CITY OF FLINT

Dr. Karen Weaver
Mayor

February 28, 2018

Mr. Chris Korleski, Director
Water Division, Region 5
United States Environmental Protection Agency
Ralph Metcalfe Federal Building
77 West Jackson Boulevard (W-15J)
Chicago, Illinois 60604-3590

Sent via Email

Dear Mr. Korleski:

This correspondence is intended to address requirements of USEPA's January 21, 2016 Emergency Order, *Paragraph 59* and several of the requirements found in the November 17, 2016 First Amendment to the Emergency Administrative Order, *Paragraph 60.* On April 19, 2017, the City of Flint informed USEPA that it intended to maintain Great Lakes Water Authority (GLWA) as it's primary, long term water source and establish a back-up water source through an interconnection with the Genesee County Drain Commissioner (GCDC). This recommendation was subject to a Public Participation period and approvals of various parties. The Flint City Council and the Flint RTAB has approved the GLWA, GCDC and KWA contracts required to implement this water source plan on November 21, 2017 and December 20, 2017 respectively. All contracts have an effective date of December 1, 2017.

With this new 30-year contract, the City of Flint will continue to receive its primary potable water supply from GLWA. This GLWA water source will originate from Lake Huron and is processed through GLWA's Lake Huron Water Treatment Plant (WTP). From the WTP, treated water flows primary through a single 72-inch transmission main to the Flint system, terminating at the Flint WTP site.

To enhance the reliability of the GLWA water source, a secondary supply will be derived from the GCDC system. This supply also originates at Lake Huron and, after transmission and storage, the raw water is treated at a treatment facility in Lapeer County. The GCDC WTP purifies the water with a treatment process similar to GLWA, which should promote the compatibility of the two supplies.

Under the contract terms, GLWA will provide up to a maximum of 15 mgd under both maximum day and peak hour demand conditions at its standard rate during its peak demand/summer season. Under non-peak demand conditions, GLWA can provide Flint up to 24 mgd at standard contract rates. All water supplied to Flint from either the GLWA or GCDC supplies will by contractually considered as GLWA water for accounting and billing purposes. The City of Flint intends to strategically use its available finished water storage to stay within the designated contract limits.

<u>Flint's Secondary Supply</u>

The proposed Flint secondary/back-up water source would connect to the GCDC system at a 36-inch ductile iron water main in the vicinity of Francis and Lewis Road. As shown in the attached Project 3 Location figure, the proposed water main would proceed south on Lewis Road, then proceed east along West Boulevard (just north of the Flint WTP property) and then turn south to connect to the 60-inch water main supplying GLWA water to the WTP site. Some minor modifications may occur to this route during design.

The proposed water main would have a minimum hydraulic capacity of 13mgd to provide the average day demand requirements of the Flint system if there was a failure in the primary GLWA supply. However, a minimum flow must be established to maintain a proper water age in the main at a desired percentage blend of GLWA/GDCD water. The initial GLWA/GCDC blend will be restricted to no more than 5 percent GCDC water. Given the Flint system demands, this corresponds to a flow rate of approximately 0.5 mgd. Therefore, to maintain water quality in this projected 5.5 mile water main and provide the required hydraulic capacity, a 36-inch main has been selected. At the routine flow rate of 0.5 mgd, the water age in the 36-inch main will be approximately 3 days.

The estimated construction cost of this secondary supply water main is $7.3M. Design and permitting would be completed in 2018 and construction would be completed before the end of 2019.

Flow Control

Because of the hydraulics of the Flint, GLWA and GCDC systems and the desire to control the GLWA/GCDC blend of water supplied to Flint, flow control will be required for the primary and secondary supplies to Flint. The flow from GLWA will be metered and controlled at GLWA's Baxter and Potter control/meter station. This station will provide adequate backpressure to serve GLWA's customers upstream of the meter while controlling the flow and minimizing the pressure in the 72-inch line supplying Flint. The GCDC flow to Flint will be monitored at a metering station near Francis/Lewis Road. A control valve at the Flint WTP will respond to the Francis/Lewis Road meter to control the flow (and blend) of GCDC water. A schematic of the piping and controls is attached.

Chemical Building

A new chemical building is proposed to treat the combined future GLWA/GCDC water source. The attached *Chemical Storage and Feed Improvements – Conceptual Design Memorandum* provides a detailed description of the proposed facility location, layout and equipment. The proposed facilities have been designed to accommodate the full range of orthophosphate doses and pHs that could be recommended from the on-going Flint corrosion control study.

The estimated construction cost of these chemical feed facilities will range from $2.3M to $3.4M depending on the number of chemical feed systems that will be required. The specific chemicals to be included in the final design will be established by the results of the CCT Study and the future quality of water provided by GLWA. Design, permitting and bid advertisement will be completed in 2018 and construction should be completed by the end of 2019.

As co-responders to the Order, Mr. Eric Oswald (Director – Drinking Water and Municipal Assistance Division, Michigan Department of Environmental Quality (MDEQ)) has reviewed this submittal on behalf of the State and concurs with the content of the document. The MDEQ and State will continue to support the City with its monitoring and compliance programs and funding approval process.

If you have clarifying questions and/or need additional information, please contact me at (810) 237-2035 or via email at kweaver@cityofflint.com.

Respectfully submitted,

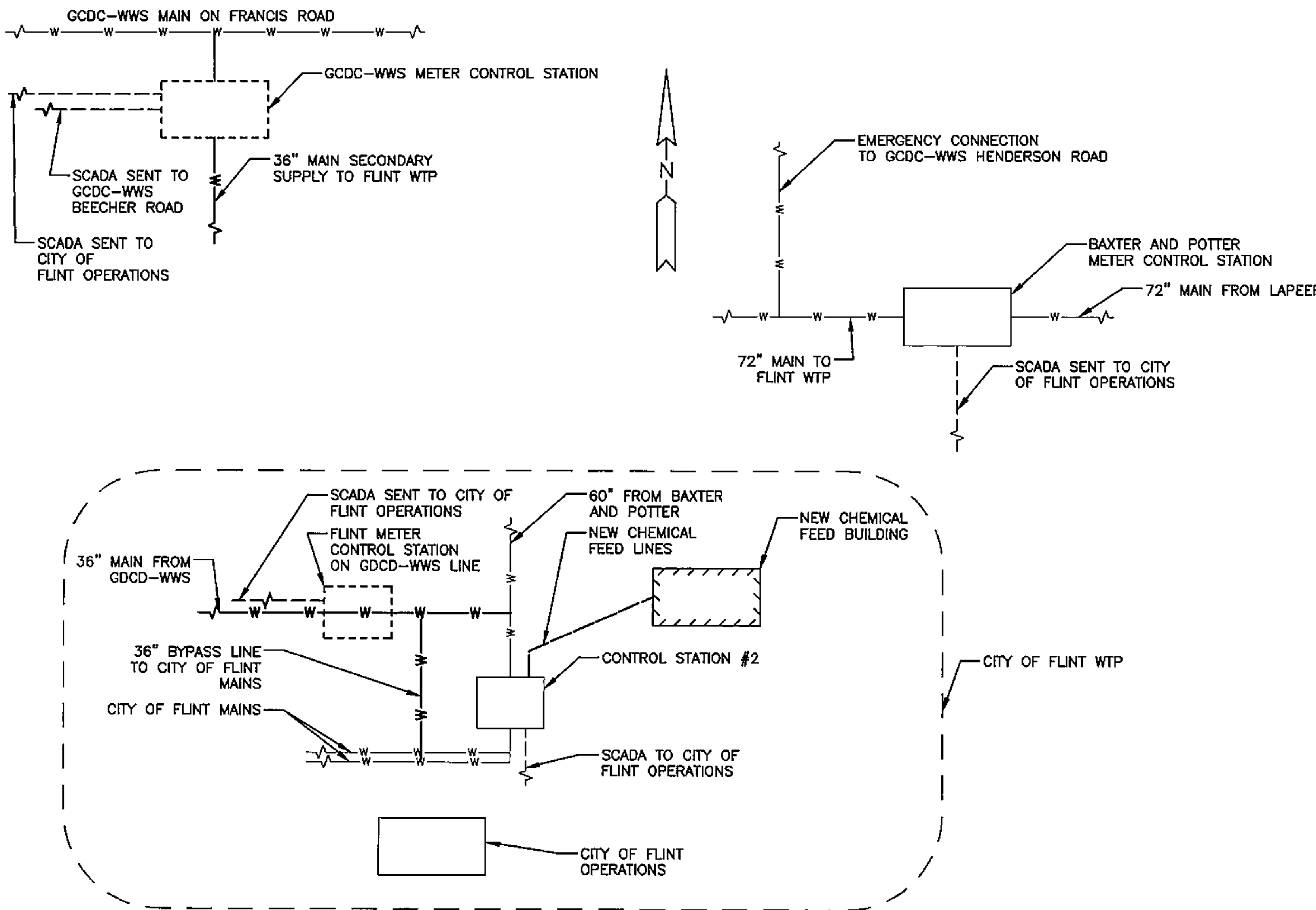
Karen W. Weaver

Dr. Karen W. Weaver
Mayor

cc: Mr. Rich Baird, Governor's Office
Mr. Keith Creagh, MDNR
Mr. Eric Oswald, MDEQ
Mr. Steve Branch, City of Flint

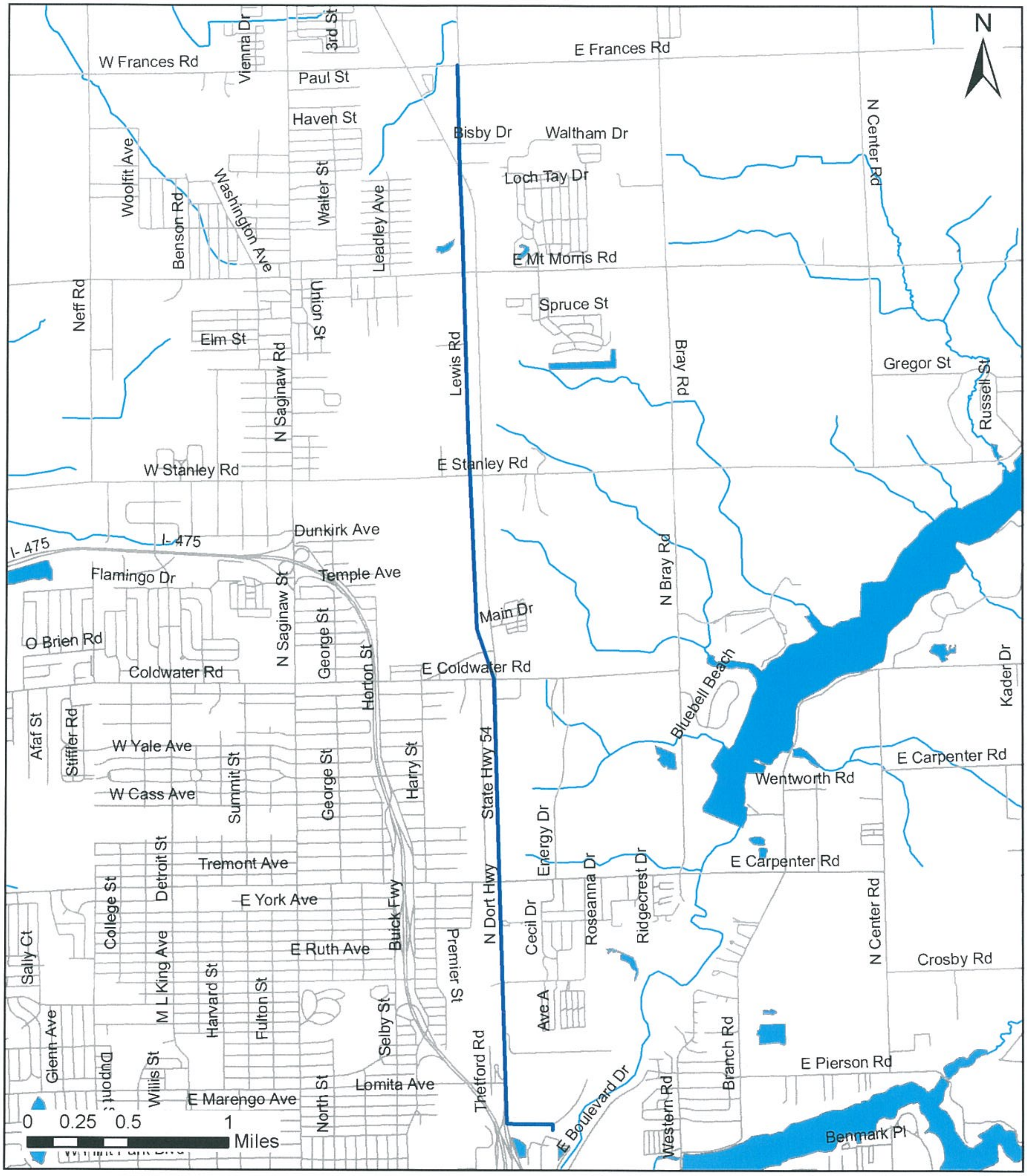
Attachments:
Secondary Supply Water Main Location Exhibit
Metering and Control Schematic
Chemical Storage and Feed Facilities – Design Concept Memorandum

PROJECT 3 SCHEMATIC



AECOM

CITY OF FLINT
WATER TREATMENT PLANT
CITY OF FLINT, MICHIGAN
Project No.: 60560664 Date: 02/21/18



Legend

Flint Secondary Water Source

AECOM
303 East Wacker, Suite 1400
Chicago, Illinois 60601
312-373-7700

City of Flint
Program Management Services

Project 3 - Flint Secondary Water Source
(Backup Water Supply)

DRAWN	CHECKED	DATE
APD	ELT	February 2018

FILENAME: SOURCE P:\60560664 - FLINT PROGRAM MANAGEMENT\900_CAD_GIS\920_GIS\921_MAPS\FLINT_WATER_SYSTEM PROJECT_3.MXD

PROJECT NUMBER 60560664

Memorandum

To: *John Young*

From: *CDM Smith*

Date: *February 16, 2018*

Subject: *Flint Water Treatment Plant*
Chemical Storage and Feed Improvements
Conceptual Design Memorandum

1.0 Project Description

CDM Smith understands that the City of Flint will continue to purchase treated water from the Great Lakes Water Authority (GLWA) in the future. Additionally, the City will purchase treated water from Genesee County Drain Commissioner (GCDC) to serve as a redundant source of supply. To supply the City's customers with the purchased water from GLWA and GCDC, the City will need to add additional chlorine to maintain distribution system residuals. The City may also be required in the future to add corrosion control chemicals and adjust the pH of the purchased water depending upon the results of the current corrosion control study being conducted by others.

The purpose of this project is to provide the City with a permanent bulk chemical storage and feed facility at the existing Flint Water Treatment Plant (WTP) with the capability to adjust to these various conditions.

2.0 Chemical Characteristics

The physical and chemical characteristics of sodium hypochlorite, sodium hydroxide and orthophosphate are provided in **Table 1.**

Table 1: Physical/Chemical Characteristics of the Proposed Chemicals

Characteristics	Sodium Hypochlorite	Orthophosphate	Sodium Hydroxide
Concentration, % by weight	12.5%	70%/30%[1]	25%
Specific Gravity @ 77°F	1.24	1.33 to 1.41	1.27
Viscosity @ 70°F, mPa/s	2.60	10.0	7.94
Freezing Point, °F	-17	Not Published	-13
pH	12.3 to 12.7	5.3 to 6.3	14
CAS Number	7681-52-9		1310-73-2

1. Based upon a 70% orthophosphate, 30% polyphosphate blend.

3.0 Hazard and Occupancy Classifications

Table 2 lists the treatment chemicals along with the associated hazard classification and occupancy classification for the Flint WTP.

Table 2: Chemical Classifications

Chemical Name	Hazard Classification	Occupancy Classification
Sodium Hypochlorite	Corrosive Toxic Oxidizer	H-4
Orthophosphate	Irritant	H-4
Sodium Hydroxide	Corrosive	H-4

4.0 Regulatory Requirements

The primary guidance document for design of chemical feed systems in Michigan is commonly referred to the "10 States Standards" (*Great Lakes Upper Mississippi River Board Recommended Standards for Water Works*). For the new chemical storage and feed facility, the following standards must be followed:

- Positive displacement type solution feed pumps shall be used to feed liquid chemicals.(10 States Standards, Paragraph 5.1.4.a)
- Calibration tubes or mass flow monitors which allow for direct physical measurement of actual feed rates shall be provided. (10 States Standards, Paragraph 5.1.4.c)
- A pressure relief valve should be provided on the pump discharge line. (10 States Standards, Paragraph 5.1.4.d)
- Liquid chemical feeders shall be such that chemical solutions cannot be siphoned or overfed into the water supply by (a) assuring discharge at a point of positive pressure, (b) providing vacuum relief, (c) providing a suitable air gap or anti-siphon device, or (d) providing other suitable means or combinations as necessary. (10 States Standards, Paragraph 5.1.5)
- At least 30 days of chemical supply shall be provided. (10 States Standards, Paragraph 5.1.9.a.1)
- A minimum storage volume of 1.5 truckloads shall be provided where purchase is by truck load lots. (10 States Standards, Paragraph 5.1.9.a.4)
- Liquid chemical storage tanks shall have a liquid level indicator and have an overflow receiving basin capable of receiving accidental spills or overflows without uncontrolled discharge that provides sufficient containment volume to prevent accidental discharge in the event of failure of the largest tank. (10 States Standards, Paragraph 5.1.9.d)
- Day tanks shall be provided where bulk storage of liquid chemical is provided. (10 States Standards, Paragraph 5.1.11.a)

- Day tanks should hold no more than a 30-hour supply. (10 States Standards,Paragraph 5.1.11.c)

Any portions of the design that do not meet the requirements listed and the other requirements included in the Michigan Rules and 10 States Standards will require a variance from MDEQ.

5.0 General Design Criteria

5.1 Truck Unloading Area

The bulk chemical storage areas will each have the following features for safely transferring chemicals from the delivery truck tanks to the plant's bulk chemical storage tanks.

- One cam-lock pipe connection will be provided for each bulk chemical storage tank for transferring chemical from truck tanks to bulk storage tanks. The cam-lock connections will protrude from the chemical room exterior wall at a point nearest to the associated storage tank.
- Removable spill containers will be provided to contain small spills and drips that may occur at the hose/cam-lock connection.
- Emergency shower / eyewash stations and hose stations will be installed in the delivery areas.
- Lighting and signage will be installed for the safe delivery of chemicals to the storage tanks.
- Individual Truck Unloading Panels for each chemical will be mounted on exterior walls near the cam-lock connections (see general control descriptions).
- Doorways into each of the separate chemical storage containment areas will provide for easy access and egress.

5.2 Tank Volume Considerations

The 10 States Standards requires a minimum bulk storage capacity of 30 days at average dose and average flow rate. This volume was compared to the required chemical volume for 7 days under peak conditions (i.e., ultimate buildout maximum-day daily flow and maximum dose), and the larger volume was used for tank sizing. In some cases, storage tank size may have been increased to support a full truck load of chemical to reduce the overall chemical cost. The 10 State Standards require that in those cases, the storage tank be at least 1.5 times the delivery volume.

Day tanks will be provided for all chemicals. The day tanks will have a capacity for no more than 30 hours of supply. The day tanks will not have automated filling controls but will have manual and automatic filling shutoff controls.

All chemical storage tanks will be vertical and cylindrical in shape constructed of carbon steel, high-density crosslinked polyethylene (XLPE), or fiberglass reinforced plastic (FRP), as is appropriate for individual chemicals.

5.3 Secondary Containment Considerations

Separate secondary containment areas will be provided for each of the chemicals in the new chemical building. The chemical containment will be designed to prevent mixing of incompatible chemicals. Concrete containment areas will be protected with a concrete coating system that is compatible with the stored chemical. No penetrations will be allowed in the containment walls between in compatible chemicals.

Railings, stairs, and grating within the containment areas will be constructed of materials that are compatible with the chemical(s) stored in that room.

Table 3 shows the containment volume for each chemical room. The containment volume is the volume of the largest tank within the containment area plus fire sprinkler water (20-minute duration at 0.2 gpm/ sq. ft., equivalent to approximately 6-inches of water.)

Table 3: Secondary Containment Volume

Chemical Area	Largest Storage Tank (gal)	Fire Sprinker Volume (gal)	Total Volume (gal)	Maximum Liquid Height During Spill (in)
Sodium Hypochlorite	3,000	2,000	5,000	22
Orthophosphate	2,100	1,600	3,700	18
Sodium Hydroxide	6,000	3,200	9,200	24

To provide sufficient freeboard and additional protection against spills, a containment wall height of 30 inches is recommended.

5.4 Chemical Metering Pump Considerations

The chemical metering pumps will be installed on concrete pedestals to elevate the pumps in the containment area. This will provide better access for O&M staff and prevent damage from possible tank spills.

A metering pump will be provided for each primary application point. A standby metering pump will be used to backup primary metering pump(s). A minimum of two metering pumps will be installed.

Hydraulic diaphragm or peristaltic metering pumps will be used to transfer chemicals to application points. The metering pumps and all associated appurtenances will be skid mounted to facilitate convenient maintenance and access. See the General Description of Controls for further information on the metering pumps.

5.5 Chemical Piping Considerations

All chemical piping outside of containment areas will be secondarily contained. Secondary containment of the piping will be achieved by commercially available secondary containment piping systems. All piping will be either PVC or carbon steel depending upon the chemical utilized. Threaded joints will be minimized to minimize the potential for leaks.

5.6 Emergency Eyewash and Shower Stations

Emergency eyewash and shower stations shall be provided in both the containment area of each chemical storage room and at truck unloading areas. The station location will be within 10 to 50 feet from the potential exposure point and within a 10 second maximum walking travel time along normal egress routes with no doors or obstacles. Tepid water will be used with flow switches on the feed pipes to alarm if the station is triggered. For outdoor locations, a freeze proof shower and eyewash will be utilized.

5.7 System Reliability and Safety

Sodium hypochlorite, orthophosphate, and sodium hydroxide are critical for disinfection, corrosion protection, and to control the pH of the finished water leaving the plant. Therefore, it is recommended to maintain uninterrupted chemical addition when the Flint WTP is in operation. To increase reliability, the following items will be included in the system:

- Redundant chemical feed pumps and piping.
- Dual injection ports at the application point.
- Containment around chemical storage tanks.
- Bulk storage in a central facility with two tank systems for the sodium hypochlorite, one in service and one to be filled. Orthophosphate and sodium hydroxide will each have one tank.
- Chemical injection near bulk storage tanks resulting in short piping runs.
- Coat concrete containment areas with suitable chemical resistant lining material.
- Use materials compatible with chemicals.

6.0 Feed Requirements and Locations

Sodium hypochlorite, orthophosphate, and sodium hydroxide will be metered using hydraulically actuated diaphragm or peristaltic metering pumps. A day tank will be provided with a maximum of 30 hours of storage and a weigh scale to monitor chemical usage in SCADA. Two metering pumps will be provided (one duty and one standby) for redundancy. The specifics of each feed system are described below.

6.1 Sodium Hypochlorite

Sodium hypochlorite will be added to the purchased water to boost the chlorine residual in the distribution system. The anticipated sodium hypochlorite doses were provided by the Flint WTP. The anticipated sodium hypochlorite doses and the resulting feed rates used for design are shown in **Table 4**.

Table 4: Sodium Hypochlorite Feed Requirements

Filtered Water	Feed Requirements		
	Minimum	**Average**	**Maximum**
Dose, mg/L	0.5	1.0	1.5
Flow, mgd	5	11	15
Feed Rate, gph sodium hypochlorite solution	0.8	3.7	7.5
Metering Pumps			
Number	2 (1 duty, 1 standby)		
Nominal Capacity Range per Pump, gph	0.8 – 8.3		
Type	Peristaltic or Hydraulically Actuated Diaphragm		
Materials	Thermoplastic Elastomer		
Drive	VFD		
Power, hp	Fractional		
Feeder Turndown Capability at Average Feed Rate	2.2:1		
Feeder Turndown Capability at Minimum Feed Rate	10:1		
Metering Accessories Materials			
Calibration Columns	PVC		
Relief Valves	PVC body; PVC diaphragm; PVC top		
Relief Line Flow Indicators	Teflon body; Pyrex inner cylinder; Buna-N seals		
Backpressure Valves	PVC body; PVC diaphragm; PVC top		
Pulsation Dampeners	PVC body; EPDM diaphragm		
Injection Quill	PVC		

Piping for sodium hypochlorite applications may include schedule 80 PVC or CPVC piping. Fittings should be solvent welded for CPVC and PVC, with flanges as needed for assembly. For this application, PVC with welded joints is recommended.

Valves for sodium hypochlorite may be CPVC or PVC diaphragms with either flange or true-union design. For this application, PVC valves with solvent welded connections are recommended with diaphragm valves used for isolation.

6.2 Orthophosphate

Orthophosphate will be added to the purchased water to prevent corrosion in the distribution system. The anticipated orthophosphate doses were provided by the Flint WTP. The anticipated orthophosphate doses and the resulting feed rates used for design are shown in **Table 5**. These doses and feed rates should be confirmed with the pipe loop corrosion studies (by others) prior to finalizing the design criteria.

Table 5: Orthophosphate Feed Requirements

Filtered Water	Feed Requirements		
	Minimum	Average	Maximum
Dose, mg/L	1.0	3.5	4.0
Flow, mgd	5	11	15
Feed Rate, gph orthophosphate solution	0.2	1.4	2.1
Metering Pumps			
Number	2 (1 duty, 1 standby)		
Nominal Capacity Range per Pump, gph	0.2-2.4		
Type	Peristaltic or Hydraulically Actuated Diaphragm		
Materials	Thermoplastic Elastomer		
Drive	VFD		
Power, hp	Fractional		
Feeder Turndown Capability at Average Feed Rate	8.5:1		
Feeder Turndown Capability at Minimum Feed Rate	14:1		
Metering Accessories Materials			
Calibration Columns	PVC		
Relief Valves	PVC body; PVC diaphragm; PVC top		
Relief Line Flow Indicators	Teflon body; Pyrex inner cylinder; Buna-N seals		
Backpressure Valves	PVC body; PVC diaphragm; PVC top		
Pulsation Dampeners	PVC body; EPDM diaphragm		
Injection Quill	PVC		

Piping for orthophosphate applications may include schedule 80 PVC or CPVC piping. Fittings should be solvent welded for CPVC and PVC, with flanges as needed for assembly. For this application, PVC with welded joints is recommended.

Valves for orthophosphate may be CPVC or PVC diaphragms with either flange or true-union design. For this application, PVC valves with solvent welded connections are recommended with ball valves used for isolation.

6.3 Sodium Hydroxide

Sodium hydroxide will be added to the filtered water to increase the pH prior to disinfection and distribution. The anticipated sodium hydroxide doses were developed by CDM Smith using data from the titration study by Dr. Pressman, EPA, to raise the pH by 0.2 units on average (0.1 units as a minimum and 0.3 units as a maximum). The anticipated sodium hydroxide doses and the resulting feed rates used for design are shown in **Table 6.**

Piping for sodium hydroxide applications may be CPVC, PVC (for ambient temperature), carbon steel or 304 and 316 stainless steel. Fittings should be solvent welded for CPVC and PVC, or welded for metals, with flanges as needed for assembly. Threaded joints should be avoided along with aluminum, copper, zinc, brass and bronze alloys, which are all rapidly corroded by sodium hydroxide. For this application, carbon steel pipe with welded joints is recommended. Additionally, heat tracing of all pipes is recommended between the metering pumps and the application point to prevent crystallization of the chemical in the piping when located outside a temperature controlled area.

Valves for sodium hydroxide application may be CPVC, PVC (for ambient temperature), or iron body with stainless steel ball, or diaphragm with either flange or true-union design. Diaphragm valves are less susceptible than ball valves to failure caused by crystallization. For this application, iron body valves with flanged connections are recommended with diaphragm valves used for isolation.

Table 6: Sodium Hydroxide Feed Requirements

Filtered Water	Feed Requirements		
	Minimum	Average	Maximum
Dose, mg/L	1.84	3.52	5.04
Flow, mgd	5	11	15
Feed Rate, gph orthophosphate acid solution	1.2	5.1	9.9
Metering Pumps			
Number	2 (1 duty, 1 standby)		
Nominal Capacity Range per Pump, gph	1.2 – 10.9		
Type	Peristaltic or Hydraulically Actuated Diaphragm		
Materials	Thermoplastic Elastomer		
Drive	VFD		
Power, hp	Fractional		
Feeder Turndown Capability at Average Feed Rate	1.8:1		
Feeder Turndown Capability at Minimum Feed Rate	9:1		
Metering Accessories Materials			
Calibration Columns	Clear lucite		
Relief Valves	316 stainless steel body; PTFE diaphragm; stainless steel top		
Relief Line Flow Indicators	Teflon body; Pyrex inner cylinder; Buna-N seals		
Backpressure Valves	316 stainless steel body; PTFE diaphragm; stainless steel top		
Pulsation Dampeners	316 stainless steel body; EPDM diaphragm		
Injection Quill	316 stainless steel		

6.4 Application Point

The application points for sodium hypochlorite, orthophosphate, and sodium hydroxide will be within the Existing Control Station west of the proposed chemical storage building. Obtaining proper mixing is critical to the control of the metering pumps (described further below) to obtain the desired disinfection, corrosion protection, and pH. Chemicals will be injected using a retractable injection quill by Saf-T-Flo or equal.

7.0 Bulk and Day Storage Facilities

7.1 Sodium Hypochlorite

Approximately 2,600 gallons of capacity is required to achieve 30 days of sodium hypochlorite storage, which is equivalent to approximately half of a bulk delivery per month. Two 3,000-gallon tanks will be installed for redundancy. This provides approximately 34 days of storage in each tank at average daily flow and average dosage. Approximately 90 gallons of capacity are required for the day tank. One, 110-gallon tank will be installed, providing 30 hours of storage in the tank at average daily flow and average dosage. The sodium hypochlorite storage facility is summarized in **Table 7.**

The recommended bulk storage tanks are 8 feet in diameter and 10 feet tall. The recommended day tank is 2.5 feet in diameter and 4 feet tall, with additional freeboard above the required liquid storage level. The tanks are recommended to be flat bottom, cylindrical tanks. For this application, fiberglass reinforced plastic (FRP) tanks are recommended.

Table 7: Sodium Hypochlorite Storage Requirements

Description	Requirements
Bulk Tank	
Type	Vertical, FRP
No. of Tanks	2
Capacity per Tank, gallons:	3,000
Storage Capacity, Ave. Flow/Ave. Dose, days (each tank)	34
Diameter, ft	8
Height, ft	10
Accessories	Level Indication
Day Tank	
Type	Vertical, FRP
No. of Tanks	1
Capacity per Tank, gallons:	110
Storage Capacity, Ave. Flow/Ave. Dose, hours	30
Diameter, ft	2.5
Height, ft	4

7.2 Orthophosphate

Approximately 1,000 gallons of capacity are required to achieve 30 days of orthophosphate storage, which is equivalent to approximately one-quarter of a bulk delivery per month. One 2,100-gallon tank will be installed. This provides approximately 65 days of storage in the tank at average daily flow and average dosage. Approximately 35 gallons of capacity are required for the day tank. One 40-gallon tank will be installed, providing 29 hours of storage in the tank at average daily flow and average dosage. The orthophosphate storage facility is summarized in **Table 8.**

The recommended bulk storage tank is 6 feet in diameter and 12 feet tall. The recommended day tank is 1.5 feet in diameter and 4 feet tall. The tanks are recommended to be flat bottom, cylindrical tanks. For this application, a crosslinked high-density polyethylene (XLHDPE) tank is recommended.

Table 8: Orthophosphate Storage Requirements

Description	Requirements
Bulk Tank	Orthophosphate Bulk Storage Tank
Type	Vertical, Crosslinked high-density polyethylene (XLHDPE)
No. of Tanks	1
Capacity, gallons:	2,100
Storage Capacity, Ave. Flow/Ave. Dose, days	65
Diameter, ft	6
Height, ft	12
Accessories	Level Indication
Day Tank	
Type	Vertical, Crosslinked high-density polyethylene (XLHDPE)
No. of Tanks	1
Capacity per Tank, gallons:	40
Storage Capacity, Ave. Flow/Ave. Dose, hours	29
Diameter, ft	1.5
Height, ft	4

7.3 Sodium Hydroxide

Approximately 3,600 gallons of capacity is required to achieve 30 days of storage, which is equivalent to approximately one bulk delivery per month. One 6,000-gallon tank will be installed to allow for a full truckload delivery. This provides approximately 55 days of storage at average daily flow and average dosage. Approximately 120 gallons of capacity are required for the day tank. One, 200-gallon tank will be installed, providing 15 hours of storage in the tank at average daily flow and average dosage. The sodium hydroxide storage facility is summarized in **Table 9.**

The recommended bulk storage tanks are 9 feet in diameter and 15 feet tall. The tank is recommended to be flat bottom, cylindrical tanks. For this application, rubber lined carbon steel tanks are recommended.

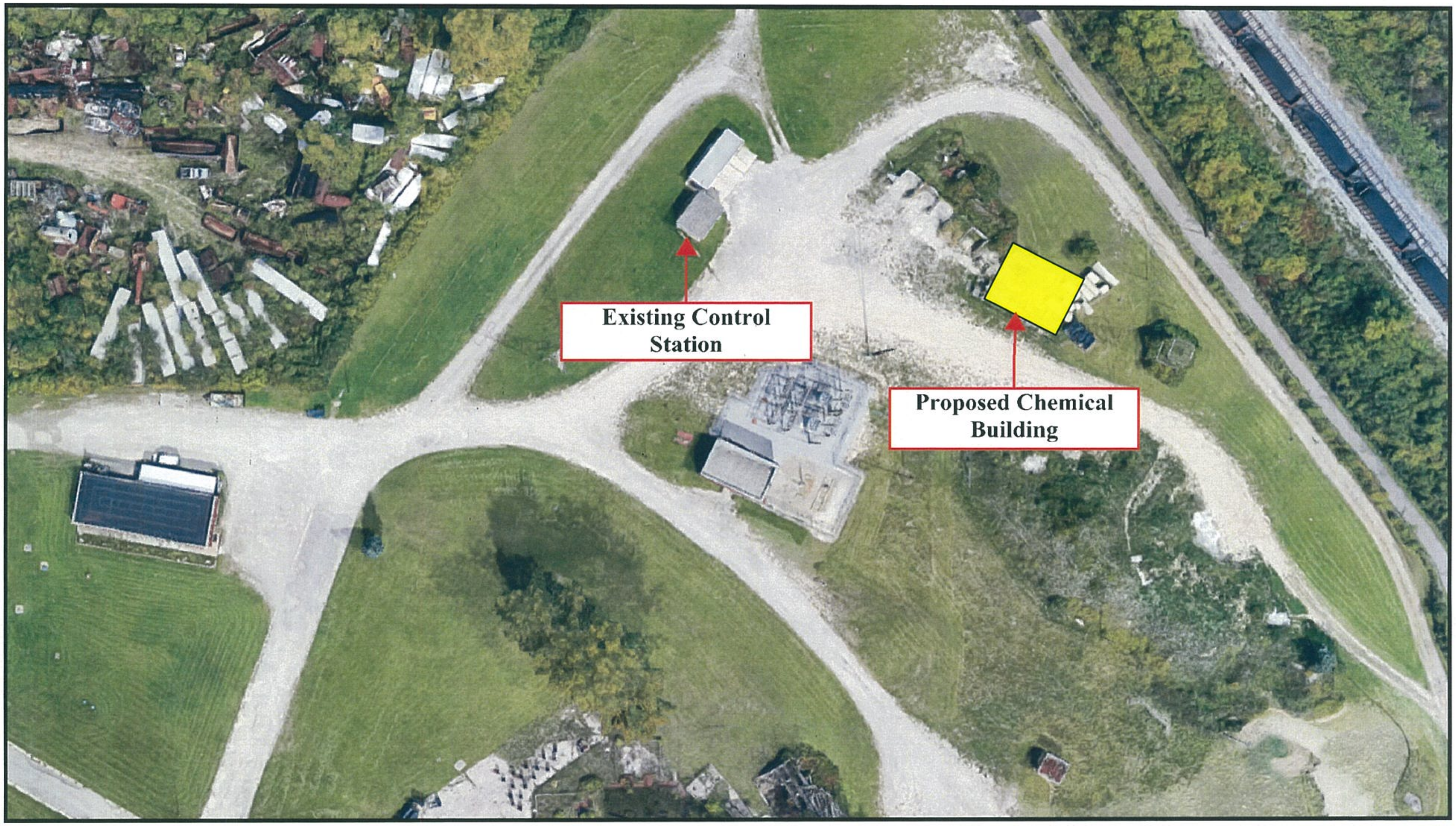
Table 9: Sodium Hydroxide Bulk Storage Requirements

Description	Requirements
Bulk Tank	Sodium Hydroxide Bulk Storage Tank
Type	Vertical, Rubber Lined Carbon Steel
No. of Tanks	1
Capacity, gallons:	6,000
Storage Capacity, Ave. Flow/Ave. Dose, days	55
Diameter, ft	9
Height, ft	15
Accessories	Level Indication
Day Tank	
Type	Vertical, Rubber Lined Carbon Steel
No. of Tanks	1
Capacity per Tank, gallons:	120
Storage Capacity, Ave. Flow/Ave. Dose, hours	13
Diameter, ft	3
Height, ft	5

8.0 Preliminary System Location and Layout

The new chemical building is proposed to be located in the northeastern portion of the Flint WTP as shown in **Figure 1.** This location was chosen as it is the closest available land adjacent to the existing control structure. Purchased water from GLWA and GCDC will converge in this location, allowing a single application point for each chemical.

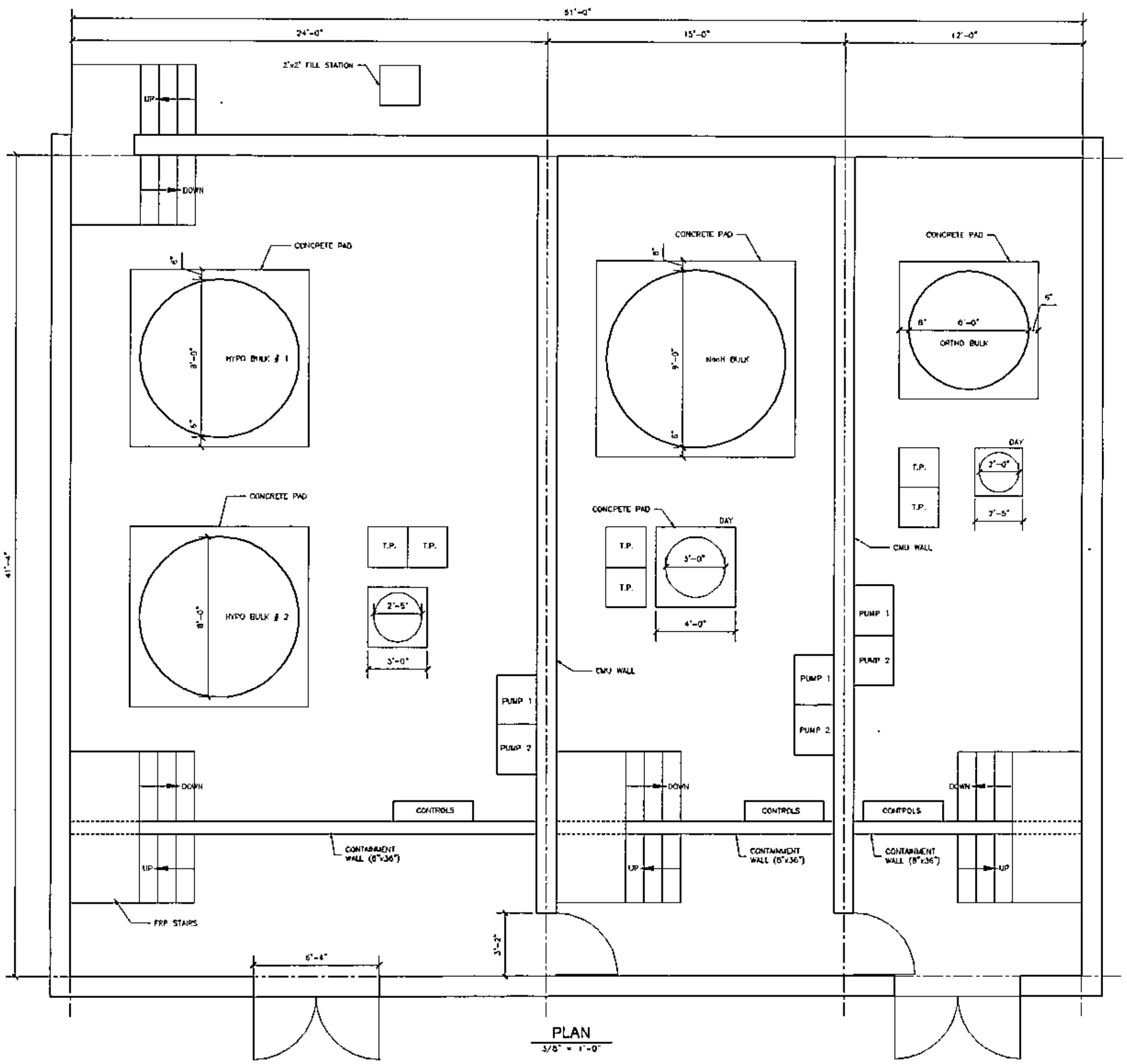
A preliminary process-mechanical drawing showing the proposed chemical storage and feed room configuration is included in **Figure 2.** The layout proposed includes space for sodium hypochlorite, orthophosphate and sodium hydroxide. If orthophosphate and sodium hydroxide addition are determined to not be necessary, the proposed chemical room is laid out such that only the sodium hypochlorite storage area could be constructed.



CDM Smith N

Flint Water Treatment Plant
Potential Chemical Storage Location

FIGURE 1



PLAN

3/8" = 1'-0"

REV NO	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: A.E.P.
DRAWN BY: S.H.
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY: R.S.J.
DATE: 02.15.2018

CDM Smith

FLINT WATER TREATMENT PLANT

CHEMICAL STORAGE & FEED IMPROVEMENTS

CHEMICAL ROOM - PLAN

PROJECT NO. X
FILE NAME: 1.DWG
SHEET NO.

FIGURE 2

10% FLINT REV 1

9.0 Process Control Description

The process control description for the individual components of the proposed chemical storage and feed systems is described below.

9.1 Chemical Unloading

Twelve and one-half (12.5%) percent sodium hypochlorite will be delivered in liquid form in approximately 4,000-gallon tanker truckloads and will be unloaded into two FRP storage tanks, each with a capacity of 3,000 gallons.

Seventy-five (75%) orthophosphate will be delivered in liquid form in partial tanker truckloads and will be unloaded into one crosslinked high-density polyethylene (XLHDPE) storage tank with a capacity of 2,100 gallons.

Twenty-five (25%) percent sodium hydroxide will be delivered in liquid form in approximately 4,000-gallon tanker truckloads and will be unloaded into a single rubber-lined steel storage tanks with a capacity of 6,000 gallons.

The tank fill station will consist of a quick connection, and a manifold of two tank fill lines for the sodium hypochlorite system and a single line for the other chemicals. Each tank fill line for the sodium hypochlorite system will have an open/close motor operated tank fill valve.

Control of tank fill valves can be performed from the local fill station control panel (manually) or from the SCADA system. SCADA control will allow the operator to select the tank to be filled from the operator screens. The SCADA system will automatically open the appropriate valve provided that the selected tank has adequate capacity for additional chemical to be added. Once all permissives are satisfied, a fill ready light will be energized at the fill station control panel indicating that it is safe to begin filling. The chemical supplier will then begin transfer of the chemical to the storage tank. The amount of chemical transferred will be calculated based upon the starting and ending levels in the storage tank.

If the tank reaches a high-high level, an audible alarm at the fill station control panel will alert the operator to cease the tank filling process.

9.2 Bulk Storage Tanks

Liquid level in the bulk storage tanks will be monitored via an ultrasonic level sensor, which will send a signal to the SCADA system indicating the tank level. Each tank will have a high-high level alarm, low-level alarm, and a low-low level alarm. Tank levels and high-high level alarms will be displayed on a local control panel.

Each tank will have one discharge line for the metering pump suction header. A spring return open/close motorized valve will be located on each of these discharge lines. The valve will automatically close on loss of power to the valve or loss of signal to the valve. Control of the valves will be local manual and remote manual or automatic. The motorized outlet valves will provide emergency shutoff of flow from the storage tank. Control of the valves will be local manual and remote manual or automatic.

For the sodium hypochlorite feed system, only one of the two tanks will be in service at one time to allow accounting of chemical usage and to facilitate control of the feed system. Placing a tank in service or out of service can be performed locally (from the bulk storage tank control panel) or from the SCADA system. SCADA control will allow the operator to select the desired sodium hypochlorite tank for service from the operator screens. Low level in the selected tank will cause the system to switch to the next sequential available tank by opening its discharge valve and then closing the discharge valve of the previous tank. If there are no tanks with adequate level available, an alarm will alert the operator and the tank in service will continue to be used until low-low level is reached or the operator takes corrective action.

9.3 Transfer Pumps

Chemical will be transferred from the bulk tanks to the day tanks via transfer pumps. Transfer pump operation will be manually initiated. The pumps will operate until the high level setpoint is reached.

9.4 Day Tanks

Day tanks will be installed for each chemical system to provide the required air break between the bulk storage and the application point. Additionally, chemical usage can be more accurately monitored through the use of a day tank. The day tanks are designed for a maximum storage duration of 30 hours. Each day tank will be equipped with a weigh scale, which will monitor chemical usage by change in weight and send a SCADA signal indicating the tank level. Each tank will have a high-high level alarm, a low-level alarm, and a low-low level alarm. Tank levels and high-high level alarms will be located at the control panel.

The storage tank control panel will display the weight and volume of chemical remaining within the tank. If the high-high level alarm is triggered, an audible alarm will be sounded to alert the operator to cease operation of the transfer pumps.

9.5 Metering Pump Control

Metering pumps will be installed in each chemical room to convey the chemicals to the application point. There will be one duty metering pump and one standby metering pump. Each pump will have a capacity large enough to cover the required flow range. Each pump will have a single motor with variable motor speed control. Each pump will have a manual stroke adjustment. Pump motor speed will be transmitted to the SCADA system, along with the pump status.

The pump speed will be paced by a speed control signal from the SCADA system based on the chemical dosage setpoint and the metered purchased water flow. The pump speed may also be controlled manually from the SCADA system or the local control panel. Primary metering pump control output shall be flow paced based on the measured flowrate, the chemical dose, chemical solution concentration (percent in decimal format, 0- 1.0), chemical specific gravity (0-2.0), maximum pump capacity (gph), current pump stroke, maximum pump stroke, pump calibration factor (percent in decimal format, 0-1.0).

Secondary control output shall be used to trim the dose at an operator adjustable percentage based on chlorine residual, pH or phosphate setpoints. Trimming of the dose shall be based on measured water quality from the instruments located with the control building and control input locations within the HMI for operator input of the chlorine, pH or phosphate setpoint and a contribution limit (0-100%).

The metering pumps run failure alarm will be based on motor failure. Metering pumps will also have a leak alarm for diaphragm/hose failure. In the event of a failed pump, the standby pump will be started up automatically. Pumps will have a motor high temperature switch and pressure indication. If the pump discharge pressure exceeds the pressure relief valve set point, the pressure relief valve on the discharge line will open and direct flow back to the bulk storage tank. If the pressure exceeds the pressure switch set point, the pump will shut down. In the event the bulk storage tank reaches the low-low level, then all pumps that are in remote manual mode or remote automatic mode and are pumping from the tank that has the low-low level alarm condition will be shut down to prevent the pumps from operating dry. In local mode, the pumps will not be shut down automatically. A low-low level alarm light will be provided at the associated metering pump control panel.

9.6 Metering Pump Accessories

Adjustable backpressure valves in the pump discharge lines ensure constant feed rates by inducing pressure against the pumps. The valve will maintain a constant upstream pressure higher than the downstream injection pressure. When the pressure on the upstream side of the valve reduces below the set pressure, the valve will close, eliminating siphoning into the process line and/or back mixing in the injection line. A pulsation dampener will be connected to the piping near the pump discharge to control the pulsation resulting from the pump stroking action. The pulsation dampener consists of two separate chambers separated by an elastomeric diaphragm. The lower section will be wetted by the process fluid, while the upper section will be isolated from the fluid and filled with compressed air.

9.7 Containment Area

The storage tanks will be located in a liquid tight containment area. The containment area floor will be coated to provide chemical resistant, liquid-tight containment. The containment area will have a high-level alarm that will be transmitted to the HMI to alert the operator that the containment area contains a measurable amount of liquid. A portable sump pump can be placed into the containment area to pump the sump contents to either a portable container (chemical spill) for offsite disposal or to the plant drain system for disposal.

10.0 Cost Estimating

This section provides information on the factors that influence cost estimates for the proposed Bulk Chemical Storage and Feed Facility at the Flint WTP.

10.1 Estimating Costs

Several types of cost estimations can be made and updated at different stages of a project. The type of cost estimate made depends on the state of development of the project, the definition of scope, and the level of design detail. The three main categories of cost estimates as defined by the American Association of Cost Engineers are:

- **Order-of-Magnitude Estimate:** An approximate estimate, this type of cost estimate is made without detailed engineering data. Examples include cost capacity curves, scale-up or scale-down factors, and approximate ratios. Order of magnitude estimates are usually provided with accuracy within 50% above or 30% below the actual construction cost.
- **Budget Estimate:** This type of estimate is used to help establish the facility owner's project budget and is prepared from flow diagrams, layout drawings, and equipment details. Accuracy is expected within 30% above or 15% below the actual construction cost.
- **Definitive Estimate:** This estimate is prepared from engineering data. Plot plans and elevations, piping and instrument diagrams, structural sketches, soil data, sketches of major foundations and buildings, one-line electrical diagrams, equipment data sheets and quotations, and a complete set of specifications are the minimum requirements for a definitive estimate. "Approved for Construction" drawings and specifications give a maximum definitive estimate. Accuracy is expected within 15% above or 5% below the actual construction cost.

The estimates provided in this report should be considered budgetary estimates based upon the criteria set forth by the American Association of Cost Engineers. Subsequent estimates prepared from the 60% and 90% complete documents will be considered definitive estimates.

10.2 Cost Escalation

When preparing cost estimates, the same basis of comparison should be used to evaluate all the alternatives and to project future costs. Methods commonly used for projecting costs are: (1) escalation based on an assumed rate of inflation; or, (2) a published cost index. The Engineering News-Record Construction Cost Index (ENRCCI), published in the magazine ENR (a McGraw-Hill publication), is one of the commonly used indexes in the water engineering field. For this project, the ENRCCI for December 2017 of 10,873 was used.

For purpose of comparison, data in engineering reports and in the literature can be adjusted to a common basis by using the following relationship:

$$CurrentCost = \frac{CurrentValueOfIndex}{ValueOfIndexAtTimeOfEstimate} * EstimatedCost$$

It should be noted that updating or projecting costs for periods of more than 3 to 5 years can result in inaccuracies, especially if the index has increased or decreased significantly.

For the cost estimation of the proposed improvements, the cost escalation (4% per year) has been included to the project mid-point, which is estimated to be in February 2019.

10.3 Contingency

Contingency, added to the construction cost estimate, attempts to account for construction costs not identified or that may be required due to incomplete information. The more detailed the design, the less the contingency will be required. The AWWA textbook recommends a contingency between 25% and 35% for an order-of-magnitude estimate, between 15% and 25% for a budgetary estimate, and between 5% and 15% for a definitive (or final design) estimate.

For this budgetary estimate, a contingency of 25% was used.

10.4 Opinion of Probable Construction Cost

The detailed opinion of probable construction cost for this project is $3,400,000 if all three chemical systems are constructed. If only the sodium hypochlorite system is constructed, the opinion of probable construction cost is $2,300,000. A detailed breakdown of the cost estimate is included in **Table 10**.

Table 10: Opinion of Probable Construction Cost

Description	Three Chemical Systems		Hypochlorite System Only	
	Quantity	Amount	Quantity	Amount
Sitework	1 LS	$ 150,000	1 LS	$ 150,000
Earthwork	650 CY	$ 15,000	420 CY	$ 10,000
Concrete Slab	79 CY	$ 46,000	40 CY	$ 23,000
Concrete Containment Wall	5 CY	$ 5,000	3 CY	$ 3,000
Concrete Foundation Wall	42 CY	$ 33,400	21 CY	$ 17,000
Concrete Foundation Footing	94 CY	$ 53,000	94 CY	$ 53,000
Concrete Equipment Pads	8 CY	$ 6,000	5 CY	$ 4,000
Concrete Stairs	2.5 CY	$ 2,500	2.5 CY	$ 2,500
Hollow Core Roof Planks	2140 SF	$ 34,000	1000 SF	$ 17,000
Masonry Walls - Exterior	3640 SF	$ 187,000	2590 SF	$ 133,000
Masonry Walls - Interior	1906 SF	$ 61,000	-	-
Miscellaneous Metals	1 LS	$ 30,000	1 LS	$ 20,000
Membrane Roof	2140 SF	$ 38,500	1000 SF	$ 16,000
Doors	7 EA	$ 28,000	3 EA	$ 12,000
Painting	1 LS	$ 40,000	1 LS	$ 25,000
Hypochlorite Feed Pumps	2 EA	$ 21,200	2 EA	$ 21,200
Orthophosphate Feed Pumps	2 EA	$ 20,600	-	-
Hydroxide Feed Pumps	2 EA	$ 21,200	-	-
Transfer Pumps	6 EA	$ 21,000	2 EA	$ 7,000
Orthophosphate Bulk Tank	1 EA	$ 10,000	-	-
Orthophosphate Day Tank	1 EA	$ 4,000	-	-
Hypochlorite Bulk Tank	2 EA	$ 121,000	2 EA	$ 121,000
Hypochlorite Day Tank	1 EA	$ 9,000	1 EA	$ 9,000
Hydroxide Bulk Tank	1 EA	$ 25,000	-	-
Hydroxide Day Tank	1 EA	$ 10,000	-	-
Instrumentation Allowance	1 LS	$ 150,000	1 LS	$ 110,000
Process Piping/Valve Allowance	1 LS	$ 150,000	1 LS	$ 100,000
Yard Piping Allowance	1 LS	$ 100,000	1 LS	$ 80,000
Plumbing Allowance	1 LS	$ 35,000	1 LS	$ 25,000
HVAC Allowance	1 LS	$ 100,000	1 LS	$ 75,000
Electrical Allowance	1 LS	$ 250,000	1 LS	$ 180,000

Description	Three Chemical Systems			Hypochlorite System Only		
	Quantity	Amount		Quantity	Amount	
SUBTOTAL		**$**	**1,777,400**		**$**	**1,213,700**
GC General Conditions	10%	$	177,740	10%	$	121,370
SUBTOTAL		$	1,960,000		$	1,340,000
Permits and Insurance	3.5%	$	68,600	3.5%	$	46,900
SUBTOTAL		$	2,030,000		$	1,390,000
Contractor OH&P	10%	$	203,000	10%	$	139,000
SUBTOTAL		$	2,233,000		$	1,529,000
Construction Contingency	25%	$	558,250	25%	$	382,250
SUBTOTAL		$	2,790,000		$	1,910,000
Escalation to Mid-Point	4%	$	111,600	4%	$	76,400
Total Construction		$	2,900,000		$	2,000,000
Engineering and Legal	15%	$	435,000	15%	$	300,000
PROJECT TOTAL		**$**	**3,400,000**		**$**	**2,300,000**