Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-6

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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.

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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 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.

Alternative CCB2 – Construct New Replacement CCB

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

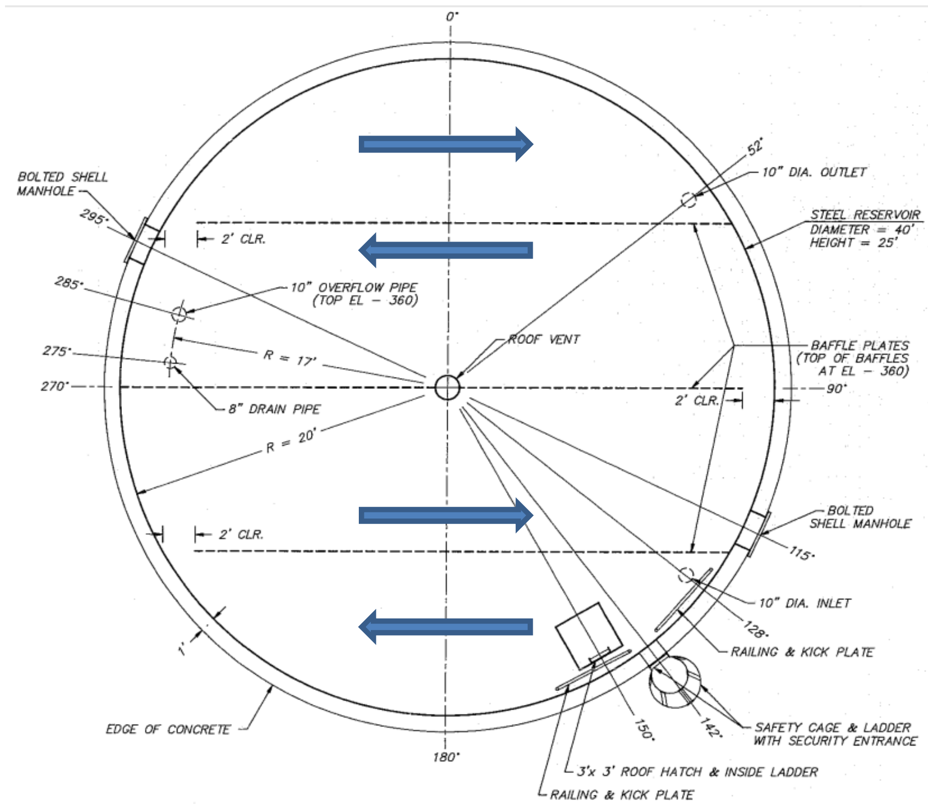


FIGURE A-2

Chlorine Contact Basin Plan

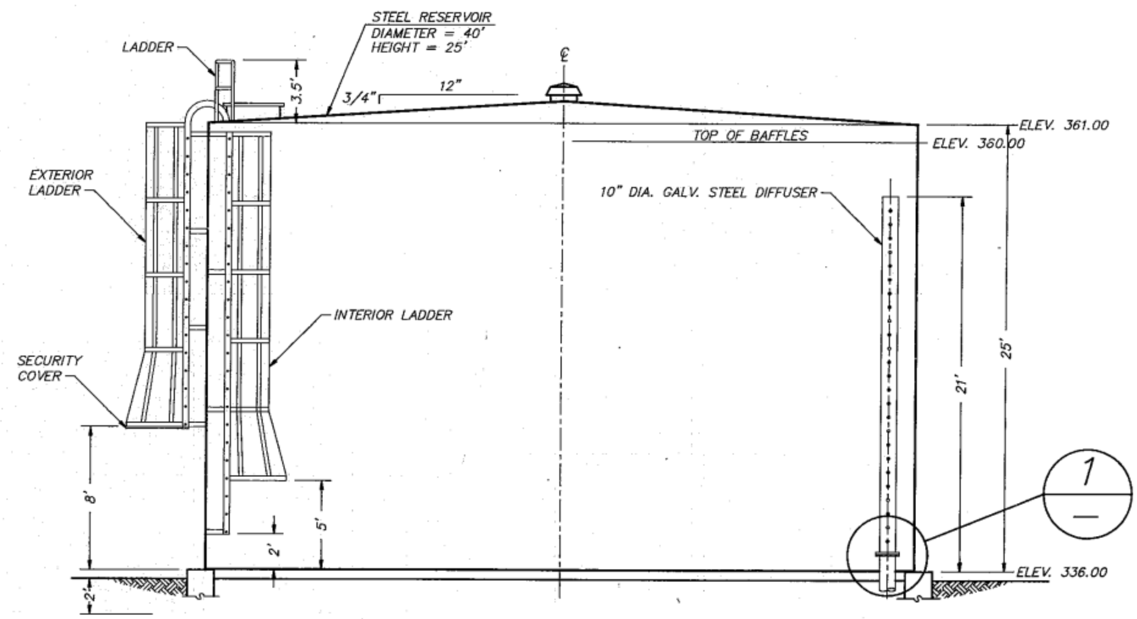
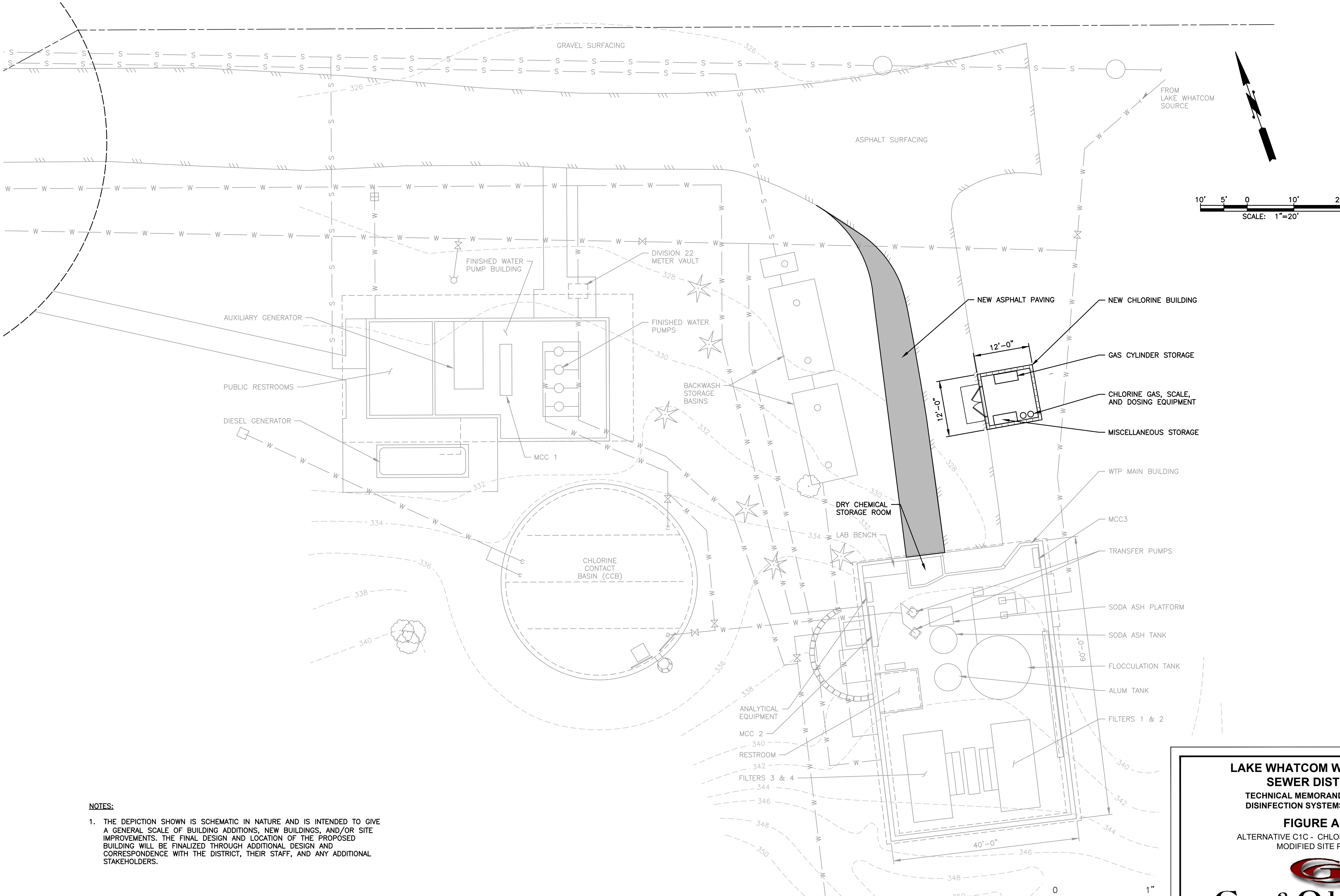


FIGURE A-3

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.

0 1"

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

LAKE WHATCOM WATER AND SEWER DISTRICT

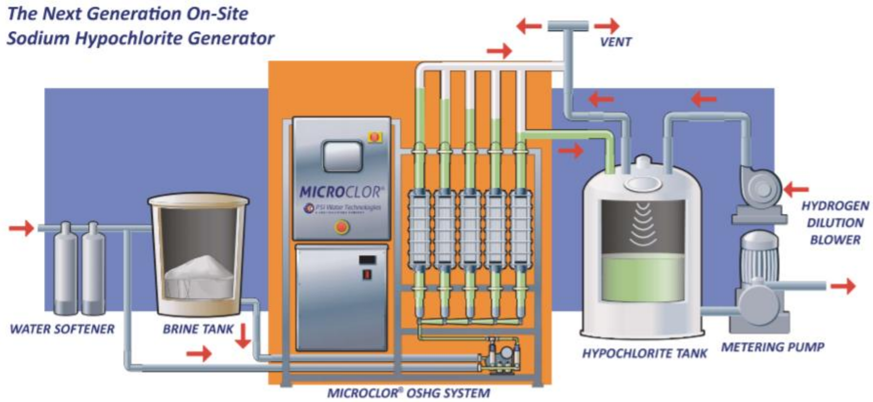
TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-5

ALTERNATIVE C1C - CHLORINE BUILDING
MODIFIED SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

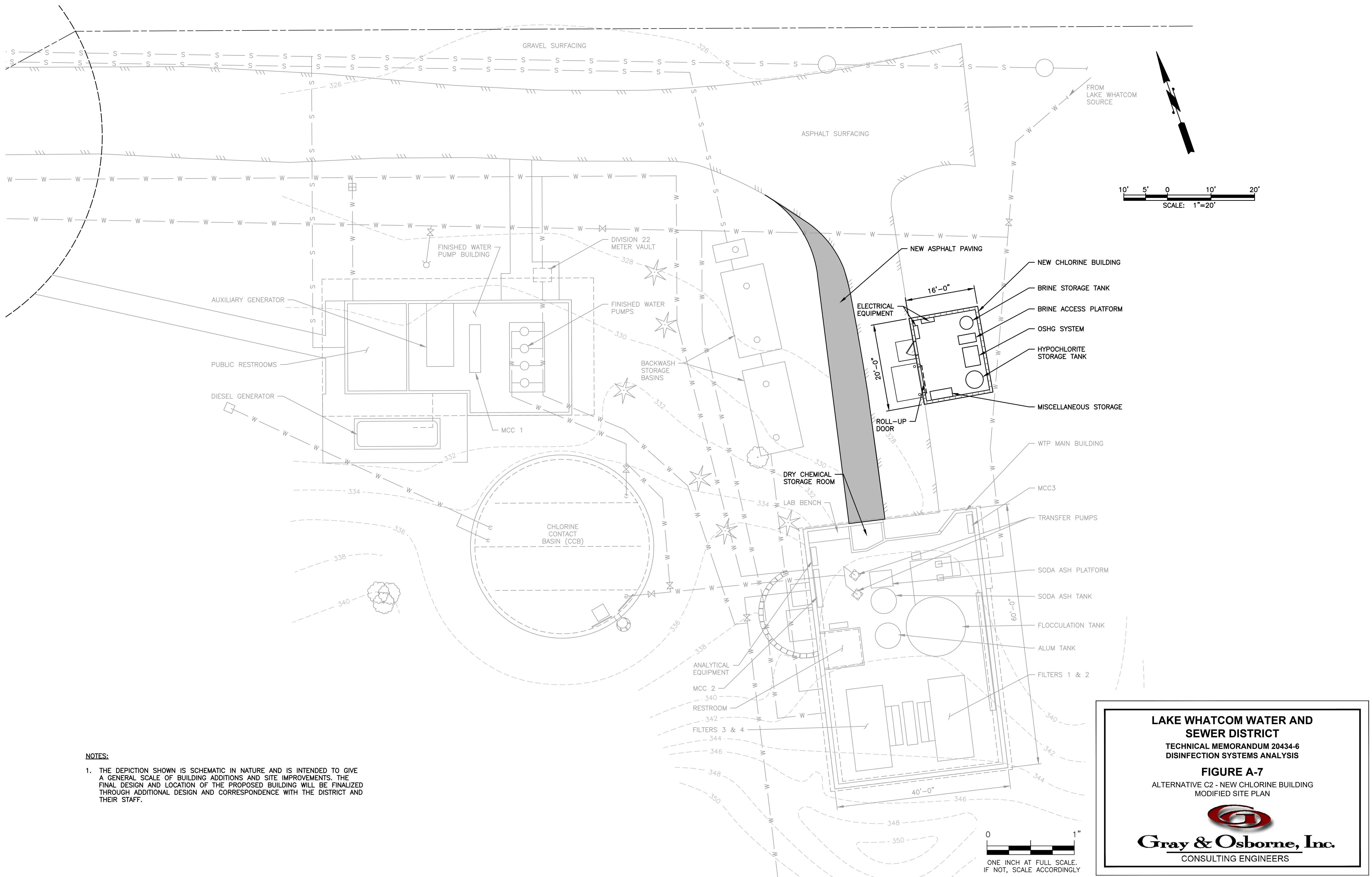
L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\Figures 2021-01-10\FIGURE A-5-ALT C1C.dwg, 1/11/2021 8:42 AM, PHILIP MARSHALL



Courtesy of UGSI/PSI

FIGURE A-6

UGSI/PSI OSHG System



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.

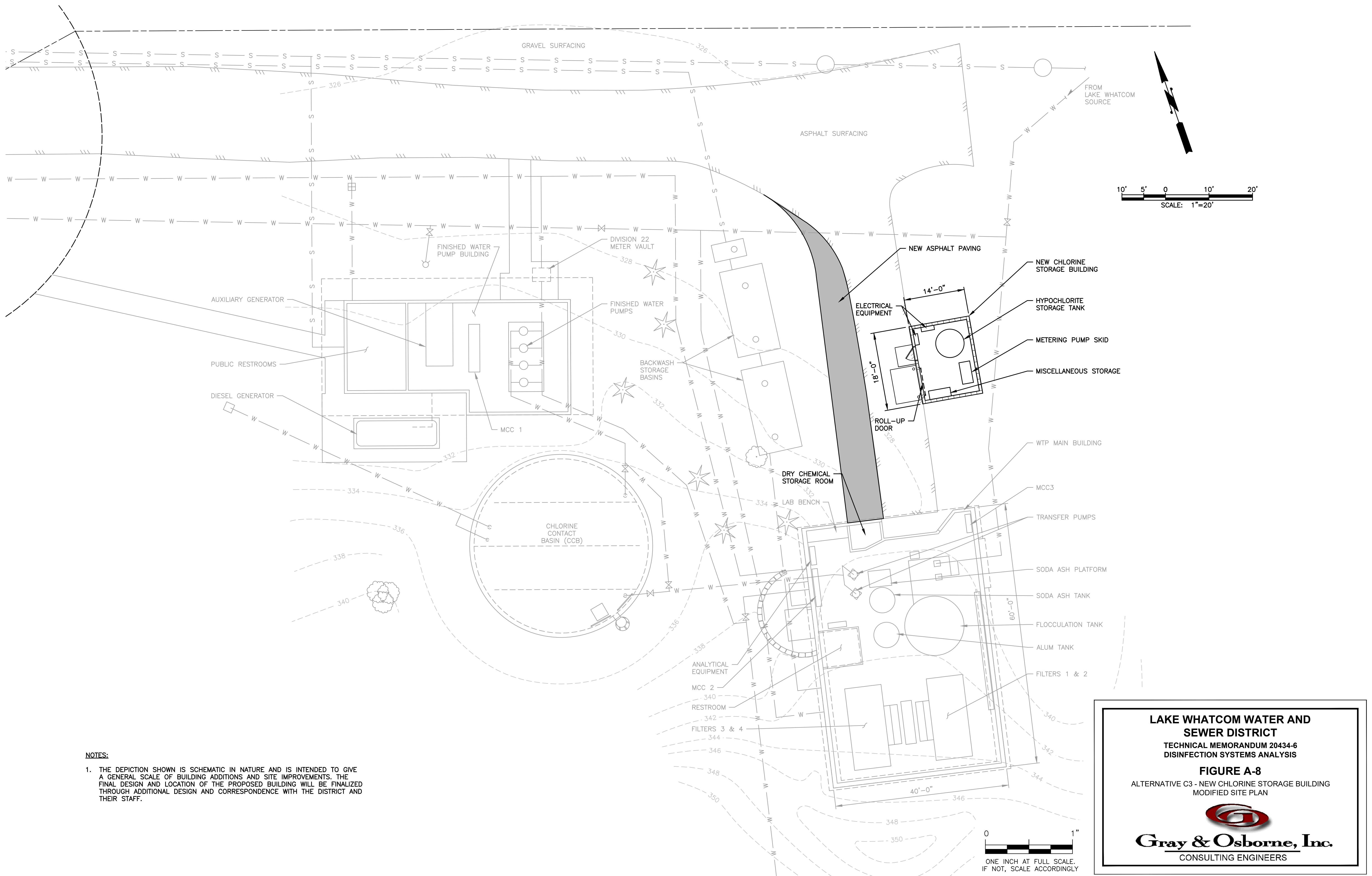
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-7

ALTERNATIVE C2 - NEW CHLORINE BUILDING
MODIFIED SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS



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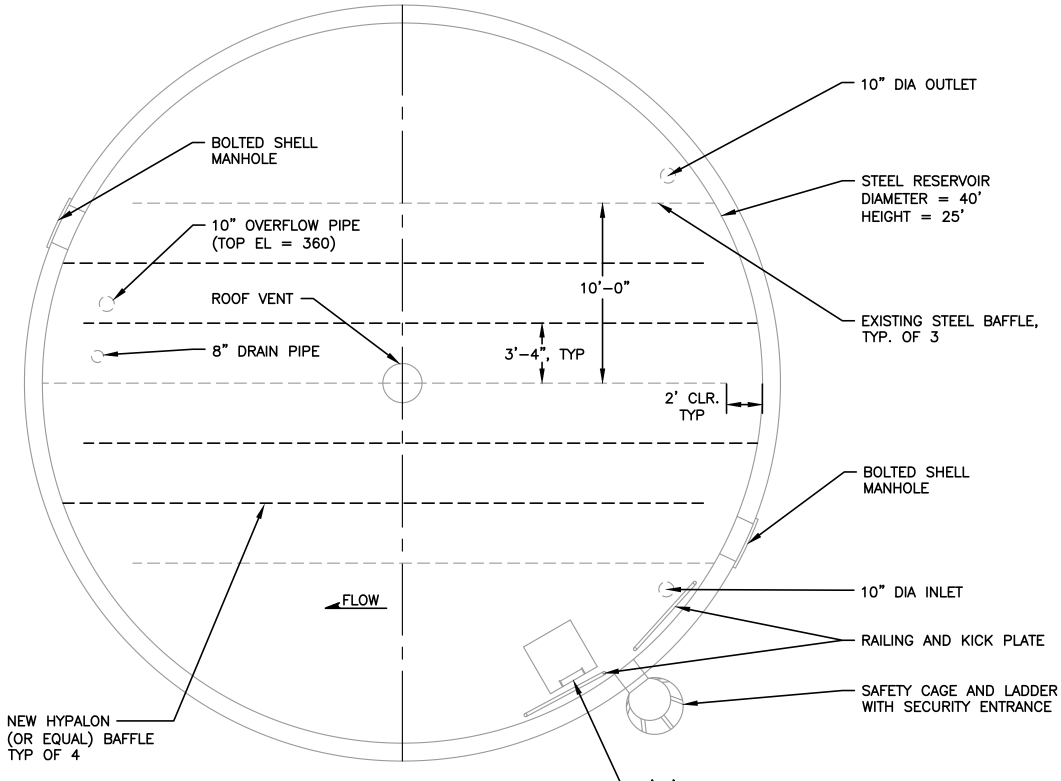
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

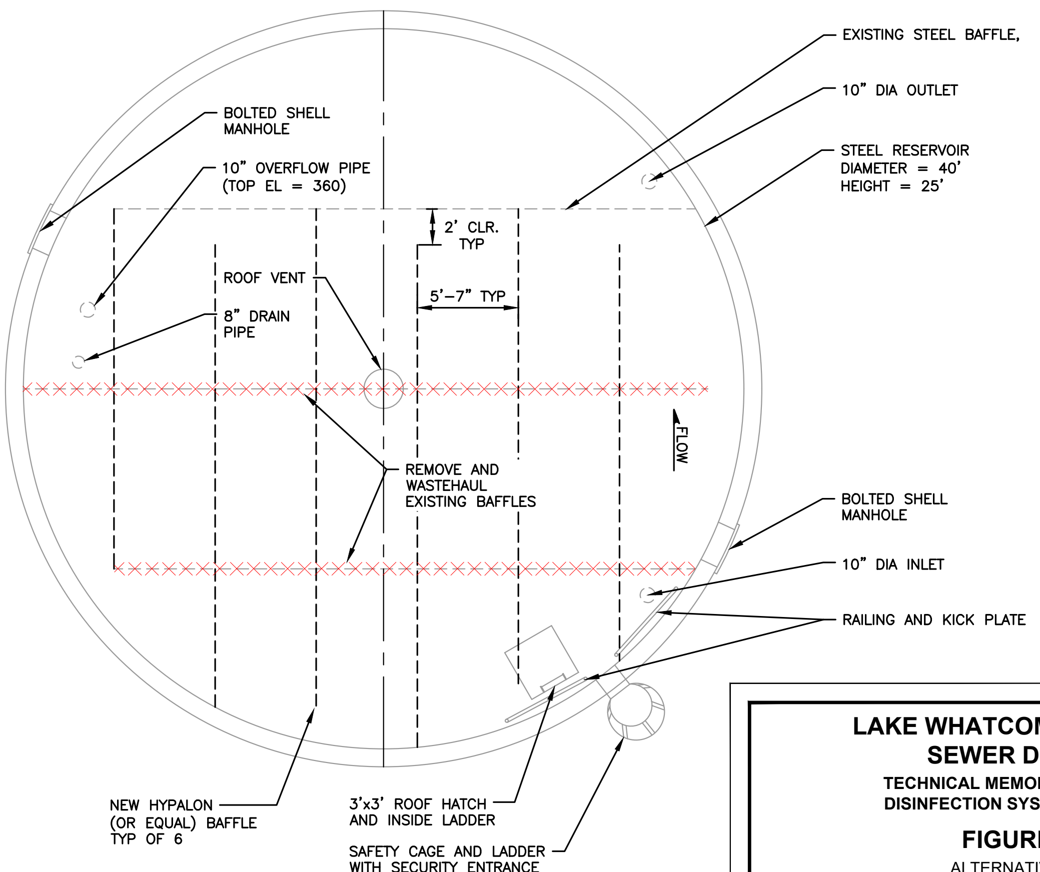
FIGURE A-8

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"

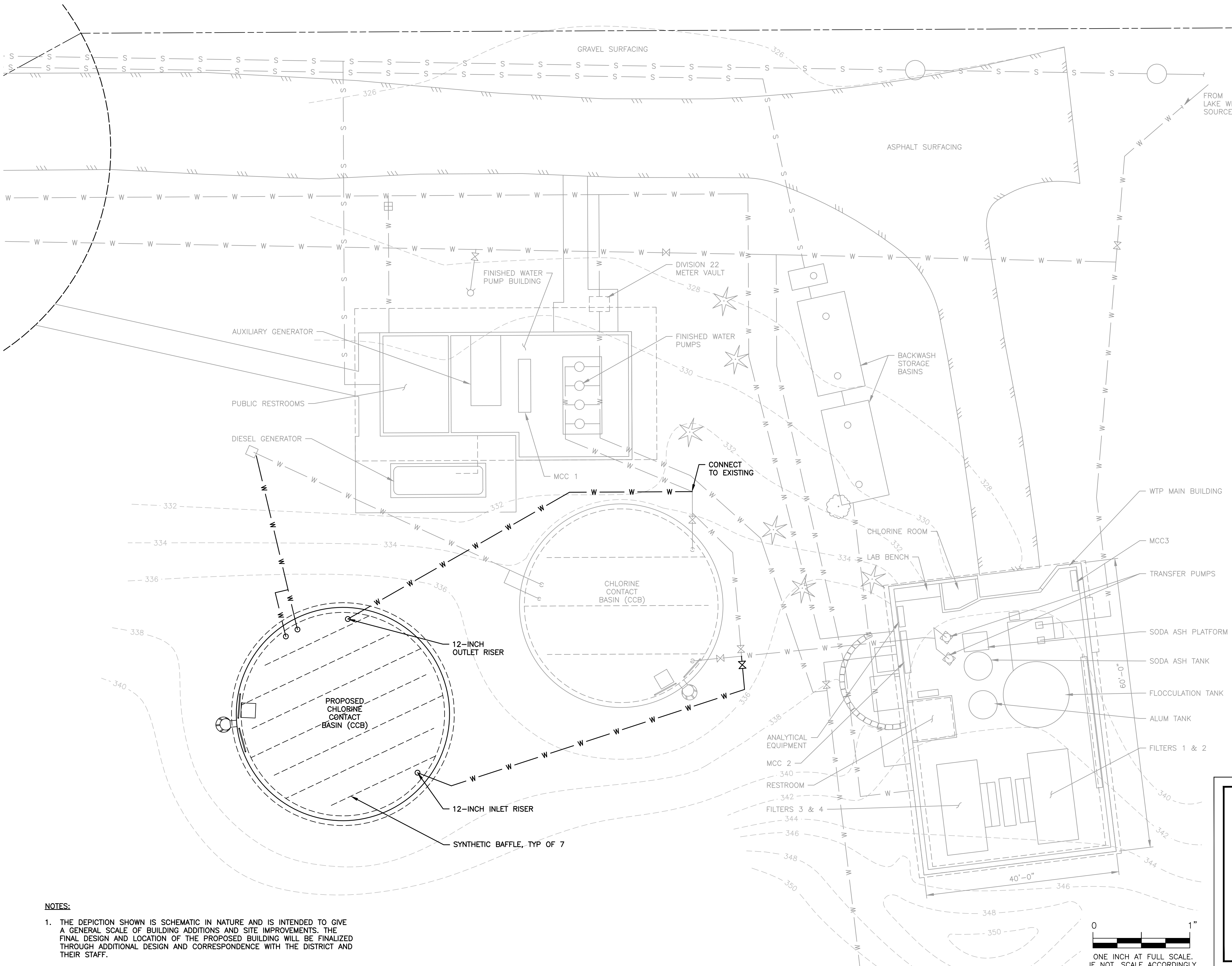
LAKE WHATCOM WATER AND SEWER DISTRICT

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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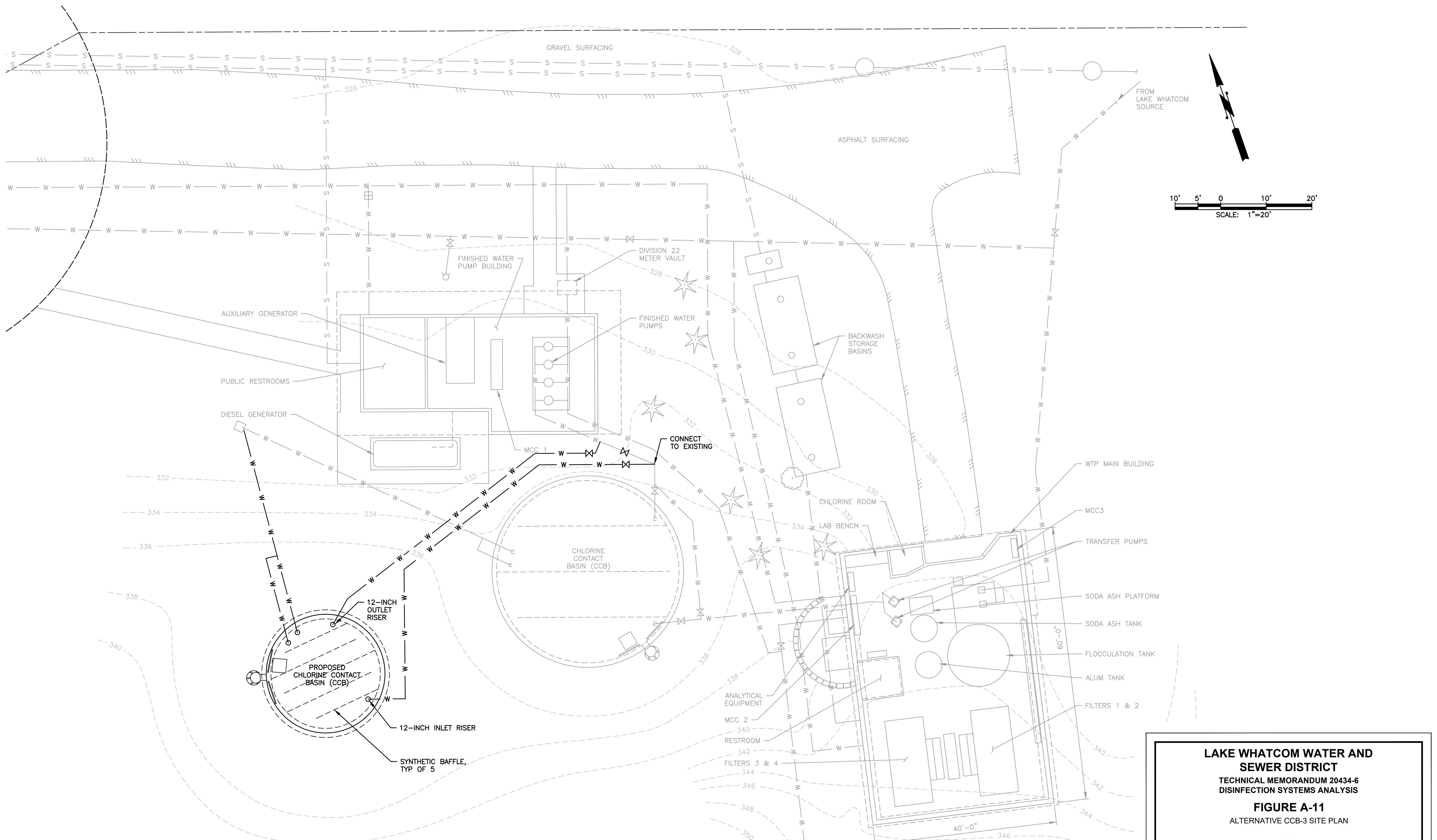
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-6
DISINFECTION SYSTEMS ANALYSIS

FIGURE A-10

ALTERNATIVE CCB-2 SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS



NOTES:

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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]