

# Investigation of DBP Exceedance East Longmeadow Water Distribution System

**To:** Felix Vachon; Water and Sewer Administrator, East Longmeadow  
Department of Public Works  
Bruce Fenney; Superintendent, East Longmeadow Department of Public  
Works

**FROM:** Thomas LeCourt, PE; Tighe & Bond  
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**DATE:** March 3, 2023

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The Town of East Longmeadow (Town) has received a Notice of Noncompliance (NON) from the Massachusetts Department of Environmental Protection (MassDEP) for violation of the Disinfection Byproducts Rule (DBPR). The violation resulted from exceeding the maximum contaminant level (MCL) for haloacetic acids (HAA5) and total trihalomethanes (TTHMs) in routine monitoring samples collected in the Town's water distribution system.

This technical memorandum reviews historical water quality in the Town's distribution system to identify potential causes for the exceedance of the MCLs for HAA5 and TTHMs and evaluates possible options for lowering HAA5 concentrations in the future.

Tighe & Bond performed a similar evaluation for the Town in April 2020 in response to increased HAA5 concentrations, most notably at Harkness Pump Station. Since that time, compliance with the MCLs for HAA5, and more recently, TTHMs has become more challenging for the Town. This technical memorandum updates the information in the April 2020 memorandum.

## 1 Background

The Town's water is purchased and supplied from the Springfield Water and Sewer Commission (SWSC). The purchased water originates from a surface water supply consisting of two waterbodies—the Cobble Mountain Reservoir and the Borden Brook Reservoir—in Blandford and Granville, MA. From there, the reservoir water flows to the West Parish Filters (WPF) Treatment Plant in Westfield, MA, where it is filtered via slow and rapid sand filtration and chemically treated to protect against lead and copper leaching in home plumbing. Chlorine is applied as a disinfectant before the water flows to the 42-million-gallon underground storage tanks at Provin Mountain Reservoir in Agawam, MA.

The Town has four locations to draw from the SWSC treated water supply: Elm Street, Harkness Avenue, North Main Street, and Dwight Road. This water supplies more than 115 miles of water mains throughout the Town. A map of all of the Town's sampling stations, including the DBP sampling sites, is provided in Attachment A.

### 1.1 Disinfection By-Products

It is typical for water from surface water treatment plants (such as the WPF Treatment Plant) to contain disinfection byproducts (DBPs) that form from reactions between chlorine added for disinfection and organic matter that is present in natural waters. The United States Environmental Protection Agency (USEPA) has established MCLs for two groups of DBPs that

are linked to health problems: haloacetic acids (HAA5) and trihalomethanes (TTHM). The MCL for HAA5 is 60 µg/L and the MCL for TTHM is 80 µg/L. Compliance with these MCLs is determined as locational running annual averages (LRAAs) of quarterly samples taken at specified sites throughout the distribution system.

The amount of DBPs that form depends on the amount of organic matter and chlorine in the treated water, which are variable and can be affected by precipitation events and other causes. DBP formation is also dependent on the contact time between the organic matter and chlorine. As chlorine contact time increases, chlorine residuals decrease. HAA5 formation tends to increase to a point, and then subsequently decreases with increasing contact times and decreased chlorine residual due to biodegradation, whereas TTHM formation tends to continuously increase under these same conditions. Therefore, it is expected that the Town's distribution system will have higher HAA5 concentrations closer to its points of entry (POE) where the chlorine residual is higher, and higher TTHM concentrations farther out in the distribution system where chlorine residual is lower.

## 2 Water Quality Data Review

Water quality data from the Town's distribution system, WPF Treatment Plant, and raw source water were reviewed to understand the causes of the elevated DBP concentrations and to assess the risk of such exceedances in the future.

Because the concentrations of DBPs in water are primarily dependent on: 1) organic matter concentrations, 2) chlorine concentrations, and 3) the contact times between organic matter and chlorine, we focused our review on these three aspects of the available water quality data. Our findings are summarized below.

### 2.1 DBP Sampling Within the Distribution System

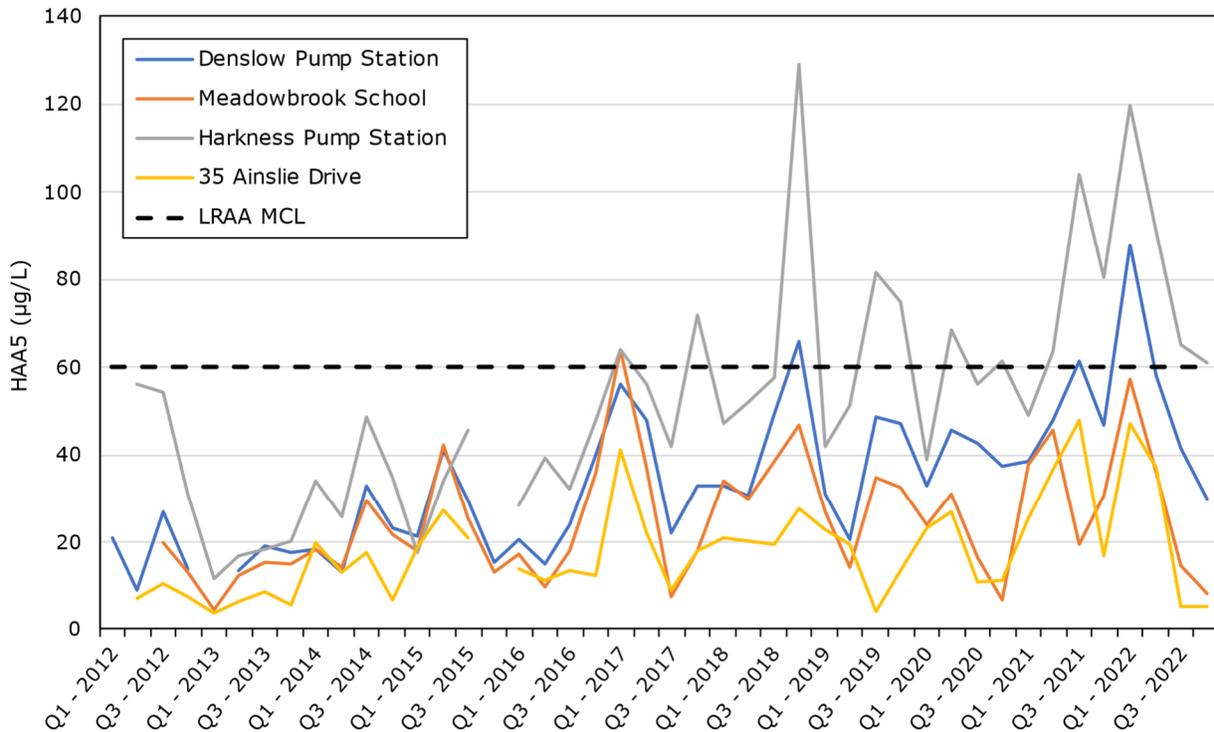
HAA5 and TTHM are measured at four locations within the Town's distribution system on a quarterly basis. These four locations—Denslow Pump Station, Meadowbrook School, Harkness Pump Station, and 35 Ainslie Drive—can be found on the map provided in Attachment A. Harkness Pump Station is also the primary point of entry (POE) into the Town's distribution system. The other three sampling locations are dispersed across the Town; the sampling location at 35 Ainslie Drive is farthest from the POE.

#### 2.1.1 HAA5

Figure 2-1 presents the quarterly HAA5 concentrations from individual sampling events within the Town's distribution system from Quarter (Q) 1 - 2012 to Q4 - 2022. It is important to note that the HAA5 MCL is based on the LRAA concentration, not the individual sampling result. The LRAA is the average of analytical results for samples at a particular monitoring location during the previous four calendar quarters. The LRAA MCL line is provided for reference, but points above this line in Figure 2-1 do not necessarily constitute a violation.

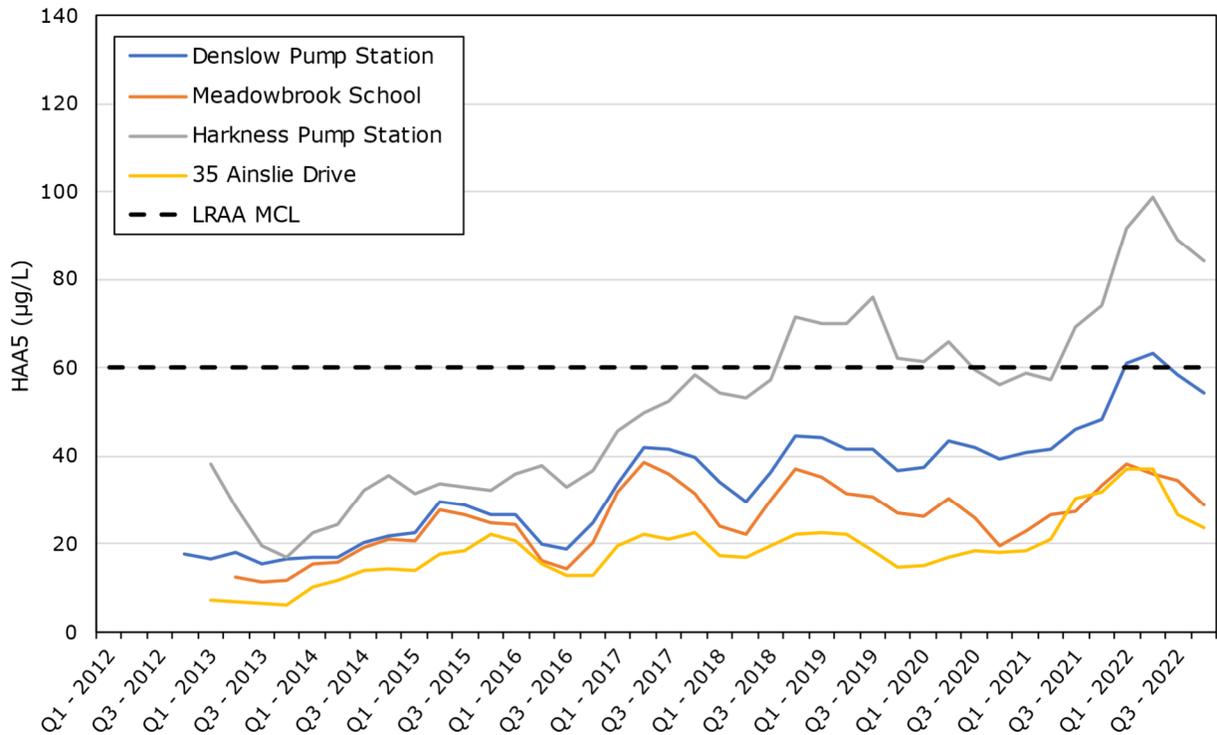
Overall, the HAA5 concentration measured at the Harkness Pump Station was consistently higher than the HAA5 concentrations measured at the three other DBP sampling sites, and the HAA5 concentration measured at 35 Ainslie Drive was consistently lower than the HAA5 concentration measured at the three other DBP sampling sites. Between Q1 - 2017 and Q4 - 2022, the HAA5 concentration measured at the Harkness Pump Station exceeded 60 µg/L fourteen (14) times, peaked at 129 µg/L in Q4 - 2018, and has been consistently greater than 60 µg/L since Q2 - 2021. Over this same time period, the HAA5 concentrations measured

at Denslow Pump Station have exceeded 60 µg/L three times, at Meadowbrook School only once, and the HAA5 concentration measured at 35 Ainslie Drive has never exceeded 60 µg/L.



**FIGURE 2-1**  
Individual Sample HAA5 Concentrations

Figure 2-2 presents the quarterly HAA5 LRAA concentrations within the Town’s distribution system from Q1 - 2012 to Q4 - 2022. The HAA5 LRAA exceeded the MCL at Harkness Pump Station from Q4 - 2018 to Q2 - 2020 and from Q3 - 2021 to the most recent quarter, Q4 - 2022. These exceedances correlate with higher-than-average natural organic matter concentrations experienced in the raw water from Q4 - 2018 and Q3 and Q4 - 2019 and after the summer of 2021. The three other sampling locations have remained mostly in compliance with the HAA5 LRAA MCL, although the MCL was exceeded slightly at Denslow Pump Station for two quarters in the first two quarters of 2022. These results agree with the expectation that the Town’s distribution system will have higher HAA5 concentrations closer to its points of entry (POE) where the chlorine residual is higher.

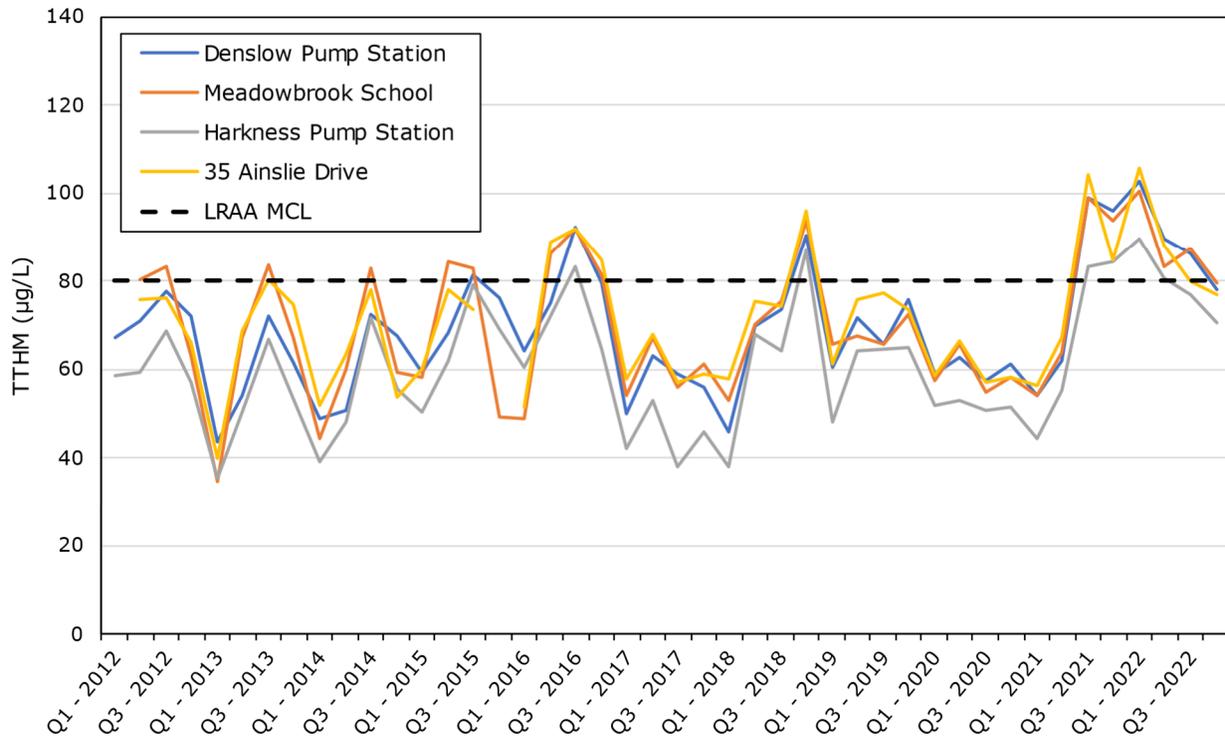


**FIGURE 2-2**  
HAA5 LRAA Concentrations

**2.1.2 TTHM**

Figure 2-3 presents the quarterly TTHM concentrations from individual sampling events within the Town’s distribution system from Q1 -2012 to Q4 - 2022. Again, it is important to note that the TTHM MCL is based on the LRAA concentration, not the individual sampling result. The LRAA MCL line is provided for reference, but points above this line in Figure 2-3 do not necessarily constitute a violation.

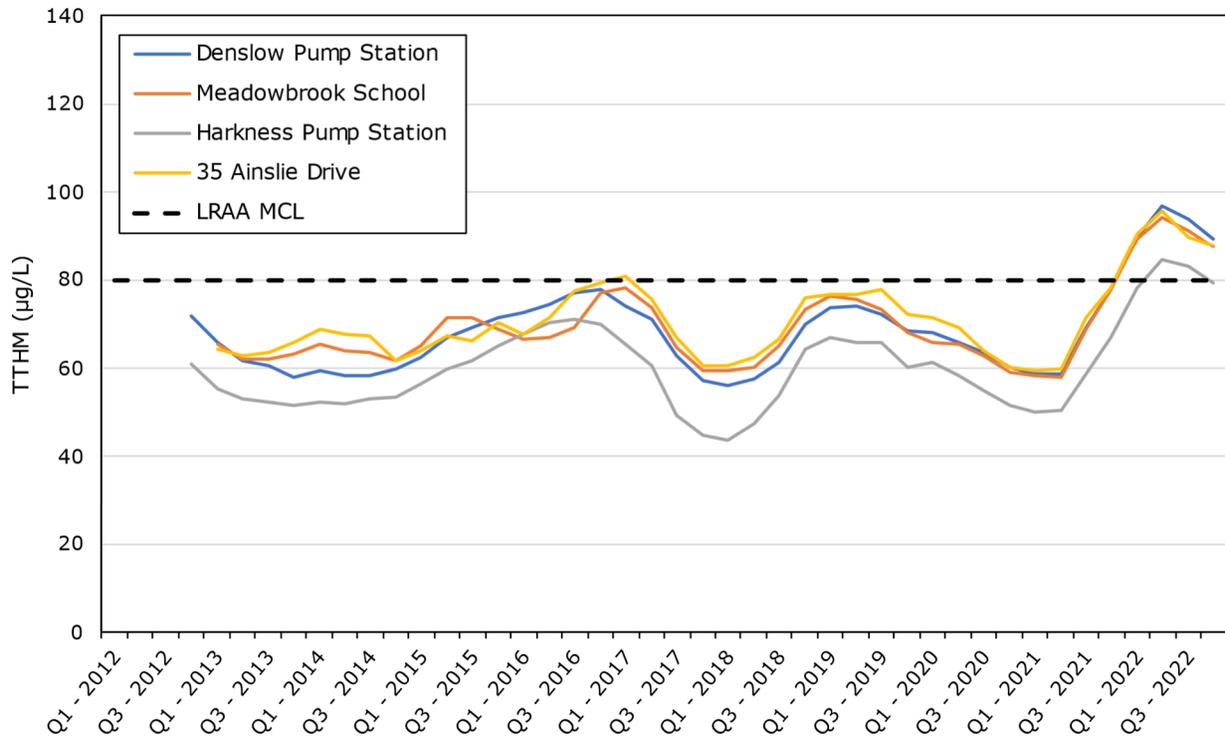
Overall, the TTHM concentrations measured at the four sampling locations were fairly similar, with TTHM concentrations measured at the Harkness Pump Station slightly lower than the TTHM concentrations measured at the three other DBP sampling sites. TTHM concentrations typically follow a seasonal pattern, with the lowest TTHM concentrations of the year often measured in Quarter 1, and the highest TTHM concentrations (often exceeding 80 µg/L) of the year measured in Quarter 3, although 2022 was an anomalous year with respect to this trend, as TTHM concentrations were highest in the first quarter. It is anticipated that this anomaly was due to abnormal rainfall levels in the summer of 2021 – this will be discussed further later in this memorandum.



**FIGURE 2-3**  
Individual Sample TTHM Concentrations

Figure 2-4 presents the quarterly TTHM LRAA concentrations within the Town’s distribution system from Q1 -2012 to Q4 - 2022. The TTHM LRAA just barely exceeded the MCL at 35 Ainslie Drive during Q1 - 2017; then, the TTHM LRAA was 80.9 µg/L, but since Q1 - 2022, the TTHM LRAA at all of the sites have exceeded the MCL, largely due to the higher-than-normal TTHM concentrations experienced in Q1 - 2022. Note that Q1 is typically the quarter with the lowest concentrations of TTHMs, with Q1 - 2022 being an anomaly. If TTHM concentrations return to typical levels experienced in Q1 during the Q1 - 2023 sampling (schedule for March 2023), the Town will likely return to compliance with the MCL for TTHMs.

The trend in TTHM LRAA concentrations among sample sites is the opposite of the trend in HAA5 LRAA concentrations among sample sites. While the HAA5 LRAA concentrations are consistently the highest at Harkness Pump Station, the TTHM LRAA concentrations are consistently the lowest at Harkness Pump Station. Similarly, the HAA5 LRAA concentrations are consistently the lowest at 35 Ainslie Drive, yet 35 Ainslie Drive typically has the highest TTHM concentrations. These results agree with the expectation that the Town’s distribution system will have higher HAA5 concentrations closer to its points of entry (POE) where the chlorine residual is higher, and higher TTHM concentrations farther out in the distribution system where chlorine residual is lower.



**FIGURE 2-4**  
TTHM LRAA Concentrations

## 2.2 Source Water

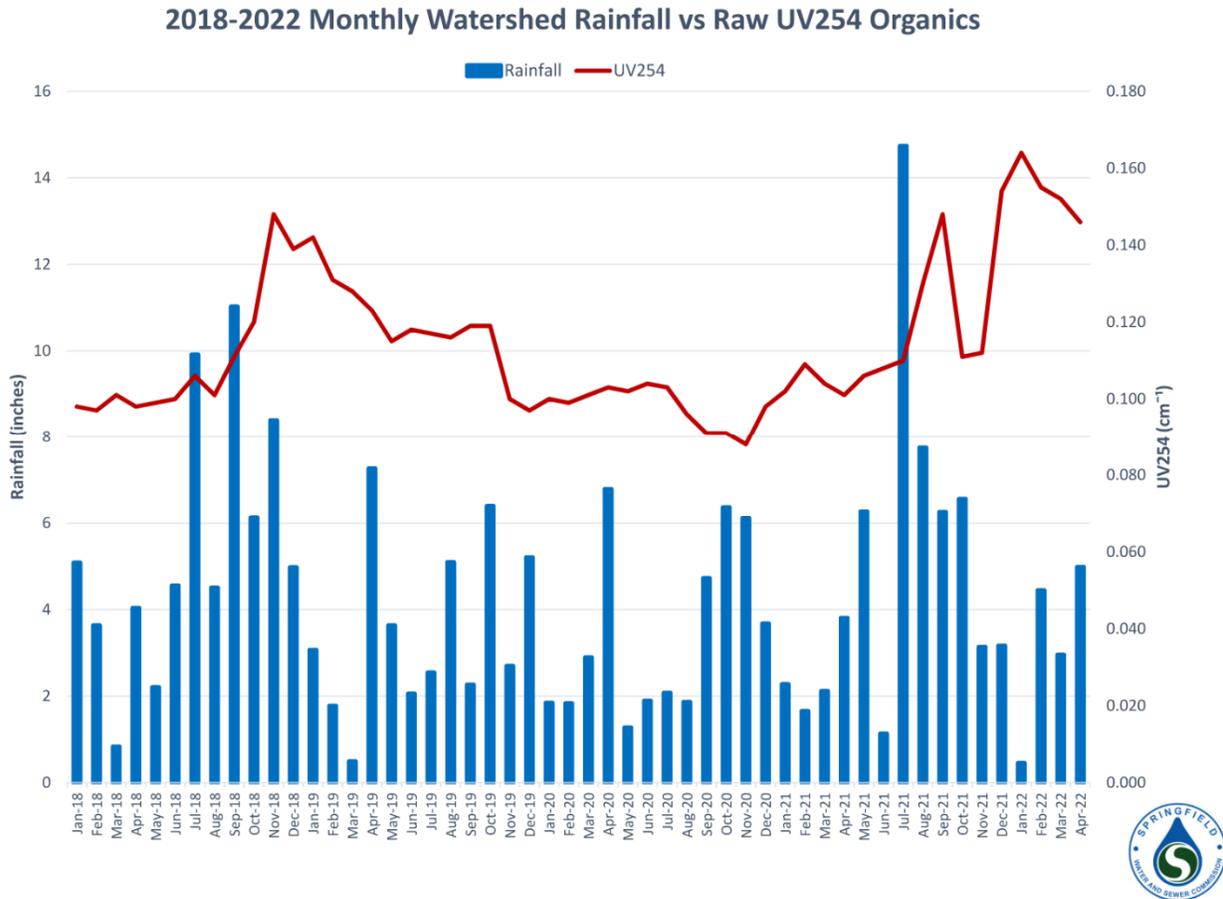
In 2018, more than 60 inches of rain fell in the Cobble Mountain watershed, which contains the reservoir that serves the Town of East Longmeadow. This heavy rainfall, about 40% more than is typical in a year, followed two years of drought conditions. These unique series of events increased the amount of dissolved natural organic matter (NOM) in the reservoir by close to 50% (Dissolved NOM enters the reservoir from rain and snow melt from the surrounding forest).

In the summer of 2021, higher than average rainfall occurred in the Cobble Mountain watershed, including rainfall from two hurricanes. During Q3 2021, the Cobble Mountain watershed experienced over 30 inches of rainfall, which was the highest quarter of rainfall experienced over the past ten years. This higher-than-average rainfall resulted in an increase of in the amount of dissolved natural organic matter (NOM), which are the precursors to DBP formation, in the Cobble Mountain Reservoir.

Additionally, annual reservoir turnover occurred in the fall 2021, resulting in higher NOM levels deeper in the reservoir, where the water intake is located. This continued to impact raw water quality into the winter of 2022 and NOM levels in the reservoir have remained unprecedentedly high. The increased NOM in the raw water and the higher chlorine dosages necessary to maintain disinfectant residuals contributed to elevated DBP levels throughout the distribution system.

Figure 2-5 below was extracted from the SWSC’s presentation to EPA in May 2022 and shows monthly rainfall and raw water organics, characterized as absorbance at 254 nm (UV<sub>254</sub>), measured in the source water from January 2018 to April 2022. The Town has not been provided with raw water organics data after April 2022. The figure demonstrates that periods

of high rainfall, such as late 2018 and late 2021, are followed by period of elevated organic levels in the source water. The extremely heavy rainfall observed in 2021 caused raw water organic levels to increase to their highest concentrations observed in the reservoir, and while organics began to trend downward in early 2022, the reduction in organics has been slow.



**FIGURE 2-5**  
Rainfall & Raw Water Organics

The higher concentration of raw water organics in the source water indicates that higher concentrations of DBP precursors existed in the source water. The slow sand filters and direct filtration processes at the WPF Treatment Plant likely removed some of the organic material and DBP precursors, but the finished water likely contained higher-than-usual DBP precursor concentrations. The current direct filtration and slow sand processes at the West Parish Filters treatment plant are not capable of removing enough DBP precursors for regular compliance with the Disinfection By-Products Rule.

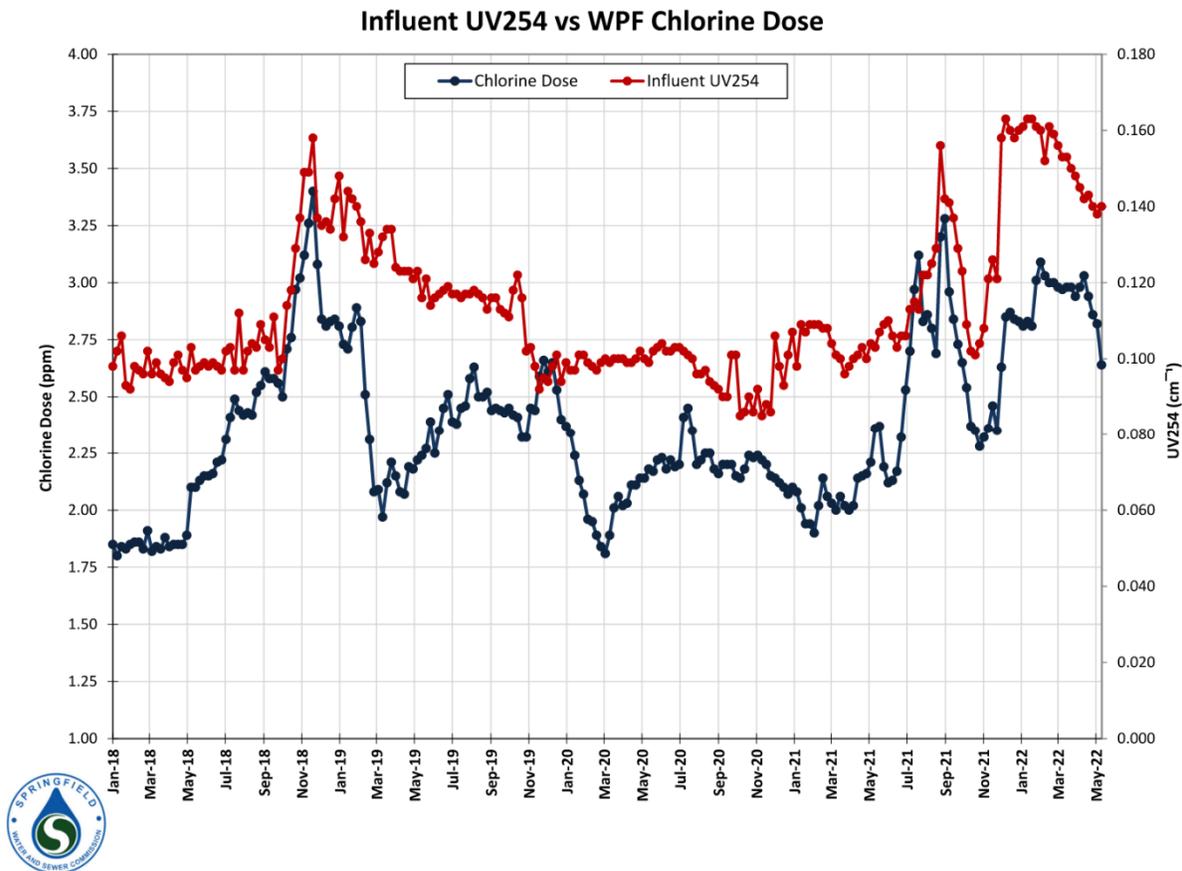
## 2.3 WPF Treatment Plant

### 2.3.1 Chlorine Dose

At the WPF Treatment Plant, chlorine is added to the filtered water as a disinfectant. Chlorine will react with inorganic and organic impurities in the water requiring a higher chlorine dose to maintain adequate disinfection. An increase in chlorine dose (due to this increased chlorine

demand) indicates that there may be an increase in the amount of impurities (i.e., DBP precursors) in the water.

Figure 2-6, which also came from SWSC’s May 2022 presentation to EPA, compares the chlorine dosage at WPF Treatment Plant from January 2018 – May 2022 with the raw water organics, characterized by UV<sub>254</sub>. The figure shows that the amount of chlorine added follows a similar trend to the level of raw water organics measured, presumably because the higher amount of organics passing through the filtration processes at the WPF Treatment Plant exerted a higher chlorine demand. Thus, more chlorine is required to maintain an adequate disinfectant residual when organics are higher, which exacerbates the problem of DBP formation in the distribution system.



**FIGURE 2-6**  
Chlorine Dosage at WPF Treatment Plant vs. Raw Water Organics

The SWSC is currently in the process of implementing two projects that are expected to address DBP formation: 1) construction of a new finished water clearwell, and 2) construction of a new water treatment facility. The new finished water clearwell will replace the existing clearwell, which is failing due to structural deficiencies. Completion of the new clearwell is expected to provide a slight decrease in the amount of organics in the finished water. It is expected that the construction of the new clearwell will be completed within the next six months.

SWSC is currently in the design phase for treatment process modifications at the WPF Treatment Plant. The new facility will employ dissolved air flotation ahead of filtration to

provide improved NOM removal and a significant reduction in DBP formation. Construction of the new facility is expected to be completed in 2027.

### 3 Possible Options for Lowering DBP Concentrations

The Town of East Longmeadow has limited options for lowering DBP concentrations in its distribution system because concentrations are already high, potentially above their respective MCLs, when water enters the distribution system from the Provin Mountain Storage Reservoir, which is owned and operated by SWSC. Unlike HAA5, which degrade over time, TTHMs continue to form in the East Longmeadow distribution system, although it is noted that in recent sampling, TTHMs have also exceeded the MCL in the water that enters the East Longmeadow system. Possible options for lowering DBP concentrations are listed below, and the likely effectiveness of each is discussed.

- **Install an aeration system.** Although aeration systems remove TTHM formed upstream of the application point, they do not remove HAA5 because HAA5 are not volatile. In the past, the Town has investigated the use of in-tank aeration systems but has not installed a system in either of its elevated tanks. Given that TTHMs have only recently become problematic in East Longmeadow's distribution system, largely due to increased organics from higher-than-average rainfall in fall 2021, the expense of installing an aeration system in the elevated tanks to address TTHMs may not be justified if NOM concentrations in the raw water return to "normal" levels. (It is noted that the impact of an abnormally high DBP sampling result, as was seen in Q1 – 2022, lasts for four quarters worth of sampling.) Therefore, installing an aeration system for DBP removal is not recommended at this time.
- **Modify storage tank operation to manage water age.** HAA5 are biodegradable, so increasing water age to facilitate biodegradation could possibly lower HAA5 concentrations, but effectiveness would not be guaranteed. Promoting longer water age could negatively impact water quality by lowering the chlorine residual, increasing microbial regrowth, increasing the risk of pathogens, and increasing TTHM and other DBP concentrations. However, given that the high HAA5 concentrations are found at the point of entry and not at other locations within the Town's distribution system, modifying the storage tanks operation to increase water age could likely have a detrimental impact on overall water quality due to the reasons listed above, and therefore is not appropriate. The Town has experimented with modifying its water storage tank operations to address DBPs, but given that the objectives for managing HAA5 compete with the objectives for managing TTHMs, a definitive storage tank level management solution that addresses both types of DBPs is not practical.
- **Construct a new water treatment plant.** This option would entail constructing a new facility to treat all water from SWSC. It could effectively lower the HAA5 concentration and improve water quality overall. Three treatment processes could be implemented at the new water treatment plant:
  - Biofiltration. HAA5 are readily biodegradable, so treating all water with biologically active filters would lower the HAA5 concentration.
  - Reverse osmosis (RO). This system would be designed to filter a portion of the water so that the HAA5 concentration in the finished water would be less than 80% of the MCL.

- Aeration. Aeration treatment could potentially reduce TTHM concentrations.

It would take 3-5 years to design, permit, and construct a new water treatment plant. Constructing and operating a new water treatment plant would be cost-prohibitive for the Town. In addition to purchasing water from SWSC, the Town would be financially responsible for increased staffing, sampling, and reporting requirements to operate and maintain the new water treatment plant. Furthermore, while Harkness Pump Station is the Town's primary point of entry from the SWSC system, the Town has other interconnection points that may also require treatment if used more regularly. Therefore, the option of constructing one or more treatment plants is not ideal for the Town. Furthermore, it is expected that SWSC's new treatment facility will be completed before a new Town facility could be completed. Assuming that the new SWSC facility will remove organics and reduce DBP formation, it would render a new Town treatment facility unnecessary and therefore it is not recommended that the Town move forward considering this as an option

The Town does not have control over the formation of DBPs upstream of the POE. Operational modifications in the distribution system would not lower or remove DBPs. The only option that would effectively remove the DBPs already formed without potentially causing other water quality problems is to construct a new water treatment facility. However, this option is not viable because of its high capital costs, high operating costs, and long timeframe to implement.

## 4 Conclusions

The high DBP concentrations measured during the 2021 and 2022 sampling can be attributed to higher-than-average rainfall during the fall of 2021, which included two hurricane events. Not only did high the heavy rainfall increase organics in the source water, but it also created a higher chlorine demand in the filtered water at the WPF Treatment Plant. A higher chlorine dose was required to maintain the target residual for disinfection, resulting in elevated levels of DBPs.

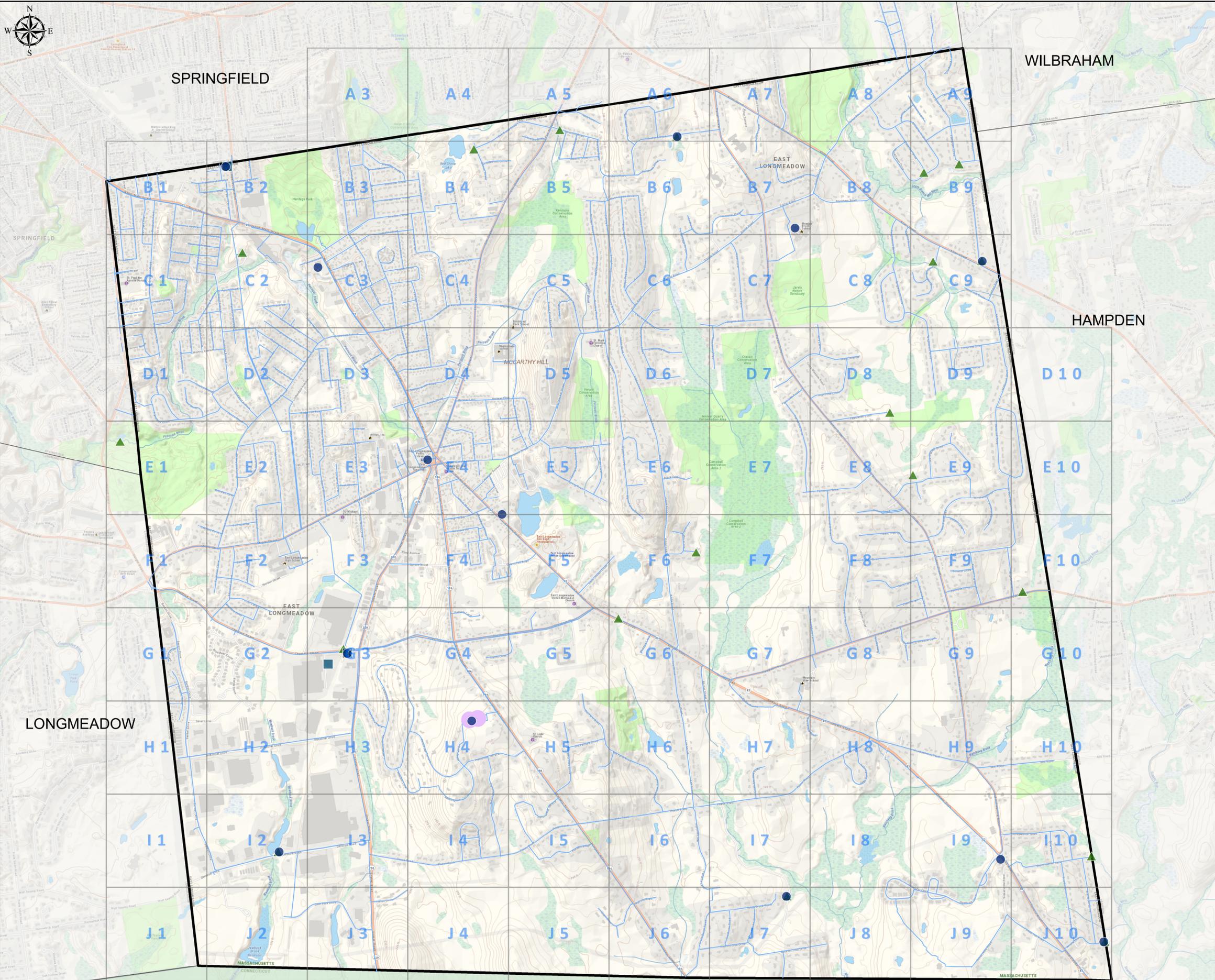
The Town relies on SWSC for their water supply, and the sample site at Harkness Pump Station, its primary POE, consistently has the highest HAA5 concentration. Therefore, the Town cannot modify current treatment or distribution system operations in an attempt to lower HAA5. The only effective way to remove HAA5 without potentially causing other water quality problems is to construct a new water treatment facility. However, Tighe & Bond does not recommend this option because it would not provide any near-term benefit, is cost-prohibitive, and is unnecessary because SWSC currently under the design phase of a new treatment process at the WPF Treatment Plant that will provide more effective removal of natural organic matter and ultimately reduce DBP formation. The current target date for completion of construction of the new treatment facility is 2027.

Beginning in 2022, increased levels of TTHMs were also observed in East Longmeadow's distribution system, and although there are distribution system operational modifications that may be effective for lowering TTHMs, these methods are ineffective towards HAA5, which tend to decrease through the system through biological processes. The exceedance of the MCL for TTHMs is largely due to the higher-than-normal concentrations measured in Q1 – 2022, which resulted from elevated organics due to reservoir turnover. In a typical year, Q1 is when the Town see its lowest formation of TTHMs, but in 2022, Q1 had the highest concentrations of TTHMs. If Q1 – 2023 results return to "normal" Q1 levels, it is expected that the Town will return to compliance with the MCL for TTHMs.

SWSC is undertaking the following steps to improve water quality for its downstream customers:

- Optimize filter operations to improve NOM removal and limit DBP formation.
- Optimize chlorine dosing. SWSC has implemented a flushing program in its distribution system to help maintain its target chlorine residual. In turn, this program may allow for reduced chlorine dosing at the WPF Treatment Plant. Lowering the chlorine dose may decrease DBP formation and lead to lower DBP concentrations in the Town of East Longmeadow. The Town of East Longmeadow also flushes their system annually.
- SWSC is in the process of constructing a new finished water clearwell, which will replace the existing failing clearwell. Completion of the new clearwell is expected to provide a slight decrease in the amount of organics in the finished water.
- SWSC is currently in the design phase for treatment process modifications at the WPF Treatment Plant. The new facility will employ dissolved air flotation ahead of filtration to provide improved NOM removal and a significant reduction in DBP formation. Construction of the new facility is expected to be completed in 2027.

Tighe & Bond recommends that the Town continue its regular operations because the SWSC is working to improve water quality for its downstream customers, including the Town of East Longmeadow.



# Water Sampling and Distribution EAST LONGMEADOW, MA

3/5/2020

- Sample Stations
- Water Pumping Station
- ▲ Sewer Pumping Station
- Water Tower
- Water Main

*The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analysis. Please use this information as a guide and confirm all locations before instituting any plan or policy.*

*These data are not suitable for engineering applications or site work nor can the data be used to determine absolute delineation. Instead, the data should be used to portray zones of uncertainty and possible risks.*

Map created by East Longmeadow Department of Public Works  
Basemap c/o MassGIS

| Sampling Stations    | Feature Name                        | Description                            | Index |
|----------------------|-------------------------------------|--|-------|
| Water Sample Station | Ainslie Drive Sampling Station      | 35 Ainslie Drive                       | J10   |
| Water Sample Station | Watchaug Sampling Station           | Behind 153 South Brook Road            | J7    |
| Water Sample Station | 733 Somers Rd Sampling Station      | Location Estimated                     | I9    |
| Water Sample Station | Denslow Road Sample Station         | 84 Denslow Road                        | I2    |
| Water Sample Station | 2.5 MMG Water Tank Sampling Station | Water Tower behind 335 Prospect Street | H4    |
| Water Sample Station | Chestnut Street Sampling Station    | SW Chestnut/ Shaker                    | G3    |
| Water Sample Station | DPW Garage Sampling Station         | 84 Somers Road                         | F4    |
| Water Sample Station | Town Hall Sampling Station          | 60 Center Square                       | E4    |
| Water Sample Station | Council on Aging Sampling Station   | 328 North Main Street                  | C3    |
| Water Sample Station | Allen Street Sampling Station       | Allen/Holland                          | C9    |
| Water Sample Station | Meadow Brook Sampling Station       | Meadowbrook School                     | B7    |
| Water Sample Station | Harkness Ave Sample Station         | 82 Harkness Ave                        | B2    |
| Water Sample Station | Orchard Road Sample Station         | West of 35 Orchard                     | A6    |

| Water Pumps           | Feature Name              | Description                 | Index |
|-----------------------|---------------------------|-----------------------------|-------|
| Water Pumping Station | Old Chestnut Pump Station | 330 Chestnut Street - Modak | G3    |
| Water Pumping Station | Chestnut pump Station     | SW Chestnut/ Shaker         | G3    |
| Water Pumping Station | Harkness Pump Station     | 82 Harkness Ave             | B2    |

| Sewer Pumps        | Feature Name                | Description | Index |
|--------------------|-----------------------------|-------------|-------|
| Sewer Pump Station | Ainslie Pump Station        |             | J10   |
| Sewer Pump Station | Watchaug Brook Pump Station |             | J7    |
| Sewer Pump Station | Glen Heather Pump Station   |             | I10   |
| Sewer Pump Station | Denslow Pump Station        |             | I2    |
| Sewer Pump Station | Chestnut Pump Station       |             | G3    |
| Sewer Pump Station | Somers Pump Station         |             | G6    |
| Sewer Pump Station | Hampden Pump Station        |             | F10   |
| Sewer Pump Station | Chatham Pump Station        |             | F6    |
| Sewer Pump Station | Nottingham Pump Station     |             | E9    |
| Sewer Pump Station | Franconia Pump Station      |             | E1    |
| Sewer Pump Station | Peach Tree Pump Station     |             | D8    |
| Sewer Pump Station | Woodbridge Pump Station     |             | C9    |
| Sewer Pump Station | Allen Street Pump Station   |             | C9    |
| Sewer Pump Station | Vineland Pump Station       |             | C2    |
| Sewer Pump Station | Brookhaven Pump Station     |             | B9    |
| Sewer Pump Station | Evergreen Pump Station      |             | B9    |
| Sewer Pump Station | Dawes Pump Station          |             | B4    |
| Sewer Pump Station | Orchard Pump Station        |             | A6    |
| Sewer Pump Station | Lynwood Pump Station        |             | A5    |

| Water Towers | Feature Name       | Description                     | Index |
|--------------|--------------------|---------------------------------|-------|
| Water Tower  | 1.5 MMG Water Tank | Multi-Legged Steel Storage Tank | H4    |
| Water Tower  | 2.0 MMG Water Tank | Composite Storage Tank          | H4    |

## Attachment A

Connecticut