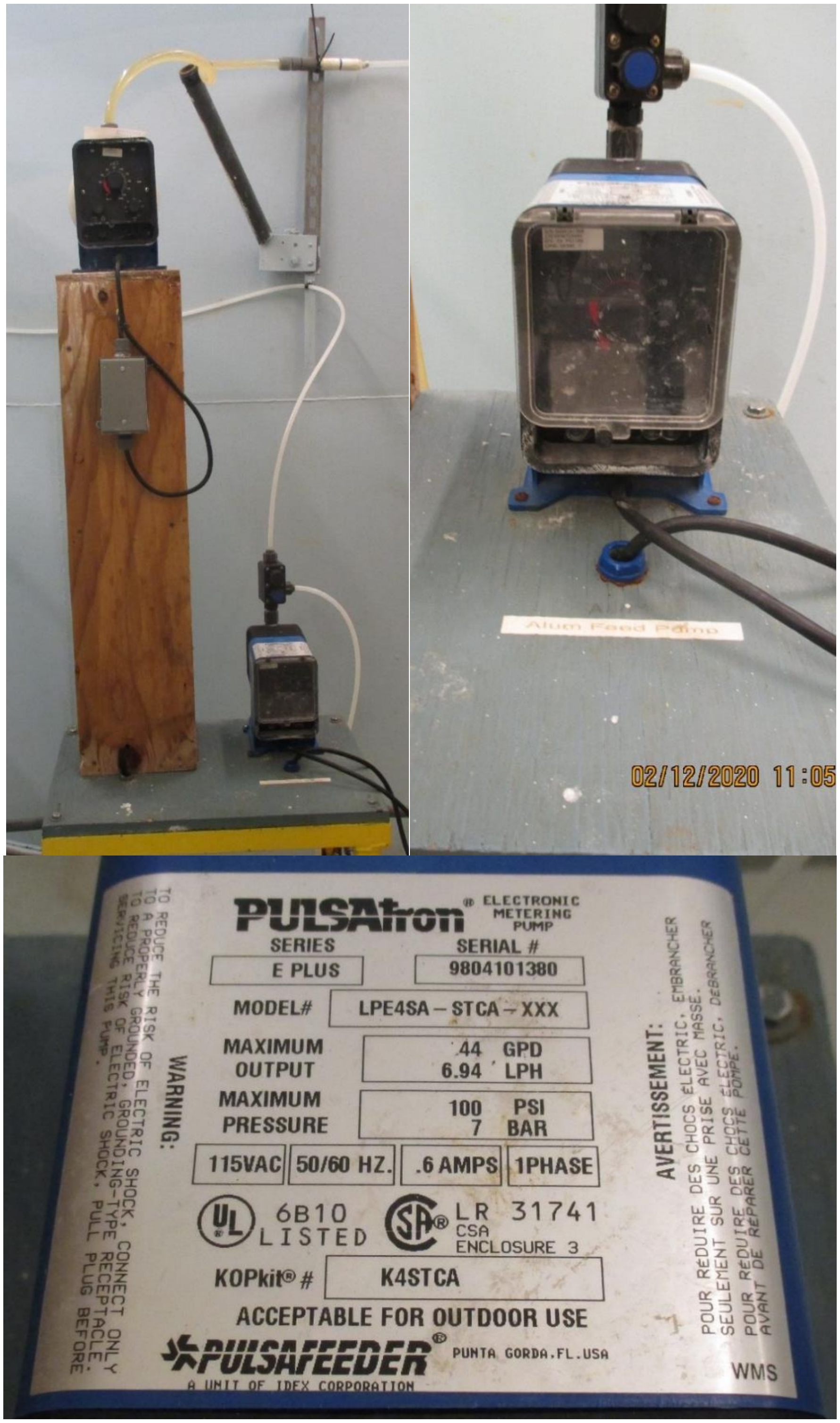


FIGURE A-2

Existing Alum Metering Pump

FIGURE A-3

Existing Alum Injection Location

FIGURE A-4

Existing Soda Ash Storage Tank

FIGURE A-5

Existing Soda Ash Metering Pump

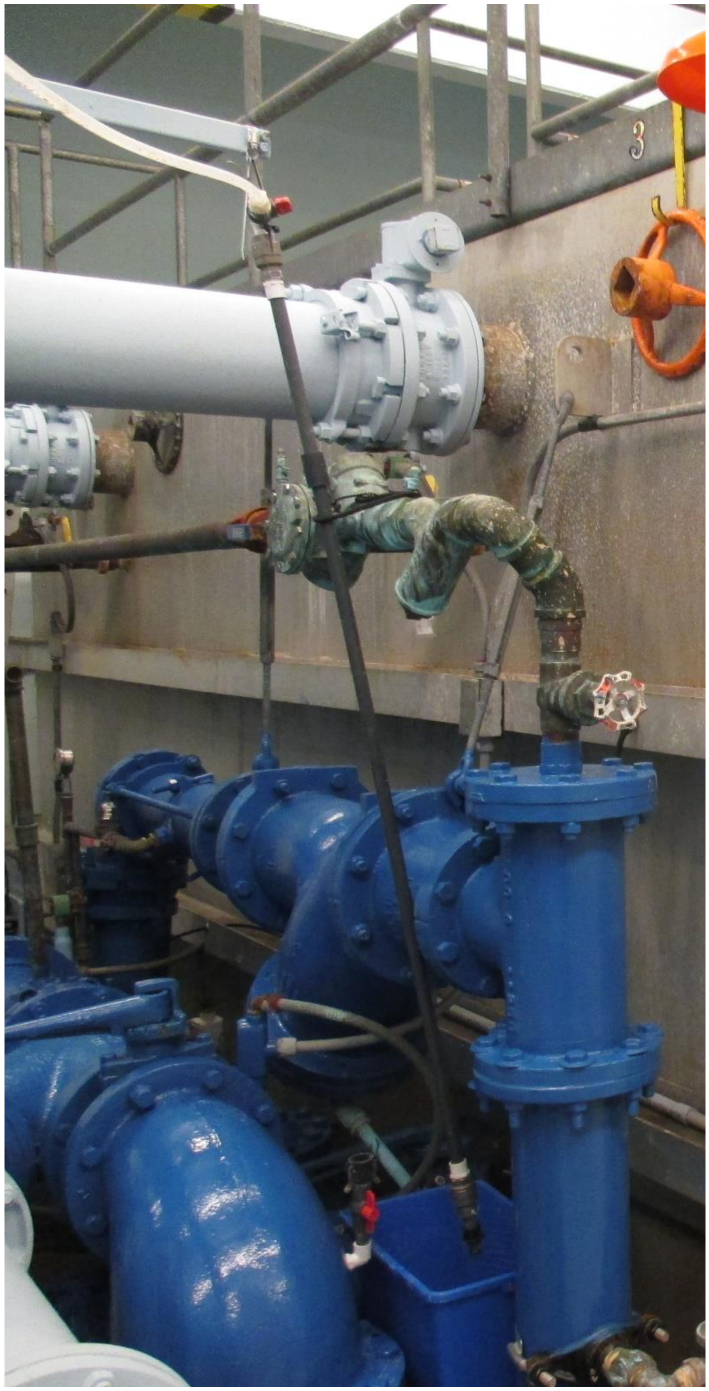
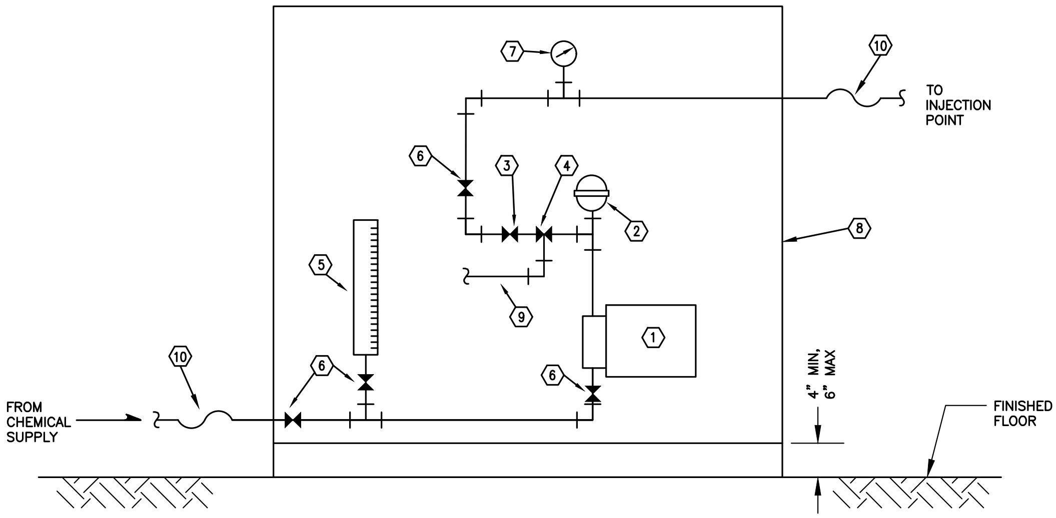


FIGURE A-6

Existing Soda Ash Injection Location



LEGEND:

1 CHEMICAL FEED PUMP
2 PULSATION DAMPENER
3 BACK PRESSURE VALVE
4 PRESSURE RELIEF VALVE
5 CALIBRATION COLUMN
6 ISOLATION VALVE
7 PRESSURE GAUGE
8 FREE STANDING PVC/HDPE SKID & BACKPLATE
9 TO PRESSURE RELIEF CONTAINMENT UNIT
7 FLEXIBLE CONNECTION

CHEMICAL METERING SKID TYPICAL SCHEMATIC

SCALE: 3/8"=1'–0"

0 1"

ONE INCH AT FULL SCALE.
IF NOT, SCALE ACCORDINGLY

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-4
CHEMICAL SYSTEMS ANALYSIS

FIGURE A-7

CHEMICAL PUMP SKID SCHEMATIC

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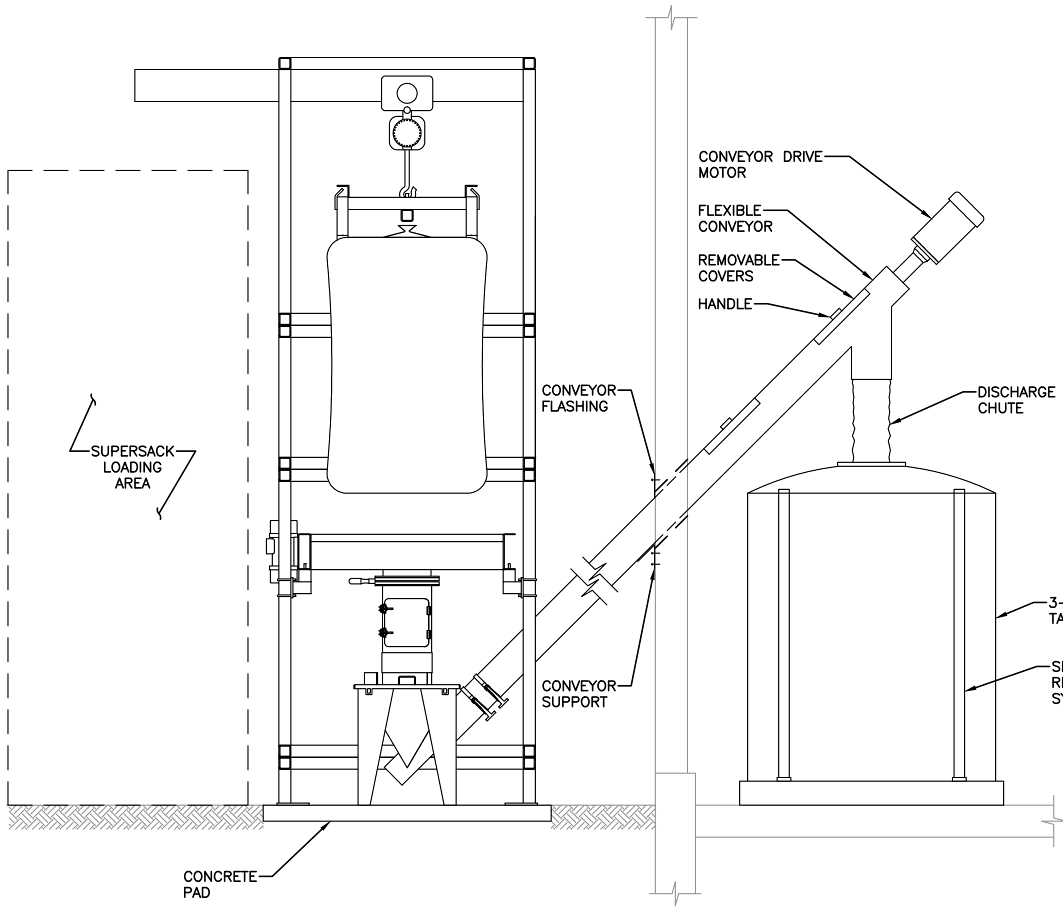
L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\Archive\FIGURE A7.dwg, 11/9/2020 3:13 PM, PHILIP MARSHALL

FIGURE A-8

Typical Duplex Chemical Metering Pump Skids



A
–
ELEVATION
SCALE: 1/4"=1'-0"

0 1"
ONE INCH AT FULL SCALE.
IF NOT, SCALE ACCORDINGLY

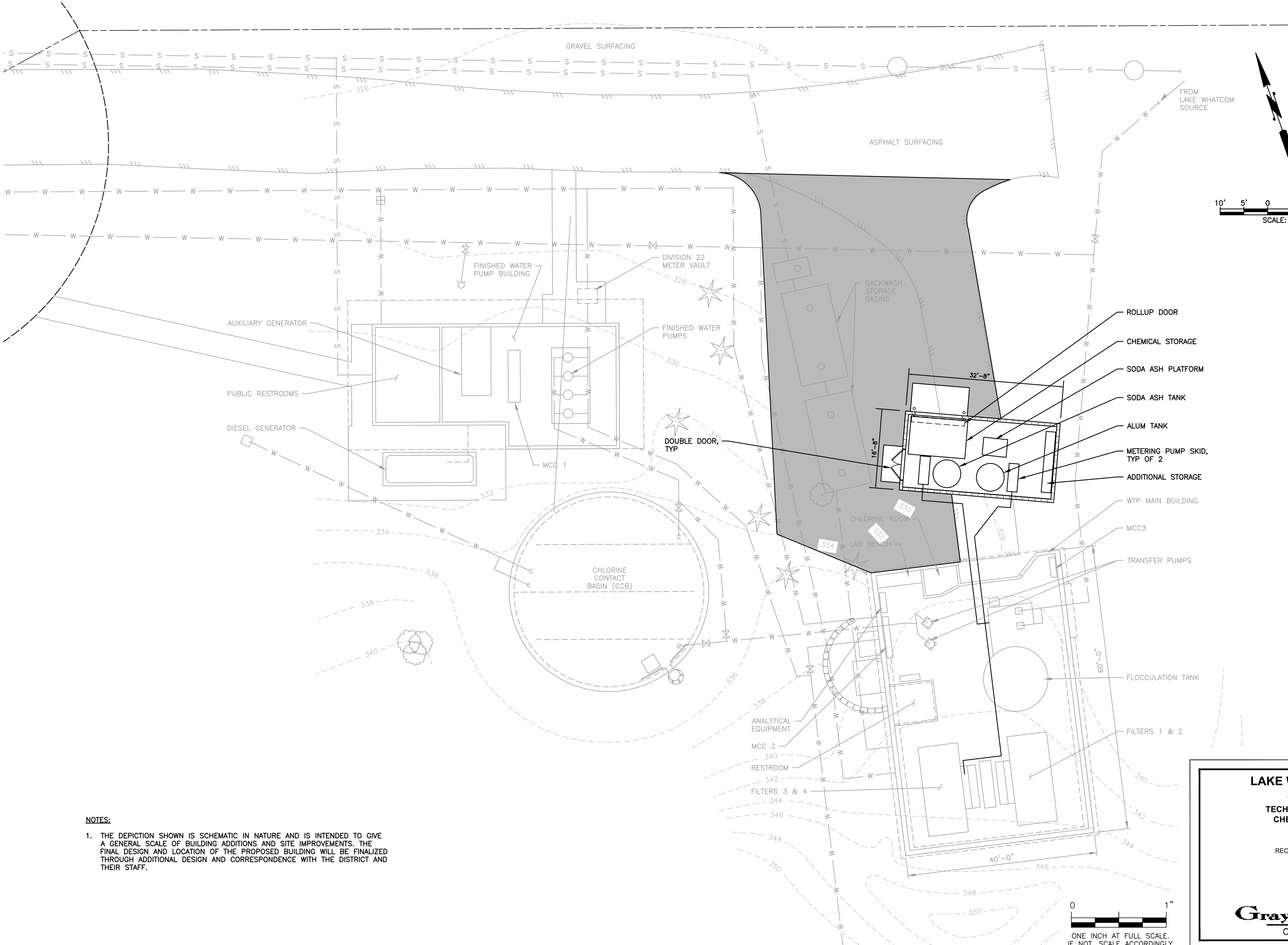
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-4
CHEMICAL SYSTEMS ANALYSIS

FIGURE A-9

SUPERSACK HANDLING EQUIPMENT

Gray & Osborne, Inc.
CONSULTING ENGINEERS



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-4
CHEMICAL SYSTEMS ANALYSIS

FIGURE A-10

RECOMMENDED ALTERNATIVE SITE AND BUILDING PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

EXHIBIT B

RECOMMENDED ALTERNATIVE COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-4 - Liquid Alum in Existing WTP Main Building
November 4, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 6,500	$ 6,500
2	Alum System Modifications	1	LS	$ 18,000	$ 18,000
3	Piping, Valves, and Appurtenances	1	LS	$ 5,000	$ 5,000
4	Telemetry / SCADA Modifications	1	LS	$ 8,000	$ 8,000

Subtotal*	**$ 37,500**
Contingency (25%)	$ 9,400
Subtotal	**$ 46,900**
Washington State Sales Tax (9.0%)**	$ 4,200
Subtotal	**$ 51,100**
Design and Project Administration (25.0%)***	$ 12,800
TOTAL CONSTRUCTION COST	**$ 64,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-4 - Liquid Alum in New Chemical Building
November 4, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 60,800	$ 60,800
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 25,000	$ 25,000
5	New Chemical Building	500	SF	$ 750	$ 375,000
6	Alum System Modifications	1	LS	$ 18,000	$ 18,000
7	Piping, Valves, and Appurtenances	1	LS	$ 15,000	$ 15,000
8	Electrical Modifications	1	LS	$ 100,000	$ 100,000
9	HVAC Modifications	1	LS	$ 40,000	$ 40,000
10	Telemetry / SCADA Modifications	1	LS	$ 10,000	$ 10,000

Subtotal*	**$ 668,800**
Contingency (25%)	$ 167,200
Subtotal	**$ 836,000**
Washington State Sales Tax (9.0%)**	$ 75,200
Subtotal	**$ 911,200**
Design and Project Administration (25.0%)***	$ 227,800
TOTAL CONSTRUCTION COST	**$ 1,139,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-4 - Manual Addition of Soda Ash in WTP Main Building
November 4, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 60,200	$ 60,200
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 25,000	$ 25,000
5	New Chemical Building	500	SF	$ 750	$ 375,000
6	Soda Ash System Modifications	1	LS	$ 12,000	$ 12,000
7	Piping, Valves, and Appurtenances	1	LS	$ 15,000	$ 15,000
8	Electrical Modifications	1	LS	$ 100,000	$ 100,000
9	HVAC Modifications	1	LS	$ 40,000	$ 40,000
10	Telemetry / SCADA Modifications	1	LS	$ 10,000	$ 10,000

Subtotal*	**$ 662,200**
Contingency (25%)	$ 165,600
Subtotal	**$ 827,800**
Washington State Sales Tax (9.0%)**	$ 74,500
Subtotal	**$ 902,300**
Design and Project Administration (25.0%)***	$ 225,600
TOTAL CONSTRUCTION COST	**$ 1,128,000**

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-4 - Mini-Bulk Addition of Soda Ash in New Chemical Building
November 4, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	66,500	$	66,500
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	10,000	$	10,000
4	Site Improvements	1	LS	$	25,000	$	25,000
5	New Chemical Building	500	SF	$	750	$	375,000
6	Soda Ash System Modifications	1	LS	$	15,000	$	15,000
7	Dry Chemical Handling Equipment	1	LS	$	60,000	$	60,000
8	Piping, Valves, and Appurtenances	1	LS	$	15,000	$	15,000
9	Electrical Modifications	1	LS	$	100,000	$	100,000
10	HVAC Modifications	1	LS	$	40,000	$	40,000
11	Telemetry / SCADA Modifications	1	LS	$	10,000	$	10,000

Subtotal*	**$**	**731,500**
Contingency (25%)	$	182,900
Subtotal	**$**	**914,400**
Washington State Sales Tax (9.0%)**	$	82,300
Subtotal	**$**	**996,700**
Design and Project Administration (25.0%)***	$	249,200
TOTAL CONSTRUCTION COST	**$**	**1,246,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-4 - Chemical System Modification Recommendations
November 4, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 63,300	$ 63,300
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 25,000	$ 25,000
5	New Chemical Building	500	SF	$ 750	$ 375,000
6	Soda Ash System Modifications	1	LS	$ 15,000	$ 15,000
7	Coagulant System Modifications	1	LS	$ 18,000	$ 18,000
8	Piping, Valves, and Appurtenances	1	LS	$ 25,000	$ 25,000
9	Electrical Modifications	1	LS	$ 100,000	$ 100,000
10	HVAC Modifications	1	LS	$ 40,000	$ 40,000
11	Telemetry / SCADA Modifications	1	LS	$ 10,000	$ 10,000

Subtotal*	**$ 696,300**
Contingency (25%)	$ 174,100
Subtotal	**$ 870,400**
Washington State Sales Tax (9.0%)**	$ 78,300
Subtotal	**$ 948,700**
Design and Project Administration (25.0%)***	$ 237,200
TOTAL CONSTRUCTION COST	**$ 1,186,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is

APPENDIX G

TECHNICAL MEMORANDUM 20434-5, SUDDEN VALLEY WTP FILTRATION SYSTEMS ANALYSIS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-5

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	FEBRUARY 15, 2022
SUBJECT:	SUDDEN VALLEY WTP FILTRATION SYSTEM ANALYSIS LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water and Sewer District (District) contracted with Gray & Osborne to perform a condition assessment of their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively continue to provide clean potable water for existing and projected customers for decades to come.

This memo summarizes the assessment of the existing filtration system at the WTP, provides alternatives for water filtration, and provides a recommendation for modifications to the existing filter equipment.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

1130 Rainier Avenue South, Suite 300 Seattle, Washington 98144 (206) 284-0860 Fax (206) 283-3206

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley WTP. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD), which is equivalent to approximately 1,400 gallons per minute (gpm), but currently operates at a reduced flow of 1.0 MGD (700 gpm). The maximum allowable water right for this source is 1,526 gpm; however, the equipment and components listed in the alternatives below will be sized to accommodate up to the rated flow of 1,400 gpm. This design flow is suitable to serve the projected buildout water demand of 1.3 MGD as listed in the District's 2018 Water System Comprehensive Plan.

Historically, the plant has performed well and provides high-quality finished water with turbidities of less than 0.1 nephelometric turbidity units (NTU). Raw water is collected from the adjacent Lake Whatcom from an outfall located at a depth of approximately 80 feet and approximately 350 feet from the typical shoreline. Lake Whatcom is a large lake that is moderately developed on the northern and western shores but is largely undeveloped on its eastern shore. Raw water quality from the Lake Whatcom source is fairly consistent with turbidity below 1.0 NTU for most of the year. Turbidity increases during the spring and fall runoff season, but typically remains below 5.0 NTU during these periods. Raw water pH is typically between 7.5 and 7.7 and raw water temperature varies between 6 and 8 degrees Celsius.

The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. Prior to filtration, two centrifugal raw water pumps pump water from the Lake Whatcom intake to the WTP where alum coagulant is injected. After mixing with coagulant, water enters the flocculation basin before entering the filter distribution trough and the mixed-media filters. Water proceeds through the filters into the underdrain system, is combined with soda ash for pH adjustment, then proceeds to the below-grade clearwell. Two transfer pumps located in the WTP move water from the clearwell to the chlorine contact basin, which is a welded steel reservoir located adjacent to the WTP that provides additional chlorine contact time. From the chlorine contact basin, four finished water pumps pump water to the District's storage reservoirs and distribution system for consumption. Additional information on the coagulation, flocculation, and filtration systems – which are the primary subject of this memorandum – are provided below.

Coagulation and Flocculation

The District adds potassium aluminum sulfate (alum) to their raw water upstream of the existing flocculation basin to optimize their removal by coagulation of particles prior to direct filtration. The District purchases alum from a commercial vendor and has it delivered to the WTP. Coagulant is stored within a polyethylene storage tank and then injected to the raw water upstream of the flocculation tank. The existing alum storage tank has a capacity of 1,900 gallons, is a fully molded style, was originally installed in 1992, and does not have any seismic bracing or restraints. The existing alum metering pump is a PULSAtron diaphragm metering pump with a capacity of 44 gallons per day (gpd) at 100 pounds per square inch (psi).

Once alum is injected, raw water flows into the flocculation tank. The flocculation tank is a painted, welded steel tank with a diameter of 13.5 feet, a height of 8.6 feet, and a nominal volume of 9,000 gallons. The tank is divided into three equal sections and water flows through the tank in an over-under-over pattern. WTP staff drain and clean the flocculation tank and static mixer annually and any solids accumulated in the tank are disposed of as refuse. The staff typically remove up to 5 gallons of solids from this cleaning effort. The flocculation tank feeds the filter equalization trough, which in turn diverts water to each of the four filters described below.

The Sudden Valley WTP Assessment Report (Assessment Report) completed by Gray & Osborne in 2019 noted that the alum storage tank is old, in fair/poor condition, is beyond its recommended useful life, lacks seismic restraints or tiedowns, does not have direct line of sight from the parking lot during filling, does not contain level sensing equipment, and is adjacent to electrical equipment including Motor Control Center (MCC) 2. The Assessment Report also noted that the chemical metering pump must be calibrated on a daily basis by removing the injection fittings from the raw water piping which requires additional effort by the staff to maintain optimal chemical feed.

The Assessment Report also noted that the existing flocculation tank shows some localized areas of corrosion and coating fatigue – especially at the base, is undersized for the current and maximum operational flows (according to theoretical design values), is located in the center of the WTP Main Building which restricts access to other treatment components, and contributes to elevated moisture within the building which can lead to damage and/or corrosion of the electrical equipment.

Filtration

Water leaves the flocculation tank via 12-inch diameter ductile iron piping and is conveyed by gravity to the equalization trough. At the trough, water is evenly distributed between two separate filter structures. Filters 1 and 2 are contained within a welded and coated steel vessel while Filters 3 and 4 are contained within a marine-grade aluminum vessel. Both vessels sit atop concrete equipment pads. Each filter vessel contains two filter units and each unit consists of an inlet trough, filter media, underdrain system, surface wash and backwashing equipment, and filtered water piping.

Design criteria and technical information on filter media are listed in Table 1. The surface loading rate for all four filters of 2.4 gpm per square foot (gpm/sf) is within the maximum allowable rate listed by the Washington State Department of Health (DOH) for a multimedia filter (6 gpm/sf). The surface loading rate using only two filters is 4.8 gpm/sf (700 gpm/144 sf), which suggests that the WTP can operate at the typical flow rate with only two filters (one vessel) in service. Typically, the WTP operates for 10 to 16 hours each day, and often longer during warm summer months when water demand is high.

For comparison with the current rated capacity of the WTP (1,400 gpm), all of the filtration alternatives described later in this memorandum will be capable of providing filtration/treatment up to 1,400 gpm, even though the WTP currently operates at a flow of only 700 gpm. Providing filtration capacity up to 1,400 gpm now will allow the District, if desired, the flexibility to address/expand the components that currently limit their flows to 700 gpm. The WTP is physically limited to a flow of 1,000 gpm based on directive from DOH. This restriction is based on the level of CT they can provide with their existing system. The staff operates the WTP at 700 gpm in order to incorporate an additional factor of safety into their operations.

TABLE 1

WTP Filter Media Summary

Parameter	Value
Type	Gravity, Rapid-Rate Direct Filtration
Vessel Dimensions (ft, L x W x H)	8 x 9 x 8
Filter Area (sf)	288 (4 filters at 72 sf each)
Rate of Filtration @ 700 gpm (gpm/sf)	2.4
Rate of Filtration @ 1,000 gpm (gpm/sf)	3.5
Rate of Filtration @ 1,390 gpm (gpm/sf) (1)	4.8
Rate of Filtration @ 1,526 gpm (gpm/sf) (2)	5.3
Rate of Backwash (gpm/sf)	18.0
Design Media Depth (inches)	
#1A Anthracite (1.0 mm–1.1 mm)	18
F16 Sand (0.45 mm–0.55 mm)	9
#50 Garnet Sand (0.28 mm–0.38 mm)	4.5
#12 Garnet Gravel (1.46 mm–1.56 mm)	4.5
#3 Gravel (0.375 in.–0.1875 in.)	3
#2 Gravel (0.75 in.–0.375 in.)	3
#1 Gravel (1.50 in.–0.75 in.)	10

(1) Value is based on the WTP rated capacity of 2.0 MGD.
(2) Value is based on current South Shore Water System water right.

During normal filter operation, water is distributed evenly to all four cells and flows through the filter media and into the respective underdrain chambers. As it passes through the filter media, flocculated sediment and small particles are trapped and removed by the media, while filtered water passes into the underdrain system and on through the discharge piping to the clearwell. The discharge piping at each filter consists of isolation valves, flow control valves, chemical injection fittings, sample taps, and flow meters to ensure consistent operation.

As additional particles are adsorbed onto the filter media, the head loss through the filter media, the turbidity of the filtered water, and the water level within the filter vessel increases. To remove these trapped particles from the filter media, each filter bed is backwashed daily prior to operation. During the backwash of a filter cell, water from the distribution system served by the Division 7 Reservoir flows upward through the filter at approximately 1,300 gpm (18.0 gpm/sf). The backwash flow rate is measured by a magnetic flow meter on the backwash line located on the south wall of the WTP. At this flow rate, the media bed is fluidized to remove the accumulated sediment particles and the particle-laden backwash water flows into the filter cell waste trough and then to the backwash storage basin. Each filter also includes a surface wash system that consists of two supply arms with nine nozzles on each side (18 total nozzles). The pressure and flow of backwash water through these nozzles causes the arms to rotate and disperse spray that agitates the media surface. Spray from these nozzles only occurs during backwash and helps to prevent the formation of mudballs on the media bed. The complete backwash sequence includes the following steps:

- 4.0 minutes of surface wash only
- 2.5 minutes of surface wash and filter backwash
- 5 minutes of filter backwash
- Up to 20 minutes settling, equalization, and drainage
- 15 minutes of filter to waste

After this backwash sequence, the filters return to normal operation and water flows through the filters and into the clearwell. According to WTP staff, the entire backwash process for all four filters typically takes 120 to 160 minutes.

The backwash storage basin is located underground between the WTP Main Building and the Finished Water Pump Building. The basin has a volume of approximately 16,000 to 17,000 gallons and provides an opportunity for settling of the removed particles. Backwash water within the basin is pumped via submersible pumps several times during each backwash sequence to the residential sewer system where water proceeds to the City of Bellingham's Post Point Wastewater Treatment Plant (WWTP) for treatment. Overflow from the backwash basin is directed back to Lake Whatcom. An assessment of the backwash system and options for handling backwash wastewater will be addressed as part of this project, but will be discussed in a separate memorandum.

The existing flocculation tank, filter vessels, filters, and filter discharge piping are shown on Figures A-1, A-2, A3, and A-4 in Exhibit A.

The Assessment Report noted that the filters appear to be performing adequately and do not show a noticeable decrease in performance, filter run times, or rebound after backwashing within the past several years. Furthermore, the WTP meets all of the DOH Treatment Optimization Program (TOP) requirements, which set higher standards for monitoring and surface water treatment plant performance.

The Assessment Report did note that access to the filter discharge piping is very restricted due to spatial limitations, each filter vessel is accessible only via a single vertical ladder mounted to the side of the filter vessel, and the Filters 1 and 2 vessel does show some minor signs of corrosion and/or coating fatigue which has allowed localized corrosion of the steel.

The next section provides a brief description of some filtration alternatives for the District's consideration.

ALTERNATIVES ANALYSIS

The five alternatives listed below are provided to help the District determine the best course of action for their filtration system. Any modifications to the filtration equipment should be considered in the context of other changes that are recommended or desired for the WTP.

The goal for these alternatives is to address the findings for the flocculation tank and filter system listed in the Assessment Report and to continue to provide high-quality water to the District's customers for the next decades.

Alternative F1 – Continued Use of Existing Mixed Media Rapid Rate Direct Filtration Equipment

General

This alternative includes continuing to use the existing flocculation and filtration equipment with minimal modifications. Per our discussions with WTP operations staff, the existing equipment performs adequately and shows no noticeable decrease in performance.

Filtration

For this alternative, there are no recommended modifications to the existing operation of the filters or the filter discharge piping. The operations staff would continue to provide regular maintenance of the existing filters which includes maintaining an operable surface wash system, regular replacement or replenishment of filter media, visual observation of filter operation, recordkeeping of filter performance, and monitoring filter run times and post-backwash turbidity.

Based on the findings listed in the Assessment Report, we recommend that an additional ladder be provided at each filter vessel to improve access and safety, and to provide a secondary path of egress from the filter platform in the event that one of the paths is blocked. Additional ladders should be installed in the northeast corner of Filters 1 and 2, and in the northwest corner of Filters 3 and 4. These ladders can be welded or bolted to the filter vessels and will provide secondary access to the tops of the filter vessels.

Ladder materials should be painted steel and aluminum to match the materials for the respective filter vessels.

Additionally, we recommend that the coating system on Filters 1 and 2 be repaired in locations where corrosion is evident. Areas where repair is needed are mostly located along the baseplate around the perimeter of the filter vessel. For this repair, the corroded areas should be prepared using machine tool cleaning to bare metal (SSPC-SP11) and should be coated with two coats of high-grade, NSF 61-certified, epoxy coating system from Tnemec, Sherwin Williams, Ameron, or equal. It should be noted that during the WTP assessment, the filter's interior coating system could not be inspected because the filter was in operation. Given the relatively minor corrosion visible on the exterior and the fact that there is no visual evidence of significant corrosion or coating damage/deterioration on the steel exposed to view on the filter vessel, it is not anticipated that significant corrosion or coating damage exists below the media/water surface. If this alternative is selected, we recommend removing enough media to allow for an inspection of the filter's interior coating and if the coating is found to be damaged, repairing/replacing the damage with new coating materials.

Additionally, there are other modifications that could be done to improve the filters and ensure their longevity. The condition of the filter underdrain system is not known since it is inaccessible. The filter underdrains may require replacement with an updated system. The new underdrains would likely be modular with a media support deck and a collector system for the filtered water. It may be possible to retrofit the existing filter vessels with access ports to allow inspection of the underdrain system, a feature that is currently not available.

Another modification that could improve backwash performance is the addition of air scour. It may be possible to add a blower and an air scour system to improve the removal of particles during backwash. Most new installations include air scour. If air scour is added, it might be possible to remove the existing surface wash equipment. Plant staff have indicated that the surface wash equipment is maintenance intensive.

Lastly, we recommend that the flocculation tank coating system be repaired and/or replaced to prevent further corrosion and/or deterioration of the steel. Given the size of the tank, we recommend that the entire tank be prepared and recoated, even though corrosion is most evident above the existing water surface and at the baseplate/wall interface. Preparation and recoating of the flocculation tank will require that the tank be removed from service. We estimate that draining, drying, preparation, recoating, curing, and filling the tank can be accomplished in 2 to 4 weeks. During this period, temporary piping or tankage could be used to either bypass the existing flocculation tank or provide temporary flocculation volume. During this period, special attention should be given to operation of the WTP to ensure that the equalization trough does not overflow. Furthermore, if the District proceeds with this recommendation, we suggest that this work be completed during periods of low demand between December and March in order to minimize the duration of WTP operation.

An alternative to preparation and recoating the existing flocculation tank is to replace the tank with a plastic (fiberglass reinforced plastic [FRP] or high-density polyethylene [HDPE]) tank. Such a tank could be fabricated to mimic the existing tank and could be installed onto the existing concrete pad. An FRP tank would last for 20 to 30 years, would not be subject to corrosion, and could include a molded lid which would reduce ambient moisture within the WTP Main Building. This option would also decrease the downtime for the WTP. We estimate that draining the existing flocculation tank, removing the tank, installing a new plastic tank, reconnecting various components, and refilling the tank could be completed in 3 to 4 days. During this time, the WTP staff could provide temporary piping from the raw water pumps to the equalization basin trough or could elect to not operate the WTP if sufficient storage is available to serve system demands. Because the only access to the WTP is via a 3.5-foot wide single door, installation of a new plastic tank would require that the existing storefront windows be removed temporarily. In addition to these requirements, we recommend that if this option is selected, the District complete this replacement during periods of low system demand (December through March).

Building and Other

For this alternative, there are no recommended modifications to the existing WTP Main Building, WTP site, HVAC system, or Supervisory Control and Data Acquisition (SCADA) systems.

Furthermore, there are no recommended modifications to the existing WTP electrical equipment for the filters. Technical Memorandum 20434-1 provides some recommendations for existing MCC 1, MCC 2, and MCC 3 as well as the associated pumping equipment. It is anticipated that the capacity of the existing electrical service is sufficient to accommodate the recommendations for this alternative.

While this alternative does have a low capital cost, it does not adequately address the space restrictions in the WTP Main Building, or address the proximity of chemical storage and moisture to the existing electrical gear.

It is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

<u>Cost Estimate</u>

The estimated cost to provide two new ladders, spot repair the coating on Filters 1 and 2, and prepare and recoat the flocculation tank is $90,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B. The estimated cost to modify the existing filters as described above but replace the existing steel flocculation tank with a new plastic tank is $170,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B. These costs represent a minimal project cost. If the condition of the underdrains proves sufficiently bad to require replacement or if the District decides to upgrade the filters with the optional features, such as air scour, to ensure filter system longevity and minimize operation and maintenance effort, the cost of this alternative could increase significantly. The extent of these modifications will depend upon the total scope so the cost at this time is speculative but could be in the range of $1 million.

Alternative F2 – Modified Use of Existing Mixed-Media Rapid-Rate Direct Filtration Equipment with New Flocculation Equipment

<u>General</u>

This alternative includes continuing to use the existing mixed-media direct-filtration systems, construction of a new separate building, removing the existing flocculation tank from service, installing stand-alone pretreatment equipment upstream of the existing filters within a new building, relocating the existing chemical systems to the new building, construction of an enclosed electrical room within the WTP Main Building, and rehabilitating the WTP Main Building to include additional work/laboratory and storage space.

<u>Filtration</u>

This alternative includes replacement of the existing flocculation tank with a new pretreatment system that could be a new flocculation tank, adsorption clarifier, or a dissolved air flotation unit. The new flocculation tank would be sized to optimize coagulation and flocculation.

An adsorption clarifier allows for coagulation and flocculation and also provides prefiltration of the flocculated particles and reduces the particle load on the filters, which can extend filter run times. Adsorption clarifiers use a raw water flush and air scour so backwashing with finished water is minimized. For this alternative, two adsorption clarifiers would be used, both of which are installed within a single vessel. The clarifiers would be operated in parallel and each clarifier would be capable of filtering up to 700 gpm. Clarifiers will be provided with level sensors, alarm floats, and control valves as required to provide successful pretreatment of the source water.

The clarifiers would require blowers to provide air for the air scour during the flush cycle. Typically, a single blower is sufficient; however, a redundant blower may be provided in the event that the primary blower is taken offline for maintenance. Given the residential and recreational nature of the site, the building may need to have features to attenuate the blower noise such as acoustical louvers or a dedicated blower room.

A third possible type of pretreatment is dissolved air flotation (DAF). DAF clarifies source water by injecting air into the flocculated water. The released air forms tiny bubbles which adhere to the flocculated particles causing the floc to float to the surface where it may be removed by a skimming device. DAF equipment is available in package units that include all of the components, equipment, controls, and tankage. Photo examples of DAF units are included as Figure A-10 in Appendix A. DAF technology was installed at the City of Bellingham water treatment plant.

With this alternative, the operations staff would continue to provide regular maintenance of the existing filters as described in Alternative F1. For this alternative, there are no recommended modifications to the existing operation of the filters or the filter discharge piping. We recommend that additional ladders be provided for the filters and that the existing coating system on Filters 1 and 2 be repaired as described in Alternative F1.

Liquid alum will continue to be added to the raw water supply upstream of the pretreatment and mixing will be provided by a static mixer in line with the raw water piping, downstream of the raw water pumps. The existing raw water pumps have a capacity of approximately 1,400 gpm at 25 feet total dynamic head (TDH), which should be sufficient to feed the proposed pretreatment and existing filter equipment.

Currently, the WTP adds a small amount of chlorine prior to the existing flocculation tank upstream of the filter vessels. This chlorine is not used for disinfection but is added to help reduce algae growth in the flocculation tank and filter vessels. Chlorine injection upstream of the filter vessels will be maintained in this alternative.

<u>Building and Other</u>

While the proposed pretreatment might physically fit within the existing WTP Main Building, installation would require significant effort due to the presence of existing treatment equipment and piping. Installation within the WTP Main Building would require the removal of the existing flocculation tank, chemical systems, piping, and storefront windows. Furthermore, it is not feasible to maintain WTP operation and produce water during the removal of the existing flocculation equipment and installation of a new system. Since replacement of the existing flocculation tank with pretreatment equipment in 1 to 2 days is not feasible, placing the new equipment in a separate building is the only feasible way to add pretreatment. Additionally, a new structure should be large enough to accommodate new alum equipment and relocated soda ash equipment as recommended in Technical Memorandum 20434-4. Providing additional space for the chemical addition systems in the proposed building will separate the chemical system from the electrical systems, thus reducing the potential for corrosion and/or damage. Furthermore, a new building to house the pretreatment and chemical systems would provide extra space in the existing WTP Main Building for a separate enclosed electrical room as well as laboratory and storage space. Approximately 1,800 square feet (sf) (57′ x 33′) is suitable to provide space for the new pretreatment equipment, chemical equipment, access clearances, piping, and a future pretreatment vessel as needed to accommodate future demands. The building could be constructed from a variety of materials, including wood truss/CMU, and would include several rollup doors for clarifier installation, maintenance, and removal. A proposed site/building plan is provided as Figure A-5. The figure shows an adsorption clarifier as the pretreatment technology.

Site improvements associated with the proposed building include asphalt paving to provide access to the facility. New facilities will be subject to all applicable stormwater requirements for construction of new buildings and the addition of new asphalt pavement. The construction of a new building adjacent to the existing WTP would be subject to the stipulations listed by Whatcom County for the Lake Whatcom Watershed. These requirements will include the need to provide either full infiltration on site or advanced treatment for phosphorous removal. Design of the required stormwater facilities will be provided once the building footprint and paving have been finalized, but a budget estimate for the anticipated requirements has been included with the alternative cost estimate included in Exhibit B. In addition, it should be noted that these regulations restrict clearing of the site so that only 35 percent of the existing tree canopy can be cleared.

The additional process treatment equipment recommended in this alternative will increase the electrical load on the facility by 10 to 20 horsepower (hp) to accommodate the proposed air scour blower(s). In addition to this new load, the proposed building will require additional heating, ventilation, and dehumidifier equipment. Furthermore, the proposed electrical room within the WTP Main Building will require separate ventilation and cooling equipment to maintain an appropriate temperature for the motor starters and other electronic components. For the purposes of this analysis, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will include a new heating and ventilation system for the proposed building addition and new ventilation and cooling equipment for the proposed electrical room.

This alternative will require modifications to the District's existing SCADA system. New control set points, monitoring information, and alarms will be required to successfully operate the new clarifier equipment. The new signals can be incorporated into the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

It is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

This alternative successfully addresses spacing issues within the WTP, removes the flocculation tank as a source of moisture from the WTP Main Building, and along with relocation of the chemical delivery equipment, provides sufficient space to expand the WTP Main Building storage/laboratory space and construct an enclosed electrical room in order to protect the electrical equipment from exposure to moisture and chemicals. This alternative does represent a significantly higher capital cost when compared to Alternative F1.

Cost Estimate

The estimated cost to provide the items described above using an adsorption clarifier is $3,583,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative F3 – Installation of New Mixed-Media Rapid-Rate Direct Filtration Equipment

General

This alternative includes removing the existing filters from service, construction of a new separate building, installation of new package filtration units that include a contact adsorption clarifier in the new building, relocating the existing chemical systems to the new building, construction of an enclosed electrical room within the WTP Main Building, and rehabilitating the WTP Main Building to include additional work/laboratory and storage space.

Filtration

Even though the existing filters were installed in 1972, rapid-rate mixed-media filtration technology has not changed significantly since that time. Current package filtration technology functions similarly to the WTP's existing filters, but can also include a pre-sedimentation basin (PSB), and/or a contact adsorption clarifier (CAC) upstream of the filter media. Package filtration units typically include a single vessel with separate sections for a PSB (if desired), a CAC, and the filter media. The units also include instrumentation and controls to ensure successful equipment operation as well as a control panel used to monitor and optimize the treatment process. PSBs accept raw water combined with coagulant and promote rapid settling and removal of the coagulated particles prior to introduction to the CAC. However, because raw water quality from the Lake Whatcom source is consistently less than 5 NTU and does not show significant seasonal variation, a PSB is not recommended for this application and will not be considered further. CACs provide prefiltration of coagulated particles and reduce the particle load on the media bed which can improve filter performance and extend filter run times. After the CAC, water flows to the filtration media where smaller particles are removed. Technical information for a typical package filtration with a CAC is provided in Exhibit C.

In addition to mixed-media filtration, there are other configurations of media that will successfully provide filtration for the District. The most notable of these is deep-bed monomedia filtration. In this configuration, a thicker volume of media with a consistent gradation is used to remove coagulated particles. The primary advantage of monomedia filtration is that longer filter run times can be achieved if filter rates are maintained below 6 gpm/sf. Additional benefits, including higher filtration rates, are possible with this technology if a media depth between 56 and 72 inches can be provided. For monomedia filtration, the diameter of the media particles should be between 1.2 and 1.5 millimeters (mm) and the depth of the media should be at least 60 inches in order to achieve the recommended bed depth-to-media particle diameter ratio of 1,300 (*Integrated Design and Operation of Water Treatment Facilities*, 2nd Edition, Kawamura, 2000).

Deep-bed monomedia is not usually available with steel package vessels because of the geometry of the units. For example, the existing filters have 52 inches of media including support gravels. Consequently, the existing filters just do not have the depth in the filter chamber to hold the 56 to 72 inches of media required for a deep bed. If this additional media were added to existing filters, the upper portion would be washed out during backwash. Deep-bed filtration is usually used in filter plants with deep cast concrete basins such as the City of Everett rather than package plants.

This alternative includes two 700 gpm package filters which would allow the WTP to operate with only one filter in service and provide filter capacity for up to the WTP's current rated capacity of 1,400 gpm. The proposed package filtration units will include CACs and are each roughly 28′ x 9′ x 9′ (L x W x H). A cross section of the proposed unit is provided on Figure A-6.

Filters will be provided with a control panel, level sensors, high-level alarm floats, and control valves as required to provide successful treatment of the source water.

The proposed mixed-media filters require blowers to provide air for the air scour mode of the backwash cycle. Typically, a single blower is sufficient; however, a redundant blower will be provided in the event that the primary blower is taken offline for maintenance.

Liquid alum will continue to be added to the raw water supply upstream of the filter unit and mixing will be provided by a static mixer in line with the raw water piping downstream of the raw water pumps. The existing raw water pumps have a capacity of approximately 1,400 gpm at 25 feet TDH, which should be sufficient to feed the proposed filtration equipment.

Currently, the WTP adds a small amount of chlorine to their existing flocculation tank upstream of the filter vessels. This chlorine is not used for disinfection, but is added to help reduce algae growth in the flocculation tank and filter vessels. Chlorine injection upstream of the filter vessels will be maintained in this alternative.

<u>Building and Other</u>

While the proposed filter units would physically fit within the existing WTP Main Building, installation would require significant coordination due to the presence of existing treatment equipment and piping. Installation at the current filter location would require the removal of the existing flocculation tank, chemical systems, existing piping, existing storefront windows, as well as reorganization of the existing backwash discharge trench drain that conveys water from the filter discharge piping to the buried backwash storage tank located adjacent to the WTP. Furthermore, any modifications will require significant coordination and/or planning to ensure that the WTP can remain functional during execution of the work. Since replacement of the existing filters in 1 to 2 days is not feasible, a second option is to install new components in a different location, connect them to the treatment system, and then remove the existing components. As such, we recommend that the District construct a separate building to house the new filter equipment. Additionally, a new structure should be large enough to accommodate new alum equipment and relocated soda ash equipment. Providing additional space for the chemical addition systems in the proposed building will separate the chemical system from the electrical systems, thus reducing the potential for corrosion and/or damage. Furthermore, a new building to house the filters and chemical systems would provide extra space in the existing WTP Main Building for a separate enclosed electrical room as well as laboratory and storage space. Approximately 3,300 sf (78′ x 42′) is required to provide suitable space for the new filter equipment, access clearances, piping, and a future third filtration package. The building could be constructed from a variety of materials, including wood truss/CMU, and would include several rollup doors to facilitate clarifier installation, maintenance, and removal. A proposed site/building plan is provided as Figure A-7.

After the new filter units are operational and the existing flocculation tank and filter vessels have been removed from the WTP Main Building, the existing building can be modified to provide for expanded laboratory/workspace as well as an enclosed electrical room.

Site improvements associated with the proposed building include asphalt paving to provide access to the facility. Stormwater facilities for this alternative would be similar to Alternative F2.

The additional process treatment equipment recommended in this alternative will increase the electrical load on the facility by 20 to 40 hp to accommodate the proposed air scour blowers. In addition to this new load, the new space will require additional heating, ventilation, and dehumidifier equipment. Furthermore, the proposed electrical room in the WTP Main Building will require separate ventilation and cooling equipment to maintain an appropriate temperature for the motor starters and other electronic components. For the purposes of this investigation, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will include new heating and ventilation system for the proposed building addition, and new ventilation and cooling equipment for the proposed electrical room.

This alternative will require modifications to the District's existing SCADA system. New control set points, monitoring information, and alarms will be required to successfully operate the new filtration equipment. Typically, package filtration systems are provided with a control panel that allows the WTP operations staff to monitor and control the function of the filter system. This control panel can be incorporated into the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

It is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

This alternative successfully addresses spacing issues within the WTP, removes the flocculation tank as a source of moisture from the WTP, and along with relocation of the chemical delivery equipment, provides sufficient space to expand the WTP Main Building storage/laboratory space and construct an enclosed electrical room in order to protect the electrical equipment from exposure to moisture and chemicals. This alternative does represent a significantly higher capital cost when compared to Alternatives F1 and F2.

Cost Estimate

This alternative is estimated to cost $5,876,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative F4 – Installation of New Membrane Filtration Equipment

General

This alternative includes removing the existing filters from service, construction of a new separate building, installation of new membrane filtration equipment in the new building, relocating the existing chemical systems to the new building, construction of an enclosed electrical room within the WTP Main Building, and rehabilitating the WTP Main Building to include additional work/laboratory and storage space.

Filtration

Although still a relatively new technology, membrane filtration is now used more frequently for municipal water treatment. The process utilizes manufactured membranes of various materials (ceramics, polymers) under pressure to remove solids, turbidity, and to provide a 3-log reduction of *Giardia* and 2-log reduction of *Cryptosporidium*. In some membrane applications, specifically in ultra- and/or nano-filtration applications, additional credits can be provided for 1.5-log removal of waterborne viruses. Most membranes used for municipal water treatment are cylindrical, hollow-fiber materials and provide filtration via outside/in water flow.

For membrane filtration, raw water is treated via a 200 micrometer (µm) prefilter for removal of larger debris. As the membrane surface accumulates filtered particles, they must occasionally be cleaned via backwashing and air scouring. For this, filtered water is sent to a backwash supply tank, where the backwash cycle removes accumulated foulants through a reverse inside/out flow approximately every 20 to 60 minutes. Air scouring is provided during this phase to optimize the backwash process. A drain or filter-to-waste step is used to remove any additional accumulated material. Membrane integrity testing is conducted automatically once every 24 hours and this integrity test is capable of detecting a single fiber break. Maintenance cleans, chemically enhanced backwashes, and/or clean-in-place procedures are automated chemical cleaning processes used to recover membrane permeability and typically occur every 1 to 4 weeks, depending on the cleaning process.

For the purposes of this analysis, the proposed membrane filtration system will consist of the following components:

- Two skid-mounted, hollow-fiber membrane modules
  - 30 filter cartridges on each skid for a total of 60 cartridges
- Two prefilter water feed pumps
  - Pumps shall be approximately 1,600 gpm at 100 feet TDH
- One backwash pump
  - Pump shall be approximately 900 gpm at 90 feet TDH
- Two prefiltration units
- One compressed air system
  - Pneumatically operated valves
  - One regenerative blower
  - One airflow meter and transmitter
- Two turbidimeters
  - HACH TU5300sc
- Two flow meters
  - Magnetic flow meter with integral transmitter

- Pressure gauges as required for system monitoring
- One electrical control panel
- Two tanks
  - One feed supply equalization tank
  - One backwash supply tank
- One clean-in-place chemical cleaning skid
  - Sodium hypochlorite
  - Citric acid

The equipment listed above would allow the WTP to operate with only one membrane skid in service but would provide filter capacity for up to 1,400 gpm and would require an additional membrane skid in order to provide complete redundancy. Although only two filters are proposed for this alternative, space should be provided for a future third membrane skid unit. Each membrane skid has a footprint of approximately 150 sf (25′ x 6′) and an example of a typical membrane filtration unit is shown on Figure A-8. Typically, the filtration equipment is provided as a skid-mounted system that is ready for connection to the inlet and outlet piping reduces installation time and provides a clear definition for components to be provided by the equipment manufacturer and the contractor performing the installation.

Given that the existing filters are located at the rear of the WTP Main Building and because the proposed membrane filter skids are longer than the existing filters, it is not feasible to install the proposed membrane skids in the location of the existing filter vessels. As such, we recommend that the District install the membrane skids in a new building, connect them to the existing treatment system, then remove the existing filters and supporting equipment.

Given the raw water quality parameters of the Lake Whatcom source, liquid alum is not needed prior to membrane filtration. Removal of this equipment will increase the available space in the proposed building.

Although the existing raw water pumps have sufficient capacity for the current treatment equipment, membrane filtration equipment operates at a significantly higher pressure. New supply pumps will be installed to push water through the membrane cartridges in accordance with the manufacturer's recommendations.

The backwash system has specific flow and pressure requirements to ensure successful membrane filtration and the existing backwash system cannot meet these new requirements. A new backwash pump and backwash supply tank are provided for this alternative and will be sized per the membrane manufacturer's design criteria.

The backwash system for the membranes is automatic and based on filter run times and/or pressure drop across the filter membrane. The total water wasted between both the backwash and flow-to-waste cycles for the membrane system is approximately 45,000 gpd. Given the current filter wash cycle and flow-to-waste cycles, approximately 50,000 gallons is wasted. Thus, the use of membranes may reduce the total volume of water wasted by approximately 10 percent. This is of particular interest to the District since they pay municipal rates for all water wasted to the City of Bellingham's municipal wastewater treatment system, and any reduction in wastewater volume from the WTP will reduce operational costs.

Additional chemical cleaning equipment is required to maintain successful function of the filters. These systems are typically provided with the membrane filtration package, and include both sodium hypochlorite and citric acid storage and dosing equipment. These systems should be located in the proposed building addition described below.

Lastly, given that this alternative represents a "new" filtration technology for the District, it is likely that some form of pilot testing must be completed in order to demonstrate that the proposed technology is feasible for the Lake Whatcom source.

<u>Building and Other</u>

Due to space and project sequencing limitation, we recommend that the District construct a separate building to accommodate the new membrane equipment. A proposed site/building plan is provided as Figure A-9. This also includes relocation of the existing chemical equipment and reorganization of the existing WTP Main Building as described in Alternative F3.

Site improvements, stormwater improvements, electrical modifications, HVAC modifications, and telemetry and SCADA modifications will be similar to those described in Alternative F3.

Even though this alternative utilizes different technology than what is currently utilized, it is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

This alternative successfully addresses spacing issues within the WTP, removes the flocculation tank as a source of moisture from the WTP, and along with relocation of the chemical delivery equipment, provides sufficient space to expand the WTP Main

Building storage/laboratory space and construct an enclosed electrical room in order to protect the electrical equipment from exposure to moisture and chemicals. This alternative does represent a significantly higher capital cost when compared to Alternatives F1 and F2.

Cost Estimate

This alternative is estimated to cost approximately $4,948,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

SUMMARY OF ALTERNATIVES AND COST ESTIMATES

The alternatives described above highlight feasible alternatives for providing water filtration for the South Shore Water System. The alternatives are further analyzed below, and a final recommendation based on this analysis and discussions with District staff is provided at the end of this section.

It is important to note that all of these alternatives will require additional design and coordination with various stakeholders, one of which includes the Sudden Valley Community Association (SVCA). The SVCA owns much of the property adjacent to the WTP and would need to be consulted prior to implementation of any of the alternatives discussed in this memorandum. Furthermore, the District must consider that the property adjacent to the WTP is a public park with waterfront access and use of this public space will likely need to be maintained at all times. Other stakeholders include neighboring residential landowners and utility providers serving the area.

Alternative Summary

Alternative F1

Alternative F1 includes modifying the existing filter vessels with ladders and rehabilitating the existing Filters 1 and 2 coating system. No building, site, electrical, HVAC, or telemetry/SCADA improvements are included with this alternative.

Alternative F2

Alternative F2 includes removing the existing flocculation tank and installing new pretreatment equipment, either a new flocculator, adsorption clarifier, or DAF unit. The new pretreatment equipment would be installed within a new separate building that would be sized to also house new chemical dosing tanks and metering pump equipment.

Site improvements would include new piping and asphalt paving to provide access to the new building. Electrical, HVAC, and telemetry/SCADA improvements would be provided to equip and power the proposed building and new treatment equipment. Also, the existing WTP Main Building would be reconfigured to include additional storage/laboratory space. Finally, an electrical room will be constructed within the WTP Main Building to house the MCCs and other electrical gear, which will provide separation from the moisture associated with the treatment process.

Alternative F3

Alternative F3 includes installation of new package filtration equipment. This new equipment would be installed within a new separate building that would be sized to also house new chemical dosing tanks and metering pump equipment. Site improvements would include new piping and asphalt paving to provide access to the new building. Electrical, HVAC, and telemetry/SCADA improvements would be provided to equip and power the proposed building and new treatment equipment. The existing filters would be removed from the WTP Main Building, which would be reconfigured to include additional storage/laboratory space. Finally, an electrical room will be constructed within the WTP Main Building to house the MCCs and other electrical gear, which will provide separation from the moisture associated with the treatment process.

Alternative F4

Alternative F4 includes installation of new membrane filtration equipment. This new equipment would be installed within a new separate building that would be sized to also house new chemical dosing tanks and metering pump equipment. Site improvements would include new piping and asphalt paving to provide access to the new building. Electrical, HVAC, and telemetry/SCADA improvements would be provided to equip and power the proposed building and new treatment equipment. The existing filters would be removed from the WTP Main Building, which would be reconfigured to include additional storage/laboratory space. Finally, an electrical room will be constructed within the WTP Main Building to house the MCCs and other electrical gear, which will provide separation from the moisture associated with the treatment process.

Alternative Analysis

Advantages to Alternative F1 are its low capital cost. Disadvantages to Alternative F1 are that it does not address space constraints within the WTP Main Building, does not address the moist environment partially due to the presence of the flocculation tank, and does not allow for adequate separation between the chemical and electrical components. Alternative F1 allows for continued operation but does not address the long-term space and maintenance issues that would allow for assurance that the plant can continue producing high-quality water for the next decades.

Advantages to Alternative F2 are that it will provide additional space in the WTP Main Building for laboratory/storage and allow for construction of an electrical room to provide separation from a moist environment as well as treatment chemicals. Disadvantages to this alternative include a high capital cost and issues with construction of a new building near the existing WTP Main Building.

Advantages to Alternative F3 are that it will provide additional space in the WTP Main Building for laboratory/storage and allow for construction of an electrical room to provide separation from a moist environment as well as treatment chemicals. It will also replace equipment that is nearly 50 years old. Disadvantages to this alternative include a high capital cost and issues with construction of a new building near the existing WTP Main Building.

Advantages to Alternative F4 are that it will provide additional space in the WTP Main Building for laboratory/storage and allow for construction of an electrical room to provide separation from a moist environment as well as treatment chemicals. It will also replace equipment that is nearly 50 years old with new technology. Lastly, it should reduce the operation and maintenance requirements for WTP operational staff. Disadvantages to this alternative include a high capital cost and issues with construction of a new building near the existing WTP Main Building. In addition, the new system must be pilot tested prior to implementation, which will extend the project by 6 to 12 months.

It is difficult to provide a filtration recommendation without considering the other issues that are being considered at the treatment plant. For example, if the District decides to relocate the chemical feed equipment into a separate building, Alternatives F2, F3, and F4 become more favorable since the expansion of a new chemical building to house new prefiltration or filtration has an economy of scale.

Consequently, the final filtration recommendation will be deferred until the summary report is prepared that contains all of the information in the various technical memoranda to provide an optimized recommendation for the entire filter plant to ensure the District's goal of continuing to provide high-quality treated water for decades to come.

EXHIBIT A

PHOTOGRAPHS OF EXISTING EQUIPMENT

FIGURE A-1

Flocculation Tank

FIGURE A-2

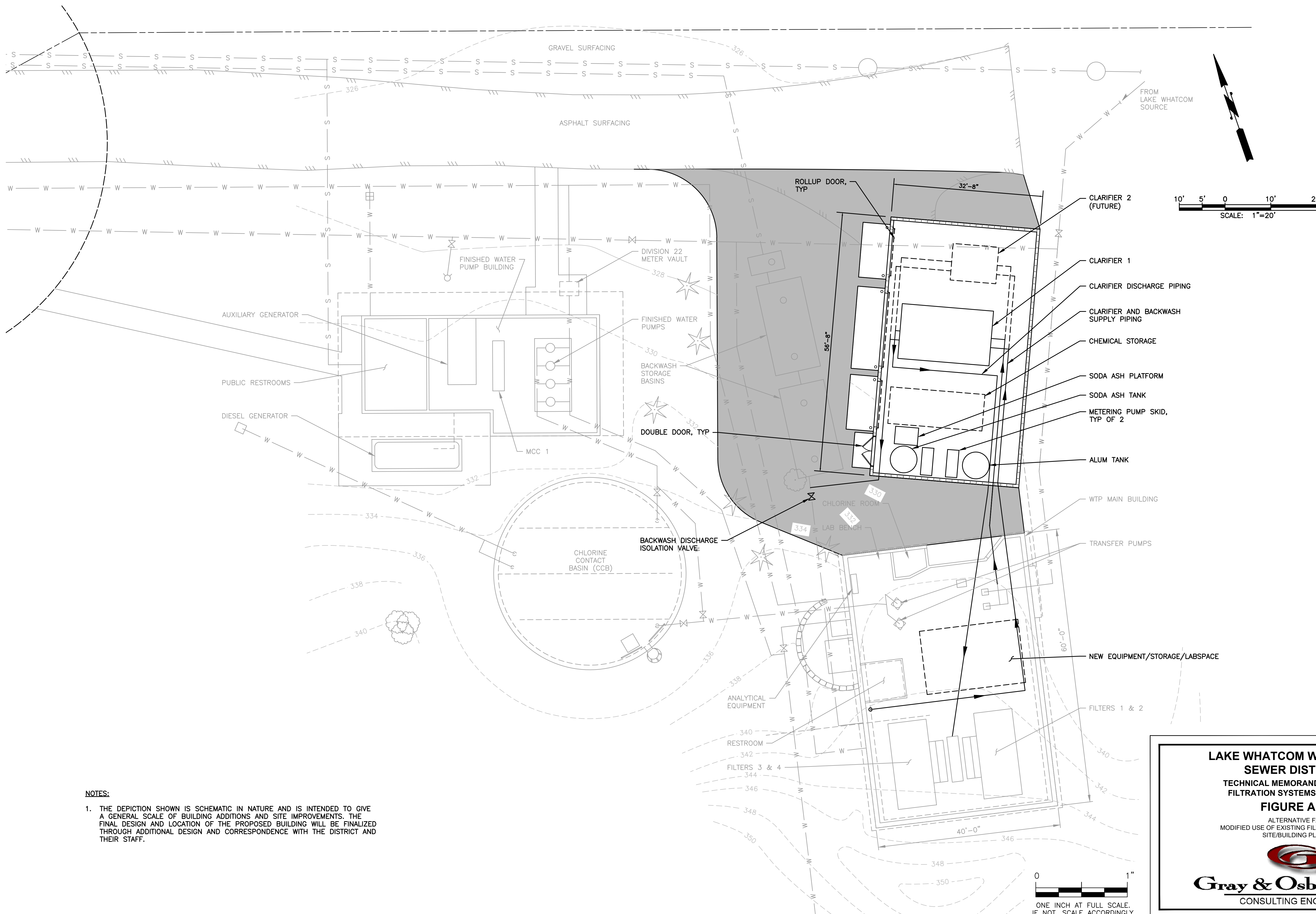
Filters 1 and 2

FIGURE A-3

Filters 3 and 4

FIGURE A-4

Filter Discharge Piping



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

LAKE WHATCOM WATER AND SEWER DISTRICT

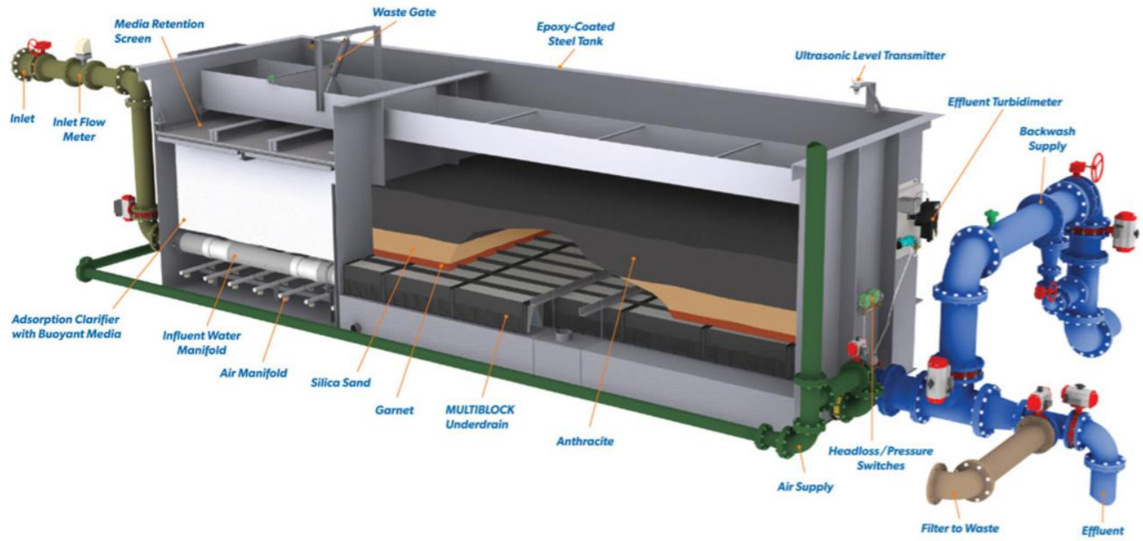
TECHNICAL MEMORANDUM 20434-5
FILTRATION SYSTEMS ANALYSIS

FIGURE A-5

ALTERNATIVE F2
MODIFIED USE OF EXISTING FILTER EQUIPMENT
SITE/BUILDING PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

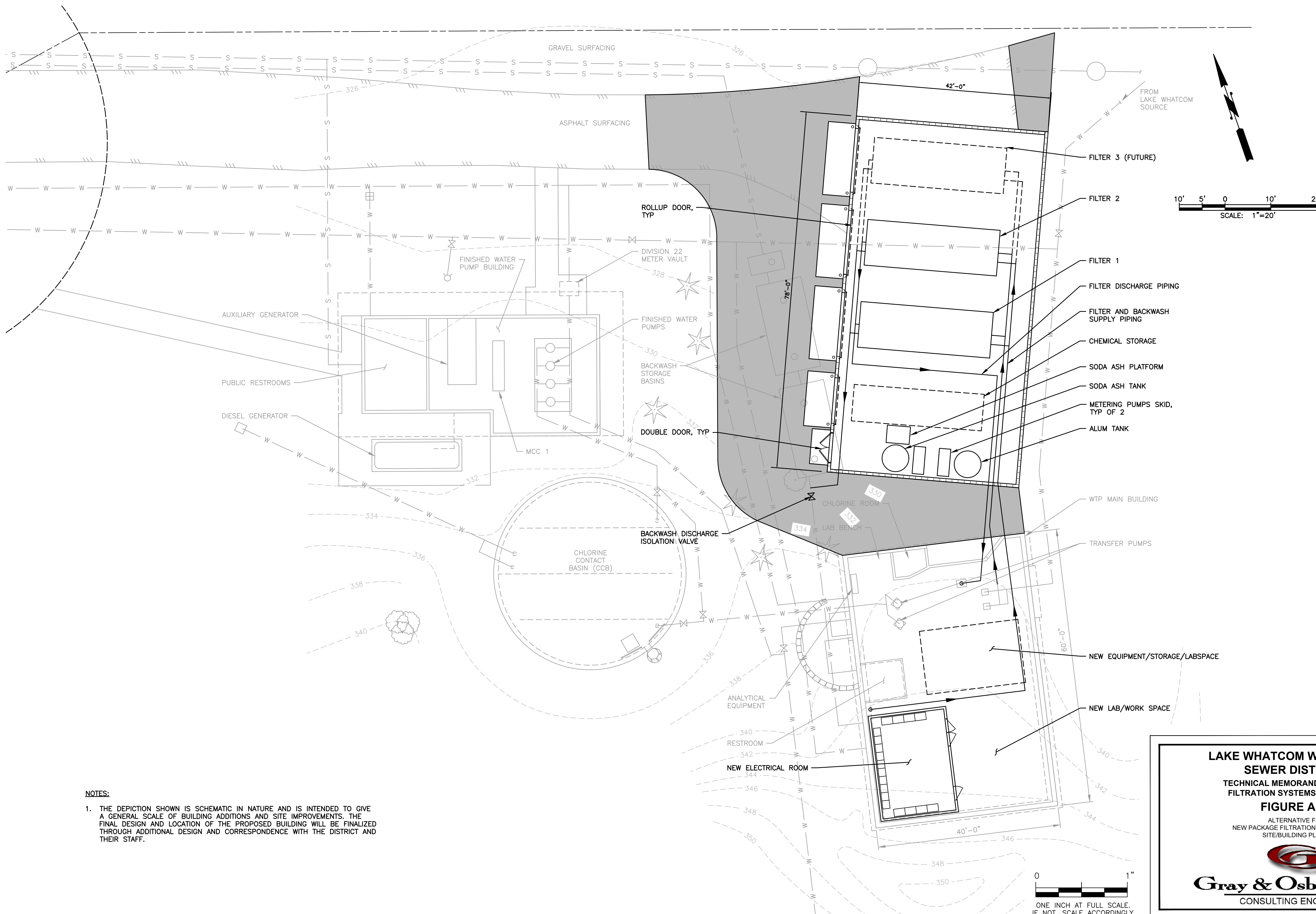
L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\FIGURE A-5 Site.dwg, 12/21/2020 8:36 PM, PHILIP MARSHALL



Courtesy of WesTech

FIGURE A-6

WesTech Trident Package Filtration System with CAC



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

0 1"

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-5
FILTRATION SYSTEMS ANALYSIS

FIGURE A-7

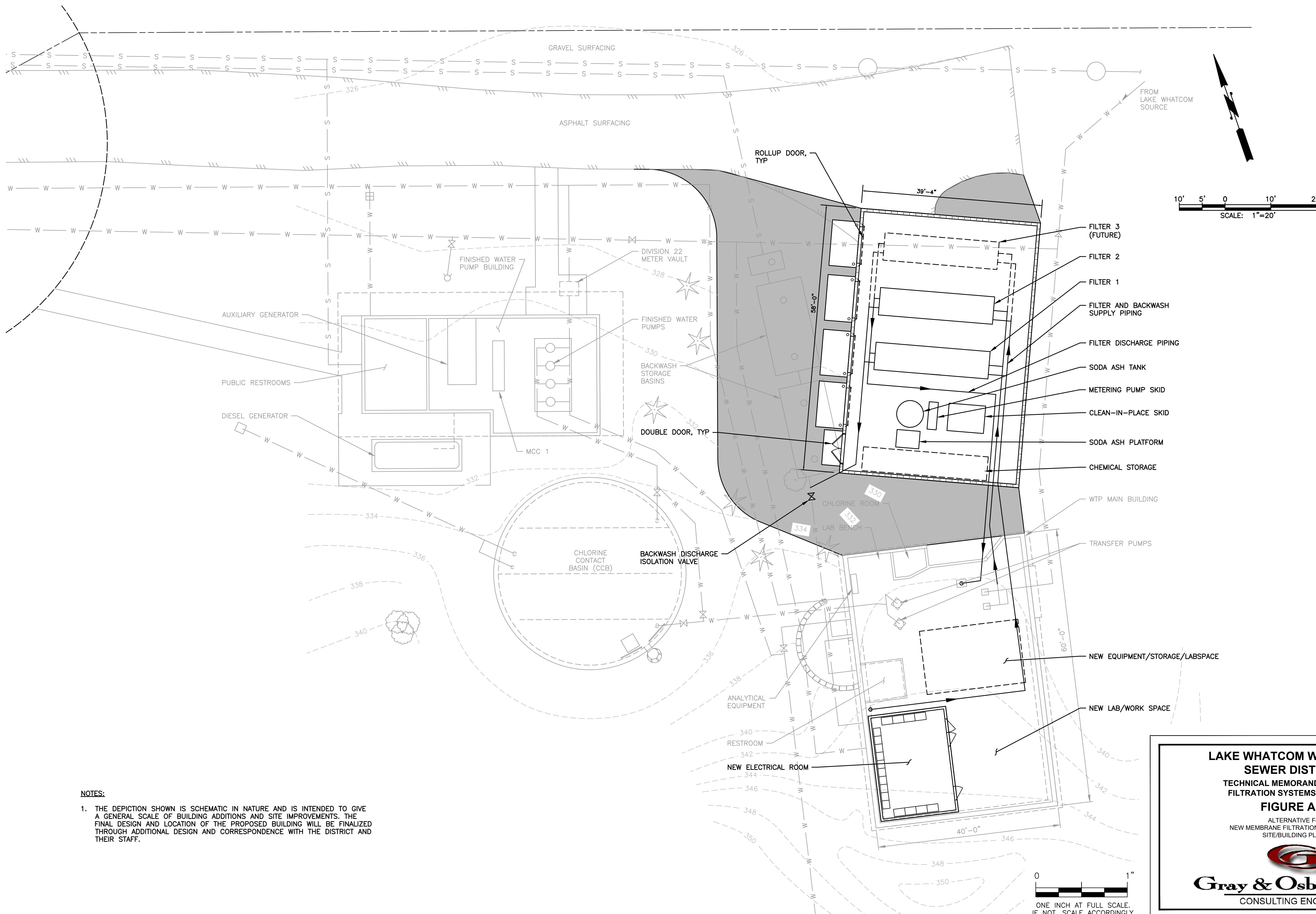
ALTERNATIVE F3
NEW PACKAGE FILTRATION EQUIPMENT
SITE/BUILDING PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\FIGURE A7 Site.dwg. 12/21/2020 8:35 PM, PHILIP MARSHALL

FIGURE A-8

WesTech Ultrafiltration Module



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-5
FILTRATION SYSTEMS ANALYSIS

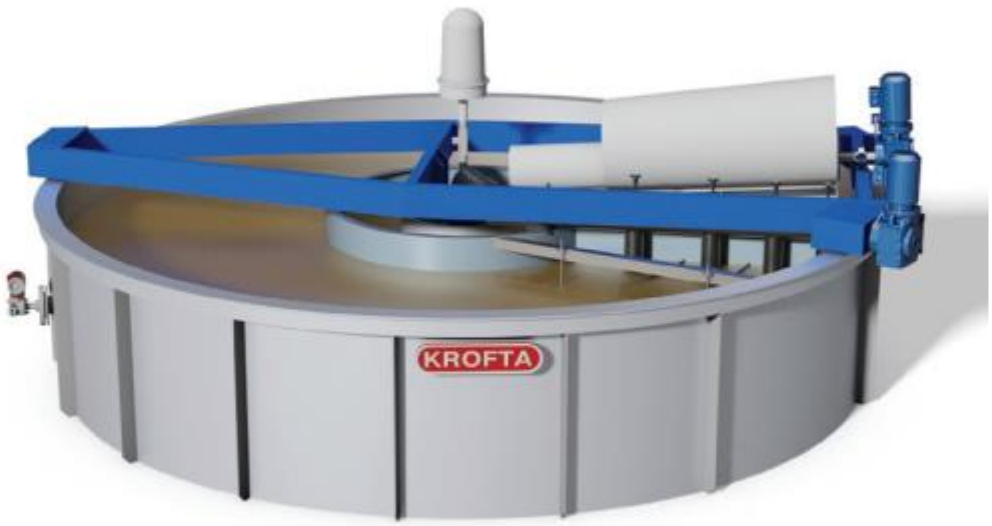
FIGURE A-9

ALTERNATIVE F4
NEW MEMBRANE FILTRATION EQUIPMENT
SITE/BUILDING PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

Evoqua RT Series

FRC PCL Series



Krofta Supracell Series

FIGURE A-10

Package DAF System and Circular DAF Clarifier

EXHIBIT B

RECOMMENDED ALTERNATIVE COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F1
Continued Use of Existing Filters - Modified Flocculation Tank
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 8,000	$ 8,000
2	Furnish and Install Additional Ladders	2	EA	$ 6,000	$ 12,000
3	Repair Filter 1/2 Coating	1	LS	$ 15,000	$ 15,000
4	Repair Flocculation Tank Coating	1	LS	$ 18,000	$ 18,000

Subtotal*	**$ 53,000**
Contingency (25%)	$ 13,300
Subtotal	**$ 66,300**
Washington State Sales Tax (9.0%)**	$ 6,000
Subtotal	**$ 72,300**
Design and Project Administration (25.0%)***	$ 18,100
TOTAL CONSTRUCTION COST	**$ 90,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F1
Continued Use of Existing Filters - New FRP Flocculation Tank
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 8,000	$ 8,000
2	Furnish and Install Additional Ladders	2	EA	$ 6,000	$ 12,000
3	Repair Filter 1/2 Coating	1	LS	$ 15,000	$ 15,000
4	Replace Existing Flocculation Tank	1	LS	$ 25,000	$ 25,000
				Subtotal*	**$ 60,000**
				Contingency (25%)	$ 15,000
				Subtotal	**$ 75,000**
				Washington State Sales Tax (9.0%)**	$ 6,800
				Subtotal	**$ 81,800**
				Design and Project Administration (25.0%)***	$ 20,500
				TOTAL CONSTRUCTION COST	**$ 102,000**

* Costs listed are in 2020 dollars

** Current sales tax rate is 8.7%.

*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F2
Modified Use of Existing Filters
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	174,000	$	174,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	20,000	$	20,000
5	New Building	1,800	SF	$	600	$	1,080,000
6	Adsorption Clarifier	1	LS	$	375,000	$	375,000
7	Proposed Building Piping	1	LS	$	20,000	$	20,000
8	Chemical System Modifications	1	LS	$	65,000	$	65,000
9	Electrical Modifications	1	LS	$	225,000	$	225,000
10	HVAC Modifications	1	LS	$	75,000	$	75,000
11	Telemetry / SCADA Modifications	1	LS	$	40,000	$	40,000

Subtotal*	**$**	**2,104,000**
Contingency (25%)	$	526,000
Subtotal	**$**	**2,630,000**
Washington State Sales Tax (9.0%)**	$	236,700
Subtotal	**$**	**2,866,700**
Design and Project Administration (25.0%)***	$	716,700
TOTAL CONSTRUCTION COST	**$**	**3,583,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F3
New Mixed Media Package Filtration Equipment
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	285,000	$	285,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	20,000	$	20,000
5	New Building	3,300	SF	$	600	$	1,980,000
6	Package Filtration Equipment	1	LS	$	700,000	$	700,000
7	Proposed Building Piping	1	LS	$	30,000	$	30,000
8	Chemical System Modifications	1	LS	$	65,000	$	65,000
9	Electrical Modifications	1	LS	$	225,000	$	225,000
10	HVAC Modifications	1	LS	$	75,000	$	75,000
11	Telemetry / SCADA Modifications	1	LS	$	40,000	$	40,000

Subtotal*	**$**	**3,450,000**
Contingency (25%)	$	862,500
Subtotal	**$**	**4,312,500**
Washington State Sales Tax (9.0%)**	$	388,100
Subtotal	**$**	**4,700,600**
Design and Project Administration (25.0%)***	$	1,175,200
TOTAL CONSTRUCTION COST	**$**	**5,876,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F4
New Membrane Filtration Equipment
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	240,000	$	240,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	20,000	$	20,000
5	New Building	2,300	SF	$	600	$	1,380,000
6	Membrane Filtration Equipment	1	LS	$	775,000	$	775,000
7	Proposed Building Piping	1	LS	$	30,000	$	30,000
8	Chemical System Modifications	1	LS	$	40,000	$	40,000
9	Electrical Modifications	1	LS	$	225,000	$	225,000
10	HVAC Modifications	1	LS	$	75,000	$	75,000
11	Telemetry / SCADA Modifications	1	LS	$	40,000	$	40,000
12	Filter Pilot Testing	1	LS	$	50,000	$	50,000

Subtotal*	**$**	**2,905,000**
Contingency (25%)	$	726,300
Subtotal	**$**	**3,631,300**
Washington State Sales Tax (9.0%)**	$	326,800
Subtotal	**$**	**3,958,100**
Design and Project Administration (25.0%)***	$	989,500
TOTAL CONSTRUCTION COST	**$**	**4,948,000**

* Costs listed are in 2020 dollars

** Current sales tax rate is 8.7%.

*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F5
New Deep Bed Mono Media Package Filtration Equipment
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	248,000	$	248,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	20,000	$	20,000
5	New Building	2,500	SF	$	600	$	1,500,000
6	Package Filtration Equipment	1	LS	$	775,000	$	775,000
7	Proposed Building Piping	1	LS	$	30,000	$	30,000
8	Chemical System Modifications	1	LS	$	65,000	$	65,000
9	Electrical Modifications	1	LS	$	225,000	$	225,000
10	HVAC Modifications	1	LS	$	75,000	$	75,000
11	Telemetry / SCADA Modifications	1	LS	$	40,000	$	40,000
12	Filter Pilot Testing	1	LS	$	50,000	$	50,000

Subtotal*	**$**	**3,058,000**
Contingency (25%)	$	764,500
Subtotal	**$**	**3,822,500**
Washington State Sales Tax (9.0%)**	$	344,000
Subtotal	**$**	**4,166,500**
Design and Project Administration (25.0%)***	$	1,041,600
TOTAL CONSTRUCTION COST	**$**	**5,208,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5
New Dissolved Air Flotation Clarifier
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	79,000	$	79,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	30,000	$	30,000
5	Circular Clarifier	55	CY	$	1,200	$	66,000
6	DAF Clarifier Equipment	1	LS	$	600,000	$	600,000
7	Proposed Building Piping	1	LS	$	20,000	$	20,000
8	Chemical System Modifications	1	LS	$	25,000	$	25,000
9	Electrical Modifications	1	LS	$	100,000	$	100,000
10	Telemetry / SCADA Modifications	1	LS	$	10,000	$	10,000

Subtotal*	**$**	**960,000**
Contingency (25%)	$	240,000
Subtotal	**$**	**1,200,000**
Washington State Sales Tax (9.0%)**	$	108,000
Subtotal	**$**	**1,308,000**
Design and Project Administration (25.0%)***	$	327,000
TOTAL CONSTRUCTION COST	**$**	**1,635,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

EXHIBIT C

SUPPORTING TECHNICAL INFORMATION

Trident®

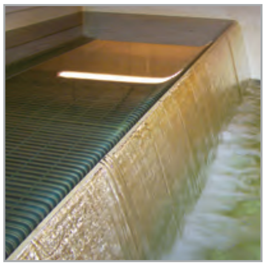
Package Water Treatment System

microfloc

The Trident® Package Water Treatment System

When Microfloc™ products first introduced the Trident technology, it represented a significant advancement in water and wastewater treatment for plant owners and operators. Not only did it remove turbidity, suspended solids, color, iron, manganese, odor, taste, and pathogens such as Giardia lamblia and Cryptosporidium, but it did so at a lower capital cost than conventional systems, in a smaller space, and at higher flow rates per unit area.

Today, more than 800 Trident technology systems, large and small, are at work all across North America and the world. Our Trident systems continue to evolve as we constantly strive to find ways to produce even higher quality treated water at higher flow rates per unit area and further reduce installation and operating costs.



Surface Water Treatment
- **Turbidity reduction**
- **Color removal**
- **Reduction of High TOC/DBP precursors**

Groundwater Treatment
- **Iron and manganese removal**
- **Arsenic**
- **Groundwater under the influence of surface water**

Tertiary Treatment
- **Water reuse**
- **Phosphorus removal**

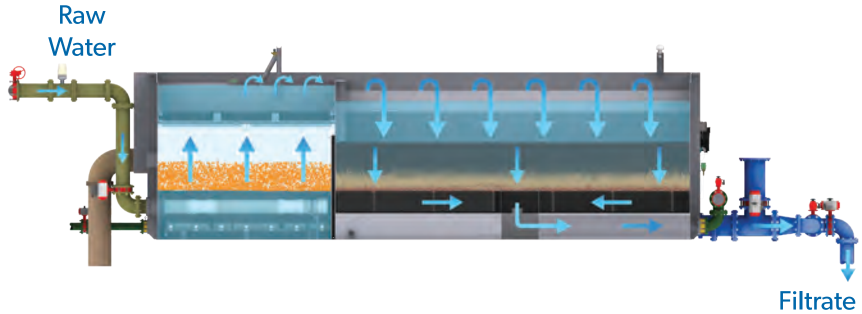
Industrial Process Water

Trident Design Criteria		
	Raw Water	**Finish Water**
Turbidity (NTU)	< 75	< 0.1
True Color (Pt-Co Units)	< 35	< 5
Combined Turbidity + Color	< 75	
Iron & Manganese (mg/L)	< 10	< 0.3 / 0.05

Proven and Efficient

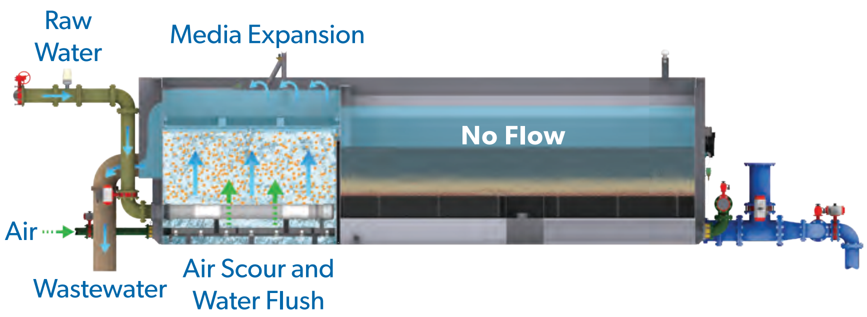
The Trident water treatment system utilizes a two-stage configuration consisting of an up-flow buoyant bead and compressible media Adsorption Clarifier® system followed by a conventional down-flow mixed media filter to produce high quality water.

Filtration Mode



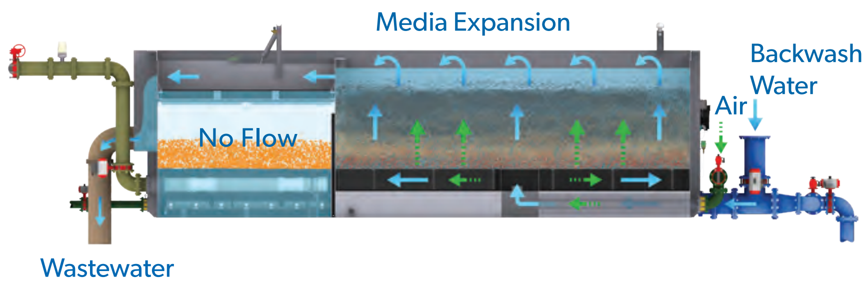
The treatment process is started when chemically dosed raw water enters the Adsorption Clarifier near the bottom of the tank where an upflow treatment process combines flocculation and clarification. From the Adsorption Clarifier, flow continues over a weir into the collection trough where it is distributed into the mixed media filtration chamber, after which it is collected by the MULTIBLOCK® underdrain with Laser Shield™ media retainer and exits the tank.

Buoyant Media Flush Mode



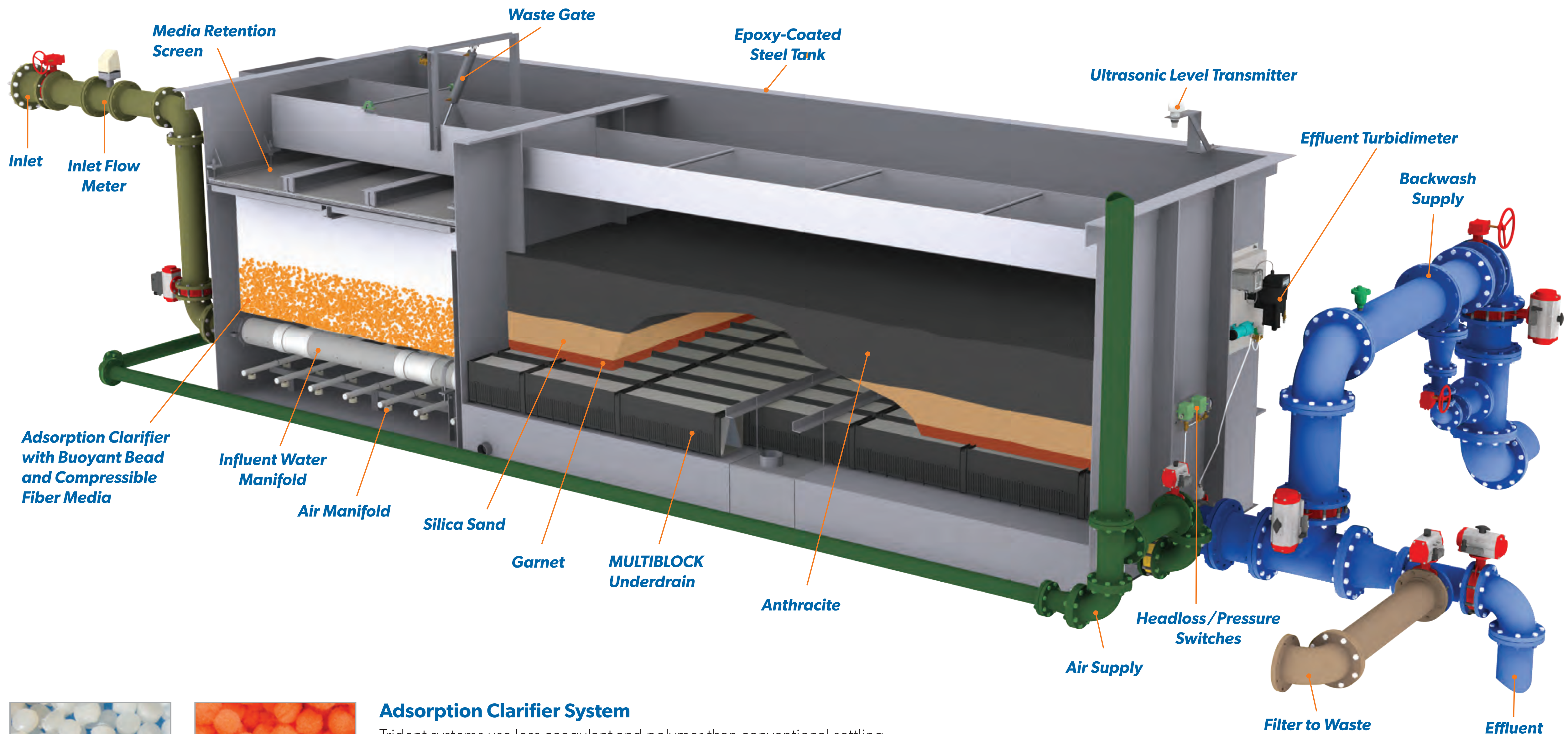
The Adsorption Clarifier is engineered to automatically initiate a flush cycle once headloss indicates that cleaning is required. When the cleaning is initiated, the waste gate and air scour valves are opened as raw water continues to flow. The air/water flush aggressively separates and removes the solids from the media. Solids are then discharged out through the waste pipe.

Backwash Mode



Like the Adsorption Clarifier flush, the backwash cycle is initiated when dirty bed headloss is reached in the mixed media filter section. The Trident inlet and outlet valves are closed and the air scour valve is opened to allow an air scour cycle. Solids from the backwash are then removed by water flowing up into the collection trough and discharged out through the waste pipe. A filter-to-waste sequence follows to ripen the filter media before returning the unit to service.

Complete Package Plant



Standard Components
Epoxy-coated steel tanks
Media
Internals
Actuated and manual valves
Inlet magnetic flow meter
Pressure transmitters
Ultrasonic level transmitter
Effluent turbidimeter
Automated PLC controls
Backwash control valves
Blower package
Chemical feed packages (coagulant and polymer)

Optional Components
Air compressor package
Integrated plant PLC controls package
Backwash magnetic flow meter
Interconnecting walkways and platforms
Aluminum or stainless steel tanks
Inlet turbidimeter
pH monitor
Streaming current monitor
Static mixer

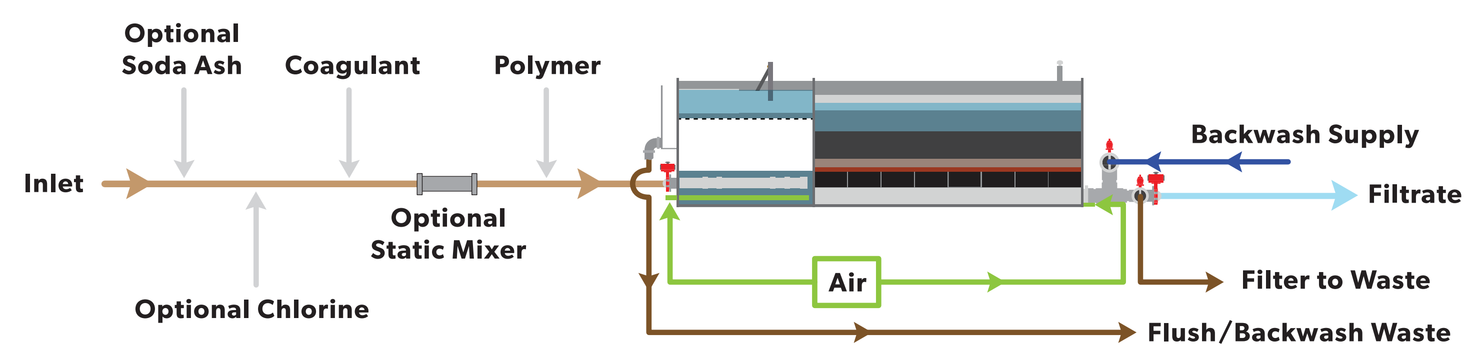
Adsorption Clarifier System

Trident systems use less coagulant and polymer than conventional settling type clarifiers. Within the Adsorption Clarifier system it is not necessary to form a settleable floc, which means floc size and settling time are not factors.
The buoyant media is rolled and scarified to greatly improve particulate removal. The compressible fiber media is used to capture more solids. The buoyant and compressible fiber media are NSF-61 certified and typically will last the life of the system.

Mixed Media Filtration

Microfloc pioneered mixed media technology, which has become the industry filtration standard. By using three or more granular materials of differing size and specific gravity, the progressive coarse-to-fine mixed media produces superior quality finished water.

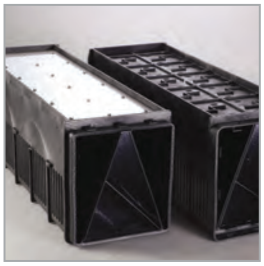
Trident Process Flow Diagram



Highly Efficient, Simple Operation

MULTIBLOCK

MULTIBLOCK underdrains provide a high-quality, low-cost, engineered product that is economical and versatile. MULTIBLOCK underdrains are fitted with the unique Laser Shield media retaining system that eliminates the need for support gravel. Combined air and water backwash is provided using this system.



- **Reduced profile underdrain**
- **Superior media retention capability**
- **Uniform distribution of water and air backwash**
- **NSF-61 approved**
- **Resistant to plugging and fouling**

Trident Process Controller Including the AQUARITROL® III

Trident package treatment units are supplied with fully automated programmable logic controls (PLC). These controls allow plant personnel to easily monitor operational parameters and control all treatment equipment and processes.

Changes in raw water characteristics and flow rate are automatically detected by the AQUARITROL III program. This PLC-based, feed-forward, loop control system monitors the filter effluent quality and continually evaluates and regulates influent chemical feed to maintain desired effluent water quality parameters. The operator sets an adjustable effluent quality setpoint and the Trident controls, utilizing the AQUARITROL III program, do the rest.

WesTech's electrical engineers and programmers can also integrate new whole plant operation or existing plant instruments into the Trident PLC controls. Complicated plant expansions are simplified by providing seamless integration of new and existing equipment.

- **Optimized and flexible process controls**
- **Chemical usage is maximized while maintaining performance**

Get More with Microfloc

Big Performance in a Small Water Treatment System

For lower flows, Microfloc offers the Tri-Mite® Package Water Treatment Plant. Using the same process as the Trident system, the Tri-Mite comes factory-assembled with pumps, controls, piping, valves, and an air scour blower mounted on the tank. These items are pre-plumbed and wired for simple, fast installation.

The Tri-Mite unit is available in five standard sizes as single units from 50 gpm to 350 gpm and as a two-unit system up to 700 gpm capacity. For flows less than 50 gpm, a single unit can be operated on an intermittent or reduced flow basis. These systems are perfect for new designs with future expansion in mind. The future additional tank would share the control panel, blower, and backwash pump of the first tank.

Equipment Upgrades and Expansions

If your unit is more than 10 years old, or has seen changes in raw water quality, it may be worthwhile to inquire about upgrading your Trident system. Common upgrades include enhanced PLC control systems, underdrain replacement accompanied with backwash upgrade, Trident HSR integrated presedimentation systems, and replacement of up-flow media. Retrofits are also available for other package treatment systems.

Stretch Customization

Some regulatory requirements may dictate a lower hydraulic loading through the filter cell. This is a simple change for the Trident system. An optional stretch filter cell is available to lower the hydraulic loading rate from 5 gpm/ft^2 to 4 gpm/ft^2. Other filter loading rates may also be achieved through custom design.

Standard Sizes

		Tri-Mite					Trident			
Influent Flow Rate GPM		**50**	**75**	**100**	**175**	**350**	**175**	**350**	**700**	**1400**
Tank Dimensions (Shipping)	Length	9 ft 0 in	9ft 2 in	11 ft 2 in	13 ft 9 in	23 ft 2in	10 ft 1 in	14 ft 6 in	27 ft 10 in	39 ft 10 in
	Width	5 ft 8 in	7 ft 10 in	7 ft 8 in	9 ft 11 in	10 ft 2 in	6 ft 11 in	8 ft 11 in	8 ft 11 in	11 ft 11 in
	Height	8 ft 5 in	8 ft 6 in	8 ft 6 in	8 ft 2 in	8 ft 3 in	8 ft 5 in	8 ft 5 in	8 ft 5 in	10 ft 1 in
Weights	Shipping (lbs)	6,300	8,100	9,600	9,200	14,600	7,000	10,250	17,000	34,000
	Operating (lbs)	14,000	20,000	25,000	43,000	78,000	35,000	70,000	140,000	330,000
Tank Connections	Influent	2 in	3 in	3 in	4 in	6 in	4 in	6 in	8 in	12 in
	Effluent	2 in	3 in	3 in	4 in	6 in	6 in	8 in	12 in	16 in
	Backwash Supply	3 in	4 in	4 in	5 in	8 in	6 in	8 in	12 in	16 in
	Waste/Overflow	4 in	6 in	6 in	8 in	10 in	8 in	10 in	14 in	20 in
	Air Wash (Clarifier)	1.5 in	2 in	2 in	2 in	3 in	2 in	3 in	4 in	6 in
	Air Wash (Filter)	1.5 in	2 in	2 in	2 in	3 in	3 in	4 in	6 in	8 in
Waste Production	Flushing Flow Rate (gpm)	50	75	100	175	350	175	350	700	1,400
	Flushing Volume Per Cycle (gal)	500	750	1,000	1,750	3,500	1,750	3,500	7,000	14,000
	Mixed Media Per Cycle (gal)	900	1,350	1,800	3,150	6,300	3,500	7,000	1,4000	28,000
	Filter to Waste Per Cycle (gal)	250	375	500	875	1,750	875	1,750	3,500	7,000

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Represented by:

WesTech®
Tel: 801.265.1000
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info@westech-inc.com
Salt Lake City, Utah, USA

Trident® HS

Multi-Barrier Package Water Treatment System

microfloc

WesTech®

The Trident® HS Package Water Treatment System

The Trident HS package treatment system provides multi-barrier protection for difficult-to-treat surface water, groundwater, industrial process water, and tertiary wastewater. The multi-barrier design of the Trident HS package consists of high-rate settling, adsorption clarification, and mixed media filtration.

Individually and collectively, the multiple treatment stages of the Trident HS system maintain superior effluent performance. The multi-barrier process is extremely well-suited for:

Water sources with:

- **High turbidity and color**
- **"Flashy" rivers and streams**
- **Reduction of High TOC/DBP precursors**
- **Cold waters**

Tertiary treatment in:

- **Water reclamation**
- **Phosphorus removal**

Trident HS Design Criteria

	Raw Water	Finish Water
Turbidity (NTU)	< 400	< 0.1
True Color (Pt-Co Units)	< 100	< 5
Combined Turbidity + Color	< 400	
Iron & Manganese (mg/L)	< 10	< 0.3 / 0.05
TOC (mg/L)		50 - 70% Removal
Phosphorus (mg/L)	< 5	< 0.1

Multi-Barrier Protection

Stage 1 - Chemical Conditioning / Tube Settling

Before water enters the treatment unit, coagulant and polymer are added to begin the coagulation and flocculation process. A sludge recycle flow is introduced near the coagulation point to aid in floc formation. This recycle flow also serves to maintain a steady-state solids concentration, minimizing variations in influent solids concentration.

For plants incorporating enhanced coagulation, the tube clarification stage reduces influent solids concentration prior to the Adsorption Clarifier® stage, leaving the majority of coagulated particles in the tube settler clarifier. For cold water conditions, the tube clarifier provides added detention time.

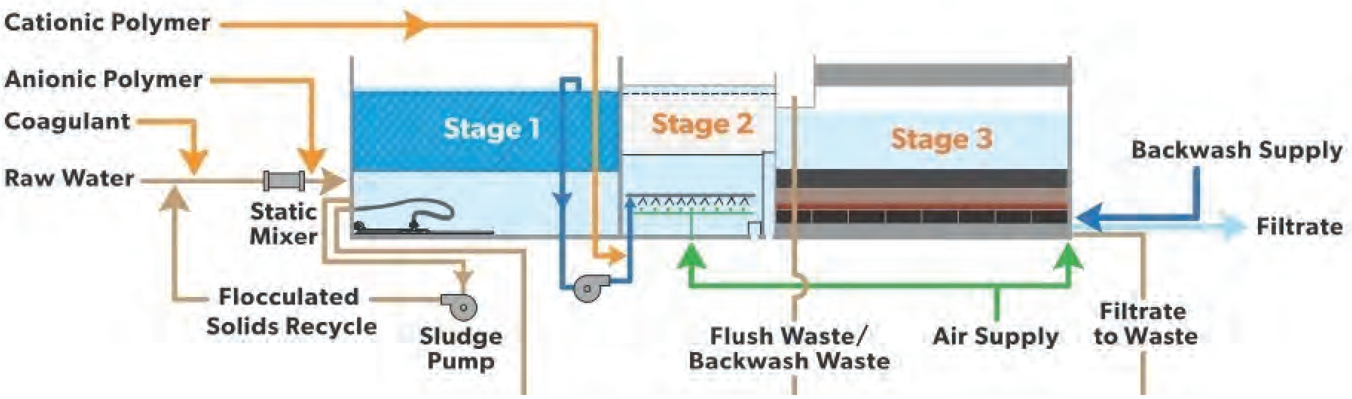
Stage 2 - Enhanced Clarification

A combined bed of both compressible and buoyant bead adsorption media provides second-stage clarification. The Adsorption Clarifier media further reduces solids prior to filtration. Captured solids are periodically flushed from the clarifier using an air / water combination. Tube-clarified water is used for the flushing process.

Stage 3 - Mixed Media Filtration

Mixed media filtration removes the remaining solids using a bed of anthracite, sand, and high-density garnet supported by a direct retention underdrain. For improved filtration, the media surface area per volume increases from top to bottom and the backwashing process incorporates simultaneous air / water backwashing and baffled washtroughs to prevent media loss and assure clean media.

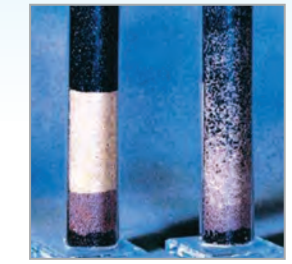
Trident HS Process Flow Diagram

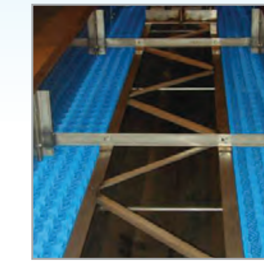


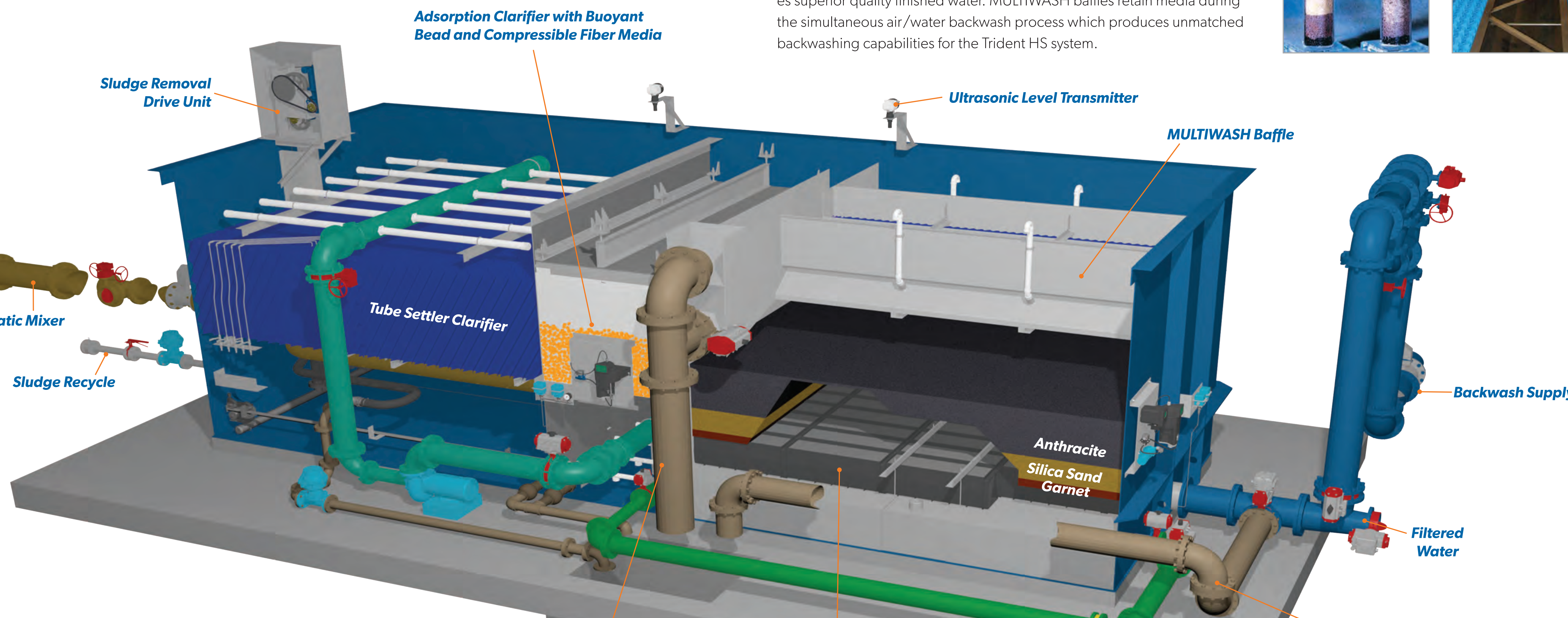
Complete Package Plant

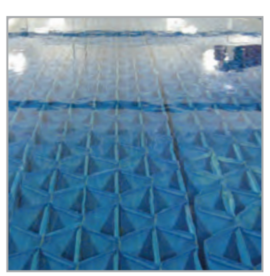
Mixed Media Filtration and MULTIWASH® Baffling

This Microfloc™ pioneered mixed media technology has become the industry standard for filtration. By using three or more granular materials of differing size and specific gravity, the progressive coarse-to-fine mixed media produces superior quality finished water. MULTIWASH baffles retain media during the simultaneous air/water backwash process which produces unmatched backwashing capabilities for the Trident HS system.







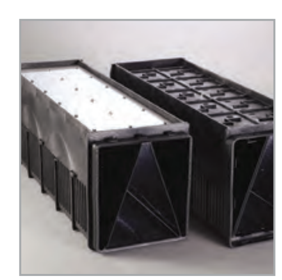


Tube Clarification

The tube clarifiers reduce plant waste volume and improve organics removal. The tube clarifier module can also be retrofitted to existing packaged clarification and filtration systems to improve process performance and reduce waste.

Adsorption Clarifier System

The unique design of the Adsorption Clarifier eliminates the need for settleable floc formation. Therefore, floc size and settling time are not factors. Because of this, Trident systems, as a whole, use significantly less coagulant and polymer than conventional settling clarifiers. The buoyant media is rolled and scarified to greatly improve particulate removal. The compressible fiber media is used to capture more solids. The buoyant and compressible fiber media are NSF-61 certified and typically will last the life of the system.

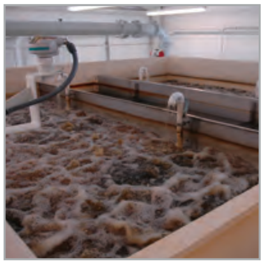


MULTIBLOCK® Underdrain with Laser Shield™

MULTIBLOCK underdrains offer the proven effectiveness of compensating dual lateral underdrain technology, which evenly collects filtered water. The MULTIBLOCK compensating orifice design also uniformly distributes backwash water and air to keep filters running at peak performance.

At less than one-tenth of an inch thick, the Laser Shield design reduces underdrain surface area per filter area by as much as 200 times when compared to porous bead designs, thus minimizing fouling potential.

Trident HS Efficiencies



Space Efficient

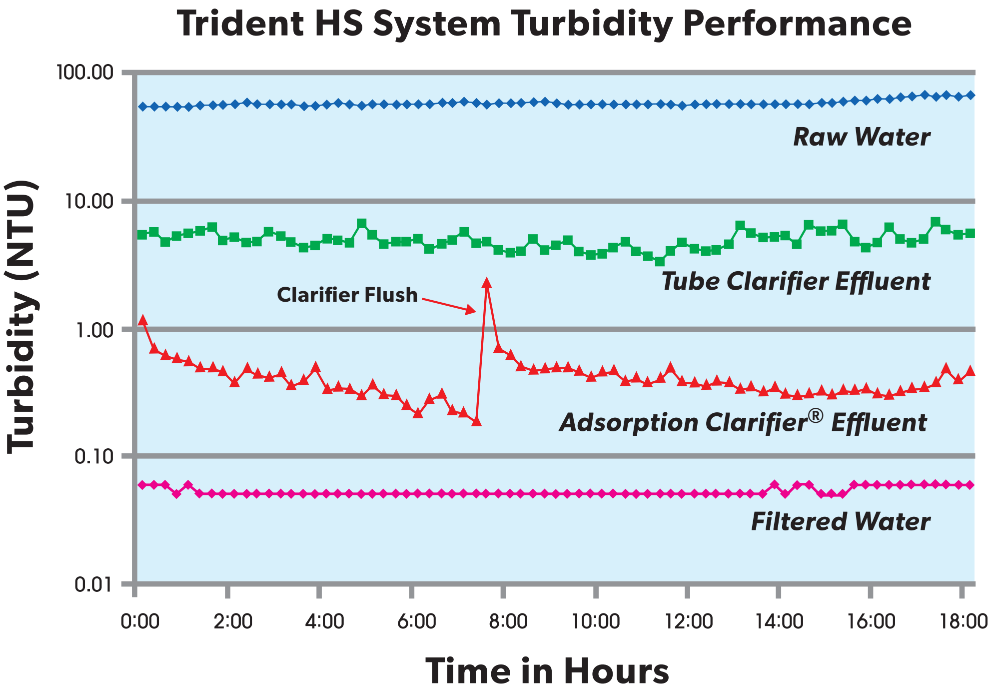
- The package design of the Trident HS system significantly reduces space between different treatment processes in your flow sheet, thus reducing floor space required.
- Operates at higher hydraulic loading rates than conventional systems.

Chemically Efficient

- The Aquaritrol® III process controller uses inlet and outlet turbidity signals to automatically adjust chemical dosage. This results in a more efficient use of chemicals than a simple flow pacing.
- Keeps previously-reacted solids in the system to build floc in incoming water.
- Keeps a high solids inventory in the tube settler to compensate for sudden changes in raw water.
- Reuses partially-reacted chemicals.

Waste Efficient

- MULTIWASH systems provide a sustained air/water backwash at high rates, resulting in a vigorous backwash unmatched in the market.
- Proprietary MULTIWASH troughs retain media in the system.
- Can offer cleanliness and media-loss prevention guarantees.
- Tube settler leads to longer duration between Adsorption Clarifier flush sequences, reducing waste.
- Combined tube settler sludge blowdown, Adsorption Clarifier flush, and MULTIWASH backwash will generally be <5% total waste.



Trident HS Standard Sizes

Trident HS Tank Sizes				
Model	**Length**	**Width**	**Height**	**Flow/Tank**
HS - 700	21′ 6″	9′ 0″	10′ 0″	350 gpm
HS - 1050	25′ 7″	11′ 0″	10′ 0″	525 gpm
HS - 1400	30′ 10″	12′ 0″	10′ 0″	700 gpm
HS - 2100	36′ 1″	15′ 0″	10′ 0″	1,050 gpm
HS - 2800	47′ 9″	15′ 0″	10′ 0″	1,400 gpm

Stretched models are available for applications that require larger filtration areas.

Standard Components
Epoxy-coated steel tank
Media
Internals
Actuated and manual valves
Inlet magnetic flow meter
Pressure transmitters
Ultrasonic level transmitter
Turbidimeters
Automated PLC controls
Backwash magnetic flow meter and control valve
Blower package
Transfer pump
Recirculation pump
Chemical feed packages (coagulant and polymer)

Optional Components
Integrated plant PLC controls package
Air compressor package
Interconnecting walkways and platforms
Aluminum or stainless steel tanks
Streaming current monitor

Getting the Right Fit

Trident HS Pilot and Lab Work

Trident HS package treatment pilots are available for onsite test work and can be used in a variety of treatment applications. Pilot testing may follow bench-scale testing as the final step in determining full-scale design and projected performance. WesTech's fully equipped sedimentation/filtration lab performs testing of site-sourced water samples to help determine the appropriate treatment for any given water.

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Represented by:

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ULTRAFILTRATION MEMBRANE SYSTEMS

Versatile membrane solutions for potable and process water treatment

SYSTEMS DESIGNED WITH YOU IN MIND

WesTech leads the way in membrane system innovation with versatile, open-platform designs, packaged pre-engineered systems, and solutions for challenging retrofit applications.

WesTech membranes provide potable and process water treatment solutions that are targeted to your needs. Our range of solutions include:

Open-Platform Systems

– A versatile, flexible system that is compatible with several modules from leading manufacturers

– VersaFilter™ Open-Platform Membrane Technology

Package Systems

– A standarized solution that is full featured but with a compact footprint

– AltaPac™ Ultrafiltration Membrane System

Conventional Ultrafiltration Membrane Systems

– Advanced membrane filtration technology with applications in potable and process water

– Innovative, space-saving designs

Retrofits

– Creative and cost-conscious solutions to upgrade existing membrane or conventional systems

– Available for most manufacturers' systems

Containerization

– Stand-alone, skid-mounted units allow for rapid installation for mobile or temporary needs

– Permanent installations and rental options

Refer to WesTech's reverse osmosis equipment options for post-treatment solutions that work seamlessly with our ultrafiltration systems.

MOBILE AND CONTAINERIZED ULTRAFILTRATION UNITS

QUICK SETUP.
SECURE INSTALLATION.
FLEXIBLE TIME PERIOD.

SIMPLE SOLUTIONS TO ENSURE UNINTERRUPTED SERVICE

Containerized or skid-mounted ultrafiltration units are effective solutions for your mobile or temporary needs.

BENEFITS

- Minimized downtime due to emergency situations– operations back online quickly
- Equipment can be contracted for as little as one month or for as long as the project requires
- Smaller footprint
- Installation and operations expertise provided
- Minimal setup time

OPEN-PLATFORM MEMBRANE TECHNOLOGY

VersaFilter: Better Design, More Options

Our ultrafiltration/microfiltration system featuring VersaFilter Open-Platform Membrane Technology offers more choices without increased costs. This innovative and versatile system is compatible with several modules from leading manufacturers.

VersaFilter™
Open-Platform Membrane Systems

VERSATILE AND ADAPTABLE

Adjustable features allow for future innovation; advanced automation and controls provide for flexible operation; and ancillary equipment is sized for wide compatibility.

10+ UF/MF MODULES

Compatible with more than 10 UF/MF module types, including: Dow, Toray, Nanostone, Scinor, Hydranautics, and more.

VERSAFILTER ACHIEVES PERFORMANCE EXCELLENCE

- PRICE
- FLEXIBILITY
- RELIABILITY

The VersaFilter Open-Platform Membrane Technology will accommodate the best UF/MF modules now and in the future.

PACKAGE MEMBRANE SYSTEMS

AltaPac Ultrafiltration Package Membrane System

The WesTech AltaPac is a skid-mounted package membrane system that includes all pumps, valves, and ancillary components for rapid installation and seamless operation of the equipment. Its complete automation, remote monitoring, low cost, and compact design make it an ideal choice for industrial and municipal applications.

KEY ALTAPAC BENEFITS

01
Guaranteed filtrate turbidity <0.1 NTU

02
Guaranteed SDI <3 for NF/RO pre-treatment

03
Certified 4-log for giardia, cryp-tosporidium

04
Flanged, single-side connections for <1 day install

05
3-sided access with low footprint

5 – 350 GPM

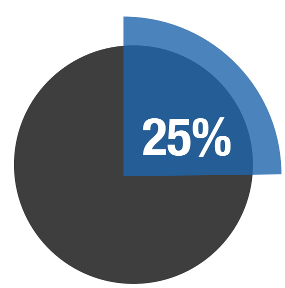
A full-featured water treatment system optimized for flow rates of 5 – 350 gpm

PRE-ENGINEERED.

STANDARDIZED.

FULL-FEATURED.

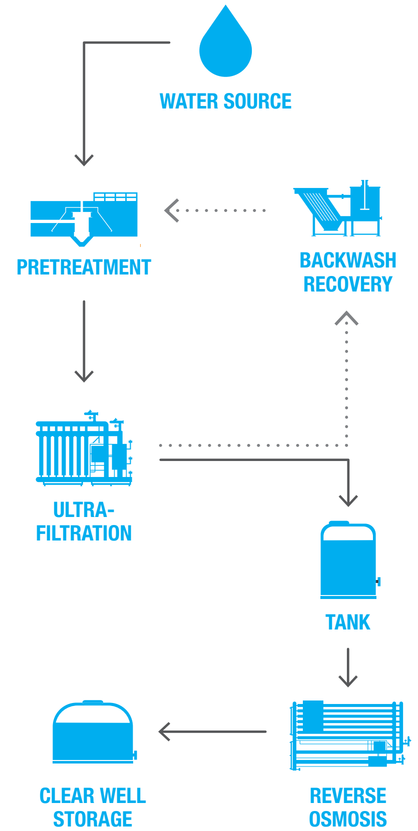
COMPACT FOOTPRINT.



Reduces footprint by more than 25% vs. comparable systems

THE WESTECH ADVANTAGE

Customers have been coming to WesTech for reliable solutions for over 45 years. Our technical expertise, complete process knowledge, and strong commitment to service make WesTech the best partner to achieve a state-of-the-art treatment system.



WE'RE BY YOUR SIDE THROUGH THE ENTIRE PROCESS

INTEGRATED CONTROLS WITH REMOTE MONITORING

Our Intelligent Controls simplify your operation with remote monitoring, data analysis, automatic sequencing with alarm protections, and complete plant integration.

WESTECH IS THE SUPERIOR CHOICE FOR:

01 Extensive ultrafiltration experience

02 Long-term customer service and support

03 Pre and post-treatment options

04 Optimized in-house controls

05 Packaged, pre-engineered systems

06 Flexible, open platform/universal custom systems

07 Mobile/ containerized options

08 Versatility – solutions work with existing equipment

801.265.1000 info@westech-inc.com WesTech® westech-inc.com Salt Lake City, UT

Ultrafiltration Pilot Unit

Pilot Plant R212

WesTech ultrafiltration (UF) is the solution for reliable high-quality water production for potable water, wastewater, reuse, and industrial process applications. A pilot is used to demonstrate performance, test specific criteria, and verify design parameters for full-scale systems.

Applications:

- Potable Water
  - >99.99% Crypto/Giardia Removal
- Tertiary Wastewater
- Industrial Process Water
- Small Communities and Camps
- Sites with Footprint Constraints
- Pretreatment to RO/NF
  - Filtrate SDI <3

Pilot Specifications	
Flow Rate	5 - 75 gpm
Dimensions	11′- 4″ L x 4′- 10″ W x 11′- 1″ H
Shipping Weight	3,500 Pounds
Power Requirements	480 V, 3 ph, 60 Hz, 30 amp or 240 V, 1 ph, 60 Hz, 100 amp
Connection Sizes	2″ Flange - UF Feed 2″ Flange - Filtrate 2″ Flange - Backwash waste/Drain
Operational Control	Automatic

Contact WesTech today to implement a pilot test at your facility. Our responsive engineering team will help facilitate scheduling and pilot setup of the ultrafiltration pilot plant.

The R212 pilot plant includes:

- Feed and backwash supply tanks
- Feed and backwash supply pumps
- 200 µm pre-strainer
- Ultrafiltration membranes
- CIP and maintenance cleaning system
- Membrane integrity monitoring
- Automatic control system
- Instrumentation:
  - Feed turbidimeter
  - Filtrate turbidimeter
  - Flowmeters
  - Pressure transmitters
  - pH transmitter
- Compressed air system

WesTech®

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APPENDIX H

TECHNICAL MEMORANDUM 20434-6, SUDDEN VALLEY WTP DISINFECTION SYSTEMS ANALYSIS

TECHNICAL MEMORANDUM 20434-6

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	FEBRUARY 15, 2022
SUBJECT:	SUDDEN VALLEY WTP DISINFECTION SYSTEM ANALYSIS LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively provide clean potable water for its existing and projected customers.

This memorandum summarizes the assessment of the existing disinfection system at the WTP, provides a description of alternative disinfection methods, and provides analysis and preliminary cost estimates for these alternatives.

Final recommendations for disinfection modifications will be presented in the final alternatives analysis report, which is scheduled to be completed in spring 2021. The final alternatives analysis report will consider all of the alternatives and recommendations compiled for each of the treatment systems and will provide a coordinated set of recommendations based on capital costs, District needs, operational costs, and other factors.

1130 Rainier Avenue South, Suite 300 Seattle, Washington 98144 (206) 284-0860 Fax (206) 283-3206

BACKGROUND AND EXISTING FACILITIES

Background

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD), which is equivalent to approximately 1,400 gallons per minute (gpm), but currently operates at a reduced flow of 1.0 MGD (700 gpm). The maximum allowable water right for this source is 1,526 gpm; however, the equipment and components listed in the alternatives below will be sized to accommodate up to the rated flow of 1,400 gpm. This design flow is suitable to serve the projected buildout water demand of 1.3 MGD as listed in the District's 2018 Water System Comprehensive Plan.

The WTP is located at 22 Morning Beach Drive in Bellingham, Washington 98229 and is housed in a partially below-grade concrete building located adjacent to Morning Beach Park. The facility was constructed in 1972 and has undergone several minor improvements since that time but was most recently upgraded in 1992. Two centrifugal raw water pumps pump water from the Lake Whatcom intake to the WTP where alum coagulant is injected. After mixing with coagulant, water enters the flocculation basin before entering the filter distribution trough and the mixed-media filters. Water proceeds through the filters into the underdrain system then exits the filter through the filter discharge piping. The filter discharge piping includes injection points for both soda ash (pH adjustment) and chlorine. This piping then directs the filtered water to the below-grade clearwell. Two transfer pumps located in the WTP move water from the clearwell to the chlorine contact basin, which is a welded steel reservoir located adjacent to the WTP that provides additional chlorine contact time. From the chlorine contact basin, four finished water pumps pump water to the District's storage reservoirs and distribution system for consumption. Additional information on the chlorine disinfection system – which is the primary subject of this memorandum – is provided below.

Historical WTP Performance

Historically, the plant has performed well and provides high-quality finished water with turbidity less than 0.1 nephelometric turbidity units (NTU). Raw water is collected from the adjacent Lake Whatcom from an outfall located at a depth of approximately 80 feet and approximately 350 feet from the typical shoreline. Lake Whatcom is a large lake that is moderately developed on the northern and western shores but is largely undeveloped on its eastern shore. Raw water quality from the Lake Whatcom source is fairly consistent with turbidity below 1.0 NTU for most of the year. Turbidity increases during the spring and fall runoff seasons, but typically remains below 5.0 NTU during these periods. Raw water pH is typically between 7.5 and 7.7 and raw water temperature varies between 5 and 8 degrees Celsius.

In 2017, Gray & Osborne performed a tracer study analysis at the WTP to verify the contact time used for disinfection of filtered water prior to introduction to the distribution system. To conduct this study Gray & Osborne injected a chemical tracer (sodium fluoride) to the discharge piping of the existing clearwell transfer pumps, then measured the tracer concentration over time from the discharge of the finished water pumps in the Finished Water Pump Building. Using this method, it is possible to estimate the baffling efficiency (BE) for the basin, which is then used to determine the contact time (CT) provided by the chorine contact basin (CCB). CT is a disinfection requirement mandated by the Washington State Department of Health (DOH) and is equal to the minimum daily concentration of chlorine measured in a contact basin multiplied by the minimum daily residence time through the contact basin – which is also a function of the baffling efficiency. Prior to conducting the tracer study, the District utilized a BE for the CCB of 0.7 which is a typical value assumed for baffled tanks. However, empirical data collected during the tracer study showed an average BE value of 0.35 – a value much lower than the assumed value. Additional information on the specifics for this investigation and the impacts of this discovery are provided in subsequent sections of this memorandum.

Chorine Disinfection Equipment

The WTP utilizes a gas chlorine injection system to provide disinfectant chemicals to the filtered water. This disinfectant provides the necessary chlorine residual to meet the concentration and CT requirements set forth by DOH. Commercially prepared chlorine gas is delivered to the WTP in 150-pound cylinders and stored within a small (40- to 50-square-foot [sf]) room inside the WTP. For redundancy, two active cylinders and two spare cylinders are stored on site at all times. The active cylinders are stored on a scale and specialized gas regulators provide the desired gas flow which is measured by a gas flow meter. Chlorine gas is mixed with a sidestream of filtered water, creating a hypochlorite solution that is then injected to the piping between the filter units and the clearwell. Additionally, a small amount of chlorine solution is injected to the first chamber of the flocculation tank, which helps prevent algal growth within the tank and on the filter media. Because the WTP operates at a constant flow rate, the chlorine system is adjusted manually as needed and does not include automated flow control equipment. The chlorine supply to Filters 1 and 2, Filters 3 and 4, and the flocculation tank are all controlled separately using individual flow regulators and meters.

The chlorine room at the WTP contains two chlorine gas sensors which will warn operations staff of a potential leak so that appropriate ventilation and safety procedures can be followed.

The WTP measures chlorine concentration in two locations. The first location is from the clearwell transfer pump discharge piping while the second location is from the CCB discharge piping prior to entry to the distribution system. The chlorine concentration measured from the CCB discharge piping is subsequently used for CT calculations. For both sampling locations, a sidestream of water from the discharge piping is directed to the corresponding chlorine analyzers, which are both located on the west wall of the WTP Main Building near the transfer pumps and laboratory counter. In 2018, the WTP replaced their existing chlorine analyzers with two new Hach CL17 chlorine analyzers to measure the chlorine concentration.

Table 1 summarizes critical design criteria for the chlorine disinfection system and Figure A-1 in Exhibit A shows a photograph of the existing equipment.

TABLE 1

Chlorine Disinfection System Summary

Parameter	Value
Type	Gas
Manufacturer	Regal
Injection Locations	Preflocculation Tank Post Filters 1/2 Post Filters 3/4
Dose (mg/L)	1.2–1.4
Target Residual (mg/L)	1.0–1.2 (CCB discharge)
Average Consumption (lb/d)	7.2 (winter) 9.8 (summer)

In 2018 and 2019, the WTP consumed between 7 and 10 pounds per day of gaseous chlorine, depending on the season (winter versus summer). As such, the WTP staff must replace one gas cylinder approximately every 2 to 3 weeks. The staff dose chlorine solution in order to maintain a chlorine residual of 1.0 to 1.2 milligrams per liter (mg/L) at the entry point to the distribution system.

In February 2020, Gray & Osborne completed a condition assessment for the Sudden Valley WTP and noted the findings in the *Sudden Valley Water Treatment Plant Assessment Report* (Assessment Report). This report included recommendations and provided budgetary cost estimates to complete the recommended modifications. With regard to the chlorine disinfection system, the Assessment Report noted the following items:

- Although the chlorine equipment met the codes in place at the time of construction, the existing system does not meet current building code requirements. Specifically, the volume of gas stored exceeds the allowable amount (150 pounds, or one standard cylinder) for a facility without fire suppression, gas monitoring, and gas storage systems. This exceedance typically pushes the occupancy category to H-3 from F-1 or F-2), which has more stringent requirements for safety, storage, and fire suppression systems (additional information on the requirements for H-3 occupancy are provided in Exhibit C).

- Component labeling is inaccurate or absent.

- The coating system within the chlorine room has failed or is failing.

- The gas cylinders utilize only a single restraining chain, which is insufficient to protect the system during a seismic event.

Even with the issues listed above, it is important to note that the existing system performs well and the WTP staff have no issues with the required operation or maintenance of the equipment. However, chlorine gas is a toxic oxidant gas that does pose some risk to operational staff as well as surrounding residences and their tenants. To mitigate this risk, many municipalities have replaced their gas chlorine systems with alternative disinfection systems, and these alternatives are discussed in greater detail later in this memorandum.

Chlorine Contact Basin

The WTP utilizes a CCB to provide chlorine contact time for filtered water prior to introduction to the distribution system. Technical information for the CCB is provided in Table 2. Figure A-2 shows a plan view of the CCB, Figure A-3 shows a section view of the CCB, and Figure A-4 includes photographs of the existing tank.

TABLE 2

Chlorine Disinfection System Summary

Parameter	Value
Type	Circular, Welded Steel
Year Installed	1994
Diameter (ft)	40
Base Elevation (ft)	336.0
Overflow Elevation (ft)	360.0
Volume (gal)	225,000
Gallons per Foot (gal/ft)	9,400
Inlet and Outlet	Vertical, 10-Inch Perforated Riser
Baffles	Three, Steel Plate
Minimum Water Height (ft)	16.5 (1)
Residence Time (min at 700 gpm)	320

(1) As directed by DOH to provide the minimum desired CT for finished water.

Water enters the CCB via a diffuser riser at one end and flows in a serpentine fashion between three steel baffles to the outlet diffuser. The inlet diffuser consists of a 10-inch diameter PVC pipe with twenty-five 2-inch diameter holes drilled at 9.25 inches on center. The outlet diffuser riser consists of a 10-inch diameter PVC pipe with fifty 2-inch diameter holes drilled at 9.25 inches on center. These risers act to promote consistent flow throughout the full depth of the water column from the inlet to the outlet. The CCB has both exterior and interior coatings. The CCB is inspected every 5 years and was most recently inspected in 2017. Technical Memorandum 20434-2 (Gray & Osborne, 2020) discusses the existing CCB coating system and provides a set of recommendations to help ensure its longevity and service life.

The CCB utilizes a single pressure switch for the high-level alarm within the tank; however, the District plans to install a redundant alarm (Endress & Hauser DeltaBar Series) sometime in 2021. The switch communicates the alarm signal to the WTP programmable logic controller (PLC) which relays the alarm to WTP staff. Access to the

CCB is provided by two 36-inch diameter manways located on opposite sides of the tank at ground level as well as a 24-inch access hatch on the roof of the tank.

With regard to the CCB, the Assessment Report and Technical Memorandum 20434-2 noted the following items:

- The interior coating system is in fair condition, but should be replaced within 5 years.

  As part of this recoating process, the interior wall and roof members should be seal welded to minimize corrosion in areas difficult to coat, and the entire structure should be stripe-coated prior to topcoating.

- The exterior coating system is in fair/poor condition and should be replaced within 5 years.

- The existing roof vent should be replaced to address corrosion.

- An additional access hatch should be installed to provide an additional access/inspection point.

- Security improvements such as removing the existing ladder guards, installing padlock covers, and installing additional tamperproof components should be completed.

CT System

Surface water systems in Washington must provide a minimum level of CT to protect water quality and ensure disinfection of treated water. CT is the product of the chlorine residual (C) and the residence time within the contact basin (T). The residence time used for calculating CT is a function of the flow through the basin, minimum volume within the contact basin, and the baffling efficiency of the basin. As described above, Gray & Osborne previously conducted a formal tracer analysis on the District's CCB. Prior to conducting the tracer study, the District utilized a BE for the CCB of 0.7 which is a typical value assumed for baffled tanks. However, empirical data collected during the tracer study showed an average BE value of 0.35.

The data analysis and recommendations report for the study conducted on the CCB at the WTP in 2017 recommended that the District utilize a revised BE of 0.3, which is less than the theoretical value of 0.7 that the WTP had previously been using. The report also recommended that the District consider modifying their CT calculation to include unused clearwell volume, maintain a minimum volume of water in the CCB, and increase the target chlorine residual during the cold winter months. As a result of the tracer study, the WTP staff have made several operational changes in order to ensure that they consistently provide suitable disinfection of treated water leaving the WTP. One of these operational changes was to maintain a consistent flow through the plant of 700 gpm while a second operational change was to increase the target chlorine residual dose from 0.6 to 0.8 mg/L. This flow reduction was so that the WTP can provide adequate hydraulic residence time through the CCB. If flows greater than 1,000 gpm are used, then additional chlorine must be added to the system, which increases the residual of water leaving the WTP, operational costs for the additional chlorine consumption, and the potential for customer complaints about the finished water quality and taste.

These changes help ensure that the WTP provides sufficient disinfection for its treated water; however, this reduced operational flow will inhibit the WTP's ability to meet projected average daily and maximum daily demands for the South Shore water system.

ALTERNATIVES ANALYSIS

Two sets of alternatives are described below. The first set deals with the disinfection system while the second set deals with the CCB. Although these systems act in concert to provide the required disinfection prior to entry into the distribution system, they are unique in their function and have independent alternatives for modifications and as such, will be investigated separately.

The disinfection system alternatives reviewed below include continued utilization of chlorine gas, on-site sodium hypochlorite generation, or commercially provided hypochlorite solution. CCB alternatives include modifications to the existing tank, construction of a replacement tank, or construction of a supplemental tank. Each of these alternatives is more thoroughly investigated below and it is important to note that these alternatives are provided to help the District determine the best course of action for their treatment operation and any modifications to the disinfection system should be considered in the context of other changes that are recommended or desired for the WTP.

Disinfection System

Alternative C1A – Utilize Existing Chlorine Gas System with No Modifications

General

This alternative includes continuing to utilize the existing chlorine gas system within the existing chlorine room of the WTP Main Building. The system will continue to operate as described previously in this memorandum.

Disinfection

The disinfection process will not be modified in this alternative. The WTP will continue to inject gas into a sidestream of finished water and the resulting chlorinated solution will continue to be injected to the flocculation tank as well as the discharge piping from each of the filters.

Building and Other

No modifications will be completed to the WTP Main Building, chlorine room, or WTP site. If any modifications are made to the chlorine room, it is assumed that the room and system must be brought up to current building codes. The modifications associated with these requirements are described in Alternative C1B below.

Advantages and Disadvantages

While this alternative has no capital cost for the District, it also provides no additional benefits for the treatment process. Furthermore, this alternative does not address the fact that the current disinfection system does not meet current building codes or that it continues the use of gaseous chlorine, which does pose more significant health and safety risks when compared to other disinfection technologies.

Cost Estimate

There is no capital cost associated with this alternative. Operation and maintenance costs will also not change.

Alternative C1B – Utilize Existing Chlorine Gas System with Modifications

General

This alternative includes utilizing chlorine gas disinfection but includes providing upgrades to the facility so that it meets current building and safety codes.

Disinfection

The disinfection process will not be modified in this alternative. The WTP will continue to inject gas into a sidestream of finished water and the resulting chlorinated solution will continue to be injected to the flocculation tank as well as the discharge piping from each of the filters.

Building and Other

As mentioned above, the chlorine room and associated equipment does not meet current building and safety codes for use and/or storage of gaseous chlorine. This alternative includes modifications to the existing facility so that it does meet current code requirements. Additional information on these code requirements and regulations is provided in Exhibit C, and the proposed modifications to the facility are summarized below:

- Replace the existing mechanical ventilation equipment and ensure that this equipment is connected to the auxiliary power source.
- Replace the existing fire alarm system and install a fire suppression system within the chorine room.
- Replace the chlorine gas detection and alarm system.
- Spare cylinders not in use shall be stored within an approved storage cabinet and this cabinet shall be anchored to the wall.
- Reconfiguration of the room to allow for anchoring gas cylinders in use to the wall.
- Investigate the existing electrical power distribution in the chlorine room and provide additional safeguards.

- Prepare and store a Hazardous Materials Management Plan and Hazardous Materials Inventory Sheet.

New ventilation (HVAC) equipment will be installed to ensure that it provides the required number of air changes per hour and is connected to the auxiliary power source so the system can remain in operation during an interruption in the primary power service. The fire alarm and suppression system will be replaced with new technology and will include both heat and smoke detection. The fire suppression system will include an automatic sprinkler system. The gas detection and alarm system will be replaced with new technology and will act to warn the WTP staff if chlorine gas is detected. This alarm will be connected to the Supervisory Control and Data Acquisition (SCADA) system to warn the staff if they are not at the facility, and various visual and audible alarms will be provided at the WTP to notify staff.

If the modifications summarized above are installed, the existing facility will meet current codes for the use and storage of gaseous chlorine for disinfection.

Advantages and Disadvantages

One advantage to this alternative is that no significant structural modifications are needed and the system can remain in place within the existing chlorine room. Another advantage is that the staff is familiar with disinfection via gaseous chlorine and no additional training or experience is required. One disadvantage to this alternative is that it utilizes gaseous chlorine, which does pose more significant health and safety risks when compared to other disinfection technologies.

Cost Estimate

The estimated cost to provide the items described above is $271,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (30 percent). The budget line item for the design/project administration for this alternative is slightly larger than typical planning values because the fire suppression and alarm system must be designed by a firm specializing in this equipment. A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative C1C – Utilize New Chlorine Gas System within a New Building

General

This alternative includes utilizing chlorine gas disinfection that will be located within a new separate building. The existing chlorine disinfection equipment will be removed from service.

Disinfection

The disinfection process will not be modified in this alternative. The WTP will continue to inject gas into a sidestream of finished water and the resulting chlorinated solution will continue to be injected to the flocculation tank as well as the discharge piping from each of the filters.

Building and Other

While Alternative C1B included modifying the existing chlorine room at the WTP, Alternative C1C includes installing new chlorine gas equipment within a new separate building. The new building would be approximately 140 sf and could be located as shown on Figure A-5 in Exhibit A. The building would be constructed from CMU or other noncombustible materials and would include new mechanical ventilation equipment, a new fire alarm system, a fire suppression (sprinkler) system, gas detection system with audible and visual alarms, and sufficient space to provide storage for gas cylinders that meets current building and safety codes. The building would also include some space for miscellaneous storage.

The new facility will be subject to all applicable stormwater requirements for construction of new buildings and the addition of new asphalt pavement. The construction of a new building adjacent to the existing WTP would be subject to the stipulations listed by Whatcom County for the Lake Whatcom Watershed. These requirements will include the need to provide either full infiltration on site or advanced treatment for phosphorous removal. Design of the required stormwater facilities will be provided once the building footprint and paving have been finalized, but a budgetary estimate for the anticipated requirements has been included with the alternative cost estimate included in Exhibit B. In addition, it should be noted that these regulations restrict clearing of the site so that only 35 percent of the existing tree canopy can be cleared.

It is important to note that this alternative will require additional design and coordination with various stakeholders, one of which includes the Sudden Valley Community

Association (SVCA). The SVCA owns much of the property adjacent to the WTP and would need to be consulted prior to implementation of any of the alternatives discussed in this memorandum. Furthermore, the District must consider that the property adjacent to the WTP is a public park with waterfront access and use of this public space will likely need to be maintained at all times. Other stakeholders include neighboring residential landowners and utility providers serving the area.

This additional equipment will increase the electrical load on the facility to accommodate the new building lighting, heating equipment, and fire alarm system. The existing circuit that feeds the chlorine room ventilation equipment will be extended to the new building, but additional circuits will be required for new lighting and heating equipment. For the purposes of this investigation, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will require modifications to the District's existing SCADA system. The new fire and gas alarm signals can be incorporated into the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

Advantages and Disadvantages

One advantage to this alternative is that the proposed building and chemical delivery system will be designed to current building codes regarding use of chlorine gas. Another advantage is that the existing chlorine room will become available for use as storage or other desired uses. Disadvantages to this alternative are that it will require construction of a new building and that this alternative will continue the use of gaseous chlorine, which does pose more significant health and safety risks when compared to other disinfection technologies.

Cost Estimate

The estimated cost to provide the items described above is $725,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (30 percent). The budget line item for the design/project administration for this alternative is slightly larger than typical planning values because the fire suppression and alarm system must be designed by a firm specializing in this equipment. A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative C2 – On-Site Generation of Hypochlorite

General

This alternative includes removing the existing chlorine gas equipment from service and installing new on-site hypochlorite generation equipment within a new building.

Disinfection

For this alternative, the existing gas chlorination equipment will be removed and will be replaced with an on-site hypochlorite generation system.

On-site hypochlorite generation (OSHG) is commonly used to generate a dosing solution (usually 0.8 percent) which is then injected into the filtered water either directly or via sidestream predilution. The 0.8 percent solution is dilute enough that it is not considered a hazardous material. OSHGs create hypochlorite by applying an electrical current across a saturated brine (salt) solution, which generates both the desired hypochlorite as well as hydrogen gas. OSHG systems are commonly used at WTPs across the Pacific Northwest and typically include the following components:

- Electrolytic Cells
- Hydrogen Gas Blower
- Water Softening System
- Brine Storage Saturator and Dosing System
- Hypochlorite Storage
- Hypochlorite Metering Pump Equipment
- Controls, Instrumentation, and Telemetry Equipment

Several manufacturers have streamlined the OSHG process and provide package systems that include many of the components listed above on a common skid/frame which simplifies the installation and design process. A schematic diagram of a typical OSHG system and a photo of one such system provided by UGSI/PSI is included as Figure A-6 in Exhibit A.

Table 3 highlights the design criteria for the proposed OSHG system at both typical and design flow values.

TABLE 3

OSHG Design Criteria

Parameter	Typical Flow	Design Flow
Flow (gpm)	700	1,400
Target Chorine Residual (mg/L, as Cl)	1.2	1.2
Chlorine Consumption (lb/d)	10.1	20.3
Hypochlorite Consumption (gpd)	158.4	316.7
Salt Consumption (lb/d) (1)	30.4	60.8
Power Consumption (kWh/d) (2)	20.3	40.5

(1) Using a typical conversion rate of 3 pounds of salt per pound of chlorine.
(2) Using a typical conversion rate of 2 kilowatt-hours (kWh) per pound of chorine.

Even though the WTP operates almost exclusively at 700 gpm, the proposed OSHG system will be capable of providing up to 25 pounds of chlorine per day, which is sufficient for the design flow listed in Table 3.

A typical OSHG system has a footprint of approximately 8 sf (2′ x 4′). This footprint is for the OSHG system only and does not account for additional appurtenances such as the brine storage tank, hypochlorite storage tank, or hypochlorite metering pump equipment. The system will include a hydrogen blower to remove hydrogen gas created as part of the electrolysis process and will also include a hydrogen gas sensor/alarm equipment. The water softener system will be provided by the OSHG manufacturer, which will further optimize the installation process. This softener will remove various chemical ions/compounds to optimize the water chemistry for electrolysis. A softener system typically consists of a brine storage tank (less than 100 gallons) from which saturated brine solution is dosed into the OSHG system. The saturated brine solution is created by combining salt granules/pellets with potable water within the brine storage tank. Although mechanical systems exist for handling salt addition to the brine tank, these systems are likely cost-prohibitive for the current and projected salt consumption listed in Table 3 (up to 60 pounds per day). In this alternative, a mechanical brine management system is not included, and this alternative assumes that staff will manually add approximately one bag of salt (50 pounds) to the brine storage tank every 1 to 2 days.

Once hypochlorite solution is generated, it is temporarily stored prior to being injected into the treatment process using the chemical metering pumps. Most manufacturers recommend that up to 2 days of solution be stored within this tank to optimize the space required for the system with the capital cost for the system. Given the proposed hypochlorite solution consumption listed in Table 3, the hypochlorite storage tank should have a capacity of at least 700 gallons. This tank can be provided by the OSHG manufacturer as part of the equipment package or can be provided separately. The hypochlorite storage tank would feed a set of chemical metering pumps that would inject the solution to the filtered water piping upstream of the clearwell. For this application, a duplex metering pump skid is recommended for reliability and redundancy. The metering pumps can be diaphragm style and should have a pumping capacity of approximately 15 gallons per hour (gph), which would accommodate both the typical and design flows. If desired, the OSHG manufacturer can provide a pumping skid to deliver the chlorine solution to the injection location. Lastly, the proposed system would include its own control panel that can be used to control and monitor the equipment. This control panel will connect to the District's SCADA system so that the WTP staff can be notified of the operating conditions and any alarms or faults as they occur.

Building and Other

The equipment listed above will not fit within the existing WTP footprint and as such, must be installed within a new separate building. To accommodate the new equipment, storage tank, and supporting components, the new building should be approximately 300 to 350 sf and could be located as shown on Figure A-7 in Exhibit A. The building would be constructed from CMU or other noncombustible materials and would include new heating and mechanical ventilation equipment. It should be noted that the building shown on Figure A-7 is currently designed to accommodate only the proposed OSHG equipment; however, as noted in previous technical memoranda (Technical Memoranda 20434-4 and 20434-5), it may be beneficial to expand the size of the proposed building to accommodate other treatment equipment currently located within the WTP Main Building. Relocating some of this existing equipment would free up space in the existing building, which could be used for additional storage, laboratory space, or construction of an enclosed electrical room which would provide separation between the wet treatment equipment and the sensitive electrical equipment. Considerations for the final building size proposed in this alternative should be considered in the context of other changes desired for the WTP.

Site improvements with this alternative include some additional asphalt paving to improve access to the proposed building.

Similar to Alternative C1, this alternative will be subject to all applicable stormwater requirements for construction of new buildings and will require coordination with various stakeholders, most prominently the SCVA.

This additional equipment will increase the electrical load on the facility to accommodate the new building heating equipment, new chlorine equipment, and supporting appurtenances. Both 480- and 120-volt circuits are required for operation of the OSHG system, both of which are available at the WTP. For the purposes of this investigation, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will require modifications to the District's existing SCADA system. The new fire and gas alarm signals can be incorporated into the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

Advantages and Disadvantages

One significant advantage to this alternative is that the District can produce their own hypochlorite solution without the safety concerns associated with use of gaseous chlorine. One disadvantage of this alternative is the high capital cost for required equipment and the additional operation and maintenance requirements associated with manual addition of salt to the brine storage tank.

Cost Estimate

The estimated cost to provide the items described above is $1,511,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

<u>Alternative C3 – Commercial Delivery of Sodium Hypochlorite</u>

General

This alternative includes removing the existing chlorine gas equipment from service and installing new hypochlorite storage and dosing equipment within a new building. Hypochlorite solution would be delivered by a commercial vendor.

Disinfection

For this alternative, the existing gas chlorination equipment will be removed and will be replaced with a hypochlorite storage and dosing system.

Hypochlorite would be delivered by a commercial vendor from a distribution facility to the WTP. Sodium hypochlorite is commercially available as a 12.5 percent solution and is used at water treatment facilities throughout Washington State. It is important to note that 12.5 percent solution is considered a hazardous material and depending on the volume maintained on site, storage of this solution would incur additional safety considerations for operations and building equipment. The solution is delivered via a large tanker truck and is pumped from the truck to the storage vessel. Once delivered, the owner can either utilize the solution directly or can further dilute the solution until it reaches the desired concentration. Hypochlorite naturally degrades with time, and the rate of degradation is more significant for stronger solutions. As such, it is best if the hypochlorite within the storage tank is maintained at a solution strength of 5 percent or below.

Table 4 summarizes the approximate consumption of solution at various solution strengths.

TABLE 4

Alternative CC3 Chlorine Consumption

Parameter	**12.5%**		**5.0%**		**0.08%**	
Flow (gpm)	**Typical (700)**	**Design (1,400)**	**Typical (700)**	**Design (1,400)**	**Typical (700)**	**Design (1,400)**
Chlorine Consumption (lb/d)	10	20	10	20	10	20
Solution Consumption (gpd)	10	20	25	50	158	316

In lieu of bulk delivery, the District can purchase 55-gallon drums or 300-gallon mini-totes of 12.5 percent solution and manually transfer them to the dosing tank or feed directly from the container.

For this alternative, it is assumed that the District will procure a small to moderate volume of 12.5 percent sodium hypochlorite (less than 500 gallons), then manually add the desired volume of 12.5 percent solution to a new large-volume dosing tank, then dilute with a known volume of water in order to achieve the desired dosing concentration.

Building and Other

The equipment required for bulk hypochlorite will not fit within the existing WTP footprint and as such, must be installed within a new separate building. To accommodate the new equipment, storage tank, and supporting components, the new building should be approximately 200 to 250 sf and could be located as shown on Figure A-8 in Exhibit A.

The building would be constructed from CMU or other noncombustible materials and would include new heating and mechanical ventilation equipment. It should be noted that the building shown on Figure A-8 is currently designed to accommodate only the proposed hypochlorite storage and dosing equipment; however, as noted in previous technical memoranda (Technical Memoranda 20434-4 and 20434-5), it may be beneficial to expand the size of the proposed building to accommodate other treatment equipment currently located within the WTP Main Building. Relocating some of this existing equipment would free up space in the existing building, which could be used for additional storage, laboratory space, or construction of an enclosed electrical room which would provide separation between the wet treatment equipment and the sensitive electrical equipment. Considerations for the final building size proposed in this alternative should be considered in the context of other changes desired for the WTP.

It is important to note that the type and volume of chemical stored will significantly impact the safety system required for the building. Depending on the chemical and its strength, a fire sprinkler system may or may not be required. According to current building and fire codes, for a solution strength between 5 and 15 percent, storage of less than 500 gallons of sodium hypochlorite will result in a building occupancy rating of F-1, which does not require installation of a fire suppression (alarm and sprinkler) system. If more than 500 gallons of this solution are stored on site, then the occupancy rating will increase to H-4, which will require installation of a fire suppression system. If the solution strength is less than 5 percent, this solution is not considered hazardous, toxic, or corrosive, the building occupancy rating would be F-1, and a fire suppression system is not required. Furthermore, the only limitations on the maximum storage volume of this solution are those of the building that will house the storage container.

Site improvements with this alternative include some additional asphalt paving to improve access to the proposed building.

Similar to Alternative C1, this alternative will be subject to all applicable stormwater requirements for construction of new buildings and will require coordination with various stakeholders, most prominently the SCVA.

This additional equipment will increase the electrical load on the facility to accommodate the new building heating equipment, new chlorine equipment, and supporting appurtenances. For the purposes of this investigation, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will require modifications to the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

Advantages and Disadvantages

One advantage to this alternative is that the existing chlorine room will become available for use as storage or other desired uses and that the safety risks associated with gaseous chlorine will be eliminated. Furthermore, this alternative will have less operational and maintenance requirements than OSHG and utilizes less space which will allow for construction of a smaller building. Disadvantages to this alternative are that it will require construction of a new building as well as continuous additional coordination with commercial vendors to ensure a sufficient supply of hypochlorite is available at all times.

Cost Estimate

This alternative is estimated to cost approximately $836,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B. The cost for 12.5 percent sodium hypochlorite is between $2.20 (bulk) and $3.00 (drums and totes) per gallon. This ongoing operational expense must be considered when comparing disinfection alternatives and is addressed in subsequent sections of this memorandum.

CT System

Current drinking water regulations required the WTP to meet disinfection criteria using CT calculations. CT is calculated using the maximum daily peak hour flow, the contact tank volume, the baffling efficiency, and the minimum daily chlorine residual as measured prior to entry into the distribution system. This calculated value is then compared to the published regulatory CT value for a given temperature and pH. The ratio of the CT provided to the CT required is called the inactivation ratio (IR), and for public water systems, the IR must be greater than 1 at all times.

To determine whether the existing CT system is sufficient for both current and projected flows, Gray & Osborne conducted a sensitivity analysis. The sensitivity analysis was performed by listing the existing CT values using current conditions, then changing one aspect of the CT calculation and comparing the results. The changes investigated included raising the minimum water depth within the existing CCB, modifying the existing CCB to improve the baffling efficiency, raising the minimum chlorine residual, and expanding the CCB volume through modifications to the existing tank or construction of a new tank. Table 5 highlights the information and results used for this analysis.

TABLE 5

CT Calculation Comparison

Flow (gpm)	CCB Volume (gal) (1)	Baffling Efficiency (2)	Contact Time (T, min) (3)	Chlorine Residual (C, mg/L) (4)	CT Provided (5)	CT Required (6)	Inactivation Ratio (7)
Existing CCB							
700	155,000	0.3	66.4	0.9	59.8	60	1.00
1,000	155,000	0.3	46.5	0.9	41.9	60	0.70
1,400	155,000	0.3	33.2	0.9	29.9	60	0.50
Higher Minimum Depth							
700	174,000	0.3	74.6	0.9	67.1	60	1.12
1,000	174,000	0.3	52.2	0.9	47.0	60	0.78
1,400	174,000	0.3	37.3	0.9	33.6	60	0.56
Higher BE							
700	155,000	0.5	110.8	0.9	99.6	60	1.66
1,000	155,000	0.5	77.5	0.9	69.8	60	1.16
1,400	155,000	0.5	55.4	0.9	49.8	60	0.83
Higher Chlorine Residual							
700	155,000	0.3	66.4	1.3	86.5	60	1.44
1,000	155,000	0.3	46.5	1.3	60.5	60	1.00
1,400	155,000	0.3	33.2	1.3 (8)	43.2	60	0.72
Larger CCB (9)							
700	192,000	0.5	137.1	0.9	123.4	60	2.06
1,000	192,000	0.5	96.0	0.9	86.4	60	1.44
1,400	192,000	0.5	68.6	0.9	61.7	60	1.03

(1) Assumes a minimum height of 16.5 feet and a value of 9,400 gallons per foot for the CCB.
(2) Existing CCB BE is 0.3 as listed in the Tracer Study Report and the District's current CT calculation.
(3) Calculated as the CCB volume divided by the flow, multiplied by the baffling efficiency.
(4) Historical daily minimum chlorine residual.
(5) Calculated as the Contact Time multiplied by the Chlorine Residual.
(6) Assumes 1.0-log inactivation of *Giardia* at a residual of 1.0 mg/L and a temperature of 5 degrees Celsius.
(7) Calculated as CT Provided divided by CT Required.
(8) To achieve an IR of 1.0 at the design flow, a chlorine residual of approximately 1.8 mg/L would be required.
(9) Assumes a total reservoir volume of 275,000 gallons and a minimum volume ratio of 70 percent – which matches the minimum volume ratio of the current CCB ((16.5 feet ∗ 9,400 gallons per foot)/(24 feet ∗ 9,400 gallons per foot)). Also assumes a BE of 0.5, which should be achievable with a new tank.

Table 5 reveals the following conclusions:

- The existing system is not sufficient using current operational parameters to provide the required CT for flows above 700 gpm.

- Raising the minimum depth within the CCB from 16.5 to 18.5 feet would improve the CT provided, but still does not provide sufficient CT for flows greater than 800 gpm and provides significantly less operational flexibility due to the reduced operational volume utilized with the CCB.

- Increasing the baffling efficiency to 0.5 through CCB modifications, along with a slight increase in chlorine residual, could provide sufficient CT for flows up to 1,400 gpm.

- Increasing the chlorine residual to approximately 1.3 mg/L would provide sufficient CT for flows up to 1,000 gpm, but would result in increased gas consumption, which would in turn increase operational costs and gas cylinder replacement frequency. Furthermore, increased chlorine levels could also lead to customer complaints.

- Increasing the size of the CCB volume would provide sufficient CT for flows beyond 1,400 gpm.

Given the conclusions listed above, it appears that modifying the existing CCB to improve the existing baffling efficiency and/or increasing the contact volume would be most successful at improving the District's CT system. Three alternatives for these modifications are discussed in more detail below.

<u>Alternative CCB1 – Rehabilitate Existing CCB</u>

General

This alternative includes modifying the existing CCB with additional baffles.

Chlorine Contact

This alternative will include installation of additional baffles within the CCB. The existing CCB has three steel baffle plates located on the tank interior as shown on Figure A-2 in Exhibit A. The baffles promote a serpentine flow through the tank which extends the residence time and increases the contact time value. Given the current baffle location and tank diameter, two alternatives are feasible and both of these options are shown on Figure A-9 in Exhibit A. The baffles can be either welded steel to match the existing units, or can be Hypalon® or other synthetic material. For the purposes of this investigation, it is assumed the new Hypalon baffles will be installed. This will require that the CCB be taken offline, drained, and cleaned prior to installation. Installation will include attachment of cables at the top of the tank to support the baffle clips and bottom/wall brackets that will provide a watertight seal with the CCB floor plate. A tight seal is critical to ensure that all water follows the desired path.

If the CCB is taken offline, accommodations for temporary CT must be provided during the construction period, which could include temporary tankage, assembly of a temporary CT piping system, or water service via the existing intertie with the City of Bellingham. For a temporary tank, approximately 300,000 gallons of storage would be required, while the length of temporary pipe required would depend upon the pipe diameter. For example, if 18-inch pipe is provided, at least 2,150 feet of pipe would be necessary. This length assumes a required CT value of 60, a flow of 700 gpm, and a target chlorine residual of 1.0 mg/L. Larger-diameter pipe would require less piping length while smaller-diameter pipe would require more piping length. In addition to these accommodations, temporary chlorine injection and analysis piping would also need to be provided. To reduce the volume of temporary CT equipment required, it would be beneficial to construct the CCB modifications during the winter months when system demand is low. Furthermore, any further reduction in operational flow below 700 gpm would help reduce the required CT volume.

Given the numerous complexities of providing temporary CT piping at the WTP which include a lack of available adjacent private land to install the piping, the public nature of the adjacent park, the temporary modifications that would be required to existing equipment, safety equipment, and additional monitoring that would be required as well as potential permitting and approval that would be required from DOH, if this alternative is selected we suggest utilizing the existing intertie with the City of Bellingham to provide water service to the South Shore system during construction. The modifications listed above could likely be completed in 2 to 3 months, which would limit the cost of procuring water service from the City.

At this point in time, it is difficult to know what the resulting baffling efficiency will be if modifications to the CCB are enacted. As part of the tracer study project referenced above, Gray & Osborne analyzed the baffling efficiency for four circular baffled tanks and the highest baffling efficiency identified was 0.6. The final report associated with this tracer study project (*Summary Report of State-Wide Tracer Study Project*, Gray & Osborne, 2017) found that cross-sectional velocity was the best value to estimate the anticipated BE. The report noted that BE was related to cross-sectional velocity through the equation $y = 1.9141x^{(0.3002)}$, where x is the cross-sectional velocity and y is the baffling efficiency. For the existing CCB, using this equation and a range of cross-sectional velocities between 0.007 and 0.012 feet per second (fps) (as calculated for the minimum and maximum potential cross-sectional areas), the predicted BE is between 0.43 and 0.51. This range of values is above the currently utilized value of 0.3 and below the previously assumed value of 0.7.

Using the equation above, a cross-sectional velocity of 0.11 fps should provide a BE of 0.5 and given the minimum operational flow of 700 gpm, the maximum cross-sectional area to achieve this desired velocity is 140 sf. If this area is provided as part of the design for a new CCB, we believe that the desired BE of 0.5 is achievable. Both of the options shown on Figure A-9 provide cross-sectional velocities that should achieve at least the desired BE of 0.5 at all flows up to the design flow of 1,400 gpm.

Technical Memorandum 20434-2 provided an assessment of the existing CCB coating system, and this memorandum concluded that the existing coating system should be removed and a new coating system applied within 5 years to address areas of coating stress, fatigue, and failure. Furthermore, Technical Memorandum 20434-2 provided additional recommendations including seal welding between the roof rafters and roof plates and installing additional hatches, instrumentation, and safety appurtenances to improve the functionality of the tank and to simplify operation and maintenance activities. Because the existing CCB will be taken offline for modifications and will continue to be used to provide CT volume, the recommendations listed within Technical Memorandum 20434-2 are included with this alternative.

In addition to the improvements listed above, the District may consider expanding their CT calculation to include the existing clearwell, which is currently not included in the CT calculations. Given the current volumes and operational parameters, it is estimated that including the unbaffled clearwell could provide an additional 1 to 2 minutes of contact time, which would improve the IR by less than 0.1. This alternative would require modification of the District's existing CT calculations to accommodate the new proposed BE value. A tracer study should be performed to verify the baffling efficiency of the modified CT system.

Building and Other

No modifications to the existing WTP site and/or building are proposed as part of this alternative.

Advantages and Disadvantages

One advantage to this alternative is that the existing tank can be reused which will reduce the capital cost of the project. A second advantage is that the modification period would also be a good time to address the coating system – which was recommended for replacement in Technical Memorandum 20434-2. Combining these two tasks as a single project will reduce the overall downtime for the CCB. One disadvantage to this alternative is that during construction the CCB must be taken out of service, and during this time period the District must provide alternative temporary CT facilities or purchase water from the City of Bellingham.

Cost Estimate

This alternative is estimated to cost approximately $1,199,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B. It is important to note that this cost estimate includes a budget line item for service from the City of Bellingham, but that this amount is subject to change based on negotiations for service with the City.

<u>Alternative CCB2 – Construct New Replacement CCB</u>

General

This alternative includes construction of a new CCB to replace the existing steel tank.

Chlorine Contact

To ensure sufficient CT for the WTP, it is advantageous to provide a new tank larger than the existing tank. Given the analysis summarized in Table 5, it appears that a tank volume of 300,000 gallons should be sufficient to provide CT up to the design flow of 1,400 gpm with sufficient redundancy.

While precast concrete tanks offer significant value for capital and installation costs, they are not readily available in the desired volume. As such, this alternative assumes that a new welded steel reservoir will be constructed. The tank is proposed for the location shown on Figure A-10 in Exhibit A and would have the design criteria listed in Table 6. The proposed CCB would include appurtenances such as access ladders and hatches, instrumentation, and would be coated both on the interior and exterior surfaces. This alternative would allow the existing CCB to remain in service at all times – which would eliminate the need for temporary CT volume.

TABLE 6

Alternative CCB2 Proposed Design Criteria

Parameter	Value
Type	Circular, Welded Steel
Diameter (ft)	44
Base Elevation (ft)	345.0 (1)
Overflow Elevation (ft)	372.0
Volume (gal)	307,000
Gallons per Foot	11,373
Inlet	12-Inch Perforated Riser
Outlet	12-Inch Perforated Riser
Interior Baffles	7, Hypalon
Baffling Efficiency	0.5
Instrumentation	Ultrasonic Level Sensor (2x) Float Switch (2x) Intrusion Switch

(1) Approximate and based on estimates of surrounding grades. Not based on actual survey information.

This alternative would require modification of the District's existing CT calculations to include the new tank volume. Additionally, a tracer study should be performed to verify the baffling efficiency of the new tank as well as the entire CT system.

Building and Other

Site improvements included with this alternative include grading and earthwork required to create a flat and suitable area for the proposed CCB. Prior to construction of the proposed CCB, a thorough geotechnical investigation should be completed in order to ensure suitable hillside stability south of the proposed tank. This geotechnical investigation will also identify whether or not a retaining wall is recommended. Given the slope of the adjacent terrain, a retaining wall may be required to provide suitable slope stabilization. For the purposes of this investigation, it is assumed that a retaining wall is not required for construction of the new CCB, and that only basic earthwork and grading are required.

If a new CCB is constructed, the existing CCB could be used for other purposes. This could include additional CT storage, filter backwash and recycle storage, or emergency/auxiliary equalization storage. The existing CCB could be demolished and removed; however, to provide suitable redundancy in the event that the new CCB must be taken offline for maintenance, recoating, or from damage, we recommend that the District maintain the structure in usable condition. For the purposes of this analysis, this alternative assumes that the existing CCB will be maintained and repurposed or left empty as a redundant tank. It is important to note that Technical Memorandum 20434-2 noted various items on the existing CCB that should be addressed if the tank is to be utilized for service; however, these improvements are not included in this alternative. Additionally, the new CCB could be constructed while the existing CCB remains in service. This would eliminate the need to provide temporary CT facilities and would reduce the operational impact on District staff.

The new CCB will be subject to all applicable stormwater requirements for construction of new buildings and the addition of new asphalt pavement. The construction of a new building adjacent to the existing WTP would be subject to the stipulations listed by Whatcom County for the Lake Whatcom Watershed. These requirements will include the need to provide either full infiltration on site or advanced treatment for phosphorous removal. Design of the required stormwater facilities will be provided once the building footprint and paving have been finalized, but a budgetary estimate for the anticipated requirements has been included with the alternative cost estimate included in Exhibit B. In addition, it should be noted that these regulations restrict clearing of the site so that only 35 percent of the existing tree canopy can be cleared.

It is important to note that this alternative will require additional design and coordination with various stakeholders, one of which includes the SVCA. The SVCA owns much of the property adjacent to the WTP and would need to be consulted prior to implementation of any of the alternatives discussed in this memorandum. Furthermore, the District must consider that the property adjacent to the WTP is a public park with waterfront access and use of this public space will likely need to be maintained at all times. Other stakeholders include neighboring residential landowners and utility providers serving the area.

Advantages and Disadvantages

One advantage to this alternative is that the existing tank can remain in service during construction of the new tank. This eliminates the need to provide temporary CT facilities during modification/construction of a new tank. Furthermore, this alternative would allow the District to utilize the existing CCB for other treatment processes. This could include providing additional CT, backwash storage and recycle volume, or temporary equalization volume. The primary disadvantage of this alternative is its high capital cost, and the need to acquire or utilize property not owned by the District.

Cost Estimate

This alternative is estimated to cost approximately $1,671,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative CCB3 – Construct New CCB to Supplement the Existing CCB

General

This alternative includes construction of a new smaller CCB to provide additional CT volume that will accommodate the full design flow of 1,400 gpm.

Chlorine Contact

As shown in Table 5, the existing CCB does not provide sufficient CT volume for the design flow of 1,400 gpm. This alternative includes construction of a smaller supplementary tank that will provide the additional CT volume necessary to accommodate the design flow. Design criteria for a tank that will meet the CT requirements is provided in Table 7 and a location for the proposed tank is provided on Figure A-11 in Exhibit A.

TABLE 7

Alternative CCB3 Proposed Design Criteria

Parameter	Value
Type	Circular, Precast Concrete
Diameter (ft)	26
Base Elevation (ft)	336.0 (1)
Overflow Elevation (ft)	360.0
Volume (gal)	95,300
Gallons per Foot	3,970
Inlet	12-Inch Perforated Riser
Outlet	12-Inch Perforated Riser
Interior Baffles	5, Hypalon
Instrumentation	Ultrasonic Level Sensor (2x) Float Switch (2x) Intrusion Switch

(1) Proposed tank should match the hydraulic grade line of the existing CCB.

A precast concrete tank was selected for this alternative because it is a very cost-effective solution for potable water storage for a reservoir of this size. Tank rings are cast on site starting at the base using slipforms, then these forms are pulled upward to cast successive rings until the desired height is achieved. Once the tank is cast, the baffles can be installed, the tank cleaned and disinfected after which it can be placed into service. This alternative would allow the existing CCB to remain in service at all times – which would eliminate the need for temporary CT volume.

This alternative would require modification of the District's existing CT calculations to include the new tank volume. Additionally, a tracer study should be performed to verify the baffling efficiency of the new tank as well as the entire CT system.

Building and Other

The site improvements for this alternative are very similar to those described in Alternative C2 for the new larger replacement tank. The primary difference is that for this alternative, the scale and area affected by the clearing, grading, and earthwork is smaller than that required for Alternative C2.

Additionally, the recommendations for the existing CCB provided in Technical Memorandum 20434-2 are also included with this alternative. As with Alternative CCB1, temporary water service must be acquired from the City of Bellingham during the period of time that the existing CCB is offline for modifications because the tank proposed as part of this alternative is not large enough to provide sufficient CT volume prior to entry into the distribution system.

Advantages and Disadvantages

One advantage to this alternative is that the existing tank can remain in service during construction of the new tank. This eliminates the need to provide temporary CT facilities during modification/construction of a new tank. Another advantage is that the tank is smaller and can be constructed from concrete – both of which should reduce the level of maintenance required for the tank. The primary disadvantage of this alternative is the need to acquire or utilize property not owned by the District and the requirement to procure water from the City of Bellingham during modification to the existing CCB.

Cost Estimate

This alternative is estimated to cost approximately $1,794,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

SUMMARY

The alternatives described above provide various options for modifications to the WTP's existing chlorine disinfection equipment as well as the CCB which is used to provide CT volume. The alternatives described above are summarized and analyzed below.

Alternative Summary

Each of the alternatives are briefly described below, and Table 8 provides a summary and comparison for the various alternatives.

<u>Disinfection System</u>

Alternative C1A – Utilize Existing Chlorine Gas System with No Modifications

This alternative includes utilizing the existing chlorine gas system in the existing chlorine room with no modifications.

Alternative C1B – Utilize Existing Chlorine Gas System with Modifications

This alternative includes utilizing the existing chlorine gas disinfection system within the existing chlorine room, but also includes building modifications that will bring the facility up to current building codes.

Alternative C1C – Utilize New Chlorine Gas System within a New Building

This alterative includes installation of a new gas chlorine system inside a new separate building. The existing chlorine gas equipment will be removed and the existing chlorine room will be repurposed.

Alternative C2 – On-Site Generation of Hypochlorite

This alternative includes installation of a new OSHG system within a new separate building. The existing chlorine gas system will be removed from service and disinfection will be provided using 0.8 percent sodium hypochlorite. The existing chlorine room will be repurposed.

Alternative C3 – Commercial Delivery of Sodium Hypochlorite

This alternative includes installation of a new sodium hypochlorite storage and dosing system within a new separate building. The existing chlorine gas system will be removed from service and disinfection will be provided using less than 5 percent sodium hypochlorite. The existing chlorine room will be repurposed.

<u>CT System</u>

Alternative CCB1 – Rehabilitation of Existing CCB

This alternative includes modification of the existing CCB to include additional baffles in order to increase the BE to 0.5. It also includes removal of the existing CCB coating system and application of a new coating system. Temporary CT facilities must be provided during construction and a tracer study must be conducted after completion of the project to verify the new BE.

Alternative CCB2 – Construction of a New Replacement 300,000-Gallon CCB

This alternative includes construction of a new 300,000-gallon CCB which will replace the existing CCB. The tank will be constructed adjacent to the existing tank and will be constructed from welded steel. Once the new tank is completed, the existing tank can be rehabilitated and then repurposed.

Alternative CCB3 – Construction of a New Supplemental 100,000-Gallon CCB

This alternative includes construction of a new 100,000-gallon CCB that will increase the overall CT volume of the system and will supplement the existing CCB. The tank will be constructed adjacent to the existing tank and will be constructed from precast concrete. It also includes removal of the existing CCB coating system and application of a new coating system. A tracer study must be completed on the new tank to verify the baffling efficiency and should additionally include a tracer assessment of the combined CT components (existing tank and new tank).

TABLE 8

Alternatives Summary

Alt.	Description	Capital Cost	O&M Cost	Advantages	Disadvantages
C1A	Chlorine Gas with No Modifications	$0	$$	• No capital cost • Familiarity with process and equipment	• Facilities not up to current codes • Maintains use of chlorine gas
C1B	Chlorine Gas with Some Modifications	$271,000	$$	• Facilities brough up to current codes • Familiarity with process and equipment	• Maintains use of chlorine gas
C1C	New Chlorine Gas in New Building	$725,000	$$	• Facilities brough up to current codes • Familiarity with process and equipment	• Maintains use of chlorine gas • Construction of new building required
C2	On-Site Hypochlorite Generation	$1,511,000	$$$	• Self-sufficient process • No longer use chlorine gas	• New technology and equipment for District staff • Construction of new building required
C3	Commercial Bulk Hypochlorite Delivery	$836,000	$$	• Easy and low maintenance • No longer use chlorine gas	• Rely on commercial vendors • Coordination for delivery • Ongoing operational expense • Construction of new building required
CCB1	Rehabilitation of Existing CCB	$1,199,000	—	• Utilizes existing tank • Simple modifications	• Temporary CT facilities must be provided
CCB2	New Larger Replacement CCB	$1,671,000	—	• Temporary CT facilities not required • Allows for simple rehabilitation and repurposing of existing CCB • Provides operational flexibility	• Construction of new tank required
CCB3	New Smaller Supplemental CCB	$1,794,000	—	• Temporary CT facilities not required • Provides operational flexibility	• Construction of new tank required • Temporary CT facilities must be provided

Recommendations

It is difficult to provide a disinfection recommendation without considering the other issues that are being considered at the treatment plant. For example, if the District decides to relocate other components such as media filters or chemical delivery equipment into a new separate building, Alternatives C1, C2, and C3 become more favorable since construction of the facility required to house new filters or chemical delivery equipment can easily and cost-effectively be expanded to provide space and accommodations for new disinfection equipment. This economy of scale when considering the modifications for the WTP can help drive the decision-making process.

Consequently, the final filtration recommendation will be deferred until the summary report is prepared that contains all of the information in the various technical memoranda to provide an optimized recommendation for the entire filter plant to ensure the District's goal of continuing to provide high-quality treated water for decades to come.

For the CT system, we recommend that the District construct a new CCB (Alternative CCB2) that can provide sufficient CT for the proposed design flow (1,400 gpm). Construction of the new tank would not require construction and operation of temporary CT facilities, can be completed with the WTP in operation, provides operational flexibility by providing a second redundant tank, and will allow the District to rehabilitate and repurpose the existing CCB as desired.

EXHIBIT A

FIGURES

FIGURE A-1

Chlorine Disinfection Equipment

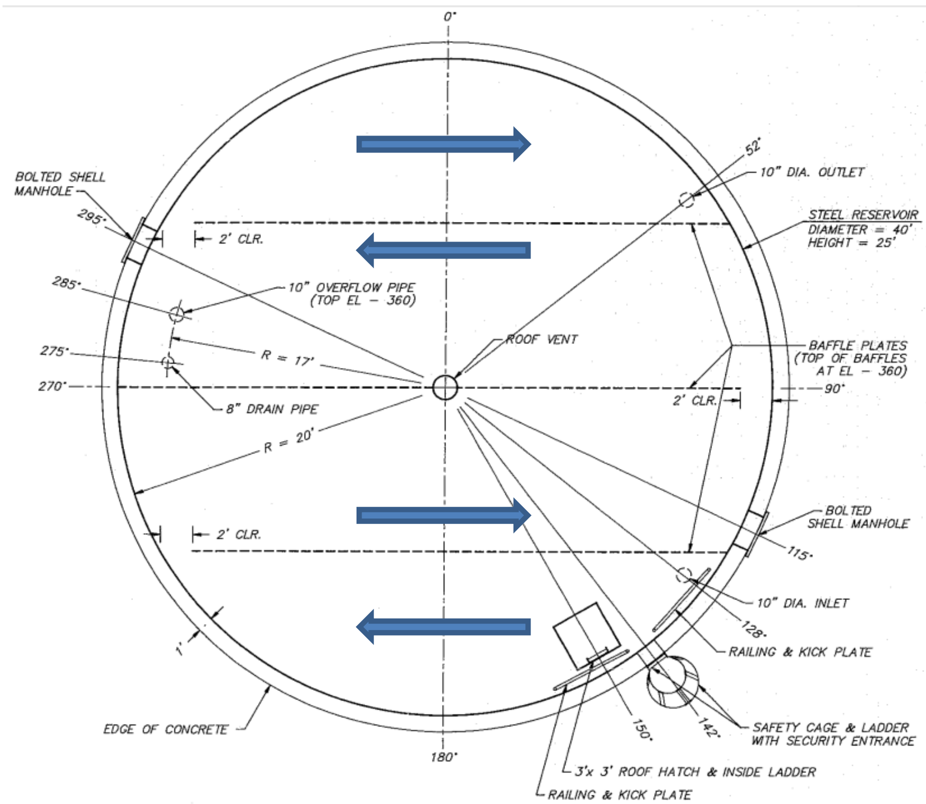


FIGURE A-2

Chlorine Contact Basin Plan

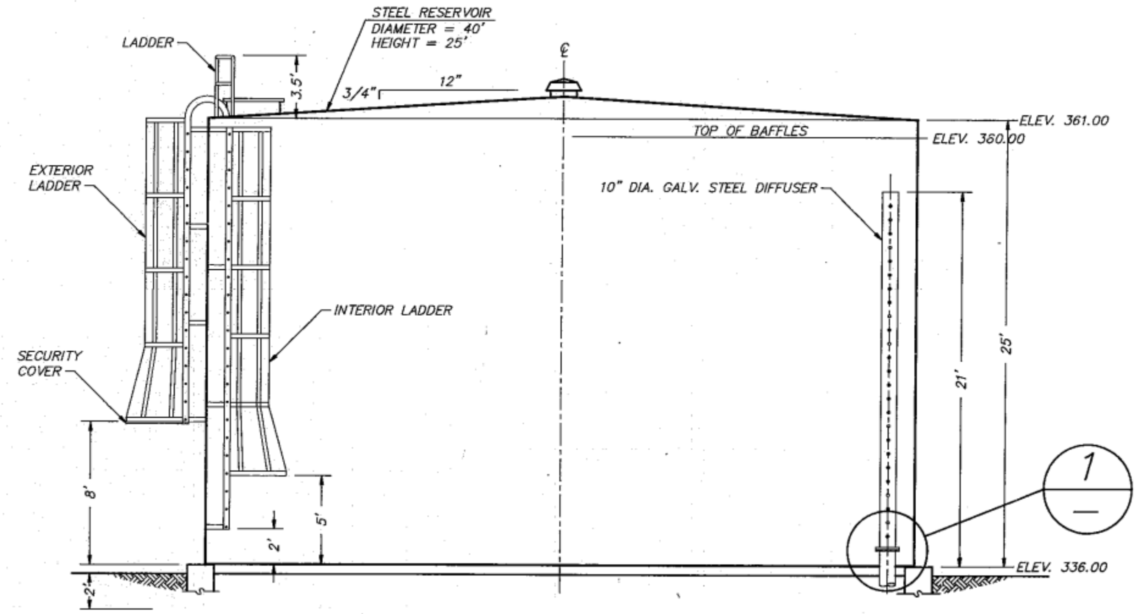
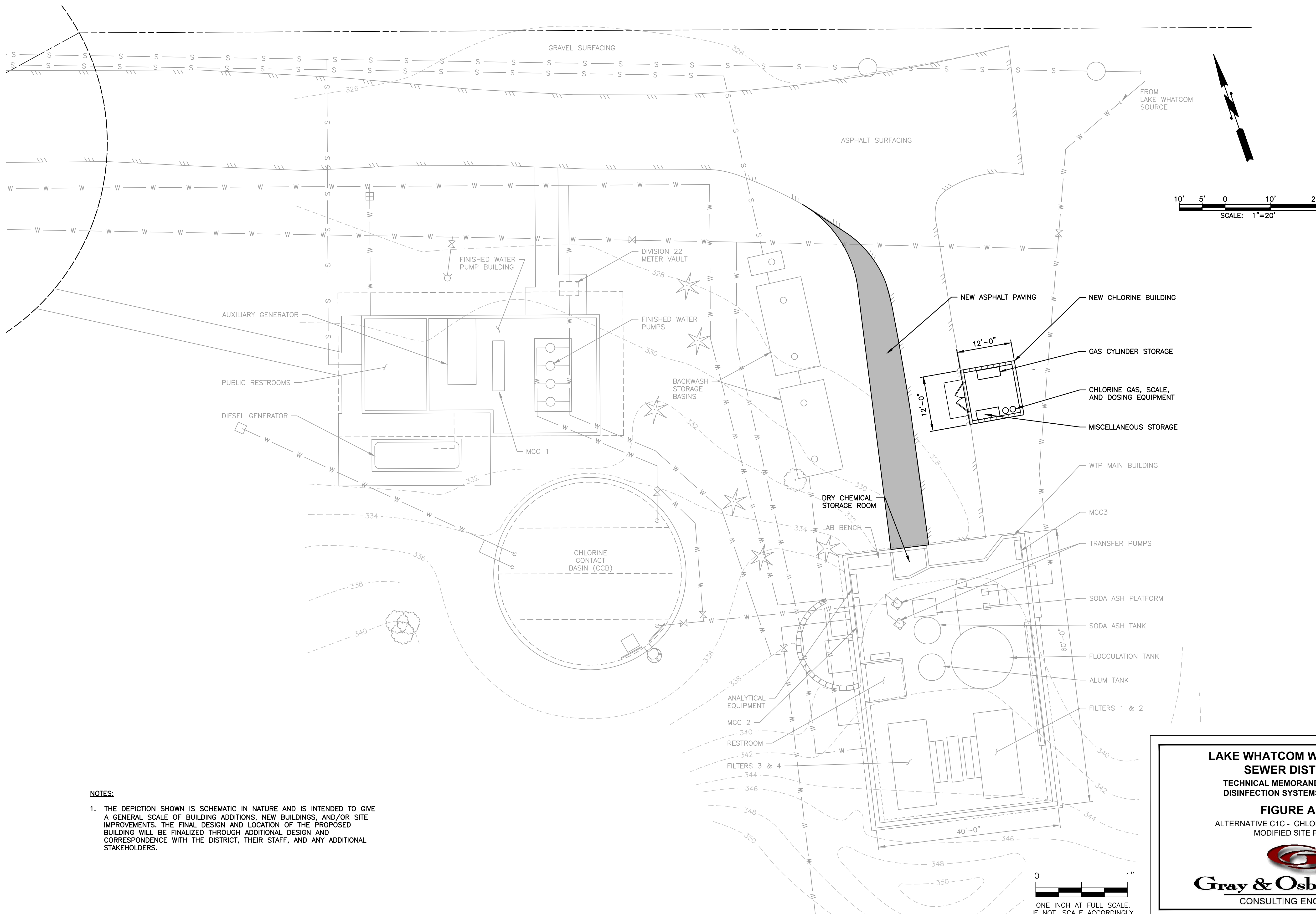


FIGURE A-3

Chlorine Contact Basin Section

FIGURE A-4

Chlorine Contact Basin Photograph



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS, NEW BUILDINGS, AND/OR SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT, THEIR STAFF, AND ANY ADDITIONAL STAKEHOLDERS.

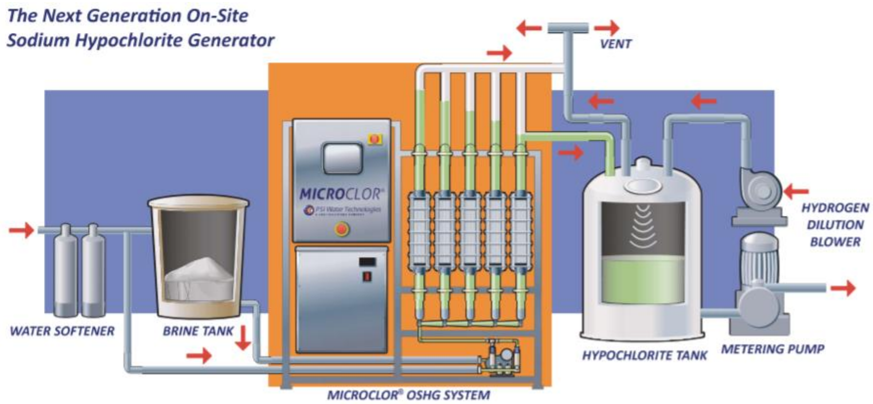
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-5

ALTERNATIVE C1C - CHLORINE BUILDING
MODIFIED SITE PLAN

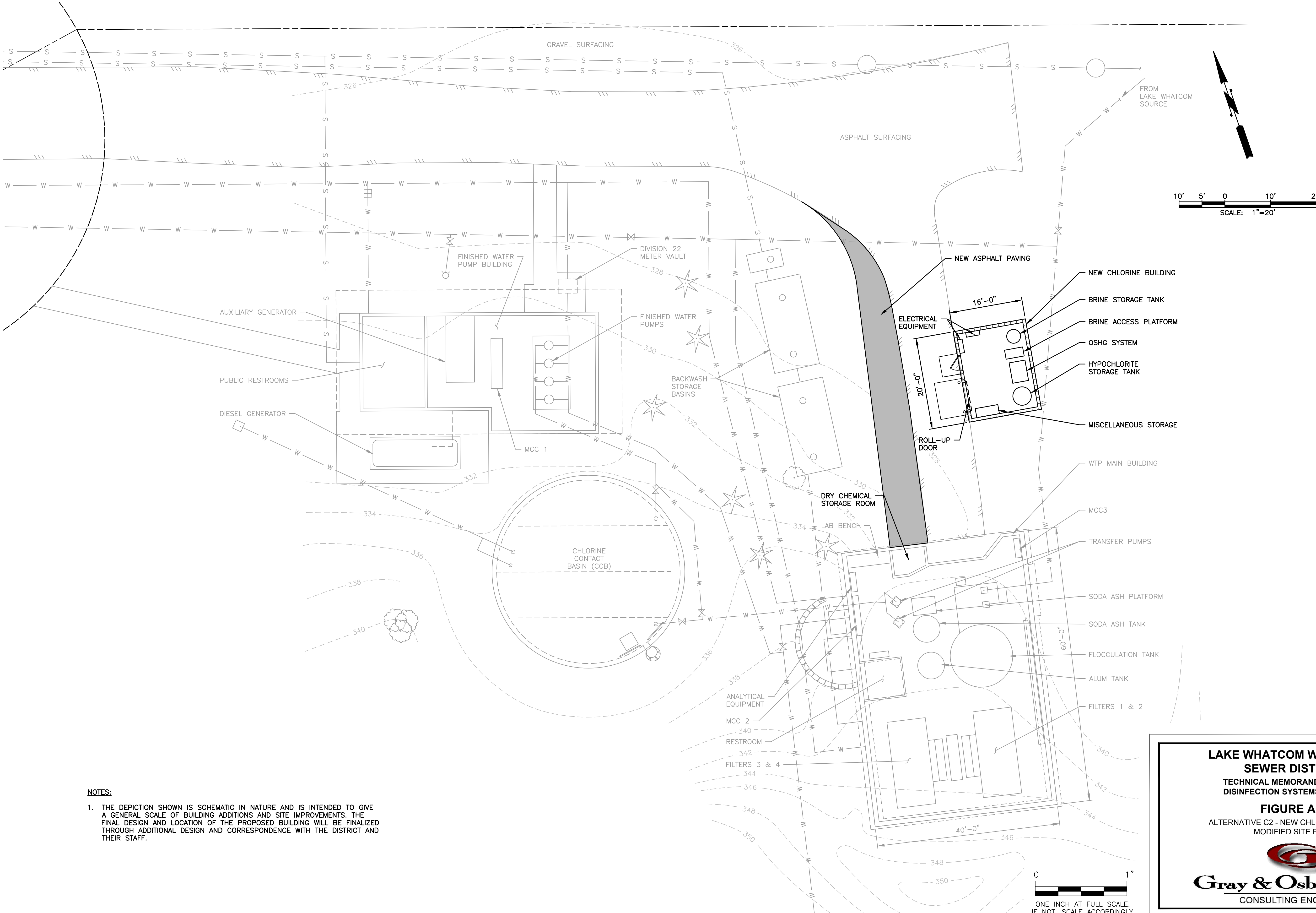
Gray & Osborne, Inc.
CONSULTING ENGINEERS



Courtesy of UGSI/PSI

FIGURE A-6

UGSI/PSI OSHG System



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ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

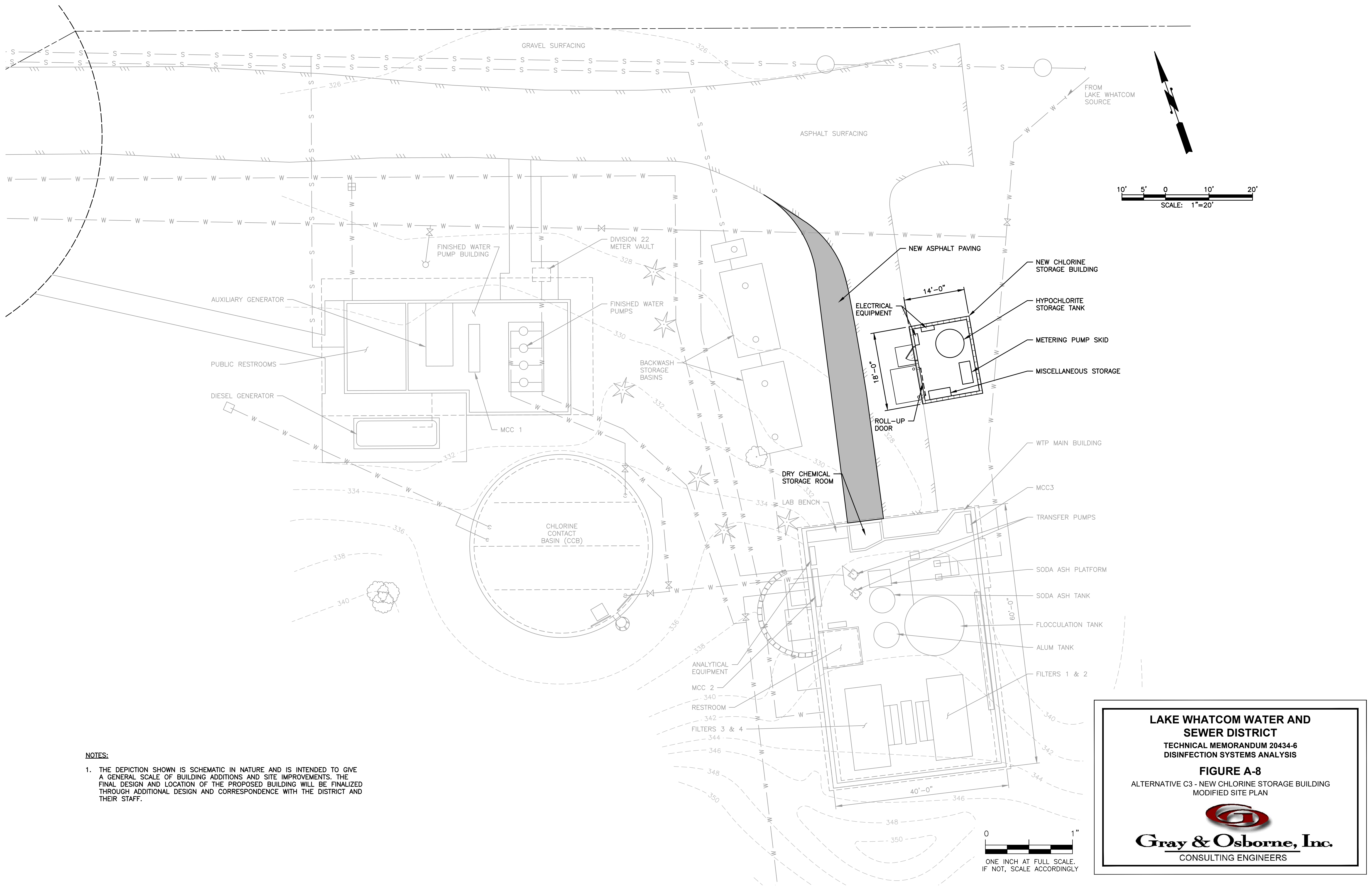
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-7

ALTERNATIVE C2 - NEW CHLORINE BUILDING
MODIFIED SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS



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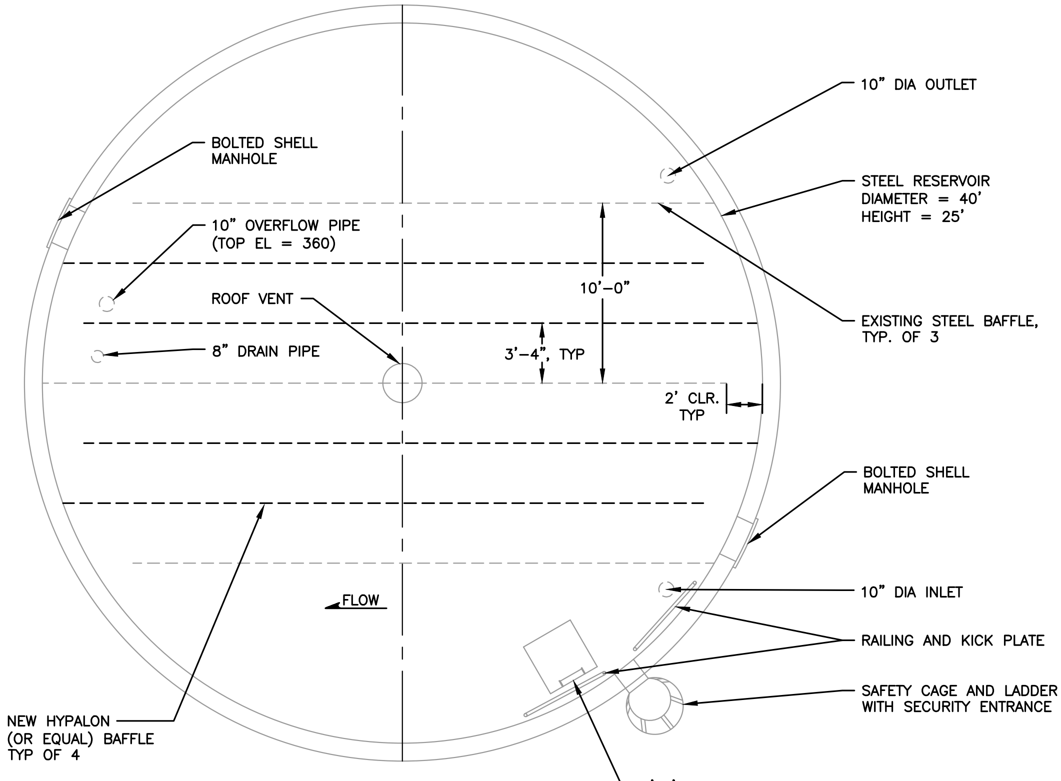
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

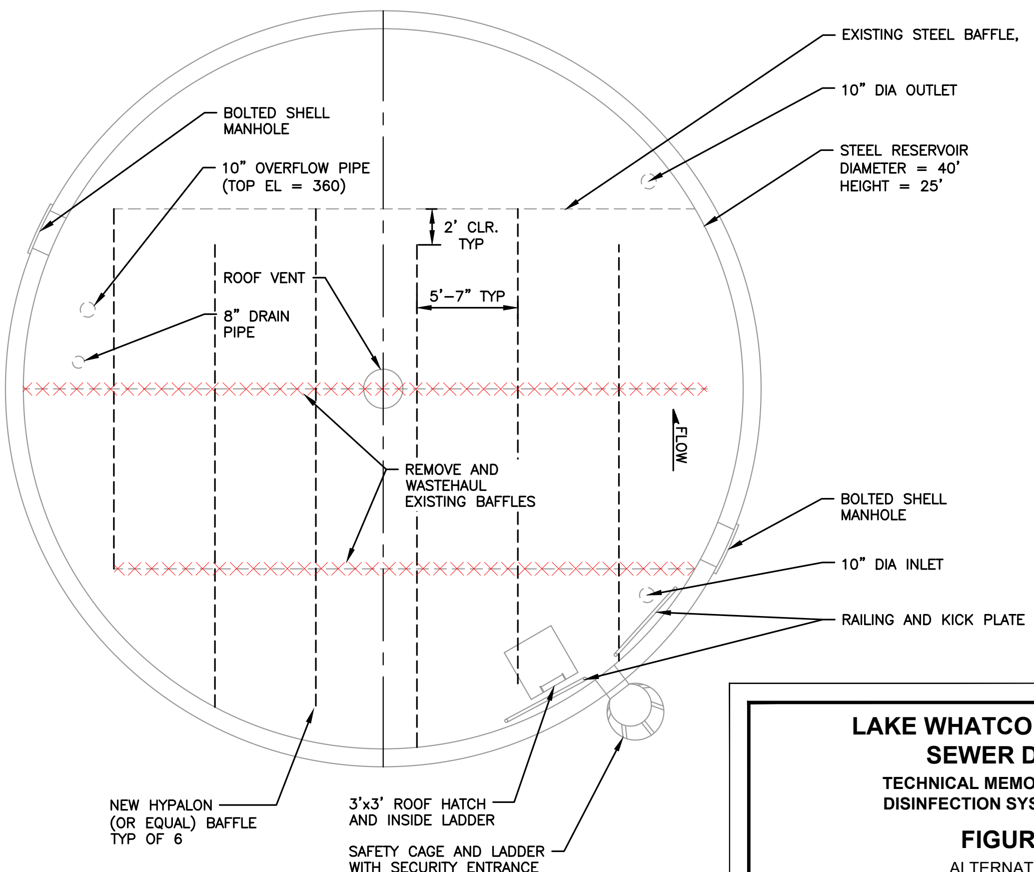
FIGURE A-8

ALTERNATIVE C3 - NEW CHLORINE STORAGE BUILDING
MODIFIED SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS



BAFFLE OPTION 1



BAFFLE OPTION 2

6' 4' 2' 0 6' 12'

SCALE: 3/16"=1'-0"

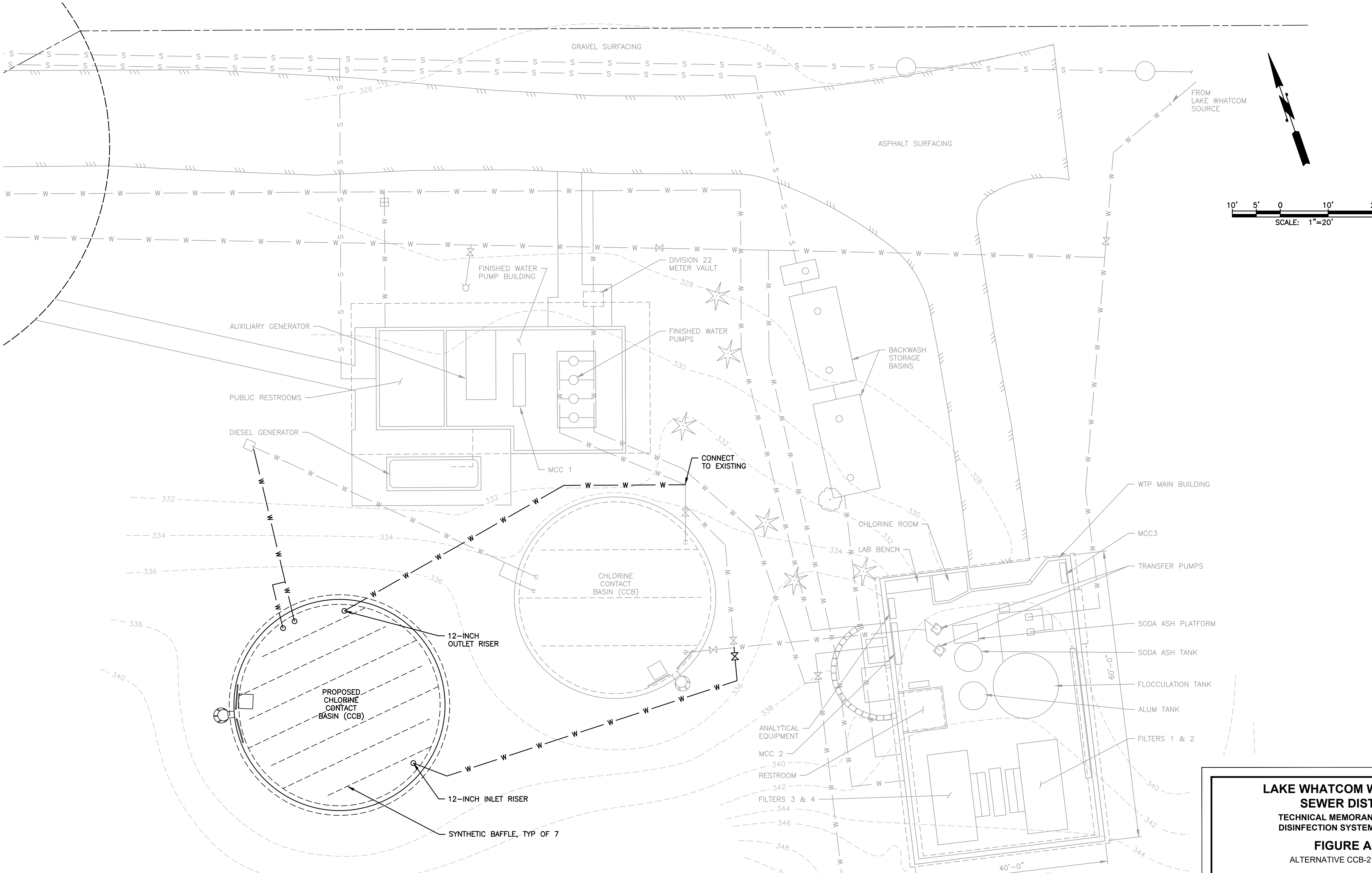
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-9

ALTERNATIVE CCB-1
MODIFIED CCB CONFIGURATIONS

Gray & Osborne, Inc.
CONSULTING ENGINEERS



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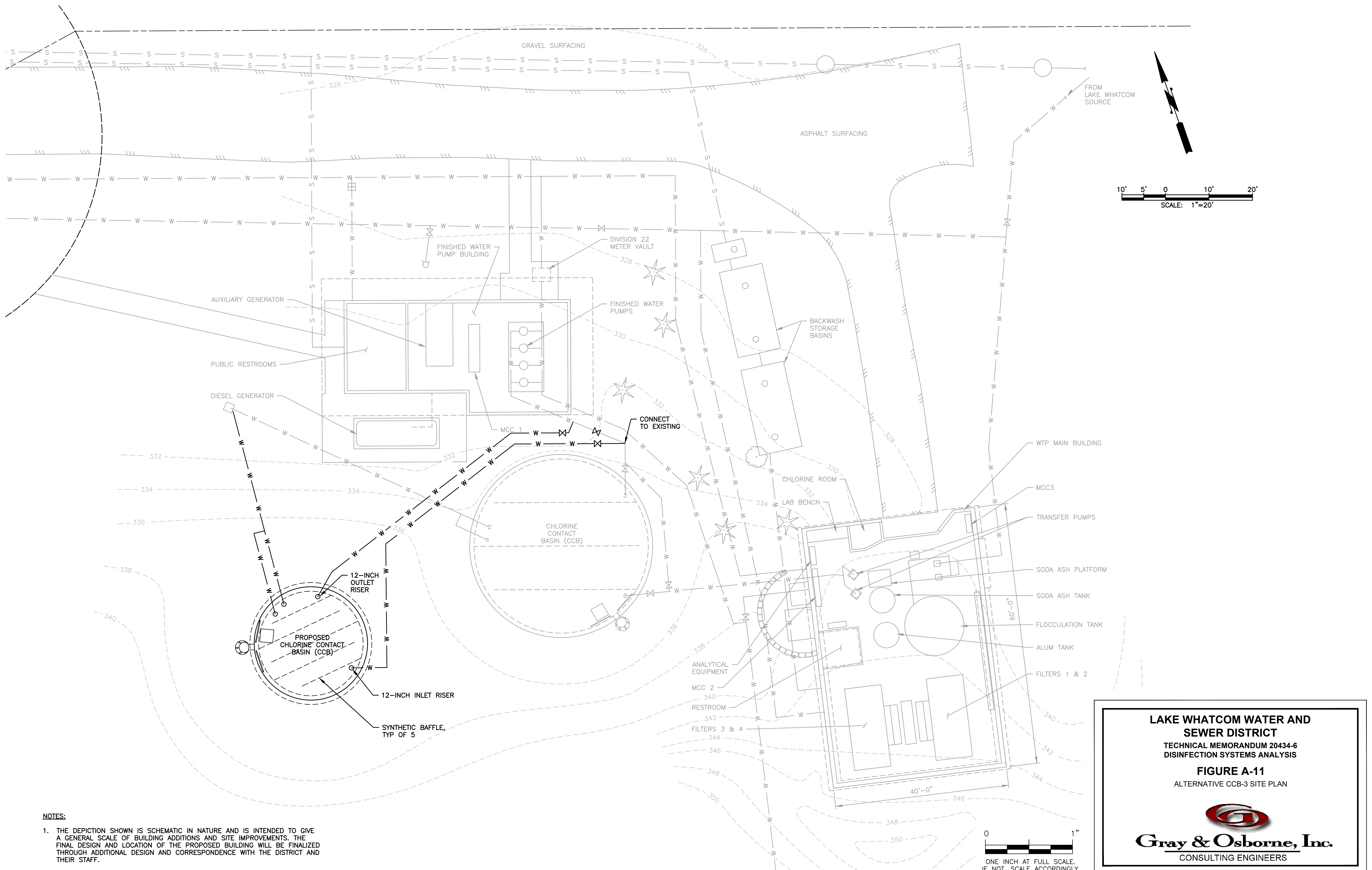
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-10

ALTERNATIVE CCB-2 SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS



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LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-11

ALTERNATIVE CCB-3 SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

EXHIBIT B

RECOMMENDED ALTERNATIVE COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative C1B - Utilize Existing Chlorine Equipment with Chlorine Room Modifications
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 13,000	$ 13,000
2	Minor Change	1	LS	$ 10,000	$ 10,000
3	Hazardous Materials Plans	1	LS	$ 15,000	$ 15,000
4	Fire Alarm and Supression System	1	LS	$ 25,000	$ 25,000
5	HVAC Improvements	1	LS	$ 20,000	$ 20,000
6	Miscellaneous Room Improvements	1	LS	$ 10,000	$ 10,000
7	Gas Storage Equipment	1	LS	$ 5,000	$ 5,000
8	Gas Detection Equipment	1	LS	$ 15,000	$ 15,000
9	Electrical Improvements	1	LS	$ 30,000	$ 30,000
10	Telemetry / SCADA Improvements	1	LS	$ 10,000	$ 10,000

Subtotal*	**$ 153,000**
Contingency (25%)	$ 38,300
Subtotal	**$ 191,300**
Washington State Sales Tax (9.0%)**	$ 17,200
Subtotal	**$ 208,500**
Design and Project Administration (30.0%)***	$ 62,600
TOTAL CONSTRUCTION COST	**$ 271,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative C1C - New Chlorine Equipment in New Chlorine Building
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	34,000	$	34,000
2	Minor Change	1	LS	$	10,000	$	10,000
3	Hazardous Materials Plan	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	10,000	$	10,000
5	Stormwater Improvements	1	LS	$	100,000	$	100,000
6	New Building	150	SF	$	800	$	120,000
7	Gas Disinfection Equipment	1	LS	$	15,000	$	15,000
8	Gas Sensing Equipment	1	LS	$	10,000	$	10,000
9	Electrical Modifications	1	LS	$	40,000	$	40,000
10	HVAC Modifications	1	LS	$	35,000	$	35,000
11	Telemetry / SCADA Modifications	1	LS	$	20,000	$	20,000

Subtotal*	**$**	**409,000**
Contingency (25%)	$	102,300
Subtotal	**$**	**511,300**
Washington State Sales Tax (9.0%)**	$	46,000
Subtotal	**$**	**557,300**
Design and Project Administration (30.0%)***	$	167,200
TOTAL CONSTRUCTION COST	**$**	**725,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative C2 - New OSHG Equipment in New Building
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	73,000	$	73,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	5,000	$	5,000
4	Site Improvements	1	LS	$	15,000	$	15,000
5	Stormwater Improvevments	1	LS	$	100,000	$	100,000
6	New Building	320	SF	$	700	$	224,000
7	Proposed Building Piping	1	LS	$	25,000	$	25,000
8	Hypochlorite Generation & Storage	1	LS	$	200,000	$	200,000
9	Electrical Modifications	1	LS	$	150,000	$	150,000
10	HVAC Modifications	1	LS	$	50,000	$	50,000
11	Telemetry / SCADA Modifications	1	LS	$	30,000	$	30,000

Subtotal*	**$**	**887,000**
Contingency (25%)	$	221,800
Subtotal	**$**	**1,108,800**
Washington State Sales Tax (9.0%)**	$	99,800
Subtotal	**$**	**1,208,600**
Design and Project Administration (25.0%)***	$	302,200
TOTAL CONSTRUCTION COST	**$**	**1,511,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative C3 - Commercial Delivery of Hypochlorite in a New Building
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	41,000	$	41,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	5,000	$	5,000
4	Site Improvements	1	LS	$	15,000	$	15,000
5	Stormwater Improvevments	1	LS	$	100,000	$	100,000
6	New Building	250	SF	$	700	$	175,000
7	Proposed Building Piping	1	LS	$	10,000	$	10,000
8	Hypochlorite Storage	1	LS	$	40,000	$	40,000
9	Electrical Modifications	1	LS	$	40,000	$	40,000
10	HVAC Modifications	1	LS	$	35,000	$	35,000
11	Telemetry / SCADA Modifications	1	LS	$	15,000	$	15,000

Subtotal*	**$**	**491,000**
Contingency (25%)	$	122,800
Subtotal	**$**	**613,800**
Washington State Sales Tax (9.0%)**	$	55,200
Subtotal	**$**	**669,000**
Design and Project Administration (25.0%)***	$	167,300
TOTAL CONSTRUCTION COST	**$**	**836,000**

* Costs listed are in 2020 dollars

** Current sales tax rate is 8.7%.

*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative CCB1 - Rehabilitation / Modification of Existing CCB
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	58,000	$	58,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	5,000	$	5,000
4	Site Improvements	1	LS	$	-	$	-
5	Stormwater Improvevments	1	LS	$	-	$	-
6	CCB Interior Modifications	1	LS	$	75,000	$	75,000
7	TM 20434-2 Recommendations	1	LS	$	416,000	$	416,000
8	Temporary Water Service	1	LS	$	100,000	$	100,000
9	Tracer Study	1	LS	$	15,000	$	15,000
10	Electrical Modifications	1	LS	$	15,000	$	15,000
11	Telemetry / SCADA Modifications	1	LS	$	5,000	$	5,000

Subtotal*	**$**	**704,000**
Contingency (25%)	$	176,000
Subtotal	**$**	**880,000**
Washington State Sales Tax (9.0%)**	$	79,200
Subtotal	**$**	**959,200**
Design and Project Administration (25.0%)***	$	239,800
TOTAL CONSTRUCTION COST	**$**	**1,199,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative CCB2 - Construction of new 400,000 Gallon Replacement CCB
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 81,000	$ 81,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 50,000	$ 50,000
5	Stormwater Improvevments	1	LS	$ 100,000	$ 100,000
6	0.3MG Welded Steel Reservoir	1	LS	$ 450,000	$ 450,000
7	Reservoir Preparation and Coating	1	LS	$ 200,000	$ 200,000
8	Tracer Study	1	LS	$ 15,000	$ 15,000
9	Electrical Modifications	1	LS	$ 40,000	$ 40,000
10	Telemetry / SCADA Modifications	1	LS	$ 20,000	$ 20,000

Subtotal*	**$ 981,000**
Contingency (25%)	$ 245,300
Subtotal	**$ 1,226,300**
Washington State Sales Tax (9.0%)**	$ 110,400
Subtotal	**$ 1,336,700**
Design and Project Administration (25.0%)***	$ 334,200
TOTAL CONSTRUCTION COST	**$ 1,671,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-6
Alternative CCB3 - Construction of New 100,000 Gallon Supplemental CCB
January 13, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 87,000	$ 87,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 50,000	$ 50,000
5	Stormwater Improvevments	1	LS	$ 100,000	$ 100,000
6	0.1MG Concrete Reservoir	1	LS	$ 200,000	$ 200,000
7	TM 20434-2 Recommendations	1	LS	$ 416,000	$ 416,000
8	Temporary Water Service	1	LS	$ 100,000	$ 100,000
9	Tracer Study	1	LS	$ 15,000	$ 15,000
10	Electrical Modifications	1	LS	$ 40,000	$ 40,000
11	Telemetry / SCADA Modifications	1	LS	$ 20,000	$ 20,000

Subtotal*	**$ 1,053,000**
Contingency (25%)	$ 263,300
Subtotal	**$ 1,316,300**
Washington State Sales Tax (9.0%)**	$ 118,500
Subtotal	**$ 1,434,800**
Design and Project Administration (25.0%)***	$ 358,700
TOTAL CONSTRUCTION COST	**$ 1,794,000**

* Costs listed are in 2020 dollars

** Current sales tax rate is 8.7%.

*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

EXHIBIT C

ADDITIONAL INFORMATION ON CHLORINE GAS STORAGE

EXHIBIT C

CHLORINE GAS STORAGE INFORMATION

MAXIMUM ALLOWABLE QUANTITIES

The hazardous materials provisions of the building codes begin with Tables 307.1(1) and 307.1(2) of the *2015 International Building Code*. These tables set the maximum allowable quantities (per control area) of hazardous materials that pose either physical or health hazards. Gaseous chlorine is considered both an oxidizing gas (physical hazard) and a toxic gas (health hazard) and as such is regulated under the stricter of the requirements of either table. As a physical hazard, the maximum allowable quantity for liquefied oxidizing gases is 150 pounds. As a health hazard, the maximum allowable quantity for corrosive or toxic materials is 150 pounds as a liquefied gas or 810 cubic feet at NTP as a gas (which is equivalent to a standard 150-pound cylinder). There are some exceptions to these quantities, allowing two to four times the quantity to be stored or used. However, for the quantities in storage and use at the Sudden Valley WTP, these exceptions would not have an effect on the code limits.

HAZARDOUS OCCUPANCY AND CODE REQUIREMENTS

When the quantity of chlorine gas exceeds the maximum allowable, the occupancy of the building or control area is typically upgraded to H-3. A summary of the building code requirements for H-3 occupancies is outlined below. The list below is not a complete and thorough list of code requirements, but rather a summarized listing of the many requirements.

International Building Code Requirements

- Provide a technical information report identifying the maximum expected quantities of hazardous materials and the methods of protection. This may include a Hazardous Materials Management Plan and a Hazardous Materials Inventory Statement as required by the local fire code official. [IBC 414.1.3, IFC 5001.5.1, IFC 5001.5.2]

- Provide mechanical ventilation where required by IBC, IFC, and IMC. [IBC 414.3]

- Provide an emergency power supply for mechanical ventilation, treatment systems, temperature control, fire and emergency alarm systems, gas and smoke detection systems, or other electrically operated systems. [IBC 414.5.2, IBC 2702.2.8, IFC 6004.2.2.8]

- Standby power for mechanical ventilation, treatment systems, and temperature control systems shall not be required where an approved failsafe engineered system is installed. [IBC 414.5.2.2, IFC 6004.2.2.8.1]

- Provide an automatic fire detection system in accordance with IBC 907.2. [IBC 415.3]

- Provide an automatic sprinkler system in accordance with IBC 903.2.5. [IBC 415.4]

- Provide an approved manual emergency alarm system for storage areas. The alarm-initiating device should be installed outside each access door and should sound a local alarm. [IBC 415.5.1]

- If hazardous materials are transported through corridors or exit passageways, there shall be an emergency telephone system, a local manual alarm station, or an approved alarm-initiating device at not more than 150-foot intervals and at each exit and exit access doorway throughout the transport route. [IBC 415.5.2]

- Alarm systems should be monitored at an approved central location. [IBC 415.5.3]

- At least 25 percent of perimeter walls shall be exterior walls. [IBC 415.6]

- Hazardous occupancies shall be in detached buildings. [IBC 415.8]

- Detached buildings for hazardous occupancies shall be set back not less than 50 feet from lot lines.

- Floors should be liquid tight and non-combustible. [IBC 415.8.4]

- Storage and use cylinders of toxic gas shall be located within gas cabinets, exhausted enclosures, or gas rooms. [IFC 6004.2.2.1]

- Gas rooms shall be separated from other areas by not less than 1-hour fire barriers. [IBC 415.10.2]

International Fire Code Requirements

- Provide a readily accessible manual valve or automatic remotely activated failsafe emergency shutoff valve on all piping at the point of use and at the storage cylinder. [IFC 5003.2.2.1]

- Provide safeguards to prevent the backflow of hazardous materials. [IFC 5003.2.2.1]

- Any gas piping greater than 15 psi requires an approved means of leak detection and automatic shutoff. [IFC 5003.2.2.1]

- Equipment using hazardous materials shall be braced and anchored to resist seismic forces per IBC. [IFC 5003.2.8]

- An automatic sprinkler system shall be installed in all Group H occupancies. [IFC 903.2.5, IFC 5004.5] The sprinkler system shall be designed per NFPA 13. [IFC 903.3.1.1]

- Indoor rooms or areas in which hazardous materials are dispensed or used shall be protected by an automatic fire-extinguishing system. [IFC 5005.1.8]

- One or more gas cabinets or exhausted enclosures shall be provided to handle leaking cylinders. [IFC 6004.2.2.3]

  Exemption:

  - Gas cabinets or exhausted enclosure are not required if:

    1. Approved containment vessels or systems capable of fully containing a release;

    2. Trained staff are at an approved location;

    3. Containment vessels or systems are capable of being transported to the leaking cylinder, container, or tank.

- The ventilation exhaust from a gas room shall be directed to a treatment system, which shall be utilized to handle the accidental release of gas. The treatment system shall be capable of neutralizing the contents of the largest single vessel. [IFC 6004.2.2.7]

  Treatment System Exemptions:

  - Storage of Toxic Gas – A treatment system is not required to protect a storage area if:

    1. Valve outlets are equipped with gastight plugs or caps;

2. Handwheel-operated valves are secured to prevent movement; and

3. Approved containment vessels are provided for leaking cylinders, as noted below.

- Use of Toxic Gas – A treatment system is not required to protect a use area for toxic gases supplied in cylinders not exceeding 1,700 pounds water capacity and if:

  1. An approved gas detection system with a sensing interval of less than 5 minutes is provided; and

  2. An approved automatic closing failsafe valve is located immediately adjacent to cylinder valves.

- Provide a gas detection system capable of detecting the presence of gas at or below the permissible exposure limit and also capable of monitoring the discharge of an exhaust treatment system at or below one-half of the immediately dangerous to life and health limit. [IFC 6004.2.2.10]

- The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended location. [IFC 6004.2.2.10.2]

- The gas detection system shall automatically close the shutoff valve at the source. [IFC 6004.2.2.10.3]

International Mechanical Code Requirements

- Provide either natural ventilation or a mechanical exhaust ventilation system. [IMC 502.8.1]

- Mechanical ventilation shall be provided at a rate of not less than 1 cfm per square foot of floor area. [IMC 502.8.1.1]

- Mechanical ventilation shall be continuous. [IMC 502.8.1.1]

- Provide a labeled emergency manual shutoff for the ventilation system. Shutoff should be located outside of the room adjacent to the main access door. [IMC 502.8.1.1]

- Ventilation system for gas rooms shall operate under negative pressures within the room. [IMC 502.8.1.2, IFC 5003.8.4.2]

APPENDIX I

TECHNICAL MEMORANDUM 20434-7, SUDDEN VALLEY WTP BACKWASH SYSTEMS ANALYSIS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-7

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	FEBRUARY 18, 2022
SUBJECT:	SUDDEN VALLEY WTP BACKWASH SYSTEMS ANALYSIS LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively provide clean potable water for its existing and projected customers.

This memorandum summarizes the assessment of the existing filter backwash system at the WTP, provides a description of alternative backwash handling and storage methods, and provides analysis and preliminary cost estimates for these alternatives.

Final recommendations for backwash system modifications will be presented in the final alternatives analysis report, which is scheduled to be completed in spring 2021. This final report will consider all of the alternatives and recommendations compiled for each of the treatment systems and will provide a coordinated set of recommendations based on capital costs, District needs, operational costs, and other factors.

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BACKGROUND AND EXISTING FACILITIES

Background

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley Water Treatment Plant. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD), which is equivalent to approximately 1,400 gallons per minute (gpm), but currently operates at a reduced flow of 1.0 MGD (700 gpm). The maximum allowable water right for this source is 1,526 gpm; however, the equipment and components listed in the alternatives below will be sized to accommodate the WTP's rated flow of 1,400 gpm. This design flow is suitable to serve the projected buildout water demand of 1.3 MGD as listed in the District's 2018 Water System Comprehensive Plan.

The WTP is located at 22 Morning Beach Drive in Bellingham, Washington, and is housed in a partially below-grade concrete building located adjacent to Morning Beach Park. The facility was constructed in 1972 and has undergone several minor improvements since that time but was most recently upgraded in 1992. Two centrifugal raw water pumps pump water from the Lake Whatcom intake to the WTP where alum coagulant is injected. After mixing with coagulant, water enters the flocculation tank before entering the filter distribution trough and the mixed-media filters. Water proceeds through the filters, into the underdrain system, then exits the filter through the filter discharge piping. The filter discharge piping includes injection points for both soda ash (pH adjustment) and chlorine. This piping then directs the filtered water to the below-grade clearwell. Two transfer pumps located in the WTP move water from the clearwell to the chlorine contact basin (CCB), which is a welded steel reservoir located adjacent to the WTP that provides additional chlorine contact time. From the CCB, four finished water pumps pump water to the District's storage reservoirs and distribution system for consumption. Additional information on the filter backwash system – which is the primary subject of this memorandum – is provided below.

Historical WTP Performance

Historically, the plant has performed well and provides high-quality finished water with turbidities of less than 0.1 nephelometric turbidity units (NTU). Raw water is collected from the adjacent Lake Whatcom from an intake located at a depth of approximately 80 feet and approximately 350 feet from the typical shoreline. Lake Whatcom is a large lake that is moderately developed on the northern and western shores but is largely undeveloped on its eastern shore. Raw water quality from the Lake Whatcom source is fairly consistent with turbidity below 1.0 NTU for most of the year. Turbidity increases during the spring and fall runoff season, but typically remains below 5.0 NTU during these periods. Raw water pH is typically between 7.5 and 7.7 and raw water temperature varies between 5 and 8 degrees Celsius.

Filter Backwash System

The WTP utilizes a backwash system to maintain the performance of their mixed-media filter beds. The backwash system consists of four media filters, backwash supply, flow measurement, and waste handling system and each of these components is described in greater detail below.

During normal filter operation, water is distributed evenly to all four filter cells and flows through the filter media and into the respective underdrain chambers. As it passes through the filter media, flocculated sediment and small particles are trapped and removed by the media while filtered water passes into the underdrain system and on through the discharge piping to the clearwell.

As additional particles are adsorbed onto the filter media, the head loss through the filter media and the water level within the filter vessel increases. To remove the adsorbed particles from the filter media, each filter bed is individually backwashed daily prior to filter operation. Table 1 summarizes critical design criteria for the existing filter backwash system and Figure A-1 in Exhibit A shows photographs of the existing equipment. During the backwash of a filter cell, finished water from the distribution system served by the Division 7 Reservoir flows upward through the filter at approximately 1,300 gpm (18.0 gpm/sf) for approximately 9 minutes. At this loading rate, the media bed is fluidized to remove the accumulated sediment particles and the particle-laden backwash water flows into the filter cell waste trough and then to the backwash storage basin. The recently completed WTP Assessment Report (Assessment

Report) produced by Gray & Osborne in 2020 noted that the filters and backwash sequence appear to be performing adequately and do not show a noticeable decrease in performance, filter run times, or rebound after backwashing within the last several years.

TABLE 1

Filter Backwash System Summary

Parameter	Value
Filter Type	Direct Filtration, Rapid-Rate Mixed Media
Filter Area (sf)	288 (4 filters @ 72 sf each)
Fluid Type	Finished Water
Backwash Flow Rate (gpm)	1,300
Backwash Loading Rate (per bed, gpm/sf)	18.0
Backwash Duration (min., per bed)	9–10 (1)
Backwash Volume (gal, total)	45,000

(1) Includes 2 minutes of surface wash, 2.5 minutes of surface wash and backwash, and 5 minutes of backwash. Time listed does not include up to 20 minutes of settling, equalization, and/or drainage or up to 15 minutes of filter to waste. Estimated volume for filter to waste is 10,000 to 15,000 gallons.

The backwash flow rate to the filter cells is measured by a Badger® magnetic flow meter installed in 1992 on the backwash supply piping located on the south wall of the WTP. The meter has not been recalibrated since its installation, but according to WTP staff the meter provides consistent performance when compared to previously recorded values. The Assessment Report did note that the existing backwash flow meter is an old model and is likely no longer supported by the manufacturer, which will make it difficult to complete calibration and/or repairs.

After the backwash sequence (including up to 15 minutes for the filter-to-waste cycle) is completed, the filters return to normal operation and water flows through the filters and into the clearwell. According to WTP staff, the entire backwash process for all four filters typically takes 120 to 160 minutes.

Water from the filter backwash process exits the filter vessel via the backwash waste trough and proceeds to a temporary storage basin. The backwash storage basin is located underground between the Main Building and the Finished Water Pump Building, has a volume of approximately 16,000 to 17,000 gallons, and provides flow attenuation for the spent backwash water. Backwash water within the basin is pumped via one of two submersible pumps to a manhole near the Finished Water Pump Building, then flows by gravity to the Afternoon Beach Lift Station. This lift station then pumps the wastewater to the municipal gravity sewer system where water proceeds to the City of Bellingham's

Post Point Wastewater Treatment Plant (WWTP) for treatment. Overflow from the backwash basin is directed back to Lake Whatcom.

Two backwash pumps are installed within the backwash basin. The larger pump is capable of pumping approximately 400 gpm while the smaller pump is capable of pumping approximately 180 to 200 gpm. Operation of either pump is controlled by a set of level floats within the backwash basin. WTP staff select which pump operates using a manual selector switch within the Main Building, and typically utilize the larger pump during the dry summer months and the smaller pump in the wet winter months. The pumps operate in this fashion so as not to overwhelm the Afternoon Beach Lift Station. The limited capacity of the smaller pump used during winter restricts the speed at which the WTP can complete a backwash sequence because staff must wait for the backwash basin to empty (partially) before backwashing additional filters. This process is cumbersome, time-consuming, and requires visual inspection of the basin during the backwash sequence. It is also noteworthy that the WTP does not maintain any redundant pumps for the backwash basin should either pump fail or be taken offline for maintenance.

The Assessment Report noted that the backwash basin is small and that the current backwash disposal process is expensive as a result of charges incurred while discharging to the municipal sewer system. Although the current backwash procedure provides adequate backwash of the filter vessels, the process is cumbersome for WTP staff and costs for disposal will continue to increase as a result of future sewer discharge rate increases. Backwashing less frequently is one option to reduce operating costs; however, discussions with WTP staff indicate that the current summer filter run time of 12 to 16 hours is the maximum run time possible based on turbidity readings during filter operation. As such, given the current water quality and operational parameters, extending the filter run times by backwashing less frequently, or operating the filters over the course of multiple days, is not feasible.

In order to provide a cost-effective option for backwash waste disposal, reduce operational costs, and provide a convenient and efficient system for WTP staff, the District is interested in investigating alternative methods for spent backwash water handling and disposal. The backwash sequence and components in use at the WTP should have the capacity to handle both current and design flows, sufficient volume for waste handling, provide a convenient and efficient way for WTP staff to backwash all four filters, and should provide redundancy or auxiliary accommodations/connections so that the WTP can remain in operation even if specific components must be taken offline for maintenance or rehabilitation.

To accomplish these goals, we have identified three alternatives that are feasible for the District's WTP operations. The next section describes these three alternatives with variations for backwash waste handling.

ALTERNATIVES ANALYSIS

In this section, three alternatives for backwash waste handling are presented. The alternatives are based around the various discharge locations, and within each alternative there are two options for temporary storage and handling. The alternatives discussed are continued discharge to the municipal sewer system, discharge to Lake Whatcom, or recycling flows back through the treatment system. A general description, specifics about the proposed alternative, impacts to existing buildings and supporting systems, (HVAC, electrical, structural, etc.), advantages/disadvantages, and a cost estimate are provided for each alternative.

Alternative B1 – Discharge to Municipal Sewer

General

This alternative includes continued discharge to the municipal sewer. The alternative is further divided into Options B1A and B1B for both below- and above-grade storage, respectively.

Backwash

In this alternative, all backwash waste would be pumped to the municipal sewer system via the existing Afternoon Beach Lift Station with improvements to optimize operations. The District would continue to pay municipal discharge rates to the City of Bellingham (City).

The District has noted that the current process is expensive and it may be possible to reduce the cost by coordinating with the City to meter the flows to the sewer system during non-peak hours. Typically, municipal sewer systems experience periods of high flows between approximately 6:00 and 9:00 a.m., and again between 5:00 and 10:00 p.m. This is often referred to as a diurnal peak and these peaks typically correspond to times when water system demand is high. Pumping spent backwash water to the sewer system during peak hours further increases the peak flows to the treatment facility, which places additional stress on the wastewater treatment facility equipment. If the District was able to send the backwash waste to the sewer system outside of these windows, it may be possible to negotiate a lower charge which will reduce the overall cost.

Because the existing backwash storage basin is not large enough to contain and store the full volume of a complete backwash sequence (approximately 50,000 gallons), additional storage volume would allow for operational flexibility. This additional storage volume will allow staff to manually initiate the filter backwash sequences during normal working hours, then temporarily store the backwash volume until non-peak discharge hours or would allow them the flexibility to discharge the backwash water at a constant, low flow rate throughout a 24-hour period. It will also allow the staff to sequentially backwash each filter without waiting for the backwash basin to drain to the lift station.

Currently, the WTP staff operate the filters at 700 gpm and backwash each filter once per day prior to operation. To accommodate the full design flow of 1,400 gpm, it is assumed that the WTP staff will need to backwash twice as often to maintain filter performance. Thus, for the design flow of 1,400 gpm it is estimated that 120,000 gallons of storage must be provided. This volume includes two full backwash sequences of 50,000 gallons each plus 20,000 gallons of storage for spare/flexible capacity (20 percent). This storage volume could be provided by new below-grade or above-grade tankage, each of which are described as Options B1A and B1B below.

Both options for additional storage volume are shown on Figure A-2 in Exhibit A. Option B1A is for a new below-grade tank. While a concrete reservoir is one possibility, it is more cost effective to provide detention tank storage similar to those used for stormwater detention. In this alternative, the existing backwash storage basin could be utilized to provide additional attenuation volume, could be abandoned in place and bypassed, or could be removed. Given the added flexibility that this basin could provide, this alternative includes continued use of the existing basin, but modifying the components to include a gravity or pumped drainage to the proposed detention tank. For the purposes of this analysis, it is assumed that the backwash waste will need to be pumped from the existing backwash storage basin to the proposed detention tank, although a more thorough survey and field investigation may show that gravity drainage between the two tanks is feasible. The detention tank would provide below-grade storage and would drain by gravity to a separate submersible pump station – also located below grade. This pump station would accommodate up to three pumps (two duty, one redundant) and would include valves and controls to allow the WTP staff or the programmable logic controller (PLC) to remotely start the pumps based on a timer so that the backwash can be distributed to the lift station during off-peak hours. The detention tank could be made from polyethylene or fiber reinforced plastic (FRP) materials and would consist of prefabricated sections joined in the field. The system includes three access ports to allow for inspection and can accommodate various instruments and floats to provide information on the level within the tank. The tank could be installed within the adjacent land associated with Morning Beach Park. This location would allow access to the tank for WTP staff and still provide an open park setting for use by the general public. Preliminary design criteria for a detention-style tank suitable for this application are provided in Table 2.

Option B1B includes installation of an above-grade concrete storage tank. For this option, the existing below-grade storage basin could be utilized, but instead of pumping to an existing manhole, the pumps would pump backwash water to a new above-grade temporary storage tank located adjacent to the existing CCB. The proposed tank would include inlet piping, a center drain connection for full and complete drainage, access ladder, roof safety railing, level monitoring instrumentation, and access hatches. To ensure that the existing backwash storage basin provides sufficient flexibility and storage to allow WTP staff to sequentially backwash each filter, the existing 200 and 400 gpm pumps should be replaced with larger 600 to 800 gpm submersible pumps. The pumps could be operated with variable frequency drive (VFD) motor starters and discharge from the existing backwash basin would be controlled by adjusting the pump motor speed to maintain the desired flow of 600 to 800 gpm. Gravity discharge from the proposed tank would be controlled by a mechanized butterfly valve and flow meter. The flow meter will measure the flow through the piping and the position of the butterfly valve will be adjusted by the PLC in order to maintain the desired flow to the Afternoon Beach Lift Station.

Design criteria for the proposed above-grade tank are provided in Table 2.

TABLE 2

Alternative B1 Storage Tank Design Criteria

Parameter	Value
New Below-Grade Tank	
Type	Prefabricated (FRP, PE)
Quantity (number of sections)	7
Diameter (ft)	8
Length (ft)	48
Footprint (sf)	7,200
Volume (gal)	123,000
Inlet/Outlet	Pipe Connection
Instrumentation	Ultrasonic Level Sensor High-Alarm Float Switch Duplex Pump Station (floats, ultrasonic level sensor)
New Above-Grade Tank	
Type	Cast-in-Place Concrete, Cylindrical
Diameter (ft)	26
Base Elevation (ft)	342
Overflow Elevation (ft)	377
Volume (gal)	138,000
Volume per Foot (gal/ft)	3,942
Inlet/Outlet	Elevated Inlet Center Drain Connection
Instrumentation	Ultrasonic Level Sensor High-Alarm Float Switch Magnetic Flow Meter Electrically Actuated Butterfly Flow Control Valve

Both Options B1A and B1B will require that any solids accumulated during temporary storage be removed on a regular basis. Based on discussions with WTP staff and our understanding of backwash timing and the backwash storage basin, it is likely that a significant majority (more than 90 percent) of solids are currently discharged to the Afternoon Beach Lift Station. The storage options noted above will provide additional volume and flexibility to retain backwash solids; however, a large portion of these solids should remain suspended and will proceed to the lift station as they do in the current process. Any solids retained within the proposed tank should be removed on a semiregular basis and appropriate access ports and hatches will be provided on the tanks to facilitate this removal. For the purposes of this analysis, it is estimated that solids will need to be removed two times per year and that solids can be removed with a vactor truck, then deposited to the Afternoon Beach Lift Station or directly to the City WWTP. Alternatively, mixing equipment could be added to the tank that would help more solids remain suspended so that they could be pumped to the downstream municipal sewer.

It should be noted that depending on other changes or modifications made by the District to the current disinfection system, it may also be feasible to utilize the existing CCB for temporary backwash waste storage. This would potentially eliminate the need to construct an additional storage tank but would remove the CCB from use for the disinfection system. A final alternatives analysis report proposed as part of this project will be provided separately from this technical memorandum and will combine all of the various options and recommendations for each treatment component. However, each of the recommendations or alternatives presented herein will depend on the full scale of changes desired by the District over the long-term planning process and should always be considered within the full scale of potential changes for the WTP.

Building and Other

No other modifications to the Main Building or Finished Water Pump Building are proposed as part of this alternative. There will be various modifications to the existing Supervisory Control and Data Acquisition (SCADA) system that are required, but these services and modifications will be provided by the District's preferred telemetry and integration service provider.

Site improvements included with this alternative include grading and earthwork required to create a flat and suitable area for the proposed backwash storage tank. Prior to construction of the proposed tank (Option B1B), a thorough geotechnical investigation should be completed. Given the slope of the adjacent terrain, a retaining wall may be required to provide suitable slope stabilization. For the purposes of this investigation, it is assumed that a retaining wall is not required for construction of the new tank and that only basic earthwork and grading are required.

Regardless of which option is selected, modifications to the existing electrical system will be required. For both options (B1A and B1B), the existing backwash basin submersible pumps must be replaced with larger equipment and new flow meters must be installed. Additionally, Option B1B includes the installation of an electrically actuated valve. This additional/new equipment will increase the electrical load on the facility. Additionally, new VFD motor starters are larger than the existing non-VFD starters and may require additional space for new motor control center (MCC) buckets or a reconfiguration of the existing MCCs. For the purposes of this investigation, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished

Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption and an assessment of the capacity for the existing MCCs to accept new larger VFD motor starters should be completed.

The new facility will be subject to all applicable stormwater requirements for construction of new structures. The construction of a new tank adjacent to the existing WTP would be subject to the stipulations listed by Whatcom County for the Lake Whatcom Watershed. These requirements will include the need to provide either full infiltration on site or advanced treatment for phosphorous removal. Design of the required stormwater facilities will be provided once the building footprint and paving have been finalized, but a budgetary estimate for the anticipated requirements has been included with the alternative cost estimate included in Exhibit B. In addition, it should be noted that these regulations restrict clearing of the site so that only 35 percent of the existing tree canopy can be cleared.

It is important to note that this alternative will require additional design and coordination with various stakeholders, one of which includes the Sudden Valley Community Association (SVCA). The SVCA owns much of the property adjacent to the WTP and would need to be consulted prior to implementation of any of the alternatives discussed in this memorandum. Furthermore, the District must consider that the property adjacent to the WTP is a public park with waterfront access and use of this public space will likely need to be maintained at all times. Other stakeholders include neighboring residential landowners and utility providers serving the area.

Advantages and Disadvantages

Both Options B1A and B1B maintain the current discharge location and sequence, which is familiar to WTP staff.

One advantage to Option B1A is that the proposed location for construction of the storage tank is open and accessible. One disadvantage to Option B1A is that a new pump station is required, which increases the electrical load to the facility and increases the complexity of the system.

One advantage to Option B1B is that the system could flow by gravity to the existing Afternoon Beach Lift Station. One disadvantage to Option B1B is that it requires construction of a new structure, which will require additional geotechnical investigation and stormwater treatment systems.

Cost Estimate

Option B1A for this alternative is estimated to cost approximately $1,494,000 while Option B1B is estimated to cost approximately $1,022,000. Both of these cost estimates include contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative B2 – Discharge to Lake Whatcom

General

This alternative includes revising the existing backwash discharge so that it discharges to Lake Whatcom instead of the municipal sewer system. Similar to Alternative B1, this alternative is further divided into Options B2A and B2B for both below- and above-grade storage, respectively.

Backwash

Discharges to surface water governed by the State of Washington are covered by the National Pollutant Discharge Elimination System (NPDES) Permit which is managed by the Washington State Department of Ecology (Ecology). Ecology maintains a general permit (General Permit) available to all WTPs for discharge of backwash waste and this permit allows WTPs to discharge backwash water to surface water such as Lake Whatcom if they adhere to the requirements listed in the General Permit. The current General Permit is included in Exhibit C, but the key components are summarized below:

- Facilities (WTPs) may discharge to surface water if they provide potable water (more than 35,000 gallons per day) and the discharge is part of a normal operating process (filtration, backwash, etc.).

- Water discharged meets specific maximum requirements for settleable solids, residual chlorine, and pH.

- Facilities must have a valid and current Operation and Maintenance Manual.

- Facilities must complete additional water quality monitoring based on their maximum rate of water production, and must monitor and record these analyses and their results using a web-based monitoring system.

- Provide notice to various stakeholders, including Ecology, in the event that a system disruption or anomaly occurs.

To apply for coverage under the General Permit, the District must complete and sign the application form as well as provide documentation of adherence to all aspects of the General Permit. Conditions for adequate public notice and compliance with all applicable State Environmental Policy Act (SEPA) requirements must also be met. If coverage under the General Permit is granted, the District would need to reapply for coverage every 5 years. This reapplication process is very simple and minimal effort is needed to complete the reapplication process.

Coverage under the General Permit is utilized by many WTPs in Washington State and could potentially reduce the operational costs by reducing the volume sent to the City municipal sewer system.

Discharge limits are highlighted in Section S-2.2 of the General Permit, but include maximum daily limits on settleable solids (0.2 mL/L), total residual chlorine (0.07 mg/L), and pH (9.0). Additional monitoring parameters are listed in Exhibit C (Section S-5.2) and include various inorganic parameters analyzed on a monthly or quarterly basis.

Although no historical data exists for these analytes for the backwash discharge, the WTP staff recently collected samples to estimate potential compliance and treatment required for adherence to the conditions set forth in the General Permit. For this, two 1,000 mL bottles (A and B) were filled every 60 seconds during a backwash cycle (one filter only, Filter 4) on January 26, 2021. These samples were then analyzed by the District (pH, chlorine) as well as a local commercial analytical laboratory (TSS, turbidity). Results of these analyses are shown in Table 3.

TABLE 3

Backwash Discharge Sample Analysis Summary

Sample	Elapsed Time (min) (1)	pH (2)	Total Residual Chlorine (mg/L) (3)	Total Suspended Solids (TSS, mL/L) (4)	Turbidity (NTU) (5)
1	1.0	6.92	0.02	145	36
2	2.0	6.91	0.08	300	70
3	3.0	6.86	0.06	310	90
4	4.0	7.01	0.05	270	39
5	5.0	7.17	0.61	41	9.5
6	6.0	7.24	0.70	19	9.2
7	7.0	7.31	0.81	8	4.8
8	8.0	7.38	0.82	6	1.7

(1) Two-liter sample collected from the backwash waste discharge trough at each time point. One liter used for pH, residual chlorine, TSS, and turbidity samples, and 1 liter used for settleability analysis.
(2) Measured using the District's pH sensor.
(3) Measured using the District's HACH handheld pocket colorimeter.
(4) Measured by Edge Analytical via Method I-3765-85.
(5) Measured by Edge Analytical via SM180.1.

To estimate the settleability of the backwash waste, samples were collected from various time points in the backwash cycle and were allowed to settle. At various times during the settling process, the volume of clear water (supernatant) was measured and recorded. After 24 hours of settling, the supernatant solution was transferred to a separate container, measured for pH and chlorine residual, then submitted to a commercial laboratory for TSS and turbidity analysis. The results of these analyses are provided in Table 4.

TABLE 4

Backwash Discharge Settleability Analysis Summary

Parameter	Clear Volume (mL) (1)		
	Sample 1	**Sample 4**	**Sample 8**
Settling Time (min)			
1	1,000	1,000	1,000
5	920	1,000	1,000
15	920	990	1,000
30	960	980	1,000
60	960	975	1,000
240 (4 hours)	960	975	1,000
480 (8 hours)	960	975	1,000
1,440 (24 hours)	960	975	1,000
Other			
pH (2)	6.92	6.99	7.36
Chlorine Residual (mg/L) (2)	0.07	0.05	0.84
Total Suspended Solids (mL/L) (2)	—	—	—
Turbidity (NTU) (2)	—	—	—

(1) Value listed is the approximate volume of supernatant (clear volume) within the graduated cylinder after the time noted.
(2) Value recorded was measured from sample supernatant after 24 hours of settling time.
(3) Value recorded was measured from sample supernatant after 8 hours of settling time.

The data listed in Table 3 suggest that the proposed backwash discharge to Lake Whatcom would meet permit requirements for pH, but would need additional treatment or accommodations to meet the requirements for residual chlorine and possibly settleable solids. The data in Table 4 suggest that the solids entrained within the backwash water settle rapidly as indicated by the large volume of clear water within the sample and the low rate of change in the clear water volume over a 24-hour period.

Various chemical compounds can be used for dechlorination, most commonly sulfur dioxide gas, sodium metabisulfite, sodium sulfite, calcium thiosulfate, and ascorbic acid. Sulfur dioxide is a hazardous gas similar to chlorine but could be successful at removing chlorine down to the proposed maximum threshold of 0.07 mg/L. Calcium thiosulfate solution is a safer and more user-friendly solution when compared to sodium metabisulfite and sodium sulfite, and does not have safety concerns associated with compressed sulfur dioxide gas. To remove 0.8 mg/L residual chlorine with calcium thiosulfate, which is very conservative given the data in Tables 3 and 4, it is estimated that 9 pounds per day per million gallons per day would be required. Given the potential daily discharge of up to 50,000 gallons, this results in a consumption of up to 1 pound per day. Dechlorination equipment provided with this alternative includes a duplex chemical metering pump system, chemical storage space, and connections to the existing or proposed piping system. This equipment would be housed within a small freestanding building near the backwash storage tank and assumes that the building would be installed on a concrete slab. Sodium thiosulfate is commercially available as a ready-to-use liquid in drums or totes and costs approximately $0.40 per pound.

In addition to dechlorination, the backwash system may require additional treatment or accommodations for reducing and monitoring settleable solids in the discharge water.

To ensure that the discharge requirements listed in the General Permit for settleable solids are met, it is recommended that the District install storage facilities for this alternative. Options and inclusions for these facilities are similar to those described in Alternative B1 (for both below- and above-grade tanks). Some key differences for storage tanks in Alternative B2 are that the tank will be designed to discharge to either Lake Whatcom or the Afternoon Beach Lift Station. During normal operation, backwash supernatant will be pumped to the outfall diffuser within Lake Whatcom; however, the tank will also include accommodations to divert the pumped flow to the lift station during periods where the discharge water quality does not meet the requirements set forth in the NPDES permit. Additionally, monitoring and sampling piping will be provided so the WTP staff can monitor water quality at various locations within the tank and from the discharge stream. Lastly, the tanks will need to be larger to provide sufficient volume to accommodate solids accumulated during the settling process.

Both Options B2A and B2B will require that solids accumulated during storage/settling be removed on a regular basis. Solids retained within the proposed tank should be removed and appropriate access ports and hatches will be provided on the tank to facilitate this removal. It is estimated that solids will need to be removed three to four times per year, and that solids can be removed with a vactor truck, then deposited to the lift station or directly to the City WWTP. Other decanting and/or separation facilities are also feasible if additional separation of solids is desired. Given the data for TSS in Table 3, the average TSS concentration for backwash water is 137 mg/L. If a conservative value of 150 mg/L is combined with an average daily backwash volume of 50,000 gallons (189,270 liters) it is estimated that approximately 22,900 pounds of solids will be generated per year. This weight is equivalent to approximately 68,000 gallons of slurry/sludge if we assume a solids concentration of 4 percent. Table 5 highlights design criteria for the tanks proposed with Alternative B2.

TABLE 5

Alternative B2 Storage Tank Design Criteria

Parameter	Value
New Below-Grade Tank	
Type	Prefabricated (FRP, PE)
Quantity (number of sections)	11
Diameter (ft)	8
Length (ft)	48
Footprint (sf)	14,500
Volume (gal)	193,000
Inlet/Outlet	Pipe Connection
Instrumentation	Ultrasonic Level Sensor High-Alarm Float Switch Duplex Pump Station (floats, ultrasonic level sensor)
New Above-Grade Tank	
Type	Cast-in-Place Concrete, Cylindrical
Diameter (ft)	30
Base Elevation (ft)	342
Overflow Elevation (ft)	382
Volume (gal)	211,400
Volume per Foot (gal/ft)	5,285
Inlet/Outlet	Elevated Inlet Center Drain Connection
Instrumentation	Ultrasonic Level Sensor High-Alarm Float Switch Magnetic Flow Meter Electrically Actuated Butterfly Flow Control Valve

Building and Other

Modifications to the Main Building, Finished Water Pump Building, and associated electrical systems are identical to those described in Alternative B1. Stormwater and land acquisition components are also identical. Proposed facilities for this alternative are shown on Figure A-3 in Exhibit A.

This alternative will include installation of a concrete slab and small building. This building would be located near the storage tank discharge connection, which should provide sufficient reaction time prior to discharge to Lake Whatcom. The new building will house the dechlorination system as well as the backwash discharge monitoring equipment. This alternative will also require construction of an outfall discharge within Lake Whatcom. The discharge should be located at depth (greater than 60 feet) and should be constructed as far away from the WTP intake piping as feasible. The outfall should have a diffuser on the outlet end to reduce the potential for lakebed erosion and should be constructed from ductile iron or high-density polyethylene (HDPE) materials.

Advantages and Disadvantages

One advantage to Option B2A or B2B is that backwash is no longer discharged to the City municipal sewer system. One disadvantage to Option B2A or B2B is that it will require construction within Lake Whatcom, will require additional water quality monitoring, and may require additional treatment for dechlorination and to reduce solids within the discharge. There may also be resistance to discharging a "waste" stream to Lake Whatcom by community members and the general public.

One advantage to Option B2A is that the proposed location for construction of the storage tank is open and accessible. The space would be maintained as a public park and would only be unavailable for use during the active construction period. One disadvantage to Option B2A is that a new pump station is required, which increases the electrical load to the facility and increases the complexity of the system.

One advantage to Option B2B is that a new separate pump station is not required, and the system could conceivably drain by gravity to the Lake Whatcom outfall. One disadvantage to this option is that it requires construction of a new structure, which will require additional geotechnical investigations and stormwater treatment systems.

Cost Estimate

Option B2A for this alternative is estimated to cost approximately $2,126,000 while Option B2B is estimated to cost approximately $1,819,000. Both of these cost estimates include contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative B3 – Recycle Backwash Flows to Treatment System

General

This alternative includes revising the backwash handling system so that backwash supernatant can be redirected through the existing treatment equipment. Similar to

Alternative B1, this alternative is further divided into Options B3A and B3B for both below- and above-grade storage, respectively.

Backwash

Prior to 2004, the United States Environmental Protection Agency (EPA) enacted a rule allowing water treatment facilities to recycle spent filter backwash water from a direct filtration plant back through the treatment process and into the distribution system. In 2004, the EPA amended this rule to include more stringent water quality requirements in order to continue this process. The rule is commonly referred to as the Filter Backwash Recycling Rule (FBRR) and is employed by several WTPs in the Pacific Northwest. In this alternative, the WTP would temporarily store backwash waste within a below- or above-grade tank, allow the solids entrained with this water to settle, then reintroduce the supernatant (uppermost clear water layer) back into the treatment process. According to the FBRR, recycled water must be reintroduced so that is undergoes every step of treatment, which in this case means that it must be introduced prior to chemical addition and the existing flocculation tank. Connection at this location is feasible and would require minimal modifications or disruptions to the existing treatment equipment.

There are additional monitoring, recording, and reporting requirements that must be completed for compliance. These requirements include both additional water quality and treatment process parameters and the key components to the existing *FBRR Technical Guidance Manual* are provided in Exhibit D. Additional guidance is available in the 2019 *Water System Design Manual* (Washington State Department of Health) as well from the *10 State Standards Water Treatment Guidance* (2018). In general, the additional monitoring requirements are not significant and would not increase the WTP staff operation and maintenance requirements.

To ensure that the discharge requirements for backwash recycle are met, the District will need to install additional storage/settling facilities to reduce the solids loading to the filters from the recycled flow. Options for providing these additional storage facilities are identical to those described in Alternative B2 for both below- and above-grade facilities. The only difference with this alternative is that the storage tank supernatant will be directed back to the treatment process instead of to the municipal sewer system or to Lake Whatcom. During normal operation, backwash supernatant will drain (or be pumped) to the connection point upstream of the flocculation tank; however, the tank will also include accommodations to drain to the Afternoon Beach Lift Station during periods where the discharge water quality does not meet the requirements set forth in the FBRR. Additionally, monitoring and sampling piping will be provided so the WTP staff can monitor water quality at various locations within the tank and from the discharge stream. Lastly, the maximum percentage of flow that can be recycled during filtration is

10 percent. For the current operational flow of 700 gpm, this equates to a recycle flow of 70 gpm (630 gpm raw water). In order to recycle a typical backwash sequence volume of 42,000 gallons (approximately 85 percent of the total volume), this would require approximately 10 hours of recycle flow – which is feasible given the current filtration and backwash sequences utilized at the WTP. For the full design flow of 1,400 gpm, a recycle flow of 140 gpm (1,260 gpm raw water) is allowed, which will result in a backwash volume pump time of approximately 5 hours.

Additionally, adjustment of disinfection chemicals and/or other chemicals utilized at the WTP (alum, soda ash) may be required during recycle events. This will add complexity and could impact overall water quality.

Both Options B3A and B3B will require that solids accumulated during storage/settling be removed on a regular basis. Solids retained within the proposed tank should be removed and appropriate access ports and hatches will be provided on the tanks to facilitate this removal. For the purposes of this analysis, it is estimated that solids will need to be removed three to four times per year, and that solids can be removed with a vactor truck, then deposited to the Afternoon Beach Lift Station or directly to the City WWTP.

<u>Building and Other</u>

Modifications to the Main Building and associated electrical systems are identical to those described in Alternative B1. Stormwater and land acquisition components are also identical. The proposed facilities for this alternative are shown on Figure A-4 in Exhibit A.

Both Options B3A and B3B will require modification of the existing WTP raw water piping. Although gravity drainage from an above-grade tank (Option B3B) to a new connection point at the WTP is feasible, gravity feed will result in lower flow control and more operator interaction. To provide additional flow control and less operator interaction with the system, both Options B3A and B3B include a small duplex pump station that will pump water from the proposed tank to the raw water connection location. Option B3A includes a new submersible pump station within a below-grade manhole while Option B3B includes centrifugal pumps housed within a small building adjacent to the proposed storage tank. The raw water connection location could be outside the footprint of the Main Building below grade, or piping could be brought within the footprint of the Main Building and be connected above grade just downstream of the existing raw water flow meter. From this connection location, recycled water will continue through the normal treatment process and equipment.

Advantages and Disadvantages

The advantage to Alternative B3 is that it no longer discharges backwash waste to the City municipal sewer system which could potentially reduce operational costs for backwash waste handling. Additionally, the monitoring requirements for Alternative B3 are less intensive than those required to discharge backwash to Lake Whatcom (Alternative B2). Lastly, Alternative B3 would allow a more full and complete utilization of the District's surface water right. One disadvantage is that this alternative will likely require approval from the Washington State Department of Health prior to implementation. Additionally, introduction of backwash recycle water may negatively impact the existing treatment process and/or finished water quality – although it is not likely that these negative impacts would be significant.

One advantage to Option B3A is that the proposed location for construction of the storage tank is open and accessible. The space would be maintained as a public park and would only be unavailable for use during the active construction period. A disadvantage to this alternative is that a new pump station is required, which increases the electrical load to the facility and increases the complexity of the system.

One disadvantage to Option B3B is that it requires construction of a new structure, which will require additional geotechnical investigations and stormwater treatment systems.

Cost Estimate

Option B3A for this alternative is estimated to cost approximately $1,889,000 while Option B3B is estimated to cost approximately $1,564,000. Both of these cost estimates include contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

SUMMARY

Alternative Summary

Each of the alternatives is briefly described below and Table 6 provides a summary and comparison for the various alternatives.

Alternative B1 – Discharge to the Municipal Sewer System

Under this alternative, the WTP will continue to discharge backwash waste to the municipal sewer system. To potentially reduce costs through off-peak discharge and to help reduce backwash time and improve discharge water quality, this alternative includes two options for additional storage and settling volume. Option B1A includes installation of a new below-grade storage facility, new duplex pump station adjacent to the Main Building, and replacement of the existing backwash discharge pumps. Option B1B includes installation of an above-grade concrete storage tank adjacent to the existing CCB and replacement of the existing backwash storage basin submersible pumps.

Solids handling will be provided by discharging and draining the tank to the municipal sewer several times each year.

Alternative B2 – Discharge to Lake Whatcom

This alternative will direct backwash waste to a new outfall in Lake Whatcom but will maintain a connection to the City's municipal sewer system in the event that spent backwash water does not meet NPDES discharge water quality requirements. The District will apply for coverage under the WTP General Permit for Backwash Discharge as governed by Ecology.

To provide operational flexibility and to help ensure that the water quality stipulations of the General Permit are met, this alternative includes two options for additional storage and settling volume. Option B2A includes installation of a new below-grade storage facility, duplex pump station, and replacement of the existing backwash discharge pumps. Option B2B includes installation of an above-grade concrete storage tank adjacent to the existing CCB, new duplex pump station, and replacement of the existing backwash discharge pumps. Both alternatives include a new building to house the dechlorination and discharge monitoring equipment.

Solids handling will be provided by discharging and draining the tank to the municipal sewer several times each year.

Additional water quality monitoring will be required to ensure that the discharge water meets NPDES discharge requirements.

Alternative B3 – Backwash Recycling

This alternative will direct backwash supernatant back to the existing raw water piping upstream of the existing flocculation tank but will maintain a connection to the City's municipal sewer system in the event that recycle water does not meet water quality requirements. The District will provide information to DOH in compliance with the EPA FBRR.

This alternative includes two options for additional storage and settling volume. Option B3A includes installation of a new below-grade storage facility, duplex recycle pump station, and replacement of the existing backwash discharge pumps. Option B3B includes installation of an above-grade concrete storage tank adjacent to the existing CCB, duplex recycle pump station, and replacement of the existing backwash discharge pumps. For either tank option, supernatant from the storage/settling volume will be pumped to a connection within the Main Building upstream of the existing flocculation tank. This will allow the recycled water stream to flow through the entire treatment process. Both alternatives include a new building to house the backwash recycle pumps and associated electrical and monitoring equipment.

Solids handling will be provided by pumping and draining the tank to the municipal sewer several times each year.

Additional water quality monitoring will be required to ensure that the discharge water meets FBRR discharge requirements.

TABLE 6

Alternatives Summary

Alt. Option	Description	Capital Cost	Advantages	Disadvantages
B1A	Discharge to Municipal Sewer – Below-Grade Tank	$1,494,000	• Familiar process • No additional water quality monitoring required	• Requires additional pump station • Permit and land acquisition
B1B	Discharge to Municipal Sewer – Above-Grade Tank	$1,022,000	• Familiar process • No additional water quality monitoring required	• Permit and land acquisition
B2A	Discharge to Lake Whatcom – Below-Grade Tank	$2,126,000	• Reduces sewer discharge costs	• Requires additional pump station • Additional water quality monitoring required • Increases system complexity • Permit and land acquisition
B2B	Discharge to Lake Whatcom – Above-Grade Tank	$1,819,000	• Reduces sewer discharge costs	• Requires additional pump station • Additional water quality monitoring required • Increases system complexity • Permit and land acquisition
B3A	Backwash Recycle – Below-Grade Tank	$1,889,000	• Less monitoring than Alt. B2 • Greater use of full water right • Reduces sewer discharge costs	• Requires additional pump station • Additional water quality monitoring required • May affect current water quality • Increases system complexity • Permit and land acquisition
B3B	Backwash Recycle – Above-Grade Tank	$1,564,000	• Less monitoring than Alt. B2 • Greater use of full water right • Reduces sewer discharge costs	• Requires additional pump station • Additional water quality monitoring required • May affect current water quality • Increases system complexity • Permit and land acquisition

The current estimated annual cost for discharge to the municipal sewer is approximately $45,000. This was estimated using the monthly billing sheet provided by the District proportioning the calculated backwash flows (50,000 gallons per day) to the total metered flows, then applying this same ratio to the monthly cost. Dividing the capital costs listed in Table 6 by the current estimated annual cost for sewer discharge, the minimum payback period can be calculated. The payback periods for the options listed in Table 6 range between 22 and 40 years and represent the ***minimum*** period since the costs listed in Table 6 do not include additional operational costs for chemicals, electrical, maintenance, etc., which are very difficult to estimate at this point in time. This minimum payback period is relatively high, and as such the District must weigh the value of reducing annual operational costs against the potential increase in system complexity, required monitoring, and the planning and expenditures required to complete Alternative B2 or B3.

Recommendations

It is difficult to provide a backwash system recommendation without considering the other issues that are being considered at the treatment plant. For example, if the District decides to construct a new CCB, then utilizing the existing CCB as a backwash storage and/or recycle tank becomes more favorable as the capital costs to implement this change are less and the minimum payback period decreases. This economy of scale when considering the modifications for the WTP can help drive the decision-making process.

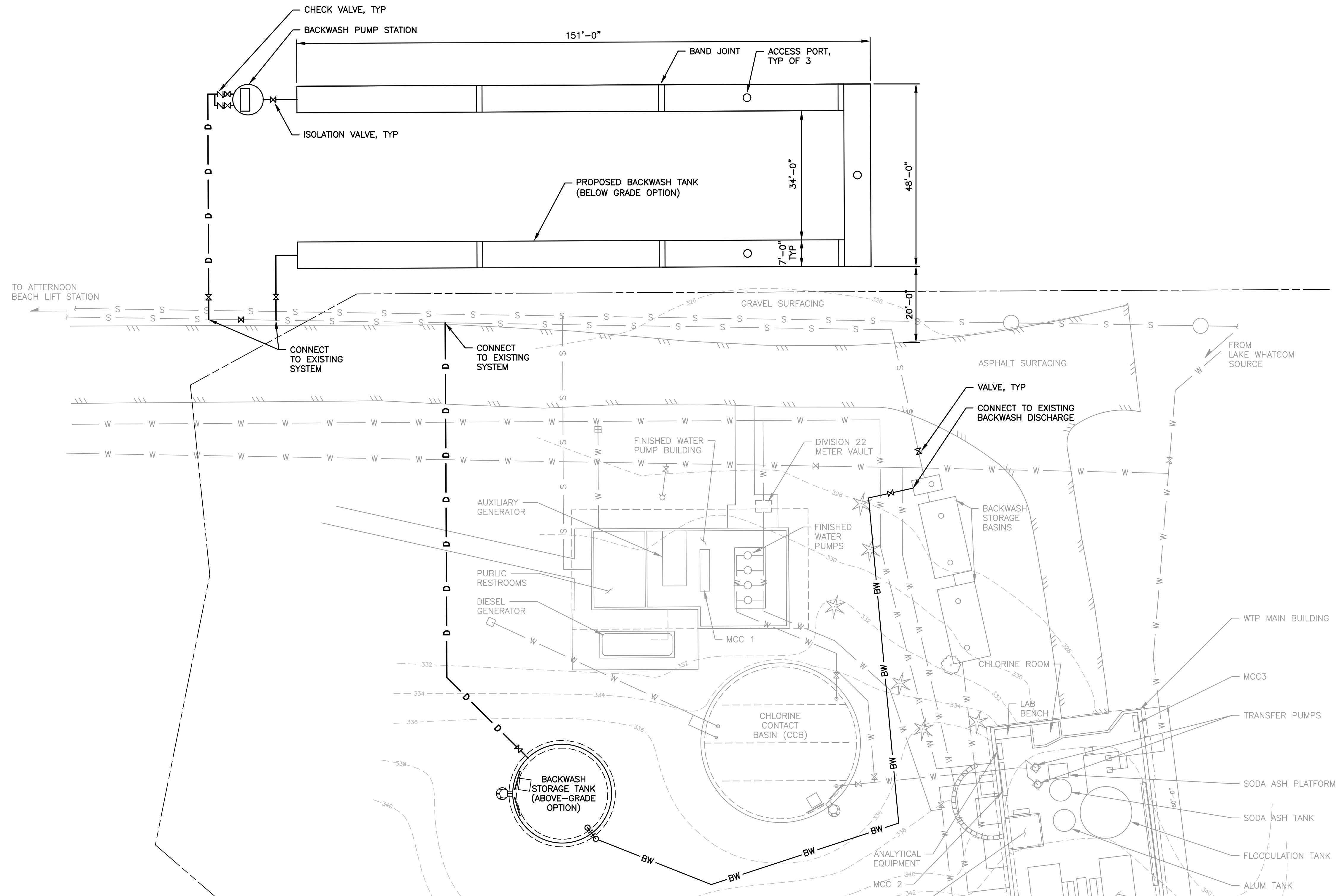
Consequently, the final filtration recommendation will be deferred until the summary report is prepared that contains all of the information in the various technical memoranda to provide an optimized recommendation for the entire filter plant to ensure the District's goal of continuing to provide high-quality treated water for decades to come.

EXHIBIT A

FIGURES

FIGURE A-1

Photographs of Existing Backwash Components



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

0 1"
ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

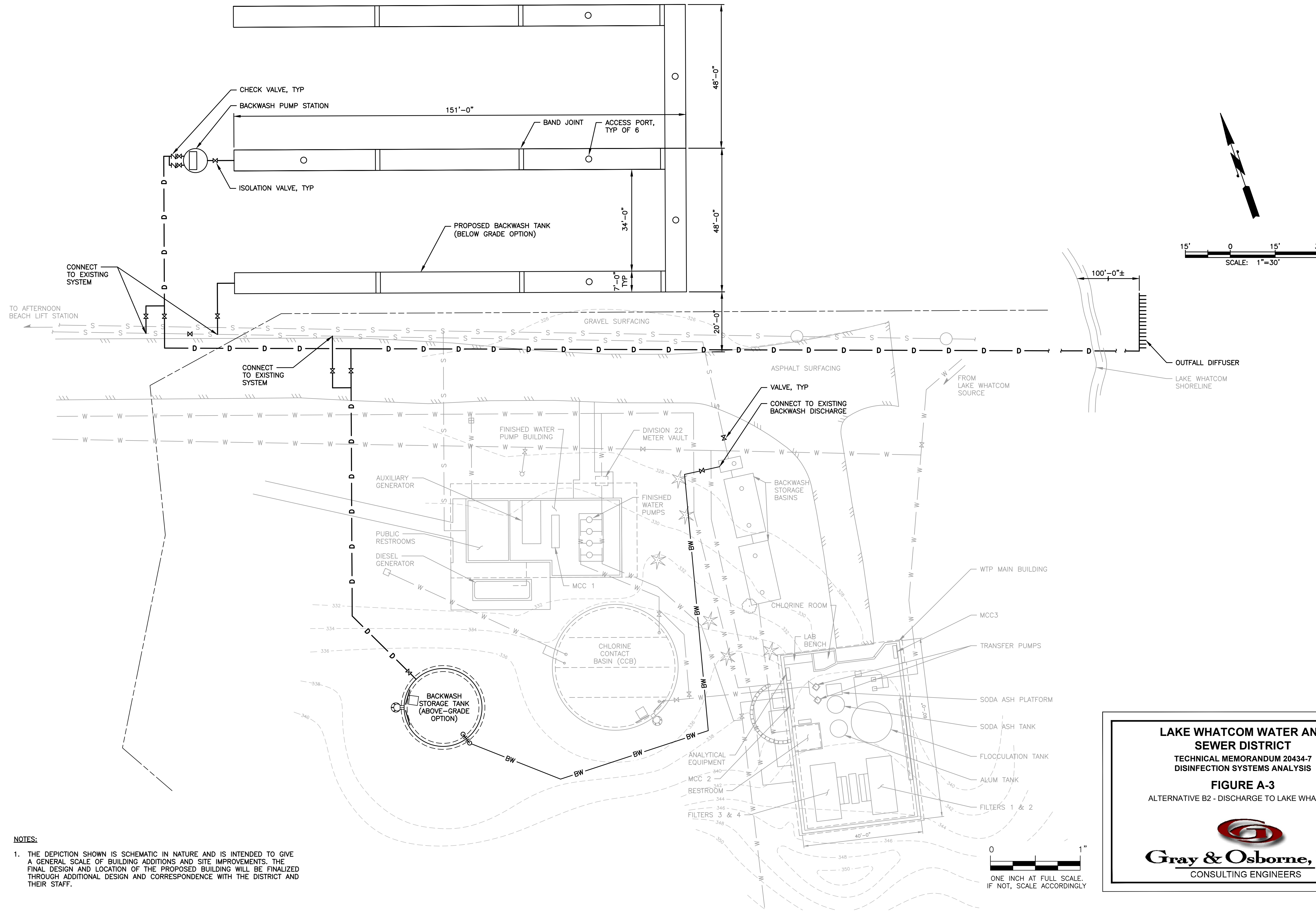
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-7
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-2

ALTERNATIVE D1 - DISCHARGE TO MUNICIPAL SEWER

Gray & Osborne, Inc.
CONSULTING ENGINEERS



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

0 1"

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

LAKE WHATCOM WATER AND SEWER DISTRICT

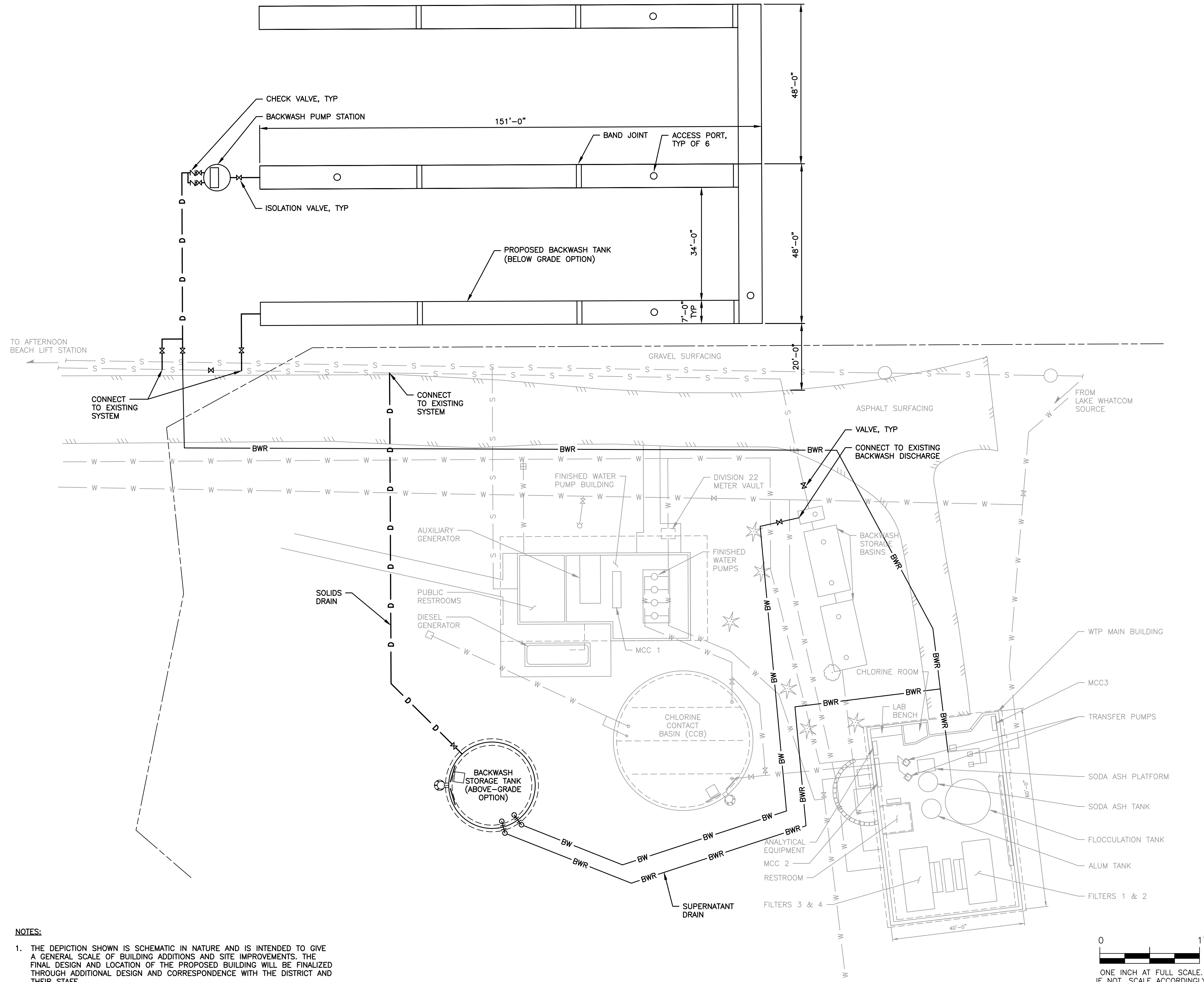
TECHNICAL MEMORANDUM 20434-7
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-3

ALTERNATIVE B2 - DISCHARGE TO LAKE WHATCOM

Gray & Osborne, Inc.
CONSULTING ENGINEERS

L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\Figures TM-7 2021-01-19\FIGURE A-3 ALT B2.dwg, 2/25/2021 9:07 AM, PHILIP MARSHALL



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-7
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-4

ALTERNATIVE B3 - BACKWASH RECYCLE

Gray & Osborne, Inc.
CONSULTING ENGINEERS

EXHIBIT B

RECOMMENDED ALTERNATIVE COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-7
Alternative B1 - Option A
Discharge to Municipal Sewer and Construction of New Below Grade Storage Tank
February 11, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 72,000	$ 72,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 40,000	$ 40,000
5	Stormwater Improvevments	1	LS	$ 15,000	$ 15,000
6	Site Piping & Appurtenances	1	LS	$ 50,000	$ 50,000
7	120,000 Gallon Storage Tank	1	LS	$ 350,000	$ 350,000
8	Duplex Pump Station	1	LS	$ 120,000	$ 120,000
9	Pump Replacement	1	LS	$ 80,000	$ 80,000
10	Electrical Modifications	1	LS	$ 75,000	$ 75,000
11	Telemetry / SCADA Modifications	1	LS	$ 50,000	$ 50,000

Subtotal*	**$ 877,000**
Contingency (25%)	$ 219,300
Subtotal	**$ 1,096,300**
Washington State Sales Tax (9.0%)**	$ 98,700
Subtotal	**$ 1,195,000**
Design and Project Administration (25.0%)***	$ 298,800
TOTAL CONSTRUCTION COST	**$ 1,494,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-7
Alternative B1 - Option B
Discharge to Municipal Sewer and Construction of New Above Grade Storage Tank
February 11, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 50,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 60,000	$ 60,000
5	Stormwater Improvevments	1	LS	$ 50,000	$ 50,000
6	Site Piping & Appurtenances	1	LS	$ 35,000	$ 35,000
7	120,000 Gallon Storage Tank	1	LS	$ 200,000	$ 200,000
8	Duplex Pump Station	1	LS	$ -	$ -
9	Pump Replacement	1	LS	$ 80,000	$ 80,000
10	Electrical Modifications	1	LS	$ 50,000	$ 50,000
11	Telemetry / SCADA Modifications	1	LS	$ 50,000	$ 50,000

Subtotal*	**$ 600,000**
Contingency (25%)	$ 150,000
Subtotal	**$ 750,000**
Washington State Sales Tax (9.0%)**	$ 67,500
Subtotal	**$ 817,500**
Design and Project Administration (25.0%)***	$ 204,400
TOTAL CONSTRUCTION COST	**$ 1,022,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-7
Alternative B2 - Option A
Discharge to Lake Whatcom and Construction of New Below Grade Storage Tank
February 11, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 103,000	$ 103,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 40,000	$ 40,000
5	Stormwater Improvevments	1	LS	$ 15,000	$ 15,000
6	Site Piping & Appurtenances	1	LS	$ 100,000	$ 100,000
7	193,000 Gallon Storage Tank	1	LS	$ 500,000	$ 500,000
8	Duplex Pump Station	1	LS	$ 120,000	$ 120,000
9	Pump Replacement	1	LS	$ 80,000	$ 80,000
10	Backwash Treatment and Monitoring	1	LS	$ 100,000	$ 100,000
11	Solids Handling	1	LS	$ 15,000	$ 15,000
12	Electrical Modifications	1	LS	$ 100,000	$ 100,000
13	Telemetry / SCADA Modifications	1	LS	$ 50,000	$ 50,000

Subtotal*	**$ 1,248,000**
Contingency (25%)	$ 312,000
Subtotal	**$ 1,560,000**
Washington State Sales Tax (9.0%)**	$ 140,400
Subtotal	**$ 1,700,400**
Design and Project Administration (25.0%)***	$ 425,100
TOTAL CONSTRUCTION COST	**$ 2,126,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-7
Alternative B2 - Option B
Discharge to Lake Whatcom and Construction of New Above Grade Storage Tank
February 11, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 88,000	$ 88,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 50,000	$ 50,000
5	Stormwater Improvevments	1	LS	$ 50,000	$ 50,000
6	Site Piping & Appurtenances	1	LS	$ 100,000	$ 100,000
7	211,000 Gallon Storage Tank	1	LS	$ 290,000	$ 290,000
8	Duplex Pump Station	1	LS	$ 120,000	$ 120,000
9	Pump Replacement	1	LS	$ 80,000	$ 80,000
10	Backwash Treatment and Monitoring	1	LS	$ 100,000	$ 100,000
11	Solids Handling	1	LS	$ 15,000	$ 15,000
12	Electrical Modifications	1	LS	$ 100,000	$ 100,000
13	Telemetry / SCADA Modifications	1	LS	$ 50,000	$ 50,000

Subtotal*	**$ 1,068,000**
Contingency (25%)	$ 267,000
Subtotal	**$ 1,335,000**
Washington State Sales Tax (9.0%)**	$ 120,200
Subtotal	**$ 1,455,200**
Design and Project Administration (25.0%)***	$ 363,800
TOTAL CONSTRUCTION COST	**$ 1,819,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-7
Alternative B3 - Option A
Backwash Recycling and Construction of New Below Grade Storage Tank
February 11, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 79,000	$ 79,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 10,000	$ 10,000
4	Site Improvements	1	LS	$ 40,000	$ 40,000
5	Stormwater Improvevments	1	LS	$ 15,000	$ 15,000
6	Site Piping & Appurtenances	1	LS	$ 55,000	$ 55,000
7	193,000 Gallon Storage Tank	1	LS	$ 500,000	$ 500,000
8	Duplex Pump Station	1	LS	$ 120,000	$ 120,000
9	Pump Replacement	1	LS	$ 80,000	$ 80,000
10	Backwash Treatment and Monitoring	1	LS	$ 30,000	$ 30,000
11	Solids Handling	1	LS	$ 15,000	$ 15,000
12	Electrical Modifications	1	LS	$ 100,000	$ 100,000
13	Telemetry / SCADA Modifications	1	LS	$ 50,000	$ 50,000

Subtotal*	**$ 1,109,000**
Contingency (25%)	$ 277,300
Subtotal	**$ 1,386,300**
Washington State Sales Tax (9.0%)**	$ 124,800
Subtotal	**$ 1,511,100**
Design and Project Administration (25.0%)***	$ 377,800
TOTAL CONSTRUCTION COST	**$ 1,889,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-7
Alternative B3 - Option B
Backwash Recycling and Construction of New Above Grade Storage Tank
February 11, 2021
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	63,000	$	63,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	10,000	$	10,000
4	Site Improvements	1	LS	$	50,000	$	50,000
5	Stormwater Improvevments	1	LS	$	50,000	$	50,000
6	Site Piping & Appurtenances	1	LS	$	45,000	$	45,000
7	211,000 Gallon Storage Tank	1	LS	$	290,000	$	290,000
8	Duplex Pump Station	1	LS	$	120,000	$	120,000
9	Pump Replacement	1	LS	$	80,000	$	80,000
10	Backwash Treatment and Monitoring	1	LS	$	30,000	$	30,000
11	Solids Handling	1	LS	$	15,000	$	15,000
12	Electrical Modifications	1	LS	$	100,000	$	100,000
13	Telemetry / SCADA Modifications	1	LS	$	50,000	$	50,000

Subtotal*	**$**	**918,000**
Contingency (25%)	$	229,500
Subtotal	**$**	**1,147,500**
Washington State Sales Tax (9.0%)**	$	103,300
Subtotal	**$**	**1,250,800**
Design and Project Administration (25.0%)***	$	312,700
TOTAL CONSTRUCTION COST	**$**	**1,564,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

EXHIBIT C

ECOLOGY WATER TREATMENT PLANT GENERAL PERMIT

Issuance Date: July 17, 2019
Effective Date: September 1, 2019
Expiration Date: August 31, 2024

WATER TREATMENT PLANT GENERAL PERMIT

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
WASTE DISCHARGE GENERAL PERMIT
for
Water Treatment Plants

State of Washington
Department of Ecology
Olympia, Washington 98504-7600

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington

and

The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1251 et seq.

Until this permit expires, is modified, or is revoked, Permittees that have properly obtained coverage under this permit are hereby authorized to discharge in accordance with the Special and General Conditions contained herein.

Heather R Bartlett

Heather R. Bartlett
Water Quality Program Manager
Washington State Department of Ecology

TABLE OF CONTENTS

Page

SUMMARY OF REQUIRED SUBMITTALS

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S-6.3.4	Discharge Monitoring Report (DMR) (a)	Monthly	October 15, 2019
S-6.3.1	Questionnaire: Excerpts from Operations, (a) Maintenance, and Planning Documents	Once	January 1, 2020 current Permittees
S-6.3.1	Questionnaire: Excerpts from Operations, (a) Maintenance, and Planning Documents	Once	Within 90 days of coverage for new Permittees
S-6.3.5	DMR with site-specific monitoring data (a)	Quarterly	April 15, 2021 for selected Permittees
S-6.3.6	Survey Regarding Discharge to Ground (a)	Once	February 15, 2022 for selected Permittees
G-2.6	Application for Renewal of Permit Coverage (a)	Once per permit cycle	March 1, 2024
S-6.2.1	Notification of Non-Compliance	As necessary	
S-4.2.1 S-6.2.2	Notification of Planned Bypass	As necessary	
S-6.2.3 G-4.7	Permit Application Supplement or Notification of Significant Change in Process or Discharge	As necessary	
S-6.3.2	Additional Monitoring Results	As necessary	
S-6.3.5	Telephone Notice of Turbidity Greater than 250 NTUs	As necessary	
G-2.7	Notification of Spills or Other Discharges	As necessary	
G-2.10	Other Information	As necessary	
G-4.2	Signature Authorization	As necessary	
G-4.11	Notice of Permit Transfer	As necessary	

Note: The first use of a defined term in the text appears in ***bold italics*** font.

Electronic submittal is required via the Permittee’s SecureAccess Washington account at https://secureaccess.wa.gov/ecy/wqwebportal/. More information is available at http://www.ecy.wa.gov/programs/wq/permits/paris/portal.html.

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SPECIAL CONDITIONS

S-1 PERMIT COVERAGE

S-1.1 Activities, Discharges, and Facilities that Require this Permit

This ***general permit*** covers all Water Treatment Plants (WTPs) that ***discharge*** backwash ***effluent*** to ***surface water*** and that meet all of the following criteria:

1. Produce potable water or non-potable industrial water (primary treatment/settled water) where the ***treatment*** and distribution of water is the primary function of the ***facility***.
2. Have an ***actual production rate*** equal to or greater than 35,000 gallons per day of treated product water (finished water), as determined on an average monthly basis. The Washington State Department of Ecology (Ecology) reserves the right to determine that ***permit*** coverage is needed for facilities with actual production rates less than 35,000 gallons per day in order to protect ***water quality***.
3. The wastewater discharge is from water treatment filtration processes (filter backwash, ***sedimentation***/pre-sedimentation basin washdown, sedimentation/clarification, or filter-to-***waste***).
4. The water treatment works are not part of a larger, permitted facility, such as a pulp and paper mill.

S-1.2 Discharges Authorized under this Permit

S-1.2.1 Process Wastewater

Beginning on the effective date of this permit, all WTP facilities covered under the *WTP General Permit* effective in September 2014, and that reapplied by March 1, 2019, are authorized to discharge filter backwash water associated with finished water production to ***surface waters of the State,*** subject to the limits identified in this permit. Other WTP facilities that later apply for and obtain coverage under this general permit, have the same authorization to discharge.

S-1.2.2 Non-Routine and Unanticipated Wastewater

Non-routine and unanticipated wastewater consists of process wastewater not identified in Special Condition S-1.2.1 (Process Wastewater), not routinely discharged, and not anticipated at the time of permit application, such as waters used to pressure-test storage tanks or fire water systems, or leaks from drinking water systems.

This permit authorizes non-routine and unanticipated discharges under the following conditions. The ***Permittee*** must characterize the non-routine wastewater for ***pollutants*** and examine the opportunities for reuse. Prior to discharging the non-routine wastewater, the Permittee must obtain approval from Ecology on a case-by-case basis.

Any discharges not specified in Special Condition S-1.2.1 (Process Wastewater) must be addressed in accordance with the terms and conditions of this section.

1. Beginning on the effective date of this permit, prior to any discharge of non-routine and unanticipated wastewater, the Permittee must contact Ecology and provide the following information at a minimum:
   (a) The proposed discharge location.
   (b) The nature of the ***activity*** that will generate the discharge.
   (c) Any alternatives to the discharge, such as reuse, storage, or recycling of the water.
   (d) The total volume of water it expects to discharge.
   (e) The results of the chemical analyses of the water.
   (f) The date of the proposed discharge.
   (g) The expected rate of discharge, in gallons per minute.

2. The Permittee must analyze the wastewater for all parameters with an ***effluent limit*** or ***benchmark*** in this permit as required by Special Condition S-5 (Monitoring Requirements) and must report the results as required by Special Condition S-6 (Reporting and Recordkeeping Requirements), along with any other parameter deemed necessary by Ecology, using the methods and ***quantitation levels*** specified by Ecology.
3. Depending on the nature and extent of pollutants in the wastewater and any opportunities for reuse, Ecology may:
   - Authorize the facility to discharge the wastewater.
   - Require the facility to ***treat*** the wastewater.
   - Require the facility to reuse the wastewater.

   All discharges must comply with the effluent limits established in Special Condition S-2 (Limits and Standards).
4. The discharge may not proceed until Ecology has reviewed the Permittee's request and has authorized the discharge by Administrative Order. Once approved, and if the proposed discharge is to a municipal storm drain, the Permittee must obtain prior approval from the ***municipality*** and notify it when it plans to discharge.

S-1.3 Covered Geographic Area

The geographic area covered by this general permit is the entire State of Washington.

S-1.4 Activities, Discharges, and Facilities that Do Not Require Permit Coverage

Discharges to surface water of wastewaters produced from ion exchange, reverse osmosis, or slow sand filtration water treatment processes do not require coverage under this permit and may require application for an ***individual permit***.

Discharges of wastewater from water treatment filtration processes to ***publicly-owned treatment works*** do not require coverage under this permit.

Discharges of wastewater from water treatment filtration processes to the land do not require coverage under this permit only if that discharged wastewater has no potential, during all weather conditions, to ***runoff*** or overflow into surface water. The operator of a facility that discharges such wastewater to the land must inform the appropriate Ecology Regional Office, identified in Special Condition S-6.2.1 (Notification of Non-Compliance) so that Ecology may determine whether that facility must apply for coverage under an individual State waste discharge permit to ensure that ***waters of the State*** (both underground and surface) are protected from degradation.

Ecology may require facilities that meet the requirements of Special Condition S-1.1 (Activities, Discharges, and Facilities that Require this Permit) but cannot meet the water quality requirements of Special Condition S-2.2 (Discharge Limits) to apply for an individual permit. Such facilities with coverage under this general permit will retain permit coverage until the effective date of the individual permit.

S-2 LIMITS AND STANDARDS

S-2.1 Benchmarks

Special Condition S-5.4 (Turbidity) identifies the ***benchmark*** for the ***turbidity*** of wastewater discharges (not a limit or standard) and explains the Permittee's associated responsibilities.

S-2.2 Discharge Limits

The Permittee must comply with effluent limits for ***settleable solids***, ***pH***, and ***total residual chlorine*** shown in the table below.

EFFLUENT LIMITS			
Parameter	**Effective Term**	**Average Monthly Discharge Limit (a)**	**Maximum Daily Discharge Limit (b)**
Settleable Solids	Sept 2019 – Aug 2024	0.1 mL/L	0.2 mL/L
Total Residual Chlorine	Sept 2019 – Aug 2024	Not applicable	0.07 mg/L
Parameter	**Effective Term**	**Daily Minimum**	**Daily Maximum**
pH (c)	Sept 2019 – Aug 2024	6.0 S.U.	9.0 S.U.

(a) The ***average monthly discharge limit*** is defined as the greatest average of ***daily discharges*** allowed for a calendar month, calculated as the sum of all the daily discharges measured during a calendar month divided by the number of daily discharges measured during that month. Where only one sample is measured in a month, its value may not exceed the ***monthly average***.

(b) The maximum daily ***discharge limit*** is defined as the greatest daily discharge allowed during a calendar day. Except for pH, if a parameter is measured more than once within a single calendar day, the daily discharge is the arithmetic average of the values from that single day.

(c) The averaging of pH values is not allowed.

S-2.3 Impaired Waterbodies and TMDL Requirements

The Permittee must comply with any applicable ***total maximum daily load*** (TMDL) determination that is completed and accepted by the U.S. Environmental Protection Agency (EPA) as of either the effective date of this permit or the effective date of facility coverage under this permit, whichever is later.

If the Permittee discharges pH, settleable solids, or total residual chlorine pollutants to a waterbody listed as impaired for any of those pollutants per the ***303(d) list*** approved by the U.S. EPA on July 22, 2016, the Permittee must monitor for the listed pollutant(s) unless it demonstrates that the listed pollutant(s) is not present in its discharge. The applicable listing of impairment is the listing that is final as of the effective date of this permit or the effective date of facility coverage under this permit, whichever is later.

1. A new facility may not cause or contribute to an exceedance of the listed pollutant(s).
2. An existing facility that has the potential to cause or contribute to impairment of a listed waterbody must demonstrate that its discharge will cause no increase in the pollutant(s) of concern, identify steps that it can take to reduce the discharge of those pollutant(s), and incrementally implement those steps. Ecology will either set the schedule for meeting this requirement with an administrative order or require an individual permit for the facility.

S-3 PLANNING REQUIREMENTS

S-3.1 Operations and Maintenance Manual

The Permittee must prepare an ***Operations*** and ***Maintenance*** (O&M) manual in accordance with WAC 246-290 Parts 2 and 5. The O&M manual must identify the main water treatment processes employed by the facility and document the procedures for operating and maintaining the wastewater treatment and discharge systems (e.g., the filter backwash systems). At a minimum the O&M manual must include:

1. Maintenance schedule and procedures for treatment and discharge systems.
2. Monitoring necessary to assure proper functioning of treatment and discharge systems.
3. Emergency shut down and containment procedures in the event of uncontrolled discharge due to plant maintenance activities, severe ***stormwater*** events, start-ups or shut-downs, or other causes.

The Permittee must update the O&M manual as necessary to reflect changes in the water treatment processes and procedures and must keep the manual on ***site*** (as an electronic or hard-copy document) and available for inspection by Ecology.

S-3.2 Solid Waste Control Plan

The Permittee must maintain a solid waste ***control*** plan. The plan must include, at a minimum, a description of the ***solid waste***, identification of the source of the solid waste, the generation rate of the solid waste, and identification of the disposal methods of the solid waste. The plan must comply with any applicable requirements of the jurisdictional health department and any local requirements for a solid waste permit. The Permittee must update the plan as necessary to reflect changes in solid waste handling and disposal and keep the plan on site (as an electronic or hard-copy document) and available for inspection by Ecology.

S-3.3 Stormwater Pollution Prevention Plan

Not every WTP needs a ***Stormwater Pollution Prevention Plan*** (SWPPP). However, Permittees that discharge "***stormwater associated with industrial activity***" (See definitions in Appendix B.) from their sites to surface water or to a separate stormwater sewer system must prepare a SWPPP. New facilities must complete or implement all ***Best Management Practices (BMPs)*** prior to producing the authorized discharge. Existing facilities must implement ***operational*** or ***source control BMPs*** within the first 6 months following the effective date of this permit and complete ***treatment BMPs***, if required, within the first year following the effective date of this permit.

1. The SWPPP must include the following:
   (a) Assessment and description of existing and potential pollutant sources.
   (b) Description of the operational BMPs.
   (c) Description of selected source-control BMPs.
   (d) When necessary, a description of the ***erosion*** and ***sediment*** control BMPs.
   (e) When necessary, a description of the treatment BMPs.
   (f) Implementation schedule.

2. The descriptions of BMPs must include the following:
   (a) ***Operational Source Control BMPs*:** Operational BMPs are common to all facilities and include at the minimum:
      i. *Responsible Party:* Identification by name or position the ***person*** responsible for stormwater management.
      ii. *Good Housekeeping:* Listing of ongoing maintenance and cleanup activities, as appropriate, of areas that may contribute pollutants to stormwater discharges.
      iii. *Preventive Maintenance:* Schedule for inspection and maintenance of the stormwater drainage and treatment systems (if any) and plant equipment and systems that could fail and result in contamination of stormwater.
   (b) ***Structural Source Control BMPs*:** Source control BMPs eliminate or minimize the exposure of stormwater to pollutants.
   (c) **Treatment BMPs:** Treatment BMPs reduce the amount of pollutants in stormwater and maintain compliance with water quality standards.
   (d) ***Erosion and Sediment Control BMPs*:** Erosion and sediment control BMPs prevent soil erosion. The SWPPP must identify the locations on site with the potential for soil erosion that could contaminate stormwater.

The Permittee must update the SWPPP as necessary to reflect changes in potential pollutant sources and BMPs and must keep the plan on site (as an electronic or hard-copy document) and available for inspection by Ecology.

S-3.4 Other Spill Contingency Plan

The Permittee must have, maintain, and implement a spill plan for preventing the accidental release of pollutants to State waters and for minimizing damages if such a spill occurs. At a minimum, the plan must include the following:

1. Documentation of the procedures the Permittee will employ for the prevention, containment, and control of spills or unplanned discharges of the following:
   (a) Oil and petroleum products.
   (b) Materials which, when spilled or otherwise released into the environment, are designated ***dangerous waste*** or extremely ***hazardous waste*** by the procedures set forth in WAC 173-303-070.
   (c) Other materials that may become pollutants or cause ***pollution*** upon reaching waters of the State, such as untreated hyper-chlorinated water.
2. A description of the reporting system that will alert responsible managers and legal authorities in the event of a spill.
3. A description of the preventive measures and facilities that prevent, contain, or treat spills (including an overall facility plot showing drainage patterns).
4. A list of all oil and chemicals used, processed, or stored at the facility that may be spilled into State waters.

For the purpose of meeting this requirement, plans and manuals, or portions thereof, required by 33 CFR 154; 40 CFR 109; 40 CFR 110; 40 CFR Part 112; the Federal Oil Pollution Act of 1990, Chapter 173-181; and contingency plans required by Chapter 173-303 WAC may be included by reference as long as they are available on site.

The Permittee must review the plan at least annually and update it as necessary. The reviewer must initial and date the plan and note any updates to the plan to keep it current. This plan must be kept on site (as an electronic or hard-copy document) and be available for inspection by Ecology.

S-4 OPERATIONAL REQUIREMENTS

S-4.1 Operation and Maintenance (O&M)

The Permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed to achieve compliance with this permit. Proper O&M includes adequate laboratory controls; any maintenance activities that will produce a wastewater discharge to or through the filter backwash wastewater treatment area (e.g., settling basin); all sampling procedures, notifications, and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems that the Permittee installs only when their operation is necessary to achieve compliance with this permit.

S-4.2 Operational Restrictions

S-4.2.1 Bypass Prohibition and Procedures

Fully effective operation of treatment systems is required at all times. Although this generally requires the use of all portions of an existing treatment system, in some cases maintenance necessary to ensure effective operation may require bypassing portions of a system. Where such a bypass will not cause an exceedance of effluent limits or water quality standards, the bypass may occur without notification to Ecology. However, where the Permittee undertakes a bypass for reasons other than ***essential maintenance***, or where a bypass would cause exceedance of an effluent limit or water quality standard, the Permittee may undertake a bypass only in accordance with the provisions of this section.

This permit prohibits all ***bypasses***, except (a) When the bypass is for essential maintenance, as authorized in Item 1, below, or (b) When Ecology has approved an anticipated bypass following the procedures in Item 2, below.

1. Bypass for Essential Maintenance without the Potential to Cause Violation of Permit Limits or Conditions

   This permit allows bypasses for essential maintenance of the treatment system when necessary to ensure effective operation of the system. The Permittee may bypass the treatment system for essential maintenance only if doing so does not cause a violation of an effluent limit. The Permittee is not required to notify Ecology when bypassing for essential maintenance. However, the Permittee must comply with the monitoring requirements specified in Special Condition S-5 (Monitoring Requirements).

2. Anticipated Bypasses for Non-Essential Maintenance

   This permit prohibits any anticipated bypass that is not approved through the following process. Ecology may approve an anticipated bypass under the conditions listed below.

   (a) If a bypass is for non-essential maintenance, the Permittee must notify Ecology, if possible, at least ten days before the planned date of bypass. The notice must contain:

   - A description of the bypass and the reason the bypass is necessary.
   - An analysis of all known alternatives which would eliminate, reduce, or mitigate the potential impacts from the proposed bypass.
   - A cost-effectiveness analysis of alternatives.
   - The minimum and maximum duration of bypass under each alternative.
   - A recommendation as to the preferred alternative for conducting the bypass.
   - The projected date of bypass initiation.
   - A statement of compliance with SEPA.
   - A request for modification of water quality standards as provided for in WAC 173-201A-410, if an exceedance of any water quality standard is anticipated.
   - Details of the steps taken or planned to reduce, eliminate, and prevent recurrence of the bypass.

(b) For probable construction bypasses, the Permittee must notify Ecology of the need to bypass as early in the planning process as possible. The Permittee must consider the analysis required above during the project planning and design process. The project-specific engineering report as well as the plans and specifications must include details of probable construction bypasses to the extent practical. In cases where the Permittee determines the probable need to bypass early, the Permittee must continue to analyze conditions up to and including the construction period in an effort to minimize or eliminate the bypass.

(c) Ecology will determine if the Permittee has met the conditions of Items (a) and (b) above and consider the following prior to issuing a determination letter, an administrative order, or a permit modification as appropriate for an anticipated bypass:

- If the Permittee planned and scheduled the bypass to minimize adverse effects on the public and the environment.
- If the bypass is unavoidable to prevent loss of life, personal injury, or ***severe property damage***.
- If feasible alternatives to the bypass exist, such as:
    - The use of auxiliary treatment facilities.
    - Retention of untreated wastes.
    - Stopping production.
    - Maintenance during normal periods of equipment downtime, but not if the Permittee should have installed adequate backup equipment in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance.
    - Transport of untreated wastes to another treatment facility.

S-4.2.2 Application of Chemicals

The addition of excessive quantities of treatment chemicals to the wastewater is prohibited. The use of treatment chemicals that will result in a water quality violation in the ***receiving water*** is prohibited.

Non-Pesticidal Use
Any addition of chemicals to treat the wastewater (discharge) must comply with manufacturers' recommendations and be administered only at a rate appropriate for treatment.

Pesticidal Use
Any addition of chemicals to treat the wastewater (discharge) must comply with the relevant Federal Insecticide, Fungicide, and Rodenticide Act label.

S-4.2.3 Solid Waste Management

The Permittee must handle and dispose of all solid waste in such a manner as to prevent its entry into waters of the State, either ***groundwater*** or surface water. The Permittee must follow its Solid Waste Control Plan, as described in Special Condition S-3.2 (Solid Waste Control Plan).

S-4.2.4 Spill Prevention and Control

The Permittee must prevent or control pollutant discharges from site runoff, spillage and leaks, sludge and waste disposal, and materials handling and storage. The Permittee must follow its SWPPP, as described in Special Condition S-3.3 (Stormwater Pollution Prevention Plan), and its Spill Prevention and Control Plan, as described in Special Condition S-3.4 (Other Spill Contingency Plan).

S-5 MONITORING REQUIREMENTS

S-5.1 Monitoring Objectives

Samples and measurements taken to meet the requirements of this permit shall be ***representative*** of the volume and nature of the monitored discharge or pollutant, including representative sampling of any unusual discharge or discharge condition, including bypasses, ***upsets***, and maintenance-related conditions affecting effluent quality. Monitoring must occur at intervals sufficiently frequent to yield data that reasonably characterize the nature of the monitored discharge or pollutant.

Ecology may require by administrative order monitoring of intake water, influent to treatment facilities, internal waste streams, and/or receiving waters to verify compliance with net ***discharge limits*** or removal requirements, to verify the maintenance of proper waste treatment or control practices, or to determine the effects of the discharge on the waters and sediments of the State.

S-5.2 Sampling Procedures

S-5.2.1 Event Criteria, Frequency, and Timing

Permittees must monitor the wastewater (discharge) in accordance with the testing schedule appropriate for their facilities, based on the ***design maximum production capacity*** of product water (drinking and industrial water) and the source of the raw source water (surface water or groundwater). For the purpose of determining whether the source of raw water is surface water or groundwater, Ecology will use the same classification method as the Washington State Department of Health (DoH), which additionally specifies a third source of raw water: "***groundwater under the direct influence of surface water***" (GWI). Ecology will consider GWI the same as surface water unless the DoH designates a specific source at a particular WTP as groundwater.

WTP facilities are divided into two monitoring groups as follows:

- **Group 1:** Facilities designed to produce less than 4 million gallons per day (gpd) ***or*** use only groundwater for their source water. Group 1 facilities must follow Testing Schedule A below.
- **Group 2:** Facilities designed to produce 4 million gallons per day or more ***and*** treat surface water or GWI. Group 2 facilities must follow Testing Schedule B below.

	< 4 Million gpd	≥ 4 Million gpd
Surface Water / GWI	Group 1	Group 2
Groundwater	Group 1	Group 1

Testing Schedule A: Monitoring Methods and Frequency for Group 1 WTP Facilities

Parameter	Analytical Method (Accuracy)	Detection Limit (a)	Quantitation Level (b)	Sampling Frequency	Sample Type
Settleable Solids	SM 2540 F – Imhoff Cone (±0.1 mL/L or ±1.0%)	0.1 mL/L	0.1 mL/L	Monthly	Grab
pH	SM 4500-H^+ B – Meter (±0.02 standard units)	NA	NA	Monthly	Grab
Total Residual Chlorine	SM 4500 Cl G – Photometer (±0.01 mg/L)	0.01 mg/L	0.02 mg/L	Monthly	Grab
Turbidity	EPA 180.1 – Nephelometric (±0.5 NTU ±1.0%)	0.1 NTU	0.5 NTU	Monthly	Grab
Chloride (c)	SM 4500 B/C/D/E – Titration (±1 mg/L)	0.2 mg/L	1.0 mg/L	Quarterly 2021 Only	Grab
Total Dissolved Solids (c)	SM 2540 C – Gravimetric (±10 mg/L)	10 mg/L	20 mg/L	Quarterly 2021 Only	Grab
Total Iron (c)	EPA 200.7 – ICP/MS (±50 ug/L)	12 ug/L	50 ug/L	Quarterly 2021 Only	Grab
Dissolved Iron (c)	EPA 200.7 – ICP/MS (±50 ug/L)	12 ug/L	50 ug/L	Quarterly 2021 Only	Grab
Total Manganese (c)	EPA 200.8 – ICP/MS (+0.5 ug/L)	0.1 ug/L	0.5 ug/L	Quarterly 2021 Only	Grab
Dissolved Manganese (c)	EPA 200.8 – ICP/MS (+0.5 ug/L)	0.1 ug/L	0.5 ug/L	Quarterly 2021 Only	Grab
Total Daily Volume of Discharge	Meter or Estimate (±30 gallons)	10 gallons per event	10 gallons per event	Daily	NA
Total Daily Number of Discharge Events	Count	Count	Count	Daily	NA

Testing Schedule B: Monitoring Methods and Frequency for Group 2 WTP Facilities

Parameter	Analytical Method (Accuracy)	Detection Limit (a)	Quantitation Level (b)	Sampling Frequency	Sample Type
Settleable Solids	SM 2540 F – Imhoff Cone (±0.1 mL/L or ±1.0%)	0.1 mL/L	0.1 mL/L	Weekly	Grab
pH	SM 4500-H^+ B – Meter (±0.02 standard units)	NA	NA	Weekly	Grab
Total Residual Chlorine	SM 4500 Cl G – Photometer (±0.01 mg/L)	0.01 mg/L	0.02 mg/L	Weekly	Grab
Turbidity	EPA 180.1 – Nephelometric (±0.5 NTU ±1.0%)	0.1 NTU	0.5 NTU	Weekly	Grab

Testing Schedule B: Monitoring Methods and Frequency for Group 2 WTP Facilities

Parameter	Analytical Method (Accuracy)	Detection Limit (a)	Quantitation Level (b)	Sampling Frequency	Sample Type
Chloride (c)	SM 4500 B/C/D/E – Titration (±1 mg/L)	0.2 mg/L	1.0 mg/L	Quarterly 2021 Only	Grab
Total Dissolved Solids (c)	SM 2540 C – Gravimetric (±10 mg/L)	10 mg/L	20 mg/L	Quarterly 2021 Only	Grab
Total Iron (c)	EPA 200.7 – ICP/MS (±50 ug/L)	12 ug/L	50 ug/L	Quarterly 2021 Only	Grab
Dissolved Iron (c)	EPA 200.7 – ICP/MS (±50 ug/L)	12 ug/L	50 ug/L	Quarterly 2021 Only	Grab
Total Manganese (c)	EPA 200.8 – ICP/MS (+0.5 ug/L)	0.1 ug/L	0.5 ug/L	Quarterly 2021 Only	Grab
Dissolved Manganese (c)	EPA 200.8 – ICP/MS (+0.5 ug/L)	0.1 ug/L	0.5 ug/L	Quarterly 2021 Only	Grab
Total Daily Volume of Discharge	Meter or Estimate (±30 gallons)	10 gallons per event	10 gallons per event	Daily	NA
Total Daily Number of Discharge Events	Count	Count	Count	Daily	NA

Analytical methods are from "Guidelines Establishing Test Procedures for the Analysis of Pollutants," 40 CFR Part 136, Revised August 2017.

(a) **Detection Limit** (also known as ***method detection limit*** or MDL):
The minimum concentration of an analyte that can be measured and reported with a 99% confidence that the analyte concentration is greater than zero as determined by the procedure given in 40 CFR Part 136, Appendix B.

(b) **Quantitation Level** (also known as minimum level of quantitation, practical quantitation limit, or PQL):
(1) The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the laboratory has used all method-specified sample weights, volumes, and clean-up procedures. The quantitation level is calculated by multiplying the method detection limit by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10^n, where n is an integer. (64 FR 30417)
(2) The smallest detectable concentration of an analyte greater than the method detection limit where the accuracy (precision & bias) achieves the objectives of the intended purpose. (*Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in **Clean Water Act** Programs*, Submitted to the U.S. EPA December 2007.)

(c) Only those Permittees required to complete the Survey regarding discharge to ground, in accordance with Special Condition S-6.3.6, must analyze wastewater for this parameter.

GWI = Groundwater under the direct influence of surface water.
gpd = Gallons per day.
mg/L = Milligrams per liter.
ug/L = Micrograms per liter.
mL/L = Milliliters per liter.
NA = Not applicable.
NTU = Nephelometric turbidity unit.

The first monitoring period begins on the effective date of this permit.

Monitoring for chloride, total dissolved solids, total and dissolved iron, and total and dissolved manganese (secondary pollutants) is required only four times during the calendar year 2021, i.e., once each quarter: Jan-Mar, Apr-June, July-Sept, and Oct-Dec. Permittees must collect and analyze two samples each quarter for the six secondary pollutants. One of the samples must be from the same monitoring point as normally monitored, which is the ***outfall*** where treated filter backwash wastewater discharges to surface water. The other sample must be ***untreated*** filter backwash wastewater from a location between its creation at the filtration system where backwashing occurs and its entry into the treatment area, e.g., settling basin. Condition S-5.2.3 contains a schematic illustration of the sampling locations.

Based on the results of secondary ***contaminant*** monitoring, Ecology may modify this or a future permit by adding monitoring requirements for some or all of the secondary pollutants. Additionally, Ecology may change the activities, discharges, and facilities that require coverage under this permit, or may require certain Permittees to apply for an individual permit.

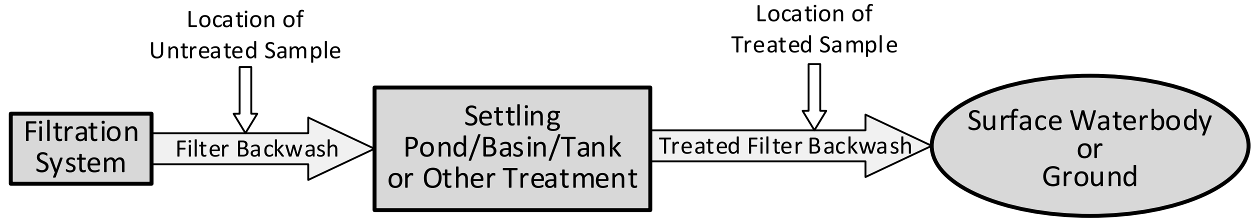
S-5.2.2 Field Documentation

For each measurement or sample taken, the Permittee must record the following information:

1. The date, exact place, method, and time of sampling or measurement.
2. The individual who performed the sampling or measurement.
3. The dates the analyses were performed.
4. The individual who performed the analyses.
5. The analytical techniques or methods used.
6. The results of all measurements and analyses.

S-5.2.3 Location

The Permittee must conduct all monitoring of treated filter backwash wastewater as close to the point of discharge to surface water (end of pipe) as is reasonably possible. The location for special purpose sampling of ***untreated*** filter backwash wastewater should be downstream of and as close as is reasonably possible to the filtering system undergoing backwash (at or prior to its entry into the treatment area as described in Section S-5.2.1). The illustration below provides a conceptual model of the wastewater handling system and shows where sampling for secondary pollutants in untreated wastewater is to occur.



S-5.2.4 Sampling Methods

Sampling methods used to meet the monitoring requirements specified in this permit must conform to the latest revision of the "Guidelines Establishing Test Procedures for the Analysis of Pollutants" contained in 40 CFR Part 136, (or as applicable in 40 CFR subchapters N [Parts 400-471] or O [Parts 501-503]) unless otherwise specified in this permit. Ecology may specify alternative methods only for parameters without limits or without a U.S. EPA-approved test method in 40 CFR Part 136. Sampling must yield samples representative of the wastewater discharged by the Permittee.

S-5.3 Analytical Procedures

S-5.3.1 Laboratory Accreditation

All monitoring data required by Ecology must be prepared by a laboratory registered or accredited under the provisions of Chapter 173-50 WAC, "Accreditation of Environmental Laboratories." Flow, temperature, settleable solids, specific conductance, pH, turbidity, and internal process control parameters are exempt from this requirement, except that specific conductance, pH, and turbidity must be accredited if the laboratory must otherwise be registered or accredited. An accredited laboratory must provide all ***chlorine*** and secondary pollutant data.

S-5.3.2 Laboratory Documentation

All laboratory reports providing monitoring data must include the following information: sampling date, sample location, date of analysis, parameter name, CAS number, analytical method/number, ***method detection limit*** (MDL), laboratory reporting limit or practical quantitation level (PQL), reporting units, and concentration detected. Analytical results from samples sent to a contract laboratory must also include information on the chain of custody, QA/QC results, and documentation of accreditation for each parameter.

S-5.3.3 Laboratory Methods

The Permittee must analyze all wastewater samples for the parameters and using the methods, MDLs, and PQLs specified in Special Conditions S-5.2.1 (Event Criteria, Frequency, and Timing) and S-5.2.4 (Sampling Methods) unless:

- Another permit condition specifies other methods, MDLs, or PQLs; ***or***
- The method used produces measureable results in the sample, and the U.S. EPA has listed it as an EPA-approved method in 40 CFR Part 136.

The analyses must also include any other parameter deemed necessary by Ecology. If the Permittee uses an alternative method, not specified in the permit and allowed as above, it must report the test method, MDL, and PQL on the ***discharge monitoring report (DMR)*** or other required report. If the Permittee is unable to obtain the required MDL or PQL in its effluent due to matrix effects, the Permittee must submit a matrix-specific MDL and PQL to Ecology along with appropriate laboratory documentation.

S-5.4 Turbidity

The benchmark for turbidity in discharges of treated wastewater from backwashing of water treatment filtration systems is 25 Nephelometric turbidity units (NTUs).

If during scheduled monitoring of treated backwash effluent, the Permittee finds the turbidity to exceed 25 NTU, the Permittee must take either of the following ***actions*** as appropriate.

- If the measured turbidity was in the range of 26 to 250 NTUs, the Permittee must review facility operations, determine the likely cause of the benchmark exceedance, modify operations to prevent a reoccurrence of the exceedance, update the relevant planning document(s) as needed, and preserve documentation of the exceedance and corrective action within 10 ***calendar days*** of the date the discharge exceeded the benchmark.
- If the measured turbidity exceeded 250 NTUs, the Permittee must:
    1) First, immediately take action to stop, contain, and clean up the unauthorized discharge, and minimize any adverse impacts to waters of the State.
    2) Second, telephone a report of the incident to the appropriate Ecology Region Emergency Response Tracking System (ERTS) and the regional permit administrator. Contact information is provided in Special Condition S-6.2.1.
    3) Third, review facility operations, determine the likely cause of the benchmark exceedance, modify operations to prevent a reoccurrence of the exceedance, update the relevant planning document(s) as needed, and preserve documentation of the exceedance and corrective action within 10 calendar days of the date the discharge exceeded the benchmark.

S-5.5 Supporting Documentation

The Permittee must maintain supporting documentation for all field and laboratory measurements and any calculations used to determine the total daily volume of discharges and total daily number of discharge events.

S-6 REPORTING AND RECORDKEEPING REQUIREMENTS

S-6.1 Permit-Required Submittals

Unless otherwise specified in this permit, the Permittee must use the on-line "Water Quality Permitting Portal" at http://www.ecy.wa.gov/programs/wq/permits/paris/portal.html to submit all permit-required reports by the specified due dates. Where another condition of this permit requires submission of hardcopy paper documentation, the Permittee must ensure that the submission is postmarked or received by Ecology no later than the specified due date. The Permittee must submit hardcopy paper documentation to the water quality permit coordinator at the appropriate address provided in Special Condition S-6.2.1 (Notification of Non-Compliance).

S-6.2 Notification Requirements

S-6.2.1 Notification of Non-Compliance

In the event that the Permittee fails to comply with any of the terms and conditions of this permit, or in the event of a spill or other discharge not authorized by this permit, such that the resulting non-compliance may threaten human health or the environment, the Permittee must:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges and otherwise stop the non-compliance, correct the problem, and minimize any adverse impacts to waters of the State.
2. Immediately notify Ecology of a spill by calling the appropriate regional Emergency Response Tracking System (ERTS) phone number and the regional permit administrator. The phone numbers are provided below:

Ecology Central Regional Office Water Quality Program 1250 West Alder Street Union Gap, WA 98903-0009 509-575-2490 TDY: 711 or 1-800-833-6341	**Counties** Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, and Yakima
Ecology Eastern Regional Office Water Quality Program 4601 North Monroe Spokane, WA 99205-1295 509-329-3400 TDY: 711 or 1-800-833-6341	**Counties** Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, and Whitman
Ecology Northwest Regional Office Water Quality Program 3190 - 160th Avenue SE Bellevue, WA 98008-5452 (425) 649-7000 TDY: 711 or 1-800-833-6341	**Counties** Island, King, Kitsap, San Juan, Skagit, Snohomish, and Whatcom
Ecology Southwest Regional Office Water Quality Program 300 Desmond Drive SE Lacey, WA 98503 360-407-6300 TDY: 711 or 1-800-833-6341	**Counties** Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Lewis, Mason, Pacific, Pierce, Skamania, Thurston, and Wahkiakum

3. Notify the Ecology regional permit administrator of any other non-compliance, including any unanticipated bypass and/or upset that exceeds any effluent limit in the permit, orally within 24 hours from the time the Permittee becomes aware of the non-compliance.
4. If applicable, repeat the sampling and analysis that identified the non-compliance, and submit the results to Ecology within 5 days of becoming aware of the non-compliance.

5. Submit a detailed written report to Ecology at the appropriate address provided in Step 2 above within 5 days of the time the Permittee becomes aware of the non-compliance. The report must include all of the following information, at a minimum:
   (a) A description of the nature and cause of the non-compliance, including the quantity and quality of any unauthorized discharges.
   (b) The period of non-compliance, including the beginning and ending dates and times of the non-compliance, or if the Permittee has not yet corrected the non-compliance, the anticipated date and time when the Permittee will return to compliance.
   (c) The results of any additional sampling and analyses.
   (d) A description of the corrective action taken or planned by the Permittee.
   (e) Steps the Permittee has taken or plans to take to reduce, eliminate, and prevent a recurrence of the non-compliance.
   (f) Any other pertinent information.
6. Ecology may temporarily waive the written report required in Step 5, above, on a case-by-case basis upon written request if it has received a timely oral report, but in no case for more than 30 days after the Permittee becomes aware of the non-compliance.

Reportable failures of compliance include, but are not limited to:

1. Any bypass that exceeds any effluent limit in this permit.
2. Any upset that exceeds any effluent limit in this permit.
3. Any exceedance of a maximum ***daily discharge limit*** for any of the pollutants listed in Special Condition S-2 (Limits and Standards).

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with any of the terms and conditions of this permit or from any resulting liability for failure to comply.

S-6.2.2 Notification of an Anticipated Bypass

The requirements for notifying Ecology of an intended bypass are identified in Special Condition S-4.2.1 (Bypass Prohibition and Procedures).

S-6.2.3 Notification of a Change in Covered Activities

The Permittee must report to Ecology any facility expansion, production increase, or significant process modification that may cause a new or increased discharge of pollutants that may cause either an exceedance of an effluent limit or a discharge beyond that reported in the original ***application for coverage***. This report must be in the form of a new application or a supplement to the original application.

Significant process changes include a ***substantially*** increased discharge of pollutants or a change in the nature of the discharge of pollutants, including:

- A wastewater discharge increase of 25% more than the previous permit covered;

- A new source of raw water that requires different treatment processes, consequently altering the characteristics of the discharged wastewater; or
- A change or addition of treatment to remove a substance not previously removed, consequently altering the characteristics of the discharged wastewater.

S-6.3 Required Reports

S-6.3.1 Questionnaire: Excerpts from Operations, Maintenance, and Planning Documents

At least once during every 5-year permit term, the Permittee must provide to Ecology certain information from its Operations and Maintenance Manual, Solid Waste Control Plan, Stormwater Pollution Prevention Plan, and any other spill contingency plan. The Permittee must provide this information by (a) 90 days after its coverage under this permit begins, or (b) January 1, 2020, whichever is later; and whenever that information changes due to updates of any of these plans. Appendix C contains a blank "Questionnaire" for the required information. An electronic version of the Questionnaire is available on the Ecology Water Treatment Plant website, (https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Water-treatment-plants).

If the Permittee wishes, rather than completing the entire Questionnaire, they may provide:

- Electronic versions of the entirety of some or all of its operations, maintenance, and planning documents, ***and***
- Simplified responses in the Questionnaire, itself. These simplified responses must include the specific page, table, or figure numbers in the submitted document(s) where Ecology can readily find the requested detailed information.

S-6.3.2 Additional Monitoring by Permittee

If the Permittee monitors any pollutant more frequently than required by Special Condition S-5 (Monitoring Requirements) of this permit, then the Permittee must include the results of such monitoring in the calculation and reporting of the data submitted in the Permittee's discharge monitoring report.

S-6.3.3 Bypasses

The Permittee must report bypasses to Ecology as described in Special Condition S-4.2.1 (Bypass Prohibition and Procedures).

S-6.3.4 Discharge Monitoring Report (DMR)

The Permittee must submit a DMR each calendar month, whether or not a discharge occurred. If the facility did not discharge during a given monitoring period, the Permittee must submit a completed DMR with "No Discharge" entered as the DMR Reporting Code. Submission of DMRs must be completed by no later than the 15th day of the month following the completed monitoring period.

Permittees must sign up for and submit monitoring data through the Ecology WebDMR program via the Permittee's SecureAccess Washington account, which is accessible at https://secureaccess.wa.gov/ecy/wqwebportal/. More information is available at the "Water Quality Permitting Portal" at http://www.ecy.wa.gov/programs/wq/permits/paris/portal.html and at "About WQWebDMR" at http://www.ecy.wa.gov/programs/wq/permits/paris/webdmr.html.

Permittees unable to submit electronically (e.g., those who do not have an Internet connection) must contact the Ecology Water Treatment Plant permit administrator at the locations provided in Special Condition S-6.2.1 (Notification of Non-Compliance) to request a waiver and obtain instructions on how to obtain a hardcopy paper DMR. Permittees with waivers must submit hardcopy paper DMRs to be received by Ecology no later than the 15th day of the month following the completed monitoring period.

All DMRs must contain the following information:

1. Include data for each of the parameters for which monitoring is required by Special Condition S-5 (Monitoring Requirements) and as required by the DMR entry screen or hardcopy paper form. Report a value for each day sampling occurred and for the monthly values.
2. If the Permittee did not discharge wastewater during a given monitoring period, enter the "No Discharge" reporting code.
3. Record onto the DMR those analytical values reported as "less than the detection limit" by entering "<" followed by the numeric value of the ***detection limit*** (e.g., < 2.0). If the method used did not achieve the detection limit or quantitation level identified in Special Condition S-5.2.1 (Event Criteria, Frequency, and Timing), report the actual detection limit and quantitation level in the DMR comments section or other location provided.
4. Report the analytical test method actually used in the DMR comments section or other location provided if the laboratory used an alternate method not specified in the permit and as allowed in Special Condition S-5.2.1 (Event Criteria, Frequency, and Timing).
5. Calculate average and total values (unless otherwise specified in the permit) using:
   (a) For all quantitative results measured at levels equal to or greater than the agency-required detection limit value: The reported numeric value.
   (b) For results reported at less than the detection limit numerically (e.g., <0.01 mg/L or not detected ***with*** a specified detection limit value): One-half the reported detection limit value.
   (c) For results reported as less than the detection limit non-numerically (e.g., ND or not detected) and ***without*** a specified detection limit value,
      i. If the same parameter was detected in another sample from the same monitoring point for the reporting period: One-half the detection limit value reported for the other sample.
      ii. If the same parameter was not detected in another sample from the same monitoring point for the reporting period: Zero.
6. Submit an electronic copy of the laboratory report as an attachment using the link for "About WQWebDMR" or as a paper copy along with the hardcopy paper DMR form. Laboratory reports must include a record of the chain of custody, QA/QC results, and documentation of accreditation for each parameter.

S-6.3.5 Exceedance of Turbidity Benchmark

Whenever monitoring that has been performed in accordance with Special Condition S-5 finds that the effluent turbidity exceeded 250 NTUs, the Permittee must telephone a report of the incident to the appropriate Ecology Region Emergency Response Tracking System (ERTS) and the regional permit administrator. Their contact information is provided in Condition S-6.2.1. Special Condition S-5.4 identifies additional requirements for documentation.

S-6.3.6 Survey Regarding Discharge to Ground

Shortly after Ecology receives the Permittee's Notice of Intent (NOI) and its responses to the planning documents questionnaire (see Special Condition S-6.3.1), Ecology will inform the Permittee whether it must complete and submit a survey regarding discharges to ground (Survey). Some of the requested information includes as-built engineering drawings of the filter backwash wastewater settling tanks and constructed settling, storage, and infiltration basins and ponds (Question 4). Appendix D lists the questions in the Survey, and the Ecology Water Treatment Plant website, (https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Water-treatment-plants), will provide guidance for completing the Survey. Survey participants must submit the entire completed Survey to Ecology no later than February 15, 2022.

S-6.4 Record Retention

The Permittee must retain records of all monitoring information resulting from any monitoring activity required as a condition of the application for or as a condition of coverage under this permit for a minimum of 5 years following the specified expiration date of this permit. Such information must include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. The Permittee must extend this period of retention during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

The Permittee must keep a copy of this permit (electronic or paper) at the facility and make it available upon request to Ecology inspectors.

S-7 PERMIT ADMINISTRATION

S-7.1 Application for Coverage

S-7.1.1 Who May Apply for Coverage

New facilities, or facilities currently operating without permit coverage, that qualify under Special Condition S-1 (Permit Coverage) must apply for coverage under this general permit.

S-7.1.2 How to Obtain Coverage

An applicant must submit to Ecology a completed and signed application for coverage (an electronic notice of intent, or eNOI), specifically prescribed by Ecology for this general permit, available for example via the Ecology webpage: https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Water-treatment-plants. All such applications for coverage must be submitted within 180 days prior to commencement of the activity which may result in the discharge of any pollutant to waters of the State.

All applications for coverage under this permit must:

1. Contain sufficient information necessary for adequate program implementation;
2. Contain the legal name and address of the owner or operator, the facility name and address, type of facility and discharges, and the receiving waterbodies;
3. Bear a certification of correctness;
4. Be signed by a responsible person, as identified in General Condition G-4.2 (Certification and Signature Requirements); ***and***
5. Include any other information that Ecology deems relevant.

S-7.1.3 Public Notice

All new applicants for this permit and any existing Permittee that plans a significant process change, as described in Special Condition S-6.2.3 (Notification of a Change in Covered Activities), must cause notice to be circulated within the geographical area of the proposed discharge and certify this fact to Ecology. Such notice must:

1. Be published twice, with at least a 1-week interval between, in the newspaper of greatest general circulation within the county in which the discharge is proposed to occur;
2. Be circulated by any other method as Ecology may direct; ***and***
3. Contain, at a minimum, the following:
   (a) The name, address, and location of the facility requesting coverage under this permit;
   (b) The applicant's activities or operations that result in a discharge;
   (c) The name of the general permit under which coverage is requested; ***and***
   (d) The following statement: “Any person desiring to present their views to Ecology regarding this application may do so in writing, within 30 days of the last date of publication of this notice. Comments should be submitted to Ecology. Any person interested in Ecology's action on this application may notify Ecology of their interest within 30 days of the last date of publication of this notice.”

S-7.1.4 Proof of Compliance with SEPA

All new applicants must submit to Ecology, along with an application for coverage, proof and certification that their facility has met all applicable requirements of the ***State Environmental Policy Act*** (SEPA) under Chapter 197-11 WAC.

GENERAL CONDITIONS

G-1 OPERATION AND MAINTENANCE

G-1.1 Activities and Discharges Authorized by this Permit

All activities and discharges authorized by this permit must be consistent with the terms and conditions of this permit. The Permittee is at all times responsible for continuous compliance with the terms and conditions of this permit. The discharge of any pollutant more frequently than or at a concentration or amount in excess of that authorized by this permit constitutes a violation of the terms and conditions of this permit.

G-1.2 Discharges from Activities Not Covered by this Permit

The discharge of pollutants resulting from activities not covered under this permit for which the ***discharger*** has requested coverage is a violation of this permit.

G-1.3 Maintaining Compliance if Treatment System Fails

The Permittee, in order to maintain compliance with this permit, must control production and all discharges such that, in the event of reduction, loss, failure, or bypass of any portion of the treatment system, the Permittee maintains compliance with this permit until the treatment system is fully restored or an alternate method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power of the treatment system is reduced, lost, or fails.

G-1.4 Removed Substances

The Permittee must not allow collected screenings, grit, solids, sludges, or other pollutants removed in the course of treatment or control of the wastewater and/or stormwater covered by this permit to be resuspended or reintroduced to the storm sewer system or to waters of the State.

G-1.5 Upset

An upset is an exceptional incident in which an unintentional and temporary non-compliance with ***technology-based permit effluent limits*** occurs due to factors beyond the reasonable control of the Permittee. An upset does not include non-compliance to the extent caused by operational error, improperly designed treatment facilities, inadequate storage or treatment facilities, lack of preventive maintenance, or careless or improper operation.

An upset constitutes an affirmative defense to an action brought for non-compliance with such technology-based permit effluent limits if the requirements of this paragraph are met. No determination made during administrative review of claims that non-compliance was caused by upset, and before an action for non-compliance, is a final administrative action, subject to judicial review. A Permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed contemporaneous operating logs or other relevant evidence, that:

1. An upset occurred, and that the Permittee can identify the cause(s) of the upset;

2. The permitted facility was being properly operated at the time of the upset;
3. The Permittee submitted notice of the upset as required in Special Condition S-6 (Reporting and Recordkeeping Requirements) of this permit; ***and***
4. The Permittee complied with any remedial measures required under this permit.

In any enforcement proceeding, the Permittee seeking to establish the occurrence of an upset has the burden of proof.

G-2 OTHER DUTIES AND RESPONSIBILITIES

G-2.1 Additional Monitoring Requirements

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G-2.2 Compliance with Other Laws and Regulations

Nothing in this permit excuses the Permittee from any requirement for compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

The Permittee must comply with effluent standards and prohibitions for ***toxic*** pollutants established under Section 307(a) of the ***Clean Water Act***, the Resource Conservation and Recovery Act (Public Law 95.190), the Hazardous Waste Management Act (Chapter 70.105 RCW), the Solid Waste Management–Reduction and Recycling Act (Chapter 70.95 RCW), and all other applicable requirements of 40 CFR 122.41 and 122.42 within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G-2.3 Duty to Comply with this Permit

The Permittee must comply with all Conditions of this permit. Any permit non-compliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; permit termination, revocation and reissuance, or modification; or denial of an application for renewal of coverage.

G-2.4 Duty to Mitigate

The Permittee must take all reasonable steps to minimize or prevent any discharge, use, or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

G-2.5 Duty to Provide Information

The Permittee must provide to Ecology, within a reasonable time, all information that Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also provide to Ecology, upon request, copies of records required to be kept by this permit.

G-2.6 Duty to Reapply

If the Permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the Permittee must reapply for coverage under this permit (or under an individual permit) at least 180 days prior to the specified expiration date of this permit. An expired general permit and coverage under the general permit continue in force and effect until Ecology issues a new general permit (or a new individual permit) or until Ecology cancels the general permit. Coverage under this permit continues for only those Permittees who reapply for coverage in a timely manner.

G-2.7 Notification of Spills and Other Discharges

If the Permittee has knowledge of a discharge or spill that could constitute a threat to human health, welfare, or the environment, the Permittee must:

1. Take appropriate action to correct or minimize the threat to human health, welfare, and the environment.
2. Notify the Ecology regional office and other appropriate spill response authorities immediately, but in no case later than within 24 hours of obtaining that knowledge.
3. Immediately report spills or other discharges which might cause bacterial contamination of marine waters to the Ecology regional office and to the Department of Health, Shellfish Program.
4. Immediately report spills or discharges of oils or hazardous substances to the Ecology regional office and to the Washington Emergency Management Division.

The relevant 24-hour phone numbers are:

- Department of Ecology Northwest Regional Office (425) 649-7000
- Department of Ecology Southwest Regional Office (360) 407-6300
- Department of Ecology Central Regional Office (509) 575-2490
- Department of Ecology Eastern Regional Office (509) 329-3400
- Washington Emergency Management Division (800) 258-5990
- Department of Health Shellfish Program (360) 789-8962

G-2.8 Plan Review Required

Prior to constructing or modifying any wastewater control facilities, the Permittee must provide all engineering reports and detailed plans and specifications to Ecology for approval in accordance with Chapter 173-240 WAC. Submission of engineering reports, plans, and specifications must occur in accordance with a ***compliance schedule*** issued by Ecology or at least 30 days before the time approval is desired. Construction and operation of the facilities must occur in accordance with the approved plans.

G-2.9 Prohibited Discharges

Discharge of pollutants by the Permittee to waters of the State are prohibited except as authorized through coverage under this permit.

This permit does not authorize any person to discharge any of the following:

1. Any radiological, chemical, or biological warfare agent or high-level radioactive waste into waters of the State.
2. Any pollutants that the Secretary of the Army acting through the Chief, Corps of Engineers, finds would substantially impair anchorage and navigation.
3. Any pollutant that the U.S. EPA, not having waived its right to object pursuant to Section 402(e) of the Clean Water Act, has objected to in writing pursuant to Section 402(d) of the Clean Water Act.
4. Any pollutant in conflict with plans or amendment thereto approved pursuant to Section 208(b) of the Clean Water Act.
5. Any pollutant subject to a toxic pollutant discharge prohibition under Section 307 of the Clean Water Act.
6. Any dangerous waste, as defined in the dangerous waste regulations, Chapter 173-303 WAC, into a subsurface disposal system, such as a ***well*** or drainfield.

G-2.10 Reporting Other Information

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to Ecology, the Permittee must promptly submit such facts or information.

G-3 ENFORCEMENT AND PENALTIES

G-3.1 Enforcement

Ecology, with the assistance of the attorney general, may sue in courts of competent ***jurisdiction*** to enjoin any threatened or continuing violation of this permit or the Conditions thereof without the necessity of a prior revocation of coverage under this permit. Any violation of the terms and conditions of this permit, the state Water Pollution Control Act, or the federal Clean Water Act are subject to the enforcement sanctions, direct and indirect, as provided for in WAC 173-226-250.

G-3.2 Penalties for Tampering

Any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, by imprisonment for not more than 2 years per violation, or by both fine and imprisonment. If a conviction of a person is for a violation committed after a first conviction of such person under this Condition, punishment shall be a fine of not more than $20,000 per day of violation, by imprisonment of not more than 4 years, or by both fine and imprisonment.

Any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance, shall, upon conviction, be punished by a fine of not more than $10,000 per violation, by imprisonment for not more than 6 months per violation, or by both fine and imprisonment.

G-3.3 Penalties for Violating Permit Conditions

Any person who is found guilty of willfully violating the terms and conditions of this permit is guilty of a crime and, upon conviction thereof, may be punished by a fine of up to $10,000 and costs of prosecution, by imprisonment, or by both fine and imprisonment, in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of this permit may incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to $10,000 for every such violation. Each and every such violation is a separate and distinct offense, and in the case of a continuing violation, every day's continuance may be deemed a separate and distinct violation.

G-3.4 Property Rights

This permit does not convey any property rights of any sort, or any exclusive privilege.

G-3.5 Right of Inspection and Entry

The Permittee must allow Ecology or its authorized representative, upon the presentation of credentials and such other documents as may be required by law, at reasonable times, for the purpose of inspecting and investigating; (a) Conditions relating to the pollution or the possible pollution of any waters of the State, or (b) Actual or suspected violations of water quality standards, effluent standards or limits, or the terms and conditions of this permit:

1. To enter upon the premises, public or private, in which an effluent source or discharge is located or where any records must be kept under the terms and conditions of this permit.
2. To have access to and to copy at reasonable cost any records that must be kept under the terms and conditions of this permit.
3. To investigate, inspect, or monitor any facility, operation, or practice regulated by or required under this permit, including:
   (a) Postings.
   (b) Collection, control, treatment, pollution management, and discharge facilities.
   (c) Monitoring equipment or methods.
4. To sample or monitor any discharge, internal waste stream, substances, or parameters at any location, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act.

“Reasonable times” includes regular business hours and any other times when Ecology suspects the occurrence or evidence of a violation requiring immediate inspection.

G-4 PERMIT MANAGEMENT AND COORDINATION

G-4.1 Appeal

Any person may appeal the terms and conditions of this general permit, as they apply to the appropriate class of dischargers, within 30 days of issuance of this general permit, in accordance with Chapter 43.21B RCW and Chapter 173-226 WAC.

Any person may appeal the terms and conditions of this general permit, as they apply to an individual discharger, within 30 days of the effective date of coverage of that discharger, in accordance with Chapter 43.21B RCW. Consideration of an appeal of general permit coverage of an individual discharger is limited to the general permit's applicability or inapplicability to that individual discharger.

The appeal of general permit coverage of an individual discharger does not affect any other dischargers covered under this general permit. If the terms and conditions of this general permit are found to be inapplicable to any individual discharger(s), the matter shall be remanded to Ecology for consideration of issuance of an individual permit or permits.

G-4.2 Certification and Signature Requirements

The Permittee must sign and certify as correct all applications, reports, or information that it provides to Ecology. The person who provides such signature and certification must be any of the following:

1. In the case of corporations, a responsible corporate officer who may be:
   (a) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function or any other person who performs similar policy- or decision-making functions for the corporation; ***or***
   (b) The manager of one or more manufacturing, production, or operating facilities, provided:
      i. The manager is authorized to make management decisions which govern the operation of the permitted facility or activity, including having the explicit or implicit duties of making major capital investment recommendations and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations;
      ii. The manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; ***and***
      iii. Authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
2. In the case of a partnership, a general partner.
3. In the case of a sole proprietorship, the proprietor.
4. In the case of a municipal, state, or other public facility or activity, either a principal executive officer or ranking elected official.
5. A duly authorized representative of a person identified among items 1 through 4 of this Condition. A person is a duly authorized representative only if:

(a) A person identified among items 1 through 4 of this Condition makes the authorization in writing and submits it to Ecology; ***and***

(b) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity or a position having overall responsibility for environmental matters for the Permittee. A duly authorized representative may thus be either a named individual or any individual occupying a named position.

If an authorization under item 5 of this Condition is no longer accurate because a different individual or position has responsibility for the overall operation of the facility or activity, the Permittee must provide to Ecology a new authorization satisfying the requirements of this Condition prior to or together with any applications, reports, or information to be signed by an authorized representative.

Any person signing a document under this Condition must make the following certification:

> *"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."*

G-4.3 Dates of Coverage under this Permit

Starting on the date that Ecology receives a Notice of Intent application for permit coverage, Ecology has 30 days to inform the applicant whether or not the application is complete. If the applicant has submitted a complete NOI, and Ecology does not respond to the applicant within those 30 days, permit coverage automatically commences on the later of the following, as applicable:

1. For Permittees already covered under the expiring general permit who met all renewal requirements (WAC 173-226-220 (2) and (3)), the effective date of this general permit. Ecology sends all such Permittees a new coverage letter after the reissuance of the general permit.
2. For new applicants without current coverage under the general permit:
   a. The date specified on the coverage letter that Ecology sends to the applicant.
   b. The 31st day following Ecology's receipt of the applicant's completed Notice of Intent application for coverage (61st day following the publication date of the second public notice per WAC 173-226-130 (5)).

When a Permittee has made a timely and sufficient application for the renewal of coverage under this permit prior to its expiration, this permit remains in effect and enforceable until Ecology:

1. Denies the application;
2. Issues a replacement permit; ***or***
3. Cancels the expired permit.

Coverage under an expired general permit for Permittees who fail to submit a timely and sufficient application expires on the expiration date of the general permit.

G-4.4 Severability

The provisions of this permit are severable, and if any provision of this permit, or application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances and the remainder of this permit are not affected thereby.

G-4.5 Payment of Fees

The Permittee must provide payment of fees associated with this permit as assessed by Ecology pursuant to Chapter 173-224 WAC until the permit is either terminated or revoked.

G-4.6 Termination of Coverage upon Issuance of an Individual Permit

When an NPDES waste discharge individual permit is issued to a discharger otherwise subject to this general permit, the applicability of this general permit to that Permittee is automatically terminated on the effective date of the individual permit.

G-4.7 Reporting a Cause for Modification or Revocation

The Permittee must provide a new application or information supplemental to the previous application whenever:

1. The Permittee anticipates a significant change to the permitted activity or in the quantity or type of discharge authorized by this permit; ***or***
2. The Permittee knows, or has reason to believe, that any activity has occurred or will occur which would constitute cause for modification or revocation pursuant to 40 CFR 122.62.

A significant change includes, but is not limited to, any facility expansion, production increase, or process modification that would change the nature or increase the quantity of pollutants discharged such as to cause either non-compliance with effluent limits or discharges beyond those reported in the previous application for coverage. The Permittee must provide its plans, supplemental information, or new application for coverage to Ecology at least 60 days prior to any proposed changes. This reporting to Ecology does not relieve the Permittee of the duty to comply with the existing permit until it is modified or reissued.

G-4.8 Request to be Excluded from Coverage under this Permit

Any discharger authorized by this general permit may request to be excluded from coverage under this general permit by applying for an individual permit. Such discharger must provide to Ecology an application as described in WAC 173-216-070 or WAC 173-220-040, whichever is applicable, with reasons supporting the request for exclusion from coverage under this permit. These reasons must fully document how an individual permit will apply to the applicant in a way that this general permit cannot.

Ecology may require the applicant to provide information to support the request for exclusion from coverage under this general permit. Ecology will either issue an individual permit or deny the request with a statement explaining the reason for the denial.

G-4.9 Modification, Revocation, and Termination of this General Permit

Ecology may modify, revoke and reissue, or terminate this permit during its term for cause in accordance with the provisions of Chapter 173-226 WAC. Grounds for modification, revocation and reissuance, or termination include, but are not limited to, any of the following:

1. A change in the technology or practices for control or abatement of pollutants applicable to the category of dischargers covered under this permit.
2. Promulgation of effluent limit standards or guidelines pursuant to the Clean Water Act or Chapter 90.48 RCW for the category of dischargers covered under this permit.
3. Approval by Ecology of a water quality management plan containing requirements applicable to the category of dischargers covered under this permit.
4. Receipt of information that indicates that cumulative effects on the environment from dischargers covered under this permit are unacceptable.
5. Establishment by the U.S. Environmental Protection Agency of a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) under Section 307(a) of the Clean Water Act for a toxic pollutant which is more stringent than any limit upon such pollutant in this permit.

In the event that a material change occurs in the condition of the waters of the State, Ecology may, by appropriate order, modify permit Conditions or specify additional Conditions in permits previously issued.

The filing of a request by the Permittee for a permit modification, revocation and reissuance, or termination, or of a notification of planned changes or anticipated non-compliance does not stay any permit Condition.

G-4.10 Termination of Coverage under this Permit

Ecology may revoke coverage for any discharger under this permit for cause in accordance with Chapter 173-226 WAC. The discharger has 30 days during which to respond to any notification from Ecology of termination of coverage under this permit before coverage under this permit is automatically revoked. Cases where coverage may be terminated include, but are not limited to, any of the following:

1. Violation of any term or condition of this permit.
2. Failure or refusal of the Permittee to comply with an interim or final requirement contained in this permit or submitted as part of its application for coverage under this permit.
3. Misrepresentation or failure to disclose fully all relevant facts when applying for and obtaining coverage under this permit.
4. A material change in the quantity or type of waste disposed or in any other condition that requires either a temporary or permanent reduction or elimination of the permitted discharge.
5. A determination that the permitted activity endangers human health or the environment or contributes to a water quality standard violation.
6. Incorporation of an approved local ***pretreatment*** program into a municipality's permit.

7. Failure of the Permittee to satisfy the public notice requirements of WAC 173-226-130(5) when applicable.
8. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090 and General Condition G-3.5 (Right of Inspection and Entry).
9. Nonpayment of permit fees or penalties assessed pursuant to RCW 90.48.465 and Chapter 173-224 WAC.

Ecology may require any discharger, whether or not already covered under this general permit, to apply for and obtain coverage under an individual permit or another more appropriate general permit.

Permittees whose coverage has been revoked for cause according to WAC 173-226-240 may request temporary coverage under this permit during the time an individual permit is being developed, provided that the request is made within 90 days from the time of revocation and is submitted along with a complete individual permit application.

G-4.11 Transfer of Permit Coverage

Coverage under this permit is not transferable to any person except after notice to Ecology.

In the event of any change in control or ownership of the facility or activity from which the authorized discharge emanates, the Permittee must notify the succeeding owner or controller of the existence of this permit by letter, and provide a copy of that letter to Ecology.

A Permittee may transfer coverage under this permit to a succeeding owner or operator of the facility or activity producing the discharge, including owners or operators of lots or parcels within a common plan of development or sale, by:

1. Preparing a written agreement, signed by both the current Permittee and the new discharger, that specifies the proposed date of the transfer of coverage, responsibility, and liability for this permit; ***and***
2. Submitting to Ecology a copy of that written and signed agreement at least 30 days prior to the proposed transfer date; ***and***

   Provided that:

   Ecology does not notify the current Permittee and the new discharger by the proposed transfer date of its intent to modify, to revoke and reissue, or to terminate permit coverage. If Ecology does not notify the current Permittee and the new discharger, the transfer of permit coverage is effective on the date specified in the written agreement between the current Permittee and the new discharger.

When a current Permittee of a construction stormwater discharge site transfers control or ownership of a portion of that permitted site to another person, the current Permittee must also submit an updated application for coverage to Ecology indicating the acreage remaining after the transfer.

Upon consent of the Permittee, Ecology may transfer coverage under this permit to a succeeding Permittee by a minor modification in accordance with 40 CFR 122.63(d) to identify the new Permittee and incorporate such other requirements as Ecology may deem necessary.

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APPENDIX A. ACRONYMS AND UNITS OF MEASURE

Acronym	Meaning
AKART	All known, available, and reasonable methods of prevention, control, and treatment
BMP	Best management practice
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
DoH	Washington State Department of Health
DMR	Discharge monitoring report
Ecology	Washington State Department of Ecology
eNOI	Electronic notice of intent
EPA	Environmental Protection Agency
ERTS	Emergency Response Tracking System
GWI	Groundwater under the direct influence of surface water
MDL	Method detection limit
ND	Not detected
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and maintenance
PQL	Practical quantitation level
QA/QC	Quality assurance and quality control
RCW	Revised Code of Washington State
SEPA	State Environmental Policy Act, RCW 43.21C
SOP	Standard operating procedures
SWPPP	Stormwater pollution prevention plan
TMDL	Total maximum daily load
U.S.	United States
USC	United States Code
WAC	Washington Administrative Code
WTP	Water Treatment Plant

Unit of Measure	Meaning
gpd	Gallons per day
ug/L	Micrograms per liter
mg/L	Milligrams per liter
mL/L	Milliliters per liter
NTU	Nephelometric turbidity units
S.U.	Standard units

APPENDIX B. DEFINITIONS

303(d) List
The list of waterbodies in Washington State that do not meet the water quality standards specified in Chapter 173-201A WAC. The Washington State Department of Ecology (Ecology) prepares and the U.S. Environmental Protection Agency approves this list periodically (every 2 years). The list is posted on the Ecology web site at https://apps.ecology.wa.gov/approvedwqa/ApprovedSearch.aspx.

Action
Any human project or activity.

Activity
A discernible set of related actions or processes conducted within a facility, operation, or site that may cause a discharge of pollutants. Examples include, but are not limited to, construction; manufacturing; production or use of raw materials, products, or wastes; transportation; and cleanup or treatment of machinery, structures, land, or water.

Actual production rate
For the Water Treatment Plant General Permit, the amount of finished water that a treatment facility actually produces on any given day. To calculate the value of the actual production rate on an average monthly basis, add the value of each daily production rate during a calendar month, and divide the sum by the total number of days in the month.

Adaptive Management
A structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool which should be used not only to change a system, but also to learn about the system. Since adaptive management is based on a learning process, it improves long-run management outcomes. The challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge.

All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART)
A technology-based approach of decision making for limiting pollutants from discharges. AKART represents the most current methodology for preventing, controlling, and abating pollution that can be installed or used at a reasonable cost.

Application for coverage
A formal request for coverage under this general permit using the paper or electronic form developed by the Washington State Department of Ecology for that purpose.

Average monthly discharge limit
The greatest average of daily discharges allowed for a calendar month. To calculate the value of the actual average monthly discharge for comparison with the limit, add the value of each daily discharge

measured during a calendar month, and divide this sum by the total number of daily discharges measured.

Background
The biological, chemical, physical, and radiological conditions that exist in the absence of any influences from outside an area potentially influenced by a specific activity.

Benchmark
A pollutant concentration used as a threshold, below which a pollutant is unlikely to cause a water quality violation, and above which it may. Benchmark values are not water quality standards and not numeric effluent limits – they are indicator values. Often when a pollutant concentration exceeds a benchmark, some active response may be necessary, i.e., ***adaptive management***.

Best Management Practice (BMP)
Activity, prohibition, maintenance procedure, or other physical, structural, and/or managerial practice to prevent or reduce pollution of and other adverse impacts to the waters of Washington State. BMPs include treatment systems, operating schedules and procedures, and practices used singularly or in combination to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

Bypass
The diversion of stormwater or a wastestream from any portion of a treatment facility. A bypass may be intentional or unintentional.

Calendar Day
A period of 24 consecutive hours starting at 12:01 A.M. and ending at the following 12:00 P.M. (midnight).

Carcinogen
Any substance or agent that produces or tends to produce cancer in humans. The term carcinogen applies to substances on the U.S. Environmental Protection Agency lists of A (known human) and B (probable human) carcinogens, and any substance which causes a significant increased incidence of benign or malignant tumors in a single, well conducted animal bioassay, consistent with the weight of evidence approach specified in the U.S. Environmental Protection Agency Guidelines for Carcinogenic Risk Assessment.

Chlorine
A chemical used to disinfect wastewaters of pathogens harmful to human health. Chlorine is extremely toxic to aquatic life.

Clean Water Act (CWA)
The primary federal law in the United States governing water pollution and that includes goals for eliminating releases of large amounts of toxic substances into water, eliminating additional water pollution by 1985, and ensuring that surface waters will meet standards necessary for human sports and recreation by 1983. (Federal Water Pollution Control Act, Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117, and 100-4; USC 1251, et seq.)

Color
The optical density at the visual wavelength of maximum absorption, relative to distilled water. One hundred percent transmittance is equivalent to zero optical density. The analytical procedure for measuring this parameter is typically Standard Methods for the Examination of Water and Wastewater, Method 204.

Completed Notice of Intent application for permit coverage (Completed application)
A permit application form received by Ecology for which: (1) The applicant has filled out all applicable form fields with the correct information and had the application signed and certified by an individual who meets the requirements of WAC 173-226-200 (3); (2) The applicant has completed the publication of the required public notice for its application (WAC 173-226-130 (5)); and (3) The 30-day public comment period (which starts on the publication date of the second public notice) has ended (WAC 173-226-200 (2)).

Compliance schedule
A schedule of remedial measures that includes an enforceable sequence of actions or operations leading to compliance with an effluent or other limit, prohibition, or standard.

Contaminant
Any biological, chemical, physical, or radiological substance that does not occur naturally in a given environmental medium or that occurs at concentrations greater than those in the natural or ***background*** conditions.

Control

1. To direct, oversee, supervise, manage, perform, or give instruction about any decision, action, or operation of the specific facility, site, field, wastestream, or other object "under control."
2. The partial removal or complete eradication of native plants, non-native non-noxious plants, algae, noxious or quarantine-list weeds, or other nonnative invasive ***organisms*** from a waterbody. The purpose of control activities may be to protect some of the beneficial uses of a waterbody, such as swimming, boating, water skiing, fishing access, etc. The goal may be to maintain some native aquatic vegetation for habitat, while accomplishing some removal for beneficial use protection. Control activities may include the application of chemical(s) to all or part of a waterbody.

Conveyance
A mechanism for transporting water, wastewater, or stormwater from one location to another location, including, but not limited to, gutters, ditches, pipes, and/or channels.

Daily discharge
The amount of a pollutant discharged during any 24-hour period that reasonably represents a calendar day for purposes of sampling. For pollutants with limits expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged during the day. For pollutants with limits expressed in other units of measurement, the daily discharge is calculated as the average measurement of the pollutant throughout the day.

Dangerous waste
Any discarded, useless, unwanted, or abandoned nonradioactive substances, including but not limited to certain pesticides, or any residues or containers of such substances which are disposed of in such quantity

or concentration as to pose a substantial present or potential hazard to human health, wildlife, or the environment because such wastes or constituents or combinations of such wastes: (1) Have short-lived, toxic properties that may cause death, injury, or illness or have mutagenic, teratogenic, or ***carcinogenic*** properties; or (2) Are corrosive, explosive, flammable, or may generate pressure through decomposition or other means. The exact definition of dangerous waste is provided at WAC 173-303-040.

Design maximum production capacity
The amount of finished water that a water treatment facility is designed to produce at peak output and 24-hour production.

Detection limit
The minimum observed result such that the lower 100(1- α) percent confidence limit of the result is greater than the mean of the method blanks.

Detention
The temporary collection of water into a storage device or pond, with the subsequent release of that water either at a rate slower than the collection rate or after a specified time period has passed since the time of collection. The purposes of detention include, but are not limited to, improving the quality of the water released and reducing or smoothing the mass flow rate of its discharge over time.

Detention pond
Man-made structure constructed specifically to collect and manage stormwater. Detention ponds are generally dry until a significant storm event and subsequently gradually release the accumulated stormwater through an outlet.

Dilution factor (DF)
A measure of the amount of mixing of effluent and receiving water that occurs at the ***mixing zone*** boundary, expressed as the inverse of the effluent fraction. For example, a dilution factor of 16 means that, assuming complete mixing at the mixing zone boundary, the effluent comprises 6.25 percent by volume, and the receiving water comprises 93.75 percent by volume of the mixture of effluent and receiving water [DF = 1/(6.25/100) = 16].

Discharge (the noun form is the same as Effluent)
To release or add material to waters of the State, including via surface runoff.

Discharge limit (same as Effluent limit)
Any restriction, including schedules of compliance, established by the local government, the Washington State Department of Ecology, or the U.S. Environmental Protection Agency on quantities, rates, and/or concentrations of biological, chemical, physical, radiological, and/or other characteristics of material discharged into any site including, but not limited to, waters of the State of Washington.

Discharge Monitoring Report (DMR)
A report submitted periodically (usually monthly or quarterly) by a Permittee to the Washington State Department of Ecology that provides the results of effluent monitoring tests conducted by or on the behalf of the Permittee.

Discharger
An owner or operator of any facility, operation, or activity subject to regulation under Chapter 90.48 of the Revised Code of Washington State or the federal Clean Water Act.

Domestic wastewater
Waste and wastewater containing human wastes, including kitchen, bath, and laundry wastes from residences, buildings, industrial establishments, or other places, together with such groundwater infiltration or surface waters as may be present.

Effluent (same as the noun form of Discharge)
Material (usually an aqueous liquid) released to waters of the State, including via surface runoff.

Effluent limit (same as Discharge limit)
Any restriction, including schedules of compliance, established by the local government, the Washington State Department of Ecology, or the U.S. Environmental Protection Agency on quantities, rates, and/or concentrations of biological, chemical, physical, radiological, and/or other characteristics of material discharged into any site including, but not limited to, waters of the State of Washington.

Entity
Any person or organization, including, but not limited to, cities, counties, municipalities, Indian tribes, public utility districts, public health districts, port authorities, mosquito control districts, special purpose districts, irrigation districts, state and local agencies, companies, firms, corporations, partnerships, associations, consortia, joint ventures, estates, industries, commercial pesticide applicators, licensed pesticide applicators, and any other commercial, private, public, governmental, or non-governmental organizations, or their legal representatives, agents, or assignees.

Erosion
The detachment and movement of soil or rock fragments and the wearing away of the land surface by precipitation, running water, ice, wind, or other geological agents, including processes such as gravitational creep.

Erosion and Sediment Control Best Management Practice (ESC BMP)
Best management practice (BMP) intended to prevent erosion, sedimentation, or the release of sediment-laden water from the site. Examples include preserving natural vegetation, seeding, mulching and matting, and installation of plastic covering, filter fences, sediment traps, or ponds. (synonymous with stabilization and structural BMP)

Essential Maintenance
Maintenance required to ensure the proper and successful operation of the subject structure, equipment, mechanism, or facility. Examples of essential maintenance are: (1) Frequent cleaning of oily materials from an in-line pH sensor that controls whether or not an episodic discharge occurs; (2) Removal of accumulated sediment and trash from a catch basin prior to the basin becoming so filled that it no longer functions as intended; and (3) Testing and replacing emergency batteries that would provide, in the event of a regional power outage, electrical power to critical operations central to the purpose of the facility.

Facility (same as Operation)
The physical premises (including the land and appurtenances thereto) owned or operated by a Permittee from which wastewater or stormwater is discharged subject to regulation under the ***National Pollutant Discharge Elimination System*** program.

General permit
A single permit that covers multiple characteristically similar dischargers of a ***point source*** category within a designated geographical area, in lieu of many individual permits that are specifically tailored and issued separately to each discharger.

Groundwater (same as Underground water)
The water located in a ***saturated zone*** or stratum beneath the surface of the land or below a surface waterbody. Groundwater is a water of the State and includes ***interflow***, which is a type of perched water, and water in all other saturated soil pore spaces and rock interstices, whether perched, seasonal, or artificial. Although ***underground water*** within the ***vadose zone*** (unsaturated zone) also is a type of groundwater, the Washington State groundwater quality standards do not specifically protect soil pore water or soil moisture located in the vadose zone.

Groundwater under the direct influence of surface water (GWI)
Any water beneath the surface of the ground with: (a) Significant occurrence of insects or other microorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*; or (b) Significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. GWI is groundwater located close enough to nearby surface water to receive direct surface water recharge. Potential sources of GWI include all infiltration galleries, Ranney wells, springs, and wells less than 50 feet deep located within 200 feet of surface water. Identifying a potential GWI to be an actual GWI requires either: (a) Determination of a hydraulic connection between the groundwater and the surface water; or (b) Demonstration through water quality monitoring of a correlation between groundwater and surface water measurements.

Hazardous waste
That waste designated by 40 CFR Part 261, and regulated by the U.S. Environmental Protection Agency.

Individual permit
A permit that covers only a single point source, discharger, or facility.

Interflow
Underground water derived directly from rainfall or snowmelt that percolates into the shallow soil, travels a relatively short distance laterally through the soil near the land surface, and subsequently seeps either: (1) Back onto the land surface where it may evaporate, mix with runoff, or discharge to a surface waterbody, or (2) Below the surface into a surface waterbody. The presence and amount of interflow is a function of the soil system depth, permeability, and water-holding capacity.

Jurisdiction
1. The practical authority granted to a formally constituted legal body to deal with and make pronouncements on legal matters and, by implication, to administer justice within a defined area of responsibility.

2. The geographical area or subject-matter to which such practical authority applies.

Load Allocation (LA)
Within the context of a total maximum daily load, that portion of the ***loading capacity*** of a pollutant entering a waterbody attributed to: (1) Existing or future ***nonpoint sources*** of pollution (i.e., all sources not covered by a National Pollutant Discharge Elimination System permit); and (2) Natural background sources. Wherever possible, nonpoint source loads and natural loads should be distinguished. LA does not include reserves for future growth or a margin of safety.

Loading capacity
The greatest amount of pollutant that a waterbody can receive and still meet water quality standards.

Maintenance
Activities conducted on currently serviceable structures, facilities, and equipment that involves no expansion or use beyond that previously existing. Maintenance includes those usual activities taken to prevent a decline, lapse, or cessation in the use of structures and systems. Those usual activities may include replacement of dysfunctional facilities, including cases where environmental permits require replacing an existing structure with a different structure, as long as the functioning characteristics of the original structure are not changed. One example is the repair of a deteriorating paved walkway along the top of the berm enclosing a settling pond that otherwise is fully functional with no overtopping or leaks to the ground surface. Maintenance of WTP settling ponds includes periodic assessment to ensure ongoing proper operation, removal of built-up pollutants (e.g., sediments), replacement of spent or failing treatment media, and other actions taken to prevent or correct degraded performance.

Method Detection Limit (MDL)
Minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte. The MDL (or simply "detection limit") is the smallest measured amount or concentration of analyte in a sample that gives rise to a Type I error tolerance of alpha under the null hypothesis that the true amount or concentration of analyte in the sample is equal to that of a blank. (The alternative hypothesis is that the true amount or concentration of analyte is greater than that of a blank).

Mixing zone
That portion of a waterbody adjacent to an effluent discharge point where mixing dilutes the effluent with the receiving water. The water within this zone need not meet numeric water quality criteria, but must allow passage of aquatic organisms and not upset the ecological balance of the receiving water. The permit specifies the mixing area or volume fraction of the receiving water surrounding the discharge point.

Monthly average
The sum of all daily measurements obtained during a calendar month divided by the number of days measured during that month (arithmetic mean).

Municipality
A political unit incorporated for local self-government, such as a city, town, borough, county, parish, district, association, or other public body (including an intermunicipal agency of two or more of the foregoing entities) created by or pursuant to state law; an authorized Indian tribe or tribal organization;

or a designated and approved management agency under Section 208 of the Clean Water Act. Municipalities include special districts created under state law, such as a water district, sewer district, sanitary district, utility district, drainage district, or similar ***entity***.

National Pollutant Discharge Elimination System (NPDES)
The federal wastewater permitting system for discharges of pollutants from point sources to the navigable ***waters of the United States*** authorized under Section 402 of the Clean Water Act. The U.S. Environmental Protection Agency has authorized the State of Washington to issue and administer NPDES permits for non-federal point sources within the State.

Nonpoint source
A source from which pollutants may enter waters of the State that is not readily discernible, such as any dispersed land-based or water-based activities including, but not limited to, atmospheric deposition; surface water runoff from agricultural lands, urban areas, or forest lands; subsurface or underground sources; or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System program.

Operation (same as Facility)
The physical premises (including the land and appurtenances thereto) owned or operated by a Permittee from which wastewater or stormwater is discharged subject to regulation under the National Pollutant Discharge Elimination System program.

Operational Source Control Best Management Practice (Operational source control BMP)
The schedule of activities, prohibition of practices, maintenance procedures, employee training, good housekeeping, and other managerial best management practices to prevent or reduce the pollution of waters of the State.

Organism
Any individual life form: an animal, plant, fungus, protistan, or moneran.

Outfall
The location of a point source where a discharge leaves a facility, site, or municipal separate storm sewer system and flows into waters of the State. Outfalls do not include open ***conveyances*** connecting two municipal separate storm sewers; or pipes, tunnels, or other conveyances which connect segments of the same stream or other waters of the State and are used to convey waters of the State (e.g., culverts).

Permit
An authorization, license, or equivalent control document issued by a formally constituted legal body, such as the Washington State Department of Ecology, to a facility, activity, or entity to treat, store, dispose, or discharge materials or wastes, specifying the waste treatment and control requirements and waste discharge conditions. Unless the context requires differently, "permit" refers to individual and general permits authorized under the National Pollutant Discharge Elimination System program.

Permittee
The entity who receives notice of coverage under this general permit.

Person
Any individual or organization, including, but not limited to, cities, counties, municipalities, Indian tribes, public utility districts, public health districts, port authorities, mosquito control districts, special purpose districts, irrigation districts, state and local agencies, companies, firms, corporations, partnerships, associations, consortia, joint ventures, estates, industries, commercial pesticide applicators, licensed pesticide applicators, and any other commercial, private, public, governmental, or non-governmental organizations, or their legal representatives, agents, or assignees.

pH
A measure of the acidity or alkalinity of water. A pH of 7.0 is defined as neutral. Large variations above or below 7.0 are harmful to most aquatic life. Mathematically, pH is the negative logarithm of the activity of the hydronium ion (often expressed as the negative logarithm of the molar concentration of the hydrogen ion). The analytical procedure for determining this amount is typically Standard Methods for the Examination of Water and Wastewater, Method 423.

Point source
Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters of the State, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft. Point source does not include agricultural stormwater discharges and return flows from irrigated agriculture. See 40 CFR 122.3 for exclusions.

Pollutant (in water)
Any discharged substance or pathogenic organism that would: (1) Alter the biological, chemical, physical, radiological, or thermal properties of any water of the State, or (2) Would be likely to create a nuisance or render such water harmful, detrimental, or injurious (a) to the public health, safety, or welfare, (b) to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (c) to any animal or plant life, either terrestrial or aquatic, either directly from the environment or indirectly by ingestion through the food chain.

Pollutants may include, but are not limited to, the following: solid waste, incinerator residue, garbage, sewage, sewage sludge, filter backwash, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, dredged spoil, rock, sand, cellar dirt, and other industrial, municipal, and agricultural wastes.

Pollutant does not mean: (1) Sewage from marine vessels or a discharge incidental to the normal operation of a vessel of the Armed Forces, within the meaning of Section 312 of the Clean Water Act (CWA); (2) Dredged or fill material discharged in accordance with a permit issued under Section 404 of the CWA; or (3) Water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if that well is approved by authority of the Washington State Department of Ecology (Ecology), and if Ecology determines that such injection or disposal will not result in the degradation of groundwater or surface water resources.

Pollution (of water)
The man-made or man-induced contamination or other alteration of the biological, chemical, physical, or radiological properties of any water of the State, including change in temperature, taste, odor, ***color***, or turbidity of the water; or such discharge of any solid, liquid, gaseous, or other substance into any water

of the State that will, or is likely to, create a nuisance or render such water harmful, detrimental, or injurious to: (1) The public health, safety, or welfare; (2) Domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses; or (3) Any animal or plant life, either terrestrial or aquatic, either directly from the environment or indirectly by ingestion through the food chain.

Pretreatment
The reduction of the amount or concentration of pollutants, elimination of pollutants, or alteration of the nature of pollutant properties to a less harmful state prior to or in lieu of discharging wastewater to a treatment plant. This reduction or alteration may be obtained by biological, chemical, or physical processes, by process changes, or by other means, except by diluting the pollutants.

Publicly-owned treatment works (POTW)

1. A sewage treatment plant and its collection system that is owned by a municipality, the State of Washington, or the federal government. A POTW includes the sewers, pipes and other conveyances that convey wastewater to the treatment plant, and any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature.

2. The municipality or other entity that has jurisdiction over the indirect discharges to and the discharges from the treatment works.

Quantitation level (QL)
The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. The QL is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed. The QL may be calculated by multiplying the method detection limit (MDL) by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10n, where n is an integer.

Receiving water
The waterbody at the point of discharge, whether that discharge is through a point source or via sheet flow. If the discharge is to a stormwater conveyance system, either surface or subsurface, the receiving water is the waterbody to which the stormwater conveyance system discharges. Systems designed for groundwater drainage, redirecting stream natural flows, or conveyance of irrigation water/return flows that coincidentally convey stormwater, are considered the receiving water. Receiving waters may also be groundwater to which surface runoff is directed by infiltration.

Representative (sample)
A sample that yields data that accurately characterizes the nature of a discharge or other sampled matrix for the parameters of concern. A representative sample should account for the factors that contribute to the variability of the parameters, such as the quantity of the discharge, the date and time of the sampling event, and whether the particular sampling location or associated physical events may affect the material sampled. Combining grab samples collected from multiple outfalls from a designated area of the facility during a certain time range to create a flow-weighted composite sample may be required to obtain a representative sample.

A random sample may not be a representative sample. Representative sampling schemes should vary based on the population distribution and variability. For a relatively constant discharge, a grab sample is representative. For a discharge that varies greatly over time or space, a grab sample would likely not be representative.

Runoff
Water derived directly from rainfall or snowmelt that travels across the land surface and discharges: (1) To waterbodies either directly or through a constructed collection and conveyance system, or (2) To the subsurface through a constructed collection and conveyance system.

Sanitary sewer
A sewer designed to convey ***domestic wastewater***.

Saturated zone
The subsurficial zone in which all soil pore spaces and rock interstices are completely filled with groundwater. Saturated zones include aquifers, whether or not they produce a significant yield, areas of perched groundwater, and interflow.

Sediment
The fragmented material that originates from the weathering and erosion of rocks, unconsolidated deposits, or unpaved yards; and is suspended in, transported by, or deposited by water.

Sedimentation
The deposition or formation of sediment.

Settleable solids
The material that settles out of suspension within a certain timespan measured volumetrically. The analytical procedure for determining this amount is typically Standard Methods for the Examination of Water and Wastewater, Method 209E.

Severe property damage
Substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to exist. Severe property damage does not include economic loss caused by delays in production.

Site
1. The land or water area where any facility, operation, or activity is physically located or conducted, including any adjacent land or buffer areas used in connection with such facility, operation, or activity.
2. The land or water area receiving any effluent discharged from any facility, operation, or activity.

Solid waste
All putrescible, nonputrescible, solid, and semisolid waste. Examples of solid waste are: garbage, rubbish, ashes, industrial wastes, swill, demolition and construction wastes, abandoned vehicles or parts thereof, discarded commodities, sludge from wastewater treatment plants and septic tanks, woodwaste, contaminated soils, contaminated dredged material, dangerous waste, and problem wastes.

Source Control Best Management Practice (Source control BMP)
Best management practice intended to prevent or reduce the release of pollutants. Two types of source control BMPs exist: (1) Structural, which include physical, structural, or mechanical devices or

facilities (e.g., roofs covering storage and working areas); and (2) Operational, which include management of activities that are sources of pollutants (e.g., directing wash water and similar discharges to the ***sanitary sewer*** or a dead-end sump).

State
The State of Washington.

State Environmental Policy Act (SEPA)
The Washington State law intended to prevent or eliminate damage to the environment that requires State and local agencies to consider the likely environmental consequences of development proposals prior to their approval (Chapter 43.21C RCW, as implemented through Chapter 197-11 WAC).

Stormwater
Water derived directly from rainfall or snowmelt that either: (1) Travels across the land surface and discharges to waterbodies either directly or through a collection and conveyance system; or (2) Percolates into the shallow soil, travels laterally through the soil near the land surface, and subsequently seeps back onto the land surface where it mixes with runoff or discharges to a surface waterbody. (Same as Runoff plus Interflow)

Stormwater associated with industrial activity
Stormwater discharged from any conveyance that: (1) Is used for collecting and conveying stormwater; and (2) Drains stormwater from manufacturing, processing, or raw materials storage areas at an industrial facility. (See 40 CFR 122.26(b)(14).)

Stormwater Pollution Prevention Plan (SWPPP)
The written plan that describes the measures to be employed at a facility to identify, prevent, and control the contamination of point source discharges of stormwater.

Structural Source Control Best Management Practice (Structural source control BMP)
Physical, structural, or mechanical devices or facilities that are intended to prevent pollutants from entering stormwater. Examples of structural source control BMPs typically include:
(1) Enclosing and/or covering the pollutant source (building or other enclosure, a roof over storage and working areas, temporary tarp, etc.); and (2) Segregating the pollutant source to prevent run-on of stormwater, and to direct only contaminated or potentially contaminated stormwater to appropriate treatment BMPs.

Substantial
Of considerable size, quality, value, degree, amount, extent, or importance.

Surface water
Lakes, rivers, ponds, streams, inland waters, ***wetlands***, marine waters, estuaries, and all other fresh or brackish waters and water courses, plus drainages to those waterbodies. Surface waters do not include hatchery ponds, raceways, pollution abatement ponds, and wetlands constructed solely for wastewater treatment.

Surface waters of the State of Washington
All waters within the geographic boundaries of the State of Washington defined as "waters of the United States" in 40 CFR 122.2, and all waters defined as "waters of the State" in RCW 90.48.020 excluding

underground waters. These include lakes, rivers, ponds, streams, inland waters, wetlands, marine waters, estuaries, and all other fresh or brackish waters and water courses, within the jurisdiction of the State of Washington, plus drainages to those waterbodies. Surface waters of the State do not include hatchery ponds, raceways, pollution abatement ponds, and wetlands constructed solely for wastewater treatment.

Technology-based effluent limit
A permit limit that is based on the ability of a treatment method to reduce the amount (e.g., concentration) of a pollutant.

Total maximum daily load (TMDL)

1. An estimate of the maximum amount of a pollutant that a specific impaired waterbody or waterbody segment can receive in a day and still be protective of its designated beneficial uses, i.e., meet water quality standards. The TMDL must incorporate seasonal variation, include a margin of safety, and account for all of the point and nonpoint sources that contributed to the impairment of the specific waterbody.

2. A water cleanup plan and a mechanism for establishing water quality-based controls on all point and nonpoint sources of pollutants within a watershed basin, sub-basin, or hydrographic segment associated with a specific impaired waterbody. Percentages of the TMDL of a single pollutant are allocated to the various pollutant sources as waste ***load allocations*** for point sources and load allocations for nonpoint sources and background. A TMDL becomes effective after the U.S. Environmental Protection Agency has reviewed and approved it.

Total residual chlorine
The amount of chlorine remaining in water or wastewater, which is equivalent to the sum of the combined residual chlorine (non-reactive) and the free residual chlorine (reactive). The analytical procedure for determining this amount is typically Standard Methods for the Examination of Water and Wastewater, Method 408.

Toxic
Causing death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in any organism or its offspring upon exposure, ingestion, inhalation, or assimilation.

Treat

1. To apply an algaecide, herbicide, or other control product to the water, vegetation, or soil to control or kill algae, vegetation, insects, or some other pest or target species, or to remove or inactivate bioavailable phosphorus.

2. To remove a pollutant from wastewater or to perform some other manipulation of wastewater to reduce or control the adverse effects of a pollutant therein.

Treatment

1. The application of an algaecide, herbicide, or other control product to the water, vegetation, or soil to control or kill algae, vegetation, insects, or some other pest or target species, or to remove or inactivate bioavailable phosphorus.

2. The removal of a pollutant from wastewater or some other manipulation of wastewater to reduce or control the adverse effects of a pollutant therein.

Treatment Best Management Practice (Treatment BMP)
Best management practice intended to remove pollutants from wastewater, such as ***detention ponds***, oil/water separators, biofiltration, and constructed wetlands.

Turbidity
The optical property of water that causes light to be scattered and absorbed rather than transmitted in a straight line. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and plankton and other microscopic organisms. Turbidity is a measure of water clarity using a calibrated turbidimeter according to the analytical procedure described typically by Standard Methods for the Examination of Water and Wastewater, Method 214A.

Underground water (same as Groundwater)
The water located in a saturated zone or stratum beneath the surface of the land or below a surface waterbody. Groundwater is a water of the State and includes interflow, which is a type of perched water, and water in all other saturated soil pore spaces and rock interstices, whether perched, seasonal, or artificial. Although underground water within the vadose zone (unsaturated zone) also is a type of groundwater, the Washington State groundwater quality standards do not specifically protect soil pore water or soil moisture located in the vadose zone.

Upset
An exceptional incident in which an unintentional and temporary non-compliance with technology-based, permit effluent limits occurs due to factors beyond the reasonable control of the Permittee. An upset does not include non-compliance to the extent caused by operational error, improperly designed treatment facilities, inadequate storage or treatment facilities, lack of preventive maintenance, or careless or improper operation.

Vadose zone
The subsurficial zone where soil pore spaces and rock interstices are typically occupied at least partially by air. The vadose zone may extend from the surface of the ground down to the top of the water table, i.e., the top of the saturated zone, whether perched or not.

Waste
Any discarded, abandoned, unwanted, or unrecovered material, except the following are not waste materials for the purposes of this permit: (1) Discharges into the ground or groundwater of return flow, unaltered except for temperature, from a groundwater heat pump used for space heating or cooling, provided that such discharges do not have significant potential, either individually, or collectively, to affect groundwater quality or uses; and (2) Discharges of stormwater that are not contaminated or potentially contaminated by industrial or commercial sources.

Water Quality (WQ)
The biological, chemical, physical, and radiological characteristics of water, usually with respect to its suitability for a particular purpose.

Water quality-based effluent limit
A limit on the concentration of an effluent parameter that is intended to prevent the concentration of that parameter from exceeding its water quality criterion after it is discharged into a receiving water. The limit may include a dilution factor if ***all known, available, and reasonable methods of prevention, control, and treatment*** have been accomplished and other restrictions are met.

Waters of the State of Washington
All waters within the geographic boundaries of the State of Washington defined as "waters of the United States" in 40 CFR 122.2, and all waters defined as "waters of the State" in RCW 90.48.020. These waters of the State include lakes, rivers, ponds, streams, inland waters, wetlands, marine waters, estuaries, underground waters, and all other fresh or brackish waters and water courses within the jurisdiction of the State of Washington, plus drainages to those waters.

Waters of the United States
All waters within the geographic boundaries of the State of Washington defined as "waters of the United States" in 40 CFR 122.

Well
A bored, drilled, or driven shaft, or dug hole whose depth is greater than the largest surface dimension.

Wetland
Any area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Jurisdictional wetlands are wetlands that have been identified as such by local, state, or federal agencies. Wetlands do not include those artificial wetlands intentionally created from non-wetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from non-wetland areas to mitigate the conversion of wetlands.

APPENDIX C. QUESTIONNAIRE: EXCERPTS FROM OPERATIONS, MAINTENANCE, AND PLANNING DOCUMENTS

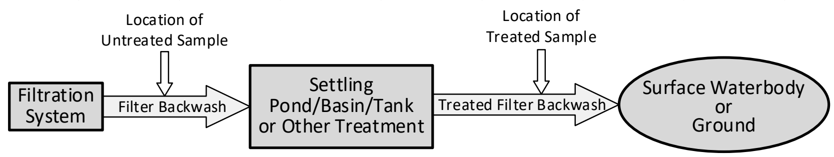
Questionnaire: Excerpts from Operations, Maintenance, and Planning Documents

For the Water Treatment Plant General Permit

Section S-3 Planning Requirements

Type in the required information; Copy and Paste the relevant portions of the facility O&M Manual and Solid Waste Control, Stormwater Pollution Prevention, and Spill Contingency Plans; or upload the existing documents and explain on this form where the required information is located within those documents, e.g., by page numbers.

Facility Name:		**Permit Number:**	
Completed by:		**Date:**	
Email Address:		**Phone:**	



Provide in-house SOPs and schedules for operating, maintaining, and periodic cleaning and servicing of the filter backwash system:

Approximate frequency of **filter backwashing** (number of backwash events/month):

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

Approximate average volume of **untreated filter backwash wastewater** generated from each backwash event (gals/backwash event):

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

Provide the methods used to dechlorinate the filter backwash wastewater prior to discharging it to surface water or the ground:

Provide a list of the oils and chemicals used, processed, or stored on site, and that may be a source of pollutants to any waters of the State. Identify how and where these materials are used and processed, in part by showing their locations on the Site Plan.

Provide in-house SOPs for sampling and analyses of the monitoring parameters required by this permit:

Approximate frequency of discharges from the **filter backwash wastewater treatment area** (number of discharges/month):

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

Approximate average volume of **treated filter backwash wastewater** discharged from each event (gallons/discharge event)

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

Page 1 of 3

Questionnaire: Excerpts from Operations, Maintenance, and Planning Documents

For the Water Treatment Plant General Permit

Section S-3 Planning Requirements

Provide a list of the solid wastes generated on site, the sources and locations where generated, their chemical compositions, and their final dispositions. Show on the accompanying Site Plan the locations where solid wastes are temporarily stored or finally disposed on site. If applicable, identify the contractor who removes solid wastes from the site for final disposal off site.

Approximate amount of solid waste generated monthly (pounds/month):

Waste	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

Provide the emergency shut-down and containment procedures for responses to unexpected discharges or spills, severe weather, and unexpected or major maintenance activities, where releases of pollutants to waters of the State may occur. Describe the emergency notification procedures for alerting responsible managers and local pollution control authorities, and list the names and phone numbers of the facility emergency contacts.

Identify and describe the best management practices (BMPs) employed to control existing and potential sources of pollutants, including contaminated stormwater runoff and spills of petroleum and other chemicals. BMPs must explicitly address operational source control, structural source control, treatment, and erosion and sediment control. (See the permit for any definitions.)

Supporting attachments must include both a **Site Plan** and a **Facility Schematic**.

The **Site Plan** must be drawn to scale and show the following elements:

(a) Approximate scale bar.
(b) North arrow.
(c) Source of the base map.
(d) Complete property line or boundary of the site.
(e) All significant structures, chemical and fuel storage areas, and secondary containment structures.
(f) All filter backwash wastewater settling tanks and constructed settling, storage, and infiltration basins and ponds (Ponds).
(g) Surficial drainage patterns, such as the distinct on-site stormwater catchment areas.
(h) All pipelines, both above and underground, that convey water treatment wastewater.
(i) All outfalls to each surface waterbody that may receive discharged treated wastewater.
(j) All outfalls to each infiltration-to-ground area that may receive discharged treated wastewater.
(k) Complete boundary of each infiltration-to-ground area.

The **Facility Schematic** must show the following elements and be accompanied by the text described below:

(a) All tanks, piping, valving, and in-line monitoring and control systems that comprise the filtration system for producing potable or industrial water.
(b) All tanks, piping, valving, and in-line monitoring and control systems related to the generation, treatment, and disposal of filter backflush wastewater.
(c) Text that briefly describes the raw water source(s), treatment process(es), generation of filter backwash wastewater, treatment of that wastewater, and discharge of the treated wastewater, including seasonal variations.

Questionnaire: Excerpts from Operations, Maintenance, and Planning Documents

For the Water Treatment Plant General Permit

Section S-3 Planning Requirements

Submit this completed report, Site Plan, Facility Schematic, and any other supporting information to the Department of Ecology electronically via your SecureAccess Washington account at https://secureaccess.wa.gov/ecy/wqwebportal/. More information is available at the "Water Quality Permitting Portal" at http://www.ecy.wa.gov/programs/wq/permits/paris/portal.html.

I certify under penalty of law that this completed Questionnaire and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information hereby submitted. Based on my inquiry of the person or persons who are responsible for environmental management and pollution control at my facility and who were directly responsible for gathering the information and attachments, this completed Questionnaire is, to the best of my knowledge and belief, true, accurate, complete, and in full compliance with Permit Condition S-6. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

______________________________ ______________________

Printed Name* Title

______________________________ ______________________

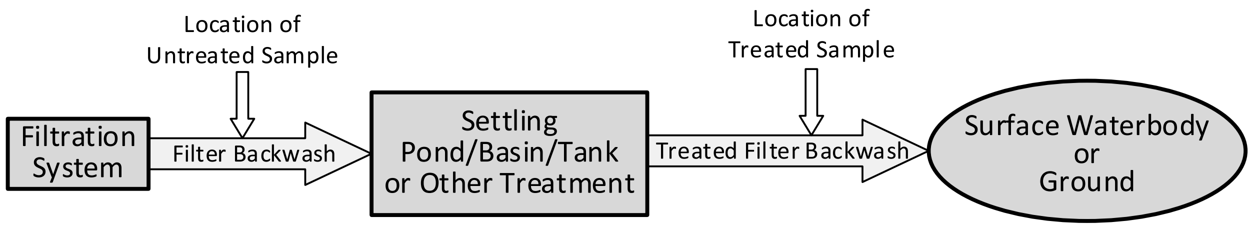
Signature* Date Signed

* The person signing this certification must do so in accordance with Permit Condition G-4.2.

Page 3 of 3

APPENDIX D. SURVEY QUESTIONS FOR SELECTED WATER TREATMENT PLANTS

Answer questions in the spaces provided, and attach the specified documentation.



1. Permit Number:
2. Water Treatment Plant Name:
3. Your Name:
   Your phone number:
   Your email address:
4. Attach as-built engineering drawings of the filter backwash wastewater settling tanks and constructed settling, storage, and infiltration basins and ponds (Ponds), including:
   (a) Horizontal and vertical dimensions.
   (b) Maximum capacity.
   (c) Construction materials of the bottom and sides, including the liner material, if any.
   (d) Shortest horizontal distance between each Pond and the nearest surface waterbody, including that waterbody's name.
   (e) Shortest horizontal distance between each infiltration-to-ground area and the nearest surface waterbody, including that waterbody's name.
   (f) Estimated rates of discharge (average, maximum, and minimum) in units of gallons per minute to the Ponds ***and*** to the surface waterbody or ground.
5. Provide maintenance procedures for the Ponds, including:
   (a) Method of excavating accumulated solids.
   (b) Management of on-site storage and disposal areas.
   (c) The stage at which accumulated solids, if any, are permanently removed from the site.
6. Provide GPS-determined latitude and longitude to at least 5 decimal places of each outfall to each surface waterbody and infiltration-to-ground area.

EXHIBIT D

EPA FILTER BACKWASH RECYCLE RULE

United States Environmental Protection Agency
Office of Water (4606)
EPA 816-F-01-019
June 2001
www.epa.gov/safewater

EPA

Filter Backwash Recycling Rule: A Quick Reference Guide

Overview of the Rule

Title	Filter Backwash Recycling Rule (FBRR) 66 FR 31086, June 8, 2001, Vol. 66, No. 111
Purpose	Improve public health protection by assessing and changing, where needed, recycle practices for improved contaminant control, particularly microbial contaminants.
General Description	The FBRR requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.
Utilities Covered	Applies to public water systems that use surface water or ground water under the direct influence of surface water, practice conventional or direct filtration, and recycle spent filter backwash, thickener supernatant, or liquids from dewatering processes.

Public Health Benefits

Implementation of FBRR will result in . . .	‣ Reduction in risk of illness from microbial pathogens in drinking water, particularly *Cryptosporidium*.
Estimated impacts of the FBRR include . . .	‣ FBRR will apply to an estimated 4,650 systems serving 35 million Americans. ‣ Fewer than 400 systems are expected to require capital improvements. ‣ Annualized capital costs incurred by public water systems associated with recycle modifications are estimated to be $5.8 million. ‣ Mean annual cost per household is estimated to be less than $1.70 for 99 percent of the affected households and between $1.70 and $100 for the remaining one percent of affected households.

Conventional and Direct Filtration

- Conventional filtration, as defined in 40 CFR 141.2, is a series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal. Conventional filtration is the most common type of filtration.
- Direct filtration, as defined in 40 CFR 141.2, is a series of processes including coagulation and filtration, but excluding sedimentation, and resulting in substantial particulate removal. Typically, direct filtration can be used only with high-quality raw water that has low levels of turbidity and suspended solids.

Recycle Flows

- **<u>Spent Filter Backwash Water</u> - A stream containing particles that are dislodged from filter media when water is forced back through a filter (backwashed) to clean the filter.**
- **<u>Thickener Supernatant</u> - A stream containing the decant from a sedimentation basin, clarifier or other unit that is used to treat water, solids, or semi-solids from the primary treatment processes.**
- **<u>Liquids From Dewatering Processes</u> - A stream containing liquids generated from a unit used to concentrate solids for disposal.**

Critical Deadlines and Requirements

For Drinking Water Systems

December 8, 2003	**Submit recycle notification to the state.**
June 8, 2004	**Return recycle flows through the processes of a system's existing conventional or direct filtration system or an alternate recycle location approved by the state (a 2-year extension is available for systems making capital improvements to modify recycle location).** **Collect recycle flow information and retain on file.**
June 8, 2006	**Complete all capital improvements associated with relocating recycle return location (if necessary).**

For States

June 8, 2003	**States submit FBRR primacy revision application to EPA (triggers interim primacy).**
June 8, 2005	**Primacy extension deadline - all states with an extension must submit primacy revision applications to EPA.**

What does a recycle notification include?

- **Plant schematic showing origin of recycle flows, how recycle flows are conveyed, and return location of recycle flows.**
- **Typical recycle flows (gpm), highest observed plant flow experienced in the previous year (gpm), and design flow for the treatment plant (gpm).**
- **State-approved plant operating capacity (if applicable).**

What recycle flow information does a system need to collect and retain on file?

- **Copy of recycle notification and information submitted to the state.**
- **List of all recycle flows and frequency with which they are returned.**
- **Average and maximum backwash flow rates through filters, and average and maximum duration of filter backwash process (in minutes).**
- **Typical filter run length and written summary of how filter run length is determined.**
- **Type of treatment provided for recycle flows.**
- **Data on the physical dimension of the equalization and/or treatment units, typical and maximum hydraulic loading rates, types of treatment chemicals used, average dose, frequency of use, and frequency at which solids are removed, if applicable.**

For additional information on the FBRR

Call the Safe Drinking Water Hotline at 1-800-426-4791; visit the EPA web site at www.epa.gov/safewater; or contact your state drinking water representative.

Additional material is available at www.epa.gov/safewater/filterbackwash.html.

United States
Environmental Protection
Agency

Filter Backwash Recycling Rule

Technical Guidance Manual

Office of Ground Water and Drinking Water (4606M)
EPA 816-R-02-014
www.epa.gov/safewater
December 2002

Printed on Recycled Paper

This document provides public water systems and States with Environmental Protection Agency's (EPA's) current technical and policy recommendations for complying with the Filter Backwash Recycling Rule (FBRR). The statutory provisions and EPA regulations described in this document contain legally binding requirements. This document is not a regulation itself, nor does it change or substitute for those provisions and regulations. Thus, it does not impose legally binding requirements on EPA, States, or public water systems. This guidance does not confer legal rights or impose legal obligations upon any member of the public.

While EPA has made every effort to ensure the accuracy of the discussion in this guidance, the obligations of the regulated community are determined by statutes, regulations, or other legally binding requirements. In the event of a conflict between the discussion in this document and any statute or regulation, this document would not be controlling.

The general description provided here may not apply to a particular situation based upon the circumstances. Interested parties are free to raise questions and objections about the substance of this guidance and the appropriateness of the application of this guidance to a particular situation. EPA and other decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from those described in this guidance where appropriate.

Mention of trade names or commercial products does not constitute endorsement or recommendation for their use.

This is a living document and may be revised periodically without public notice. EPA welcomes public input on this document at any time.

Acknowledgements

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CONTENTS

Appendices

Figures

Tables

ABBREVIATIONS

List of abbreviations and acronyms used in this document:

ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
CADD	Computer Aided Drafting and Design
CFR	Code of Federal Regulations
CT	The Residual Concentration of Disinfectant (mg/l) Multiplied by the Contact Time (minutes)
DAF	Dissolved-Air Floatation
DBP	Disinfection By-Products
DE	Diatomaceous Earth
DOC	Dissolved Organic Carbon
EPA	Environmental Protection Agency
FBRR	Filter Backwash Recycling Rule
FR	Federal Register
gal	gallons
gpd	gallons per day
gpm	gallons per minute
gpm/ft^2	gallons per minute per square foot
GWUDI	Groundwater Under Direct Influence of Surface Water
HAA5	Haloacetic Acids (monochloroacetic, dichloroacetic, trichloroacetic, monobromoacetic, and dibromoacetic acids)
hrs	Hours
IESWTR	Interim Enhanced Surface Water Treatment Rule
Kgal	Thousand Gallons
LT1ESWTR	Long-Term 1 Enhanced Surface Water Treatment Rule
MCL	Maximum Contaminant Level
MF	Microfiltration
MG	Million Gallons

mg/L	milligrams per liter
MGD	Million Gallons per Day
m/h	meters per hour
M/R	Monitoring/Reporting
NOM	Natural Organic Matter
NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
PN	Public Notification
PWS	Public Water System
PWSID	Public Water System Identification
SOP	Standard Operating Procedure
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TT	Treatment Technique
TTHM	Total Trihalomethanes
TTHMFP	Total Trihalomethanes Formation Potential
UF	Ultrafiltration
UV_{254}	Ultraviolet absorbance at 254 nanometers
WTP	Water Treatment Plant
X log removal	Reduction to $1/10^x$ of original concentration
µ or µm	Micron (10^-6 meter)
µg/L	Micrograms per liter

1. INTRODUCTION

1.1 OVERVIEW

The Filter Backwash Recycling Rule (FBRR) establishes regulatory provisions governing the way that certain recycle streams are handled within the treatment processes of conventional and direct filtration water treatment systems. The FBRR also establishes reporting and recordkeeping requirements for recycle practices that will allow States and EPA to better evaluate the impact of recycle practices on overall treatment plant performance. The FBRR published in the Federal Register (66 FR 31086, June 8, 2001) presents the specific regulatory requirements that must be met by affected systems. Figure 1-1 contains a flowchart that presents the FBRR requirements. Figure 1-2 contains a timeline with the key dates for both States and systems. This document has been developed to provide operators with the practical guidance and relevant information to assist them in complying with the FBRR provisions. It outlines detailed methods for complying with each portion of the FBRR, and provides other useful information regarding recycle practices and filter backwashing not specifically required by the FBRR.

1.2 FBRR COMPONENTS

The FBRR applies to public water systems (PWSs) that meet **all** of the following three criteria (40 CFR 141.76(a)):

- System is a Subpart H system (i.e., uses surface water or ground water under the direct influence of surface water);
- System treats water by conventional or direct filtration processes; and,
- System recycles one or more of the following: spent filter backwash water, thickener supernatant or liquids from dewatering processes. Chapter 2 provides more information on regulated recycle streams.

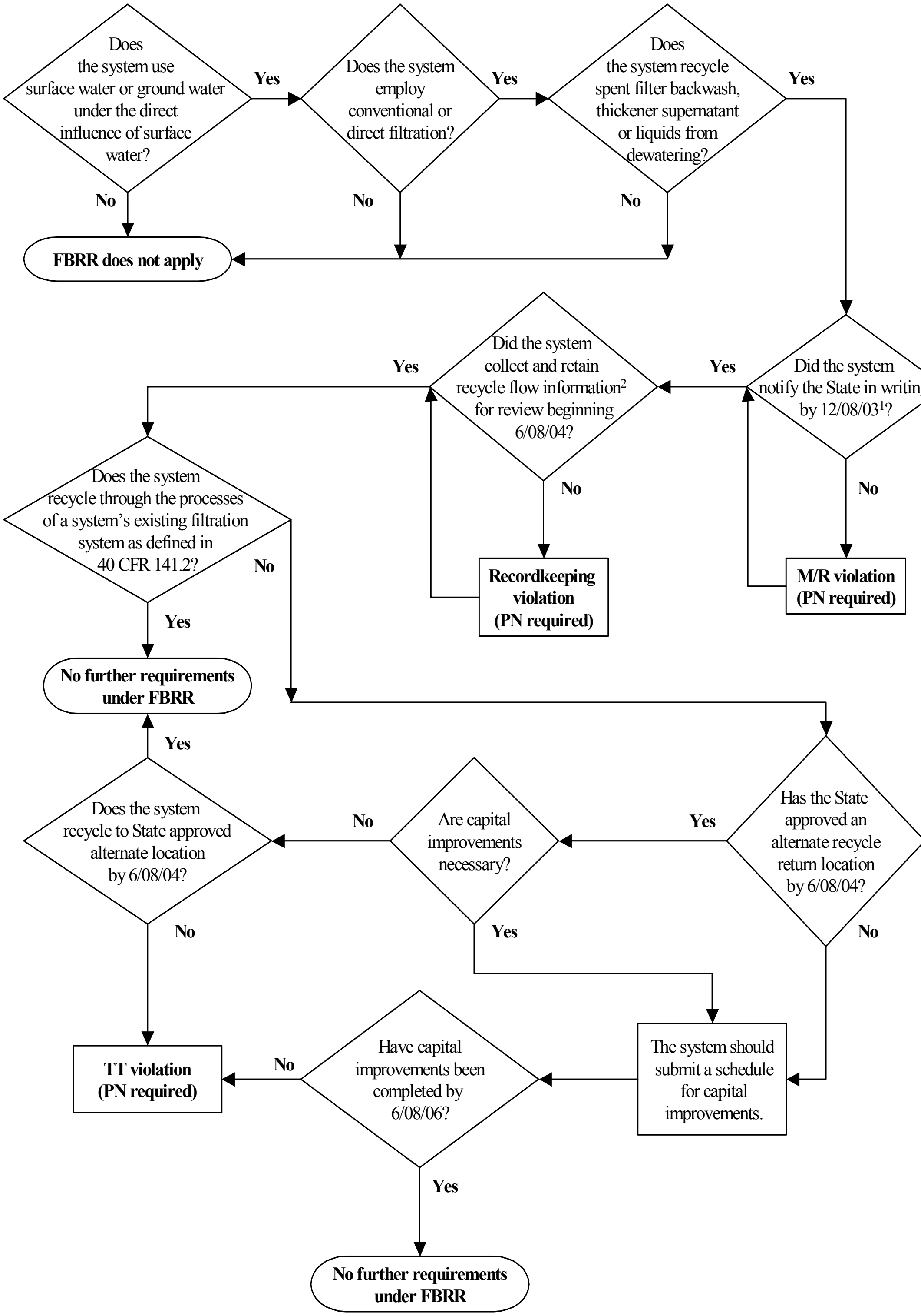
Conventional filtration, as defined in 40 CFR 141.2, is a series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal.

Direct filtration, as defined in 40 CFR 141.2, is a series of processes including coagulation and filtration, but excluding sedimentation, and resulting in substantial particulate removal.

The FBRR consists of three distinct components:

- Reporting (40 CFR 141.76(b)): The FBRR requires a system to notify the State about its recycle practices if the system is a Subpart H system, a conventional or direct filtration plant, and recycles one or more of the regulated recycle streams.

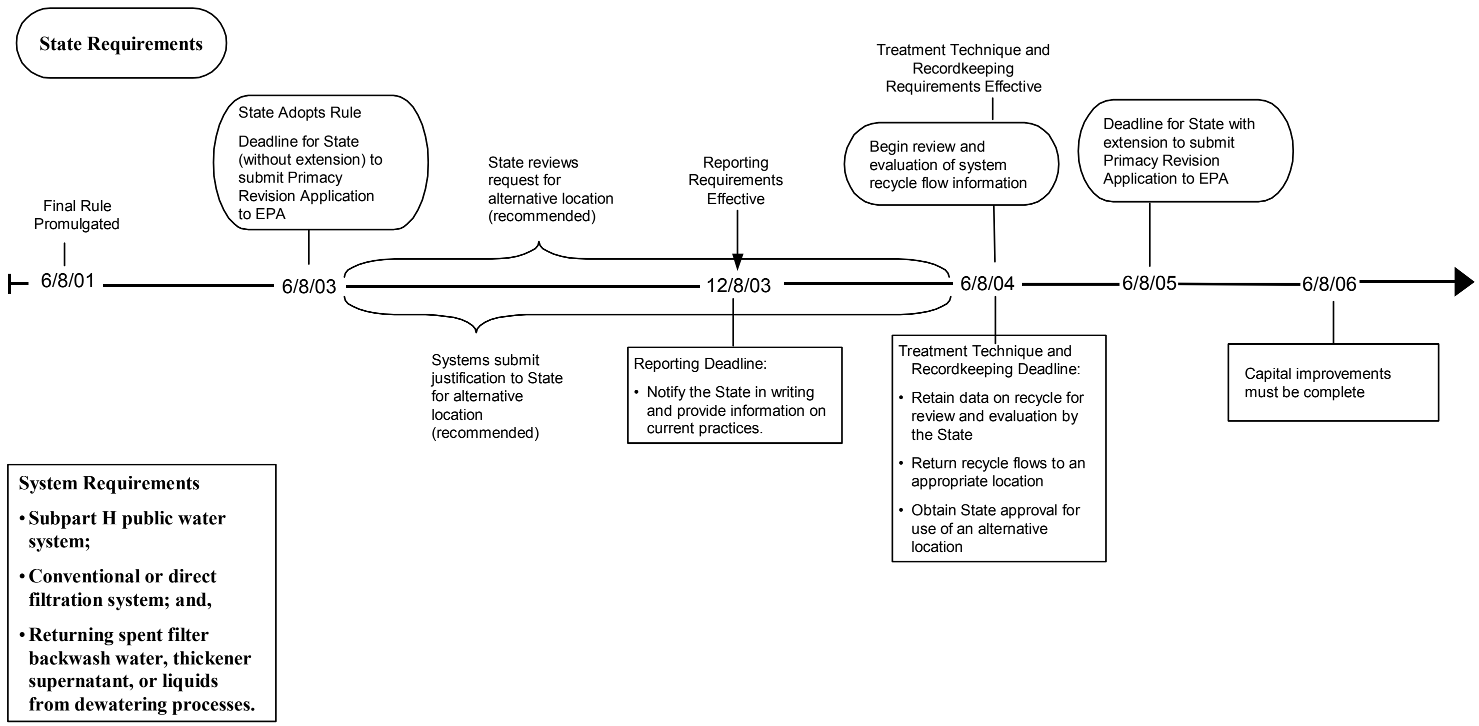
Figure 1-1. Filter Backwash Recycling Rule Provisions



1. Notification includes information specified in 40 CFR 141.76 (b) (1) and (2)
2. Recycle flow information is specified in 40 CFR 141.76 (d) (1) through (6)

Figure 1-2. Filter Backwash Recycling Rule

Rule Requirements and Implementation Timeline



Systems must notify the State by December 8, 2003. Reporting requirements are contained in Chapter 3.

- Recycle Return Location (40 CFR 141.76(c)): The FBRR requires spent filter backwash, thickener supernatant, or liquids from dewatering processes to be returned through all the processes of a system's existing conventional or direct filtration system (if the system practices recycle), as defined in 40 CFR 141.2. Systems can receive State approval to recycle at an alternate location. Details of the recycle return location requirements are discussed in Chapter 4.

- Recordkeeping (40 CFR 141.76(d)): The FBRR also includes recordkeeping requirements related to recycling procedures. Systems must collect and retain certain recycle information beginning June 8, 2004. Recordkeeping requirements are presented in Chapter 5.

If systems are unsure if the rule applies to them, they should contact their State office or Primacy Agency.

1.3 FBRR OBJECTIVE

The objective of the FBRR is to improve the control of microbial pathogens, particularly *Cryptosporidium,* in public drinking water systems by helping to ensure that recycle practices do not compromise the ability of treatment plants to produce safe drinking water. Recycle streams have the potential to contain higher concentrations of *Cryptosporidium* oocysts than source water streams and could therefore introduce additional *Cryptosporidium* oocysts into the treatment process. An increase in the concentration of *Cryptosporidium* oocysts in the treatment process may increase the risk of *Cryptosporidium* oocysts in finished water and threaten public health. *Cryptosporidium* oocysts are of concern because they are not easily inactivated by commonly used disinfectants, such as chlorine (sedimentation and filtration are the main barriers for removal of *Cryptosporidium*).

What is *Cryptosporidium*?

Cryptosporidium is an intestinal parasite that can be passed through a water treatment plant and into the drinking water supply. Infection can cause gastrointestinal illness, lasting up to two weeks, and may even be life threatening for people with weakened immune systems. Several outbreaks of cryptosporidiosis have been traced to *Cryptosporidium* in drinking water. The worst outbreaks occurred in Milwaukee in 1993 when more than 400,000 people fell ill with flu-like symptoms. *Cryptosporidium* is difficult to treat (inactivate) because it is resistant to most disinfectants used by water treatment systems. Consequently, other treatment processes, such as sedimentation and filtration, must be effective in removing *Cryptosporidium* oocysts from raw water and recycle streams.

1.4 OUTLINE OF THE DOCUMENT

This guidance manual is divided into two parts. Part I addresses issues specifically related to the FBRR regulatory requirements. It is designed to guide systems through the requirements for regulatory compliance with the FBRR. To make this process as straightforward as possible, EPA has developed flowcharts and worksheets that can be used as a reference during assessment of relevant filter backwash issues.

Part II provides guidance on recycle management options and operational considerations that may assist systems in understanding recycle processes. It addresses issues that are important to the effective management of potential recycle streams, but **are not specifically required by the FBRR regulations**. While compliance with the regulatory requirements is important for all affected systems, there are additional non-regulatory issues comprising the full scope of management of potential recycle streams. By addressing this broader range of recycling issues, systems will be able to develop strategies to achieve and maintain optimal overall treatment plant performance. This guidance manual should be a useful tool for any public water supply operator interested in improving plant performance, and not just those affected by the FBRR provisions.

Part I of the guidance is organized into four chapters and presents rule requirements:

> ***Chapter 2. Regulated Recycle Streams:*** This chapter identifies the three regulated recycle streams and discusses the sources of recycle streams with respect to conventional and direct filtration processes.
>
> ***Chapter 3. Reporting Requirements:*** This chapter contains information on the reporting requirements for systems.
>
> ***Chapter 4. Recycle Return Location:*** This chapter presents the requirements for recycle return location to ensure compliance with the FBRR. This chapter also presents issues associated with recycling to a location that does not take advantage of the entire treatment train.
>
> ***Chapter 5. Recordkeeping Requirements:*** This chapter presents recordkeeping requirements for systems and provides a detailed description of the data collection components of the FBRR.

Part II of the document is organized as follows and is strictly guidance for systems:

> ***Chapter 6. Part II Overview:*** This chapter discusses the purpose of Part II and how to evaluate collected data on recycle practices.
>
> ***Chapter 7. Recycle Streams:*** This chapter describes different recycle streams (regulated and non-regulated) and characteristics of recycle streams.

Chapter 8. Operational Considerations and Modifications: This chapter presents information on how to modify the main treatment train process or better manage recycle streams to minimize the impacts of recycle streams on finished water.

Chapter 9. Equalization: This chapter describes equalization of recycle streams and discusses the advantages and disadvantages of equalization. Case studies are presented.

Chapter 10. Treatment of Recycle Streams: This chapter describes the concept of treatment and discusses the advantages and disadvantages of treating recycle streams. This chapter also describes specific treatment options and issues associated with each treatment option. Case studies are presented.

Appendix A – Glossary
Appendix B – Worksheets
Appendix C – Reporting Example for 3.0 MGD Plant
Appendix D – Reporting Example for 20 MGD Plant
Appendix E – Reporting Example for 48 MGD Plant
Appendix F – Characteristics of Spent Filter Backwash
Appendix G – Characteristics of Thickener Supernatant
Appendix H – Characteristics of Liquids from Dewatering Processes

1.5 ADDITIONAL INFORMATION

A rule summary (eight pages long) and quick-reference guide (two pages) are available on the FBRR and provide a brief summary of the rule requirements. The implementation guide developed for States is also available. These documents can be obtained from your State office or on EPA's website (www.epa.gov/safewater/filterbackwash.html). You can also contact the Safe Drinking Water Hotline at 1-800-426-4791 for general information or visit the EPA Office of Ground Water and Drinking Water website (www.epa.gov/safewater).

PART I

2. REGULATED RECYCLE STREAMS

2.1 INTRODUCTION

> ***Rule Reference:***
> **40 CFR 141.76 (a)**
>
> **(a)** ***Applicability.*** All subpart H systems that employ conventional filtration or direct filtration treatment and that recycle spent filter backwash water, thickener supernatant, or liquids from dewatering processes must meet the requirements in paragraphs (b) through (d) of this section.

The prime objective of the FBRR is to ensure an adequate level of public health protection by minimizing the risk associated with *Cryptosporidium* in recycle flows. Under the Interim Enhanced Surface Water Treatment Rule (IESWTR) and Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) provisions, all surface water and ground water under the direct influence of surface water systems are required to achieve at least 2-log removal of *Cryptosporidium*. The recycling of spent filter backwash water and other recycle streams could impact treatment processes and finished water quality. Recycle streams may affect treatment processes due to hydraulic surges or high concentrations of contaminants in the recycle stream. The FBRR regulates three recycle streams: spent filter backwash water, thickener supernatant, and liquids from dewatering processes. These three recycle streams have the potential to adversely impact finished water quality because they may occur in sufficient volumes to create unmanageable hydraulic surges and may contain elevated concentrations of *Cryptosporidium* oocysts and other microbial and chemical contaminants.

2.2 TREATMENT PROCESSES AND ORIGINS OF RECYCLE STREAMS

> ***Regulated Recycle Streams***
> Spent filter backwash water
> Thickener supernatant
> Liquids from dewatering processes
>
> ***Unregulated Residual Streams (not all-inclusive)***
> Filter-to-waste
> Membrane concentrate
> Ion exchange regenerate
> Sludge
> Diatomaceous earth slurry

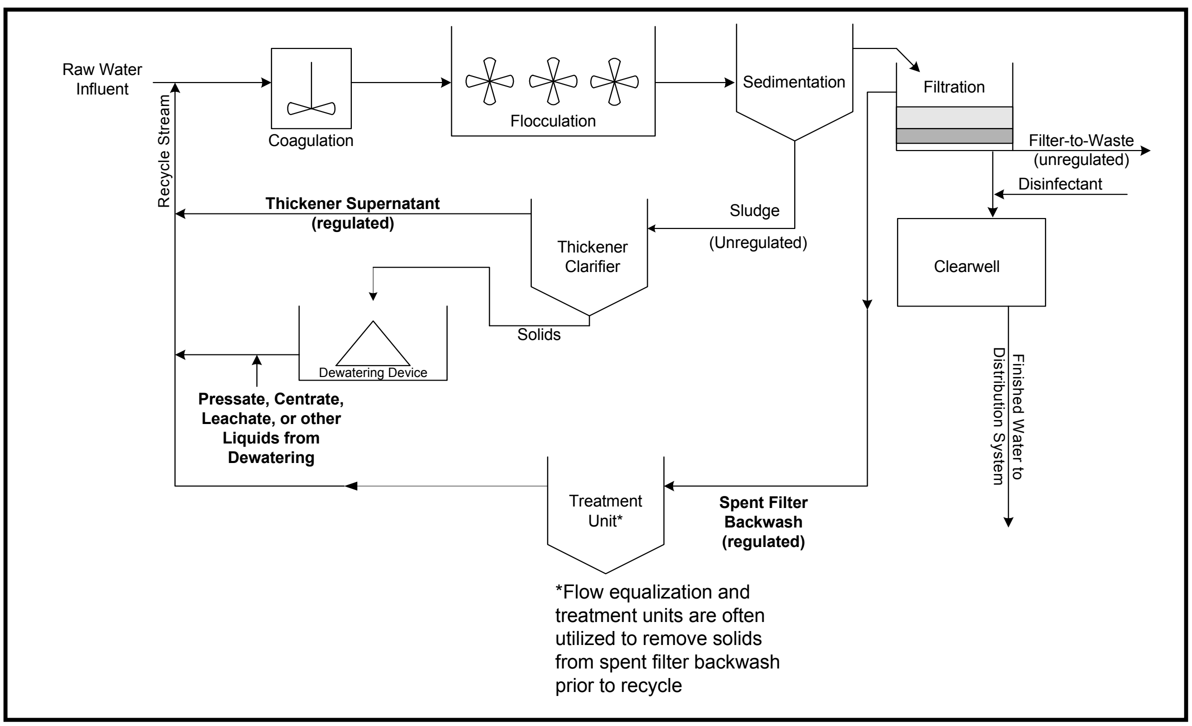
The FBRR applies to conventional and direct filtration systems that recycle spent filter backwash water, thickener supernatant, or liquids from dewatering processes. While conventional and direct filtration systems have the potential to create other unregulated recycle streams, such as filter-to-waste flows, only the three aforementioned recycle streams are regulated by the FBRR. The following sections provide a general background on conventional and direct filtration treatment processes and the origin of recycle streams. Although there are several variations of conventional and direct filtration processes, only the basic configurations will be presented here. More detailed information on recycle stream origins is contained in Chapter 7.

2.2.1 Conventional Treatment Plants

Conventional treatment plants, by definition (40 CFR 141.2), employ the following four unit processes: coagulation, flocculation, sedimentation, and filtration. The coagulation and rapid mix process usually has a short reaction time and is followed by the flocculation process. The flocculation process forms floc, which then settle in the sedimentation basin. Periodically, accumulated solids from sedimentation basins are removed. Solids can either be disposed to the sanitary sewer, discharged to a sewer or surface water (this option requires a discharge permit), or thickened and possibly dewatered, with ultimate disposal to a landfill or land-application. Particles not removed by coagulation, flocculation, and sedimentation are typically removed by the filters. Figure 2-1 shows a typical conventional treatment system.

In a conventional plant, flows that may be recycled include: spent filter backwash (regulated), gravity thickener supernatant from sedimentation solids (regulated), dewatering liquids (regulated), and filter-to-waste (not regulated). The potential recycle stream origin locations are shown in Figure 2-1.

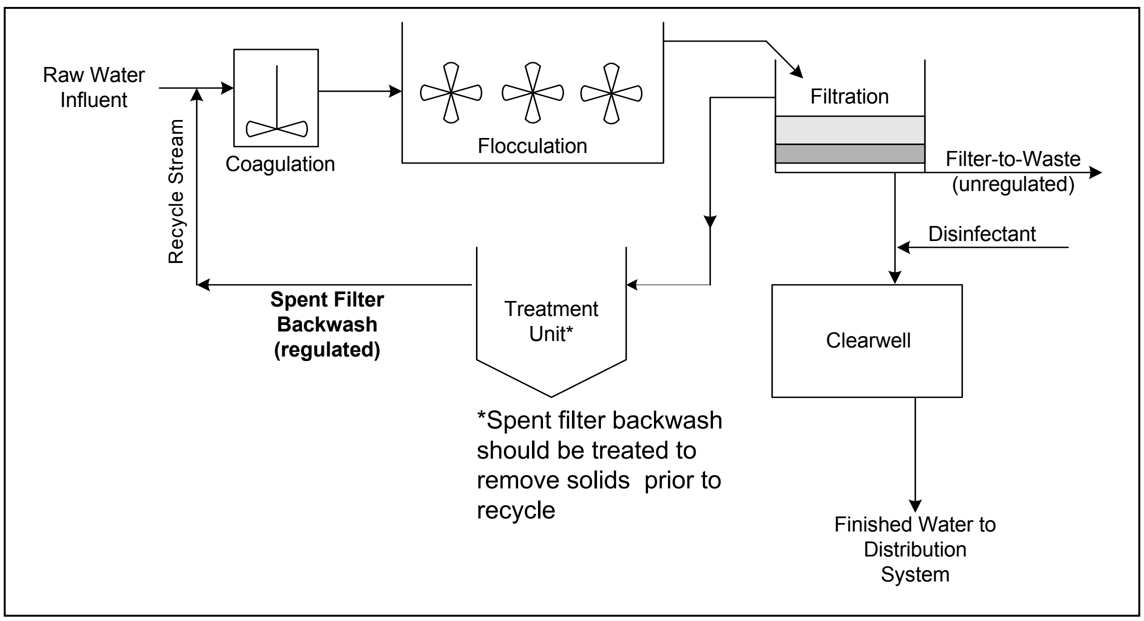
Figure 2-1. Example Conventional Filtration System with Recycle



2.2.2 Direct Filtration Plants

Direct filtration treatment omits the sedimentation process but is otherwise similar to conventional filtration treatment. Water in the treatment train goes directly from coagulation/flocculation to filtration, where solids are removed (see Figure 2-2). Hence, direct filtration systems do not produce sedimentation solids or clarification residuals during primary processes. Although the raw water turbidity of direct filtration plants is usually lower than most conventional plants, the solids loading to the filters may be higher because of the absence of the sedimentation process prior to filtration. If spent filter backwash is not treated prior to recycle, solids loading onto the filters will increase over time because there is no other way for solids to be removed from the treatment train. Therefore, solids are typically removed from recycle streams prior to being returned to the primary treatment train/plant headworks.

Figure 2-2. Example Direct Filtration System with Recycle



2.3 RECYCLE FLOWS REGULATED BY THE FBRR

Many different types of residual streams may be recycled at drinking water treatment plants. EPA originally identified twelve recycle streams for study in the proposed rule. Based on *Cryptosporidium* occurrence data and possible effects on finished water, three recycle streams were selected for regulation by the FBRR. These recycle streams are:

- Spent filter backwash water;
- Thickener supernatant (sometimes referred to as sludge thickener supernatant); and,
- Liquids from dewatering processes.

These three recycle streams are described in more detail in the following sections. Process solids recycled from clarification units are not regulated by the FBRR. However, if softening systems or contact clarification systems recycle any of the regulated flows (spent filter backwash, thickener supernatant, or liquids from dewatering processes), then these systems must comply with the requirements of the FBRR.

2.3.1 Spent Filter Backwash

A filter during backwash

Spent filter backwash is generated when water is forced through the filter, counter to the flow direction used during treatment operations. This action cleans the media by dislodging accumulated particles, including microorganisms, captured by the filter media. Consequently, the resulting spent filter backwash contains particles trapped in the filter during treatment operations, including particles produced from coagulation and pathogens such as *Cryptosporidium.* The practice of recycling may reintroduce these particles into the treatment process. Spent filter backwash water typically averages 3% to 6% of total plant production (McGuire, 1997). However, on an instantaneous basis, the spent filter backwash flows could be as high as 60% (or higher in some instances) of the plant flow. More information on spent filter backwash water characteristics is available in Chapter 7.

Spent filter backwash can be recycled with or without treatment or flow equalization.

2.3.2 Thickener Supernatant

Thickener supernatant is the decanted clear water that exits a sludge thickening basin after gravity settling. Some plants recycle the supernatant from the thickener. Depending on whether the thickener is operated in a batch mode or a continuous mode, the supernatant can be recycled to the plant intermittently or continuously.

Some plants combine the flows from several plant processes prior to thickening. The flow entering gravity thickeners primarily consist of sedimentation basin sludge but can also include spent filter backwash and flows from dewatering devices. Factors affecting the quantity of thickener supernatant produced include:

- The raw water quality;
- The quantity of residuals produced (dependant upon the raw water quality, coagulation scheme, and the sludge collection/removal efficiency);
- The level of treatment provided to thickener influent flows; and,
- The volume of the spent filter backwash (if spent filter backwash is discharged to the thickener).

More information on thickener supernatant is contained in Chapter 7.

2.3.3 Liquids from Dewatering Processes

The liquids removed from sludge, by mechanical or other means, are referred to as liquids from dewatering processes. In mechanical dewatering processes, drinking water plants often use belt presses, centrifuges, filter presses, vacuum presses, and other similar sludge-concentrating equipment. Sludge can also be dewatered in a sludge drying bed, lagoon, or monofill (sludge-only landfill). Sludges are dewatered in order to reduce their volume, which facilitates handling and disposal. The volume of the dewatering liquid depends on the volume and solids content of the thickened sludge fed to the dewatering devices. Recycle flows from dewatering devices are produced at low rates and unlikely to cause a plant to exceed operating capacity. However, the dewatering liquid may contain *Cryptosporidium* oocysts because it is derived from solids that may hold high concentrations of oocysts. More information on liquids from dewatering processes is contained in Chapter 7.

2.4 REFERENCE

McGuire, M. J. 1997. (Draft) Issue Paper on Waste Stream Recycle and Filter-to-Waste in Water Treatment Plants. Prepared for an American Water Works Association (AWWA) Technical Work Group.

3. REPORTING REQUIREMENTS

3.1 INTRODUCTION

The FBRR has specific reporting requirements. Systems must submit the required information to the State by December 8, 2003 (see Figure 3-1). This information is known as the Recycle Notification and can provide useful data for evaluating system recycle practices. A worksheet has been developed to assist systems with reporting the required information (Recycle Notification form in Appendix B). A completed example of this worksheet is included at the end of this chapter. Systems will want to check with their State to make sure the reporting format is acceptable. Examples that may be useful when completing the forms are presented in Appendices C, D, and E.

3.2 RECYCLE NOTIFICATION

Each system that uses conventional or direct filtration and recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes must provide the State with the following written information by December 8, 2003:

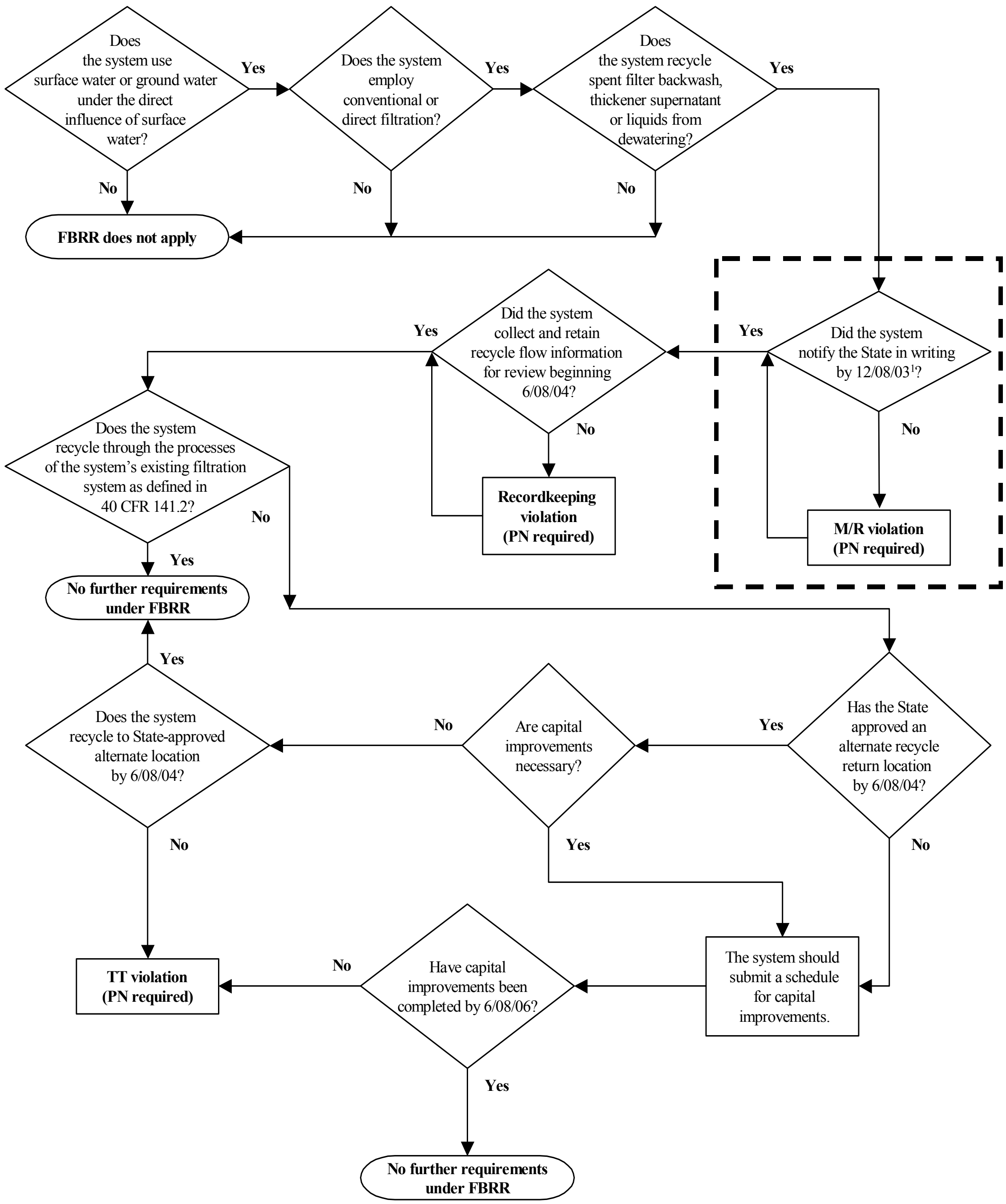
> ***Rule Reference:***
> **40 CFR 141.76 (b)**
>
> **(b) *Reporting*.** A system must notify the State in writing by December 8, 2003, if the system recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes. This notification must include, at a minimum, the information specified in paragraphs (b)(1) and (2) of this section.

- A plant schematic showing the origin of all recycle streams, the hydraulic conveyance used to transport the recycle streams, and the location where the recycled streams enter the treatment process.
- Typical recycle flow, highest observed plant flow experienced in the previous year, and design flow for the treatment plant. All flows must be reported in gallons per minute (gpm).
- The State-approved operating capacity for the plant, if the State has made such a determination.

The submitted data will be evaluated by the State to determine whether the system's current recycle return location is acceptable or if the system must make modifications. A system that fails to submit this information to the State commits a monitoring/reporting violation, which requires Tier 3 public notification. Failure to notify the public within one year of the violation is a violation of the Public Notification Rule.

The Recycle Notification form (provided in Appendix B and included as an example at the end of this chapter) can be used for the Recycle Notification, if the form is accepted by the State. Systems are required to keep a copy of the Recycle Notification and all other information submitted to the State. Systems that use, or plan to use, an alternate recycle return location may want to request approval for the alternate recycle location when submitting the Recycle Notification to the State. All alternate recycle return locations must be approved by the State by June 8, 2004. Chapter 4 provides more information on the required recycle return location.

Figure 3-1. Filter Backwash Recycling Rule Provisions- Reporting Requirements



1. Notification includes information specified in 40 CFR 141.76 (b) (1) and (2). 40 CFR 141.76 (b)(1) requires a plant schematic showing the origin of all recycle flows, the hydraulic conveyance used to transport them, and the recycle return location.
40 CFR 141.76 (b)(2) requires typical recycle flow (in gpm), highest observed plant flow for previous year (in gpm), treatment plant design flow (in gpm), and State-approved operating capacity (if a State determination has been made).

3.2.1 Plant Schematic

The plant schematic may take a variety of formats, such as Computer Aided Drafting and Design (CADD), Power Point, neatly hand-drawn figures, copy of an existing plant schematic, or other formats acceptable to the State. The contents of the schematic are more important than its format. The schematic must clearly show the following:

- Origin of all recycle streams;
- Method of transporting recycle streams, including conduits, pipes, pumps, valves, and flow controllers; and,
- Location of re-entry for recycled stream to the treatment process.

If the recycle streams undergo equalization or treatment prior to re-entering the main treatment train, this information should also be displayed in the schematic. Figures 3-2 and 3-3 are examples of acceptable schematics.

Figure 3-2. Example Plant Schematic for Recycle Notification

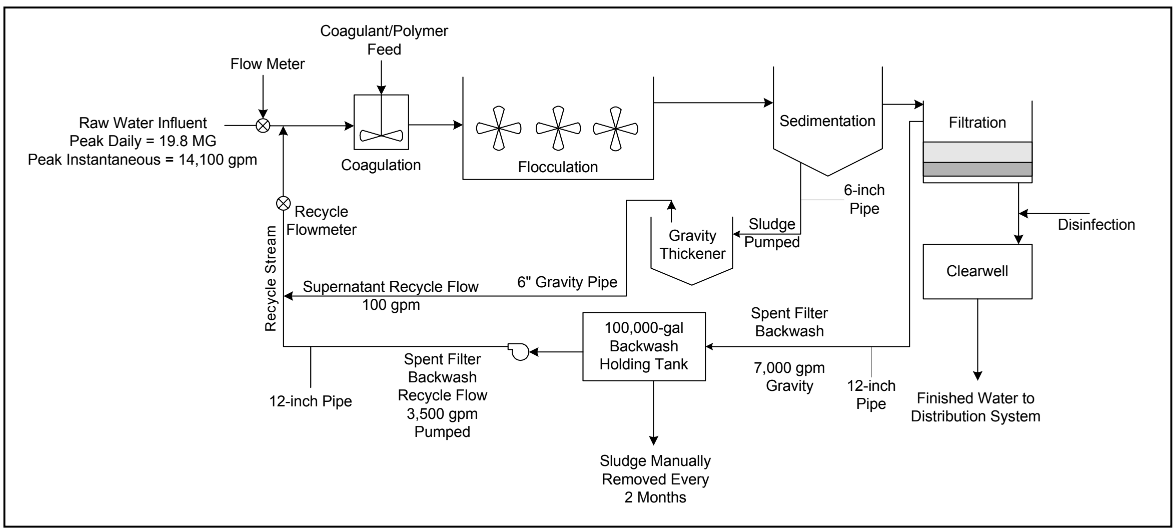
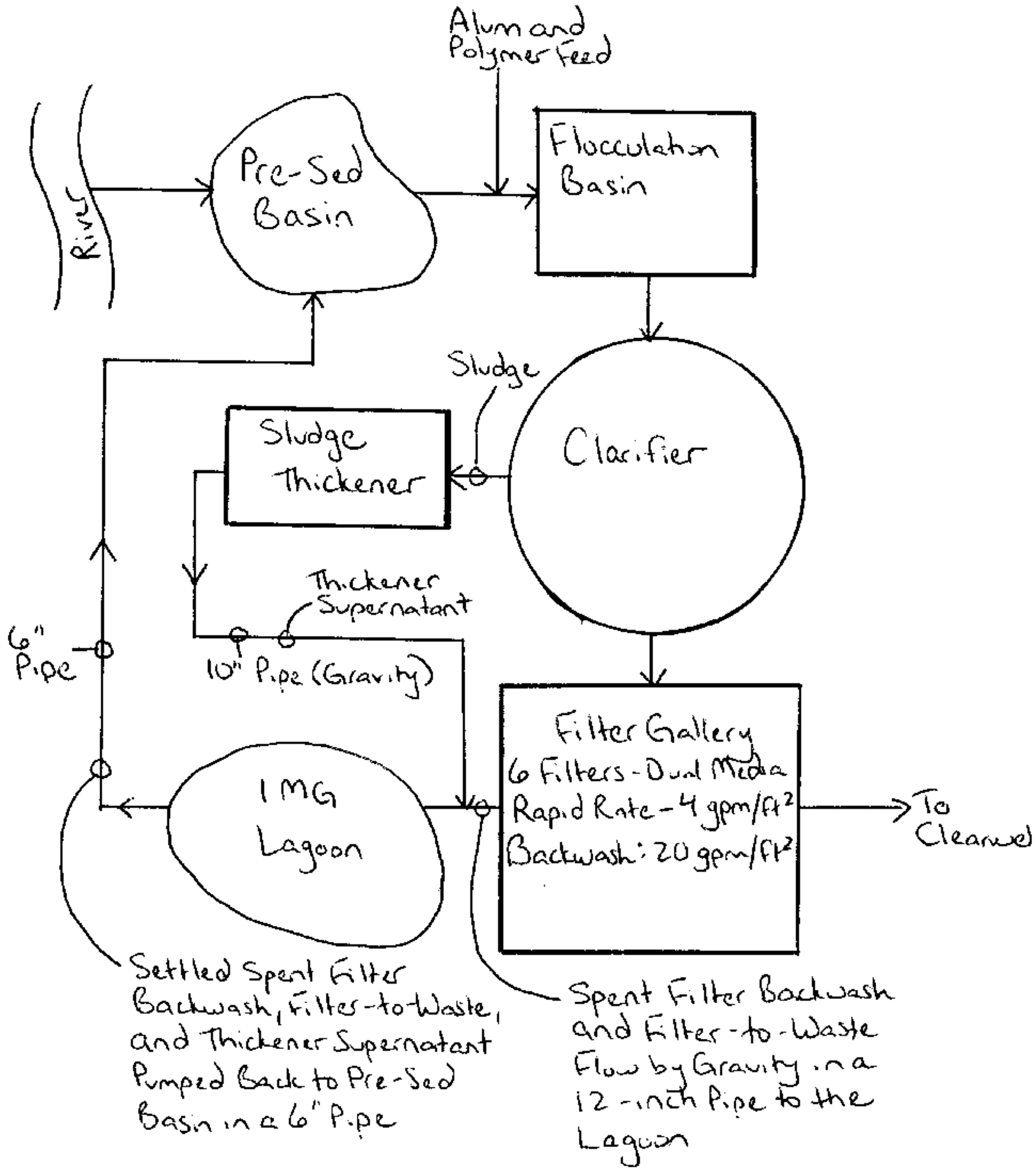


Figure 3-3 Example Hand-drawn Plant Schematic for Recycle Notification



3.2.2 Flow Information

Under the FBRR, four types of flow information are required to be reported to the State:

- Typical recycle flow (in gpm);
- Highest observed plant flow experienced in the previous year (in gpm);
- Design flow for the treatment plant (in gpm); and,
- State-approved operating capacity (if available).

The State can evaluate this information to determine if recycle practices create design flow exceedances or exceedances of the State-approved operating capacity.

Typical Recycle Flow

The typical recycle flow must be reported to the State. This value must include all recycle flows covered by this rule (spent filter backwash, thickener supernatant and liquids from dewatering processes) that are returned to the treatment train. Some States may regulate additional recycle streams and may require these to be reported as well. Methods for determining recycle flows include:

- Metering at one location or individually;
- Estimating based on backwash rates or basin overflow rates;
- Estimating from pump records, if pumps are used;
- Estimating from hydraulic conveyance capacity of the conduit; or,
- Estimating by drop in water surface elevation in a tank.

Appendices C, D, and E provide examples of how to determine the typical recycle flow. The recycle flow must be reported to the State in gpm.

Highest Observed Plant Flow in the Previous Year

To determine the highest observed plant flow experienced in the previous year, a review of plant monitoring records should be conducted. The flow should be measured at a point that accurately captures the total amount of water passing through the treatment system at a given time, including raw water and recycle flows. Locations for measuring this flow may include:

- Flowmeters at the plant inlet that record both raw water and recycle flow. In some plants, these flows may be measured separately or the flowmeter may be located such that both flows are recorded simultaneously.

- Flow into the clearwell (if representative of plant influent flow, such as in a small system). This flow may be obtained from pumping records, metered, or estimated. Measuring the flow exiting the clearwell may not provide an accurate plant flow if clearwell water is used for backwashing filters or other plant processes or if the distribution pump rate varies from the raw water rate.

- Raw water and recycle pump records (if pumps are used).

The important point to remember is that both raw water and recycle flows should be included in determining the highest observed plant flow for the previous year. The Recycle Notification form (in Appendix B) can be used to report flow information to the State. A completed example of this form is included at the end of this chapter. Systems will want to check with their State first to make sure this reporting form is acceptable.

Examples in Appendices C, D, and E provide guidelines for identifying the highest observed plant flow. Some plants may operate in a manner such that the highest observed raw water flow will not coincide with the highest observed recycle flow. Also, the highest observed raw water flow may not represent the highest observed plant flow if recycle flows are significant (see example in Appendix C for an illustration of a situation where the highest observed plant flow occurred when recycle flows were being returned at a significant rate). The highest observed plant flow must be reported in gpm.

Design Flow

The design flow for the treatment plant does not require measurement and should be available from design documents, facility plans, or operation and maintenance manuals. The design flow must be reported to the State in gpm.

State-Approved Operating Capacity

If the State has determined and approved an operating capacity for a system, the system must provide this information as part of the Recycle Notification. Systems may want to contact the State to verify if they have a State-approved operating capacity.

3.2.3 Recycle Notification Form

The Recycle Notification form in Appendix B can be used for the Recycle Notification to the State, if the form is acceptable to the State. A completed example of this form is shown on the next page (also found in Appendix C). Other examples illustrating how to complete this form can be found in Appendices C, D, and E.

FILTER BACKWASH RECYCLING RULE
RECYCLE NOTIFICATION FORM

SYSTEM NAME _Example 3.0 MGD Plant_______________________________

PWSID ___________________________________ **DATE** __Dec 1, 2003__________

Check with your State or Primacy Agency to make sure this form is acceptable.

Does your system use conventional or direct filtration? __Yes (conventional)_______________
Does your system recycle spent filter backwash water, thickener supernatant, or liquids from dewatering processes? __Yes (spent filter backwash)__________________________________
If you answered yes to both questions, please report the following:

1. What is the typical recycle flow (in gpm)?___1,500 gpm______________________________
2. What was the highest observed plant flow for the system in the previous year (in gpm)?
___2,500 gpm____
3. What is the design flow for the treatment plant (in gpm)? __2,080 gpm_________________
4. Has the State determined a maximum operating capacity for the plant? If so, what is it? __2,080 gpm____
5. Please include a plant schematic that shows:
   - the origin of **all** recycle flows (spent filter backwash, thickener supernatant, liquids from dewatering processes, and any other);
   - the location where **all** recycle flows re-enter the treatment plant process; and
   - the hydraulic conveyance used to transport **all** recycle flows.

Comments: ___The highest observed plant flow of 2,500 gpm exceeds State-approved operating capacity.____

____

---

6. Are you requesting an alternate recycle location? __________Yes ____X_____ No
An alternate recycle location is one that does not incorporate all treatment processes of a conventional filtration plant (coagulation, flocculation, sedimentation, and filtration) or direct filtration plant (coagulation, flocculation, and filtration). The State or Primacy Agency must approve the recycle location by June 8, 2004. Please contact your State or Primacy Agency on what additional information may be needed.

Comments: ____

____

4. RECYCLE RETURN LOCATION

4.1 INTRODUCTION

> ***Rule Reference:***
> **40 CFR 141.76 (c)**
>
> **(c)** ***Treatment technique requirement***. Any system that recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes must return these flows through the processes of a system's existing conventional or direct filtration system as defined in 40 CFR 141.2 or at an alternate location approved by the State by June 8, 2004. If capital improvements are required to modify the recycle location to meet this requirement, all capital improvements must be completed no later than June 8, 2006.

To ensure at least 2-log removal of *Cryptosporidium*, regulated recycle streams must be introduced at a location where the flow passes through the treatment processes of the system's existing conventional or direct filtration system or at an alternate location approved by the State (see Figure 4-1). The preamble of the FBRR cites eight studies on conventional and direct filtration systems that demonstrate 2-log *Cryptosporidium* removal. The 2-log *Cryptosporidium* removal was achieved in those studies when:

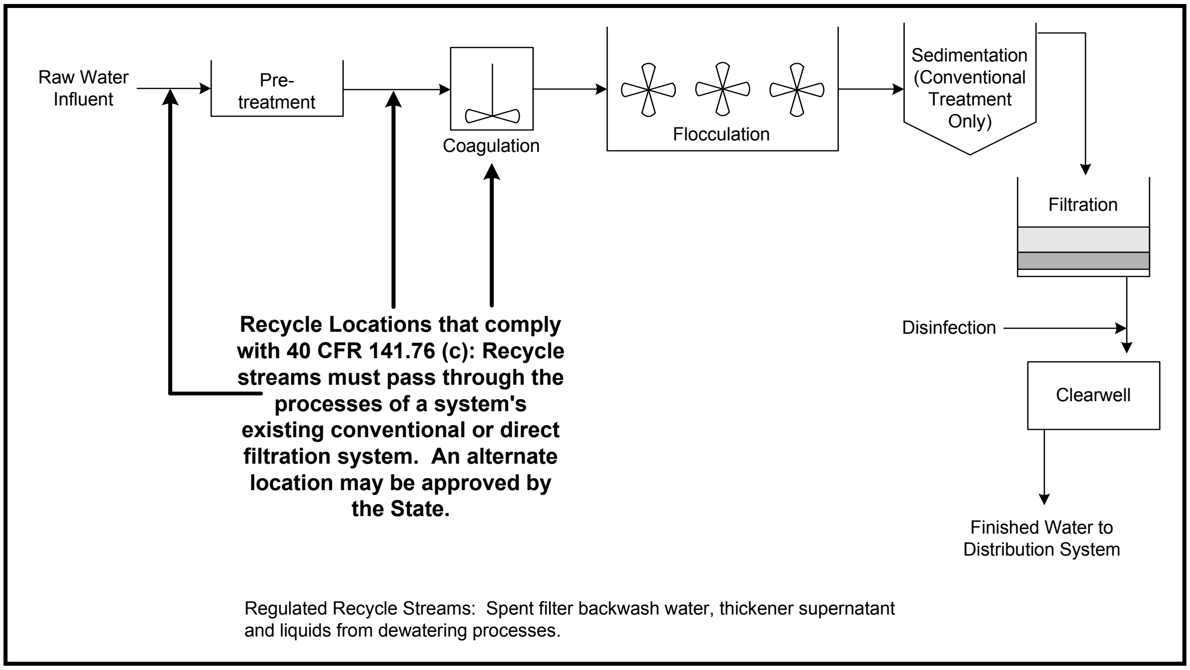
- Coagulation, flocculation, sedimentation (in conventional filtration only), and filtration were employed; and,
- The turbidity limits in the finished water as specified in the IESWTR and LT1ESWTR were met.

To obtain the 2-log *Cryptosporidium* removal, the FBRR requires recycle streams to pass through all conventional (coagulation, flocculation, sedimentation, and filtration) or direct (coagulation, flocculation, and filtration) filtration processes to receive optimum treatment.

An existing system may have a recycle location that does not incorporate all conventional or direct filtration treatment processes. The concerns associated with these recycle locations are:

- The return of the recycle stream after the point of primary coagulant addition may disrupt the chemistry of the treatment process and may impair treatment performance.
- If the recycle stream is not treated through coagulation and flocculation, oocysts and other contaminants could pass through the filters. Sedimentation and filtration are the main barriers to *Cryptosporidium* since it is resistant to certain disinfectants (primarily chlorine and chloramines) and proper coagulation and flocculation are necessary for optimum filter performance.
- The 2-log *Cryptosporidium* removal may not be achieved if the recycle stream does not pass through all treatment processes in a conventional or direct filtration system.

Figure 4-1. Examples of Recycle Return Locations



Treatment plants that return recycle streams to an alternate location (i.e., a location other than shown in Figure 4-1) in order to maintain optimal treatment performance may apply to the State to recycle at an alternate location. If the system has questions regarding the required recycle return location, they should contact the State or Primacy Agency.

4.2 TIMELINE FOR COMPLIANCE

A timeline for recycle location compliance is presented in Table 4-1. It presents several compliance scenarios and deadlines for submitting information or completing activities. Figure 4-2 contains a flowchart for recycle return location compliance. For a timeline of all rule requirements and deadlines, see Figure 1-2 in Chapter 1.

If a system currently recycles to a location that allows the recycle stream to be processed through the treatment processes of the existing conventional or direct filtration system, the system is not required to make any changes to the recycle return location. However, the system must comply with all reporting and recordkeeping requirements of the FBRR, as presented in Chapters 3 and 5.

If a system currently recycles to a location in the treatment process that does not allow the recycle stream to pass through the treatment processes of the system's existing conventional or direct filtration processes, the system may submit a request to the State for approval of this alternate recycle location. The checklist on page 27 may be useful when evaluating an alternate recycle return location. The State must approve or deny such a request by June 8,

2004. Systems may want to consider submitting an alternate return location request with the Recycle Notification information due on December 8, 2003 (see Chapter 3 for details).

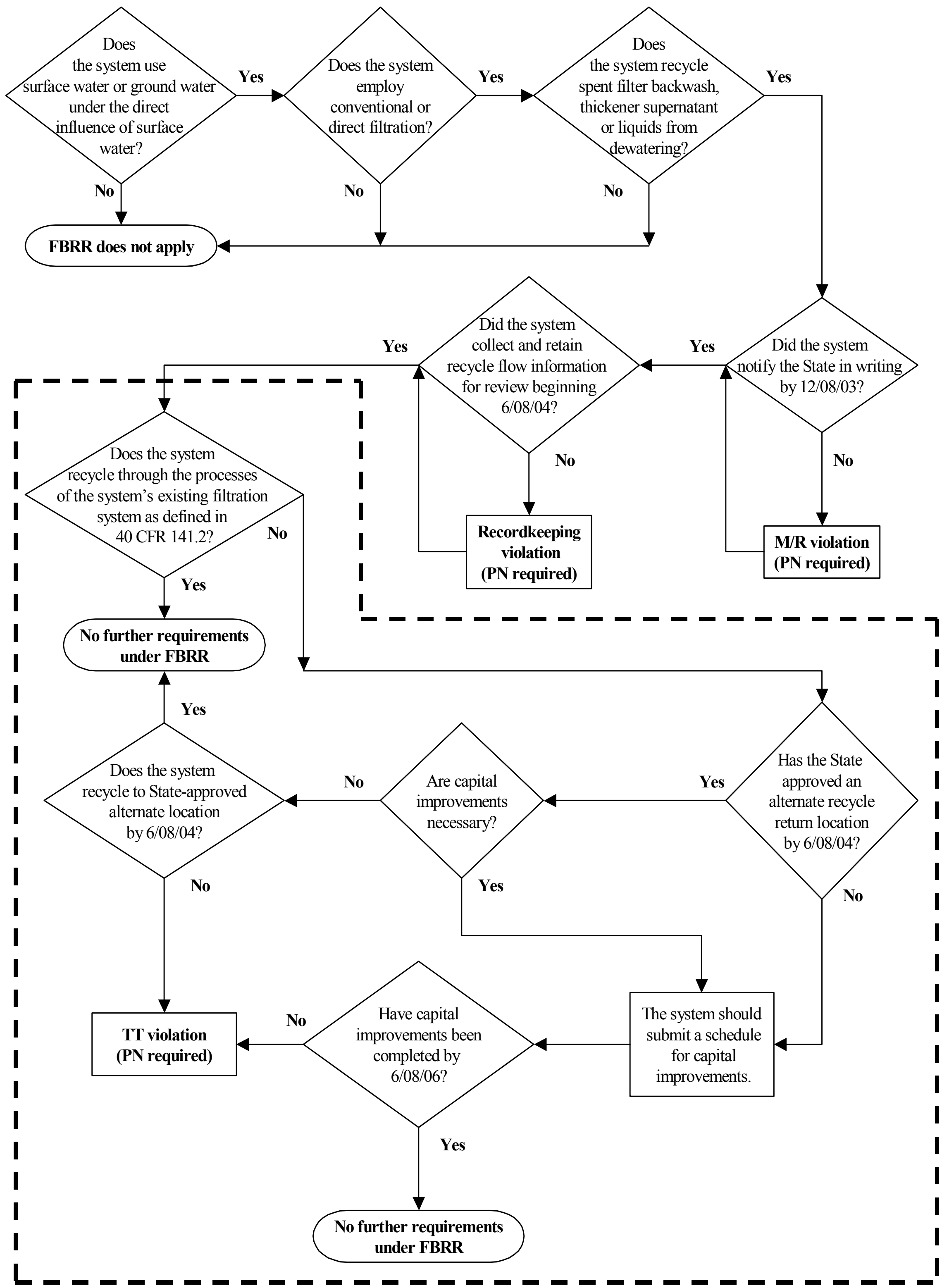
If the State does not approve the alternate location and capital improvements are needed to relocate the recycle return point, or if the State approves an alternate recycle location that requires capital improvements, the system must complete the necessary capital improvements by June 8, 2006.

If the system decides to relocate the existing recycle return point so that recycle is returned through all processes of the system's existing conventional or direct filtration treatment train (as defined in 40 CFR 141.2), capital improvements must be completed no later than June 8, 2006.

Table 4-1 Recycle Return Location Compliance Schedule

If:	The System Must:	By:
No capital improvements are necessary and the system is not seeking approval for an alternate location . . .	meet only the reporting and record-keeping requirements of the FBRR . . .	See Chapters 3 and 5.
The system is planning to request state approval for use of an alternate location . . .	receive approval from the State . . .	June 8, 2004.
The system is planning to request State approval for use of an alternate location AND capital improvements are necessary . . .	receive approval from the State for alternate recycle return location . . .	June 8, 2004; and,
	complete all improvements . . .	June 8, 2006.
Capital improvements are necessary to relocate the point of recycle return . . .	complete all improvements . . .	June 8, 2006.

Figure 4-2. Filter Backwash Recycling Rule Provisions- Recycle Return Location



Systems seeking approval of an alternate recycle return location should consider submitting:

- A written request explaining the reason and/or rationale for using the alternate recycle location (such as if the plant requires recycle to an alternate location to maintain optimal finished water quality, or other reason), including an explanation of why the alternate recycle location would not or does not cause a negative impact upon the finished water quality.

- A plant schematic identifying the alternate recycle location (which may be the schematic required in 40 CFR 141.76(b) if the alternate location is currently used).

- Demonstration of compliance with IESWTR/LT1ESWTR turbidity limits through submission of combined filter effluent and/or individual filter effluent data.

- A description of the type of treatment(s) applied to the recycle stream (if any).

- A comparison of plant influent water quality to the recycle stream water quality. Data for comparison may include, but are not limited to:
  - Turbidity;
  - Cysts and oocysts;
  - Cyst and oocyst-sized particles;
  - Iron and/or manganese;
  - Disinfection Byproduct (DBP) levels;
  - Level of organic matter (TOC, DOC, UV_{254}); and,
  - pH.

- Information on sedimentation performance (as evidenced by settled water turbidity as related to recycle practices).

- Design and monitoring data for the alternate recycle location.

- Information on the current loading rates of unit processes, and the impact to the loading rates caused by the alternate location.

- Information on flow control during recycle.

- An analysis of other impacts that the alternate location may have on finished water quality.

5. RECORDKEEPING REQUIREMENTS

5.1 INTRODUCTION

The FBRR has specific recordkeeping requirements in addition to the reporting requirements (see Chapter 3) and recycle return location requirements (see Chapter 4).

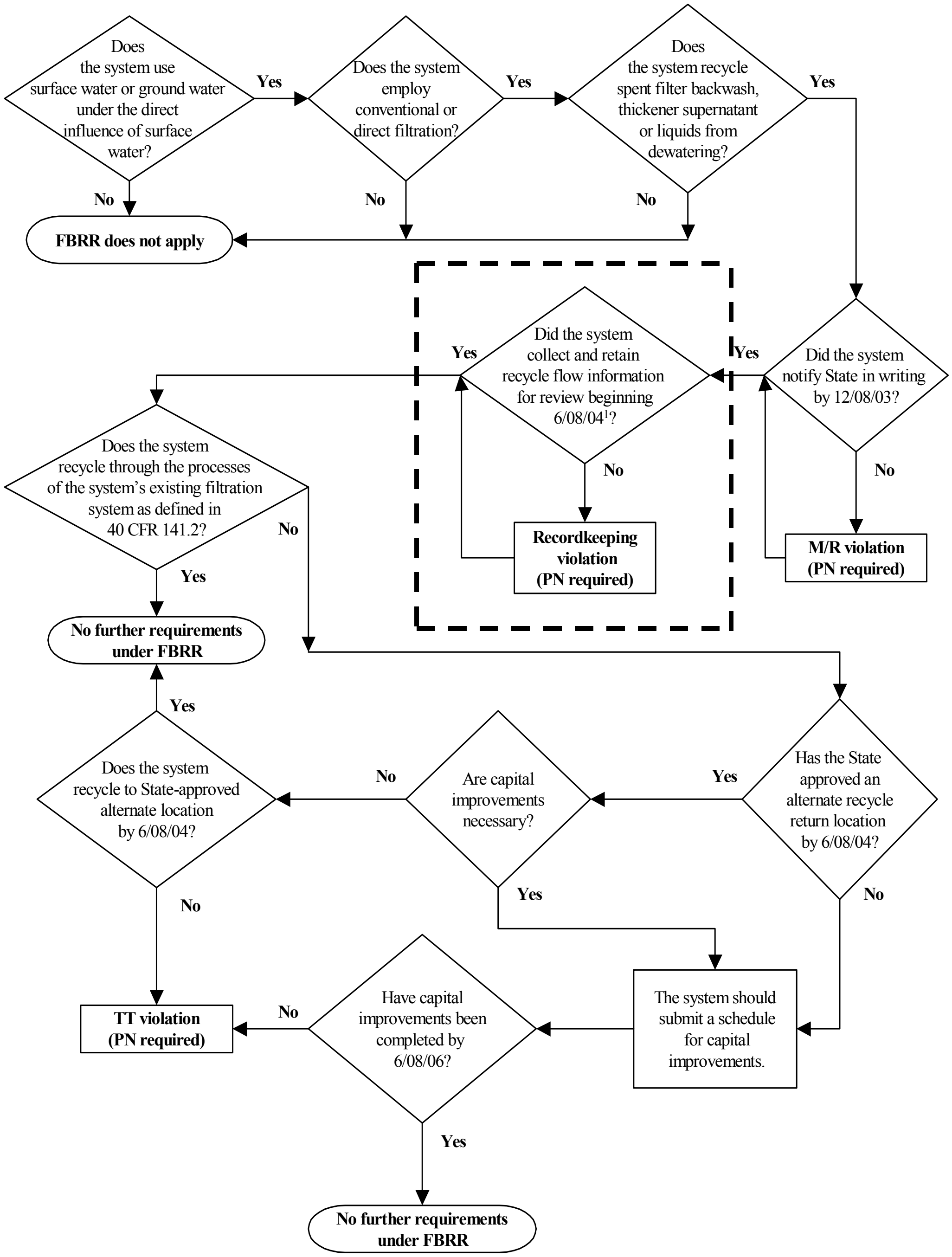
For FBRR compliance, a system must collect and retain the following information for review and evaluation by the State beginning June 8, 2004 (see Figure 5-1):

> ***Rule Reference:***
> **40 CFR 141.76 (d)**
>
> **(d)** ***Recordkeeping.*** The system must collect and retain on file recycle flow information specified in paragraphs (d)(1) through (6) of this section for review and evaluation by the State beginning June 8, 2004.

- A copy of the Recycle Notification (see Chapter 3);
- A list of all recycle flows and the frequency at which they are returned;
- Average and maximum backwash flow rates through the filters and the average and maximum duration of the filter backwash process, in minutes;
- Typical filter run length and a written summary of how filter run length is determined (e.g., headloss, turbidity, time, etc.);
- If applicable, the type of treatment provided for the recycle stream before it re-enters the conventional or direct filtration process; and,
- If applicable, data about the physical dimensions of the equalization and/or treatment units, typical and maximum hydraulic loading rates, types of treatment chemicals used, average dose of chemicals, frequency of chemical addition, and frequency of solids removal.

With the exception of the Recycle Notification, systems are not required to submit this information unless requested to do so by the State. However, all of the information must be made available by the system for State review during sanitary surveys, Comprehensive Performance Evaluations, or other inspections or activities. After the State reviews this information, a system may be required to modify its recycling practices or undertake other activities. Failure to comply with the recordkeeping requirements is a recordkeeping violation, which requires Tier 3 public notification. Failure to notify the public of the violation within the appropriate time frame is a public notification violation. The worksheet in Appendix B (Recordkeeping Form) can be used for collecting data (if this form is acceptable to the State). A completed example of this form is included at the end of this chapter. Appendices C, D, and E contain examples that may be helpful when completing the forms.

Figure 5-1. Filter Backwash Recycling Rule Provisions- Recordkeeping Requirements



1. System must collect and retain the following information: a copy of the Recycle Notification; a list of all recycle flows and the frequency with which they are returned; average and maximum backwash flow rates through the filters and the average and maximum durations of the filter backwash process, in minutes; typical filter run length and a written summary of how filter run length is determined (e.g. headloss, turbidity, time, etc.); if applicable, the type of treatment provided for the recycle flow before it re-enters the conventional or direct filtration process; if applicable, data about the physical dimensions of the equalization or treatment units, typical and maximum hydraulic loading rates, type of treatment chemicals used, average dose of chemicals, frequency of chemical addition, and frequency of solids removal.

5.2 REQUIRED RECORDKEEPING INFORMATION

The following sections provide information on the required recordkeeping information the system must collect. Systems should consult the State on frequency of data collection. The State could require a system to collect data as operating conditions change, such as on a seasonal basis.

5.2.1 Recycle Notification

Systems must maintain a copy of all information that is submitted to the State, as described in Chapter 3.

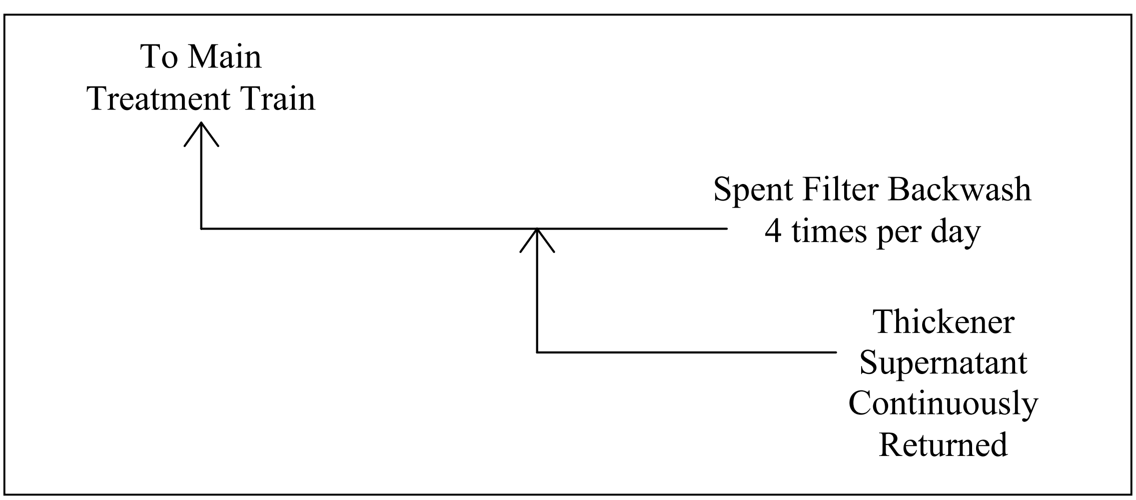
5.2.2 Recycle Flows

The system must retain a list of all recycle flows (regulated and non-regulated) and the frequency of return of each flow. Recycle streams are often generated at varying frequencies and flow rates. It is important to recognize that the rate at which each recycle stream is generated may differ from the rate at which these flows are returned to the treatment train if equalization and/or treatment of recycle streams is provided. The FBRR requires systems to record the frequency at which recycle flows are returned. If allowed by the State, the Recordkeeping Form can be used to record recycle flow information (see Appendix B). A completed example of this form is included at the end of this chapter. Examples in Appendices C, D, and E provide examples of ways to collect recycle flow information.

<u>Recycle without Treatment or Equalization</u>

If recycle streams are returned to the main treatment train without equalization and/or treatment, then the system must record the frequency at which the flows are returned to the main treatment train (see Figure 5-2).

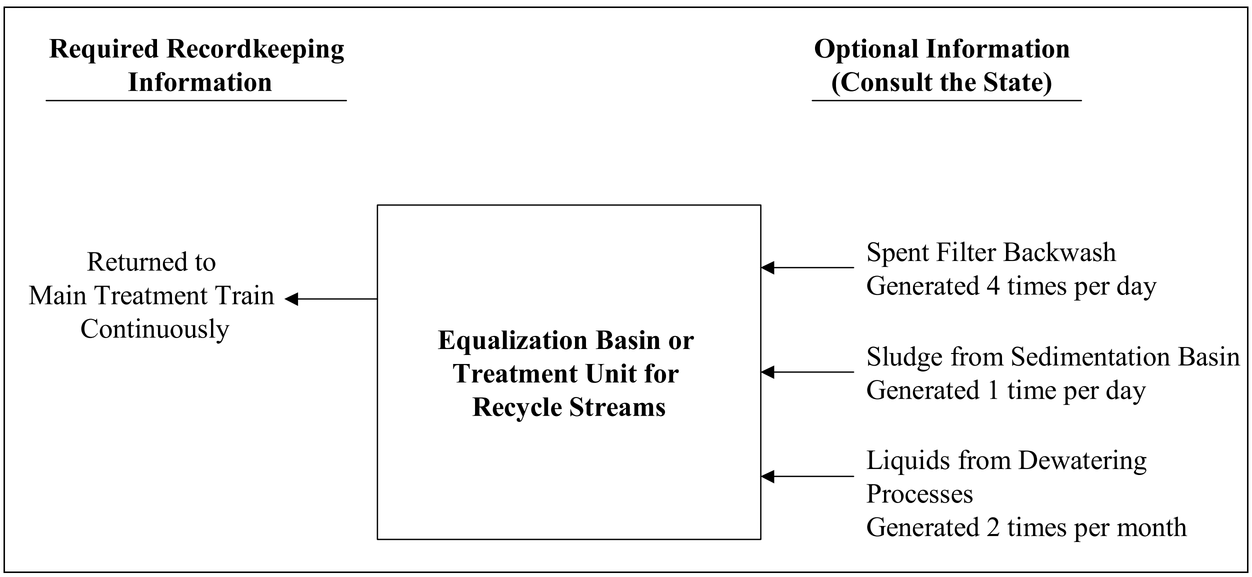
Figure 5-2. Example of Recycle Flow Frequency Recordkeeping Information (No Equalization or Treatment of Recycle Streams Provided)



Recycle with Treatment and/or Equalization

If recycle streams are discharged to an equalization basin or treatment unit, then the frequency at which these flows are returned to the main treatment train must be recorded. States may want systems to also record the frequency at which recycle flows are generated if equalization and/or treatment is provided to the recycle flows. Knowing the frequency at which recycle flows are generated and returned will assist systems and States in assessing recycle practices. Figure 5-3 provides a schematic that illustrates the required information that systems must record and some of the types of optional information States could request.

Figure 5-3. Example of Recycle Flow Frequency Information (Equalization and/or Treatment Provided)



5.2.3 Backwash Information

Systems must collect the following backwash information for the filter(s):

- Average backwash flow rate through the filter;
- Average duration of filter backwash;
- Maximum backwash flow rate through the filter; and,
- Maximum duration of filter backwash.

Filters tend to be backwashed in a highly regulated and well-monitored manner. The plant records should be specific about the filter backwash process. Some systems may not vary the backwash rate throughout the backwash process, so that the average and maximum backwash rates are the same. Other systems may vary the backwash rate throughout the backwash process. For instance, a system may use air scour or surface wash in addition to backwashing. The average and maximum backwash rates are different in this case because of the varying backwash rate. Also, some systems may vary the backwash rates seasonally based on changing water temperature or system loading rates. States may require systems to collect backwash information for different operating conditions. Systems should check with the State to determine the frequency of data collection. Backwash flow rates can be reported based on metered values, rise-rate tests, pump records, or other means.

The Recordkeeping Form in Appendix B can be used to record backwash information. A completed example of this form is included at the end of this chapter. Examples in Appendices C, D, and E illustrate how backwash information can be collected and recorded.

5.2.4 Filter Run Length and Termination of Filter Run

Systems must provide to the State the typical filter run length (typical time that a filter is operated before it is backwashed). The filter run length is the sum of the time that the filter is operating between backwashes. As water passes through, a filter becomes clogged with particles that eventually could begin to compromise the treatment ability of the filter. Systems may have different methods for determining typical filter run length.

Systems must maintain a written summary of the methods used to determine the run time along with the typical filter run time. If turbidity, head loss, or filter effluent turbidity thresholds are used to determine the filter run time, these thresholds should be provided. If the filter run is terminated based on a pre-determined time established by the system or other means, this determination should also be noted.

The Recordkeeping Form in Appendix B can be used to record this information. A completed example of this form is included at the end of this chapter. Examples in Appendices C, D, and E provide an example of how to report the information.

5.2.5 Recycle Stream Treatment

If a system treats or equalizes its recycle streams, then information about these processes must be included in records maintained for the FBRR. The system must record information on the type of treatment that is provided.

5.2.6 Equalization and Treatment Information

If equalization or treatment of the recycle stream is provided, systems must collect the following information on the units:

- Physical dimensions of the equalization and/or treatment units. A sketch of the unit with dimensions may be helpful. This information will be used to determine the capacity of the unit;

- Typical and maximum hydraulic loading rates. This could include generated rates for each recycle stream (see Figure 5-3);

- Type of treatment chemical(s) used, if the recycle stream is chemically treated. It may be useful to note whether the chemical is introduced to the recycle stream prior to entering the unit or directly into the unit;

- Average dose rate of the treatment chemical and frequency of chemical use must be provided; and,

- Frequency of solids removal. Solids removal is important because solids can reduce the equalization/treatment capability of the unit by occupying a significant volume in the unit. Systems will need to record the frequency of solids removal (for example, once a month).

The Recordkeeping Form in Appendix B can be used to record this information. A completed example of this form is included at the end of this chapter. Examples in Appendices D and E illustrate how this information can be collected and recorded.

FILTER BACKWASH RECYCLING RULE RECORDKEEPING FORM

SYSTEM NAME __Example 3.0 MGD Plant________________________

PWSID ______________________________ **Operating Period**[1] _Jun 2003-Jun 2004

Check with your State or Primacy Agency to make sure this form is acceptable.

Type of Recycle Stream	Frequency at which flow is returned[2]
Spent Filter Backwash	4 times/day returned to main treatment train
Thickener Supernatant	
Liquids from Dewatering Process	
Other	
Other	

Filter Information	Filter Number[3]			
	1-8, all filters the same			
Average Duration of Backwash (in minutes)	15 minutes			
Maximum Duration of Backwash (in minutes)	15 minutes			
Average Backwash Flow[4] (in gpm)	1,500 gpm			
Maximum Backwash Flow[4] (in gpm)	1,500 gpm			
Run Length Time of Filter[5] (include units)	48 hrs			
Criteria for Terminating Filter Run[6]	Time, unless individual filter turbidity exceeds 0.2 NTU.			

Is treatment or equalization provided for recycle flows? __________Yes ____X_____ No

If yes, complete the following table.

Type of Treatment Provided		
Physical Dimensions of Unit		
Typical Hydraulic Loading Rate		
Maximum Hydraulic Loading Rate		
Type of Chemical Used		
Average Dose of Chemical (mg/L)		
Frequency of Chemical Addition		
Frequency of Solids Removal		

See instructions on back.

Instructions

1. Note the operating period for the information provided. Check with your State or Primacy Agency for required operating period.

2. The frequency at which the recycle stream is returned can be described as continuous, once a day, or as another frequency.

3. Fill out all information for each of your filters. If some or all filters are operated the same, note the appropriate filter numbers.

4. The backwash flow is obtained by multiplying filter surface area (in ft^2) by backwash rate (gpm/ft^2). Use the average backwash rate to get the average flow and the maximum backwash rate to get the maximum flow. If the flow is varied throughout the backwash process, then the average can be computed on a time-weighted basis as follows:

$$\frac{(\text{Backwash Rate 1 X Duration 1}) + (\text{Backwash Rate 2 X Duration 2}) + \ldots}{\text{Duration 1} + \text{Duration 2} + \ldots}$$

5. The filter run length time is the sum of the time that the filter is producing water between backwashes.

6. Describe how run length time is determined. For example, is the run length based on head loss across the filter, turbidity levels of filter effluent, a predetermined amount of time, or another method?

PART II

6. PART II OVERVIEW

Water treatment systems typically recycle residual streams for one or both of the following reasons:

- Water resources are limited, such as in the arid southwest, and the system may not be able to access additional water. Therefore, certain residual streams (such as spent filter backwash) are recycled to maximize production.

- Recycling of residual streams may be more cost-effective than disposal, such as discharge to a storm sewer or sanitary sewer. Therefore, the system recycles the residual stream.

For those systems regulated by the FBRR, specific reporting, recycle return location, and recordkeeping requirements apply (as described in Chapters 3, 4, and 5). States will most likely evaluate the information collected and submitted by systems and decide if recycle practices are impacting finished water quality. If the State identifies problems with recycle practices or the recycle return location, then States and systems should revise or alter main treatment plant processes and/or recycle practices to minimize impacts on finished water. For instance, an exceedance of turbidity limits may be linked to recycle practices. Part II of this document provides information on how States and systems can evaluate recycle practices, recycle stream characteristics, and alternatives to consider to minimize the impacts of recycle practices on treatment plant performance and in particular, finished water quality. **States and systems should note that the information presented in Part II is provided as an additional resource and is not required by the FBRR. In some instances the information is very site specific. Therefore, if systems are considering modifying their treatment process or recycle practices, the State should be consulted prior to any modification.**

Part II contains the following chapters:

- ***Chapter 7. Recycle Streams:*** This chapter describes different recycle streams (regulated and non-regulated) and characteristics of recycle streams.

- ***Chapter 8. Operational Considerations and Modifications:*** This chapter presents information on how to modify the main treatment train process or better manage recycle streams to minimize the impacts of recycle streams on finished water.

- ***Chapter 9. Equalization:*** This chapter describes equalization of recycle streams and discusses the advantages and disadvantages of equalization. Case studies are presented.

- ***Chapter 10. Treatment of Recycle Streams:*** This chapter describes the concept of treatment and discusses the advantages and disadvantages of treating recycle streams. This chapter also describes specific treatment options and the issues associated with each treatment option. Case studies are presented.

States and systems can also refer to the references listed at the end of each chapter and AWWA's *Self Assessment of Recycle Practices* (2002) for more detailed information on a specific case study or evaluation of recycle practices.

7. RECYCLE STREAMS

7.1 INTRODUCTION

Water treatment plants throughout the United States recycle or reintroduce a variety of residual streams back into their treatment plants. Some of these flows may contain *Cryptosporidium* oocysts and other contaminants, while others may be quite harmless. As indicated elsewhere in this document, only three recycle streams (spent filter backwash water, thickener supernatant, and liquids from dewatering processes) are regulated by the FBRR. (Note: The FBRR only applies to conventional and direct filtration systems that recycle one or more of the regulated recycle streams.) These streams are regulated because they are the recycle streams most likely to contain *Cryptosporidium* oocysts (and other contaminants) and may represent a large percentage of overall plant production. Spent filter backwash water data indicates that both *Cryptosporidium* and *Giardia* cysts can occur in greater concentrations than raw water concentrations. Thickener supernatant and liquids from dewatering processes both result from sludge that may contain elevated *Cryptosporidium* and *Giardia* cyst concentrations in comparison to raw water concentrations. Data show that microbial contaminants, in addition to other contaminants, can be released from the sludge into the recycle stream if the sludge is not properly settled, treated, and/or removed. In addition to contaminants, the volume and/or flow rates of the recycle stream are also of concern. Two of the regulated streams- spent filter backwash water and thickener supernatant- can be produced at sufficient rates to create hydraulic surges or cause a water treatment plant to exceed operating capacity.

Regulated Recycle Streams
- Spent filter backwash water
- Thickener supernatant
- Liquids from dewatering processes

Unregulated Residual Streams (not all-inclusive)
- Filter-to-waste
- Membrane concentrate
- Ion exchange regenerate
- Sludge
- Diatomaceous earth slurry

In addition to the regulated recycle streams, water treatment plants produce other streams that, as of yet, are not regulated. Examples of typical unregulated streams are filter-to-waste, membrane concentrate, ion exchange regenerate, and sludge. These streams were not regulated in the FBRR because of one or more of the following:

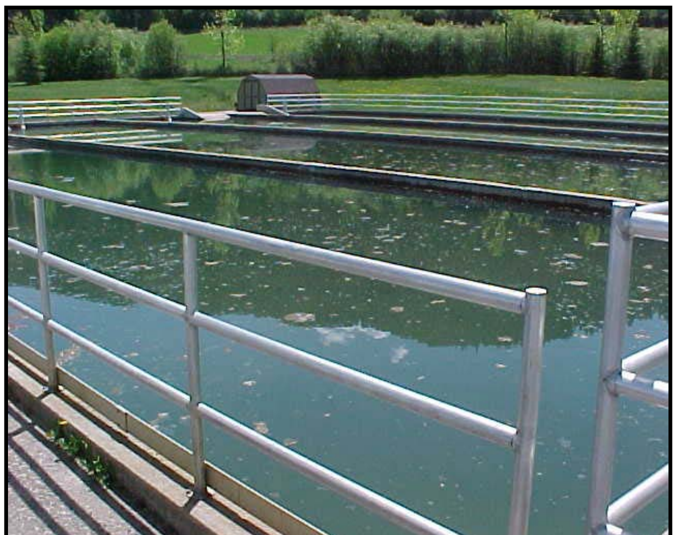
- The quality of the stream was of high quality and probably would not adversely impact overall treatment plant efficiency (such as filter-to-waste);
- The stream was of such small volume that the chance of hydraulic surge was minimal (such as waste flows from turbidimeters); or,
- The stream was not typically recycled due to the quality of the stream (such as ion exchange regenerate).

This chapter provides a discussion of each of the regulated recycle streams and a brief discussion of some recycle streams not regulated by the FBRR.

7.2 SPENT FILTER BACKWASH WATER

Filter backwashing is an integral part of treatment plant operation. Filters are typically cleaned by flushing them with water in the reverse direction to normal flow. The water flow must have sufficient force to separate particles from the filter media, so a greater than normal flow is used. The resulting water, which carries particles flushed from the filters including microbes (such as *Cryptosporidium*), raw water particles, and particles from the coagulation process, is called waste or spent filter backwash water. The backwash period generally lasts for 10-25 minutes at a rate of approximately 15 to 20 gpm/ft^2, and produces a significant volume of spent filter backwash. Of all the processes that produce residual streams, filter backwash typically produces the largest volume of water and at the highest rate.

7.2.1 Frequency and Quantity



This backwash holding basin is used to allow settling of spent filter backwash.

Filter runs generally last between 24 and 72 hours in length, but vary from plant to plant. Filters are taken off-line for backwashing based on time (hours of filter run time), turbidity and/or particle counts in filter effluent, head loss across the filter, or other system-specific methods. A typical backwashing operation lasts for 10-25 minutes with maximum rates of 15 to 20 gpm/ft^2, but the backwash rate varies for each plant and filter type. Since a high water flow is used, a large volume of spent filter backwash water is produced in a relatively short amount of time. Some plants only produce spent filter backwash sporadically (small plants), but larger plants with numerous filters may produce it continuously as filters are rotated for backwashing. Medium and small plants typically produce spent filter backwash as an intermittent stream in large volumes over a short time span. The return of the spent filter backwash to the main treatment train without treatment or equalization is known as direct recycle. Direct recycle could result in the plant exceeding its operating capacity or experiencing hydraulic disruptions if the raw water flow is not properly managed during recycle.

Spent filter backwash can comprise 2% to 10% of the total plant production, but on the average accounts for 2.5% of average plant production (Environmental Engineering and

Technology, 1999). Recycled spent filter backwash can represent a significant percentage of plant instantaneous flow during recycle events, particularly if no equalization is provided. High recycle flows can result in hydraulic surges and possibly upset treatment plant performance. For instance, the spent filter backwash scenario presented in the example in Appendix C illustrates that the spent filter backwash recycle volume constitutes 4% of the total plant production, but during periods of recycle it constitutes 60% of the plant instantaneous flow.

7.2.2 Quality

The quality of spent filter backwash varies from plant to plant. Spent filter backwash quality has been analyzed in several studies. One research project funded by the American Water Works Association Research Foundation (AWWARF) surveyed 25 representative water treatment plants to compare the differences in microbial, physical, and chemical water quality of raw waters to untreated spent filter backwash (Cornwell et al., 2001). Of the 146 raw water samples collected, *Giardia* and *Cryptosporidium* were detected in 30% and 11% of samples, respectively. The observed geometric mean levels of *Giardia* and *Cryptosporidium* in the raw water samples for the detections were 89 and 108/100 L, respectively. For the 148 spent filter backwash samples, 8% and 5% were positive for *Giardia* and *Cryptosporidium*, respectively. The geometric mean levels of *Giardia* and *Cryptosporidium* in the spent filter backwash samples with detections were 203 and 175/100 L, respectively. All of the data were collected by means of the immunofluorescence assay method. Concentrations of *Giardia* and *Cryptosporidium* in spent filter backwash were observed to be approximately 16 and 21 times higher than corresponding raw water samples, respectively, after adjusting for recovery efficiency. Infectious *Cryptosporidium* was observed in six raw water samples (4.9%) and nine spent filter backwash samples (7.4%). Other water quality parameters were also sampled, including dissolved organic carbon (DOC), TTHMs, HAA5s, and metals. DOC and zinc concentrations showed a three-fold increase and TTHMs had a 92-fold increase in concentration in spent filter backwash when compared to raw water samples after chemical addition. Appendix F has additional information on contaminants in spent filter backwash.

This newly constructed lagoon will be used to equalize and settle spent filter backwash prior to recycling.

Kawamura (2000) indicates that spent filter backwash water from a conventional treatment plant generally has a turbidity of 150 to 250 NTU. Other data shows a range from 7 to 148 NTU for spent filter backwash turbidity from conventional treatment plants (HDR, 1997). Data from another study (Cornwell and Lee, 1993) showed that turbidity during backwash at one plant varied between 0.57 and 97 NTU (See Table F-1, Appendix F). A study by Tobiason et al.,

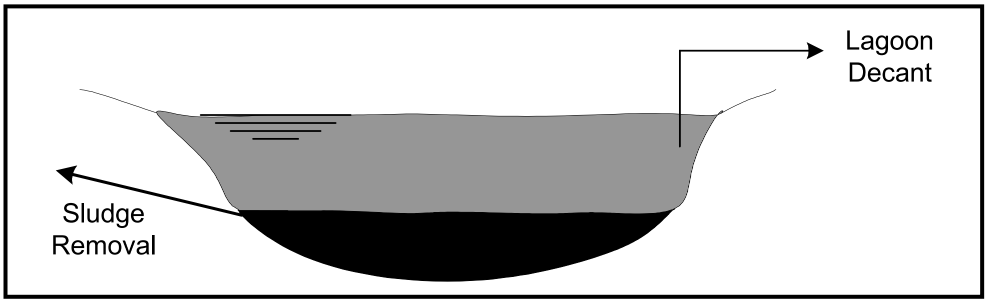
(1999) found high peak turbidity levels of 150 to 400 NTU that fell to 1 to 7 NTU at later stages of recycle. The peak turbidity levels were associated with the settling of solids in the backwash storage tank after the flow of spent filter backwash water into the tank ended. The variability of the spent filter backwash turbidity is due to the variability of raw water, upstream treatment processes, filter design and operation, and backwashing practices. For example, the amount of solids trapped in a filter will be highly dependent upon the amount of solids in the raw water, the amount and type of coagulant used, whether lime softening is used (as it can add greatly to the solids load), and the efficiency of the sedimentation unit process (in conventional treatment systems). The quality of the spent filter backwash water also depends on the volume of backwash water used. The more water used, the more diluted the spent backwash water will become (HDR, 1997).

Other contaminants contained in the spent filter backwash can impact plant performance and finished water. TOC, aluminum, manganese, and iron concentrations in the spent filter backwash can be higher than those found in both the raw water and raw water after chemical addition. In a study by Levesque, et al., (1999) a facility with flow equalization but no solids removal had peak grab sample concentrations of 143 mg/L TOC, 158 mg/L total aluminum, and 1.23 mg/L total manganese. These contaminants are typically more of a concern when thickener supernatant is recycled in combination with the spent filter backwash (HDR, 1997). Total suspended solids (TSS) may also be a concern. TSS in the spent filter backwash varies between plants and during the backwash cycle. A study by Bashaw et al., (2000) indicated that TSS was very high, with a peak of approximately 300 mg/L and an average TSS of 71 mg/L, during the first three minutes of backwash. Another study by Myers et al., (2000) showed an average TSS of backwash water of 300 mg/L. A study by Tobiason et al., (1999) found high peak levels of 600 to 7,000 mg/L TSS in recycled spent filter backwash water. These peak levels were associated with the settling of solids in the backwash storage tank after the flow of spent filter backwash water into the tank ended. The recycled spent filter backwash from a backwash holding tank may have lower TSS values since solids are settled in the holding tank. However, if the backwash holding tank is mixed, no solids removal will occur and TSS could be high in the recycle stream.

7.3 THICKENER SUPERNATANT

Thickener supernatant results from gravity thickening of solids. In the gravity thickener unit, solids in the water stream settle out as a result of gravity. Gravity-thickeners can consist of clarifiers, sedimentation basins, backwash holding tanks, lagoons, and other similar units. After settling, the clarified water or decant that exits the unit is called thickener supernatant (see Figure 7-1). The sludge at the bottom of the sedimentation basin and other sludge-holding units could contain elevated levels of microbial (such as *Cryptosporidium* and *Giardia* cysts), organic, and inorganic contaminants as compared to the raw water. These contaminants can remain in the supernatant if the sludge is not properly settled, treated, and/or removed. The supernatant should be removed from the thickener unit in a manner such that the settled solids are not disturbed to minimize contamination issues.

Figure 7-1. Lagoon Used to Settle Solids



7.3.1 Frequency and Quantity

Thickener supernatant can be recycled continuously or intermittently. The frequency of thickener supernatant recycling depends on the quantity of sludge that is produced and thickener supernatant recycle practices. Thickener supernatant is often combined with other plant flows (such as spent filter backwash, filter-to-waste, or liquids from dewatering processes).

Approximately 65% to 75% or more of the sludge generated at a treatment facility settles out in sedimentation basins at a conventional alum coagulant plant. Generally, the sludge is 0.05% to 3% solids and the remainder is water. Sludge volumes are typically 0.1% to 3% of the plant flow (Environmental Engineering and Technology, 1999). The volume of sedimentation basin sludge supernatant is dependent on sludge production, sludge solids content, and method of thickener operation. Sludge production is a function of plant production, raw water suspended solids, plant process (such as lime softening), coagulant type and coagulant dose. The quantity of sedimentation basin thickener supernatant is approximately 75% to 90% of the original volume of sedimentation basin sludge produced (Environmental Engineering and Technology, 1999). The volume of lagoon decant depends on the volume of influent waste streams, concentration of solids in the waste stream, loading duration and frequency, drainage rates, overflow rates, and evaporation rates (Environmental Engineering and Technology, 1999).

7.3.2 Quality

Contaminant concentrations in thickener supernatant depend on the raw water characteristics, thickener design, thickener loading rate, and the type and amount of coagulant added.

Data for *Giardia* and *Cryptosporidium* in untreated sedimentation basin sludge showed concentrations of 3,000 to 5,000 cysts/100 L in a plant with two sampling points (Environmental Engineering and Technology, 1999). In another study, the *Giardia* concentration was 40 cysts/L and the *Cryptosporidium* concentration was 80 cysts/L in the sludge (Cornwell and Lee, 1993). The same study indicated that recycling the supernatant did not impact finished water quality. More detailed influent water, sludge, and supernatant data can be found in Table G-1, Appendix G, Characteristics of Thickener Supernatant.

Residual characteristics in lagoon decant are altered due to treatment in the lagoon and storage. Anaerobic conditions may occur, promoting the release of some metals from solid state to dissolved form. This may also occur for organics, and could result in taste and odor problems. However, anaerobic biological decomposition may reduce virus, parasite, or pathogenic microbial concentrations. Data on lagoon decant characteristics are presented in Table G-2, Appendix G.

A study by Hoehn, et al., (1987) reported significant release of manganese, iron, and TOC from sludges held in manually cleaned, anaerobic sedimentation basins (sedimentation basins that receive sludge and act as gravity thickeners). The study also concluded that sludge stored in lagoons can also be expected to degrade the overlying water, a consideration when recycling thickener supernatant.

Another study confirmed Hoehn's observations that manually-cleaned sedimentation basins caused more manganese to be released than mechanically cleaned basins (Cornwell and Lee, 1993). As the sludge accumulated in a manually cleaned basin, manganese levels in the clarified water gradually increased. Generally, if solids were removed from the waste stream prior to recycle, TTHM formation potential and TOC in the recycle stream was no higher than in the raw water.

7.4 LIQUIDS FROM DEWATERING PROCESSES

Some filtration plants prepare waste solids (sludge) for disposal by concentrating solids and removing excess water, which reduces the volume of waste that must be disposed. The sludge typically comes from sedimentation basins, clarifiers, backwash holding tanks, or other units, and contains only 1% to 2% solids. Removing liquids from these waste solids can concentrate the sludge up to 50% solids (Kawamura, 2000). The liquids that are removed are referred to as liquids from dewatering processes.

Liquids from dewatering can be produced from a lagoon or sludge drying bed as decant and underflow, from monofill as leachate, or from mechanical dewatering devices as pressate, filtrate, or centrate. If recycled, these liquids are subject to the FBRR.

7.4.1 Quantity and Quality

Liquids from dewatering processes can be of reduced quality since they consist of water extracted from thickened sludge. Most of the *Cryptosporidium* oocysts that are removed from raw water by treatment are concentrated, first as sludge in the sedimentation basin, clarifier, or other treatment processes. They can be settled a second time in a gravity thickener and then dewatered. The recycle stream created by the dewatering process typically has a smaller volume than spent filter backwash, but its size depends on the volume of sludge produced in the plant, and on the solids content of the sludge. Most plants will produce a small, intermittent stream as a result of the dewatering process.

Non-mechanically Dewatered Sludge Recycle Streams

Sludge drying beds, lagoons, and monofills can be used as non-mechanical processes to dewater sludge. Each of these dewatering processes creates a waste stream. Sludge drying beds are used for dewatering sludge through draining, percolation, decanting, and evaporation (see Figure 7-2). The quantity of decant and underflow depends on the volume of sludge applied to a bed, the sludge solids content, loading duration and frequency, and drainage and evaporation rates. The underflow and decant account for 50% to 75% of applied volume. If a thickener is not used, the underflow and decant volume would be in the range of 0.3% to 0.4% of plant production based on average sludge volumes reported elsewhere (Environmental Engineering and Technology, 1999). No published data exists that demonstrates the potential impact of recycling sludge drying bed decant and underflow. See Appendix H, Table H-1, for data on sludge drying bed underflow. Lagoons can be designed and operated in a manner similar to a sludge drying bed for dewatering.

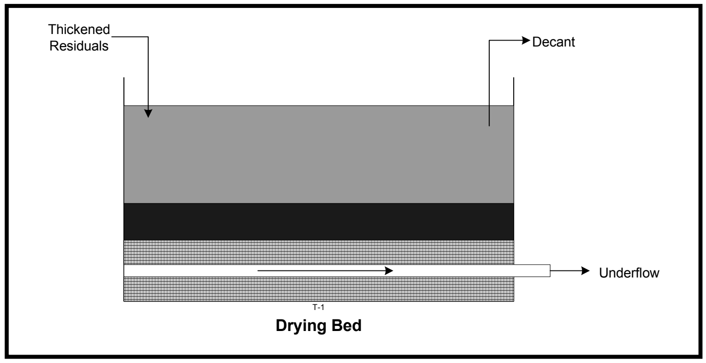


Figure 7-2. Sludge Drying Bed

Monofill (sludge-only landfill) is available in some States as a means of disposal of dewatered plant residuals from a water treatment plant. Water percolates through the monofill and is a potential recycle stream if it is collected by an underdrain (see Figure 7-3). The quantity of monofill leachate is dependent on the quantity and quality of dewatered residuals and the quantity of rainfall entering the monofill. The rate of seepage through the monofill is a function of sludge permeability and hydraulic gradient (Environmental Engineering and Technology, 1999). Three sets of pilot data from a study are presented in Table H-1, Appendix H. The leachate was generated by constructing pilot-scale monofills using two alum sludges and one ferric sludge. Although none of the metals concentrations shown in Table H-1 exceed primary MCLs, dissolved iron and manganese concentrations for a few of the data sets exceeded secondary MCLs. Metals and pH are typically the constituents of concern in leachate.

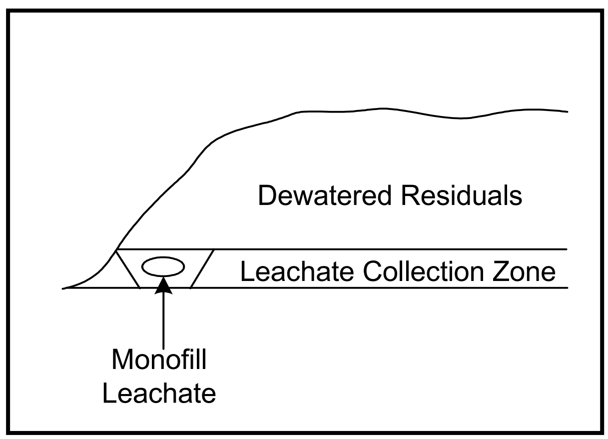


Figure 7-3. Monofill used for Dewatering Residuals

Mechanically Dewatered Sludge Recycle Streams

The conveyer is used to transport sludge from the centrifuge (background) after dewatering.

Water treatment plant residuals can also be dewatered by mechanical means, such as a centrifuge or belt filter press. The quantity depends on the volume and solids content of the thickened residuals feed. If the sedimentation basin average sludge flow is 0.6% of plant production, the dewatering device concentrate flow may be approximately 0.1% to 0.2% of plant flow. Belt filter presses and centrifuges, particularly at smaller facilities, are typically operated for only 8 to 12 hour shifts per day, often only five days per week. Operating routines would also affect potential recycle rates (Environmental Engineering and Technology, 1999). Data presented in Table H-2, Appendix H, shows that turbidity, TOC, and TTHMs can be high in liquids from mechanically dewatered sludge. Both total and dissolved aluminum and manganese concentrations may also be high. Elevated aluminum is expected to be present in waste streams of water plants practicing alum coagulation, and release of significant levels of manganese from residuals has been demonstrated. No published data exists on the potential impacts of recycling mechanical dewatering device concentrates. Plants generally dilute the dewatered residuals stream with other recycle streams prior to return to the main treatment train. The concentrates may often undergo further settling when put into thickeners prior to recycle.

7.5 NON-REGULATED RECYCLE STREAMS

The FBRR only regulates spent filter backwash water, thickener supernatant, and liquids from dewatering processes at conventional and direct filtration systems. However, other residual streams are produced at treatment plants. Table 7-1 provides a summary of some common residual streams produced by water treatment plants.

Table 7-1. Commonly Produced Non-Regulated Residual Streams

Residual Stream	Description
Filter-to-Waste	Generated by filters when the filter is placed back on-line after backwashing and prior to discharging to the clearwell. Typically of high quality since the stream has been treated by all treatment processes. Typically 0.5% of total amount of filtered water and second largest potential waste stream (after spent filter backwash) generated at a plant (HDR, 1997). Can be recycled or disposed.
Membrane Concentrate Reject Stream	Generated when the source water is passed through the membrane for treatment. Either returned back through the membrane for treatment or disposed (discharged to surface water, sanitary sewer, or land-applied).
Ion Exchange Residual Streams	Generated when the resins are regenerated, rinsed, or backwashed. Quality may be of concern if recycled.
Sludge from Softening Plants and Contact Clarifiers	Solids generated in the sedimentation basin or contact clarifiers. Recycled as an intrinsic part of the treatment process.
Slow Sand Filter-to-Waste	Generated over 1 to 2 days during the slow sand filter ripening period. Quality and volume may be of concern if recycled.
Diatomaceous Earth (DE) slurry	Generated when the DE filter is cleaned. Consists of filter medium and particles removed from the source water. Quality and volume may be of concern if recycled.
Minor Streams	Streams that result due to spills, laboratory analyses, washdown of plant facilities, and leaks. Typically of small volume, but quality may be a concern if recycled. AWWA's *Self-Assessment of Recycle Practices* (2002) provides more information on minor streams.

7.6 REFERENCES

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8. OPERATIONAL CONSIDERATIONS AND MODIFICATIONS

8.1 INTRODUCTION

As States and systems evaluate recycle practices, there are operational considerations and modifications that can be employed by water systems to minimize the impacts that the recycle of process flows and backwashing practices have on treatment. They all may not be appropriate for any given system; however, they have been proven appropriate in site specific situations. Operational considerations that systems may investigate include the following:

- Adjust chemical feed practices in the main treatment train during recycle events;
- Return recycle stream(s) to presedimentation basin;
- Control raw water or recycle stream flow to avoid unmanageable hydraulic surges;
- Reduce the amount of spent filter backwash generated through backwash modifications or increased filter run times;
- Reduce the filter-to-waste volume if filter-to-waste flows are recycled; and,
- Equalize (see Chapter 9) and/or treat (see Chapter 10) recycle stream(s) prior to returning stream(s) to the main treatment train.

While these operational considerations and modifications are not required by the FBRR, they are practices that can help systems optimize treatment and minimize the impact of recycle on treatment plant performance. Modifications can be implemented with or without pretreatment and/or equalization of the recycle stream. In addition, system modifications may or may not involve capital improvements at the plant. **Each operational consideration and modification is site-specific and pilot- or full-scale testing is recommended prior to modifying plant operations. Also, the State should be consulted prior to modifying any processes.** The operational considerations and modifications presented in this section are not all-inclusive.

8.2 ADJUST CHEMICAL FEED PRACTICES DURING RECYCLE EVENTS

Jar Testing References

- ❑ Draft LT1ESWTR Turbidity Provisions Technical Guidance Manual (under development by EPA)
- ❑ Operational Control of Coagulation and Filtration Processes, AWWA M37, 1992 [Denver, CO] (available from AWWA)

Some plants have successfully tracked influent changes by streaming current readings, zeta potential readings, or other means and adjusted the chemical feed rate and type accordingly during recycle events. Jar testing prior to any modifications will be important to identify the type and amount of chemicals that perform best when recycle streams are introduced to the plant. Most systems will want to develop a Standard Operating Procedure (SOP) to assist operators with proper chemical feed operations during recycle events. Also, maintaining the recycle stream flow at a certain percentage of the total plant flow may be essential to properly implement this operational modification without major plant upsets. Equalization of the recycle stream may be necessary to maintain the target recycle percentage (see Chapter 9). The case studies presented in this section illustrate successes and concerns with modifying chemical feed practices during recycle events.

Case Study- Success with chemical feed modifications (Moss, 2000)

The Salt Lake City Public Utilities Department (SLCPUD) noticed an increase in particle counts and decrease in streaming current values during spent filter backwash recycle events. Operators were able to adjust coagulant feed rates to compensate for influent water quality variations such that finished water was not effected during recycle. In addition, SLCPUD fed polymer (high charge anionic polymer) to the spent filter backwash clarifier to increase sedimentation of the spent filter backwash prior to recycling.

Case Study- Issues with chemical feed modifications (Goldgrabe-Brewen, 1994)

A study of three plants in northern California reported coagulant underdosing when a streaming current detector was used in coagulant dosage control mode. Positively charged particles contained in the spent filter backwash caused the streaming current monitor reading to increase, resulting in chemical underdosing. This same study also demonstrated that using polymer exclusively for coagulation had negative impacts on clarification when the recycle percentage exceeded five percent of the total raw water treated.

This option may be complicated due to residual chemicals contained in the recycle stream and the intermittent nature of some recycle streams. These residuals can cause a fluctuation of chemical demands at the head of the plant when mixed with raw water. Also, determining the appropriate chemical dose may be difficult, as presented in the case studies. A polymer feed system may need to be installed for successful treatment if one does not already exist. EPA estimates the cost of installing a polymer feed system on a 1.8 MGD plant was $8,900 in capital costs and $4,000 in operation and maintenance costs (EPA, 2000).

8.3 RETURN RECYCLE STREAM(S) TO PRESEDIMENTATION BASIN

If presedimentation basins are available, the recycle stream can be returned to the presedimentation basin prior to coagulation. Additional settling prior to the main treatment train may reduce particle loading onto the filters. Another added benefit of discharging recycle streams to a presedimentation basin, if configured to avoid short-circuiting, is the mixing that will occur with the raw water. A more consistent influent water quality to the plant allows for more uniform chemical feed operations and overall improved treatment plant efficiency. A disadvantage with this operational consideration is that more frequent sediment/solids removal will be required.

8.4 CONTROL RAW WATER FLOW OR RECYCLE RETURN FLOW

Systems should be careful to avoid unmanageable hydraulic surges or plant capacity exceedances during recycle events. Two options systems may want to consider to avoid unmanageable hydraulic surges or plant capacity exceedances are:

- Control raw water flow during recycle events such that the raw water flow plus recycle flow will not create a hydraulic surge or plant capacity exceedance.
- Control the rate of return of recycle flows by providing equalization of recycle streams (see Chapter 9).

Maintaining the recycle flow at or below 10 percent of the plant influent (raw water flow plus recycle flow) should be sufficient (SPHEM, 1992; Kawamura, 2000; Cornwell and Lee, 1994). The appropriate recycle flow percentage will vary from system to system depending on site specific water quality and treatment conditions.

8.5 REDUCE THE AMOUNT OF GENERATED SPENT FILTER BACKWASH

Several options are available for reducing the amount of generated spent filter backwash, including:

- Using air scour or surface wash to supplement the backwash process;
- Determining the minimum backwash duration necessary to produce optimum filtered water; and,
- Increasing filter run times and decreasing the frequency of backwashes.

Systems should be careful, when modifying backwash practices, to monitor the resulting impact on filtered water quality. Modifying backwash practices can affect filtered water turbidity (causing either increases or decreases in turbidity) and systems must maintain compliance with all filter effluent turbidity standards. The LT1ESWTR Turbidity Provisions Technical Guidance Manual has additional information on filter assessments and backwash practices (under development by EPA).

8.5.1 Air Scour with Backwash

Air scour can be used in conjunction with backwash and in some instances has been shown to provide better cleaning than water-only backwash, and saves on backwash water. A water works in southern Nevada that upgraded to an air/water backwash system was able to reduce its backwash water volume by 500 million gallons per year (Logsdon et al., 2000).

The process can consist of three scenarios (AWWA, 1999):

- **Air scour alone before backwash.** This process is recommended for fine sand, dual media, and triple media filters.

- **Simultaneous air scour and backwash during rising water level but before overflow.** Air scour and backwash can be done simultaneously, with air scour terminating before overflow. This process is recommended for fine sand, dual media, triple media, and coarse monomedium anthracite.

- **Simultaneous air scour and water backwash during overflow.** This process consists of air scour with water backwash throughout the overflow period. This process is recommended for coarse monomedium sand or anthracite filters. Special baffled overflow troughs are essential for anthracite filters to prevent loss of anthracite.

The use of air scour in the backwash process may allow a reduction in the backwash rate and duration, producing less spent filter backwash.

8.5.2 Surface Wash with Backwash

A surface wash arm.

Surface wash systems inject jets of water from orifices located about 1 to 2 inches above the surface of the fixed bed. Surface wash jets are operated for 1 to 2 minutes before the upflow wash and usually are continued during most of the upflow wash. Surface wash is terminated 2 or 3 minutes before overflow to prevent media loss. Surface wash may allow the time of backwash to be decreased and result in less generated spent filter backwash. EPA estimates that the cost of installing a surface wash system at a 1.8 MGD plant was \$159,400 in capital costs and \$5,700 in operation and maintenance costs (EPA, 2000).

Case Study (Myers, et al., 2000)
The Ann Arbor Water Treatment Plant (WTP) (50 MGD lime softening plant) evaluated four backwash durations: 5, 8, 10, and 15 minutes. Particle counts were measured in the subsequent filter run for each backwash duration. The results indicated the 8- or 10-minute backwash duration produced the best particle removal for their system configuration in the subsequent filter run. Eight minutes produced the lowest particles in the first hour and 10 minutes produced the lowest particles over the filter run. A backwash duration of 8 minutes was selected, resulting in approximately 20% reduction in backwash volume as opposed to a 10-minute backwash duration.

8.5.3 Reduce the Length of Backwash

Under some conditions, it may be possible to reduce the time of backwash and still comply with turbidity standards. In fact, backwashing for too long can be detrimental to the media and filter performance. Backwashing should typically be terminated when the filter backwash turbidity is between 10 and 15 NTU (Kawamura, 2000); however, the optimum filter backwash turbidity value will vary from system to system. Full-scale tests are necessary to determine the backwash duration that minimizes the filter ripening time when the filter is placed back on-line and results in the optimum filtered water quality.

8.5.4 Increase Filter Run Times

Evaluating an increase in the filter run time may be worthwhile and can result in a significant reduction in generated spent filter backwash volume over time. **Caution should be exercised so as not to compromise finished water by operating a filter to or past the point of breakthrough.** Chemical feed practices can also be modified to optimize coagulation, flocculation, and sedimentation, resulting in increased filter run times.

Case Study (Myers, et al., 2000)

Pilot and full-scale tests were conducted on extending filter run times at the Ann Arbor WTP (50 MGD lime softening plant). The addition of a fine garnet layer to the filters allowed the filter run times to be increased from 75 hours to 96 hours. Headloss in all the extended filter runs did not exceed three feet. Extending the filter runs resulted in a 30% decrease in backwash volume and also eliminated about 700 filter backwashes per year, simplifying operations and reducing costs.

8.6 REDUCE THE AMOUNT OF FILTER-TO-WASTE

If filter-to-waste flows are recycled, several options exist to reduce this particular stream. Although this stream is not regulated by the FBRR, systems may be concerned about its potential for causing hydraulic surge. Such systems may consider terminating the filter-to-waste process when the filtered water turbidity level reaches a predetermined level, as opposed to terminating the filter-to-waste process after a preset time. For example, some systems may filter-to-waste for a preset time limit of 15 minutes on all filters during initial filter start-up. Systems may want to re-evaluate the filter-to-waste procedure. Evaluation of filter-to-waste practices may reveal that desired turbidity or particle count levels in the filtered water may be achieved prior to the preset time limit.

Another option is to reduce the filter ripening period, which will in turn reduce the filter-to-waste volume. The following practices have been demonstrated in certain systems to decrease the initial turbidity spike that occurs when a filter is placed back on-line:

- **Delayed start.** The delayed start consists of letting the filter rest for a period of time between backwashing and placing the filter back into service. This option may not be possible during peak flow periods, but is a good option to consider for reducing initial turbidity spikes.

- **Slow start.** The slow start is a technique that involves a gradual increase of flow to the filter until the desired hydraulic loading rate is achieved. Again, this option can potentially reduce initial turbidity spikes but may require modification of the system to properly control the flow to the filter.

- **Add a coagulant or polymer during the backwash process.** Some studies have shown that coagulants added to the backwash water during the later stages of the backwash process could accelerate the filter ripening process (Hess et al., 2000).

- **Add polymer during initial start-up of filter.** A polymer can be fed to the filter influent during the initial start-up period to enhance initial filtration performance. Polymer feed is then terminated once the filter has reached optimal performance. Systems should be careful when adding polymer during initial filter start-up. Polymer addition can create mud balls and other problems in the filter.

Systems should exercise caution when modifying filter-to-waste practices. Systems will need to verify that their filter-to-waste practices maintain compliance with finished water turbidity standards.

Case Study (Carmichael, Lewis, and Aquino, 1998)

The Milwaukee Water Works compared filter performance for three different scenarios:

- Backwash with no polymer addition;
- Backwash with cationic polymer (Cat-Floc T) added to the backwash water; and,
- Adding cationic polymer to the filter influent water for the last hour of a filter run and then adding it again during the first hour of the following run.

The strategy of adding polymer to the filter influent water both before and after backwash at a dosage of 0.4 mg/L controlled the initial spike better than adding polymer to the backwash water. Filter performance was measured based on particle counting. Full-scale practice has been modified to include the addition of a slug dose (0.4 mg/L) of undiluted cationic polymer in the filter box in front of the influent valve as the settled water flows into the filter box after the influent valve is opened. Then during the first hour of the filter run, polymer is fed at a dose of 0.4 mg/L. Polymer is no longer fed in the last hour of a filter run before backwash, as this did not improve filter performance.

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9. EQUALIZATION

9.1 INTRODUCTION

Water treatment plants are designed to treat up to a specific flow rate and water is typically introduced to the plant via pumps at a controlled rate. When additional flows during recycle events are introduced, the recycle stream may cause one or more of the following:

- The plant exceeds the design capacity. Recycle streams (spent filter backwash water in particular) can be generated rapidly and in large volumes, and have the potential to cause a plant to exceed its design capacity.

- Hydraulic surge. The introduction of recycle streams can cause the flow to the plant to increase suddenly, which can disrupt treatment processes.

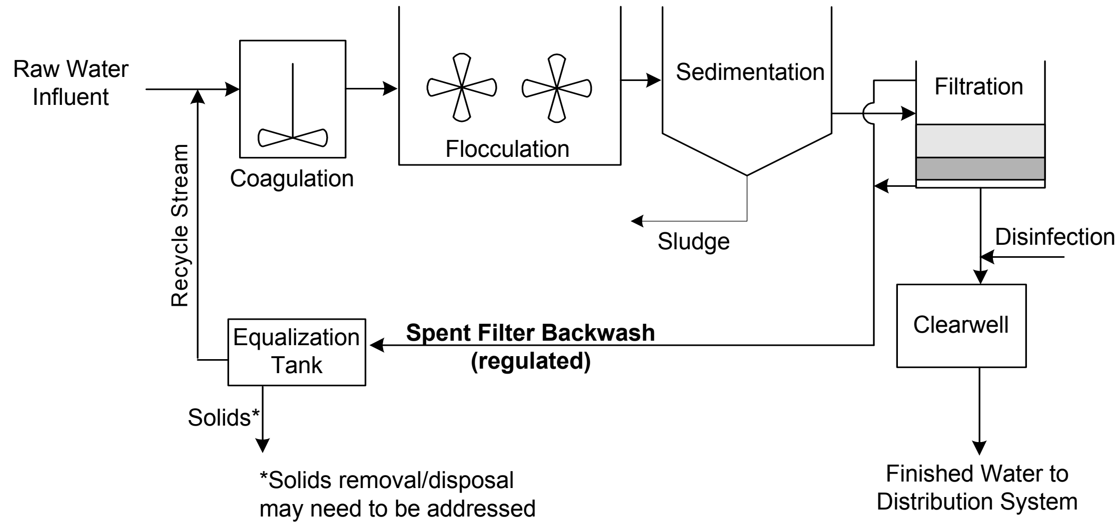
- The influent water quality is significantly altered by the recycle stream. The potential exists for recycle streams to contain higher concentrations of contaminants, particularly pathogens, than the raw water. Also, the chemistry of the recycle stream may influence water quality such that the overall treatment efficiency of the plant may be affected.

Equalization of recycle streams can be provided to help reduce the impacts of recycle streams on plant processes. Equalization consists of providing storage or detention of the recycle stream and returning the recycle stream at a rate different than the generated rate. For instance, spent filter backwash is generated at a particular plant at a rate of 2,000 gpm. Equalization is provided in a spent filter backwash holding tank, and the holding is operated such that the spent filter backwash is returned at a rate of 500 gpm. Figure 9-1 provides a schematic for equalization of spent filter backwash. With equalization, flows can be returned at a rate less than the generated flow rate. Equalization of recycle streams can be provided by basins similar to sedimentation basins, lagoons, or other similar units. The case studies presented in this chapter provide information on equalization tank design considerations.

When determining the rate of return from the equalization basin, the rule of thumb has been to maintain the recycle flow at or below 10% of the plant flow (SPHEM 1997; Kawamura, 2000; Cornwell and Lee, 1994). However, the actual percentage varies from plant to plant and systems need to evaluate the percentage of recycle stream that creates the minimal impacts on finished water. In addition, a continuous recycle return flow (as opposed to intermittent recycle return flow) has been recommended for optimum plant performance (McGuire, 1997; Petersen and Calhoun, 1995).

This chapter discusses the advantages and disadvantages of equalization and methods for assessing the impacts of equalization or lack of equalization at a system. Two case studies are presented later in this chapter to provide real-life scenarios and concerns.

Figure 9-1. Example of Equalizing Recycle Streams



Note: Equalization is typically used for spent filter backwash, but may be used for other unregulated recycle streams such as filter-to-waste. Pumps may be required to convey the recycle streams from the equalization tank.

9.2 ADVANTAGES

Benefits of Equalization

- ✓ Minimize hydraulic surge
- ✓ Better flow pacing of chemicals
- ✓ Subsequent recycle stream treatment processes may be downsized

Flow equalization provides hydraulic stabilization that can help to maintain optimal finished water quality. Equalization of recycle streams can provide the following benefits:

- Minimize hydraulic surges and the possibility of hydraulic overload of sedimentation basins, filters, and other treatment units. Settled water quality has been shown to deteriorate as surface-loading rates of the sedimentation basin increase (AWWA, 1999). Hydraulic overload can compromise overall treatment plant efficiency and removal of pathogens and other contaminants. Hydraulic surges can also result in a plant exceeding its design or State-approved capacity. Equalization can help eliminate the situation where clarification and filtration operating rates may be exceeded at precisely the time recycle streams may be returning large numbers of oocysts to the treatment process. Example 9-1 illustrates a situation where direct recycle practices resulted in a plant exceedance and other plant process impacts.

- Allow better flow pacing of chemicals at the head of the treatment plant when the flow is more consistent. Recycle streams vary with quality as the stream is produced. For instance, spent filter backwash typically contains more particles during the beginning of filter backwash than at the end of the backwash process. Equalization can allow the spent filter backwash to be mixed (if mixing is provided in the equalization basin) and of a more consistent quality, in addition to controlling the flow. A more consistent recycle stream, both in quantity and quality, will allow for consistent chemical feed operation.

- Equalization can allow a reduction in the size of a recycle stream treatment unit (if provided) by reducing the peak recycle stream flow.

Equalization basins can be operated such that settling of particles can occur. Chapter 10 has more information on treatment through sedimentation.

Example 9-1. Evaluating Recycle Practices

Note: The following example is intended to illustrate how a system or State could evaluate recycle practices and resulting modifications. This example is not intended to establish plant operation or modification criteria.

Using the example and information for the 3.0 MGD plant presented in Appendix C, recycle practices were evaluated. Following is a quick summary of the plant information:

- Plant design flow: 3.0 MGD (2,080 gpm);
- Observed Peak Plant Influent: 2,500 gpm, consisting of 1,000 gpm raw water flow and 1,500 gpm spent filter backwash recycle flow; and,
- Typical Recycle Flow: 1,500 gpm- This flow represents spent filter backwash. Backwash is conducted at a rate of 15 gpm/ft^2 and each filter has a surface are of 100 ft^2. Filters are backwashed individually, four filters per night. Filters were backwashed for a duration of 15 minutes.

To evaluate their recycle practices, the system determined the percent of peak plant influent flow that was recycle flow on an instantaneous basis:

$$\% \text{ Recycle flow} = \frac{\text{Recycle Flow}}{\text{Total Plant Flow}} = \frac{1{,}500 \text{ gpm}}{2{,}500 \text{ gpm}} = 60\%$$

The percent recycle flow on an instantaneous basis of 60% was rather high. Also, the peak plant influent flow of 2,500 gpm exceeds the plant design flow of 2,080 gpm. Further evaluation of plant flows during recycle indicated the design flow was typically exceeded during recycle events. The sedimentation basin and filters were both subjected to hydraulic surges during recycle. Turbidity and particle counts in the finished water were recorded at 30-second intervals as another means of evaluating impact of recycle practices. The results indicated substantial increases in both turbidity and particle counts during recycle events as opposed to periods where recycle was not occurring.

The system decided to install a lagoon to provide equalization. The lagoon was sized for two backwash volumes plus adequate freeboard. The lagoon was operated such that recycle flows were reduced from 1,500 gpm under direct recycle practices to 500 gpm. The lagoon was allowed to fill completely during backwash (15 minutes) to allow mixing and then pumped back to the plant before the next backwash commenced.

9.3 DISADVANTAGES

Few disadvantages are associated with flow equalization, however, as with any water treatment plant improvement, costs are a consideration. Multiple or redundant facilities may be required for adequate operation. Should the equalization basin not be operated on a continuous basis or operation suspended for an extended time (2 to 3 days), sludge may form in the bottom and be subsequently discharged to the plant influent. Sludge can taint the equalized flow, create objectionable tastes and odors, and carry other undesirable substances in the recycle stream. Another disadvantage is the required amount of space needed to accommodate the equalization basin.

Case Study (Myers, et al., 2000)
Four alternatives for handling spent filter backwash at the Ann Arbor WTP (50 MGD lime softening plant) were evaluated:

- Discharge to a storm sewer (equalization required to meet discharge permit flow requirements);
- Discharge to a sanitary sewer (equalization required by receiving wastewater plant);
- Discharge to a lime sludge lagoon; and,
- Equalization with recycle.

The system evaluated all four alternatives for feasibility, flexibility, and cost-effectiveness. For this particular plant, equalization with recycle in conjunction with discharge to the lime sludge lagoon was the most feasible and cost-effective option. Discharge to the lime sludge lagoon was recommended to be included as a back-up and added operational flexibility.

The conceptual equalization basin design included an equalization basin with a capacity of at least two backwash volumes and variable speed pumps to maintain the recycle flow between 5% and 10% of the raw water flow. Equalization of recycle provided the following benefits for the Ann Arbor WTP:

- Reduced the possibility of plant capacity exceedance during recycle;
- Reduced hydraulic surge through the plant, resulting in better settling and particle removal through the filters; and,
- Allowed for more consistent chemical feed, which resulted in more consistent water quality.

The conceptual design also included a recommendation that the equalization basin allow for future chemical addition if treatment becomes necessary in the future.

9.4 COSTS

Costs are associated with both the construction and operation and maintenance (O&M) of equalization basins. EPA developed a range of costs as part of the FBRR making process. Capital costs associated with equalization basins for design recycle flows into the equalization basins of 0.59 MGD and 83.59 MGD were $317,000 per MGD and $14,360 per MGD, respectively. O&M costs associated with equalization basins for design flows of 0.59 MGD and 83.59 MGD were $11,000 per MGD and $130 per MGD, respectively (EPA, 2000).

9.5 EVALUATING EQUALIZATION

Evaluating existing equalization or evaluating the need for equalization is an important step in examining the effects of recycle practices on a system, particularly when a plant is out of compliance (for example, unable to meet current turbidity standards). In order to evaluate if equalization improvements would be beneficial, the following information and plant performance data should be assessed:

- Evaluate the data collected on recycle practices, as discussed in Chapters 3, 4, and 5. Systems may want to examine frequency of recycle streams, recycle stream flow rates, backwash practices, and other information. Systems may be able to determine that plant capacity and individual treatment unit process loading rates are exceeded during recycle events. The system should then evaluate the impact to finished water quality as a result of recycle practices.

- Evaluate loading rates to treatment units (specifically clarifiers, sedimentation basins, and filters) during recycle events. Compare the loading rates during recycle events to the design loading rates. In order to ensure finished water quality meets all standards, the design loading rates should rarely be exceeded.

- Examine turbidity and/or particle count levels in finished water during recycle events. If turbidity and particle counts increase during recycle events, equalization may be one option to reduce these impacts (see Example 9-1).

- Examine daily operation information and assess the chemical feed practices during recycle events. If the system must modify chemical feed practices during recycle events, equalization may allow a more consistent chemical feed practice.

Again, equalization can allow the recycle stream to be returned at a more controlled rate and at a more consistent quality. As the system evaluates equalization, treatment options may also be considered. Chapters 10 provides more information on treatment for recycle streams. If treatment is not installed at the time the equalization units are installed, the system may want to allow room in the design for future treatment.

Case Study (Bashaw, et al., 2000)

The James E. Quarles WTP is a 64 MGD conventional filtration treatment plant located in Marietta, Georgia. The recycle practices were evaluated as part of the expansion process (upgrade to a capacity of 96 MGD) and recycle stream equalization and treatment alternatives were investigated. As seen in Figure 9-2, the existing system recycles spent filter backwash, thickener supernatant, filtrate, and filter-to-waste. All recycle streams are treated in a clarifier, equalized in a recycle tank, and then recycled to the raw water reservoir.

Four alternatives were evaluated for the recycle streams:

1. Adding polymer to flocculate the solids in the spent filter backwash water before settling. Jar tests were conducted to determine the type and dose of polymer needed.

2. Equalizing backwash flows and thickener overflows prior to settling. Flows to the clarifier during backwash were 2.7 times the average flow to the clarifier. Equalization would provide a consistent flow to the backwash clarifier for better detention and treatment. Also, the suspended solids in the spent filter backwash varied greatly over the backwash cycle. With mixing the full backwash flow volume in the equalization tank, a more uniform concentration of solids is obtained. The added benefit of mixing is that the polymer feed rate could be maintained at a more uniform rate.

3. Discharge filter-to-waste flows downstream of the clarifier. Since filter-to-waste contains almost no solids, little treatment is accomplished in the clarifier. By-passing the clarifier reduces the loading to the clarifier and provides better detention and treatment (removal of solids) of spent filter backwash flow.

4. Provide additional treatment after the clarifier.

The following options were selected for final design and are presented in Figure 9-3:

- Two new equalization tanks will be installed to receive spent filter backwash and thickener supernatant. The equalization tanks were designed to accommodate two backwash volumes plus thickener overflows. Each tank will be equipped with submersible mixers for blending contents and with vertical, mixed flow transfer pumps that will discharge to a flocculation tank.

- The discharge piping from the equalization tanks will be equipped with polymer feed injection capabilities.

- A two-stage flocculation tank will be installed downstream of the equalization tanks and will provide 10 minutes of detention time at peak flow rate.

- Filter-to-waste flows will be discharged downstream of the clarifier.

- The existing clarifier capacity will not be modified due to the elimination of filter-to-waste flows and longer filter runs (to be achieved with deep-bed filters that will be installed as part of the plant upgrades). The clarifier will be able to provide 4.2 hours of detention time.

- Treatment of the flow exiting the clarifier was not included as part of the final design, but the final design allows for installation of treatment if needed in the future.

Figure 9-2. Existing Layout of James E. Quarles Water Treatment Plant

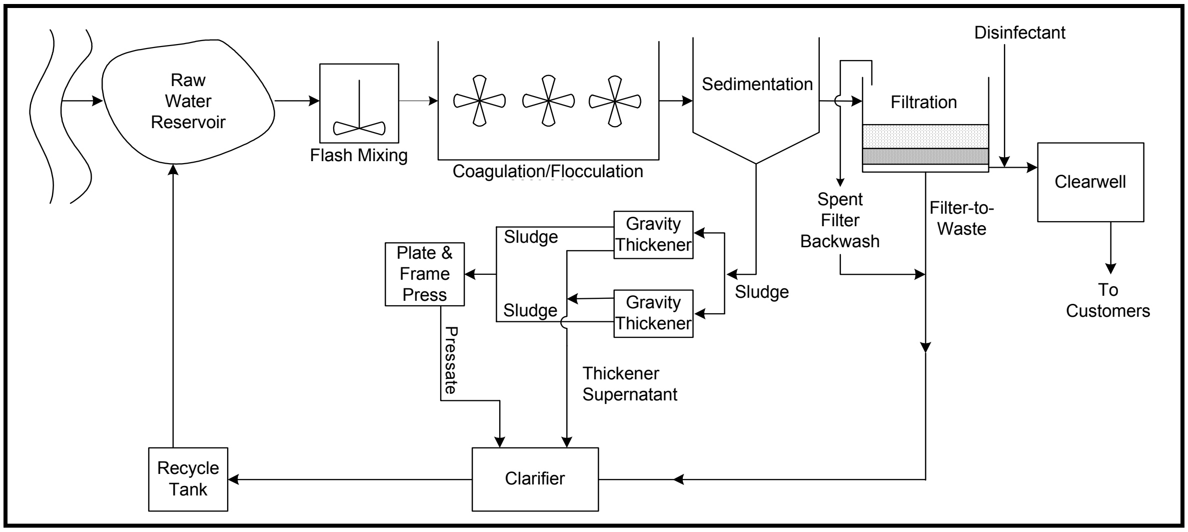
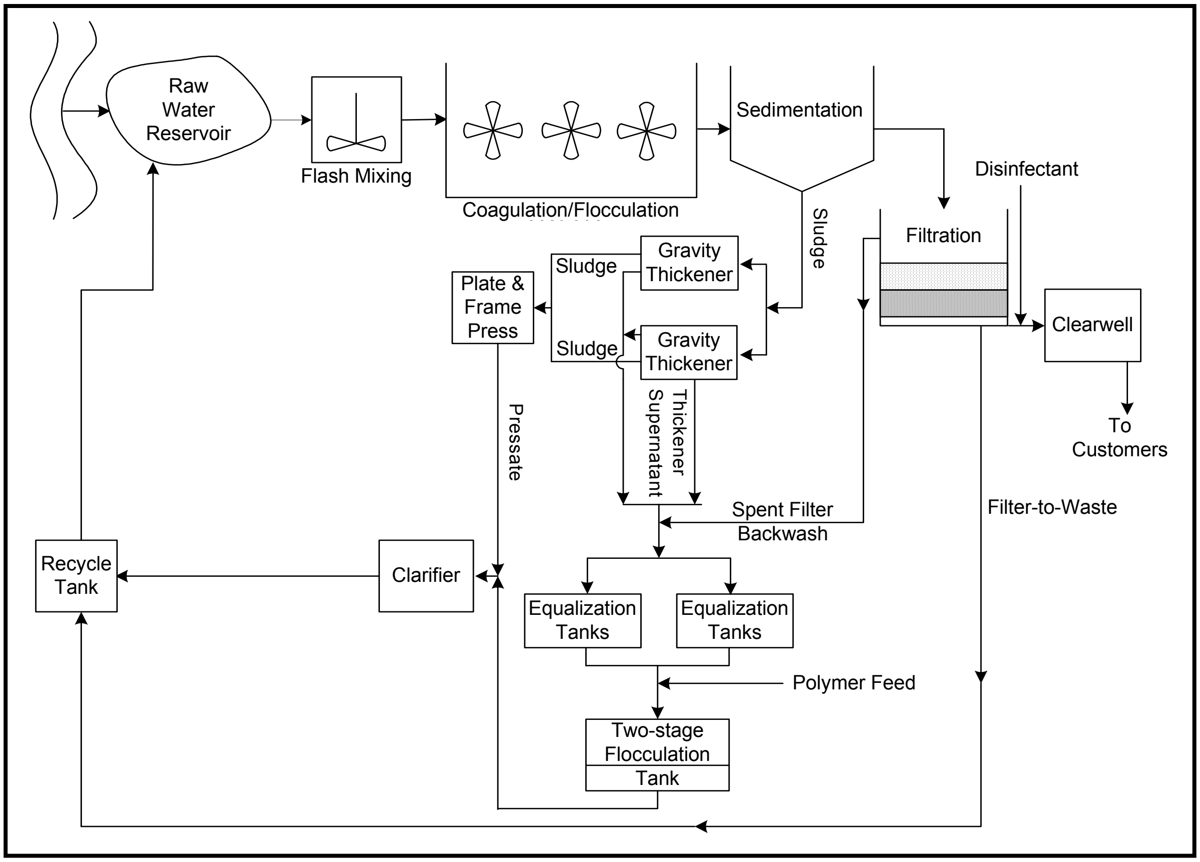


Figure 9-3. Proposed Improvements for Recycle Streams at the James E. Quarles Water Treatment Plant



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10. TREATMENT OF RECYCLE STREAMS

10.1 INTRODUCTION

Residual streams are often high in particulates, solids, and other contaminants. It may be necessary to treat residual streams prior to recycling so finished water quality is not compromised. An AWWA FAX survey taken in 1998 found that the majority of systems that recycle (approximately 70%) treat and/or equalize the stream prior to its return to the main treatment train (AWWA, 1998). The most common type of treatment is sedimentation. See Table 10-1 for the results of the AWWA FAX survey.

The FBRR does not require treatment of recycle streams beyond returning flows through the processes of a system's existing conventional or direction filtration system. However, EPA recognizes that additional treatment of recycle streams may be appropriate to reduce risks of microbial contamination and optimize the operational performance of the system. As systems and States begin to evaluate recycle practices, they may decide that treatment of recycle streams or modifications to existing recycle stream treatment processes is warranted.

Table 10-1. Results of AWWA FAX Survey on Systems that Recycle

TREATMENT TYPE	PERCENTAGE OF SYSTEMS
No Treatment	30
Sedimentation	38
Equalization	14
Sedimentation and Equalization	10
Lagoon	3
Other	5

Some systems may decide that recycle of residual streams is not cost-effective and may elect to dispose of residual streams. Disposal of residual streams may need to meet requirements under other Federal and State statutes and regulations. Some options that may be available include:

- Discharge to the sanitary sewer;
- Discharge to a surface or ground water body; or,
- Irrigation/land application.

Systems should check with their State and EPA regional offices to determine what restrictions or permit requirements apply to any of these disposal options. This document will not cover disposal options.

This chapter presents a description of recycle stream treatment concepts, the advantages and disadvantages associated with treatment, guidelines for treatment, methods for assessing existing recycle stream treatment or the need for treatment, and a brief description of different treatment options. Case studies are also provided that give examples of different recycle stream treatment options.

10.2 ADVANTAGES

Treatment processes for recycle streams that are properly designed and operated can reduce levels of *Cryptosporidium* and *Giardia*, contaminants of concern in recycle streams. Treatment processes can also be designed and operated to remove other contaminants, such as solids, particulates, DBP precursors, TOC, aluminum, iron, and manganese. These contaminants can create aesthetic and health issues in the finished water if not removed from recycle streams. Other benefits of treatment are as follows:

- Treatment of recycle streams may be cheaper and less time- intensive for the operator than modifying main treatment train processes during recycle events. Because both quantity and quality of plant influent change during recycle events, operators may need to modify chemical feed processes and other main treatment plant processes to ensure that finished water quality is not compromised. Treatment of recycle streams can allow more consistent operation of the main treatment train processes.

- Treatment of recycle streams can reduce particle loading on sedimentation basins (in conventional filtration plants) and filters in the main treatment train, thus possibly extending the useful life of these units.

<u>Benefits of Treating Recycle Streams</u>

- ✓ Removal of contaminants, particularly *Cryptosporidium* and *Giardia.*
- ✓ Allows more consistent operation of main treatment train, resulting in saved money and operator time.
- ✓ May extend useful life of sedimentation basins and filters in main treatment train.

It may be necessary to equalize flow in addition to providing treatment to control the recycle stream flow. The use of equalization may also reduce the size of the treatment unit required to handle the recycle flow.

10.3 DISADVANTAGES

There are some disadvantages associated with treatment of recycle streams. As with any other treatment plant improvement, more equipment requires more maintenance. Again, when compared to other residual management options (such as disposal), the O & M of treatment units may be a more cost-effective option.

10.4 COSTS

The costs will vary depending on the type of treatment, flows, level of treatment, and other site-specific issues. However, treatment may be cheaper than other alternatives (such as discharge to a surface water body or wastewater treatment plant). EPA estimated a sedimentation basin with polymer feed and tube settlers to have a capital cost of $228,000 and $1,560,000 for design loading rates to the sedimentation basin of 0.022 MGD and 19.87 MGD, respectively (EPA, 2000). Annual operation and maintenance costs were estimated to be $4,600 and $34,700 for design loading rates to the sedimentation basin of 0.022 MGD and 19.87 MGD, respectively (EPA, 2000).

10.5 RECOMMENDED DESIGN GOALS

The FBRR does not provide specific requirements for treatment. Some States and professionals have developed treatment guidelines that are presented for consideration in the following sections. Systems should check with their State on specific treatment requirements or guidelines when considering treatment for recycle streams.

10.5.1 Ten States Standards

The Great Lakes Upper Mississippi River Board of State Public Health and Environmental Managers, (or Ten States Standards) (SPHEM, 1997), recommend that spent filter backwash be returned at a rate less than 10% of the raw water flow entering the plant. Spent filter backwash should not be recycled when raw water contains excessive algae, when finished water taste and odor problems occur, or when trihalomethane levels in the distribution system exceed allowable levels.

10.5.2 California

California recommends that treatment plants establish an operational goal for turbidity of less than 2.0 NTU for recycled spent filter backwash and other recycle streams. If this turbidity limit cannot be achieved, the system should treat the recycle stream to a quality equal to the average raw water quality. In addition, new facilities should remove 80% of solids before recycle and the recycle flow should be less than 10% of the plant flow.

10.5.3 Maryland

Maryland has a policy for both new and existing surface water treatment plants. New surface water plants should provide treatment for recycle streams. Existing systems can continue to recycle under the following controlled circumstances:

- The recycle ratio should be less than 5%;
- A minimum of two hours of polymer-enhanced sedimentation should be provided; and,
- Sedimentation should be provided with very low, continuous overflow rates (0.3 gpm/ft^2).

10.5.4 Ohio

Ohio recommends recycle streams be treated prior to their return to the main treatment train. In addition, the recycle flow should be less than 10% of the plant flow.

10.5.5 Cornwell and Lee (1993)

Based on an evaluation of eight systems, Cornwell and Lee (1993) made the following observations which may minimize impacts on finished water quality:

- Equalization should be provided so that recycle is continuous rather than intermittent.
- The recycle stream should be properly treated for cyst removal with an 80 percent treatment efficiency.
- Overflow rates from the backwash water clarifier should be less than 0.07 gpm/ft^2 to achieve the 80% treatment efficiency (when chemical addition is not used).

10.5.6 United Kingdom Water Industry Research (UKWIR) (1998)

The UKWIR developed a water treatment guidance manual that addresses recycling of spent filter backwash water (Logsdon, et al., 2000). The UKWIR recognized the risk posed by concentrated suspensions of *Cryptosporidium* oocysts in spent filter backwash. UKWIR developed the following guidelines to prevent passing oocysts into finished water:

- Backwash water should be settled to achieve a treatment objective of greater than 90% solids removal before recycling.

- Recycle flows should be at less than 10% of raw water flow and continuous rather than intermittent.

- Continuous monitoring of the recycle stream with on-line turbidimeters should be conducted.

- Jar tests should be conducted on plant influent containing both recycle streams and raw water to properly determine coagulant demand.

- Polymers should be considered if high floc shear or poor settling occurs.

- The recycle of liquids from dewatering processes should be minimized, particularly when quality is unsuitable for recycling.

10.6 EVALUATING TREATMENT

The evaluation of existing treatment processes used for recycle streams or evaluating the need for treatment is an important process. The following checklist can be used to conduct the evaluation:

✓ Compare finished water quality during periods of recycle to periods when recycling is not occurring. Contaminants of concern are *Cryptosporidium*, *Giardia*, DBPs, DBP precursors, TOC, iron, aluminum, and manganese. Other water quality parameters that could be examined are pH, turbidity, particle counts, and taste and odor. If contaminant concentrations increase during recycle events as compared to periods when recycling is not occurring, then treatment (or improvements to existing recycle stream treatment processes) may be warranted. Also, if treatment technique violations or MCL violations occur during recycle events, then treatment (or improvements to existing recycle stream treatment processes) should seriously be considered.

✓ Perform a similar process as previously described on individual treatment unit processes in the main treatment train for more information on how individual units are being impacted during recycle events.

✓ Examine flows and hydraulic loading rates during periods of recycle events. Make sure that hydraulic surge, plant capacity exceedance, and/or hydraulic loading rates of individual treatment units in excess of design rates are not occurring.

As a system considers treatment options for recycle streams, the following items should be considered:

✓ Estimate or measure the amount of residuals produced by the plant. Mass balance calculations can be used to determine residual stream loading rates. The liquid and solid residual stream quantities (peak and overall volume) should be obtained to properly size treatment units.

- ✓ Consider the benefits of adding equalization. Equalizing the recycle stream may allow a reduction in the required treatment unit loading rates.

- ✓ When designing any treatment process, allow for future modifications- flexibility is key.

The AWWA *Self-Assessment of Recycle Practices* provides additional information on how to evaluate existing recycle stream treatment facilities or the need for treatment (AWWA, 2002).

The case study (Bashaw, et al., 2000) presented in Chapter 9 (page 65) provides information on how treatment and equalization options for recycle streams can be evaluated. The following case study presents additional information on evaluating treatment.

Case Study (Nielson, et al., 1995)

The Cleveland Division of Water (CDW) is upgrading one of its four water treatment plants (Crown WTP) from 50 MGD to 125 MGD capacity. The upgrade will involve modifying existing conventional unit treatment processes (coagulation, flocculation, sedimentation and filtration) to high-rate processes. As part of the upgrades, the system evaluated recycle practices. Figure 10-1 contains a schematic of the existing system and residual streams. The Crown WTP handles residual streams as follows:

- Spent filter backwash is either equalized and recycled to the head of the plant or sent to the gravity thickeners for ultimate discharge to Lake Erie.
- Solids are thickened, dewatered, and the filter cake disposed in sanitary landfills. The pressate is sent to the sanitary sewer after pH adjustments. Thickener supernatant is discharged to Lake Erie.

In evaluating recycle practices, CDW developed a residual solids management plan. CDW considered the following to develop this plan:

- Existing data on both the quantity and quality of residual streams. An important part of this process was identifying additional data collection needs.
- Solids production throughout the treatment process. A mass balance was conducted to identify the point in the treatment train where solids were generated. The mass balance showed how residual solids were processed, and checking the results against existing data enabled the identification of erroneous data. Average quantity and average quality of residual streams in addition to maximum day, maximum week, and maximum monthly values were calculated.
- Cost and non-cost issues associated with each residual solids management alternative.
- The impacts on individual treatment processes or operational practice in the main treatment train during recycle events. For instance, the TOC concentrations in water leaving clarifiers and filters during recycle events was compared to periods of no recycling. In addition, DBP levels in the distribution system were monitored.
- Future needs and flexibility for future upgrades and expansions.

CDW selected the following options for residual solids management as part of the overall plant upgrade (see Figure 10-2):

- Filter-to-waste capabilities would be installed and filter-to-waste streams would be recycled directly to the head of the plant. This alternative was selected based on costs, the fact that the stream would be treated again by plant processes, and that the stream's quantity and quality would have little impact on operation of the expanded WTP.
- Spent filter backwash would be discharged to Lake Erie after being equalized and clarified. Spent filter backwash would not be recycled (and would not undergo chemical treatment). This alternative was selected to reduce solids loading on treatment units and eliminate water quality issues in the finished water (taste and odor, iron, manganese, TOC, DBP and DBP precursor concentrations, *Giardia,* and *Cryptosporidium*).

Figure 10-1. Crown Water Treatment Plant – Existing

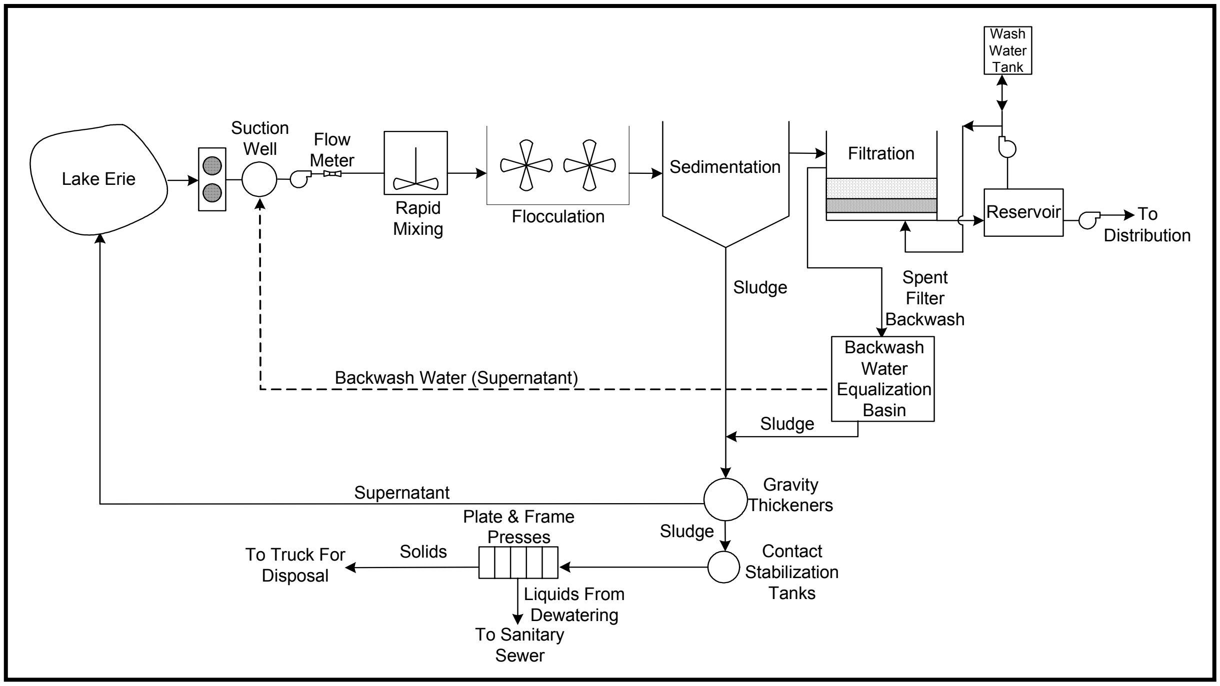
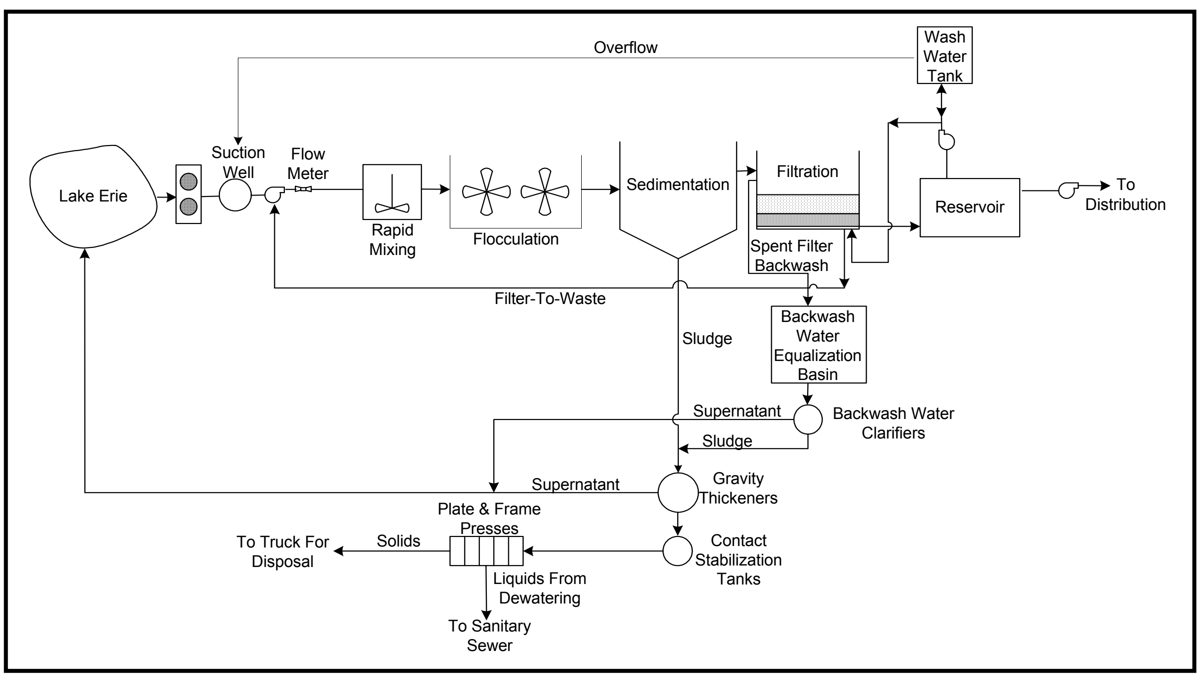


Figure 10-2. Crown Water Treatment Plant – Proposed



10.7 TREATMENT OPTIONS

Treatment options for recycle streams are similar to the treatment options used for raw water at a water treatment plant. Treatment can consist of solids removal and/or disinfection. There are several options for solids separation from spent filter backwash water and other recycle streams: sedimentation, granular-bed filtration, and membrane filtration. Disinfection can also be employed for treatment of recycle streams to provide inactivation of pathogens. This chapter presents general treatment capabilities, advantages, disadvantages, operational considerations, and case studies (where available) for each treatment type. Not all aspects of recycle stream treatment are discussed.

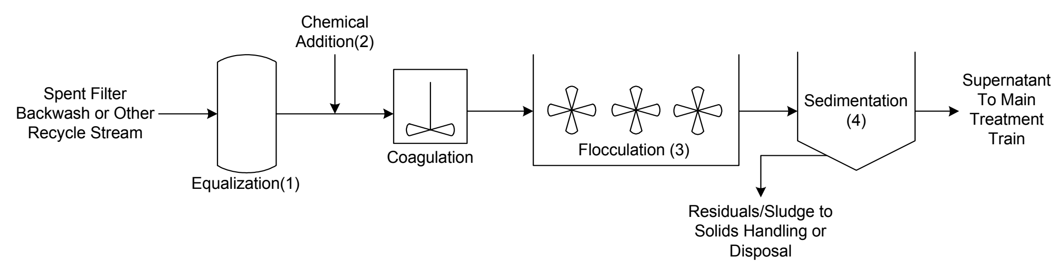
10.7.1 Sedimentation

General

Sedimentation is a process for removal of solids from liquids either by gravity or physical separation. The use of sedimentation on recycle streams has been shown to be effective in removing particles and pathogens. An example of a typical sedimentation process for recycle streams (in addition to the main treatment train) is shown in Figure 10-3.

Sedimentation can either be batch-flow or continuous-flow. Batch-flow sedimentation processes combine equalization and treatment in a single unit, and for this reason, are commonly used to treat recycle streams. Generally, batch flow systems consist of one or more basins sized to receive a large volume of flow, such as spent filter backwash water, in a short period of time.

Figure 10-3. General Sedimentation Process for Treatment of Recycle Streams (In Addition to the Main Treatment Train)



(1) Equalization is optional except for continuous-flow sedimentation.

(2) Chemical addition can consist of a coagulant or polymer. Chemical addition is optional but has been shown to improve treatment of the recycle stream.

(3) Flocculation is optional but may enhance treatment.

(4) Sedimentation unit can consist of a circular clarifier, a unit equipped with tube or plate settlers, or a solids contact clarifier.

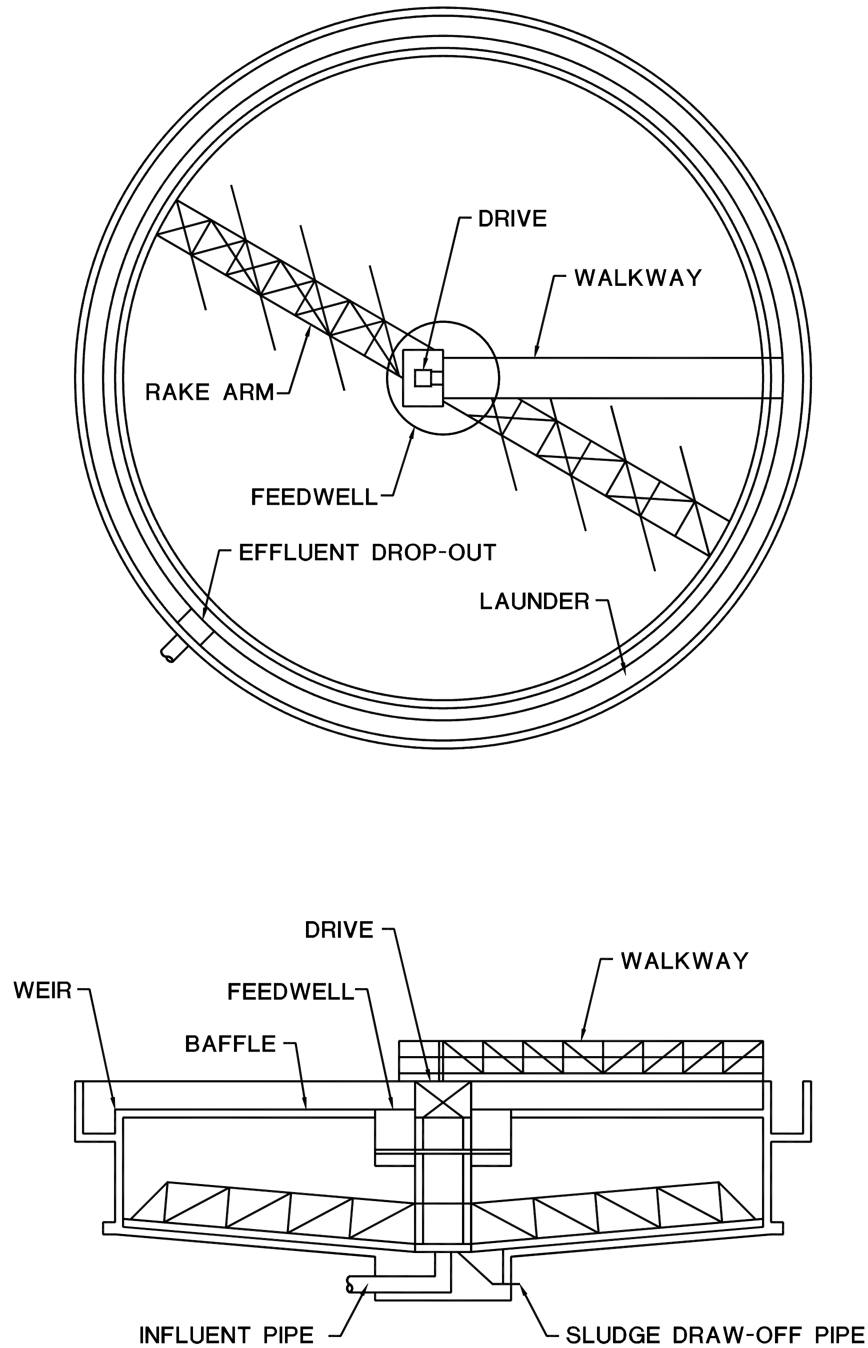
Continuous flow sedimentation basins (both circular and rectangular), similar to those used to treat the main process flow, may also be considered for recycle stream treatment. It is best to avoid operating continuous-flow systems intermittently. If generation of the recycle stream is too variable, then accommodation in the design for operational flexibility (e.g., variable flow rate from pumps) may be needed to maintain continuous flow.

A sedimentation basin typically consists of an inlet, an outlet for clarified water, and a solids collector and removal mechanism (see Figure 10-4). Clarified water may be removed by a floating decanter or from one or more fixed outlets above which all water is collected. The recycle stream can either be pumped or conveyed by gravity to the main treatment train. A pretreatment chemical may or may not be added to the flow before it enters the basin. The chemical mixing process could use a static in-line mixer or rapid-mix basin depending on the plant layout, hydraulic grade line, and capacity.

If recontamination of the recycle flow by the settled sludge is a concern, the system should employ a method to remove the solids frequently. This contamination could lead to objectionable taste, odors, and other undesirable qualities in finished water. Sludge removal should also be conducted at an appropriate frequency to avoid compromising the active storage and treatment capability in the sedimentation basin. Systems should use sedimentation basins with automatic sludge removal since manual cleaning has been shown to release significant amounts of manganese, iron, and TOC into the supernatant (Cornwell and Lee, 1993). For continuous-flow units, sludge removal should be automatic and continuous so as not to disrupt the continuous-flow process.

The remainder of this section provides information on three types of sedimentation processes: lagoons, chemical additions, and tube and plate settlers. Advantages and disadvantages of sedimentation are also provided and case studies of each type of sedimentation are included to further describe each.

Figure 10-4. Circular Radial-flow Clarifier



Source: AWWA and ASCE, 1990.

Lagoons

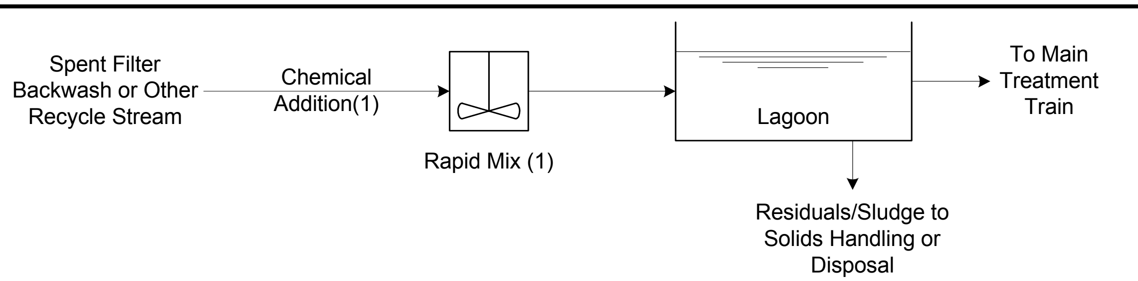
Where adequate land is available, lagooning may be an economical alternative for treating spent filter backwash water and other recycle streams. Lagoons are relatively simple earthen structures for sedimentation. They have an inlet for the recycle stream, an outlet for the settled water, access to remove the settled solids, and (typically) drain and overflow provisions. A generic schematic diagram for treating recycle streams in lagoons is presented in Figure 10-5.

Lagoons do not require a separate tank to equalize the incoming flow. However, the potential mixing effect created by a high rate of incoming flow does require special consideration. To minimize resuspension of settled solids by the influent, Kawamura (2000) recommends that the lagoon be sized to contain at least 10 backwashes. A series of three or more smaller lagoons, each holding three or four filter backwash volumes, may also be used.

All lagoons should be elongated in shape to maximize the distance between the inlet and outlet, and the inlet should be provided with an energy dissipator. The outlet should be designed to decant as well as drain the lagoon, and should act as an overflow facility. Depending on the design conditions, either a mixing device or a static in-line mixer that uses the turbulence of the influent flow may provide chemical mixing when chemical addition is used.

Additional considerations when using lagoons are the release of contaminants by the settled sludge, contamination by outside sources, or contamination to the local environment from the lagoon. Lagoons are often designed for infrequent sludge removal by equipment such as a front loader. If recontamination of the recycle flow from constituents of the stored sludge (e.g., manganese) is a concern, then the design should incorporate a method of frequent sludge removal. Also, contamination of the recycle flow by sources outside the lagoon, such as chemical delivery trucks, should be considered. The lagoon should be lined with an impervious liner to prevent contamination to the ground water. Another option is to install underdrains to collect leachate. Underdrains may be included in the lagoon design to collect and recycle the leachate, although quality of this water may be of concern. All of these considerations add costs to the installation of a lagoon.

Figure 10-5. Lagoon Process for Recycle Streams



(1) Chemical addition and rapid mix are optional but may enhance treatment of recycle stream.

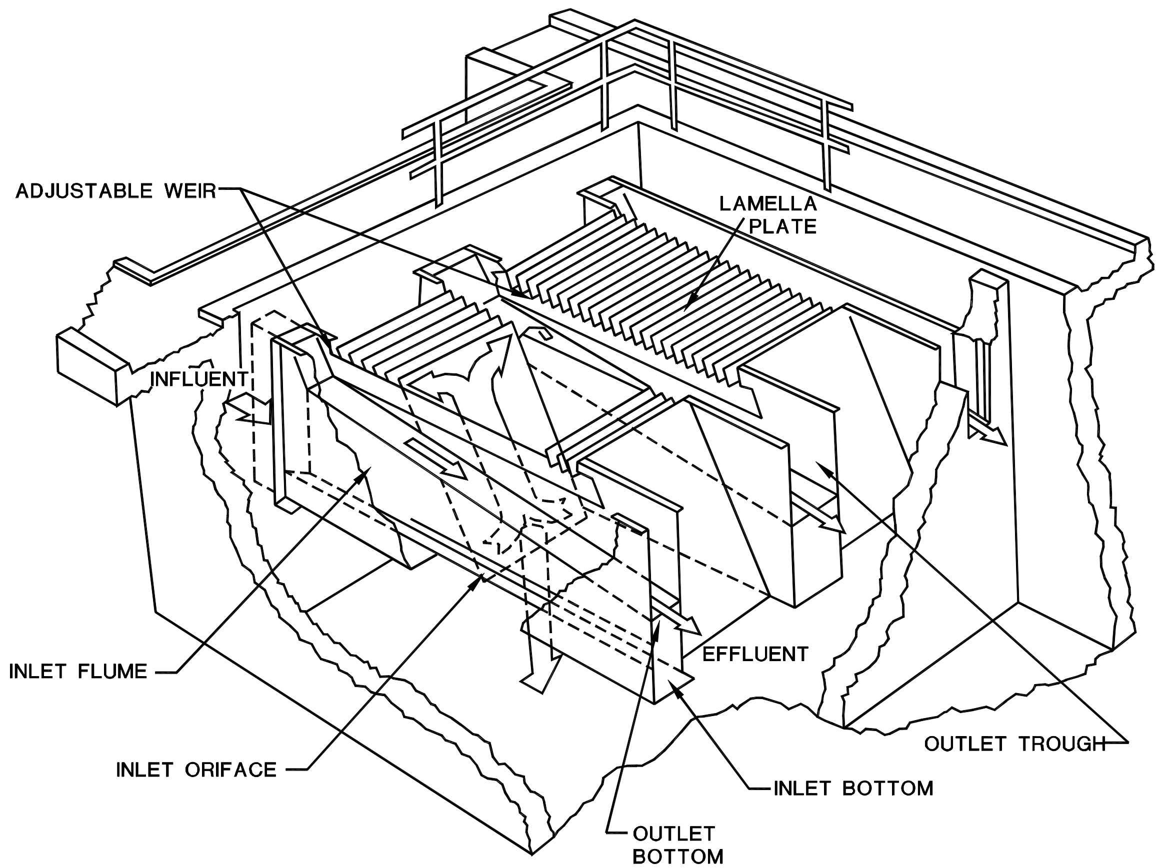
Chemical Addition

The sedimentation process can be enhanced by the addition of chemicals. The use of flocculation prior to sedimentation is recommended when the settling characteristics of the spent filter backwash water are less than desired unless conventional flocculation and sedimentation are implemented (Kawamura, 2000). A schematic diagram of this treatment train is shown in Figure 10-3. The optimal chemical type and dose should be determined based on jar tests and the particular application. The overflow rate should also be based on the desired amount of sedimentation. The case studies presented in this section demonstrate the benefits that can be realized with chemical addition.

Tube and Plate Settlers

Inclined tubes and plates can be used in sedimentation basins to allow greater loading rates than conventional sedimentation. Figure 10-6 shows a typical plate settler design. This technology relies on the theory of reduced-depth sedimentation: particles need only settle to the surface of the tube or plate for removal from the process flow. Generally a space of two inches is provided between tube walls or plates to maximize settling efficiency. The typical

Figure 10-6. Typical Plate Settler Design



Source: AWWA and ASCE, 1998.

angle of inclination is about 60 degrees, so that settled solids slide down to the bottom of the basin. The disadvantages of these processes are that the tubes and plates can become easily clogged in some applications, can serve as a surface for biological growth (often algae when uncovered), and can be difficult to clean. Uneven flow distribution at the inlet and inadequate spacing of the discharge flumes can create inefficiencies.

A generic process schematic diagram for tube and plate settling is shown in Figure 10-3. Flocculation may be beneficial for recycle streams, depending on the settling characteristics of the recycle stream. The type of chemical mixing used, if necessary, depends on factors such as the plant layout, hydraulic grade line, and design flow rate.

Tube and Plate Settler Case Study (Ashcroft, et al., 1997)

A full-scale plant was using both tube and plate settlers. The tube settlers were installed in an existing circular clarifier and the plate settlers were installed in a new circular basin. The spent filter backwash water was pumped to the clarifiers from an equalization basin. No separate flocculation facilities were provided.

Both clarifiers consistently achieved greater than 90% reductions in turbidity and 2- to 5-μm particles with the addition of 0.7 mg/L anionic polymer. Treated turbidities were in the range of 2.0-3.6 NTU. Loading rates of 0.20-0.38 gpm/ft^2 were tested with little variation in performance. These loading rates are very low when compared to the typical rates of 2-3 gpm/ft^2 used in treating main process flows.

TTHMs and TTHM formation potential were also measured in the untreated and treated backwash waters. TTHMs were about 40 μg/L in the untreated water, and were not significantly affected by treatment. Total TTHM formation potential, however, was reduced by 45% to 55%, to approximately 100 μg/L. Little difference between the performance of the tube and plate settlers was shown.

Plate Settler Case Study (Narasimhan, 1997)

Two full-scale WTPs in metropolitan Phoenix, AZ- the Verde and Mesa plants- have plate-settling facilities that include polymer feed, rapid mix, flocculation, and plate settlers to treat recycle streams. At the Verde plant, a combination of spent filter backwash water, centrate, and gravity thickener overflow is treated; the Mesa plant treats only spent-filter backwash water. Facilities at both plants are operated continuously for six to eight hours per day.

Results from the Verde plant showed consistent treated turbidities of less than 25 NTU with the addition of 0.4 mg/L polymer and loading rates of up to 0.39 gpm/ft^2 (0.95 m/h). At the Mesa plant, treated turbidities were consistently below 20 NTU at loading rates of up to 0.6 gpm/ft^2. Polymer addition did not have much impact on turbidity removal at Mesa. Turbidities of the influents to the recycle treatment facilities at both plants ranged from below 20 NTU to about 100 NTU.

Tube Settler Case Study (Cornwell, et al., 2001)

A full-scale study on a Central Utah Water Conservancy District direct filtration plant was conducted. The plant was equipped with a sidestream plant to treat spent filter backwash prior to recycle. The sidestream was equipped with rapid mix, flocculation, and sedimentation with tube settlers. The tube settler overflow rate range investigated in the plant was 0.19 to 0.37 gpm/ft^2 and treatment was compared with and without polymer. Average settled turbidities without and with polymer were 2.4 NTU and 1.2 NTU, respectively. The addition of 0.1 mg/L of the appropriate polymer resulted in 50% reduction in average settled turbidities. This study also demonstrated that the turbidity levels from the sedimentation basin increased steadily as the overflow rate was increased from 0.19 to 0.37 gpm/ft^2 when no polymer was added. In contrast, the turbidity levels from the sedimentation basin only increased marginally as overflow rates were increased when polymer was added.

Plate Settler Case Study (Hess, et al., 1993)

Plate settlers were used to treat spent filter backwash water from a direct filtration plant. The backwash solids were of low density, were highly organic, and had poor settling characteristics. The plate settlers were operated at a maximum of 0.25 gpm/ft^2 with polymer addition. The treated water averaged less than 1.5 NTU and was returned to the headworks, where the raw water is typically less than 1.0 NTU.

Advantages

When properly designed and operated, the sedimentation unit can remove significant amounts of turbidity and particles, including *Cryptosporidium* and *Giardia*. If overflow rates are low enough, additional contaminants, such as disinfection byproduct precursors, may also be removed.

Disadvantages

If not properly designed and operated, solids removal capabilities will be compromised. Adequate equalization and storage should be provided to avoid this situation. Sludge removal should be conducted frequently enough to avoid compromising the active storage and treatment capability of the sedimentation basin.

Sedimentation with Polymer Addition Case Study (Moss, 2000)

The Salt Lake City Public Utilities Department (SLCPUD) examined optimization of its recycle practices. SLCPUD recycles spent filter backwash at all three of its plants. The spent filter backwash passes through clarifiers prior to its return to the plant headworks. Turbidity levels in filtered water did not exhibit significant changes during recycle; however, increased particle counts in filtered water were very noticeable during recycle events. At one plant, particle counts in the filtered water (measured as particles greater than 2 µm) went from approximately 1,800 prior to recycle to greater than 8,000 during recycle. Recycle of spent filter backwash also resulted in an increase of *Cryptosporidium* and *Giardia* in plant influent as compared to raw water. SLCPUD examined a combination of treatment strategies to reduce the impacts of recycle on its plants. Optimization consisted of increasing settling time, polymer addition, adjusting rate of return at one of the plants, and adjusting coagulant dose at one of the plants in response to streaming current monitoring data. SLCPUD conducted jar testing to determine which polymer to feed to the spent filter backwash. A high charge anionic polymer was selected for two plants and a medium charge anionic polymer was selected for the other plant. The polymer dose at all plants was 0.1 mg/L. All plants exhibited a decrease in particle counts in filtered water due to optimization of recycle practices. Also, turbidity and TOC concentrations in the recycled spent filter backwash decreased as a result of optimization.

10.7.2 Microsand-Assisted Sedimentation

Microsand-assisted settling is not a new principle. The process has been used in the water treatment industry since the 1970's and has been identified by numerous names such as ballasted floc, ballasted sand, and Actiflo®. Microsand-assisted sedimentation relies on improved settling through the addition of microsand and a coagulant chemical to improve flocculation and clarification. The microsand is separated and recycled through the system numerous times. Figure 10-7 shows the typical process of microsand-assisted sedimentation. This process may have application in facilities that need clarification and do not have the space for conventional sedimentation or that need rapid startup clarification ability for variable source water qualities.

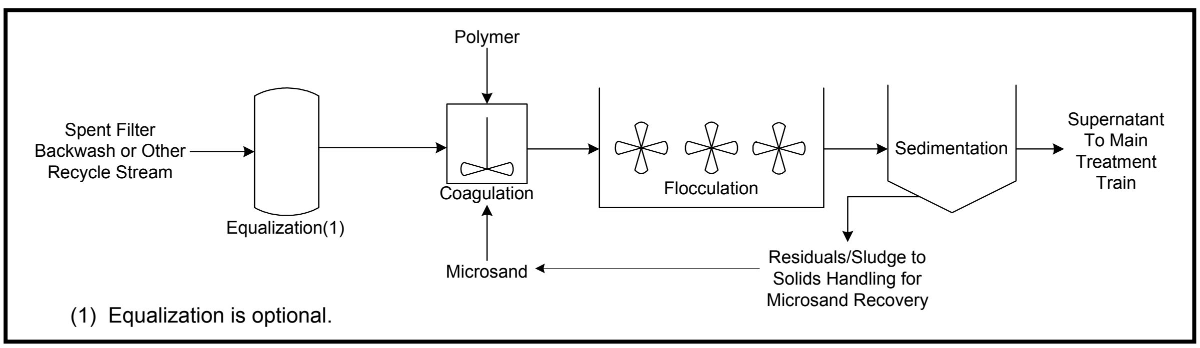
Advantages

According to Kawamura (2000) the advantages of this process are: requires a small footprint, has good performance, has a very quick process start up time, and may have reduced capital costs. As a result, systems may want to consider microsand-assissted sedimentation versus other sedimentation processes if space or money is limited.

Disadvantages

The disadvantages include heavy dependence on mechanical equipment and short processing time, dependence upon power, and may require higher dosage of coagulant.

Figure 10-7. Microsand-Assisted Sedimentation Process for Recycle Streams (In Addition to the Main Treatment Train)

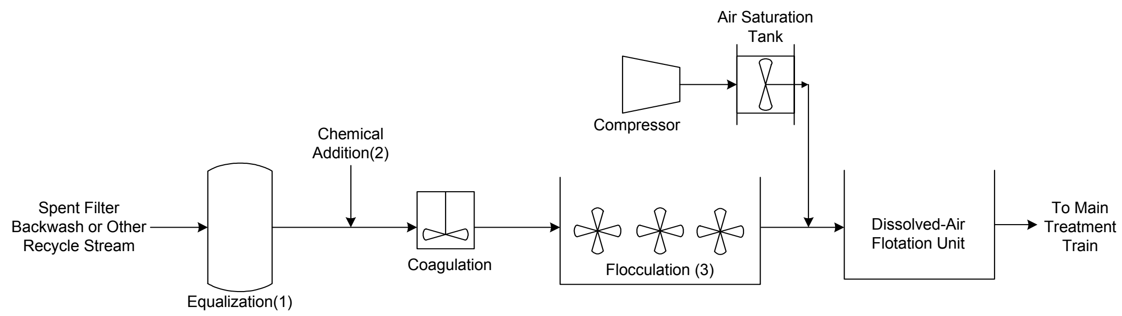


10.7.3 Dissolved-Air Flotation

Dissolved-air flotation (DAF) is most commonly used in two applications: potable water treatment as a clarification step prior to filtration, and wastewater treatment for sludge thickening. The DAF process is another form of solids separation and may be an appropriate technology for treating recycle streams.

In a typical water treatment system installation, DAF replaces sedimentation in a conventional treatment train. The upstream and downstream processes are similar; the raw water is coagulated and flocculated, and the DAF effluent is sent to the filters. A similar process train is likely to be used for treating recycle streams, as shown in Figure 10-8, where the treated stream is recycled to the head of the plant.

Figure 10-8. Dissolved-Air Flotation Process for Recycle Streams (In Addition to the Main Treatment Train)



(1) Equalization is optional but will allow reduction of dissolved-air flotation treatment unit size.

(2) Chemical addition is optional but has been shown to enhance treatment of the recycle stream.

(3) Flocculation is optional.

In the DAF process itself, a side-stream is saturated with air at high pressure and then injected into the flotation tank to mix with the incoming recycle stream. As the side-stream enters the flotation tank, the pressure drop releases the dissolved air. The air bubbles then rise, attaching to floc particles and creating a layer of sludge (also called float) at the surface of the tank. The float is removed either by a mechanical scraper or by flooding the tank over a weir. The clarified water is collected near the bottom of the tank.

DAF can be highly effective at removing low-density particles such as algae, protozoan cysts, coagulated natural organic material, and alum floc from low-turbidity, soft waters. In a bench-scale study on *Cryptosporidium* removal, DAF was shown to achieve at least 2-log removal of oocysts under most process conditions (Plummer, et al., 1995). In a pilot-scale study of DAF and lamella sedimentation, the average log removals by DAF for *Giardia* and *Cryptosporidium* were 2.4 and 2.1 respectively, compared to 1 to 1.2 and 0.91 to 1.1, respectively, for lamella sedimentation (Edzwald, et al., 2000). However, this study was conducted on a main treatment process rather than a recycle stream. These results were included in another study by Edzwald, et al., (2001). The same considerations for sludge removal, storage, and equalization apply to DAF, as discussed in Section 10.7.1.

Advantages

DAF has several advantages over sedimentation:

- *More compact:* DAF loading rates are high, so that much smaller tanks can be used than in sedimentation.

- *Shorter startup time:* The smaller tanks result in good effluent quality in less time.
- *Lower chemical dose:* In many cases DAF requires less coagulant than sedimentation.
- *Shorter flocculation time:* Flocculation times for DAF are normally one-half to one-fifth of those for sedimentation.
- *Thicker sludge:* The floated sludge from a DAF unit typically has a much higher solids concentration than does sludge from a sedimentation basin.

Disadvantages

The main disadvantage of DAF compared to sedimentation is that it requires more complex equipment, particularly the air saturation and recycle control equipment. A higher level of skill is needed to operate and maintain this equipment than is needed for equipment associated with sedimentation facilities.

As with sedimentation, the need for chemical pretreatment and flocculation prior to DAF treatment of the recycle stream is uncertain. DAF normally requires less coagulant and shorter flocculation times than does sedimentation, and particles in spent filter backwash water have already been coagulated and flocculated to some degree in the main treatment train. If DAF can provide adequate treatment without pretreatment, then DAF becomes a cost-effective option to treat recycle streams.

DAF Case Study (Cornwell, et al., 2001)

A bench-scale study was conducted using DAF with polymer addition to treat spent filter backwash. The pilot DAF plant could treat spent filter backwash at a rate between 36 and 54 gpm and had varying surface overflow rates and recycle ratio range capabilities. The spent filter backwash fed to the pilot plant had turbidity levels ranging from 30 to 300 NTU. The DAF was able to produce clarified effluent with turbidities of 1 to 2 NTU (99% or 2-log turbidity reduction) with 0.3 mg/L of polymer at surface overflow rates of 4 to 5 gpm/ft^2. A DAF recycle ratio of 10% was found to be adequate for effective treatment.

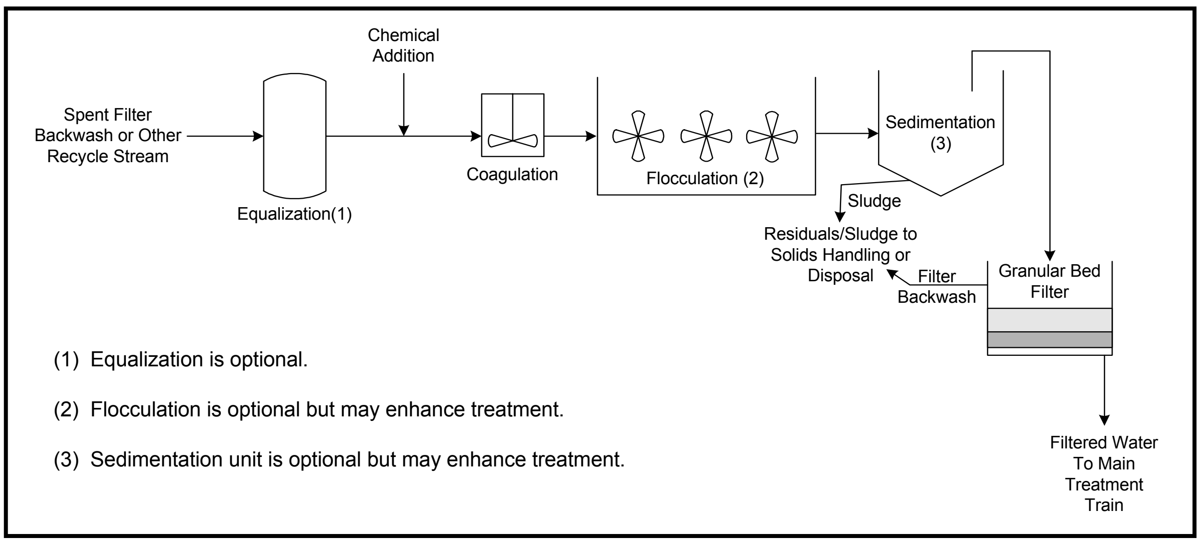
DAF Case Study (Lew and Patawaran 2000)

The Betasso Water Treatment Plant (Boulder, CO) selected DAF as the best treatment technology for spent filter backwash after assessing six alternative treatment types. The DAF process was able to achieve turbidity levels of 1 NTU on a consistent basis without extensive chemical manipulation. With consistent dosage of polymer, DAF was able to adsorb significant turbidity spikes and varying loading rates without compromising effluent water quality.

10.7.4 Granular Bed Filtration

Granular bed filtration may be an effective treatment method for spent filter backwash water and other recycle streams. Pretreatment by chemical addition with or without flocculation prior to the filter should be practiced. The high solids content of some backwash waters may result in unacceptable short filter runs, suggesting that clarification is needed prior to filtration, but higher-quality spent filter backwash waters may be quite amenable to filtration without sedimentation. A process schematic diagram for granular bed filtration, with pretreatment by chemical mixing, flocculation, and sedimentation, is shown in Figure 10-9. Pumping facilities may be required to convey the treated recycle stream depending on site-specific conditions.

Figure 10-9. Granular Bed Filtration Process for Recycle Streams (In Addition to the Main Treatment Train)



Advantages

The expected advantage of granular bed filtration over sedimentation and DAF is that it has a much higher rate of particle removal. Depending on water quality, pretreatment, filter media, and loading rates (among other factors), filtration of recycle streams may remove particles at or above the level achieved by the main treatment train.

Disadvantages

The disadvantages of filtration, compared to either sedimentation or DAF alone, are its high cost, process complexity, and greater volume of waste. Waste would be generated through the backwash of the recycle stream filter.

Granular Filtration Case Study (MacPhee, et al., 2000)

Several treatment scenarios were examined for spent filter backwash. The treatment scenarios consisted of sedimentation with polymer and DAF with polymer followed by granular media filtration. This treatment scenario provided 2.2 to 3.0 log reduction of turbidity and 2.4 to 4.4 particle log reduction of the spent filter backwash.

10.7.5 Membrane Filtration

A membrane treatment process, such as microfiltration (MF) or ultrafiltration (UF), is capable of very high levels of particle removal. MF has been used for a variety of industrial applications and, in recent years, has been used for particle removal in potable water treatment. Limited information is available on MF treatment of spent filter backwash water and other recycle streams, but research continues on this technology.

Microfilters provide an absolute barrier to particulates by straining them from the flow stream at the membrane surface. Nominal pore sizes for microfilters fall in the range of 0.05 to 5.0 µm. Microfilters with smaller pore sizes (≤0.2 µm) can remove virtually all bacteria and protozoa, including *Cryptosporidium* and *Giardia* (Jacangelo and Buckley, 1996). The removal of viruses is more highly dependent upon the specific virus, membrane, and water quality (Jacangelo and Buckley, 1996), though the removal of viruses may be less of a concern because of their high susceptibility to inactivation by most disinfectants.

Depending on the membrane and water quality, MF membranes can remove some natural organic matter (NOM), DBP, and TOC. The removal of NOM by MF membranes can also be improved by coagulation. NOM found in spent filter backwash water, having previously been coagulated to an extent, may be removed to a good degree by MF. Some membranes are susceptible to fouling by chemicals and chemical use should be carefully evaluated for each membrane type. A simple process schematic diagram for membrane filtration of recycle streams is shown in Figure 10-10. As noted above, microfiltration may require chemical pretreatment, depending on the recycle stream characteristics and treatment goals. Also, facilities for membrane cleaning would be required.

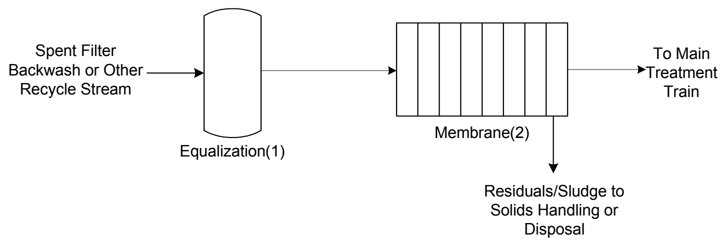
Advantages

One advantage of MF for recycle stream treatment is that it can normally treat wide variations in influent water quality with little or no adjustment to the process. Another advantage is that MF systems are compact and available as prefabricated, modular units that can easily be expanded. Also, hydraulic head is not typically “broken” in membrane systems, so a unit may be located at any elevation and require only one pumping facility.

Disadvantages

The primary disadvantage of a MF system, when compared to sedimentation or DAF, is the greater complexity of its equipment. Another disadvantage is that membranes are subject to fouling from bacteria, chlorine residual, coagulants, and polymers. The contaminants contained in the recycle stream may be substantial enough to foul the membranes. Therefore, extensive pilot testing should be conducted on the membrane for each type of recycle stream to evaluate potential fouling.

Figure 10-10. Membrane Treatment Process for Recycle Streams (In Addition to the Main Treatment Train)



(1) Equalization is recommended to provide some treatment (sedimentation) and reduce the size of membrane footprint.

(2) Depending on the type of membrane, pumps may be needed.
Chemical pretreatment may be necessary to remove organics but chemicals may cause membrane fouling.

Microfiltration (MF) Case Study (Thompson, et al., 1995)

Thompson, et al. (1995) reported on pilot-scale testing of MF for recycle stream treatment. A membrane with a nominal pore size of 0.2 µm was used in all tests. In these tests, spent filter backwash water with turbidities around 500 NTU were reduced to less than 5 NTU. At another plant, MF was used to treat a combination of spent filter backwash water and clarifier sludge blowdown from a conventional treatment train. The recycle stream was spiked with *Giardia* cysts and *Cryptosporidium* oocysts before MF treatment. No cysts, oocysts, or coliforms were detected in the MF-treated water, and turbidities were consistently 0.1 NTU. High levels of particle removal were also shown using particle counters.

Ultrafiltration (UF) Case Study (Shealy, et al., 2000)

Several recycle water treatment alternatives were evaluated at the Orangeburg, SC plant. After narrowing the alternatives, the system chose to pilot test micro/ultrafiltration membrane treatment. The main objectives of the study were: contaminant removal and membrane flux rate, feasibility of full-scale application, and potential capital and operating costs. After months of research and evaluation, membrane treatment with immersed UF technology was selected for full- scale implementation. The conclusion was that, coupled with equalization basins, UF membranes produced excellent treated water quality. The permeate from the membrane unit is proposed to discharge to the head of the plant.

Microfiltration Case Study (Taylor, et al., 2000)

Bench-scale testing of MF to treat spent filter backwash water was conducted at the University of Central Florida. Backwash waters from nine water treatment plants across the United States were used in the testing. The treatment unit used in the study was an MF unit fitted with a single microfilter membrane (surface area of 1 m^2). One liter of filtrate water was collected approximately five minutes into filtration for chemical water quality analysis. True color, UV-254, total suspended solids (TSS), turbidity, and particle counts were the parameters measured. The changes in UV-254 and true color were not significant and therefore not considered a consequence of treatment. However, turbidity and TSS were significantly reduced by MF. Water turbidity was reduced from 31-168 NTU to 0.02-0.16 NTU. TSS was reduced from 66-206 mg/L to 1-3 mg/L (the limit of accurate TSS measurements).

A cost estimate for applying membrane filtration (MF and UF) to the treatment and recovery of spent filter backwash water was included in the study. Estimates for flows of 0.01, 0.1, 1.0, and 10.0 MGD were developed. The membrane system cost included feed water pumps, backwash and recycle pumps, air compressor, membrane modules and racks, piping and valves, instrumentation and controls, and the membrane cleaning system. The researchers found that unit capital and O & M costs decreased significantly by capacity and varied significantly by source. Unit capital costs varied from $10.35/gpd at 0.01 MGD to $0.38/gpd at 10 MGD. Unit O & M costs varied from $2.68/Kgal at 0.01 MGD to $0.16/Kgal at 10 MGD.

10.7.6 Disinfection

Disinfection can be a barrier to the recycling of pathogens from recycle streams. Results from the AWWA utility survey show that a small percentage of plants that do recycle practice disinfection of those streams (Pedersen and Calhoun, 1995). The most common disinfectant used by far was chlorine. The California Department of Health Services recommends that disinfection be considered for recycle streams (CDHS, 1995).

The main issues to be addressed when considering disinfection of recycle streams are:

- The level of inactivation to be provided for specific organisms;
- Whether disinfection is to be used alone or with a solids removal process; and,
- The potential impacts of recycle stream disinfection on finished water quality, particularly the formation of DBPs.

If disinfection is to be applied to recycle streams, the required level of disinfection and inactivation must be known in order to size the facility. No guidelines have yet been issued in regard to pathogen inactivation or removal from recycle streams. Under the current SWTR, IESWTR, and LT1ESWTR, the amount of disinfection provided to water supplies is determined by the inactivation and removal of *Giardia* and viruses. Credit is given for the removal of pathogens by properly operated treatment processes, such as filtration, and credit for inactivation is given based on the disinfectant concentration and contact time provided.

For the treatment of recycle streams, the removal and/or inactivation of *Cryptosporidium, Giardia,* and viruses is a concern. Disinfection options and inactivation levels are well known for *Giardia* and viruses. Ozone and UV both appear to provide inactivation of *Cryptosporidium*.

Disinfection Case Study (Cornwell, et al., 2001)

The oxidant demand of both potassium permanganate and chlorine dioxide was examined for spent filter backwash samples from five participating water utilities. Overall, the potassium permanganate demands were approximately 5.5 times higher for spent filter backwash with particles than in samples without particles. Potassium permanganate disinfection at 2,400 mg-min/L (CT value) with and without particles resulted in *Cryptosporidium* inactivations of 0.21 and 0.27-log, respectively. The presence of particles in spent filter backwash increased the chlorine dioxide demand by a factor of four when compared to samples without particles. Chlorine dioxide dosed at 115 mg-min/L (CT value) produced 2.7 and 2.1-log inactivation of *Cryptosporidium* for spent filter backwash with and without particles, respectively. Ultraviolet (UV) treatment was also examined for its effectiveness on *Cryptosporidium* in clarified spent filter backwash with turbidities between 10 and 14 NTU. UV doses as low as 3 milliJoules per square centimeter used in collimated beam experiments resulted in *Cryptosporidium* inactivations greater than 4 logs.

Advantages

Pathogens are contaminants of concern in recycle streams. Depending on the type and amount of disinfectant used, *Cryptosporidium*, *Giardia*, and/or viruses can be inactivated. More advantages may be realized through disinfection of recycle streams as more studies are conducted on this practice.

Disadvantages

Recycle stream disinfection should be examined for its potential effects on the main treatment train and finished water quality. Untreated recycle streams can have significant concentrations of TTHM precursors and TOC (Cornwell and Lee, 1993). If the recycle stream is treated with chlorine, then recycling may cause problems for the treatment plant in meeting DBP limits. The potential formation of DBPs through disinfection should be considered. Chapter 7 provides more information on DBP and DBP precursor levels in recycle streams.

10.8 COMPARISON OF TREATMENT OPTIONS

Seven different treatment scenarios for spent filter backwash at seven different treatment plants were examined (Cornwell, et al., 2001). Table 10-2 presents the turbidity and particle log reductions obtained from each treatment type. The results in Table 10-2 are based on both pilot-scale and full-scale plants. Sedimentation with polymer, DAF with polymer, granular media filtration with pretreatment, and membrane microfiltration appear to provide the best turbidity and particle reduction. Table 10-2 also presents relative costs of each treatment type. Membrane microfiltration was the most expensive treatment option based on this study. However, costs will vary from plant to plant depending on site-specific conditions, recycle stream characteristics, and desired level of treatment.

Table 10-2. Spent Filter Backwash Turbidity and Particle Log Reductions by Treatment Type

Treatment Process[1]	Turbidity Log Reduction	Particle Log Reduction	Relative Cost Ranking[2]
Sedimentation without polymer[3]	0.1 to 0.8	0.2 to 0.9	1
Dissolved Air Flotation (DAF) without polymer	0.7 to 1.4	0.8 to 1.7	-----
Sedimentation with polymer[3]	1.4 to 2.3	1.9 to 3.3	2
DAF with polymer	1.7 to 2.7	1.9 to 3.5	3
Coagulation/ Flocculation followed by Sedimentation[3]	0.5 to 1.7	0.4 to 2.1	------
Granular Media Filtration with pretreatment[4]	2.2 to 3.0	2.4 to 4.4	4
Membrane Microfiltration	2.6 to 3.9	1.6 to 3.5	5

[1]Treatment processes were conducted at seven different sites and consisted of both pilot-scale and full-scale studies.
[2]Relative costs are presented with 1 being the lowest-cost treatment process and 5 being the highest-cost treatment process. Costs were not available for DAF without polymer and coagulation/flocculation followed by sedimentation.
[3]Sedimentation consisted of either tube settlers or plate settlers.
[4]Pretreatment consisted of either sedimentation with polymer or DAF with polymer.

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APPENDIX J

TECHNICAL MEMORANDUM 20434-8, SUDDEN VALLEY WTP STRUCTURAL AND ARCHITECTURAL SYSTEMS ANALYSIS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-8

TO:	BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	FEBRUARY 15, 2022
SUBJECT:	SUDDEN VALLEY WTP STRUCTURAL AND ARCHITECTURAL SYSTEM ANALYSIS LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP). This assessment is part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively provide clean potable water for its existing and projected customers.

This memorandum summarizes an assessment of the existing WTP Main Building and Finished Water Pump Buildings, and provides three basic options for expansion/modification. This memo then provides an analysis of factors to consider for each of these options.

Final recommendations for modifications to the WTP Main Building and/or layout will be presented in the final Alternatives Analysis Report, which is scheduled to be completed in spring 2021. This final report will consider all of the alternatives and recommendations compiled for each of the treatment systems and will provide a coordinated set of recommendations based on capital costs, District needs, operational costs, and other factors.

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BACKGROUND AND EXISTING FACILITIES

Background

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley WTP. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD), which is equivalent to approximately 1,400 gallons per minute (gpm), but currently operates at a reduced flow of 1.0 MGD (700 gpm). The maximum allowable water right for this source is 1,526 gpm; however, the WTP and its components will be sized to accommodate the WTP's rated flow of 1,400 gpm. This design flow is suitable to serve the projected buildout water demand of 1.3 MGD as listed in the District's 2018 Water System Comprehensive Plan.

The WTP is located at 22 Morning Beach Drive in Bellingham, Washington, and is housed in a partially below-grade concrete building located adjacent to Morning Beach Park. The facility was constructed in 1972 and has undergone several minor improvements since that time but was most recently upgraded in 1992. Two centrifugal raw water pumps pump water from the Lake Whatcom intake to the WTP where alum coagulant is injected. After mixing with coagulant, water enters the flocculation basin before entering the filter distribution trough and the mixed-media filters. Water proceeds through the filters into the underdrain system then exits the filter through the filter discharge piping. The filter discharge piping includes injection points for both soda ash (pH adjustment) and chlorine. This piping then directs the filtered water to the below-grade clearwell. Two transfer pumps located in the WTP move water from the clearwell to the chlorine contact basin, which is a welded steel reservoir located adjacent to the WTP that provides additional chlorine contact time. From the chlorine contact basin, four finished water pumps pump water to the District’s storage reservoirs and distribution system for consumption.

Historical WTP Performance

Historically, the plant has performed well and provides high-quality finished water with turbidities of less than 0.1 nephelometric turbidity units (NTU).

The individual building structures have also performed well and are generally in good condition. Additional information on the construction of these buildings as well as the findings of a recently completed WTP assessment are provided in the next section.

BUILDING CONSTRUCTION

WTP Main Building

The WTP Main Building (Main Building) was constructed in 1972 and is a three-room one-story building consisting of cast-in-place concrete walls with a roof made from precast concrete tee beams overlain by a 4-inch concrete topping slab at the roof. The tee beams are supported at the perimeter of the building by the concrete walls. The building is built into a hillside so its walls are partially to fully below grade, except at the entrance on the north side of the building – which is fully exposed. The north wall with the entrance is a glass and metal framed “storefront” façade. According to record drawings, the roof structure has three-ply built-up roofing, overlain by 2 inches of sand, overlain by up to 18 inches of soil fill. Some photographs of the Main Building are shown as Figure A-1 in Exhibit A and a plan drawing of the building is shown as Figure A-2.

The Main Building contains a large treatment room that houses treatment equipment including raw water pumps, primary treatment equipment, filtration equipment, filtered water storage and pumping, laboratory, and storage space. Below grade, there is a concrete clearwell which provides equalization volume for filtered water prior to being pumped to the chlorine contact basin (CCB). The footprint of the clearwell is approximately 440 square feet (sf) with a total depth of approximately 9 feet. Within the treatment room is a small enclosed washup facility with a sink, toilet, and small storage closet. The washup facility is separated from the treatment room by wood framing, gypsum wallboard, and a hollow-core wood access door. The Main Building also includes an adjoining room that houses the chlorine gas disinfection equipment. Although there is a glass window that provides visibility to the chorine room from the treatment room, the chlorine room is only accessible via an external entrance with a single metal access door. Lastly, the Main Building contains a metal security cage on the front façade to provide protection from vandalism and further restrict public access to the building.

In 2020, Gray & Osborne completed an assessment of the WTP and compiled the findings of the assessment into the *Sudden Valley Water Treatment Plant Assessment Report* (Assessment Report). The assessment included findings and recommendations from a mechanical, process, electrical, and structural/architectural perspective. The structural findings from this Assessment Report are summarized below while the mechanical, process, electrical, and coating assessment findings are addressed in other technical memoranda associated with this project.

- In general, the concrete structure is in good condition. No major cracks or spalling were found.

- According to record drawings, the topping slab over the tee beams is only 2 inches thick at the perimeter. It increases to 4 inches thick at the center of the roof to provide an external slope to promote drainage. The flanges of the tee beams are also relatively thin, tapering down to 1.5 inches thick at the ends of the flange. According to the record drawings, the roof was designed for 40 pounds per square foot (psf) live load and a maximum soil depth of 18 inches.

- The building is categorized as a Type C2 with concrete shear walls and stiff diaphragm and a preliminary Tier 1 seismic analysis did not find any major seismic deficiencies in the building.

- Miscellaneous structural steel supports such as pipe, conduit, and equipment supports are corroded. In some cases, the corrosion is severe enough that the strength of the support has been reduced.

- There are two coated steel tanks (flocculation and Filters 1 and 2) inside the building. The steel for these tanks is coated with paint and in some areas the paint has failed leading to corrosion of the steel. The corrosion does not appear to be advanced enough to affect the structural integrity of the tanks. The vessel for Filters 3 and 4 is made from aluminum and does not show signs of corrosion.

- Various segments of piping and associated fittings show minor signs of corrosion. This corrosion tends to be located at joints, fasteners, or edges, which is typical for piping within a moist environment. The corrosion does not appear to have affected the integrity of the piping and/or fittings.

- Many of the interior tanks and miscellaneous items supported from the building structure do not appear to have adequate seismic anchorage and/or bracing.

With regard to the layout of the Main Building, the Assessment Report had the following architectural observations:

- The building is extremely cramped due to the presence and location of large treatment equipment, most notably the flocculation tank, chemical tanks, and filter vessels. Furthermore, the existing footprint does not have adequate space or accommodations for additional equipment.

- Working clearances to all sides of each treatment component are limited due to the presence and location of stored materials used for maintenance and/or operation of the facility.

- Removal of any large treatment components (i.e., filters) will require removal of storefront windows as well as removal of the flocculation tank and/or chemical storage tanks.

- The laboratory space and computer monitoring equipment occupy the same space/counter, which places the electronic equipment at risk from damage due to spills/moisture. In addition to this, there is no dedicated office space where staff can complete water quality forms and/or monitor and control the treatment equipment.

- Storage space is limited. To ensure successful operation of the facility, a significant number of parts and tools are required. These parts and tools should be readily accessible; however, the available storage space is limited. Additionally, a tool cart and additional storage and workspace would make it easier for WTP staff to operate and maintain the facility. Furthermore, chemicals are stored in close proximity to electrical components, which promotes deterioration and degradation due to corrosion.

- The existing restroom facility and associated finishes show signs of deterioration.

- The existing safety shower and eyewash units installed at the WTP do not meet the requirements listed in ANSI Z358.1.

- Various areas throughout the WTP (concrete walls, storefront windows, etc.) show signs of current and/or previous moisture intrusion. Furthermore, moisture continually present on the floor is likely due to insufficient drainage slopes and presents a safety hazard.

- The existing structure contains significant plant (ivy) growth on its exterior. This growth provides some camouflaging effect, but also inhibits the ability to inspect the structure and could potentially damage waterproofing systems if left unmanaged.

- The building components associated with the chlorine gas disinfection system show signs of deterioration and the chlorine gas system itself does not meet current codes for use/storage of the chemicals.

- The structure does not utilize an effective smoke alarm or fire suppression system.

- Site security is limited for the facility and the general public currently has access to both treatment buildings as well as the chlorine contact basin.

Per the previously completed Assessment Report, no seismic deficiencies were found in the structure of the Main Building. However, some nonstructural items such as partition walls and seismic bracing for piping were found to be deficient and require retrofits to meet the desired seismic performance level. The structural items noted above can all be addressed with minimal effort and expense when compared to the cost of substantial building modifications and/or replacement. Also, per the Assessment Report, the safety systems such as showers/eyewashes and the fire/smoke alarm systems do not meet current codes. Repairs to these systems, to equipment showing fatigue, and repairs to address moisture issues can all be addressed through individual projects based on available funding. Issues with capacity for expansion and space allocation for the various WTP staff work requirements at the WTP are more complex and are discussed in subsequent sections of this memorandum.

Finished Water Pump Building

This one-story building was constructed in 1992 and consists of prefabricated wood trusses at the roof supported by concrete masonry unit (CMU) walls at the perimeter of the building. The building exterior is provided with wood plank siding and the roof is constructed with asphalt shingle materials. The portion of this building that is utilized by the District contains a single large room that houses the finished water pumps and piping, the electrical components and starters associated with these pumps, various security and monitoring equipment, and the auxiliary generator that serves both the WTP and the Afternoon Beach Lift Station. The building also contains separate men's and women's restrooms at the west end of the building. The restroom facilities are each accessed via the building exterior by a single metal door, and these restrooms are only open to the public and Morning Beach Park users during the warmer summer months. Some photographs of the Finished Water Pump Building are provided as Figure A-3 in Exhibit A while a plan drawing of the building is shown as Figure A-4. Adjacent to the building is a freestanding 2,500-gallon diesel fuel tank that provides up to 96 hours of fuel for operation of the auxiliary generator.

The structural findings from the Assessment Report for this building are summarized below:

- In general, the prefabricated wood trusses and CMU walls are in good condition.
- Electrical conduit in the attic had only occasional bracing that did not appear to be adequate for the design-level earthquake.
- The building is categorized as a Type RM1 with reinforced masonry bearing walls and flexible diaphragm and a preliminary Tier 1 seismic analysis found two seismic deficiencies of concern:
    - The first deficiency concerns the transfer of horizontal shear forces from the roof diaphragm to the CMU wall at the south side of the building.
    - The second deficiency is insufficient out-of-plane anchorage of the tops of the CMU walls to the roof diaphragm.

The Assessment Report had no significant architectural observations for the Finished Water Pump Building and, in general, the building has sufficient space for access and maintenance on the equipment located within the building.

The items noted above can all be addressed with minimal effort and expense when compared to the cost of substantial building modifications and/or replacement. The next section describes options and analysis for potential modifications to the WTP structures.

BUILDING ANALYSIS

In this section, we will discuss the factors involved with modifying the existing WTP structures in order to accomplish the District's goals for their treatment operations which include:

1. Provide adequate space and accommodations for operation and maintenance of the equipment.

2. Provide suitable accommodations for expansion or replacement of treatment equipment including flows up to the maximum design flow of 1,400 gpm.

3. Provide treatment process redundancy so that the WTP can maintain operations if selected equipment must be removed from service for maintenance.

4. Provide components that will help preserve the function and condition of the electrical components used for treatment analysis.

5. Continue to provide exceptionally high-quality potable water to service area customers as efficiently and as cost-effectively as possible.

WTP Main Building

In its current orientation, space within the Main Building is very limited and the existing facility does not accomplish Goal 1, 2, 3, or 4 listed above. Additionally, the orientation and size of the treatment equipment will make it very difficult to meet these goals without some modifications to the Main Building. In order to meet these goals, additional facility space is required and can be provided in three main ways: expansion above the existing structure, expansion adjacent to the existing structure, and construction of a new separate building/structure. The sections below provide additional information and considerations for several key factors to consider when weighing these alternatives.

<u>Alternative 1 – Building Expansion Above the Existing Structure</u>

Alternative 1 includes expanding the existing structure vertically to create a second floor/story within the building. The new space would have an identical footprint to the existing structure and could be accessed from the Main Building ground floor, exterior stairs, and/or a separate access driveway.

Condition and Code Adherence

Per the previously completed Assessment Report, no seismic deficiencies were found in the structure of the Main Building. However, some nonstructural items such as partition walls and seismic bracing for piping were found to be deficient and require retrofits to meet the desired seismic performance level.

Expansion of the existing facility would be more difficult than construction of a new facility with regard to meeting current codes. If the existing facility is expanded, the entire building, including the chlorine gas room, must be brought into compliance with current building and safety codes. For the chlorine room, this would include additional security, chemical storage, ventilation, and fire alarm systems. Additionally, if this option is selected, there are several nonstructural recommendations in Technical Memorandum 20434-3 (Gray & Osborne, 2020), including bracing of equipment and addressing minor corrosion of equipment/materials that should be completed in order to provide a robust treatment system.

Constructability

Factors that affect the constructability include (but are not limited to) preparation of the space, materials of construction, joining of materials, construction sequencing, equipment needed, space needed for construction, and equipment staging.

The Main Building is located partially below grade, at the base of a steep hillside under cover of approximately 18 inches of soil, and utilizes a roof which is not designed to support heavy or point loading. All of these factors will reduce and complicate access by vehicles, materials, and workers during construction.

Any modifications to the existing structure should be preceded by a thorough geotechnical and hillside analysis to ensure that construction of the proposed expansion is appropriate given the terrain and to potentially identify any geotechnical requirements that should be included in the construction methods for facility expansion.

While technically feasible, expansion of the existing facility above the existing structure is not recommended because of the restricted access for construction vehicles and slope/location of the adjacent hillside. It is likely that construction of this alternative would require specific geotechnical construction considerations.

Property, Land Acquisition, and Land Use

The District does not own the parcel that contains the existing WTP and as such, would need to purchase or lease the land from its owner, the Sudden Valley Community Association (SVCA). The SVCA manages the operation of its property and works to ensure that the values of the community are maintained with regard to development and utility services. The land adjacent to the WTP is a public park and continuous availability to community members is a high priority for the SVCA. Impacts to the adjacent park are a significant factor when considering a plan of action for any WTP modification project.

Expansion of the existing facility above the existing structure is most desirable from a land acquisition/land use standpoint because the footprint of the WTP would not increase.

Access

Currently, the WTP is accessible via Morning Beach Drive and shares access with the adjacent Morning Beach Park parking lot. Morning Beach is a highly popular park in the summer months and adequate parking for visitors must be maintained. Additionally, the District must maintain access to the WTP for operations staff, for maintenance vehicles, and for chemical delivery vehicles. Currently, chemical delivery vehicles are small to medium size, but depending on whether or not the treatment process is modified, additional space may be necessary to accommodate larger delivery vehicles with larger turning radii.

Expansion of the existing facility above the existing structure would provide the lowest level of access to the facility. Expansion above the existing facility would necessitate the use of high slope roads and most likely a significant retaining wall for vehicular access to the upper level. It would also require stairs and/or elevators to access the upper floors from the building interior; however, the existing building footprint is not conducive to the space required to provide a stairway.

In addition to vehicular and pedestrian access to the WTP, there is also a question of conformance with the Americans with Disabilities Act (ADA). The current facility is not ADA compliant with regard to ingress/egress points, aisleway clearances, or restroom spacing. This is very common for water and wastewater treatment facilities given that these facilities are designed with heavy and moving equipment and often necessitate the use of large elevation changes or access to tight spaces; however, many entities have made their treatment facilities fully compliant with ADA requirements to corroborate with their status as an Equal Opportunity Employer, out of personal preference or company policy, or at the request/direction of building permit officials. Modifications to either the existing building or for any new structures should consider whether these facilities will be compliant with ADA as the accommodations for clearances, parking, building access, and restroom facilities are a significant consideration in the design of any structure. Of the three options, expansion of the existing structure above the Main Building would provide the greatest number of challenges in complying with ADA requirements.

Capacity for Expansion and Rehabilitation

One of the District's primary goals for modifications to the existing WTP is to provide sufficient accommodations for facility expansion/rehabilitation. Although the existing operational flow of 700 gpm is suitable to serve the current demands and the WTP is rated for treatment up to 1,400 gpm which will meet the projected design flow for the service area, the District would like to provide treatment capacity of the design flow ***with redundancy.*** This will help ensure that the WTP can provide potable water if selected components are offline for maintenance. The orientation of the existing treatment equipment does not provide accommodations for replacement/expansion of the filter equipment, flocculation tank, or chemical storage tanks – all of which would require modifications to the existing storefront window façade and/or temporary relocation or removal of selected equipment. Furthermore, there are other treatment components, most notably the chlorine contact basin, that limit the treatment capacity of the WTP but are not specifically located within the Main Building.

Expansion of the existing facility above the existing structure would not improve the capacity for equipment expansion/replacement because the upper floors could only be used for laboratory/work space or light storage and not treatment equipment or chemical storage. The lower floor must continue to house all of the treatment equipment and accessing/replacing the treatment components would still require significant modifications to the facility.

Summary

Based on the factors and descriptions noted above, expansion of the existing facility above the existing Main Building footprint does not appear to help the District meet its treatment and/or building expansion goals.

<u>Alternative 2 – Expansion Adjacent to the Existing Structure</u>

Alternative 2 includes expanding the existing structure horizontally to expand the footprint. The new space would be accessed from the existing access driveway or through the existing Main Building ground floor.

Condition and Code Adherence

Similar to Alternative 1, expansion of the existing facility would be more difficult than construction of a new facility with regard to meeting current codes. Upgrades to comply with current chlorine gas codes would need to be completed, and nonstructural recommendations listed in Technical Memorandum 20434-3 for the Main Building should be completed.

Constructability

Expansion of the existing facility adjacent to the existing structure is more feasible than above the existing structure as discussed in Alternative 1. This is largely because the area to the north of the existing structure is open and available for construction equipment and/or staging and the expansion is not constrained by the footprint and construction type of the existing facility as in Alternative 1. Access to the existing facility would need to be maintained at all times, which would add significant complications to the construction schedule and sequencing. Furthermore, the new building expansion could be constructed with less-expensive construction materials such as wood framing or prefabricated metal buildings to limit cost. It should be noted, however, that these lower-cost materials may have a shorter lifespan.

Property, Land Acquisition, and Land Use

Expansion of the existing facility adjacent to the existing structure would require input and substantial coordination with the SVCA as well as other stakeholders. Special consideration would need to be given to maintaining access to Morning Beach Park and the District should consider how the expansion may affect use of the park by the public.

Access

Expansion of the existing facility adjacent to the existing structure would improve access to the facility but would also potentially decrease access to Morning Beach Park. Turnarounds and access by delivery vehicles would be maintained with this option.

Expansion of the existing facility adjacent to the Main Building structure would provide a better opportunity to comply with ADA requirements when compared to expansion above the existing structure; however, compliance would still be more difficult with this alternative when compared with construction of a new separate structure.

Capacity for Expansion and Rehabilitation

Expansion of the existing facility adjacent to the existing structure could provide accommodations for equipment expansion/rehabilitation depending on the building size, layout, and orientation. If specific equipment is relocated to the expanded structure, it should be oriented in a fashion that will provide for easy removal/rehabilitation. While this would allow for reorganization of the space within the existing Main Building, access to the existing building would still be through a single door via the expanded space. Expansion of the existing building would not accomplish the District's goals unless all of the treatment equipment is relocated to the expanded space. However, relocating the existing treatment equipment to an expanded space would require that the WTP be taken offline for a significant period of time and would require that water service be provided by another source during this period. This temporary service could be avoided if new treatment equipment were included with the building expansion project as this new equipment could be installed, connected, and tested, and the WTP would only be taken offline to make final connections and for testing/startup.

<u>Alternative 3 – Construction of a New Separate Structure</u>

Alternative 3 includes construction of a new separate building. The building would be located near the existing Main Building, but would allow access to each building through unique access doors. Access to both structures would be from the existing access driveway.

Condition and Code Adherence

Construction of a separate structure would be simpler than vertically or horizontally expanding the existing facility. For the existing Main Building, upgrades to comply with current chlorine gas codes would need to be completed, the safety shower and eyewash systems should be brought into conformance with ANSI Z385.1, the fire/alarm system should be upgraded, and nonstructural recommendations listed in Technical Memorandum 20434-3 for the Main Building should be completed.

Constructability

Construction of a new facility is the most feasible of the three options because design of a new building could be tailored and optimized for the facility's needs. It would also provide for an open construction area and could be designed to provide more room for District staff to access the existing Main Building. If the new building is separate from the existing building, it allows greater flexibility in choosing the construction type for the new building. Less-expensive construction types such as wood-framed or prefabricated metal buildings could be considered to limit cost.

Property, Land Acquisition, and Land Use

Construction of a new separate structure would require input and substantial coordination with the SVCA as well as other stakeholders. Special consideration would need to be given to maintaining access to Morning Beach Park and the District should consider how construction would affect use of the park by the public.

Access

Construction of a new facility would provide the greatest improvement in access to the WTP but would also potentially decrease access to the adjacent beach park. Turnarounds and access by delivery vehicles could be optimized with this option.

Of the three alternatives, construction of a new building would provide the simplest and most cost-effective method for complying with ADA requirements if desired by the District.

Capacity for Expansion and Rehabilitation

Construction of a new facility would have the most significant benefit on improving accommodations for rehabilitation/expansion. A new facility could be designed and sized to accommodate current and future treatment equipment.

Building Costs

Capital cost is a significant consideration for any utility provider and is a critical factor in determining the option with the greatest value for the District's operations. Each of the options discussed herein has various possible construction techniques and each of these techniques has variable costs for design and construction.

Wood-framed structures are the least expensive and require the least design effort, but are more susceptible to damage from elements such as moisture. Wooden structures may sit on concrete foundations and can be constructed to a wide range of heights and dimensions. They are easily modified using standard construction practices and tools, and these materials are typically the most readily available from local sources. Wood-framed structures typically cost between $150 and $250 per square foot and have a design life of 30 to 50 years if properly maintained, but are less appropriate for damp environments such as water treatment facilities.

Prefabricated metal structures are slightly more expensive than wooden structures, but have a longer design life (40 to 60 years) if properly maintained and are usually more durable than wooden-framed buildings. These materials are typically provided by a fabricator specializing in the manufacturing of metal components and are often available as a built system that includes framing, siding, roofing, insulation, and supporting materials. This combined system can often result in lower construction costs when compared to other building materials. Metal buildings typically cost between $250 and $350 per square foot. Coatings and material grades should be carefully specified for metal structures to help ensure that they are appropriate for damp environments due to the potential for corrosion of the structural members and/or siding materials.

The structure could also be constructed from CMU block and metal roofing materials. This type of building is more durable than both the wood-framed or metal structures described above and more suitable for damp environments such as water treatment facilities. These materials are readily available and commonly used for utility buildings, but do cost more than the alternatives discussed above. CMU/metal roof buildings typically cost between $400 and $500 per square foot, but also have the longest design life (more than 50 years) if well maintained.

<u>Other Building Improvements</u>

The alternatives listed above highlight three options for generic building modifications that would accomplish the goals set forth by the District for water treatment. In addition to these treatment goals, the District would like to try and address as many of the architectural observations and recommendations made in the Assessment Report for the Main Building as practicable. The specifics on how to address these items largely depends on the alternative selected, but if a new building or building expansion is selected, it would be feasible and most cost effective to address these recommendations as part of the design for the new facility. A brief description of how some of these recommendations could be accomplished as well as a budgetary cost for these elements is provided below. All of the costs provided are for equipment only and additional costs would be incurred for design, construction, contingencies, and/or Washington State sales tax.

Laboratory/Office Space

The existing laboratory/office space is small, cramped, and does not provide adequate separation between electronic equipment and wet sampling/testing areas. This increases the risk to the electronic equipment, which is necessary for recordkeeping and tracking the WTP performance in accordance with DOH requirements. Providing separate areas for wet sampling/analysis and office work would provide the highest value for the District; however, this separation is not possible given the current Main Building configuration. If the Main Building is modified or a new building is constructed, separate areas for sampling/analysis and treatment plant operation/monitoring could be provided. To provide the most efficient laboratory space for District staff, the following components are recommended:

- Additional upper and lower cabinetry for equipment, chemical, and laboratory storage.
- Separately plumbed sample stations for raw water, filtered water, and finished water.
- Additional storage for manuals, standard operating procedures, and other critical written documents.
- Additional counterspace for testing, analysis, and recordkeeping.

Additional office space would also provide additional value to WTP staff and would provide them with a space to efficiently complete their work and would also allow them to easily monitor the treatment process. Including additional separate office space is not feasible given the current Main Building configuration; however, if the building is modified or a new building is constructed, new treatment plant operation/monitoring could be provided. To provide the most efficient operation for District staff, the following components are recommended:

- Space separated from noisy treatment plant processes and equipment.
- Heated, well-ventilated space designed for human occupancy/work.
- Generous desk area for computers, phone(s), and other electronic equipment.
- File cabinets and storage for manuals, procedures, historical data, DOH forms, and other documents.
- General office equipment such as a printer and fax machine.
- Space for at least two WTP staff and guests/other District staff.

In addition to these basic office requirements, the District may wish to consider additional facilities designed to accommodate longer-term use. In the event of an emergency (earthquake, flooding, contamination of other sources, etc.), the WTP may be required to operate continuously, which would necessitate long-term use by District staff. Furthermore, the WTP may also be designated as an alternate Emergency Operations Center (EOC) from which District activities may be coordinated and dispatched. If either of these conditions are realized, then the following facilities would provide additional value to the District:

- Simple meal storage, preparation, and consumption area (refrigerator, microwave, toaster oven, coffeemaker, etc.).
- Small space for resting.
- Washup facility with sink.

The scope and modifications to the existing sampling/analysis and office spaces will be based on the District's desires and will be in conjunction with other modifications made to the WTP. If modifications to the existing Main Building or a new building is constructed, we recommend including the desired spaces and/or accommodations for these spaces in the future. Costs to construct and outfit new office/laboratory space range between $50 and $250 per square foot, and greatly depend on the size, finishes, and desired function of the space.

Storage and Workspace

While the existing Main Building does maintain some storage space, it is small and lacks organization for small parts and the capacity to store large heavy items. Storage could be provided via an organized unit for small parts/components but should also include heavy-duty shelf storage for heavier items such as pumps, pipe fittings, etc. It also may be beneficial to locate at least some of this storage space outside of the moist treatment plant environment so that electronic equipment could be safety stored. Approximately three to four standard industrial shelving units would be recommended in addition to the existing shelving.

While the Main Building does contain a single workbench for repairs or modifications to equipment, the space is small and has little room for expansion given the current layout of the building. Furthermore, access to tools is restricted by the existing storage space and additional space for tool storage, including mobile tool storage, is desired. Additional tool storage and providing easy access to these tools would provide additional value to the District and would allow the WTP staff to more efficiently complete required maintenance tasks. Depending on the layout for any building modifications, additional storage could likely be provided for less than $5,000.

Lifting Equipment

Currently, there is no lifting equipment for the raw water pumps in the Main Building, which makes removing these pumps and associated piping very difficult and cumbersome for District staff. Lifting equipment could include a bridge/trolley hoist above the raw water pump pit or a jib/davit crane installed within the existing floor slab. Alternatively, space could be provided for a manual mobile hoist. While a bridge/trolley hoist is likely not cost effective for this facility, a small jib crane and some structural slab modifications could significantly improve the ability of the staff to remove/service this equipment. An appropriately sized jib crane and structural modifications would likely cost between $5,000 and $15,000 depending on the extent of modifications required to support the loads.

Site Security

Currently, there are no security measures to separate the treatment facilities from the public facilities associated with Morning Beach Park. This presents a safety, access, and potential public health hazard and could be addressed through installation of various access control and/or monitoring equipment. Fencing and gates could be added that would limit access to the treatment facilities to authorized staff. Additionally, security cameras and/or site lighting can improve monitoring capability and visibility for the site. Security fencing typically costs between $45 and $70 per linear foot, depending on the number of gates, terrain, materials and finishes, and overall length. To limit access to the general public, approximately 550 linear feet of fencing might be required, which results in an estimated cost of $25,000 to $38,000. Basic camera security equipment could be provided for an additional $20,000 to $50,000 depending on the level of coverage, quality, and amount of storage desired.

Access

Currently, the only point of access into the Main Building is a single pedestrian door. Removal of large equipment would require that it be demolished within the building then removed, piece by piece, or the existing storefront windows/door must be temporarily removed. A commercial-style coiling door could provide excellent site security, but also allow for the movement of large pieces of equipment. These types of doors are common at municipal treatment facilities, can be provided with a variety of finishes and features, and cost between $15,000 and $20,000 depending on the size, finish, and features provided.

Restrooms and Public Facilities

The existing restroom at the Main Building is in fair condition, but should be updated with new coatings and fixtures to ensure its continued trouble-free operation. In addition to this, depending on the construction or development of an EOC within the new/modified building, additional facilities such as showers or additional toilets may be warranted. A larger restroom facility would provide added value to the District if staff must remain at the EOC for long periods of time during an emergency. The Main Building does not have sufficient space to expand the existing restroom to include additional toilets or a shower; however, these facilities could be included into the design if a new building is constructed. Updating the existing restroom would cost between $5,000 and $10,000. New restroom facilities for a new building typically cost between $100 and $200 per square foot depending on the size and quality of fixtures, and type of finishes installed.

Additionally, because the WTP may be occasionally visited by selected members of the general public, the District may wish to consider accommodating these visits by providing wide spaces, convenient and open pathways, and clear access to the treatment process for viewing. Furthermore, it may also be desirable to allow for some level of educational space where placards, cutaways, or informational bulletins could be posted that explain the operation of selected pieces of equipment. These wide, clear pathways and additional space near critical pieces of equipment would provide additional value to District staff by improving their access to equipment for maintenance and service which makes completion of these tasks safer and more efficient.

Finished Water Pump Building

Because the Finished Water Pump Building does not contain any treatment equipment, it does not have the same considerations for expansion/modifications as the Main Building. The sections below discuss some of the considerations for expansion/modification of the existing Finished Water Pump Building. The impetus for modifications to this building are less significant than for the Main Building because space and access to the existing equipment is sufficient to maintain the components.

<u>Condition and Code Adherence</u>

The Finished Water Pump Building, as noted above, does not meet current seismic design parameters with regard to the roof and shear wall diaphragm connections. These issues are easily and inexpensively addressed and additional information on methods for addressing this issue are provided in Technical Memorandum 20434-3 (Gray & Osborne, 2020). Briefly, they include new roof sheathing nails, additional wall diaphragm blocking, and new roofing materials. The estimated cost to address these seismic issues is $100,000 to $110,000, not including tax, contingency, or project design and administration. Additional nonstructural considerations such as seismic bracing of equipment and piping should be completed in order to help the structure meet the desired seismic performance objective identified in the Assessment Report; however, these modifications could be completed over several years based on available funding.

If these structural and/or nonstructural modifications are completed, the building would meet current codes and should be suitable to provide for the District's needs for many years.

Building Expansion

The existing Finished Water Pump Building was constructed in 1992 and is generally in good condition. Given the differing functions of the Main Building and the Finished Water Pump Building, using or expanding the Finished Water Pump Building to improve the space issues at the Main Building, such as adding chemical storage to the Finished Water Pump Building, is not recommended. Consequently, only the adequacy of the existing building relative to the District's finished water pumping needs will be analyzed.

The Finished Water Pump Building houses two pumps that move water to the Division 7 Reservoir, each with a capacity of approximately 700 gpm, and two pumps that move water to the Division 22 Reservoir, each with a capacity of 700 gpm. The current building layout provides good access to the pumps, piping, and motor control centers. Typically, demand for the Division 7 Reservoir is much less than that of the Division 22 Reservoir, such that the current Division 7 pumps provide sufficient capacity and redundancy for the total design flow of 1,400 gpm. The Division 22 pumps; however, do not. To accommodate the desire for process redundancy, the District could either replace the existing Division 22 pumps with new larger units or install a third similarly sized pump. Given the current ratio of flows to each reservoir, new Division 22 pumps should have a capacity between 1,000 and 1,100 gpm each in order to provide suitable flow and redundancy. Replacing the existing pumps with larger units would not require physical building modifications or expansion; however, there would be mechanical and electrical modifications required. On the other hand, installation of a third 700 gpm pump would require expansion of the existing structure as well as mechanical and electrical modifications.

One alternative for providing additional space within the existing structure, if it is ever required, is to relocate the existing restrooms to a new separate restroom facility to accommodate Morning Beach Park users and then repurpose the existing restroom space for District uses. The existing restrooms (Figure A-3) would provide an additional 330 sf within the existing building. This space could potentially be used to house new or relocated electrical equipment, new security monitoring equipment, storage space, or additional laboratory space.

RECOMMENDATIONS

It is difficult to provide a formal recommendation for modifications to the existing structures without considering the other issues that are being analyzed at the WTP. For example, if the District decides to replace the filtration equipment, this cannot reasonably be completed within the existing Main Building given the operational and continuity constraints, and as such a new separate building would be required. If a new building is provided for the filtration equipment, it is advantageous to relocate other treatment components such as primary treatment and/or chemical addition equipment to this building as well. The economy of scale when considering the modifications for the WTP will drive the decision-making process. However, given the goals stated previously and the considerations discussed above, constructing a new separate building for treatment equipment seems more feasible when compared with expansion of the existing structure (above or adjacent). A new building would also allow the District to easily incorporate some of the additional methods to address items identified in the Assessment Report such as additional workspace, site security, additional storage, and improving access to and within the WTP. Furthermore, expansion or modifications to the existing Finished Water Pump Building structure do not significantly benefit District operations unless a third redundant Division 22 pump is desired and additional space is needed within this specific structure. If full and complete redundancy for the Division 22 pumps is desired, we recommend the District investigate replacement of the existing pumps with larger units instead of modifying the existing building structure to accommodate a third pump.

Additional recommendations will be deferred until the final Alternatives Analysis Report is prepared that contains all of the information in the various technical memoranda to provide an optimized recommendation for the entire filter plant to ensure the District's goal of continuing to provide high-quality treated water for decades to come.

EXHIBIT A

FIGURES

FIGURE A-1

Existing WTP Main Building Structure

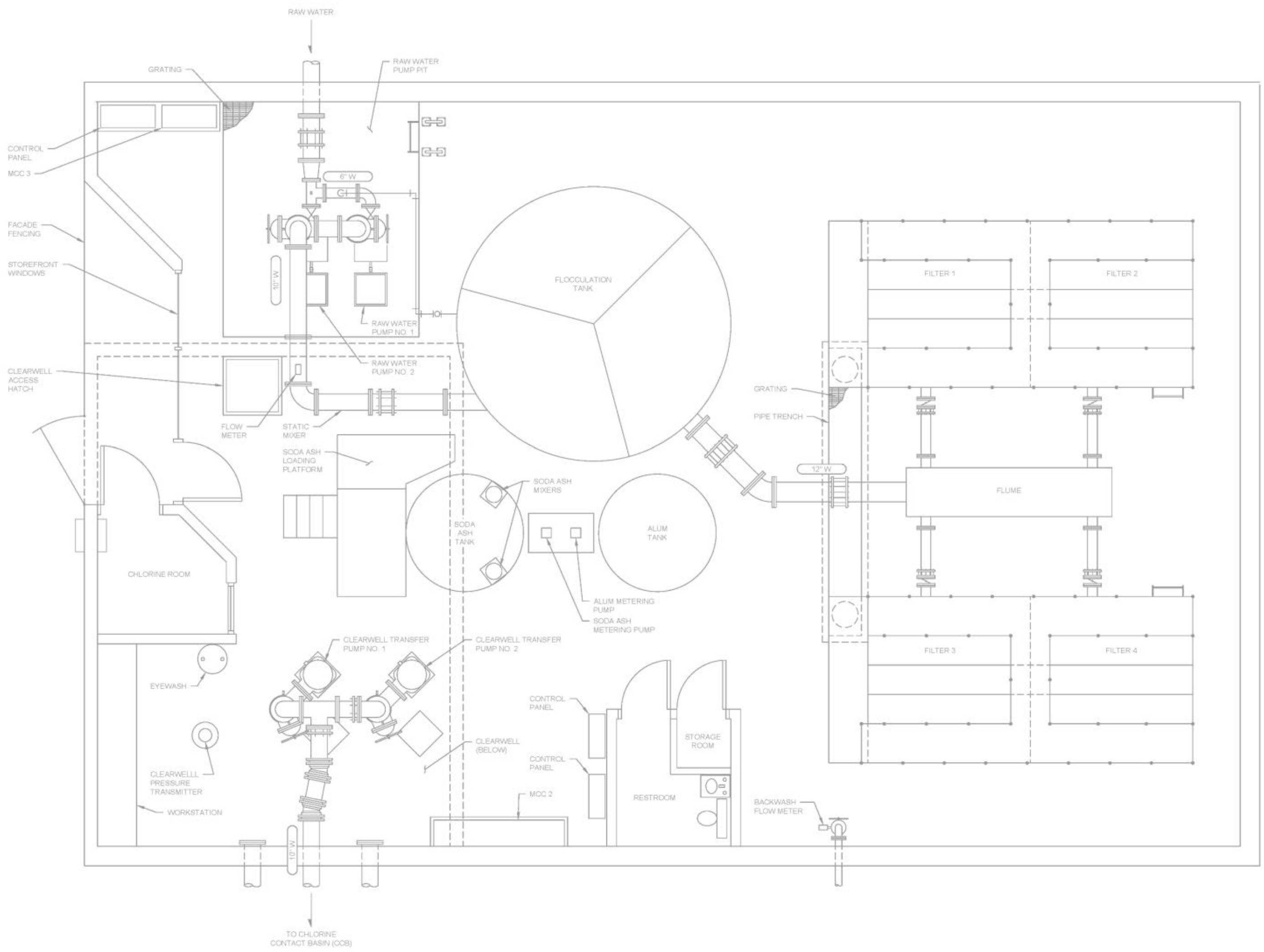

FIGURE A-2

Existing WTP Main Building Plan

FIGURE A-3

Existing Finished Water Pump Building Structure

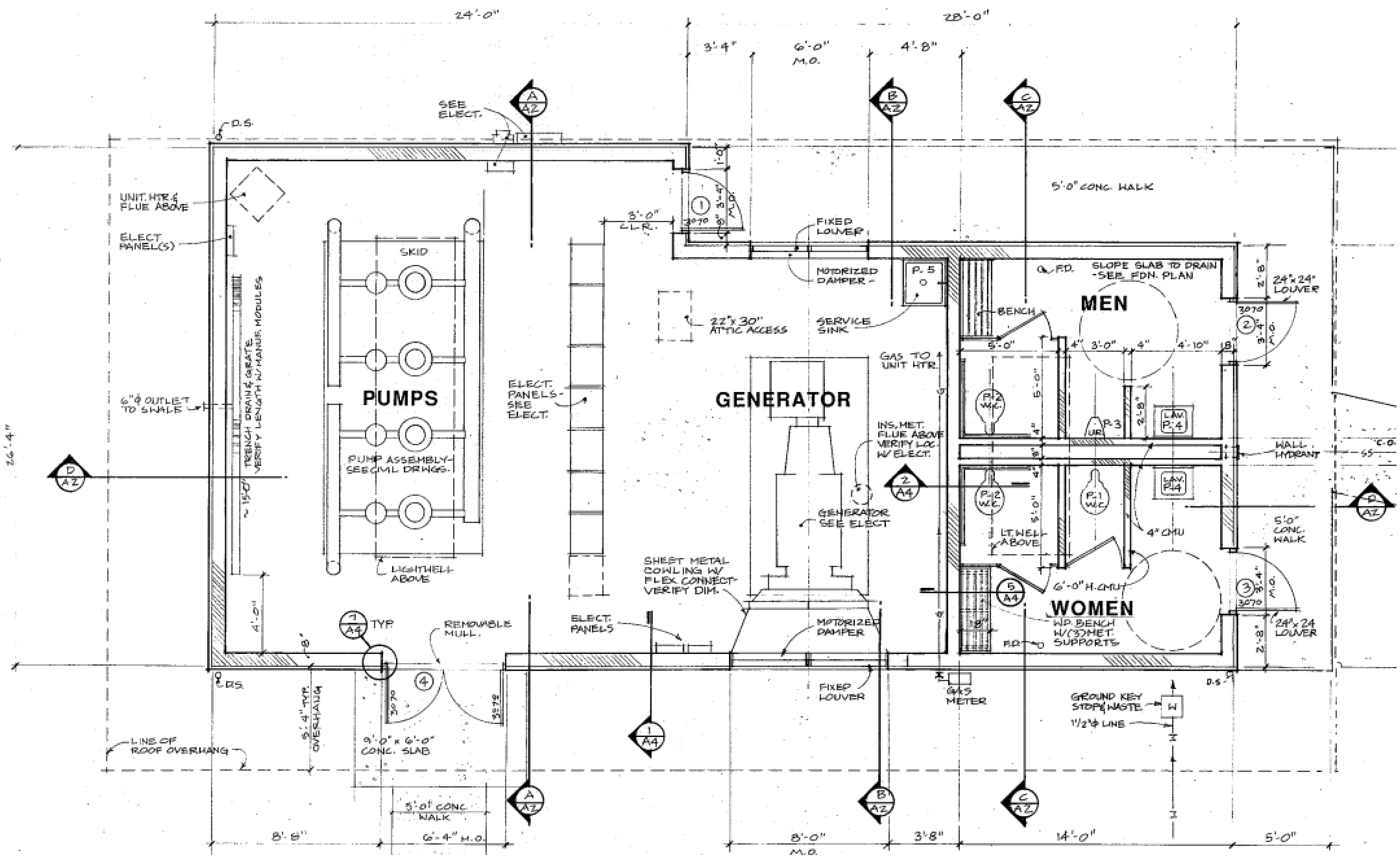

FIGURE A-4

Existing Finished Water Pump Building Plan

APPENDIX K

TECHNICAL MEMORANDUM 20434-9, SUDDEN VALLEY WTP EQUIPMENT RISK ASSESSMENT

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-9

TO: BILL HUNTER, P.E., ASSISTANT GENERAL MANAGER/DISTRICT ENGINEER
FROM: KEITH STEWART, P.E.
RUSSELL PORTER, P.E.
DATE: FEBRUARY 18, 2022
SUBJECT: SUDDEN VALLEY WTP EQUIPMENT RISK ASSESSMENT
LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON
G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water & Sewer District (District) contracted with Gray & Osborne to perform a condition assessment for their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost effectively provide clean, potable water for the existing and projected service areas.

In conjunction with the reports and memos highlighted above, the District is interested in quantifying the risk associated with the treatment system components in order to prioritize their rehabilitation efforts and funds. This memorandum summarizes the findings of the treatment component risk assessment analysis.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and

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commercial water system connections with a residential population of approximately 10,000 people.

The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley WTP. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities that serve this system. The District's distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD) but currently operates at approximately 1.01 MGD (700 gpm). The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. The WTP provides coagulation, flocculation, filtration, disinfection, and chlorine contact time before treated water is pumped to the distribution system and storage reservoirs.

PREVIOUS WORK

Phase 1 of the Sudden Valley WTP Assessment and Alternatives Analysis project included a condition assessment of the WTP and preparation of the WTP Condition Assessment Report (Assessment Report). This report highlighted the findings from the assessment and provided a listing of both high- and low-priority items that should be addressed in order to ensure long-term success of the WTP. The condition assessment was completed by Gray & Osborne, Inc. on February 12, 2020, and the accompanying report was finalized in July 2020 and includes structural, architectural, electrical, mechanical, and treatment process analysis.

Phase 2 of the Sudden Valley WTP Assessment and Alternatives Analysis project builds upon the condition assessment described above and includes alternatives analysis and recommendations for modifications to the WTP based on the condition of the existing equipment and the District's short- and long-term goals for treatment operations. To evaluate alternatives for the WTP, the treatment components were separated by treatment process and were analyzed individually in various technical memoranda. Each of the following technical memoranda includes a description of the existing components, a description of their condition, an analysis of alternatives for modifications, recommendations, and preliminary cost estimates for the proposed alternatives:

- Technical Memorandum 20434-1 – Pump Performance Testing
- Technical Memorandum 20434-2 – Chlorine Contact Basin Coating Investigation
- Technical Memorandum 20434-3 – Structure Seismic Analysis
- Technical Memorandum 20434-4 – Chemical Systems Analysis
- Technical Memorandum 20434-5 – Filtration Systems Analysis
- Technical Memorandum 20434-6 – Disinfection Systems Analysis
- Technical Memorandum 20434-7 – Backwash Systems Analysis
- Technical Memorandum 20434-8 – Structural and Architectural Component Analysis

The recommendations within each of these memoranda will then be compiled into a WTP Alternatives Analysis Report (Alternatives Analysis Report). This final Alternatives Analysis Report will then be used to guide decision making and planning processes for both short- and long-term WTP modifications.

This memorandum is the last memorandum of Phase 2. It provides a risk assessment for the entire water plant and incorporates the work from the previous memoranda.

RISK ASSESSMENT

In order to help the District prioritize modifications to WTP components, maximize the overall value of the improvements, and help ensure that the projects are incorporated in the most cost-effective manner possible, we have quantitatively and qualitatively assessed the risk associated with each treatment component. We have completed this assessment using two separate methods.

Method 1

The first method utilizes a likelihood and severity scale commonly used for water and wastewater treatment facilities (Falakh and Setiani, 2017). This method quantifies both the likelihood of an event occurring and the severity of the effect of the event on a numerical scale, multiplies these values together, and the resulting "score" can be used to quantify and compare risk of that component to other treatment components. While other similar methods quantify event frequency and value of losses (Loj-Pilch and Zakrzewska, 2019), or probability of occurrence and severity (Ali El-Quliti, et al., 2016), each of these permutations of likelihood and severity attempts to quantify the risk factor and associated effects of component failure. Using these methods, the higher the score, the more risk associated with a particular component. For example, a component that is likely to fail frequently and will negatively impact the District's ability to provide potable water will have a higher score than a component that is unlikely to fail and will not significantly impact the performance of the WTP. In order to reduce the overall level of risk for failure, modifications to the components with the highest scores should be prioritized over other, lower-scoring components.

Method 2

The second analysis method utilizes the District's Business Risk Exposure Index (BREI), which is similar to the likelihood versus severity ranking described above but utilizes more variables and scoring categories. This method utilizes the component's effective life, physical condition grade, consequence of failure, probability of failure, and renewal strategy to quantify the risk that a particular component presents to District operations. As with Method 1 described above, the higher the score, the more risk this component presents to the District and the sooner it should be modified/addressed.

Additional information and references for risk assessment at municipal treatment facilities is provided in Exhibits A and B.

RESULTS

For simplicity and to better identify which components present the highest level of risk to successful treatment operations, the WTP process treatment components were broken down as follows:

- Raw Water Intake
- Raw Water Pumps
- Raw Water Instrumentation
- Alum Delivery System
- Flocculation Tank
- Filters 1 and 2
- Filters 3 and 4
- Clearwell
- Clearwell Transfer Pumps
- Chlorine Disinfection System
- Soda Ash Delivery System
- Chlorine Contact Basin
- Finished Water Instrumentation
- Finished Water Pumps
- WTP Main Building Piping
- Finished Water Pump Building Piping
- WTP Main Building Electrical

- Finished Water Pump Building Electrical
- WTP Supervisory Control and Data Acquisition System (SCADA)
- WTP Security
- Auxiliary Generator

Method 1

Each of the components listed above was scored according to the two methods described above and then ranked according to their overall score. Additional information on the scoring rubric is provided in Exhibit B, and Table 1 below highlights the results of the scoring according to Method 1 described above. For this table, scores between 1 and 3 are considered minimal risk and colored green, scores between 4 and 6 are considered low risk and are colored yellow, scores between 8 and 12 are considered moderate risk and colored orange, and scores between 15 and 25 are considered high risk and colored red. Table 2 presents the same information but organizes the individual components according to their risk group based on the scoring listed in Table 1.

TABLE 1

Scoring Summary According to Analysis Method 1

Component	Impact(s) [1]	Confined Space/Health & Safety Hazard? [2]	Likelihood [3]	Severity [4]	Combined Score [5]	Rank
Raw Water Intake	Loss of production, no service.	Y	2	2	4	15
Raw Water Pumps	Loss of production, no service.	Y	3	3	9	6
Raw Water Instrumentation	DOH noncompliance, regulatory action.	N	2	1	2	17
Alum Delivery System	Decrease in water quality, increase in maintenance.	Y	4	4	16	1
Flocculation Tank	DOH noncompliance, decrease in water quality, increase in maintenance.	N	3	3	9	6
Filters 1 and 2	Loss of production, decrease in water quality, no service.	N	3	3	9	6
Filters 3 and 4	Loss of production, decrease in water quality, no service.	N	2	3	6	13
Clearwell	Loss of production, increase in maintenance.	Y	1	1	1	21
Clearwell Transfer Pumps	Loss of production, increase in maintenance.	N	3	3	9	6
Chlorine Disinfection System	Loss of production, DOH noncompliance, regulatory action, health hazard.	Y	3	4	12	3
Soda Ash Delivery System	Loss of production, increase in maintenance.	Y	3	4	12	3
Chlorine Contact Basin	Loss of production, DOH noncompliance, regulatory action, health hazard.	Y	4	4	16	1

TABLE 1 – (continued)

Scoring Summary According to Analysis Method 1

Component	Impact(s) [1]	Confined Space/Health & Safety Hazard? [2]	Likelihood [3]	Severity [4]	Combined Score [5]	Rank
Finished Water Instrumentation	DOH noncompliance, regulatory action.	N	2	1	2	17
Finished Water Pumps	Loss of production, increase in maintenance.	N	3	3	9	6
WTP Main Building Piping	Loss of production.	N	1	2	2	17
Finished Water Pump Building Piping	Loss of production.	N	1	2	2	17
WTP Main Building Electrical	Loss of production.	N	3	3	9	6
Finished Water Pump Building Electrical	Loss of production.	N	3	3	9	6
WTP SCADA	DOH noncompliance, regulatory action.	N	2	3	6	13
WTP Security	Loss of production, regulatory action, health hazard.	N	2	5	10	5
Auxiliary Generator	Loss of production, regulatory action.	N	1	3	3	16

(1) Impacts for qualitative purposes only and provide high-level effects if a catastrophic failure were to occur with the component in question.
(2) Indicates whether or not a particular component involves confined space entry or significant safety/health hazards. Components with confined space entry or significant safety/health hazards are assumed to be more difficult to remedy. For qualitative purposes only.
(3) Scored on a scale from 1 to 5. See Exhibit B for additional information.
(4) Scored on a scale from 1 to 5. See Exhibit B for additional information.
(5) Likelihood score multiplied by the Severity score.

TABLE 2

Method 1 Analysis Risk Group Summary

High Risk Score (15–25)	**Moderate Risk** Score (8–12)	**Low Risk** Score (4–6)	**Minimal Risk** Score (1–3)
Alum Delivery System	Raw Water Pumps	Raw Water Intake	Raw Water Instrumentation
Chlorine Contact Basin	Filters 1 and 2	Filters 3 and 4	Clearwell
	Clearwell Transfer Pumps	WTP Main Building Electrical	Finished Water Instrumentation
	Finished Water Pumps	Finished Water Pump Building Electrical	WTP Main Building Piping
	Flocculation Tank		Finished Water Pump Building Piping
	Soda Ash Delivery System		Auxiliary Generator
	Chlorine Disinfection System		
	WTP SCADA		
	WTP Security		

The information in Tables 1 and 2 suggest that the alum delivery system and the chlorine contact basin present the greatest risk to successful WTP operations. For the alum components, this risk is largely due to the age of the tank, lack of system redundancy, and risk to adjacent electrical equipment should the tank rupture or leak. For the chlorine contact basin, the risk is largely due to the fact that the size of the tank limits the flow through the WTP, the condition of the exterior/interior coating systems, and the fact that there is no redundancy for providing chlorine contact time should the existing tank need to be removed from service.

The moderate risk category includes chemical delivery systems, disinfection systems, flocculation tank, pumping systems, SCADA, Filters 1 and 2, and WTP site security. The raw water, clearwell transfer, and finished water pumps are old and utilize aging and antiquated electrical components that are increasingly difficult to replace. The disinfection system utilizes gas chorine which carries some inherent safety and health risks and is subject to supply limitations. Filters 1 and 2 are old, have not been recently inspected, and show signs of corrosion and deterioration. The flocculation tank shows signs of deterioration and does not have any redundant systems. The SCADA system lacks redundancy and sophistication. Finally, the WTP utilizes limited security measures, is adjacent to a public park, and even shares a common wall with two public restrooms.

The remaining treatment components are considered low/minimal risk and while they should be maintained and possibly modernized as technology changes, these components should be addressed only after other, higher risk components are addressed.

Method 2

Each of the components listed above was also scored according to Method 2 described above, and then ranked according to their overall score. Additional information on the scoring rubric is provided in Exhibit C, and Table 3 below highlights the results of the scoring according to Method 1 described above. Table 4 provides the same results as Table 3 but organizes the components in order of their scoring/rank.

TABLE 3

Scoring Summary According to Analysis Method 2

Component	Effective Life (years)	Consequence of Failure (CoF)	Probability of Failure (PoF)	Reduction	Score	Rank
Raw Water Intake	60	7	5	0	35	9
Raw Water Pumps	40	9	7	0.5	31.5	13
Raw Water Instrumentation	10	2	2	0	4	20
Alum Delivery System	20	6	10	0	60	2
Flocculation Tank	20	6	5	0	30	14
Filters 1 and 2	50	9	6	0	54	3
Filters 3 and 4	50	9	5	0	45	4
Clearwell	100	9	4	0	36	5
Clearwell Transfer Pumps	40	8	8	0.5	32	11
Chlorine Disinfection System	15	9	5	0.5	22.5	15
Soda Ash Delivery System	10	6	6	0	36	5
Chlorine Contact Basin	25	9	8	0	72	1
Finished Water Instrumentation	10	2	2	0	4	20
Finished Water Pumps	40	8	8	0.5	32	11
WTP Main Building Piping	60	6	6	0	36	5
Finished Water Pump Building Piping	60	6	6	0	36	5
WTP Main Building Electrical	10	8	4	0.5	16	16
Finished Water Pump Building Electrical	20	8	4	0.5	16	16
WTP SCADA	30	2	4	0	8	19
WTP Security	30	7	5	0	35	9
Auxiliary Generator	40	8	2	0.5	16	16

TABLE 4

Summary of Rank for Method 2

Component	Rank
Chlorine Contact Basin	1
Alum Delivery System	2
Filters 1 and 2	3
Filters 3 and 4	4
Clearwell	5
Soda Ash Delivery System	5
WTP Main Building Piping	5
Finished Water Pump Building Piping	5
Raw Water Intake	9
WTP Security	9
Clearwell Transfer Pumps	11
Finished Water Pumps	11
Raw Water Pumps	13
Flocculation Tank	14
Chlorine Disinfection System	15
WTP Main Building Electrical	16
Finished Water Pump Building Electrical	16
Auxiliary Generator	16
WTP SCADA	19
Raw Water Instrumentation	20
Finished Water Instrumentation	20

The data in Tables 3 and 4 are consistent with the results from Tables 1 and 2. The components in the high and moderate risk categories in Method 1 all rank highly in Method 2.

SUMMARY AND CONCLUSIONS

The results in Tables 1 through 4 above provide a quantitative analysis for the risk associated with individual treatment components at the WTP. In general, the quantitative results match the qualitative analysis provided by both the District staff and the Assessment Report provided by Gray & Osborne in 2020 as documented in the Assessment Report.

Results from the quantitative risk analysis can be summarized as follows:

- The alum delivery system and chlorine contact basin represent the highest risk to WTP operations, and modifications to these systems should be prioritized over other treatment components.

- The items listed below present the next highest level of risk to WTP operations and should be addressed after other higher-priority items, or as feasible based on other revisions implemented at the WTP:

    - Raw Water Pumps
    - Filters 1 and 2
    - Clearwell Transfer Pumps
    - Finished Water Pumps
    - Chlorine Disinfection System
    - Soda Ash Delivery System
    - WTP SCADA
    - WTP Security
    - Flocculation Tank

- The remaining treatment components as noted below should be maintained to prolong their effective life, but a major replacement or rehabilitation is not necessary based on their risk to WTP operations. It may be advantageous to modify or replace some of these components, but this can be done as part of larger projects and as funding allows:

    - Raw Water Intake
    - Filters 3 and 4
    - WTP Main Building Electrical
    - WTP Finished Water Pump Building Electrical
    - Raw Water Instrumentation
    - Clearwell
    - Finished Water Instrumentation
    - WTP Main Building Piping
    - Finished Water Pump Building Piping
    - Auxiliary Generator

EXHIBIT A

ADDITIONAL RISK ASSESSMENT REFERENCES

Procedure for Hazard Identification and Risk Assessment in Waste-water Treatment Planting Saudi Arabia

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***Abstract** : It is well known that wastewater treatment projects worldwide has become one of the most important, vital projects and linked to civilization. Since potable water and irrigation for agriculture water considered a very low resources in the Kingdom of Saudi Arabia - desert regions - soit is necessary to pay more attention to these projects, which already happened, where billions of Saudi Riyals have been invested in the sewage and industrial water treatment projects.*
Wastewater treatment industryin Saudi Arabiahas expanded to include a lot of units and departments, machines and hundreds of workers and has become a danger to staff and the areas surrounding these stations.
In this research we mention the steps and methods to be used and followed by workers in dealing with the various hazards. We start by identifying the hazards then point out how to analyze these hazards and classified into several degrees according totheir severity.
However it's necessary to specify the responsibilities and roles of employees in dealing with these risks.

I. INTRODUCTION

There are two kinds of wastewater treatment plants in Saudi Arabia,industrial wastewater treatment plant and sanitary wastewater treatment plant. The industrial wastewater treatment plant is designed to treat incoming industrial wastewater from industries like factories and plants. The sanitary wastewater treatment plant is designed to treat incoming sanitary wastewater from community area.
Hazard assessments and controls help build safe and healthy workplaces. They are at the core of every organization's occupationalhealth and safety management system. The hazard assessment and control process provides a consistent approach for employers and workers to identify and control hazards in the workplace. It allowseveryone to focus their efforts in the right areas, andto develop worker training, inspections, emergencyresponse [1].
This research aims to identify the OH&S hazards of (equipment, substances and / or movements) which may cause harms -in order to determine the level of risk associated with the hazard and its controls.
The procedurecan be implemented for:

- Routine and non-routine activities.
- Activities for all personnel having access to the work place
- Activities of contractors and/or subcontractors.
- Facilities at the workplace (Water Treatment Plant, Workshop, Buildings, electrical Substation, warehouses for Spares and Material, labs, etc.…..).

II. Basic Terminology:

- **HSEC**:Health, Safety and Environment Committee.
- **Hazard**:source, situation, or act with a potential for harm in terms of human injury or ill health, or a combination of these.
- **Hazard identification**: process of recognizing that a hazard exists and defining its characteristics.
- **Risk**: combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can because by the event or exposure(s).
- **Risk assessment**: process of evaluating the risk(s) arising from a hazard(s), taking into account the adequacy of any existing controls, and deciding whether or not the risk(s) is acceptable.
- **Acceptable risk**: risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own OH&S policy

- **Behavior Based Safety (BBS):** workplace behaviors are what one sees when observing people conducting tasks in their workplace.
- **OH&S:** occupational health & safety.
- **HSER:** Health, Safety&environmental Management Representative.
- **IMS Management representative:** A member appointed by the top management to be responsible for certain quality, safety and environmental tasks irrespective of his other responsibilities.

III. THEWASTE WATER TREATMENT PLANT: AN OVERVIEW

Water is one of the most significant sectors in the Kingdom the National Water Company (NWC) established in 2008, as a Saudi joint stock company fully owned by the government (namely the Public Investment Fund), aims to provide water and wastewater treatment services in accordance with the latest international standards. This is achieved by the concerted efforts of national cadres in partnership with carefully selected international operators through foreign PPP.

NWC specializes in providing the highest quality drinking water, ensuring the presence of water and wastewater connections in all households, preserving natural water resources and the environment, using the Treated Sewage Effluent (TSE) with maximum efficiency, and training qualified Saudi employees in accordance with the latest international standards.

Throughout its new phase, NWC is able to implement radical changes in the water sector's performance. This was achieved through raising the company's operational efficiency in line with international standards, establishing a solid infrastructure that can accommodate the evolving demands of a growing KSA population, providing high-quality services to clients and customers, and investing all essential efforts for preserving natural water resources, protecting the environment, and ensuring sustainability.Figure 1.

Figure 1. Wastewater Treatment Plant

3. PROCEDURE

3.1 Hazard Identification

There are many hazards that may cause injury, illness. Hazard Identification is the basis for the risk assessment process. (Table 1) contains questions that will lead to identifying commonly observed hazards [2] and [3].

Table 1: Hazard Identification Checklist

	HAZARD IDENTIFICATION	
A	**ENTANGLEMENT**	
A1	Can anyone's hair, clothing, gloves, neck-tie, jewellery, cleaning brushes, rags or other materials become entangled with moving parts of the plant, or materials in motion?	
B	**CRUSHING**	
B1	Can anyone be crushed due to:	
	a	Material falling off the plant?
	b	Uncontrolled or unexpected movement of the plant or its load?
	c	Lack of capacity for the plant to be slowed, stopped or immobilized?
	d	The plant tipping or rolling over?
	e	Parts of the plant collapsing
	f	Coming in contact with moving parts of the plant during testing, inspection, operation, maintenance, cleaning or repair?
	g	Being thrown off or under the plant?
	h	Being trapped between the plant and materials or fixed structures?
	i	Other factors not mentioned?
C		**CUTTING, STABBING & PUNCTURING**
C1		Can anyone be cut, stabbed or punctured due to:
	a	Coming in contact with sharp or flying objects?
	b	Coming into contact with moving parts of the plant during testing inspection, operation, maintenance, cleaning or repair of the plant?
	c	The plant, parts of the plant or working pieces disintegrating?
	d	Work pieces being ejected?
	e	The mobility of the plant?
	f	Uncontrolled or unexpected movement of the plant?
	g	Other factors not mentioned?
D.		**SHEARING**
1		Can anyone's body parts be sheared between two parts of the plant, or between two parts of the plant, or between a part of the plant and a work piece or structure?
E		**FRICTION**
E1		Can anyone be burnt due to contact with moving parts or surfaces of the plant?
F		**STRIKING**
F1		Can anyone be struck by moving objects due to:
	a	Uncontrolled or unexpected movement of the plant or material handled by the plant?
	b	The plant, parts of the plant or pieces disintegrating?
	c	Work pieces being ejected?
	d	Mobility of the plant
	e	Other factors not mentioned?
G	**HIGH PRESSURE FLUID**	
G1	Can anyone come into contact with fluids under high pressure, due to plant failure or misuse of the plant?	
H	**Working at height**	

H1	Guardrail systems	
H2	Scaffolding system inspection and maintenance	
H3	All required PPEs are in use (helmet , safety shoes , gloves , etc....)	
H4	Working at height permits	
I	**ELECTRICAL**	
I1	Can anyone be injured by electrical shock or burned due to:	
	a	The plant contacting live electrical conductors?
	b	The plant working in close proximity to electrical conductors?
	c	Overload of electrical circuits?
	d	Damaged or poorly maintained electrical leads & cables?
	e	Damaged electrical switches?
	f	Water near electrical equipment?
	g	Lack of isolation procedures?
	h	Other factors not mentioned?
J	**EXPLOSION**	
J1	Can anyone by injured by explosion of gases, vapours, liquids, dusts or other substances, triggered by the operation of the plant or by material handled by the plant?	
K	**Confined space**	
K1	Confined spaces Work permits	
K2	Confined space safety inspection	
K3	Using suitable PPEs for working at confined spaces (helmets , safety shoes, oxygen cylinders	
L	**SLIPPING, TRIPPING & FALLING**	
L1	Can anyone using the plant, or in the vicinity of the plant, slip, trip or fall due to:	
	a	Uneven or slippery work surfaces?
	b	Poor housekeeping.
	c	Obstacles being placed in the vicinity of the plant?
	d	Other factors not mentioned?
L2	Can anyone fall from a height due to:	
	a	Lack of proper work platform?
	b	Lack of proper stairs or ladders?
	c	Lack of guardrail or other suitable edge protection?
	d	Unprotected holes, penetrations or gaps?
	e	Poor floor or working surfaces, such as the lack of slip resistant surfaces?
	f	Steep walking surfaces?
	g	Collapse of the supporting structure?
	h	Other factors not mentioned?
M	**ERGONOMIC**	
M1	Can anyone be injured due to:	
	a	Poorly designed seating?
	b	Repetitive body movement?

	c	Constrained body posture or the need for excessive effort?
	d	Design deficiency causing mental or psychological stress?
	e	Inadequate or poorly placed lighting?
	f	Lack of consideration given to human error or human behaviour?
	g	Mismatch of the plant with human traits and natural limitations?
	h	Other factors not mentioned?
N	**SUFFOCATION**	
N1	Can anyone be suffocated due to the lack of oxygen, or atmospheric contamination?	
O	**HIGH TEMPERATURE OR FIRE**	
O1	Can anyone come into contact with objects at high temperatures?	
P	**TEMPERATURE (THERMAL COMFORT)**	
P1	Can anyone suffer ill health due to exposure to high or low temperature?	
Q	**OTHER HAZARDS**	
Q1	Can anyone be injured or suffer ill-health from exposure to:	
	a	Chemicals?
	b	Biological?
	c	Toxic gases, vapours or fumes?
	d	Dust?
R	**OTHER HAZARDS (Cont'd)**	
	e	Noise?
	f	Vibration?
	g	Radiation?
	h	Other factors not mentioned?
S	**ENTRAPMENT**	
S1	Can anyone be locked or trapped in an area of space?	

3.2 Risk Assessment Team

A team approach is adopted for the risk assessments where representatives from relevant work places make up the risk assessment team, and are actively involved in the risk assessments. Team members consist of (At least)

- One Safety department representative,
- One area Section Head or supervisor
- One of the HSERs members.

It should be noted that:

- Team members must be trained on this risk assessment method and procedure.
- TheHSEC will lead the team as the risk assessment advisor/moderator.
- Risk assessment team identifies the hazards using hazard identification, Risk assessment and observation record sheet form (HSE-HI/FR01) which reviewed by the process owner manager and approved by HSSE Manager.
- Team members can include others up to six persons if needed.

3.3 Risk Identification and Assessment

When the hazard identification is completed, the following questionsare asked:

- What is the severity or consequences of the hazard (e.g. injury, damage, spillage, business interruption, fire, explosion, etc.)? As a rule, the most severe consequence is considered.
- What is the probability of occurrence? The probability should be estimated from previous experiences or, if possible, with the help of statistics.
- Is the hazard related to any Legal Requirement? Any hazard related to legal requirement and not compiling with it; the severity should be 5.
  Using the severity and probability criteria defined below, the risk can be introduced into a Risk Matrix based on [4] and [5].

$$\text{RISK} = \text{SEVERITY} \times \text{PROBABILITY}$$

3.4 Acceptable Risks

Acceptable risks of potential and/or existing hazards will be determined per hazard after finalizing the preparing of risk assessment sheet and applying the necessary control, which has to comply with legal obligations, canbe tolerated by the organization & will be updated per risk assessment updating.

3.5 Behavior Based Safety (BBS)

Everybody who works to reduce accidents and improve safe performance is concerned with human behavior. “Behavior and accidents is what it’s all about,” is a commonly heard phrase[6].

Behavior is defined as “an observable act”; i.e. workplace behaviors are what one sees when observing people conducting tasks in their workplace. The behavior is assessed as dangerous action, dangerous condition or positive point.

The BBS objective is improving the safety at work by privileging constructive dialogs and eliminating hazardous working conditions and acts [7].

Since the risk assessment will include person's behaviors, which isthe base of culture change, the following steps will be followed whenassessing employee's behavior

Announce your visit to the person to be visited and to his Supervisor (at the latest 24 hours before the visit)

- Explain to him the objective of your visit
- Observe the person work (10-15 minutes)
- Identify: The positive points (PP) - The Dangerous Acts (DA) - The Dangerous Conditions (DC).

After the observation, engage the dialog with the visited person, starting with the positive points (PP) that the visitors have observed.

Make him aware of the DC & DA and what are the improvements that could be done right now?

Each Process Owner is responsible for updating the hazard identification; risk assessment & observations register on annual basis.

If a major change in the process takes place the Head of Department is responsible for updating the hazard identification, risk assessment & observations Register and informing the department Health & Safety Coordinator. Changes could be the following and other pertinent information:

- Installation of new Equipment or new material
- Asset Transfers
- After Reported Accidents
- Machine Acceptance of Modified Equipment
- Chemical Approval Requests
- Operational Reviews
- Management Reviews.

Table 2: Criteria for evaluating the severity

Severity of Consequences					
Category/ Descriptive Word	**Personnel Illness/ Injury**	**Equipment Loss ($)**	**Down Time**	**Product Loss ($)**	**Environmental Effects**
5 CATASTROPHIC	Death	>1M	>1 Month	>1M	Long-term (>5yrs) environmental damage or requiring >$1M to correct and/or in penalties
4 CRITICAL	Severe injury or severe occupational illness >2 Week hospitalization	250K to 1M	1 Month to 1 week	250K to 1M	Medium-term (1-5 yrs) environmental damage or requiring $250K - $1M to correct and/or in penalties
3 SIGNIFICANT	Major injury or major occupational illness <2 Week hospitalization	50K to 250K	3 days to 1 week	50K to 250K	Short-term (3 mo-1 yr) environmental damage or requiring $50K - $250K to correct and/or in penalties.
2 MARGINAL	Minor injury or minor occupational illness No hospitalization Day case	1K to 50K	1 day to 3 days	1K to 50K	Brief-term (<3 mo) environmental damage or requiring $1K - $50K to correct and/or in penalties.
1 NEGLIGIBLE	First Aid No injury or illness	<1K	<1 day	<1K	Minor environmental damage, readily repaired and/or requiring <$1K to correct and/or in penalties

Table 3: Criteria for evaluating the probability

PROBABILITY		
Level	**Descriptive word**	**Definition**
5	**FREQUENT**	Expected to occur in all circumstances (Once per week)
4	**PROBABLE**	Expected to occur in most circumstances (Once per month)
3	**OCCASIONAL**	Will probably occur in most circumstances (Once per year)
2	**REMOTE**	Might occur at some time (Once per 10 years)
1	**IMPROBABLE**	Could occur at some time, but less possible (Once per 100 years)

Table 4: Risk Matrix

Probability	**5**	**5**	**10**	**15**	**20**	**25**
	4	**4**	**8**	**12**	**16**	**20**
	3	**3**	**6**	**9**	**12**	**15**
	2	**2**	**4**	**6**	**8**	**10**
	1	**1**	**2**	**3**	**4**	**5**
		1	**2**	**3**	**4**	**5**
			Severity			

Legend

≥20	E	Extreme risk - immediate action required (Red)
>10&<20	H	High risk - urgent management attention needed (Yellow)
>5 & ≤10	M	Medium risk - management attention as soon as possible (Green)
≤5	L	Low risk – non urgent management attention needed (White)

Table 5: Risk assessment procedure steps.

Step	Action	Explanations
1	Decide to perform a risk assessment	The risk assessment may be the result of: • New equipment being introduced or existing equipment or workplace being modified • Significant changes being introduced to the tasks performed in the workplace; • Safety control systems being modified; • Regulatory requirements • Equipment that is being used for another purpose • New information about the identified hazards being available • An incident investigations revealing new information regarding workplace hazards and/or the level of risk • An accident.
2	Establish a risk assessment team	A team of trained and appropriate people covering all domains of the projected assessment shall conduct the risk assessment. Team to be no more than 6 people.
3	Identify the hazards	Is there a hazard or issue (e.g. electricity, chemicals, thermal stress, moving equipment, human error, external event, etc.)? As an aid for assessors, Appendix A contains questions that will lead to identifying commonly observed hazards.
4	Assess the risk for all the hazards identified in Step 3 above	The Risk Assessment Team • Evaluates what is the likely severity (consequence) of such a hazard • Evaluates what is the probability of the hazard causing injury or loss.
5	Prioritize the risk	The severity and probability are introduced onto the Risk Matrix to prioritise the risks as: E: Extreme risk; immediate action required H: High risk; urgent management attention needed M: Medium risk; management attention as soon as possible L: Low risk; longer term action may be required
6	Develop action plans	Identified risks shall be prioritised for action and control measures. The following hierarchy will apply to reduce the risk as far as practicable: • Elimination; • Substitution; • Engineering controls; • Signage/warnings and/or administrative controls; • Personal protective equipment.
7	Communicate results and arrange training	The outcomes of risk assessments shall be communicated to all concerned people. Existing and new staff working in the assessed workplace must be made aware of the risks and trained on the mitigation and control measures.

3.6 Responsibility

3.6.1. The HSC in each department is responsible for maintainingthe hazard identification; risk assessment & observations register for each area.

3.6.2. OH&S Manager is responsible to review and update this procedure.

3.6.3. OH&S Manager is responsible to coordinate or establishing of hazard identification and risk assessment for subcontractors' activities and setting the need of controls with the concerned departments.

3.6.4. OH&S Manager is responsible for setting the need of controls for visitors as well as safety training & awareness of new employees.

IV. CONCLUSIONS

The employer's hazard assessment and management will determine, in large part which Standards and procedure shall be used in the workplace to provide safe and healthful working conditions. Therefore, it will be incumbent for the employer, and / or all persons involved in the hazard assessment to know which Standards will apply to any given situation.

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Hazard Identification and Risk Assessment in Water Treatment Plant considering Environmental Health and Safety Practice

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Abstract. Water Treatment Plant (WTP) is an important infrastructure to ensure human health and the environment. In its development, aspects of environmental safety and health are of concern. This paper case study was conducted at the Water Treatment Plant Company in Semarang, Central Java, Indonesia. Hazard identification and risk assessment is one part of the occupational safety and health program at the risk management stage. The purpose of this study was to identify potential hazards using hazard identification methods and risk assessment methods. Risk assessment is done using criteria of severity and probability of accident. The results obtained from this risk assessment are 22 potential hazards present in the water purification process. Extreme categories that exist in the risk assessment are leakage of chlorine and industrial fires. Chlorine and fire leakage gets the highest value because its impact threatens many things, such as industrial disasters that could endanger human life and the environment. Control measures undertaken to avoid potential hazards are to apply the use of personal protective equipment, but management will also be better managed in accordance with hazard control hazards, occupational safety and health programs such as issuing work permits, emergency response training is required, Very useful in overcoming potential hazards that have been determined.

1 Introduction

Occupational safety and health is heavily influenced by occupational hazards identified and managed in a competent risk assessment process. Hazards in the workplace can be physical, chemical or psychological and can lead to workplace incidents and work-related injuries, which have an impact on organizational productivity and profitability. [1]

Hazard Identification Risk Assessment (HIRA) is a method for determining and providing hazards based on their probability, frequency and severity and evaluating adverse consequences, including potential loss and injury. The work process in the industry must pay attention to aspects of environmental health and safety in order to support the effectiveness of the industry. The industry must identify hazards, assess the associated risks to tolerate continuous levels, risk assessments have been made using risk guidelines and standards. [2][3]

Water Treatment Plant (WTP) is an important infrastructure to guarantee human and environment health. As water supply, they have a key role in giving healthy clean water access to the society. In the progress of this, environmental and health safety aspect becomes things to be concerned about. [4] The high hazard impacts in workplace often become the cause of work accident and occupational disease.

Working in the field of water treatment is considered dangerous, especially as it can lead to frequent deaths in confined spaces. Occupational safety and health is not particularly noticed in this area, many decision makers consider it to be somewhat less dangerous at the moment, but processing workers are still experiencing the possibility of health problems and deaths, especially exposure to chemicals as materials for water purification. [4][5].

Water treatment companies use machines and equipment that are likely to cause injury to workers. Accidents that occur can be caused by negligence of workers when operating machinery and equipment or unsafe working environment conditions. Potential hazards that often occur are defects in operation, exposure to chemicals and work fatigue.

The study was conducted using the HIRA (Hazard Identification and Risk Assessment) method to identify potential hazards found in the workplace. By identifying potential hazards and work risks, it is expected to facilitate the company in the management and control of safety in the workplace and minimize the possibility of accidents.

2. Literature review

Hazard Identification is a proactive process to identify hazards and eliminate or minimize/reduce the risk of injury/illness to workers and damage to property, equipment and the environment. It also allows us to show our commitment and due diligence to a healthy and

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safe workplace. We must identify hazards and potential hazards in the workplace in order to be able to take action to eliminate or control them. [8]

Table 1. Description of Likelihood Level

Level	Likelihood	Expected or actual frequency experienced
1	Rare	May only occur in exceptional circumstances; simple process; no previous incidence of non-compliance
2	Unlikely	Could occur at some time; less than 25% chance of occurring; non-complex process &/or existence of checks and balances
3	Possible	Might occur at some time; 25 – 50% chance of occurring; previous audits/reports indicate non-compliance; complex process with extensive checks & balances; impacting factors outside control of organisation
4	Likely	Will probably occur in most circumstances; 50-75% chance of occurring; complex process with some checks & balances; impacting factors outside control of organisation
5	Almost certain	Can be expected to occur in most circumstances; more than 75% chance of occurring; complex process with minimal checks & balances; impacting factors outside control of organisation

This is a step by step process to guide responsible persons to an effective hazard identification, assessment and controls system. The steps include:

- Hazard Assessment: identifying the hazards and potential hazards, determining the risks and the risk designation (rating) associated to the hazard based on: Likelihood and severity
- Hazard control - controlling the hazards and the risks associated with the hazard
- Providing information, education, training and supervision on the hazards, risks and controls for employees affected by the hazards
- Review of the hazard assessment and control process

Table 2. Risk Assessment Matrix

Likelihood	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Severity				

Extreme	: 15-25
High Risk	: 8-12
Medium Risk	: 4-6
Low Risk	: 1-3

Table 3. Description of Severity Level

Level	Description of Severity
1	• Minor onsite injuries (first aid and nondisabling, reportable injuries). • Property damage less than base level amount * • Minor environmental impact (no remediation). • Loss of production less than base level amount * • No offsite impact or damage. No public concern or media interest.
2	• Serious onsite injuries (temporary disabling worker injuries). • damage from 1 to 20 times base level. • Moderate environmental impact (cleanup or remediation in less than 1 week and no lasting impact on food chain, terrestrial or aquatic life). • Loss of production from 1 to 20 times base level • Minor offsite impact (public nuisance—noise, smoke, odor, traffic). • Potential adverse public reaction. Some media awareness.
3	• Permanent disabling onsite injuries or possible fatality. • Property damage from 20 to 50 times base level. • Significant environmental impact (cleanup or remediation less than 1 month and minor impact on food chain, terrestrial or aquatic life). • Loss of production from 20 to 50 times base level. • Moderate offsite impact limited to property damage, minor health effects to the public or first aid injuries. • Adverse public reaction. Local media concern.
4	• Onsite fatality or less than four permanent disabling worker injuries. • Property damage from 50 to 200 times base level. • Serious environmental impact (cleanup or remediation requires 3–6 months and moderate impact on food chain, terrestrial and/or aquatic life). • Loss of production from 50 to 200 times base level. • Significant offsite impact property damage, short-term health effects to the public or temporary disabling injuries. • Significant public concern or reaction. National media concern.
5	• Multiple onsite fatalities or four or more permanent disabling onsite injuries. • Property damage greater than 200 times base level.

	• Extensive environmental impact (cleanup or remediation exceeding 6 months, significant loss of terrestrial and aquatic life or damage to food chain uncertain). • Loss of production greater than 200 times base level. • Severe offsite impact property damage, offsite fatality, long-term health effect, or disabling injuries. • Severe adverse public reaction threatening facility continued operations. International media concern

During the interview process, worker and safety officer is given a table containing the scale / category of likelihood and severity, so that the worker and the safety contractor can know and determine for themselves the category level of likelihood and severity. The value scale for likelihood is 1-5 ranging from an unlikely to almost certain level of probability.

While the value scale for severity is 1-5 ranging from insignificant to catastrophic severity. After the value of relative risk obtained then analyzed using Risk Assessment Matrix table. [7]

Risk is a measurement to analyze and evaluate the hazard. The measurement is made by identification on how severe and when likely of the hazard. In other words, the risk assessment is an in-depth look to specify situations, process and other harmful activities or hazard at workplace. [8]

Rating the hazard is one way to help determine which hazard is the most serious and thus which hazard to control first. Priority is usually established by taking into account the severity and Likelihood. By assigning a priority to the hazard, you are creating a rating or an action list.

The following factors play an important role:

- Severity of exposure - impact when exposed to the hazard.
- Likelihood - that an incident will occur when exposed to the hazard.

When the hazard is identified, determine the controls which are already in place to ensure this information is taken into account when assigning a risk designation.

Risk is presented in variety of ways to communicate the distribution of the risk throughout a plant and area in a workplace. The results of risk assessment that presented in a risk matrix are essential to make decision on risk control. Risk can be calculated using the following formula:

Risk (R) = Likelihood (L) x Severity (S). [7]

The phase of risk identification is essential, because it puts the bases of the risk analysis. Indeed, the data of risk identification will be the input of the evaluation, Therefore it is necessary to make an identification phase in an exhaustive way, to obtain the best results. [9]

4 Methodologies

The type and design of this research based on time research is cross sectional because the process of collecting data and observation of the variables done at once or at one particular time. While in terms of place, this research includes field research, because the research conducted and the way researchers in getting the data is directly plunged into the field by conducting interviews and observation

When viewed from the way of data collection, this study is observational because researchers obtain data through observations and interviews to workers and related parties in the company. In addition, the objects in this study were not treated during the course of the observational / observational study. Based on the nature of the problem and its data analysis, this research is included in descriptive research because this research does not make comparisons or connections between variables. This study describes a situation objectively.

Variables to be studied in this research are hazard identification, risk assessment, and risk level determination on water installation process. The data collected in this study there are two types of primary data and secondary data. Primary data obtained through observation and interview. These observations and interviews are used to determine the potential water hazard clearance process, the magnitude of occupational risks and the working environment.

While the secondary data collected is a general description of the company, the work procedure, the number of workers, tools and hazardous materials in the water treatment process and accident control efforts that have been done.

Processing techniques and data analysis conducted based on observation and interview data. Based on the results of observation and interviews are known potential hazard and value. Identification of potential risk hazards in the water treatment plant will be very effective if done on the basis of the factual conditions of the workplace and existing work processes, this is an effort that can be done so that industrial health and environmental health programs can be done well in accordance with policies and Regulations that have been set.

4. Result

Risk Assessment is performed using the Risk Matrix as described in the literature study, the results obtained from this risk assessment are the 22 potential hazards present in the water purification process, these findings are based on assessments of workshops and processing units at subsequent water treatment plants Described in detail in table 4. According the existing categories of extreme risk, high risk, medium risk and low risk then the findings are grouped into each risk category.

Extreme categories that exist in the risk assessment are chlorine leak and industrial fires. Leakage of chlorine and fires get the highest value because their impact threatens many things, such as industrial disasters that can harm human life and the environment.

Hazards Chlorine can be absorbed through the skin and cause burns ranging from mild to severe depending on the length of the contact In addition chlorine can also be absorbed through the eye, causing burning or discomfort, irregular blinking, unconscious closure of

eyelids, redness, and tearing. Large amounts of chlorine in the air can cause severe burns, pain, and blurred eyesight.
Therefore workers in storage must conduct a well-scheduled inspection so that the presence of chlorine can be safely maintained, besides that it is also necessary to have an emergency management control system that refers to leakage of chlorine and industrial fires, Prevention efforts from known potential hazards.

Table. 4 Hazard Identification Risk Assessment in Water Treatment Plant

No	Workshop or Treatment unit	Hazard / Hazardous Situation	Potential Risk	Consequence	Risk Assessment Matrix		
					L	S	Risk Value
1	Flow Meter Chamber	Possible entrance and entering the flow meter chamber	Chlorine inhalation by operator working inside the chamber	Lost-time accident up to fatality due to chlorine inhalation	3	2	6 (medium Risk)
2	Demolition in Chemical Building	Work at height (8m) for demolishing walls and floors	Falling from a height of approximate 8 meter to the ground	Permanent injury up to fatality	2	4	8 (High Risk)
3	Control Room	Electrical Hazard	Electric short circuit	fractures, Fatality, Disaster	3	5	15 (Extreme Risk)
4	Process of Treatment	Cleaning accumulation sludge in channel raw water inlet of accerator 1,2 at once a month	harmful atmosphere, difficulty of entry/exit access	Fatality accident more than 1 person	2	5	10 (High Risk)
5	Process of treatment	Cleaning once a month sludge extraction	All confined space risks, including fall, electrical shock	Fatality accident	2	4	8 (High Risk)
6	Process of treatment	Working at height for routine operating main drain valve, noise, smell	Falling, slippery	Fatality accident	1	4	4 (Medium Risk)
7	Process of treatment	Working/cleaning over compartment	Falling, drowning	Fatality accident	1	4	4 (Medium Risk)
8	Water treatment line	Working at height around sand filter	Drowning, Falling	Concussion, fracture	3	2	6 (Medium Risk)
9	Backwash pump room	Rotating part, noise, slippery at backwash pump	Injury at arm or hand in Projection of loose bolt, noise, fall	Arm amputation, fracture, hearing disorders, concussion	3	3	9 (High Risk)
10	Gear box of the turbine	Exposed rotating parts	Injury at arm or hand in Projection of loose bolt	Arm amputation, shut down machine, fracture	2	3	6 (Medium Risk)
11	Chlorine Facilities	Crash inside the site	Personnel crashed by chlorine vehicle	Fatality accident	3	4	12 (High Risk)
12	Chlorine Facilities	Chlorine Leakage	Inhalation of chlorine gas	Fatality accident, Disaster	3	5	12 (Extreme Risk)
13	Chlorine Facilities	Falling container when loading/unloading	Impacted by falling heavy objects (weight: +1.8 ton, height: 1.5 m)	Fracture/irreversible harm	2	2	4 (Medium Risk)
14	Purchasing	Wrong/miss specification when purchased devices, equipments, tools or materials and services	Use of improper devices, equipments, tools, materials	Stop production, fatality	5	1	5 (Medium Risk)
15	Filter gallery	Working at height	Falling at a height (6 M)	Fatality accident	2	4	8 (High Risk)

16	Laboratory	Exposure to UV radiation (The device has a UV germicidal lamp with a wavelength of 257.7 nm, including UV-C type)	Erythema (damage / disorder) on the skin and damage the cornea of the eye	Skin disorders or skin and cataracts in the eyes for the long term	4	2	8 (High Risk)
17	Reservoir	Confined space hazard	Inadequate O2 content, high toxic gas content, leakage current on electrical	Fainting, poisoning, death	2	4	8 (High Risk)
18	Acid material	Strong acid vapor in the laboratory	Inhalation, skin contact	Respiratory disorders, Skin sores	3	1	3 (Low Risk)
19	Storrage & dosing system H2SO4	Exposure to H2SO4	Steam H2SO4 strong acid operation of H2SO4 dosing pump for water neutralization	Blind, burns, irritation	2	4	8 (High Risk)
20	Submersible Pump	Electrical	Electric caution, Fire	Disaster, Injury	1	5	5 (Medium Risk)
21	Storage of hazardous chemical waste	Waste spills	Hazardous chemical waste spills at the time of pouring, the occurrence of waste leakage	Environmental pollution, poisoning, fainting	3	2	6 (Medium Risk)
22	Storage Poly Aluminum Chloride	Poly Aluminum Chloride	Leaks on pipe connections and ball valves	Irritation, impaired vision, indigestion	3	2	6 (Medium Risk)

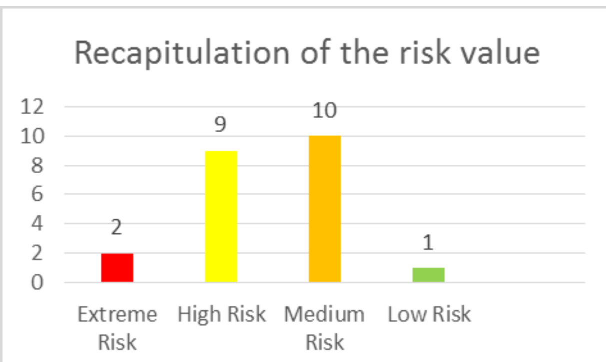

Fig 1. Recapitulation of the risk value

4. Conclusion

Potential occupational hazards in the water treatment industry are exposed to chemicals to workers, the potential danger of leaking chlorine gas can also greatly affect the safety and health of the industrial environment. Control measures undertaken to avoid potential hazards are to apply the use of personal protective equipment, but management will also be better managed in accordance with hazard control hazards, occupational safety and health programs such as issuing work permits, emergency response training is required, Very useful in overcoming potential hazards that have been determined.

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Analysis of Risk Assessment in a Municipal Wastewater Treatment Plant Located in Upper Silesia

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Abstract: Nowadays, risk management applies to every technical facility, branch of the economy, and industry. Due to the characteristics of the analyzed wastewater treatment plant and the specificity of the used processes, one must approach different areas individually. Municipal sewage treatment plants are technical facilities; they function as enterprises and are elements of larger systems—water distribution and sewage disposal. Due to their strategic importance for the environment and human beings, it is essential that they are covered by risk management systems. The basic stage of risk management is its assessment. On its basis, strategic decisions are made and new solutions are introduced. Constant monitoring of the operation of a treatment plant allows for assessment of whether actions taken are correct and whether they cause deterioration of the quality of sewage. In our work, we present a method of risk assessment based on historical data for an existing facility and obtained results.

Keywords: municipal wastewater treatment plant; risk management; risk assessment; risk analysis; biological treatment; chemical treatment

1. Introduction

Municipal sewage treatment plants are strategic elements of infrastructure and special technical facilities, whose proper functioning determines environmental cleanliness, as well as, people's health. The individual stages of wastewater treatment use physical, biological, and chemical processes that are interrelated and dependent on each other. The effectiveness of each stage is affected by various negative factors, such as the variable composition of incoming sewage and atmospheric conditions. Operators need to limit the effects of events caused by these factors and even prevent their occurrence [1–3]. Therefore, the proper functioning municipal sewage treatment plant should be supported by a risk management system.

The risk of municipal sewage treatment plants can be examined and analyzed at various stages of the treatment plant operation. Considering the potential risk as early as the design stage of the facility allows for choice of the most appropriate trade-off between costs of measures and risks [4,5]. Currently, in Poland, modernization of existing obsolete objects is more common than emergence of new ones. Correctly carried out modernization should be based on risk analysis [6]. Modernization may involve repairs of existing equipment and improvement of technological conditions, or it may be considered as an extension of the technological line with modern devices, e.g., membranes. In particular, the second case should be preceded by a thorough analysis of costs, losses, and risks [7]. In addition, the risks should be monitored throughout the operation of the treatment plant, and the risk management system should be used effectively [8].

This paper discusses the application of risk assessment procedures for the management of municipal wastewater treatment plants, using a facility in Poland as a case study. The method of risk assessment is presented based on historical data.

Current research concerns individual chemical compounds: pharmaceuticals [9], antibiotics [10], individual devices of a treatment plant's technological line, and assessment of ecological risk of receiver after discharge from a sewage treatment plant [11–13]. In contrast to the cited papers (which are examples of research conducted thus far), we assess the risk associated with the entire wastewater treatment plant, which is a novelty in the scientific literature.

2. Theory of Risk Management

Defining the risk management process is difficult due to the multitude of various scientific and economic areas in which it is used. It can be defined as a way to find the most optimal methods for conscious, uninterrupted diagnosis and risk control [14]. Risk management should lead to risk setting at an acceptable level [15]. With regard to municipal wastewater treatment plants, risk management can be defined as preventing an occurrence of undesirable events and reducing the size of resulting damage after such events occur [16]. These actions should be carried out on the basis of continuous monitoring of the treatment plant operation, staff training, maintenance of technological process equipment, and maintenance of technical services.

The risk management process can be divided into two basic stages: risk assessment and risk control [17]. The components of risk assessment are identification, estimation, and determination of its acceptability [16]. Risk control involves the monitoring of sewage treatment plant operation and observation of introduced changes.

2.1. Risk Identification

The basic method of risk identification of a municipal sewage treatment plant is analysis of historical data, during which attention should be paid to all events causing damage. Due to the nature of the sewage treatment plant, risk identification should be an ongoing process in order to identify new threats and verify those already recognized [18,19]. The process of risk identification is the basis for risk management, and its correct functioning determines the success of the entire risk management process [20].

2.2. Risk Estimation

Risk estimation consists of determining its measure, which is dependent on the availability of data, reliability, and expected results [16,21]. In general, risk estimation methods can be divided into three groups [22]:

- Quantitative methods consist of two defining parameters: frequency of occurrence and value of losses; the results are objective and comparable.
- Qualitative methods include a subjective assessment based on knowledge and experience; the results are presented in a descriptive form.
- Mixed methods are the most commonly used type of strategy, involving the simultaneous use of quantitative and qualitative methods.

In the case of sewage treatment plants, the specificity of the collected data allows only the mixed method to be used. The qualitative method is used to identify risk, while the quantitative method is used in risk assessment, assigning specific values to described events.

The result of the mixed method is the so-called risk map (Figure 1). The risk map gives the possibility of a comprehensive presentation of the identified and quantified risk, but it is also a tool helpful in indicating which methods of risk control will work best for a given risk [23]. The risk map presented in this paper is the simplest type of possible risk matrix, determined by the size of losses and the frequency of their occurrence.

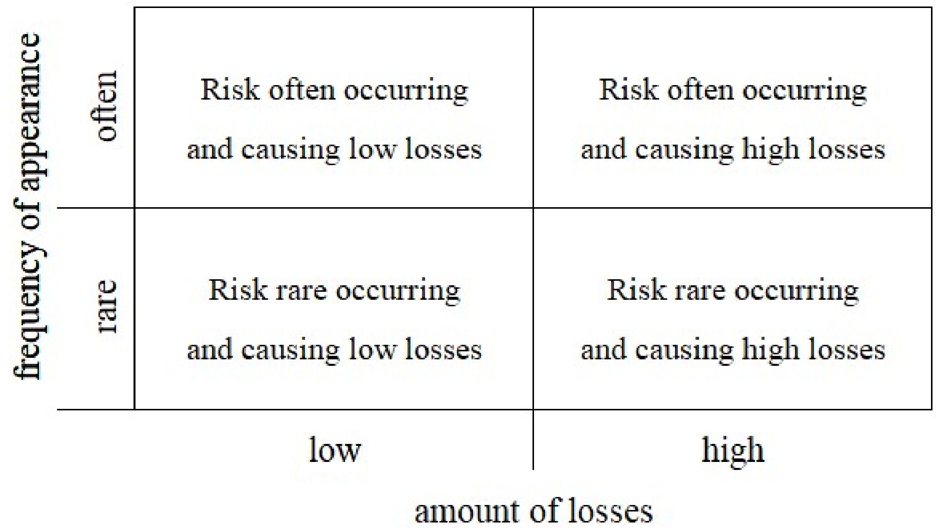

Figure 1. Sample scheme of a very simple risk map [19].

2.3. Risk Admissibility

In the literature [16,24] and practice, three basic degrees of risk acceptability are distinguished as follows:

- Acceptable risk—an event irrelevant to the general operation of the facility as a "daily risk"; it does not require special security measures.
- Tolerable risk—medium risk, requires intervention, provided that the cost of reducing the risk is reasonable for the damage caused.
- Unacceptable risk—high risk, means an immediate threat to the environment and people and requires immediate steps to limit it.

The degree of admissibility is determined on the basis of legal acts, applicable norms and standards. The Polish legal act for municipal sewage treatment plants is the Regulation of the Minister of Environment from 18 November 2014 [25]. The regulation defines the conditions for discharge of sewage to the receiver. When analyzing a single object, you should also permit considerations for specific water treatment. Graphical interpretations of risk hierarchization (Figure 2) are obtained by applying the acceptability of risk to the risk map (Figure 1) based on the aforementioned documents.

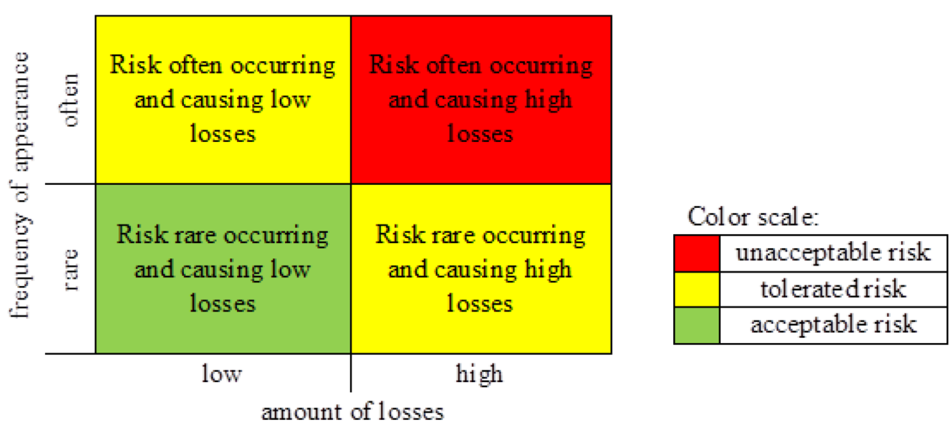

Figure 2. Risk hierarchy for the sample scheme presented in Figure 1 [21,22,26,27].

3. Obtained Results and Discussion

We analyzed the work of a sewage treatment plant located in Upper Silesia that uses activated sludge technology. The municipal wastewater treatment plant serves 62,000 inhabitants. Based on historical data collected by the operator of the sewage treatment plant from 2014 to 2016, risk identification and assessment were carried out. Our previous work [28] presents the risk identification that is assessed in the present paper (Table 1). The occurring risk factors (inside, outside, internal, external, latent, explicit) were identified, and the type of risk event (qualitative, operational, ecological, financial) was recognized according to the classification by Iwanejko and Rybicki [16].

Table 1. Examples of events together with the incidence rate (I) and the number of losses (L).

Device	Event	Type of Risk *	Risk Identification [16]			Risk Assessment		
			Factor **	Effect	Action Taken/Proposed	Number of Losses(L)	Frequency of Appearance (1/year)	Frequency of Appearance (F)
sifters	sifter scraper failure	Q	O	clogging of sifter	repair of scrapper	1	0.67	1
grit chamber	large dump of greasy sewage	Q	E	clogging of grease chamber outflow	unclogging the outflow	1	0.33	1
activated sludge chamber	emergence of filamentous bacteria	Q, OP	I	formation of scum layer	breaking the scum layer and actions aimed at stopping bacteria development	2	13.67	3
secondary settling tank	auxiliary devices failure	Q, OP	O	minor disturbance in the settling tank operation	repair of auxiliary devices	2	4.67	2
all devises of sewage treatment	electrical power outage	Q, OP, EC, Fi	E	no power for electrical powered devices	connection to emergency power supply	4	0.33	1

* Q—qualitative, OP—operational, EC—ecological, Fi—financial. ** O—Ordinary, E—external, I—internal.

In the process of risk identification [28], 32 different threats were identified, which occurred 114 times at different frequencies. All of these events were divided according to the frequency of their occurrence, as seen in Table 2, and on the basis of their specific type of risk, a quantitative loss value was assigned to them (Table 3). Results obtained in this way are presented in Table 1. Based on Table 2, a risk map was prepared with the admissibility hierarchy indicated. In order to accurately analyze these events, a risk map was divided into individual devices of the technological line (Figure 3).

Table 2. Frequency of appearance (F).

Occuring Events:	Frequency of Appearance (1/year)	Frequency of Appearance (F)
rarely	≤4 or 5	0–1
often	4 or 5–9	1–2
very often	≥9	2–3

Table 3. Number of losses (L).

Type of Risk	Amount of Losses (L)
qualitative	1
qualitative, operational	2
qualitative, operational, financial	3
qualitative, operational, ecological, financial	4

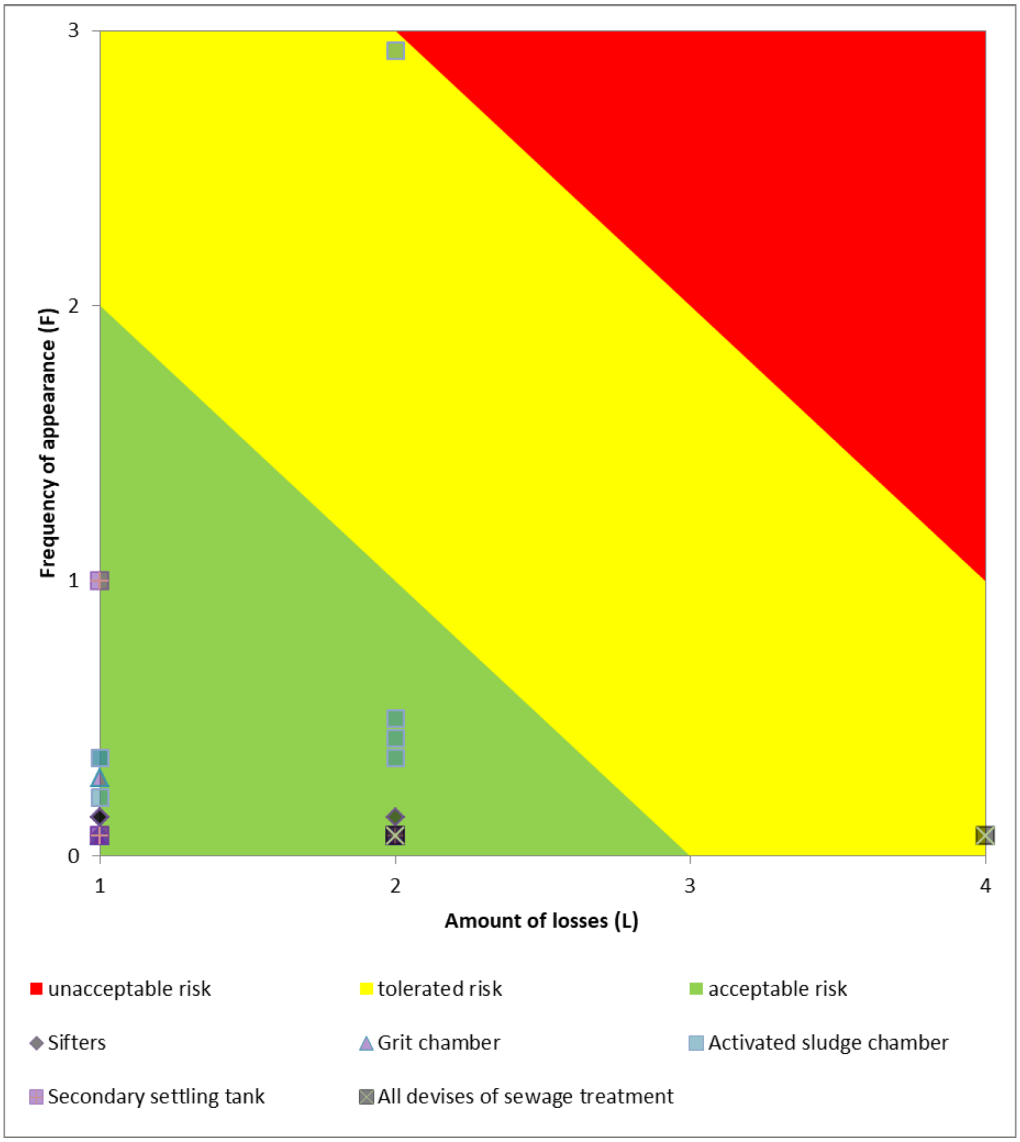

Figure 3. The risk map divided into technological line devices, taking into account the risk hierarchy.

The green color in Figure 3 is an acceptable risk area—these are events that do not require a reaction from the operator, and their effects are removed during the normal work of the personnel. The area of tolerated risk is marked in yellow; these events require a response from the staff, but those actions do not have to be taken immediately. The unacceptable risk area is represented by the red color, corresponding to the events that require immediate response from staff and relevant services, regardless of cost. Figure 3 presents 32 events that occurred 114 times. Almost all of the identified hazards are in the area of acceptable risk (30 events that occurred 72 times [28]), which proves the proper functioning of the municipal wastewater treatment plant. Only two events (emergence of filamentous bacteria in an activated sludge chamber, which occurred 41 times, and electrical power outage, which occurred once [28]), posed a greater threat to operation of the treatment plant, and therefore, they are in the area of tolerated risk.

The activated sludge chamber, where a tolerated risk event occurred, is a technological device, responsible for biological wastewater treatment. It works under variable loads of pollutant and under conditions of variable hydraulic loads. This device should be under strict control and supervision. The identified disruption of work in the activated sludge chamber was caused by the emergence of filamentous bacteria. The bacteria, analyzed in 2015, often appeared due to attempts to improve working conditions in the chamber and the testing of new technological solutions. This is an example of an attempt to modernize, which was not preceded by a risk analysis and gave the operator more problems than benefits.

Another event where the risk was tolerated was for the whole treatment plant. The recorded event concluded in a power failure to the entire facility. Such an event causes a great threat to the proper functioning of the treatment plant and may led to environmental contamination. In the case of the analyzed treatment plant, this did not occur because the facility was equipped with a power generator, and during the failure, strategic devices of the process line were working.

We conducted a similar study for another sewage treatment plant [27] (SWT-2). In comparison with the treatment plant presented in this paper (SWT-1), there were bar screens instead of sifters, and SWT-2 carried out a chemical dephosphatation process that does not occur at SWT-1. No events for sifters were classified as a tolerated risk for bar screens; there were two such events that occurred 14 times (large fat and meat dump that occurred once and clogging of bars that occurred 13 times [27,28]). In both cases, one event in the activated sludge chamber was classified as a tolerated risk. In SWT-1, it was the emergence of filamentous bacteria that occurred frequently (41 times) with a small number of losses (2). While in SWT-2, it was a problem with the agitators and aeration rotors that occurred once but with a very high number of losses (4) [27]. Thus, events with very different frequencies and different numbers of losses may have a similar level of risk.

For the process of chemical dephosphatation in SWT-2, one event occurred 14 times: sludge floated on the surface of the dephosphatation chamber [27,28]. This did not happen in SWT-1 because there was no dephosphatation chamber in the technological line.

In the case of SWT-2, there were also two events classified as tolerated risk—the dump of greasy wastewater in the grit chamber and auxiliary device failure of the clarifier [27,28]. The dumping of greasy wastewater into the grit chamber was also reported in SWT-1, but in this case, it was classified as an acceptable risk because it occurred more frequently (once in SWT-1 but eight times in SWT-2 [27,28]). The auxiliary device failure of the clarifier did not occur in SWT-1. Based on these analyses, it can be concluded that SWT-1 is more reliable than SWT-2.

4. Conclusions

The analyzed municipal sewage treatment plant functions properly—none of the identified threats were classified as an unacceptable risk area. In addition, only two events were in the area of tolerated risk. The remaining 112 irregularities that occurred in the three-year period analyzed were events of acceptable risk—everyday risk. These are minor irregularities in the operation of individual devices that a well-trained crew can easily handle in the course of normal operations.

The proposed risk assessment method is only adequate for sites that have complete and good-quality historical data (detailed, consistently described, regularly collected), because it is based on risk identification. Assigned, on the basis of previously performed identification, weights for individual frequency of occurrence and the start size, determined on the basis of the type of risk, were correctly selected, which we concluded after identifying an adequate events distribution on the risk map (Figure 3).

Research to date has focused on risks associated with environmental pollution with chemicals and their impact on the functioning biological part of a sewage treatment plant and on the effects of discharge of such treated wastewater to receivers (rivers) [9–13]. In the framework of a larger project, this article presents only a fragment of research, the purpose of which is to look at sewage treatment plants as one organism. Based on the results obtained, the next stage of research is to develop appropriate weights for individual technological line devices. They will be assigned to individual devices based on their impact on the quality of treatment plant operations. These weights are necessary to define strategies to minimize risks and to prepare the risk management procedures in sewage treatment plants. The introduction of procedures, which are going to be developed, will facilitate the management of municipal wastewater treatment plants. Currently, there is a lack of unified procedures for managing risk at sewage treatment plants.

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EXHIBIT B

RISK ASSESSMENT SCORING RUBRIC – METHOD 1

Each treatment component was provided with a likelihood score. The modes of failure and frequency of failure were assessed qualitatively, then the results of this qualitative assessment were matched with the information in Table B-1, and the corresponding likelihood score was tabulated and included in the final scoring equation.

TABLE B-1

Method 1 Likelihood Scoring Rubric

Frequency Scoring		
Score	**Likelihood**	**Expected Frequency**
1	Rare	May only occur in exceptional circumstances.
		Simple process.
		No previous incidence of noncompliance or poor performance.
2	Unlikely	Could occur at some time (<25%).
		Noncomplex process.
		Existing system of checks and balances.
3	Possible	Might occur at some time (25%–50%).
		Previous issues with noncompliance and poor performance.
		Complex process with extensive checks and balances.
		Impacting factors outside of owner control.
4	Likely	Will probably occur in most circumstances (50%–75%).
		Complex process with some checks and balances.
		Impacting factors outside of owner control.
5	Almost Certain	Can be expected to occur in most circumstances (>75%).
		Complex process with minimal checks and balances.
		Impacting factors outside of owner control.

Each treatment component was provided with a severity score. The impacts of a potential failure were assessed qualitatively, then the results of this qualitative assessment were matched with the information in Table B-2, and the corresponding severity score was tabulated and included in the final scoring equation.

TABLE B-2

Method 1 Severity Scoring Rubric

Severity Scoring				
Score	**Personnel Injury/Illness**	**Equipment Loss**	**Down Time**	**Environmental Effects**
1	Minor First Aid	<$1K	1 day	Immediate term (<1 month). Minimal damage. Insignificant public image damage.
2	Minor Injury (<1 week)	$1K–$50K	2–3 days	Brief term (1–6 months). Minor damage. Minor public image damage.
3	Major Injury (1–2 weeks)	$50K–$250K	4–7 days	Short term (6–12 months). Some damage. Moderate public image damage.
4	Severe Injury (>2 weeks)	$250K–$1M	8–30 days	Medium term (1–5 years). Moderate damage. Significant public image damage.
5	Long-Term Injury or Death	>$1M	>30 days	Long term (>5 years). Significant damage. Severe public image damage.

The likelihood and severity scores were multiplied to achieve a final score. This final score was then color coded for the risk level (high, moderate, low, minimal) based on the range of scores shown in Table B-3.

TABLE B-3

Method 1 Combined Risk Assessment Scoring Rubric

Scoring Template						
Frequency	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Severity				

EXHIBIT C

RISK ASSESSMENT SCORING RUBRIC – METHOD 2

The effective life for various components is assigned. This effective life plays a role in scoring the Probability of Failure described below.

TABLE C-1

Method 2 Effective Life Scoring Rubric

Effective Life (years)	Asset Type
100	Sewers
75	Civil
60	Pressure Pipe
40	Pumps
35	Motors
30	Buildings
30	Valves
30	Electrical
25	Controls

Each treatment component was provided with a physical condition grade. The component's physical condition qualitatively, based on their current condition as well as the condition listed in the Assessment Report, then the results of this qualitative assessment were matched with the information in Table C-2, and the corresponding physical condition grade was tallied.

TABLE C-2

Method 2 Physical Condition Scoring Rubric

Grade	Condition	Remaining Life	Definition
1	Excellent	90%	Asset is like new, fully operable, well maintained, and performs consistently at or above current standards. Little wear shown and no further action required.
3	Good	75%	Asset is sound and well maintained but may be showing some signs of wear. Delivering full efficiency with little or no performance deterioration. Virtually all maintenance is planned preventive in nature. At worst, only minor repair might be needed in near term.
5	Moderate	50%	Asset is functionally sound, showing normal signs of wear relative to use and age. May have minor failures or diminished efficiency and some performance deterioration. Likely showing modest increased maintenance and/or operations costs. Minor to moderate refurbishment may be needed in the near term.
7	Poor	25%	Asset functions but requires a sustained high level of maintenance to remain operational. Shows substantial wear and is likely to cause significant performance deterioration in the near term. Near term scheduled rehabilitation or replacement needed.
9	Very Poor	10%	Very near end of physical life. Substantial ongoing maintenance with short, recurrent maintenance intervals required to keep the asset operational. Unplanned corrective maintenance is common. Renewal (refurbish or replacement) is expected in near term.
10	Failing	0%	Effective life exceeded and/or excessive maintenance cost incurred. A high risk of breakdown or imminent failure with serious impact on performance. No additional life expectancy; immediate replacement or rehabilitation needed.

Each treatment component was provided with a Consequence of Failure (CoF) score. The impacts of a potential failure were assessed qualitatively, then the results of this qualitative assessment were matched with the information in Table C-3, and the corresponding CoF score was tabulated and included in the final scoring equation.

TABLE C-3

Method 2 CoF Scoring Rubric

Rating	Description	Level Affected	Percent Affected
1	Minor Component Failure	Asset	0%–25%
2	Major Component Failure	Asset	25%–50%
3	Major Asset	Asset	0%–25%
4	Multiple Asset Failure	Facility/Subsystem	25%–50%
5	Major Facility Failure	Facility	50%–100%
6	Minor System Failure	Total System	20%–40%
7	Medium System Failure	Total System	40%–60%
8	Intermediate System Failure	Total System	60%–80%
9	Significant System Failure	Total System	80%–90%
10	Total System Failure	Total System	90%–100%

Each treatment component was provided with a Probability of Failure (PoF) score. The potential for failure were assessed qualitatively, then the results of this qualitative assessment were matched with the information in Table C-4, and the corresponding PoF score was tabulated and included in the final scoring equation.

TABLE C-4

Method 2 CoF Scoring Rubric

Rating	% of Effective Life Consumed
1	0%
2	10%
3	20%
4	30%
5	40%
6	50%
7	60%
8	70%
9	80%
10	90%

The reduction factor accounts for any redundancy already in place. For example, if two pumps are present, then failure of a single pump does not prevent the WTP from providing water service. If redundancy exists for a particular treatment component, then the PoF score described above is reduced by the factors listed in Table C-5.

TABLE C-5

Method 2 PoF Reduction Factor Scoring Rubric

Reduce PoF by	Level of Redundancy
50%	50% Backup
90%	100% Backup
98%	200% Backup

The renewal strategy is a qualitative assessment for the overall risk score of a particular asset. T covers a range from no action to complete replacement and provides a qualitative recommendation for additional methods to addressed shortcomings or issues associated with a particular treatment component. These strategies are summarized in Table C-6.

TABLE C-6

Method 2 Renewal Strategies Scoring Rubric

Option	Description	Type
1	Do Nothing	Non-Capital
2	Continue with Status Quo	Non-Capital
3	Maintain Differently	Non-Capital
4	Operate Differently	Non-Capital
5	Repair	Capital
6	Refurbish	Capital
7	Replace with Similar Asset	Capital
8	Replace with Improved Asset	Capital
9	Reduce Levels of Service	Non-Asset