WATER DISTRIBUTION SYSTEM STUDY UPDATE

January 2024

West Newbury, Massachusetts

TATA & HOWARD

TATA & HOWARD

January 22, 2024

Mr. Mark Marlowe, Water Superintendent
West Newbury Water Department
381 Main Street
West Newbury, MA 01985

Subject: Water Distribution System Study Update
T&H No. 7152

Dear Mr. Marlowe:

In accordance with our agreement, Tata & Howard is pleased to provide four paper copies and one electronic copy of the Water Distribution System Study Update for the West Newbury water distribution system. The adequacy of the distribution system was evaluated. Supply and storage needs were also evaluated in this report.

Hydraulic recommendations were developed as part of this study by updating the existing hydraulic model for the system to reflect current conditions. A detailed description of the improvements and estimated costs is presented in Section 7.

During the course of this project, Mr. Steven Daunais, P.E. served as Project Manager, Ms. Karen Gracey Carroll, P.E. provided technical reviews, and the undersigned served as Project Officer.

At this time, we wish to express our continued appreciation to the Town for their participation in this study and for their help in collecting information and data. We appreciate the opportunity to assist the Town of West Newbury with this important project. Please call should you have any questions or require additional information.

Sincerely,

TATA & HOWARD, INC.

Jon W. Gregory, P.E.
Vice President

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Section 1

TATA & HOWARD

SECTION 1 - EXECUTIVE SUMMARY

1.1 General

Tata & Howard, Inc. was retained by the Town of West Newbury Board of Water Commissioners to conduct a hydraulic model update and water distribution system (WDS) study update of the West Newbury water system. The study evaluates the overall distribution system relative to its ability to meet current and estimated future demands and provides prioritized recommendations for implementation.

Tasks in this study included the following:

- Update and verify the existing hydraulic model.
- Utilize Department of Conservation and Recreation (DCR) demand projections to project demands through the year 2042.
- Assess water supply needs based on existing and future demands.
- Assess water storage needs based on existing and future demands, as well as fire flow protection.
- Estimate needed fire flow recommendations throughout the distribution system.
- Recommend distribution system improvements to meet the existing and future needs of the system.
- Prepare a capital improvements plan with prioritized recommendations and budget estimates for system upgrades necessary to correct existing deficiencies and meet future needs.

The analysis was completed in two phases. The first phase included updating and verifying the existing WaterGEMS hydraulic model of the water distribution system under steady state conditions. An updated system map was created incorporating recent infrastructure improvements, such as new water mains and the new Brake Hill Water Storage Tank. The updated Water Distribution System Map, included in Appendix A, shows water mains, supply sources, and storage facilities. The computer model can be used as a planning tool to assess the potential impact of proposed developments and system improvements prior to their construction.

A water distribution analysis was conducted in the second phase. Future population and water demands through the year 2042 were estimated and the inherent capability of the distribution system to meet water demands was evaluated. Demand projections were calculated based on DCR's draft water needs forecast dated January 23, 2017. DCR developed demand projections through 2033 under two different scenarios. The first set of calculated demand projections assumes that water usage will follow established conservation standards of 65 gallons per capita day (gpcd) and ten percent unaccounted for water. This calculates to a 2042 projected average day demand (ADD) of 0.31 million gallons per day (mgd), including a five percent buffer as allowed by DCR. The second set of projections assumes usage will remain at West Newbury's current trends of residential water usage of 50 gpcd and unaccounted-for water of six percent. This calculates to a 2042 projected ADD of 0.23 mgd including the five percent buffer allowed by DCR.

The existing water supply sources were evaluated relative to current and future water demands. The Town currently exceeds its total authorized withdrawal volume of 0.16 mgd by approximately 0.01 mgd and must purchase water from the City of Newburyport to meet demands. Using DCR guidelines, this deficit is projected to increase to 0.15 mgd by 2042. It is recommended the Town pursue additional sources so it is not dependent on other systems which may not have spare capacity to supply the Town in future years. It is also recommended that the Town update their agreement with the City of Newburyport to reflect current supply needs.

The projected demands and existing water distribution system operating conditions were considered to evaluate the available storage in the system. The current needed storage was estimated to be 0.30 million gallons (mg) in the High Service Area (HSA) and 0.25 mg in the Low Service Area (LSA) and was based on storage needed to meet peak demands and provide fire protection. Based on the ground elevations of the highest customers served, there is a current storage surplus of approximately 0.10 mg of usable storage in the HSA and a current storage surplus of 0.11 mg of usable storage in the LSA. Based on the DCR projected demands using 65 gpcd and 10 percent unaccounted-for water, the projected needed storage for the year 2042 in the HSA is approximately 0.34 mg and 0.26 mg in the LSA. Based on the total usable storage in the HSA, there is projected to be a storage surplus of approximately 0.06 mg for the design year 2042. Based on the total usable storage in the LSA, there is projected to be a storage surplus of approximately 0.10 mg for the design year 2042.

The adequacy of the water distribution system was evaluated using the computer model. The model was updated and verified under steady state conditions based on data collected during flow testing completed in October 2022. Once the computer model was verified and considered representative of the existing system, future demand conditions were simulated. As a result of these simulations, distribution improvements were recommended to address deficiencies in the system and the recommendations were prioritized for future implementation. The recommendations are broken into three components as follows:

- General Operation and Maintenance Practices: General operation and maintenance practices should be completed on an as-needed basis. Regularly scheduled maintenance programs should include tank inspections, well cleaning, meter replacement, and hydrant replacement, and the Town should continue with its hydrant flushing program.

- Priority I Recommended Improvements: Priority I recommended improvements are intended to strengthen transmission capabilities and improve fire flow capabilities. Recommended Priority I Improvements include the replacement of the water mains along Main Street, Church Street, Prospect Street, Crane Neck Street, and Bailey's Lane. The Priority I Recommended Improvements are estimated to cost approximately $14,062,000.

- Priority II Recommended Improvements: Priority II recommended improvements are intended to remove bottlenecks and a 2-inch diameter water main in the distribution system. Recommended Priority II Improvements include the replacement of water mains on Crane Neck Street, Pleasant Street, and a cross country water main. The Priority II Recommended Improvements are estimated to cost approximately $1,506,000.

- Priority III Recommended Improvements: Priority III recommended improvements are intended to increase the water supply for the system. Recommended Priority III improvements include the development of the Dole Place Wellfield, or another new local water supply source. The Priority III Recommended Improvements are estimated to cost approximately $12,830,000.

Section 2

TATA & HOWARD

SECTION 2 - EXISTING WATER DISTRIBUTION SYSTEM

2.1 Distribution System

The Town of West Newbury water distribution system serves approximately 3,030 customers with 1,099 service connections. The distribution system consists of approximately 28 miles of water mains ranging in diameter from two to twelve inches. These mains are constructed of various materials including ductile iron (DI), unlined cast iron (CI), and asbestos cement (AC). Approximately two percent of the system is 4-inch diameter or less, 18 percent is 6-inch diameter, 63 percent is 8-inch diameter, 11 percent is 10-inch diameter, and six percent is 12-inch diameter. The Town's distribution system service elevations range from approximately ten feet near the Merrimack River shoreline to 200 feet on Crane Neck Street. All elevations in this report are expressed in feet above mean sea level (MSL). The water system includes two water supply sources and two water storage tanks. The sources are located within the Merrimack Watershed.

The distribution system is divided into two service areas, the Low Service Area (LSA) and the High Service Area (HSA). The LSA includes Wellfield No. 1, the Bedrock Well and the Pipestave Tank and has a hydraulic gradeline elevation of 232 feet. Approximately 17 percent of the system demand is in the LSA. The Pipestave Booster Pump Station conveys water from the LSA to the HSA. The Brake Hill Tank is located in the HSA and has a hydraulic gradeline elevation of 300 feet. Approximately 83 percent of the system demand is in the HSA.

A map of the existing water distribution system is included in Appendix A.

2.2 Existing Water Supply Sources

As previously stated, the Town of West Newbury has two water supply sources which are equipped with chemical injection facilities. The chemicals include sodium hypochlorite for disinfection, potassium hydroxide for pH adjustment, and sodium fluoride for fluoridation. The Town purchases additional water from Newburyport at an interconnection located at the well site. Water from Newburyport is purchased most days except during low demand periods in the winter months. In addition, a new intermunicipal agreement with the Town of Groveland allows the Town of West Newbury to purchase additional water on an emergency basis.

Wellfield No. 1

Originally constructed in 1991, Wellfield No. 1 consists of seven 2-1/2 inch diameter wells and one horizontal well. The horizontal well was dug in 1994 in an effort to regain capacity due to the declining yield in the wellfield. The 2-1/2 inch wells range in depth from 32 feet to 47 feet. The wellfield pump station houses chemical feed equipment for pH adjustment, fluoridation, and chlorination. Wellfield No. 1 is located at 999 Main Street (Route 113) in West Newbury. The maximum permitted daily withdrawal volume for Wellfield No. 1 is 0.155 mgd.

Bedrock Well

The Bedrock Well is located at the same location as Wellfield No. 1. The well was constructed to a depth of 645 feet and brought online in 2021. The maximum permitted daily withdrawal volume of the Bedrock Well is 0.081 mgd.

Newburyport Interconnection

The Town of West Newbury has a water supply interconnection with the City of Newburyport. The interconnection is an 8-inch diameter water main located at the same location as Wellfield No. 1 and the Bedrock Well. The connection is automated and metered. In 2021, the year that the Bedrock Well was put in service, the Town was supplied an average of 35,000 gallons per day by Newburyport. Since the Bedrock Well was put in service, the highest daily average for a month occurred in June 2022 when Newburyport supplied an average of 132,000 gallons per day.

Groveland Interconnection

The Town has recently signed an intermunicipal agreement with the Town of Groveland to supply water on an emergency basis. The interconnection is located on Main Street near the Pentucket Regional High School. Valves at the interconnection must be manually opened to allow water to flow by gravity from the Town of Groveland to the HSA in West Newbury.

2.3 Existing Water Storage Facilities

Brake Hill Water Storage Tank

The Brake Hill Water Storage Tank, constructed in 2021, is a 0.4 million-gallon (mg) capacity tank located off Hilltop Circle and serves the HSA. The tank is a spheroid-style tank with a pedestal height of 17.5 feet, a tank height of 37.5 feet. The overflow elevation is 300 feet above MSL, and the base water elevation is 262.5 feet.

Pipestave Water Storage Tank

The Pipestave Water Storage Tank, located at the Dr. John C Page School off Main Street, was constructed in 1982. The pre-stressed concrete tank has a height of approximately 40 and is 46 feet in diameter with a storage capacity of 0.50 mg. The tank has an overflow elevation of approximately 232 feet above MSL. The tank serves the LSA and the Page School fire suppression system. The tank was most recently cleaned and rehabilitated in the Spring of 2023.

2.4 Supervisory Control and Data Acquisition System (SCADA)

The Town of West Newbury currently uses a Supervisory Control and Data Acquisition (SCADA) system to operate and monitor flows from the wells, interconnection, and pump station and water levels in the water storage tanks.

Section 3

SECTION 3

TATA & HOWARD

SECTION 3 – WATER SYSTEM DEMANDS

3.1 General

For the purposes of evaluating the water needs of a community, several parameters are typically reviewed to better understand the demands of a distribution system. These parameters are defined in the sections below and are presented with their existing and projected demand estimates.

The DCR follows specific guidelines when projecting the water usage for communities in conjunction with the MassDEP WMA. These guidelines incorporate trends in the use of water conservation devices in homes and industry and emphasize the importance of monitoring the distribution system through water audits and leak detection surveys to reduce unaccounted-for water. It is important to note that the DCR has a key role in the water management approval process. Draft water demand projections were completed for the Town by the DCR in January 2017. Any alternative demand projections must be approved by the DCR before the MassDEP will approve development of a new water supply source or authorize the withdrawal of additional volume from existing sources.

The MassDEP has adopted Water Management Standards for all withdrawals. The policy includes performance standards and conditions for all public water suppliers in the following areas:

- Maximum residential consumption of 65 residential gallons per capita day (rgpcd),
- Maximum of 10 percent unaccounted-for water.

3.2 Residential Consumption

Residential consumption is calculated by dividing water supplied to residential connections by the reported population. The DCR guideline for residential water consumption is 65 gpcd. Public Water Suppliers currently exceeding 65 rgpcd will be required to develop an Offset Feasibility Study to manage non-essential outdoor water usage. According to MassDEP, the Town had a residential consumption ranging between 47 rgpcd and 49 rgpcd (see Table No. 3-1).

Table No. 3-1
2017 – 2021 RGPCD

Year	RGPCD
2017	47
2018	46
2019	46
2020	49
2021	49

3.3 Unaccounted-for Water

Unaccounted-for water consists of unmetered water used for street cleaning, water main flushing, meter inaccuracy, unauthorized water uses, firefighting, leakage in the distribution system, and other uses. This term is typically expressed as a percentage of the total water supplied to the system. Unaccounted-for water can be estimated by taking the difference between the total amount of water supplied and the total water billed and dividing by the total water supplied.

The Town's unaccounted-for water from 2017 through 2021 ranged from 6 to 16 percent as shown in Table No. 3-2.

Table No. 3-2
2017 – 2021 Unaccounted-For Water

Year	RGPCD
2017	14
2018	16
2019	9
2020	12
2021	6

3.4 Average Day Demand

Average day demand (ADD) is the total water supplied to a community in one year divided by 365 days. This term is commonly expressed in million gallons per day (mgd) and includes all water used for domestic (residential), commercial, institutional, industrial, agricultural, and municipal purposes. The municipal component includes water used for municipal buildings and recreational areas. The ADD includes unaccounted-for water from unmetered water uses and system leakage. Unmetered water uses include water used for system maintenance such as hydrant flushing, fire flows, and bleeders. According to ASRs and distribution system pumping records from 2017 through 2021, the ADD for the West Newbury water system ranged from 0.16 mgd to 0.18 mgd.

DCR used two sets of criteria to develop the 2034 ADD. The first using West Newbury water distribution system usage between 2011 and 2015 (current trends):

- Residential consumption of 50 gpcd
- Unaccounted-for water of 6 percent
- Year 2034 service population of 3,669

The second using DCR performance standards used:

- Residential consumption of 65 gpcd
- Unaccounted-for water of 10 percent
- Year 2034 service population of 3,669

The DCR demand projection methodology also allows for a five percent buffer to account for uncertainty in growth projections. Utilizing a residential consumption of 50 rgpcd and unaccounted for water of six percent plus a five percent buffer, the estimated 2042 ADD for the Town is approximately 0.23 mgd. Utilizing a residential consumption of 65 rgpcd and unaccounted-for water of 10 percent, the estimated 2042 ADD for the Town is approximately 0.31 mgd, including a five percent buffer.

3.5 Summer Average Day Demand

MassDEP guidelines recommend that a system consider a projected summer ADD (SADD). The current SADD is estimated by averaging demands from the three maximum months for each of the past five years. As shown in Table No. 3-3, the SADD ranged from 0.18 mgd to 0.23 mgd from 2017 to 2021. The SADD peaking factor is determined by dividing the SADD by the annual ADD for each of the past five years. These peaking factors are averaged to estimate the future summer peaking factor. Based on the 2017 through 2021 monthly demand data, the average summer peaking factor is 1.20. Based on the projected ADD using current trends of 0.23 mgd, the estimated 2042 SADD is 0.28 mgd. Based on the projected ADD using DCR performance standards of 0.31 mgd, the estimated 2042 SADD is 0.37 mgd.

3.6 Maximum Day Demand

Maximum day demand (MDD) is the maximum one-day (24-hour) total quantity of water supplied during a one-year period. This term is typically expressed in mgd.

MDD is a critical factor when determining the adequacy of a water supply system. The water distribution system must be capable of meeting MDD with coincident fire demands at a minimum pressure of 20 psi. Estimates of the projected MDD and an allowance for the required fire flow are used to evaluate or design pumping, transmission, and storage facilities.

The MDD/ADD ratio provides a relationship between the two demands, which can be used to estimate future demands. As shown on Table No. 3-3, the MDD from 2017 to

2021 ranged from 0.26 mgd to 0.38 mgd. Upon comparison of MDD to ADD, the ratios ranged from 1.5 to 2.08. To be conservative, the highest historical peaking factor was used to estimate future MDD. The resulting projected MDD for 2042 using current trends is estimated to be 0.48 mgd based on the 2042 ADD of 0.23 mgd. The projected MDD for 2042 using the DCR's performance standards is estimated to be 0.64 mgd based on the 2042 ADD of 0.31 mgd.

3.7 Peak Hour Demand

Peak hour demand is the maximum total quantity of water supplied in a single hour over a one-year period typically expressed in mgd. These demands are typically met by distribution water storage facilities.

Since system records of peak hourly demands are not available, the peaking factor for the current usage and design year 2042 was estimated based on typical historical consumption for communities of similar size. The peak hour peaking factor for the system is estimated to be 3.5. Using the current trends projected ADD of 0.23 mgd, the projected peak hour demand for the year 2042 is estimated at 0.81 mgd. Using the projected ADD from DCR performance standards of 0.31 mgd, the projected peak hour demand for the year 2042 is estimated at 1.09 mgd.

Table No. 3-3
Historic and Projected Water Use

Year	ADD (mgd)	SADD (mgd)	Peaking Factor (SADD/ADD)	MDD (mgd)	Peaking Factor (MDD/ADD)	Peak Hour (mgd)
2017	0.17	0.21	1.24	0.28	1.62	*
2018	0.18	0.21	1.18	0.28	1.58	*
2019	0.16	0.18	1.12	0.26	1.62	*
2020	0.18	0.23	1.26	0.38	2.08	*
2021	0.17	0.21	1.20	0.35	2.04	*
-						
2042 Current Trends	0.23	0.28	1.20	0.48	2.08	0.81
2042 DCR Performance Standards	0.31	0.37	1.20	0.64	2.08	1.09
*Peak Hour Information for 2017 through 2021 is not available.						

Section 4

TATA & HOWARD

SECTION 4 – WATER SUPPLY EVALUATION

4.1 General

In accordance with standard waterworks practices and current MassDEP guidelines, the supply sources of a water system must be capable of meeting MDD conditions with all supplies online and SADD conditions with the largest source out of service. Additionally, the sources should be permitted or registered to withdraw volumes adequate to meet ADD.

4.2 Adequacy of Existing Water Supply Sources

In 1987, the Water Management Act (WMA) program was implemented by MassDEP to regulate withdrawal of water from the State's watershed basins. Under this program, all new sources withdrawing more than 100,000 gallons per day (gpd) and existing sources exceeding their registered withdrawal volume by 100,000 gpd are required to obtain a withdrawal permit under the WMA. When first implemented, the registered withdrawal volume for a public water system was based on that system's historical pumping rate of the water supply source(s) between 1981 and 1985. Permits can be renewed and amended as system demands increase and additional supply sources are utilized. The WMA program considers the need for the withdrawal, the impact of the withdrawal on other hydraulically connected water suppliers, the environmental impacts of the withdrawal and the water available in the river basin or subbasin (the basin safe yield) prior to issuing a permit. It is important to note that the basin safe yield is different from the safe yield of a supply. In accordance with the WMA Permit application instructions, the basin safe yield is the total water available to be withdrawn from a river basin or subbasin, whereas the safe yield of a well is the volume of water the well is capable of pumping under the most severe pumping and recharge conditions that can be realistically anticipated.

As stated in Section 3, the projected ADD, SADD, and MDD using DCR performance standards for the year 2042 are 0.31 mgd, 0.37 mgd, and 0.64 mgd, respectively. The projected ADD, SADD and MDD for the year 2042 using current trends are 0.23 mgd, 0.28 mgd, and 0.48 mgd, respectively. MassDEP recommends that a system have adequate supply to meet (1) the projected MDD and (2) the projected SADD with the largest source offline.

The system's total combined maximum pumping rate of all active supply sources is 0.236 mgd. Compared to the projected MDD of 0.64 mgd in 2042, a deficit of 0.404 mgd is estimated. Wellfield No. 1 is the largest source. Therefore, the available pumping rate with Wellfield No. 1 offline is 0.081 mgd. Compared to the projected 2042 SADD of 0.37 mgd, a deficit of 0.289 mgd is estimated.

The total permitted authorized withdrawal volume for the West Newbury water system is 0.16 mgd. The Town does not have a registered withdrawal volume. The 2042 projected ADD based on current trends is 0.23 mgd. Compared to the total permitted withdrawal volume of 0.16 mgd, a deficit of 0.07 mgd is estimated. The 2042 projected ADD using DCR performance standards is 0.31 mgd. Compared to the total permitted withdrawal volume of 0.16 mgd, a deficit of 0.15 mgd is estimated. Table No. 4-1 shows the maximum daily withdrawal rate for each source.

Table No. 4-1
Source Details
West Newbury, Massachusetts

Name	I.D. Number	Max Daily Withdrawal Volume (MGD)
Wellfield No. 1	3324000-01G	0.155
Bedrock Well	3324000-02G	0.081
	Total	0.236

It should be noted that the Dole Place Wellfield had been approved by MassDEP for a maximum daily withdrawal rate of 0.98 mgd, however this permit expired in May 2022. It is recommended the Town develop this, or another new local water supply source, to eliminate the projected supply deficit. MassDEP has granted approval of the Source Final Report for the proposed Dole Place Wellfield. As detailed in the Dole Place Wellfield Development Evaluation dated January 28, 2021, the Town will need to complete several steps to develop this source. A new Water Management Act (WMA) permit application will need to be submitted to increase the Town's authorized withdrawal volume. Drilling and development of three 18-inch by 12-inch gravel packed wells by a qualified well driller, construction of a new chemical feed building to treat the raw water, and installation of approximately 500 linear feet of 8-inch diameter water main to connect the gravel packed wells to the chemical feed building will need to be completed to bring the well online. In addition, three phase power will need to be brought to the site. Due to the close proximity of the wellfield to the Merrimack River, a microparticulate analysis (MPA) at each of the three wells will be required to determine whether the wellfield is considered "groundwater under the direct influence of surface water" (GWUDI). This analysis is performed after the wellfield has been in service for six months. The results of this analysis will determine if the wellfield is considered GWUDI and if design and construction of the 1.0 mgd water filtration plant will be required. The Dole Place Wellfield Development Evaluation provides further information on cost estimates and other WMA permit requirements to develop this source.

Development of an additional source would eliminate the need to purchase water from Newburyport on a regular basis. It is recommended the Town's interconnections remain in place in the event of an emergency or in the event that the City of Newburyport or the Town of Groveland wants to purchase water from West Newbury.

Section 5

TATA & HOWARD

SECTION 5 – COMPUTER MODEL

5.1 General

To evaluate the Town's existing water distribution system and to obtain a basis for recommending water distribution system improvements, a comprehensive computer model was utilized to mathematically simulate the water distribution system. The Town of West Newbury will be able to use the updated computer model as a planning tool to assess the potential impact of proposed developments and system improvements prior to construction.

A hydraulic computer model software WaterGEMS was used to update the existing West Newbury water distribution system model. WaterGEMS allows the user to conduct hydraulic simulations using mathematical algorithms while in an ArcGIS environment. As part of this study, the hydraulic model was verified under steady state conditions based on fire flow testing and information pertaining to the sources and storage facilities provided by the Town of West Newbury.

5.2 Model Verification

The computer model was updated and verified in three phases. First, the model was updated to include improvements to the distribution system since the Town's 2009 Water Distribution System Study Update based on data provided by the Town. Water system demands were allocated to the nearest junctions to represent actual metered demand in the system. When allocating demands, the ADD and MDD for 2021 and 2042 were used to obtain a gallons per minute (gpm) rate. Then, using the existing demands in the model, ratios were used to multiply the base demand to represent current and future demands.

The computer model is represented by the node, pipe, and tank information provided in Appendix B. A link map of the water distribution system model is also provided in Appendix C. The water distribution system map in Appendix A provides information on storage facilities, water supply sources, and sizes of water mains and a general layout of the distribution system. The hydraulic input data in Appendix B provides data on system demands, length and diameter of water mains, roughness coefficient or "C-value" of water mains, elevations, pumping rates at water supply sources, and overflow elevations at storage facilities.

In the second phase of the model update, fire flow testing was conducted at various locations throughout the distribution system. Thirteen fire flow tests were conducted on October 26, 2022. The flow tests provided data for the computer model verification and for available fire flows and pressures in the area of each test. Table No. 5-1 presents the results of the fire flow tests conducted by the Town and Tata & Howard personnel.

Table No. 5-1
Fire Flow Tests – October 16, 2022

Test No.	Location of Flowing Hydrant	Flowing Hydrant Static Pressure (psi)	Residual Hydrant Static Pressure (psi)	Residual Hydrant Residual Pressure (psi)	Observed Flow (gpm)	Estimated Flow at 20 psi (gpm)
1	87 Bridge Street	124	122	60	1,000	1,300
2	3 Main Street	110	100	90	650	1,900
3	30 Rivercrest Drive	118	114	70	1,250	1,800
4	On Pleasant Street Behind 7 Waterside Lane	114	108	70	1,220	1,900
5	13 Mechanic Street	86	82	64	750	1,400
6	34 Meetinghouse Hill Road	54	40	16	590	500
7	169 Crane Neck Street	43	56	40	190	250
8	134 Stewart Street	68	68	24	750	750
9	14 Cortland Lane	85	90	34	590	650
10	15 Norino Drive	74	70	30	650	700
11	On Main Street Behind 1 Parsons Road	73	72	28	530	550
12	16 Bailey's Lane	66	72	60	200	400
13	66 Maple Street	66	84	48	650	850

Verification of the computer model was completed under steady state conditions in the third phase. The data obtained from the fire flow tests served as input data for the model verification. This data included water levels in storage tanks, pumping rates of water supply sources, static and residual pressure readings, and measurement of flows from hydrants. It is important that each simulation reflect actual field conditions at the time of testing. Actual field conditions include current demands on the system, varying flows from each water supply source and pump station that is online, as well as varying tank elevations.

When the results of the computer runs compared to within five percent of the hydraulic data collected from the fire flow tests, the computer model was considered verified under steady state conditions and mathematically represented the physical operating conditions of the current West Newbury water distribution system. It should be noted that verification under an Extended Period Simulation (EPS) was outside the scope of work of this study. EPS verified models allow simulations over time to evaluate items such as water age and water quality in various locations of the system.

During the current flow testing, the observed pressure and modeled pressure did not verify along Meetinghouse Hill Road. A residual pressure of 16 psi was observed at this location. The model did not verify to within five percent at this location but is within five psi and is considered accurate.

In addition, the observed pressure and modeled pressure did not verify along Bailey’s Lane. A residual pressure of 60 psi was observed. The residual pressure in the model was 67 psi. A C-factor test is recommended along various stretches of Main Street to help determine the accuracy of the C-factor along Main Street. A C-factor test involves flowing one hydrant and taking pressure readings at multiple hydrants to help estimate the roughness coefficient in a particular section of pipe which directly correlates to available carrying capacity of the water main.

Once the model was verified, hypothetical conditions such as increased demands and required fire flows were simulated using the model. The simulation of these conditions provided the opportunity to identify system deficiencies and to develop necessary improvements. Projected demands through the design year 2042 were simulated.

Section 6

TATA & HOWARD

SECTION 6 – WATER DISTRIBUTION SYSTEM ANALYSIS

6.1 General

A hydraulic analysis, using available data on the water distribution system and fire flow test results, provides an indication of the distribution system's ability to meet the criteria described in this section. A computerized hydraulic analysis was conducted on West Newbury's water distribution system. Recommendations set forth by the Insurance Services Office (ISO) for water storage necessary for fire protection, fire flows, and peak demands were utilized in the analysis of the distribution system.

6.2 Adequacy of Existing Distribution System

A distribution system must be able to provide adequate pressures during varying demand conditions. For the purposes of this study, a minimum pressure of 35 psi at street level was required during average day, maximum day, and peak hour demand conditions. An upper limiting pressure of 120 psi is generally recommended, as older fittings in the system are generally rated at 125 to 150 psi. The MassDEP published Guidelines for Public Water Systems recommends that pressure reducing devices be utilized on mains or on individual services lines when static pressures exceed 100 psi. Pressure above this level can result in increased water use and leaks from fixtures and also increased leakage throughout the distribution system. In addition, plumbing code states that water heaters in homes can be affected when pressures exceed 80 psi.

During fire flow conditions, a minimum pressure of 20 psi is required at ground level throughout the system.

Minimum/Maximum Pressures

During the projected year 2042 ADD, MDD, and peak hour demand conditions, the recommended minimum pressure requirement to be met at street level throughout the distribution system is 35 psi. In general, customers with ground elevations in the LSA of 146 feet above MSL, or greater, could experience pressure less than 35 psi during normal operating conditions. The current highest water users in the LSA are located at approximately 144 feet above MSL. These users are located off Main Street east of the Pipestave Water Storage Tank. Elevations in the HSA above 214 feet above MSL could experience pressure less than 35 psi during normal operating conditions, respectively. The current highest water user in the HSA is located at approximately 200 feet above MSL. Therefore, the West Newbury water distribution system can meet the minimum pressure requirement of 35 psi under projected 2042 average day, maximum day, and peak hour demand conditions.

Based on the lowest elevation in the LSA and the overflow elevation of the Pipestave Tank, the highest pressures in the LSA are approximately 86 psi. Based on the lowest elevation in the HSA and the overflow elevation of the Brake Hill Tank, the highest pressures in the HSA are approximately 125 psi, which exceeds the recommended upper limit of 100 psi. The MassDEP published Guidelines for Public Water Systems recommends that pressure reducing devices be utilized on mains or on individual services lines when static pressures exceed 100 psi. Also, plumbing code states that water heaters in homes can be affected when pressures exceed 80 psi. These locations are near the riverbank of the Merrimack River. Pressure reducing valves (PRV) should be installed at customers where pressures exceed 100 psi. See Figure No. 6-1 for locations exceeding 100 psi.

Fire Flow Recommendations

A review of the water system was completed to identify areas where larger buildings exist. This review of buildings and estimates of necessary fire flow does not factor in fire protection systems. Examples include condominiums, apartment complexes, schools, and other commercial or industrial buildings. Typically, the recommended fire flow in any community is established by the Insurance Services Office (ISO). The ISO determines a theoretical flow rate needed to combat a major fire at a specific location; taking into account the building structure, floor area, the building contents, and the availability of fire suppression systems. In general, the flows required for proper fire protection are based on maintaining a residual pressure of 20 psi in the system. This residual pressure is considered necessary to maintain a positive pressure on the suction side of a fire department pumper truck with an allowance for frictional losses in the hydrant and fire hose. Because the ISO data was not provided, recommended flows were estimated for these areas using the 2014 ISO published Guide for Determination of Needed Fire Flow. The guide uses factors including building size, material, location and contents. These factors were estimated based on aerial photos and street level observations. For the West Newbury system, individual fire flows for each large building identified were estimated. The fire flow recommendations were applied in the hydraulic model at each building identified in the water system review.

According to the 2014 ISO published Guide for Determination of Needed Fire Flow, the minimum recommended fire flow in residential areas with homes greater than 30 feet apart is approximately 500 gpm. The recommended fire flow for homes between 21 feet and 30 feet apart is approximately 750 gpm. Areas with homes between 11 feet and 20 feet apart have a recommended fire flow of 1,000 gpm. A fire flow of 1,500 gpm is recommended for homes closer than 10 feet apart. The residential neighborhoods in the Town were evaluated to determine average distances between homes for determination of the recommended residential fire flow in those areas. An estimated fire flow of 500 gpm was used for most residential areas of the system with homes greater than 30 feet apart. Improvements were recommended for areas in the system that could not meet the minimum fire flow recommendation. A description of the recommended improvements is provided in Section 7.

6.3 Adequacy of Existing Water Storage Facilities

Distribution storage is provided to meet peak consumer demands such as peak hour demands and to provide a reserve for firefighting. Storage may also serve as emergency water supply in case of temporary breakdown of pumping facilities, or for pressure regulating during periods of fluctuating demand. West Newbury has two storage tanks

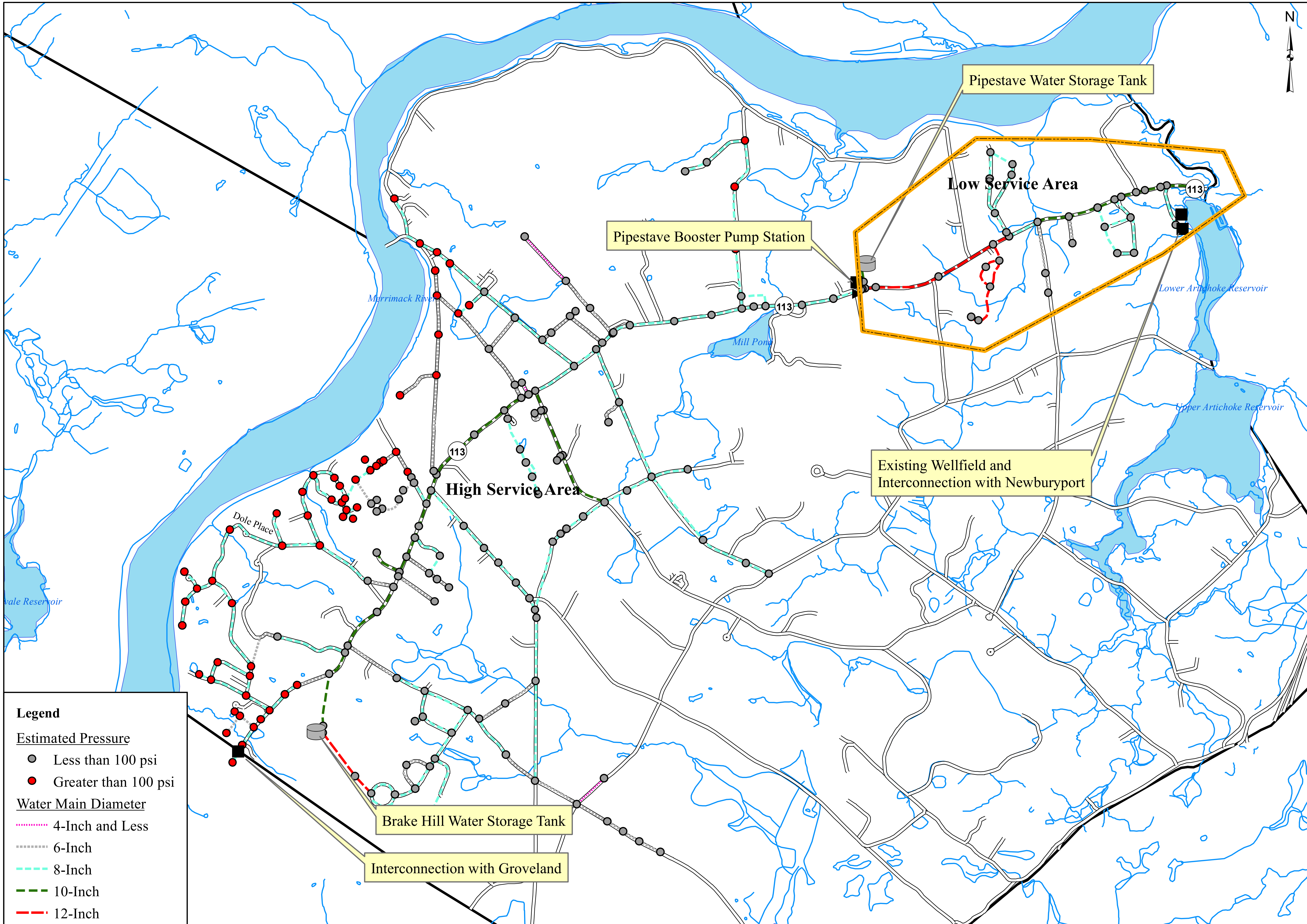

Figure No. 6-1

High Pressure Locations

Water Distribution System Study Update
West Newbury, MA

TATA & HOWARD

Date: January 2024

Scale: 1:24,000

that serve two distinct service zones. The Brake Hill tank serves the HSA and the Pipestave tank serves the LSA. Approximately 83 percent of the water system demand is in the HSA and 17 percent of the demand is in the LSA.

There are three components that must be considered when evaluating storage requirements: equalization, fire flow requirements, and emergency storage.

Equalization storage provides water from the tanks during peak hourly demands in the system. Typically, this quantity is a percentage of the maximum day demands. The percentages can range from fifteen to twenty-five percent, with fifteen percent used for a large system, twenty percent for a mid-sized system, and twenty-five percent used for a small system. A system is considered small if it has less than 3,300 customers, while a system is considered large if it has more than 50,000 customers. The Town currently serves a population of approximately 3,030 people and is considered a small system. As a result, twenty-five percent of the current MDD was used for the current equalization storage calculation. To be conservative, the 2020 MDD was used to calculate equalization because it is the highest MDD. With a projected 2042 population served of approximately 3,669 people, the West Newbury system would be considered a medium size system because the population is projected to increase to more than 3,300 people. As a result, twenty percent of 2042 projected DCR MDD was used for the projected equalization storage calculation.

The fire flow storage component is based on a representative fire flow multiplied by the required duration of the flow. For the West Newbury water system, a fire flow of 2,000 gpm with a duration of two hours was used for the storage evaluation based on the estimated needed fire flow in the downtown area.

The emergency storage component is typically equivalent to one ADD. However, if there is emergency power available at the pumping stations allowing the stations to supply a minimum of one ADD on emergency power, the emergency storage component of one ADD can be waived. This component was waived from subsequent calculations because West Newbury's well site and the pump station have emergency generators.

The three components of the storage evaluation were calculated under current and future demand conditions:

High Service Area

1. Equalization

- Small-sized system (2020) = 25 percent of the Maximum Day Demand
- Mid-sized system (2042) = 20 percent of the Maximum Day Demand
- Maximum Day Demand in year 2020 = 0.38 mgd
- HSA represents 83 percent of the total demand
- HSA Maximum Day Demand in year 2020 = 0.38 x 0.83 = 0.32 mgd
- Estimated Maximum Day Demand in year 2042 (DCR guidelines) = 0.64 mgd
- HSA Estimated Maximum Day Demand in year 2042 = 0.64 x 0.83 = 0.53 mgd

- Equalization (2020) = 0.25 x 0.32 = 0.08 mg
- Equalization (2042) = 0.20 x 0.53 = 0.11 mg

2. Basic Fire Flow Requirement
- Representative fire flow for West Newbury = 2,000 gpm
- Duration of 2 hours or 120 minutes
- Basic Fire Flow Requirement = 2,000 x 120 = 0.24 mg

3. Emergency – waived

The total required storage for any given year is the equalization component plus the basic fire flow requirement. Therefore, the current (year 2020) and projected (year 2042) total required storage is as follows:

- HSA Total Required Storage (2020) = 0.08 + 0.24 = 0.32 mg
- HSA Total Required Storage (2042) = 0.11 + 0.24 = 0.35 mg

A minimum pressure of 20 psi should be maintained at the highest served customer under MDD conditions with a coincident fire flow. The highest customer in the HSA is located at an elevation of approximately 200 feet above MSL. To maintain a minimum pressure of 20 psi at the highest customer elevation of 200 feet, the level of the water in the storage tanks should not drop below 247 feet. The low water level of the Brake Hill Tank is 262.5 feet. Based on this scenario, the entire volume of the Brake Hill Tank is usable and the HSA has a useable storage volume of 0.40 mg. The HSA currently has a storage surplus of 0.08 mg and is projected to have a storage surplus of 0.05 mg in 2042.

Low Service Area

1. Equalization
- Small-sized system (2020) = 25 percent of the Maximum Day Demand
- Mid-sized system (2042) = 20 percent of the Maximum Day Demand
- Maximum Day Demand in year 2020 = 0.38 mgd
- LSA represents 17 percent of the total demand
- LSA Maximum Day Demand in year 2020 = 0.38 x 0.17 = 0.06
- Estimated Maximum Day Demand in year 2042 (DCR guidelines) = 0.64 mgd
- LSA Estimated Maximum Day Demand in year 2042 = 0.64 x 0.17 = 0.11

- Equalization (2020) = 0.25 x 0.06 = 0.02 mg
- Equalization (2042) = 0.20 x 0.11 = 0.02 mg

2. Basic Fire Flow Requirement
- Representative fire flow for West Newbury = 2,000 gpm
- Duration of 2 hours or 120 minutes
- Basic Fire Flow Requirement = 2,000 x 120 = 0.24 mg

3. Emergency – waived

The total required storage for any given year is the equalization component plus the basic fire flow requirement. Therefore, the current (year 2020) and projected (year 2042) total required storage is as follows:

- LSA Total Required Storage (2020) = 0.02 + 0.24 = 0.26 mg
- LSA Total Required Storage (2042) = 0.02 + 0.24 = 0.26 mg

The highest customer in the LSA is located at an elevation of approximately 157 feet above MSL. To maintain a minimum pressure of 20 psi at the highest customer elevation of 157 feet, the level of the water in the storage tanks should not drop below 203 feet. The low water level of the Pipestave Tank is 192 feet. Based on this scenario, the LSA has a useable storage volume of 0.36 mg. The LSA currently has a storage surplus of 0.10 mg under existing and projected conditions.

Section 7

TATA & HOWARD

SECTION 7 – RECOMMENDATIONS

7.1 General

The following summarizes the findings of the study and presents a prioritized plan for recommended improvements and associated costs. The prioritization of improvements allows for constructing the necessary reinforcements as funds allow.

The recommendations are broken into three components. The first presents general recommendations that include general maintenance and operations practices that the Town should complete on an annual basis. The second, third and fourth components are the Priority I, II, and III recommendations for system improvements relative to the water distribution system. Priority I improvements are intended to strengthen the transmission capabilities of the system and improve fire flow capabilities and should be completed over the next ten years. Priority II improvements are intended to eliminate bottlenecks and replace small diameter mains in the distribution system and should be completed over the next 10 – 15 years. Priority III improvements are intended to increase the Town's water supply and should be completed when funding and land becomes available. Table No. 7-1 presents the estimated costs for the Priority I, Priority II, and Priority III recommended improvements for the water distribution system. Construction costs are based on the January 2024 Engineering News Record (ENR) construction cost index of 13515.02 and include costs associated with water services, hydrants, and permanent and temporary trench pavement and a 25 percent allowance for engineering and contingencies. This index can be used to estimate future construction costs. Estimates do not include costs for land acquisition, easements, or legal fees. Costs were increased for water main improvements of less than 1,000 feet. Cost savings may be realized if the smaller projects are grouped together. The recommended improvements are described herein and shown on the Recommended Improvements Map provided in Appendix D. The Town may need to make additional system improvements as other needs arise based on future system conditions.

7.2 General Operation and Maintenance Practices and Improvements

The Town should continue performing regularly scheduled maintenance programs, including routine inspection and maintenance at the pump stations, meter testing/calibration, and its unidirectional flushing program. In addition, all wells in the system should be evaluated annually and maintenance should be performed depending upon results of performance tests. The frequency of cleaning will depend on the source water quality.

The Town should also implement a replacement program during which hydrants and valves that do not function as intended are identified and replaced. These deficiencies are normally identified through routine operation and during the system-wide flushing program. By replacing hydrants that are old or broken, the Town will improve fire protection in the system and eliminate potential leaks. The Town should update its GIS database of all hydrants to include information regarding the make, model, repair history, and maintenance records of each hydrant. Over time, the database will provide the Town with a means of identifying problem hydrants to include in replacement programs. Eliminating broken valves will help improve the transmission capacity of the system.

Whenever improvements or expansion of a water distribution system occur, factors such as size and location of the water main should be considered to provide adequate flows and pressures. Any water main that is designed to provide fire protection should have a minimum diameter of 8-inches. Wherever possible, dead-end mains should be eliminated by looping or interconnecting and all water mains should be interconnected at reasonable intervals. All older and smaller water mains that do not meet fire flow recommendations in an area should be replaced with larger diameter mains. In addition, “bottlenecks” such as smaller water mains being the sole means of transporting water between larger mains should be eliminated. Improvements necessary to address these recommendations are included below. The Town should also evaluate all areas with parallel water mains in the distribution system to see if existing hydrants should be moved to the parallel water main.

In addition, the availability of the updated computer hydraulic model will provide the Town with an important tool in evaluating expansion or changes in the future, particularly when evaluating impacts of proposed new developments or water main replacement.

7.3 Priority I Recommended Improvements – Water Distribution

1. To improve flows from the Brake Hill Water Storage Tank to the center of town, a new 16-inch diameter water main from the Brake Hill Water Storage Tank to Main Street (Route 113) and along Main Street (Route 113) to the intersection with Church Street is recommended. This improvement will improve transmission in the HSA and help to assist in improving the inherent capacity for fire flow in several areas of the system. The estimated probable construction cost of approximately 6,600 linear feet of 16-inch diameter water main is approximately $3,322,000. This cost includes an additional 15 percent markup for additional MassDOT paving requirements and assumes that a waiver for control density fill (CDF) will be obtained from MassDOT.

2. To improve flows from the Pipestave Booster Pump Station to the center of town, a new 12-inch diameter water main along Main Street from the intersection with Church Street to the booster pump station is recommended. This improvement will improve transmission in the HSA and assist in improving the inherent capacity for fire flow in several areas of the system. The estimated probable construction cost of approximately 10,800 linear feet of 12-inch diameter water main is approximately $5,047,000. This cost includes an additional 15 percent markup for additional MassDOT paving requirements and assumes that a waiver for control density fill (CDF) will be obtained from MassDOT.

3. To provide the inherent capacity for the recommended fire flow of 500 gpm along Church Street, Prospect Street, and Old Wharf Road, a new 8-inch diameter water main is recommended along Church Street from Main Street (Route 113) to Ferry

Lane and along Prospect Street from Main Street (Route 113) to Church Street. This water main is currently in the design phase. Construction is expected to begin in 2024. The estimated probable construction cost of approximately 7,400 linear feet of 8-inch diameter water main is approximately $3,325,000.

4. The recommended fire flow for Crane Neck Street is 500 gpm. To meet this recommended fire flow on the southern end of Crane Neck Street, a new 8-inch diameter water main is recommended to replace the existing 6-inch diameter water main on the eastern end of Crane Neck Street. The estimated probable construction cost of 4,200 linear feet of 8-inch diameter ductile iron water main is approximately $1,444,000.

5. The estimated available fire flow along Bailey's Lane is less than 500 gpm. To meet the recommended residential fire flow of 500 gpm, a new 8-inch diameter water main is recommended from Main Street (Route 113) to the end of the 6-inch diameter water main. At the end of the 6-inch diameter main there is approximately 1,000 linear feet of 2-inch diameter main serving one house. Unless fire protection service will be extended to this location, it is recommended that the existing 2-inch diameter water main remain in place. The estimated probable construction cost of 1,600 linear feet of 8-inch diameter ductile iron water main is approximately $550,000.

6. To further strengthen the transmission grid in the HSA, the existing 6-inch diameter water main along Main Street from the end of the 10-inch diameter water main to the existing 8-inch diameter water main should be replaced with a new 8-inch diameter water main. In addition, a flow test should be conducted on the existing 8-inch diameter water main to the interconnection with the Groveland system to determine if the pipe has adequate carrying capacity to handle peak flows from the newly activated interconnection with Groveland. This section of main may need to be cleaned and lined or replaced. The estimated probable construction cost of 800 linear feet of new 8-inch diameter ductile iron water main is approximately $374,000. This cost includes an additional 15 percent markup for additional MassDOT paving requirements and assumes that a waiver for control density fill (CDF) will be obtained from MassDOT.

7.4 Priority II Recommended Improvements – Water Distribution

7. To eliminate a bottleneck and improve flows in the HSA, a new 8-inch diameter water main along Crane Neck Street is recommended to replace the existing 6-inch diameter water main from the intersection with Main Street (Route 113) to the existing 8-inch diameter water main. The estimated probable construction cost of 1,400 linear feet of 8-inch diameter ductile iron water main is $482,000.

8. A bottleneck exists at the intersection of Pleasant Street and Main Street (Route 113). To eliminate this bottleneck, a new 8-inch diameter water main along Pleasant Street from Main Street (Route 113) to Harrison Avenue is recommended to replace the

existing 6-inch diameter water main. The estimated probable construction cost of 600 linear feet of 8-inch diameter ductile iron water main is $244,000.

9. A new 8-inch diameter water main is recommended to replace the existing 6-inch diameter cross country water main from Barberry Lane to Meadowsweet Road to eliminate the bottleneck between two, 8-inch diameter water mains. The estimated probable construction cost of 1,200 linear feet of 8-inch diameter ductile iron water main is $413,000.

10. A 2-inch diameter water main currently services residences on Middle Street, located off Crane Neck Street. Industry standard states that any main less than 8-inch will not provide recommended fire flows for residences. Therefore, it is recommended that if the recommended fire flow is to be provided to homes on Mill Street, the 2-inch should be upgraded to an 8-inch diameter water main. The estimated probable construction cost for 900 linear feet of 8-inch diameter ductile iron water main improvement is $367,000.

7.5 Priority III Recommended Improvements – New Source

11. To meet projected system demands, it is recommended the Town develop the Dole Place Wellfield, or another new local water supply source. An evaluation of developing and bringing the Dole Place Wellfield online was completed in January 2021. The estimated cost of developing and bringing this source online from the January 2021 letter is $4,060,000, not including land acquisition, easement, or legal costs. Due to the close proximity of the Dole Place property to the Merrimack River, there is the potential that the wellfield will be considered "ground water under the direct influence of surface water" (GWUDI) under the Federal Surface Water Treatment Rule (SWTR) and susceptible to *Giardia* contamination. This analysis would be performed after the wellfield has been in service for six months and includes spring and fall sampling rounds. In the event that the wellfield is classified as GWUDI, design and construction of a 1.0 mgd capacity water filtration plant at the Dole Place Wellfield will be required. The estimated cost to construct a new 1.0 mgd water filtration plant from the January 2021 letter is approximately $8,770,000. If the Town proceeds with this recommendation, new cost estimates will need to be prepared.

Table No. 7-1
Priority I, Priority II, and Priority III Recommended Improvements – Water Distribution and New Source

Improvement No.	Location	Length (LF)	Proposed Diameter (in.)	Estimated Cost
Priority I Improvements				
1	Main Street – Brake Hill Tank to Church Street	6,600	16	$3,322,000
2	Main Street – BPS to Church Street	10,800	12	$5,047,000
3	Church Street and Prospect Street	7,400	8	$3,325,000
4	Crane Neck Street	4,200	8	$1,444,000
5	Bailey's Lane	1,600	8	$550,000
6	Main Street – 10-inch main leading to the Brake Hill Tank to the 8-inch main	800	8	$374,000
Priority I Recommended Improvements Total:				**$14,062,000**
Priority II Improvements				
7	Crane Neck Street	1,400	8	$482,000
8	Pleasant Street	600	8	$244,000
9	Cross Country	1,200	8	$413,000
10	Middle Street	900	8	$367,000
Priority II Recommended Improvements Total:				**$1,506,000**
Priority III Improvements				
11A	New Source – Dole Place Wellfield	n/a	n/a	$4,060,000
11B	Water Filtration Plant – Dole Place Wellfield	n/a	n/a	$8,770,000
Priority III Recommended Improvements Total:				**$12,830,000**

Appendix A

TATA & HOWARD


N
RIVER ROAD
WORTHS LANE
EMERY'S LANE
WAY TO THE RIVER
MIRRA WAY
NORINO DRIVE
FELTON LANE
PARSONS ROAD
COFFIN STREET
BRIDGE STREET
BAILEYS LANE
PROSPECT STREET
STEED AVENUE
ALBION LANE
CHURCH STREET
MIDDLE STREET
CHASE STREET
GARDEN STREET
BROWNS LANE
POORE HOUSE LANE
MAIN STREET
SULLIVAN COURT
WHETSTONE STREET
ARCHELAUS PLACE
ARCHELAUS HILL ROAD
SAWMILL BROOK ROAD
ROGERS STREET
RIVER MEADOW DRIVE
WATERSIDE LANE
RIVER MEADOW COURT
STEWART STREET
AVON LANE
MEETING HOUSE HILL ROAD
DONOVAN DRIVE
DOLE PLACE
MARSHALL DRIVE
NEWELL FARM DRIVE
PLEASANT STREET
MECHANIC STREET
MAPLE STREET
PIKES BRIDGE ROAD
MERRILL STREET
INDIAN HILL STREET
BACHELOR STREET
CHERRY HILL STREET
RIVERCREST DRIVE
MEADOW SWEET ROAD
KIMBALL ROAD
INDIAN RIDGE ROAD
CHESTNUT STREET
ASH STREET
FARM LANE
CRANE NECK STREET
TEWKSBURY STREET
GEORGETOWN ROAD
ROBIN CIRCLE
ROBIN ROAD
HILLTOP CIRCLE
ILSLEYS HILL ROAD
CRESCENT DRIVE
WOODCREST DRIVE
MONTCLAIR HILL ROAD
MOULTON STREET
Interconnection with Groveland
BRICKETT STREET
SOUTH STREET
CAPTAIN PIERCE DRIVE
SPRING HILL ROAD
BROWN ISLAND STREET
Legend
Water Main Diameter
4-Inch & Smaller
6-Inch
8-Inch
10-Inch
12-Inch
Low Service Area
Water Distribution System
West Newbury, Massachusetts
TATA & HOWARD
Approximate Scale: 1" = 1,000'
January 2024

Appendix B

TATA & HOWARD

Pipe Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Diameter (in)	Hazen-Williams C	Length (Scaled) (ft)
P-1	8	50	638
P-2	10	110	724
P-2	8	50	561
P-4	8	110	925
P-4	8	110	995
P-5	8	90	689
P-6	8	90	845
P-7	10	70	634
P-8	10	100	422
P-8	10	70	602
P-9	8	110	880
P-10	10	100	669
P-10	8	110	903
P-11	8	110	496
P-12	10	100	718
P-12	8	110	557
P-14	8	100	714
P-15(1)	8	25	670
P-15(2)	8	25	455
P-16	12	110	402
P-16	8	25	594
P-17(1)	6	60	419
P-17(2)	6	100	427
P-18	6	100	527
P-18(1)	12	110	1,417
P-18(2)	12	110	1,458
P-19	8	32	103
P-20	12	110	234
P-20	8	32	497
P-21	8	110	2,159
P-22	8	110	93
P-23	8	25	459
P-24	8	25	290
P-25	8	110	1,566
P-26	8	110	268
P-26	8	110	223
P-27	8	110	59
P-28	8	110	17
P-29	8	110	40
P-30	8	110	20
P-30(1)	8	110	414
P-30(2)	8	110	28
P-31	8	110	649
P-32	8	70	315

Pipe Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Diameter (in)	Hazen-Williams C	Length (Scaled) (ft)
P-32	8	110	41
P-33(1)	8	110	544
P-33(2)	8	110	132
P-34	8	70	198
P-36	8	70	620
P-36	6	110	231
P-37	6	110	146
P-38	8	70	1,033
P-38	6	110	211
P-39	6	110	143
P-40	10	70	171
P-42	10	70	182
P-42	8	110	308
P-45	6	110	637
P-46(1)	8	130	394
P-46(2)	8	130	166
P-48	10	70	379
P-48	6	110	495
P-49	6	45	341
P-50	10	70	307
P-57	6	110	231
P-58	8	110	110
P-61	6	45	87
P-63	6	42	148
P-64	10	70	478
P-65	10	70	858
P-67(1)	8	50	577
P-67(2)	8	50	464
P-68	6	90	763
P-68	8	50	172
P-70(1)	8	90	345
P-70(2)	8	90	494
P-72	8	50	281
P-73(1)	8	120	318
P-73(2)(1)	8	120	358
P-73(2)(2)	8	120	415
P-74	8	50	232
P-74	8	120	202
P-75	8	120	744
P-76	8	50	478
P-77	12	120	183
P-78	8	100	539
P-78	12	120	75
P-79	12	120	1,204

Pipe Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Diameter (in)	Hazen-Williams C	Length (Scaled) (ft)
P-80	8	100	812
P-80	12	120	539
P-81	8	120	265
P-82	8	100	377
P-82	8	120	464
P-84	8	100	667
P-86	8	100	619
P-88	8	100	457
P-90	6	95	599
P-91	6	110	288
P-92	6	100	1,155
P-94	6	100	439
P-98	8	55	963
P-100	8	55	232
P-102	8	55	563
P-104(1)	8	55	591
P-104(2)	8	32	820
P-112	8	110	1,024
P-114	8	110	529
P-116(1)	6	50	753
P-116(2)	6	50	812
P-118	2	50	1,355
P-120	6	40	936
P-122	6	40	556
P-124	6	40	252
P-126	8	100	920
P-128	6	40	173
P-130	8	100	793
P-132	8	100	896
P-134(1)	8	100	998
P-134(2)	8	110	380
P-136	8	100	427
P-138	8	100	1,230
P-142	8	110	624
P-144	8	110	1,049
P-146	8	110	993
P-148	8	110	327
P-150	2	50	165
P-152	2	50	300
P-154	6	55	909
P-162	6	90	987
P-164	8	110	1,291
P-166	8	110	1,820
P-168	8	110	1,820

Pipe Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Diameter (in)	Hazen-Williams C	Length (Scaled) (ft)
P-170(1)	8	110	1,096
P-170(2)	8	100	564
P-172	6	100	585
P-178	8	50	253
P-180	8	50	1,571
P-182	8	50	173
P-184	8	50	1,417
P-186	8	50	2,235
P-188	10	100	1,501
P-190	10	100	1,096
P-192	10	100	469
P-194	6	100	55
P-196	6	100	147
P-198	6	100	411
P-200	6	100	51
P-202	6	100	178
P-204	6	100	142
P-206	8	25	1,079
P-212	6	42	515
P-216	8	120	116
P-218	8	100	728
P-220	8	100	454
P-222(1)	6	55	215
P-222(2)	6	55	328
P-224	6	55	628
P-226	6	55	988
P-228	10	60	693
P-230	6	50	589
P-232	8	110	1,342
P-234(1)	8	110	720
P-234(2)	8	100	544
P-236	8	110	452
P-238	8	110	725
P-240	8	110	246
P-242	8	110	202
P-244	8	110	173
P-246	8	110	249
P-248	8	110	238
P-252	8	110	541
P-254	8	110	484
P-256	8	110	215
P-258	8	110	847
P-260	8	110	773
P-262	8	110	1,336

Pipe Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Diameter (in)	Hazen-Williams C	Length (Scaled) (ft)
P-264	8	110	1,245
P-266	8	110	389
P-268(1)	8	110	404
P-268(2)	8	110	539
P-270	8	110	478
P-272	8	110	681
P-276	6	90	1,102
P-278	8	110	1,613
P-280	8	110	446
P-282	8	110	860
P-284	8	110	425
P-286	8	110	802
P-288	8	90	290
P-290	8	110	626
P-292	6	50	402
P-294	6	50	144
P-296	6	50	493
P-298	6	110	1,311
P-300	8	110	685
P-302	8	110	1,053
P-304	8	120	322
P-306	8	120	1,009
P-308	6	100	886
P-310	6	70	1,072
P-312	6	60	783
P-316	2	50	843
P-318(1)	6	50	672
P-318(2)	6	50	853
P-320	8	90	618
P-322	8	90	692
P-324	8	90	206
P-326	8	90	590
P-328	8	90	494
P-330	8	90	745
P-332	8	90	868
P-334	8	110	1,585
P-336	6	100	584
P-338	6	100	632
P-342	8	110	1,137
P-344	8	90	743
P-346	8	100	208
P-348	8	90	587
P-350(2)	10	90	1,181
P-352	8	110	718

Pipe Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Diameter (in)	Hazen-Williams C	Length (Scaled) (ft)
P-366	10	110	147
P-368(1)	10	110	353
P-368(2)	10	110	207
P-370(1)	10	110	348
P-370(2)	10	110	156
P-372	10	40	682
P-374	10	45	1,024
P-376	10	70	539
P-378	10	70	266
P-380	8	110	455
P-382	8	110	300
P-384	8	120	440
P-386	12	110	398
P-388	12	110	631
P-390	12	110	887
P-392	12	110	196
P-394	12	110	572
P-396	12	110	362
P-398	8	130	94
P-402	8	130	103
P-406	8	130	92
P-410	8	130	84
P-413	8	110	813
P-414	8	110	268
P-415	8	130	278
P-416(1)	8	130	1,060
P-416(2)	8	110	1,399
P-417	8	110	774
P-418	8	100	824
P-419	10	70	465
P-420	10	40	376
P-421	10	40	109
P-422	10	40	251
P-423	10	45	163
P-424	10	45	618
P-425	10	110	149
P-426	10	110	306

Junction Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Elevation (ft)	Demand (gpm)	Pressure (psi)
J-2	596: Low Service	10	0	95.6
J-4	596: Low Service	13	0	94.3
Wellfield	596: Low Service	20	0	91.3
J-8	596: Low Service	64	0.11	72.2
J-10	596: Low Service	59	0.18	74.4
J-12	596: Low Service	56	0.67	75.7
J-14	596: Low Service	57	0.49	75.3
J-16	596: Low Service	75	0.25	67.5
J-18	596: Low Service	75	0.54	67.5
J-20	596: Low Service	157	0.26	32
J-22	596: Low Service	157	0	32
J-24	595: High Service	82	1.07	91.9
J-26	595: High Service	75	0.2	95
J-28	595: High Service	89	0.27	88.9
J-30	595: High Service	121	1.32	75.1
J-32	595: High Service	132	0.27	70.3
J-34	595: High Service	121	0.42	75.1
J-36	595: High Service	113	1.21	78.5
J-38	595: High Service	115	1.26	77.7
J-40	595: High Service	131	0.87	70.8
J-42	595: High Service	131	0.19	70.8
J-44	595: High Service	125	0.39	73.4
J-46	595: High Service	115.4	1.42	77.5
J-48	595: High Service	118	0.07	76.4
J-50	595: High Service	112	1.56	79
J-52	595: High Service	113	0.98	78.6
J-54	595: High Service	115	0.89	77.7
J-56	595: High Service	109	0.78	80.3
J-58	595: High Service	108	0.37	80.8
J-60	595: High Service	108	0.47	80.8
J-62	595: High Service	95	0.89	86.4
J-64	595: High Service	102	0.83	83.4
J-66	595: High Service	118	0.96	76.5
J-68	595: High Service	89	1.06	89.1
J-70	595: High Service	66	0.62	99
J-72	595: High Service	46	0.42	107.6
J-74	595: High Service	43	0.3	108.9
J-76	595: High Service	39	0.01	110.7
J-78	595: High Service	43	0.28	108.9
J-80	596: Low Service	59	0.91	74.4
J-82	596: Low Service	60	0.57	74
J-84	596: Low Service	62	0.35	73.1
J-86	596: Low Service	69	0.5	70.1

Junction Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Elevation (ft)	Demand (gpm)	Pressure (psi)
J-88	596: Low Service	62	0.61	73.1
J-90	596: Low Service	62.3	0.14	73
J-92	596: Low Service	71.4	0.68	69
J-94	596: Low Service	71.3	0.37	69.1
J-96	596: Low Service	66	0.31	71.4
J-98	596: Low Service	66	0.37	71.4
J-100	596: Low Service	59.7	0.41	74.1
J-104	595: High Service	39	0.11	110.6
J-106	595: High Service	90	1.77	88.5
J-108	595: High Service	102	0.61	83.3
J-110	595: High Service	138	0.46	67.7
J-112	595: High Service	108	0	80.7
J-114	595: High Service	134	0.52	69.5
J-116	595: High Service	108	0.66	80.7
J-118	595: High Service	98	0.4	85
J-120	595: High Service	148	0.53	63.4
J-122	595: High Service	85	1.27	90.7
J-124	595: High Service	69	0.69	97.6
J-126	595: High Service	13	0	121.8
J-128	595: High Service	11	0.15	122.7
J-130	595: High Service	35	0.18	112.3
J-132	595: High Service	27.5	0.8	115.5
J-134	595: High Service	39	0.49	110.6
J-136	595: High Service	85	1.48	90.7
J-138	595: High Service	128	0.64	72.1
J-140	595: High Service	128	0.41	72.1
J-142	595: High Service	23	0.96	117.5
J-144	595: High Service	23	1.93	117.5
J-146	595: High Service	72	1.57	96.3
J-148	595: High Service	111.5	0.3	79.2
J-150	595: High Service	138	0.43	67.7
J-152	595: High Service	138	0.23	67.7
J-154	595: High Service	89	0.35	88.9
J-156	595: High Service	131	0.35	70.8
J-158	595: High Service	206	0	38.3
J-160	595: High Service	128	0.33	72.1
J-162	595: High Service	121	0.23	75.1
J-164	595: High Service	108	0.31	80.8
J-166	595: High Service	108	0.56	80.8
J-168	595: High Service	82	0.57	92.1
J-170	595: High Service	128	0.07	72.1
J-172	595: High Service	128	0.42	72.1
J-174	595: High Service	128	0	72.1

Junction Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Elevation (ft)	Demand (gpm)	Pressure (psi)
J-176	595: High Service	128	0.94	72.1
J-178	595: High Service	128	0.06	72.1
J-180	595: High Service	128	0.69	72.1
J-182	595: High Service	100	0.96	84.2
J-184	595: High Service	43	0.08	108.9
J-186	595: High Service	30	0.32	114.5
J-188	595: High Service	35	0	112.3
J-190	595: High Service	43	0.1	108.9
J-192	595: High Service	102	1.05	83.4
J-194	595: High Service	102	0.44	83.4
J-196	595: High Service	95	0.23	86.4
J-198	595: High Service	108	0.97	80.8
J-200	595: High Service	98	0.99	85.1
J-202	595: High Service	89	1.16	89
J-204	595: High Service	59	1.62	102
J-206	595: High Service	35	0.44	112.3
J-208	595: High Service	29.3	0.57	114.8
J-210	595: High Service	43	0.83	108.9
J-212	595: High Service	43	0	108.9
J-214	595: High Service	43	0	108.9
J-216	595: High Service	39	0.83	110.6
J-218	595: High Service	59	0.39	102
J-220	595: High Service	43	0.46	108.9
J-222	595: High Service	43	0.15	108.9
J-224	595: High Service	30	0.48	114.5
J-226	595: High Service	30	0.26	114.5
J-228	595: High Service	43	1.66	108.9
J-230	595: High Service	41	0.4	109.8
J-232	595: High Service	30	0.51	114.5
J-234	595: High Service	49	1.92	106.3
J-236	595: High Service	36.2	0.61	111.9
J-238	595: High Service	25	0.94	116.7
J-240	595: High Service	23	1.42	117.6
J-242	595: High Service	39	1.16	110.7
J-244	595: High Service	66	0.52	99
J-246	595: High Service	184	1.13	47.9
J-248	595: High Service	49	0.62	106.3
J-250	595: High Service	39	0.26	110.7
J-252	595: High Service	66	0.84	99
J-254	595: High Service	30	0.19	114.6
J-256	595: High Service	30	0	114.6
J-258	595: High Service	30	0	114.6
J-260	595: High Service	30	0	114.6

Junction Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Elevation (ft)	Demand (gpm)	Pressure (psi)
J-262	595: High Service	98	0.57	85.2
J-264	595: High Service	92	1.23	87.8
J-266	595: High Service	89	0.52	89.1
J-268	595: High Service	92	0.15	87.8
J-270	595: High Service	82	0.6	92.1
J-272	595: High Service	121	0.33	75.2
J-274	595: High Service	161	0.29	57.9
J-276	595: High Service	200	0.61	41
J-278	595: High Service	112	0.15	79.1
J-280	595: High Service	102	0.99	83.4
J-282	595: High Service	88	0.06	89.5
J-284	595: High Service	98	1.2	85.2
J-286	595: High Service	108	0.7	80.9
J-288	595: High Service	149.6	1.22	62.9
J-290	595: High Service	177.5	0.75	50.8
J-292	595: High Service	98	0.67	85.2
J-294	595: High Service	118	0.96	76.5
J-296	595: High Service	16	0.15	120.5
J-298	595: High Service	79	0.61	93.4
J-300	595: High Service	71	0.23	96.8
J-302	595: High Service	82	0.08	91.9
J-306	596: Low Service	26	0	88.7
J-308	596: Low Service	33	0.04	85.7
J-310	595: High Service	90	1.35	88.6
J-312	595: High Service	98	1.05	85.1
J-314	595: High Service	39	0.56	110.6
J-316	595: High Service	33	0	113.3
J-318	596: Low Service	90	0	61
J-320	596: Low Service	88	4.38	61.9
J-322	596: Low Service	82	0	64.5
J-324	596: Low Service	84	0	63.6
J-326	596: Low Service	95	0.58	58.8
J-331	595: High Service	75	0.4	95
J-332	595: High Service	89	0.62	88.9
J-333	595: High Service	111	0	79.4
J-334	596: Low Service	157	0	32
J-1	595: High Service	88.4	0.07	89.2
J-2	595: High Service	138.7	1.42	67.4
J-3	595: High Service	124	0.56	73.8
J-4	595: High Service	99.1	1.05	84.6
J-5	595: High Service	27.6	0.82	115.5
J-6	595: High Service	25.3	0.06	116.5
J-7	595: High Service	122.3	0.59	74.6

Junction Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Elevation (ft)	Demand (gpm)	Pressure (psi)
J-8	595: High Service	122.3	0.91	74.6
J-10	595: High Service	175.1	0.12	51.8
J-11	596: Low Service	75	0.21	67.5
J-12	595: High Service	118	0.14	76.4
J-13	595: High Service	121	0.08	75.1
J-14	595: High Service	66	0.5	99
J-15	596: Low Service	157	0	32
J-16	595: High Service	157	0	59.5
J-18	595: High Service	82	0	92
J-19	595: High Service	72	2.32	96.3
J-20	595: High Service	76	0	94.6
J-21	595: High Service	86	0	90.3
J-23	595: High Service	94	0	86.8
J-27	595: High Service	78	0	93.7
J-28	595: High Service	43	0.11	108.9
J-29	595: High Service	37.6	0	111.2
J-30	595: High Service	73.9	0	95.5
J-31	595: High Service	121.2	1.57	75
J-33	595: High Service	190.2	0.2	45.2
J-34	595: High Service	150	0	62.5
J-35	595: High Service	128	0	72.1
J-36	595: High Service	123	1.12	74.2
J-37	595: High Service	242	0	22.9
J-38	595: High Service	245	0	21.6
J-39	595: High Service	190	0	45.4
J-40	595: High Service	37	0.4	111.5
J-41	595: High Service	30	0.32	114.5
J-42	595: High Service	134.2	0	69.4
J-43	595: High Service	141.3	1.92	66.3
J-44	595: High Service	41	0.71	109.7
J-56	595: High Service	74	0.11	95.5
J-59	596: Low Service	113.3	1.67	50.9
J-60	595: High Service	17	0.76	120.1
J-61	595: High Service	67	0.29	98.6
J-62	595: High Service	34.2	1.07	112.7
J-63	595: High Service	50	0.49	105.9
J-64	595: High Service	100	0.46	84.2
J-65	595: High Service	171	0.27	53.5
J-66	595: High Service	168	0.23	54.9
J-67	595: High Service	138	0.34	67.7
J-68	596: Low Service	69	0.33	70.1
J-69	596: Low Service	63	0	72.7
J-70	595: High Service	143	0.45	65.6

Junction Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Elevation (ft)	Demand (gpm)	Pressure (psi)
J-71	595: High Service	116	1.08	77.3
J-72	596: Low Service	64	0.15	72.2
J-73	595: High Service	129	0.36	71.6
J-74	595: High Service	99.1	0.33	84.7

Water Storage Tanks Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Zone	Base Elevation (ft)	Overflow Elevation (ft)
PIPE STAVE TANK	596: Low Service	192	232
Brake Hill Tank - New	595: High Service	262.5	300

Pump Input Data
Water Distributiuon System Study
West Newbury, MA

Label	Elevation (ft)	Hydraulic Grade (Discharge) (ft)	Head (Design) (ft)	Flow (design) (gpm)
Newbury Port Pump	18.5	231	323	355
Pipe Stave Hill BPS No.	157	294.5	70	360
Pipe Stave Hill BPS No.	157	294.5	70	360
West Newbury Pump	18.5	231	231	130

Appendix C

APPENDIX C

TATA & HOWARD

Legend

- Junction
- Water Main
- Low Service Area

Link Map
West Newbury, Massachusetts

TATA & HOWARD

Approximate Scale: 1" = 1,000'

January 2024

Appendix D

APPENDIX D

TATA & HOWARD

Recommended Improvements
West Newbury, Massachusetts

TATA & HOWARD

Approximate Scale: 1" = 1,000'

January 2024

TATA & HOWARD

OFFICE LOCATIONS:
MA | NH | CT | VT | AZ

800-366-5760
www.tataandhoward.com