A Sustainable Accounting and Maintenance Management System for the Infrastructure of the West Boylston Water District

An Interdisciplinary Qualifying Project
Submitted to the faculty of
Worcester Polytechnic Institute
In partial fulfillment of the requirements for the
Degree of Bachelor of Science

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Executive Summary

Water systems have been a vital part of American civilization since the late 18th century. Over the past 20 years communities have spent over $1 trillion dollars on drinking water treatment, supply of water, wastewater treatment and disposal of water.[1] The first systems were very crude in design and several of these many public water systems have been updated, but many still use outdated technology and equipment. Much of the nation's water infrastructure was constructed just after WWII and is aging close to the end of its useful life. Until recently, this issue has been constantly overlooked because it does not immediately affect our country. Over the last few years, new federal regulations have passed in this country to make sustainable clean water a priority.

One of these regulations is the Governmental Accounting Standards Board (GASB) Statement #34. GASB 34's main goal is to track all capital assets and to report the condition of individual assets. In this case, the capital assets are the assets of the West Boylston Water District. Specifically, this project added home connection assets to the existing organized infrastructure databases relative to GASB 34. By complying with GASB 34, The Water District could potentially use the insight gained to prioritize its activities and implement more efficient procedures to make better short and long term plans.

West Boylston is a small town of approximately 7,500 residents with just over 2,100 home and business connections to the water district, which has been servicing the public since 1938. The system has been continually updated since its implementation, but the majority of records are still in paper form. Using more modern forms to maintain records will allow for easier and more efficient access to infrastructure information, which will aid in the functionality of the company.

Federal regulations suggest that all governments with yearly revenue of less than $10 million comply with GASB 34 accounting procedures by the 2004 fiscal year. The West Boylston Water Company falls in this category, which was

[1] U.S. Environmental Protection Agency

a problem because The West Boylston Water District was still using the old accounting standards and is not yet prepared to switch to the new procedures.

In order to comply with GASB 34 regulations, The West Boylston Water District sponsored an Interactive Qualifying Project (IQP) conducted by students from Worcester Polytechnic Institute in 2005. The project was intended to aid in the advancement of the water district's systems. The team compiled and organized data electronically concerning water mains, pump stations, hydrants, valves, tanks and wells. Assets were evaluated by condition, age, cost and maintenance.

Following up on the previous project, this project was intended to compile and organize the remaining infrastructure, which was all home connection data. Home connections include corporations, curb stops, home service pipes and water meters.

The town of West Boylston is run by a form of government which allows registered voters to vote on all issues presented at the town meetings. The West Boylston Water District is not run by the town, but is rather self sufficient and has an income that is based on the water rates that it charges to its customers in West Boylston. The district is run by the district superintendent, Mike Coveney, and in order to ensure that The District is able to meet all financial needs, it is important that rates are set at a price which will cover all necessary costs. It is equally important that future costs are forecasted so that long term plans can be created. This is where the GASB 34 results are able to help.

The ultimate goal of GASB is to establish and improve standards of state and local government accounting and financial reporting. The end result of all this work will lead to useful information for users of financial reports, provide insight to prioritize projects, make better short and long term plans and it will also guide and educate the public. The public includes issuers, auditors, and users of those financial reports. GASB is an authority that provides guidance on how to prepare financial statements to conform to generally accepted accounting principles (GAAP). People who use these financial statements rely on these consistent standards for all governments in the United States. With this consistent application, users can easily compare and assess the financial condition of one government with regards to any other.

Statement 34 is one of 38 currently issued pronouncements. Statement 34 deals strictly with Infrastructure Capital Assets. GASB's definition of Infrastructure is "long-lived Capital Assets associated with Governmental Activities that normally are stationary in nature and can be preserved for a significantly greater number of years than most capital assets."[2] For a more detailed description of Statement 34, refer to chapter 2.4.

The most important step in starting this project was to gather and computerize all the home connection data of West Boylston. Using the prior project's work, MassGIS, Microsoft Access and the mapping program MapInfo, we were able to place infrastructure on maps in their real world locations. Once this was in place, information such as age, size, and material were attached to each element. Using the databases that were created, results were formulated. An analysis was completed on the home connections in the water district, which were added to the prior assets to deliver the total assets of The District. The analysis includes all relevant data for GASB 34 calculations.

Figure 1 below is a cost analysis of how much it would cost to replace all the infrastructure in the entire water district. The total is shown to be $17,638,215.76.

With all the proper data collected for each home connection infrastructure, an analysis of the data relative to GASB 34 was completed. The only assets that are of interest with regards to GASB 34 are those assets that are built in or after 1980.

All home connections installed or maintained in or after 1980 were filtered from the total home connections. When tallying the results, a simple depreciation formula was used in order to account for aging infrastructure. The formula used was: Current Value = (Historic Cost) * [(Age – Life Expectancy) / Life Expectancy].

[2] Practical Guide to Implementing GASB #34

Valves		**Water Mains**	
Total Number of Valves	443	Total Number of Segments	223
Total Replacement Cost	$352,400.00	Total Length of Pipe (ft)	296,669
Hydrants		Total Replacement Cost	$12,357,927
Total Number of Hydrants	353	**Wells**	
Total Replacement Cost	$353,000	Total Number of Wells	3
Tanks		Total Replacement Cost	$131,951.00
Total Number of Tanks	4	**Pump Stations**	
Total Replacement Cost	$1,941,575.00	Total Number of Pump Stations	2
Curb Stops		Total Replacement Cost	$133,270.00
Total Number of Curb Stops	2143	**Corporations**	
Total Replacement Cost	$76,847.98	Total Number of Corporations	2143
Home Services		Total Replacement Cost	$75,005.00
Total Number of Home Services	2143	**Water Meters**	
Total Replacement Cost	$2,094,039.78	Total Number of Water Meters	2143
		Total Replacement Cost	$121,400.00
Overall Total Replacement Cost	$17,638,215.76		

Figure 1- Total Replacement Cost

The total home connection GASB assets totaled $211,943.46. Home connections are about ¼ of the total GASB assets. The total GASB assets when combining the project from last year and our project was found to be $799,994.85.

GASB 34 Relevant Asset	Current Value
Home Connection Pipes	$16,994.82
Curb Stops	$37,220.89
Corporations	$36,328.25
Water Meters	$121,400.00
Water Mains	$526,677.11
Valves	$14,306.94
Hydrants	$26,570.12
Pump Stations	$20,496.72
Total=	$799,994.85

Figure 3- Total GASB Infrastructure

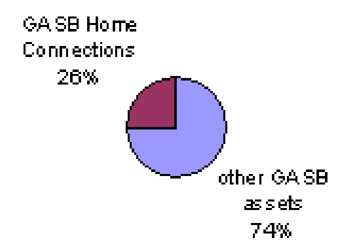

Figure 2- GASB % Home Connections

For home connections, 1,192 out of 2,143 total home connections were relevant to GASB. Home connection pipes, curb stops and corporations each had 1,192 GASB relevant assets. Water meters only had 607 because West Boylston is currently installing new water meters, and only the new water meters were considered relevant to GASB. Over the next few years all water meters will be replaced, so very soon, all water meters will be relevant to GASB.

In order to properly analyze the data for things such as future maintenance and upgrades, more information is still needed. Also, the group would suggest using a more user friendly program such as LOUIS (Local Online Urban Information System). Using a program such as LOUIS allows all information to be accessed and updated in a very simple manner.

Currently, there is no easy way to update the information without a firm grasp of how use MapInfo. In order to update asset information using MapInfo, multiple steps must be taken to do so. First, the asset must be drawn on the proper layer and then the new information for that asset must be entered into the correct field such as length, diameter, material, etc. Once this is completed, MapInfo is up to date, but the databases from which the queries are run are not. In order to update information it must be updated in both MapInfo and the databases which contain information about the asset. Using a program such as LOUIS allows for information to be easily updated by connecting all programs involved in maintaining accurate records.

This project has continued in transferring data that is currently in paper form into a more easily accessible electronic form. Maps that place all assets in their real world locations of all current infrastructure of The District have been created, as well as maps of GASB relevant data. Information about the assets are included in the map layers and from this, results were obtained. Results included number, age, size, and material of the assets. With the completion of this project, all GASB 34 assets are known, and there is a computerized layout of all qualifying assets and their value.

The work of this and the previous project have helped to direct the West Boylston Water District to maintain more accurate and up to date records which are more organized. However, there are still big strides that need to be made in order to turn this information into a system which is easily updated and can help to predict future maintenance needs and costs.

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Abstract

This project was intended to assist the Water District of the Town of West Boylston to manage its water infrastructure assets and comply with Governmental Accounting Standards Board (GASB) Statement 34. After compiling information about The District's assets, our project group developed a sustainable information system that allows the district to effectively maintain the water infrastructure and to estimate the value of the assets in compliance with GASB 34 standards.

1 Introduction

Water systems have been a vital part of American civilization since the late 18th century. Over the past 20 years communities have spent over $1 trillion dollars on drinking water treatment, supply of water, wastewater treatment and disposal of water.[3] The first systems were very crude in design and several of these many public water systems have been updated, but many still use outdated technology and equipment.

West Boylston is a small town of approximately 7,500 residents with just over 2,100 home and business connections to the water district, which has been servicing the public since 1938.[4] The system has been continually updated since its implementation but there is a need to further update the water system's technology. More modern forms of equipment and systems need to be introduced in order to aid in the functionality of the company.

The West Boylston water district currently has multiple concerns it is trying to deal with. One issue is a need to create a more modern system for data entry. This data includes maintenance done on the districts pump stations and pipelines, implementation of new water meters or when any other maintenance is done on the system. The current system is paper based, resulting in an excess of files which need to be organized and stored. Another matter is that it is difficult to locate the appropriate valve shut-offs in the event that emergency maintenance must be done during less than ideal weather conditions. The water district has the necessary information but it is not organized in a manner that allows for quick and easy access.

The West Boylston Water District recognizes its need to update its data entry systems to a more modern form. It has installed new water meters in order to address this problem. These new meters transmit readings through a radio signal which allows employees to simply drive by each residence in order to

[3] U.S. Environmental Protection Agency
[4] West Boylston IQP 2005, p. 13

obtain readings. Old meters required that the employees exit their vehicles and read the meters manually, which is a time consuming and paper based process.

The Water District sponsored an Interactive Qualifying Project (IQP) conducted by students from Worcester Polytechnic Institute last year, which was intended to aid in the advancement of the water district's systems. The project was designed to assess the system's pipe lines, hydrants, and curb stops and input this data into an electronic database. These calculations help the water district fulfill its accounting requirements. Federal regulations suggest that all governments with yearly revenue of less than $10 million comply with GASB 34 accounting procedures by the 2004 fiscal year. The West Boylston Water Company falls in this category, which is a problem because currently West Boylston is still using the old accounting standards and is not yet prepared to switch to the new procedures. This new regulation requires the town to first inventory all of its capital assets such as pipes, valves, hydrants, water towers, pump stations, etc. Then the town must evaluate these assets by condition, age, cost, and maintenance, to name a few. This is a problem because the town keeps most of its records in paper form, so the information that it needs is not readily available.[5] They also allow staff to easily find the locations and dimensions of pieces of infrastructure if necessary.

This project continued the research conducted by undergraduate students in the previous year's project. During this project, data was collected and compiled to complete infrastructure accounting requirements. An electronic data entry system for the maintenance of the six pump stations in the district was implemented in place of the current log book. Ideally, the maintenance done will be recorded in the electronic databases that were created, and information will be relayed to the district's office for convenient access.

[5] West Boylston IQP 2005, p. 13

2 Background

Public water supply in the United States has evolved drastically in a relatively short period of time. Simple innovations such as the invention of cast iron pipe were the predecessors which led to the highly developed public water supplies of today. This pipe, manufactured in Siegerland, Germany, was implemented in the Dillenburg Castle in 1455.

The first municipal water system in the United States was constructed in the city of Bethlehem, Pennsylvania in 1754 by Hans Christopher Christiansen. Spring water was pumped through logs, with holes bored through the middle, providing the town with a plentiful water supply[6]. Approximately ten years later, horses would be replaced by steam driven pumps and hollowed out logs would be replaced by wood stave pipes made with iron hoops. These landmark construction projects set the standard for future water system development throughout the country.

Wooden pipes were first replaced by metal pipes shortly after 1800. Cast iron piping was introduced to the US by England and was first employed for city water distribution in Philadelphia. By 1819 iron pipes were replacing leaky wood conduits and increasing water main life. By 1850 cast iron was the preferred material for water system pipe and is still the major pipe material today[7].

Public water distribution began growing rapidly and in 1914 the first drinking water standards were established in the United States to ensure water quality and protect the health of its citizens. Today, the United States Environmental Protection Agency (EPA) is responsible for regulating water quality standards. These standards are continually evolving to improve water quality.

The evolution of computers has aided in the advancement of water distribution systems. Computers allow engineers to quickly solve complex hydraulic problems. In the 1960's and 1970's, researchers began to create pipe

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[6] History of Public Works, p. 217
[7] Ibid p. 233

network models with the aid of computers. In 1980, the modernization of computers led to the first personal computer which allowed engineers to move hydraulic analysis to desktop systems. Consequently, the first water quality models were developed in the early 1980's. Stemming from the 1990's and continuing to present day, technological advancements have played and integral part in water distribution advancement, including Global Positioning System (GPS), which help determine precise coordinates for hydraulic models, and many software programs which allow hydraulic engineers to produce complex water systems with greater ease. This project utilized several of these technologies to transfer paper documentation of home connections into computerized repositories and databases. These have been created to log maintenance and repair done to elements of the West Boylston Water District infrastructure in order to create a more efficient work system.

Throughout the decade of the 1990's, the privatization of water utilities became commonplace in much of the United States. These private entities became responsible for maintaining water quality standards during the distribution process.

2.1 Massachusetts Water Supply

Early water systems in Massachusetts were built to deliver water to the Boston area because a large percentage of the Massachusetts population is centered in Boston and its surrounding areas. Prior to 1795, before the main water systems of Massachusetts were created, residents of Boston relied on local wells, rain barrels, and natural bodies of water as their source of water[8]. In 1795, a water delivery system was created which carried water from Jamaica Pond, approximately four miles from Roxbury, to the City of Boston. As the population of Boston grew to over 50,000 in the 1840's, water quality and quantity problems evolved. Several damaging fires occurred that could not be contained due to the lack of water capacity. The Cochituate Water Board was created in 1845 and a plan was soon devised to address and deal with water issues. A water

[8] http://www.mwra.state.ma.us/04water/html/hist1.htm

transmission system was constructed to import water from nearby water bodies such as Lake Cochituate, Brookline Reservoir, and the Mystic Lake System[9].

As the mid 1870's approached, Boston's population grew rapidly to over 200,000 and more water was needed. Between 1875 and 1878, the process of diverting water from an upland source was again used. Sources included Framingham and Chestnut Hill Reservoirs, and Beacon Street Mains[10].

In the mid 1890's, indoor plumbing became commonly used, and water was again in short supply. The Metropolitan Water Board decided to use a gravity-operated system which would utilize water from the Nashua River. In 1897, the Wachusett Dam blocked off the Nashua River and in turn flooded six and ½ square miles. The watershed flooded in the towns of Boylston, West Boylston, Clinton and Sterling. Water from the reservoir was transferred to the Weston Reservoir by means of the Wachusett Aqueduct. The Wachusett reservoir, filled in 1908, holds 65 billion gallons of water and is still used today[11].

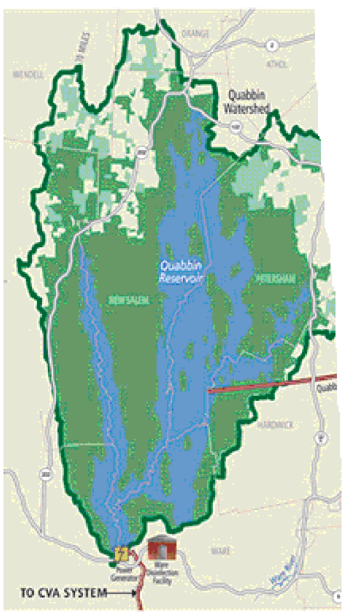

Figure 4- Quabin Reservoir

In 1926, The Metropolitan Water Supply Commission reached out again for more water to supply Eastern Massachusetts. The Quabbin Reservoir resulted from the damming of the Swift River (Figure 4). The reservoir resulted in a loss of the towns of Dana, Enfield, Greenwich and Prescott. In 1939 construction was completed, but it took seven years to completely fill the 412 billion gallon reservoir. The Quabbin Reservoir is the largest man-made reservoir in the world solely devoted to water supply[12].

By the time World War II began in 1941, pressure aqueducts had been built to inhibit water pressure fluctuations during the work day. Pressure aqueducts were built from the

[9] Ibid p. 2
[10] Ibid p. 3
[11] Ibid p. 4
[12] Ibid p. 5

Wachusett Reservoir to the new Norumbega Reservoir and then split to form a loop around the city of Boston (Figure 5). To pay for this system, a considerable price jump resulted as water rose from $50 to $100 per million gallons[13]. Throughout the mid 1900's numerous pump stations and water tunnels were built which are still currently in use.

The Massachusetts Water Resources Authority was created in 1985 and is still the current water legislation. The MWRA has developed an integrated water supply program to improve water quality and to meet all requirements of the federal Safe Drinking Water Act (Figure 6). The program includes overlooks projects in: watershed protection, water treatment, transmission and reliability of the MetroWest water supply tunnel, covered water storage, and pipeline maintenance. "Watershed is the total area that drains directly across the land and indirectly through the groundwater, to a particular stream, river, pond or reservoir. Precipitation that falls anywhere in the watershed of a given reservoir or stream eventually ends up in that body of water" [14].

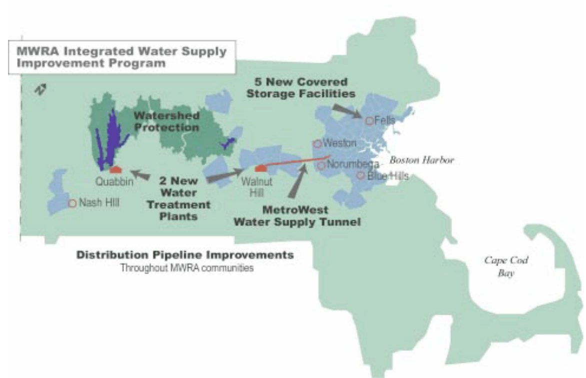

Figure 5- Massachusetts Resevoir and Distribution System

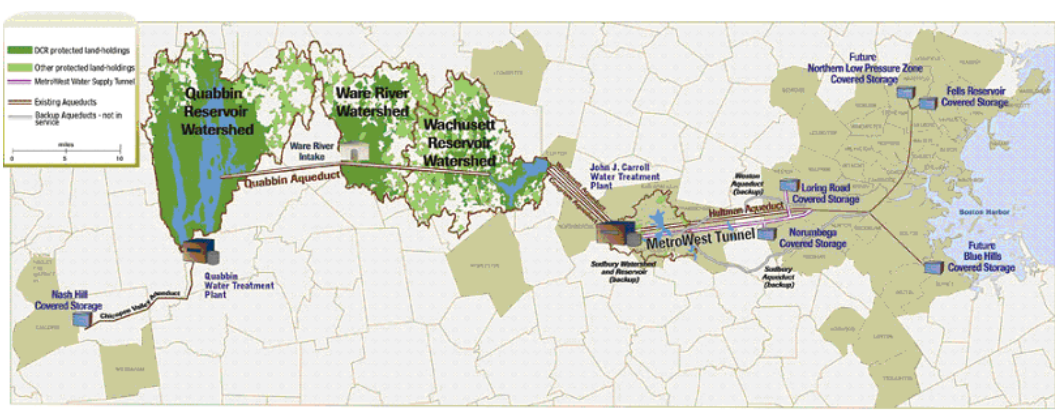

Figure 6- MWRA's Integrated Water Supply Improvement Plan

[13] Ibid p. 6
[14] Ibid p. 7

Watershed areas are very important to monitor because all activities that take place in them have impacts upon water quality in some degree. The MetroWest water supply tunnel was finished in 2004. It was created to replace the, aging Hultman Aqueduct that was built in the 1940's and was the sole supplier of water to the Metro Boston area. The MetroWest water supply tunnel enhances water quality and reliability as it serves nearly 2.5 million people in 39 different communities (Figure 7). The tunnel is 17.6 miles long and between 200 and 500 feet below the surface.

The MWRA is also responsible for covered water storage tanks to protect and store treated drinking water. Covered tanks have been constructed to comply with the Federal Sage Drinking Water Act, and are a substitute for open reservoirs which are at risk of contamination by natural sources such as algae, bacteria and animals. Storage tanks hold approximately 180 million gallons of treated water and are continually replenished as water is used[15]. The West Boylston Water District uses water tanks as well as underground wells. As part of our project we will explore how the water district maintains their pump stations, which are located at tanks and wells, which includes chemical processes used to clean the water.

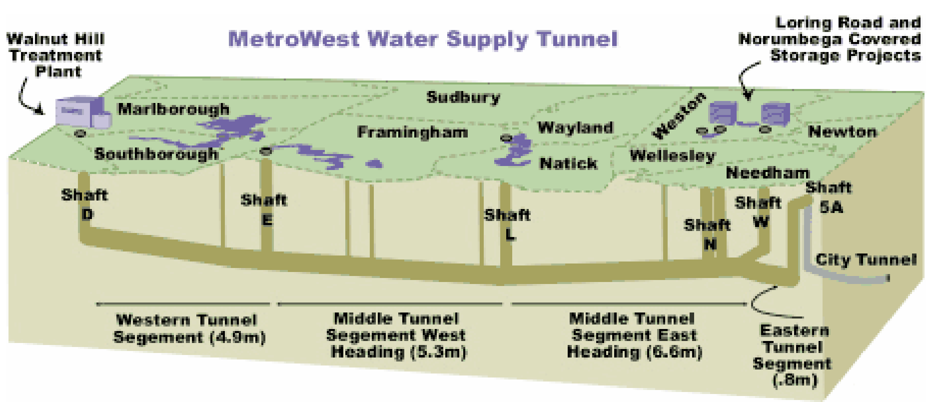

Figure 7- Metro West Water Supply Tunnel

15 http://www.mwra.state.ma.us/04water/html/cov.htm

2.2 West Boylston Water District

The History of the West Boylston Water District cannot be told without some history of the Town itself. The town of West Boylston was established in 1808. When first formed, West Boylston was an agricultural community and it continued to grow during the remainder of the nineteenth century. Multiple water sources including the Stillwater and Quinapoxet Rivers provided the power needed for manufacturing to flourish in the area[16].

West Boylston was one of the first communities in Central Massachusetts to identify the health advantages of a public water system. An 1892 town meeting vote approved an article to organize a Water Works Investigating Committee whose main responsibility was to determine the viability and cost that would be needed for a water system to service the entire town. Unknown to many citizens, during this same time the Massachusetts State Board of Health began their own research for a possible water supply, for Boston and the surrounding areas, in the Nashua River valley.

1895 was not a good year for many residence of West Boylston and several other surrounding towns. That was the year that the state legislature passed Chapter 488 of that year. This law created the Metropolitan Water Board. This new board was given the duty of constructing a damn in Clinton and acquiring lands in West Boylston and surrounding areas for the construction of reservoir that would cover a six and a half square mile area. A total of 2100 acres were acquired from West Boylston for the project and nearly all the homes and factories in that area were demolished. This project greatly diminished the towns' population, lowering it from 3,000 in 1890 to 1,270 members in 1910[17].

[16] http://westboylstonwater.com/history.htm
[17] Idem

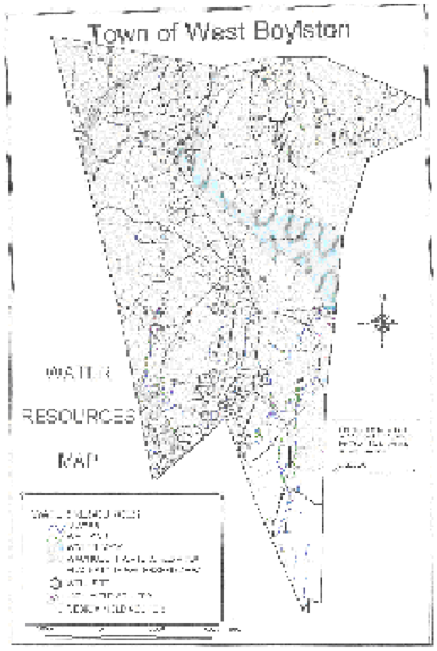

Figure 8- West Boylston Water District Limits

West Boylston recovered and in 1915 another committee was appointed to investigate the possibility of constructing a public water supply. This committee did nothing to further the plans for a public water system. Legislature finally passed in 1933 which allowed the citizens of West Boylston to establish a water district. Four years were allowed for acceptance by the residents, but again this time passed with out citizens taking action. Chapter 55 of the Acts of 1939 was passed by legislature, containing nearly exactly what the 1933 legislation with a few small changes[18]. Later that year another town meeting was held in which the townspeople accepted the act, which officially established the West Boylston Water District. Since its' creation the Water District has been able to function with a paper based records system. Our project is going to work with the water district to modernize their systems of data collection. The water district has complete records of homes and their connections to the water system, but there is no way to easily access them. Our team is going to move these systems to an electronic form which will ideally be brought into the field when work needs to be done for more efficient time usage.

2.3 West Boylston Water Distribution System

Water provided by the West Boylston Water District is taken from ground sources rather than surface sources. Currently there are three wells that the district gathers water from and four storage facilities that hold water. The three wells in the district are the Oakdale Well, Lee Street Well No. 4, and the Pleasant Valley well. The Oakdale Well was constructed in 1956 and is 56 feet below

[18] Idem

Figure 9- Lee Street Pump Station

ground level. It is approved to pump up o 725 gallons per minute. Lee Street Well No. 4 is part of a group of wells which it is the only one still in operation due to poor water quality in wells 1, 2, and 3. This pump was constructed in 1966, also 56 feet below the surface and is allowed to pump up to 230 gallons per minute. The Pleasant Valley Well is the newest well in the district, constructed in 1970. It is 11 feet below the surface and is able to pump up to 500 gallons per minute. Water distributed from the Oakdale and Pleasant Valley Wells are treated right at the pump upon its exit from the well and entrance into the water system. The chemical treatment plant for water gathered from the Lee Street Well is a separate building, but the process of water treatment is the same.

Water is treated with potassium hydroxide (KOH) and polyphosphate before it enters the distribution system. Each day, an employee goes to the pump station and records the time the pump ran that day, the KOH, pH and Polyphosphate levels in the log book at each pump station. The log book contains information regarding maintenance, repairs, and daily readings. Having all this data in one log book with no real organization makes for a difficult time when trying to see when the last maintenance was done on a piece of equipment in the pump station. Also, when such information is needed, someone must travel to the pump station and get the information from the log book, which is time consuming. It is risky not to have this information backed up in case the log book is damaged or lost. This project proposes an electronic process in which information can be entered, organized and sent back to the main station so that information is available when needed.

There are four water storage facilities: Lawrence Street Storage Facility No. 1, Lawrence Street Storage Facility No. 2, Oakdale Tank, and the Stockwell Road

Tank. The Stockwell Road Tank, constructed in 1965 and Lawrence Street Tank, No. 2, constructed in 1978 are the two newest facilities. Each holds 1 million gallons of water[19].

The water distribution system is comprised of approximately 53 miles of water mains, most of which are 8 inches or less, although pipe sizes have varying diameters between 2 inches to 16 inches. In most cases, the turbine pump at each well creates enough pressure to allow water to travel through the water mains of the district. In the case of low pressure situations, there are 3 booster pump stations that boost water from low service areas to high service areas. The main booster station is located on West Boylston Street while the others are located at Western Avenue and at the Lee Street pump station which service small residential areas.

The section of pipe that branches off the water main is called the corporation. The corporation, usually a 1 inch pipe, meets the curb stop located in the front of most resident's yards.

Curb stops are metal fittings that connect the corporation and the home connection. They function as a means for the water district to stop the flow of water to a household in the event of an emergency, so it is important that curb stop locations are documented accurately. Using MapInfo, a program that will help create maps of infrastructure assets in their real world locations, the locations of each curb stop can be accessed electronically.

Corporations and curb stops are both owned by the water district, but all infrastructures between the curb stop and water distribution inside a household other than the water meter is owned by the property owner.

Water meters are generally located on the side of the house nearest the street to allow for easy meter reading. Water meters are used to measure the volume of water in cubic feet used by a specific unit connected to the water lines of the water district. This is not only important so that the water company is able to correctly bill the resident of that household, but it is also and effective tool to detect water leaks. Low flow dials on most water meters are small colored

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[19] WestBoylstonWater.org

triangles. Some older meters may not have low flow dials which help to detect leaks in the house, but ones that do should not spin when all the water is turned off inside the house. If the low flow dial is spinning, it most likely indicates a leak of some sort[20]. Together, the corporation, curb stop and water meter are referred to as home connections.

Currently, The District is undergoing a process of replacing old water meters. Meters are replaced based on water usage. Units with high water usages are given priority over low water usage units. The new water meters send out radio waves every 4 seconds and allow for more efficient meter readings for billing. Employee's of the water district simply drive by the house with a personal digital assistant or PDA and are able to acquire meter readings of the houses with new water meters. Another advantage of the new water meters is that leaks are automatically detected. Leaks of just one drop per second will equate to 2,700 lost gallons of water each year, so these meters will potentially save residents a considerable amount of money each year should they have leaks on their property[21].

2.4 Governmental Accounting Standards Board Statement

The Governmental Accounting Standards Board (GASB) consists of several notable government and accounting personnel which conducts research, participates in public hearings, analyzes oral and written comments received from the public on documents, and prepares drafts of documents for consideration[22]. These seven members are chosen based on their knowledge of governmental accounting and finance. Financial Accounting Foundation (FAF) Trustees appoint Board members based on their experience and general concern for the public interest in matters of financial accounting and reporting. GASB is an independent body not associated with the United States Government or any State Government. Therefore, "GASB pronouncements are not a federal or state mandate for

[20] Residential Water Conservation
[21] Residential Water Conservation
[22] http://gasb.org/

financial statement reporting" although there are sometimes benefits from federal or state governments for complying with GASB pronouncements. [23]

The ultimate goal of GASB is to establish and improve standards of state and local government accounting and financial reporting. The end result of all this work will lead to useful information for users of financial reports, provide insight to prioritize projects, make better short and long term plans and it will also guide and educate the public. The public includes issuers, auditors, and users of those financial reports. GASB is an authority that provides guidance on how to prepare financial statements to conform to generally accepted accounting principles (GAAP). People who use these financial statements rely on these consistent standards for all governments in the United States. With this consistent application, users can easily compare and assess the financial condition of one government with regards to any other.

It is important for governments to stay consistent with GAAP, because users of the financial statements also use the auditors' opinion. If the auditors see that you do not adhere to the GAAP they can issue a qualified opinion stating so. These types of opinions could lead to adverse effects on a government's bond rating which will affect the government's ability to borrow money. Failure to issue an audited financial statement could lead to a violation of existing bonds, and serious implications. [24]

2.4.1 GASB Statement #34

Statement 34 Basic Financial Statements - and Management's Discussion and Analysis – for State and Local Governments was released in June of 1999 by the Government Accounting Standards Board[25]. Statement 34 is one of 38 currently issued pronouncements. Statement 34 deals strictly with Infrastructure Capital Assets. GASB's definition of Infrastructure is "long-lived Capital Assets associated with Governmental Activities that normally are stationary in nature and

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[23] Practical Guide to Implementing GASB #34
[24] Sustainable Information System for Water Infrastructure Maintenance and GASB 34
[25] NCHRP Report 522, *A Review of DOT Compliance with GASB 34 Requirements*

can be preserved for a significantly greater number of years than most capital assets."[26] Example of infrastructure include:

-roads
-bridges
-tunnels
-water and sewer systems
-pipelines
-levees and damns
-airports
-transitways
-ports and harbors
-fixed lighting systems.

Items that are excluded from the definition of infrastructure include shorter lived capital assets such as:

-buildings
-equipment
-furniture
-computer hardware.

These assets are covered by previous statements in GASB. Statement 34 explains that long-lived capital infrastructure assets must be reported in the annual financial statements of state and local governments. Previously these assets were not reported in annual accounting reports.

This statement was intended to force local municipalities to account for all utilities and infrastructure as assets purchased, constructed, or donated after June 30, 1980 in order to be in compliance with generally accepted accounting principles. GASB 34 was implemented in three phases in which governments with larger annual revenue were expected to account for infrastructure faster than smaller governments, but all were expected to comply by June 15, 2003. However governments with less than $10 million in total annual revenue are not required to retroactively report on their existing major general infrastructure assets, although they are encouraged to do so.

[26] Practical Guide to Implementing GASB #34

2.4.2 GASB 34 in West Boylston

The town of West Boylston has annual revenue of less than $10 million and falls in the last category that is not required to report on their infrastructure. Many of the assets of the West Boylston Water District were built over 25 years ago and are closing in on the end of their usable life. Although it is not required, for maintenance purposes of its aging infrastructure, it is beneficial for West Boylston to comply with GASB 34 regulations. Although assets constructed after July 1,1980 are not included in GASB 34 calculations, it is advantageous for efficiency purposes to collect data on those assets as well.

2.5 2005 Project Summary

Until last year when the West Boylston Water District first sponsored and IQP, much of the data the water district maintained was solely in paper form. This is an inefficient way to keep information because the paper files take up valuable space and the information is not backed up. Computerized and organized information is more easily accessible and efficient.

The main task of the project group from WPI in 2005 was to create and introduce an efficient way for West Boylston to comply with new GASB 34 standards. The first step toward computerizing data was to compile and organize the data of the West Boylston Water District. Using MassGIS and the mapping program MapInfo, infrastructure assets were displayed in their real world locations. Individual parameters were attached to each element of each asset type to give a complete database. Assets included water tanks, wells, pump stations, valves, hydrants and water mains. Using the databases, a series of results were formulated and an analysis of all assets within the water district was completed. The analysis included all relevant data for GASB 34 except home connections. The map on the next page shows the placement of each asset inventoried by the 2005 project group in the town of West Boylston.

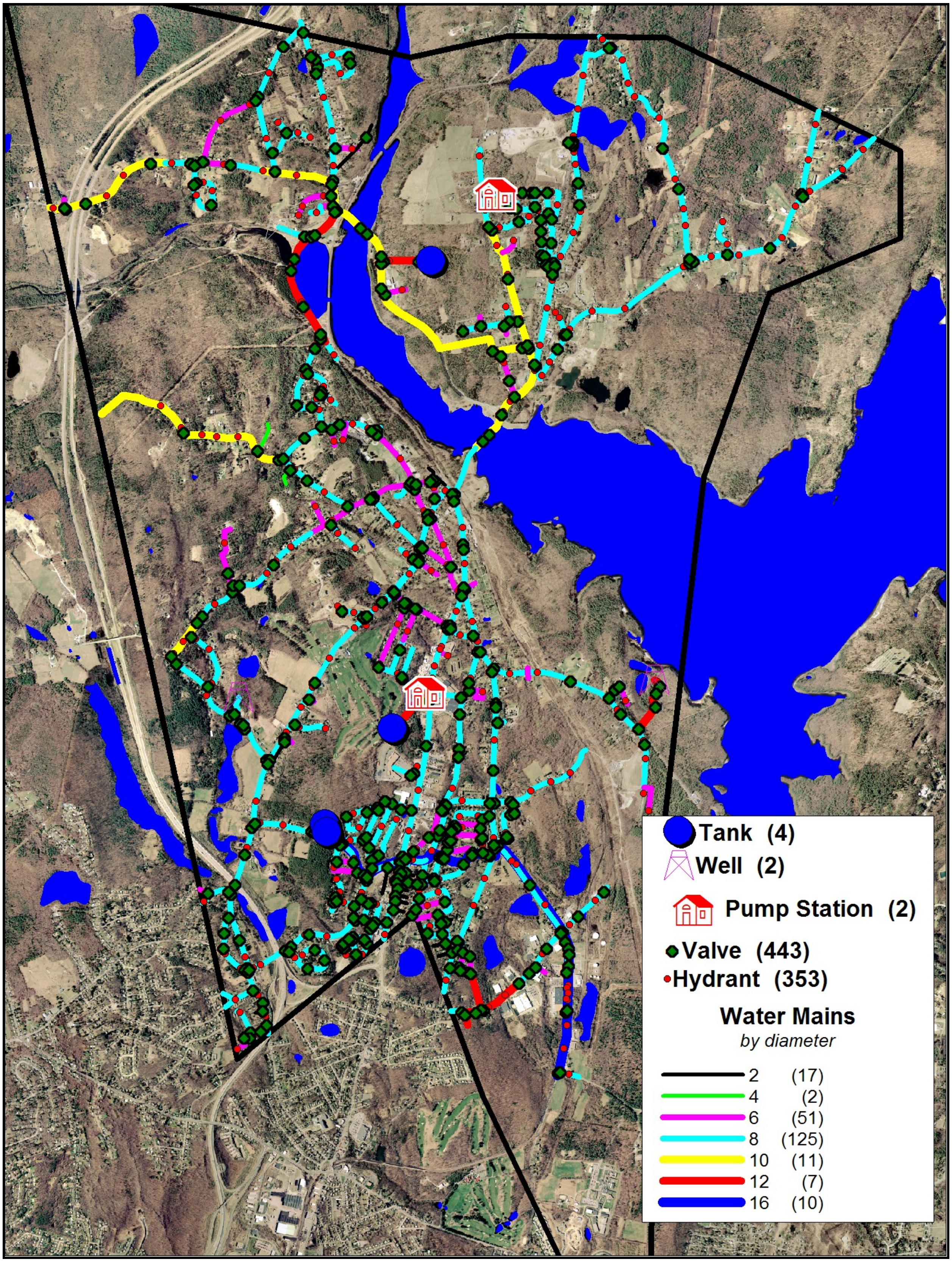


Figure 10- Assets of West Boylston Water District

Each type of asset, including pipes, hydrants, valves, pump stations, tanks and wells were looked at individually. The results include the physical properties of the assets as well as the replacement costs of the assets. Both of these results are important for GASB 34 calculations.

3 Methodology

This project is intended to assist the West Boylston Water District in modernizing its maintenance and accounting procedures by creating a computerized geographic information system. The team will create a database of the water district's total assets for GASB-34 calculations as well as forecast future maintenance needs for the districts pump stations to aid the district in creating a schedule for maintenance. This project will help maintain more accurate records, and help to improve the efficiency of the water company in West Boylston.

1- To expand computerized repository of water district documentation by adding information about home connections
2- To design a computerized process for logging maintenance and repair done to the hydrants and pump stations
3- To revise/update the estimated value of the water systems infrastructure for GASB-34 calculations by adding the publicly owned elements of home connections
4- To propose a system for the continued accounting and maintenance of the water district's infrastructure

Our project will deal with the implementation of a new data entry system for the West Boylston Water District. This will include data which relates to the scheduling of maintenance of the district's pump stations maintenance done on the actual piping system, and the locations of valves shut-offs.

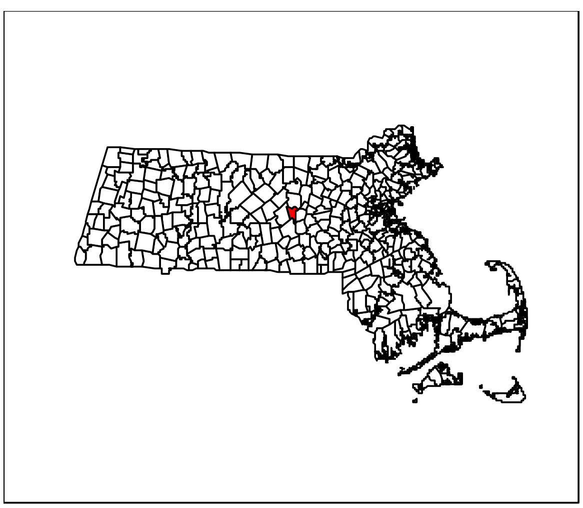


Figure 11 - West Boylston Water Distict Limits

Our project will be done within the boundaries of the West Boylston Water District, which is located within the town limits of West Boylston (Figure 6). We will collect data and finish work on this project during the B05, C06 and D06 terms. We also plan to review previous calculations of infrastructure value in order to verify their validity.

3.1 Inventorying of assets regarding home connections for the West Boylston Water District

Taking inventory of the all of the home connection assets in the water district allowed us to be able to look at the data in many ways using MapInfo. All data pertinent to this area of our study was contained in logbooks which we obtained from Mike Coveney. Other data, mainly water main location, was revealed while working with orthographic photos on MapInfo. We scanned these logbooks into PDF files to gain easier access to the information while populating databases.

The first step in gathering this information for inventory was to list every asset present within each home connection as described in the background. These assets are:

-service pipes
-curb stops
-corporations
-water meters

For each asset certain information was needed that would allow us to comply with GASB 34 regulations. This included information such as location, size, replacements costs, construction dates, life expectancy, and maintenance records. Construction dates, replacement costs and life expectancy are used to calculate the depreciated or current values of each asset. The specific information that was gathered for each asset type is detailed in the following sections. Tables of all assets and data can be found in the Appendix.

3.1.1 Inventorying pipes for home connections in West Boylston

The inventorying of this asset was the most particularly tedious and time consuming part of the project because of the abundance of these pipes. To ensure higher accuracy of the true locations of the service pipes, it was first necessary to relocate the positions of the water mains to the side of the road they lie on rather than the center-line of the road as was previously established. Previous estimates of water main locations were based on road layers which lie on the center-line of the road.

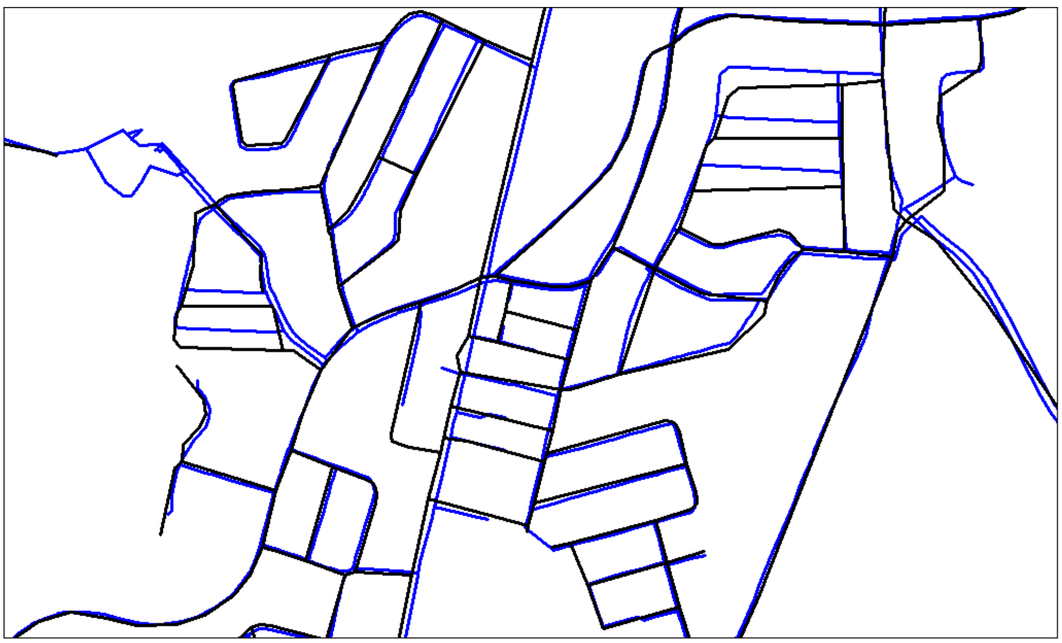


Figure 12 - Actual pipe location (blue) versus center-line location (black)

Home connections schematics revealed that the true locations of the pipes were most often on the side of the road. We downloaded orthographic photos from the Mass GIS website and we then overlapped the existing pipe layer on the orthographic photo. The figure above shows the distance the pipes were moved to better display their true locations on the map.

Each pipe unit was implemented into MapInfo and given a unique code. This code is based on the street ID number on which the pipe segment lies and the address number of the residence it services. We determined the street ID numbers using a 3-digit code already established by the water district. This was done to facilitate a user-friendly labeling system which employees are currently familiarized with. For example 19 Alhambra Rd was given the unique code of "001_19". The position of each service pipe was estimated in reference to the shop drawing on each home connection schematic.

The group obtained a copy of West Boylston Assessors Data from Mike Coveney from which we obtained a buildings layer that was translated into MapInfo. In referencing both the buildings layer and the home connection schematics, we were able to place each service pipe in its actual location with a negligible amount of error.

Once these pipe segments had been established in MapInfo in their real world locations, we were then able to gather information about the physical properties of each home service connection. These properties included:

-length
-pipe material
-pipe diameter
-water main material
-water main diameter
-year of installation

This data was accumulated and used to populate Microsoft Access tables and was later uploaded into MapInfo.

3.1.2 Inventorying curb stops in West Boylston

After implementing each service pipe into MapInfo, the location of the curb stops was much easier to plot.

Each curb stop was located at the end of the service pipe nearest to the residence it serviced. Data collected on curb stops included:

-type
-diameter

Curb stops were given a code based on the street ID, the address number, and then adding a suffix of –CS.

Figure 13 - Curb stop

3.1.3 Inventorying corporations in West Boylston

Corporations were placed at the intersection of the service pipes and the water mains. Data collected on corporation included:

-type

-diameter

Figure 14 - Corporation with Saddle

Figure 15 - Corporation with Sleeve

Corporations were given a code based on the street ID, the address number and then adding the suffix –CR.

3.1.4 Inventorying water meters in West Boylston

The location of the water meters was estimated and identified in MapInfo based on its apparent location as shown on the home connection schematics. Pertinent information gathered on water meters included:

-meter serial number

-module serial number

-read method

-account number

Figure 16 – New Water Meter

Water meters were given a unique ID code based on the street ID, the address number, and then adding the suffix –M.

3.2 Tracking maintenance and repairs on hydrants and pump stations

The hydrants within the water distribution system are flushed on a yearly basis in order to ensure that the hydrants of the town are functioning and that necessary repairs are done. The hydrants are flushed to remove sediment from the pipes while also inspecting each hydrant in regard to how it performs.

The current pump station logbooks are stored at each site and daily entries are made concerning the performance of the pumps as well as daily chemical level values. The information within this logbook is not effectively organized in regard to separating the maintenance procedures performed and the aforementioned daily readings. This leads to confusion when the water district needs information on past maintenance.

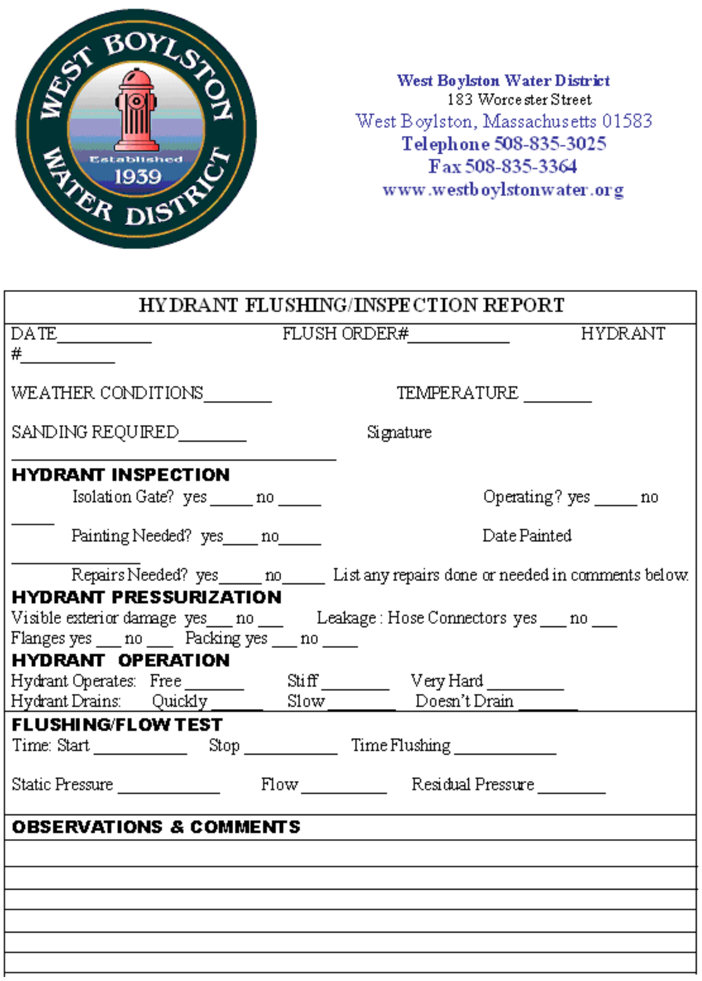
3.2.1 Developing computerized process for hydrant maintenance

Recently, the water district has created a detailed plan which describes how do go about flushing the water distribution system. Following these detailed instructions we have created several sequences of maps using MapInfo as well as Microsoft Powerpoint. The maps reveal which valves are to be closed and which hydrants are to be opened. The hydrants and valves are labeled on the maps, each with their own unique codes. The entire sequence of maps can be found in the Appendix.

Annual checks are also made on each hydrant throughout the flushing process. Each hydrant is inspected in regard to:

- painting
- damage
- leakage
- operation
- drainage

We have created a simple form in Microsoft Access to facilitate the ease of these inspections which also allows the information to be stored and accessed quickly for later reference.


West Boylston Water District
183 Worcester Street
West Boylston, Massachusetts 01583
Telephone 508-835-3025
Fax 508-835-3364
www.westboylstonwater.org

HYDRANT FLUSHING/INSPECTION REPORT

DATE__________ FLUSH ORDER#__________ HYDRANT #_________

WEATHER CONDITIONS_______ TEMPERATURE _______

SANDING REQUIRED_______ Signature _______________

HYDRANT INSPECTION

Isolation Gate? yes _____ no _____ Operating? yes _____ no _____

Painting Needed? yes____ no_____ Date Painted _____________

Repairs Needed? yes_____ no_____ List any repairs done or needed in comments below.

HYDRANT PRESSURIZATION

Visible exterior damage yes___ no ___ Leakage : Hose Connectors yes ___ no ___
Flanges yes ___ no ___ Packing yes ___ no ___

HYDRANT OPERATION

Hydrant Operates: Free ______ Stiff _______ Very Hard ________
Hydrant Drains: Quickly ______ Slow _______ Doesn't Drain ______

FLUSHING/FLOW TEST

Time: Start _________ Stop _________ Time Flushing ___________

Static Pressure __________ Flow ________ Residual Pressure _______

OBSERVATIONS & COMMENTS

Figure 17 - Hydrant Inspection Form

3.2.2 Developing a computerized process for logging pump station maintenance

The West Boylston Water District currently has a system where information is sent from each pump station to the office. We created a database using Microsoft Access which stores this information and allows the water district to look up past information more easily if needed.

No longer will it be necessary for a water district employee to go travel to a certain pump station to locate information on when certain types of maintenance was done or what a reading was. This will save time and manpower.

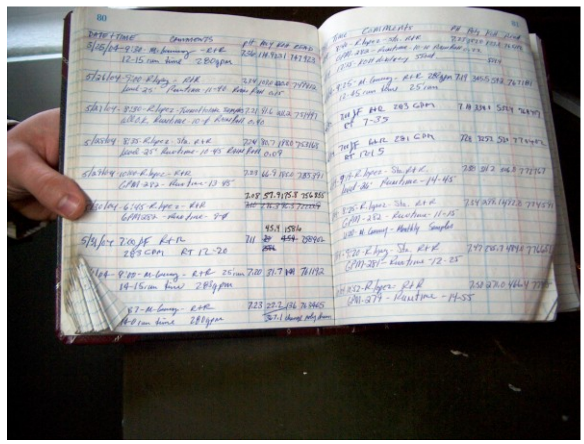


Figure 18 - Current Pump Station Log Book

The Microsoft Access database that we created contains the following information, much of which is recorded on a daily basis at each pump station:

Pump Run Time
Flow (GPM)
Level (PPM)
Polyphosphate amount (lb)
KOH level (gallons)
Reading

Monthly and yearly maintenance is also done along with daily checks at each site including:

pH checks (monthly)
Eye wash/shower check/maintenance (monthly)
Bacteria sampling (monthly)
Motor greasing (annually)
O-ring replacement (annually)

3.3 Updating GASB-34 calculations

The final analysis of the 2005 WPI group that worked with the West Boylston Water District was a report for the towns GASB 34 calculations. As discussed in our background GASB stands for the Governmental Accounting Standards Board. Our group collected more information on the water districts infrastructure, concentrating on the house connections, which the 2005 group left out of their project and added it to the information and calculations done by the 2005 project group.

Through our research of the house connections and entry of their information into our Microsoft Access databases we already had the information we needed to complete our part of the GASB 34 calculations for the water district. The values needed to complete the analysis of the house connection infrastructure were provided by the Mike Coveney. These values and the information collected in the Microsoft Access databases were then used to construct Microsoft Excel spreadsheets, with the aid of simple formulas to finalize our GASB 34 calculations for the water district. One of the formulas we used was:

Current Value = (Historic Cost) * [(Age – Life Expectancy) / Life Expectancy]

The Microsoft Excel spreadsheets were set up in a way that as new infrastructure, unique to our project limits, is added to the water district this information can be entered and easily recalculated.

3.4 Proposing continued accounting system

By using the databases we created, the water district will be able to input new or changed information about an item in the water district. If a unit's details need to be changed, a query can be completed in both Map Info and Microsoft Access to locate that unit and change what is needed. If a new unit is added to the water district the information can be input into the Access database and will be organized automatically.

It is our hope that in the future the Access and MapInfo files we have created can be organized in a user-friendly software program such as LOUIS (Local Online Urban Information System). This system can then be used to access all the information pertaining to infrastructure that the Water District will need over a broadband server. Details about the system are further described in section 4.4.

4 Results and Analysis

There are four main topics to discuss in this chapter. The first topic of discussion pertains to the inventorying of home connection assets in West Boylston and show results for each infrastructure type. Next is to display a computerized process for logging the maintenance and repair done to pump stations and hydrants. The third topic is to show the calculations performed to fulfill GASB-34 requirements. Lastly, we must discuss a platform which can be used to combine the information that we have input into Microsoft Access and MapInfo into a user-friendly information system.

4.1 Inventory of home connection assets in West Boylston

This section of the report shows important results and totals for each type of infrastructure assets regarding home connections including service pipes, curb stops, corporations, and newly installed water meters. It also contains a summary of totals.

4.1.1 Inventory of pipes for home connections

Figure 15 shows a map of all the Home Connections in West Boylston. There were 2143 connections that were created to make this map. Each connection was assigned its own unique code.

Figure 16 is a more detailed map which indicates each home connection material by color. C/L W/I and plastic are the materials which the majority of home connections are made of. Figure 17 reveals a closer look of the home connections in the downtown West Boylston region.

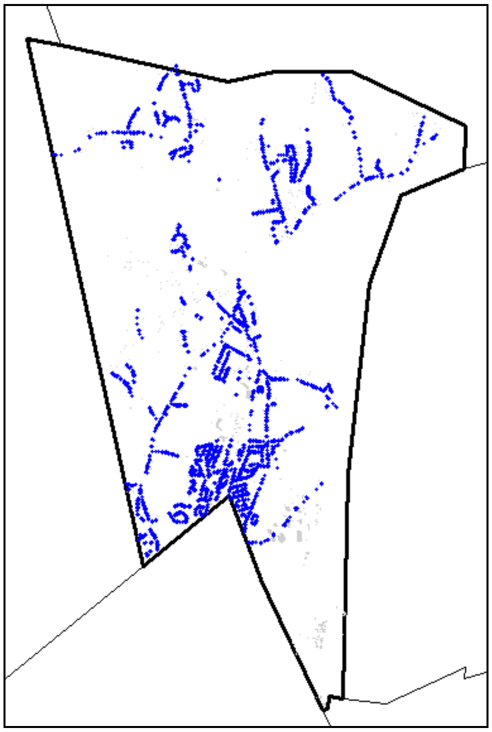


Figure 19 - Home Services of West Boylston

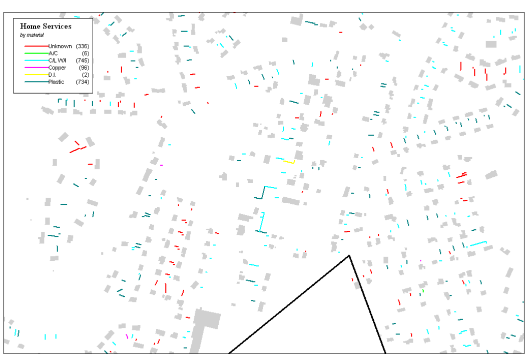


Figure 20 - Home Services by Material Downtown

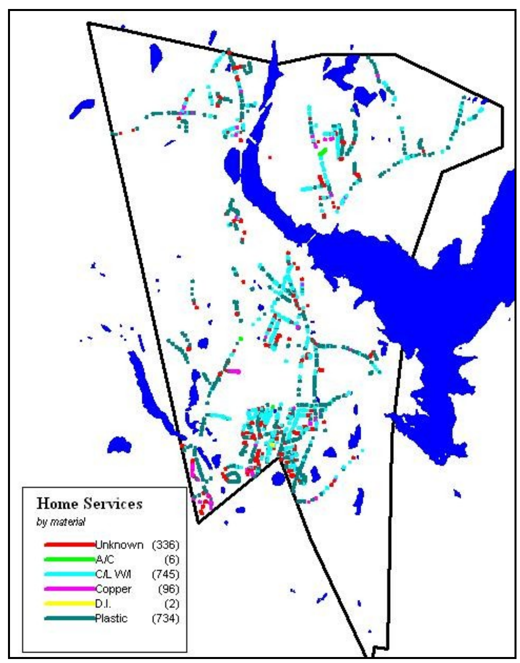


Figure 21 - Home Services by Material

Figure 18 displays a graph of the service materials by percentage. The total replacement cost for all home service pipes was valuated to be $2,094,039.78. Figure 19 reveals replacement costs by pipe material. Plastic and C/L W/I make up 93% all pipes. Nearly all of the home connection services were of 1" pipe so it was not necessary to show maps and graphs displaying these values.

4.1.2 Inventory of curb stops

As discussed in the methodology chapter, each curb stop was placed in its real world location at the end of each publicly owned home service pipe segment. The curb stops are most often located in the homeowners' front yard.

There are 2,143 curb stops within the water distribution system. As mentioned before, nearly all of the services are 1" which means that all of the curb stops are essentially 1". Each curb stop is worth $35.86. The total replacement cost for all curb stops was valuated to be $76,847.98.

Figure 22 - Curbstops of West Boylston

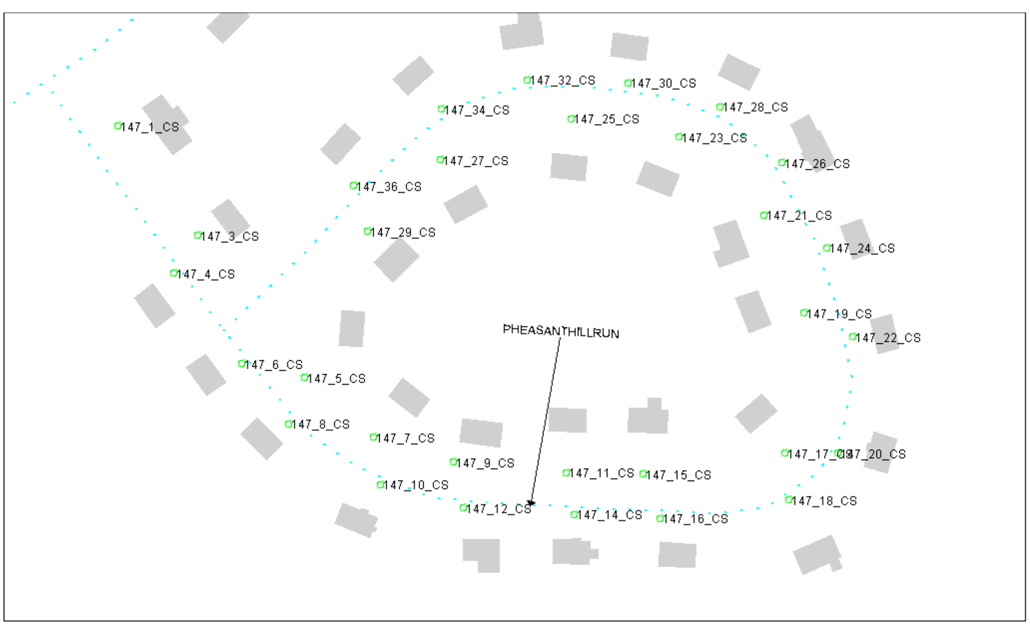


Figure 23 - Curbstops (Pheasant Hill Run)

4.1.3 Inventory of corporations

Figure 24 - Corporations of West Boylston

Each corporation was placed at the intersection of the publicly owned pipe stub and the water main. The corporation is connected to the main by a saddle (Figure 11) or if the main has begun to deteriorate greatly a repair sleeve (Figure 12) is used.

The total number of corporations was calculated to be 2,143. Each corporation has a replacement value of $35. The total replacement cost for all of the corporations in the water distribution system was valuated to be $75,005.

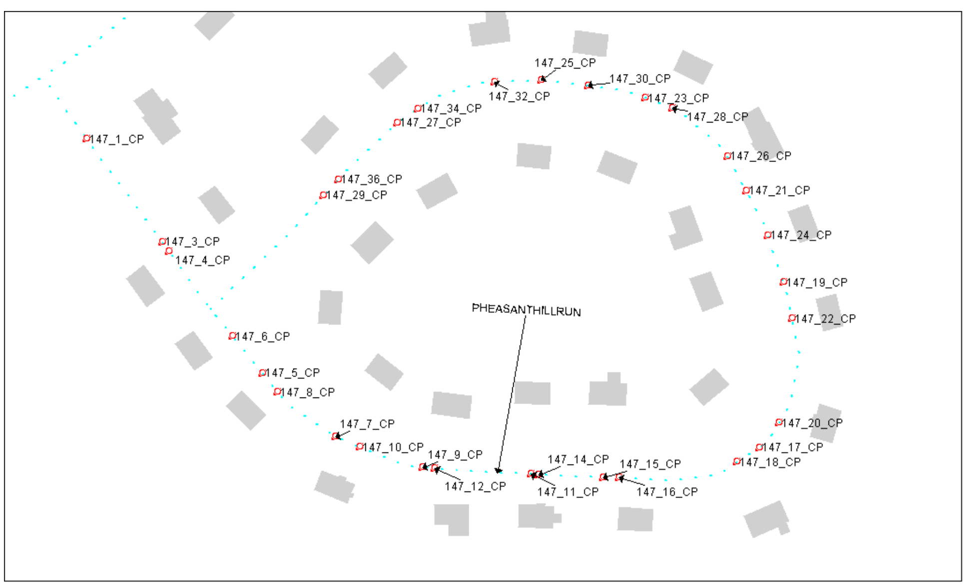


Figure 25 - Corporations (Pheasant Hill Run)

4.1.4 Inventory of water meters

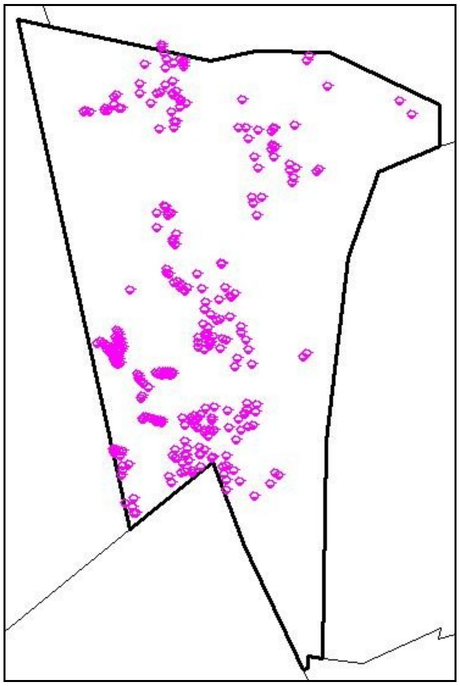


Figure 26 - West Boylston New Water Meters

As discussed in the methodology, each water meter was snapped in MapInfo to the building which it services in its real world location as identified on the home connection schematics. Due to time constraints within the project, we were only concerned with mapping new electronic water meters (Figure 13) that are currently being implemented by the Water District.

There are a total of 607 new water meters, most of which are 1" meters with a few 2" meters that service large commercial properties. Each meter has a value of $200. The total replacement cost for all of the new electronic water meters was valuated to be $121,400.

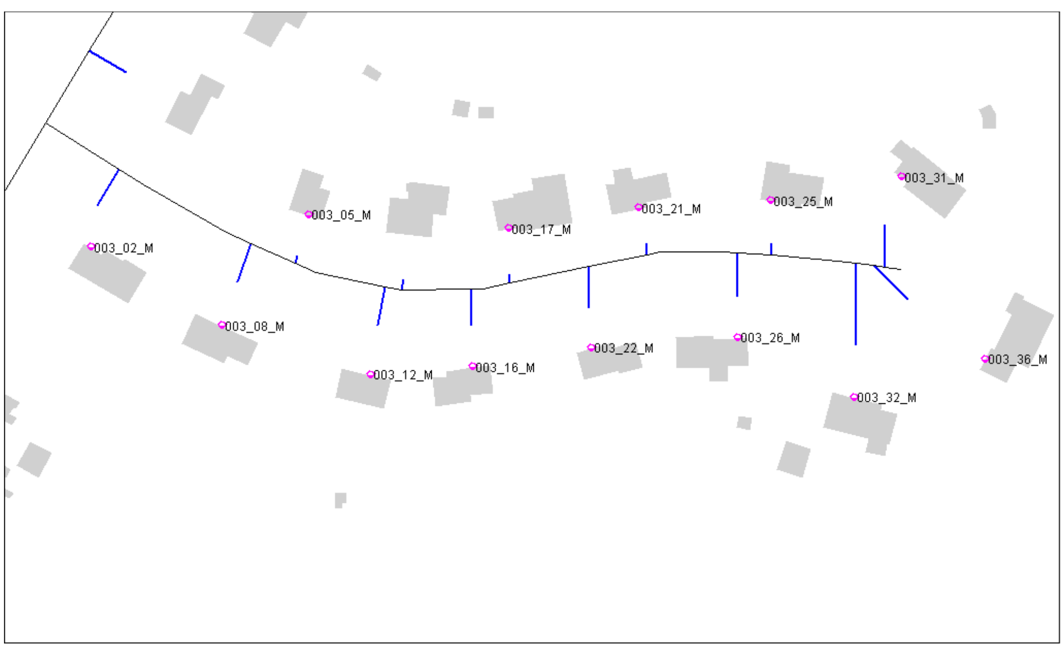


Figure 27 - Water Meters (Applewood Rd)

4.2 Computerized process for logging maintenance on hydrants and pump stations

This section of the report shows the computerized processes and forms to be used to catalogue maintenance activities. The activities include hydrant flushing and inspection as well as routine pump station maintenance. This information will then be stored in an electronic format for quick and easy access in the future.

4.2.1 Hydrant Maintenance

Our group created a Microsoft Access Database for the entry of maintenance done to the hydrants of the West Boylston Water District.

Information used to construct the database was taken from hydrant inspection reports received from the water district.

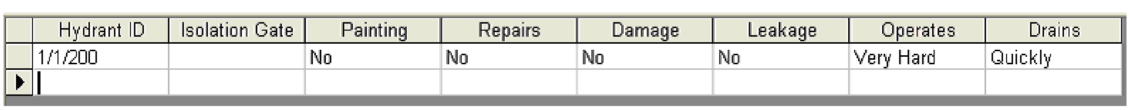
4)_West_Boylston_Hydrant_Mai...

Hydrant ID	1/1/200
Isolation Gate	
Painting	No
Repairs	No
Damage	No
Leakage	No
Operates	Very Hard
Drains	Quickly

Record: 1 of 1

Figure 28 - Hydrant Maintenace Electronic Form

This database will be useful in that employees will be able to insert information done to each hydrant which can be easily accessed in the field through a laptop computer or handheld PDA. Also, using Access, hydrants can be categorized based on performance criteria in order to show which hydrants are in the greatest need of maintenance or replacement.



Hydrant ID	Isolation Gate	Painting	Repairs	Damage	Leakage	Operates	Drains
1/1/200		No	No	No	No	Very Hard	Quickly

Figure 29 - Hydrant Maintenance Database

We created a series of slides using Microsoft Powerpoint and MapInfo which show the sequence the water district follows to flush the water distribution system. The slides include detailed maps with individually labeled infrastructure as well as detailed instructions about the flushing process. Figure 26 shows the preliminary steps for flushing order number one which begins on Temple Street. The entire sequence of slides for flushing order number one can be found in the Appendix.

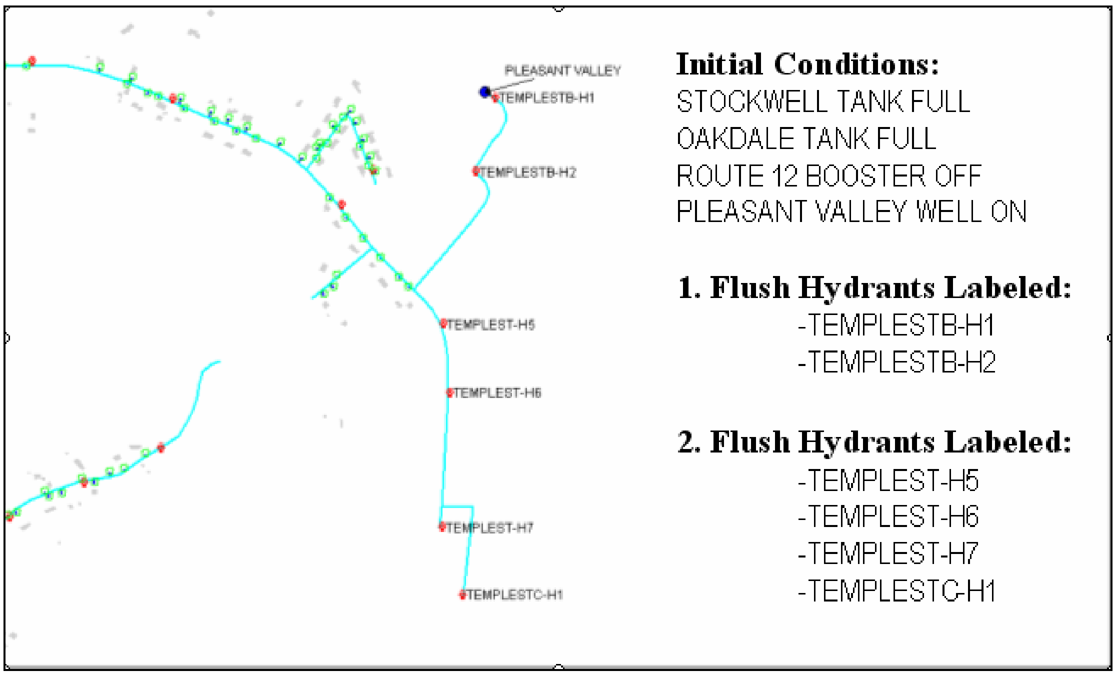


Figure 30 - Flushing Order #1 Low

4.2.2 Pump Station Maintenance Log

Our group took the information collected from our visits to a West Boylston pump stations to create a Microsoft Access Database. The database was populated with information taken from past entries of actual logbook. This information was entered to show the usefulness of this tool for the West Boylston Water District.

Using this computerized format, the Water District will be able to quickly and easily search when the last date a certain maintenance procedure was performed.

Date	Time	Pump Location	Run Time	Flow(GPM)	pH	Level(PPM)	Polyphosphate(lb)	KOH(gallons)	Reading	Notes
5-25-04	9:30		12-15	280	7.36		114.9	239	747923	
5-26-04	9:00		11-40		7.34	25	103.0	220.0	749812	rainfall=.015
5-27-04	8:30		10-0		7.21		91.6	211.2	751447	rainfall=.40
5-28-04	8:35		10-45		7.24	25	80.7	188.0	753168	rainfall=.09
5 29 04	10:00		13 45	282	7.23		68.9	185.0	736391	
5-30-04	6:45		9-0	282	7.03		57.9	175.3	756855	
5-31-04	7:00		12-20	283	7.11		45.4	158.5	758902	
6-1-04	9:00		14-15	283	7.20		31.7	149	761192	
6-2-04	8:30		14-0	280	7.23		367.1	136	763465	change poly drum
6-3-04	8:40		10-10	282	7.23		367.8	123.2	765112	rainfall=.72
6-4-04	9:25		12-45	282	7.13		345.5	542	767181	
6-5-04	7:00		7-35	283	7.13		338.1	532.4	768417	
6-6-04	7:00		12-15	281	7.29		325.1	528	770402	
6 7 04	9:49		14 45		7.39		311.2	308.3	772767	
6-8-04	8:25		11-15	282	7.34		299.1	492.3	774591	11:00 Monthly samples
6-9-04	9:20		12-25	281	7.47		285.7	484.0	776651	
6-10-04	10:52		14-55	279	7.50		271.0	466.4	477885	
6-11-04										
6-3-04	12:15							554.4		KOH delivery start
*										

Figure 31- Computerized Log Book

4.3 Estimate of Current Worth of West Boylston GASB 34 Water Infrastructure

In order to set any type of worth on the GASB 34 relevant data, the infrastructure had to be separated from the rest. GASB 34 relevant data includes all infrastructures that were installed after July 1, 1980. The total current values of all GASB 34 relevant assets are much lower than the total replacement cost.

4.3.1 GASB 34 home connection pipes

Figure 29 and 30 below show information regarding home connections relative to GASB 34.

There are 1192 home connections that are relative to GASB 34 calculations with a total current worth of $16,994.82.

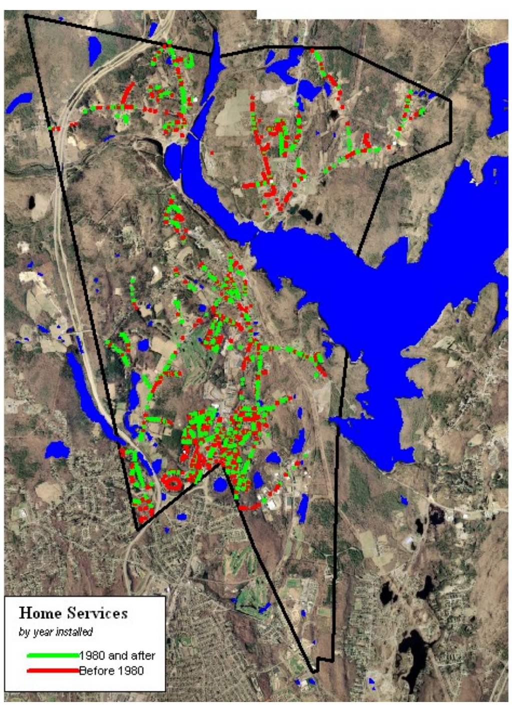


Figure 32- GASB Home Connections

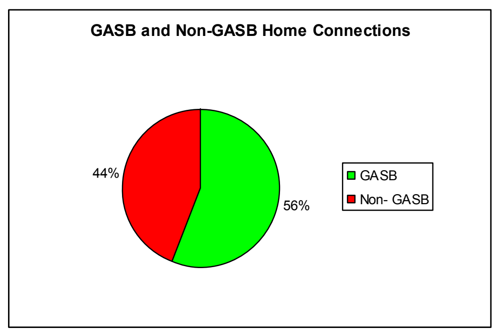


Figure 33- Percentage of GASB vs. Non-GASB Home Connections

4.3.2 GASB 34 curb stops

Figure 31 below shows information regarding curb stops relevant to GASB 34 calculations.

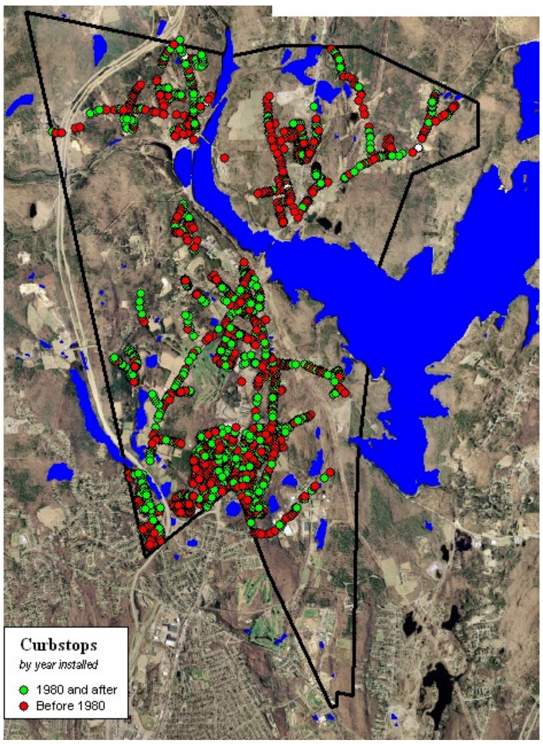


Figure 34- GASB Curbstops

There are 1192 curb stops that are relative to GASB 34 calculations with a total current worth of $37,220.89.

4.3.3 GASB 34 corporations

Figure 32 below shows information regarding corporations relative to GASB 34 calculations.

There are 1,192 corporations relative to GASB 34 calculations with a total current worth of $36,328.25.

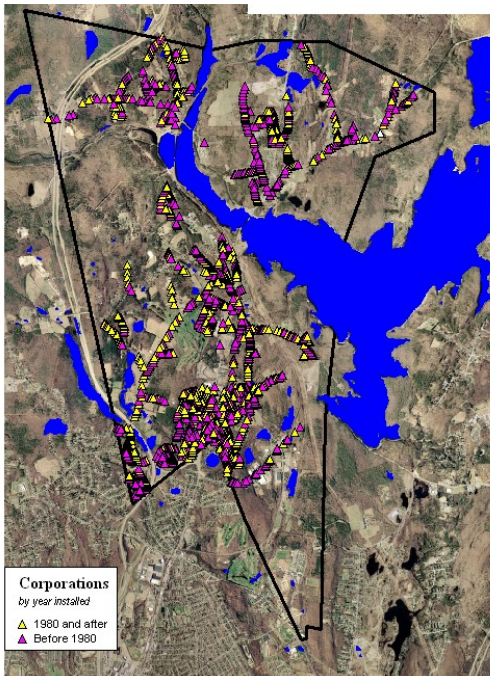


Figure 35- GASB Corporations

4.3.4 GASB 34 water meters

Below, in figures 33 and 34 information regarding water meters relative to GASB 34 calculations is shown.

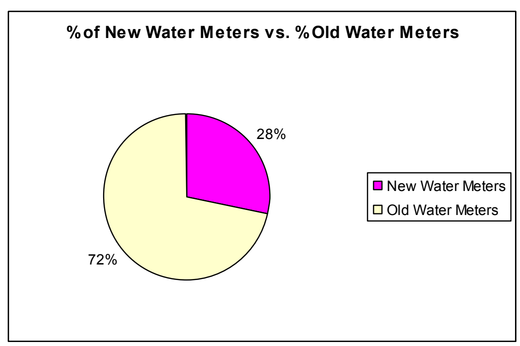


Figure 36- Percentage of New Water Meters vs. Percentage of Old Water Meters

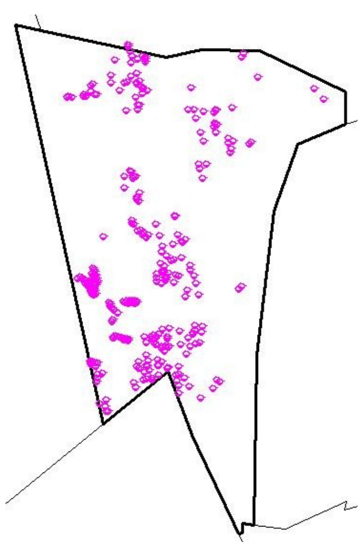


Figure 37- GASB Water Meters

Currently The West Boylston Water District is replacing old water meters with new water meters. There are currently 607 new water meters in working order in the district.

Since all the water meters will be replaced with new water meters within the next few years, only the new water meters were calculated for GASB 34 calculations.

The total worth of all the new water meters in the district is $121,400.

4.3.5 GASB 34 Related Capital Assets

Below is a table that includes all relevant GASB 34 information for the West Boylston Water District. Home Connections have been added to the existing inventory from the 2005 IQP group. The new updated table shows that all of the GASB 34 relevant data has a total worth of $799,994.85.

GASB 34 Relevant Asset	Current Value
Home Connection Pipes	$16,994.82
Curb Stops	$37,220.89
Corporations	$36,328.25
Water Meters	$121,400.00
Water Mains	$526,677.11
Valves	$14,306.94
Hydrants	$26,570.12
Pump Stations	$20,496.72
Total=	$799,994.85

Figure 38- Total GASB 34 Relevant Data

4.4 Proposal of continued accounting system

A need developed during the completion of this project for an information system to combine all of our data and results. The program that is planned to be used in the future is called LOUIS, which is a data information system supported by WPI. This program will allow for information to be uploaded, viewed and manipulated in a user friendly format.

MapInfo layers will be viewable through the tabs located on the right side of the screen. The user will have the capability to zoom in on each element of the map to view the layer in more detail. By selecting a specific piece of infrastructure the user will be able to view information pertaining to that item. New information can be input through the use of customizable buttons located in the bottom right hand corner of LOUIS, which allows the system to remain up to date.

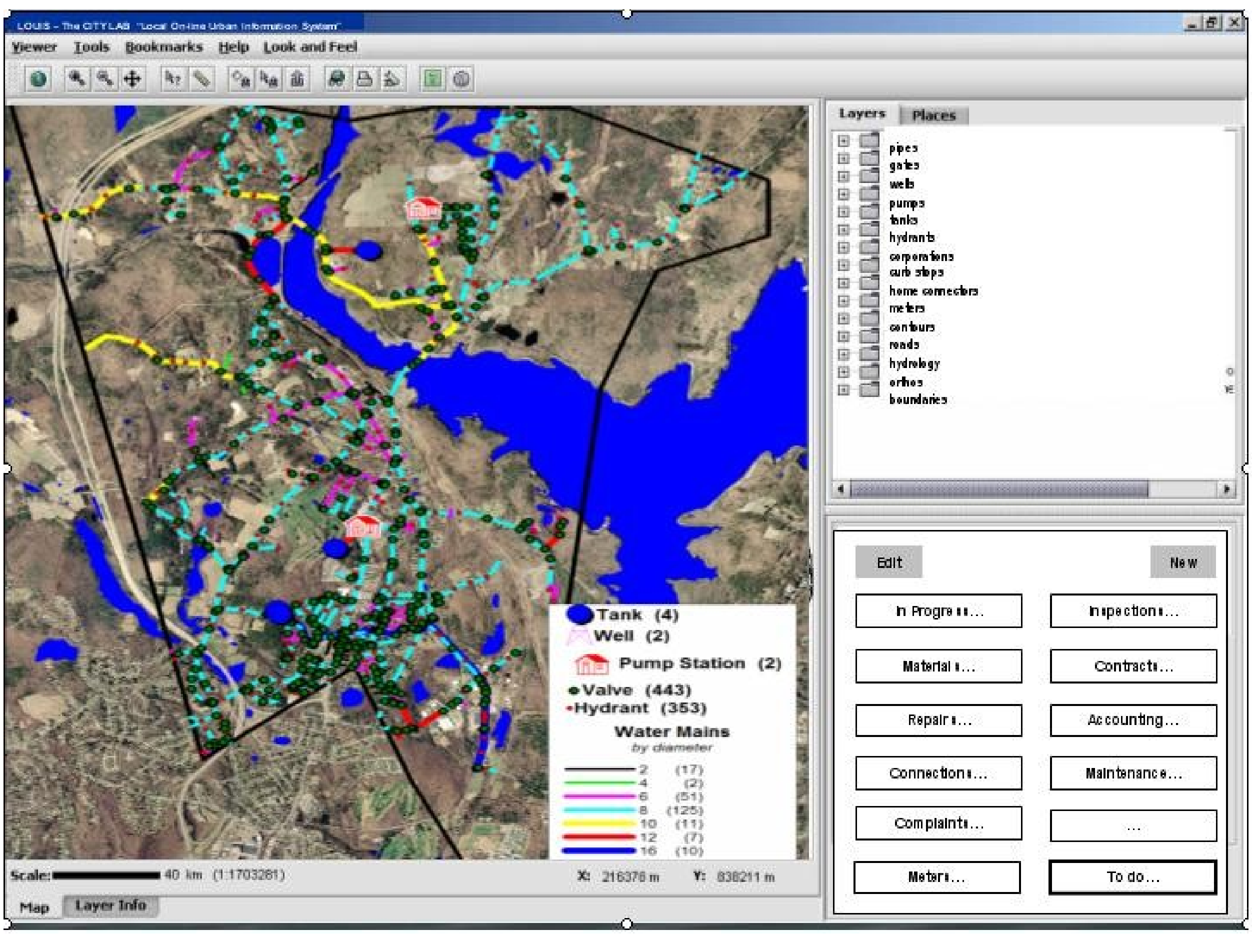


Figure 39 - Proposed LOUIS format

5 Conclusions and Recommendations

The West Boylston Water District now has all details relating to home connections entered into electronic databases. All information in Access and MapInfo can be viewed to aid in servicing the water district more efficiently. These databases can be very useful in their current form; however these programs are not very user-friendly. The maps and databases we have created can be a much more effective tool if implemented into the LOUIS software program in the future. This system will allow the information connected with each piece of infrastructure to be manipulated in a very user-friendly manner. LOUIS gives the user the ability to turn any layer on and off and also the ability to input new information as necessary. Other features include the capability of being able to track water usage or frequent problem areas within the system.

Although our project was completed and will hopefully help the water district function better, there are parts of the project that could have been improved. Every connection schematic did not contain all information needed by our group. Many schematics lacked information pertaining to pipe stub length or diameter. If we had this information we would have been able to create more accurate map layers, data tables and GASB calculations. For an example refer to figure 18 which shows a line in its legend names "unknown" which refers to the pipe stubs which did not have a material labeled in that connections schematic.

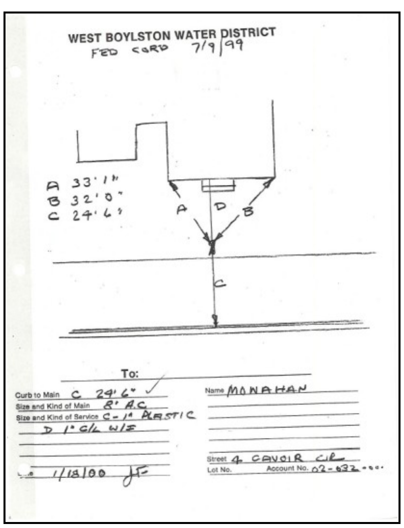


Figure 40 - Schematic w/Information

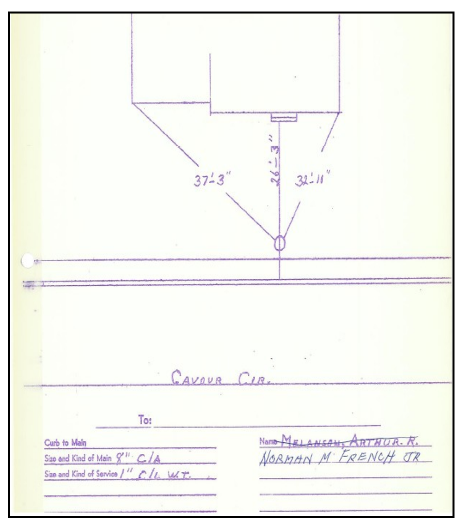


Figure 41 - Schematic w/out information

Figures 37 and 38 located above are another example of how some of the connection schematics did not contain all information needed by us to complete our project.

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