Section

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Section 5
Asset Management Considerations

General

The Wayland water distribution system has been in operation since 1878. The existing system includes approximately 100 miles of water main varying in size and material. A number of factors including age, material, diameter, break history, soil conditions and water quality affect the decision to replace or rehabilitate a water main. Using an Asset Management approach, each water main in the system was assigned a numerical grading based on these factors. The gradings were then used to establish a prioritized schedule for water main replacement or rehabilitation.

Data Collection

Information was obtained through meetings with Wayland Water Department personnel and review of town records including old maps, tie cards, invoices and annual reports. Because record drawings did not exist, water main ages and materials were estimated based on construction records and personnel field experience.

Evaluation Criteria

In order to prioritize water main replacement or rehabilitation, a water main grading system was established. The grading system used the water main characteristics such as age, material, break history, water quality, diameter size and soil characteristics to assign point values to each pipe in the system. Each category was assigned a grading between zero and 100 with zero being the most favorable and 100 being the worst case within the category. Each category was then given a weighted percentage, which represents priorities within the system. It is the WWD's discretion to adjust the weight based on system performance and condition. Our recommendation was that a maximum of 30 percent be given to any one category. The grading was then multiplied by the weight. The weighted grading for each performance criteria will be utilized to determine the overall grading per pipe. Those pipes with the highest grade were considered most in need of replacement or rehabilitation.

In order to establish a rating system specific to the system, discussions with the Wayland Water Department were incorporated. The WWD has stated that water quality issues are their largest concern at this time. The discolored water quality issue is likely related to the well water residual iron and manganese remaining in the pipes and/or from deterioration of the interior of unlined cast iron water mains themselves. This was taken into account when developing the rating system. The grading system is shown in Table 5-1 and discussed in detail later in this section.

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, until about the year 1958,

Table 5-1
Asset Management Grading System
Capital Efficiency Plan™
Wayland, Massachusetts

Weight	Performance Criteria	Rating	Weighted Rating
15%	Break History		
	History of Breaks	100	15
	No History of Breaks	0	0
20%	Material		
	Unlined Cast Iron	100	20
	Asbestos Cement	50	10
	Cement Lined Cast Iron	30	6
	Ductile Iron	5	1
20%	Installation Date		
	Pre 1920	100	20
	1920-1932	90	18
	1933-1939	50	10
	1940-1954	40	8
	1955-1969	20	4
	1970-1979	10	2
	1980-1989	5	1
	1990-1999	2	0.4
	2000-2007	0	0
25%	Water Quality		
	Water quality problems	100	25
	No water quality problems	0	0
15%	Diameter		
	4-inch water main	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
5%	Soils		
	Identified as poor soils	100	5
	Wetlands	80	4
	Gravel, sand	0	0

Table No. 5-2
Pipe Material by Installation Year
Capital Efficiency Plan™
Wayland, Massachusetts

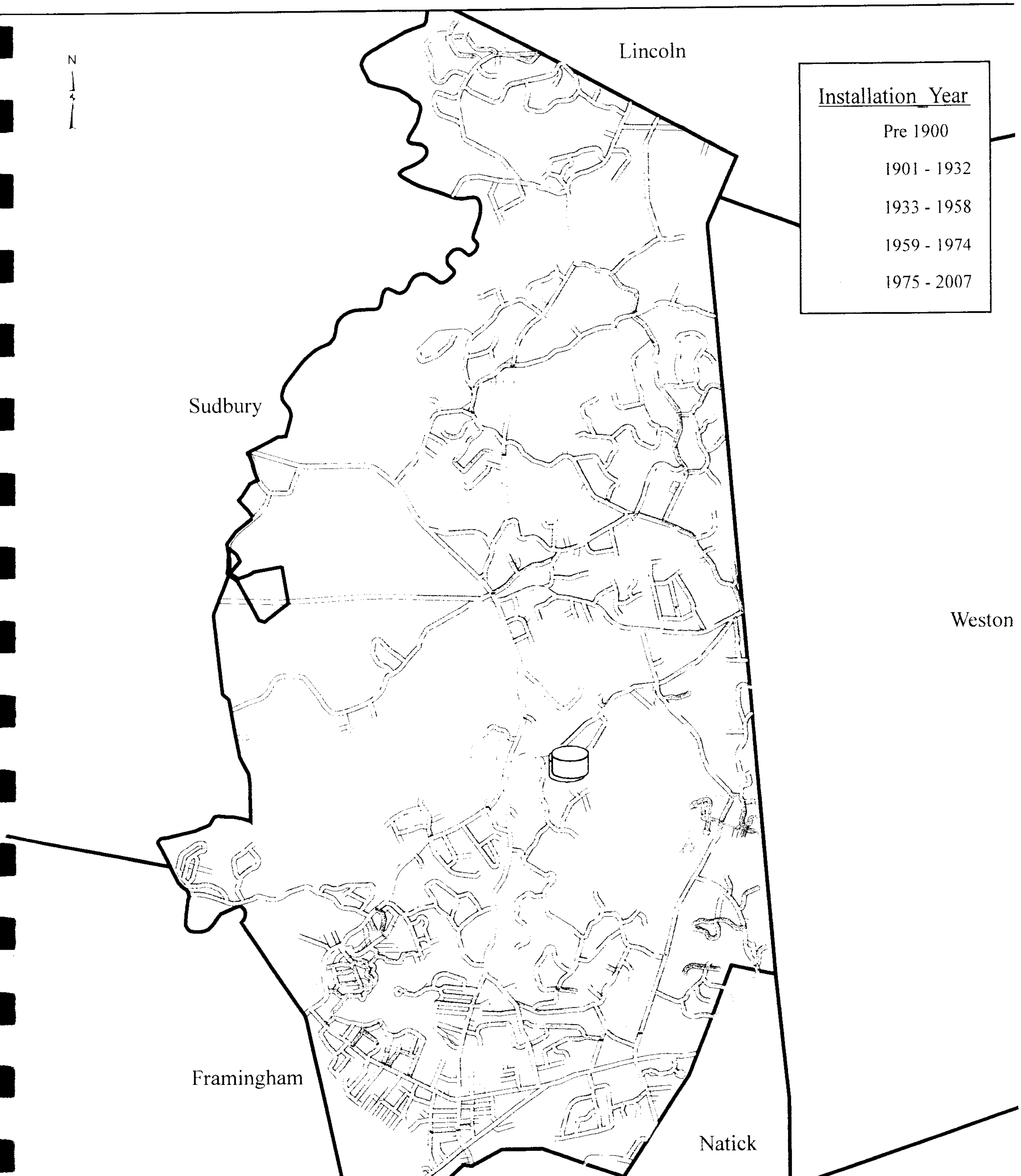
Length (ft)	Material				
Installation Year	Asbestos Cement	Cement Lined Cast Iron	Ductile Iron	Unlined Cast Iron	Grand Total
Pre 1920				13,776	13,776
1920 - 1932				56,068	56,068
1933 - 1939				84,480	84,480
1940 - 1954	2,083			163,270	165,353
1955 - 1969	2,287	86,192	154	41,228	129,861
1970 - 1979		23,516	8,251		31,767
1980 - 1989			14,569		14,569
1990 - 1999			13,328		13,328
Grand Total	4,370	109,708	63,136	358,822	536,036

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 1950's to the mid 1970s, when pipe manufactures switched primarily to factory cement lined ductile iron pipe.

Cast iron water mains consist of two types: pit cast and sand spun (a.k.a. centrifugally cast). Pit cast mains were manufactured from the 1800's up until approximately 1930, while sand spun mains were 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. Although sand spun mains have a uniform wall thickness, the overall wall thickness was thinner than the pit cast mains. The uniformity and improved iron purity provided added strength, however, the thin wall thickness made it more susceptible to corrosion and breaks. Pit cast mains 16-inch diameter and larger have very thick pipe walls and are generally stronger than the thinner walled spun cast mains. Prior to about the year 1958, cast iron mains were unlined, which increased the potential for internal corrosion. The year 1958 is also when rubber gasket joints were introduced. Prior to this date joint material was either jute (rope type material) packed in place with lead or a lead-sulfur compound, also known as "leadite" or "hydrotite." Leadite type joints 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 at the spigot end of the pipe. Therefore, the grading score is higher for water mains manufactured before 1958 as opposed to water mains manufactured after this time. After 1958, factory lined cast iron was manufactured and installed up until about 1970. Cement lining provides increased protection against internal corrosion. Unlined cast iron water mains make up approximately 67 percent of the Wayland water system.

Between the 1930's and 1970's, the water industry also utilized asbestos cement (AC) pipe for their expanding water systems. An advantage of AC pipe is that it resisted tuberculation build up, resulting in less system head loss. However, depending on the water quality, the structural integrity of AC mains can deteriorate over time, thereby becoming sensitive to pressure fluctuations and/or nearby construction activities. In addition, external influences such as soil type and high groundwater can corrode AC mains, thus reducing the strength further. Only one percent of the system consists of AC water mains and according to personnel these mains have not had many failures and are not a cause of concern at this time.

Approximately 10 percent of the system is cement lined ductile iron water main. This material was introduced in the United States in 1950's, however, was not widely used until the 1970's. 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. However, ductile iron pipe typically has a much thinner pipe wall and may not have the overall



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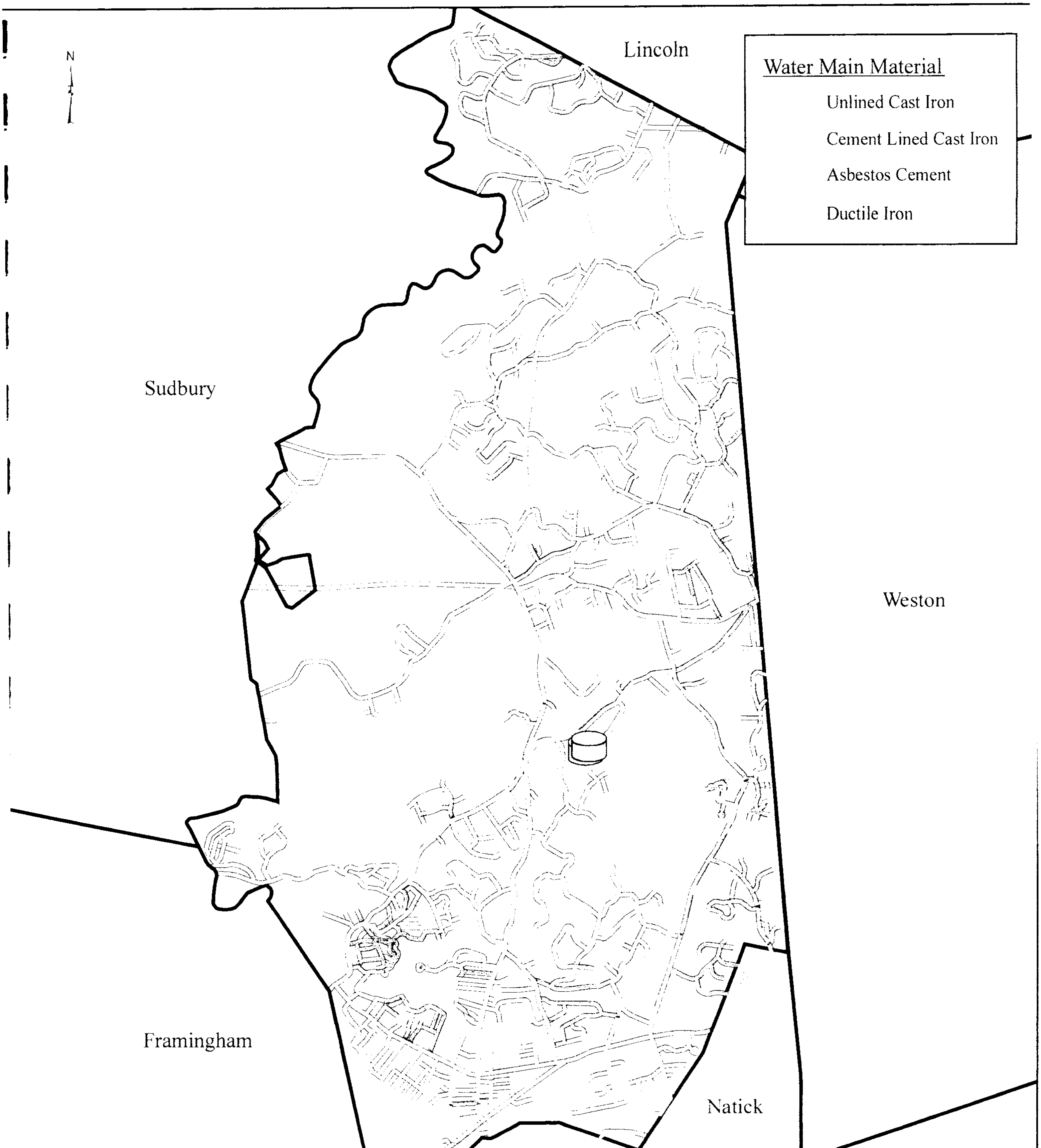
Water Main Installation Year

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.
5-1



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Water Main Material

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-2

useful life as cast iron pipe due to external corrosion unless it is wrapped in polyethylene encasement.

In general, the oldest water mains in the system received a high rating of 100, while the newest received a rating of zero. A ratings decrease occurs after 1932, which reflects the switch in Wayland from a surface water source to groundwater sources. Surface water in this area of the country is typically more corrosive to the interior of water mains than groundwater and this is reflected in the rating decrease. Another significant rating decease can be seen in the materials score around 1958, which reflects the introduction of factory lining. Figures No. 5-1 and 5-2 present the installation year of the water mains and the materials, respectively.

Diameter

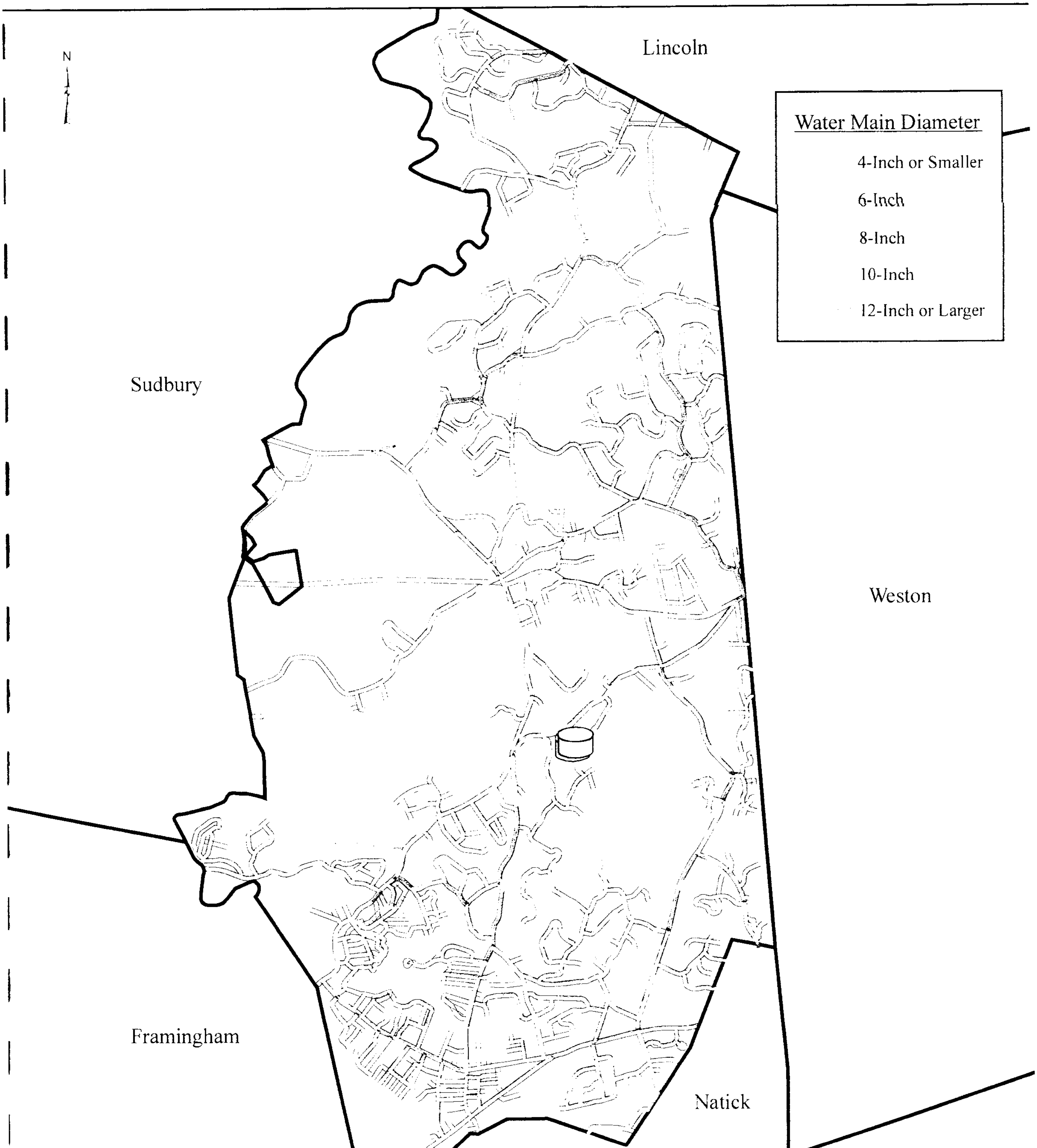
The Wayland water distribution system consists of approximately 100 miles of water mains ranging in diameter from four to sixteen inches. In general, as the diameter of a pipe increases, the strength increases. In most cases, failure occurs in the form of ring cracks. This is the result of bending forces 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 due to their increased wall thickness and increased moment of inertia. Pipes that are 16-inches in diameter and larger have significantly thicker walls than 12-inch diameter pipe and smaller. 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 sixteen-inch diameter water mains. Therefore, a rating of 100 was given to 4-inch diameter water mains and a rating of five was given to the 16-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 8-inch diameter water main (50). This is due to superior bending resistance.

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. Mains which are 4-inch diameter or less should be replaced with at least an 8-inch diameter main because an 8-inch diameter main has a 77 percent greater carrying capacity than a 6 inch main resulting in lower headloss and water velocities during fire flow events. Figure No. 5-3 presents the various diameters throughout the distribution system.

Break History

Based on conversations with staff and Water Department records, the water system experiences an average of approximately eight to ten breaks per year. In relation to the total miles of water main in the system, this equates to approximately eight breaks per 100 miles per year. In comparison to the national average of 25 breaks per 100 miles per year, the Wayland water system is in good condition.



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Water Main Diameter

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-3

Each water main break costs the water Town time and labor. They also cause disruption to the public and water consumers. At some point, it becomes more efficient to replace the main than to continue repairing it. Based on discussions with WWD staff, there are several areas in the system that have experienced breaks. These areas are given a rating of 100 while areas with no known breaks received a rating of zero. Figure No. 5-4 presents areas with a history of breaks.

Pressures

Approximately 50 percent of the Wayland water system has a pressure above 80 psi. 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. Approximately four percent of the system experiences pressures above 100 psi. Massachusetts Department of Environmental Protection Guidelines and Policies for Public Water Systems states that normal working pressures should be approximately 60 psi and not less than 35 psi. Areas with pressures exceeding 125 psi are required to have pressure reducing valves on the water mains. These areas are more susceptible to water main breaks. In addition, main failures in areas of higher pressure typically cause more disruption, and result in more costly repairs for damages. Because none of the system has pressure above 125 psi, a pressure criteria was not considered in the asset management rating. Figure No. 5-5 presents static pressure ranges in the system as summarized below.

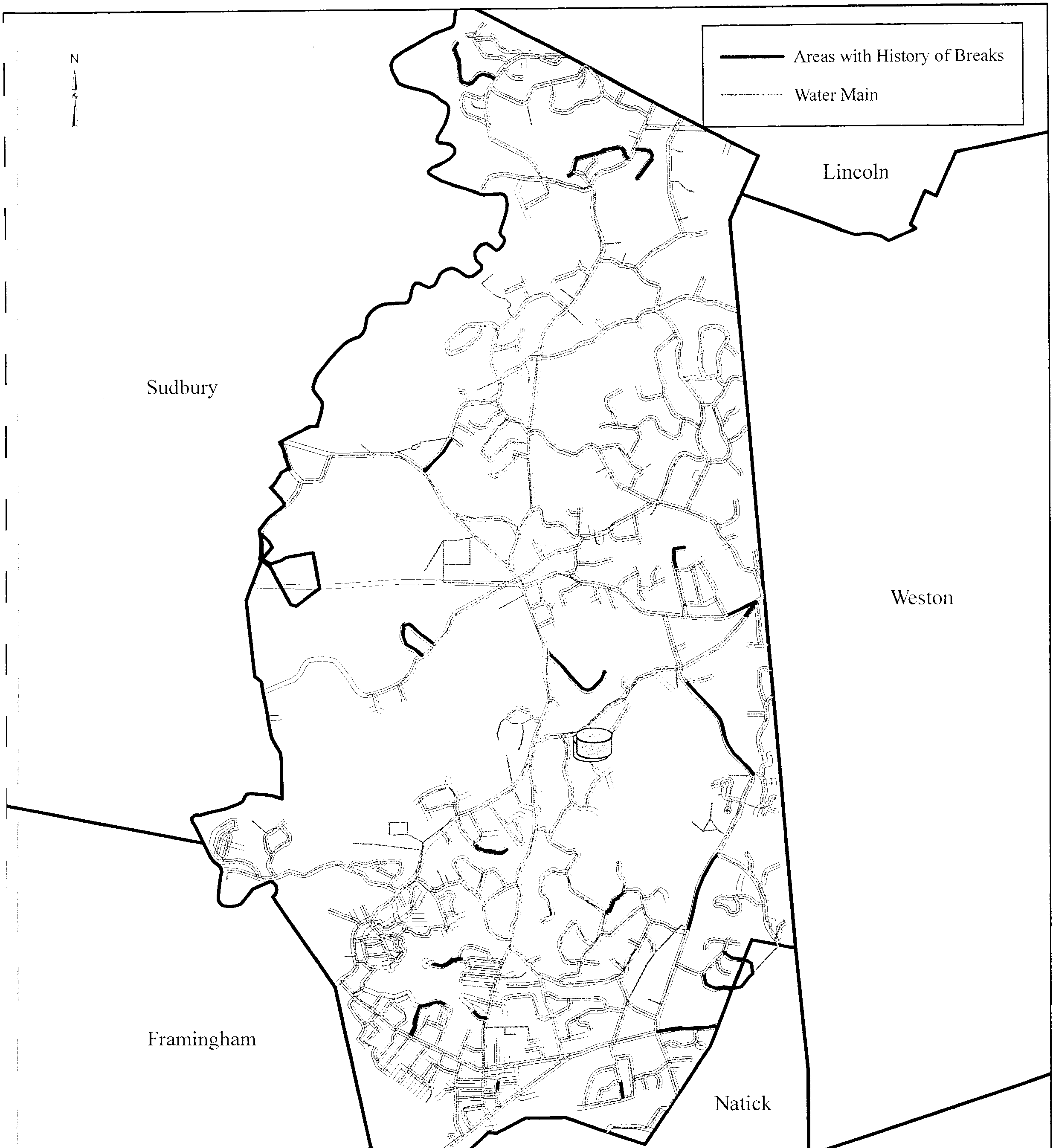
Pressure Range	Percentage in System
Less than 80 psi	50
80 – 100 psi	46
100 – 125 psi	4
Greater than 125 psi	0

Soils

Water main degradation can occur both internally and externally. Factors that increase the rate of external corrosion include high groundwater, clay soils, potentially contaminated soils, soils with low calcium carbonate, or soils with high acidity or sulphate. Wetland areas have greater potential to cause external corrosion of water main than other soil conditions. As shown on Figure No. 5-6, wetland areas are scattered throughout Wayland. Areas where the water system and the wetlands coincide were considered areas of potential exterior corrosion. There were also areas identified to have a high groundwater level or known corrosive soils based on soil conditions observed during main repairs. These areas were given the highest rating (100) because they were known areas of potential corrosion. Areas identified as wetlands through soils maps were given a rating of 80. All other pipe was assigned a rating of zero.

Water Quality

Based on discussions with the Wayland Water Department, there are some areas of the system with water quality concerns. The Meadowview Well produces high concentrations of manganese. As a result, this well is no longer used, but there is residual manganese in the pipes in this area of the system that cause black water complaints.



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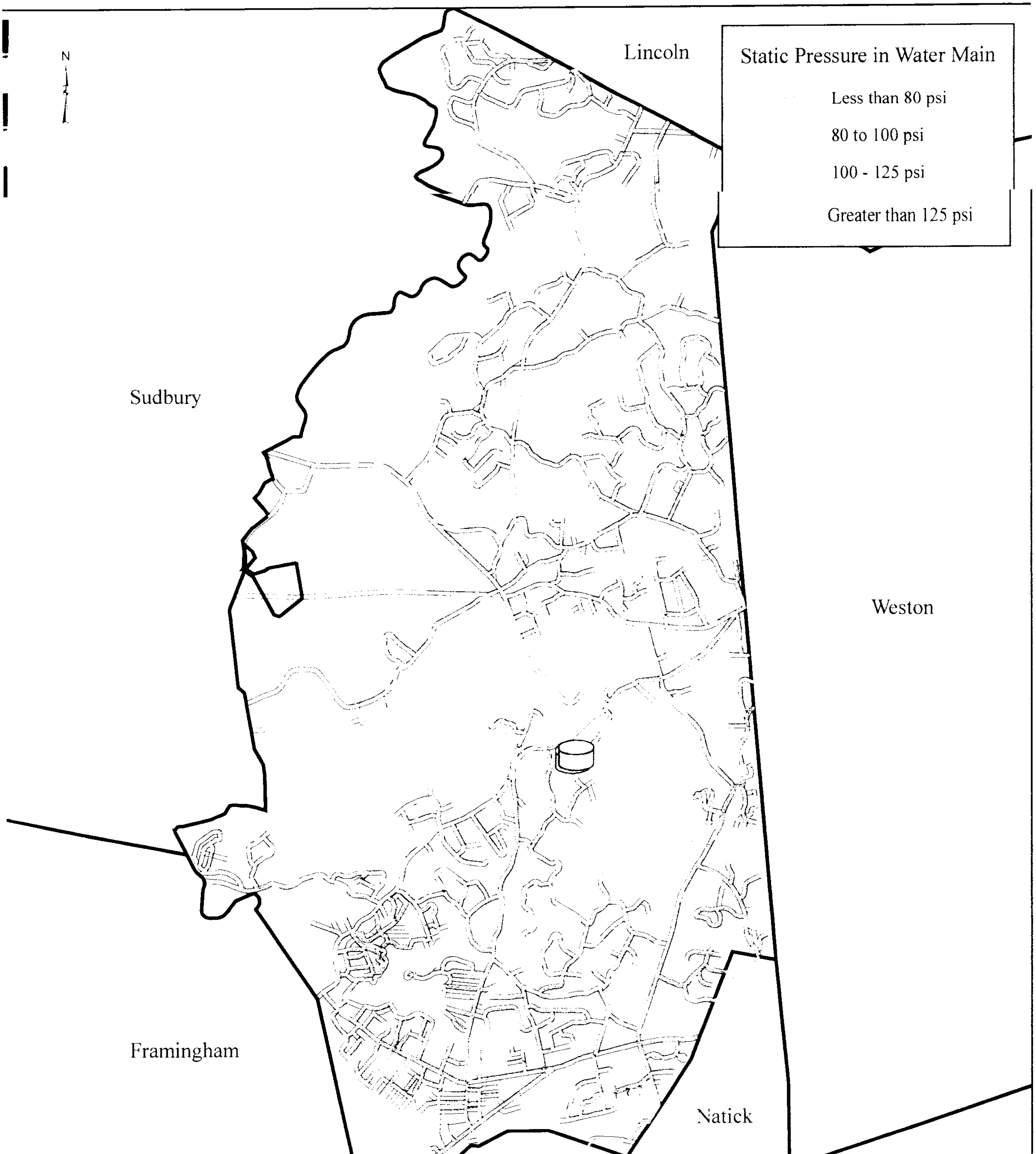
Areas with History of Breaks

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.
5-4



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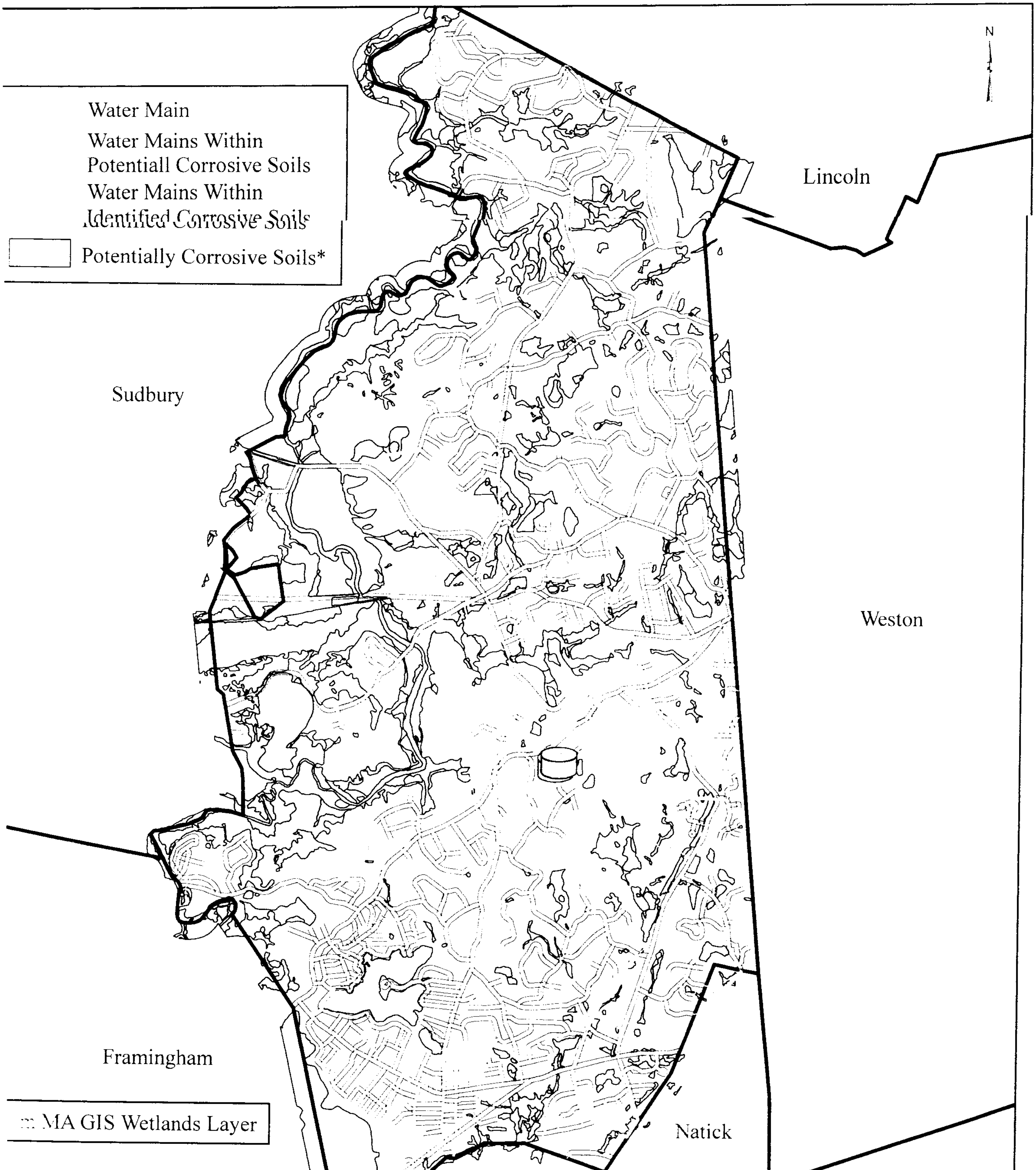
Static Pressure in Water Main

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-5



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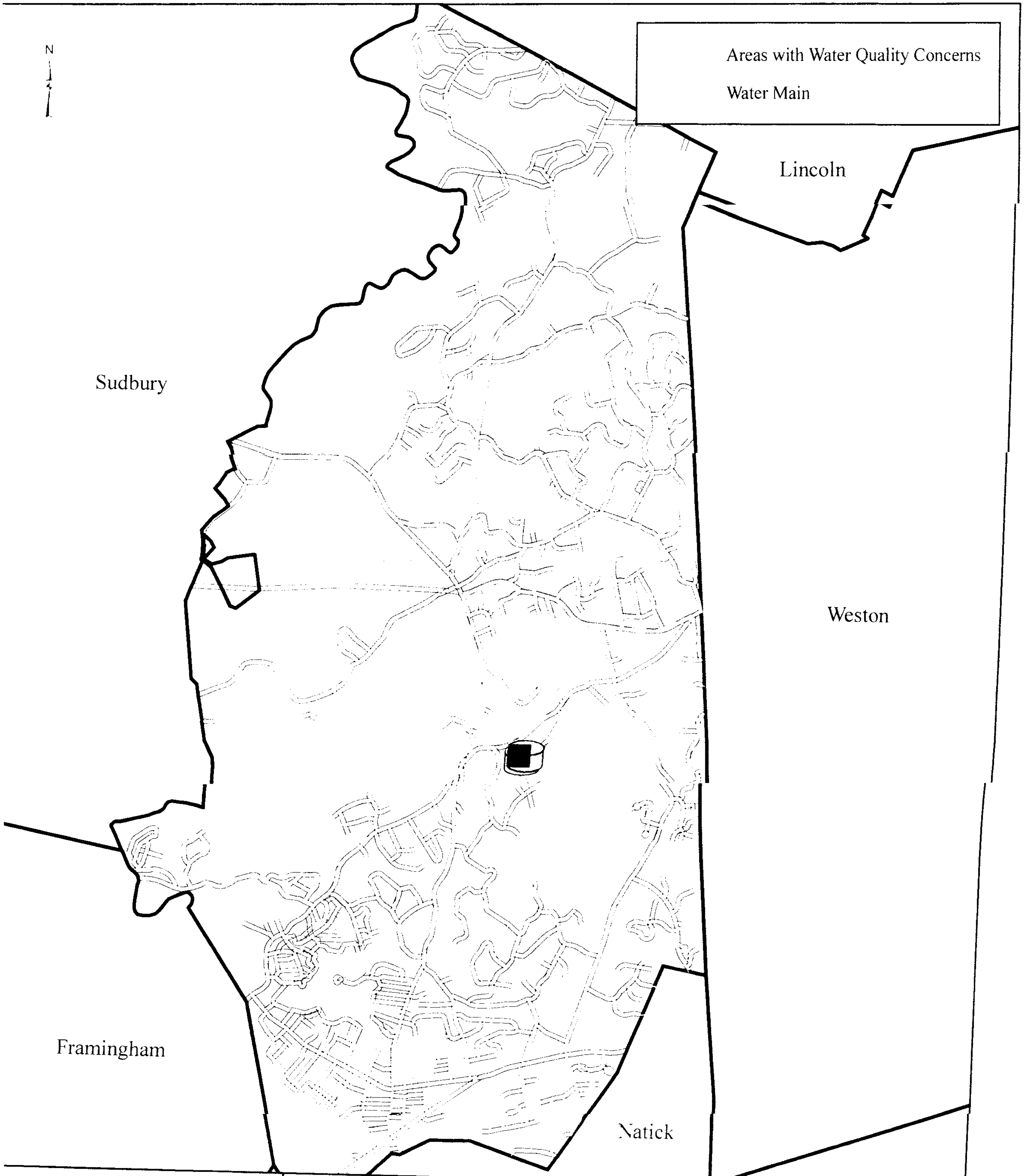
Potentially Corrosive Soils

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-6



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Areas with Water Quality Concerns

Capital Efficiency Plan
Wayland, Massachusetts

Figure No.

5-7

Also, there have been numerous brown water complaints over the years in the north-eastern portion of Town. Much of the water main in this area is unlined cast iron, which is most likely in poor condition and resulting in increased iron in the water. Finally, Baldwin Pond Wells No. 1 and 2 are currently not used due to high iron and manganese levels. The proposed Baldwin Pond Water Treatment Facility should alleviate this problem and allow for these wells to be used again. Figure No. 5-7 represents the areas with water quality concerns.

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 29 are considered good to excellent. Areas with a total rating between 30 and 59 are considered good to fair, and areas with a total rating greater than 60 are considered poor to fair. Water mains considered poor to fair are included in Table No. 5-3. Asset management ratings are presented graphically in Appendix C.

Table No. 5-3
Asset Management Areas of Concern
Capital Efficiency Plan^{TM}
Wayland, Massachusetts

Location	Rating
Poor to Fair	
Boston Post Road from Cochituate Road to Westway Road	63/84
Rich Valley Road	67/82
Pinebrook Road	71
Concord Road from Old Sudbury Road to Moore Road	63/69
Bow Road	69
Plain Road from Concord Road to Claypitt Hill Road	63/69
Glezen Lane from Concord Road to the Town Line	61/67
Pear Tree Lane	67
Folsom Pond Road	67
Jericho Lane	67
Training Field Road from Concord Road to Pheasant Run	61/67
Bennett Road	67
Lee Road	61/67
Hayward Road from Rich Valley Road to Sylvan Way	67
Westway Road	67
Shore Drive and Riverview Circle	61/67
Oak Hill Road	61/67
Meadowview Road	61/67
Claypitt Hill Road from concord Road to Plain Road	61/66
Forty Acres Drive	66
Commonwealth Avenue from Oak Street to Town Line	61/65

Table No. 5-3 (Continued)
Asset Management Areas of Concern
Capital Efficiency Plan™
Wayland, Massachusetts

Location	Rating
Jeffrey Road	64
Dudley Road from Bayfield Road to end	64
Mellen Lane	63
Lingly Lane	63
Farmcrest Lane	63
Plainview	63
Glen Road from Boston Post Road to Millbrook Road	63
Michael Road	63
Holbrook Road	63
Saddle Lane	61
Barley Lane	61
Springhill road	61
Glover Road	61
Wheelock Road	61
Stonebridge Road	61
Overlook Road	61

Section

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Section 6
Above Ground Facilities

General

As discussed in Section 2, the water system includes eight wells located at five locations, two above ground water storage tanks and a booster pump station. In addition, each well has chemical storage and injection facilities. All facilities are connected to the Town's SCADA system. In November 2007, Tata & Howard conducted a site visit of the wells, tanks and pump station to take inventory and evaluate the condition of each structure and associated equipment.

Evaluation Criteria

The above ground facilities in the system were evaluated based on installation date, expected life span and current condition. The installation date was determined based on conversations with Wayland Water Department staff, inspection and rehabilitation reports and invoices from suppliers. The life span was estimated based on AWWA papers and standard water works practices. An inspection of each facility was conducted to determine if the estimated life span of a particular piece of equipment should be adjusted based on its current condition.

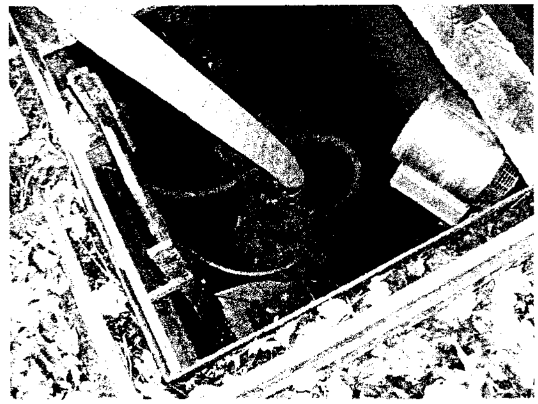
Condition of Above Ground Facilities

The results of the evaluation of the above ground facilities are discussed below.

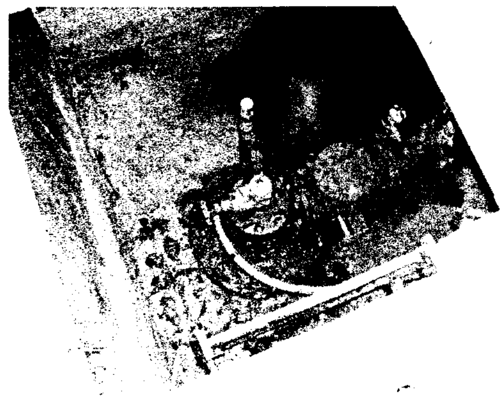
Baldwin Pond Wells

The Baldwin Pond Wells consists of three wells, a control building and an operations building. The control building was built in 1927 and turned into the current pump station in 1962. The building houses the chemical storage for Wells No. 1 and 2, the master venturi meter, emergency generator and the motor control center for all three wells. The building walls are in good condition, but the roof is missing shingles. The generator is the original generator from 1962. Wells No. 1 and 2 are currently offline, therefore, the chemical storage tanks at this location are empty.

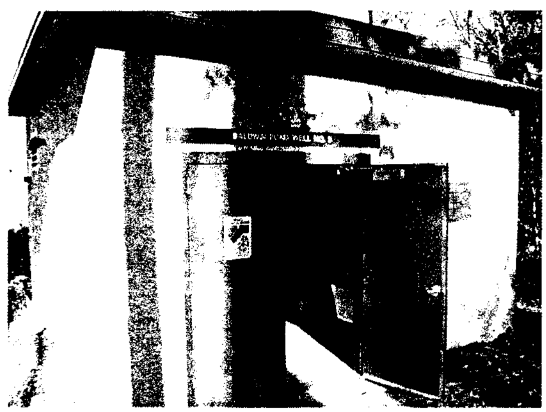
Well No. 1 was replaced in 2001 and is located in the original concrete vault. Well No. 1 is currently offline due to high iron and manganese levels and is used as a sampling location only.



Well No. 2 was installed in 1944. The current pump was installed in 1993 and the pump motor was replaced in 2003. The pump and motor are located in the original concrete vault. The well was inspected in 2007 and found to be in good condition. Well No. 2 is currently offline due to high iron and manganese levels.



Well No. 3 was installed in 1955 and is located in a concrete building with a concrete slab roof installed in 1998. The pump and pump motor were replaced in 1993. The well was redeveloped in 1998. The 2007 well inspection report recommends the pump be pulled and inspected. Chemical storage and injection was added to the building in 1999.



A summary of the installation year and expected life span of each piece of equipment at the Baldwin Pond Wells is included in Table No. 6-1. A new Water Treatment Facility has been designed for this location. Construction of the new facility would include a 1. mgd treatment facility with a new building and add an addition to the existing garage. Also, the Well No. 1 vault will be replaced and a new pump installed. Modifications made to Well No. 3 will include a new pump and motor. Also, a new generator will be installed in the treatment facility building to operate all three wells during a power failure.

Table No. 6-1
Baldwin Pond Wells
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Control Building			
Building	1927	100	2027
Roof	1927	20	2027
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014
Master venturi	1962	50	2012
Generator	1962	50	2012
Motor control center	1999	25	2024
Well No. 1 (not in use except for sampling)			
Well pump	1992	50	2042
Pump motor	1992	25	2019
Vault	1938	100	2038
Well No. 2 (not in use)			
Well pump	1993	50	2043
Pump motor	2003	25	2028
Vault	1944	100	2044
Well No. 3			
Well pump	1993	50	2044
Pump motor	1993	25	2019
Building	1998	100	2098
Concrete roof	1998	50	2048
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014
Magnetic meter	1998	25	2023

Campbell Well

The Campbell Well and station was originally installed in 1965. The station is a concrete building with a concrete slab roof. It is the original building and roof from 1965. An addition was added to the building in 1999 for the chemical storage and injection. Both portions of the building are in good condition. A new pump and pump motor were installed in 1994. The 2007 well inspection report recommends the well be cleaned and redeveloped.

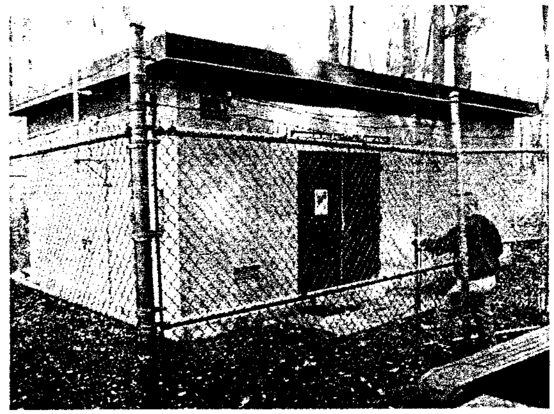
A summary of the installation year and expected life span of each piece of equipment at the Campbell Well is included in Table No. 6-2.

Table No. 6-2
Campbell Well Equipment
Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Station building	1965	100	2065
Concrete roof	1965	50	2015
Well pump	1994	50	2044
Pump motor	1994	25	2019
Motor control center	1999	25	2024
Master venturi	1993	50	2043
Chemical storage building	1999	50	2049
Concrete roof	1999	30	2029
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Chamberlain Well

The Chamberlain Well and station was constructed in 1991. The well station houses all the original equipment including a direct drive generator that runs the pump only. A motor control center was installed in 1999 with chemical storage and feed equipment. The station is in good condition, but the direct drive generator is of minimal benefit because it will run only the pump and not the chemical feed equipment if there is a power outage. The 2007 well inspection report requests information on the well and pump.



A summary of the installation year and expected life span of each piece of equipment at the Chamberlain Well is included in Table No. 6-3.

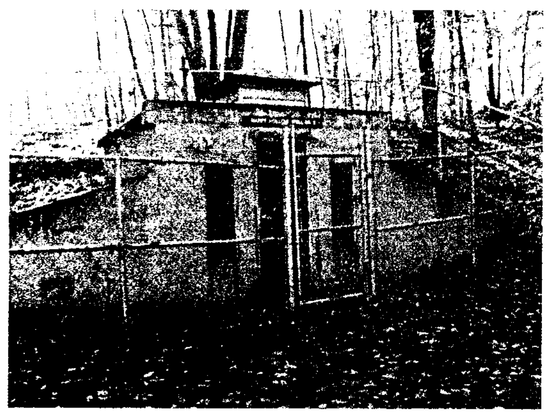
Table No. 6-3
Chamberlain Well
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Well pump	1991	50	2041
Pump motor	1991	25	2016
Building	1991	100	2091
Concrete roof	1991	50	2041
Direct drive generator	1991	25	2015
Motor control center	1999	25	2024
Master venturi	1991	50	2041
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

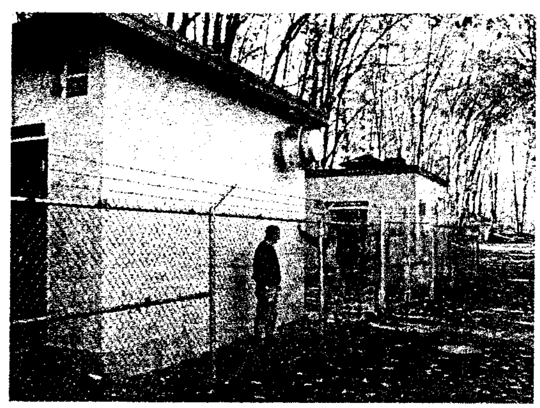
Happy Hollow Wells

Happy Hollow Well No. 1 was originally installed in 1949 in a concrete building with a concrete slab roof. The well was cleaned and redeveloped in 2003. It is unknown if the pump and pump motor has been replaced since they were installed, and no repairs have been made to the roof or building since construction. Chemical storage and feed equipment were added in 1999 along with a new motor control center for Wells 1 and 2. There is a master venturi located in a pit outside of the building. The exact location is currently unknown. The 2007 well inspection report recommends that the well be cleaned and redeveloped.

Happy Hollow Well No. 2 was originally installed in 1951 in a concrete building with a concrete slab roof. The pump motor was rebuilt in 2006, but it is unknown if the pump has been replaced. No repairs have been made to the roof or building since construction. The 2007 well inspection report claims that the well and pump appear to be in good condition.



A new building was constructed near the Well No. 1 building for chemical storage in 1999. All of the chemicals for Well No. 2 are stored here, along with some of the chemicals for Well No. 1. Chemical injection occurs in a manhole outside of the building.



A summary of the installation year and expected life span of each piece of equipment at the Happy Hollow Wells is included in Table No. 6-4.

Table No. 6-4
Happy Hollow Wells
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Well No. 1			
Building	1949	100	2027
Concrete roof	1949	50	1999
Well pump	Unknown	-	-
Pump motor	Unknown	-	-
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014
Master venturi	Unknown	-	-
Motor control center	1999	25	2024
Well No. 2			
Building	1951	100	2051
Concrete roof	1951	50	2001
Well pump	Unknown	50	2001
Pump motor	2006	25	2019
Magnetic meter	1999	25	2024
Chemical storage building			
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Meadowview Well

The Meadowview well pit was originally installed in 1970. The well was cleaned and redeveloped in 2001 and the pump and motor were replaced in 1993. Two concrete buildings were constructed in 1999 for chemical injection and storage. One building houses the potassium hydroxide tank and the other building houses the rest of the chemical storage, the chemical injection equipment, motor control center and the magnetic meter. The chemical tanks are all empty and the well is not in use due to high manganese concentrations. The 2007 well inspection report requests information on the pump.

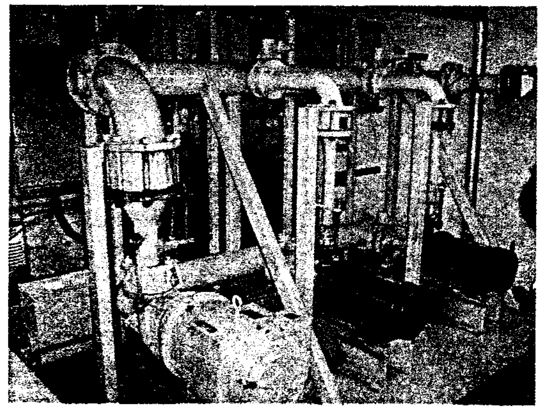
A summary of the installation year and expected life span of each piece of equipment at the Meadowview Well is included in Table No. 6-5.

Table No. 6-5
Meadowview Well
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Well pit	1970	100	2070
Well pump	1993	50	2043
Pump motor	1993	25	2018
Buildings	1999	100	2099
Concrete roofs	1999	50	2049
Motor control center	1999	25	2024
Magnetic meter	Unknown		
Sodium hypochlorite system	1999	15	2014
Fluoride system	1999	15	2014
Potassium hydroxide system	1999	15	2014

Reeves Hill Pump Station

The Reeves Hill Booster Pump Station was installed in 1973 at the same site as the two water storage tanks. The building is a concrete building with a concrete slab roof. There is one fire pump and two domestic pumps inside the station. There is also natural gas generator inside of the building. The pump station was rehabilitated in 1999, when an EFI skid was installed. The domestic pumps were replaced again in 2006.



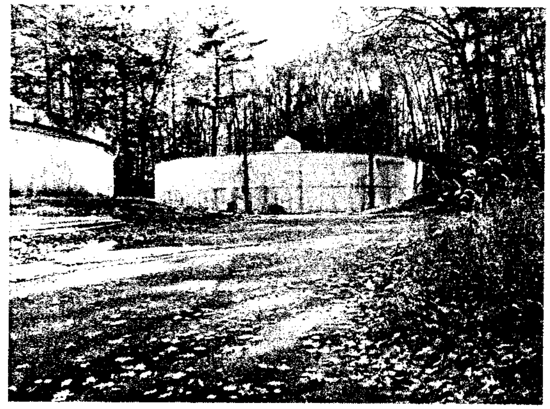
A summary of the installation year and expected life span of the equipment in the Reeves Hill booster pump station is included in Table No. 6-6.

Table No. 6-6
Reeves Hill Booster Pump Station
Equipment Installation Years and Estimated Life Spans
Capital Efficiency Plan™
Wayland, Massachusetts

	Installation Year	Life Span (Years)	Replacement Year
Domestic booster pumps	2006	25	2031
High capacity pump	1999	25	2024
Building	1973	100	2073
Concrete roof	1973	50	2023
Generator	1973	25	1998

Reeves Hill Water Storage Tanks

The Reeves Hill Water Storage Tank No. 1 is a steel standpipe constructed in 1927. The tank interior and exterior were repainted in 1985. The interior of the tank was again painted in 2004. The exterior of the tank is in very poor condition with severe pitting at the base. The tank was inspected in 2006.



The Reeves Hill Water Storage Tank No. 2 is a prestressed concrete tank constructed in 1958. This tank was cleaned in 2002. The tank was inspected in 2006 and was considered to be in very good condition. The Wayland Water Department is planning to power wash the tank in the summer of 2008.