

Water Distribution System Modeling Report

Housatonic Water Works Company

April 2022

Prepared for:

**Housatonic Water Works Company
Great Barrington, Massachusetts**



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CIVIL, ENVIRONMENTAL AND HYDROGEOLOGICAL CONSULTANTS

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HOUSATONIC WATER WORKS WATER SYSTEM MODELING REPORT

EXECUTIVE SUMMARY

Lenard Engineering, Inc. (LEI) constructed a water distribution system model of the Housatonic Water Works (HWW) system, and evaluated the impact of various water main and water storage tank improvement options on available fireflows.

The primary focus of this report was to identify options that would increase available fireflows to the main core (Housatonic Village) of the water distribution system. Secondly, the report evaluated the impacts of other distribution system improvements on locations throughout the distribution system.

As discussed in this report, LEI recommends HWW construct a new 200,000 gallon minimum volume elevated water storage tank on High Street, which would improve fireflows from the current 650 gpm to over 1,000 gpm, while at the same time stabilizing pressures at the system's higher elevations in the system during fireflow events.

I. INTRODUCTION

Maintaining adequate pressure and fire hydrant flows is important for water distribution systems. Lenard Engineering, Inc. (LEI) conducted a modeling study of the Housatonic Water Works Company (HWW) water distribution system to help identify any potential issues with low pressure or low fire-fighting flows, and to propose appropriate solutions as needed.

The HWW system operates as a single pressure zone, with system pressures regulated by the water level in the 1.0 MG concrete water storage tank located at the Long Pond treatment plant. This tank has an overflow elevation of 960 feet above sea level.

The existing HWW water distribution system consists of approximately 103,000 feet of water mains ranging from 2" to 12" in diameter. Piping materials consist of ductile iron, cast iron, asbestos cement, and PVC piping.

Water service elevations within the HWW system range from approximately 700 – 865 feet, a difference of 165 feet. This corresponds to a static pressure range during average daily demand conditions of between ~40 and ~110 psi. The highest location within the HWW system and thus lowest static pressure is located on Prospect Street at approximately 865 feet elevation.

II. GOALS

Pressure: Massachusetts drinking water regulations require a minimum of 35 psi water pressure at all locations during normal conditions, which is met in the HWWC system with a minimum pressure of 40 psi. The regulations also require a minimum 20 psi pressure during all conditions including fire flow. That is expected to be maintained at most locations within the HWW system during fire flow except for the most elevated locations such as Prospect Street.

Available fire flows: The Insurance Service Office (ISO) provides recommendations for needed fire flow for various types of structures and uses. For single-family residential areas, the typical needed fire flow is between 500 – 750 gpm, while maintaining 20 psi at all system locations. For commercial and industrial zoned areas, needed fire flows of 1,000 gpm or more are generally recommended, which varies by building use, construction materials, and proximity to adjacent structures.

III. MODEL DATA INPUT

A) Mapping- LEI utilized the June 2017 Tighe & Bond map to generate a hydraulic model using the WaterCAD software program. This map was reviewed for accuracy by HWW, and several more recent pipe improvements were added.

B) Water Demands - HWW provided updated water production records from the Long Pond slow sand filtration plant, which provided an average daily demand value of **0.11 MGD**, and a maximum daily demand value of **0.23 MGD**, which occurred during hydrant flushing.

LEI utilized a value of **0.15 MGD**, approximately 140 % of the average daily demand, to simulate peak daily demand conditions in our model, during non-flushing periods.

IV.. HYDRANT FLOW TESTING AND MODEL CALIBRATION

HWW conducted ten fireflow tests within the distribution system, to provide updated pressures and flows for model calibration purposes. **Figure 1** shows the flow test locations, taken throughout the system. Copies of the flow test results are provided in **Attachment A**.

Table A compares field flow and pressure results to those predicted by the model. The model was calibrated under both static conditions (no hydrants flowing), as well as dynamic conditions (with hydrants flowing). Good calibration is typically defined as the majority of the model predicted values being within 10 psi of observed field conditions. These are shown highlighted in yellow. The model had good calibration for 9 out of 10 locations for static conditions, and 7 out of 10 locations during dynamic conditions.

Several key observations during model calibration:

- 1) The Hazen-Williams “C” factor for water mains measures the relative roughness of the piping. The “C” factors throughout the HWW system were surprisingly higher (smoother) than expected for pipes approaching 100 years in age. Whereas older piping C values typically range from C=30 to C= 60, the model calibrated reasonably well assigning a C = 100 to the majority of the pipes. Note that brand new ductile iron piping is assigned a C factor of C = 140.

A “C” factor of 100 is indicative of pipes with little or no buildup, which confirms HWW observations of smooth piping in good condition made during main tapping and repairs.

2) The model calibrates very well for Flow Test # 1 on North Plain Road. This location is critical, as this is reflective of the long 7,300 feet of 10" and 12" water main between the plant and the first customer. As all the water passes through this piping, getting this pipe accurately modeled is critical.

3) Flow tests # 5 and # 6, Front Street and Pleasant Street- also had good calibrations. This area – Front Street and Pleasant Street (Node J-50), will be used to compare the impacts of various system improvements on available fireflow in Housatonic Village.

4) The calibrated model predicted that negative pressures are occurring during fire flow conditions at local high point on Prospect Street (Node J-73). Maintaining positive pressures at all system locations, especially at the systems high points, is critical. Predictions of pressures at this high point during various system improvement options are shown in the tables.

High point pressures on Prospect Street should be monitored during future hydrant flow testing, to help confirm residual pressures at this critical location.

5) The three locations that fell outside the 10 psi calibration threshold are at system dead ends, which do not impact the calibration of the remainder of the modeling.

IV. POTENTIAL SYSTEM IMPROVEMENTS

LEI evaluated the impact of eliminating several smaller water mains, which could increase available flows and fireflows to the system. These potential improvements are shown on **Figure 2**, and included:

- Improvement # 1- Replacing 2,700 feet of 6" asbestos cement (AC) main on Van Deusenville Road with new 12" ductile iron (DI) piping. 12" piping was chosen, as it will connect a 10" main coming from the Water Treatment Plant, to a 12" main to the north which extends towards Housatonic Village.
- Improvement # 2- Replacing 5,600 feet of 6" CI main on North Plain Road with new 8" DI piping. An 8" main was chosen, as it continues an 8" main coming from the plant and connects at Crimson Lane.
- Improvement # 3- Replacing 2,400 feet of 4" and 6" CI main on Main Street North with new 8" DI piping.
- Improvement # 4- Replacing 2,100 feet of 6" CI main on Park Street with new 8" DI piping.
- Improvement # 5- Installing 7300 LF of parallel 12" piping between the treatment plant and North Plain Road.
- Improvement # 6- Constructing a 200,000 gallon elevated water storage tank on High Street.

V. WATER MODELING RESULTS

LEI used our model to evaluate alternative solutions to improve available fireflows within the HWW system.

LEI used the recent hydrant flow testing to create a baseline existing condition run, which was used for comparisons with other runs. Then LEI modeled fireflows at five different locations in the system, as shown in **Tables 1-5**. For each option, we simulated peak daily demands of 0.15 MGD, coincident with fire flow conditions, and evaluated residual pressures at the highest elevation in the system on Prospect Street (Node J-73).

LEI simulated fireflows of 750 gpm in residential areas, as this is the typical available fireflow required by the Insurance Service Office (ISO) to be provided in residentially zoned areas, while maintaining 20 psi residual pressure in all remaining locations.

ISO recommends higher available flows in commercial and industrial locations, and LEI plugged in flows as high as 1,500 gpm to evaluate their impacts.

A) IMPACTS OF PIPELINE IMPROVEMENTS ON FIRE FLOWS AT FRONT ST. (Node J-50)

Table 1 provides a summary of our modeling results of the existing conditions, and various pipe upgrades to improve fire flows on Front Street near the intersection of Pleasant Street.

Current Conditions: The model indicates that during a fire flow of 750 gpm the upstream node would drop in pressure from 91 psi to 49 psi and the pressure on Prospect St. would drop from 40 psi to -3 psi.

With Improvement Options 1, 2 and 3 In Place: LEI evaluated each of the piping improvements on Van Deusenville Road, North Plain Road, and on Main Street North, to see what impacts they have by themselves and in combination, on increasing available fireflows. As shown in **Table 1**, fireflows can be increased marginally, from 750 to 1000 gpm, but negative pressures will still occur at the system high point on Prospect Street.

B) IMPACTS OF PIPELINE IMPROVEMENTS ON FIRE FLOWS AT SPRUCE ST. (Node J-34)

Table 2 provides a summary of our modeling results of the existing conditions, and pipe upgrades to improve fire flows on Park Street, near the intersection of Spruce Street (Node J-34). .

Current Conditions: The model indicates that during a fire flow of 440 gpm the upstream node would drop in pressure from 93 psi to 63 psi and the pressure on Prospect Street would drop from 40 psi to 29 psi.

The model predicts that during a fire flow of 750 gpm the upstream node would drop in pressure from 93 psi to 13 psi and the pressure on Prospect Street would drop from 40 psi to 14 psi.

- **With Option 4 Improvements In Place:** Option 4 includes replacing approximately **2,100 feet** of undersized existing 6" water main with new 8" water main on Park Street. At a simulated fire flow of 750 gpm, with this improvement in place, residual pressures increase from 13 psi to 58 psi. The residual pressure at the Prospect Street high point would remain at 14 psi.

C. IMPACTS OF PIPELINE IMPROVEMENTS ON FIRE FLOWS AT NORTH PLAIN ROAD (Node J-124)

Table 3 provides a summary of our modeling results of the existing conditions, and pipe upgrades to improve fire flows on North Plain Road near Linda Street.

Current Conditions: The model indicates that during a fire flow of 380 gpm the upstream node would drop in pressure from 82 psi to 59 psi and the pressure on Prospect Street. would drop from 40 psi to 25 psi.

The model predicts that during a fire flow of 750 gpm the upstream node would drop in pressure from 82 psi to 7 psi and the pressure on Prospect Street. would drop from 40 psi to -5 psi.

With Option 2 Improvements In Place: Option 2 replaces approximately **5,600 feet** of undersized existing 6" water main with new 8" water main on North Plain Rd. With Option 2 improvements in place, at 750 gpm the residual pressure increases significantly, from **7 psi to 43 psi**.

With this improvement in place, the pressure on the end of the line on Great Barrington Rd. is predicted to drop from 68 psi to 7 psi.

D. IMPACTS OF 7,300 LF OF PARALLEL 12" WATER MAIN FROM WATER TREATMENT PLANT TO NORTH PLAIN ROAD

Table 4 evaluates the impacts of installing a parallel 12" water main from the treatment plant to North Plain Road, in combination with the existing 10" and 12" main. The impacts generally improve pressures systemwide by approximately 16 psi, as this parallel pipe eliminates that amount of head loss, prior to branching off into the system.

Note that in the Housatonic Village area, residual pressures during fireflows at Front Street (Node J-50) are better, but slightly sub-standard pressures at the Pleasant Street high point (Node J- 73) still exist (13 psi at 750 gpm, and -4 psi at 1000 gpm).

E. IMPACTS OF PROPOSED 200,000 GALLON ELEVATED STORAGE TANK AND PIPELINE IMPROVEMENTS ON FIRE FLOWS AT FRONT STREET (Node J-50)

Table 5 provides a summary of our modeling results of the existing conditions, adding a 200,000 gallon water tank to improve fireflows in the core of the water distribution system. LEI chose 200,000 gallon sizing initially to provide two hours of fireflow storage at a rate of 1000 gpm (totaling 120,000 gallons), along with an additional 80,000 gallons reserved to meet typical peak domestic demands.

Current Conditions: The model indicates that during a fire flow of 750 gpm on Front Street the upstream node would drop in pressure from 91 psi to 49 psi, and the pressure on Prospect Street would drop from 40 psi to -2 psi.

Adding New Tank Only: Adding a new 200,000 gallon elevated water storage tank only and using the existing piping will allow full use of the 750 gpm fireflow, while drastically improving the water pressure at the high point in the system (41 psi).

Increased flow to 1,500 gpm would be available at Front Street, but predicted pressures at the high point are 9 psi, below the recommended 20 psi. Conservatively, we estimate an increased fireflow of **1,000 gpm** can be provided, while maintaining greater than 20 psi at all point in the system.

VI. CONCLUSIONS

- 1) LEI evaluated the impacts of both water distribution piping replacements, as well as adding a new water storage tank on the HWW system. Although pipeline replacement in the system has some positive results, the optimum improvement to enhance fireflows in the core of the system would be to construct a 200,000 gallon elevated water storage tank on High Street.

This improvement would increase available fireflows to over 1,000 gpm, while maintaining adequate pressures at the systems high point on Prospect Street.

- 2) The added benefit to providing a tank within the distribution system is that HWW could potentially reduce the amount of water storage required at the Long Pond treatment plant.

A smaller tank would still meet the chlorine contact time requirements of the Surface Water Treatment Rule, but also reduce water age which could potentially also reduce the concentrations of disinfection by-products (TTHM's and HAA5).

FIGURES

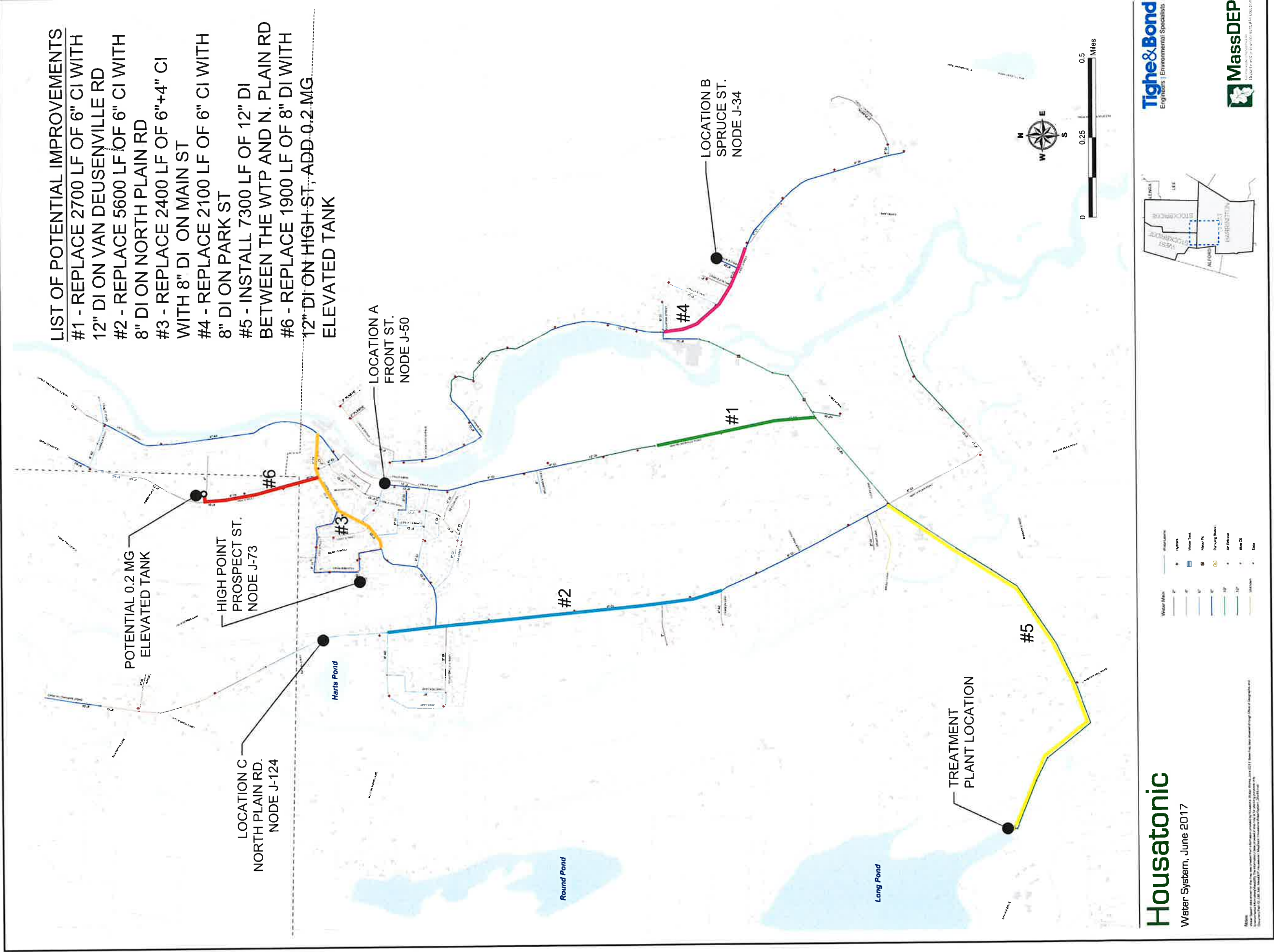
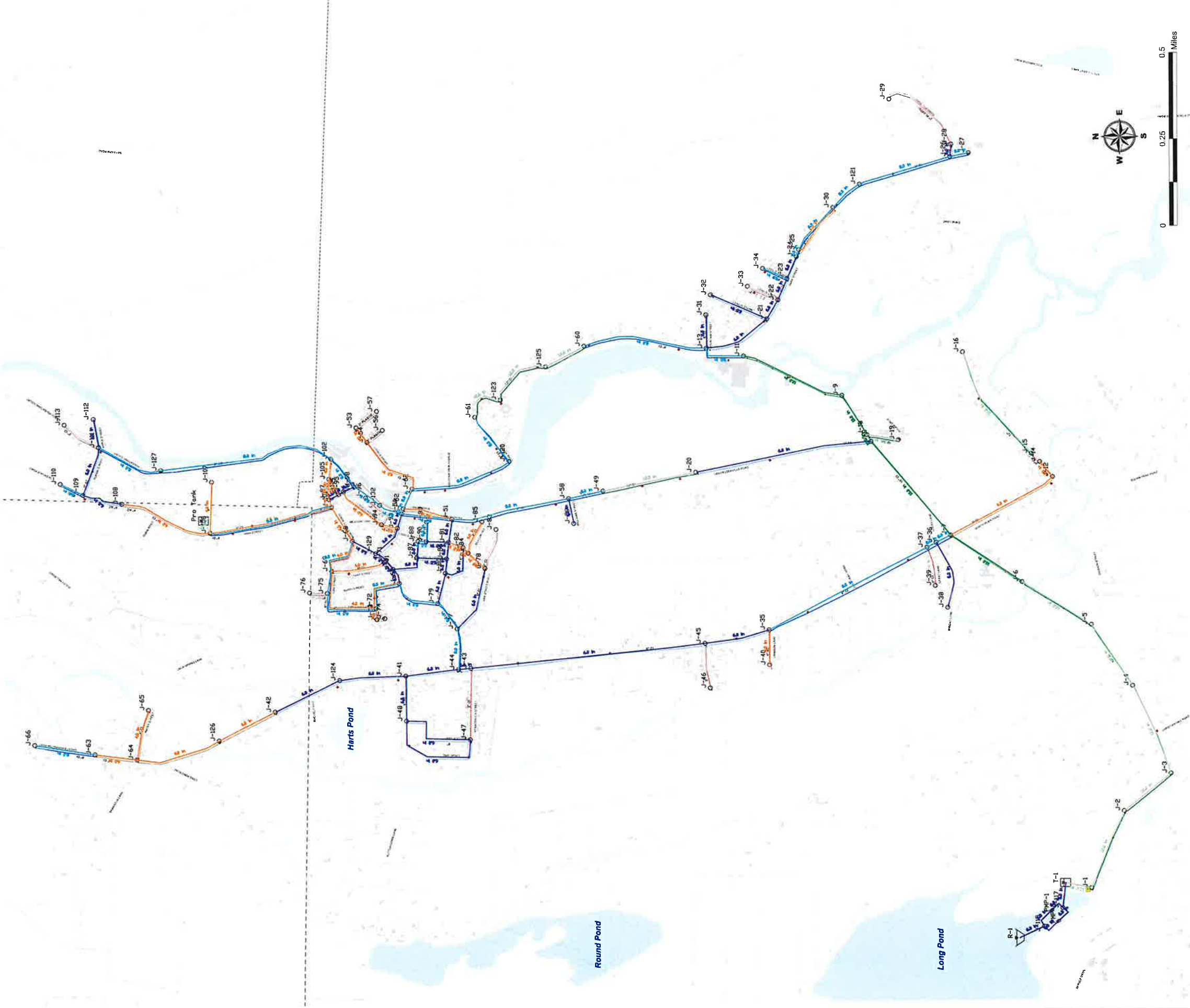


FIGURE 2 - POTENTIAL WATER SYSTEM IMPROVEMENTS

Attachment A - WaterCAD Node Map



Housatonic

Water System, June 2017

- Water Main
- 12"
 - 18"
 - 24"
 - 30"
 - 36"
 - 42"
 - 48"
 - 54"
 - 60"
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- Valve
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- Water Pk
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- Pumping Station
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- Air Release
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Notes:
1. This map was prepared by Lenard Engineering, Inc. for the Housatonic Water System, June 2017. It is not to be used for any other purpose without the written consent of Lenard Engineering, Inc.
2. The information on this map is based on the data provided by the Housatonic Water System, June 2017. It is not to be used for any other purpose without the written consent of Lenard Engineering, Inc.
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MassDEP
Massachusetts Department of Environmental Protection

Drawing #: **1**
Job #: 21-382

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WATERCAD NODE MAP
PREPARED FOR
Housatonic Water Works
Great Barrington, Massachusetts

Designed By:	JED	Drawing Scale:	AS SHOWN
Drawn By:	JED	Revision	By
Checked By:	JEE		
CAD File:	BasePipes		