AECOM

HOUSATONIC WATER WORKS COMPANY

WATER SYSTEM EVALUATION

Submitted to:
Town of Great Barrington, MA

June 29, 2021

Prepared by:
AECOM

Table of Contents

List of Tables

List of Figures

List of Appendices

1 Introduction

The Housatonic Water Works Company (HWWC) serves residents in the towns of Great Barrington (Village of Housatonic), Stockbridge, and West Stockbridge. The water system provides water to 824 services and serves a population of approximately 1,400 residents. The supply and distribution system are comprised of one surface water source, one drinking water treatment plant (WTP), and one finished storage tank. The water distribution system consists of 16 miles of piping which range in size from 2 inch to 14 inch.

1.1 Purpose and Scope

The Town of Great Barrington contracted with AECOM to prepare a comprehensive evaluation of the HWWC water system which includes the water supply, water treatment plant, and water distribution system and storage tank. In addition, AECOM has prepared a 20-year water system Capital Improvement Plan based on the findings of the evaluation.

The scope of work for this evaluation focuses on conducting physical and hydraulic evaluations of the existing water treatment plant and distribution system, as well as addressing impacts resulting from potential future regulatory compliance issues based on current operations. Specifically, the following tasks were performed:

1. Data Review. Review available data on the water system provided by HWWC, including plans of the existing water system, existing water quality data, studies, and reports.
2. Water Supply Review. Review existing data, studies and reports.
3. Water Demand Review. Review existing data, studies, reports, and ongoing projects pertaining to water demand. Prepare water demand projections for HWWC's water system to the year 2040 and compare to available water supply.
4. Water Treatment Plant Evaluation. Evaluate the treatment performance of HWWC's water treatment plant and identify upgrades or modifications required to address deficiencies and to comply with current and anticipated future regulations.
5. Water Distribution System Evaluation. Evaluate HWWC's water distribution system and storage tank.
6. Capital Improvement Plan. Prepare a 20 year Capital Improvement Plan for the HWWC's water system based on findings of the evaluation.
7. Report. Prepare a report summarizing the findings of the evaluation and 20 year Capital Improvement Plan.

The development of the capital improvements recommended in this report are based on the initial site visit, assessments of current conditions at HWWC's facilities, discussions with HWWC personnel, inquiries to equipment vendors, and general engineering practice. The capital improvements have been assigned a planning level cost estimate. As a result, a capital improvements plan has been developed to prioritize these improvements by their relative importance to delivering a reliable potable water supply that meets regulatory requirements for HWWC's residents.

Note that all elevations presented in evaluation are in NAVD 88 datum unless otherwise noted.

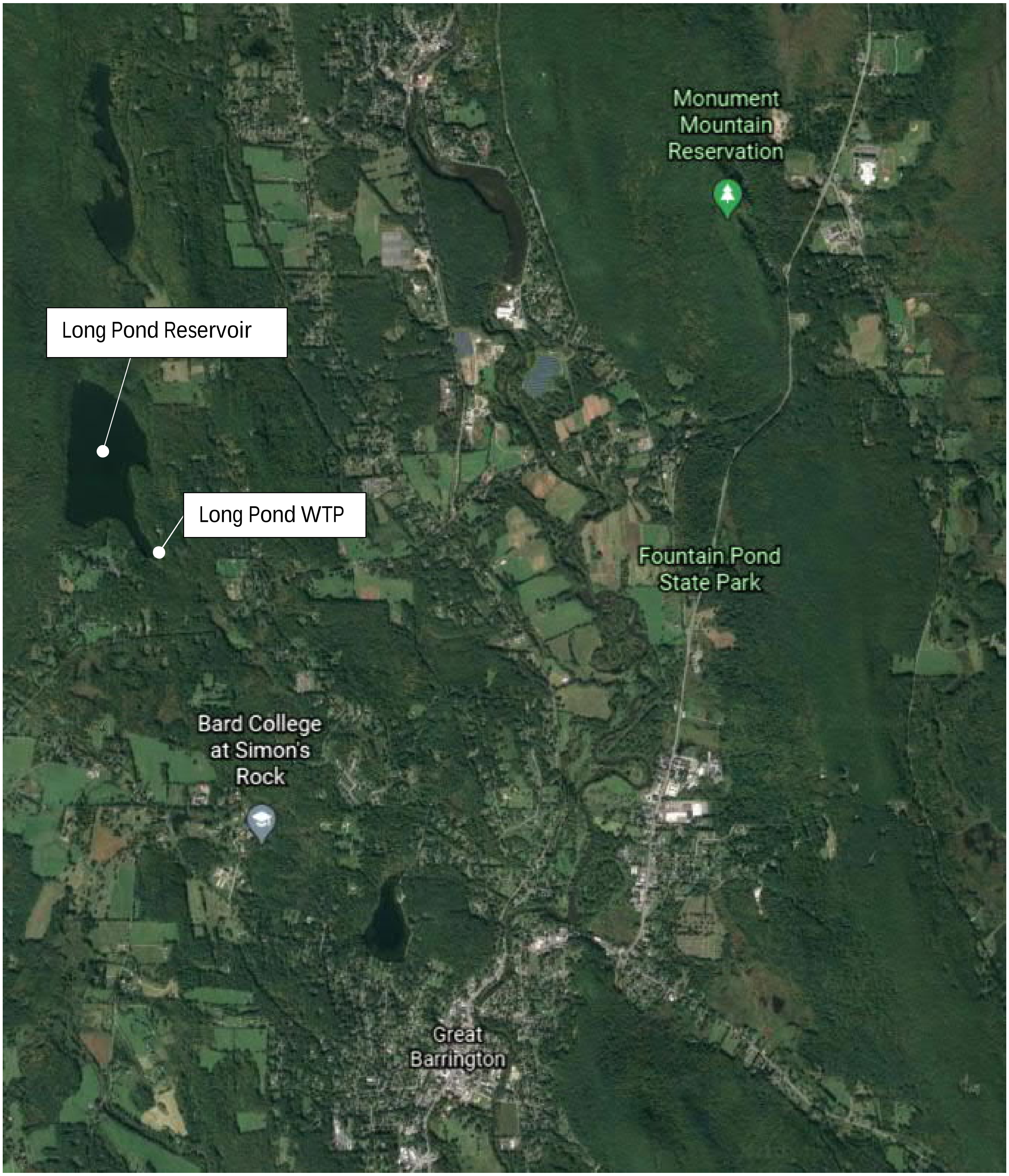
2 Water Supply

2.1 Introduction

The system owned by Housatonic Water Works Company (HWWC) includes one reservoir which provides raw water to the Long Pond Water Treatment Plant (WTP) for treatment, and subsequently to the distribution system. The reservoir is identified on an aerial shown in Figure 2-1. This section will focus on the operation, maintenance, safe yield, and water withdrawal registration for HWWC’s sole source, Long Pond Reservoir. The water treatment plant and the distribution system will be discussed more fully in Sections 4 and 5 of this report, respectively.

AECOM reviewed available information including sanitary surveys, previous capital improvement plans, dam inspection reports, and public water supply annual statistical reports as part of its evaluation of the water supply source. AECOM also conducted a site visit on January 21, 2021 to the Long Pond Reservoir to supplement the available information on HWWC’s water supply.

Figure 2-1: Aerial View of Long Pond Reservoir and WTP



2.2 Long Pond Reservoir

2.2.1 Evaluation of Long Pond Reservoir Yield

The Long Pond Reservoir serves as the only source for the HWWC system. The reservoir is situated southwest of the Village of Housatonic at the foot of Tom Ball Mountain. The reservoir has a surface area of about 115 acres and receives water from snow melt, surface runoff, precipitation, and likely bottom springs.

The reservoir is naturally formed with the exception of the southern-most section of the source which was excavated for the construction of the earthen dam and spillway in 1902. The man-made section is approximately 2 to 5 feet deep. According to the January 2016 Housatonic Water Works Company Master Plan report, Long Pond has two 8-inch diameter screened intake pipes. The first intake is approximately 100 feet from the dam while the second is about 800 feet north of the dam. Both intakes are reportedly used at all times, with the deepest intake 9 feet below the spillway elevation. Based on our review of available information, we believe that the first intake is located in the shallow section of the reservoir, while the second intake is in the deeper part of the reservoir. It should be noted that the 1980 USACE Dam Inspection Report for Long Pond Dam suggests that the first intake is a 10-inch diameter cast iron pipe while the second intake is a 14-inch cast iron pipe, with the second intake being approximately 8 feet below the normal pool elevation. The 2016 Master Plan report also contains a diagram of the dam that shows a 10-inch and 14-inch intake; therefore, we believe the USACE Dam inspection report information to be correct unless HWWC recently updated the two intake pipes.

A summary of the reservoir statistics is included as Table 2-1.

Table 2-1: Long Pond Reservoir Data

Useable Storage (Million Gallons)	Safe Yield (MGD)	Water Management Act (WMA) authorized annual withdrawal volume (MGD)
263[1]	0.60[1]	0.27[2]

Notes:
[1]Source: MassDEP Sanitary Survey Report, November 6, 2020
[2]Source: Public Water Supply Annual Statistical Report, 2019

Between the years of 2015 and 2019, the average daily water withdrawal reported in the Massachusetts Department of Environmental Protection (MassDEP) Annual Statistical Report (ASR) was between 0.14 million gallons per day (mgd) and 0.21 mgd, which is lower than the Water Management Act (WMA) authorized annual withdrawal volume of 0.27 mgd for the Long Pond Reservoir. The Long Pond Reservoir has more than sufficient capacity to meet the current demand, however, Long Pond Reservoir is the only source of potable water. There is no connection with any of the nearby water systems in the event of a water emergency or the Long Pond Reservoir becomes inaccessible. HWWC should investigate the feasible of constructing an emergency connection with the closest water utility, Great Barrington Fire District.

2.2.2 Dam Inspection

The Long Pond Dam was constructed at the southernmost section of Long Pond Reservoir to enlarge the reservoir to be used as a water supply. Long Pond Dam is classified as an Intermediate size structure with a Significant hazard potential. The dam was inspected by Lenard Engineering, Inc. (LEI) on October 15, 2020 and an inspection report was issued in December of that year. Inspections of Long Pond Dam are required every 5 years due to the dam having a significant hazard potential. AECOM has reviewed the dam inspection report and the improvements recommended in the report to address the deficiencies identified.

The LEI report presents an evaluation of the dam and makes recommendations for improvements to address deficiencies. LEI reviewed existing reports and performed a visual inspection of the dam. The report indicates that the dam is in satisfactory condition, however, there is a specific concern about the adequacy of the existing spillway to pass the Spillway Design Flood (SDF), which is the 100-year storm, with the 10 inch flashboards in place. According to a 1980 dam inspection by the Army Corps of Engineers, the spillway has adequate capacity to pass the 100-year flood without he flashboards in place, however, the dam could possibly be overtopped if the flashboards were installed during a 100-year flood event. LEI recommended the following minor repairs to improve the condition of the dam:

- Remove, repair, or replace the failed spillway retaining wall
- Remove trees from the downstream slope and adjacent to the retaining wall
- Clean the outlets to the of the emergency spillway pipes

LEI also recommended several yearly maintenance items to be performed regularly, including grading of the road on the crest of the dam, exercise the outlet control valves, clean the inlets and outlets of the emergency spillway pipes, and fill low spots and areas of erosion and reseed areas of thin vegetation. LEI also recommended an evaluation be performed to evaluate the need to provide additional spillway capacity because of the potential inability to pass the 100-year storm without overtopping the dam. LEI recommended the spillway capacity evaluation use the most recent rainfall data and look at options to increase the spillway capacity including removal of the flashboards, construction of an auxiliary spillway, widening the existing spillway, raising the dam, or armoring the dam to withstand an overtopping event. The LEI Dam Inspection is included in Appendix G.

The estimated costs of these recommendations are included in the Capital Improvement Plan section of this report. An evaluation of the spillway capacity will be required before potential costs associated with increasing spillway capacity are known.

3 Water Demand

3.1 Existing Water Demand

The HWWC system serves residents in the Town of Great Barrington (Village of Housatonic), Stockbridge, and West Stockbridge. The system includes Long Pond Reservoir, a treatment plant, and water distribution system and storage tank. According to the 2019 ASR submitted by HWWC to the MassDEP, HWWC serves a population of 1,400 and has 824 accounts with service connections which are broken down as follows:

- 792 residential accounts
- 10 residential institutions accounts
- 9 commercial/businesses accounts
- 1 agricultural account
- 3 industrial accounts
- 8 municipal accounts

A summary of water usage organized by category is provided in Table 3-1. HWWC reports that 99% of service connections are metered. The largest demand comes from the residential category which accounts for 83% of the total water demand. The smallest demand is from the agricultural and municipal categories which combined account for 0.8% of the total water demand.

Table 3-1: Summary of Water Usage by Category (2017 – 2019)

Category	Average Annual Use - million gallons per year (mgy)	Average Daily Use – gallons per day (gpd)[1]	Percent of Total Water Usage
Residential	29.2	78,894	83.0%
Residential Institution	3.2	8,793	9.1%
Commercial/Business	1.1	3,068	3.2%
Agricultural	0.1	326	0.3%
Industrial	1.3	3,677	3.8%
Municipal	0.2	477	0.5%

[1]Calculated by converting Average Annual Use to gallons and dividing by 365 days

To identify the baseline water demand volume in the HWWC system, an average of raw water production data from HWWC's ASR for years 2017 through 2019 was used as well as production rates from 2015 – 2020 provided by HWWC. The baseline average day demand (ADD) for this five-year period was 0.17 mgd. The average day peaking factor, or ratio of maximum day demand (MDD) to ADD, is 1.58 for the years 2017 through 2019. The baseline water demand for the years 2015 through 2020 are summarized in Table 3-2 and 3-3.

Table 3-2: Baseline Water Demand

Year	Total Pumped (mgy)	ADD (mgd)[1]	MDD (mgd)[2]	MDD/ADD Peaking Factor
2015	68.03	0.19		
2016	74.84	0.21		
2017	52.84	0.14	0.22	1.57
2018	60.71	0.17	0.30	1.76
2019	55.41	0.15	0.21	1.40
Average	62.37	0.17	0.24	1.44

[1]ADD: Average day demand, rounded to the nearest 0.01 mgd.
[2]MDD: Maximum Daily Raw Water Pumping reported in MassDEP Annual Statistical Report. Only reports from 2017 to 2019 were available.

Table 3-3: Baseline (Current) Water Use

Year	Base System ADD (mgd)	Residential			Non-Residential[2]		Unaccounted for water (UAW)	
		ADD (mgd)	% of Base ADD	RGPCD[1]	ADD (mgd)	% of Base ADD	ADD (mgd)	% of Base ADD
2017	0.14	0.08	57.1%	56	0.01	7.1%	0.05	35.7%
2018	0.17	0.08	47.1%	56	0.02	11.8%	0.07	41.2%
2019	0.15	0.09	60.0%	60	0.01	6.7%	0.05	33.3%
Average	0.15	0.08	54.7%	57	0.02	8.5%	0.06	36.7%

[1]RGPCD: Residential gallons per capita per day
[2]Non-Residential: Includes the category Residential Institution

3.2 Projected Water Demand

The 2016 Water Master Plan report for HWWC noted a declining population trend between 1990 and 2010. The report also notes that the Town of Great Barrington's significant redevelopment strategies, including redeveloping the mills into mixed use residential/commercial space and revitalizing the school campus which could increase demands in the future. The 2016 Water Master Plan report did not go as far as preparing projected water demands. For planning purposes, this report uses the allowable 0.27 mgd withdrawal volume as the projected average day demand and 0.39 mgd as the projected maximum day demand (based on peaking factor of 1.44 from Table 3-2). The evaluation of the treatment plant was based on 0.30 mgd which was the 2018 MDD. Options to meet a potential future MDD of 0.39 mgd are discussed in Section 4.

4 Water Treatment Plant

As part of the HWWC water system evaluation, AECOM was tasked with evaluating the Long Pond WTP. As part of the evaluation, AECOM reviewed existing data and reports pertaining to raw and treated water quality. In addition, AECOM conducted a site visit on January 21, 2021 in order to perform a multi-disciplinary plant assessment and interview HWWC personnel. The goal of this evaluation was to identify any deficiencies in the current water treatment process, to check compliance with current and anticipated regulations, and to recommend improvements to the treatment plant based on our findings. Due to the risk of COVID19 infection and in accordance with local guidelines, AECOM personnel were unable to physically enter the treatment plant. Additionally, an unexpected snow squall covered the top of buried structures with a blanket of snow. Observations are based predominately on photos of the treatment plant provided by HWWC personnel. The following sections will provide an overview of the current operations and treatment processes at the plant, a review of water quality regulations, a conditional assessment of the plant and its equipment, and recommended improvements for the HWWC to consider.

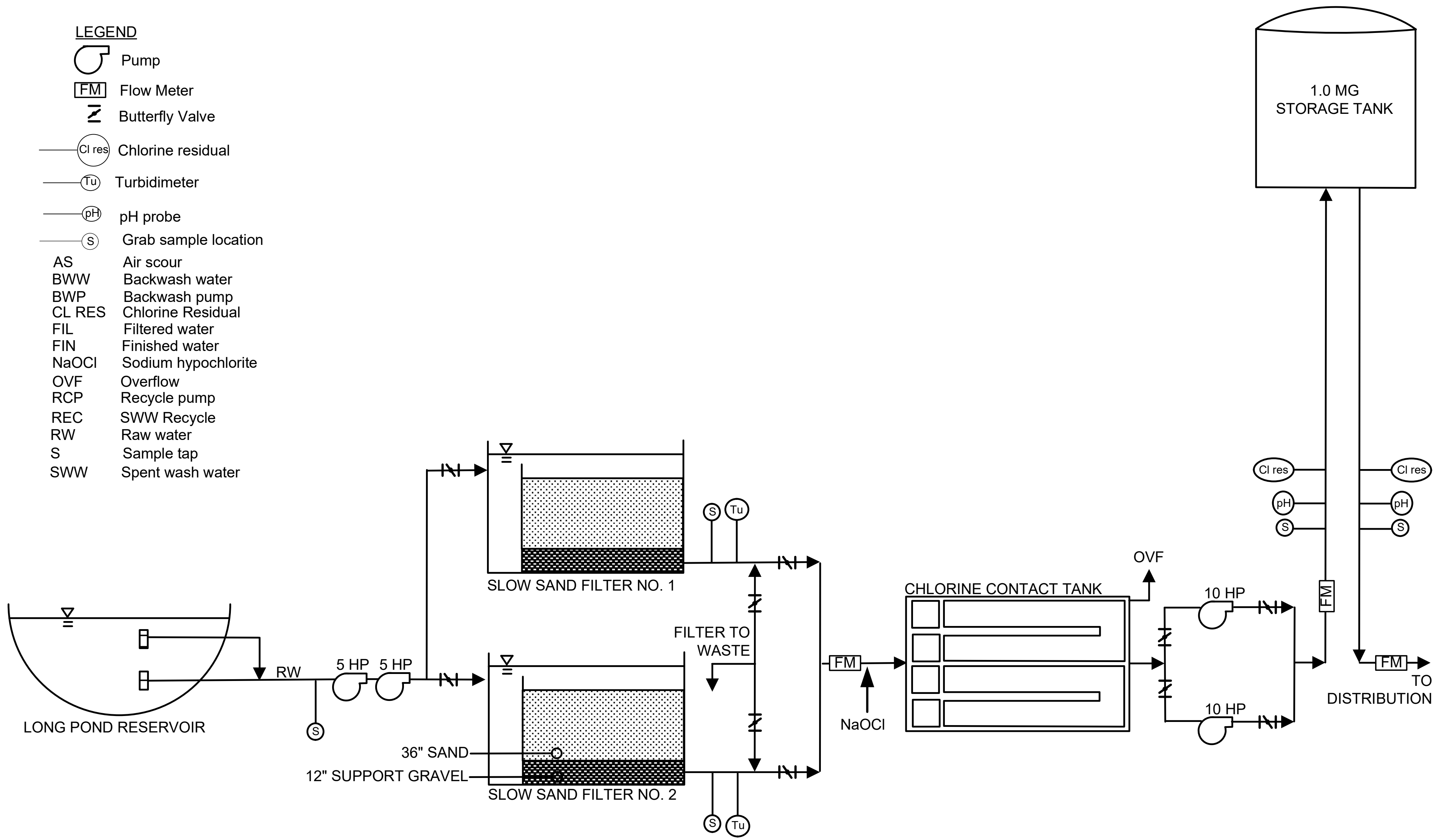
4.1 Overview of Water Treatment Plant

The Long Pond WTP treats water from the Long Pond Reservoir. The treatment plant was constructed in 1939 at the southern point of Long Pond with road access from Division Street. Modifications to the plant, including the installation of a chlorine contact tank (CCT), piping and instrumentation changes, and construction of a 1.0 MG storage tank were completed in 1997.

The Long Pond WTP is a surface water treatment plant which utilizes slow sand filtration as the main treatment process. The process involves passing water from the reservoir through a sand bed and relies on the bacterial film which forms on the surface of the sand for treatment. A basic flow schematic for the facility is shown in Figure 4-1.

Water flows by gravity from the reservoir through the filter bed using the hydraulic head created by the difference in height between the reservoir level and the filter bed. The difference in height between the reservoir and the filter bed is minimal and as the filters get dirty, the water level above the filters increases. In the event the water level above the filters increases to be above the level in the reservoir, one of two 5-horsepower lift pumps are used to increase the flow to the filters. The second pump is maintained for redundancy.

Each of the filters are 48 feet by 48 feet for a total of 2,304 square feet of surface area. The filter beds are comprised of 36 inches of sand over 12 inches of support gravel. Both filters are run continuously based on demand unless one is offline for cleaning. Cleaning occurs every 6 to 8 weeks based on the flow rate through the filter. In order to clean the filter bed, the filter is first isolated from the system and drained. A hatch located directly above the filter (Figure 4-2.) is opened and a rake with jet nozzles on the ends is lowered into the chamber. Highly pressurized water is discharged from the nozzles and dislodges whatever has accumulated on the filter bed surface. An ejector pump is then used to flush the dislodged material out of the filter. This process typically takes an hour and the filter is immediately put back into operation. While the plant is capable of filter-to-waste, it is not typically used due to the effectiveness of the raking and flushing process. No ripening period is required after cleaning the filter.



PLOT DATE: 3/26/2021

NO SCALE

AECOM

Figure 4-1: Long Pond WTP – Basic Process Flow Diagram

HOUSATONIC WATER WORKS COMPANY
Water System Evaluation

Figure 4-2: Access Hatch to Filter Sand Bed

Figure 4-3: Hypochlorite Chemical Feed Pumps

Filtered water is disinfected by injecting sodium hypochlorite into a common header pipe via one of two redundant chemical feed pumps. The chemical feed pumps are Stenner SVP Digital Peristaltic Pumps (Figure 4-3) and the chemical feed rate is paced on filtered water flow. Sodium hypochlorite is pumped directly from a 400-gallon tank that is refilled on a monthly basis.

Once disinfected with sodium hypochlorite, filtered water flows by gravity to a two-cell, baffled Chlorine Contact Tank (CCT) located to the east of the filters. The two cells are identical with dimensions of 46 feet by 15 feet with a water depth of 6 feet for a volume of approximately 31,000 gallons per cell. The baffle wall in each cell is 39 feet long and creates a 7 foot wide channel. Water exiting the CCT flows by gravity back to the operations building where high lift pumps discharge treated water to the 1.0 MG storage tank. Two high lift pumps (10 HP each) are used, which operate in duty/stand-by mode and are controlled by the level in the storage tank. There is a third 20 HP pump that is not used and is locked out. The high lift pumps can be operated manually or automatically based on tank levels. There is no emergency generator for the WTP, so in the event of a power failure, HWWC relies on the volume in the storage tank to supply the distribution system until power is restored.

4.2 Raw and Treated Water Quality

4.2.1 Raw Water Quality

A summary of raw water quality parameters measured for the previous three years (January 2018 through December 2020) is presented in Table 4-1 below using the following format:

Average (Min-Max) [Number of Samples]

The data presented was collected for the purposes of regulatory compliance or as requested by HWWC.

Table 4-1: Long Pond Reservoir Water Quality (2018 –2020)

Parameter	Units	Long Pond Reservoir (Raw Water)	Compliance Values		Laboratory MDL
			MCL	SMCL	
Iron	mg/L	0.06 (0.05-0.10) [6]	-	0.3	0.05
Manganese	mg/L	0.019 (0.007-0.039) [10]	-	0.05	0.002
Alkalinity	mg/L as CaCO3	76.3 (75.0-77.5) [2]	-	-	-
Color	C.U.	9 (1-20) [8]	-	15	1
Total Dissolved Solids	mg/L	109 (96-136) [6]	-	500	25
pH	s.u.	8.19 (7.60-8.50) [6]	-	-	-
Temperature	^{o}C	18.6 (14.1-27.2) [6]	-	-	-
T. Coliform[1]	Count/100mL	862.2 (49.6-2,419.6) [56]	-	-	1.0
E. Coli[1]	Count/100mL	19.3 (0.0-770.1) [56]	-	-	1.0
Total Organic Carbon[2]	mg/L	3.28 (2.88-4.24) [4]	-	-	0.500

[1]The reported result “Absent” was considered 0.0/100mL, the reported result <1/100mL was considered 1/100mL, and the reported result >2,419.6/100mL was considered 2,419.6/100mL
[2]Collected October 2020

The range of iron and manganese concentrations measured from the reservoir for the past three years show little variability and the maximum concentrations measured are below their respective Secondary Maximum Contamination Level (SMCL). Whereas primary standards are established to protect public health, secondary standards cover water quality parameters that have aesthetic impacts rather than health impacts. As a result, secondary standards are not typically enforced by MassDEP unless customers complaints related to these aesthetic issues become excessive and warrant addressing. Additionally, this data may not be representative of typical iron and manganese concentrations due to the low sample size (n=6) over a three year time frame

4.2.2 Treated Water Quality

A review of the treated water and distribution system water quality in the context of regulatory compliance is presented herein. Basic finished water quality is summarized in Table 4-2. These parameters are measured routinely at the WTP to represent the finished water as it enters the distribution system (i.e., the point-of-entry (POE)).

Table 4-2: Summary of POE Water Quality (2018 – 2020)

Parameter	Units	Point of Entry to Distribution	Compliance Values		Laboratory MDL
			MCL	SMCL	
Free Chlorine	mg/L	1.22 (0.40-2.28) [54]	4.0	-	-
Iron	mg/L	0.05 (0.05-0.05) [23]	-	0.3	0.05
Manganese	mg/L	0.020 (0.002-0.095) [27]	-	0.05	0.002
Alkalinity	mg/L as CaCO3	79.9 (75.0-85.0) [18]	-	-	-
Color	C.U.	9 (1-40) [20]	-	15	1
Total Dissolved Solids	mg/L	130 (98-436) [16]	-	500	25
pH	s.u.	7.54 (7.09-7.94) [16]	-	-	-
Temperature	ºC	19.0 (6.1-25.7) [16]	-	-	-
Turbidity	NTU	0.047 (0.000-0.103) [821]	1.0[2]	-	-
T. Coliform[1]	Count/100mL	0.0 (0.0-0.0) [39]	-	-	1.0
E. Coli[1]	Count/100mL	0.0 (0.0-0.0) [39]	-	-	1.0
Chloride[3]	mg/L	14.2 (13.4-14.8) [4]	-	250	2.00
Sulfate[3]	mg/L	5.0 (5.0-5.0) [4]	-	250	5.0

[1]The reported result “Absent” was considered 0.0/100mL, the reported result <1/100mL was considered 1/100mL, and the reported result >2,419.6/100mL was considered 2,419.6/100mL
[2]95% of samples need to be below 1.00 NTU and all samples need to be below 5.00 NTU
[3]Collected August 2020

With the exception of turbidity and chlorine residual, for which primary maximum contaminant levels (MCLs) apply, most of the other parameters in this table are SMCL goals.

Overall, Table 4-2 shows that the WTP typically produces high quality finished water. Filtered water turbidity from the treatment plant is typically less than 0.1 NTU, meeting the 1.0 NTU regulatory limit set by the Surface Water Treatment Rule. A discussion of the regulatory implications of turbidity is presented in Section 4.3.1.

There have been periodic dirty water complaints by residents within the HWWC service area which have been investigated to determine if there is a link between the complaints and effluent water quality from the WTP. A report from Cornwell Engineering Group investigated the elevated manganese concentrations while attempting to determine the cause of customer complaints of colored water. The color and manganese concentrations are plotted in Figure 4-4.

Figure 4-4: Point of Entry, Manganese and Color

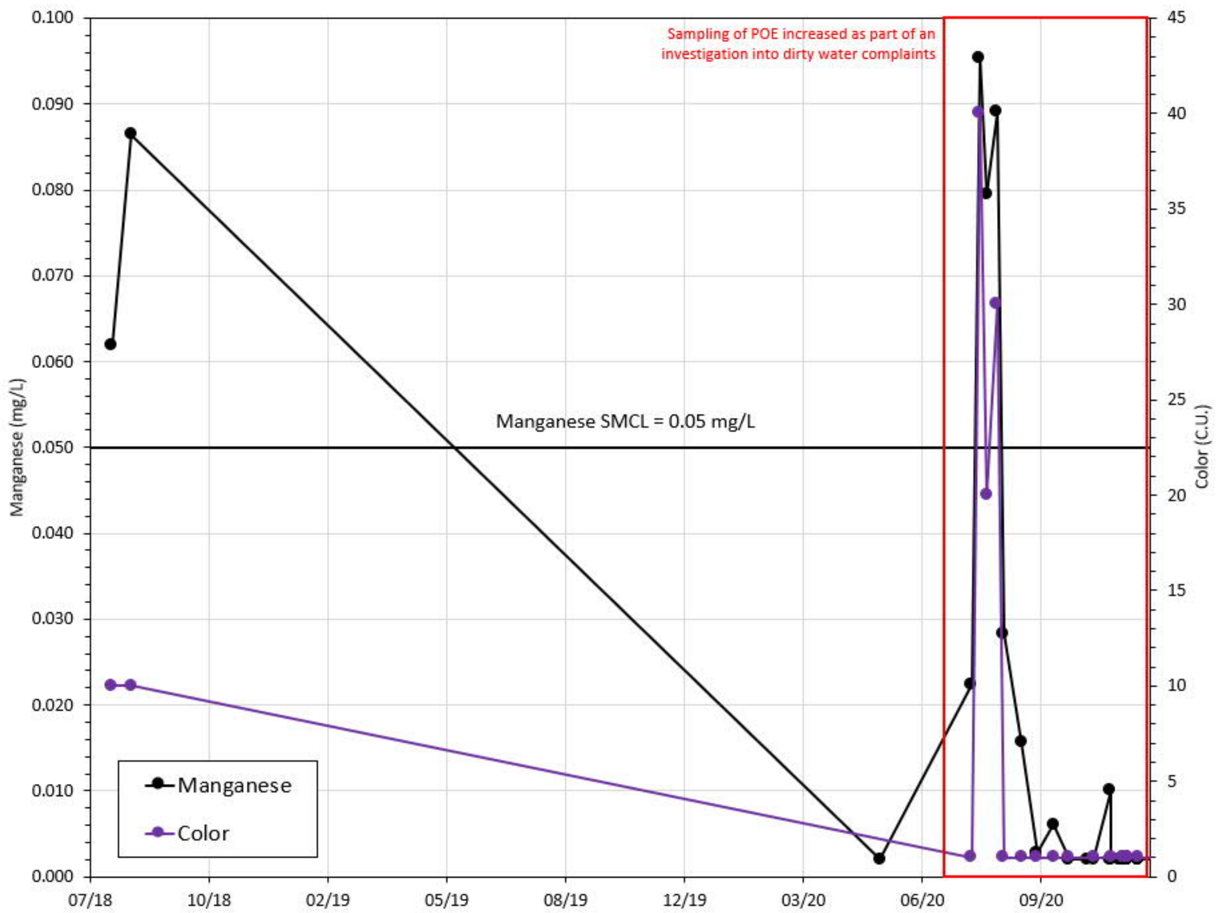


Figure 4-4 shows the inconsistency of measuring manganese and color entering the distribution system because most of the samples were collected in 2020. There appears to have been a spike in manganese and color in the summer of 2020, around the same time as dirty water complaints were filed by HWWC customers. This led Cornwell Engineering Group to determine the discolored water was caused by a seasonal spike in manganese and suggested a process be added to the treatment facility to remove manganese. Figure 4-5 plots the manganese concentrations measured in the distribution system over the same time period.

Figure 4-5: Distribution Samples, Manganese

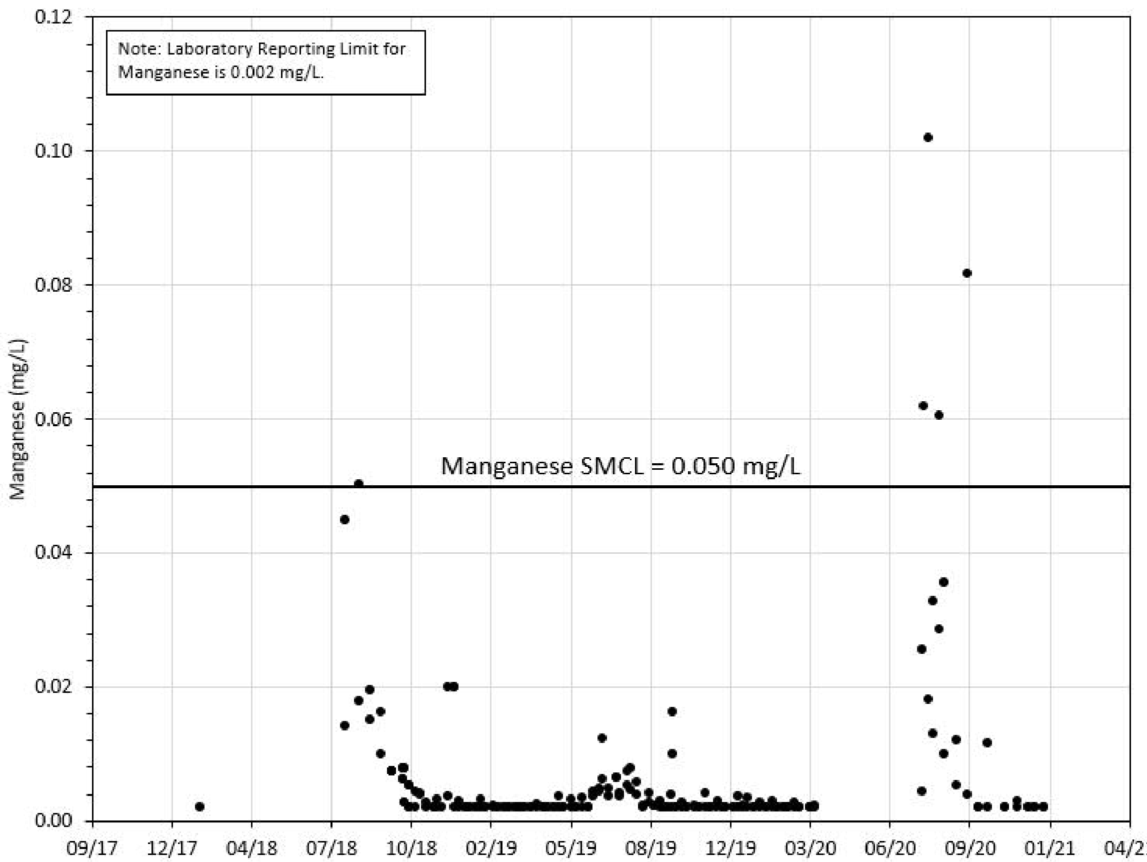


Figure 4-5 shows that the manganese concentration measured at several sampling points throughout the distribution system appears to spike in the summer months of 2018 and 2020. There also appears to be a slight increase in manganese concentration above the detection limit in the summer of 2019. The data however is incomplete and does not show the complete extent of the manganese spike.

Another water quality parameter to note is the measured temperature. Table 4-2 shows a wide range of temperatures measured the last few years. For a surface water source, temperature change is to be expected, but for this source it's unusually large. The point of entry temperature data is plotted in Figure 4-6. The temperature measured at the 200 foot tap leading to the storage tank is also plotted.

Figure 4-6: 200 foot Tap and Point of Entry, Temperature

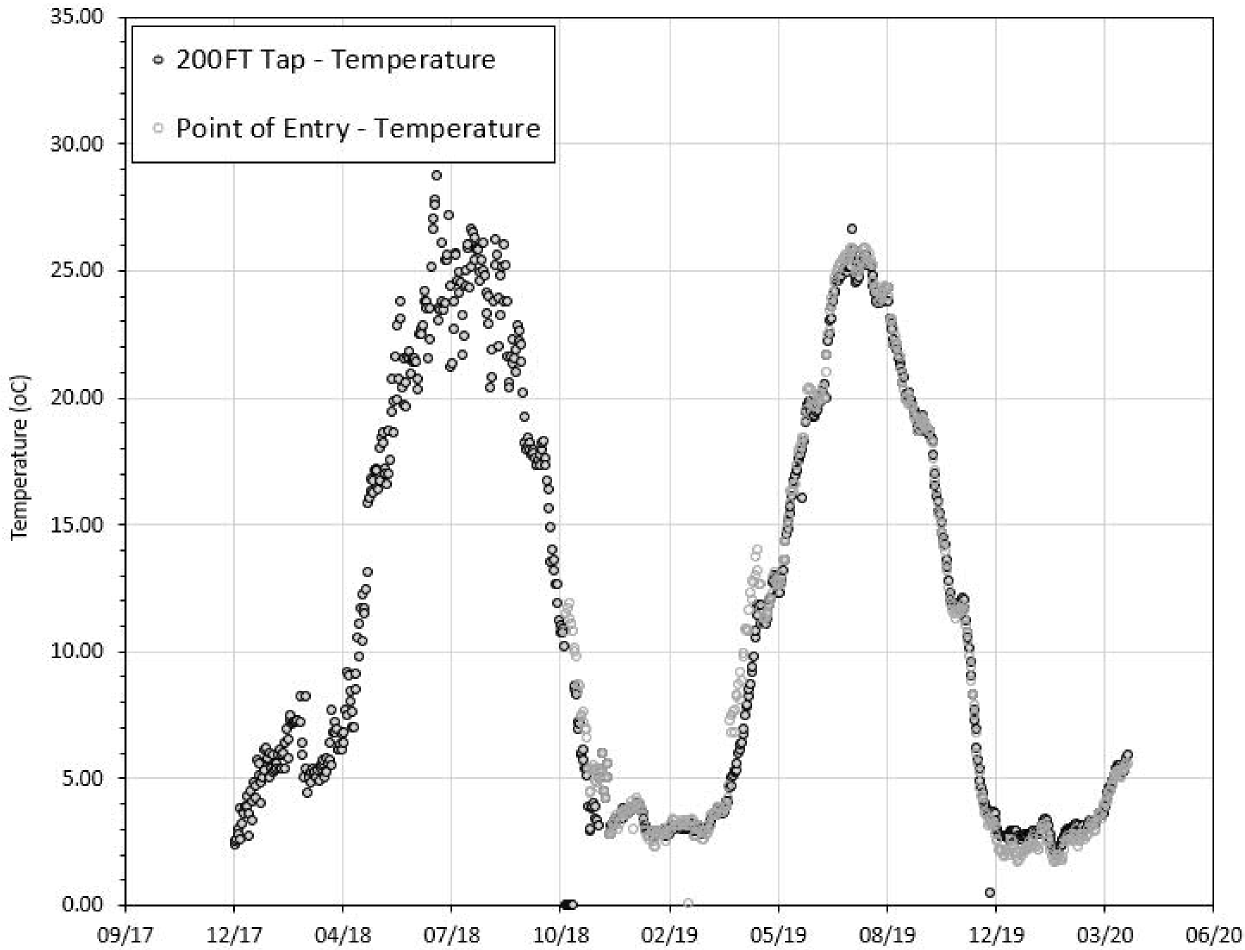


Figure 4-6 shows the temperature does vary with the seasons as expected, however the temperature swings are quite large. This is likely because the shallower of the two intakes is so close to the reservoir surface (Section 2.2.1). It has been suggested in correspondence with MassDEP that the depth of the shallow intake could be the cause of water quality issues due to the dramatic temperature swings and risk of increased organics.

4.3 Regulatory Compliance

Water treatment is regulated broadly at the federal level through the EPA. The state level regulatory agency, the MassDEP is responsible for enforcing EPA standards, and can set more stringent requirements. This section includes a review of existing regulations and HWWC compliance with the regulations, including an evaluation of the EPA Lead and Copper Rule (LCR) and an evaluation of the Long Pond Reservoir WTP disinfection byproducts (DBPs).

EPA drinking water standards fall into four broad categories: microbial, disinfectants and DBPs, inorganic compounds, and organic compounds. All of the various drinking water regulations are under the purview of the Safe Drinking Water Act (SDWA), although there are various rules within the SDWA that govern different parameters. Regulations of primary concern with respect to water quality are listed below:

- Enhanced Surface Water Treatment Rule (ESWTR) Long Term 1 and 2
- Lead and Copper Rule (LCR)
- Total Coliform Rule
- Disinfectants and Disinfection Byproducts Rule (DBPR) Stage 1 and 2
- Filter Backwash Recycling Rule (FBRR)
- Inorganic chemicals (radionuclides and arsenic rule)
- Volatile and synthetic organic chemicals (VOCs and SOCs)
- Perchlorate Rule

4.3.1 Surface Water Treatment Rule and Primary Disinfection

The Surface Water Treatment Rule (SWTR), promulgated by the EPA on June 29, 1989, requires a certain amount of removal/inactivation of pathogens such as Giardia and viruses. The amount of removal required is expressed in base 10 logarithms, as shown in the following example:

Log Removal = Log10 (influent) – Log10 (effluent)

As an example, assuming the influent value is 1,000 cysts (or viruses), and the effluent is 10 cysts, the log removal achieved is:

Log Removal = Log10 (1,000) – Log10 (10) = 2

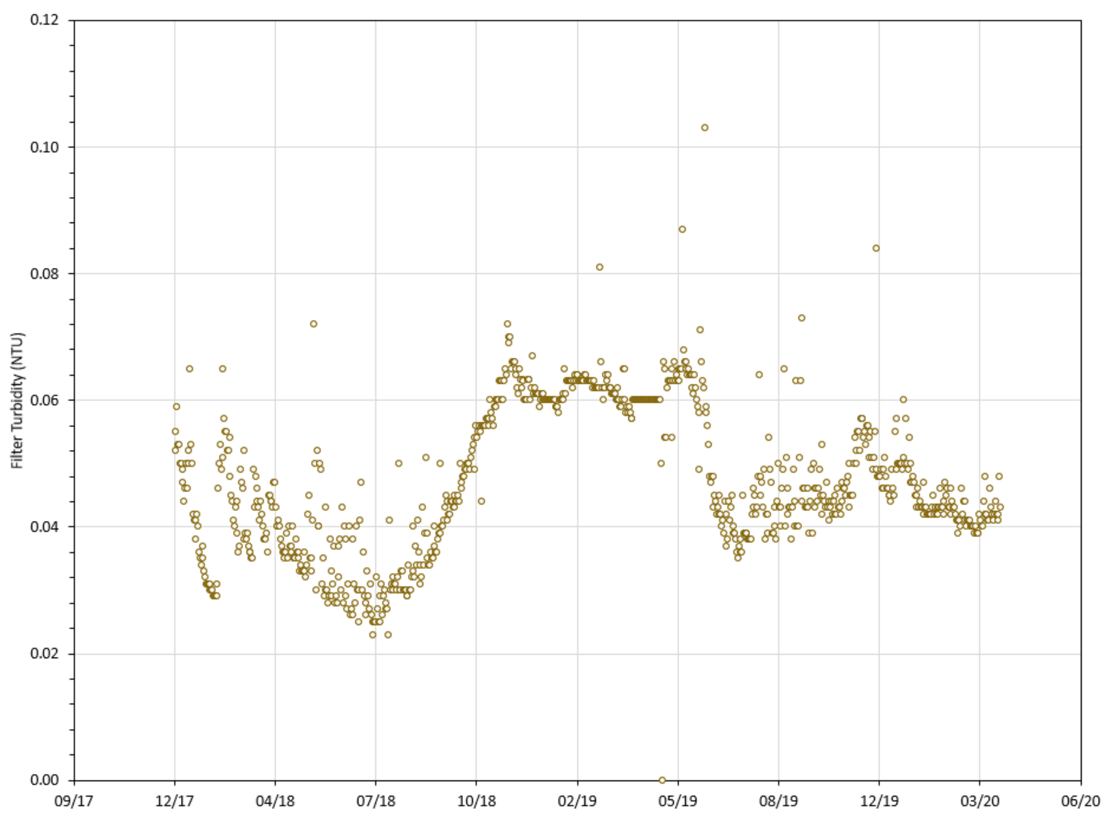
Alternatively, a 2-log removal also can be expressed as 99% removal. Similarly, a 2.5-log removal is 99.68% removal; a 3-log removal is 99.9% removal; and a 4-log removal is 99.99% removal.

The SWTR requires that a 3-log removal of Giardia and a 4-log removal of viruses be achieved, using a double barrier approach of removal and disinfection, and at least a 2-log removal of Cryptosporidium. The “removal” is provided by the treatment process. The slow sand filtration process utilized by the Long Pond WTP is granted a “credit” of 2.0-log removal of Giardia and 2.0-log removal of viruses if the turbidity standard is met. The disinfection process is relied on to provide the remaining log removal values of 1.0-log Guardia and 2.0-log viruses. Sufficient chlorine contact time within the chlorine contact tank provides this disinfection to achieve the remaining log removal credits. Additional chlorine contact time is achieved within the 1.0 MG storage tank which receives all flow from the WTP plant effluent.

The turbidity standard set for slow sand filtration has remained unchanged since the SWTR. The regulation states the combined filter effluent (CFE) of all slow sand filters, must be less than or equal to 1.0 NTU in at least 95% percent of the measurements taken each month and the maximum turbidity must never exceed 5.0 NTU. At the time of this report, no CFE turbidimeter exists at the Long Pond WTP. MassDEP has sited HWWC for the absence of a combined filter effluent turbidity measurement. HWWC reports their maximum turbidity measured each day which is assumed to be the maximum turbidity measured between the effluent of the two slow sand filters.

Figure 4-7 shows the maximum filtered water turbidity for the Long Pond WTP, which are well in compliance with the turbidity standards. All turbidity data of the filtered water is less than 0.12 NTU which means the treatment system is well in compliance with the LT2SWTR which requires filtered water turbidity.

Figure 4-7: Treatment Plant Effluent, Turbidity



In order to ensure that the pathogen disinfection requirements are achieved, the SWTR has other inherent requirements related to disinfection, aside from turbidity, referred to as the "CT" product which is used to ensure that primary disinfection is achieved. As part of the SWTR and the Filtration and Disinfection Requirement for Public Water Sources (AWWA, 1991), the EPA developed a method for evaluating the effectiveness of primary disinfection in a water treatment system. Under this method, actual disinfection conditions at a water treatment plant are converted to a theoretical level of inactivation known as the CT product, where C, the residual disinfectant concentration (mg/L) after storage time, is multiplied by T, which is the disinfection contact time in minutes, at or before the first service connection.

The CT is calculated as follows:

CT (mg/min-L) = residual disinfectant concentration (mg/L) x T (minutes)

HWWC calculates the CT at two points, after the chlorine contact tank at the 200-foot tap, and just prior to entering the distribution system which is downstream of the storage tank. To calculate the CT for each day, free chlorine is measured at both of these points using online instrumentation and the time is calculated using the peak hourly flow. The required CT is determined by using Inactivation Tables in 310CMR 22.20A Tables 1.1-1.6, 2.1 and/or 3.1 and the following conditions in the chlorine contact basin:

- Average Chlorine Concentration = 1.4 mg/L
- Average pH = 7.4 s.u.
- Range of Water Temperature = 5^{o} – 25^{o} C

The CT calculated for the chlorine contact basin, reported daily, is shown in Figure 4-8.

Figure 4-8: CT Required Compared to CT Required for 1-log Giardia Removal

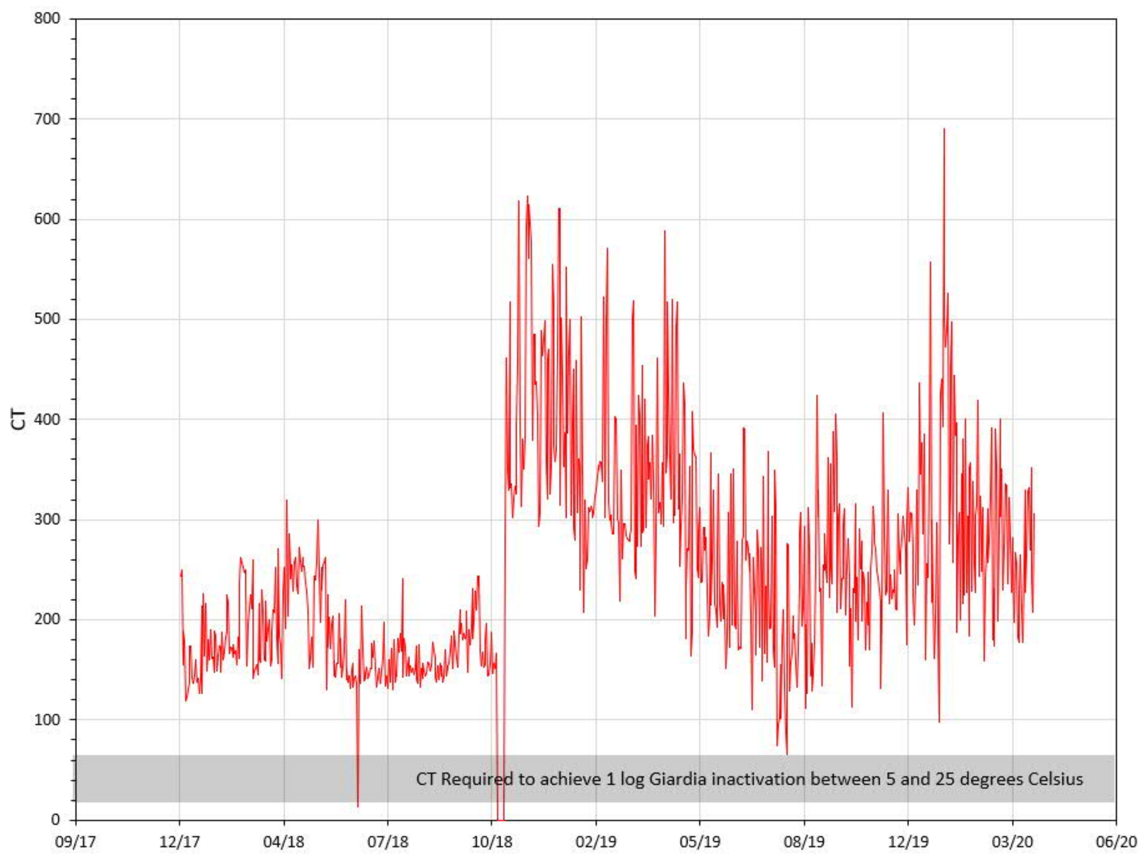


Figure 4-8 shows, with the exceptions of in June and October 2018, the CT achieved in the chlorine contact basin has been well over the required CT for 1-log removal of Giardia.

When the EPA finalized ESWTR LT2 in December 2005, an additional requirement was to determine if additional removal of Cryptosporidium would be required based on source water sampling for Cryptosporidium. Based on the data provided for the purposes of this report, Cryptosporidium has not been detected in the Long Pond Reservoir. Under the SWTR, slow sand filtration is assumed to provide a 2-log removal for Cryptosporidium if the turbidity limits are met.

A summary of regulatory compliance regarding the Surface Water Treatment Rule is provided in Table 4-3.

Table 4-3: Log Removal Credits Earned by Long Pond WTP

	Log Removal Credits				Notes
	Required by SWTR	From Slow Sand Filtration	From Chlorine Contact Basin	Total Credits Achieved	
Viruses	4.0	2.0	2.0	4.0	Achieving 1.0-log removal of Giardia would also achieve a 2.0-log removal of viruses
Giardia	3.0	2.0	1.0	3.0	The daily calculated CT is well over the requirements for 1.0-log removal for Giardia.
Cryptosporidium	2.0	2.0	-	2.0	Slow sand filtration is assumed by the EPA to achieve a 2.0-log removal of Cryptosporidium.

4.3.2 Lead and Copper Rule

The Lead and Copper Rule (LCR) was designed to protect the public health by minimizing lead (Pb) and copper (Cu) levels in drinking water. Lead and copper are seldom present in appreciable concentrations in source water. Rather, the LCR addresses lead and copper by reducing corrosion of premise plumbing by the corrosivity of the finished water. Unstable water can be corrosive to iron, lead, copper, and alloys that contain lead and copper as are often found in household plumbing or in service lines. In particular, lead service lines were an obvious source of lead corrosion that the LCR sought to address. When the LCR was first established in 1991, all community water systems were required to comply.

The basics of compliance are as follows:

1. The LCR established an action level (ALs) of 0.015 mg/L (15 ug/L) for lead and 1.3 mg/L for copper. These are based on the 90th percentile of tap water samples (i.e., 90% of samples must be below the action levels for compliance). Exceedance of the action levels could require:
    a. Water quality parameter monitoring (pH, alkalinity, calcium, conductivity, orthophosphate [if phosphate is used], silica [if silica based inhibitors are used], and temperature)
    b. Source water monitoring and treatment
    c. Public education
    d. Lead service line replacement
2. Initial sampling for lead and copper was required every 6 months, with the number of samples based on system size. If ALs were achieved, sampling reduced to once every 3 years.
3. Corrosion control treatment was required for large systems, and for small and medium systems not able to comply with the ALs.
4. Sample locations comprised of residences served by lead service lines, and also where no point of use treatment system is in use. Samples collected from single family residences with copper pipe and lead solder installed after 1982 (but before the effective date of the State's lead ban), or with lead pipes; and/or are served by lead service lines. For any system with lead service lines, 50% of the samples must come from lead service line sites.
5. In addition, in Massachusetts, in accordance with 310 CMR 22.06B, the MassDEP requires each community water system supplier to collect lead and copper samples from at least two schools. Each school shall have two sampling sites from which a 250 ml sample must be taken (one from a kitchen tap and one from a drinking water source, such as a water fountain).
6. Utilities that cannot achieve the ALs by treatment technique were required to conduct lead service line replacements. EPA has required 7% lead service line replacement annually, although states can increase this frequency.

The LCR is the most complex of EPA's rules and the summary above is abbreviated. The EPA is currently working to revise the LCR. The proposed revisions to the rule include a trigger level for lead of 0.010 mg/L (10 ug/L) which is in addition to the ALs. Water systems which exceed the trigger level but not the AL will have to implement a goal-based lead service line replacement program, conduct annual outreach to lead surface line customers, conduct a corrosion control strategy if one is not already in place, and re-optimize the corrosion control treatment if one is in place. HWWC has not exceeded 0.010 mg/L for lead since the Winter 2017 so the proposed addition does not immediately affect the distribution system. Considering there is no corrosion control treatment currently in place, this could change in the near future.

In the HWWC's service area, compliance is based on 20 sample sites throughout the distribution system. HWWC collects samples for lead and copper twice per year, the measured concentrations are summarized in Figure 4-9 and 4-10 for lead and copper, respectively.

Figure 4-9: Lead Concentrations Measured in HWWC System (2016 – 2020)

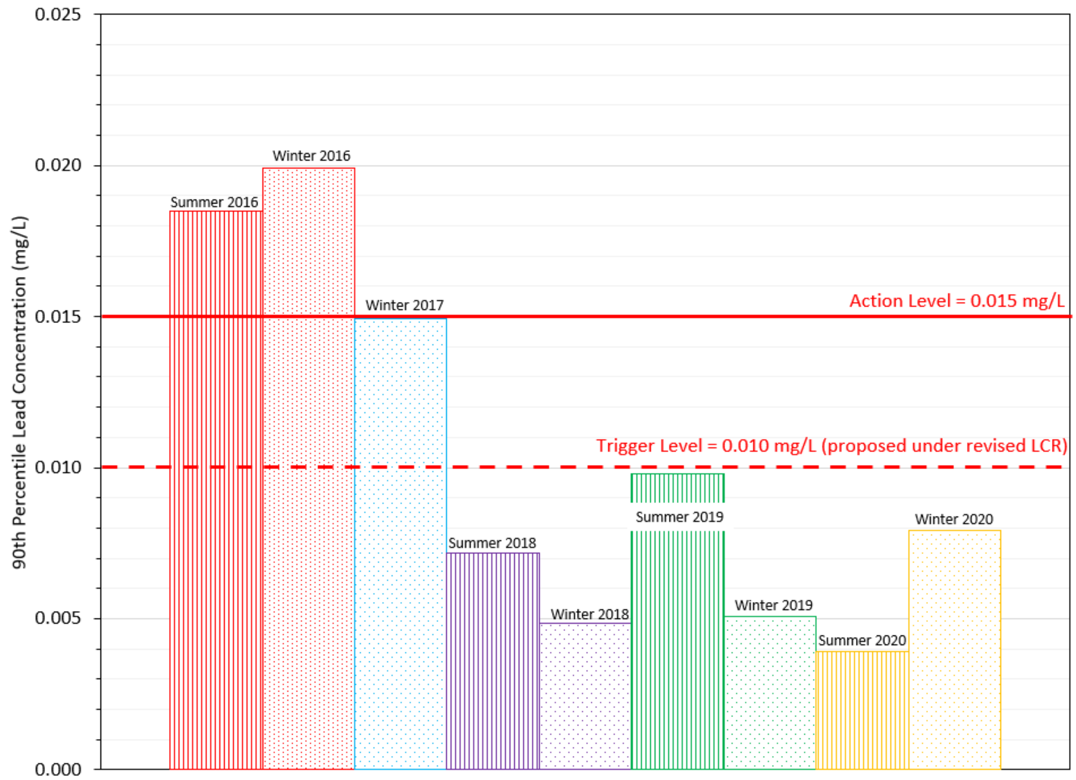
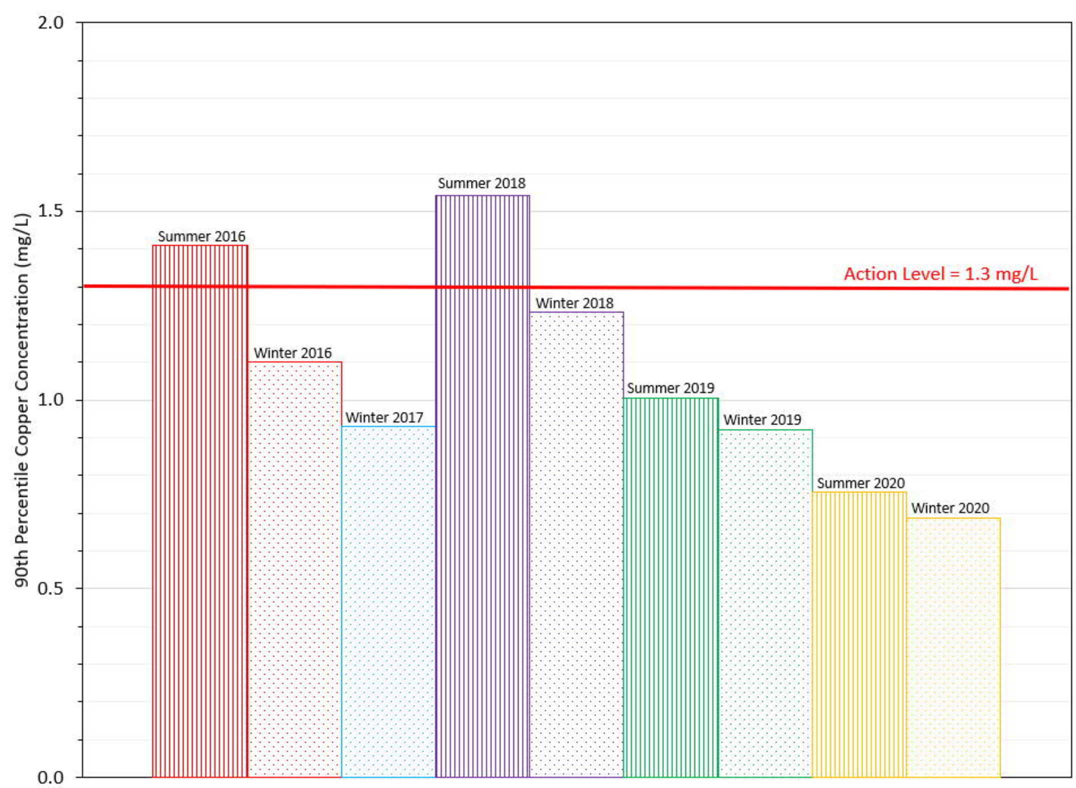


Figure 4-10: Copper Concentrations Measured in HWWC Service Area (2016 – 2020)



The 2016 sampling shows HWWC exceeded the action level (AL) for lead (AL = 0.015 mg/L) in both seasons of sampling and copper (AL = 1.3 mg/L) in the summer. In response, MassDEP required HWWC to submit a desktop evaluation for corrosion control treatment, a basis of design report, and a chemical addition retrofit BRP WS 34 permit application. The desktop evaluation recommended the addition of caustic to raise the pH and a blended phosphate as an inhibitor.

Another exceedance was reported for copper in the summer of 2018. In response, MassDEP issued an Administrative Consent Order for corrosion control equipment to be installed which included a pH control chemical and an addition of a blended ortho/polyphosphate. Although approved, no corrosion control equipment has been installed. At the time of this report, there is no plan for corrosion control in place. HWWC asserts that improved sampling procedures, a reduction in the application of chlorine for primary disinfection, and the effects of its storage tank re-piping, has sufficiently reduced lead and copper to below Action Levels. HWWC's 2020 Sanitary Survey stated by not adding the components for corrosion control, the water system was in violation of their 2018 Administrative Consent Order and would reevaluate the conditions of the consent order based on the color and corrosion evaluation conducted by Cornwell Engineering Group (Appendix D). One of the conclusions of the Cornwell Engineering Group evaluation was if the lead and copper cannot be controlled under current conditions, the addition of orthophosphate may need to be evaluated.

At the time of this report, copper has not exceeded the action level since 2018 and lead has not exceeded the action level since 2016. Under the revised LCR, the proposed trigger level for lead is 0.010 mg/L which has been met by HWWC since Summer 2018.

4.3.3 Stage 2 Disinfection By-products Rule

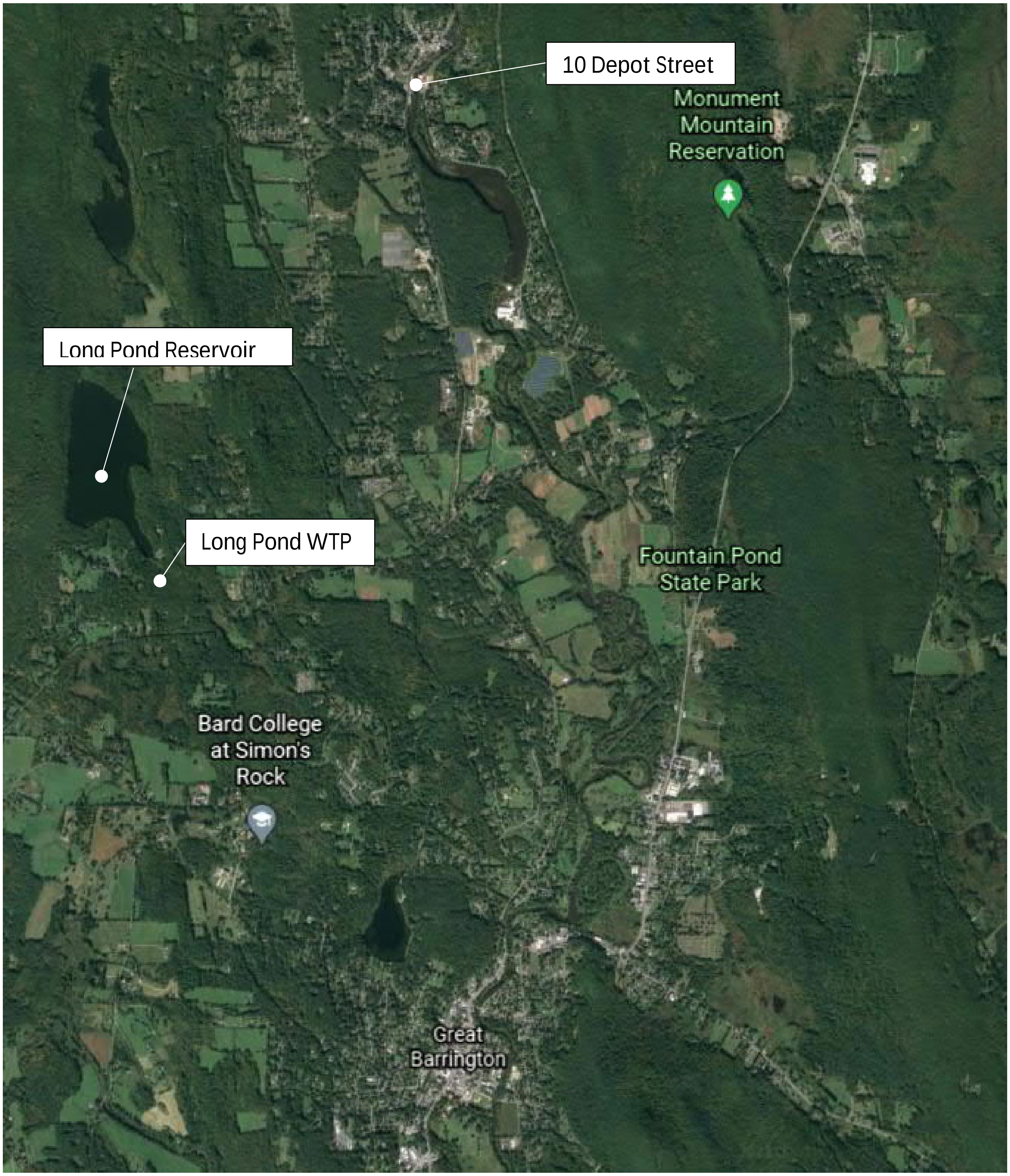
The desire to maintain a measurable free chlorine residual while simultaneously minimizing disinfection by-product formation is a competing objective for most utilities. Disinfection by-products are total tri-halomethanes (TTHMs) and a total of five haloacetic acids (HAAs) which are created when the disinfectant combines with natural organic matter, usually measured by Total Organic Carbon (TOC). DBP formation commences at the chlorine application point and will generally continue throughout the distribution system, with higher DBPs (especially TTHMs) often found where distribution system residence time is greatest. Factors that influence DBP formation are chlorine concentration, pH, water temperature, water age, and TOC.

The USEPA Stage 2 DPB Rule requires TTHM and HAA compliance on a locational running annual average (LRAA) calculated at each sample site, such that each site is its own compliance point. For the HWWC system, samples are taken at one location within the distribution system, 10 Depot Road, as shown in Figure 4-11. Figure 4-11 also shows the location of the Long Pond WTP and the location of the 1.0 MG Storage Tank.

Figure 4-12 shows the DBP results at the sampling location. Sampling is conducted quarterly, in the months of February, May, August, and November. The figure shows the actual quarterly sample results, going back to 2018, along with the LRAA result. The LRAA is calculated by averaging quarterly sample results with the previous three quarterly sample results.

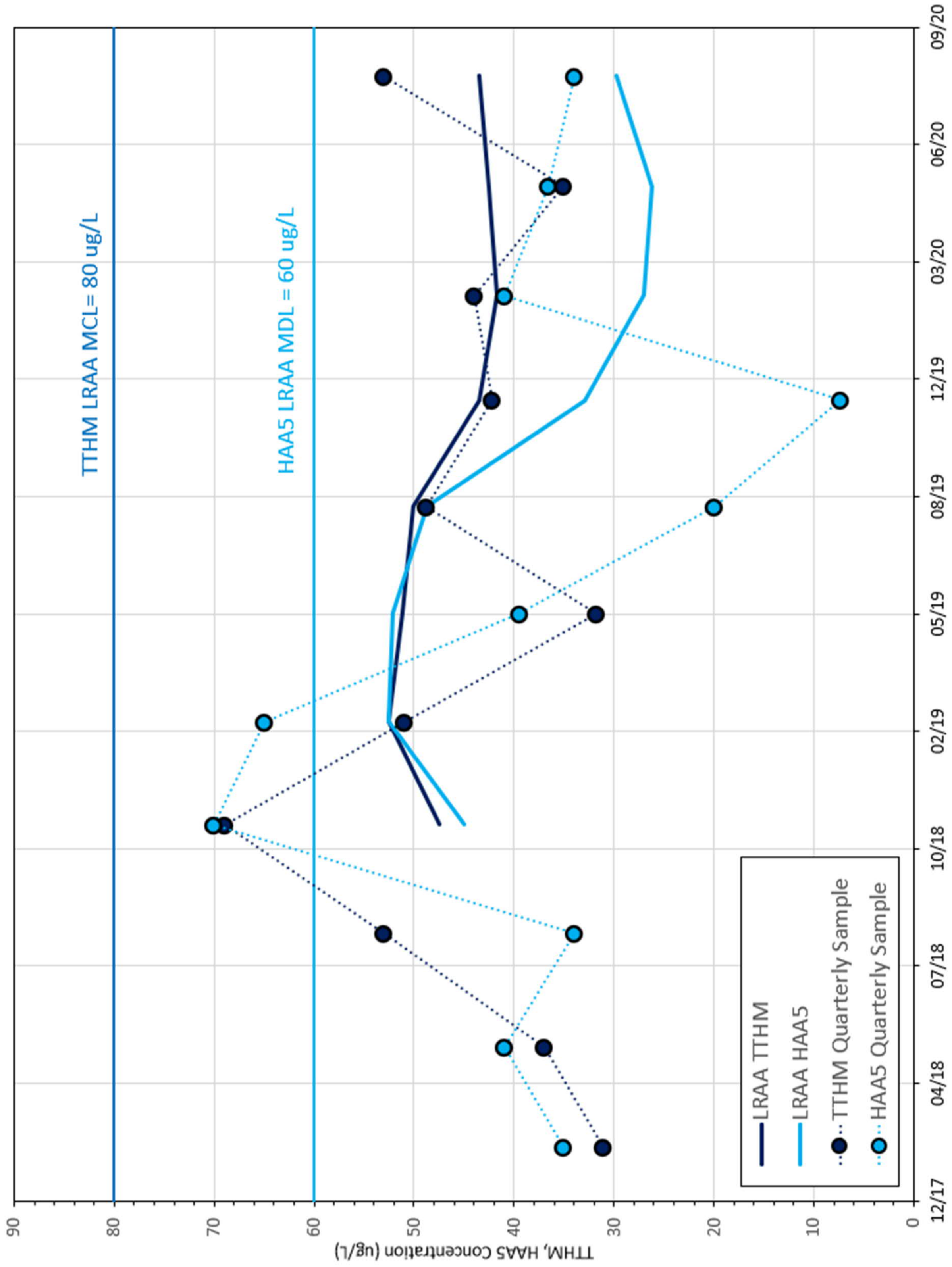
As shown, the DBPs measured at the sampling point are in compliance with the LRAA MCLs for TTHMs and HAAs. For TTHMs, the LRAA must be below 80 ug/L and for HAAs, the compliance level is 60 ug/L. It should be noted that compliance is based on the LRAA, not the quarterly sampling itself. Therefore, a quarterly sample result can in fact exceed the MCL, but as long as the particular result does not result in an LRAA exceedance, there is no Stage 2 DBP rule violation.

Figure 4-11: Stage 2 DBPR Sampling Location[1]



[1]Aerial photo taken from Google Earth

Figure 4-12: Distribution Samples, TTHMs and HAAs



4.3.4 Inorganics, VOCs, SOCs, and Radionuclides

Inorganic chemicals, volatile organic chemicals, and synthetic organic chemicals (IOCs, VOCs, and SOCs, respectively) are monitored along with radionuclides in the distribution system.

Radionuclides are naturally occurring in soils. The original Radionuclides Rule of 1976 was revised in 2003. The revised rule is based on a sliding scale and called for initial screening period from 2004 to 2007 to establish levels for future monitoring periods. Reduced monitoring is allowed for systems that showed low levels of radionuclides in the screening period.

Radionuclides were not available for review by AECOM for the past three years (2018 - 2020), however, we do not believe that there are any compliance concerns with respect to the Radionuclides Rule. Radionuclides were sampled in 2015 (Consumer Confidence Report 2015) and the contaminant levels were far below the regulatory limit. It should be noted that radon is also in this category of parameters, although the Radon Rule has yet to be finalized. Sampling of radon in water is voluntary in Massachusetts.

Inorganics include a list of 15 compounds: antimony, asbestos, barium, beryllium, cadmium, chromium (total), lead and copper, cyanide, fluoride, mercury, nitrate, nitrite, selenium, and thallium. With the exception of lead and copper on a biannual sampling frequency per the LCR and nitrate which was sampled once each in 2018 and 2020, no other inorganic contaminants have been sampled for in the past three years. Since no IOC results were received for the past three years, AECOM assumes all contaminants are below the MCL and the system is on a 9-year compliance cycle. Based on the water system's Consumer Confidence Report from 2019, the last time IOCs were sampled was 2011, therefore it would be expected IOCs would have been sampled in 2020.

For VOCs, the MassDEP requires that every community and non-transient non-community source initially sample VOCs for four consecutive quarters in each three-year compliance period. Sources that do not detect a contaminant during this initial compliance period are reduced to annual sampling. Water systems which use surface water sources can also apply for a waiver if the measured VOCs are below the MCL. There are currently 21 regulated VOCs.

AECOM received one set of results of VOCs from the Point of Entry sampling point. This sample was collected on October 21, 2020 and all regulated VOCs were reported as below the reporting limit (non-detect). It is worth noting chloroform (21.0 ug/L) and bromodichloromethane (2.82 ug/L) were measured in the Point of Entry sample. These compounds are not naturally occurring but are two of the four compounds categorized and federally regulated as total trihalomethanes (TTHMs). As previously discussed, HWWC is not currently in exceedance of either regulated groups of DBPs, but these results suggest DBP formation within the 1 MG storage tank prior to entering distribution. AECOM assumes HWWC does not have a compliance concern with VOCs and therefore does not conduct regular sampling.

For SOCs, utilities were required to initially sample SOCs for four consecutive quarters in each three-year compliance period. Sources that did not detect a contaminant during this initial compliance period were allowed to reduce sampling frequency. AECOM did not receive results from SOCs sampling, so it is assumed HWWC is on a reduced sampling schedule and that there are no compliance concerns with respect to SOCs.

4.3.5 Perchlorate Rule

Massachusetts is one of only a few states to enforce a perchlorate standard, at 0.02 mg/L. Perchlorate is often the result of aged sodium hypochlorite, which degrades to form chlorate and perchlorate. According to the 2011 Consumer Confidence Report, perchlorate concentrations were non detect. Perchlorate was sampled again in September 2020 and the results were below the 0.05 ug/L minimum detection limit.

4.3.6 Future Regulatory Requirements

The EPA evaluates potential future contaminants for regulation through the Unregulated Contaminant Monitoring Rule (UCMR) and issues a new list of unregulated contaminants to be monitored by public water systems. This is completed every five years as specified in the Safe Drinking Water Act. The most recent UCMR (UCMR4) was completed in 2017 which means the next list of contaminants, UCMR5, is currently being considered and will be proposed this year, 2021.

The UCMR4 identified a few parameters for potential future regulation, namely: cyanotoxins, haloacetic acids (HAAs), and manganese.

Cyanotoxins are toxic algae metabolites created by harmful algae blooms (HABs). It is likely that increased regulatory control of HABs will someday be enforced by EPA. Although this is probably several years out on the horizon, all water suppliers with reservoir or impounded water sources should start planning for reservoir management strategies to control algae. There are many techniques, the most common in the form of copper sulfate dosing, aeration, mixing, and a newer technique using sonication to immobilize algae.

The UCMR4 expands on the list of currently regulated HAAs from five compounds to nine. HWWC is in compliance with the current HAA regulation which regulated five compounds, but it is possible with the additional HAA compounds the system could no longer be in compliance if the regulatory limit is not changed. HWWC should focus efforts on monitoring all DBP formation in the distribution system and investigate methods of reducing formation either through more effective DBP precursor removal or decreased water age.

HWWC suspects a seasonal increase in manganese in the summer and has contracted an outside consulting firm to investigate the issue. Stricter manganese regulation in the future could compel HWWC to seek treatment alternatives either on a seasonal or continuous basis for manganese in the Long Pond Reservoir.

UCMR5 is still in the proposal phase and will be subject to public comment and hearings. Under the current proposal, the monitoring focuses on 29 perflourinated compounds and lithium.

Perflourinated compounds are commonly referred to as PFASs or PFOS, but basically, these are found primarily in groundwater sources that have been contaminated with water from industrial sites or military operations. These compounds are typically used in fire retardants, oil and water repellents, furniture, waterproof clothes, take out containers, and non-stick cookware. At the time writing and based on the water quality results provided by HWWC, Long Pond has not been found to contain PFAS.

Lithium has been added to the list of contaminants to monitor due to studies suggesting elevated levels could cause adverse health effect such as impaired thyroid and kidney function. Lithium is primarily found in groundwater and therefore not expected to be a concern for the HWWC system.

4.3.7 Customer Complaints

HWWC occasionally received complaints related to the water system. Complaints are predominately related to dirty or roily water. Customer complaints have not been formally logged as far as AECOM has been made aware, however several instances have been summarized in either documentation provided by HWWC or in records submitted to DEP.

In the summer of 2018, HWWC received customer complaints concerning roily water from their sinks. These complaints coincided with a violation of the Lead and Copper Rule for the third quarter 2018. MassDEP issued conditional approval to install corrosion control equipment which included pH adjustment with caustic and the addition of a blended ortho/polyphosphate. While the lead and copper concentrations measured have decreased, no corrosion control equipment has been installed. HWWC attributes improved sampling procedures, a reduction in the application of chlorine for primary disinfection, and the effects of its storage tank re-piping, has sufficient reduced lead and copper to below Action Levels.

In the summer of 2020, HWWC again received similar customer complaints concerning roily water and in response, HWWC contracted a consulting firm, Cornwell Engineering Group (CEG), to investigate the issue. CEG conducted a desktop corrosion control analysis and investigated historical water quality data. CEG concluded the raw manganese in the Long Pond Reservoir increasing in the warmer summer months caused the water discoloration and suggested a treatment process be constructed to address the issue. This is likely what caused the reports of discolored water from customers in the summer 2018. CEG also concluded the use of an orthophosphate and pH adjustment may need to be evaluated for corrosion control if a future LCR exceedance occurs.

4.4 Water Treatment Plant Site Assessment Evaluation

On January 21, 2021, AECOM participated in a site visit of the Long Pond WTP and 1.0 million gallon storage tank, located in Great Barrington, Massachusetts. The purpose of the visit was to perform a visual physical assessment of the plant equipment, processes, building, building services, and site grounds at the WTP and storage tank. AECOM was escorted on the site by HWWC personnel. Due to the risk of COVID19 infection and in accordance with local guidelines, AECOM personnel were unable to physically enter the treatment plant. The buried infrastructure was also buried under a fresh blanket of snow making an assessment of the structures difficult. The physical assessment was primarily completed using documentation provided by HWWC, a view of the interior of the plant from the doorway, and pictures of the interior provided by HWWC. Those in attendance from AECOM included:

Doug Gove, Project Manager
Anthony Catalano Jr., Structural Engineer
Ron Demers, Electrical / I&C Representative
Bryan Sadowski, Water Process Specialist

Memoranda from AECOM's structural assessment and electrical assessment are attached in Appendix A and Appendix B, respectively. These assessments are summarized in Sections 4.5.3 and 4.5.4 of this report.

4.4.1 Chemical Storage and Feed Systems

Based on the photos provided by HWWC, the two Stenner SVP Digital Peristaltic Pumps which feed sodium hypochlorite were in good condition. One of the pumps is in continuous operation while the other is maintained for redundancy. Sodium hypochlorite is the only chemical feed system at the Long Pond WTP.

The treatment plant has two ungraduated 400 gallon tanks available for sodium hypochlorite storage. In the 2020 Sanitary Survey, MassDEP indicated that there is typically 250 gallons stored onsite. HWWC indicated that there is a sodium hypochlorite delivery once per month, however the monthly reports list the daily chemical usage as consistently around 2.5 gallons per day. This rate of usage suggests that HWWC would only use less than a third of its stock before a delivery. At the time of this writing, there is no clear way to manually calibrate the rate of sodium hypochlorite usage at the plant.

4.4.2 Building Systems: Structural

The main purpose of the structural assessment conducted on January 21, 2020 was to observe any major structural deficiencies at the plant. The conclusion of the assessment was that there are no visible signs of major structural deficiencies. The conclusion of the assessment may change based on additional assessments of the interior of the treatment plant, the interior of the chlorine contact tank and slow sand filters, and the top slab of the chlorine contact tank when it is cleared of snow.

The full structural memo is shown in Appendix A.

4.4.3 Building Systems: General Electrical

Similar to the structural assessment, the electrical assessment conducted on January 21, 2021 was to identify any major electrical deficiencies at the plant. The conclusions of the assessment were the utility pole closest to the treatment plant (likely owned by HWWC) showed signs of damage and age and the electrical connection to the building is poorly installed and maintained. The pump motors appear to be high efficiency, but they are not new meaning replacement is likely required in the next 10 to 20 years. The main breaker appears to have space for future expansion.

The full electrical memo is shown in Appendix B.

4.4.4 Process Automation and Control

Filtered water flows by gravity to the chlorine contact tank (CCT). Prior to the CCT, sodium hypochlorite is injected based on the flow to maintain a free chlorine concentration of approximately 1.0 mg/L. Treated water leaving the CCT flows by gravity back to the operations building where it is pumped using two (10 HP) high lift pumps, to the 1.0 MG storage tank. The pumps operate based on tank water level. The operating range of the tank is 10 feet (high lift pumps are turned on at 30 feet and off at 40 feet) and the tank is equipped with both high and low level alarms.

Turbidity is continuously monitored at the plant influent and on each filter effluent. An online pH analyzer (Hach Model SC 100) and online alkalinity analyzer (Hach Model APA 6000) are installed on the line downstream of the finished water pumps. In-line chlorine analyzers (Kuntze Neon Multi) record the chlorine concentration leaving the chlorine contact tank and the Point of Entry into the distribution system. According to MassDEP (Sanitary Survey 2020), there is no Point of Entry chlorine residual alarm.

Setpoints can be changed by the operator via the plant's SCADA system either in person at the plant or remotely.

4.4.5 Recommended Improvements for the Long Pond WTP

As previously stated, the physical assessment of the treatment plant was limited due to the precautions taken to reduce risk of COVID19 exposure. An additional assessment will likely have to be performed, once it is safe to do so, in order to complete a more comprehensive evaluation of the treatment plant's physical condition and make recommendations for improvements. The following recommendations are based predominately on citations made by MassDEP during annual sanitary surveys.

Table 4-4 summarizes the capital improvements recommended to maintain the functionality of the Long Pond WTP and fulfill MassDEP requirements. These recommendations do not include new treatment processes which are discussed in Section 4.5.

In addition to the recommended improvements, the following additional evaluations are recommended:

- Access rights to the WTP property should be evaluated. Currently, operators have to drive on an access road through privately owned property to get to the WTP
- Evaluation of the exterior electrical connection to the building to minimize hazards
- An evaluation of the spillway capacity

Table 4-4: Recommended Capital Improvements for the Long Pond WTP

Chemical Storage and Feed System Capital Improvement Recommendations	
1	Replace sodium hypochlorite day tank with one that has graduations and add a clear calibration tube or chamber to allow for direct physical checking of actual feed rates.
Mechanical Process Capital Improvement Recommendations	
1	Installation of an onsite emergency generator to power the entire plant in the event of a power failure.
2	Installation of a mixer in the 1.0 million gallon storage. Consideration should also be given to installation of a THM removal system.
Electrical Capital Improvement Recommendations	
1	Install an electrical connection to allow for a portable generator to be installed until the installation of an on-site generator is completed.
2	Replace the existing utility pole on the property.
Process Automation and Control Capital Improvement Recommendations	
1	Incorporate a high raw turbidity alarm into the plant's SCADA system.
2	Incorporate a high and low point of entry chlorine residual alarm into the plant's SCADA system.

4.5 Summary and Recommendations

The review of the operating and water quality data shows that the WTP is operating as intended and is generally able to meet USEPA water quality standards. That being said, in recent years the treatment plant has not always been able to meet regulatory limits. Individual HAA5 samples exceeded the limit in 4th quarter 2018 and 1st quarter 2019, though the LRAA remained below the MCL. It is also suspected a seasonal manganese spike occurs during the summer which causes manganese concentrations to exceed the SMCL and causes discoloration in the distribution system. The current treatment system relies on an antiquated process and in order to prepare for future decreasing water quality, treatment alternatives should be considered to supplement or replace the slow sand filtration system. In addition, lead and copper in the distribution system has been a problem as recently as 2018 and the system still does not have a corrosion control program.

To reduce the chances of previous water quality issues from being repeated and to proactively address future more stringent regulations and/or worsening source water quality, recommendations are presented below.

4.5.1 Modification of Long Pond WTP Intake

As discussed in Section 4.2.2., the water temperature measured at the treatment plant, while seasonally predictable, has a significant range that is much larger than a typical treatment plant which treats a surface water source. The temperature fluctuations are likely due to the depth of the shallow intake which is approximately 4 feet deep (Section 2.2.1). The closer the intake is to the surface, the more susceptible the influent is to the ambient temperature. It has been observed that the amount of customer complaints concerning poor water quality occur predominately during the summer when the water is warmer. These complaints could be linked to a seasonal manganese spike or eutrophication in the reservoir, both of which could be reduced in severity if the intake was lower.

According to several HWWC documents, a second active intake exists at a depth of about 8 feet and is located farther into the reservoir. It is recommended to first confirm the depths and locations of the two intakes. If the second intake is deeper and further towards the center of the reservoir than the shallower intake closer to the plant, considerations should be made to close the shallow intake and rely entirely on the deeper intake. The deeper intake should reduce the temperature swings and reduce the worsening water quality conditions associated with seasonal turnover of surface water source.

4.5.2 Minimization of DBP Formation

It is recommended the HWWC keep a close watch on DBP formation and have a plan in place for DBP minimization.

Generally, there are five common techniques that are used when DBP formation is a concern, summarized below with recommendations specific to the HWWC system:

1. Switching secondary disinfection from free chlorine to chloramines. For HWWC, the DBP issue is not severe, and it is not recommended to switch to chloramines. This is typically reserved as a last resort and for situations where DBPs are much harder to control.
2. Minimizing the use of chlorine in the distribution system. Minimizing the use of chlorine would be effective for lowering DBP formation potential but could come at the expense of total coliform violations. The current practice of maintain low but “measurable” free chlorine residual appears to be doing a good job in maintaining a proper secondary disinfectant and it is probably best to continue with this practice.
3. Managing water age. Issues with DBP are very often linked to increased water age in a distribution system. The annual flow data from the Long Pond WTP suggests demand has been decreasing since 2015, which could increase the water age within the 1.0 MG storage tank and the distribution system. Efforts to periodically turnover the storage tank and flush the distribution system should assist in managing DBP formation. Additionally, it is recommended a mixing system be installed in the 1.0 MG Storage Tank in order to minimize stagnation and reduce water age.
4. Reducing the amount of TOC entering the distribution system. If the practice of water age management is not effective, reducing TOC entering the distribution system would be the next step, accomplished by making changes at the WTP. The current slow sand filtration process does not offer much flexibility to optimize TOC removal because there is no upstream chemical

addition, so treatment alternatives would have to be considered to replace the current treatment plant. Several treatment alternatives shown to provide effective TOC removal that would be appropriate to meet the HWWC system demands include:

a. KROFTA Sandfloat Dissolved Air Flotation Clarifier/ Dual Media Filter. This KROFTA system combines flocculation, flotation, and filtration in one piece of equipment. This unit has been shown to effectively reduce TOC concentrations throughout Western Massachusetts and can be manufactured to meet the HWWC system demand.
b. Ion-exchange. The use of ion exchange resin in a pressurized vessel has been shown throughout New England to effectively reduce TOC concentrations. The process operationally works similarly to pressure filtration, but instead of backwashing, the resin is regenerated by an outside service on a periodic basis. This means zero waste to be disposed of onsite.
c. In-line Filtration. The use of direct filtration is a more conventional process similar to the existing slow sand filters. The process will still rely on a gravity filtration, but the filter influent will be chemically dosed and flocculated so TOC can be removed by the filters.

4.5.3 Addressing Seasonal Manganese

The report from Cornwell Engineer Group dated October 29, 2020 concluded the discoloration of water in the distribution system was caused by a seasonal increase in manganese from the Long Pond Reservoir. Any future treatment alternatives should include a process to remove manganese on a seasonal basis. The following are common treatment alternatives for manganese:

1. Chlorine Dioxide. The oxidation of dissolved manganese to a non-aqueous form with chlorine dioxide for subsequent removal with either filtration or DAF has been implemented in several surface water treatment plants in New England. Chlorine dioxide is not able to be implemented upstream of slow sand filtration, therefore additional filtration or sedimentation would need to be installed downstream along with chlorine dioxide.
2. Potassium Permanganate. Similarly, to chlorine dioxide, potassium permanganate oxidizes manganese to a non-aqueous form for mechanical removal. The advantage of permanganate is it's applied with a chemical feed pump while chlorine dioxide requires a generator. The disadvantage is overdosing causes water to turn pink while it is usually more difficult to overdose with chlorine dioxide. Also, similarly to chlorine dioxide, potassium permanganate would need to be installed downstream of the slow sand filters with an additional filtration or sedimentation process.
3. Adsorptive media filtration. Adsorptive media filtration relies on manganese remaining in the dissolved form and adsorbing to filter media which has been chemically treated with an adsorptive coating. This process doubles as a mechanical filtration process, but the adoptive coating requires regeneration with either sodium hypochlorite or potassium permanganate on either a continuous or intermittent basis (depending on the concentration of manganese).

4.5.4 Replacement of Existing Long Pond WTP

Slow sand filtration, the process currently utilized at the Long Pond WTP, is considered an antiquated technology for surface water treatment. Many new technologies have been developed and implemented throughout New England to address a variety of contaminants in surface water sources. Taking into account the age of the process and the history of customer complaints, AECOM recommends plans be considered for the long term replacement of the system.

An upgrade to the existing plant should be able to at least meet the current maximum day demand (0.3 mgd in 2018) with one train out of service. While the potential future maximum day demand could be as high as 0.39 MGD if HWWC wanted to increase its customer base, an upgraded plant with a capacity of 0.3 MGD was evaluated. An additional treatment train could be added to increase the plant capacity to 0.39 mgd in the future or the 1.0 MG storage tank could provide the additional 0.09 MGD required if one train was out of service during maximum day conditions. The 1.0 MG storage tank has a useable storage of about 250,000 gallons which should provide supplemental flow in the event of two days in a row of future maximum day conditions. The new treatment process should provide for the removal of turbidity and TOC (discussed in Section 4.4.2, Bullet 5) as well as a seasonal manganese increase (discussed in Section 4.4.3). Previous sections of this report have outlined multiple treatment alternatives for each of these contaminants. AECOM's recommendation for a future treatment system is pressure filtration using adsorptive media followed by ion exchange.

The use of pressure filtration would provide sufficient turbidity removal and can address not only a seasonal manganese issue, but any concentration of manganese in the source water throughout the year. The adsorptive media system would require a chemical oxidant injected into the filter influent, likely sodium hypochlorite, to continuously regenerate the adsorptive coating of the filter media.

Alternatively, the manganese could be removed by oxidizing the manganese directly into a filterable particle rather than achieving removal via an adsorptive process. While chlorine dioxide is capable of oxidizing manganese for removal, it's use also requires additional processes to mitigate potential chlorite formation.

The use of potassium permanganate is still an option with adsorptive media filtration, however there is a risk of overdosing potassium permanganate causing pink water. Additionally, while potassium permanganate is able to continuously regenerate the adsorptive media, it often oxidizes a greater percentage of raw manganese than sodium hypochlorite which causes the removal mechanism to be predominately mechanical rather than adsorptive. The oxidized raw water manganese along with the additional manganese added due to the use of potassium permanganate being loaded onto the filter will cause more frequent backwashing. The use of potassium permanganate should be reserved for cases where removal via adsorptive media is not an option, particularly when the raw water metals are complexed with organics. The continuous regeneration of the adsorptive media using sodium hypochlorite, a chemical already in use by HWWC, would be preferable.

The selection of ion exchange (IEX) for the TOC removal process was based predominately on the constrictions of the site. The KROFTA Sandfloat DAF/Dual Media Filtration system has been shown to be effective for turbidity and organics removal throughout western Massachusetts, however the property owned by HWWC around the Long Pond WTP is limited and the use of DAF would require substantial space for residuals control. Direct filtration would also require similarly, but not as much, space for residual handling such as lagoons. The benefit of ion exchange is the vessels will not be backwashed, rather the exhausted brine used to regenerate the media within the vessel would need to be disposed of periodically. The exhausted brine does not require significant storage space and can be contracted for removal by a vendor.

The design criteria for a future treatment plant was based on the demands discussed in Section 3 and water quality data presented in Section 4.2. The design criteria are summarized in Table 4-5.

Table 4-5: Design Criteria for Future WTP

Parameter	Units	Flow Capacity for New Treatment Plant
Total Plant Flow Rate	MGD	0.6 MGD
Number of Process Trains		2 (1 operating and 1 standby)
Flow Rate for Each Process Train	MGD	0.3 MGD
Pressure Filtration with Greendsand Media		
Filter Surface Loading Rate	gpm/sf	3.0 gpm/sf
Working Pressure	Psi	100
Vessel Diameter	Feet	9.5
Side Shell	Feet	6
Greensand Media Depth	Inches	18
Anthracite Media Depth	Inches	12
Gravel Depth	Inches	15
IEX Process		
Vessel Loading Rate	gpm/sf	7.4
Working Pressure	Psi	100
Vessel Diameter	Feet	6
Vessel Height	Feet	11.9
Resin Depth	Inches	36
Gravel Depth	Inches	15
Anticipated Raw Water Quality		
Manganese	mg/L	0.00 – 0.10
Total Organic Carbon	mg/L	2.50 – 4.50
Color	c.u.	5 – 20

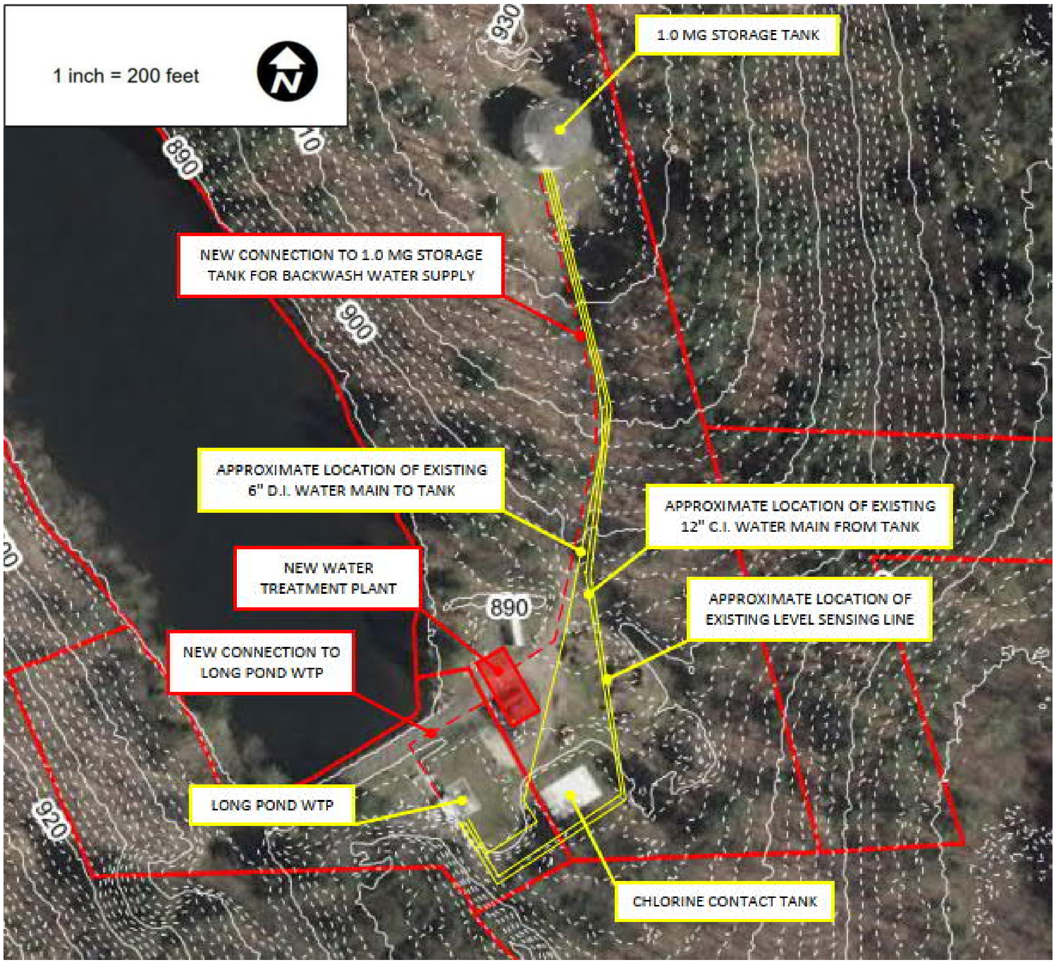
To manage the overall cost of the project while still addressing the more immediate concerns of the water system, the construction of the new treatment plant can be divided into two phases.

4.4.4.1 Phase 1: Supplemental Greensand Media Filter and New Treatment Building

The focus of Phase 1 is to address the immediate needs of the water system while planning for the addition of future processes to eventually replace the slow sand filters. The main components of the first phase include the construction of a new 30 foot x 70 foot treatment building, the installation of a single Greensand filter vessel (design capacity 0.3 MGD) and connecting the filter to the existing Long Pond WTP.

The proposed site of the new treatment building is to the northeast of the Long Pond WTP and northwest of the Chlorine Contact Tank (CCT). The location of the proposed water treatment plant is shown in Figure 4-13.

Figure 4-13: Proposed Location of new WTP



The new treatment building will contain a single Greensand media filter. As part of Phase 2 construction, a second Greensand media filter will be added. The reason for a single filter as part of Phase 1 is the filter will only be serving as a supplementary treatment process. Since the Greensand media filter will be installed downstream of the slow sand filters, turbidity removal would already have been accomplished. The main purpose of the Greensand filter under Phase 1 is to address the seasonal manganese issue. This means the filter will be used infrequently and the Long Pond WTP could remain functioning in the event the Greensand filter is not operational. The filter will likely receive flow only during the summer months and will require infrequent backwashing due to the aforementioned turbidity removal being completed by the slow sand filters.

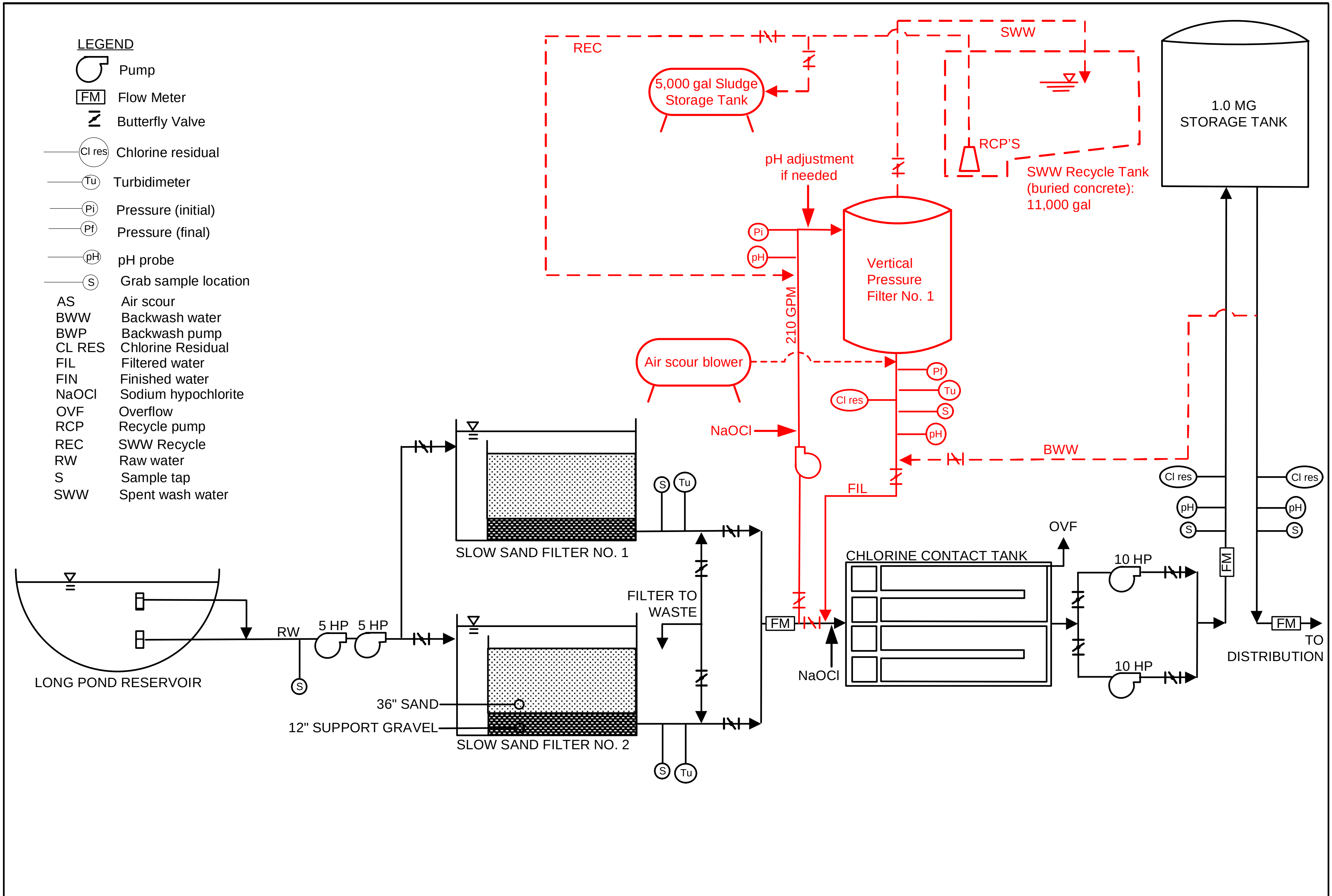
The new treatment plant will be connected to the Long Pond WTP from the 8-inch stainless steel pipe which conveys effluent from the slow sand filters to the chlorine contact tank. Phase 1 of construction will include adding two tees to the 8-inch finished water piping, upstream of the sodium hypochlorite addition. The first tee will convey water to a booster pump which will pump filtered effluent from the Long Pond WTP to the new treatment building and pressurizing the Greensand media filter.

Additionally, the second tee on the finished water piping will convey Greensand filter effluent to the chlorine contact tank. Finished water will then flow from the chlorine contact tank back to the Long Pond WTP to be pumped to the 1.0 MG storage tank as normal. An 8-inch valve will be installed in between the two tees in order to control whether filtered water goes to the new treatment plant as required.

The new treatment plant will contain additional space for a laboratory, electrical and mechanical equipment, sodium hypochlorite storage, and space for future addition of a second Greensand filter and two ion exchange vessels. The sodium hypochlorite addition is required to continuously regenerate the Greensand media in order to maintain its adsorptive properties. Since the potential exists for sodium hypochlorite to increase the pH above the acceptable range for Greensand filtration, pH adjustment may be required upstream of the filter and pH monitoring probes should be installed prior to and following filtration. Additional room has been planned for in the new treatment building in the event caustic is required to be added to increase the treatment plant effluent pH and/or if a corrosion control chemical is required. Additional chemical feed pumps and storage has not been included in the cost estimate for caustic and/or a corrosion control chemical.

The residuals control will be completed under the first phase of construction, however due to the infrequent use and backwashing of the single Greensand filter, the residuals control will be minimal until the completion of Phase 2. The residuals control consists of a spent washwater recycle tank which will be constructed out of concrete and located underneath the new treatment plant. Spent washwater will be allowed to settle within the recycle tank and the decant will be pumped out of the recycle tank to the head of the new treatment plant to be recycled. The recycle rate typical for this process is 10% of the total influent flow. Once the settled sludge accumulates at the bottom of the recycle tank, it will be transferred using a sludge transfer pump into a 5,000 gal sludge storage tank to eventually be hauled away for disposal. The washwater will be supplied from the 1.0 MG storage tank via an 8-inch pipe which will connect the storage tank to the new treatment plant.

Figure 4-14 shows a process flow diagram of the current processes utilized at the Long Pond WTP with the Phase 1 upgrades outlined in red.



PLOT DATE: 3/26/2021

NO SCALE

AECOM

Figure 4-14: Phase 1 – Supplemental Adsorptive Media Filter and New Treatment Building

HOUSATONIC WATER WORKS COMPANY
Water System Evaluation

4.4.4.2 Phase 2: Additional Greensand Filter and IEX Process

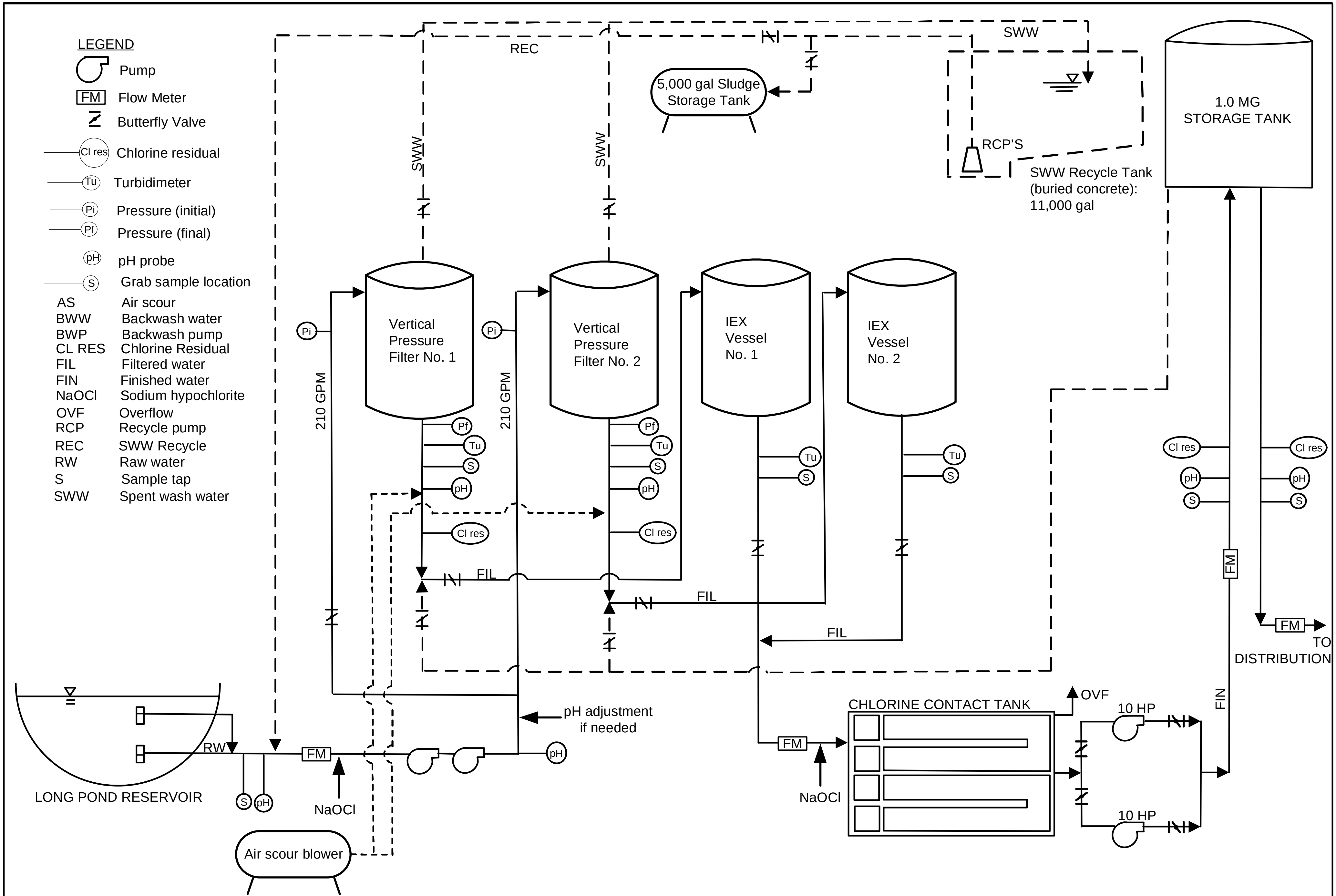
The focus of Phase 2 is to decommission the slow sand filters, install two ion exchange (IEX) vessels downstream of the Greensand filters for organics removal, and install a second Greensand media filter to bring the total capacity of the new treatment plant to 0.6 MGD or 0.3 MGD with one train out of service.

Modifications will be made in order to bypass the slow sand filters and ultimately decommission them. A reducer will be installed on the 10-inch stainless steel pipe which brings raw water into the treatment plant. The reducer will be connected to the tee which allows flow to the new treatment plant with new 8-inch pipe, effectively bypassing the slow sand filters. Additionally, a second booster pump will be installed on the pipe going to the new treatment plant as a standby in the event the first pump fails. The effluent from the new treatment plant will continue to be conveyed back to the Long Pond WTP where it will be post chlorinated prior to entering the chlorine contact tank. A section of the 8-inch pipe will be removed and two blind flanges installed between the tee conveying raw water to the new treatment plant and the tee receiving the treated effluent going to the chlorine contact basin to ensure raw water cannot bypass the new treatment plant.

At the new treatment plant, a tee will be installed to split the raw water flow into two treatment trains. The first train will consist of the original Greensand media filter which will be in series with the an IEX vessel in the new treatment building. The second train will consist of the second, newly installed Greensand media filter, which will be in series with the second IEX vessel in the new treatment building. These two treatment trains will be tied together downstream of the IEX vessels and sent back to the Long Water WTP for post chlorination. The sodium hypochlorite feed in the new treatment plant will continue to provide pre chlorination to the Greensand media filters. When the treatment is operated after the completion of Phase 2, the residual chlorine will need to be monitored and kept to a minimum coming out of the Greensand media filters. A high chlorine residual leaving the Greensand filters could compromise the IEX vessels.

The residuals control will continue to operate similarly as Phase 1, however since there are now two Greensand media filters and they are responsible for turbidity removal as well as manganese removal, it is expected the amount of spent backwash water will increase as well as the frequency the recycling of supernatant. Due to the limitations of residuals disposal at the Long Pond WTP, the resin manufacturer that will be selected for the IEX vessels will also have to be able to provide offsite resin regeneration. The amount of resin regenerations required will be determined by the resin capacity which varies depending on the water quality. The resin capacity will be determined through either pilot or bench scale testing.

Figure 4-15 shows a process flow diagram of the new treatment processes after the completion of Phase 2. Figure 4-16 shows a site plan of the new building which will house the upgrades from Phase 1 and Phase 2 (shown in a dashed line).

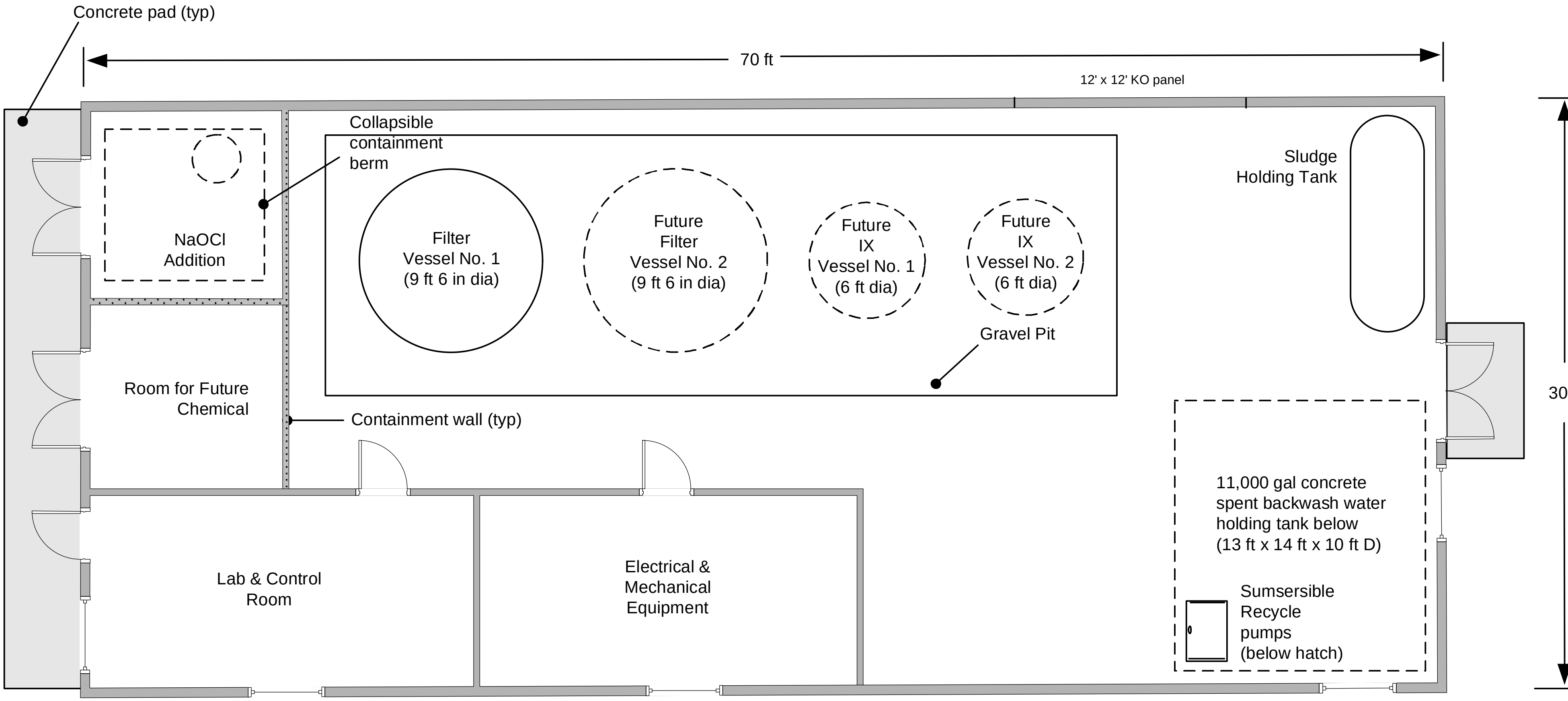


PLOT DATE: 3/26/2021

NO SCALE

Figure 4-15: Phase 2 – Additional Adsorptive Media Filter and IEX Process

HOUSATONIC WATER WORKS COMPANY
Water System Evaluation



PLOT DATE:
3/25/2021

SCALE:
1/8 inch per ft

AECOM

Figure 4-16: Proposed Layout of New Treatment Building

Housatonic Water Works Company
Water System Evaluation

4.5.5 Implementation of a Corrosion Control Program

At the time of this writing, the HWWC system is in compliance with the EPA Lead and Copper Rule (LCR). There have not been any violations of the LCR since 2018 and the concentrations of lead and copper appear to be stable. When the system violated the LCR back in 2016, MassDEP approved the installation of corrosion control equipment including chemicals for corrosion and pH control. No corrosion control equipment has been installed to date.

As part of Cornwell Engineering Group's evaluation into the cause of water discoloration in the distribution system, the group investigated several corrosion control parameters. In response to this investigation, the 2020 Sanitary Survey (issued September 2020) indicated the following:

"MassDEP requires that a final copy of the consultant's study report be provided by December 21, 2020. If MassDEP agrees with the report's recommendations, all necessary permitting and equipment installation recommended within that report must be completed by June 1, 2021 and submit a copy of that report to the Department"

The final report by Cornwell Engineering Group was issued in October 2020. The recommendations of the report regarding corrosion control included the following statement:

"9. The current distribution system pH is already close to the saturation pH (8.2), so it may not be possible to increase the pH much higher. Consequently, if lead and copper cannot be controlled under current conditions, the addition of orthophosphate may need to be evaluated. Evaluation of orthophosphate and pH adjustment should include, at minimum, laboratory solubility studies for lead and copper to evaluate optimal pH and orthophosphate dose."

To AECOM's knowledge, MassDEP has not responded to the submitted Cornwell Engineering Group report or required the design of a corrosion control system.

It is the recommendation of AECOM to defer to the conclusions of the Cornwell Engineering Group Report regarding corrosion control. The chemistry of a distribution system should not be altered without just cause. In the event another LCR violation occurs, HWWC should conduct a laboratory solubility study or pipe loop study to evaluate if the addition of an orthophosphate and establishing pH control would mitigate any lead and copper issues. In addition, if the chemistry of the distribution were changed due to the construction of a new treatment system, effluent from the new plant should be evaluated in terms of key corrosion control parameters to ensure it's similar to the current plant effluent to avoid causing an upset in the distribution system.

5 Distribution System

5.1 Introduction

The Housatonic Water Works Company (HWWC) serves approximately 1,400 people within its service area. The distribution system pressure is determined by the water level in the 1.0 million gallon (MG) storage tank located at the Long Pond WTP. The distribution system contains approximately 16 miles of piping which range in size from 2 inch to 14 inch and piping materials include asbestos cement, ductile iron, cast iron, and PVC.

5.2 Description of Water Distribution System

The water distribution system begins at the Long Pond WTP where treated water is pumped into the 1.0 MG prestressed concrete water storage tank. The tank is 40 feet in height, 65 ½ feet in diameter, and has an operating range of 10 feet (high lift pumps on at 30 feet and off at 40 feet). The tank design incorporates flow equalization and fire flow. From the storage tank, water flows by gravity back toward the treatment plant through a 12-inch pipe before entering the distribution system.

The distribution system piping measures approximately 104,000 linear feet and consists of a range of materials. Table 5-1 categorizes the distribution system piping by diameter and Table 5-2 categorizes the distribution system piping by material. Figure 5-1 shows a water system map which includes pipe diameter and material. A complete description of the distribution system is included in the Technical Memo in Appendix C of this report.

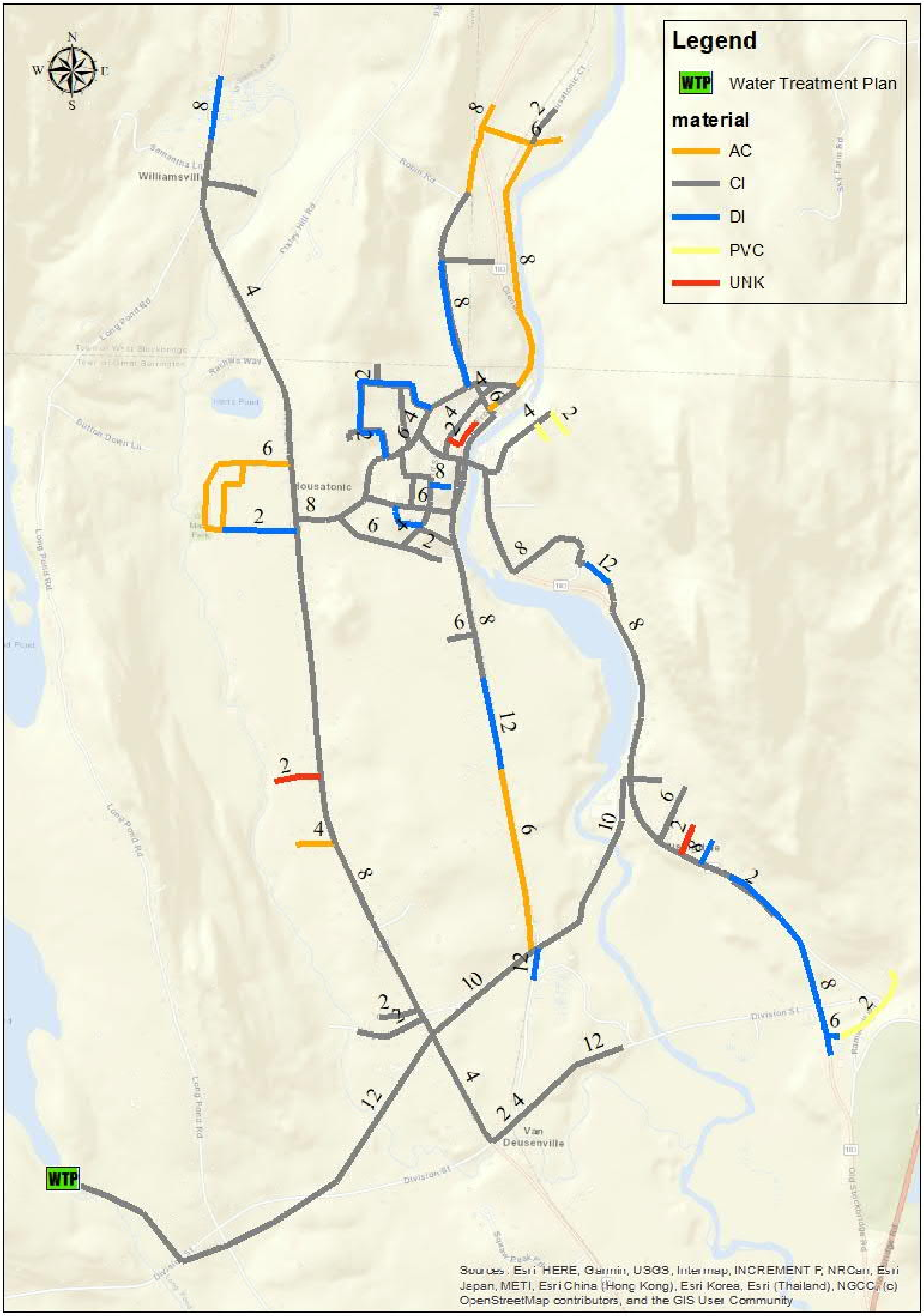
Table 5-1: Distribution of Water Mains by Diameter

Diameter of Water Main	Total Length [LF]	% total
2-inch	9,365	9%
4-inch	23,009	22%
6-inch	26,116	25%
8-inch	29,398	28%
10-inch	4,355	4%
12-inch	11,141	11%
	103,385	100%

Table 5-2: Distribution of Water Mains by Material

Material	Total Length [LF]	% total
Asbestos Cement (AC)	13,370	13%
Cast Iron (CI)	72,539	70%
Ductile Iron (DI)	13,604	13%
PVC	2,075	2%
Unknown	1,798	2%
	103,385	100%

Figure 5-1: Housatonic Water System (Diameters and Materials)



5.2.1 1.0 MG Storage Tank

The HWWC distribution system includes a 1.0 million gallon prestressed concrete water storage tank that was constructed in 1997. The tank is located adjacent to the WTP at the highest point of the distribution system. The tank has a diameter of 65 feet and is 40 feet tall with an overflow elevation of 960 feet. Water is pumped to the tank from the WTP via a 12 inch pipe that extends up the wall of the tank and penetrates the roof. From the tank the water flows by gravity to the distribution system.

HWWC recently installed a 12-inch stainless steel pipe to convey water from the contact tank to the storage tank. The installation of this pipe changed the tank filling location to the top of the tank and the water leaves the tank from the bottom. The tank operating level fluctuates by approximately 10 feet during normal system operation. Online chlorine analyzer measures residual leaving tank and is used as basis for chlorination of the distribution system.

Based on the current average day demand of 0.17 mgd discussed in Section 3 of this report, the 1.0 mg tank volume represents approximately 6.6 days of storage. This much storage volume may increase water age which in turn may negatively impact distribution system water quality.

An inspection of the tank was performed by Underwater Solutions, Inc. on November 9, 2020 to assess the overall condition of the tank structure and to remove accumulated precipitate from the tank floor. Findings from the inspection are described in detail the tank inspection report included in Appendix B and discussed further below. MassDEP requires inspections every five years so the next inspection will be required in the year 2025.

Underwater Solutions found the tank to be mostly sound and free of obvious leakage. The entire exterior of the tank was inspected. The walls were found to have shrinkage cracks that were limited to the surface of the shotcrete cover coating. The exterior coating was found to have good adhesion value but no longer seals the cracks observed. The roof was found to be sound and free of obvious fatigue of the concrete. An exterior ladder located on the west side of the tank was found to have a failed weld on the handrail on the top right side of the ladder. The ladder is secure and usable at this time.

The entire interior of the tank was also inspected. A layer of precipitate 1/16 inch in depth was found on the floor throughout the tank. After the precipitate was removed, the floor was inspected and found to be sound and free of cracks or settlement. Some mild surface spall of concrete was found over less than 5% of the surface. The interior ladder was found to have corrosion over its entire surface but no fatigue was evident. The interior walls were found to have scouring of the concrete throughout the upper 10 feet, that appeared to be the result of ice cap formation.

Recommendations for future tank maintenance included in the inspection report included the following:

- Pressure-wash and power tool clean the exterior walls and roof, and apply two coats of masonry waterproofing coating
- Repair the handrail on the top right side of the exterior ladder
- Recoat the overflow pipe and flap-valve and install a non-corrodible metal screen
- Install additional non-corrodible metal screen on the vent
- Monitor the areas of surface spall found on the floor
- Monitor the interior ladder for fatigue
- Power tool clean and recoat the interior pipes
- Hand/power tool clean the interior wall and roof surfaces and recoat with a masonry waterproofing coating
- Install active mixer to prevent ice cap formation and improve overall water quality

5.2.2 Previous Distribution Improvements

A hydraulic model was completed in 1990 and 1991 in response to low pressure areas in the distribution system. The hydraulic model recommended improvements such as pipeline replacement, higher head lift pumps as well as the installation of a water storage tank. The 1.0 MG storage tank was installed in 1997 along with the completion of a distribution system improvement project which began in the early 1990's. The distribution system improvements included the following water main replacements:

- Installation of 2,000 feet of 8-inch DI main in Van Deusenville Road
- Installation of 830 feet of 8-inch DI main in Prospect Street (North)
- Installation of 1,240 feet of 8-inch DI main in Kirk Street
- Installation of 250 feet of 8-inch DI water main between Fairview Road and Kirk Street
- Installation of 1,800 feet of 8-inch DI main in High Street
- Installation of pipe loops to loop the distribution system

The distribution system improvements replaced approximately 14,140 feet of pipe which represents about 16% of the distribution system. It is likely the remainder of the system was installed over the years from the late 1800's to the present.

5.3 Hydraulic Model Assessment

A hydraulic model was developed in order to identify any potential deficiencies in HWWC's distribution system. The model network of pipes and junctions was built using a 2017 Water System Map, Housatonic Water System GIS data, and Digital Elevation Model of the Project Area. The demands for the water system were based on the data provided by HWWC including HWWC Contact List with account numbers and addresses as well as HWWC Usage and corresponding Water Usage for the year 2014.

As outlined in Section 3.2, the Average Daily Demand of the system has been declining from 2015 to 2020. Considering this and the usage data provided by HWWC was seven years old, the system demands for each scenario run by the model are likely greater than the current system demands, and the results of the assessment should be considered conservative. The four scenarios evaluated by the hydraulic model are summarized in Table 5-3.

Table 5-3: Hydraulic Modelling Scenarios – Normal Demand Conditions

Scenario No.:	Simulated Flow from WTP	Flow (MGD)
Scenario 1	Existing ADD	Q = 0.21 MGD
Scenario 2	Existing MDD	Q = 0.30 MGD
Scenario 3	Future ADD	Q = 0.27 MGD
Scenario 4	Future MDD	Q = 0.39 MGD

The model was calibrated by simulating the flows measured by the Insurance Services Organization (ISO) and compared the results with the stated residual pressures in the ISO report. The static pressures in the ISO report were in excess of the hydraulic grade line (set by the 1.0 MG Storage Tank) at the system boundary and thus were not used. The residual pressures in the ISO report were somewhat suspect but were used to approximate the conditions in the field with high flows reported by ISO. As a result, the pipe roughness used in the model were adjusted downward to better match the model and ISO report.

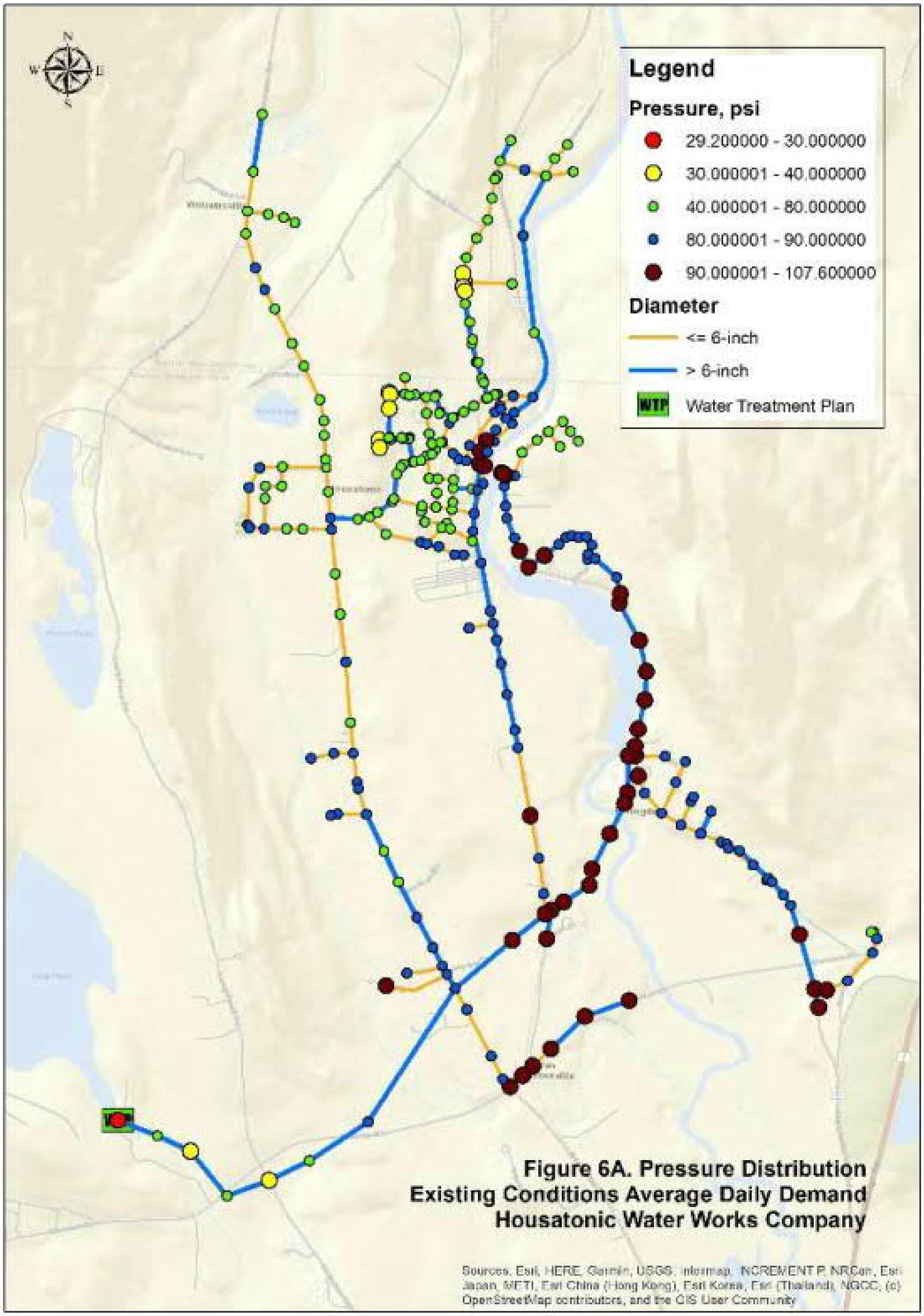
The model was used to evaluate the various scenarios to estimate the system pressure and available fire flow under the four outlined demand conditions. The following sections were summarized from the full hydraulic assessment, included in Appendix C.

5.3.1 System Pressure

The hydraulic model was run using the four scenarios to evaluate the system pressure under existing and future average and max day demand conditions. Figure 5-2 shows the pressure at each junction under the average day demand from 2014 (0.21 MGD).

The results of the analysis of system pressure showed lower pressures along High Street between Main Street North and Robin Road and along Fairview Road and Kirk Street. The low pressure was observed with each scenario. These lower pressures are indicative of the amount of friction loss due to the distance from Long Pond as well as these area’s higher elevations.

Figure 5-2: Pressure Distribution: Existing ADD 0.21 MGD



5.3.2 Available Fire Flow

The available fire flow (AFF) was evaluated using the future average day and max day demands as specified in Table 5-3. The model was able to predict AFF at 20 psi throughout the system under each of the demand conditions. These AFFs were then compared to the minimum needed fire flows (NFFs). The results of this assessment are shown in Table 5-4.

Table 5-4: Hydraulic Modelling Results – Fire Flow Demand Conditions

Scenario No.:	Simulated Flow from WTP	Number of Junctions with AFF < 750 gpm	% of System Junctions (273)	Number of Junctions with AFF < 500 gpm	% of System Junctions (273)
Scenario 2	Existing MDD (0.30 MGD)	258	94.5%	158	57.9%
Scenario 4	Future MDD (0.39 MGD)	268	98.2%	207	75.8%

In addition, information provided by Insurance Services Organization (ISO) indicated unique NFF's for six locations in the system. The determined AFF for each of these locations under existing and future average day demands are summarized in Table 5-5.

Table 5-5: Hydraulic Modelling Results – Fire Flow Demand Conditions – ISO Designated NFFs

Location	NFF, gpm	Available per model			
		Existing MDD (0.30 mgd)	Meets NFF?	Future MDD (0.39 mgd)	Meets NFF?
Front St @ Depot St	4500	402	No	370	No
Main St. @ Oak St.	1750	524	No	475	No
Highland St. @ South St.	750	520	No	472	No
Park St. North of Mountain View	1750	610	No	550	No
Park St. @ North of Division St.	2000	431	No	401	No
N. Plain Rd. @ 2nd hydrant North of Division St.	1250	961	No	877	No

5.4 Distribution System Maintenance

Proper maintenance in the distribution system is imperative to the longevity of the system and increased water quality in the future. A maintenance plan will assist HWWC in delivering high quality water to its customers and minimize downtime associate with pipe break, leaks, and periodic issues with water quality. Preventative maintenance will ensure that reaction time and system interruptions are also minimized during an emergency situation. Pipeline, valve, hydrant, and storage tank maintenance are discussed below.

5.4.1 Aging Infrastructure

Flushing of some parts of the distribution system has occurred, however it is unclear how often. The flushing of the system often coincides with an increase in customer complaints about dirty water. The existing piping seems to be susceptible to any kind of fluctuation in flow or water chemistry and seems to persist for as long as weeks. In addition, the existence of dead ends makes it difficult to flush the entire distribution system. When performed correctly and in a sequential manner, pipeline flushing removes aged water from the distribution system, improves water quality, removes sedimentation and biofilms, improves disinfection residuals and can reduce disinfection byproduct formation.

Another maintenance concern is pipeline leakage which can increase unaccounted for water (UAW), decrease operational efficiency, and increase water system treatment and operational costs. As discussed in Section 3.1, HWWC has an average UAW of 36.7%, significantly greater than the Massachusetts Water Resources Council performance standard of 10% UAW. Thorough leak detection could identify issues within the system and reduce the UAW to the performance standard.

5.4.2 Pipeline Maintenance

Replacement of aging infrastructure should be addressed by an annual water main replacement and rehabilitation program. As a rule of thumb, an annual percentage of 2% of the total distribution system piping should be replace (to completely upgrade the distribution system every 50 years). As previously discussed, the only known pipe replacements that have taken place within the distribution system were completed in the early 1990's in response to low pressure areas. These improvements represented approximately 16% of the total piping within the system. The remainder of the system is likely unchanged from when it was installed, some of which was in the late 1800's. As much as 70% of the distribution system piping consists of old cast iron pipes, most of which are presumed to be unlined. Nearly 13% of the system consists of asbestos cement material, which could cause health hazard if the pipes begin to deteriorate

5.4.3 Hydrant and Valve Maintenance

Hydrant inspections and flushing should occur annually and include confirmation that the hydrants are working and draining properly. Hydrants known to be in poor condition should be immediately repaired. Hydrant inspections and flushing should occur annually and include confirmation that the hydrants are working and draining properly. Valve maintenance should also occur annually and include the exercise of each valve to ensure operability, pavement covering valves should be removed, and clean debris from valve covers to allow access to operating nut.

5.4.4 Storage Tank Maintenance

Maintenance of the water storage tank is critical and should occur weekly. Maintenance should include the following:

- Check of security features, such as locks
- Check of overflow pipes for potential blockages and that screens are intact
- Check of foundation area for concrete spalling and vegetation intrusion
- Check of exterior paint system for potential failures
- Verification that the tank hatches are operable and secure

MassDEP requires a thorough inspection of the interior and exterior of a water storage tank every 3 to 5 years by experienced personnel. The last inspection of the 1.0 MG Storage Tank was completed in 2020.

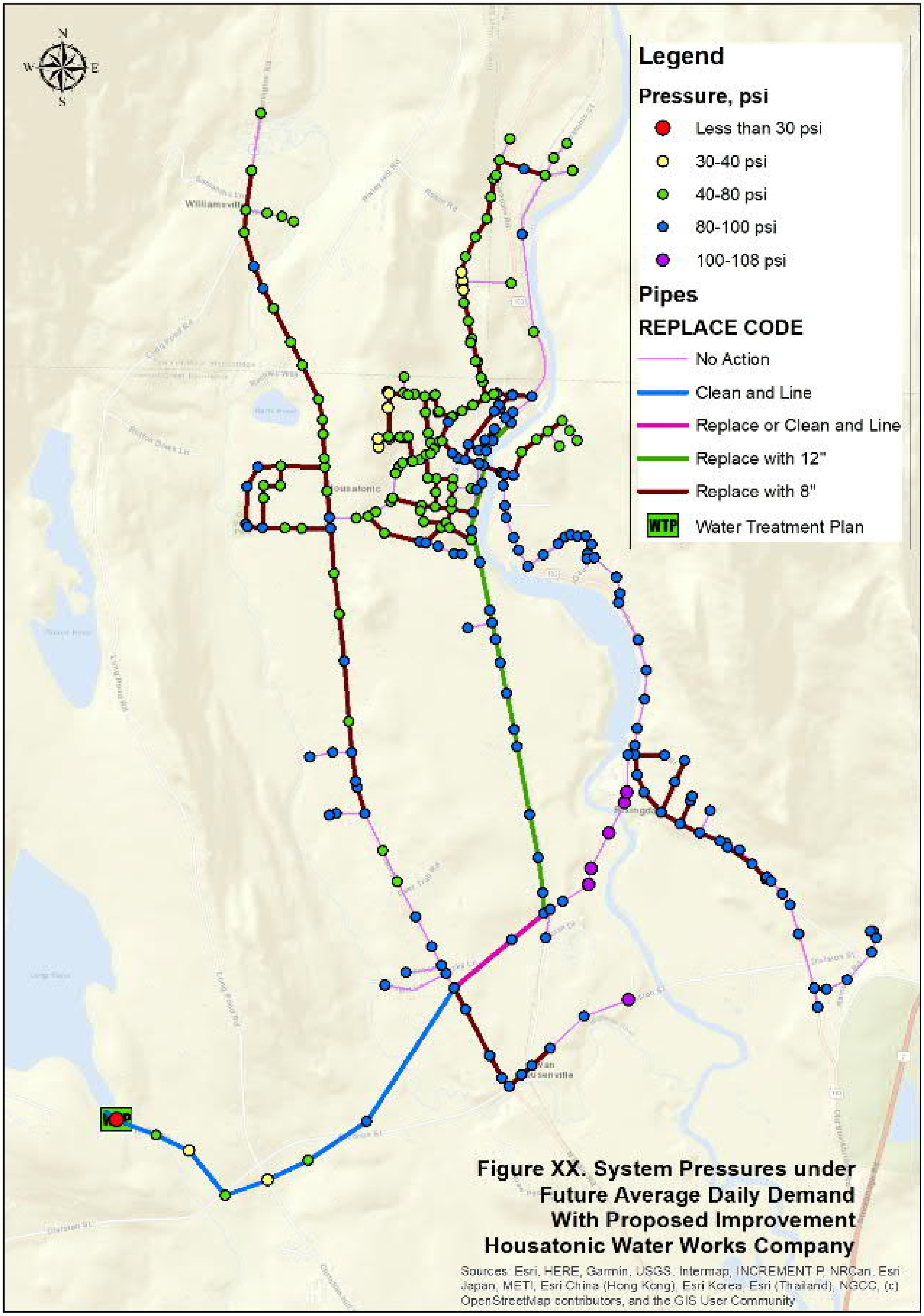
5.5 Findings and Recommendations

Based on our review of the most recent available MassDEP Sanitary Survey, the hydraulic model, and various documentation on the condition of the distribution system, AECOM has concluded a large scale pipeline replacement project should be implemented to replace the aged water mains. A summary of the proposed water main replacement is included in Table 5-6 and is further discussed in Appendix C. Figure 5-3 shows the positive effect the proposed water main replacement project would have on the distribution system under current average day demand conditions.

Table 5-6: Summary of Recommended Pipe Improvements

Size of Existing Main	Recommended Size	Recommended Action	Length, feet
2	8	Replace	3,332
4	8	Replace	20,709
6	8	Replace	25,266
8	12	Replace	6,794
10	12	Replace	1,880
12 (Easement between N. Plain Rd and Van Deusenville Rd.)	12	Replace or Clean and Line	1,378
12 (Pipe from WTP)	12	Clean and Line	7,336
Total Pipe Upgraded			66,695

Figure 5-3: Pressure Distribution with Proposed Improvements: Estimated Future ADD 0.27 MGD



The hydraulic model was then rerun using the existing and future maximum daily demand conditions summarized in Table 5-4 to determine how the AFF at 20 psi would be affected by the proposed pipeline replacement project. The results are summarized in Table 5-7.

Table 5-7: Hydraulic Modeling Results with Proposed Pipeline Improvements – Fire Flow Demand Conditions

Scenario No.:	Simulated Flow from WTP	Number of Junctions with AFF < 750 gpm	% of System Junctions (273)	Number of Junctions with AFF < 500 gpm	% of System Junctions (273)
Scenario 2	Existing MDD (0.30 MGD)	29	10.6%	26	9.5%
Scenario 4	Future MDD (0.39 MGD)	31	11.4%	26	9.5%

6 Capital Improvement Plan

6.1 Introduction

The previous sections of this report presented evaluations of the HWWC's water supply, treatment, and distribution system. These evaluations identified areas in the system that require further improvement or investigation. Based on this, AECOM has prepared the Capital Improvement Plant (CIP) presented in this section.

The CIP summarizes and itemizes major capital improvement projects that have been identified in the report for implementation in order to maintain reliable system operation. The CIP also provides planning level costs for each capital improvement project. The purpose of the CIP is to assist in planning for project design and implementation over the next 20 years from the completion of this report.

6.2 Capital Improvement Plan

The CIP is presented below in Table 6-1, which compiles and itemizes the proposed improvements recommended in the report. The duration of the CIP spans 20 years from the completion of this report.

As shown in Table 6-1, CIP projects are generally grouped by the report headings, including Water Supply, Water Treatment, and Water Distribution. Also provided are the associated estimated project costs for each project. These costs were developed based on quantities for large infrastructure (i.e. concrete, piping), vendor quotes and allowances as applicable. The basis for the cost estimate of Phase I and II of the proposed treatment plant construction are provided in Appendix F. The water main replacement costs are based on a unit price of $300 per linear foot for replacement and $200 per linear foot for relining. The costs in this estimate were made based on prices from April 2021.

Additional costs not accounted for in the capital improvement plan may be required based on the findings of evaluations recommended in this report. The results of the spillway capacity evaluation could recommend widening of the spillway, addition of an auxiliary spillway, or removing the flashboard which could impact the storage volume and yield. Additionally, the results of the pilot scale evaluation could require the treatment plant design included in this report be altered or conclude the proposed processes are not feasible to achieve adequate treatment.

Table 6-1: Capital Improvement Plan

Item	Estimated Construction Cost (2021 $)	Estimated Engineering and Owner's Contingency (40%)	Estimated Total Project Cost (2021 $)	Recommended Timeframe for Improvements		
				0-5 Years	6-10 Years	11-20 Years
Water Supply						
Analysis of spillway capacity		$7,500	$7,500	$7,500		
Remove trees around Long Pond Dam	$6,000	$2,000	$8,000	$8,000		
Remove, repair or replace training wall	$20,000	$8,000	$28,000	$28,000		
Water Treatment						
Installation of a mixing system in the 1.0 MG Storage Tank	$50,000	$20,000	$70,000	$70,000		
Replacement of sodium hypochlorite day tank with one with graduations and a clear calibration tube	$500	$200	$700	$700		
Installation of onsite emergency generator to power two 10 HP pumps in event of a power failure	$150,000	$60,000	$210,000	$210,000		
Replace the existing utility pole on the property	$10,000	$4,000	$14,000	$14,000		
Install a combined filtered effluent turbidimeter and incorporate a high turbidity alarm into the plant's SCADA system	$15,000	$6,000	$21,000	$21,000		
Incorporate a high and low point of entry chlorine residual alarm into the plant's SCADA system	$3,000	$1,000	$4,000	$4,000		
Conduct pilot study to evaluate proposed treatment technologies		$300,000	$300,000	$300,000		
Phase 1: Supplemental Greensand Filter and New Treatment Building	$1,000,000	$400,000	$1,400,000	$1,400,000		
Phase 2: Additional Greensand Filter and IEX Process	$1,100,000	$440,000	$1,540,000	$1,540,000		
Upgrade electric service to 480-volt for new WTP	$100,000	$40,000	$140,000	$140,000		
Water Distribution						
Replacement of 49,307 LF of 2", 4" and 6" with 8" Water Main	$15,000,000	$6,000,000	$21,000,000	$10,500,000	$10,500,000	
Replacement of 8,674 LF of 8" and 10" with 12" Water Main	$2,700,000	$1,080,000	$3,780,000		$3,780,000	
Clean and Line 8,714 LF 12" Water Main	$1,800,000	$720,000	$2,520,000			$2,520,000
Further Studies and Investigations						
Identify the location of both intakes to the WTP and decommission the shallower of the two intakes		$10,000	$10,000	$10,000		
Total	$21,955,000	$9,099,000	$31,053,000	$14,253,000	$14,280,000	$2,520,000

APPENDIX A

AECOM STRUCTURAL ASSESSMENT MEMO

AECOM

AECOM
250 Apollo Drive
Chelmsford
MA, 01824
USA
aecom.com

Project name:
HWW Water System Evals

Project ref:
60648812

From:
Anthony Catalano Jr., PE

Date:
February 8, 2021

To:
Doug Gove, PE

250 Apollo Drive
Chelmsford
MA, 01824
USA

CC:
Michael Malenfant, PE

Memo

Subject: Structural Condition Assessment of Existing Housatonic Water Works Company Water Treatment Plant

On January 21, 2021 a visual, non-invasive/non-destructive structural condition assessment of the existing Housatonic Water Works Company Water Treatment Plant in Great Barrington, Massachusetts was performed by Anthony Catalano Jr., PE of AECOM. The purpose of the assessment was to identify any major structural deficiencies at the plant. The purpose of this memorandum is only to provide a visual assessment of structures that were visually accessible at the time of inspection and not to provide detailed recommendations including products and methods for repair and/or alterations.

Water Treatment Plant & Slow Sand Filter Facility

- The Water Treatment Plant Building & Slow Sand Filter Facility was designed and constructed around 1940 and displayed areas of staining and other signs of typical wear that is often exhibited on a structure of its vintage (See Photos 1 through 10), but the elements of the structure that were visible did not show any major signs of structural deficiencies that would impede on the functionality of the facility.
- It was not allowed to enter the Water Treatment Plant Building due to COVID-19 restrictions, and therefore the interior structural elements in the building were not visually assessed.
- The Water Treatment Plant Building has a structure adjacent to the backside appearing to be a jersey barrier acting as a retaining wall (See Photo 10) which exhibits a potential risk of future mobilization but does not appear to be a threat to the operability of the plant.
- The Slow Sand Filter Tank was covered with snow at the time of inspection and was not drained and therefore the top slab and the interior structural elements were inaccessible for a visual assessment.
- In conclusion, based on the observed condition, no major structural deficiencies were noted in the areas that were visible, but additional assessments of the interior of the Water Treatment Building, the interior of the Chlorine Contact Tank, and top slab of the Chlorine Contact Tank when it is cleared of snow may lead to a different conclusion.

Chlorine Contact Tank

- The Chlorine Contact Tank, which was designed and constructed around 1997, was covered with snow at the time of inspection (See Photo 11) and was not drained and therefore the top slab and the interior structural elements were inaccessible for a visual assessment.

- The sides of the exposed edges of the top slab and walls showed signs of staining and some minor shrinkage cracking (See Photo 12) which is typical for a structure of its vintage.
- In conclusion, based on the observed condition, no major structural deficiencies were noted in the areas that were visible, but additional assessments in the interior of the tank, and the tank's top slab when it is cleared of snow may lead to a different conclusion.

1.0 Million Gallon Prestressed Concrete Storage Tank

- The 1.0 Million Gallon Prestressed Concrete Storage Tank was designed and constructed around 1997 and was only visually inspected from the ground surface (See Photo 13). The storage tank did not exhibit any additional noticeable items above what was mentioned in the November 9, 2020 Inspection Report issued by Underwater Solutions Inc.
- In conclusion, it is recommended that the owner of facility review the recommendations within Underwater Solutions Inc. and consider implementing the recommendations.

Photos:

Photo 1: Water Treatment Plant & Slow Sand Filter Facility Photo 1

Photo 2: Water Treatment Plant & Slow Sand Filter Facility Photo 2

Photo 3: Water Treatment Plant & Slow Sand Filter Facility Photo 3

Photo 4: Water Treatment Plant & Slow Sand Filter Facility Photo 4

Photo 5: Water Treatment Plant & Slow Sand Filter Facility Photo 5

Photo 6: Water Treatment Plant & Slow Sand Filter Facility Photo 6

Photo 7: Water Treatment Plant & Slow Sand Filter Facility Photo 7

Photo 8: Water Treatment Plant & Slow Sand Filter Facility Photo 8

Photo 9: Water Treatment Plant & Slow Sand Filter Facility Photo 9

<u>Photo 10: Water Treatment Plant & Slow Sand Filter Facility Photo 10</u>

Photo 11: Existing Chlorine Contact Tank Photo 1

Photo 12: Existing Chlorine Contact Tank Photo 2

Photo 13: 1.0 Million Gallon Prestressed Concrete Storage Tank

APPENDIX B

AECOM ELETRICAL ASSESSMENT MEMO

AECOM

Memorandum

AECOM
Elm Street
Manchester, NH
www.aecom.com

Cell 1-617-839-1243
e-mail ron.demers@ aecom.com

To: **Doug Gove PE**

CC: **Yasser Rizk PE**

Subject: Site Visit to Long Pond WTP

From: **Ron Demers**

Date: **Site Visit 1-21-21, Report 2-8-21**

Dear Sirs:

It was requested that I attend a site visit with the Client and other AECOM personnel to review existing conditions at the Long Pond Water Treatment Plant (WTP), Great Barrington Massachusetts.

It must be noted that the team was restricted from going inside the facility due to the Owner's concern with the Covid-19 virus. He was willing to take general photographs, but I had no direct contact with any of the equipment so that it could be evaluated for general condition.

The major part of the facility was constructed Circa 1939 and has had various upgrades in the areas of instrumentation, pumping and power distribution. These will be broken down in various groupings to follow:

- Water Storage Tank

  The storage tank is located on a hill behind the main facility and the reservoir. The tank has no pumps or water circulators as part of the system. The external piping is heat traced with an external pigtail that is not connected to power. The water tank has no utility service or power run to its location from the main facility at the dam.

General Utility Distribution and Power to the Main Water Treatment Structure.

- The Utility power distribution enters the property line through a utility easement to the last utility pole. This pole is located at the roadway as you cross the dam. This utility pole is dated as a 1993 installed pole. It is in fair condition but appears to be the property of the utility as well as with all the poles on the easement all the way to the main road.

This last pole before the dam has what appears to be relatively new 3 phase transformers attached to it that feed the main facility with it's 208 / 120-volt service.

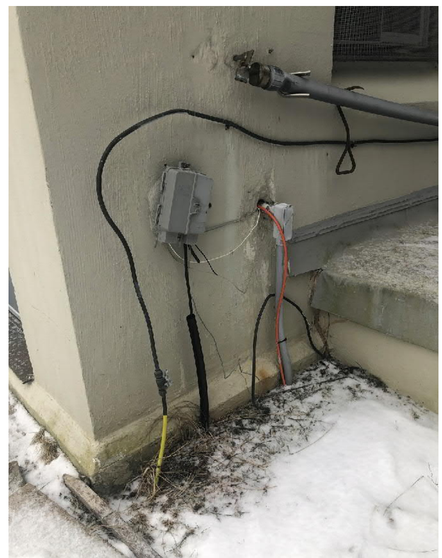
That being said, it would be prudent to determine the actual ownership of the power poles, the outline of the easement and the responsibility of tree trimming so that there are no surprises as time goes on.

From the ground, the utility lines up to the first pole with the transformer, are not showing any noticeable condition deterioration. It should be noted that the easement was not walked but only observed from the road and at ground level.

The condition from the pole transformer to the weatherhead of the building service appeared to be in good condition. The pole just prior to the weatherhead and the building service is showing signs of damage at the top and is showing its age. It should be assumed that sometime in the foreseeable future this pole will have to be changed either because of failure or that it is a known point of possible failure.

As with the other poles this pole supports not only power but also telephone and cable system.

Exterior of the Main Structure



The utility power arrives at the structure from the last power pole to the weatherhead of the building service. The telephone arrives via an underground conduit while the internet cable appears to be direct buried without a conduit. It is unclear the depth of the internet cable as buried and how subjected it is to damage.

As you can see to the right, both telephone and cable are poorly installed and maintained. The LP tank gas feed is also loosely run above the telephone termination enclosure.

As commented before, the utility power arrives at the top of the weatherhead mast supported by a 400-amp meter socket attached to the outside of the structure. It is assumed that the smaller meter socket is actually being feed from the current transformers located in the 400-amp meter socket; there is no way to tell. It is unprecedented that a secondary meter socket is being used rather than the primary 400-amp socket.

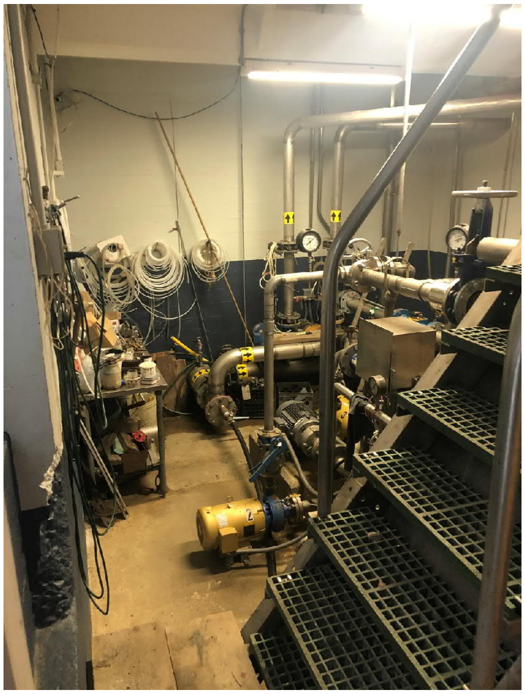
Also, you can see from the photo to the right there is a triplex cable on top of the 400-amp meter socket. It does not go into the enclosure rather it has a 3-prong range plug attached to it. It’s unclear what it actually plugs into,

I had asked the Owner what it was being used for and he said it was use when the tanks were cleaned to support the general lighting. This system is neither practical nor safe no matter how it is used.

Interior; Process Area and the Office and Electrical System

Process Area

As stated, before our site visit had a number of limitations as to where we could go and where we could take our own photos. That being said I believe that with the photo and peaking through doorway I have enough general information so that I can have an opinion on these areas.



In the process area in general the instrumentation appeared not to be new but not essentially outdated either. Overall, I could not confirm that they were recently calibrated.

I did not know what the PLC looked like or was outdated or if replacement parts were still available. That being said PLC's are no longer a premium or the costly item that they used to be. They have dropped in price to include installation so if needed a new updated PLC could easily be installed.

In the photo to the right, it was noted that several of the motors have been replaced with newer high efficiency motors. These would be the gold ones seen in the photo. Motors color coated in this manner was done some time ago to distinguish them from standard efficiency motors. So, they are high efficiency motors likely over 5 years old.

Main Electrical Panels and misc. Electrical equipment in the Office Area.

The electrical system is interesting because the pole mount transformer and the overhead electrical system to the meter weatherhead is sized for 100 amps, 3 phase, 4 wire, while the meter socket and the main distribution panel is what appears to 400 amp at the same voltage and phase/neutral configuration.

This only means that the utility overhead feed cable has less capacity that the main breaker of the main distribution panelboard. If the facility had a higher power demand, I would be concerned that such a demand could damage the aerial cable, but the demand seems low enough to not jeopardize the aerial cable. If the facility were to upgrade and additional equipment added this would become an issue.

The main electrical service appears to be a GE breaker panel assumed to be 120/208 volt. The panel has 30 breaker spaces with 17 spaces currently being used. This leaves adequate breaker spaces used for future expansion.

There is a Bryant residential single-phase panel that has been installed on the same wall, it is unclear what it supports but I would guess instrumentation and general light and receptacles.

Overall, the service equipment and the related disconnect switches are showing their age but are adequate for the state of the place. As long as parts and breaker are available, they should be usable into the foreseeable future.

Ron Demers
AECOM
Technical Leader
AECOM
Manchester NH

APPENDIX C

AECOM HYDRAULIC MODEL TECHNICAL MEMO

Technical Memorandum

To	Transmittal No	Project number	Client
Doug Gove	1	60618759	Great Barrington
Subject	**Date**	**Prepared by**	
Hydraulic Modeling Task 1	April 23, 2021	Piotr Michalowski	

Housatonic Water Works Company Hydraulic Model

Background

Great Barrington retained the services of AECOM to conduct a hydraulic assessment of the Housatonic Water Works Company (HWWC) water system using a computerized hydraulic model. This assessment will identify potential deficiencies in the Housatonic System that will need to be addressed. Tasks performed by AECOM include model development, verification of the model using prior hydrant testing results, assessing the level of service available in the system, and identifying potential improvements to correct any hydraulic restrictions or bottlenecks.

Development of Housatonic Hydraulic Model

Network Development

The following data was used to build the Housatonic water distribution model network of pipes and junctions.

- 2017 Water System Map,
- Housatonic Water System GIS data,
- Digital Elevation Model (DEM) of the Project Area

The 2017 Water System Map was georeferenced using ESRI's ArcMap, and the watermains were digitized and their diameters were assigned manually. A GIS shapefile containing geographical location of each main and their diameters was created and used to import into the WaterGEMS Software using ModelBuilder tool. Subsequent to development of this shapefile, AECOM received a GIS geodatabase of the water system which was used to confirm diameters and pipe locations in the shapefile. After importing the water main shapefile into WaterGEMS, the ModelBuilder tool automatically created junctions at the end of each pipe. Where pipe ends were coincident, a common junction was shared between the pipes.

Each Junction was then assigned an elevation extracted from the DEM. For purpose of hydraulic modelling it was assumed that all junctions are 5 feet below the ground elevation (sufficient to protect against frost).

Demand Allocation

Demands for the model were based on the following information provided by GB:

- HWWC Contact List including Account Number and addresses
- HWWC Usage and corresponding Water Usage List for year 2014, the only year provided by HWWC.

In order to allocate demand to each junction in the model, first all customers in the Contact List were geocoded and later imported into the model as Customer Meters. Each Customer metered demand representing each account number was then allocated into the model using built-in tool called Load Builder. .

Figure 1 shows a portion of the system's customer locations in GIS and how they are associated with the water system after being imported into WaterGEMS.

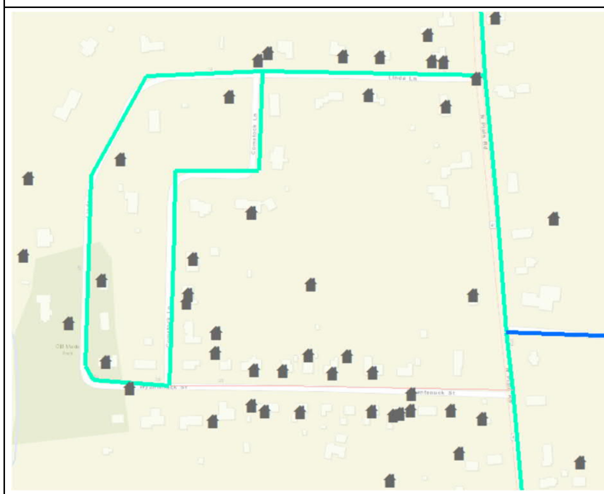
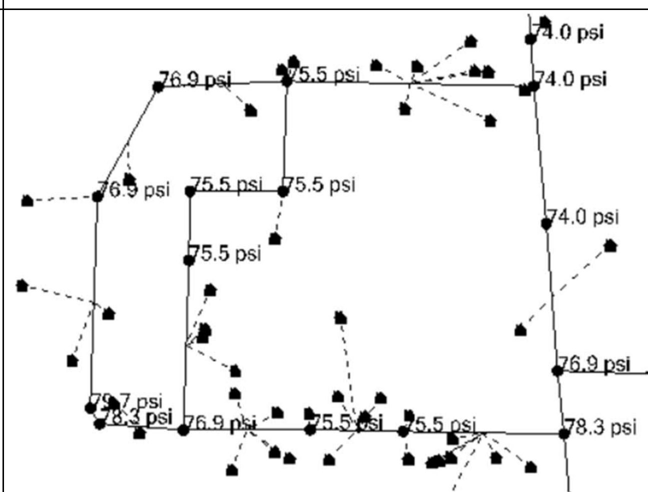
GIS representation of the system (before import)	WaterGEMS hydraulic model (after import)
	

Figure 1. Allocation of Customer Demands to Model via Nearest Pipe Methods

Flow data from the Long Pond Water Treatment Plant (WTP) from the years 2015 to 2020 (the sole source of water for the system) suggested the annual usage has been steadily decreasing. Considering the Water Usage List provided by HWWC reflects usage 7 years ago, the recommendations based on the model regarding system pressure and fire flow are likely conservative.

Table 1 presents the system demands used for the analysis which were generated from the 2014 Water Usage List and based on typical multipliers for maximum day and projected future conditions. More current system demands based on Massachusetts Department of Environmental Protection Annual Statistics Reports are summarized and discussed in HWWC Evaluation Report. The future ADD is based on the reported yield of Long Pond (0.27 mgd) while the MDD was calculated based on the current MDD to ADD ratio.

Table 1. System Demands Used for Analysis

Demand Condition	Demand, mgd	Demand, gpm	Multiplier (compared to ADD)
Existing ADD	0.21	146	1.00
Existing MDD	0.30	208	1.43
Future ADD	0.27	188	1.00
Future MDD	0.39	278	1.44

Two levels of Needed Fire Flow (NFF) demands, 500 gpm and 750 gpm, were used in the analyses to compare with the available fire flow (AFF) output by the model. Insurance Services Organization (ISO) prescribes the following needed fire flows based on the distance between buildings:

- 500 gpm where the distance is more than 100 feet
- 750 gpm where the distance is between 31 and 100 feet

Information provided by ISO indicated unique NFF's for six locations in the system as listed in Table 2. ISO information on hydrant tests conducted in the system in 2015 are also included in Table 2. Note that this information is dated with no accompanying information regarding system operations and is thus not considered a conclusive representation of the system. The fact that four of the five tests in the report have the same static and residual pressures is suspicious but these values do give an approximate sense of the head losses that would occur under high flow conditions.

Table 2. ISO Fire Flow Information

Location	Model Junction	Measured Flow, gpm	Static Pressure, psi	Residual Pressure, psi	Available Flow at 20 psi, gpm	Needed Fire Flow, gpm
Front St @ Depot St	155	380	120	55	500	4500
Main St. @ Oak St.	168	380	120	55	500	1750
Highland St. @ South St.	138	380	120	55	500	750
Park St. North of Mountain View	249	380	120	55	500	1750
Park St. @ North of Division St.	523	380	120	55	500	2000

Table 2. ISO Fire Flow Information

Location	Model Junction	Measured Flow, gpm	Static Pressure, psi	Residual Pressure, psi	Available Flow at 20 psi, gpm	Needed Fire Flow, gpm
N. Plain Rd. @ 2nd hydrant North of Division St.	331	1030	83	42	1300	1250

The static pressures of 120 psi represent HGLs of 75-110 feet above the current HGL of the tank at the Long Pond WTP, so these values were not used. The residual pressures were used as a reference to roughly calibrate the model in terms of pipe roughness.

Boundary Conditions

The Water Distribution System is fed by gravity from the Water Tank located in the south west portion of the system. The water tank is fed from the WTP on Long Pond. The is the sole source of water for the system. The tank is modelled as a fixed head reservoir with a Hydraulic Grade Line of 950 feet which represent the normal maximum drawdown in the tank. There are no other pumps or pressure regulating valves in the system.

Model Calibration

Model scenarios were set up to simulate the flows measured by ISO and to compare the results with the stated residual pressures in the ISO report. As stated above, the static pressures in the ISO report were in excess of the HGL at the system boundary at the Long Pond WTP and were thus not used. The residual pressures in the ISO report were also somewhat suspect but were used to approximate the conditions in the field with the high flows reported by ISO. As a result, the pipe roughness used in the model were adjusted downward to better match the model and the ISO report. Table 3 lists the model results as compared with the residual pressures in the ISO report.

Table 3. Model Calibration Results based on ISO Fire Flow Information

Location	Model Junction	Measured Flow, gpm	ISO Report Residual Pressure, psi	Model Results Residual Pressure, psi	Difference, psi
Front St @ Depot St	155	380	55	68.4	-13
Main St. @ Oak St.	168	380	55	55.7	-1
Highland St. @ South St.	138	380	55	54.4	1
Park St. North of Mountain View	249	380	55	67.6	-13
Park St. @ North of Division St.	523	380	55	64	-9
N. Plain Rd. @ 2nd hydrant North of Division St.	331	1030	42	48.7	-7

Pipe roughness of 85 and 75 were used in the model with the higher C-Factors representing newer pipes as indicated by the water system maps and these are shown in Figure 2.

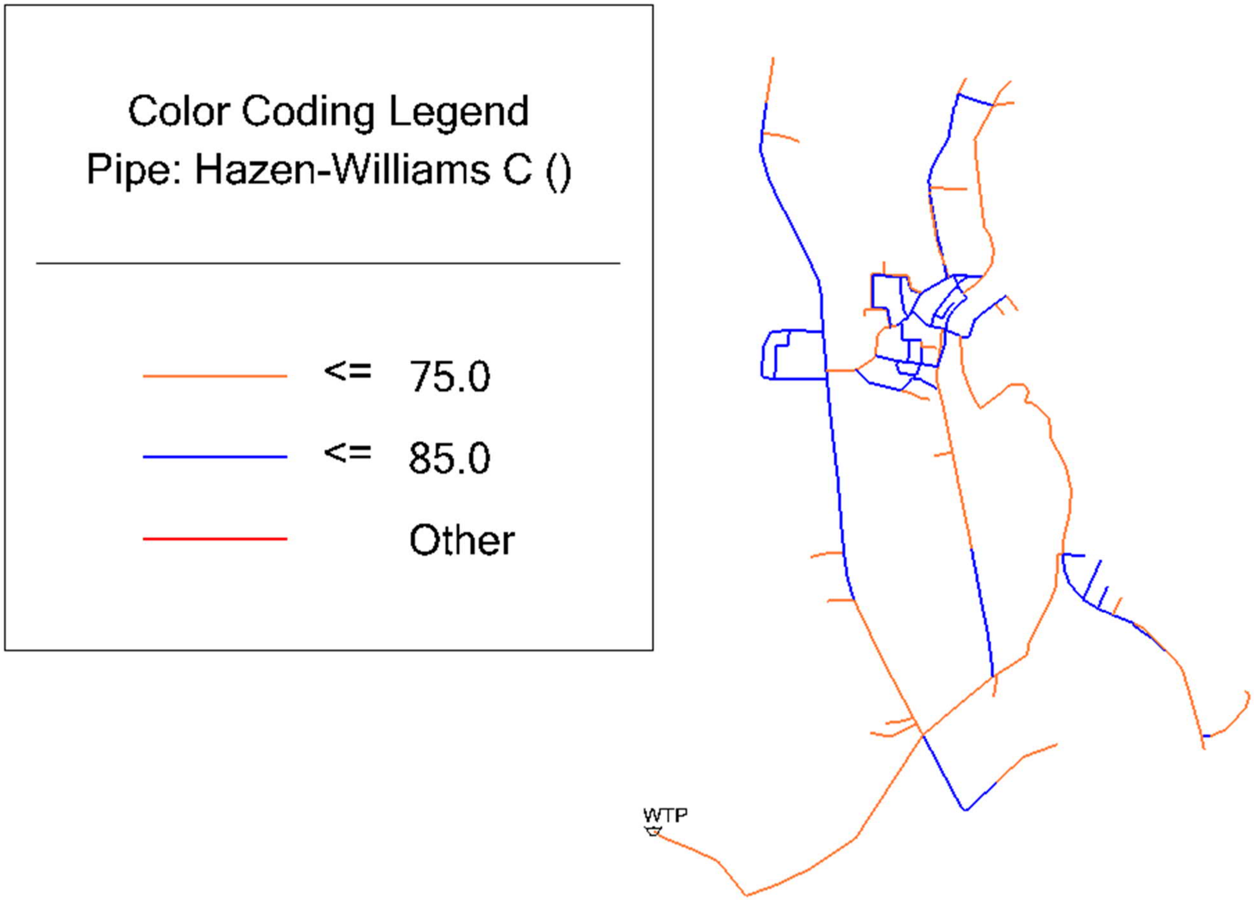


Figure 2. Pipe Roughnesses (C-Factors) used in the Model after Rough Calibration

Water Distribution System Summary

Total length of the Water Distribution System equals to 103,385 LF. Almost 60% of the total network consists of small diameter water mains that are below 6-inch. Only 15% of the total network are diameters 10-inch and 12-inch respectively. Below is the breakdown of each diameter and its corresponding length in Table 4 and Figure 3.

Table 4. Distribution of Water Mains by Diameter

Diameter of Water Main	Total Length [LF]	% total
2-inch	9,365	9%
4-inch	23,009	22%
6-inch	26,116	25%
8-inch	29,398	28%
10-inch	4,355	4%
12-inch	11,141	11%
	103,385	100%

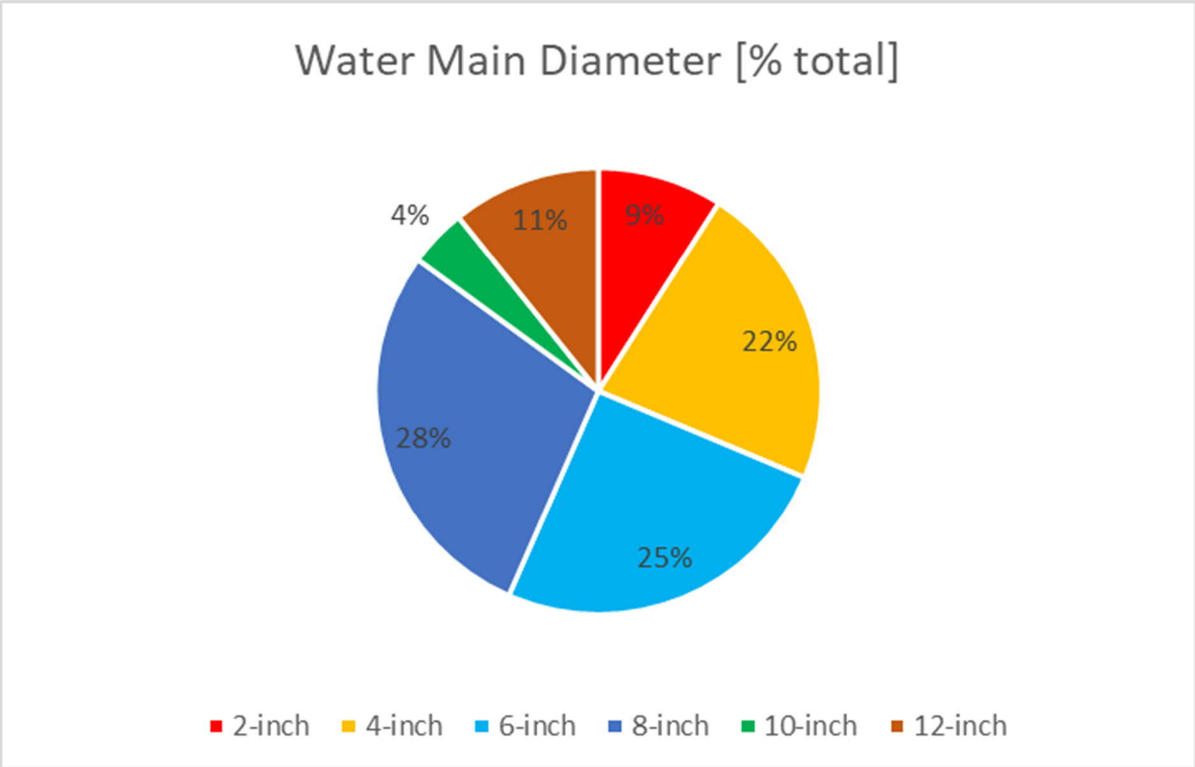


Figure 3. Distribution of Water Mains by Diameter

The Water Distribution system contains multiple bottlenecks in the form of smaller diameter pipes installed between larger diameter pipes. Those bottlenecks are unfavorable from hydraulic point of view in that they restrict flow from passing through the system and reduce pressures on their downstream end. Many of those bottlenecks are in the center of the system, close to Main Street. Housatonic Water System is represented on **Figure 5,** which shows locations of the water mains, their diameter and material.

Having almost 60% of the system consisting of pipes that are 6-inch will negatively impact potential firefighting capabilities. Per Massachusetts Guidelines for Public Drinking Water Systems, water mains with firefighting capabilities (i.e. with Fire Hydrants) must always be 8-inch diameter or greater. Thus, a default recommended improvement would be to increase the size of all smaller mains with fire hydrants (6-inch diameter or smaller) to 8-inch diameter to increase the available fire flow along those mains. In general, pipes that are smaller in diameter than 8-inches are much less efficient from hydraulic point of view, and subsequently are not capable of providing enough fire flow when needed (their available fire flow is low).

Additionally, almost 70% of the Water System consists of old Cast Iron Pipes, most of which are presumed to be unlined. Nearly 13% of the system consists of AC (Asbestos Cement) material, which could cause a health hazard if the pipes begin to deteriorate. Replacement of old and smaller pipes is inevitable in the future to keep up with both hydraulic efficiency of the system and with health requirements (AC pipes).

Material breakdown as the total length in LF and as % total was shown in Table 5 and Figure 4.

Table 5. Distribution of Water Mains by Material

Material	Total Length [LF]	% total
Asbestos Cement (AC)	13,370	13%
Cast Iron (CI)	72,539	70%
Ductile Iron (DI)	13,604	13%
PVC	2,075	2%
Unknown	1,798	2%
	103,385	100%

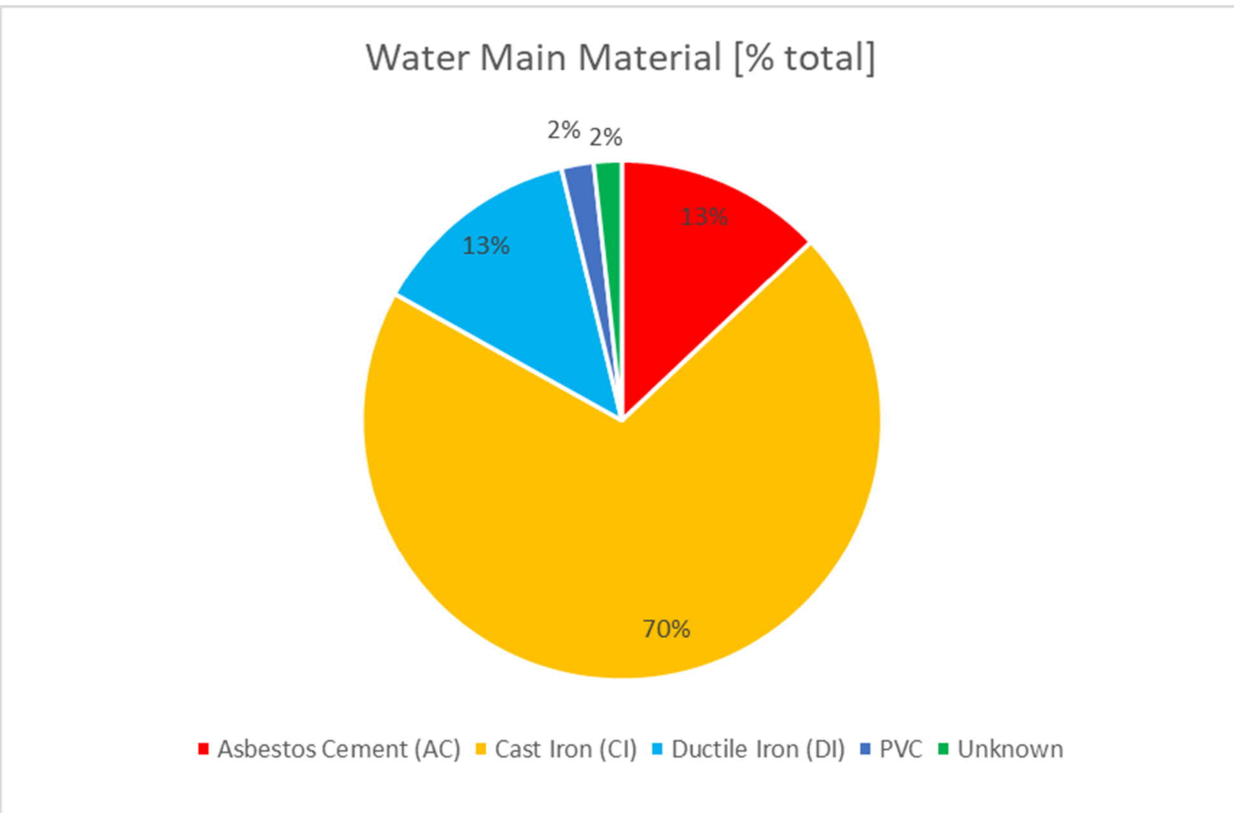


Figure 4. Distribution of Water Mains by Material

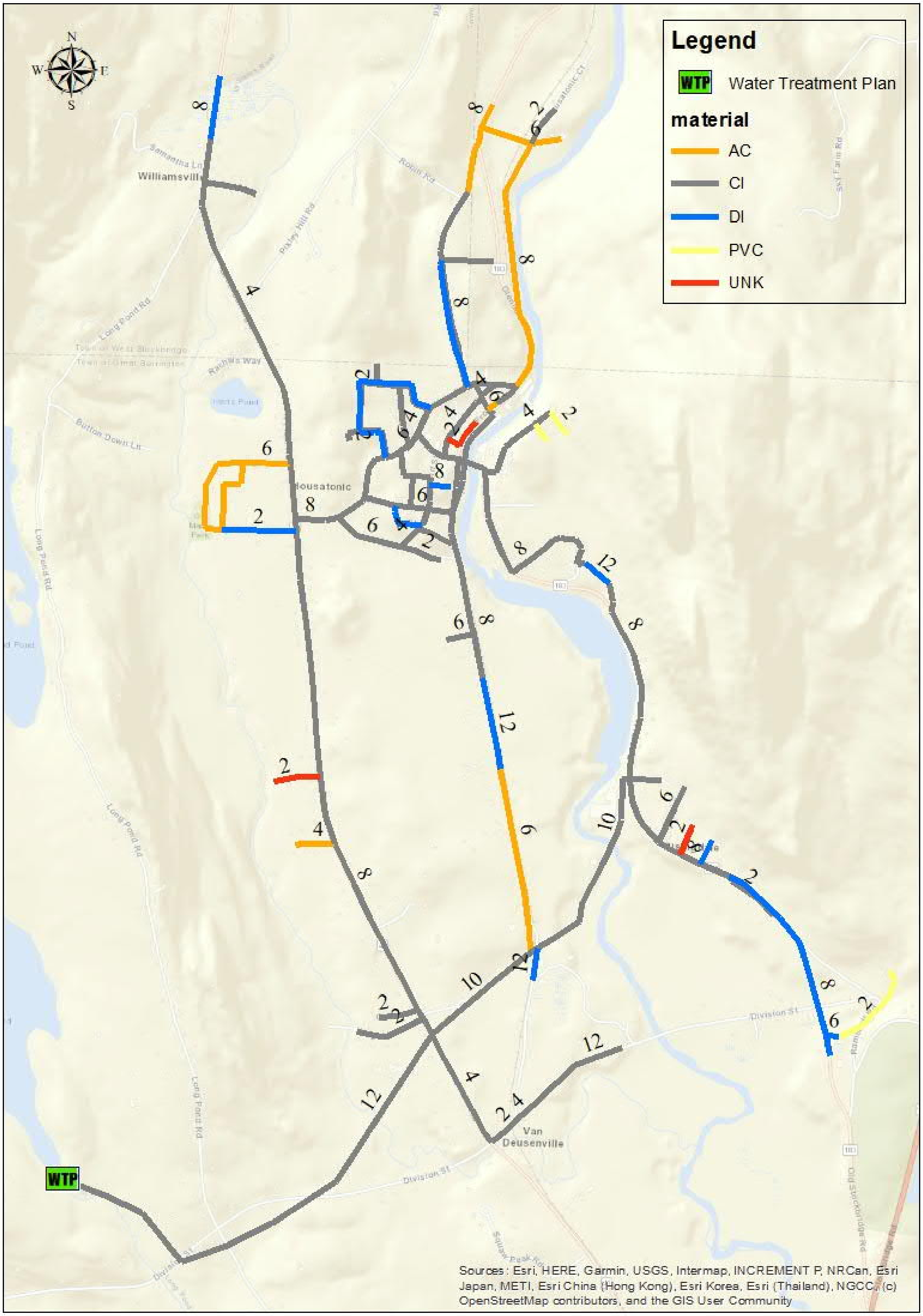


Figure 5. Housatonic Water System (Diameters and Material)

Water Distribution System Hydraulic Evaluation

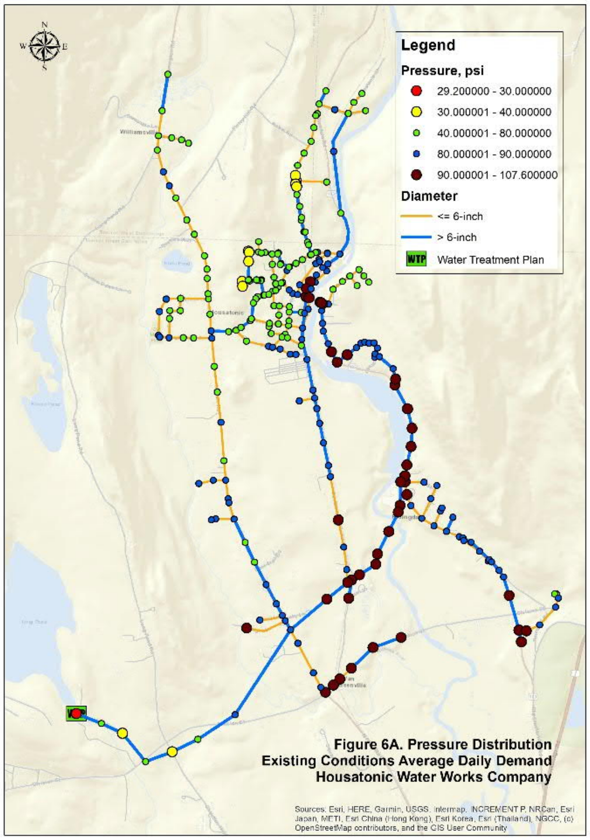
Hydraulic evaluation of the system involved simulation of normal demand conditions to assess system pressures. An adequate level of service can be expected with water pressures between 40 psi and 90 psi. Per Massachusetts Guidelines for Public Drinking Water Systems, pressures must be above 20 psi under all conditions, and normally above 35 psi. Customers with pressures between 20 and 40 psi would notice these lower pressures at their plumbing fixtures so a threshold of 40 psi was used in our analyses. Pressures above 90 psi may require a pressure reducing valve at the customer connection to prevent damage to plumbing fixtures such as water heaters. Pressure distribution of the Housatonic Water System was evaluated based on the Scenarios listed below in Table 6. Scenario demands were calculated from 2014 Water Usage data provided by HWWC.

Table 6. Hydraulic Modelling Scenarios – Normal Demand Conditions

Scenario No.:	Simulated Flow from WTP	Flow (MGD)
Scenario 1	Existing ADD	Q = 0.21 MGD
Scenario 2	Existing MDD	Q = 0.30 MGD
Scenario 3	Future ADD	Q = 0.27 MGD
Scenario 4	Future MDD	Q = 0.39 MGD

Figures 6a through 6d below present the pressure distribution in water system for each of the scenarios analysed.

Pressure distribution: Existing ADD 0.21 MGD



Pressure distribution: Existing MDD 0.30 MGD

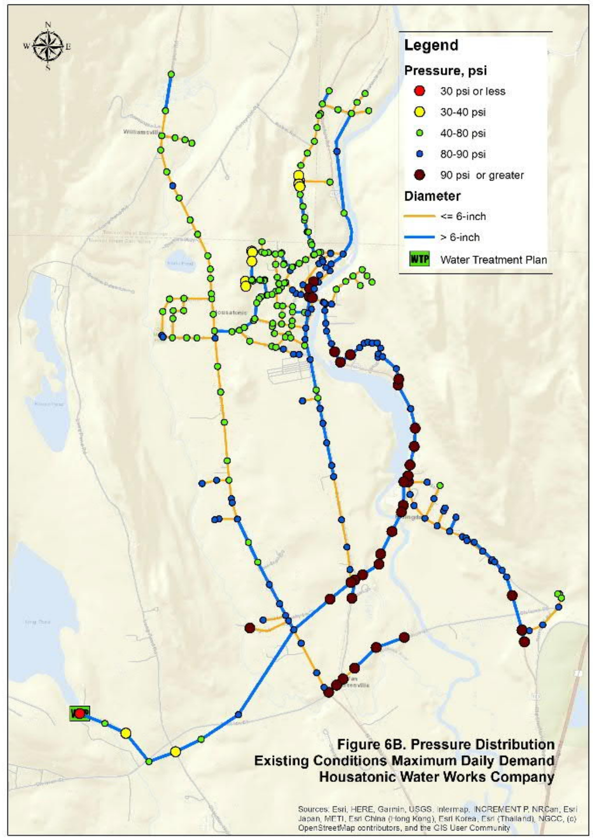


Figure 6. Housatonic Water Model Results – Pressures under Existing ADD (Figure 6A)

Figure 6B. Housatonic Water Model Results – Pressures under Existing MDD

Pressure distribution: Future ADD 0.27 MGD

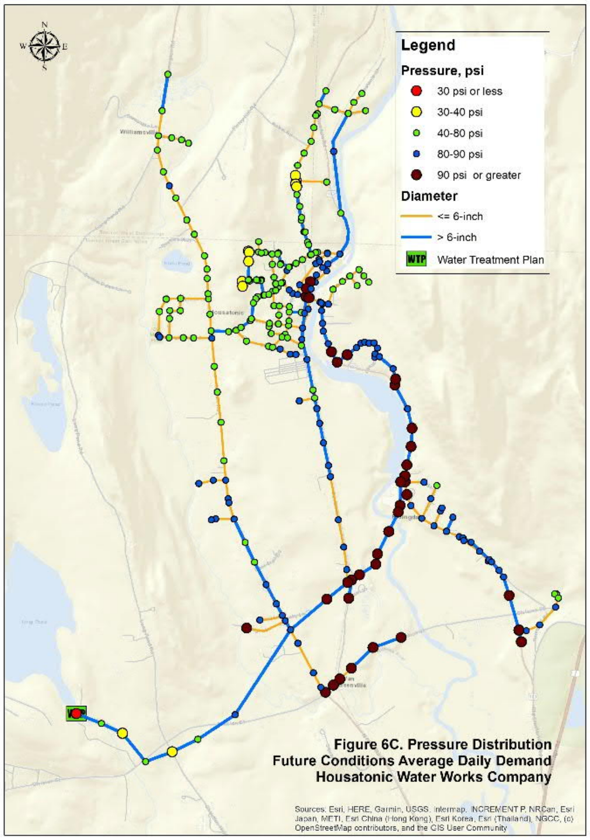


Figure 6C. Housatonic Water Model Results – Pressures under Future ADD

Pressure distribution: Future MDD 0.40 MGD

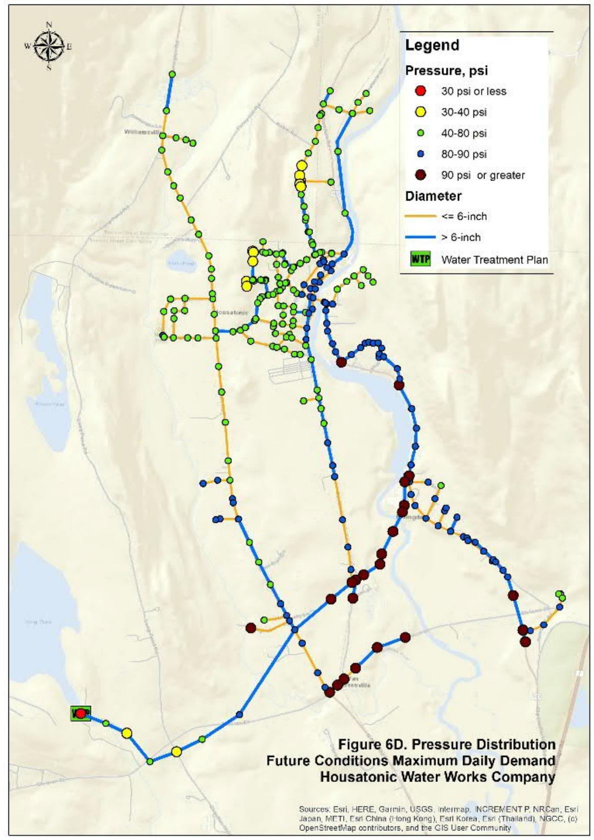


Figure 6D. Housatonic Water Model Results – Pressures under Future MDD

As these figures indicate, lower pressures were indicated along High Street between Main Street North and Robin Road and along Fairview Road and Kirk Street. These lower pressures are indicative of this areas' higher elevation since the amount of friction loss would be negligible even with the distance from Long Pond.

Additionally, an available Fire Flow Analysis was performed for the entire system for existing and future maximum day demand conditions. The WaterGEMS model can estimate available fire flows at 20 psi at all junctions in the system. The available fire flow is then compared with the needed fire flow. As indicated in Table 2, ISO has determined needed NFFs for six locations in the system. Note that the location on Front Street at Depot Street has an NFF designated by ISO of 4,500 gpm. However, ISO indicates that water utilities are not required to provide fire flows in excess of 3,500 gpm so the model scenarios at this location assumed a fire flow of 3,500 gpm. All other locations in the water distribution system were assessed based on minimum NFFs of 500 gpm and 750 gpm. These are typical values for residential locations with sufficient spacing of structures. Table 7 lists a summary of the results of the AFF analysis under existing and future MDD demand conditions.

Table 7. Hydraulic Modelling Results – Fire Flow Demand Conditions

Scenario No.:	Simulated Flow from WTP	Number of Junctions with AFF < 750 gpm	% of System Junctions (273)	Number of Junctions with AFF < 500 gpm	% of System Junctions (273)
Scenario 2	Existing MDD (0.30 MGD)	258	94.5%	158	57.9%
Scenario 4	Future MDD (0.39 MGD)	268	98.2%	207	75.8%

These results indicate that nearly all of the system cannot meet a fire flow requirement of 750 gpm. With a fire flow requirement of 500 gpm, a little less than half of the system would be able to meet that requirement under current demand conditions and about one quarter of the system could meet that requirement under future demand conditions.

In terms of the six locations where ISO has designated an NFF value, Table 8 presents the results for these junctions. None of the locations in the ISO report have available fire flows in excess of the NFF indicated by ISO under existing or future demand conditions.

Table 8. Hydraulic Modelling Results – Fire Flow Demand Conditions – ISO Designated NFFs

Location	NFF, gpm	Available per model			
		Existing MDD (0.3 mgd)	Meets NFF?	Future MDD (0.39 mgd)	Meets NFF?
Front St @ Depot St	4500	402	No	370	No
Main St. @ Oak St.	1750	524	No	475	No
Highland St. @ South St.	750	520	No	472	No
Park St. North of Mountain View	1750	610	No	550	No
Park St. @ North of Division St.	2000	431	No	401	No
N. Plain Rd. @ 2nd hydrant North of Division St.	1250	961	No	877	No

Figures 7 and 7B below show the locations where Fire Hydrants are indicated to not meet needed fire flows of at least 750 gpm (in red) under Future MDD demands. Locations where Fire Hydrants are indicated to have available fire flows between 500 gpm and 750 gpm are shown in brown. Only the first few hydrants on North Plain Road north of Division Street are indicated to have over 750 gpm under future demand conditions.

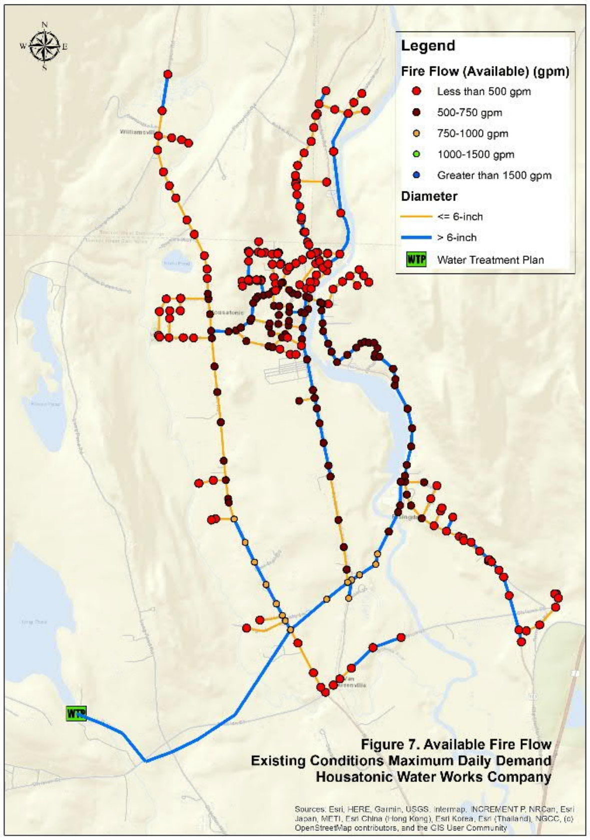


Figure 7. Available Fire Flow Results – Existing MDD Demands

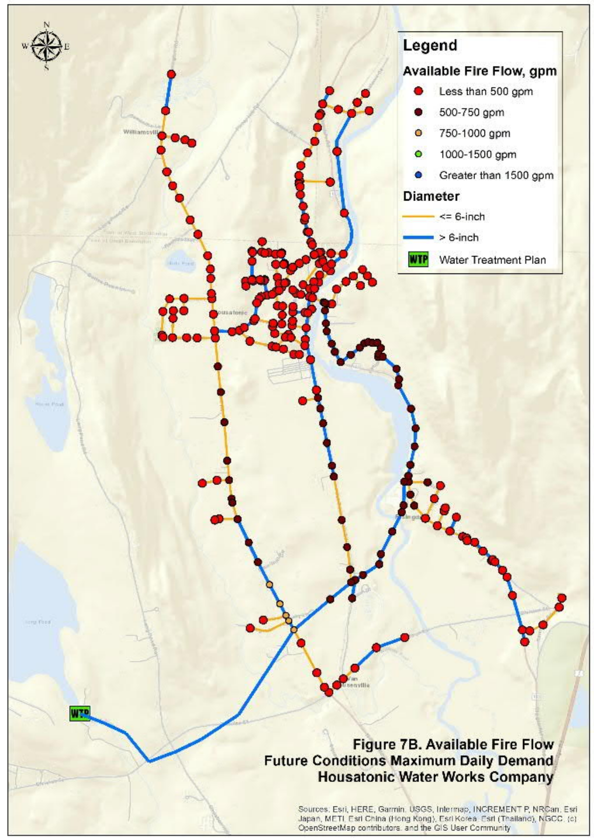


Figure 7B. Available Fire Flow Results – Existing MDD Demands

These results are indicative of the older mains in the system and of the fact that nearly 60% of the Housatonic Water System consists of smaller diameter network (6-inch and below) many of these with hydrants.

Needed Improvements

To improve performance of the water distribution system, required improvements have been identified. These improvements are intended to address areas with low pressures under normal demands and areas with deficient available fire flows. In general, the replacement of all pipes 6-inch diameter or less (so called bottlenecks) that are not dead ends or do not serve fire hydrants with a minimum 8-inch diameter water main is recommended,

These improvements would include the replacement of nearly 49,308 LF of 6-inch diameter pipe with 8-inch pipe.

In addition to these improvements, replacing all of the existing pipes in Van Deusenville Road between Main Street and the Air Release Valve vault near Nolan Drive as well as the pipes between Van Deusenville Road and North Plain Road with 12-inch diameter pipes would provide a stronger feed into the main parts of the system. Relining the water main between the WTP and North Plain Road is also recommended. Doing so would bring the system's compliance with an NFF of 750 gpm to about 87% and with an NFF of 500 gpm to about 91% for either existing or future demand conditions. Under normal (non-fire) conditions, system pressures would not change appreciably with the recommended improvements. However, most of the system is indicated to have adequate pressures without improvements. The locations where the junction elevation is above 857 feet (representing a static pressure of 40 psi) would not be able to experience pressures above 40 psi without a higher Long Pond tank level or local pumping.

Figure 8 shows the locations of proposed pipe replacements.

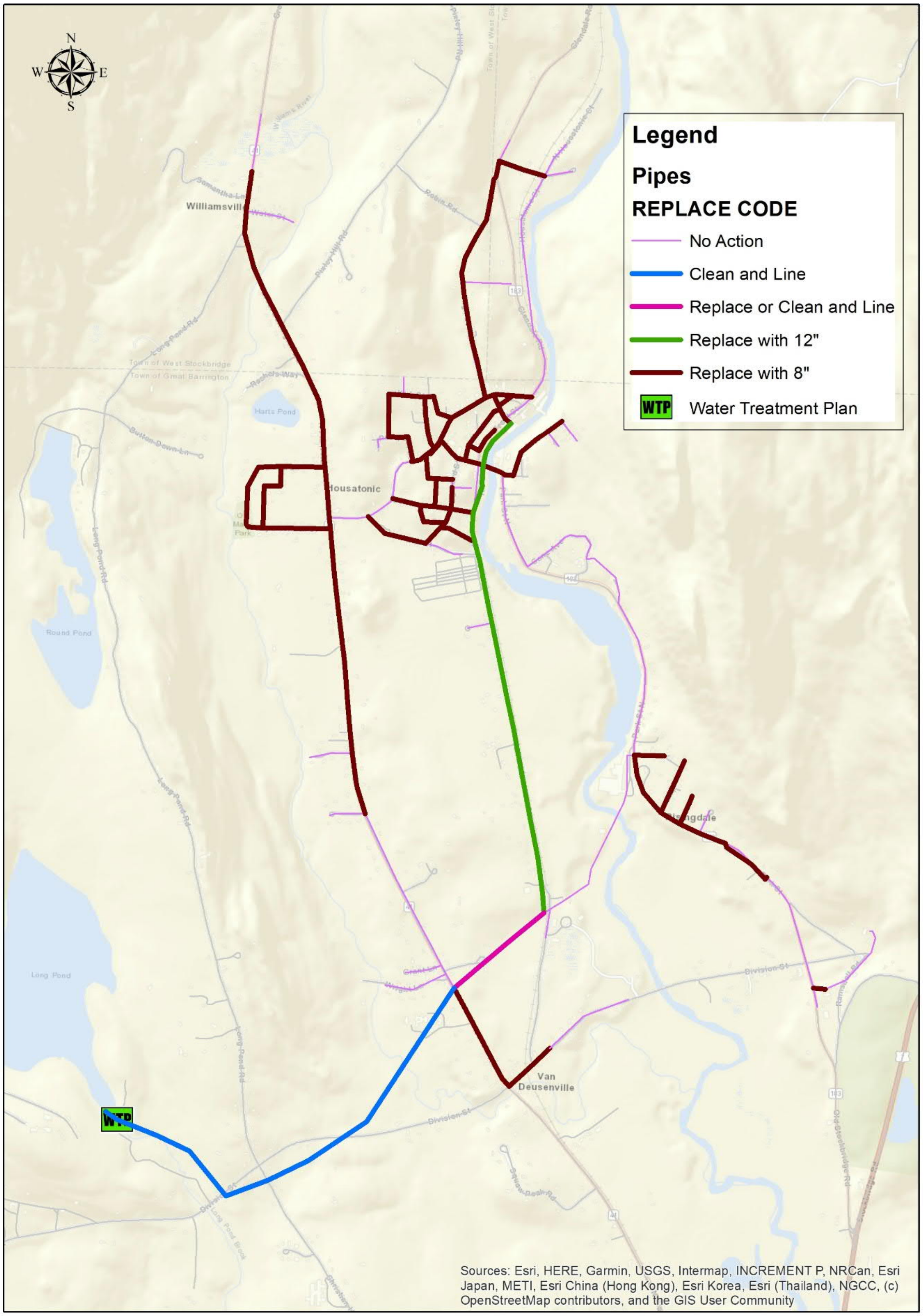


Figure 8. Housatonic Water System Recommended Improvements

In terms of available fire flows, there are dramatic improvements throughout the system as indicated in Table 9.

Table 9. Hydraulic Modelling Results – Fire Flow Demand Conditions

Scenario No.:	Simulated Flow from WTP	Number of Junctions with AFF < 750 gpm	% of System Junctions (273)	Number of Junctions with AFF < 500 gpm	% of System Junctions (273)
Scenario 2	Existing MDD (0.30 MGD)	29	10.6%	26	9.5%
Scenario 4	Future MDD (0.39 MGD)	31	11.4%	26	9.5%

Figures 9 and 10 show the results of these analyses which indicates that the locations remaining with low available fire flows are mostly on dead ends. In terms of the locations designated by ISO, the model results under future MDD conditions with improvements indicate that four of the six locations would still not achieve the NFFs as indicated in Table 10.

Table 10. Hydraulic Modeling Results – Available Fire Flow with Improvements– ISO Designated NFFs

Location	NFF, gpm	Available per model			
		Existing MDD (0.30 MGD)	Meets NFF?	Future MDD (0.40 MGD)	Meets NFF?
Front St @ Depot St	4500(1)	1,433	No	1,374	No
Main St. @ Oak St.	1750	1,475	No	1,412	No
Highland St. @ South St.	750	1,459	No	1,399	Yes
Park St. North of Mountain View	1750	1,497	No	1,435	No
Park St. @ North of Division St.	2000	929	No	901	No
N. Plain Rd. @ 2nd hydrant North of Division St.	1250	1,826	No	1,754	Yes
Notes:	1. ISO does not require water utilities to provide fire flows in excess of 3,500 gpm.				

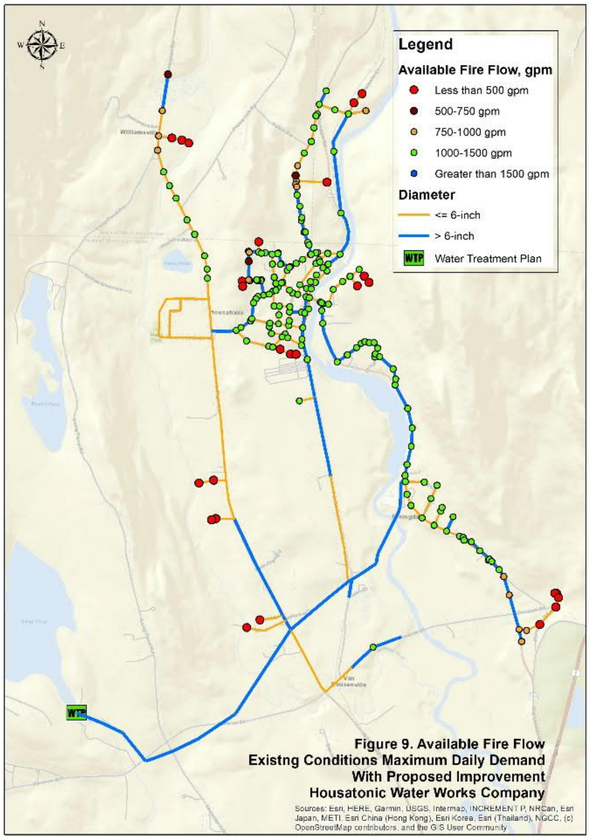


Figure 9. Available Fire Flow Results – Existing MDD Demands – With Proposed Improvements

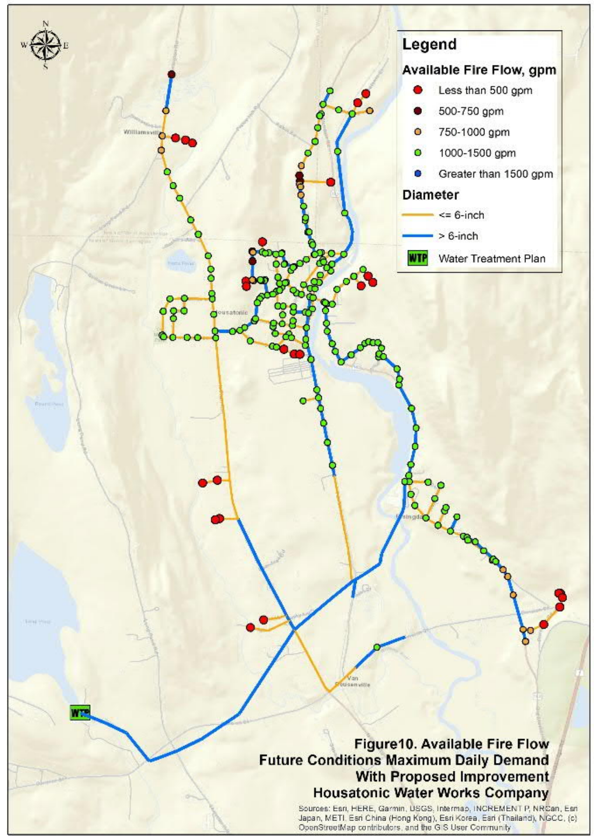


Figure 10. Available Fire Flow Results – Future MDD Demands – With Proposed Improvements

The improvements needed bring the remaining four locations AFF in compliance with their associated NFFs would likely be excessive, especially the location at Front Street at Depot Street. Even then, these flow rates may not be achievable. AECOM would suggest reviewing the NFF requirements for these locations to see if the criteria by which these locations were evaluated are still valid. Alternate means of providing these fire flows may have to be arranged by the customers at these locations.

Summary of Recommended Improvements

Table 10 lists the recommended improvements for the Housatonic Water System. It is assumed that all pipe replaced with a larger diameter pipe would require new valves and fittings at every branch connection. Further evaluation would be needed to assess how many fittings would be needed at locations with pipe replaced with the same size pipe. Access pits for cleaned and lined pipe would likely be at valve or hydrant locations so these appurtenances would also likely be replaced as part of a cleaning and lining project. Existing hydrants and hydrant leads should be inspected to determine if these would need to be replaced along sections where the water mains are being replaced.

Table 11. Summary of Recommended Improvements

Size of Existing Main	Recommended Size	Recommended Action	Length, feet
2	8	Replace	3,332
4	8	Replace	20,709
6	8	Replace	25,266
8	12	Replace	6,794
10	12	Replace	1,880
12 (Easement between N. Plain Rd and Van Deusenville Rd.)	12	Replace or Clean and Line	1,378
12 (Pipe from WTP)	12	Clean and Line	7,336
Total Pipe Affected			66,695

Closer evaluation of the condition of assets such as valves and hydrants would be needed to assess how many of these existing assets would need replacement. Also, a condition assessment of the existing pipeline should be conducted before proceeding with cleaning and lining to confirm the pipe is structurally sound.

APPENDIX D

CORNELL ENGINEERING GROUP REPORT

October 29, 2020
Housatonic Water Works
Memorandum No. 15400-002

Subject: Desktop Study – Colored Water and Corrosion Assessment

Housatonic Water Works Company (HWWC) has tasked Cornwell Engineering Group, Inc. (Cornwell) with investigating the colored water events that seasonally occur in their system (typically during warner months), as well as the corrosivity of the water. The following memorandum discusses and summarizes the HWWC water quality characteristics and their implications on solubility or precipitation of hardness, iron, manganese, lead, or copper, and provides direction for an action plan to resolve the issues.

SYSTEM DESCRIPTION

The water source for the HWWC system is surface water from Long Pond. Treatment consists of slow sand filtration, addition of sodium hypochlorite, and chlorine contact as depicted in the treatment schematic in Figure 1. Current average daily production is 0.11 MG.

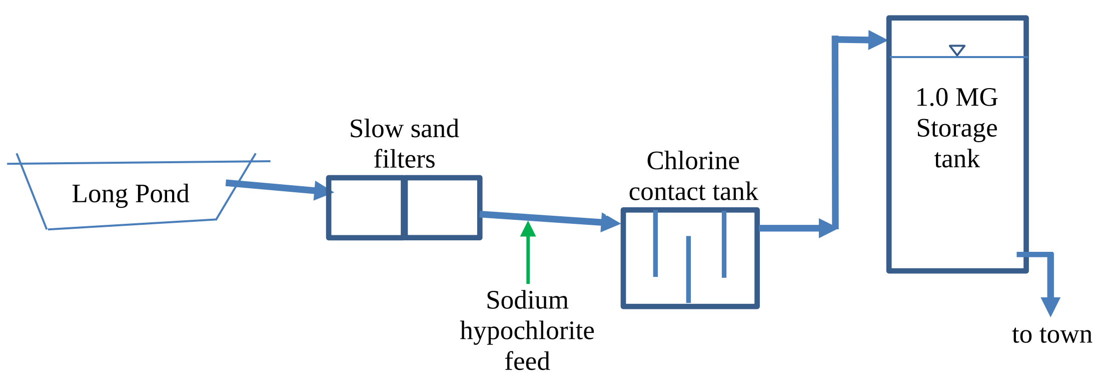


Figure 1 HWWC treatment schematic

Characteristics of the water mains and service lines, as reported in the December 2016 Desktop Study Report (Lenard 2016), are summarized in Table 1 and in the following items:

- Water main upgrades were initiated in the 1990s and included about 14,000 LF (mostly ductile iron and polyethylene as per Table 1), and most (if not all) of the remaining system pipes are >100 years old and are made of cast iron or steel.

- The characteristics of the "steel" pipe are not reported by Lenard (2016), but the data suggests that > 80 percent of the pipes are unlined cast iron or "steel" pipes >100 years old
- There are some asbestos cement (transite) pipes in the system. Information on sizes has not been reported, but these pipes are typically used for larger mains in a water system.
- No lead service lines have been identified in the system over the past ~35 years. Only a few lead goosenecks were encountered during that time, and they were removed. No other lead goosenecks are currently known to exist, and HWWC policy is to promptly remove any that may be found in the future.
- In addition to company-owned mains, there are approximately ten streets that are privately owned with privately owned water mains. These are typically steel lines, over 50 years old, and don't have hydrants or blowoffs on the end to flush out stale or dirty water. This situation may impact water quality in these areas.

Table 1 HWWC Water Mains and Service Lines (Lenard 2016)

	Water Mains	
Material	Lineal Feet (LF)	Percent of Total
Cast iron	64,497	54.3%
Steel†	34,734	29.2%
Ductile iron	14,671	12.3%
Transite (asbestos cement)	4,552	3.8%
Polyethylene (PE)	380	0.3%
Total	118,834	100.0%
	Service Lines	
Material	Number	Percent of Total
Galvanized	784	91.6%
Copper	71	8.3%
Ductile Iron	1	0.1%
Total	856	100%

HWWC WATER QUALITY – ENTRY POINT AND DISTRIBUTION SYSTEM

Historical data are summarized in Table 2, with data from the distribution system separated by low color (<15 PCU) and high color (>15 PCU). Data for the distribution system includes data from August 22, 2018 through March 16, 2020 plus data from additional five sampling events in August 2020. Data for point of entry (POE) for pH from the WTP monitoring data was only used from July 27, 2020 through most recent data provided (September 7, 2020) due to pH probe calibration issues (Figure 5). Additional data at POE was also collected and measured by an independent laboratory, similar to the distribution sites. This additional POE data included 5 sampling events, one from August 22, 2018 and four from recent sampling events in August of 2020. Therefore, POE data may not be representative of conditions observed during the colder months. Calcium hardness at POE was reported in the 2016 desktop corrosion control treatment (CCT) study (Lenard 2016), and was assumed to be similar at the distribution sites for calculated values. Calculated parameters such as Larson and Skold Index (LSK), calcium carbonate precipitation potential (CCPP), dissolved inorganic carbon (DIC), and chloride to sulfate mass ratio (CSMR) are also included. Calculations for CCPP and DIC were performed assuming a water temperature of 20°C.

Since colored water is a main concern in the HWWC system, Table 2 separates distribution data by color above or below the secondary maximum contaminant level (SMCL) of 15 PCU. Note that colored water data are still limited.

Most of the other parameters and constituents are about the same at the POE and in the distribution system, and except for color and manganese the results during high color events (>15 PCU) are about the same as on low color events (<15 PCU). On dates when the color is >15 PCU, the manganese is higher than on the dates when the color is <15 PCU. More than half of the manganese results in the distribution system samples with color <15 PCU were below the detection limit (<0.002 mg/L): 86 of 155 samples, and 145 of the 155 samples were <0.010 mg/L. For distribution samples >15 PCU, no manganese values were below the detection limit. When the color was ≥30 PCU the manganese was ≥0.09 mg/L. Further discussion on manganese and colored water is included in the next section.

Iron, manganese, and total color data are evaluated in the discussion below, followed by a discussion of pH, lead and copper, use of polyphosphate, hardness precipitation, and free chlorine residuals.

Table 2 Housatonic Water Works Water Quality (2018 – 2020)

Parameter/Constituent	POE Median, n=5	DS (color>15 PCU) Median, n=6	DS (color<15 PCU) Median, n=155
pH*	7.3	7.7	7.8
Total Alkalinity (mg/L $CaCO_3$)	80	78	80
Calcium Hardness (mg/L $CaCO_3$)	48	--	--
Total Hardness (mg/L $CaCO_3$)	--	--	--
Total Iron (mg/L)	<0.05	0.093	<0.05
Total Manganese (mg/L)	0.086	0.018	<0.002
Chloride (mg/L)	14.2	14.3	14.7
Sulfate (mg/L)	<5	<5	<5
Free Chlorine Residual (mg/L)	1.13	0.45	0.35
Apparent color (PCU) †	20	20	0
Total Dissolved Solids (mg/L)	107	113	105
DIC (mg/L as C)*	21.9	19.8	19.9
LSK	<0.32	<0.52	<0.32
CCPP (mg/L $CaCO_3$)	-18.5		
Saturation pH	8.16		
LSI	-0.96		
CSMR (mg/mg)	>2.8	>2.8	>2.9

* = the POE pH data used to determine the median included five samples from an independent certified laboratory, plus one value per day from the treatment plant's analyzer from 7/27/20 through 9/27/20. The DIC was calculated using paired pH and alkalinity data on dates when alkalinity was also measured.

† = APHA platinum/cobalt (Pt/Co) color units, unfiltered[1] (ASTM 2019)

DIC = Dissolved inorganic carbon (also known as "total carbonate")

LSK = Larson-Skold Index

CCPP = Calcium carbonate precipitation potential ("+" = precipitation, "-" = dissolution)

LSI = Langelier Saturation Index

CSMR = Chloride to sulfate mass ratio

IRON AND MANGANESE

Results from Table 2 show that iron was consistently below the SMCL, even during high color events (>15 PCU). Previously colored water complaints were thought by HWWC to be from iron corrosion due to the aging iron pipes in the system, but none of the iron results reported, including samples with total color 40 to 50 PCU, exceeded the 0.3 mg/L iron SMCL.

The Larson-Skold Index (LSK) is used to describe the corrosivity of water towards iron, although it does not account for all iron corrosion mechanisms. Table 3 shows the interpretation with respect

[1] "True" color (filtered water sample) is measured the same way as apparent color (unfiltered water sample), except with suspended material (e.g., turbidity) removed by filtration before determination of "true" color.

to potential for iron corrosion associated with calculated LSK values (Leitz and Guerra 2013). The index is calculated using the ratio of equivalent weight of chloride and sulfate ions to the equivalent weight of bicarbonate and carbonate ions, shown in the following equation.

$$LSK = \frac{(Cl^{-} + SO_4^{2-})}{(HCO_3^{-} + CO_3^{2-})} = \frac{\text{eq. weight of chloride} + \text{eq. weight of sulfate}}{\text{eq. weight of bicarbonate and carbonate}}$$

Table 3 Larson-Skold Index

(Source: Leitz and Guerra 2013)

LSK Value	Significance
< 0.8	Chloride and sulfate concentrations will not interfere with natural film formation
0.8 < LSK < 1.2	Chloride and sulfate concentrations may interfere with natural film formation; corrosion may occur
> 1.2	High corrosion rates are anticipated

Calculations based on the recent sampling, using POE alkalinity of 80 mg/L $CaCO_3$ as an estimate for the sum of carbonate and bicarbonate, a chloride of 14.2 mg/L, and sulfate as the detection limit of 5 mg/L, gives a Larson-Skold Index of about <0.32 (as shown in equation below)[2]. As shown in Table 3, an LSK of 0.3 suggests the water quality conditions are not conducive to iron corrosion. This is supported by the low measured iron levels in the distribution system, as levels are historically below the SMCL even during high color sampling events.

$$LSK = \frac{(Cl^{-} + SO_4^{2-})}{(HCO_3^{-} + CO_3^{2-})} \cong \frac{\left(\frac{14.2\ mg/L}{35.45\ mg/meq}\right) + \left(\frac{<5\ mg/L}{48\ mg/meq}\right)}{\left(\frac{80\ mg/L\ as\ CaCO_3}{50\ mg/meq}\right)} = <0.32$$

Figure 2 shows manganese in the raw water, at point of entry, and in the distribution system from Summer 2018 through Summer 2020. Manganese in the distribution system varies seasonally, with higher levels in the warmer months. Manganese exceeds the SMCL at the POE in multiple measurements in August 2018 and August 2020. One measurement in the distribution system in August 2018 is at the SMCL and two exceed the SMCL in August 2020. There are no data available for the colder months for manganese in the raw water and the point of entry.

[2] The sum of the equivalent weights of carbonate and bicarbonate at normal pH of drinking water can be approximated as the alkalinity in mg/L as $CaCO_3$ divided by a factor of 50 mg $CaCO_3$ per meq

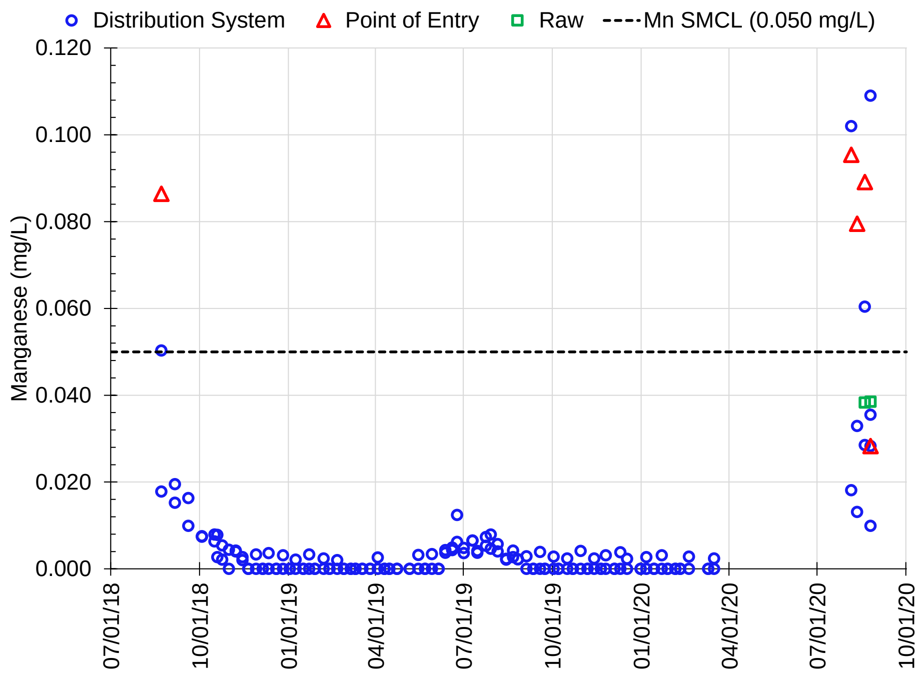


Figure 2 Manganese in raw, point of entry, and distribution system water

The higher manganese levels in the summer correspond to the same time period when most colored water complaints are received. Figure 3 compares manganese versus total color in samples where both were analyzed (see exception discussed later in this paragraph). This figure shows that events with manganese above the SMCL occur when there is high color in the same sample.

Figure 4 shows the same type of plot but with iron instead of manganese. This figure shows that even during high color events, the iron levels are below the SMCL of 0.3 mg/L. There does not appear to be any trend between high color events and high iron.

The results from these two figures for iron and manganese versus color show that:

a) iron never occurred above the SMCL, even during periods of total color up to 50 PCU

b) manganese increased on dates that higher total color was measured

c) for this particular limited data set of colored-water samples, manganese and color in the distribution system are similar to, or lower than, levels observed at the POE, suggesting that for these specific distribution system locations the color and manganese are not increasing to levels that are higher than at the entry point.

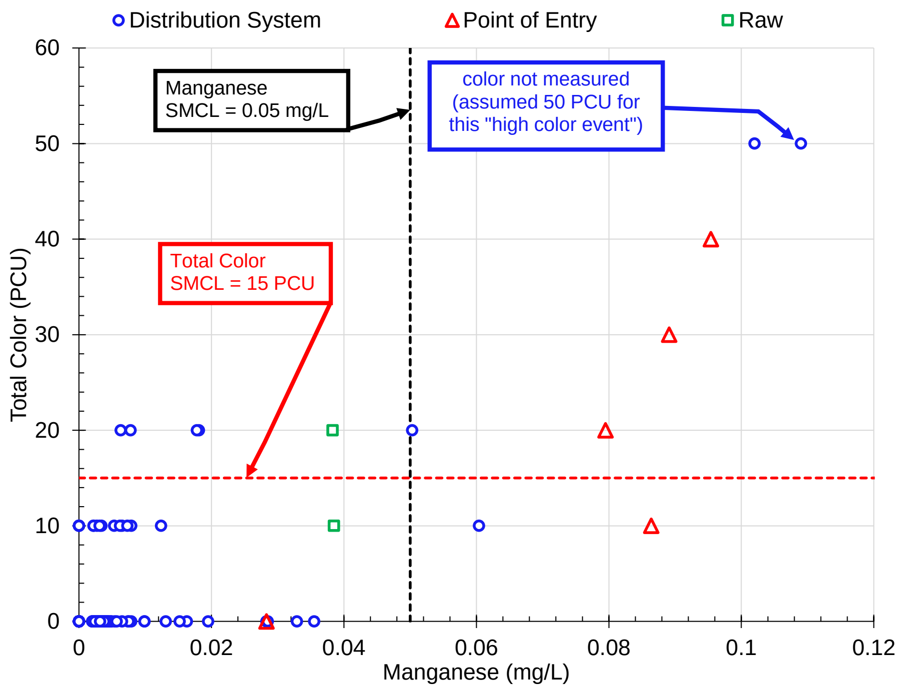


Figure 3 Manganese versus Total Color

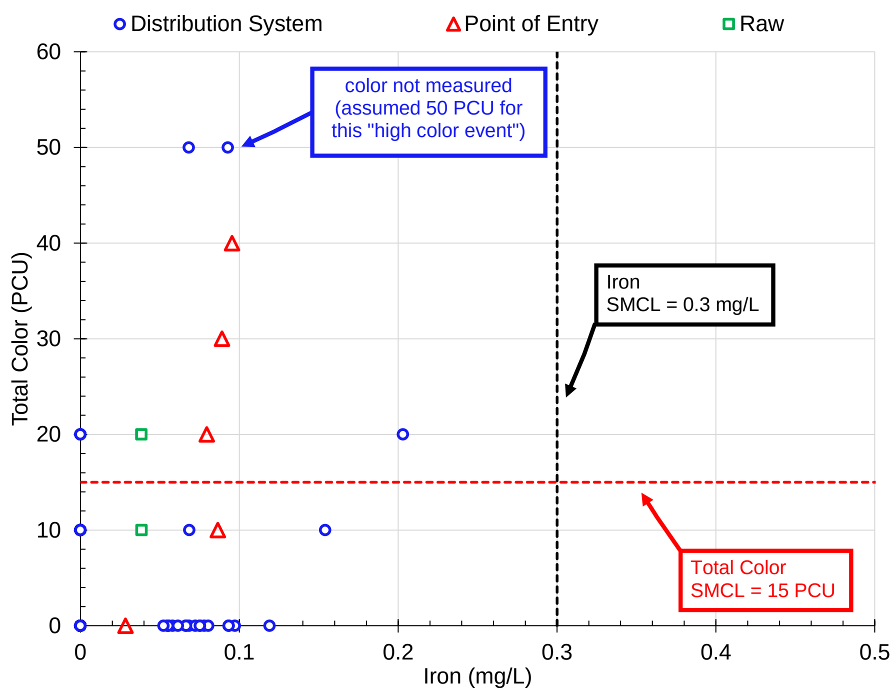


Figure 4 Iron versus Total Color

Following a hydraulic disturbance (e.g., main breaks or water main flushing) it is common for turbid water to be observed, and this has been reported in the HWWC system.

pH

HWWC provided water treatment plant data, which included pH data at two points in the water treatment process identified as “Segment 1” (exiting the contact tank) and “Segment 2” (point of entry). There were some reported issues with pH measurements at the WTP in the past, and the pH probes were re-calibrated on July 27, 2020. Figure 5 compares data before and after recalibration in the two segments, but only data after recalibration were used in Table 2 and in the following discussion. Dissolved inorganic carbon (DIC) is calculated from paired alkalinity and pH data, so only data after recalibration was used to calculate DIC at the POE. Distribution system monitoring locations have measured pH values ranging between approximately 7.2 to 8.2, though typically is in the range of 7.5 to 8.0 (Figure 6 and Figure 7). These figures demonstrate that there are fewer than 10 percent of pH values at any distribution system location that are <7.2..

The pH in the distribution system is within the desired range for lead and copper solubility control (see later discussion), so adjustment of pH at the WTP will not be necessary if this pH range can be maintained in the distribution system. Routine monitoring of the distribution system and WTP pH should be continued.

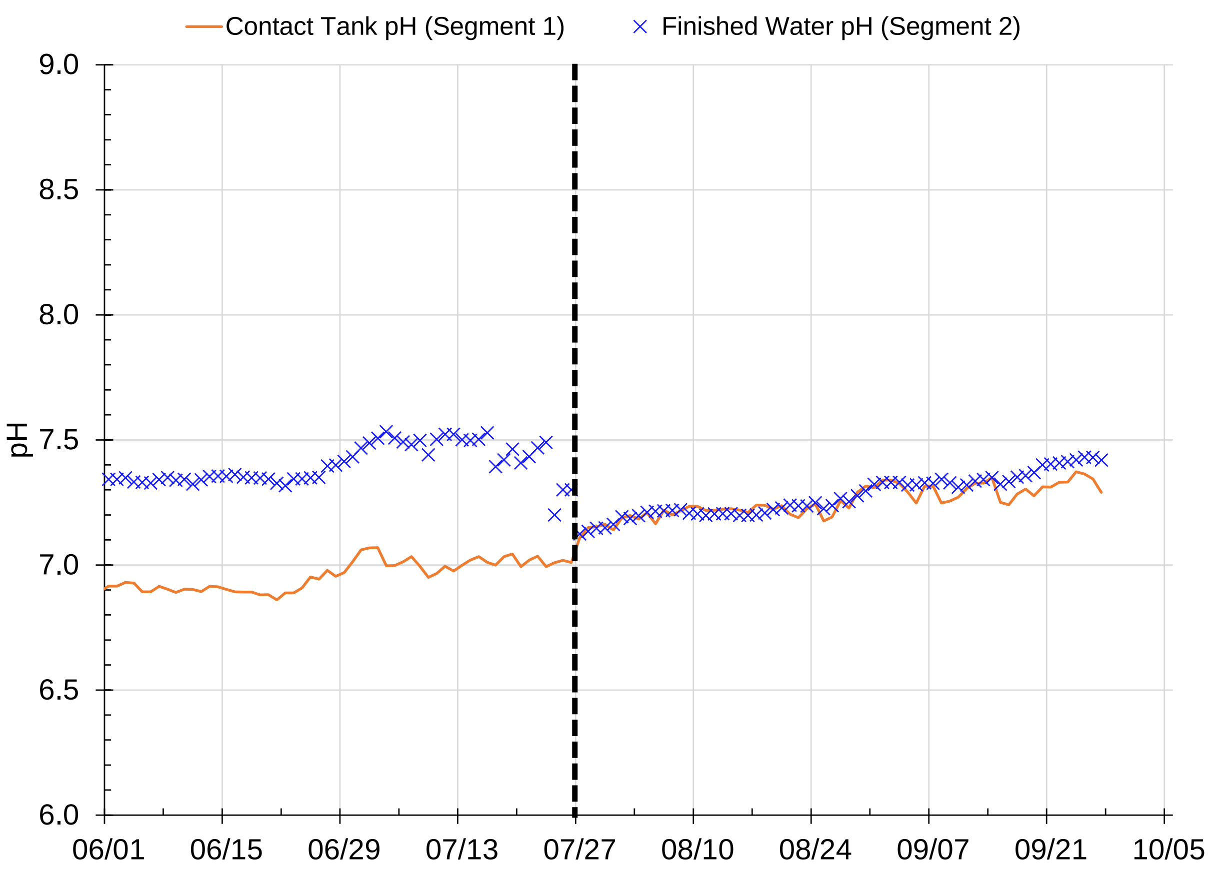


Figure 5 Historical pH data for Segments 1 and 2 at the WTP (Through September 27, 2020)

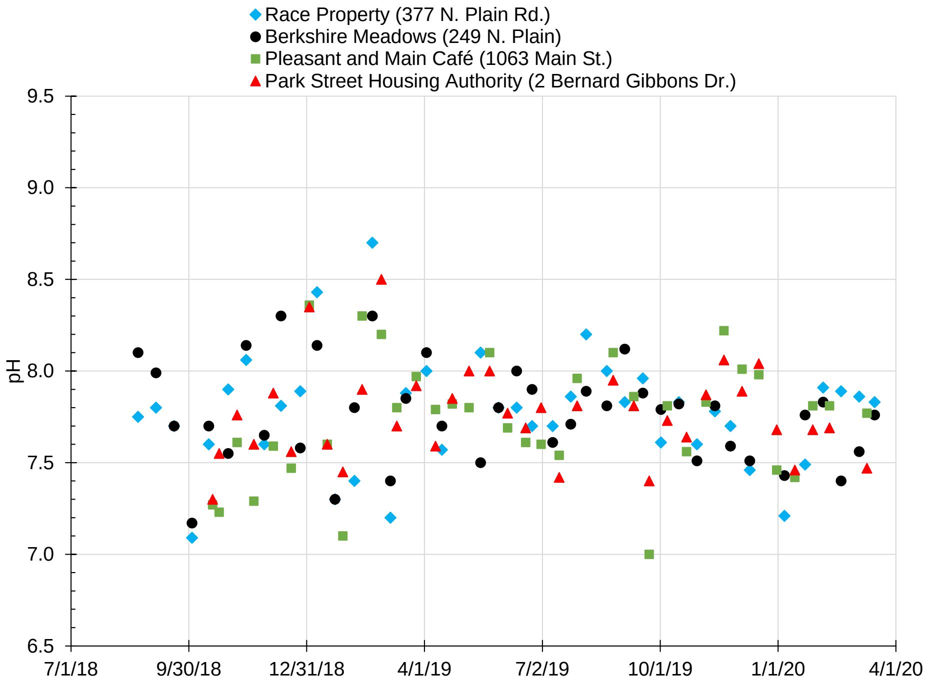


Figure 6 Distribution system (DS) pH versus date (August 2018 through August 2020)

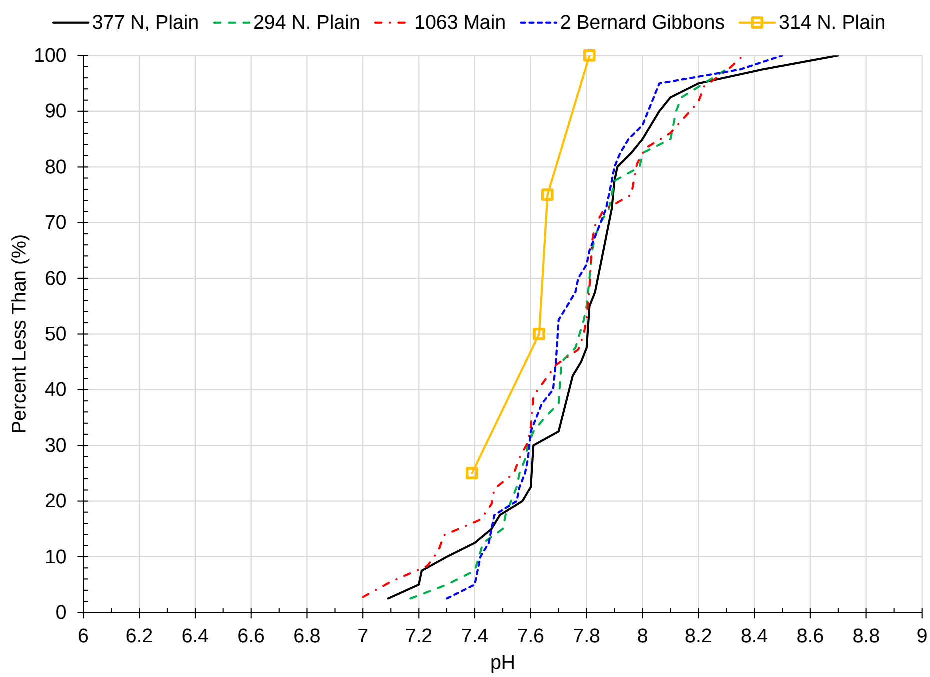


Figure 7 Percentile Distribution of DS pH (August 2018 through August 2020)

LEAD AND COPPER

Based on historical LCR data, lead and copper levels have been relatively high in certain compliance periods. In the last 7 years, there have been three lead action level (AL) exceedances and four copper action level exceedances. According to HWWC, some of the high lead levels in the system were due to a customer(s) not following LCR compliance sampling protocols. In response, HWWC implemented an education program for the sampling efforts. Recent data have been lower, without an Action Level exceedance in the past three years (six monitoring periods). Below is a summary table of the 90th percentile for lead and copper since 2013 (Table 4). Data from individual locations provided by HWWC also shows that high lead (or copper) results, including results leading to action level exceedances, are not limited to a single household location.

Table 4 Historical 90th percentile lead and copper data

Compliance Period	2013		2014	2015	2016		2017		2018		2019		2020
	Jun	Nov	Jun	Sep	Jun	Nov	Jun	Dec	Jun	Nov	May	Dec	Apr
Lead (µg/L)	16	6	6	15	18	19	17	14	7	5	12	6	3
Copper (mg/L)	1.4	1.0	1.1	1.4	1.4	1.1	1.0	0.2	1.6	1.3	1.0	0.9	0.8

Lead 90th percentile action level = 15 µg/L   Copper 90th percentile action level = 1.3 mg/L

The lead and copper in recent years is trending lower. There has been no treatment change, other than maintenance of lower chlorine residuals (see later discussion about the need to maintain free chlorine residuals). Concentrations of lead and copper can be higher in warmer months, so monitoring results in warmer periods (June to September) should be noted to see if these trends continue. Even the 0.77 copper in April 2020 is high, based on Cornwell's experience, for an LCR compliance level since this is generally old copper at existing monitoring locations. For copper, a key issue is copper solubility after a new pipe or fixture is added. Old copper pipe can eventually develop a protective scale. However, new copper pipe has a higher solubility since it has not had time to form the protective scale. One way to evaluate the potential impact of adding new pipe is to use existing solubility models in the literature, as discussed below (note these models tend to overpredict solubility).

Theoretical and experimental solubility models for lead and copper were used to characterize HWWC water quality related to potential corrosion. A summary of recommended future actions for HWWC are included later in this memorandum. The lead and copper solubility relationships described in this memorandum are based on theoretical and experimentally determined conditions, and associated assumptions, that can be used for relative comparisons of different water sources. However, data evaluated by Cornwell in field and laboratory studies with water samples from various water systems has revealed that the relationships used to develop these curves result in conservative (high) estimates of lead and copper solubility. For example, we have found the results for copper solubility are from 3 to 6 times lower in actual treated water than are predicted from the Lytle equation discussed below. So, the HWWC water may not be corrosive to copper (or lead), though this can be verified in laboratory solubility studies.

Theoretical Copper Solubility

The DIC of the water entering the distribution system was estimated to be between 20 and 22 mg/L as C. This was calculated using paired alkalinity and pH data from Table 2.

The 90th percentile from LCR copper compliance data has been consistently ≥1.0 mg/L in the last 7 years, with 4 action level exceedances in the same time period. At HWWC there are some homes with copper service lines, and copper pipe and fittings are likely in premise plumbing.

Figure 8 depicts experimental copper solubility estimated using the equation below developed by Lytle et al (2018). The HWWC used in this figure is 21.9 mg/L as C, and curves are shown in the figure for four different pH values.

$$Cu = 56.68 \times e^{-0.77 \times pH} \times e^{-0.20 \times PO4} \times DIC^{0.59}$$

Where:

Cu = predicted copper solubility (mg/L)

pH = pH (unitless)

PO4 = orthophosphate residual in mg/L as PO4

DIC = dissolved inorganic carbon (mg/L as C)

The pH in homes in the distribution system typically range between 7.2 to 8.2. Results in this figure suggest that the control of copper corrosion is achievable without the addition of orthophosphate if the pH is consistently above 7.3, since copper solubility using the Lytle equation is 1.3 mg/L or less.

A range of water quality conditions deemed "corrosive" to copper are shown in Figure 9 (no orthophosphate present). This figure reflects definitions recommended during the NDWAC (National Drinking Water Advisory Committee) discussions for the new revisions to the LCR (NDWAC 2015a&b). Water quality that falls in the unshaded region is considered to be non-corrosive to copper. Conditions that plot in the shaded region are corrosive to copper unless orthophosphate (at proper dose and pH) is added. Paired pH and alkalinity data from distribution system monitoring locations are plotted in Figure 9. Figure 9 demonstrated that when the distribution pH is >7.2, the water quality conditions are not conducive to copper corrosion. Limited copper solubility would be expected in HWWC treated water without orthophosphate if the pH is maintained >7.2 under current alkalinity/DIC conditions, as shown in Figure 8 and Figure 9. Since HWWC copper levels are higher than expected based on theory and are higher than observed in most other surface water systems, additional evaluation of copper solubility for HWWC is recommended.

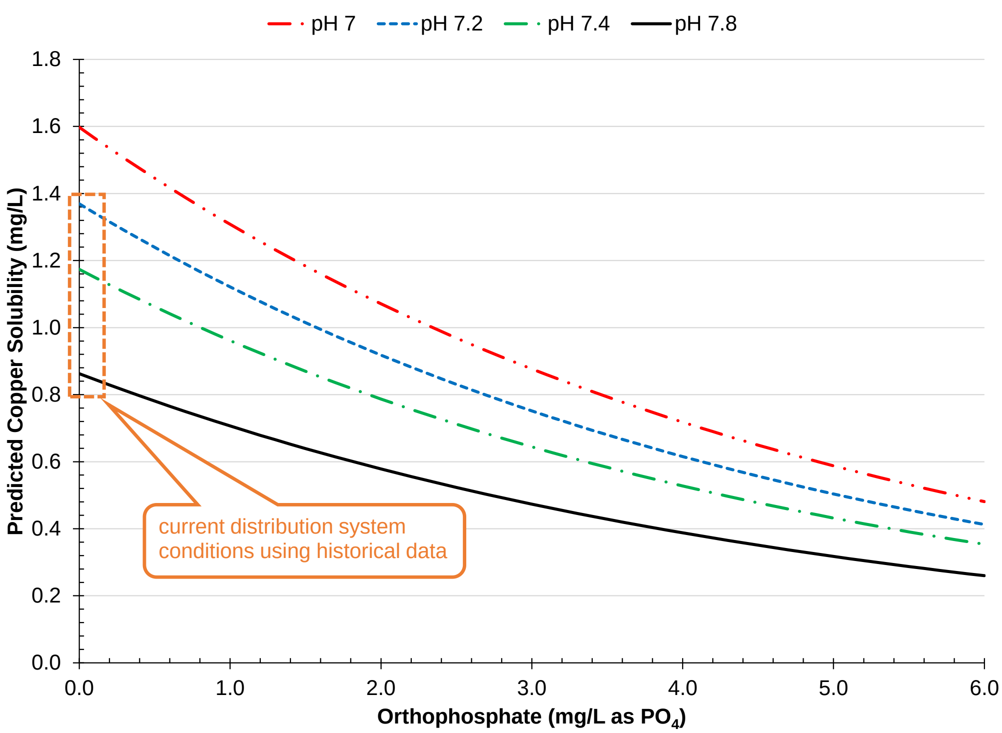


Figure 8 **Experimental copper solubility equation as a function of DIC, PO4, and pH. Assumes a constant DIC of 21.9 mg/L as C.**

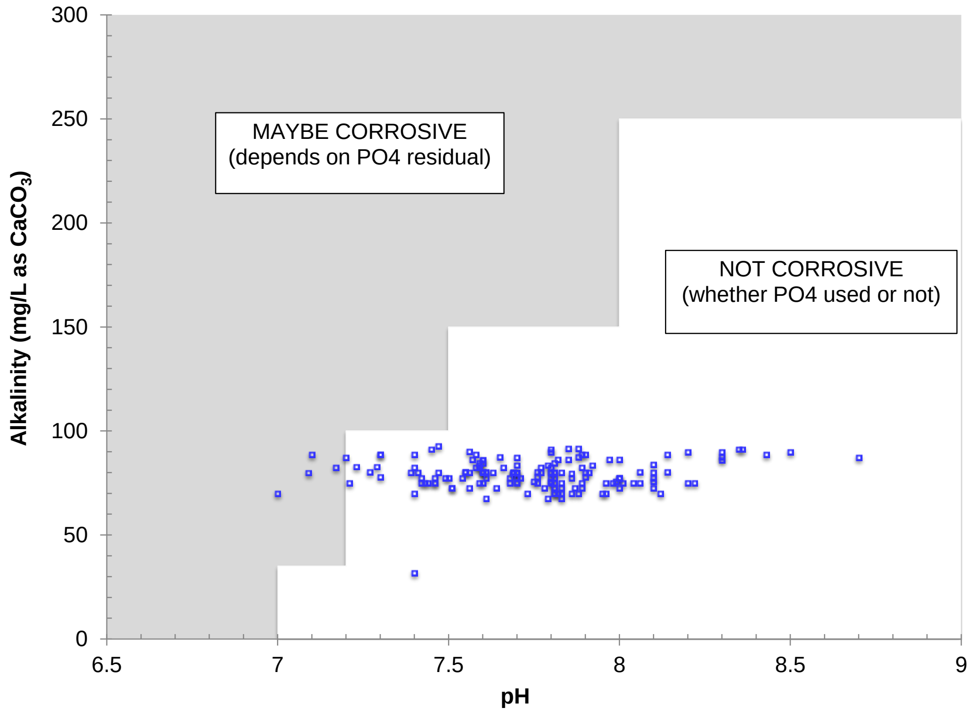


Figure 9 NDWAC defined conditions corrosive to copper (no orthophosphate present) versus paired pH and alkalinity data from the distribution system

Theoretical Lead Solubility

The HWWC system 90^{th} percentile lead exceeded the 15 µg/L action level during 2016 and 2017, and has exceeded 10 µg/L at various times since 2013 (Table 4). Recent data have been more favorable (HWWC passed the lead AL for the past three years covering the most recent six monitoring periods, perhaps due to increased attention to proper sampling procedures). HWWC has indicated there are no known lead service lines or lead goosenecks in their system, and whenever they encountered lead goosenecks (just a few were found in 35 years), the goosenecks were removed. According to HWWC, >90 percent of the service lines are galvanized iron. LCR monitoring results indicate there are likely still some sources of lead somewhere, which may be within individual household plumbing, though it is unknown whether this is due to lead solder or brass plumbing fixtures, or some other lead-containing sources.

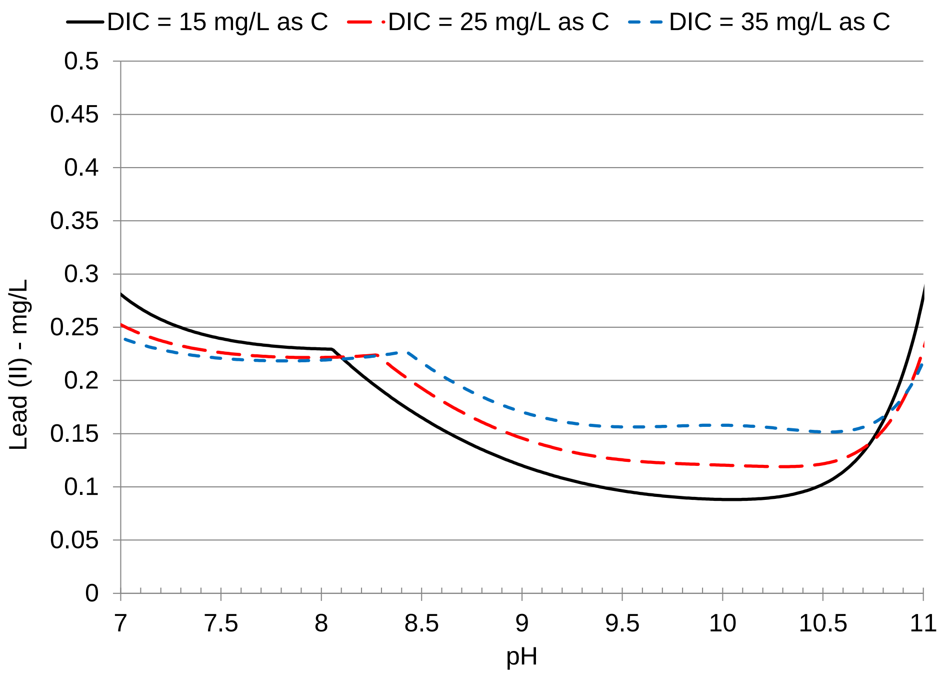


Figure 10 Theoretical Lead Solubility from Visual MINTEQ

Note: Assumes: a) DIC values are constant, b) water temperature 25 C, c) no orthophosphate present, d) no lead (IV) present, and e) cerussite and hydrocerussite are present.

Figure 10 is a theoretical lead solubility curve developed using chemical equilibrium mathematical model software (Visual MINTEQ (version 3.1 (https://vminteq.lwr.kth.se/)), literature data for stability constants and solubility products, water quality data (DIC, water temperature, pH), and assumed equilibrium with carbonate solids (hydrocerussite and cerussite). The curve was developed for three different DIC values of 15, 25, and 35 mg/L as C. The DIC of the HWWC system is similar to the 25 mg/L as C line in this figure. The figure indicates the pH would need to be raised to >9 in order to minimize the lead solubility without the use of orthophosphate. That is not recommended given the potential to precipitate calcium carbonate above the 8.2 saturation pH for this water source.

Figure 11 is a theoretical curve from Schock (2015) comparing lead solubility (vertical axis) with orthophosphate dose (horizontal axis). There are four sets of solid colored lines at bottom of the chart depicting predicted lead solubility at DIC 4.8 mg/L as C for pH 7.0, 7.5, 8.0, and 8.5. Similarly, higher in the graph are four lines for DIC 48.0 mg/L as C at the same four pH values. Note this graph assumes no polyphosphate present and assumes room temperature. This graph shows that:

- For a given DIC, when no orthophosphate is added, the lower the pH the higher the lead solubility.
- As PO_4 increases, lead solubility decreases for each combination of pH and DIC conditions.

For the HWWC system (DIC ~22 mg/L as C) the results would plot between the 4.8 and 48 mg/L DIC curves, and suggest the ability of orthophosphate to reduce the solubility of lead for the pH range of the HWWC system.

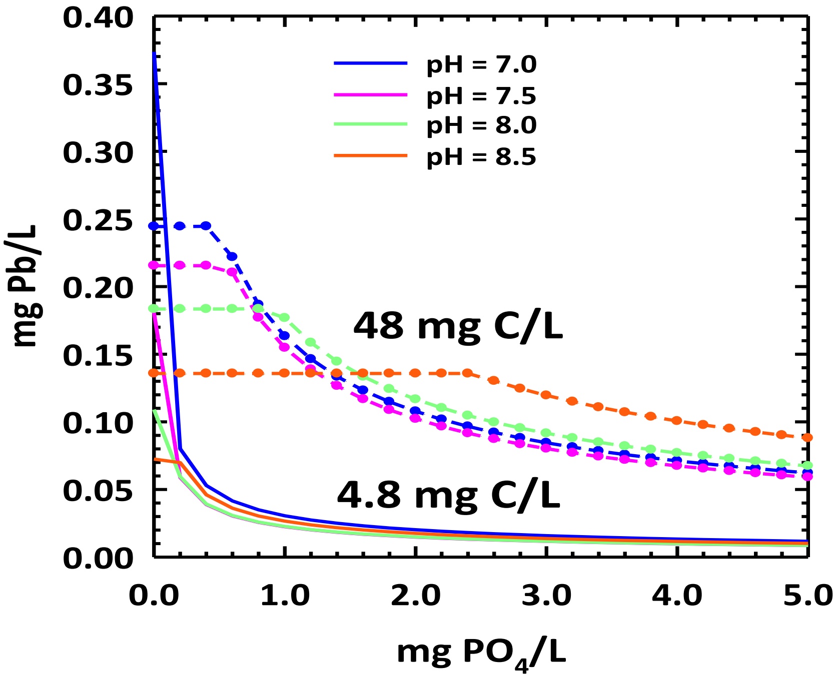


Figure 11 Lead solubility versus orthophosphate at 4.8 and 48 mg/L DIC at pH from 7.0 to 8.5 (Schock 2015)

USE OF POLYPHOSPHATE

Note that when this report refers to orthophosphate for lead and copper solubility control it is referring to the free PO_4 not a polyphosphate. Polyphosphate can be used to help keep iron and manganese from causing colored water and staining household plumbing and clothes. However, the use of polyphosphate complicates lead and copper corrosion control treatment.

Orthophosphate is used to promote formation of insoluble lead and copper phosphates. Polyphosphate added to keep iron and manganese from precipitating (i.e., forming scale), can also keep lead and copper from forming a protective crystalline scale. Furthermore, when lead and copper scales do form in the presence of polyphosphate, any polyphosphate incorporated into the scale can make the scale less stable. When polyphosphate is used with orthophosphate, the lead and copper solubility can be higher than if you add orthophosphate alone, although there is some amelioration of this as the polyphosphate gets older and naturally degrades from poly- to ortho-phosphate. Overall, there may be some instances where adding polyphosphate may be beneficial, especially when objectives other than lead and copper control are considered, but in most cases lead and copper control is optimized when orthophosphate is added alone.

Cornwell recommends adding iron or manganese removal when iron or manganese are above their SMCLs. Adding polyphosphate after this treatment will not be necessary for sequestration control of iron or manganese. In addition, if orthophosphate is needed for lead or copper control, it is recommended that it be added alone and not part of a blended phosphate. Since the treated water at the entry point in this system exceeds the 0.05 mg/L MCL for manganese, at least during warmer times of the year, it is recommended that treatment for manganese removal be added full-time, or at least seasonal, to limit manganese entering the distribution system. The best place to install manganese removal (and associated oxidation), orthophosphate injection, and any pH adjustment needs to be evaluated separately, though it is likely this will all happen following slow sand filtration.

HARDNESS AND CALCIUM CARBONATE PRECIPITATION

Since corrosion control methods may include pH adjustment, the calcium carbonate precipitation potential and saturation pH should be considered in order to anticipate the impact of raising or lowering the pH in a water system. The distribution pH ranges from about 7.2 to 8.2, and typically is between 7.5 and 8.0, which is below the saturation pH and the resulting CCPP is negative. Calcium carbonate precipitation is not expected in this water source unless the pH is raised above the saturation pH of 8.2. Distribution system pH should continue to be monitored to see if it consistently remains within the 7.2 to 8.2 range, and if additional lead or copper control is needed then it may be necessary to add orthophosphate (after evaluating dose and pH conditions needed). The current distribution system pH already ranges from 7.2 to 8.2 so an additional pH increase is not recommended due to potential calcium carbonate precipitation complications. The calcium hardness of the system is 48 mg/L as $CaCO_3$, but no total hardness data have been reported.

CHLORINE RESIDUAL

On occasion, distribution system chlorine residuals in late 2019 and early 2020 dipped below the minimum recommended target residual of 0.2 mg/L, as shown in Figure 12. The chlorine residual should be maintained at a higher level in the distribution system to ensure proper disinfection. These residuals need to balance other concerns (DBP formation versus microbial control – see also Roth and Cornwell 2018).

Corrosion chemistry is complex, and it is difficult to determine whether lower chlorine residual may or may not have any positive implication for lead or copper corrosion. Higher free chlorine can increase iron levels in the water, but it is also important to note that chlorine residuals that are too low can lead to microbial growth in the distribution system, which can result in lower pH and consequently can increase the solubility of lead, copper, iron, and other metals. Adjustment of free chlorine doses as necessary in order to achieve ≥0.2 mg/L residual in all parts of the distribution system in all seasons is recommended. This may require higher residuals in other parts of the system to ensure that all points in the system are ≥0.2 mg/L.

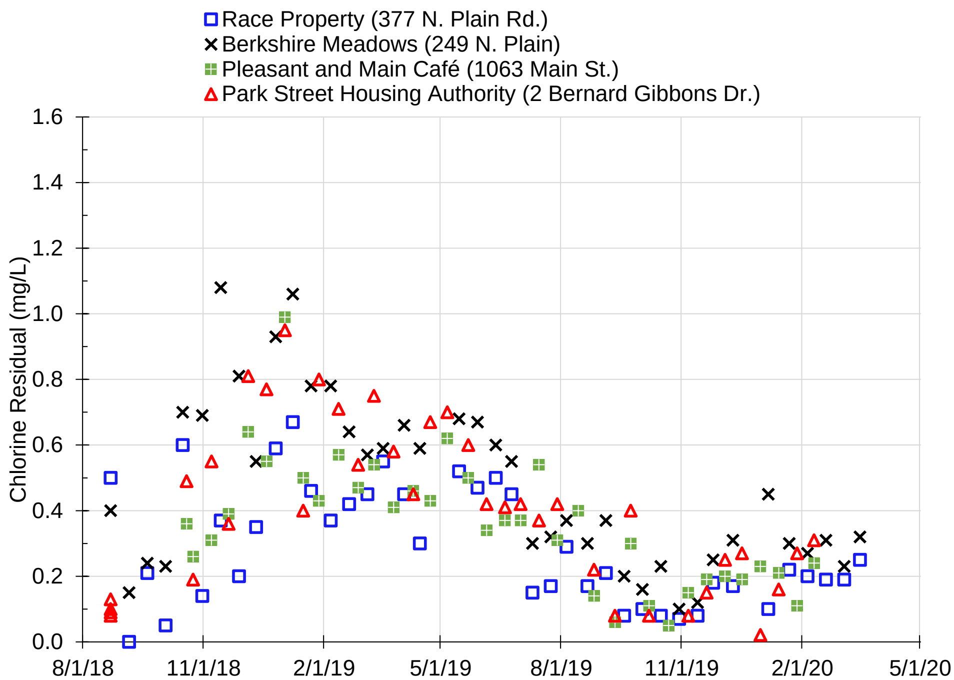


Figure 12 Distribution system chlorine residual

RECOMMENDATIONS AND ACTION PLAN

Based on previous analysis and discussion:

1. **Manganese concentrations above the secondary maximum contaminant limit (SMCL) of 0.05 mg/L are the identified source of the colored water. The manganese is in the treated water leaving the water treatment plant.**

2. Manganese removal should be evaluated and implemented at least seasonally (warmer weather) when higher manganese and higher true color results are observed.

3. The addition of a polyphosphate or a blended phosphate to sequester manganese or iron is not recommended. Polyphosphate or blended phosphate can have a negative effect on lead and copper corrosion.

4. Iron removal at the source does not appear to be necessary, but treatment installed for manganese removal should remove iron if present

5. The current water chemistry in the distribution system, using samples representing "normal" conditions, results in a low Larson-Skold Index, suggesting the water may not be susceptible to iron corrosion. Results from a designated "color event" also show an iron concentration well below the SMCL.

6. Based on the data reviewed, treated water pH has typically been ≥7.4 in the distribution system without pH adjustment. However, if future monitoring shows that these pH levels are not regularly achieved, pH adjustment should be evaluated.

7. Free chlorine residuals should be maintained at the target residual of ≥0.2 mg/L in all parts of the distribution system in all seasons.

8. Sequential sampling to identify locations of the lead source in the customers' home or service lines is suggested for locations with historically high lead levels, and should also be considered after a treatment change, for example, after addition of: a) manganese removal processes, b) pH adjustment, or c) orthophosphate addition.

9. The current distribution system pH is already close to the saturation pH (8.2), so it may not be possible to increase the pH much higher. Consequently, if lead and copper cannot be controlled under current conditions, the addition of orthophosphate may need to be evaluated. Evaluation of orthophosphate and pH adjustment should include, at minimum,

laboratory solubility studies for lead and copper to evaluate optimal pH and orthophosphate dose.

The conclusions and recommendations for action are summarized in the table below:

Table 5 Summary of recommendations for treatment of metals

Metal	Problem	Evidence	Recommended solution
Lead	Maybe	Action Level (AL) exceedance in past compliance periods, though < AL for the 6 most recent periods after improving sampling procedures	Identify lead sources. If LCR data increase again over time then possibly re-evaluate CCT
Copper	Maybe	AL exceedance in past compliance periods. Theoretical modeling shows POE water likely is corrosive to copper, while the measured values are substantially higher than is typically observed.	Conduct laboratory solubility studies
Iron	No	Levels <SMCL	None needed, but manganese removal will likely remove iron (prior to POE)
Manganese	Yes	Levels >SMCL Colored water complaints	Evaluate removal via oxidation and filtration

REFERENCES

ASTM 2019. *Standard Test Method for Color of Clear Liquids (Platinum-Cobalt Scale) – ASTM D1209-05*. ASTM International: West Conshohocken, PA.

Leitz, F., and K. & Guerra, K. (2013). *Water Chemistry Analysis for Water Conveyance, . Storage, and Desalination Projects: Manuals and Standards Program.* US Department of the Interior, Bureau of Reclamation, Technical Service Center: Denver, CO.

Lenard (Lenard Engineering, Inc.) 2016. *Desktop Corrosion Control Study (December 2016).* Housatonic Water Company: Great Barrington, MA.

Lenard (Lenard Engineering, Inc.) 2017. *Basis of Design Report: Proposed Corrosion Control Treatment (October 2017).* Housatonic Water Company: Great Barrington, MA.

Lytle, D., M. Schock, J. Leo, and B. Barnes. 2018. "A Model for Estimating the Impact of Orthophosphate on Copper in Water." *Jour. AWWA,* 110 (8): E1-E15.

NDWAC (National Drinking Water Advisory Committee) 2015a. “Recommendations to the Administrator of the Long-Term Revisions of the Lead and Copper Rule.” Accessed September 30, 2018. https://19january2017snapshot.epa.gov/sites/production/files/2017-01/documents/ndwaclcrwgfinalreportaug2015.pdf.

NDWAC (National Drinking Water Advisory Committee) 2015b. “Report of the Lead and Copper Working Group to the National Drinking Water Advisory Council – Final.” Accessed September 30, 2018). https://19january2017snapshot.epa.gov/sites/production/ files/2017-01/documents/ndwacrecommtoadmin121515_0.pdf

Roth, D. and D. Cornwell. 2018. “DBP Impacts From Increased Chlorine Residual Measurements”. *Jour. AWWA*, 110 (2): 13-28.

Schock, M. 2015. Presentation at the LCR-LTR NDWAC Working Group Meeting.

APPENDIX E

TONKA BUDGETARY PROPOSAL

TONKAWATER™
a Kurita brand

March 3, 2021

Bryan Sadowski
Project Engineer, Water
AECOM
250 Apollo Drive
Chelmsford, Massachusetts 01824

RE: Great Barrington, MA
VertaCell™ Vertical Pressure Filter System
Preliminary Proposal and Budgetary Estimate

Dear Mr. Sadowski,

In accordance with our understanding of the above project, Tonka Water, a Kurita brand, is pleased to provide information concerning the following process equipment. For this project, Tonka Water is proposing:

Tonka Water VertaCell™ Vertical Pressure Filter System for Iron and Manganese Removal

Design Parameters:	
Total Design Flow:	420 gpm
Filter Loading Rate:	3.0 gpm/sf
Number of Vessels:	2
Dimensions:	9'-6'' diameter x 6'-0'' side shell
Working Pressure:	100 psi
Test Pressure:	130 psi
Approx. Operating Weight Per Vessel:	80,100 lbs
Media - Depth:	30 inches
Gravel - Depth:	15 inches
Backwash Volume Total:	13,000 gal
Total Backwash Saved by Simul-Wash™:	11,000 gal per backwash

- Tonka Water VertaCell™ vertical pressure filters are constructed of carbon steel, ASME code stamped, and incorporate Tonka Water's Simul-Wash™ combined air/water backwash system, which provides superior media cleansing and greatly reduced backwash water volume. Each filter to include:
  - Stainless steel Simul-Wash™ backwash collection trough
  - Filter media selected specifically for the project –18" of Greensand Plus capped with 12" of anthracite
  - PVC header-lateral air wash distributor

- Graded support gravels
- PVC header-lateral underdrain with Tonka Water non-metallic gravel-retaining nozzles (concrete subfill required by installing contractor)
- Fully factory finish-painted vessel interior; tank exterior blasted and primed (finish paint by others)

- Additional components and services are included as follows:
  - Fully automated Allen-Bradley PLC control system and panel
  - System valves, including electrically actuated Bray wafer-style butterfly valves for filter backwash
  - Ductile iron filter facepiping (shipped loose for installation by others)
  - Regenerative airwash blower package
  - Loss of head pressure gauge panel, with pressure switch
  - Backwash rate of flow panel
  - Freight
  - Field services consisting of installation inspection, media installation supervision, start-up and operator training

The budgetary price for this system is: $ 350,000.00

Tonka Water Organix™ System for TOC Removal

Total Design Flow:	420 gpm
Total Treated Flow:	420 gpm
Total Bypass Flow:	0 gpm
Vessel Load Rate:	7.4 gpm/sf
Number of Vessels:	2
Dimensions:	6'-0'' diameter x 11'-11'' approx. overall height
Working Pressure:	100 psi
Test Pressure:	130 psi
Design Resin Capacity:	15,000 gal/cf
15-20,000 is typical. Final design must be based on full pilot results.	
Approx. Shipping Weight Per Vessel:	5,000 lbs
Resin - Depth:	36 inches
Resin - Approx. Total Bags Per Project:	170 bags
Gravel - Depth:	15 inches
Gravel - Approx. Total Bags Per Project:	68 bags
Approx. Operating Weight Per Vessel:	24,500 lbs

- Each vertical pressure vessel is to be constructed of carbon steel, ASME code stamped, and will include:
  - Schedule 80 PVC header-lateral inlet distributor with upturned elbows

- Schedule 80 PVC header-lateral brine distribution grid
- Thermax macroporous ion exchange resin
- 15" depth of graded support gravels
- Schedule 80 PVC header-lateral underdrain with Tonka Water non-metallic gravel retaining nozzles (concrete subfill required by installing contractor)
- Full interior finish painting; exterior blasted and primed at factory (finish painting by others on site)

- Additional components and services are included as follows:
  - System valves, including electrically actuated Bray wafer-style butterfly valves for system regeneration
  - Ductile iron vessel facepiping (shipped loose for installation by others)
  - Backwash rate of flow gauge panel
  - Vessel effluent flow meters, one per vessel
  - Fully automated Allen-Bradley PLC control system and panel
  - Brine delivery and dilution components, including brine pump, brine meter, valves, check valves, and other components for a fully functional brine delivery and dilution system (shipped separately for installation by the installing contractor; interconnecting piping by others)
  - Bypass/blend components including flow meter, throttling valve, and modulating control valve.
  - Brine maker/salt storage silo, FRP construction, insulated for placement outdoors
  - Freight
  - Field services consisting of installation inspection, media installation supervision, start-up and operator training

The budgetary price for this system is: $ 350,000.00



VERTACELL™

VERTICAL PRESSURE FILTERS

Vertical Pressure filters that meet your treatment needs

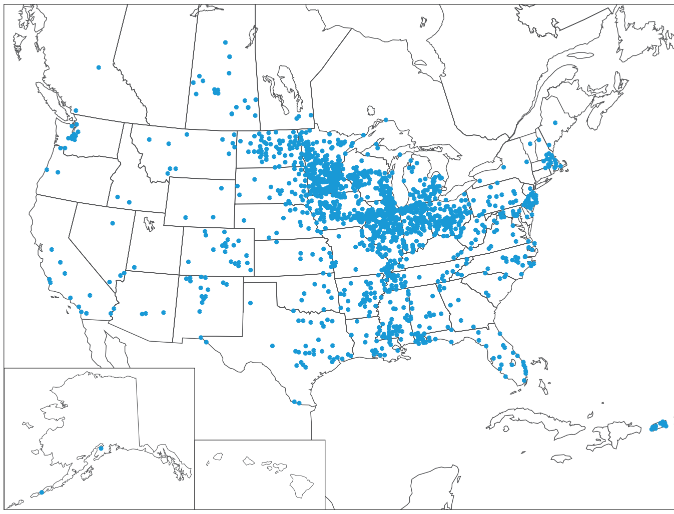
Tonka Water, a U.S. Water Brand customizes filters in many ways:

Tonka Water's VertaCell™ vertical pressure filters can be arranged in single or multiple filter configurations, can be top, bottom, end or side piped, and can be constructed from 2 to 12 feet in diameter. In multiple filter configurations, one filter can be completely removed from the system without interfering with operation of the other units, in order to backwash or perform maintenance. The tanks are long lasting, and can be customized to include a range of systems including Simul-Wash™, airwash and various underdrain systems.

TREATMENT

- Arsenic
- Iron and manganese
- Radium
- Organics
- Membrane pre-treatment
- Turbidity

TONKAWATER™
A U.S. WATER BRAND



Tonka Water Guarantee

Tonka Water provides the best custom manufactured water treatment systems in the industry. Our people will deliver excellent service and support for your project from conceptual and cost-effective design, to construction and commissioning; and throughout the system warranty and operational life of the project.

Thousands of quality water treatment installations since 1956.

VertaCell™ System Advantages

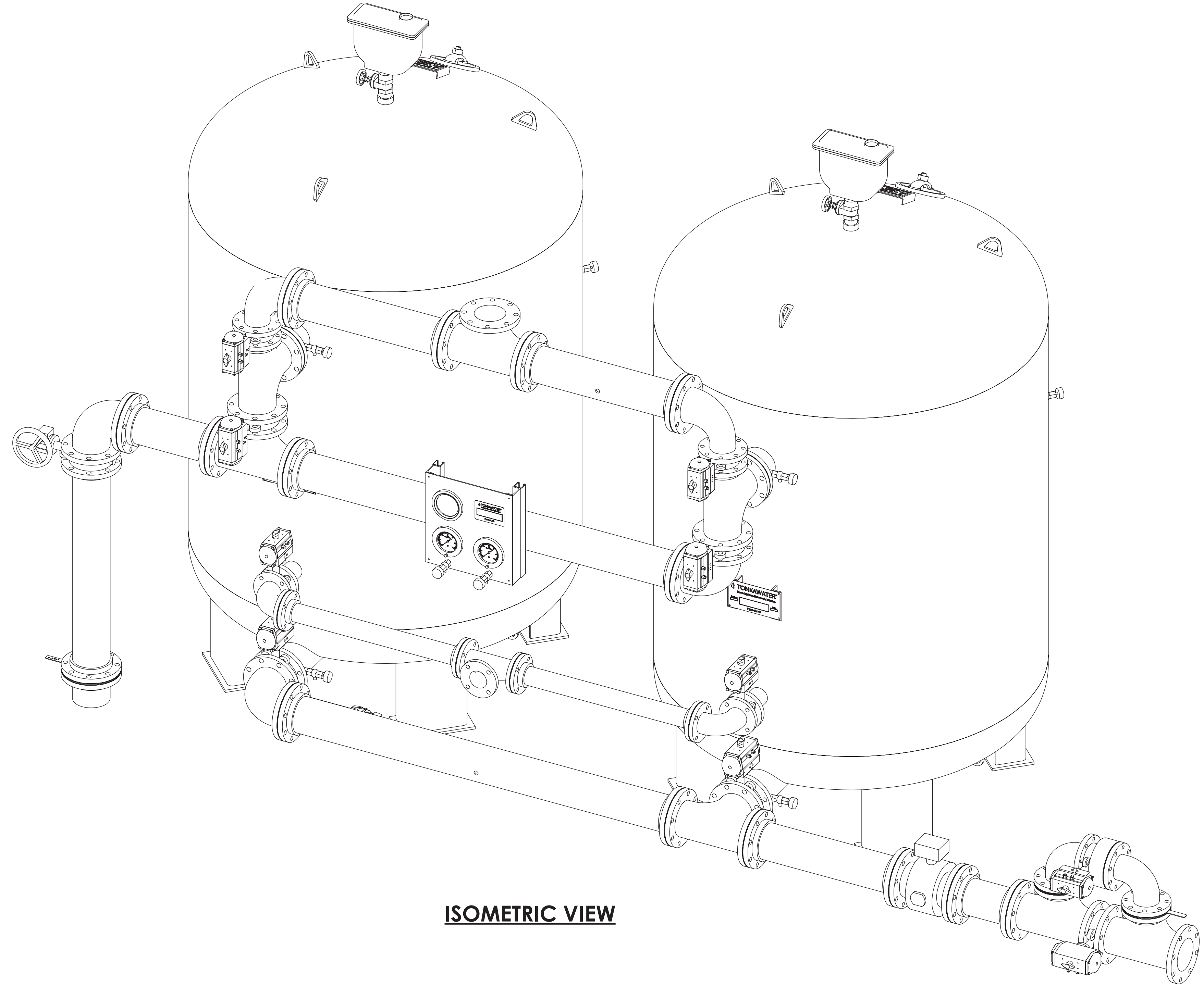
- ASME Code constructed, certified and U-Stamped
- Versatility in systems: Simul-Wash™, water only, or air followed by water backwash
- Media selections: many options available
- Smaller footprint than other systems
- Allows for future growth
- Operationally efficient, and easy to maintain

763.559.2837
www.tonkawater.com
Tonka Water, a U.S. Water Brand

U.S. WATER
The **future** of water™

TONKAWATER™
A U.S. WATER BRAND

VertaCell™ Pressure Filter System
2 Vessel System
Catalog Drawing

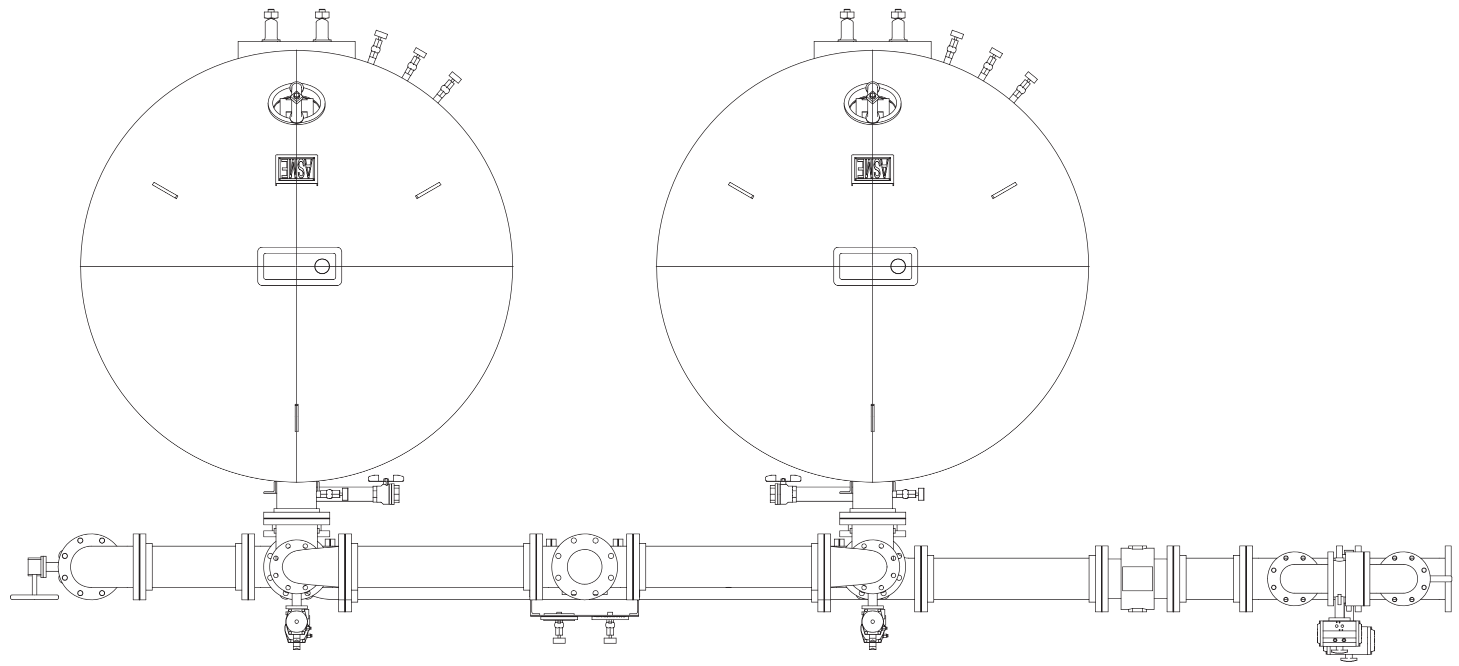


ISOMETRIC VIEW

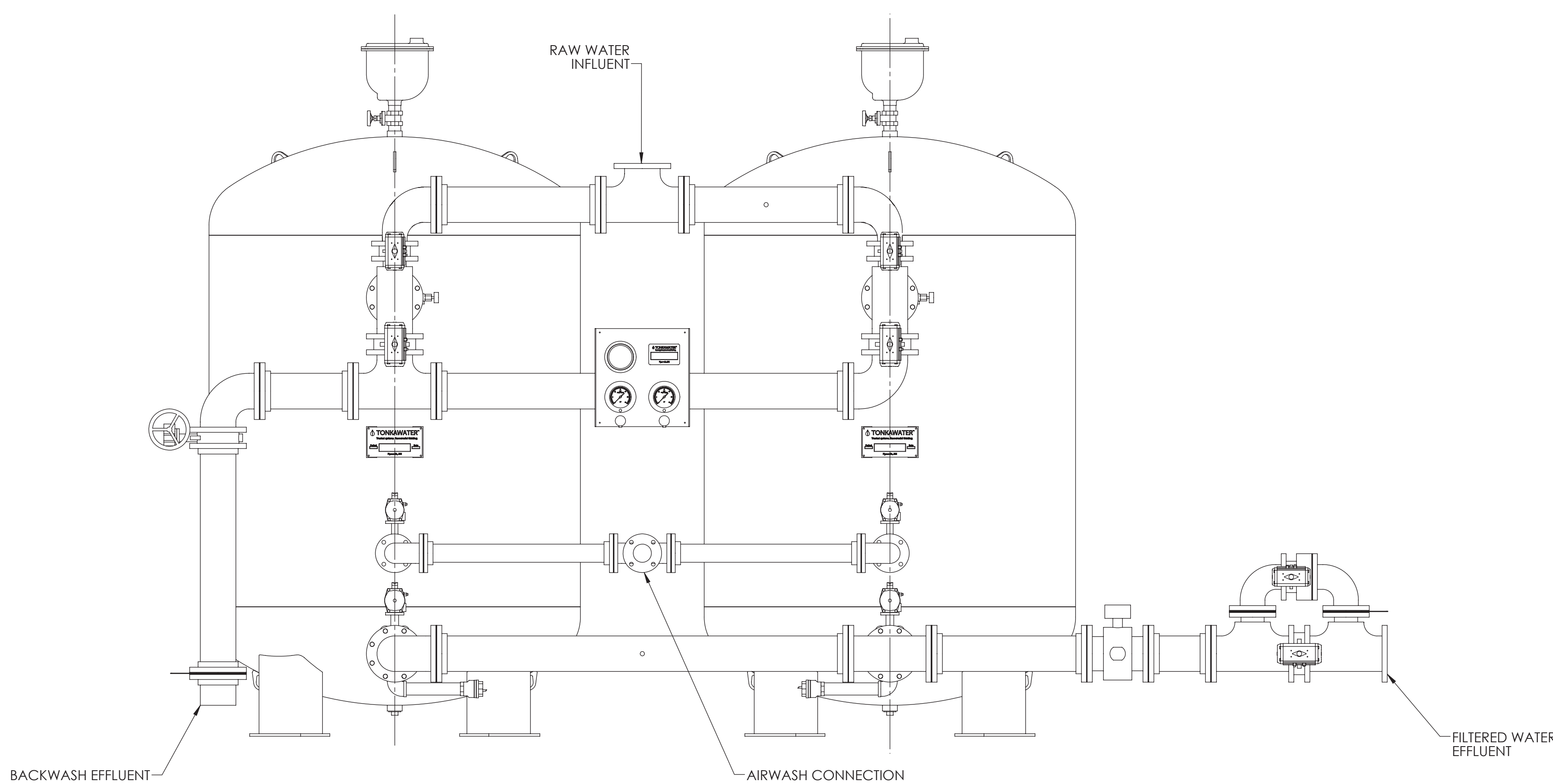
DRAWING SIZE: D	ALL RIGHTS TO MANUFACTURE, COPY, REPRODUCE OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY TONKA EQUIPMENT COMPANY. DO NOT SCALE DRAWING		TONKAWATER™ A U.S. WATER BRAND	13305 WATERTOWER CIRCLE PLYMOUTH, MN 55441 (763) 559-2837 www.tonkawater.com
DRAWN BY: DDI	START DATE: 12/13/2013	THICKNESS:	VERTACELL™ PRESSURE FILTER SYSTEM 2 VESSEL SYSTEM CATALOG DRAWING	SHEET NUMBER: 1 OF 2 — REV: 0
	DWG. SCALE: 1:24	LENGTH:		DRAWING NUMBER: 00064319
APPR. BY:	APPR. DATE:	APPROX. WEIGHT: 19596.0682		

MATERIAL:

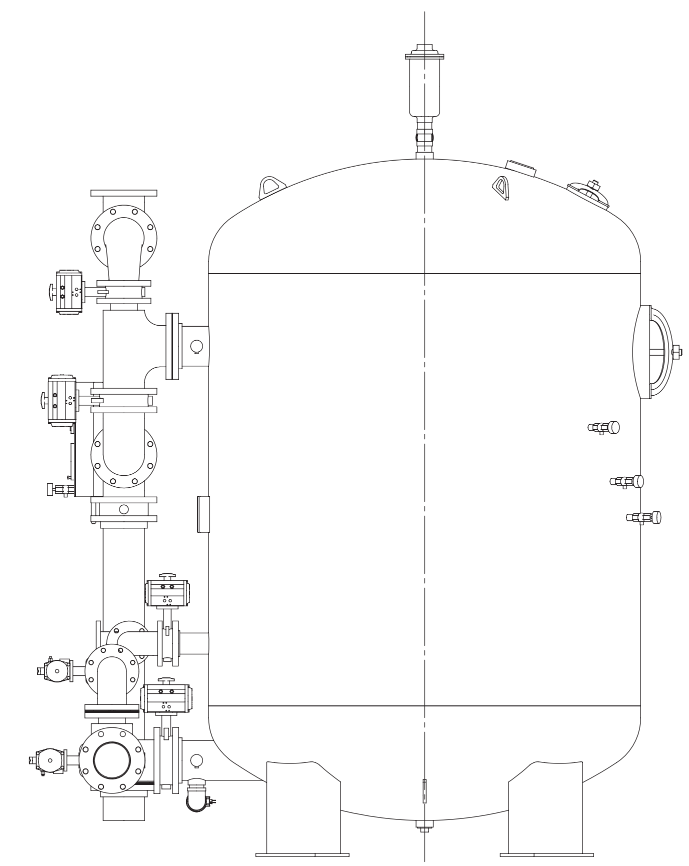
Last Saved: Thursday, July 20, 2017 1:33:21 PM



PLAN VIEW



FRONT ELEVATION



RIGHT SIDE ELEVATION

DRAWING SIZE: D	ALL RIGHTS TO MANUFACTURE, COPY, REPRODUCE OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY TONKA EQUIPMENT COMPANY. DO NOT SCALE DRAWING		TONKAWATER™ A U.S. WATER BRAND	13305 WATERTOWER CIRCLE PLYMOUTH, MN 55441 (763) 559-2837 www.tonkawater.com
DRAWN BY: DDI	START DATE: 12/13/2013	THICKNESS:	VERTACELL™ PRESSURE FILTER SYSTEM 2 VESSEL SYSTEM CATALOG DRAWING	SHEET NUMBER: 2 OF 2 REV: 0
	DWG. SCALE: 1:24	LENGTH:		DRAWING NUMBER: 00064319
MATERIAL: APPR. BY:	APPR. DATE:	APPROX. WEIGHT: 19596.0682		

Last Saved: Thursday, July 20, 2017 1:33:21 PM

ORGANIX™

Advanced Organics Removal Technology

FEATURES

- Compact footprint and simplicity
- Simple, robust design
- Easy installation and maintenance
- In-vessel technology
- Minimal waste stream

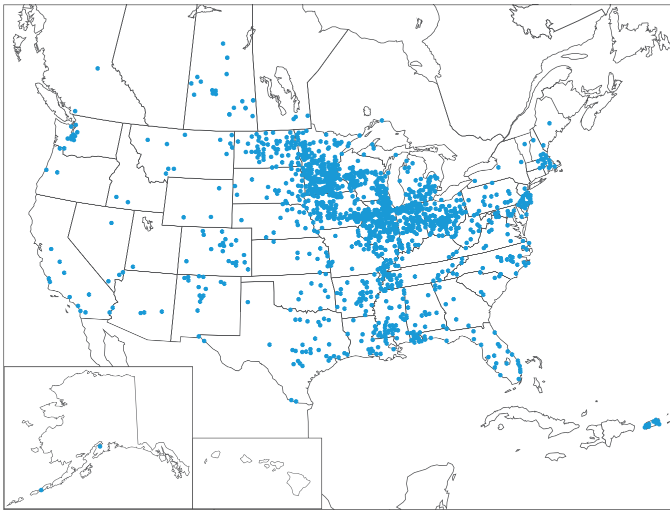
Stepping up to the challenge of organics removal

Organix™ Vs. Organics

Organix™ is the most cost-effective, customized, and user-friendly solution to the complex challenge of organics removal.

- Superior TOC, DOC, and color removal using organic selective ion exchange resin
- Guaranteed water quality
- System responsibility from an experienced manufacturer
- Easy integration into existing facilities for both ground and surface water treatment
- Trouble-free operation. No moving parts or complicated hydraulic balancing
- Proven results and a successful track record with numerous installations
- Cost-effective solutions and lowest cost of treatment

TONKAWATER™
A U.S. WATER BRAND



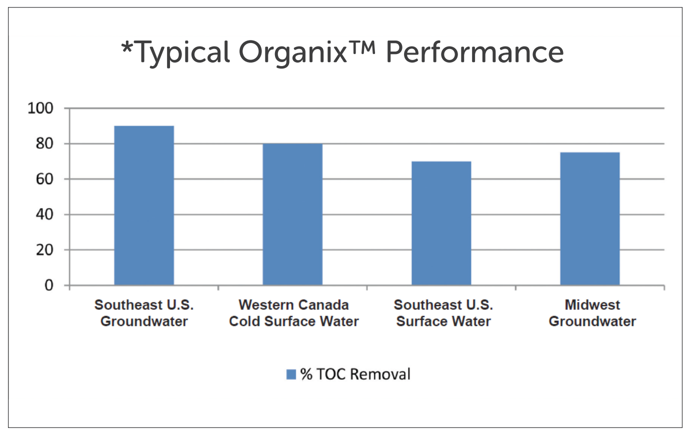
Tonka Water Brand Guarantee

Tonka Water, a U.S. Water brand provides the best custom manufactured water treatment systems in the industry. Our people will deliver excellent service and support for your project from conceptual and cost-effective design, to construction and commissioning; and throughout the system warranty and operational life of the project.

Thousands of quality water treatment installations since 1956.

Organix™ Can:

- Operate intermittently or continuously
- Provide up to 90 percent removal of TOC*
- Be incorporated as a "slip stream" treatment
- Handle a wide range of organic compounds
- Eliminate THM and HAA formation potential prior to disinfection
- Be fully automated and SCADA compatible
- Be adapted for seasonal operation as needed



Organix™ Features

- Conventional and proven process
- In-vessel technology
- Efficient footprint
- Easy to install and maintain
- Inherent system redundancy
- Simple, easy-to-use controls
- Intermittent off-line resin regeneration
- Robust system tolerates influent hydraulic and TOC fluctuations
- Guarantee against resin loss or attrition

Pressurized, Enclosed Process

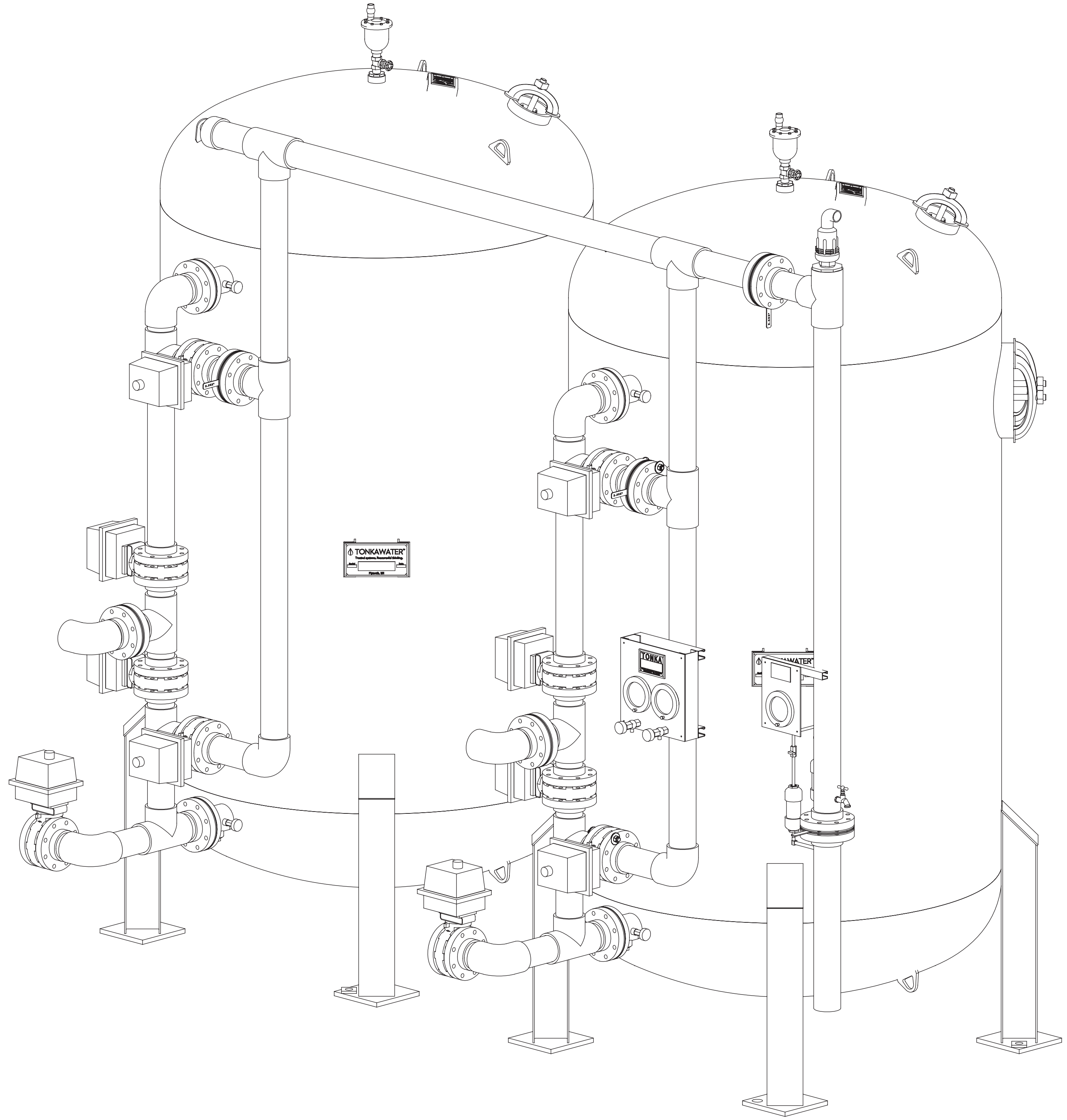
- No intermediate pumping required, stays pressurized
- Not dependent on flocculators, gear reducers, mixers, or other mechanical devices
- Avoids exposure to atmosphere and sunlight which promote biological growth
- No downstream equipment (screens, filters) required for resin capture
- Minimal waste stream

763.559.2837
www.tonkawater.com
Tonka Water, a U.S. Water Brand

U.S. WATER
a Kurita company

TONKAWATER™
A U.S. WATER BRAND

Organix™
Small Vessel - Traditional Piping
Catalog Drawing

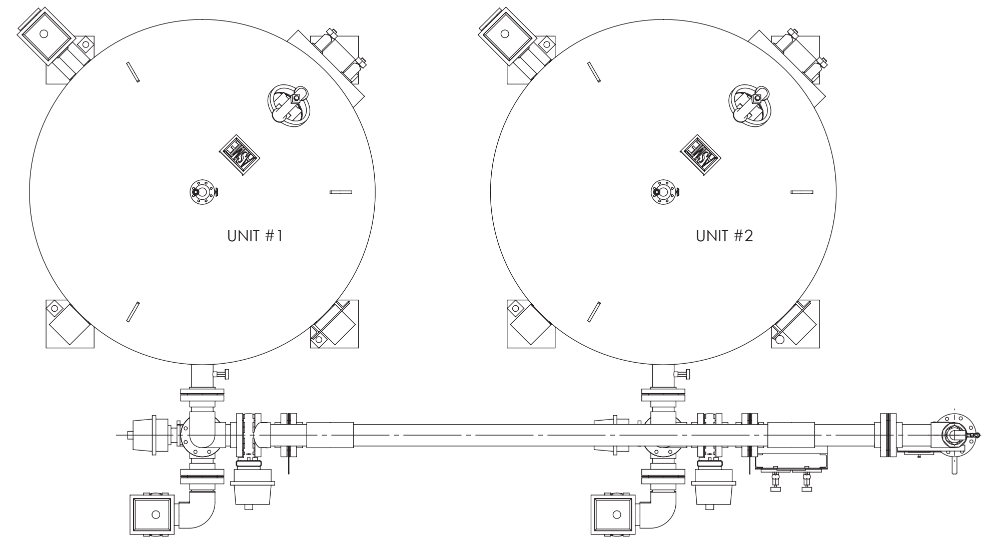


ISOMETRIC VIEW

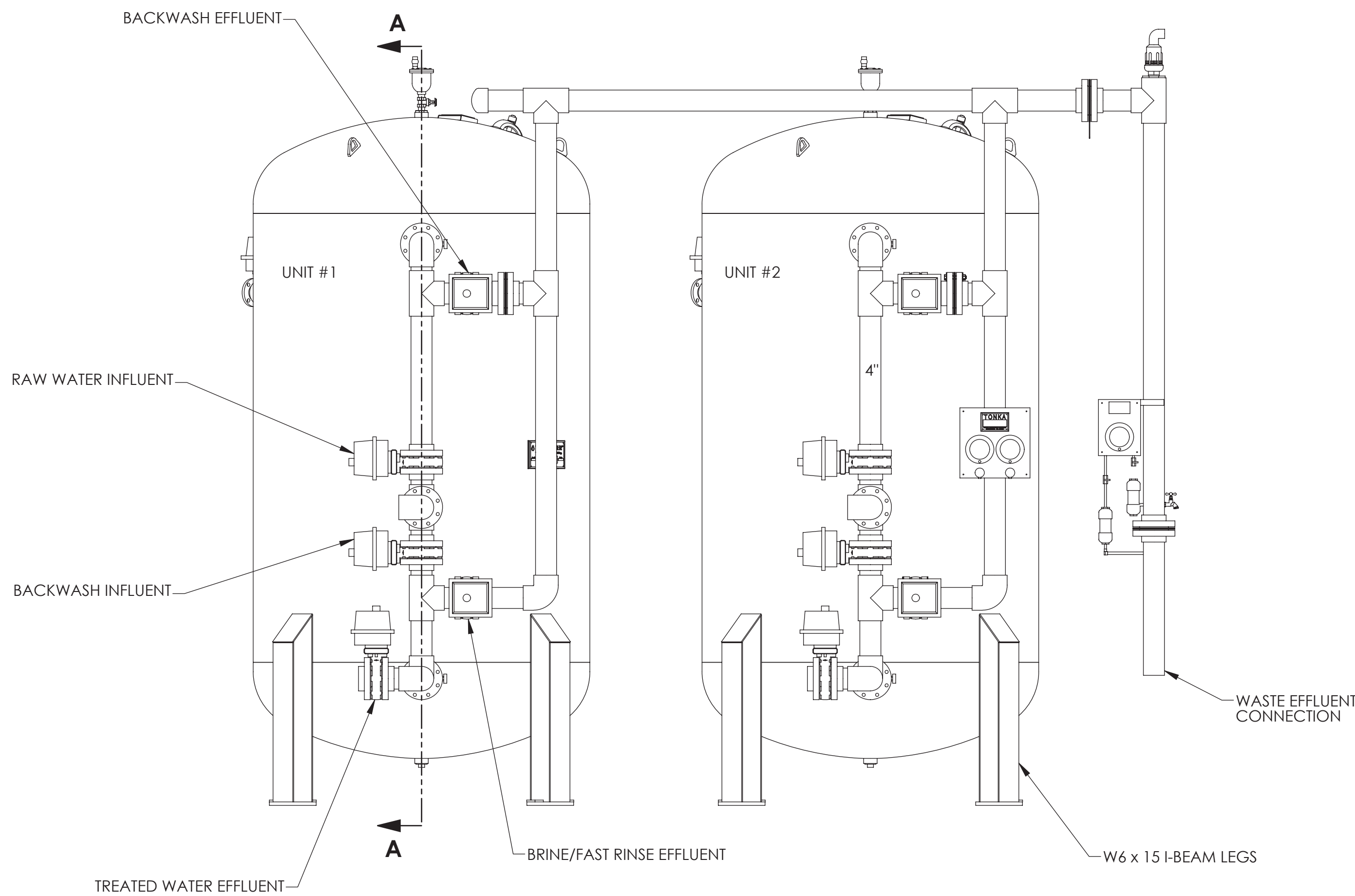
DRAWING SIZE: D	ALL RIGHTS TO MANUFACTURE, COPY, REPRODUCE OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY TONKA EQUIPMENT COMPANY. DO NOT SCALE DRAWING		TONKAWATER™ A U.S. WATER BRAND	13305 WATERTOWER CIRCLE PLYMOUTH, MN 55441 (763) 559-2837 www.tonkawater.com	
DRAWN BY: RAC	START DATE: 01/29/2014	THICKNESS:	ORGANIX™ SMALL VESSEL - TRADITIONAL PIPING CATALOG DRAWING	SHEET NUMBER: 1 OF 2	REV: 0
	DWG. SCALE: 1:16	LENGTH:		DRAWING NUMBER: 00065184	
APPR. BY:	APPR. DATE:	APPROX. WEIGHT: 31498.5628			

MATERIAL:

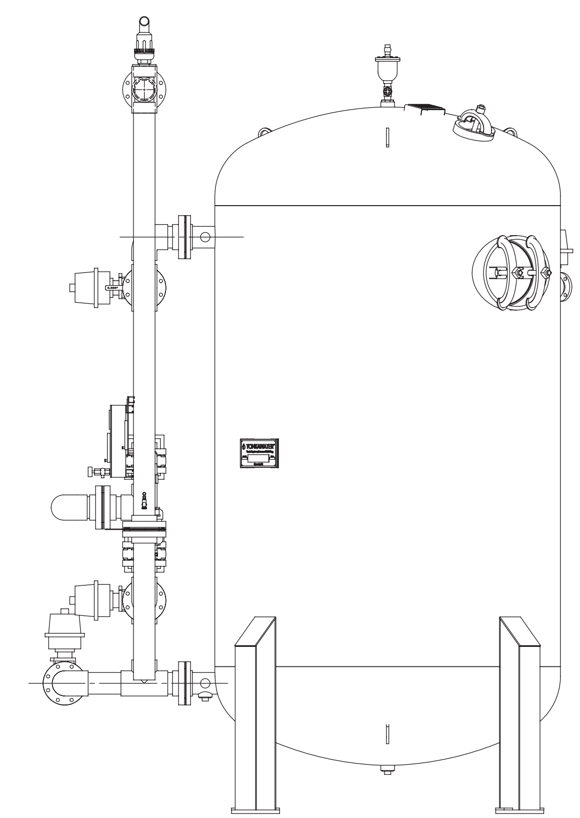
Last Saved: Tuesday, May 06, 2014 8:32:21 AM



PLAN VIEW



FRONT ELEVATION



RIGHT SIDE ELEVATION

DRAWING SIZE: D	ALL RIGHTS TO MANUFACTURE, COPY, REPRODUCE OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY TONKA EQUIPMENT COMPANY. DO NOT SCALE DRAWING		TONKAWATER™ A U.S. WATER BRAND	13305 WATERTOWER CIRCLE PLYMOUTH, MN 55441 (763) 559-2837 www.tonkawater.com	
DRAWN BY: RAC	START DATE: 01/29/2014	THICKNESS:	ORGANIX™ SMALL VESSEL - TRADITIONAL PIPING CATALOG DRAWING	SHEET NUMBER: 2 OF 2	REV: 0
	DWG. SCALE: 1:20	LENGTH:		DRAWING NUMBER: 00065184	
MATERIAL: APPR. BY:	APPR. DATE:	APPROX. WEIGHT: 31498.5628			

Last Saved: Tuesday, May 06, 2014 8:32:21 AM

APPENDIX F

NEW WTP CONCEPTUAL COST ESTIMATES

JOB NO:	60648812	AECOM Water	CLIENT :	Great Barrington	
DATE:	April 2, 2021	**Housatonic Water Works Company**	PROJECT :	HWW Evaluation	
LOCATION:	Great Barrington, MA	**Cost Estimate**	ENR CCI:	11750	
PREPARED BY:	B Sadowski	**Proposed Treatment Upgrades**	CAPACITY:	210 GPM	Phase 1
		********************************		420 GPM	Phase 2

S U M M A R Y

Item	Details	Phase 1: Supplemental Greensand Filter and New Treatment Building	Phase 2: Additional Greensand Filter and IEX Process	Phase 1+2: Replacement of Existing Process with Greensand Filtration and IEX
1.0	**Sitework**	**$98,300**	**$15,100**	**$113,400**
1.1	Yard Piping	$98,265	$3,699	$101,964
1.2	Bypass SFF in Control Building		$11,409	$11,409
2.0	**Process**	**$220,900**	**$562,100**	**$783,000**
2.1	Pumping/Piping	$18,645	$17,986	$36,632
2.2	Greensand Filtration	$175,000	$175,000	$350,000
2.3	Chemical Feed	$27,211	$19,075	$46,286
2.4	IEX Vessels		$350,000	$350,000
3.0	**Facility**	**$255,000**		**$255,000**
3.1	Building	$201,427		$201,427
3.2	Spent Washwater Tank	$53,604		$53,604
4.0	**Electrical, Instrumentation and Controls**	**$32,800**	**$68,100**	**$100,900**
4.1	Electrical	$18,420	$53,420	$71,841
4.2	Instrumentation and Controls	$14,424	$14,720	$29,144
A	**Construction Sub-Total**	**$607,000**	**$645,000**	**$1,252,000**
B	Contractor Overhead and Profit (22%)	$134,000	$142,000	$275,000
C	Estimate Contingency (40%)	$296,000	$315,000	$611,000
D	**ESTIMATED CONSTRUCTION TOTAL (2021)**	**$1,037,000**	**$1,102,000**	**$2,138,000**

Phase 1: Supplemental Greensand Filter and New Treatment Building

JOB #: 60648812
DATE: April 2, 2021
LOCATION: Great Barrington, MA
EPARED BY: Bryan Sadowski

Housatonic Water Works Company
Proposed Treatment Upgrades

CLIENT : Great Barrington, MA
PROJECT : Great Barrington HWW Eval
ENR. INDEX: 11750
CAPACITY: 210 GPM

				MANHOURS		MATERIAL		LABOR		EQUIPMENT		TOTAL
	DESCRIPTION	QUANTITY	UN	MHR/ UNIT	TOTAL MH	UNIT COST	TOTAL MATL	WAGE RATE	TOTAL LABOR	UNIT RATE	TOTAL EQUIP	DIRECT COST
	NEW TREATMENT BUILDING											
Site Work	Yard Piping											**$98,265**
	Connection Long Pond WTP to Filter inlet (8-in DI)	200	LF	0.30	60	57.05	$11,410	$85.65	$5,139	4.50	$900	$17,449
	Centrifugal Pump to Filter (10 HP)	1	EA	4.00	4	2,282.15	$2,282	$80.59	$322	50.00	$50	$2,655
	Gate Valve (8-in)	1	EA	4.00	4	1,965.18	$1,965	$80.59	$322	53.00	$53	$2,341
	90 deg Bend (8-in)	3	EA	2.50	8	469.11	$1,407	$80.59	$604	3.80	$11	$2,023
	Tee (8-in)	1	EA	4.00		665.00	$665	$80.59	$322			$987
	Connection from Filtered Water to Long Pond WTP (8-in DI)	200	LF	0.30	60	57.05	$11,410	$85.65	$5,139	4.50	$900	$17,449
	Gate Valve (8-in)	1	EA	4.00	4	2,282.15	$2,282	$80.59	$322	50.00	$50	$2,655
	90 deg Bend (8-in)	3	EA	2.50	8	469.11	$1,407	$80.59	$604	3.80	$11	$2,023
	Tee (8-in)	1	EA	4.00		665.00	$665	$80.59	$322			$987
	Connection From 1.0 MG Storage Tank to New Building For BWW (8-in DI)	500	LF	0.30	150	57.05	$28,525	$85.65	$12,847	4.50	$2,250	$43,622
	Gate Valve (8-in)	1	EA	4.00	4	1,965.18	$1,965	$80.59	$322	53.00	$53	$2,341
	Excavation	207	CY	0.10	21			$80.59	$1,672	2.00	$415	$2,086
	Bedding	59	CY	0.10	6	17.75	$1,052	$80.59	$478	2.00	$119	$1,648
Process	Process Pumping and Piping											**$18,645**
	Filter Inlet Piping (8-in)	20	LF	0.30	6	57.05	$1,141	$85.65	$514	4.50	$90	$1,745
	BF Valve (8-in)	1	EA	4.50	5	1,500.00	$1,500	$80.59	$363	55.00	$55	$1,918
	Submersible Recycle/Sludge Transfer Pump (5 HP)	1	EA	10.00	10	7,000.00	$7,000	$80.59	$806	200.00		$7,806
	Recycle Piping (2.5-in PVC)	80	LF	0.20	16	2.54	$203	$80.59	$1,289	1.55	$124	$1,616
	Ball Valve (2.5-in PVC)	1	EA			50.00	$50	$80.59				$50
	Filtered Water Piping (8-in)	10	LF	0.30	3	57.05	$571	$80.59	$242	4.50	$45	$857
	BF Valve (8-in)	1	EA	4.50	5	1,500.00	$1,500	$80.59	$363	55.00	$55	$1,918
	Sludge Storage Tank (5,000 gallons)	1	LS	6.00	6	2,000.00	$2,000	$80.59	$484			$2,484
	Sludge Transfer Piping (2.5-in PVC)	10	LF	0.20	2	2.54	$25	$80.59	$161	1.55	$16	$202
	Ball Valve (2.5-in PVC)	1	EA			50.00	$50	$80.59				$50
	Greensand Treatment											**$175,000**
	Vertical Pressure Filter System (9' - 6" diameter)	1	LS			175,000.00	$175,000					$175,000
	Chemical Feed System											**$27,211**
	NaOCl Metering Pump	1	EA	12.00	12	7,003.67	$7,004	$80.59	$967			$7,971
	Chemical Feed Internal Piping (% of pumps)	20%	%	14.00	3	7,003.67	$1,401	$80.59	$226			$1,626
	Valves, Appurtenanes (% of pumps)	100%	%	14.00	14	7,003.67	$7,004	$80.59	$1,128			$8,132
	NaOCl Day Tank (50 gal)	1	EA	16.00	16	3,804.00	$3,804	$80.59	$1,289			$5,093
	Injection Piping (0.5-in PVC)	20	LF	0.20	4	5.07	$101	$80.59	$322			$424
	Injection Nozzle	1	EA	2.00	2	760.72	$761	$80.59	$161			$922
	Containment Berms	2	EA			1,521.43	$3,043					$3,043
Facility	Building (70 ft x 30 ft)											**$201,427**
	Pre-Engineered Building	2,100	SF	0.70	1,470	15.21	$31,950	$80.59	$118,472	0.70	$1,470	$151,892
	Aluminum Doors/Frames (3' x 7')	1	EA	8.00	8	1,500.00	$1,500	$80.59	$645			$2,145
	Aluminum Double Doors/Frames (3' x 7')	2	EA	12.00	24	1,267.86	$2,536	$80.59	$1,934			$4,470
	Interior Wood Door W/H/W (3' x 7')	2	EA	4.00	8	1,204.47	$2,409	$80.59	$645			$3,054
	Finish Hardware Locksets	8	EA	1.00	8	253.57	$2,029	$80.59	$645			$2,673
	Closers	8	EA	2.00	16	253.57	$2,029	$80.59	$1,289			$3,318
	8-in CMU Interior Walls (14 ft High)	980	SF	0.15	147	4.44	$4,349	$80.59	$11,847			$16,196
	8" x 8" CMU bond beam	70	LF	0.10	7	3.17	$222	$80.59	$564			$786
	Containment Walls	490	SF	0.15	74	4.44	$2,174	$80.59	$5,924			$8,098
	Exterior Concrete Pads	10	CY	8.00	81	228.22	$2,299	$80.59	$6,495			$8,794
	SWW Tank (11,000 gal 13 ft x 14 ft x 8 ft SWD)											**$53,604**
	Excavation	89	CY	0.15	13			$80.59	$1,076	2.00	$178	$1,254
	Bedding	83	CY	0.15	13	15.21	$1,269	$80.59	$1,008	2.00	$167	$2,444
	Backfill	30	CY	0.16	5			$80.59	$382	2.00	$59	$442
	Concrete Slab (1.75' Thick)	24	CY	8.00	189	228.22	$5,384	$80.59	$15,211			$20,595
	Concrete Walls (1' Thick)	20	CY	8.00	163	234.55	$4,778	$80.59	$13,134			$17,912
	Submersible Propeller Mixer	1	EA	10.00	10	6,339.31	$6,339	$80.59	$806			$7,145
	Level Radar	1	EA	20.00	20			$80.59	$1,612	2,200.00	$2,200	$3,812
Electrical & Instrum	Instrumentation											**$14,424**
	Pressure Transducer	2	EA			2,000.00	$4,000					$4,000
	Turbidimeter	1	EA			2,000.00	$2,000					$2,000
	Chlorine Residual	1	EA			2,000.00	$2,000					$2,000
	Level Radar	1	EA	20.00	20			$80.59	$1,612	2,200.00	$2,200	$3,812
	Pump I&C	15%	%	14.00	2	16,285.82	$2,443	$80.59	$169			$2,612
	Electrical											**$18,420**
	Building Electrial (% of Filters)	10%	%			175,000.00	$17,500	$80.59		3,500.00	$350	$17,850
	Pump Electrical	8%	%	14.00	1	6,000.00	$480	$80.59	$90			$570
	SUBTOTAL				2,708		$374,883		$220,293		$11,821	$606,997

Phase 2: Additional Greensand Filter and IEX Process

JOB #: 60648812
DATE: April 2, 2021
LOCATION: Great Barrington, MA
EPARED BY: Bryan Sadowski

Housatonic Water Works Company
Proposed Treatment Upgrades

CLIENT : Great Barrington, MA
PROJECT : Great Barrington HWW Eval
ENR. INDEX: 11750
CAPACITY: 420 GPM

	DESCRIPTION	QUANTITY	UN	MANHOURS MHR/ UNIT	TOTAL MH	MATERIAL UNIT COST	TOTAL MATL	LABOR WAGE RATE	TOTAL LABOR	EQUIPMENT UNIT RATE	TOTAL EQUIP	TOTAL DIRECT COST
	NEW TREATMENT BUILDING											
Site Work	Bypass SSF in Old Control Building											**$3,699**
	10" x 8" Reducer	1	EA	3.50	4	350.00	$350	$80.59	$282	3.80	$4	$636
	90 deg Bend (8-in)	2	EA	2.50	5	469.11	$938	$80.59	$403	3.80	$8	$1,349
	DI Piping (8-in)	20	LF	0.30	6	57.05	$1,141	$80.59	$484	4.50	$90	$1,715
	Yard Piping											**$11,409**
	Centrifugal Pump to Filter (10 HP)	1	EA	15.00	15	10,000.00	$10,000	$80.59	$1,209	200.00	$200	$11,409
Process	Process Pumping and Piping											**$17,986**
	Filter Inlet Piping (8-in)	20	LF	0.30	6	57.05	$1,141	$85.65	$514	4.50	$90	$1,745
	BF Valve (8-in)	1	EA	4.50	5	1,500.00	$1,500	$80.59	$363	55.00	$55	$1,918
	Tee (8-in)	1	EA	4.00		665.00	$665	$80.59	$322			$987
	Connection from Pressure Vessels to IEX Vessels (8-in)	40	LF	0.30	12	57.05	$2,282	$85.65	$1,028	4.50	$180	$3,490
	BF Valve (8-in)	2	EA	4.50	9	1,500.00	$3,000	$80.59	$725	55.00	$110	$3,835
	Filtered Water Piping (8-in)	20	LF	0.30	6	57.05	$1,141	$80.59	$484	4.50	$90	$1,715
	BF Valve (8-in)	1	EA	4.50	5	1,500.00	$1,500	$80.59	$363	55.00	$55	$1,918
	Finished Water Piping (8-in)	20	LF	0.10	2	57.05	$1,141	$80.59	$161	4.50	$90	$1,392
	Tee (8-in)	1	EA	4.00	4	665.00	$665	$80.59	$322			$987
	Greensand Treatment											**$175,000**
	Vertical Pressure Filter System (9' - 6" diameter)	1	LS			175,000.00	$175,000					$175,000
	Ion Exchange Treatment											**$350,000**
	IEX Vessel System (6' diameter)	2	LS			175,000.00	$350,000					$350,000
	Chemical Feed System											**$19,075**
	NaOCl Metering Pump	1	EA	12.00	12	7,003.67	$7,004	$80.59	$967			$7,971
	Chemical Feed Internal Piping (% of pumps)	20%	%	14.00	3	7,003.67	$1,401	$80.59	$226			$1,626
	Valves, Appurtenanes (% of pumps)	100%	%	14.00	14	7,003.67	$7,004	$80.59	$1,128			$8,132
	Injection Piping (0.5-in PVC)	20	LF	0.20	4	5.07	$101	$80.59	$322			$424
	Injection Nozzle	1	EA	2.00	2	760.72	$761	$80.59	$161			$922
Electrical	Instrumentation											**$14,720**
& Instrum	Pressure Transducer	2	EA			2,000.00	$4,000					$4,000
	Turbidimeter	3	EA			2,000.00	$6,000					$6,000
	Chlorine Residual	1	EA			2,000.00	$2,000					$2,000
	Pump I&C	15%	%	14.00	2	17,003.67	$2,551	$80.59	$169			$2,720
	Electrical											**$53,420**
	Building Electrial (% of Filters and IEX)	10%	%			525,000.00	$52,500	$80.59		3,500.00	$350	$52,850
	Pump Electrical	8%	%	14.00	1	6,000.00	$480	$80.59	$90			$570
	SUBTOTAL				116		$634,265		$9,723		$1,321	$645,310

APPENDIX G

LONG POND DAM INSPECTION (OCTOBER 15, 2020)

LONG POND DAM

PHASE I

INSPECTION / EVALUATION REPORT

Dam Name:	LONG POND DAM
State Dam ID#:	1-2-113-10
NID ID#:	MA00024
Owner:	HOUSATONIC WATER WORKS COMPANY
Town:	GREAT BARRINGTON, MA
Consultant:	LENARD ENGINEERING, INC.
Date of Inspection:	OCTOBER 15, 2020

EXECUTIVE SUMMARY

Representatives of Lenard Engineering, Inc. visually inspected Long Pond Dam, in Great Barrington, MA, on October 15, 2020. In general, we found the dam to be in **SATISFACTORY** condition. Specific concerns include:

A. The existing spillways and outlets appear to have the capacity to safely pass the SDF; however, the owner should investigate the need to provide additional emergency spillway capacity, rather than having to remove the weir board and open all outlets during a 100 year event;

Long Pond Dam is classified as an I**NTERMEDIATE** size structure. Previous reports rate this dam as a **SIGNIFICANT** (Class II) hazard potential structure based upon the potential for damages if the dam were to fail. No changes have occurred that would change the size or hazard designation.

We believe that the following minor repair recommendations to improve the overall condition of the dam, but do not alter the current design of the dam, are required to improve the condition of the dam and emergency spillway:

A. Remove, repair or replace the failed spillway approach retaining wall;

B. Remove trees from the downstream slope and adjacent to spillway approach retaining wall;

C. Clean the outlets to the emergency spillway pipes and insure that the pipes are free of debris and are stable.

The following yearly maintenance items should be undertaken on a regular basis:

A. Grade the road along the crest of the dam to provide positive overland drainage and prevent standing water from draining down into the dam;

B. Exercise all outlet control valves;

C. Clean the inlets and outlets to the pipes in the emergency spillway and check the internal condition of the pipes;

D. Fill low spots, ruts, areas of erosion and runoff with suitable fill. Reseed areas of thin vegetation with grassy cover.

PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the dam was based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Douglas W. Bush., P.E.
Massachusetts License No.: 51824
License Type: Civil

Civil Engineer
Lenard Engineering, Inc.

COMMONWEALTH OF MASSACHUSETTS
DOUGLAS W.
BUSH
CIVIL
No. 51824
REGISTERED
PROFESSIONAL ENGINEER

12/4/2020

Dam Evaluation Summary Detail Sheet

1. NID ID:	**MA00024**	**4. Inspection Date:**	**October 15, 2020**
2. Dam Name:	**Long Pond Dam**	**5. Last Insp. Date:**	**December 8, 2014**
3. Dam Location:	**Great Barrington, MA**	**6. Next Inspection:**	**October 15, 2025**
7. Inspector:	**Roger Hurlbut, P.E.**		
8. Consultant:	**Lenard Engineering, Inc.**		
9. Hazard Code:	**Significant**	**9a. Is Hazard Code Change Requested?:**	**No**
10. Insp. Frequency:	**5 Years**	**11. Overall Physical Condition of Dam:**	**SATISFACTORY**
12. Spillway Capacity (% SDF)	**90-100% of the SDF**		

E1. Design Methodology:	**3**	**E7. Low-Level Discharge Capacity:**	**3**
E2. Level of Maintenance:	**4**	**E8. Low-Level Outlet Physical Condition:**	**5**
E3. Emergency Action Plan:	**4**	**E9. Spillway Design Flood Capacity:**	**3**
E4. Embankment Seepage:	**5**	**E10. Overall Physical Condition of the Dam:**	**4**
E5. Embankment Condition:	**5**	**E11. Estimated Repair Cost:**	**$14,000**
E6. Concrete Condition:	**N/A**		

Evaluation Description

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post design analysis show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR, annual training

E4: SEEPAGE (Embankments, Foundations, & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (See Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

E6: CONCRETE CONDITION (See Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low level outlet, no provisions (e.g. pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 50-90% of the SDF
3. 90 - 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g. open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF DAM
1. UNSAFE – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. POOR - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. FAIR - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. GOOD - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST
Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Changes/Deviations to Database Information since Last Inspection

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

Housatonic Water Works, of Great Barrington, MA retained Lenard Engineering, Inc. (LEI) to perform a visual inspection and develop a report of conditions for Long Pond Dam on Long Pond Brook, a tributary to the Housatonic River in Great Barrington, MA. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR10.07 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the site; 3) evaluate the status of an emergency action plan for the site and; 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions, and opinion of probable costs.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix D. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; and 5) miscellaneous.

1.2 Description of Project

1.2.1 Location

Long Pond Dam is located in the Town of Great Barrington, Berkshire County, Commonwealth of Massachusetts. Latitude and longitude are given as 42.22570 N and 73.38747 W on the USGS Egremont quadrangle. The dam is located about 2.1 miles northwest of Great Barrington. From Great Barrington take Christian Hill Road 1.8 miles to Division Road, make a left and go 0.2 miles to the entrance, a gated gravel road to the Dam and Treatment Filters.

1.2.2 Owner/Caretaker

See Table 1.1 for current owner and caretaker data (names and contact information).

	Dam Owner	Dam Caretaker
Name	Housatonic Water Works	Housatonic Water Works
Mailing Address	80 Maple Street	80 Maple Street
Town	Great Barrington	Great Barrington
Daytime Phone	(413) 528-1780	(413) 528-1780
Emergency Phone	(413) 446-1801	(413) 446-1801
Email Address	Housatonicwater@gmail .com	Housatonicwater@gmail .com

1.2.3 Purpose of the Dam

The dam was originally constructed to enlarge Long Pond for water supply.

1.2.4 Description of the Dam and Appurtenances

The present dam at Long Pond was constructed to enlarge the previous reservoir. Reportedly the "new dam" replaced an existing but deteriorated structure that was located approximately 800 feet upstream of the existing dam.

The present dam consists of an earthen embankment approximately 201 feet long and 16 feet high. This reflects about 190 feet of embankment plus 11 feet of spillway. Design plans and photos indicate that a concrete core exists. An 8-inch drain and gate valve are located approximately in the center of the dam. Intakes for the filtration system are located along the left abutment contact. The downstream face is benched and extends about 60 feet from the crest of the dam. The crest of the dam is about 2.5 feet above the concrete sill of the spillway and varies in width from 13 feet to 15 feet.

The principal spillway with a bridge over it is located at the right abutment. The spillway crest measures 9.6 feet. The spillway crest is a concrete sill, 7 inches above a discharge chute formed by the bridge abutment. A 2-inch x 10-inch timber placed on top of the concrete sill is used to increase storage. At present, wooden pallets have been placed in the spillway to allow for easy removal of beaver debris. It appears that past reconstruction of the bridge abutments decreased the crest length of the spillway. Upstream of the spillway an approach training wall on the right shore of the impoundment has tipped over.

An excavated area is located approximately 100 feet upstream of the left abutment. The excavated area is the approach to an emergency spillway. During construction of a water supply storage tank, pipes were placed in the invert of the channel and then a road constructed over them. A supply line to the tank is buried in the access road.

No information about the inlets to the outlet pipes has been presented in previous reports, and they were not visible during the investigation. Reportedly, the low level outlet is used periodically to insure it functions, and no problems have been reported with the outlet to the filter system.

1.2.5 Operations and Maintenance

The operation and maintenance of Long Pond Dam is performed by Housatonic Water Works.

1.2.6 DCR Size Classification

Long Pond Dam has a height of dam of approximately 16 feet and a maximum storage capacity of approximately 1000 acre-feet. Refer to Appendix D for definitions of height of dam and storage. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Long Pond Dam is an ***Intermediate*** sized structure.

1.2.7 DCR Hazard Potential Classification

Long Pond Dam is located upstream of two town roads: Division Road and Castle Road and, buildings of Bard College at Simon's Rock. It appears that a failure of the dam at maximum pool will most likely damage Division Road and possibly the some of the buildings at the college and might cause the loss of life. Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Long Pond Dam should be classified as a ***Significant*** hazard potential dam. The Hazard Potential Classification recommendation is consistent with the Hazard Potential Classification on record with the Office of Dam Safety for Long Pond Dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The 0.84 square mile drainage area for Long Pond is located in the Town of Great Barrington, Massachusetts. There is limited development and with approximately 94% of the terrain covered with forest vegetation. Discharge form the dam flows into Long Pond Brook, Seekonk Brook, Green River and then the Housatonic River. The location of the dam and drainage is show on the attached figures. The drainage area was delineated and measured using available MA GIS mapping in AutoCAD.

1.3.2 Reservoir

	Length (feet)	Width (feet)	Surface Area (acres)	Storage Volume (acre-feet)
Normal Pool	**3,500**	**2,300**	**115Ac.**	**860**

1.3.3 Discharges at the Dam Site

No records of historic discharges were available.

1.3.4 General Elevations (feet)

A.	Top of Dam	891.7 MSL
B.	Spillway Design Flood Pool	891.7
C.	Design Surcharge	unknown
D.	Normal Pool	890 MSL
E.	Spillway Crest with weir Board	890 MSL
E.	Spillway Crest without weir Board	889.2MSL
F.	Upstream Water at Time of Inspection	889.2 MSL
G.	Streambed at Toe of Dam	875.5 MSL±
H.	Low Point along Toe of Dam	875.5 MSL±
I.	Low Level Outlet Invert	876.9 MSL±

1.3.5 Main Spillway (feet NGVD)

A.	Type		Uncontrolled overflow weir
B.	Length of Weir		9.6 FT
C.	Crest Elevation	concrete	889.2
		board	890
D.	Upstream Channel		889.2
E.	Downstream Channel		875.5
F.	Downstream Water		875.5

1.3.6 Construction Records

No construction records were available for the inspection. A design drawing and photographs during construction are on display at the company office.

1.3.7 Operating Records

Dam operating records are not regularly maintained, however the owner does maintain records of water passing through the filter system.

1.4 Summary Data Table

See Table 1.4 Summary Data Table

1.4 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA00024
Dam Name	Long Pond Dam
Dam Name (Alternate)	0
River Name	Long Pond Brook tribuitary to Housatonic River
Impoundment Name	Long Pond
Hazard Class	Significant
Size Class	Intermediate
Dam Type	Earth Embankment with a concrete core wall
Dam Purpose	Water Supply
Structural Height of Dam (feet)	16
Hydraulic Height of Dam (feet)	16
Drainage Area (sq. mi.)	0.84
Reservoir Surface Area (acres)	115
Normal Impoundment Volume (acre-feet)	860 +/-
Max Impoundment Volume ((top of dam) acre-feet)	1000 +/-
SDF Impoundment Volume* (acre-feet)	1100
Spillway Type	Uncontrolled Broad Crested Weir
Spillway Length (feet)	9.6
Freeboard at Normal Pool (feet)	1.7
Principal Spillway Capacity* (cfs)	74 CFS w/ weir boards & 120 CFS wo/weir boards
Auxiliary Spillway Capacity* (cfs)	Unknown
Low-Level Outlet Capacity* (cfs)	Unknown
Spillway Design Flood* (flow rate - cfs)	100yr (132CFS) USACOE 1980 PI
Winter Drawdown (feet below normal pool)	0
Drawdown Impoundment Vol. (acre-feet)	0
Latitude	42.22570 N
Longitude	73.38747 W
City/Town	Great Barrington
County Name	Berkshire
Public Road on Crest	No
Public Bridge over Spillway	No
EAP Date (if applicable)	Dec-19
Owner Name	Housatonic Water Works
Owner Address	80 Maple Street
Owner Town	Great Barrington, MA 01230
Owner Phone	(413) 528-1780
Owner Emergency Phone	(413) 446-1801
Owner Type	Private
Caretaker Name	Jim Mercer
Caretaker Address	80 Maple Street
Caretaker Town	Great Barrington, MA 01230
Caretaker Phone	(413) 528-1780
Caretaker Emergency Phone	(413) 446-1801
Date of Field Inspection	10/15/2020
Consultant Firm Name	Lenard Engineering, Inc.
Inspecting Engineer	Roger Hurlbut, P.E.
Engineer Phone Number	(508) 721-7600

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Representatives of Lenard Engineering, Inc. visually inspected Long Pond Dam on October 15, 2020. At the time of the inspection, the weather was sunny and clear with a temperature of about 70º. Photographs to document the current conditions of the dam were taken during the inspection and are included in Appendix A. The level of the impoundment was at spillway weir board crest. Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Long Pond Dam was found to be in SATISFACTORY condition. The specific concerns are identified in more detail in the sections below:

2.1.2 Main Dam

- **Upstream Face**

  At the time of inspection, the rip rap on the upstream face was partially covered with ice. The visible portions appear to be acceptable with no evidence of subsidence.

- **Crest**

  A gravel road for access to the pump house and filter beds traverses the crest of the dam. The upstream and downstream edges of the crest are grass covered and appear to be mowed. Minor rutting caused by traffic during the winter and a very slight elevation variation as reported in previous inspection reports was observed. Reportedly the road is periodically regraded.

- **Downstream Face**

  The upper portion and bench of the downstream slope are in good condition with grass cover and no evidence of erosion. A few trees were observed at approximately the center line of the dam on the downstream edge of the bench. Based on surrounding terrain, the bench area may have been natural ground, but the trees should still be removed. The grass appears to be mowed on a regular schedule.

- **Drains**

  None were observed.

- **Instrumentation**

  None was observed.

- **Access Roads and Gates**

  The dam is located on private property. A gate at Division Road prevents public access to the site. The gravel access road from Division Road to the dam and filtration plant was in good condition.

2.1.3 Appurtenant Structures

- **Primary Spillway**

  The primary spillway and bridge appeared to be in good condition. The timber stop log apparently was replaced shortly after the 1998 inspection and is just beginning to show signs of deterioration. The approach training wall along the right abutment has almost completely fallen over.

- **Emergency Spillway**

  The emergency spillway appears to be maintained on a less frequent basis than the rest of the dam. The outlets to the two 12-inch diameter pipes under the storage tank access road were partially clogged with vegetation.

2.1.4 Downstream Area

The discharge channel appears stable with no indication of erosion. There was no evidence of seepage in the immediate downstream area.

2.1.5 Reservoir Area

The inspection was limited to the immediate dam area and downstream area. The shoreline and slopes appear stable when viewed from the dam.

2.2 Caretaker Interview

Mr. Fred Mercer of the Housatonic Water Works was present during the inspection and provided information about operation and maintenance procedures for the dam and filtration system.

2.3 Operation and Maintenance Procedures

No formal maintenance procedures were available for the inspection. Reportedly the Housatonic Water Works, Water Supply Plan contains a brief listing of maintenance items for the dam. Maintenance appears to be performed as required to keep the structure in an operable condition.

2.4 Emergency Warning System

An Emergency Action Plan (EAP) was prepared and submitted to the Massachusetts Department of Conservation and Recreation Office of Dam Safety and appropriate local emergency preparedness officials safety in December of 2019.

2.5 Hydrologic/Hydraulic Data

No significant changes have occurred in the watershed since the 1980 Army Corps Phase I inspection report that estimated the SDF (100 yr) as being 132CFS. The 1980 report estimated that the dam has sufficient outflow capacity to safely convey the SDF (100 yr) expected flows.

2.6 Structural Stability/Overtopping Potential

2.6.1 Embankment Structural Stability

Based upon the visual examination and dam geometry, the dam is considered stable at this time. However, some maintenance needs exist which may reduce the long term stability if not addressed.

2.6.2 Structural Stability of Non-Embankment Structures

Based on the visual inspection and review of previous reports the dam and spillway appears to have the capability to safely convey the SDF without overtopping the dam. However, it is believed that during the SDF event no freeboard will exist.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the Long Pond Dam was found to be in ***SATISFACTORY*** condition. The dam was found to have the following deficiencies:

1. Failed right side spillway approach training wall.
2. Debris and vegetation in the outlets to the emergency spillway pipes and the downstream channel
3. Trees on the downstream slope.

Previously Identified Deficiency	***Resolution or Current Condition***
Repair or replace the failed spillway approach training wall.	No Change
Remove trees from the downstream slope;	No Change
Clean the inlets and outlets to the emergency spillway pipe and insure that the pipes are free of debris and stable	Downstream area still needs attention

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs and remedial measure, the applicability of environmental permits needs to be determined prior to undertaking activities that may occur within resource areas under the jurisdiction of local Conservation Commissions, MADEP, or other regulatory agencies.

3.2 Studies and Analyses

The following studies or analysis are recommended to evaluate concerns and comply with current regulations.

A. The existing spillways and outlets appear to have the capacity to safely pass the SDF; however the owner should investigate the need to provide additional emergency spillway capacity, rather than having to remove the weir board and open all outlets during a 100 year event.

3.3 Recurrent Maintenance Recommendations

The following recommendations should be performed on an annual basis or more frequently as needed. These ensure the integrity of the earth embankment and structures which impound Long Pond.

A. Grade the road along the crest of the Dam creating a crown to provide positive overland drainage and prevent standing water from draining down into the dam;
B. Clean the inlets and outlets to the pipes in the emergency spillway and check the internal condition of the pipes;
C. Exercise all outlet control valves;
D. Fill low spots, ruts, areas of erosion and runoff with suitable fill. Reseed areas of thin vegetation with grassy cover.

3.4 Minor Repair Recommendations

The following recommendations are to improve the overall condition of the dam but do not alter the current design of the dam. The recommendations may require design by a professional engineer and construction by a contractor experienced in dam construction or repair

A. Remove, repair or replace the failed spillway approach training wall;
B. Remove trees from the downstream slope and adjacent to spillway approach retaining wall.

3.5 Remedial Modifications Recommendations

Remedial measures are more extensive repairs, which are usually designed and performed by qualified professionals. It is recommended that the remedial measures outlined below be conducted.

A. None.

3.6 Alternatives

The following alternatives are presented based upon conceptual review of the concerns. Additional studies and or considerations may indicate that the options presented below are not suitable for the conditions specific to the dam and dam site.

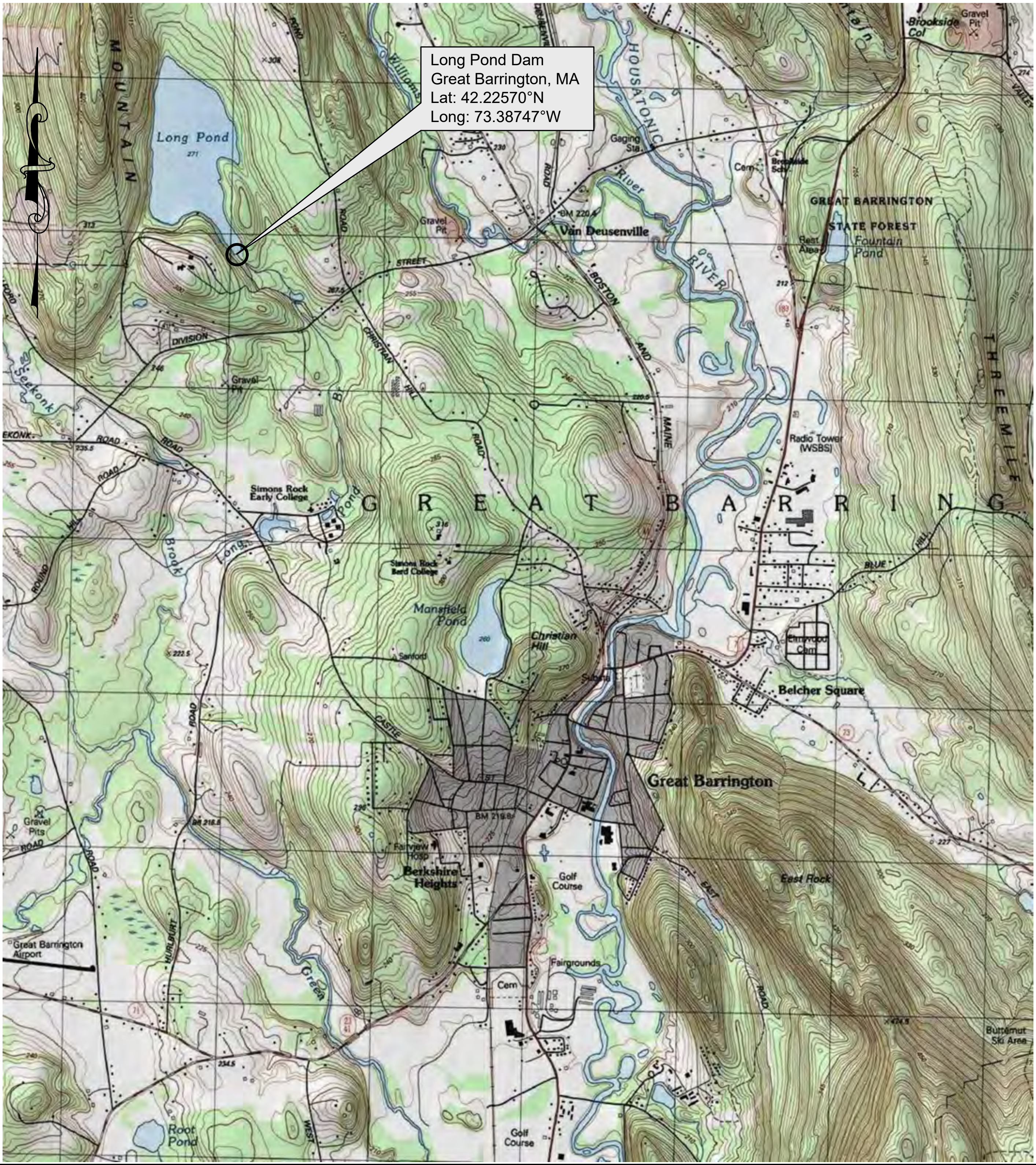
A. None.

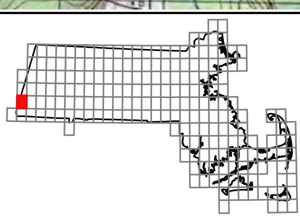
3.7 Opinion of Probable Construction Costs

The following conceptual opinions of probable costs have been developed for the recommendations and remedial measures noted above. The costs herein are based on limited investigation and are provided for general information only. This should not be considered an engineer's estimate, as construction costs may be less or considerably more than indicated.

Item	Opinion of Probable Cost
STUDIES AND ANALYSES Analysis of spillway capacity	 $4,000
YEARLY RECOMMENDATIONS Maintenance items	 $4,000
MINOR REPAIRS Remove trees Remove, repair or replace training wall	 $6,000 $10,000
Remedial Measures	-0-
TOTAL	$ 20,000 (not including yearly maintenance items)

FIGURES





Source:
USGS TOPOGRAPHIC MAP
EGREMONT, MA QUADRANGLE

Lenard Engineering, Inc.
Storrs, CT - Winsted, CT - Auburn, MA

FIG 1 - LOCUS PLAN
LONG POND DAM

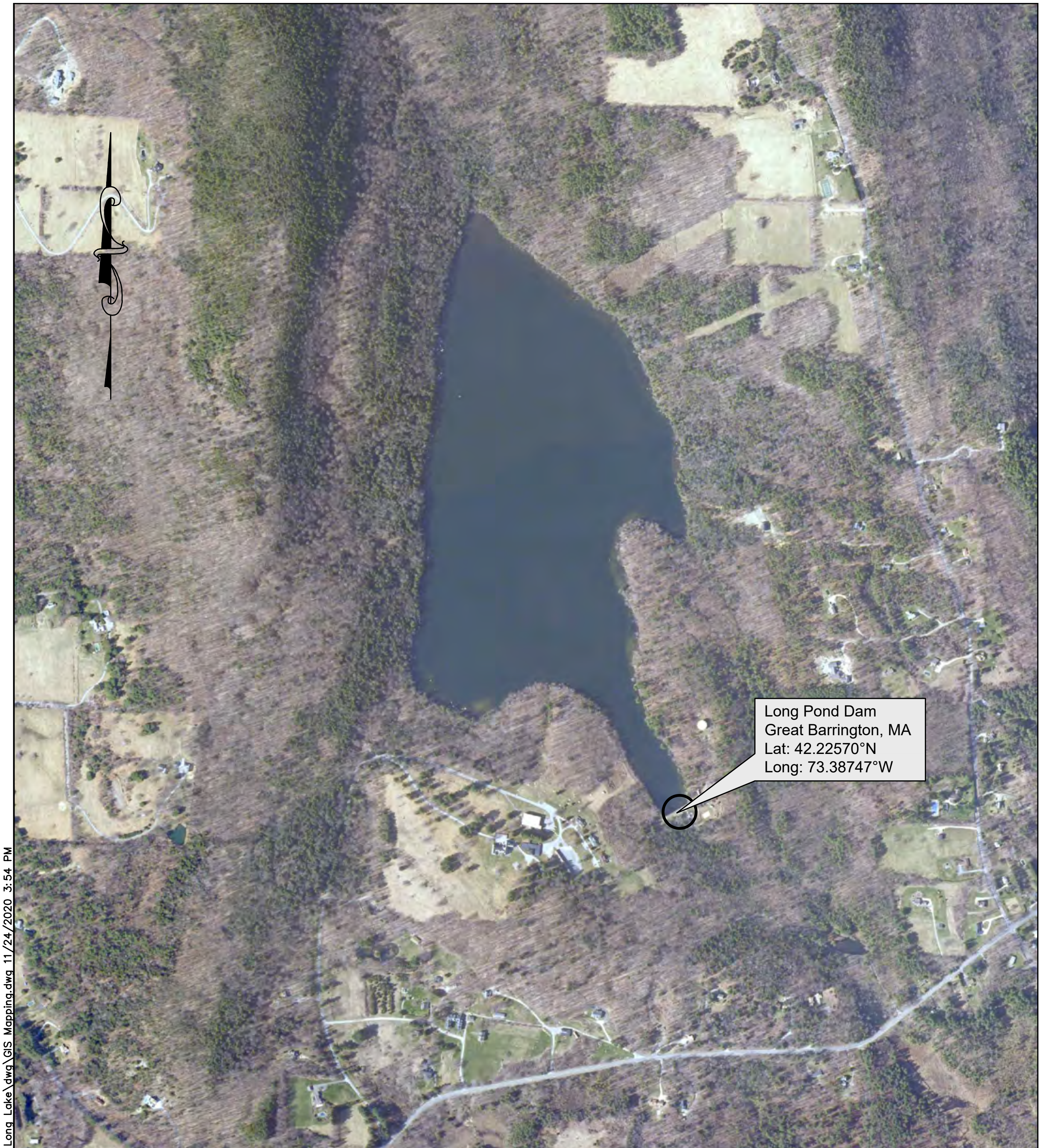
NID# MA 00024 STATE DAM ID #1-2-113-10

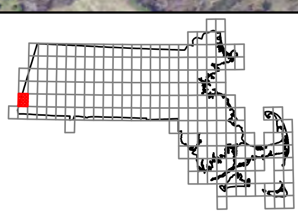
GREAT BARRINGTON, MA

Scale: 1:36000

Contour Interval 3 Meter

K:\Civil3d\20-727 Housatonic Water Works, Long Lake\dwg\TOPOMap.dwg 11/24/2020 3:53 PM





Source:
Office of Geographic and
Environmental Information (MassGIS)

Lenard Engineering, Inc.
Storrs, CT - Winsted, CT - Auburn, MA

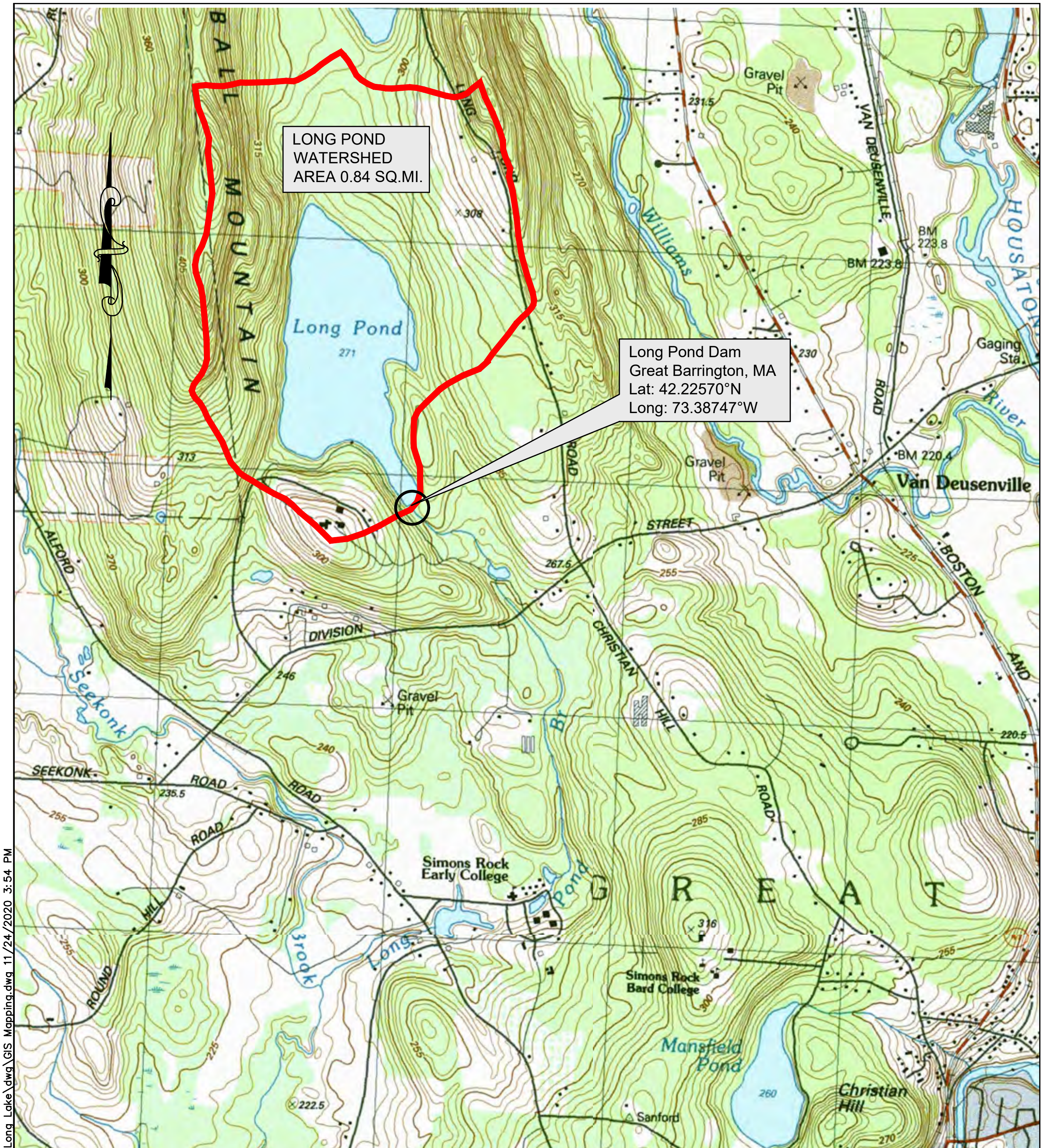
FIG 2 - AERIAL PHOTOGRAPH
LONG POND DAM

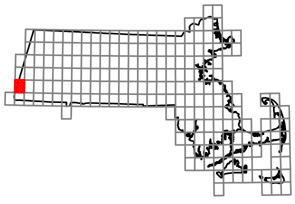
NID# MA 00024 STATE DAM ID #1-2-113-10

GREAT BARRINGTON, MA

Scale: 1:12000

K:\Civil3d\20-727 Housatonic Water Works, Long Lake\dwg\GIS Mapping.dwg 11/24/2020 3:54 PM





Source:
Office of Geographic and Environmental Information (MassGIS)

Lenard Engineering, Inc.
Storrs, CT - Winsted, CT - Auburn, MA

FIG 3 - DRAINAGE AREA
LONG POND DAM

NID# MA 00024 STATE DAM ID #1-2-113-10

GREAT BARRINGTON, MA

Scale: 1:24000

Contour Interval 3 Meter

K:\Civil3d\20-727 Housatonic Water Works, Long Lake\dwg\GIS Mapping.dwg 11/24/2020 3:54 PM

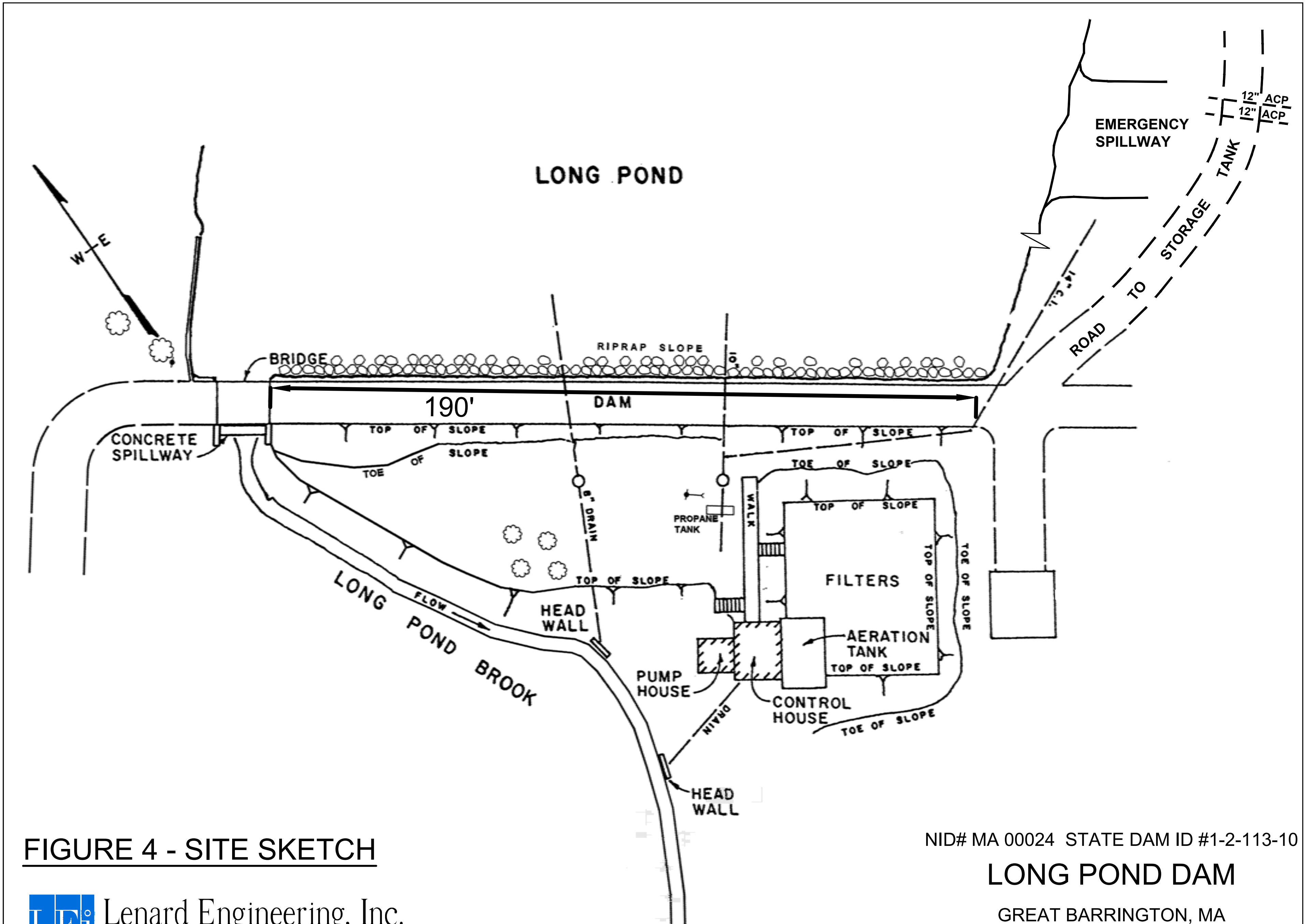


FIGURE 4 - SITE SKETCH

Lenard Engineering, Inc.
Auburn, MA

NID# MA 00024 STATE DAM ID #1-2-113-10

LONG POND DAM

GREAT BARRINGTON, MA

NOT TO SCALE

K:\Civil3d\20-727 Housatonic Water Works, Long Lake\dwg\Sketches.dwg 11/24/2020 3:56 PM

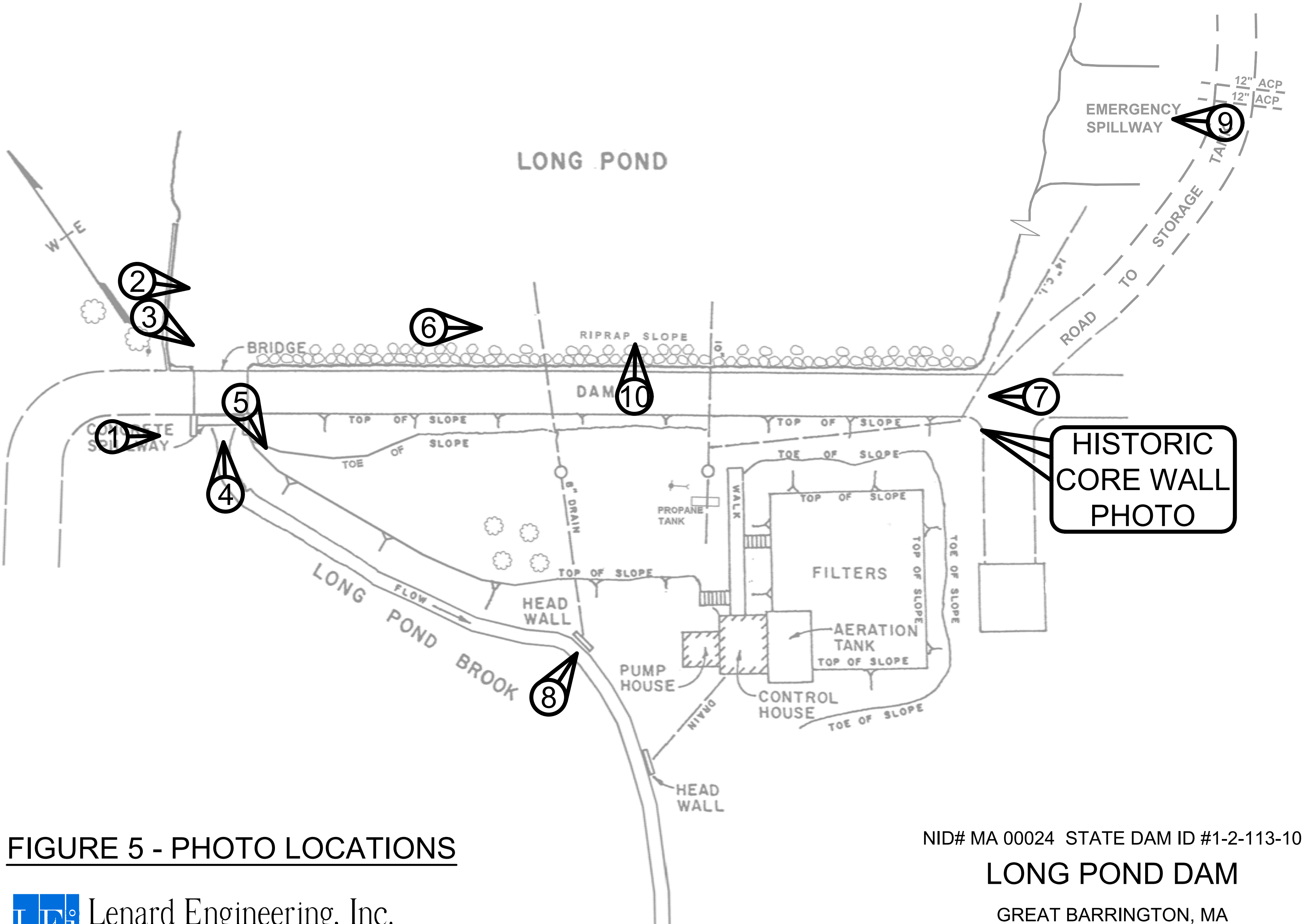


FIGURE 5 - PHOTO LOCATIONS

Lenard Engineering, Inc.
Auburn, MA

NID# MA 00024 STATE DAM ID #1-2-113-10

LONG POND DAM

GREAT BARRINGTON, MA

NOT TO SCALE

K:\Civil3d\20-727 Housatonic Water Works, Long Lake\dwg\Sketches.dwg 11/24/2020 3:55 PM

APPENDIX A
Photographs

Photo 1 Crest of dam from right   (West)

Photo 2 Upstream Face from right (west)

Photo 3 Spillway from upstream

Photo 4 Spillway and underside of bridge from downstream

Photo 5 Downstream Channel

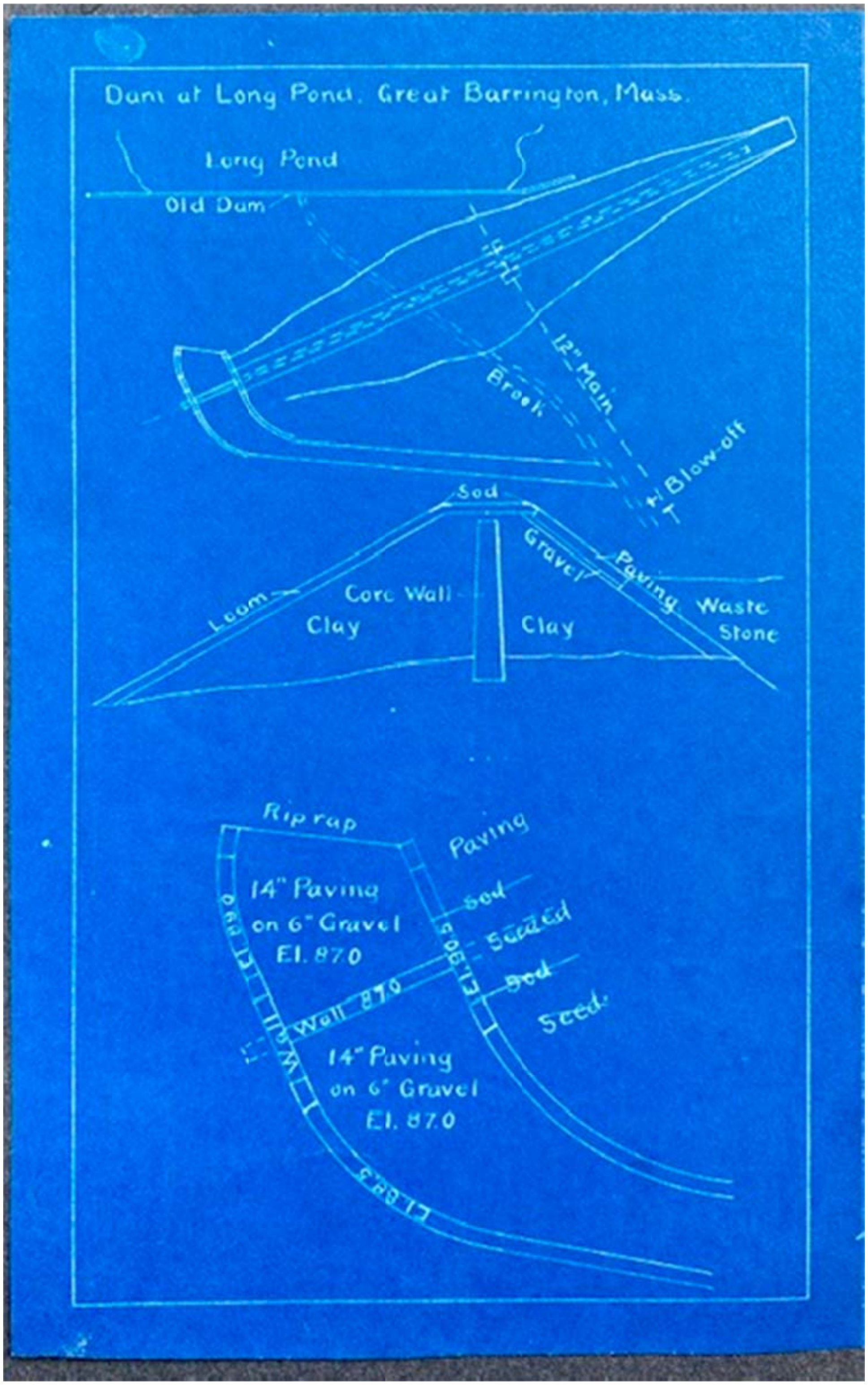
Photo 6 Rip rap on upstream face of embankment

Photo 7 Crest of dam from left (east)

Photo 8 Headwall and low level outlet

Photo 9   Emergency spillway channel

Photo 10 Impoundment



Design Plans

Historic Photo   showing core wall construct ion

APPENDIX B

Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST INSTRUCTION PAGE

The checklist (Excel file) includes sections applicable to a variety of dam structure types. Carefully follow the instructions on the first tab of the checklist. Complete those pages pertaining to each structure and omit pages that are not relevant or mark them "Not Applicable." The Checklist must be signed by the inspecting engineer and a clean, neat copy included in the final inspection report. Use the checklist to generate the Dam Evaluation Summary Detail Sheet (should immediately follow the Executive Summary) and Table 1.1 (should immediately follow Section 1.0).

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post-design analyses show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available, filed with MADCR, annual training

E4: EMBANKMENT SEEPAGE (Embankment, Foundation & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but monitored seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (see Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained, healthy uniform grass cover

E6: CONCRETE CONDITION (see Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low-level outlet, no provisions (e.g., pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 51- 90% of the SDF
3. 91- 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g., open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF THE DAM
1. *UNSAFE* – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. *POOR* - Significant structural, operation and maintenance deficiencies are clearly recognized for normal loading conditions
3. *FAIR* - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. *SATISFACTORY* - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.
5. *GOOD* - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST

Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Guidelines and Notes for Evaluations

Each of the evaluation categories has 5 rating levels. In general, the rating levels in each category are intended to reflect the following conditions:

1. Unsafe
2. Poor
3. Fair
4. Satisfactory
5. Good

<u>E10-Overall Safety Rating Guideline</u>

Unless the inspecting engineer presents compelling data, analyses, and observations that justify a higher rating, E10-Overall Safety Rating of the Dam shall not be higher than the lowest ranking in these high importance categories:

-E4-Seepage,

-E5-Embankment Condition (for embankment dams), and

-E6-Concrete Condition (for dams where concrete structures retain water).

Note 1 - Embankment Condition Factor of Safety Criteria
In addition to the inspection conditions listed, the embankment condition rating should consider the slope stability Factor of Safety (FS) according to the following guidelines for downstream (D/S) and upstream slopes (U/S).

	Normal Pool	**SDF**	**Seismic**	**Rapid Drawdown**
Rating	**D/S & U/S FS**	**D/S FS**	**D/S & U/S FS**	**U/S FS**
1	<1.3	<1.1	<1.0	<1.0
2	<1.5	<1.4	<1.0	<1.1
3	>1.5	<1.5	<1.1	<1.2
4	>1.5	>1.5	>1.1	>1.2
5	>1.5	>1.5	>1.1	>1.2

In the absence of stability analyses, use the following factors to evaluate the stability component of the embankment rating. The inspecting engineer will need to consider all factors in combination as the exact combination of conditions listed will rarely occur. For slopes, > indicates "steeper than."

Rating	**Slopes**	**Seepage**	**Material**	**Compaction**
1	>2H:1V	>5' above toe	SP, ML*, SM*	Loose or unknown
2	>2.5H:1V	>2' above toe	ML**, MH	Loose or unknown
3	>3H:1V	at toe	SM**, SW, CH	Likely compacted
4	<3H:1V	DS of toe	SC, CL	Compacted
5	<3H:1V	None	Suitably Zoned	Compacted

ML* - Non-plastic silt or any silt or clay susceptible to dispersion
ML** - Silt with some plasticity (non-dispersive)
SM* - Uniform silty fine sand
SM** - Widely graded silty sand

Note 2 - Concrete Condition Factor of Safety Criteria
In addition to the inspection conditions listed, ratings should consider the sliding stability Factors of Safety (FS) for any concrete structures that retain water according to the following guidelines.

FS Criteria for Dams with Limited Structure and Foundation Information and Testing

Rating	**Normal Pool FS**	**SDF FS**	**Ice Loading FS**	**Seismic FS**
1	<2.0	<1.3	<1.3	<1.0
2	<3.0	<2.0	<2.0	<1.3
3	>3.0	>2.0	>2.0	<1.5
4	>3.0	>2.0	>2.0	>1.5
5	>3.0	>2.0	>2.0	>1.5

FS Criteria for Dams with Well Defined Structure and Foundation Information and Testing

Rating	**Normal Pool FS**	**SDF FS**	**Ice Loading FS**	**Seismic FS**
1	<1.5	<1.3	<1.3	<1.0
2	<2.0	<1.7	<1.7	<1.0
3	<3.0	<2.0	<2.0	<1.1
4	>3.0	>2.0	>2.0	<1.3
5	>3.0	>2.0	>2.0	>1.3

See Appendix D for a complete listing of dam orientation and terminology definitions.

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: Long Pond Dam
STATE ID #: 1-2-113-10

REGISTERED: ☑ YES ☐ NO
NID ID #: MA00024

STATE SIZE CLASSIFICATION: Intermediate
STATE HAZARD CLASSIFICATION: Significant
CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Great Barrington
COUNTY: Berkshire

DAM LOCATION: 2,350-ft North of Division Street
(street address if known)
ALTERNATE DAM NAME:

USGS QUAD.: Egermont
LAT.: 42.22570 N
LONG.: 73.38747 W

DRAINAGE BASIN: Housatonic
RIVER: Long Pond Brook tribuitary to Housatonic River

IMPOUNDMENT NAME(S): Long Pond

GENERAL DAM INFORMATION

TYPE OF DAM: Earth Embankment with a concrete core wall
OVERALL LENGTH (FT): 200 FT

PURPOSE OF DAM: Water Supply
NORMAL POOL STORAGE (ACRE-FT): 860 +/-

YEAR BUILT: circa 1900
MAXIMUM POOL STORAGE (ACRE-FT): 1000 +/-

STRUCTURAL HEIGHT (FT): 16
EL. NORMAL POOL (FT): 890 (NGVD 29)

HYDRAULIC HEIGHT (FT): 16
EL. MAXIMUM POOL (FT): 891.7 (NGVD 29)

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO
CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM:	Long Pond Dam	STATE ID #:	1-2-113-10
INSPECTION DATE:	October 15, 2020	NID ID #:	MA00024

INSPECTION SUMMARY

DATE OF INSPECTION:	October 15, 2020	DATE OF PREVIOUS INSPECTION:	December 8, 2014
TEMPERATURE/WEATHER:	70 F Sunny clear	ARMY CORPS PHASE I: ☑ YES ☐ NO	If YES, date February 1980
CONSULTANT:	Lenard Engineering, Inc.	PREVIOUS DCR PHASE I: ☑ YES ☐ NO	If YES, date 8-Dec-14
BENCHMARK/DATUM:	Concrete spillway crest 889.2 (NGVD 29) USACOE Report 1980		
OVERALL PHYSICAL CONDITION OF DAM:	SATISFACTORY	DATE OF LAST REHABILITATION:	Unknown
SPILLWAY CAPACITY:	90-100% of the SDF		
EL. POOL DURING INSP.:	889.2	EL. TAILWATER DURING INSP.:	Stream Bed

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
Roger Hurlbut, P.E.	Project Engineeer	Lenard Engineering Inc.
Fred Mercer	Maintainer	Housatonic Water

EVALUATION INFORMATION

	Click on box to select E-code		Click on box to select E-code
E1) TYPE OF DESIGN	3	E8) LOW-LEVEL OUTLET CONDITION	5
E2) LEVEL OF MAINTENANCE	4	E9) SPILLWAY DESIGN FLOOD CAPACITY	3
E3) EMERGENCY ACTION PLAN	4	E10) OVERALL PHYSICAL CONDITION	4
E4) EMBANKMENT SEEPAGE	5	E11) ESTIMATED REPAIR COST	$14,000
E5) EMBANKMENT CONDITION	5	ROADWAY OVER CREST	NO
E6) CONCRETE CONDITION	N/A	BRIDGE NEAR DAM	NO
E7) LOW-LEVEL OUTLET CAPACITY	3		

NAME OF INSPECTING ENGINEER: Roger Hurlbut, P.E. SIGNATURE: Roger Hurlbut

NAME OF DAM:	Long Pond Dam	STATE ID #:	1-2-113-10
INSPECTION DATE:	October 15, 2020	NID ID #:	MA00024

OWNER:	ORGANIZATION	Housatonic Water Works	CARETAKER:	ORGANIZATION	Housatonic Water Works
	NAME/TITLE	Jim Mercer		NAME/TITLE	Jim Mercer
	STREET	80 Maple Street		STREET	80 Maple Street
	TOWN, STATE, ZIP	Great Barrington, MA 01230		TOWN, STATE, ZIP	Great Barrington, MA 01230
	PHONE	(413) 528-1780		PHONE	(413) 528-1780
	EMERGENCY PH. #	(413) 446-1801		EMERGENCY PH. #	(413) 446-1801
	FAX	(413) 528-3024		FAX	(413) 528-3024
	EMAIL	housatonicwater@gmail.com		EMAIL	housatonicwater@gmail.com
	OWNER TYPE	Private			

PRIMARY SPILLWAY TYPE	Uncontrolled Broad Crested Weir		
SPILLWAY LENGTH (FT)	9.6	SPILLWAY CAPACITY (CFS)	74 CFS w/ weir boards & 120 CFS wo/weir boards
AUXILIARY SPILLWAY TYPE	Earth approach channel with pipes	AUX. SPILLWAY CAPACITY (CFS)	Unknown
NUMBER OF OUTLETS	3 - 2 8-in filter inlets & 1 8-in low level	OUTLET(S) CAPACITY (CFS)	Unknown
TYPE OF OUTLETS	Cast Iron or Metal	TOTAL DISCHARGE CAPACITY (CFS)	120-140 CFS
DRAINAGE AREA (SQ MI)	0.84	SPILLWAY DESIGN FLOOD (PERIOD/CFS)	100yr (132CFS) USACOE 1980 PI
HAS DAM BEEN BREACHED OR OVERTOPPED	☐ YES ☑ NO	IF YES, PROVIDE DATE(S)	
FISH LADDER (LIST TYPE IF PRESENT)	None		
DOES CREST SUPPORT PUBLIC ROAD?	☐ YES ☑ NO	IF YES, ROAD NAME:	
PUBLIC BRIDGE WITHIN 50' OF DAM?	☐ YES ☑ NO	IF YES, ROAD/BRIDGE NAME:	
		MHD BRIDGE NO. (IF APPLICABLE)	

NAME OF DAM: Long Pond Dam | STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020 | NID ID #: MA00024

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Gravel Road		X	
	2. SURFACE CRACKING	None observed	X		
	3. SINKHOLES, ANIMAL BURROWS	None observed	X		
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	Minor ruts & puddles			X
	5. HORIZONTAL ALIGNMENT	Okay	X		
	6. RUTS AND/OR PUDDLES	Minor ruts & puddles			X
	7. VEGETATION (PRESENCE/CONDITION)	Road Shoulders are grassed	X		
	8. ABUTMENT CONTACT	Good	X		

ADDITIONAL COMMENTS: Monitor road & regrade as necessary to prevent puddling

NAME OF DAM: Long Pond Dam — STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020 — NID ID #: MA00024

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	None observed	X		
	2. SEEPAGE	None observed	X		
	3. SLIDE, SLOUGH, SCARP	None observed	X		
	4. EMB.-ABUTMENT CONTACT	Good	X		
	5. SINKHOLE/ANIMAL BURROWS	None observed	X		
	6. EROSION	None observed	X		
	7. UNUSUAL MOVEMENT	None observed	X		
	8. VEGETATION (PRESENCE/CONDITION)	Good with a couple of trees on lower bench			X

ADDITIONAL COMMENTS: Trees appear to be on original ground

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

EMBANKMENT (U/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	None Observed	X		
	2. SLOPE PROTECTION TYPE AND COND.	Rip Rap good condition	X		
	3. SINKHOLE/ANIMAL BURROWS	None Observed	X		
	4. EMB.-ABUTMENT CONTACT	Good	X		
	5. EROSION	None Observed	X		
	6. UNUSUAL MOVEMENT	None Observed	X		
	7. VEGETATION (PRESENCE/CONDITION)	Minor weedy growth inbetween rip rap	X		

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	None Observed			
	2. OBSERVATION WELLS				
	3. STAFF GAGE AND RECORDER				
	4. WEIRS				
	5. INCLINOMETERS				
	6. SURVEY MONUMENTS				
	7. DRAINS				
	8. FREQUENCY OF READINGS				
	9. LOCATION OF READINGS				

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam　　STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020　　NID ID #: MA00024

DOWNSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
D/S WALLS	1. WALL TYPE	Concrete & stone masonry			X		
	2. WALL ALIGNMENT	Okay			X		
	3. WALL CONDITION	Good			X		
	4. HEIGHT: TOP OF WALL TO MUDLINE	min:	max:	avg:			
	5. SEEPAGE OR LEAKAGE	Minor at base of 8-in outlet pipe				X	
	6. ABUTMENT CONTACT	Okay			X		
	7. EROSION/SINKHOLES BEHIND WALL	None observed			X		
	8. ANIMAL BURROWS	None observed			X		
	9. UNUSUAL MOVEMENT	None observed			X		
	10. WET AREAS AT TOE OF WALL	Brook is at base of wall			X		

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

UPSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
U/S WALLS	1. WALL TYPE	Spillway approach - Concrete & stone masonry					X
	2. WALL ALIGNMENT	tipped over					
	3. WALL CONDITION	poor					
	4. HEIGHT: TOP OF WALL TO MUDLINE	min:	max:	avg:			
	5. ABUTMENT CONTACT						
	6. EROSION/SINKHOLES BEHIND WALL						
	7. ANIMAL BURROWS	None observed					
	8. UNUSUAL MOVEMENT	Wall is falling over					X

ADDITIONAL COMMENTS: Low retaining wall on right side of spillway approach channel
Integrity of dam not affected by condition of wall Spillway approach is significantly wider than weir length.

NAME OF DAM: Long Pond Dam | STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020 | NID ID #: MA00024

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None Observed	X		
	2. FOUNDATION SEEPAGE	None Observed	X		
	3. SLIDE, SLOUGH, SCARP	None Observed	X		
	4. WEIRS	None Observed	X		
	5. DRAINAGE SYSTEM	None Observed	X		
	6. INSTRUMENTATION	None Observed	X		
	7. VEGETATION	Forested	X		
	8. ACCESSIBILITY	Immediately below dam is accessable by foot from access road	X		
	9. DOWNSTREAM HAZARD DESCRIPTION	2 Town Roads & 2 houses			
	10. DATE OF LAST EAP UPDATE	43800			

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam | STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020 | NID ID #: MA00024

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	8.5 Feet
	2. RESERVOIR SHORELINE	Good Forested watershed land
	3. RESERVOIR SLOPES	Stable
	4. ACCESS ROADS	Good Gravel Rd 2,350 ft from paved Town Rd
	5. SECURITY DEVICES	Gated
	6. VANDALISM OR TRESPASS	☐ YES ☑ NO WHAT:
	7. AVAILABILITY OF PLANS	☐ YES ☑ NO DATE:
	8. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	☑ YES ☑ NO DATE: Dec-19
	10. AVAILABILITY OF O&M MANUAL	☐ YES ☑ NO DATE:
	11. CARETAKER/OWNER AVAILABLE	☑ YES ☐ NO DATE: During Inspection
	12. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS: EAP was updated December 2019

NAME OF DAM: Long Pond Dam | STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020 | NID ID #: MA00024

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Uncontrolled broad crested weir	X		
	WEIR TYPE	Concrete	X		
	SPILLWAY CONDITION	Okay	X		
	TRAINING WALLS	Spillway good	X		
	SPILLWAY CONTROLS AND CONDITION	No Controls	X		
	UNUSUAL MOVEMENT	None Observed	X		
	APPROACH AREA	Small accumulation of beaver debris		X	
	DISCHARGE AREA	Clear	X		
	DEBRIS	None			
	WATER LEVEL AT TIME OF INSPECTION	At crest			

ADDITIONAL COMMENTS: Wooden pallets are in place to allow for periodic cleaning of beaver debris (see photo 4)
Right approach wall is tipped over.
Spillway training walls are also bridge abutments & are in good condition.
Discharge channel walls are in good condition.

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Earth Channel to two 12-inch pipes under road to storage tank			
	WEIR TYPE	earth channel and then orifice flow through 12-inch pipes			
	SPILLWAY CONDITION	Satisfactory			
	TRAINING WALLS	None	X		
	SPILLWAY CONTROLS AND CONDITION	None	X		
	UNUSUAL MOVEMENT	None observed	X		
	APPROACH AREA	Clear	X		
	DISCHARGE AREA	Overgrown			X
	DEBRIS	Downstream of pipe outlets			X
	WATER LEVEL AT TIME OF INSPECTION	Below channel grade			

ADDITIONAL COMMENTS: Did not observe internal condition of pipes.
Capacity of pipes under SDF conditions in unknown.

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Gated pipes			
	INTAKE STRUCTURE	Unknown under water			
	TRASHRACK	Unknown under water			
	PRIMARY CLOSURE	low level outlet is gated on downstream slope of embankmentb			
	SECONDARY CLOSURE				
	CONDUIT	see comments			
	OUTLET STRUCTURE/HEADWALL				
	EROSION ALONG TOE OF DAM	None			
	SEEPAGE/LEAKAGE	Minor			
	DEBRIS/BLOCKAGE	None observed			
	UNUSUAL MOVEMENT	None observed			
	DOWNSTREAM AREA	Clear			
	MISCELLANEOUS				

ADDITIONAL COMMENTS: Intakes are under water

Design plans indicate 12-in, but pipe was replaced when filtration plant and new intake were constructed

NAME OF DAM: Long Pond Dam | STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020 | NID ID #: MA00024

CONCRETE/MASONRY DAMS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
GENERAL	TYPE				
	AVAILABILITY OF PLANS				
	AVAILABILITY OF DESIGN CALCS				
	PIEZOMETERS				
	OBSERVATION WELLS				
	INCLINOMETERS				
	SEEPAGE GALLERY				
	UNUSUAL MOVEMENT				

Not Applicable

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

CONCRETE/MASONRY DAMS (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	TYPE				
	SURFACE CONDITIONS				
	CONDITIONS OF JOINTS				
	UNUSUAL MOVEMENT				
	HORIZONTAL ALIGNMENT				
	VERTICAL ALIGNMENT				

Not Applicable

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

CONCRETE/MASONRY DAMS (DOWNSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S FACE	TYPE				
	SURFACE CONDITIONS				
	CONDITIONS OF JOINTS				
	UNUSUAL MOVEMENT				
	ABUTMENT CONTACT				
	LEAKAGE				

Not Applicable

ADDITIONAL COMMENTS:

NAME OF DAM: Long Pond Dam

STATE ID #: 1-2-113-10

INSPECTION DATE: October 15, 2020

NID ID #: MA00024

CONCRETE/MASONRY DAMS (UPSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S FACE	TYPE				
	SURFACE CONDITIONS				
	CONDITIONS OF JOINTS				
	UNUSUAL MOVEMENT				
	ABUTMENT CONTACTS				

Not Applicable

ADDITIONAL COMMENTS:

APPENDIX C
Previous Reports and References

PREVIOUS REPORTS AND REFERENCES

The following is a list of reports that were located during the file review, or were referenced in previous reports.

1) Inspection/Evaluation Report – Long Pond Dam, by Pare Engineering Corporation, April, 1998.

2) Long Pond Dam, Phase I Inspection Report, National Dam Inspection Program , Department of the Army, New England Division, Corps of Engineer February 1980

The following references were utilized during the preparation of this report and the development of the recommendations presented herein.

1) Long Pond Dam, Phase I, Inspection/Evaluation Report –by Lenard Engineering, Inc December 8, 2014

APPENDIX D
Definitions

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exist, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

Size Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

Hazard Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

General

EAP – Emergency Action Plan – Shall mean a predetermined (and properly documented) plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam failure.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet.

Height of Dam (Structural Height) – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the lowest point on the crest of the dam.

Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.

Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.

Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.

Condition Rating

Unsafe – Major structural*, operational, and maintenance deficiencies exist under normal operating conditions.

Poor – Significant structural*, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair – Significant operational and maintance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory – Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good – No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

* Structural deficiencies include but are not limited to the following:

- Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
- Missing riprap with resulting erosion of slope
- Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
- Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
- Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
- Inoperable outlets (gates and valves that have not been operated for many years or are broken)

APPENDIX H

1.0 MG TANK INSPECTION (NOVEMBER 9, 2020)

SERVICES COMPLETED: Inspection and Cleaning

CUSTOMER NAME: Housatonic Water Works

ADDRESS: 80 Maple Avenue, Suite 1
Great Barrington, MA 01230

TANK NAME: N/A

SIZE: 1-Million-Gallon

TYPE OF TANK: Concrete Water Storage Tank

DIMENSIONS: 40'H x 65'D

INSPECTION AND INTERIOR CLEANING (SEDIMENT REMOVAL) OF THE 1 MILLION-GALLON CONCRETE WATER STORAGE TANK

HOUSATONIC WATER WORKS GREAT BARRINGTON, MASSACHUSETTS

NOVEMBER 9, 2020

SCOPE:

On November 9, 2020, Underwater Solutions Inc. inspected the 1 million-gallon concrete potable water storage tank to provide information regarding the overall condition and integrity of this concrete structure and removed the accumulated precipitate from the floor.

EXTERIOR INSPECTION:

The entire exterior of this water storage tank was inspected, to include walls and coating, roof, manway, ladder, overflow, vent and hatch.

Walls And Coating

The exterior shotcrete coated concrete walls were inspected and found having tight shrinkage cracks throughout approximately 60% of these surfaces and were observed throughout all elevations of the exterior walls. Efflorescence has accumulated within approximately 5% of these cracks and throughout the circumference of the manway and overflow pipe penetration due to moisture penetration.

The readily available cracks were sounded and appeared to be limited to the surface of the shotcrete cover coating and are free of voids, spall or other obvious fatigue of the concrete at this time.

The protective coating on these surfaces appeared to have been applied uniformly and was found having good adhesion value, however no longer seals the tight cracks observed throughout these surfaces.

A mild to moderate, non-uniform accumulation of mildew throughout the exterior walls has declined the overall aesthetics.

RECOMMENDATION(S): It is our recommendation to pressure-wash the exterior wall surfaces at 3,500 P.S.I. using a 40° tip and an environmentally approved cleaning agent to remove all soluble/insoluble surface contamination, chalk and mildew from the wall surfaces and remove the accumulated efflorescence from the cracks, followed by a clean water rinse to remove all cleaning residue.

We recommend then applying two coats of an elastomeric masonry waterproofing coating to all exterior wall surfaces showing cracks in an effort to seal the cracks, prevent moisture penetration, seal and protect the concrete and to improve the aesthetics. We recommend that the products utilized to coat the exterior walls be formulated for exterior exposure and to be applied in accordance with the product manufacturer's surface preparation and application recommendations.

Roof

The pre-cast concrete roof panels appeared sound and are free of obvious fatigue of the concrete at this time.

The concrete filled joints between the pre-cast concrete roof panels appeared mostly sound, however tight cracks were observed throughout less than 5% of these surfaces at this time.

These cracks were sounded and appeared to be limited to the surface of the concrete used to fill these joints and are free of obvious voids or spall at this time.

The cement based protective coating applied to the roof dome has lost adhesion and is lifting throughout less than 5% of these surfaces and no longer seals the cracks within the concrete filled joints between the pre-cast concrete panels.

A mild, non-uniform accumulation of mildew throughout the roof dome has declined the overall aesthetics.

A steel cable is secured around the vent and extends down and is resting on the roof adjacent to the interior access hatch with an eye splice at its end. This cable is secured around a fiberglass vent assembly and should not be used as a safety/fall prevention device.

RECOMMENDATION(S): It is our recommendation to pressure-wash the exterior roof surfaces at 4,500 P.S.I. using an oscillating tip and an environmentally approved cleaning agent to remove all soluble/insoluble surface contamination and mildew from the roof surfaces and remove any and all cement based coating that has lost adhesion from the concrete, followed by a clean water rinse to remove all cleaning residue.

We recommend then hand/power tool cleaning the concrete filled roof panel joints showing cracks to achieve a uniform anchor profile and then applying two coats of an elastomeric masonry waterproofing coating to all exterior roof surfaces in an effort to seal the cracks, prevent moisture penetration, seal and protect the concrete and to improve the aesthetics. We recommend that the products utilized be formulated for exterior exposure and to be applied in accordance with the product manufacturer's surface preparation and application recommendations.

The influent pipe extends up from the ground on the westernmost side of the tank. This insulated pipe continues up, supported to the tank wall with three sets of non-corrodible metal standoffs to a 90° elbow and the insulated pipe then extends to and penetrates the roof. The insulated sheathing on this pipe was found secure and free of obvious fatigue or failure at this time.

RECOMMENDATION(S): None at this time.

<u>*Manway*</u>

One, 24" by 19" inside diameter, non-corrodible metal manways penetrates the tank wall on the easternmost side of the tank and was found securely installed and free of obvious leakage. This manway was found secured with two locks, preventing unwanted opening.

The non-corrodible metal surfaces of this manway is not coated and appeared sound and free of obvious fatigue at this time.

RECOMMENDATION(S): None at this time.

<u>*Ladder*</u>

An aluminum ladder is located on the westernmost side of the tank and extends from approximately 9'-6" above the ground up to the roof, supported in-place with seven sets of bolted standoffs. A non-corrodible metal fall prevention device is installed throughout the length of this ladder.

The handrail located on the top right side of the ladder has failed at a weld, however this ladder remains in-place, secure and usable at this time.

RECOMMENDATION(S): It is our recommendation to complete repairs on the handrail on the top right side of this ladder in an effort to provide safe access and egress.

Overflow

The 10" inside diameter overflow pipe penetrates the tank wall on the westernmost side of the tank.

This metal pipe extends away from the tank approximately 8" to a flap-vale, located approximately 35" above the ground. This flap-vale was found in good working condition, while the outlet end of the overflow pipe was free of obvious obstructions at this time.

The protective coating on this metal pipe and flap-valve has expired, resulting in exposure of the underlying metal. No obvious fatigue of the metal pipe or flap-valve was evident within these areas of exposure, rather mild corrosion exists at this time.

RECOMMENDATION(S): It is our recommendation to install a non-corrodible metal screen having 24-mesh within the pipe and behind the flap-valve in an effort to prevent access to the interior of the pipe/tank.

It is also our recommendation to hand/power tool clean the surfaces of this pipe and flap-valve to bare metal in an effort to achieve a uniform anchor profile and to re-coat the pipe and flap-valve with a prime coat, intermediate coat and finish coat using protective coatings that are formulated for exterior exposure. These protective coatings should be applied in accordance with the product manufacturer's surface preparation and application recommendations in an effort to halt corrosion, prevent metal fatigue and to provide good protection for the overflow pipe and flap-valve.

Vent

A fiberglass vent assembly is located within the center of the roof dome, having a 24" inside diameter and stands 22" tall.

A 40" outside diameter fiberglass cap that has sides that extend down past the screen, preventing the entry of wind driven rain and a primary screen having 18-mesh and a secondary screen having 2-mesh was found installed throughout the circumference of this vent at this time.

RECOMMENDATION(S): It would be our recommendation to install an additional, non-corrodible metal screen having 24-mesh over the 2-mesh screen in an effort to prevent access to the interior of the tank.

Hatch

One, 41" by 41" aluminum hatch, located on the westernmost side of the roof provides access to the tank interior. This hatch was found in good working condition and was found secured with a lock, preventing unwanted access to the tank interior. This hatch is located on top of a 5" tall concrete trunk, preventing surface water run-off from entering the tank.

RECOMMENDATION(S): None at this time.

INTERIOR INSPECTION:

The entire interior of this water storage tank was inspected, to include sediment accumulations, floor, manway, piping, walls, overhead, overflow and aesthetic water quality.

Sediment Accumulations

A uniform layer of precipitate was found throughout the floor, averaging 1/16" in depth.

Upon completing this inspection all precipitate was removed (vacuumed) from the floor.

Floor

After removing the accumulated precipitate, the concrete floor was inspected and was found to be un-coated and appeared mostly sound and free of obvious cracks or settlement, however mild surface spall of the concrete was observed throughout less than 5% of these surfaces. The surrounding and underlying concrete within these 1/16" deep areas of spall remains sound and free of exposed reinforcement steel at this time.

Mild staining remains throughout the floor due to the accumulation of precipitate.

RECOMMENDATION(S): It is our recommendation to monitor the areas of surface spall found throughout the floor through future scheduled inspections to ensure that the depth of spall does not increase and result in exposure of the reinforcement steel and the potential for leakage.

Manway

One, 24" by 19" inside diameter, non-corrodible metal manways penetrates the tank wall on the easternmost side of the tank, located approximately 84" above the floor and was found securely installed and free of obvious leakage.

The non-corrodible metal surfaces of this manway is not coated and appeared sound and free of obvious fatigue at this time.

RECOMMENDATION(S): None at this time.

A 28" wide aluminum ladder extends from the floor up to the base of the manway and was found securely installed at this time. Corrosion was observed throughout the surfaces of this ladder; however, no obvious fatigue of the aluminum was evident at this time.

RECOMMENDATION(S): It is our recommendation to monitor the surfaces of this ladder through future scheduled inspections to ensure that fatigue of the aluminum does not occur.

A non-corrodible metal grab bar is bolted to the wall above this manway and was found in-place and secure at this time.

RECOMMENDATION(S): None at this time.

Piping

Two pipes were inspected within this potable water storage tank.

The first pipe inspected penetrates the floor of a 25” by 25” by 4” deep sump formed within the tank floor having a 12” inside diameter and stands 12” tall.

This pipe was free of obvious obstructions and was without flow at this time of this inspection.

The protective coating on the exposed surfaces of this metal pipe was found having mostly good adhesion value at this time.

Adhesion loss of the protective coating was observed throughout approximately 40% of these exposed surfaces, resulting in exposure of the underlying metal. No obvious fatigue of the metal was evident within these areas of exposure rather mild to moderate corrosion exists at this time.

RECOMMENDATION(S): It is our recommendation to monitor the exposed surfaces of this pipe showing metal exposure through future scheduled inspections to ensure that fatigue of the metal does not occur.

The second pipe inspected penetrates the overhead and appears to have a 6” inside diameter.

This metal pipe extends down approximately 12” and terminates.

This pipe was free of obvious obstructions and flow was entering the tank through this pipe at the time of this inspection.

The protective coating on the exposed surfaces of this metal pipe was found having mostly good adhesion value at this time.

Adhesion loss of the protective coating was observed throughout less than 5% of these exposed surfaces, resulting in exposure of the underlying metal. No obvious fatigue of the metal was evident within these areas of exposure rather mild to moderate corrosion exists at this time.

RECOMMENDATION(S): It is our recommendation to monitor the exposed surfaces of this pipe showing metal exposure through future scheduled inspections to ensure that fatigue of the metal does not occur.

It is also our recommendation that the next time this tank is removed from service and de-watered, to hand/power tool clean the exposed surfaces of each pipe showing corrosion to bare metal to achieve and uniform anchor profile, ensuring any and all lifted edges of the coating are feathered back tight and to re-coat these surfaces with a prime coat, intermediate coat and finish coat using protective coatings that are formulated for immersion (wet contact), have an A.N.S.I./N.S.F. 61 approval for use in structures containing potable water. These protective coatings should be applied in accordance with the product manufacturer's surface preparation and application recommendations in an effort to halt corrosion, prevent metal fatigue and to provide good protection for the exposed surfaces of each metal pipe.

Walls

The interior walls were inspected beginning at the floor and by spiraling the circumference of the tank up to the water surface.

The pre-cast concrete wall panels and concrete filled joints between panels are not coated and appeared mostly sound, however tight cracks were observed throughout approximately 5% of these surfaces at this time.

These cracks appeared to be limited to the surface of the concrete and are free of spall, while no obvious leakage was evident or occurring through these cracks at the time of this inspection.

Scour of the concrete was observed throughout the upper elevations of the interior walls that appeared to be the result of an ice cap formation.

The area of scour begins approximately 9" below the junction of where the roof and walls meet and has an average width of approximately 10' and a maximum depth of 1/4" deep at this time.

The surrounding and underlying concrete within the area of scour remains sound and free of exposed reinforcement steel at this time.

Mild staining exists throughout the interior walls at this time.

RECOMMENDATION(S): It is our recommendation to monitor the wall surfaces showing tight cracks through future scheduled inspections to ensure that spall of the concrete does not occur and result in exposure of the reinforcement steel and the potential for leakage.

We also recommend monitoring the wall surfaces showing scour of the concrete through future scheduled inspections to ensure that the depth of scour does not increase and result in exposure of the reinforcement steel.

It is also our recommendation that the next time this tank is removed from serve and de-watered, to hand/power tool clean the wall surfaces showing tight cracks and scour of the concrete to achieve a uniform anchor profile and to apply two coats of an elastomeric masonry waterproofing coating to all interior wall surfaces showing cracks and scour in an effort to seal the cracks, seal the concrete and to prevent moisture penetration.

We recommend that the products utilized be formulated for immersion (wet contact), have an A.N.S.I./N.S.F. 61 approval for use in structures containing potable water and to be applied in accordance with the product manufacturer's surface preparation and application recommendations.

Overhead

The entire overhead was inspected from the water surface.

These pre-cast concrete panels and concrete filled joints between panels are not coated and these concrete surfaces appeared mostly sound, however tight cracks were observed throughout approximately 10% of these surfaces at this time.

Efflorescence has accumulated within each cracks due to moisture penetration, however these cracks appeared to be limited to the surface of the concrete and free of obvious spall at this time.

The vent penetration in the center of the overhead was free of obvious obstructions at the time of this inspection.

RECOMMENDATION(S): It is our recommendation to monitor the cracks found throughout these surfaces through future scheduled inspections to ensure that spall of the concrete does not occur and result in exposure of the underlying reinforcement steel.

It is also our recommendation that the next time this tank is removed from serve and de-watered, to hand/power tool clean the overhead surfaces showing tight cracks to achieve a uniform anchor profile and to apply two coats of an elastomeric masonry waterproofing coating to all interior overhead surfaces showing cracks in an effort to seal the cracks and to prevent moisture penetration.

We recommend that the products utilized be formulated for immersion (wet contact), have an A.N.S.I./N.S.F. 61 approval for use in structures containing potable water and to be applied in accordance with the product manufacturer's surface preparation and application recommendations.

Overflow

The overflow consists of a 10" inside diameter pipe, encased within a 24" by 20" concrete box formed to the wall.

This concrete overflow box is not coated and appeared sound and free of cracks, spall or other obvious fatigue of the concrete at this time.

The pipe encased within the concrete box was free of obvious obstructions at the time of this inspection.

RECOMMENDATION(S): None at this time.

Aesthetic Water Quality

The aesthetic water quality was found to be good throughout this entire tank, allowing unlimited visibility for this inspection.

ADDITIONAL REMARKS/RECOMMENDATION(S):

It is our recommendation to install an N.S.F. approved active mixer within this structure to prevent ice cap formation and to improve overall water quality.

CONCLUSION:

It is the opinion of Underwater Solutions Inc. that this concrete potable water storage tank appeared mostly sound and free of obvious leakage at this time.

As always, we recommend that re-inspection and cleaning of all water storage facilities be performed in accordance with state and federal mandates, A.W.W.A. standards, and completed by an experienced and authorized inspection corporation.

UNDERWATER SOLUTIONS INC.

Christopher A. Cole, Project Manager

This report, the conclusions, recommendations and comments prepared by Underwater Solutions Inc. are based upon spot examination from readily accessible parts of the tank. Should latent defects or conditions which vary significantly from those described in the report be discovered at a later date, these should be brought to the attention of a qualified individual at that time. These comments and recommendations should be viewed as information to be used by the Owner in determining the proper course of action and not to replace a complete set of specifications. All repairs should be done in accordance with A.W.W.A. and/or other applicable standards.

1 ***Tank Identification Plate***

2 ***Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew***

3 ***Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew***

4 ***Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew***

5 ***Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew***

6 ***Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew***

7 *Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew*

8 *Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew*

9 *Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew*

10 *Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew*

11 *Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew*

12 *Exterior Wall Having Tight Cracks And A Non-Uniform Accumulation Of Mildew*

13 ***Pre-Cast Concrete Roof Panels Appearing Sound And Having Tight Cracks Within The Concrete Filled Panel Joints And A Non-Uniform Accumulation Of Mildew***

14 ***Pre-Cast Concrete Roof Panels Appearing Sound And Having Tight Cracks Within The Concrete Filled Panel Joints And A Non-Uniform Accumulation Of Mildew***

15 ***Pre-Cast Concrete Roof Panels Appearing Sound And Having Tight Cracks Within The Concrete Filled Panel Joints And A Non-Uniform Accumulation Of Mildew***

16 ***Pre-Cast Concrete Roof Panels Appearing Sound And Having Tight Cracks Within The Concrete Filled Panel Joints And A Non-Uniform Accumulation Of Mildew***

17 ***Pre-Cast Concrete Roof Panels Appearing Sound And Having Tight Cracks Within The Concrete Filled Panel Joints And A Non-Uniform Accumulation Of Mildew***

18 ***Pre-Cast Concrete Roof Panels Appearing Sound And Having Tight Cracks Within The Concrete Filled Panel Joints And A Non-Uniform Accumulation Of Mildew***

19 ***Roof Having Adhesion Lost Of The Cement Based Protective Coating***

20 ***Roof Having Adhesion Lost Of The Cement Based Protective Coating***

21 ***Roof Having Adhesion Lost Of The Cement Based Protective Coating***

22 ***Steel Cable Secured Around The Vent***

23 ***Steel Cable Secured Around The Vent***

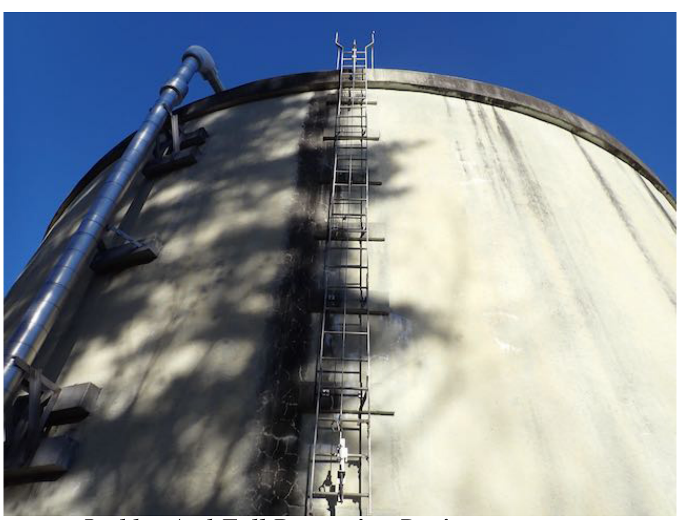
24 ***Eye Splice At The End Of The Cable Secured To The Vent***

25 ***Influent Pipe Extending Up From The Ground***

26 ***Influent Pipe Supported To The Tank Wall***

27 ***Influent Pipe Penetrating The Roof***

28 ***Secure Manway***



29 ***Ladder And Fall Prevention Device***

30 ***Hand Rail On The Top , Right Side Of The Ladder Having A Failed Weld***

31 ***Hand Rail On The Top , Right Side Of The Ladder Having A Failed Weld***

32 ***Hand Rail On The Top , Right Side Of The Ladder Having A Failed Weld***

33 ***Hand Rail On The Top , Right Side Of The Ladder Having A Failed Weld***

34 ***Overflow Pipe Having A Flap-Valve***

35 ***Overflow Pipe Found Unobstructed***

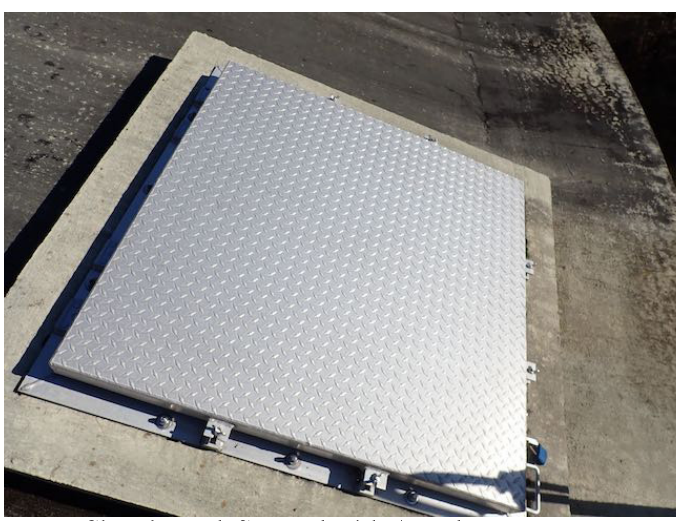
36 ***Overflow Pipe And Flap-Valve Having Corrosion***

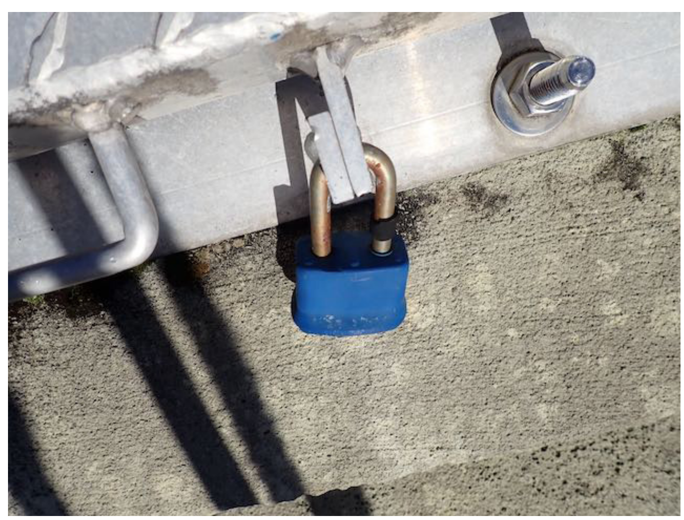

37 *Secure Vent Assembly*


38 *Secure primary And Secondary Screens*


39 *Secure primary And Secondary Screens*


40 *Open Hatch*


41 *Closed Hatch Secured With A Lock*


42 *Lock Securing The Hatch*

43 ***Floor Appearing Sound And Having A Mild Stain***

44 ***Floor Appearing Sound And Having A Mild Stain***

45 ***Floor Appearing Sound And Having A Mild Stain***

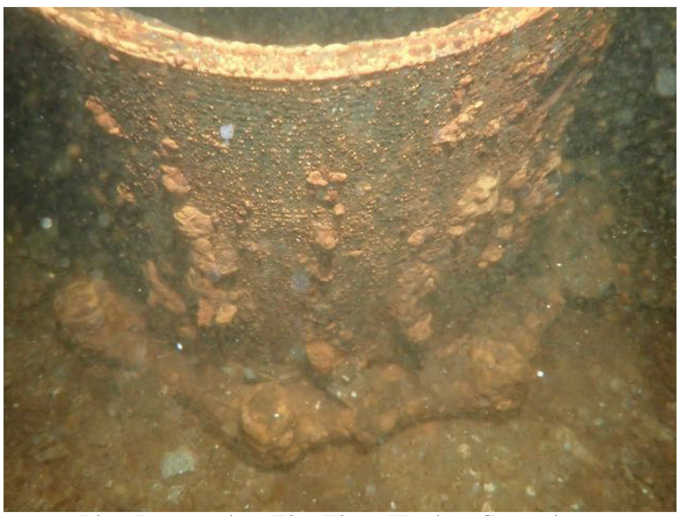
46 ***Floor Appearing Sound And Having A Mild Stain***

47 ***Secure Manway And Grab Bar***

48 ***Manway Access Ladder Having Corrosion***

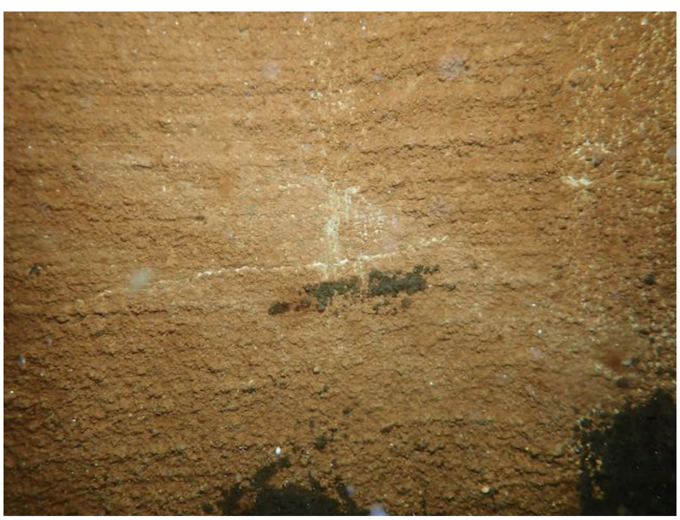
49 *Manway Access Ladder Having Corrosion*

50 *Pipe Penetrating The Floor Found Unobstructed*



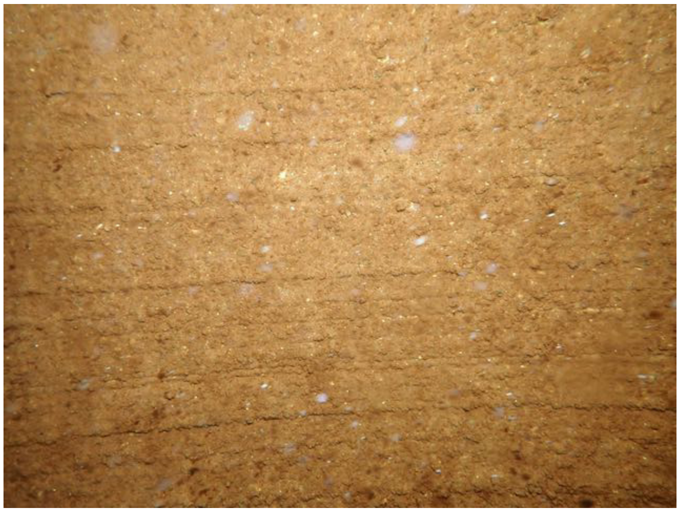
51 *Pipe Penetrating The Floor Having Corrosion*

52 *Pipe Penetrating The Overhead Having Flow Entering The Tank*



53 *Interior Wall Having Tight Cracks*

54 *Interior Wall Having Tight Cracks*



55 ***Interior Wall Appearing Sound And Having A Mild Stain***

56 ***Interior Wall Appearing Sound And Having A Mild Stain***

57 ***Interior Wall Appearing Sound And Having A Mild Stain***

58 ***Interior Wall Appearing Sound And Having A Mild Stain***

59 ***Interior Wall Appearing Sound And Having A Mild Stain***

60 ***Pre-Cast Concrete Overhead Panels And Concrete Filled Joints Appearing Mostly Sound***


61 ***Pre-Cast Concrete Overhead Panels And Concrete Filled Joints Appearing Mostly Sound***


62 ***Pre-Cast Concrete Overhead Panels And Concrete Filled Joints Appearing Mostly Sound***


63 ***Pre-Cast Concrete Overhead Panels And Concrete Filled Joints Appearing Mostly Sound***


64 ***Unobstructed Vent Penetration***


65 ***Unobstructed Interior Overflow Pipe***


66 ***Discharge From Cleaning***