SYSTEM EVALUATION STUDY

Uxbridge, Massachusetts
February 2014

TATA & HOWARD

TATA & HOWARD

February 14, 2014

Mr. Benn S. Sherman, P.E.
Department of Public Works
147 Hecla Street
Uxbridge, Massachusetts 01569

Subject: System Evaluation Study
T&H Project No. 2168

Dear Mr. Sherman:

In accordance with our agreement, Tata & Howard is pleased to present you with four copies of the System Evaluation Study. The analysis and improvements in this report are based on the Three Circles Approach for capital efficiency, which combines hydraulic and critical component considerations with an asset management rating system to evaluate the condition of the water mains in the distribution systems.

Hydraulic recommendations were developed using recommended ISO and AWWA fire flows. Areas in which the fire flow could not be met were considered hydraulically deficient. The system was evaluated for critical customers and components. It was also tested on the hydraulic model for redundancy. Finally, each water main was evaluated based on asset management considerations to determine its asset management score. The results were combined to determine the water mains most in need of replacement and to establish a prioritized set of improvements in the systems. A detailed description of the improvements and their estimated costs is presented in Section 6.

During the course of this project, the undersigned served as Project Manager, Mr. Steven Daunais served as Project Engineer, and Mr. Donald Tata, P.E. served as Project Officer and provided technical reviews.

At this time, we wish to express our appreciation to the Department of Public Works for their participation in this study and for their help in collecting information and data.

Sincerely,

TATA & HOWARD, INC.

Jenna Rzasa

Jenna W. Rzasa, P.E.
Vice President

Enclosures

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SECTION 1 – Executive Summary

1.1 General

Tata & Howard, Inc. was retained by the Uxbridge Department of Public Works (DPW) to complete a System Evaluation Study for the DPW's water system. The purpose of the study is to evaluate the impacts of the new distribution system configuration, identify areas in need of rehabilitation, repair or replacement to address hydraulic, asset management, or redundancy concerns and prioritize improvements to make the most efficient use of the Town's capital budget.

1.2 The Three Circles Approach

Tata & Howard evaluated the water distribution system using the Three Circles Approach. The Three Circles Approach consists of the following evaluation criteria:

- System hydraulic evaluation,
- Critical component assessment,
- Asset management considerations.

Each circle represents a unique set of evaluation criteria for each water system component. From each set of criteria, system deficiencies are identified. System deficiencies from each circle are then compared. A deficiency falling into more than one circle is given higher priority than one that does not. Using the Three Circles Approach, recommended improvements will result in the most efficient benefits to the system. In addition, the Three Circles Approach allows us to identify improvements of a deficiency in one circle which will eliminate a deficiency in another circle. By integrating all three sets of criteria, the infrastructure improvement decision making process and overall capital efficiency is optimized.

Tasks in this study included the following:

- Conducted a one day workshop with the DPW staff to review operations and maintenance practices, break history, and other information pertinent to the condition of the existing system.
- Obtained and reviewed all pertinent available information regarding the existing water system, including previous system studies, age of water mains, pipe materials, pump curves, soil types, known water quality issues, and water main break history.
- Conducted an inventory of the existing piping assets only. The inventory identified the general condition, age, and service history of each asset. The inventory did not include water services, meters, backflow prevention devices, operation facilities and equipment, construction equipment, or motor vehicles.
- Conducted a review of recent low service area improvements and ongoing development projects in the system. Reviewed recommended improvements in the Tata & Howard Water Master Plan Update, as well as potential improvements that

may be required by asset management (asset age, material, break history, soils) and redundancy considerations (critical components).

- Created a pipe rating system to identify areas needing rehabilitation/replacement based on priority, with particular focus on improvements required over the next five to ten years.
- Prioritized assets based on remaining useful life, importance in providing safe drinking water (existing or potential threat to public health, safety or environment), and how important the asset is to the operation of the system.

Based on the Three Circles approach, a prioritized list of improvements was compiled. Improvements were separated into three phases. Phase I represents the most needed improvements based on hydraulic needs, location in the distribution system, and the condition of the water main. In general, these improvements include water mains that fall into all three of the circles, strengthen the transmission grid, eliminate potential asset management concerns, provide redundancy, or are identified to be a priority of the DPW.

Phase II Improvements generally include areas that fall into two circles. Phase III Improvements include those that fall into only one circle and include any remaining hydraulic deficiencies and water mains with high asset management scores.

SECTION 2 – Exiting Water Distribution System

2.1 Distribution System

The DPW serves the Town of Uxbridge and portions of the Towns of Millville and Northbridge. The entire water distribution system consists of approximately 62 miles of water main ranging in size from two to 20-inches in diameter. A map of the water distribution system can be found in Appendix A. Figure No. 2-1 shows a breakdown of the water main sizes for the existing water system. As depicted, approximately one percent of the infrastructure is 20-inch diameter pipe, four percent is 16-inch diameter pipe, 15 percent is 12-inch diameter pipe, 5 percent is 10-inch diameter pipe, 51 percent is 8-inch diameter pipe, 23 percent is 6-inch diameter pipe, and one percent is 4-inch or smaller diameter pipe.

The existing water mains are constructed of various materials including cement lined ductile iron, cement lined cast iron (CLCI), unlined cast iron, Universal cast iron, and polyvinyl chloride (PVC). Figure No. 2-2 shows a breakdown of water main material. The system is comprised of approximately 38 percent ductile iron, one percent CLCI, seven percent unlined cast iron, 46 percent Universal cast iron, and eight percent PVC.

2.2 Service Areas

The existing water system consists of three service areas: the Low Service Area, the High Service Area and the East Street Service Area. The service areas are separated by a series of isolation valves throughout the Town.

The Low Service Area has a hydraulic grade line elevation (HGL) of approximately 498 feet USGS. Ground elevations range from approximately 216 feet to 452 feet USGS. This service area comprises the majority of the distribution system.

The High Service Area, located in the western portion of the distribution system, has an HGL of approximately 591 feet USGS and ground elevations range from approximately 285 feet to 506 feet USGS.

The East Street Service Area has an HGL of approximately 591 feet USGS. This small service area is located off East Street in the southeastern portion of the distribution system and does not have a storage tank. Ground elevations range from approximately 345 feet to 476 feet USGS.

Figure No. 2-1
Water Main Diameter Distribution
Uxbridge, Massachusetts

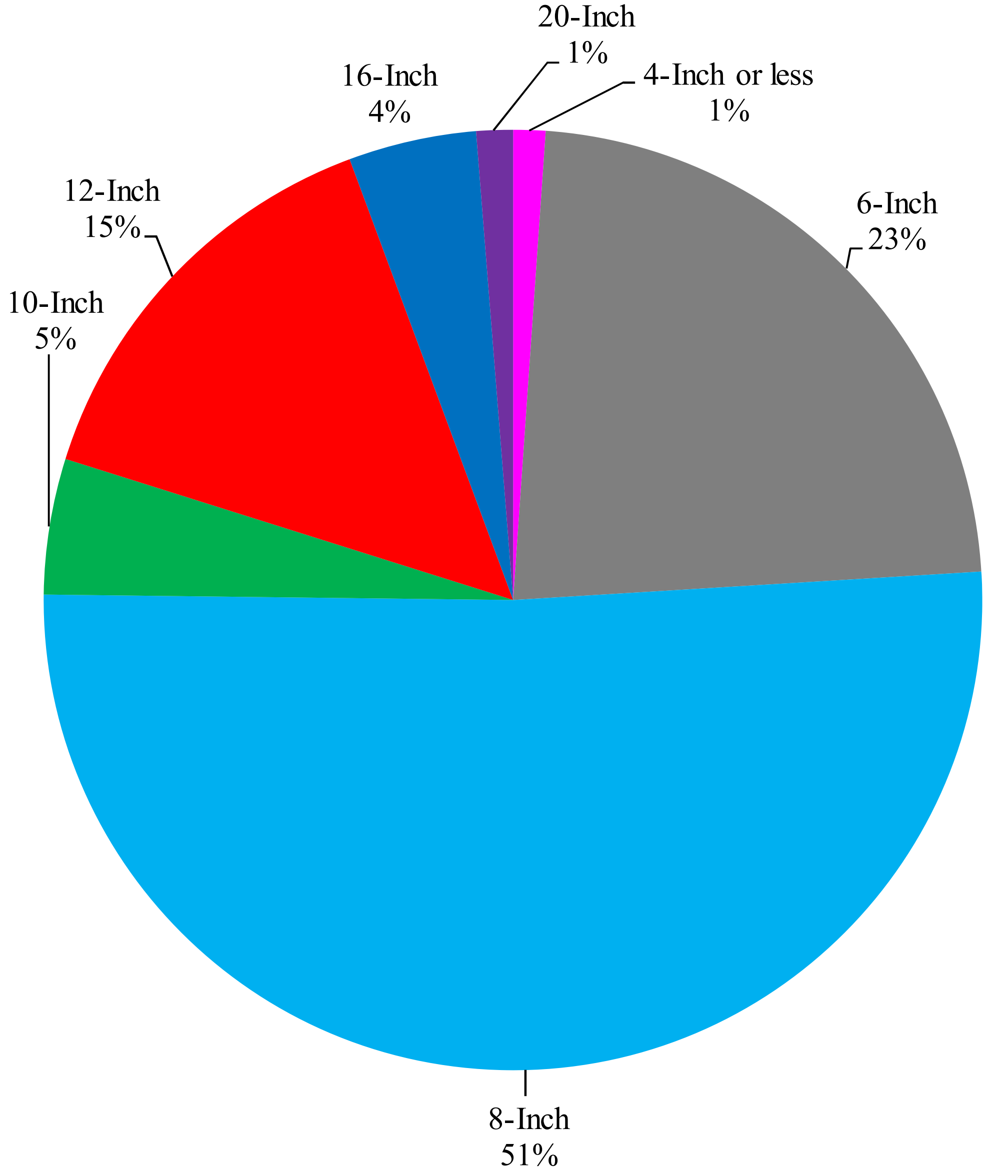
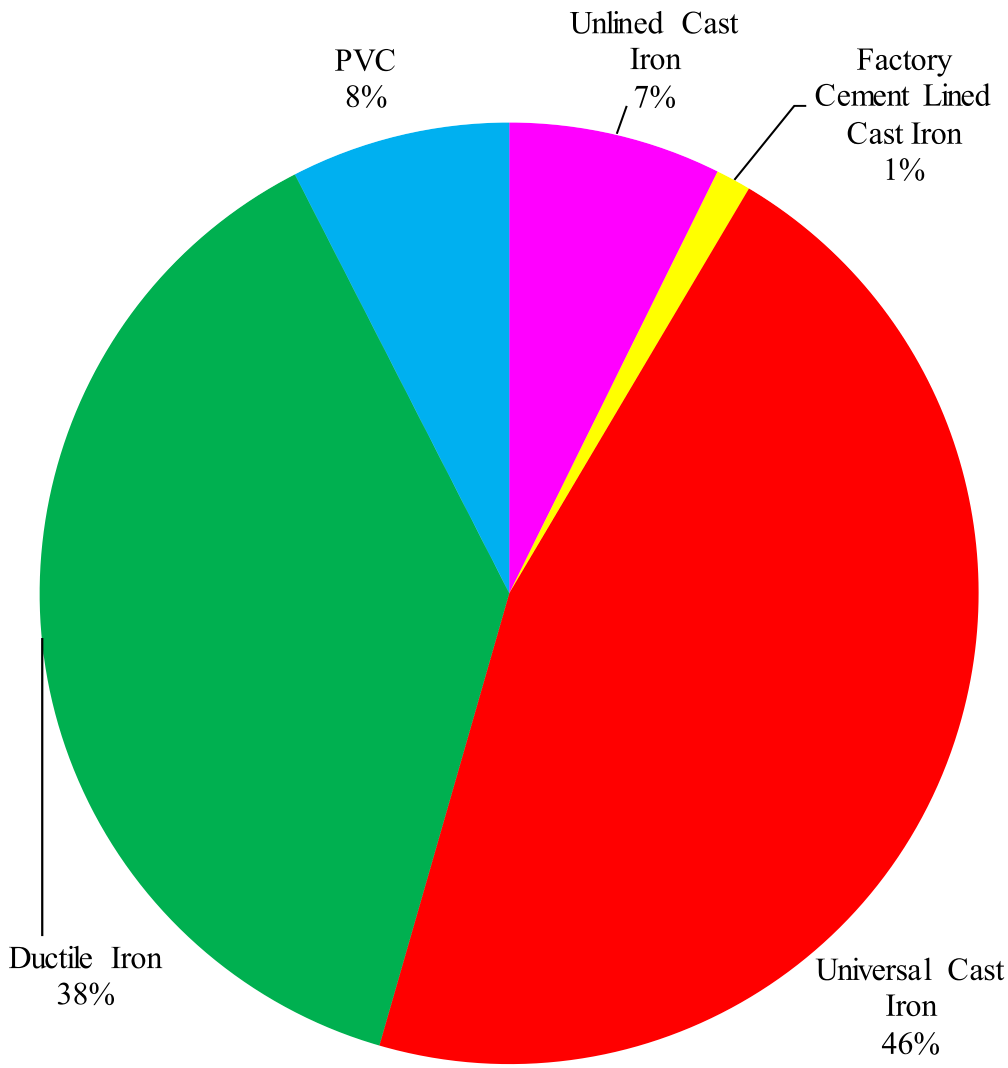


Figure No. 2-2
Water Main Material Distribution
Uxbridge, Massachusetts



2.3 Water Supply Sources

The Town has seven supply sources. The wells are located within the Blackstone River Basin and include Blackstone Wells No. 1 (2304000-01G), No. 2 (2304000-02G), and No. 3 (2304000-03G); Bernat Wells No. 4 (2304000-04G), No. 5 (2304000-05G), and No. 6 (2304000-06G) and Rosenfeld Well (2304000-07G). The DPW currently does not treat for manganese in the water; however, the Massachusetts Department of Environmental Protection (MassDEP) may require treatment to remove manganese from the water in the future.

Blackstone Street Wells

The Blackstone Street Well site, located in the central portion of the distribution system approximately 500 feet east of the West River along Blackstone Street, consists of Blackstone Wells No. 1, No. 2 and No. 3. This source was the first of the Town's three water supply sources. The three existing gravel packed wells replaced the original wellfield which consisted of 32 2-½ inch diameter wells.

Originally installed in 1944, Blackstone Well No. 1 is approximately 72 feet below ground surface (bgs) with a 25 foot long screen. Reportedly, the original pumping capacity of the 12-inch diameter gravel packed well was estimated to be approximately 400 gallons per minute (gpm). However, the original screen was replaced with a smaller one, reducing the current capacity of this well. An extended pump test should be completed to evaluate the capacity of this well. The well is equipped with a 50 horsepower (hp) vertical turbine pump and a three phase electric driven motor installed in 1985.

Blackstone Well No. 2 was originally constructed in 1946. The 12-inch diameter gravel packed well is approximately 52 feet bgs with a 16 foot long screen. Reportedly, the original pumping capacity was estimated to be approximately 500 gpm. In 2007, the original pump was replaced with a 50 hp vertical turbine pump and motor with a pumping capacity of 400 gpm. A 125 kilowatt propane fueled generator has been installed to provide back-up power for Blackstone Wells No. 1 and 2.

Blackstone Well No. 3 was installed in 1953 to serve as a back-up supply source to Blackstone Wells No. 1 and 2. The 12-inch diameter gravel packed well is approximately 63.5 feet bgs with a 16 foot long screen. Reportedly, the original pumping capacity was estimated to be 610 gpm. In 2001, the original pump was replaced with a 100 hp vertical turbine pump and the motor was replaced with a three phase electric driven motor. Blackstone Well No. 3 is connected to a propane fueled auxiliary engine and right angle gear drive to provide back-up power in the event of a power failure or motor/control failure. Due to the proximity of Blackstone Wells No. 2 and 3, interference reduces the specific capacity of Blackstone Well No. 2 when Blackstone Well No. 3 is operating.

A conceptual Zone II Delineation of the Blackstone Wells was completed under the MassDEP's Source Water Assessment Program (SWAP). The MassDEP has approved pumping rates of 0.43, 0.44, and 0.32 million gallons per day (mgd) for Wells No. 1, 2, and 3, respectively.

The Blackstone Wells discharge to a 12-inch diameter ductile iron main installed in 1997. Flow measurement is currently provided by three individual meters located on each well supply main, with recording and indicating instruments located in the office. Water from the wells is treated with potassium hydroxide for corrosion control and polyphosphate for sequestering.

Bernat Wells

In 1988, an extended pump test was conducted. Based on the drawdown data collected during the extended pump test, the calculated estimated safe yields of Bernat Wells No. 4, 5 and 6 were 1,900, 600 and 1,000 gpm, respectively. It should be noted the wells were not pumped at these rates during the pump test. The three wells were pumped at a combined rate of 925 gpm during the test. Therefore, the MassDEP approved combined pumping rate of the Bernat Wells is 925 gpm.

In 1989, the Town acquired the Bernat Wells No. 4, 5 and 6 as additional sources of water. The wells were originally constructed in 1946 for the Uxbridge Worsted Company. The wells are located approximately 1,400 feet east of Route 122, 400 feet west of the Blackstone River and 1,100 feet south of the Mumford River.

Bernat Well No. 4 is a 12-inch by 18-inch gravel packed well constructed to a depth of approximately 103 feet bgs with a 10 foot long screen. The well is equipped with a 100 hp pump and three phase motor installed in 1991.

Bernat Well No. 5 is a 12-inch by 18-inch gravel packed well. It is approximately 66 feet bgs with a 10 foot long screen and is equipped with a 75 hp pump and motor installed in 1991.

Bernat Well No. 6, equipped with a 100 hp pump and motor installed in 1991, is a 12-inch by 18-inch gravel packed well. The well is constructed to a depth of 103 feet bgs with a 10 foot long screen.

Each of the Bernat Wells is equipped with an electric motor drive vertical turbine pump. In the event of a power failure, the 115 kilowatt propane fueled generator located at the control building will start automatically and provide power to one pre-selected pump until primary power is restored. The water from the wells is treated with potassium hydroxide for corrosion control and polyphosphate is added for manganese sequestering.

The main discharge line from the Bernat Wells is a 16-inch cast iron pipe installed when the water supply was originally established for the Uxbridge Worsted Company. A 16-inch diameter ductile iron main was installed in 1990 to connect the discharge line to the distribution system after the Town's acquisition of the site.

Rosenfeld Well

The Rosenfeld Well was developed to mitigate the projected water supply deficit identified in the Water Master Plan. The Rosenfeld Well was approved by MassDEP in April 2012 with an approved yield of 510 gpm. The well, located off of Quaker Highway (Route 146A), is an 18-inch by 24-inch gravel packed well constructed to a depth of 69 feet bgs with a 15 foot screen. It is equipped with a 100 hp vertical turbine pump with a design flow rate of 510 gpm at a Total Dynamic Head (TDH) of 405 feet. A diesel generator located at the site provides backup power in the event of an emergency. The water from the well is treated with potassium hydroxide for corrosion control and has provisions for a polyphosphate chemical feed system for manganese sequestering and sodium hypochlorite feed system for emergency disinfection. The pump station and chemical feed systems were designed to accommodate potential future expansion of the wellsite to 2 mgd.

2.4 Water Storage Facilities

There are two storage facilities in the system. The two water storage tanks were constructed to mitigate the storage deficit noted in the previously mentioned Water Master Plan.

The Richardson Street Tank, located off Richardson Street, was constructed in 2005 and serves the High Service Area. The tank is an aboveground pre-stressed concrete water storage tank with a capacity of 1.0 million gallons (mg), an overflow elevation of 591 feet USGS and is connected to the distribution system by a 16-inch diameter ductile iron main. It is approximately 59 feet in diameter and 50 feet high.

The Low Service Area Water Storage Tank located off High Street, was completed in 2009 and replaced the High Street Tank. The cast in place concrete tank is a partial underground facility with a capacity of 1.5 mg and an overflow elevation of 500 feet USGS. The tank is separated into two equal sized compartments allowing for half the tank to be taken offline for maintenance. The tank is connected to the system by a 16-inch diameter ductile iron main and is approximately 150 feet long, 100 feet wide and 17 feet high.

2.5 Booster Pump Stations

There are two booster pump stations in the distribution system: the East Street Booster Pump Station and the Fafard Booster Pump Station.

East Street Booster Pump Station

The East Street Booster Pump Station, located on East Street, serves the East Street Service Area. This service area is located off East Street in the southeastern portion of the distribution system. Additionally, a portion of the Town of Millville is served through the East Street Pump Station. The station is located underground and is comprised of one 50 gpm pump equipped with a variable frequency drive and a TDH of

115 feet, and one 150 gpm pump equipped with a variable frequency drive and a TDH of 135 feet and has an emergency power supply.

Fafard Booster Pump Station

The Fafard Booster Pump Station was upgraded in 2004 and is used to supply water to the High Service Area. The station is a package booster pump station equipped with packaged three pump system, each with 175 gpm capacity constant speed pumps and emergency back-up power.

2.6 Interconnections

In addition to the wells, the Town has a 6-inch diameter interconnection with the Whitinsville Water Company in the Town of Northbridge at the town line on Linwood Street. The interconnection, which is equipped with a 4-inch diameter meter, can provide water to the Town in the event of an emergency.

SECTION 3 – Hydraulic Model Verification and Evaluation

3.1 General

To evaluate the existing water distribution system and obtain a basis for recommending water distribution improvements, a comprehensive hydraulic model was utilized to mathematically simulate the water distribution system. Uxbridge 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 their construction.

The hydraulic model uses Bentley's WaterGEMS modeling software. WaterGEMS allows the user to conduct hydraulic simulations using mathematical algorithms while in an ArcGIS environment. The model was previously verified as part of the 2003 Water Master Plan. Recommendations set forth by the Insurance Services Office (ISO) for fire flows were utilized in the analysis of the combined distribution systems under steady state conditions. The Uxbridge system was last inspected for fire insurance ratings by the ISO in 1991.

Based on the MassDEP May 2010 Guidelines for Public Water Systems, water mains providing fire protection and serving fire hydrants shall be 8-inch diameter or larger. Any recommendation in this section for water mains less than 8-inch diameter involve looping existing dead ends in the system with small sections of water mains. Additional hydrants would not be required on these sections of water main.

3.2 Model Update

The hydraulic model is represented by the node, pipe, and tank information provided in Appendix B. The hydraulic model provides information on storage facilities, water supply sources, 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. All node and pipe information has been included on a disk in Appendix B.

Billing data for all customers could not be provided. Demands were distributed evenly throughout the system.

3.3 Evaluation Criteria

The Hydraulic Evaluation facet of the Three Circle approach evaluates the system's ability to meet varying demand conditions. In general, a minimum pressure of 35 pounds per square inch (psi) at ground level is required during average day, maximum day, and peak hour (no coincident fire flow) demand conditions. During maximum day demand (MDD) with a coincident fire flow, a minimum pressure of 20 psi is required at ground level throughout the system. In order to evaluate the system's ability to meet these criteria, the following hydraulic simulations were run in the model:

Minimum/Maximum Pressure

During a projected year 2030 average day demand (ADD), MDD, and peak hour demand condition (no coincident fire flow), a minimum pressure of 35 psi is recommended throughout the distribution system at street level. An upper limiting pressure of 120 psi is generally recommended, as older fittings in the system are generally rated at 125 to 150 psi. Pressures above this level can result in increased water use from fixtures and also increased leakage throughout the distribution system. Also, plumbing code states that water heaters in homes can be affected when pressures exceed 80 psi. Under existing ADD conditions, static pressures are between 35 psi and 120 psi in most areas of the system. Some services with higher elevations near the tanks on High Street and on Pine Grove Circle can experience pressures lower than 35 psi. System pressures in the High Service Area range between 35 psi and 130 psi. The High Service Area can provide 35 psi to service elevations up to approximately 510 feet. Based on the operating HGL of the High Service Area, customers below an elevation of approximately 314 feet could experience pressures greater than 120 psi. System pressures in the Low Service Area range between 20 psi and 120 psi. The Low Service Area can provide 35 psi to service elevations up to approximately 417 feet. Based on the operating HGL of the Low Service Area, customers below an elevation of approximately 220 feet could experience pressures greater than 120 psi. Individual pressure reducing valves should be used for these customers.

Under projected MDD conditions, the system can maintain 35 psi except in the following locations: near the tanks on High Street, and at the end of the 8-inch diameter water main off of the western end of Douglas Road. Under projected peak hour conditions, the system can maintain 35 psi throughout the majority of the system except in the following locations: near the tanks on High Street, at the end of Harris Circle, in the northeast corner of Londonderry Way, at the end of Sylvan Road, at the end of the 8-inch water main off of the western end of Douglas Road, Country Squire Road east of the isolation valve, and Blackstone Road south of East Street. The operating HGL of the system cannot be adjusted without significantly increasing the static pressures downtown.

Insurance Services Office (ISO) Fire Flow Guidelines

The recommended fire flow in any community is established by the 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, contents, distance to adjacent buildings, and the availability of fire suppression systems. The flows recommended for proper fire protection are based on maintaining a residual pressure of 20 psi. This residual pressure is considered necessary to maintain a positive pressure in the system to allow continued service to the customers and avoid negative pressures that could introduce groundwater into the system. The estimated recommended fire flows, as determined by the ISO, were simulated on the hydraulic model. All scenarios were run using 2030 MDD conditions (2.9 mgd) and tank water levels set three feet below overflow. Areas where the available fire flows do not meet ISO recommended fire flow are considered hydraulically deficient. Recommended improvements have been developed to alleviate these deficiencies.

Table No. 3-1 summarizes the ISO recommendations and results of the model simulations. The test results list the estimated available flow and estimated recommended fire flow in various sections of the distribution system. The fire flows established by the ISO vary from 500 to 8,000 gpm, depending on the location and the structure. It should be noted that a water system is only required to provide a maximum of 3,500 gpm at any point in the system. The available flows are based on maintaining a residual pressure of 20 psi throughout the distribution system under 2030 MDD conditions.

Additional Fire Flow Requirements

According to the American Water Works Association (AWWA), the minimum recommended fire flow in residential areas where single-family homes are between 31 feet and 100 feet apart is approximately 750 gpm. For this study, the recommended fire flow of 750 gpm was simulated at all nodes in the hydraulic model. Improvements were then developed to meet the recommended fire flow in areas not able to meet 750 gpm.

Table No. 3-1
ISO Fire Flow Data – 1991

Test No.	Location of Flowing Hydrant	Recommended Flow at 20 psi (gpm)	Modeled Available Flow at 20 psi (gpm)
1	Scotts Lane and Elmdale Road	750	750
2	Millville Road and Quaker Highway	1,000	1,250
3	Douglas Street and Route 146	1,750	350*
4	Douglas Street and Cross Road	1,500	700*
5	Depot Street and Mendon Street	3,500	3,500
6	Mendon Street and Patrick Henry Street	3,500	1,500*
7	Capron Street and Fair Street	3,500	1,500*
8	East Hartford Avenue	500	800
9	Granite Street and Hartford Avenue East	2,250	1,750*
10	Sayles Street and North Main Street	2,000	1,700*
11	North Main Street and Parkis Street	2,500	1,600*

*Does not meet the recommended ISO fire flow.

3.4 Hydraulically Deficient Areas

Areas in the system that do not meet the ISO recommended fire flows or other recommended fire flows are considered hydraulically deficient. The following improvements include recommendations that mitigate these deficiencies. The improvements are intended to improve transmission, and help improve the inherent fire flow capacity in the system. A map depicting the recommended hydraulic improvements is provided in Appendix C.

ISO Fire Flow Improvements

1. The existing 8-inch diameter mains in the High Service Area cannot deliver adequate flow to meet the recommended fire flow for ISO location No. 3, at the intersection of Douglas Street and Route 146, and location No. 4, at the intersection of Douglas Street and Cross Road. Two alternatives can increase the available flow. A new 16-inch diameter water main, approximately 10,100 linear feet, can be installed along High Street from the end of the existing 16-inch diameter main to the vicinity of West Street and then connect to the existing 8-inch diameter main on Douglas Street (Route 16). The route involves crossing under Route 146. In addition to improving the available fire flow, the route will eliminate the dead end on Douglas Street. The second alternative involves replacing the existing 8-inch diameter water mains along Chamberlain Road, from High Street to Hunter Road, Hunter Road, from Chamberlain Road to Douglas Street, and Douglas Street (Route 16), from Hunter Road to the southern side of Route 146 with approximately 13,700 linear feet of 16-inch diameter main. In addition to helping meet the recommended ISO fire flow at the two locations, both improvements help meet the recommended fire flow of 750 gpm along Douglas Street.

2. In order to meet the recommended fire flow of 2,000 gpm at ISO location No. 10, located at the corner of Sayles Street and North Main Street (Route 122), a new 12-inch diameter water main is recommended to replace the existing 12-inch diameter Universal main on North Main Street, from Snowling Road to Hartford Avenue East. The location has an estimated available flow of approximately 1,700 gpm.

3. ISO location No. 9, located at the intersection of Granite Street and Hartford Avenue East, currently has an estimated flow of approximately 1,500 gpm available. To increase the available flow to the recommended 3,000 gpm, a new 12-inch diameter water main along North Main Street (Route 122), from Sayles Street to Hartford Avenue East, and along Hartford Avenue East, from North Main Street to Whitin Street, is recommended in addition to the improvements in recommendation No. 2.

4. It is recommended a new 12-inch diameter water main along North Main Street (Route 122) from Hartford Avenue East to Parkis Street be installed along with the previously mentioned improvements to North Main Street to provide the ISO

recommended fire flow of 2,500 gpm located at the intersection of North Main Street and Parkis Street (ISO Location No. 11). The estimated available flow at the location is 700 gpm.

5. In order to meet the ISO recommended fire flow of 3,000 gpm at ISO location No. 6, located at the intersection of Mendon Street (Route 16) and Patrick Henry Street, a new 12-inch diameter water main on Mendon Street, from South Main Street to Henry Street, and along Henry Street, from Mendon Street to Patrick Henry Street is recommended to replace the existing 12 and 8-inch diameter Universal mains along the route. The estimated available flow is approximately 1,500 gpm.

6. To meet the recommended ISO fire flow of 3,500 gpm at the ISO location No. 7, the McCloskey Middle School, a new 12-inch diameter water main along Capron Street, from Mendon Street to the middle school, is recommended along with the improvements along Mendon Street included in recommendation No. 5. This location has an estimated available fire flow of approximately 1,500 gpm.

Additional Fire Flow Improvements

7. The estimated available fire flow on Blackstone Street, south of Bacon Street, is less than 750 gpm. It is recommended a new 12-inch diameter water main be installed along South Main Street and Millville Road (Route 122) from the end of the existing 12-inch diameter main to Blackstone Street, and along Blackstone Street north to the existing 12-inch diameter main. In addition to the improved fire flow, the new main will eliminate the dead ends along South Main Street and Blackstone Street.

8. The bridge crossing the West River on Old Elmdale Road is currently out of service. A new 8-inch diameter water main is recommended along Hecla Street, from Old Elmdale Road to Brown Terrace, and along Elmdale Street, from Brown Terrace to Bacon Street, to improve the available fire flow in the vicinity of Bacon Street and Blackstone Street.

9. It is recommended a new 8-inch diameter water main along Hartford Avenue West, from Rivulet Street to Constitution Way, replace the existing 6-inch diameter main to improve the available flow on Lexington Lane.

10. To improve the available fire flow on Fletcher Street a new 8-inch diameter water main along Rivulet Street, from Hartford Avenue West to Fletcher Street, and along Fletcher Street, from Rivulet Avenue to Sylvan Road is recommended.

11. A new 8-inch diameter water main is recommended on William Ward Street, from Linwood Street to the existing 8-inch diameter main, to improve the available fire flow on William Ward Street.

12. The available fire flows on Susan Parkway are below 750 gpm. Currently, the existing mains are connected to the 6-inch diameter main on South Main Street. To increase the available fire flow, the mains should be connected to the 12-inch diameter water main on South Main Street.

13. Veterans Parkway currently has an estimated available fire flow less than 750 gpm. To increase the estimated available fire flow above 750 gpm, a new 8-inch diameter water main along Veterans Parkway, from the existing 12-inch diameter main to the end of the road, is recommended.

14. The estimated available fire flow on Upton Road is currently less than 750 gpm. A new 8-inch diameter water main along Upton Road from Hartford Avenue East to the existing 8-inch diameter main on Upton Road is recommended.

15. The existing 2-inch diameter water main on Gloria Street prevents an adequate fire flow from being available. A new 8-inch diameter main should be installed along this street.

SECTION 4 – Critical Component Assessment

4.1 General

A critical component assessment was performed for the water distribution system to evaluate the impact of potential water main failures on the water distribution system. The critical component assessment includes identification of critical areas served, critical water mains and the need for redundant mains.

4.2 Evaluation Criteria

Critical areas served are locations in the distribution system that require continuous water supply for public health, welfare or financial reasons. Examples of critical service areas include hospitals, nursing homes, schools, daycare centers, and business districts. All water mains within 500 feet of a critical area are considered a critical component. Because water storage tanks, sources, and booster pump stations provide water and maintain pressure to service areas, tanks and primary sources are considered critical components. Critical mains also include mains crossing active railroads, major highways, and rivers.

Critical water mains are mains that are the sole transmission main from a source or tank. In addition, main transmission lines that do not have a redundant main are considered critical. The evaluation included a visual review of the water mains leading into and out of the critical areas and the transmission grid.

4.3 Critical Components

Critical areas served, critical supply mains, and redundant mains were evaluated based on the criteria previously described. The following provides a listing of the areas that are considered critical components. A map of the critical components is included in Appendix D.

Critical Areas Served

A system-wide review of critical areas served such as health care facilities, and schools was completed. Other critical areas were identified during the workshop with DPW staff, and a total of 17 critical services were identified. Table No. 4-1 presents the critical areas served including critical services and critical components of the distribution system.

Table No. 4-1
Critical Customers and Components

Critical Area		Location
1.	Tri-River Family Health Care	281 East Hartford Avenue
2.	Lydia Taft House	60 Quaker Highway
3.	Whitin Elementary School	120 Granite Street
4.	Taft Early Learning Center	16 Granite Street
5.	Uxbridge High School	300 Quaker Highway
6.	Our Lady of the Valley Regional School	75 Mendon Street
7.	VCA Blackstone Valley Animal Hospital	615 Douglas Street
8.	AC Tech	660 Douglas Street
9.	McCloskey Middle School	62 Capron Street
10.	Blackstone Wells No. 1, 2 & 3	Blackstone Street
11.	Bernat Wells No. 4, 5 & 6	South Main Street
12.	Rosenfeld Well	308 Quaker Highway
13.	East Street Pump Station	East Street
14.	Fafard Pump Station	Crownshield Avenue
15.	Richardson Street Tank	Richardson Street
16.	Low Service Area Tank	High Street
17.	Interconnection with Whitinsville Water Company	North Main Street

Critical Water Mains

Critical water mains include primary transmission lines, mains greater than 12-inches in diameter, the 6-inch and 12-inch diameter mains along North and South Main Street, as well as mains connecting water storage tanks, sources, booster pump stations, and the interconnection with the Whitinsville Water Company to the system. In addition, primary distribution system water mains that do not have a redundant main are considered critical. Water mains that cross major highways, major rivers or active railroad tracks are also considered critical because of the damage that may occur during a break and the difficulty in construction and permitting involved in replacing or rehabilitation of the water main. Critical mains are highlighted on the Critical Components Map found in Appendix D.

Critical water mains were identified based on a review of the distribution system model, and by using the WaterGEMS criticality feature. The criticality feature runs multiple simulations that "break" each pipe in the model. The model calculates the impact of the break on the adequacy of flow and pressure after a pipe is taken out of service. This feature can identify areas served by multiple mains, but would no longer be able to serve customers if one of the mains were taken out of service. During the simulation, a pipe was considered critical if the simulated break left at least five percent of the system demands unmet.

The primary critical transmission mains are located along the following streets:

- The 16-inch diameter main along Richardson Street and High Street, which connects the Richardson Street Tank to the High Service Area,
- The 20-inch diameter main along Quaker Highway North (Route 146A), which connects the Rosenfeld Well to the distribution system,
- The cross country 16-inch diameter main and the 16-inch diameter mains along Douglas Street (Route 16) and Snowling Road connecting the Low Service Area Tank to the distribution system,
- The 12-inch diameter main along North and South Main Street (Route 122) from Rivulet Street to the end of the main south of Susan Parkway,
- The 6-inch diameter water main along North Main Street (Route 122) from Rivulet Street to Hartford Avenue East.

Additional critical mains are located along the following streets:

- The 6-inch diameter main along Blackstone Street, from Bacon Street to East Street,
- The 12-inch diameter main along East Street, from Blackstone Street to Patriot Way,
- The 8-inch diameter main along Chamberlain Road from High Street to Willow Lane.

SECTION 5 – Asset Management

5.1 General

The Uxbridge water distribution system includes approximately 62 miles of water mains varying in size and material. A number of factors including installation year, material, break history, soil conditions, static pressure, potential water hammer, and whether road work is scheduled affect the decision to replace or rehabilitate a water main. Using a customized Asset Management approach, each water main is assigned a rating based on these factors. The ratings are then used to help establish a prioritized schedule for water main replacement or rehabilitation.

5.2 Data Collection

Information regarding the water main diameters, material, and installation year was obtained during the previous studies and workshops with past and present Town employees and updated by the DPW. Information regarding break history and soil conditions were obtained from system records and other information provided by the DPW.

5.3 Evaluation Criteria

To assist in the prioritization of water main replacement or rehabilitation, a water main grading system was established. The grading system uses the water main characteristics such as installation year, material, break history, static pressure, soil characteristics, potential water hammer, and planned roadway construction to assign point values to each pipe in the system. Each category is assigned a rating between zero and 100 with zero being the most favorable and 100 being the worst case within the category. Each category is given a weighted percentage, which represents priorities within the system. It is at the Owner’s discretion to adjust the weight based on system performance and condition. Our recommendation is to assign a maximum of 30 percent to any one category. The rating is then multiplied by the weight and the weighted rating is utilized to determine the overall rating per pipe. Pipes with low to medium grades are candidates for rehabilitation and pipes with higher grades are candidates for replacement.

To establish a rating system specific to the Uxbridge water system, a workshop was held with the management and operators. During the workshop, it was determined that history of breaks, material, and planned roadway construction are of primary concern to the DPW. The grading system is shown in Table No. 5-1 and discussed in detail later in this section.

Table No. 5-1
Asset Management Rating

Weight	Performance Criteria	Rating	Weighted Rating
25%	Break History		
	3 or more breaks	100	25
	1 or 2 breaks	80	20
	No history of breaks	0	0
20%	Material		
	Unlined Cast Iron	100	20
	Universal	80	16
	Cement Lined Cast Iron	60	12
	PVC	10	2
	Ductile Iron	5	1
15%	Diameter		
	4-inches or Less	100	15
	6-inch water main	90	13.5
	8-inch water main	50	7.5
	10-inch water main	15	2.25
	12-inch water main	10	1.5
	16-inch water main	5	0.75
	20-inch water main or larger	3	0.45
15%	Planned Roadway Construction		
	Planned Roadway Construction	100	15
	No Planned Roadway Construction	0	0
10%	Installation Date		
	Before 1930	100	10
	1930-1949	80	8
	1950-1960	70	7
	1961-1970	60	6
	1971-1980	50	5
	1981-1990	20	2
	1991-2011	0	0
5%	Static Pressure		
	Greater than 120 psi	100	5
	100 to 120 psi	80	4
	80 to 100 psi	60	3
	Less than 80 psi	0	0
5%	Soils		
	Potentially corrosive soil	100	5
	Gravel/Sand	0	0
5%	Potential Water Hammer		
	250 psi and Greater	100	5
	Below 250 psi	0	0

Age/Material

The water industry in the United States followed certain trends over the last century. The installation date of a water main correlates with a specific pipe material that was used during that time as shown on Table No. 5-2. For example, up until the year 1958, unlined cast iron water mains were the predominant pipe material installed in water systems. Factory cement lined cast iron mains were manufactured from the late 1940s to about the mid 1970s, when pipe manufacturers switched primarily to factory cement lined ductile iron pipe.

Table No. 5-2
Pipe Material by Installation Year

Installation Year	Unlined Cast Iron	Universal	Factory Cement Lined Cast Iron	PVC	Ductile Iron	Total
Before 1930	16,510	33,324				49,834
1930 – 1949	7,491	117,195				124,686
1950 – 1960						0
1961 – 1970			3,947			3,947
1971 – 1980				1,544		1,544
1981 – 1990				21,955	47,825	69,780
1991 – 2011				1,217	76,668	77,885
Total	24,001	150,519	3,947	24,716	124,493	327,676

Cast iron water mains consist of two types; pit cast and sand spun. Pit cast mains were generally manufactured up to the year 1930 while sand spun mains were generally manufactured between 1930 and 1976. Pit cast mains with diameters between 4-inch and 12-inch do not have a uniform wall thickness and may have air inclusions as a result of the manufacturing process. This reduces the overall strength of the main, which makes it more prone to leaks and breaks.

The introduction of sand spun also included the introduction of stronger cast iron alloys and uniform wall thickness. Although sand spun mains have a uniform wall thickness, the overall wall thickness was thinner than the pit cast mains. The uniformity and improved cast iron alloys provided added strength, however, the thinner wall thickness made it more susceptible to corrosion failures and breaks. Pit cast mains 16-inch diameter and larger have very thick pipe walls and are generally stronger than the thinner walled sand spun cast mains. Research and development of factory cement lining for cast iron pipe began during the 1920s and continued for several decades. While the transition to factory cement lined cast iron mains had begun in the late 1940s, prior to the year 1958, most cast iron water mains that were manufactured were still unlined. Unlined cast iron mains increased the potential for internal corrosion. Lining the interior of mains provided increased protection against internal corrosion. By 1958, the majority of cast iron mains manufactured had a factory cement lining. Rubber gasket joints were also introduced around 1958. Prior to this date, joint material was jute (rope type material) packed in place with lead or a lead-sulfur compound, also known as leadite or hydrotite. Leadite type joint materials expand at a different rate than iron due to temperature changes. This can result in longitudinal split main breaks at the pipe bell. Sulfur in the leadite can promote bacteriological corrosion that can lead to circumferential breaks of the spigot end of the pipe.

Universal pipe was made of cast iron that used two bolts to connect the spigot and hub ends of the pipe. The pipe lengths were typically six foot long compared with typical 12 foot long sections of standard bell and spigot pit cast pipe resulting in twice as many pipe joints for a given section of water main. In addition, the bolts holding the joints together are subject to corrosion and failure.

Factory cement lined cast iron mains were manufactured and installed by the water industry up until about 1976. Overlapping this period, factory cement lined ductile iron main was manufactured from the 1950s, and continues to be manufactured today, although most New England water utilities did not begin to install ductile iron pipe until the 1970s. According to the Ductile Iron Pipe Research Association (DIPRA), ductile iron pipe retains all of cast iron's qualities such as machinability and corrosion resistance, but also provides additional strength, toughness, and ductility.

For the Uxbridge system, the changeover to factory cement lined cast iron pipe occurred in the 1960s.

Polyvinyl Chloride (PVC) pipe was first used in the United States in the early 1960s. Due to its resistance to both chemical and electrochemical corrosion, PVC pipe is not damaged by aggressive water or corrosive soils. In addition, the smooth interior of PVC pipe is resistant to tuberculation. The 1994 "Evaluation of Polyvinyl Chloride (PVC) Pipe Performance" by the AWWA Research Foundation, found that utilities have experienced minimal long term problems with PVC pipe. Generally, problems with PVC occurred when the area surrounding the pipe was disturbed after installation of the pipe, indicating that PVC pipe is not as strong as ductile iron with disturbances such as being hit by excavation equipment after installation. It should be noted that PVC is a permeable material. Low molecular weight petroleum products and organic solvents can permeate PVC pipe if the contaminants are found in high concentrations in the soil surrounding the pipe.

Cement lined ductile iron water main was introduced in the United States in 1950s. However, it was not widely used until the 1970s. According to the Ductile Iron Pipe Research Association (DIPRA), ductile iron pipe retains all of cast iron's qualities including machinability and corrosion resistance, but also provides additional strength, toughness and ductility.

Unlined cast iron water mains make up approximately seven percent of distribution system; universal cast iron water mains make up approximately 46 percent; factory cement lined cast iron water mains approximately one percent; PVC approximately eight percent; and ductile iron approximately 38 percent. Figures No. 5-1 and 5-2 present the installation year of the water mains and the materials, respectively. In general, the oldest water mains in the system received a high rating of 100, while the newest received a rating of zero.

Diameter

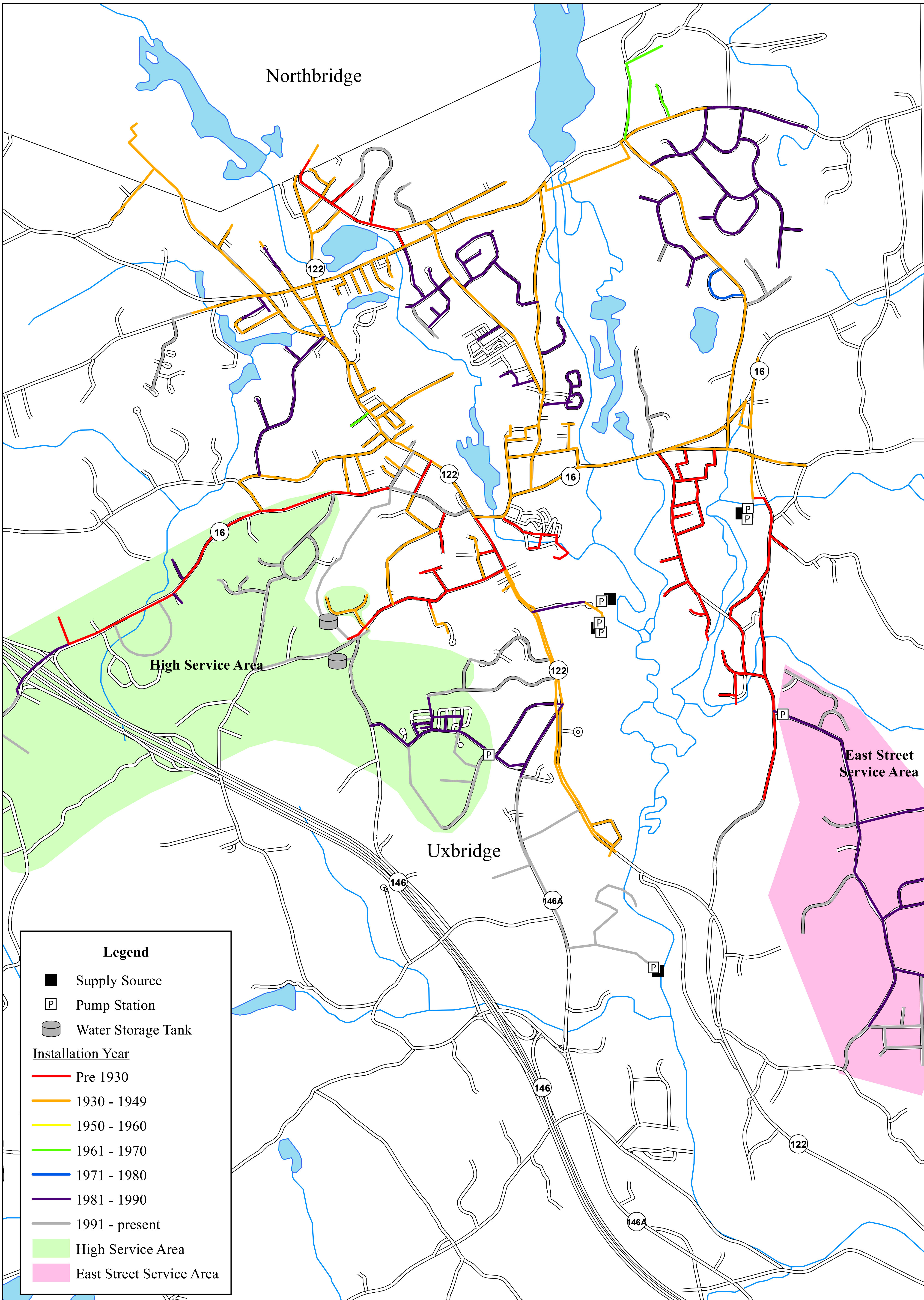
The Uxbridge distribution system consists of water mains ranging in diameter from 2-inch to 20-inch. Approximately 15 percent of the system is comprised of 12-inch diameter pipes, approximately 51 percent is comprised of 8-inch diameter pipes, and approximately 23 percent is 6-inch diameter pipes.

In general, as the diameter of a pipe increases, the strength increases. In most cases, failure occurs in the form of ring cracks. This is primarily the result of bending forces on the pipe. Pipes that are 6-inch in diameter are more likely to deflect or bend than a larger diameter main. Pipes that are 8-inch in diameter are less likely to break from bending forces than 6-inch mains due to their increased diameter and resulting increased moment of inertia. In addition, the pipe wall thickness typically increases as the pipe diameter increases. Pipes that are 16-inches in diameter and larger have significantly thicker walls than 12-inch diameter pipe and smaller diameter mains, such that in addition to superior bending resistance, they also are much more resistant to failure from pipe wall corrosion.

The rating system for the diameter of the water mains follows the concept that 4-inch diameter water mains are not as strong as 20-inch diameter water mains. Therefore, a rating of 100 was given to 4-inch diameter and smaller water mains and a rating of three was given to the 20-inch diameter water mains. Table No. 5-1 shows a significant drop in the rating score between a 6- inch diameter water main (90) and an 8-inch diameter water main (50). This is due to greater bending strength. An 8-inch diameter water main has proven to have nearly twice the bending strength of a 6-inch diameter water main. In general, 8-inch diameter water mains are stronger and less likely to break than 6-inch diameter pipes. Figure No. 5-3 presents the various diameter sizes throughout the distribution system.

Break History

Each water main break costs the system time and labor and increases non-revenue water use. They also cause disruption to the public and water consumers. At some point, it becomes more efficient to replace the main then to continue repairing it. The DPW has limited main break data; however, based on these records, there are several areas in the system that have experienced frequent breaks. Areas that have experienced three or more breaks per 1,000 feet have a score of 100 and areas that have experienced one or two breaks per 1,000 feet have a score of 80. Water mains that have had no breaks have a score of zero. Figure No. 5-4 presents areas with a history of breaks.



TATA & HOWARD

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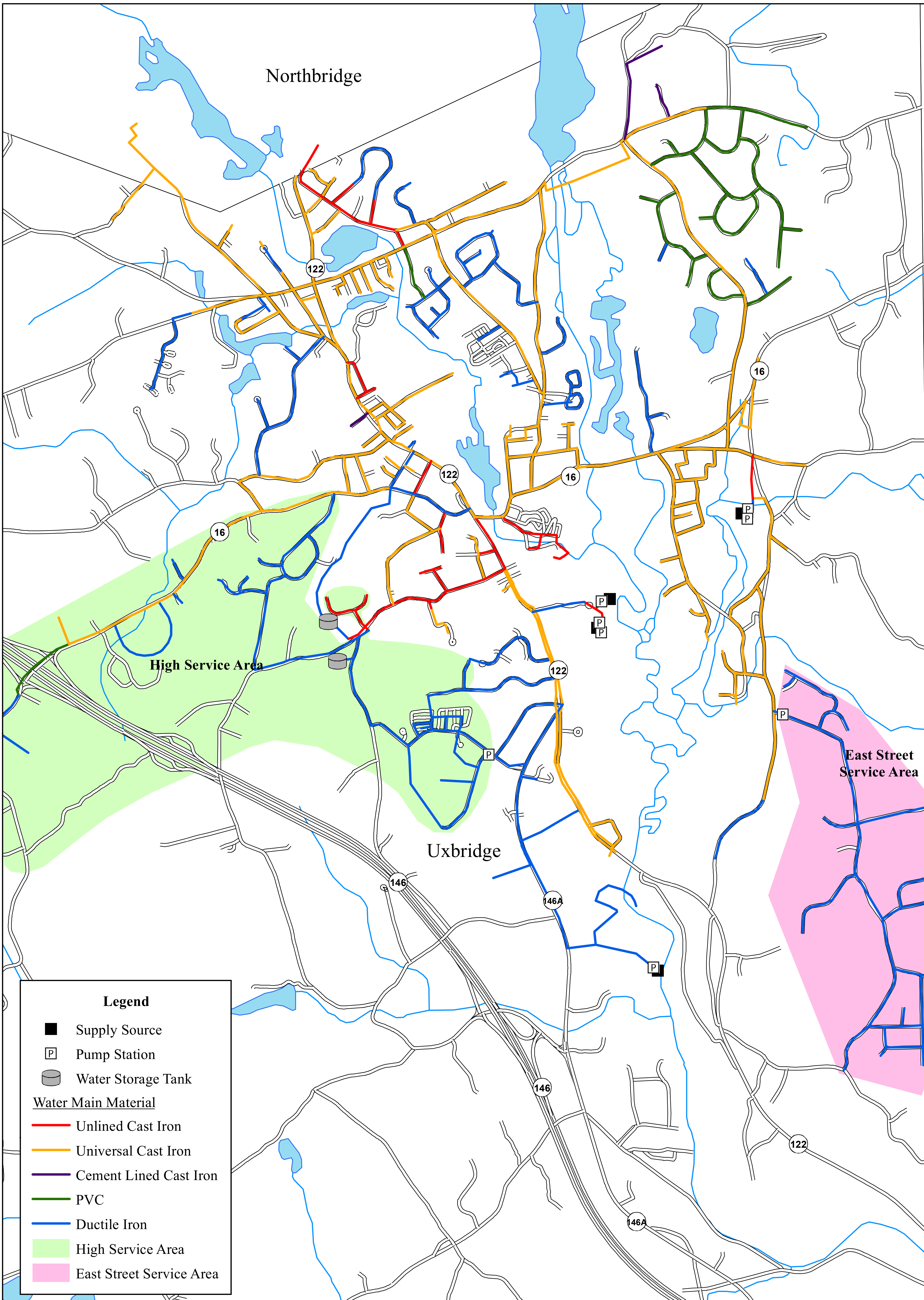
Water Main Installation Year

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-1



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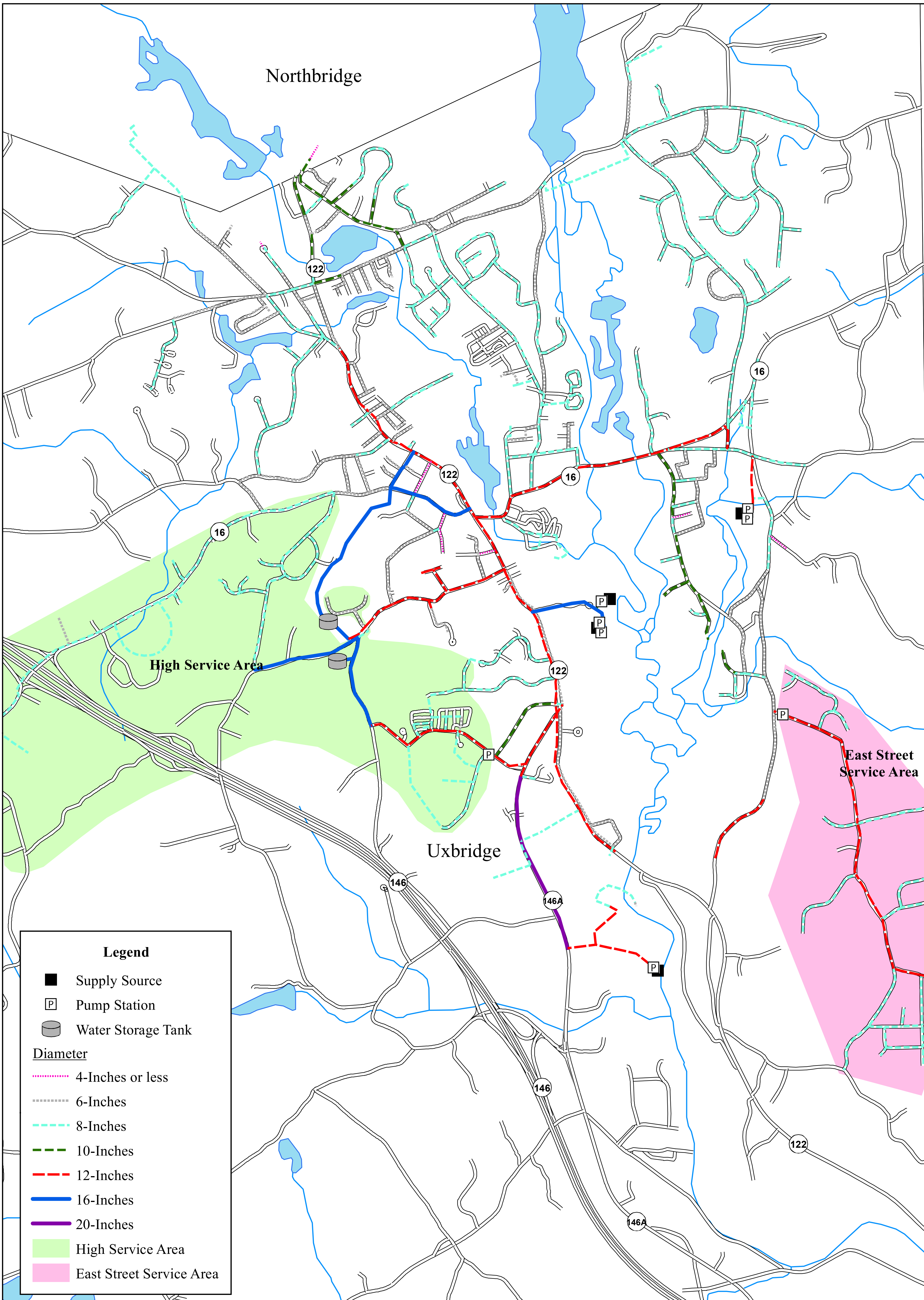
Water Main Material

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-2



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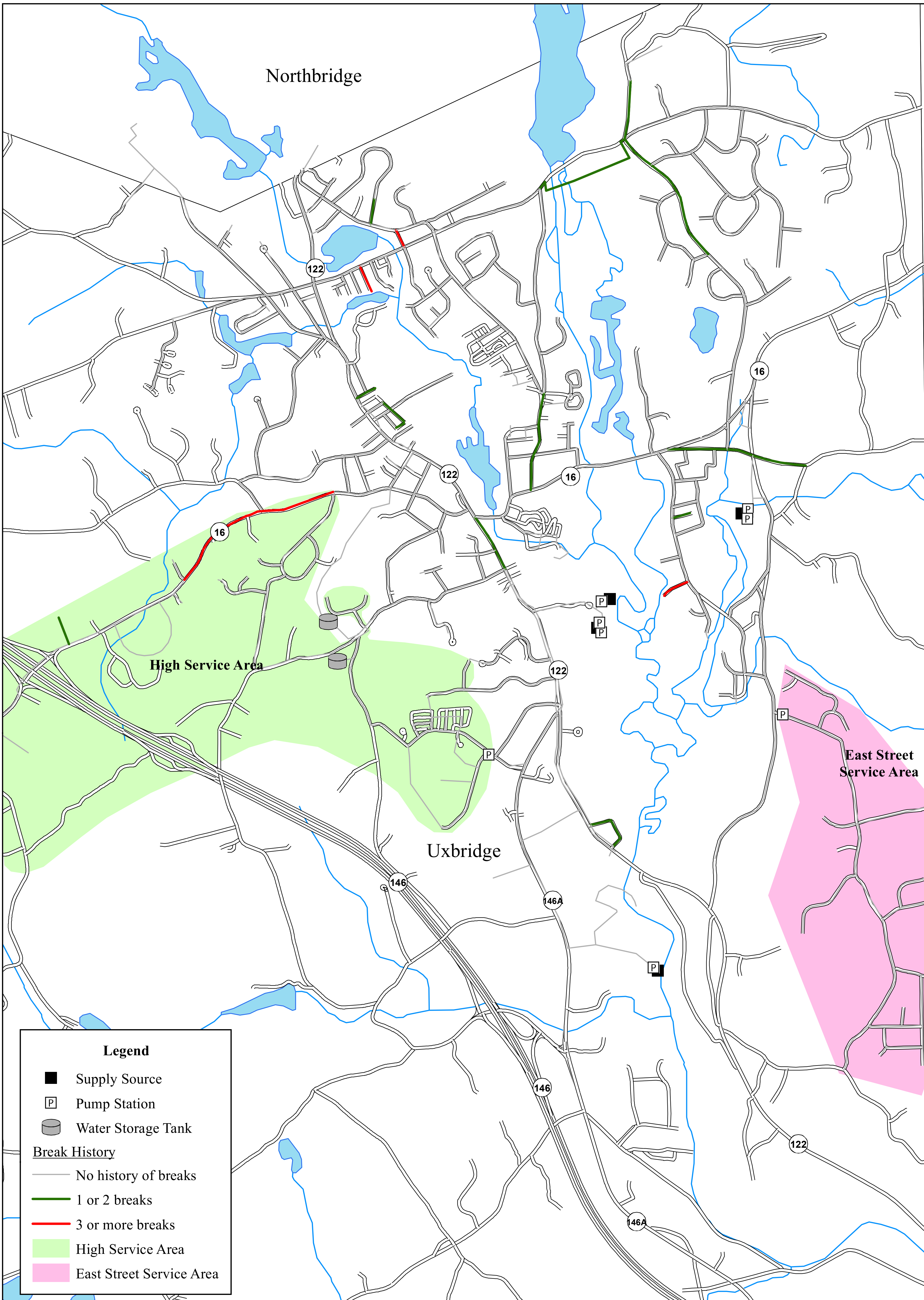
Water Main Diameter

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-3



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Areas with History of Breaks

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-4

Soils

Water main degradation can occur both internally and externally. Factors that increase the rate of external corrosion include high groundwater, clay soils, contaminated soils, soils with low calcium carbonate, or soils with high acidity or sulfate. The chemical and biological composition of soils and areas that vary in soil types can cause external pipe corrosion.

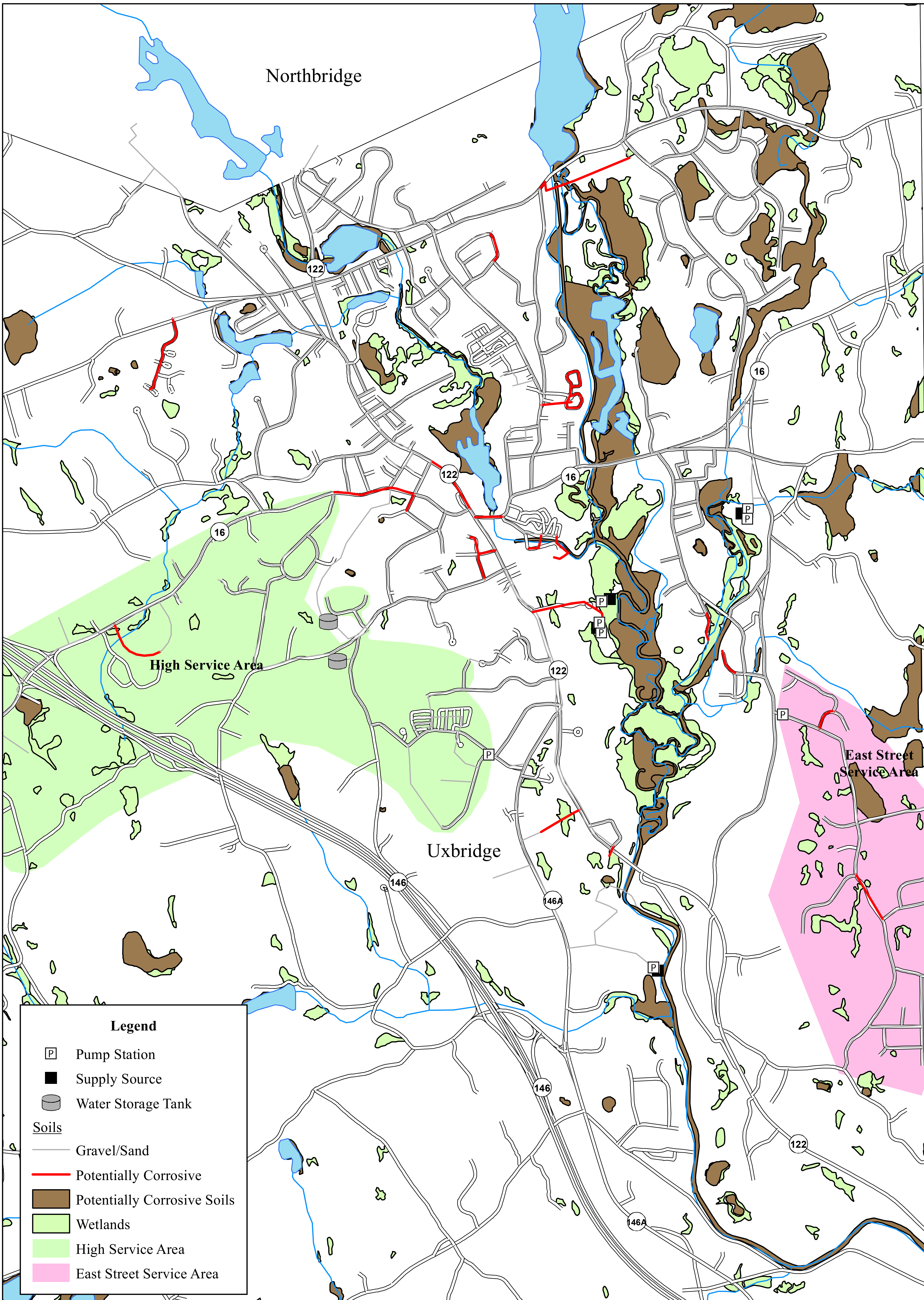
Wetlands areas, which are typically high in natural soil organics, have greater potential to cause external corrosion of water mains than other soil conditions. Figure No. 5-5 highlights areas with potentially corrosive soils. Areas where the water system and the potentially corrosive soils coincide are considered areas of potential exterior corrosion. Water mains located in potentially corrosive soils were assigned a rating of 100. All other pipe were assigned a rating of zero.

Static Pressure

Plumbing code states that water heaters can be affected when pressures exceed 80 psi. Pressures above 100 psi can result in increased water use from fixtures and also increased leakage throughout the distribution system. MassDEP Guidelines and Policies for Public Water Systems states that normal working pressures should be approximately 60 to 80 psi and not less than 35 psi. Areas with pressures exceeding 120 psi are recommended to have pressure reducing valves on the water mains. Pipes with higher pressures are more susceptible to water main breaks and the effects of water hammer. In addition, main failures in areas of higher pressures typically cause more disruption, and result in more costly repairs from damages. Water mains with a static pressure greater than 120 psi were given a rating of 100. Mains with a static pressure between 100 and 120 psi were given a rating of 80. Mains with a static pressure between 80 and 100 psi were assigned a rating of 60. All other mains were assigned a rating of zero. Figure No. 5-6 highlights approximate static pressures that are present in the system.

Potential Water Hammer

Water hammer occurs due to a sudden change in water velocity causing a high pressure wave to propagate throughout the system. This can happen if a line valve or hydrant valve is rapidly closed or a pump stops due to a power outage. A sudden pump stop often results in the rapid closure of the pump's check valve. An estimated water hammer potential was developed using the hydraulic model to determine static pressure and pipeline velocity during the peak hour of the 2030 maximum day. A potential water hammer of 250 psi approximates water traveling through a main at three feet per second with a static pressure of 100 psi. Locations with an estimated potential water hammer of 250 psi and greater were assigned 100 points. Water mains with an estimated potential water hammer of less than 250 psi were given a rating of zero. Figure No. 5-7 presents areas with potential impacts from water hammer in the system.



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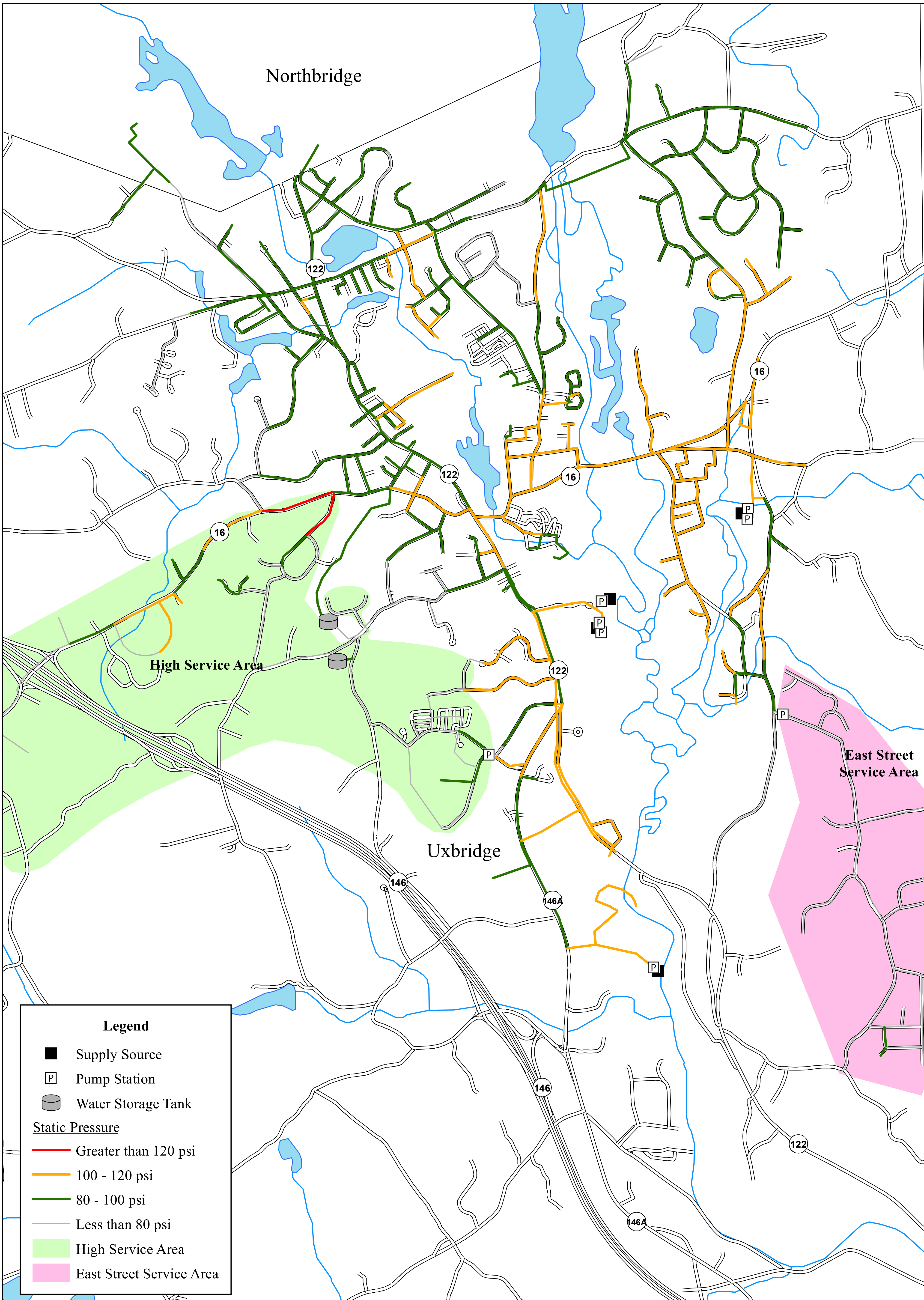
Potentially Corrosive Soils

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-5



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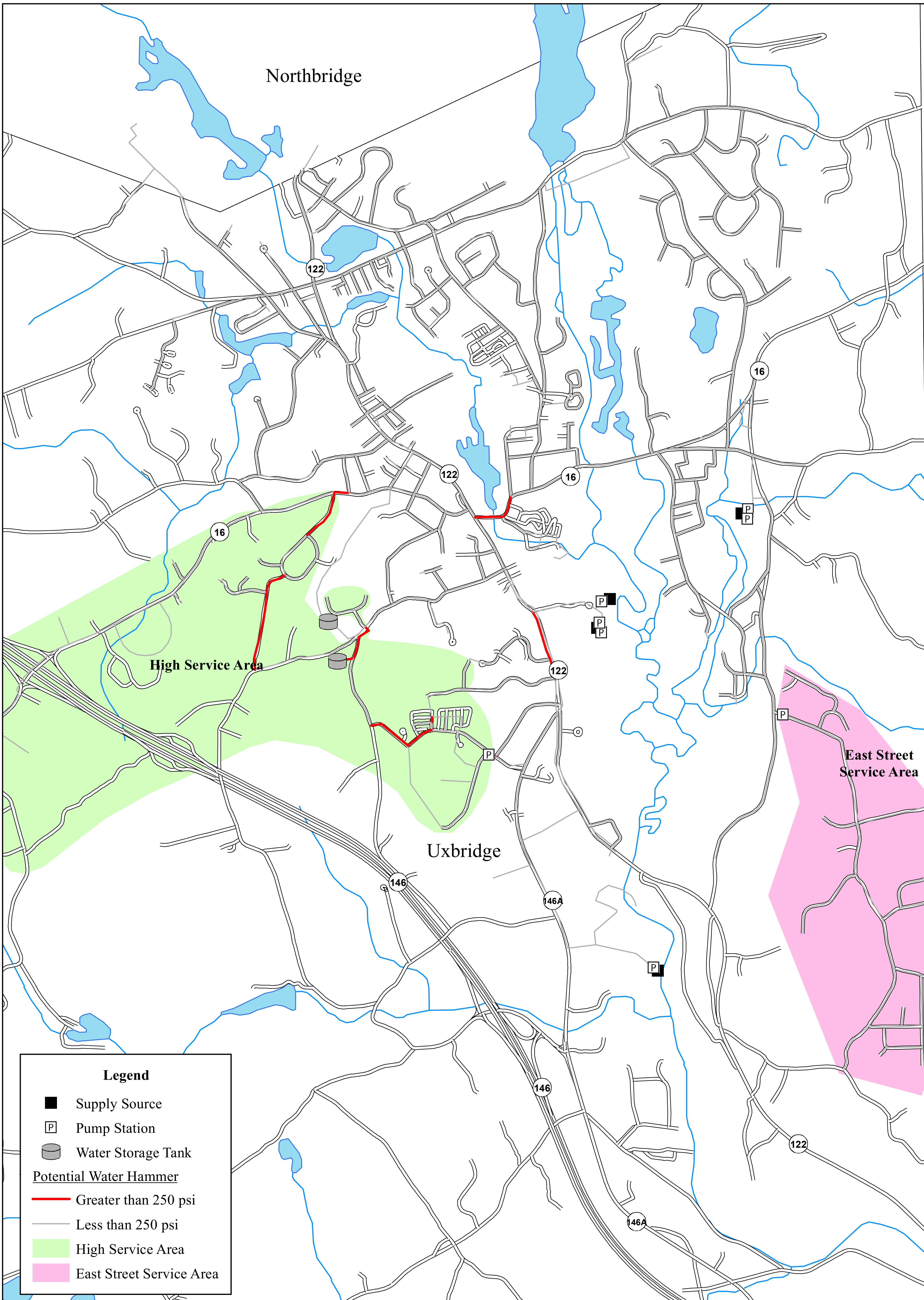
Static Pressure in Water Main

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-6



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Potential Water Hammer

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-7

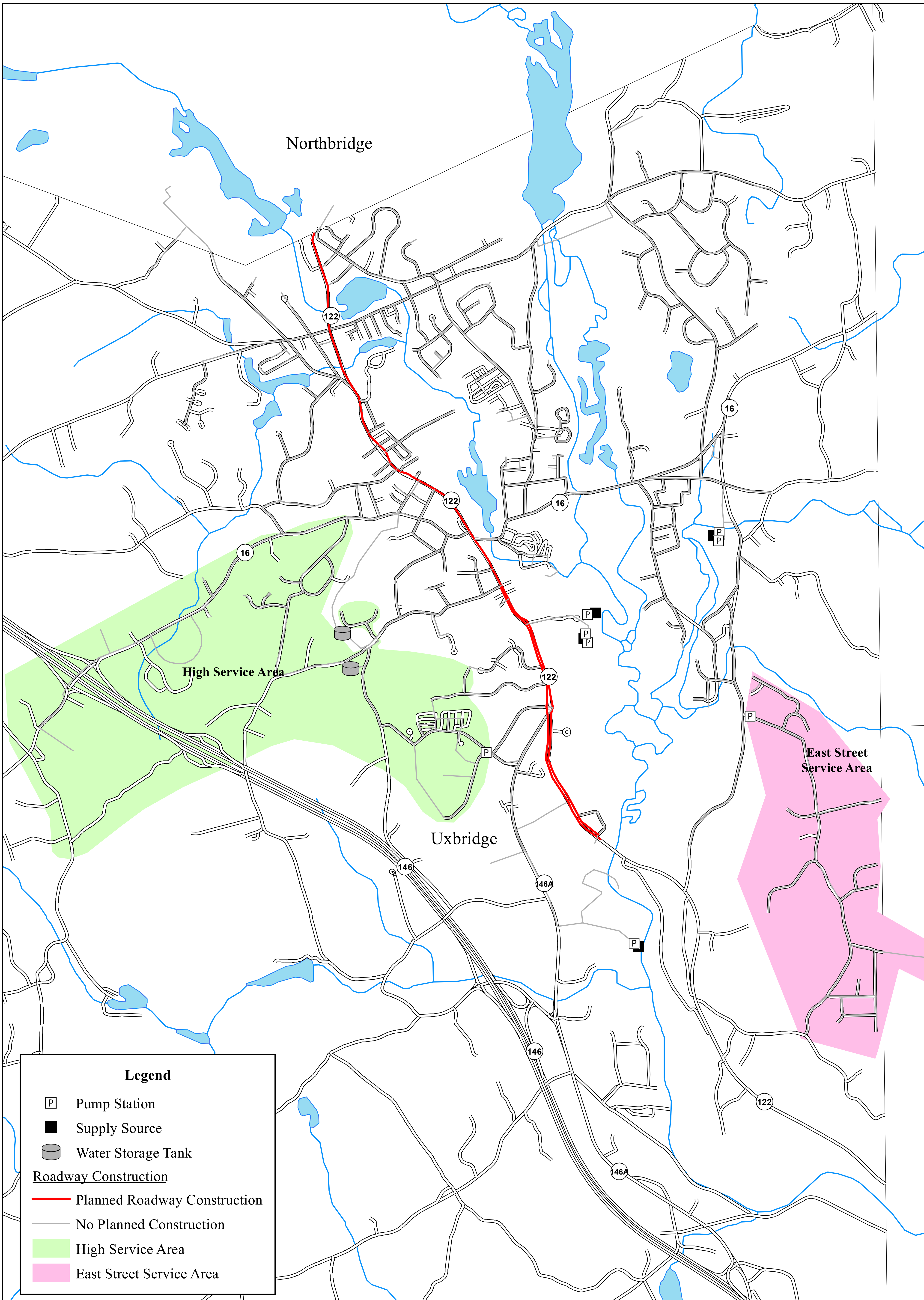
Planned Roadway Construction

North and South Main Street (Route 122) were identified by the DPW as a location that should be prioritized for main replacement. Currently, North and South Main Street is a state owned and maintained road. The State will be transferring ownership to the Town upon completion of roadway improvements and final paving. Any mains along Main Street were given a rating of 100, while mains not located along Main Street were given a rating of zero. Figure No. 5-8 highlights the mains along Main Street.

5.4 Asset Management Areas of Concern

Based on the asset management ratings, there are several areas of concern in the system. Water mains with a total rating between zero and 20 are considered to be in good to excellent condition. Areas with a total rating between 21 and 42 are considered to be in fair to good condition, and areas with a total rating of 43 or more are considered to be in poor to fair condition. The asset management scores for the individual pipe segments ranged from two to 71. Asset management ratings are presented graphically in Appendix E. Asset management input data for each pipe is included with the data included on the disk in Appendix B.

Because approximately 46 percent of the system is comprised of universal cast iron water mains, there are concerns about potential failures due to the number of joints, which are commonly subject to corrosion and failure. Additionally, disturbances to the soil surrounding the existing mains may negatively impact the integrity of the universal pipe. The water main break history collected during the study indicates that all but two of the breaks in the distribution system have occurred on the universal cast iron mains.



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Planned Roadway Construction

System Evaluation Study
Uxbridge, Massachusetts

Figure No.

5-8

SECTION 6 – Recommendations and Conclusions

6.1 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 improvements over an extended period of time as funds allow. Costs are based on the February 2013 Engineering News Record (ENR) construction cost index for Boston, MA of 12033.38 and include costs associated with water services, hydrants, permanent and temporary trench pavement and a 25 percent allowance for engineering and contingencies. Estimates do not include costs for land acquisition, easements, or legal fees.

The capital improvement projects considered by this study will provide a direct benefit to the overall level of service to the Uxbridge customers, provide redundancy, reduce operation and maintenance costs by reducing the frequency of water main failures and the damage they cause, as well as improve water quality and fire protection to the homeowners and businesses.

The Water Research Association's (formerly the American Water Works Research Foundation) study on "Cost of Infrastructure Failure," which was completed in 2002, found that in addition to direct costs paid by water utility ratepayers for water main failures, there are also societal costs, engineering costs, police assistance, fire department assistance, electrical, telephone and gas utility damage costs, landscaping restoration costs, and laboratory costs. Examples of societal costs included the cost of traffic impacts, business customer outage impacts, public health impacts (including loss of life), property damage not covered by direct costs, and the cost of reduced firefighting capability during the failure event.

Replacement of one percent of a system each year (a 100 year replacement cycle) is a reasonable guideline based on industry experience and analysis. For the Uxbridge distribution system, this would equate to approximately 3,000 linear feet of water main replacement each year as a guideline. Regular rehabilitation of water mains reduces main failures, leakage, and water quality issues. Water main rehabilitation can also provide socio-economic benefits by reducing operational costs associated with chemical and energy usage. Also, rehabilitation or replacement of water mains that are inadequately sized to provide needed fire protection will improve public safety.

Because approximately 46 percent of the system is comprised of universal cast iron water mains, there are concerns about potential water main failures. It is recommended that replacement of the universal cast iron assets should be on an accelerated replacement schedule.

6.2 General Recommendations

If the demands in the East Street Service Area continue to increase, the existing pump station will no longer be adequate. A study should be performed to investigate replacing the existing underground pump station with a new above ground pump station that can handle an increase in demands. In addition, a larger pump for fire protection should be included in the new pump station. The study should also examine the need for a hydropneumatic tank or a larger water storage tank for the service area to assist with peak demands.

As part of this study, the hydraulic model for the Uxbridge system was updated to reflect improvements to the system since the last study. The model was used to create a comprehensive database and pipe inventory. It is recommended the DPW continue to update the model and include new information on replacement water mains. The information input into the hydraulic model should include water main diameter, material, lining, joint type, soil conditions, and installation date.

It is recommended that prior to installation of all new ductile iron water mains, the DPW test the soils in the area of the new main to determine corrosion potential. If the soil is found to be potentially corrosive, the DPW should consider wrapping the main with polyethylene to protect against external corrosion. Wrapping is a relatively inexpensive practice that can extend the life of new ductile iron pipe. In addition, wrapping helps to protect the pipe from stray currents that may develop near the main.

New water mains installed should be at least 8-inches in diameter with hydrants installed approximately every 500 feet.

To maintain the integrity of the main failure database, it is recommended the DPW continue collecting data on main failures and review the existing main failure database for incorrect or missing data. Data should be organized into five categories including ring cracks (also referred to as circumferential breaks), lateral splits (also referred to as longitudinal splits), hole-in-pipe, joint leaks, and other. Service leaks and other failures not related to the water main itself should be kept as separate records from the main failure database. In addition, the exact location, date of failure (day/month/year), diameter, material, and actual cost of repair should be included in the database. If possible, the Town should include the apparent cause of the failure including frost load, traffic load, direct contractor damage, settlement, water hammer, external soil corrosion or stray current. The data should be used to create a Water Main Failure Map for identifying problem areas in the future. The map can be used to identify break locations and determine if any streets or areas have a higher frequency of failures, and to view any patterns in the location and type of failure. The water main failure database will aid the DPW in making future water main replacement decisions.

When a main breaks or during construction activities, the Town should maintain a one foot section of the pipe to use for pipe crushing. Pipe testing will allow the Town to determine the factor of safety of the various pipe cohorts in the system and estimate the useful life.

Based on the 2011 Annual Statistical Report, the unaccounted for water is 15 percent, which exceeds the 10 percent requirement in the Town's WMA permit. It is recommended that a water audit be completed to quantify and potentially reduce the amount of unaccounted for water in the system. Additionally, a leak detection survey should be completed every two years in accordance with the WMA permit.

The Town should continue to perform regularly scheduled maintenance programs, including hydrant flushing, inspection and maintenance at the wells, pump stations and water storage facilities and meter testing/calibration.

6.3 Prioritization of Water Distribution System Improvements

Based on the Three Circles Approach, a prioritized list of improvements was created. Improvements were separated into three phases. The Phase I and Phase II Improvements are prioritized based on hydraulic needs, location in the distribution system, and the condition of the water main. In general, the Phase I Improvements include water mains that fall into all three of the circles. Phase II Improvements generally include water mains that fall into two of the three circles. These improvements strengthen the transmission grid, mitigate potential asset management concerns, and provide redundancy.

Phase III Improvements generally fall into one circle. These improvements include the remaining hydraulic recommendations from Section 3 and areas with high asset management ratings. Phase III Improvements should be completed as funds become available and considered when reviewing road paving schedules. The hydraulically deficient areas, critical component considerations, and asset management ratings are combined on one Capital Efficiency Three Circles Integration Map included in Appendix F.

It should be noted that the list of improvements is extensive due to the nature of this report. This results in a high associated cost if all of the suggested improvements are constructed. The intent of the prioritization, therefore, is to serve as a guide for implementation from the most needed to the least needed improvements based on the prioritization and weighted criteria established jointly by the DPW and Tata & Howard. These improvements would most logically be constructed over an extended period of time.

Table No. 6-1, at the end of this section, includes a prioritized list of Phase I Water Distribution System Improvements and the hydraulic, critical component, and asset management status of each improvement. Table No. 6-2 includes the linear footage and estimated cost of each Phase I Improvement. Table No. 6-3 includes a prioritized list of Phase II Water Distribution System Improvements and Table No. 6-4 includes the linear footage and estimated cost of each Phase II Improvement. The Recommended Improvements Map is included in Appendix G. It should be noted that paving schedules or road improvements, except for the State paving Main Street (Route 122), were not evaluated as part of this study. The DPW may reprioritize the recommendations if paving, road work, or sewer installation or replacement is scheduled on any of the roads recommended for water main improvements; however, Phase I and II improvements should still take priority over Phase III improvements.

Phase I Improvements

1. There are multiple locations with ISO recommended fire flows in the northern part of the distribution system. To improve the available flow at the intersection of Granite Street and Hartford Avenue East and transmission capabilities to the north, a new 12-inch diameter main along North Main Street (Route 122), from Snowling Road to the end of the main at the Town line with Northbridge is recommended. The water main is considered in fair to poor condition due to an asset management rating of 44 to 56. The high rating is due to the water main's installation year, material, diameter, and location on Route 122, which is scheduled for roadway improvements and paving. The water main is considered critical because it is the primary feed for the northern part of the system, serves the downtown area, and crosses multiple rivers. The estimated probable construction cost of approximately 7,100 linear feet of 12-inch diameter ductile iron water main is $1,332,000.

   The existing main along South Main Street (Route 122), from Snowling Road to the end of the main at the Blackstone River, is considered to be in fair to poor condition due to the material, installation date, history of breaks, and the scheduled paving of Route 122. The main is considered critical because it is the primary transmission main running north and south in the distribution system and serves the downtown area. A new 12-inch diameter water main is recommended to replace the existing 12-inch diameter main. The estimated probable construction cost of approximately 11,100 linear feet of 12-inch diameter ductile iron water main is $2,007,000. In addition, the 6-inch diameter main running parallel to the 12-inch diameter main should be taken out of service and all services and water main connections should be moved to the 12-inch diameter main.

2. A new 12-inch diameter water main along Mendon Street (Route 16), from North Main Street to Henry Street, and along Henry Street to Patrick Henry Street, is recommended. The existing main is hydraulically deficient and the improvement will provide the recommended ISO fire flow. In addition, the improvement will increase the available flow at the ISO location at the McCloskey Middle School on Capron Street. The main is considered critical because it crosses the Blackstone River and serves the Our Lady of the Valley Regional School. The main along Henry Street is considered to be in fair to poor condition due to the water main's material, history of breaks, diameter, and installation year. The

estimated probable construction cost of approximately 6,200 linear feet of 12-inch diameter ductile iron water main is $1,347,000.

3. It is recommended a new 16-inch diameter water main is constructed along High Street, from Chamberlain Road to the vicinity of West Street, and then connect to the existing 8-inch diameter main along Douglas Street. In addition to meeting the two ISO recommended flows, the improvement will increase the available fire flow on the rest of Douglas Street to at least 750 gpm. The route is considered critical because Douglas Street serves two critical customers. Because there is currently no main along this route, there is no asset management rating associated with this improvement. The estimated probable construction cost of approximately 10,100 linear feet of 16-inch diameter ductile iron water main is $2,273,000.

Phase II Improvements

4. The main on Old Elmdale Road crossing the West River has been taken out of service. This has caused a hydraulic deficiency along the roads southwest of this river crossing. To improve the fire flow capabilities in this section of the distribution system and for redundancy, a new 8-inch diameter main along Hecla Street, from Old Elmdale Road to Brown Terrace, and along Elmdale Road, from Brown Terrace to Bacon Street, is recommended. Currently, there is no main along this section of Hecla Street, but the main along Elmdale Road is in fair to poor condition. The main has a high rating due to its diameter, material, and installation date. The estimated probable construction cost of approximately 2,300 linear feet of 8-inch diameter ductile iron water main is $375,000.

5. To provide the recommended fire flow at the ISO location at the intersection of Granite Street and Hartford Avenue East, a new 12-inch diameter water main is recommended to replace the existing hydraulically deficient 6 and 10-inch diameter mains on Hartford Avenue East, from North Main Street to Whitin Street. The main is considered critical because it crosses a railroad track and the Mumford River. The estimated probable construction cost of approximately 2,200 linear feet of 12-inch diameter ductile iron water main is $413,000.

6. The McCloskey Middle School, located off Capron Street, is a critical customer. To provide the recommended fire flow, a new 12-inch diameter water main is recommended to replace the existing 8-inch diameter main. The estimated probable construction cost of approximately 1,700 linear feet of 12-inch diameter ductile iron water main is $319,000.

7. An 8-inch diameter water main is recommended along Hartford Avenue West, from Rivulet Street to Lexington Lane, to provide adequate fire flow along Lexington Lane. The main is considered critical because it crosses the Cold Spring Brook. The estimated probable construction cost of approximately 2,200 linear feet of 8-inch diameter ductile iron water main is $358,000.

8. The 2-inch diameter main along Gloria Street is unable to provide adequate fire flow for this street. A new 8-inch diameter water main is recommended to replace the existing main. The existing main has an asset management rating of 65 due its diameter, history of breaks, material, and installation date. The estimated probable construction cost of approximately 400 linear feet of 8-inch diameter ductile iron water main is $115,000.

9. The existing 6-inch diameter Universal main on Susan Parkway is in fair to poor condition with an asset management rating of 62. The poor rating is due to a history of main breaks, the material, diameter, and installation date of the main. In addition, the main cannot provide adequate fire flow to the neighborhood. A new 8-inch diameter water main along Susan Parkway is recommended and the main should be tied into the 12-inch diameter main along South Main Street. The main is currently only connected to the 6-inch diameter main along South Main Street. The estimated probable construction cost of approximately 1,200 linear feet of 8-inch diameter ductile iron water main is $195,000.

10. The existing 6-inch diameter main on Upton Road, from Hartford Avenue East to the existing 8-inch diameter main, is hydraulically deficient and should be replaced with a new 8-inch diameter main. In addition, the main is in fair to poor condition with an asset management rating of 55 due to its diameter and history of breaks. The estimated probable construction cost of approximately 1,300 linear feet of 8-inch diameter ductile iron water main is $212,000.

11. The 8-inch diameter cross country main off Hartford Avenue East, west of Oak Street is considered critical because it crosses the Blackstone River and the Blackstone Canal. The main has an asset management rating ranging from 56 to 60 due to a history of breaks, the installation date, and the material. A new 8-inch diameter water main is recommended to replace the existing main. The new main should be constructed within the road right of way to allow for easier access in the event of an emergency. The estimated probable construction cost of approximately 3,100 linear feet of 12-inch diameter ductile iron water main is $582,000.

12. A new 8-inch diameter water main is recommended to replace the existing 8-inch diameter main along Henry Street, from Patrick Henry Street to the end of the main. The existing main is in fair to poor condition with an asset management rating of 56. The high rating is due to the water main's material, installation date, and history of breaks. This main is considered critical because it crosses the West River. The estimated probable construction cost of approximately 1,800 linear feet of 8-inch diameter ductile iron water main is $293,000.

13. It is recommended the existing 6 and 8-inch diameter water mains on Oak Street, from Mendon Street to Heritage Road, be replaced with new 8-inch diameter

mains. The existing mains are considered critical because of their proximity to Our Lady of the Valley Regional School. The mains are considered to be in fair to poor condition with the asset management rating ranging from 41 to 56. The high rating is due to the material, installation date, diameter, and a history of breaks of the mains. The estimated probable construction cost of approximately 2,900 linear feet of 8-inch diameter ductile iron water main is $472,000.

14 & 15. The two 8-inch diameter mains off Depot Street are considered to be in fair to poor condition. These mains have asset management ratings of 46 due to the soil conditions, water main material, and installation date. In addition, both mains cross the Mumford River and are considered critical. It is recommended both mains be replaced with new 8-inch diameter water mains. The estimated probable construction cost of approximately 1,400 linear feet of 8-inch diameter ductile iron water main is $229,000.

16. A new 8-inch diameter main along Blackstone Street, from Old Blackstone Street to East Street, is recommended to replace the existing 6-inch diameter main. The existing main is considered critical due to its proximity to the East Street Pump Station and is in fair to poor condition with an asset management rating of 44. The high rating is due to the water main's diameter, installation date, and material. The estimated probable construction cost of approximately 2,900 linear feet of 8-inch diameter ductile iron water main is $472,000.

Phase III Improvements

Phase III Improvements include recommendations that represent the remaining hydraulic improvements from Section 3 and water mains that have asset management ratings greater than 42 and are considered in fair to poor condition.

Table No. 6-1
Prioritization of Improvements – Phase I

Item No.	Location	From	To	Hydraulically Deficient?	Critical Area?	Asset Management Rating
1.	North Main Street (Route 122)	Snowling Road	Interconnection with Whitinsville Water Company	Y	Y	44 – 56
	South Main Street (Route 122)	Snowling Road	Blackstone River	N	Y	44 – 71
2.	Mendon Street (Route 16)	North Main Street	Henry Street	Y	Y	30 – 40
	Henry Street	Mendon Street	Patrick Henry Street	Y	N	56
3.	High Street and connection to Douglas Street	Chamberlain Road	Douglas Street	Y	Y	n/a

Table No. 6-2
Estimated Improvement Costs – Phase I

Item No.	Location	From	To	Water Main Diameter (in.)	Length (LF)	Estimated Cost
1.	North Main Street (Route 122)	Snowling Road	Interconnection with Whitinsville Water Company	12	7,100	$ 1,332,000
	South Main Street (Route 122)	Snowling Road	Blackstone River	12	11,100	$ 2,082,000
2.	Mendon Street (Route 16)	North Main Street	Henry Street	12	4,900	$ 1,103,000
	Henry Street	Mendon Street	Patrick Henry Street	12	1,300	$ 244,000
3.	High Street and connection to Douglas Street	Chamberlain Road	Douglas Street	16	10,100	$ 2,273,000
					Total Estimated Phase I Cost:	**$ 7,034,000**

Table No. 6-3
Prioritization of Improvements – Phase II

Item No.	Location	From	To	Hydraulic Deficient?	Critical Area?	Asset Management Rating
4.	Hecla Street	Old Elmdale Road	Brown Terrace	Y	Y	n/a
	Elmdale Road	Brown Terrace	Bacon Street	Y	Y	43
5.	Hartford Avenue East	North Main Street	Whitin Street	Y	Y	29 – 42
6.	Capron Street	Mendon Street	End of main	Y	Y	36
7.	Hartford Avenue West	Rivulet Street	Lexington Lane	Y	Y	15 – 41
8.	Gloria Street	Hecla Street	End of main	Y	N	65
9.	Susan Parkway	South Main Street	South Main Street	Y	N	62
10.	Upton Road	Hartford Avenue East	8-inch main	Y	N	55
11.	Off Hartford Avenue East	Oak Street	Upton Road	N	Y	56 – 60
12.	Henry Street	Patrick Henry Street	End of main	N	Y	56
13.	Oak Street	Mendon Street	Heritage Road	N	Y	41 – 56
14.	Off Depot Street	Depot Street	End of main	N	Y	46
15.	Off Depot Street	Depot Street	End of main	N	Y	46
16.	Blackstone Street	Old Blackstone Street	East Street	N	Y	43 – 44

Table No. 6-4
Estimated Improvement Costs – Phase II

Item No.	Location	From	To	Water Main Diameter (in.)	Length (LF)	Estimated Cost
4.	Hecla Street	Old Elmdale Road	Brown Terrace	8	900	$ 147,000
	Elmdale Road	Brown Terrace	Bacon Street	8	1,400	$ 228,000
5.	Hartford Avenue East	North Main Street	Whitin Street	12	2,200	$ 413,000
6.	Capron Street	Mendon Street	End of main	12	1,700	$ 319,000
7.	Hartford Avenue West	Rivulet Street	Lexington Lane	8	2,200	$ 358,000
8.	Gloria Street	Hecla Street	End of main	8	400	$ 115,000
9.	Susan Parkway	South Main Street	South Main Street	8	1,200	$ 195,000
10.	Upton Road	Hartford Avenue East	8-inch main	8	1,300	$ 212,000
11.	Off Hartford Avenue East	Oak Street	Upton Road	12	3,100	$ 582,000
12.	Henry Street	Patrick Henry Street	End of main	8	1,800	$ 293,000
13.	Oak Street	Mendon Street	Heritage Road	8	2,900	$ 472,000
14.	Off Depot Street	Depot Street	End of main	8	900	$ 147,000
15.	Off Depot Street	Depot Street	End of main	8	500	$ 82,000
16.	Blackstone Street	Old Blackstone Street	East Street	8	2,900	$ 472,000
					Total Estimated Phase II Cost:	**$ 4,035,000**

TATA & HOWARD

Table No. 6-5
Prioritization of Improvements – Phase III

Item No.	Location	From	To	Hydraulic Deficient?	Critical Area?	Asset Management Rating
17.	William Ward Street	Linwood Street	8-inch main	Y	N	41
18.	Linwood Street	William Ward Street	Hartford Avenue East	Y	N	41
19.	Rivulet Street/Fletcher Street	Hartford Avenue West	Sylvan Road	Y	N	32 – 41
20.	Veterans Parkway	12-inch main	End of main	Y	N	38
21.	South Main Street/Millville Road (Route 122)	Susan Parkway	Blackstone Street	Y	N	n/a
	Blackstone Street	Millville Road	12-inch main	Y	N	n/a
22.	Boston Street	Hartford Avenue East	End of main	N	N	66
23.	South Garden Street	North Main Street	End of main	N	N	65
24.	Douglas Street (Route 16)	Snowling Road	Cold Spring Drive	N	N	48 – 64
25.	Glendale Avenue	Moody Street	Dale Street	N	N	62
26.	Dale Street	Glendale Avenue	Boston Avenue	N	N	62
27.	Whitin Street	Linwood Street	Hartford Avenue East	N	N	61
28.	Main serving DPW	Hecla Street	End of main	N	N	57
29.	West River Road	Hartford Avenue East	Henry Legg Road	N	N	55
30.	Lake Street	Linwood Street	8-inch main	N	N	55
31.	Park Street	North Main Street	Pleasant Street	N	N	54
32.	Seagrave Street	Douglas Street	North Main Street	N	N	48 – 49

Table No. 6-5 (Continued)
Prioritization of Improvements – Phase III

Item No.	Location	From	To	Hydraulic Deficient?	Critical Area?	Asset Management Rating
33.	Farnum Street	Douglas Street	End of main	N	N	48
34.	Pleasant Street	High Street	End of main	N	N	46
35.	Providence Road (Route 122) Northbridge	10-inch main	End of main	N	N	46
36.	Garden Street	North Main Street	South Garden Street	N	N	45
37.	Chapin Street	Blackstone Street	End of main	N	N	45
38.	Brown Terrace	Hecla Street	Blackstone Street	N	N	44
39.	Power Street	Henry Street	Elizabeth Street	N	N	44
40.	Elizabeth Street	Power Street	Fagan Street	N	N	44
41.	Kennedy Street	Henry Street	Hecla Street	N	N	44
42.	Fagan Street	Hecla Street	Elizabeth Street	N	N	44
43.	Old Blackstone Street	Brown Terrace	Blackstone Street	N	N	44

Table No. 6-6
Estimated Improvement Costs – Phase III

Item No.	Location	From	To	Water Main Diameter (in)	Length (LF)	Estimated Cost
17.	William Ward Street	Linwood Street	8-inch main	8	1,600	$ 260,000
18.	Linwood Street	William Ward Street	Hartford Avenue East	8	400	$ 115,000
19.	Rivulet Street/Fletcher Street	Hartford Avenue West	Sylvan Road	8	3,900	$ 634,000
20.	Veterans Parkway	12-inch main	End of main	8	800	$ 130,000
21.	South Main Street/Millville Road (Route 122)	Susan Parkway	Blackstone Street	12	2,500	$ 469,000
	Blackstone Street	Millville Road	12-inch main	12	1,100	$ 207,000
22.	Boston Street	Hartford Avenue East	End of main	8	600	$ 98,000
23.	South Garden Street	North Main Street	End of main	8	500	$ 82,000
24.	Douglas Street (Route 16)	Snowling Road	Cold Spring Drive	8	5,500	$ 1,073,000
25.	Glendale Avenue	Moody Street	Dale Street	8	600	$ 117,000
26.	Dale Street	Glendale Avenue	Boston Avenue	8	300	$ 87,000
27.	Whitin Street	Linwood Street	Hartford Avenue East	12	400	$ 125,000
28.	Main serving DPW	Hecla Street	End of main	8	600	$ 98,000
29.	West River Road	Hartford Avenue East	Henry Legg Road	8	3,300	$ 537,000
30.	Lake Street	Linwood Street	8-inch main	8	600	$ 98,000
31.	Park Street	North Main Street	Pleasant Street	8	400	$ 115,000
32.	Seagrave Street	Douglas Street	North Main Street	8	800	$ 130,000
33.	Farnum Street	Douglas Street	End of main	8	900	$ 147,000

Table No. 6-6 (Continued)
Estimated Improvement Costs – Phase III

Item No.	Location	From	To	Water Main Diameter (in)	Length (LF)	Estimated Cost
34.	Pleasant Street	High Street	End of main	8	1,100	$ 179,000
35.	Providence Road (Route 122) Northbridge	End of 10-inch main	End of main	8	300	$ 104,000
36.	Garden Street	North Main Street	South Garden Street	8	900	$ 147,000
37.	Chapin Street	Blackstone Street	End of main	8	500	$ 82,000
38.	Brown Terrace	Hecla Street	Blackstone Street	8	1,400	$ 228,000
39.	Power Street	Henry Street	Elizabeth Street	8	1,000	$ 163,000
40.	Elizabeth Street	Power Street	Fagan Street	8	1,100	$ 179,000
41.	Kennedy Street	Henry Street	Hecla Street	8	900	$ 147,000
42.	Fagan Street	Hecla Street	Elizabeth Street	8	700	$ 114,000
43.	Old Blackstone Street	Brown Terrace	Blackstone Street	8	300	$ 87,000
Total Estimated Phase III Cost:						**$ 5,952,000**

APPENDIX A

TATA & HOWARD

Northbridge
Mendon
Millville
Interconnection with Whitinsville Water Company
Low Service Area Tank
Capacity: 1.5 mg
Overflow Elevation: 500 feet
Richardson Street Tank
Capacity: 1.0 mg
Overflow Elevation: 591 feet
High Service Area
Bernat Well No. 4
Bernat Wells No. 5 & 6
Blackstone Wells No. 1, 2 & 3
East Street Pump Station
Firm Capacity: 50 gpm
East Street Service Area
Fafard Pump Station
Firm Capacity: 0.5 mgd
Rosenfeld Well
Legend
Water Main Diameter
4-inches or Less
6-inches
8-inches
10-inches
12-inches
16-inches
20-inches
High Service Area
East Street Service Area
Water Distribution System
Uxbridge, Massachusetts
TATA & HOWARD
Water and Wastewater Consultants
Approximate Scale: 1"=1,000'
February 2014

APPENDIX B

TATA & HOWARD

ID	Label	Elevation (ft)	Demand (gpm)	Zone
128	J-2	296	5.92	123: Main System
129	J-4	302	5.92	123: Main System
130	J-6	394	5.92	1266: Low Pressure
131	J-8	322	5.92	123: Main System
132	J-10	292	5.92	123: Main System
133	J-12	282	5.92	123: Main System
134	J-14	278	5.92	123: Main System
135	J-18	278	5.92	123: Main System
136	J-20	269	5.92	123: Main System
137	J-22	266	5.92	123: Main System
138	J-24	267	5.92	123: Main System
139	J-26	266	5.92	123: Main System
140	J-28	262	5.92	123: Main System
141	J-30	247	5.92	123: Main System
142	J-32	253	5.92	123: Main System
143	J-34	282	5.92	123: Main System
144	J-36	299	5.92	123: Main System
145	J-38	262	5.92	123: Main System
146	J-40	279	5.92	123: Main System
147	J-42	277	5.92	123: Main System
148	J-44	276	5.92	123: Main System
149	J-46	269	5.92	123: Main System
150	J-48	256	5.92	123: Main System
151	J-50	272	5.92	123: Main System
152	J-52	276	5.92	123: Main System
153	J-54	272	5.92	123: Main System
154	J-56	289	5.92	123: Main System
155	J-58	299	5.92	123: Main System
156	J-60	299	5.92	123: Main System
157	J-62	302	5.92	123: Main System
158	J-64	276	5.92	123: Main System
159	J-66	276	5.92	123: Main System
160	J-68	269	5.92	123: Main System
161	J-70	268	5.92	123: Main System
162	J-72	339	5.92	123: Main System
163	J-74	295	5.92	123: Main System
164	J-76	294	5.92	123: Main System
165	J-78	325	5.92	123: Main System
166	J-80	335	5.92	123: Main System
167	J-82	276	5.92	123: Main System
168	J-84	285	5.92	123: Main System
169	J-86	283	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
170	J-88	269	5.92	123: Main System
171	J-90	272	5.92	123: Main System
172	J-92	272	5.92	123: Main System
173	J-94	269	5.92	123: Main System
174	J-96	256	5.92	123: Main System
175	J-98	266	5.92	123: Main System
176	J-100	275	5.92	123: Main System
177	J-102	233	5.92	123: Main System
178	J-104	256	5.92	123: Main System
179	J-106	256	5.92	123: Main System
180	J-108	259	5.92	123: Main System
181	J-110	246	5.92	123: Main System
182	J-112	276	5.92	123: Main System
183	J-114	295	5.92	123: Main System
184	J-116	295	5.92	123: Main System
185	J-118	261	5.92	123: Main System
186	J-120	253	5.92	123: Main System
187	J-122	263	5.92	123: Main System
188	J-124	259	5.92	123: Main System
189	J-126	243	5.92	123: Main System
190	J-128	279	5.92	123: Main System
191	J-130	246	5.92	123: Main System
192	J-132	249	5.92	123: Main System
193	J-134	243	5.92	123: Main System
194	J-136	237	5.92	123: Main System
195	J-138	269	5.92	123: Main System
196	J-140	279	5.92	123: Main System
197	J-142	272	5.92	123: Main System
198	J-144	305	5.92	123: Main System
199	J-146	322	5.92	123: Main System
200	J-148	364	5.92	123: Main System
201	J-150	364	5.92	123: Main System
202	J-152	315	5.92	123: Main System
203	J-154	354	5.92	123: Main System
204	J-156	253	5.92	123: Main System
205	J-158	263	5.92	123: Main System
206	J-160	246	5.92	123: Main System
207	J-162	243	5.92	123: Main System
208	J-164	237	5.92	123: Main System
209	J-166	249	5.92	123: Main System
210	J-168	256	5.92	123: Main System
211	J-170	256	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
212	J-172	236	5.92	123: Main System
213	J-174	257	5.92	123: Main System
214	J-176	259	5.92	123: Main System
215	J-178	285	5.92	123: Main System
216	J-180	253	5.92	123: Main System
217	J-182	259	5.92	123: Main System
218	J-184	253	5.92	123: Main System
219	J-186	249	5.92	123: Main System
220	J-188	233	5.92	123: Main System
221	J-190	230	5.92	123: Main System
222	J-192	243	5.92	123: Main System
223	J-194	243	5.92	123: Main System
224	J-196	243	5.92	123: Main System
225	J-198	246	5.92	123: Main System
226	J-200	253	5.92	123: Main System
227	J-202	266	5.92	123: Main System
228	J-204	272	5.92	123: Main System
229	J-206	262	5.92	123: Main System
230	J-208	253	5.92	123: Main System
231	J-210	266	5.92	123: Main System
232	J-212	269	5.92	123: Main System
233	J-214	256	5.92	123: Main System
234	J-216	272	5.92	123: Main System
235	J-218	256	5.92	123: Main System
236	J-220	253	5.92	123: Main System
237	J-222	236	5.92	123: Main System
238	J-224	256	5.92	123: Main System
239	J-226	272	5.92	123: Main System
240	J-228	272	5.92	123: Main System
241	J-230	272	5.92	123: Main System
242	J-232	272	5.92	123: Main System
243	J-234	285	5.92	123: Main System
244	J-236	269	5.92	123: Main System
245	J-238	262	5.92	123: Main System
246	J-240	270	5.92	123: Main System
247	J-242	266	5.92	123: Main System
248	J-244	253	5.92	123: Main System
249	J-246	249	5.92	123: Main System
250	J-248	251	5.92	123: Main System
251	J-250	248	5.92	123: Main System
252	J-252	246	5.92	123: Main System
253	J-254	233	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
254	J-256	233	5.92	123: Main System
255	J-258	226	5.92	123: Main System
256	J-260	259	5.92	123: Main System
257	J-262	253	5.92	123: Main System
258	J-264	252	5.92	123: Main System
259	J-266	246	5.92	123: Main System
260	J-268	243	5.92	123: Main System
261	J-270	252	5.92	123: Main System
262	J-272	262	5.92	123: Main System
263	J-274	243	5.92	123: Main System
264	J-276	233	5.92	123: Main System
265	J-278	249	5.92	123: Main System
266	J-280	240	5.92	123: Main System
267	J-282	233	5.92	123: Main System
268	J-284	226	5.92	123: Main System
269	J-286	226	5.92	123: Main System
270	J-288	243	5.92	123: Main System
271	J-290	239	5.92	123: Main System
272	J-292	276	5.92	123: Main System
273	J-294	276	5.92	123: Main System
274	J-296	266	5.92	123: Main System
275	J-298	259	5.92	123: Main System
276	J-300	249	5.92	123: Main System
277	J-302	233	5.92	123: Main System
278	J-304	236	5.92	123: Main System
279	J-306	289	5.92	123: Main System
280	J-308	230	5.92	123: Main System
281	J-310	232	5.92	123: Main System
282	J-312	233	5.92	123: Main System
283	J-314	249	5.92	123: Main System
284	J-316	249	5.92	123: Main System
285	J-318	243	5.92	123: Main System
286	J-320	240	5.92	123: Main System
287	J-322	223	5.92	123: Main System
288	J-324	230	5.92	123: Main System
289	J-326	272	5.92	123: Main System
290	J-328	230	5.92	123: Main System
291	J-330	233	5.92	123: Main System
292	J-332	240	5.92	123: Main System
293	J-334	233	5.92	123: Main System
294	J-336	223	5.92	123: Main System
295	J-338	266	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
296	J-340	243	5.92	123: Main System
297	J-342	240	5.92	123: Main System
298	J-344	256	5.92	123: Main System
299	J-346	259	5.92	123: Main System
300	J-348	272	5.92	123: Main System
301	J-350	230	5.92	123: Main System
302	J-352	240	5.92	123: Main System
303	J-354	253	5.92	123: Main System
304	J-356	253	5.92	123: Main System
305	J-358	253	5.92	123: Main System
306	J-360	226	5.92	123: Main System
307	J-362	246	5.92	123: Main System
308	J-364	272	5.92	123: Main System
309	J-366	318	5.92	123: Main System
310	J-368	345	5.92	123: Main System
311	J-370	302	5.92	123: Main System
312	J-372	381	5.92	1265: East Street Service Area
313	J-374	427	5.92	1265: East Street Service Area
314	J-376	423	5.92	1265: East Street Service Area
315	J-378	423	5.92	1265: East Street Service Area
316	J-380	423	5.92	1265: East Street Service Area
317	J-382	423	5.92	1265: East Street Service Area
318	J-384	378	5.92	1265: East Street Service Area
319	J-386	476	5.92	1265: East Street Service Area
320	J-388	443	5.92	1265: East Street Service Area
321	J-390	443	5.92	1265: East Street Service Area
322	J-392	394	5.92	1265: East Street Service Area
323	J-394	351	5.92	1265: East Street Service Area
324	J-396	364	5.92	1265: East Street Service Area
325	J-398	345	5.92	1265: East Street Service Area
326	J-400	417	5.92	1265: East Street Service Area
327	J-402	423	5.92	1265: East Street Service Area
328	J-404	447	5.92	1265: East Street Service Area
329	J-406	453	5.92	1265: East Street Service Area
330	J-408	457	5.92	1265: East Street Service Area
331	J-410	450	5.92	1265: East Street Service Area
332	J-412	397	5.92	1265: East Street Service Area
333	J-414	410	5.92	1265: East Street Service Area
334	J-416	379	5.92	1265: East Street Service Area
335	J-418	377	5.92	1265: East Street Service Area
336	J-420	279	5.92	123: Main System
337	J-422	272	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
338	J-424	269	5.92	123: Main System
339	J-426	269	5.92	123: Main System
340	J-428	272	5.92	123: Main System
341	J-430	269	5.92	123: Main System
342	J-432	262	5.92	123: Main System
343	J-434	263	5.92	123: Main System
344	J-436	269	5.92	123: Main System
345	J-438	279	5.92	123: Main System
346	J-440	253	5.92	123: Main System
347	J-442	253	5.92	123: Main System
348	J-444	272	5.92	123: Main System
349	J-446	253	5.92	123: Main System
350	J-448	246	5.92	123: Main System
351	J-450	224	5.92	123: Main System
352	J-452	269	5.92	123: Main System
353	J-454	246	5.92	123: Main System
354	J-456	239	5.92	123: Main System
355	J-458	226	5.92	123: Main System
356	J-460	224	5.92	123: Main System
357	J-462	239	5.92	123: Main System
358	J-464	256	5.92	123: Main System
359	J-466	240	5.92	123: Main System
360	J-468	450	5.92	124: High Service Area
361	J-470	474	5.92	124: High Service Area
362	J-472	423	5.92	124: High Service Area
363	J-474	259	5.92	123: Main System
364	J-476	263	5.92	123: Main System
365	J-478	341	5.92	123: Main System
366	J-480	355	5.92	123: Main System
367	J-482	361	5.92	124: High Service Area
368	J-484	423	5.92	124: High Service Area
369	J-486	433	5.92	124: High Service Area
370	J-488	413	5.92	124: High Service Area
371	J-490	446	5.92	124: High Service Area
372	J-492	459	5.92	124: High Service Area
373	J-494	459	5.92	124: High Service Area
374	J-496	486	5.92	124: High Service Area
375	J-498	473	5.92	124: High Service Area
376	J-500	443	5.92	124: High Service Area
377	J-502	414	5.92	124: High Service Area
378	J-504	446	5.92	124: High Service Area
379	J-506	440	5.92	124: High Service Area

ID	Label	Elevation (ft)	Demand (gpm)	Zone
380	J-508	440	5.92	124: High Service Area
381	J-510	456	5.92	124: High Service Area
382	J-512	282	5.92	123: Main System
383	J-514	354	5.92	123: Main System
384	J-516	318	5.92	123: Main System
385	J-518	273	5.92	123: Main System
386	J-520	292	5.92	123: Main System
387	J-522	269	5.92	123: Main System
388	J-524	263	5.92	123: Main System
389	J-526	285	5.92	123: Main System
390	J-528	259	5.92	123: Main System
391	J-530	259	5.92	123: Main System
392	J-532	272	5.92	123: Main System
393	J-534	259	5.92	123: Main System
394	J-536	240	5.92	123: Main System
395	J-538	269	5.92	123: Main System
396	J-540	279	5.92	123: Main System
397	J-542	289	5.92	123: Main System
398	J-544	305	5.92	123: Main System
399	J-546	315	5.92	123: Main System
400	J-548	246	5.92	123: Main System
401	J-550	259	5.92	123: Main System
402	J-552	268	5.92	123: Main System
403	J-554	272	5.92	123: Main System
404	J-556	272	5.92	123: Main System
405	J-558	270	5.92	123: Main System
406	J-560	272	5.92	123: Main System
407	J-562	256	5.92	123: Main System
408	J-564	256	5.92	123: Main System
409	J-566	262	5.92	123: Main System
410	J-568	279	5.92	123: Main System
411	J-570	285	5.92	124: High Service Area
412	J-572	315	5.92	124: High Service Area
413	J-574	322	5.92	124: High Service Area
414	J-576	345	5.92	124: High Service Area
415	J-578	413	5.92	124: High Service Area
416	J-580	443	5.92	124: High Service Area
417	J-582	453	5.92	1286: Low Pressure - HSA
418	J-584	482	5.92	1286: Low Pressure - HSA
419	J-588	365	5.92	124: High Service Area
420	J-590	412	5.92	124: High Service Area
421	J-592	285	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
422	J-594	279	5.92	123: Main System
423	J-596	364	5.92	123: Main System
424	J-598	423	5.92	1266: Low Pressure
425	J-600	304	5.92	123: Main System
426	J-602	338	5.92	123: Main System
427	J-604	377	5.92	123: Main System
428	J-606	452	5.92	1266: Low Pressure
429	J-610	279	5.92	123: Main System
430	J-612	282	5.92	123: Main System
431	J-614	295	5.92	123: Main System
432	J-616	351	5.92	123: Main System
433	J-618	335	5.92	123: Main System
434	J-620	354	5.92	123: Main System
435	J-622	295	5.92	123: Main System
436	J-624	391	5.92	123: Main System
437	J-626	441	5.92	1266: Low Pressure
438	J-628	423	5.92	1266: Low Pressure
439	J-630	464	5.92	1266: Low Pressure
440	J-632	364	5.92	124: High Service Area
441	J-634	413	5.92	124: High Service Area
442	J-636	417	5.92	124: High Service Area
443	J-638	459	5.92	124: High Service Area
444	J-640	476	5.92	124: High Service Area
445	J-642	397	5.92	124: High Service Area
446	J-644	361	5.92	124: High Service Area
447	J-646	407	5.92	124: High Service Area
448	J-648	394	5.92	124: High Service Area
449	J-650	266	5.92	123: Main System
450	J-652	228	0	123: Main System
452	J-656	228	0	123: Main System
454	J-660	228	0	123: Main System
456	J-664	226	5.92	123: Main System
457	J-666	216	0	123: Main System
459	J-670	216	0	123: Main System
461	J-674	216	0	123: Main System
463	J-676	280	5.92	123: Main System
464	J-678	285	5.92	123: Main System
465	J-680	290	5.92	123: Main System
466	J-682	298	5.92	123: Main System
467	J-684	265	5.92	123: Main System
468	J-686	331	5.92	123: Main System
469	J-688	331	5.92	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
470	J-690	263	5.92	123: Main System
471	J-692	436	5.92	1265: East Street Service Area
472	J-694	217	5.92	123: Main System
473	J-696	423	5.92	124: High Service Area
474	J-698	305	5.92	123: Main System
475	J-700	305	5.92	123: Main System
476	J-702	276	5.92	123: Main System
477	J-704	276	5.92	123: Main System
478	J-706	269	5.92	123: Main System
479	J-708	321	0	123: Main System
480	J-710	324	0	123: Main System
481	J-712	453	0	124: High Service Area
482	J-714	472	0	124: High Service Area
483	J-716	492	0	124: High Service Area
486	J-722	240	0	123: Main System
487	J-724	354	0	124: High Service Area
489	J-728	492	0	124: High Service Area
490	J-732	235	0	123: Main System
491	J-734	452	0	1266: Low Pressure
492	J-746	276	0	123: Main System
500	J-750	322	0	124: High Service Area
501	J-752	366	0	124: High Service Area
493	J-754	235	0	123: Main System
494	J-756	236	0	123: Main System
495	J-758	237	0	123: Main System
496	J-760	235	0	123: Main System
497	J-762	236	0	123: Main System
498	J-764	236	0	123: Main System
499	J-766	235	0	123: Main System
502	J-768	392	0	124: High Service Area
503	J-770	348	0	124: High Service Area
504	J-772	460	0	124: High Service Area
505	J-774	385	0	124: High Service Area
506	J-776	506	0	1286: Low Pressure - HSA
507	J-778	370	0	124: High Service Area
508	J-780	394	0	124: High Service Area
973	J-784	480	0	1266: Low Pressure
979	J-785	240	0	123: Main System
1044	J-797	275	0	123: Main System
1092	J-813	273	0	123: Main System
1094	J-814	274	0	123: Main System
1096	J-815	274	0	123: Main System

ID	Label	Elevation (ft)	Demand (gpm)	Zone
1098	J-816	240	0	123: Main System
1105	J-819	242	0	123: Main System
1117	J-823	241	0	123: Main System
1119	J-824	240	0	123: Main System
1130	J-825	345	0	123: Main System
1132	J-826	263	0	123: Main System
1134	J-827	226	0	123: Main System
1139	J-829	243.6	0	123: Main System
1142	J-830	423	0	1266: Low Pressure
1144	J-831	379	0	1265: East Street Service Area
1147	J-832	379	0	1265: East Street Service Area
1149	J-833	268	0	123: Main System
1152	J-834	268	0	123: Main System
1155	J-836	285.1	0	123: Main System
1158	J-837	285.1	0	123: Main System
1164	J-840	371.9	0	124: High Service Area
1168	J-841	380.3	0	124: High Service Area
1171	J-842	390	0	124: High Service Area
1173	J-843	276	0	123: Main System
1178	J-845	279.6	0	123: Main System
1181	J-846	272	0	123: Main System
1185	J-849	303	0	123: Main System
1187	J-850	280	0	123: Main System
1192	J-853	379	0	1265: East Street Service Area
1195	J-854	379	0	1265: East Street Service Area
1197	J-855	296.5	0	123: Main System
1201	J-857	272	0	123: Main System
1204	J-858	381.6	0	123: Main System
1207	J-859	390	0	123: Main System
1227	J-864	289	0	123: Main System
1289	J-869	256.8	0	123: Main System
1292	J-870	245.4	0	123: Main System

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
515	P-2	70	1940	8	Universal	1,424	0	0	83	0	86
516	P-4	70	1940	8	Universal	1,501	0	0	81	0	96
517	P-8	70	1940	6	Universal	629	0	0	72	0	62
518	P-10	70	1940	6	Universal	606	0	0	85	0	24
519	P-16	70	1940	8	Universal	617	0	0	91	0	137
520	P-18	70	1940	8	Universal	493	0	0	91	0	184
521	P-20	75	1940	10	Universal	654	0	0	95	0	138
522	P-22	70	1940	6	Universal	231	0	0	96	0	203
523	P-24	70	1940	6	Universal	232	0	0	96	0	188
524	P-26	70	1940	6	Universal	276.00	0	0	96	0	173
525	P-28	70	1940	6	Universal	369	0	0	98	0	180
526	P-30	70	1940	6	Universal	445	0	0	104	0	160
527	P-32	70	1940	8	Universal	776.00	0	0	101	0	131
528	P-36	70	1940	6	Universal	447	0	0	81	0	161
529	P-38	70	1940	6	Universal	453	0	0	91	0	110
530	P-40	110	1986	8	Ductile Iron	697	0	0	91	0	95
531	P-42	50	1940	2	Universal	175	0	0	92	0	128
532	P-44	60	1928	10	Cast Iron	414	3	0	101	0	124
533	P-46	60	1928	10	Cast Iron	589	0	0	94	0	134
534	P-48	60	1928	10	Cast Iron	757	0	0	100	0	120
535	P-50	60	1928	10	Cast Iron	256	0	0	93	0	96
536	P-52	60	1928	10	Cast Iron	263	0	0	92	0	114
537	P-54	60	1928	10	Cast Iron	1,164.00	0	0	93	0	88
538	P-56	70	1940	6	Universal	305	0	0	93	0	102
539	P-58	70	1940	6	Universal	211	0	0	82	0	99
540	P-60	70	1940	6	Universal	583	0	0	82	0	99
541	P-62	70	1940	8	Universal	563.00	0	0	93	0	131
543	P-66	70	1940	6	Universal	463.00	0	0	92	1	186
544	P-68	75	1940	10	Universal	756	0	0	95	1	142
545	P-70	70	1940	6	Universal	879	0	0	95	0	154
547	P-74	110	1992	8	Ductile Iron	1,252.00	0	0	64	0	110
548	P-76	60	1928	10	Cast Iron	575	1	0	83	0	101
550	P-80	70	1949	6	Universal	302	0	0	84	0	110
551	P-82	70	1940	6	Universal	1,601	0	0	84	0	106
552	P-84	70	1940	8	Universal	434.00	0	0	70	0	67
553	P-86	50	1940	6	Universal	195	0	0	91	0	97
554	P-90	110	1990	6	Ductile Iron	282	0	0	92	0	24
555	P-92	110	1990	6	Ductile Iron	164	0	0	88	0	71
556	P-94	110	1990	6	Ductile Iron	587	0	0	88	0	94
557	P-96	70	1940	6	Universal	1,466	0	0	95	0	126
558	P-98	70	1940	8	Universal	471	0	0	91	0	169
559	P-100	70	1940	8	Universal	1,196	0	0	94	0	192
560	P-102	70	1940	8	Universal	431	0	0	94	0	191
561	P-104	70	1940	6	Universal	310	0	0	91	0	187
562	P-106	70	1940	6	Universal	398	0	0	101	0	231
563	P-108	70	1940	6	Universal	203	0	0	101	0	133
565	P-112	70	1940	6	Universal	606.00	0	0	96	0	106
566	P-114	70	1940	6	Universal	547	0	0	96	0	102
567	P-116	70	1940	6	Universal	626	3	0	96	0	98
568	P-118	70	1940	6	Universal	852	0	0	98	0	116
569	P-120	70	1940	6	Universal	509	0	0	104	0	106
570	P-122	120	1986	8	PVC	1,266	0	0	101	0	137
571	P-124	70	1949	8	Universal	1,091	0	0	89	0	114
572	P-126	70	1949	8	Universal	365	0	0	83	0	104
574	P-130	70	1949	8	Universal	392	0	0	98	0	129
575	P-132	110	1990	8	Ductile Iron	401	0	0	98	0	92
576	P-134	110	1990	8	Ductile Iron	120.00	0	0	97	0	101
577	P-136	110	1990	6	Ductile Iron	626	0	0	97	0	104
578	P-138	110	1985	8	Ductile Iron	394	0	0	83	0	112
579	P-140	110	1985	8	Ductile Iron	377	0	0	90	0	113
580	P-142	110	1985	8	Ductile Iron	328.00	0	0	91	0	114
581	P-144	110	1985	8	Ductile Iron	141	0	0	104	0	93
582	P-146	110	1992	8	Ductile Iron	617	0	0	104	0	99
583	P-148	110	1992	8	Ductile Iron	322	0	0	106	0	106
584	P-150	110	1985	8	Ductile Iron	403	0	0	106	0	106
585	P-152	110	1985	8	Ductile Iron	794.00	0	0	94	0	111
586	P-154	110	1985	8	Ductile Iron	265	0	0	94	0	111
587	P-156	110	1985	8	Ductile Iron	486	0	0	90	0	97
588	P-158	110	1986	8	Ductile Iron	272	0	0	83	0	119
589	P-160	110	1986	8	Ductile Iron	650.00	0	0	79	0	109
590	P-162	110	1986	8	Ductile Iron	681	0	2	72	0	60
591	P-164	110	1986	8	Ductile Iron	83.00	0	0	53	0	56
592	P-166	110	1986	8	Ductile Iron	1,209.00	0	0	53	0	61
593	P-168	110	1986	8	Ductile Iron	408	0	0	74	0	88
594	P-170	110	1986	8	Ductile Iron	525.00	0	0	74	0	78
595	P-172	110	1987	8	Ductile Iron	1,672	0	0	72	0	73
596	P-176	70	1940	8	Universal	1,168	0	0	97	0	116
597	P-178	70	1940	6	Universal	2,593.00	0	0	101	0	162
598	P-180	70	1940	8	Universal	279.00	1	0	102	0	191
599	P-182	70	1940	8	Universal	467	1	0	105	0	203

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
600	P-184	70	1940	8	Universal	682	1	0	106	0	173
601	P-186	70	1940	8	Universal	812.00	1	0	109	0	184
602	P-188	110	1990	8	Ductile Iron	567	0	3	105	0	118
603	P-190	110	1990	8	Ductile Iron	115.00	0	3	100	0	112
604	P-192	110	1990	8	Ductile Iron	689	0	3	100	0	112
605	P-194	110	1990	8	Ductile Iron	256	0	3	109	0	100
606	P-196	110	1990	8	Ductile Iron	162	0	3	100	0	96
607	P-198	110	1990	8	Ductile Iron	218.00	0	3	100	0	94
608	P-200	110	1990	8	Ductile Iron	363	0	3	99	0	104
609	P-202	110	1990	8	Ductile Iron	712	0	3	88	0	101
610	P-204	70	1940	6	Universal	990	0	0	106	0	165
611	P-206	70	1940	8	Universal	425	0	0	100	0	107
612	P-208	70	1940	8	Universal	395	0	0	102	0	152
613	P-210	70	1940	8	Universal	873.00	0	0	102	0	218
614	P-212	70	1940	8	Universal	609	0	0	102	0	174
615	P-214	70	1940	8	Universal	791	0	0	109	0	178
616	P-216	70	1940	8	Universal	644.00	0	0	110	0	164
617	P-218	70	1940	6	Universal	577	0	0	110	0	120
618	P-220	70	1940	6	Universal	160.00	0	0	106	0	100
619	P-222	70	1940	6	Universal	112	0	0	106	0	100
620	P-224	110	1988	8	Ductile Iron	1,207	0	0	97	0	95
621	P-226	60	1940	8	Universal	2,423	2	1	97	0	162
622	P-228	60	1940	8	Universal	525.00	2	0	100	0	162
623	P-230	70	1940	8	Universal	1,134	0	0	94	0	109
624	P-232	70	1940	8	Universal	848.00	0	0	92	0	123
625	P-234	120	1985	8	PVC	858	0	0	96	0	114
626	P-236	120	1985	8	PVC	1,493	0	0	100	0	103
627	P-238	90	1967	8	Cement Lined Cast Iron	808.00	0	0	92	0	102
628	P-240	120	1987	8	PVC	697.00	0	0	100	0	108
629	P-242	120	1987	8	PVC	1,046	0	0	99	0	105
630	P-244	120	1987	8	PVC	1,487	0	0	99	0	110
631	P-246	120	1987	8	PVC	1,124	0	0	99	0	101
632	P-248	120	1987	8	PVC	885.00	0	0	100	0	95
633	P-250	120	1987	8	PVC	469	0	0	100	0	95
634	P-252	120	1987	8	PVC	244.00	0	0	99	0	93
635	P-254	120	1987	8	PVC	603	0	0	92	0	101
636	P-256	120	1987	8	PVC	1,248.00	0	0	92	0	106
637	P-258	120	1987	8	PVC	1,780.00	0	0	92	0	97
638	P-260	120	1987	8	PVC	622.00	0	0	92	0	100
639	P-262	120	1987	8	PVC	332.00	0	0	92	0	98
640	P-264	120	1985	6	PVC	681	0	0	96	0	113
641	P-266	120	1985	6	PVC	441	0	0	92	0	105
642	P-268	120	1985	6	PVC	276.00	0	0	92	0	133
643	P-270	120	1985	6	PVC	687	0	0	93	0	146
644	P-272	120	1985	8	PVC	407	0	0	93	0	106
645	P-274	60	1940	8	Universal	853.00	1	0	94	0	106
646	P-276	60	1940	8	Universal	857	1	0	96	0	109
647	P-278	60	1940	8	Universal	1,609.00	1	0	94	0	110
648	P-280	60	1940	8	Universal	450.00	0	0	100	0	136
649	P-282	70	1940	8	Universal	401.00	0	0	102	0	124
650	P-284	60	1940	8	Universal	398.00	0	0	101	0	120
651	P-286	70	1940	8	Universal	235	0	0	102	0	139
652	P-288	60	1940	8	Universal	2,686.00	0	0	103	0	141
653	P-290	60	1940	8	Universal	155	0	0	109	0	154
654	P-292	65	1940	12	Universal	443	0	0	109	0	117
655	P-294	120	1986	8	PVC	468	0	0	94	0	106
656	P-296	120	1986	8	PVC	945.00	0	0	98	0	110
657	P-298	120	1986	8	PVC	748	0	0	100	0	119
658	P-300	120	1986	8	PVC	459.00	0	0	98	0	109
659	P-302	110	2002	8	Ductile Iron	460	0	0	100	0	112
660	P-304	120	1986	8	PVC	340	0	0	100	0	128
661	P-306	120	1986	8	PVC	607	0	0	100	0	115
662	P-308	120	1980	6	PVC	789	0	0	102	0	125
663	P-310	120	1980	6	PVC	755	0	0	96	0	133
664	P-312	120	1995	8	PVC	560.00	0	0	103	0	102
665	P-314	120	1995	8	PVC	657	0	0	104	0	101
666	P-316	110	1998	8	Ductile Iron	936	0	0	104	0	101
667	P-318	70	1940	8	Universal	3,070	0	0	109	0	104
668	P-320	50	1940	12	Universal	1,431	0	0	109	0	143
669	P-322	50	1940	12	Universal	243.00	0	0	109	0	180
670	P-324	50	1940	12	Universal	117	0	0	112	0	220
671	P-328	50	1940	12	Universal	1,188	0	0	112	0	177
672	P-330	50	1940	12	Universal	468	0	0	104	0	239
673	P-332	50	1940	12	Universal	503	0	0	104	0	289
674	P-334	65	1940	12	Universal	628	0	4	108	0	289
675	P-336	50	1890	8	Cast Iron	1,001	0	0	108	0	114
676	P-338	50	1890	8	Cast Iron	350	0	0	93	0	112
677	P-340	50	1890	8	Cast Iron	897	0	1	93	0	108
678	P-342	50	1890	8	Cast Iron	539	0	1	93	0	109
679	P-344	70	1940	8	Universal	392	1	0	109	0	170

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
680	P-346	70	1940	8	Universal	663	1	0	102	0	152
681	P-348	70	1940	8	Universal	290.00	1	0	109	0	144
682	P-350	70	1940	8	Universal	596	1	0	112	0	179
683	P-352	50	1940	8	Universal	1,220	1	0	108	0	95
684	P-354	60	1929	6	Universal	1,027	0	0	109	0	106
685	P-356	70	1929	8	Universal	295	0	0	110	0	125
686	P-358	65	1929	8	Universal	195	0	0	110	0	110
687	P-360	60	1929	6	Universal	919.00	0	0	110	0	117
688	P-362	60	1929	10	Universal	757	0	0	112	0	172
689	P-364	60	1929	10	Universal	593	0	0	109	0	161
690	P-366	60	1929	10	Universal	252	0	0	102	0	131
691	P-368	65	1929	8	Universal	398	0	0	102	0	176
692	P-370	60	1929	10	Universal	499	0	0	105	0	150
693	P-372	60	1929	10	Universal	596	0	0	106	0	167
696	P-378	60	1929	6	Universal	517	0	0	110	0	140
697	P-382	60	1929	6	Universal	661	0	0	109	0	134
698	P-384	50	1929	2	Universal	470	1	0	102	0	148
699	P-386	70	1929	8	Universal	458	0	0	106	0	115
700	P-388	75	1929	10	Universal	644	4	0	113	0	118
701	P-390	70	1929	8	Universal	399.00	0	0	110	0	95
702	P-392	70	1929	8	Universal	548	0	0	92	0	84
703	P-394	70	1929	8	Universal	157	0	0	104	0	80
704	P-396	70	1929	8	Universal	367.00	0	0	104	0	80
705	P-398	55	1929	8	Universal	228	0	0	92	0	137
706	P-400	55	1929	8	Universal	471	0	0	97	0	127
707	P-402	50	1929	6	Universal	1,390	0	0	97	0	77
708	P-404	50	1929	6	Universal	978	0	0	110	0	82
709	P-406	50	1929	6	Universal	439.00	0	0	106	0	161
710	P-408	70	1929	8	Universal	782	0	0	100	0	97
711	P-410	70	1929	8	Universal	353	0	0	100	0	94
712	P-412	70	1929	8	Universal	532	0	0	100	0	83
713	P-414	70	1929	8	Universal	255.00	0	0	112	0	100
714	P-416	50	1929	2	Universal	486	0	0	100	0	96
715	P-420	50	1929	6	Universal	791.00	0	0	92	0	218
716	P-422	70	1929	6	Universal	2,015.00	0	0	70	0	87
717	P-424	120	2010	12	Ductile Iron	1,825	0	0	58	0	84
718	P-428	120	1990	12	Ductile Iron	2,475	0	0	75	0	109
719	P-432	120	1990	12	Ductile Iron	1,163	0	1	57	0	115
720	P-434	120	1990	12	Ductile Iron	1,155	0	0	57	0	117
721	P-436	110	1990	8	Ductile Iron	1,466	0	0	57	0	56
722	P-438	110	2000	8	Ductile Iron	1,226	0	0	57	0	99
723	P-440	120	1990	12	Ductile Iron	643	0	0	57	0	52
724	P-442	120	1990	12	Ductile Iron	1,300	0	0	34	0	70
725	P-444	110	1999	8	Ductile Iron	1,133	0	0	34	0	84
726	P-446	110	1999	8	Ductile Iron	488	0	0	48	0	70
727	P-448	110	1999	8	Ductile Iron	415.00	0	0	70	0	80
728	P-450	110	1999	8	Ductile Iron	834	0	0	70	0	78
729	P-452	110	1999	8	Ductile Iron	217.00	0	0	91	0	95
730	P-454	110	1999	8	Ductile Iron	461	0	0	83	0	100
731	P-456	110	1999	8	Ductile Iron	354.00	0	0	57	0	104
732	P-458	110	1999	8	Ductile Iron	386.00	0	0	60	0	97
733	P-460	110	1999	8	Ductile Iron	464	0	0	57	0	102
734	P-462	110	1999	8	Ductile Iron	417	0	0	57	0	100
735	P-464	110	1990	8	Ductile Iron	504	0	0	57	0	109
736	P-466	110	1990	8	Ductile Iron	534	0	0	44	0	100
737	P-468	110	1990	8	Ductile Iron	1,054	0	0	44	0	100
738	P-470	110	2000	8	Ductile Iron	1,988	0	0	57	0	96
739	P-472	110	1994	8	Ductile Iron	818	0	0	56	0	106
740	P-474	110	1990	8	Ductile Iron	1,641	0	0	56	0	106
742	P-478	50	1940	12	Universal	381	0	0	96	1	167
743	P-480	50	1940	12	Universal	844	0	0	92	1	168
744	P-482	50	1940	12	Universal	423	0	0	95	1	177
745	P-484	90	1965	8	Cement Lined Cast Iron	116	0	0	96	0	105
746	P-486	50	1940	12	Universal	238.00	0	0	96	1	172
747	P-488	50	1940	12	Universal	305	0	0	95	1	196
748	P-490	50	1940	12	Universal	242	0	0	97	1	210
749	P-492	50	1940	12	Universal	111	0	0	100	1	183
751	P-496	50	1940	12	Universal	478	0	0	97	1	117
752	P-498	50	1940	12	Universal	1,422	0	2	93	1	111
753	P-500	50	1940	12	Universal	229	0	0	104	1	110
754	P-502	50	1893	12	Cast Iron	883	1	0	110	1	245
755	P-504	50	1893	12	Cast Iron	468	1	0	104	1	242
756	P-506	60	1940	12	Universal	1,191	0	0	96	1	222
757	P-512	70	1940	6	Universal	399	0	0	96	1	177
758	P-514	70	1940	6	Universal	3,026	0	0	97	1	216
759	P-516	110	1985	8	Ductile Iron	110.00	0	0	107	0	125
760	P-518	70	1940	6	Universal	2,924	0	0	107	1	66
761	P-520	70	1940	6	Universal	714	0	0	110	1	66
762	P-522	70	1949	8	Universal	214.00	0	1	115	0	74
763	P-524	70	1949	6	Universal	1,195	1	0	115	0	76

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
764	P-526	80	1940	12	Universal	2,513	0	0	107	1	86
765	P-528	80	1940	12	Universal	1,276	0	0	110	1	63
766	P-530	110	2004	8	Ductile Iron	1,017	0	1	110	0	110
768	P-534	50	1940	12	Universal	622	0	0	109	1	215
769	P-538	110	1998	8	Ductile Iron	831	0	0	60	0	199
770	P-540	110	1998	8	Ductile Iron	723	0	0	60	0	140
771	P-542	120	1985	12	Ductile Iron	1,709	0	0	107	0	122
772	P-544	120	1985	12	Ductile Iron	175	0	0	101	0	100
773	P-546	120	1985	12	Ductile Iron	717	0	0	101	0	173
774	P-548	120	1985	12	Ductile Iron	99.00	0	0	66	0	266
775	P-552	120	1985	12	Ductile Iron	797.00	0	0	98	0	212
776	P-554	120	1985	12	Ductile Iron	301.00	0	0	71	0	185
777	P-556	120	1985	12	Ductile Iron	292.00	0	0	67	0	196
778	P-558	120	1985	12	Ductile Iron	345	0	0	76	0	272
779	P-560	120	1985	12	Ductile Iron	321	0	0	61	0	301
780	P-562	110	2003	8	Ductile Iron	246.00	0	0	56	0	165
781	P-564	120	1985	12	Ductile Iron	1,023	0	0	56	0	342
782	P-566	110	1986	8	Ductile Iron	329	0	0	61	0	176
783	P-568	110	1986	8	Ductile Iron	414	0	0	50	0	184
784	P-570	110	1986	8	Ductile Iron	78	0	0	76	0	174
785	P-572	110	1986	8	Ductile Iron	88	0	0	75	0	166
786	P-574	110	1986	8	Ductile Iron	117	0	0	63	0	254
787	P-576	110	1986	8	Ductile Iron	327	0	0	61	0	108
788	P-578	110	1986	8	Ductile Iron	360	0	0	64	0	139
789	P-580	110	1986	6	Ductile Iron	345	0	0	64	0	149
790	P-582	110	1986	8	Ductile Iron	330	0	0	64	0	150
791	P-584	110	1986	8	Ductile Iron	240	0	0	75	0	100
792	P-586	110	1986	8	Ductile Iron	752	0	0	94	0	178
793	P-588	110	1986	8	Ductile Iron	1,927	0	0	90	0	168
794	P-590	110	1986	8	Ductile Iron	1,170	0	0	59	0	205
795	P-592	110	1986	8	Ductile Iron	441	0	0	90	0	79
796	P-594	110	1986	8	Ductile Iron	702	0	0	59	0	110
797	P-596	50	1940	6	Cast Iron	257	1	0	95	0	145
798	P-598	50	1940	6	Cast Iron	215	1	0	96	0	101
799	P-600	50	1940	6	Cast Iron	864	0	0	96	0	129
800	P-604	70	1940	6	Universal	377	0	0	96	0	118
801	P-606	70	1940	6	Universal	224.00	1	0	101	0	125
802	P-608	70	1940	6	Universal	654.00	1	0	101	0	102
803	P-610	70	1940	6	Universal	421	0	0	95	0	117
804	P-612	70	1940	6	Universal	189	0	0	101	0	129
805	P-614	70	1940	6	Universal	198	0	0	101	0	149
806	P-616	70	1940	8	Universal	1,632	0	0	101	0	96
807	P-618	70	1940	6	Universal	590	0	0	99	0	107
808	P-620	70	1940	6	Universal	533	0	0	97	0	123
809	P-622	70	1949	8	Universal	839	0	0	100	0	170
810	P-624	70	1949	6	Universal	278	0	0	88	0	154
811	P-626	70	1949	6	Universal	2,097	0	0	81	0	142
812	P-628	70	1949	6	Universal	510	0	0	74	0	186
813	P-630	120	2009	16	Ductile Iron	612.00	0	0	104	0	89
814	P-632	120	2009	16	Ductile Iron	805	0	0	107	0	75
815	P-634	120	2009	16	Ductile Iron	555	0	2	101	0	102
816	P-636	50	1893	4	Cast Iron	415	0	0	101	0	87
817	P-638	50	1893	4	Cast Iron	420	0	0	96	0	92
818	P-640	120	2009	16	Ductile Iron	247	0	0	98	0	63
819	P-642	120	2009	16	Ductile Iron	231	0	0	96	0	94
820	P-644	120	2009	16	Ductile Iron	118	0	0	97	0	109
821	P-646	120	2009	16	Ductile Iron	373.00	0	0	96	0	123
823	P-650	70	1940	6	Universal	438.00	0	0	97	0	73
824	P-652	50	1940	6	Universal	409.00	0	0	96	0	56
825	P-654	70	1929	6	Universal	469	0	2	98	0	83
826	P-656	70	1929	6	Universal	503	0	2	100	0	186
827	P-658	70	1929	6	Universal	325	0	2	92	0	332
828	P-660	70	1929	8	Universal	1,687	5	0	131	0	190
829	P-670	110	2000	8	Ductile Iron	298	0	0	62	0	68
830	p	110	2000	8	Ductile Iron	669	0	0	58	0	72
831	P-674	70	1940	6	Universal	900	0	0	100	0	115
832	P-676	70	1940	6	Universal	829	0	0	81	0	196
833	P-678	70	1949	6	Universal	845	0	0	76	0	173
834	P-682	110	1985	8	Ductile Iron	279	0	0	105	0	86
835	P-684	70	1929	6	Universal	645.00	1	0	75	0	100
836	P-688	70	1940	8	Universal	155	0	0	90	0	90
837	P-690	50	1893	4	Cast Iron	402	0	0	93	0	129
838	P-692	70	1940	6	Universal	1,241	0	0	90	0	143
839	P-694	70	1940	6	Universal	1,011	0	0	56	0	146
840	P-696	50	1890	12	Cast Iron	505	0	0	96	0	120
841	P-698	60	1890	12	Cast Iron	905	0	0	82	0	149
842	P-700	60	1890	12	Cast Iron	494.00	0	0	67	0	160
843	P-702	60	1890	12	Cast Iron	837	0	0	50	0	104
844	P-704	60	1890	12	Cast Iron	441	0	0	31	0	105
845	P-708	70	1940	6	Universal	276	0	0	97	0	89

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
846	P-710	70	1940	6	Universal	597.00	0	1	82	0	129
847	P-712	70	1940	6	Universal	473	0	1	91	0	117
848	P-714	50	1893	4	Cast Iron	388	0	1	104	0	165
849	P-716	60	1890	12	Cast Iron	576	0	0	67	0	115
850	P-718	60	1890	12	Cast Iron	173	0	0	62	0	121
851	P-720	60	1890	12	Cast Iron	305	0	0	62	0	121
852	P-722	50	1893	4	Cast Iron	532	0	0	86	0	132
854	P-728	50	1930	6	Cast Iron	452	0	0	31	0	125
855	P-730	50	1930	6	Cast Iron	883	0	0	23	0	96
856	P-732	110	1993	8	Ductile Iron	1,196.00	0	0	131	0	328
857	P-734	110	1993	8	Ductile Iron	938	0	0	97	0	219
858	P-736	110	1993	8	Ductile Iron	219	0	0	76	0	208
859	P-738	110	1993	8	Ductile Iron	1,553	0	0	74	0	180
860	P-740	110	1995	8	Ductile Iron	658.00	0	0	74	0	320
861	P-742	110	1995	8	Ductile Iron	1,760	0	0	56	0	360
862	P-744	110	1998	8	Ductile Iron	620.00	0	0	56	0	104
863	P-746	110	1998	8	Ductile Iron	632	0	0	82	0	120
864	P-748	110	1998	8	Ductile Iron	453	0	0	82	0	120
865	P-750	110	1993	8	Ductile Iron	578	0	0	76	0	74
866	P-752	60	1929	8	Universal	588	0	0	102	0	82
867	P-754	90	1967	6	Cement Lined Cast Iron	1,319	1	0	94	0	85
868	P-756	60	1940	12	Cast Iron	970.00	0	0	108	0	120
869	P-758	120	1997	12	Ductile Iron	247	0	0	103	0	96
870	P-760	100	1940	8	Universal	111	0	0	111	0	72
871	P-762	120	1997	12	Ductile Iron	69	0	0	111	0	75
872	P-764	100	1940	8	Universal	102	0	0	111	0	58
873	P-766	120	1997	12	Ductile Iron	155.00	0	0	111	0	60
874	P-768	100	1940	8	Universal	102.00	0	0	111	0	50
875	P-770	120	1990	16	Ductile Iron	1,190.00	0	5	104	0	124
876	P-772	60	1946	16	Cast Iron	302.00	0	5	116	0	116.5
877	P-774	100	1946	10	Cast Iron	218.00	0	5	120	0	109
878	P-776	60	1946	16	Cast Iron	363	0	5	120	0	111
879	P-778	100	1946	8	Cast Iron	91	0	5	120	0	120
880	P-780	60	1946	16	Cast Iron	225	0	5	120	0	120
881	P-782	100	1946	8	Cast Iron	91	0	5	120	0	42
882	P-790	70	1940	6	Universal	412	0	0	90	0	151
883	P-792	70	1940	6	Universal	855.00	0	0	85	0	50
884	P-794	70	1940	6	Universal	787.00	0	0	88	0	131
885	P-798	120	1985	10	Ductile Iron	1,147	0	0	88	0	190
886	P-800	120	1985	10	Ductile Iron	288	0	0	66	0	193
887	P-802	120	1985	10	Ductile Iron	585.00	0	0	84	0	191
888	P-804	70	1940	6	Universal	75.00	0	0	102	0	168
889	P-806	70	1940	6	Universal	833	0	0	96	0	163
890	P-810	70	1940	6	Universal	799.00	0	0	67	0	170
891	P-812	70	1940	6	Universal	874	0	0	89	0	181
892	P-814	70	1940	6	Universal	475	0	0	67	0	182
893	P-816	50	1929	6	Universal	1,676	0	0	106	0	131
894	P-818	50	1929	6	Universal	429	0	0	96	0	114
895	P-820	120	1990	12	Ductile Iron	584	0	0	56	0	130
896	P-822	120	1990	12	Ductile Iron	596	0	0	52	0	80
897	P-824	50	1940	12	Universal	1,469.00	0	0	112	0	204
898	P-826	50	1940	12	Universal	243.00	0	0	117	0	153
899	P-828	120	1981	8	PVC	298.00	0	0	75	0	106
900	P-830	120	1981	8	PVC	1,444	0	0	71	0	93
901	P-838	110	1999	6	Ductile Iron	423	0	0	79	0	80.5
902	P-840	55	1940	6	Universal	598	0	0	92	0	28
903	P-844	55	1940	6	Universal	307	0	0	92	0	125
904	P-846	55	1940	6	Universal	663.00	0	0	92	0	95.5
905	P-848	90	1965	8	Cement Lined Cast Iron	177	0	0	96	0	98
906	P-850	90	1965	8	Cement Lined Cast Iron	231.00	0	0	96	0	97
907	P-852	70	1940	8	Universal	460.00	0	0	81	0	102
908	P-856	70	1940	8	Universal	973	0	0	72	0	75
909	P-858	70	1940	8	Universal	299	0	0	71	0	74
911	P-862	120	2008	8	Ductile Iron	269.00	0	0	50	0	367
912	P-868	120	2004	16	Ductile Iron	1,347.00	0	0	42	0	100.5
913	P-870	120	2004	16	Ductile Iron	1,141	0	0	42	0	100.5
915	P-876	110	1986	8	Ductile Iron	495.00	0	0	49	0	197.5
916	P-878	110	1998	8	Ductile Iron	96.00	0	0	109	0	164
917	P-880	110	1998	8	Ductile Iron	2,172.00	0	0	109	0	164
919	P-884	120	1985	12	Ductile Iron	91	0	0	98	0	95
920	P-886	120	1985	12	Ductile Iron	75.00	0	0	97	0	95
924	P-898	120	2004	16	Ductile Iron	1,633	0	0	44	0	249
925	P-900	120	2004	16	Ductile Iron	497.00	0	0	42	0	256
926	P-902	120	2004	16	Ductile Iron	374.00	0	0	97	0	397
928	P-908	70	1940	8	Universal	574.00	0	0	97	0	179
929	P-910	70	1940	8	Universal	359.00	0	0	95	1	211
930	P-912	60	1929	6	Universal	215	0	0	110	0	147
931	P-914	60	1929	6	Universal	322	0	0	108	0	70
933	P-920	50	1890	12	Cast Iron	386.00	0	0	18	0	49
934	P-932	70	1940	8	Universal	414.00	0	4	101	0	97

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
935	P-934	70	1940	6	Universal	762.00	0	0	94	0	134
936	P-944	110	1997	8	Ductile Iron	756.00	0	0	108	0	98
937	P-946	110	1997	8	Ductile Iron	288.00	0	0	108	0	87
938	P-950	110	1997	8	Ductile Iron	278	0	0	108	0	88
939	P-952	110	1997	8	Ductile Iron	157.00	0	0	108	0	94
940	P-954	110	1997	8	Ductile Iron	499.00	0	0	108	0	90
941	P-956	110	1997	8	Ductile Iron	397.00	0	0	108	0	92
942	P-958	110	1997	8	Ductile Iron	357	0	0	108	0	92
943	P-936	70	1929	8	Universal	394.00	5	0	118	0	117
944	P-938	70	1929	8	Universal	652.00	5	0	115	0	120
945	P-940	70	1929	8	Universal	599	5	0	115	0	102
946	P-960	70	1929	8	Universal	983.00	0	0	84	0	106
947	P-962	120	1990	12	Ductile Iron	216.00	0	0	70	0	109
948	P-964	120	1990	12	Ductile Iron	887.00	0	0	0	0	109
949	P-966	70	1929	8	Universal	378	0	0	105	0	101
950	P-968	70	1929	8	Universal	374	0	0	104	0	58
951	P-970	110	1995	8	Ductile Iron	1,295.00	0	0	104	0	58
952	P-972	70	1929	8	Universal	746	0	0	101	0	54
953	P-974	70	1929	8	Universal	139	0	0	88	0	104
954	P-976	110	1995	8	Ductile Iron	1,436.00	0	1	55	0	36
955	P-978	110	2000	8	Ductile Iron	1,044.00	0	0	46	0	17
956	P-980	70	1929	8	Universal	820	5	0	96	0	92
957	P-982	70	1929	8	Universal	403	0	0	94	0	90
958	P-984	110	1985	8	Ductile Iron	532.00	0	0	94	0	66
975	P-992	50	1890	12	Cast Iron	475	0	0	6	0	171
977	P-993	120	2009	16	Ductile Iron	600	0	0	6	0	99
978	P-994	120	2009	16	Ductile Iron	3,820.00	0	0	97	0	162
988	P-998	100	1940	8	Universal	175.00	0	0	97	0	100
989	P-999	100	1940	8	Universal	152	0	0	97	0	100
990	P-1000	100	1940	8	Universal	183	0	0	97	0	100
1003	P-1001	100	1946	10	Cast Iron	193	0	5	97	0	100
1004	P-1002	100	1946	8	Cast Iron	132	0	5	97	0	100
1005	P-1003	100	1946	8	Cast Iron	134.00	0	5	97	0	100
1045	P-1022	70	1940	6	Universal	297	0	0	95	1	231
1046	P-1023	70	1940	6	Universal	1,274	0	0	92	1	198
1047	P-1024	70	1940	6	Universal	191.00	0	0	92	0	127
1093	P-1046	110	2004	8	Ductile Iron	490	0	0	102	0	188
1095	P-1047	110	2004	8	Ductile Iron	586	0	0	95	0	128
1097	P-1048	110	2004	8	Ductile Iron	892.00	0	0	95	0	128
1099	P-1049	120	2011	12	Ductile Iron	642.00	0	0	109	0	142
1106	P-1053	120	2011	12	Ductile Iron	1,185	0	0	109	0	142
1107	P-1054	120	2011	20	Ductile Iron	1,477.00	0	0	99	0	141
1108	P-1055	120	2011	20	Ductile Iron	2,651.00	0	0	95	0	128
1118	P-1057	110	2011	8	Ductile Iron	1,572	0	0	108	0	142
1120	P-1058	110	2011	6	Ductile Iron	92	0	0	109	0	142
1126	P-1059	120	2011	12	Ductile Iron	1,437	0	0	109	0	142
1127	P-1060	120	2011	12	Ductile Iron	122	0	0	97	0	100
1129	P-1061	120	1985	12	Ductile Iron	121.00	0	0	60	0	253
1131	P-1062	110	1999	8	Ductile Iron	1,840.00	0	2	79	0	82
1133	P-1063	110	2000	8	Ductile Iron	364.00	0	0	99	0	133
1135	P-1064	60	1929	10	Universal	364.00	0	0	113	0	167
1136	P-1065	60	1929	10	Universal	478	0	0	112	0	166
1140	P-1067	50	1940	12	Universal	1,153	0	0	104	1	294
1141	P-1068	50	1940	12	Universal	443.00	0	0	108	1	267
1143	P-1069	110	2002	8	Ductile Iron	2,138	0	0	108	0	228
1145	P-1070	110	1996	8	Ductile Iron	573	0	4	75	0	81
1146	P-1071	110	1996	8	Ductile Iron	552.00	0	0	76	0	82
1150	P-1073	50	1940	12	Universal	422	0	0	99	1	173
1151	P-1074	50	1940	12	Universal	79	0	0	98	1	171
1153	P-1075	110	2003	8	Ductile Iron	238	0	0	98	0	99
1156	P-1076	70	1940	6	Universal	448	0	0	94	0	127
1157	P-1077	70	1940	6	Universal	247.00	0	0	87	0	120
1159	P-1078	110	2002	8	Ductile Iron	1,301	0	0	87	0	90
1166	P-1082	110	2003	8	Ductile Iron	442.00	0	0	94	0	185
1167	P-1083	110	2003	8	Ductile Iron	1,155.00	0	0	71	0	96
1169	P-1084	110	2003	8	Ductile Iron	3,200	0	0	56	0	119
1170	P-1085	110	2003	8	Ductile Iron	341	0	0	90	0	151
1172	P-1086	110	2003	8	Ductile Iron	747	0	0	90	0	83
1174	P-1087	75	1940	10	Universal	107	0	0	92	1	96
1175	P-1088	75	1940	10	Universal	805.00	0	0	92	1	96
1179	P-1090	70	1949	8	Universal	1,214.00	0	0	83	0	120
1180	P-1091	70	1949	8	Universal	1,472.00	0	0	90	0	127
1182	P-1092	110	1990	6	Ductile Iron	631.00	0	0	90	0	93
1186	P-1093	90	1967	8	Cement Lined Cast Iron	402	0	0	94	0	97
1188	P-1094	90	1967	8	Cement Lined Cast Iron	894.00	0	0	78	0	81
1193	P-1096	110	2001	8	Ductile Iron	1,352	0	0	76	0	79
1194	P-1097	110	2001	8	Ductile Iron	255.00	0	0	76	0	79
1196	P-1098	110	2001	8	Ductile Iron	356.00	0	0	76	0	79
1198	P-1099	60	1928	10	Cast Iron	641	0	0	92	0	108
1199	P-1100	110	1992	8	Ductile Iron	1,333.00	0	0	83	0	106

ID	Label	Hazen-Williams	Installation	Diameter	Material	Length (Scaled) (ft)	Number of Breaks	Soil	Static Pressure	Roadway Construction	Potential Water Hammer
1203	P-1102	70	1930	6	Universal	235	0	0	96	0	98
1205	P-1103	60	1890	12	Cast Iron	190	0	0	50	0	59
1206	P-1104	70	1940	6	Universal	395.00	0	0	48	0	61
1208	P-1105	70	1940	6	Universal	408	0	0	44	0	52
1211	P-1106	50	1930	6	Cast Iron	114.00	0	0	58	0	615
1212	P-1107	50	1930	6	Cast Iron	448.00	0	0	18	0	40
1228	P-1115	50	1942	4	Cast Iron	349.00	0	0	86	0	89
1267	P-1124	110	0	8	Ductile Iron	309.00	0	0	71	0	153
1291	P-1126	60	1929	10	Universal	1,663	0	1	110	0	139
1293	P-1127	60	1929	10	Universal	1,663	0	1	110	0	139

Name	Service Area	ID	Label	Elevation (I	Elevation (I	Elevation (I	Diameter (ft)	Volume (gallons)
Richardson Street Tank	High Service Area	511	T-2	541	541	591	60	1,000,000
Low Service Area Tank	Low Service Area	976	T-3	479	479	498	138.2	1,500,000

APPENDIX C

TATA & HOWARD


Northbridge
Mendon
Millville
14.Upton Road
New 8-Inch Water Main
11.William Ward Street and Linwood Street
New 8-Inch Water Main
Interconnection with Whitinsville
Water Company
10.Rivulet Street & Fletcher Street
New 8-Inch Water Main
4. North Main Street
New 12-Inch Water Main
9.Hartford Avenue West
New 8-Inch Water Main
3. North Main Street &
Hartford Avenue East
New 12-Inch Water Main
2. North Main Street
New 12-Inch Water Main
6.Capron Street
New 12-Inch Water Main
5.Mendon Street &
Henry Street
New 12-Inch Water Main
Low Service Area Tank
Capacity: 1.5 mg
Overflow Elevation: 500 feet
15.Gloria Street
New 8-Inch Water Main
Blackstone Wells No. 1, 2 & 3
Bernat Well No. 4
8. Hecla Street & Elmdale Street
New 8-Inch Water Main
13.Veterans Parkway
New 8-Inch Water Main
Bernat Wells No. 5 & 6
High Service Area
East Street Pump Station
Firm Capacity: 50 gpm
Richardson Street Tank
Capacity: 1.0 mg
Overflow Elevation: 591 feet
East Street
Service Area
1. High Street and West Street
New 12-Inch Water Main
Fafard Pump Station
Firm Capacity: 0.5 mgd
12.Susan Parkway
Connect to 12Inch Main
7.South Main Street & Blackstone Street
New 12-Inch Water Main
Rosenfeld Well
Legend
HydraulicImprovements
ISO Improvement
Other Improvement
Water Main Diameter
4-inches or Less
6-inches
8-inches
10-inches
12-inches
16-inches
20-inches
High Service Area
East Street Service Area
Hydraulic Improvements
Uxbridge, Massachusetts
TATA & HOWARD
Approximate Scale: 1"=1,000'
February 2014

APPENDIX D

TATA & HOWARD

Critical Locations
Uxbridge, Massachusetts
TATA & HOWARD
Approximate Scale: 1"=1,000'
February 2014
N
Northbridge
Mendon
Millville
Interconnection with Whitinsville Water Company
Low Service Area Tank
Capacity: 1.5 mg
Overflow Elevation: 500 feet
Richardson Street Tank
Capacity: 1.0 mg
Overflow Elevation: 591 feet
High Service Area
Fafard Pump Station
Firm Capacity: 0.5 mgd
Bernat Well No. 4
Bernat Wells No. 5 & 6
Blackstone Wells No. 1, 2 & 3
East Street Pump Station
Firm Capacity: 50 gpm
East Street Service Area
Rosenfeld Well
Rice City Pond
Whitin Pond
Riley Pond
Linwood Pond
Rivulet Pond
Caprons Pond
Hecla Pond
Pout Pond
Lee Reservoir
Sawmill Pond
Joels Pond
Peabody Pond
COUNTRY CLUB DRIVE
SUTTON STREET
SYLVAN ROAD
HOMESTEAD AVENUE
RIVULET STREET
ELM STREET
HARTFORD AVENUE WEST
HARTFORD AVENUE EAST
LINWOOD STREET
WILLIAM WARD STREET
LAKE STREET
CHURCH STREET
CARRINGTON LANE
PINECREST ROAD
OAK STREET
HERITAGE ROAD
UPTON ROAD
PUDDING STREET
WEST HILL DAM ROAD
CEDAR ROAD
HARVEST ROAD
MEADOW ROAD
HENRY LEGG ROAD
WITEK STREET
WEST RIVER ROAD
MENDON STREET
TERESA DRIVE
OLD ROCK MEADOW ROAD
ROCK MEADOW ROAD
BIG ROCK ROAD
WOODLAND ROAD
ERIC DRIVE
SHARON CIRCLE
WENDY LANE
MY WAY
BRANDY LANE
DEANNA DRIVE
NO WAY
LARKIN AVENUE
BLACKSTONE STREET
HENRY STREET
HOLLIS STREET
CHAPIN STREET
CHARLES AVENUE
CROSS STREET
BRUCE STREET
CAPRON STREET
HECLA STREET
POWER STREET
ELIZABETH STREET
KENNEDY STREET
GERTRUDE STREET
GLORIA STREET
FAGAN STREET
BAILEY STREET
JODIE CIRCLE
OLD FARMDALE ROAD
SCOTTS LANE
EAST STREET
FISHER STREET
EMILIA STREET
EASTWOOD HEIGHTS
PATRIOT WAY
GIAMCAMO WAY
KEMPTON ROAD
SEQUOIA LANE
CONESTOGA DRIVE
WAUCANTUCK DRIVE
SARATOGA DRIVE
ALBEE ROAD
HAZEL STREET
CROSS ROAD
BROOKSIDE DRIVE
HIGHVIEW DRIVE
BLANCHARD AVENUE
FLETCHER STREET
TALBOT TERRACE
SMITH STREET
HEWITT STREET
MARYWOOD STREET EXTENSION
CARNEY STREET
PETER STREET
MARY LANE AVENUE
FARNUM STREET
PARK STREET
VETERANS PARKWAY
EDGEWOOD DRIVE
COUNTRY SQUIRE ROAD
ELMSHADE DRIVE
SPINNING WHEEL DRIVE
COTTON MILL WAY
LANDRY LANE
HIGH STREET
EBBERTAFT ROAD
POND STREET
OLD RICHARDSON STREET
MILL STREET
SUSAN PARKWAY
OLD MILLVILLE ROAD
BEAUSOLEIL
CHOCOLOG ROAD
ACORN DRIVE
RIVER ROAD
MILLVILLE ROAD
IRONSTONE ROAD
BALM OF LIFE SPRING
COLONEL DRIVE
CHESTNUT STREET
LOCUST STREET
JOHNSON ROAD
ALDRICH STREET
ELMWOOD AVENUE
ERICKSON STREET
GLENDALE STREET
KINGS STREET
DOUGLAS STREET
HUNTER ROAD
AUTUMN ROAD
COLD SPRING DRIVE
WILLOW LANE
TYLER ROAD
GERVAIS WAY
SAINT ANDRE DRIVE
BEVERLY AVENUE
SOUTH GARDEN STREET
DEPOT STREET
PLEASANT STREET
DONNELLY WAY
MOORLAND DRIVE
ROGERSON CROSSING
MANDRIVIEW WAY
BEACON STREET
16
122
146
146A
Legend
Type
Medical Facility
Nursing Home
School
Other
Railroads
Diameter
4-Inches or less
6-Inches
8-Inches
10-Inches
12-Inches
16-Inches
20-Inches
Critical Component Area
High Service Area
East Street Service Area

APPENDIX E

TATA & HOWARD

Asset Management Ratings
Uxbridge, Massachusetts
TATA & HOWARD
Approximate Scale: 1"=1,000'
February 2014
Legend
Asset Management Score
Good - Excellent
Fair - Good
Poor - Fair
High Service Area
East Street Service Area
N
Northbridge
Mendon
Millville
Interconnection with Whitinsville Water Company
Low Service Area Tank
Capacity: 1.5 mg
Overflow Elevation: 500 feet
Richardson Street Tank
Capacity: 1.0 mg
Overflow Elevation: 591 feet
Fafard Pump Station
Firm Capacity: 0.5 mgd
Bernat Well No. 4
Bernat Wells No. 5 & 6
Blackstone Wells No. 1, 2 & 3
East Street Pump Station
Firm Capacity: 50 gpm
Rosenfeld Well
High Service Area
East Street
Service Area
Riley Pond
Linwood Pond
Whitin Pond
Rivulet Pond
Rice City Pond
Pout Pond
Hecla Pond
Caprons Pond
Lee Reservoir
Sawmill Pond
Joels Pond
Peabody Pond
Houghton Pond
Chackalog Pond
Cedar Swamp Pond
COUNTRY CLUB DRIVE
SYLVAN ROAD
SUTTON STREET
HOMESTEAD AVENUE
RIVULET STREET
HARTFORD AVENUE WEST
HARTFORD AVENUE EAST
NORTH MAIN STREET
SOUTH MAIN STREET
LINWOOD STREET
WILLIAM WARD STREET
GRANITE STREET
MENDON STREET
HENRY STREET
WEST RIVER ROAD
BLACKSTONE STREET
HAZEL STREET
CROSS ROAD
HIGH STREET
DOUGLAS STREET
RICHARDSON STREET
ELMSHADE DRIVE
SPINNING WHEEL DRIVE
QUAKER HIGHWAY NORTH
SUSAN PARKWAY
OLD MILLVILLE ROAD
MILL STREET
EBBERTAFT ROAD
POND STREET
OLD RICHARDSON STREET
CHOCOLOG ROAD
RIVER ROAD
MILLVILLE ROAD
ALBEE ROAD
KEMPTON ROAD
FISHER STREET
EAST STREET
BALM OF LIFE SPRING
CHESTNUT STREET
LOCUST STREET
JOHNSON ROAD
LAUREL STREET
ELMWOOD AVENUE
ERICKSON STREET
GLENDALE STREET
KINGS STREET
COLONEL DRIVE
IRONSTONE ROAD
ACORN DRIVE

APPENDIX F

TATA & HOWARD

Three Circles Integration Map
Uxbridge, Massachusetts
TATA & HOWARD
Approximate Scale: 1"=1,000'
February 2014
Legend
Critical Customers
Medical
Nursing Home
School
Other
Critical Component Area
Railroads
HydraulicImprovements
ISO Improvement
Other Improvement
Asset Management Score
Good - Excellent
Fair - Good
Poor - Fair
High Service Area
East Street Service Area
Northbridge
Mendon
Millville
Interconnection with Whitinsville Water Company
Low Service Area Tank
Capacity: 1.5 mg
Overflow Elevation: 500 feet
Richardson Street Tank
Capacity: 1.0 mg
Overflow Elevation: 591 feet
Fafard Pump Station
Firm Capacity: 0.5 mgd
Blackstone Wells No. 1, 2 & 3
Bernat Well No. 4
Bernat Wells No. 5 & 6
East Street Pump Station
Firm Capacity: 50 gpm
Rosenfeld Well
High Service Area
East Street
Service Area

APPENDIX G

TATA & HOWARD

Northbridge
Mendon
Millville
N
35. Providence Road (Route 122)
New 8-inch main
Interconnection with Whitinsville
Water Company
30. Lake Street
New 8-inch main
11. Off Hartford Avenue East
New 12-inch main
5. Hartford Avenue East
New 12-inch main
10. Upton Road
New 8-inch main
29. West River Road
New 8-inch main
17. William Ward Street
New 8-inch main
18. Linwood Street
New 8-inch main
27. Whitin Street
New 12-inch main
19. Rivulet Street/Fletcher Street
New 8-inch main
7. Hartford Avenue West
New 8-inch main
22. Boston Street
New 8-inch main
36. Garden Street
New 8-inch main
25. Glendale Avenue
New 8-inch main
1. North Main Street (Route 122)
New 12-inch main
13. Oak Street
New 8-inch main
2. Mendon Street (Route 16)
New 12-inch main
Henry Street
New 12-inch main
41. Kennedy Street
New 8-inch main
23. South Garden Street
New 8-inch main
26. Dale Street
New 8-inch main
32. Seagrave Street
New 8-inch main
6. Capron Street
New 12-inch main
12. Henry Street
New 8-inch main
24. Douglas Street (Route 16)
New 8-inch main
8. Gloria Street
New 8-inch main
39. Power Street
New 8-inch main
31. Park Street
New 8-inch main
42. Fagan Street
New 8-inch main
40. Elizabeth Street
New 8-inch main
Low Service Area Tank
Capacity: 1.5 mg
Overflow Elevation: 500 feet
Blackstone Wells No. 1, 2 & 3
33. Farnum Street
New 8-inch main
14. Off Depot Street
New 8-inch main
28. DPW
New 8-inch main
37. Chapin Street
New 8-inch main
34. Pleasant Street
New 8-inch main
15. Off Depot Street
New 8-inch main
Bernat Well No. 4
38. Brown Terrace
New 8-inch main
43. Old Blackstone Street
New 8-inch main
4. Hecla Street
New 8-inch main
Elmdale Road
New 8-inch main
16. Blackstone Street
New 8-inch main
20. Veterans Parkway
New 8-inch main
Bernat Wells No. 5 & 6
East Street Pump Station
Firm Capacity: 50 gpm
High Service Area
Richardson Street Tank
Capacity: 1.0 mg
Overflow Elevation: 591 feet
1. South Main Street (Route 122)
New 12-inch main
East Street
Service Area
Fafard Pump Station
Firm Capacity: 0.5 mgd
9. Susan Parkway
New 8-inch main
3. High Street
New 16-inch main
West Street
New 16-inch main
Douglas Street (Route 16)
New 16-inch main
21. South Main Street/Millville Parkway (Route 122)
New 12-inch main
Blackstone Street
New 12-inch main
Rosenfeld Well
Legend
Hydraulic Improvements
Phase I
Phase II
Phase III
Water Main Diameter
4-inches or Less
6-inches
8-inches
10-inches
12-inches
16-inches
20-inches
High Service Area
East Street Service Area
Recommended Improvements Map
Uxbridge, Massachusetts
TATA & HOWARD
Approximate Scale: 1"=1,000'
February 2014