Office of the
TOWN MANAGER

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TOWN OF SHREWSBURY

Richard D. Carney Municipal Office Building
100 Maple Avenue
Shrewsbury, Massachusetts 01545-5398

January 20, 2016

To: Board of Selectmen

From: Daniel J. Morgado

Re: Water needs for the period through 2036

Introduction

I direct your attention to the attached report entitled "Alternate Water Supply Study" (Study) dated June 30, 2015 that was funded by a SWMI Grant provided by the Department of Environmental Protection.

This report was commissioned to study what alternate water supplies exist, in addition to, or in lieu of, the Town's current water source.

A description of the Town's water system is outlined in the introduction of the Study and a more lengthy explanation is immediately attached in the form of an excerpt from the Capital Efficiency Plan dated March of 2014, prepared by Tata & Howard.

The Question Under Study

The primary question being studied is what actions must be taken to provide an adequate water supply to meet the Town's needs in 2036?

Our current system, cannot, at this time, meet this need from a water quality and water quantity standpoint.

The water quality problem can be resolved with additional treatment to remove manganese. In fact, the Town Meeting in May set this solution into motion with the appropriation of $500,000 to begin design of a treatment system to be installed at the site of the current Water Treatment Facility (WTF).

The problem that is more difficult to address is the quantity problem. We estimate that in order to meet the Town's economic development goals, that a water system must be developed to provide 6 Million Gallons Per Day (6 MGD). We are currently permitted (with offsets) for 4.35 MGD which leaves us 1.65 MGD short. Our usage for 2015 was 3.60 MGD leaving us .750 MGD

below our WMA permit limit. In 2005, the amount pumped was 3.81 MGD, in 1995 it was 3.64 MGD which indicates that in 2015 we used less water than in 2005 and 1995.

Year	MGD
2015	3.60
2005	3.81
1995	3.64

I must note that our sewer system also cannot meet our economic development needs due to regulatory barriers relative to the amount of flow that can be sent to the Westborough Water Treatment Facility. The sewer allocation study assigned Shrewsbury a maximum flow of 4.39 MGD (FY 2015 flow was 3.09 MGD). This matter is also under study and will be the subject of a subsequent report.

So, the quantity question is where do we source 6 MGD or 1.65 MGD, understanding that treatment for manganese is required should the Town continue to rely on the Home Farm Wells which provides the bulk of our current water supply.

Options for 6 MGD or 1.65 MGD

At a planning exercise on December 18, 2015, the staff and consultants identified the following seven primary options (see Table 4-1 for full list of options considered):

1. Upgrade the Water Treatment Facility (WTF) to handle manganese remove but seek out no additional capacity. This limits the Town to 4.35 MGD.
2. Maximize the underutilized Home Farm sub-basin by altering the regulatory environment that provided the Town only .44 MGD from a request of 1.37 MGD (Note that 0.62 MGD has been allocated to the Riverdale Water Co that does not operate).
3. Join the MWRA and connect directly to the Town of Northborough's water distribution system (Note that MWRA water cannot be mixed with water from our aquifer).
4. Join the MWRA connecting directly to the MWRA and bring the water cross country to Shrewsbury (Note that MWRA water cannot be mixed with water from our aquifer).
5. Connect directly to the City of Worcester and purchase 100% finished water.
6. Connect directly to the City of Worcester and purchase finished water to supplement the Shrewsbury wells.
7. Join the MWRA and move raw water from the Wachusett Reservoir to be injected into the aquifer in the Home Farm Well area which then in turn is extracted and treated at the WTF (Note upgrade to WTF is still required).

The preferred option is to maximize the local aquifer but the regulatory environment makes that currently impossible because of the current conventional wisdom that exists. The current regulatory environment creates a major barrier to good planning and engineering solutions being proposed and adopted as communities and entities must hoard capacity less additional regulatory scrutiny comes to bear. You will note that when you review the full report, there is much

discussion and expense surrounding permitting issues and current regulatory policy favors those communities and entities that have capacity created under a previous regulatory environment.

When considering options there are two main costs to consider which are the cost to acquire a gallon of water at the source and the cost to get that gallon of water to distribution. Making use of the existing aquifer puts the cost of acquisition at near zero. Connection with the City of Worcester or MWRA has both a buy in fee and an annual cost per gallon thereafter.

Cost Item	1 Maintain WTF with no Addiotnal Capacity (4.35 MGD)	2 Change Regulatory Environment (6 MGD)	3 MWRA Through Northborough (6 MGD)	4 MWRA Cross Country (6 MGD)	5 Connection to the City of Worcester for (6 MGD)	6 Maintain WTF/ Connect with City of Worcester for (1.65 MGD added to 4.35 MGD)	7 Aquifer Storage (Upgrade to WTF Still Required) (6 MGD/2 MGD Injected) (Costs are not fully developed)
Water Treatment Plant Improvements	$12,800,000	$20,000,000				$12,800,000	$15,000,000
Design & Permitting	$750,000	$1,000,000	$957,000	$1,485,000	$860,000	$2,290,000	$1,675,000
Water Main Improvements			$7,800,000	$7,400,000	$2,400,000	$800,000	$2,700,000
Booster Pump			$580,000	$800,000			$600,000
MWRA Buy In			$20,880,000	$20,880,000	$0	$0	$6,700,000
Land Costs				$5,000,000			
Regulatory Mitigation					$25,000,000		
Recharge Beds							$1,200,000
	$13,550,000	$21,000,000	$30,217,000	$35,565,000	$28,260,000	$15,890,000	$27,875,000
				Without Mitigation	$3,260,000		
First Year Bond Cost	$948,500	$1,470,000	$2,115,190	$2,489,550	$1,978,200	$1,112,300	$1,951,250
Cost Per MG's of Finished Water	$462	$462	$3,888	$3,240	$5,080	$462/$5,080	$462/$1,800
Cost of Water (at maximum)			$8,514,720	$7,095,600	$11,125,200	$3,059,430	$1,314,000
Annual O&M WTF (at max)	$733,541	$1,011,780				$733,541	$1,011,780
Annual First Year Cost	$1,682,041	$2,481,780	$10,629,910	$9,585,150	$13,103,400	$4,905,271	$4,277,030

Short of changing the regulatory environment, the best option is to upgrade the WTF and supplement the supply with the purchase of water from the City of Worcester. The MWRA and City of Worcester (at 100%) options are just too expensive from the acquisition water cost standpoint. This option also allow the Town to ease into these additional costs as the supplemental water supply is not yet required.

The primary advantage of getting out of the water supply business is that we eliminate the need to operate our own WTF and we eliminate the need to deal with the regulatory environment of being a water producer.

This matter will be reviewed at your meeting on January 26, 2016, as part of the Public Works Workshop.

Please advise with any questions.

Cc Jeff Howland
Robert Tozeski
Kristen Las
John Decillis
Vincent Thai
Paul Howard
Blake Martin

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Town of Shrewsbury
Alternate Water Information

1. The Town has a registered water withdrawal approved prior to 1983 of 2.64 mgd (million gallons per day)

2. Various additional water amount increases since that date have been requested under our Water Management Act Permit in addition to our registered volume of 2.64 mgd. Under our present permit we have increased from our last permit by 0.26 mgd bringing us presently to 4.17 mgd (3.91 + 0.26) with an allocation volume cap at 4.35 mgd which is a not to exceed figure for our annual daily usage.

3. We are grandfathered prior to 1983 under the Interbasin Transfer Act for a volume of 7.8 mgd that can be pumped from the Blackstone Basin to the Concord River Basin. The following pumping restrictions are in place today and any change requires going through the Water Resource Commission under Interbasin Transfer:
   A) Total pumping daily not to exceed 7.8 mgd
   B) Total pumping from the four Home Farm Wells 6-1, 6-2, 6-3, 6-4 not to exceed 5.4 mgd daily
   C) With 6-3 and 6-4 installed as backup wells, total flow from 6-1, 6-3, and 6-4 shall not exceed 4.32 mgd daily
   D) Sewell #4 well flow which does not run through the Plant air strippers is rated at 1.14 mgd
   E) Lambert 3-3 and 3-2 flow is rated at 1.33 mgd

4. In reality, trying to pump these wells at these rates of flows causes hydraulic restrictions As one well is fighting against the other impacting also the well levels. There are also physical limitations on the Treatment Plant configuration and 16-inch discharge piping. We are not comfortable running above 5.5 mgd for an extended period of time.

5. Additional wells may be installed on the Home Farm site but we would be pulling out of the same sub-basin and encounter similar aquifer issues with extended pumping.

6. The City of Worcester Expenses to bring water into distribution system.

Worcester

A) Out of City Rate-
$3.80/hundred cubic feet (748 gals)
Add to 5% for projected increase
$3.99/hundred cubic feet

Cost per million gallons=
$5,334.23

Annual cost for 1.65 mgd
$3,212,540

Annual cost for 1.0 mgd
$1,946,994

Annual cost for 2.0 mgd
$3,893,988

Annual cost for 0.5 mgd
$973,497

B) Pumping would be limited to our low pressure zone which we can configure by valving to meet any sizing larger or smaller that we would require within the low pressure hydraulic grade line limitations. With our average day at around 3.7 mgd, low system represents 35% of that volume which would be 1.3 mgd. Our starting point would be between 200,000 gallons (0.2 mgd) and 500,000 (0.5 mgd) at a cost of $389,399 and $973,497 respectively plus $20,000 for addition of fluoride and electricity.

SECTION 2 – Existing Water Distribution System

2.1 General

The Town of Shrewsbury's distribution system consists of approximately 185 miles of water mains ranging in diameter from one to sixteen inches. Figure No. 2-1 shows a breakdown of the water main size distribution of the existing water system. Approximately one percent of the system is 16-inch diameter or larger water main, approximately 24 percent is 12-inch diameter water main, approximately 4 percent is 10-inch diameter water main, approximately 42 percent is 8-inch diameter water main, approximately 27 percent is 6-inch diameter water main, and approximately two percent is 4-inch diameter or smaller water main. These mains are constructed of various materials including cement lined ductile iron (CLDI), cast iron (CI), asbestos cement (AC), and polyvinyl chloride (PVC). Figure No. 2-2 shows the breakdown of material distribution of the existing water system.

The distribution system consists of seven active groundwater sources, six water storage facilities, three booster pump stations, a water treatment facility, and two emergency interconnections. The distribution system is divided into three separate pressure service areas, the Low (LSA), High (HSA), and Reduced High Service Areas (RHSA). A map of the existing water distribution system is included in Appendix A.

The LSA has a hydraulic gradeline elevation (HGL) of approximately 600 feet. Ground elevations range from approximately 350 feet to 535 feet. The LSA constitutes approximately 35 percent of the overall system demands. The RHSA has a HGL of approximately 680 feet and ground elevations range from approximately 360 feet to 595 feet. The RHSA constitutes approximately 33 percent of the overall demand. The HSA has a HGL of approximately 800 feet and ground elevations range from approximately 425 feet to 740 feet. The HSA constitutes approximately 32 percent of the overall demand.

2.2 Water Supply Sources

The Shrewsbury water system is supplied by seven active groundwater supply sources at three locations. The active supplies are located in the Lake Quinsigamond aquifer. The aquifer extends along a north/south axis and is bound to the east and west by bedrock/till ridges. The Town of Shrewsbury is currently permitted to withdraw water from the Blackstone River Basin (Permit No. 9P4-2-12-271.01). The system is permitted by the Massachusetts Department of Environmental Protection (MassDEP) to withdraw a maximum daily rate of 7.87 million gallons per day (mgd) and an annual average day rate of 3.91 mgd. Table No. 2-1 presents the permitted maximum daily withdrawal rates for each of the system's active supply sources.

Figure No. 2-1
Water Main Diameter Distribution

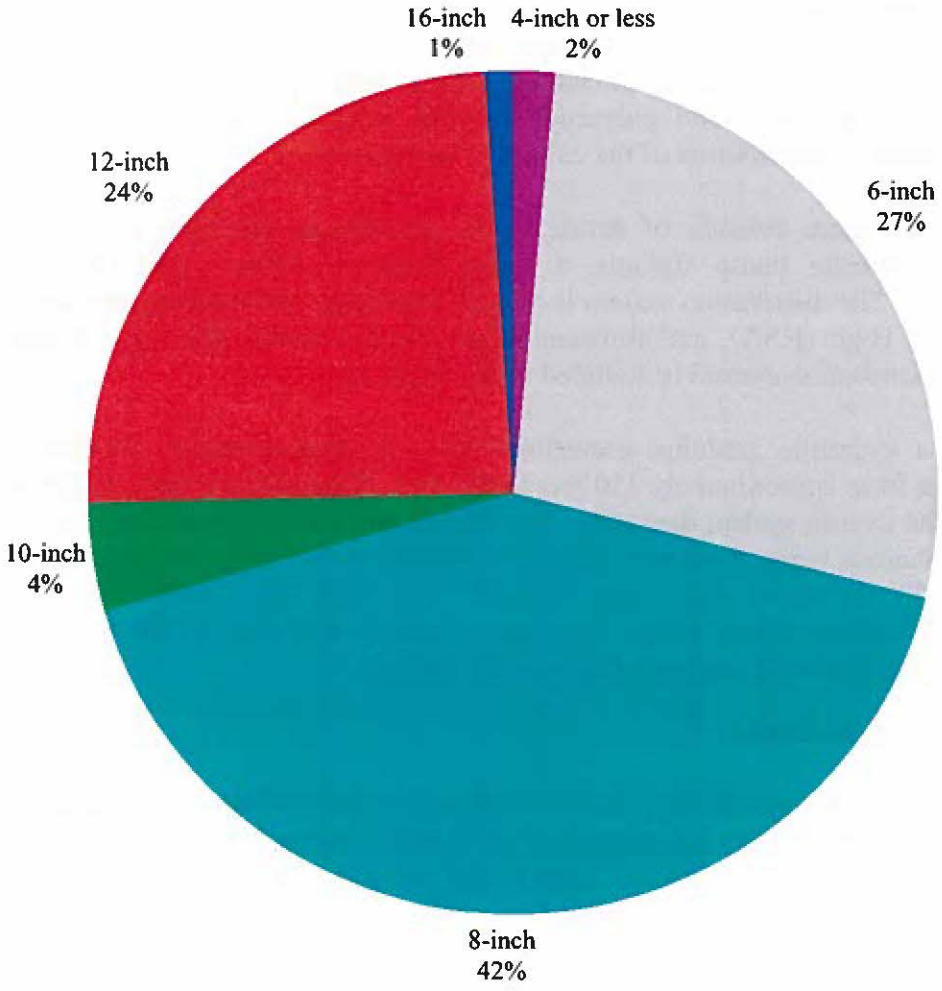

Figure No. 2-2
Water Main Material Distribution

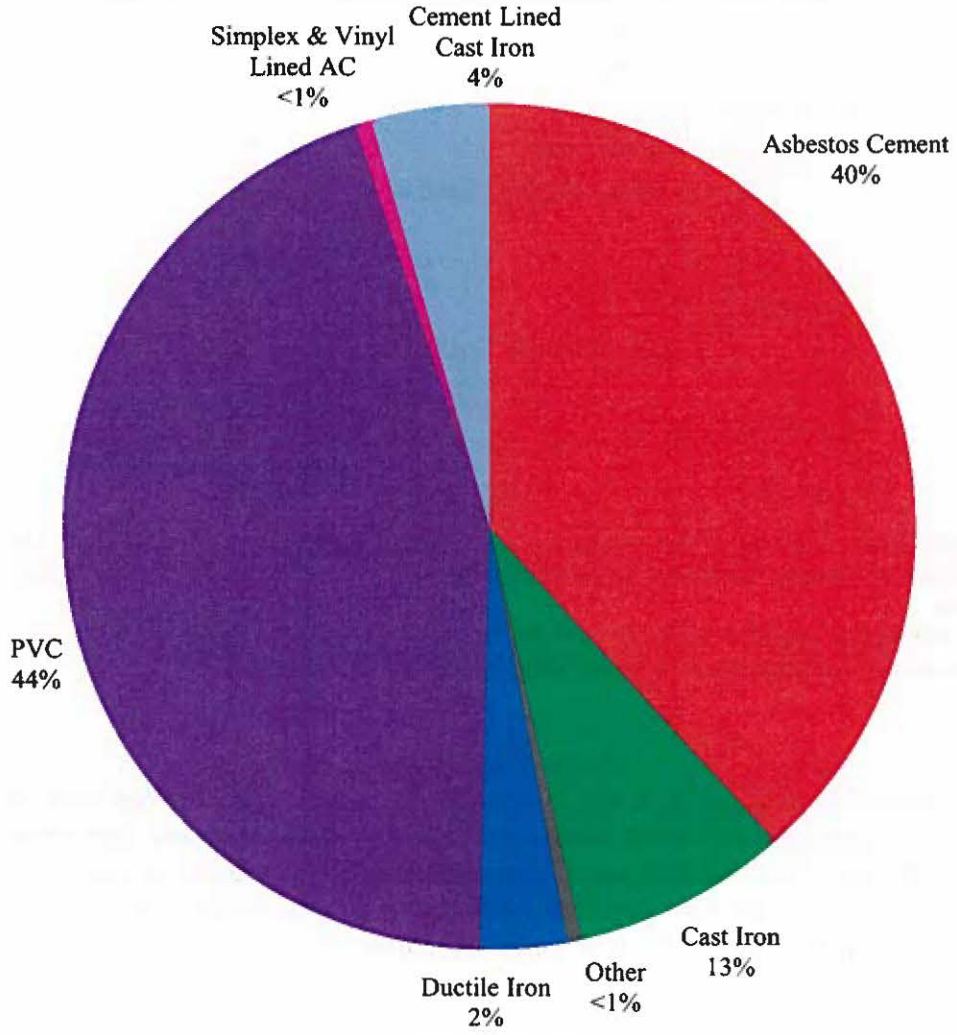

Table No. 2-1
Approved Withdrawal Volumes

Source Name	Permitted Withdrawal Volumes (MGD)
Home Farm Well No. 6-1	4.32
Home Farm Well No. 6-2	3.02
Home Farm Well No. 6-3	*
Home Farm Well No. 6-4	*
Home Farm Wells Total:	**5.4***
Lambert Well No. 3-1	0.75
Lambert Well No. 3-2	0.58
Lambert Well Total:	**1.33**
Sewall Well No. 4	1.14
Total:	**7.87****

*Home Farm Wells No. 6-3 and 6-4 were installed as supplemental wells to Home Farm Wells 6-1 and 6-2. The combined withdrawal rate for the Home Farm Wells cannot exceed the maximum daily pumping rate of 5.4 million gallons.
**Based on information provided with the 2008 Interim WMA Permit, the total amount pumped from the sources cannot exceed 7.87 mgd based on Shrewsbury's interbasin transfer limit. .

Home Farm Wells

Home Farm Wells No. 6-1, 6-2, 6-3, and 6-4 are gravel packed wells located near the northern tip of Lake Quinsigamond just south of Great Brook. Well No. 6-1 was constructed in 1974 to a depth of 89 feet. Well No. 6-2 was constructed in 1990 to a depth of 106 feet. Well No. 6-3 was constructed in 2003 to a depth of 87 feet as a supplemental to Well No. 6-1. Well No. 6-4 was constructed in 2011 to a depth of approximately 75 feet. Well No. 6-4 is supplemental well to Well No. 6-2.

Lambert Wells

Lambert Wells No. 3-1 and 3-2 are gravel packed wells located south of the Home Farm site off North Quinsigamond Avenue. Well No. 3-1 was constructed to a depth of approximately 51 feet. Well No. 3-2 was constructed to a depth of approximately 57 feet. The existing well screen at Lambert Well No. 3-1 has failed. A replacement well is currently being designed and constructed.

Sewall Well No. 4

Sewall Well No. 4 is located north of the Home Farm site and is adjacent to an active gravel mining operation. It is a 42-inch diameter gravel packed well approximately 42 feet in depth.

Home Farm Water Treatment Plant

The Home Farm Water Treatment Plant (WTP) was constructed in the early 1990's with a design capacity of approximately 6.0 mgd for VOC removal using air strippers. The air stripping towers have been replaced since the WTP was constructed. The first was replaced in 2004 with the second replaced in 2006. Based on discussions with the manufacturers, the total maximum capacity of the towers is now 7.2 mgd. The discharge pipe is the limiting factor for the tower capacity. Water from the Home Farm Wells and the Lambert Wells is pumped through the air strippers. The Town has realized cost savings by pumping water from the Lambert supply through the air strippers, even though no VOCs have been detected at this site. The air strippers effectively remove a percentage of the carbon dioxide in the water, thereby increasing the pH and reducing the costs associated with the addition of potassium hydroxide for pH adjustment.

Prior to its entry through the air strippers, a sequestering agent is added to the supply for the sequestering of iron and manganese. Additional chemical treatment is added to the water in the clearwell. Potassium hydroxide is added for further pH adjustment. The pH of the water in the clearwell is increased to approximately 8 to 8.5. Chlorine gas is added for disinfection and hydrofluosilicic acid is used for fluoride treatment.

A 12-inch transmission main conveys water from Sewall Well No. 4 to the Home Farm WTP. The Sewall transmission main is connected to the finished water transmission main outside of the WTP. Treated water from the clearwell is pumped into the distribution system through a 16-inch diameter transmission main. The water from the clearwell is mixed with raw water from the Sewall supply, which lowers the pH of the water to approximately 7.2 to 7.5 prior to entry into the distribution system.

The WTP has four high lift pumps used to pump water from the clearwell into the Town's distribution system. Pumps P1 and P3 are 200 horsepower (hp) and pumps P2 and P4 are 125 hp. The small and large pumps operating together can pump approximately 2.8 mgd. However, the number of pumps that are operated is dependent on the current demands in the distribution system. When all four pumps are operated together, the pressure at the WTP increases to approximately 130 to 140 pounds per square inch (psi). There is a 450 kW generator at the WTP for emergencies sized to run the WTP, one of the Home Farm Wells, one 125 hp pump, and one 200 hp pump.

Water Storage Facilities

The Town currently operates three water storage facilities in the LSA, two water storage facilities in the HSA, and one water storage facility in the RHSA. Information about the water storage facilities is summarized in Table No. 2-2.

Table No. 2-2
Water Storage Facility Summary

Name	Service Area	Overflow Elevation (ft)	Capacity (MG)
Browning Street Tank	LSA	600	1.0
Oak Street Tank	LSA	598	0.45
Hillside Drive Tank	LSA	596	1.0
Masonic Hill Tank No. 3	HSA	800	1.25
Masonic Hill Tank No. 4	HSA	800	1.0
Temple Hill Tank	RHSA	680	1.25

Booster Pump Stations

The West Main Street Booster Pump Station is located off West Main Street. This station was originally constructed in 1954 and updated in 1997. The station is equipped with two pumps rated at approximately 750 gallons per minute (gpm) at 277 feet of total dynamic head (TDH). This pump station pumps water from the LSA to the HSA. There is a generator located at this station for emergency power and is sized to operate one of the 750 gpm pumps.

The Gulf Street Booster Pump Station is located in the northern portion of the LSA near the Browning Street Tank. Constructed in 1970, this station has two Peerless pumps, each with a capacity of 800 gpm at 225 feet of TDH. This pump stations pumps water from the LSA to the HSA. A generator was installed at this station in March 2011 for emergency power and is sized to operate one of the 800 gpm pumps.

The Oak Street Booster Pump Station is located on Oak Street at Route 9. Constructed in 2004, this station has three pumps, each with a capacity of 1,200 gpm at 135 feet of TDH. This pump station pumps water from the LSA to the RHSA. A generator is located at this station for emergency power and is sized to operate two of the 1,200 gpm pumps.

Emergency Interconnections

The Town of Shrewsbury has two emergency interconnections with the City of Worcester, on Hartford Turnpike (Route 20) and on West Main Street. The West Main Street interconnection requires a temporary connection from hydrant to hydrant. The Hartford Turnpike interconnection is a metered connection. Due to the HGL in the City of Worcester, Shrewsbury can receive water from Worcester in an emergency, but Worcester cannot receive water from Shrewsbury. In addition, there is a 12-inch transmission main along Hartford Turnpike that once supplied water from Worcester to the Grafton State Hospital.

Final Report

Alternate Water Supply Study

SWMI Grant# BRP-2014-06

June 30, 2015

Produced by:
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1.0 INTRODUCTION

The Town of Shrewsbury has a long history of water and wastewater planning to allow for wise stewardship of the Town's natural and financial resources. Thus, current efforts under the changing state requirements dictated by the Water Management Act have led to a variety of actions over the last 5-7 years. These include early involvement under the SWMI process as a pilot community, on-going capital improvement planning, extensive investigations into local and regional water supplies, pilot testing to determine treatment options for existing sources and the current alternatives analysis under this SWMI Grant. This alternatives evaluation was conducted under BRP 2014-06 Sustainable Water Management Initiative Grant issued by Massachusetts Department of Environmental Protection (Contract CT EQE 5014 TWNSHERESBURYSWMI1502).

The original scope of services included the following key evaluation tasks.

1. Data Collection and Review
2. Evaluate Alternatives (6)
3. Alternatives Ranking
4. Detailed Cost Analysis and Implementation Plan

Following the initial data collection, meetings with Shrewsbury, Northborough, Worcester and the MWRA, it became clear that more than the originally conceived 6 alternatives which had never been considered included the potential for raw or untreated water sources from the MWRA. These alternatives are described in later chapters but generally include accessing the MWRA system through the raw water aqueduct or at the Wachusett Reservoir and utilizing "raw" water in a variety of ways. These alternatives included potential surface water treatment plants in Shrewsbury or Northborough or the use of untreated water as a recharge source to the Quinsigamond Aquifer.

1.1 History

Shrewsbury's first registered water withdrawals resulted in a total volume of 2.64 MGD. Subsequent permitting efforts allowed the addition of Home Farm Well #6.2 and the transfer of previously allocated Concord River Basin withdrawals to the Blackstone River Basin. This effort resulted in a permit issued to the town in September 2005. A history appeals and discussions (see WMA Permit, Appendix A) has led to a complex set of requirements for Shrewsbury. The current modified permit (July 2, 2015) and a settlement agreement (June 17, 2015) for permit #9P4-2-12-271.01 indicate the following.

Shrewsbury has a maximum daily pumping volume from all of its sources of 7.0 MG. These volumes are shown in Table 1-1 on the next page.

Table 1-1: Maximum Daily Withdrawal Rates

Source Name	PWS Source Code ID	Maximum Daily Rate (MGD)
Sewell #4	2271000-02G	1.14
Lamberts Sand Pit Well 3.1	2271000-04G	**
Lamberts Sand Pit Well 3.2	2271000-05G	0.58
Lamberts Sand Pit Well 3.3	2271000-11G	0.75**
Home Farm Well 6.1	2271000-07G	4.32*
Home Farm Well 6.2	2271000-08G	3.02*
Home Farm Well 6.3	2271000-09G	*
Home Farm Well 6.4	2271000-10G	*

Because of an Interbasin Transfer Act permit (issued by the Water Resource Commission) allowing the transfer of Wastewater to the Concord River Basin, the Home Farm wells are restricted to 5.4 MGD. These maximum day volumes represent short-term or daily maximums. Annual average withdrawal volumes are significantly lower. Annual average withdrawal volumes are based on a calculated safe yield for a basin. A "baseline" demand for the municipal system, and a projected demand are generally set by population projections and a water needs forecast developed by the Department of Conservation and Recreation.

Under the Water Management program safe yield for each of the 28 major river basins must be determined and can impact the amount allocated to any given utility or water supplier. For the Blackstone River Valley DEP's Interim Safe Yield is 41.76 MGD with all but .44 MGD allocated to existing users. This allocation has been incorporated into Shrewsbury authorized withdrawal volumes.

The baseline volume set for Shrewsbury is 3.91 MGD (1427.15 MGY). The current permit reflects this baseline volume with an additional allocation of up to .44 MGD – the remaining safe yield available within the basin. The permit volumes are shown in Table 1-2 below. Permit volumes for permit timeframes beyond 2017 have not yet been assigned.

Table 1-2: Maximum Authorized Annual Withdrawal Volumes

5-Year Periods		Total Raw Water Withdrawal Volumes			
		Permit		Permit + Registration	
		Daily Average (MGD)	Total Annual (MGY)	Daily Average (MGD)	Total Annual (MGY)
Period One*	3/1/2009 to 1/21/2014	1.27	463.6	3.91	1427.2
	1/21/2014 to 2/28/2017	1.53 (1.71)	558.45 (624.2)	4.17 (4.35)	1522.05 (1587.8)

The projected demands for Shrewsbury remain over the 3.91 MGD baseline value. However, variations between the 2000 and 2010 census data have resulted in a slower population growth and therefore a lower anticipated demand than originally projected to be 4.176 MGD by 2018). Demand projections are generally allowed a 5% buffer placing the theoretical future demand at 4.38 MGD. Because of the .44 MGD basin yield limitation, the authorized volume is capped at 4.35 (3.91 + .44).

In addition to multiple requirements (including mitigation) under the current permit, Shrewsbury faces potential future limitations to their water supply sources. Development of additional sources of supply, permitting, design and construction will take years of careful planning and a balance of environmental impacts with costs and potential mitigation. Many options exist both within Shrewsbury and external to the town boundaries, However, short-term solutions may not be effective if large scale long-term solutions provide more sustainable options.

1.2 System Components

The Shrewsbury system historically relied predominantly on 7 municipal supply wells. These wells located in a valley aquifer north of Lake Quinsigamond exist near the upper reaches of the Blackstone River Valley. Current withdrawals are concentrated on the Home Farm Wells. Although the aquifer is highly productive, elevated levels of manganese created the need for pilot testing for future treatment options. The current station at the Home Farm Treatment Plant includes aeration through packed column air stripping towers, chlorination for disinfection and pH adjustment. Post aeration, a liquid linear phosphate is added for manganese sequestration. Fluoridation is also added at this station. The distribution system consists of three pressure zones and is discussed in greater detail in Section 3.0.

1.3 Study Goals

The evaluation of alternate sources of supply is recognized as a component or piece of the potential long-term solutions for Shrewsbury. Changing regulatory issues and approaches have led to a concern regarding the sole reliance on the existing aquifer and the gravel pack wells currently in use. However, additional withdrawals within Shrewsbury and outside of the Blackstone basin need to be evaluated within the context of current Water Management Act requirements. Sources outside of or external to Shrewsbury also have regulatory constraints, cost implications, and long-term management considerations. The alternatives for the development of alternate supply sources within town boundaries (internal) are discussed in Section 2.0. External alternatives are discussed in Section 3.0. A comparative analysis is presented in Section 4.0 with conceptual costs provided in Section 5.0. Conclusions are provided in Section 6.0.

2.0 INTERNAL ALTERNATIVES

Internal alternatives for sources of supply include the viability of developing additional groundwater supplies within the town boundaries of Shrewsbury. Additional surface water resources were previously discarded due to the lack of protected watersheds, limited supporting watershed areas and the cost for treatment. This planning level analysis was conducted with the use of Geographic Information Systems (GIS) and data layers compiled by the Massachusetts Office of Geographic Information (MassGIS), the US Geological Survey (USGS), and Weston & Sampson. The purpose of the analysis is to identify areas that potentially meet new source approval siting requirements for ground water supply development. Using GIS, potential future areas for supply wells were identified by cutting away areas that would likely not be available for new well development under current policy, such as land within 400 feet of developed areas and federally or state owned open space or land within 100 feet of wetlands.

The mapping analysis utilized the following datasets available from MassGIS:

- Tax Map Data
- Town Boundaries
- Basin Delineations (HUC-8, HUC-10, HUC-12)
- Public Water Supplies
- Wellhead Protection Areas (Zone IIs, IWPA's)
- MassDOT Roads
- Hydrography (rivers, streams, lakes, ponds, wetlands)
- MassDEP wetlands
- SWMI Groundwater and Biological Categories, Coldwater Fishery Resources
- 1:24,000 Surficial Geology Mapping
- Bedrock Lithology
- Aquifer Mapping
- Protected and Recreational Open Space
- MassDEP Tier Classified Chapter 21E Sites

In addition, the mapping analysis made use of digitized aquifer transmissivity data from the following USGS publications:

- Water Resources of the Assabet River Basin, Central Massachusetts, 1969, Hydrologic Investigations Atlas HA-312
- Water Resources of the Blackstone River BASIN, Massachusetts, 1983, Hydrologic Investigations Atlas HA-682
- Massachusetts Bedrock Geologic Map, USGS Open-File Report 2006-1272, Preliminary Integrated Geologic Map Databases for the United States

2.1 Methodology

The aforementioned datasets were used to create a series of maps designed to a) identify areas in town that are permittable through the new source approval process and; b) are overlying favorable aquifer materials or; c) may be overlying mapped bedrock fracture systems.

The first step was to identify the land areas that are permittable through the new source approval process. This was accomplished by subtracting lands within town boundaries with restricted land uses and land covers. The first restriction removed developed land uses in addition to land uses, such as solid waste facilities, and Tier 1A and Tier 1B - 21 E Sites, with a 400 foot buffer. Additional restrictions removed included wetlands and a 100-foot buffer zone around the DEP Wetlands layer, to comply with the DEP conservancy wetlands for Shrewsbury.

The restrictions include:

- Developed land uses
  - Solid Waste Facilities w/ 400 ft. buffer
  - Tier 1A and Tier 1B 21E Sites w/ 400 ft. buffer
- Wetlands w/ 100 ft. buffer
- Federally-owned or permanently protected state- or privately-owned open space w/ 400 ft. buffer
- Roads w/ 400 ft. buffer

These areas were cumulatively removed over the total area of the municipality. The remaining 159 areas are displayed as potential new public water supply well areas (Figure 2-1). This preliminary screening or analysis includes restrictions based solely on land use, without regard to the locations of aquifers, bedrock fractures, or certain sensitive environmental areas. The result of this analysis reveals 159 areas that could potentially be developed as groundwater supply wells. Additional geologic / hydrogeologic evaluation is discussed below.

2.2 Potential Surficial Aquifer Well Sites

Using the permittable areas described in the previous section, an overlay map was created to understand if any of the sites delineated were coincident with mapped surficial aquifers within town boundaries. Having looked at the MassGIS aquifer datalayer in comparison to the 1:24,000 surficial geologic mapping compilation, it was noticed that coarse sand and gravel stratified drift deposits mapped in the SuAsCo basin were not delineated on the MassGIS aquifer datalayer and therefore limited the viable sites in that basin. As such, the USGS Hydrologic Investigations Atlas's were consulted to confirm that transmissive aquifer material was delineated within town boundaries in the SuAsCo basin. The Hydrologic Atlases were subsequently geo-referenced and digitized in order to supplement the MassGIS aquifer datalayer.

After this was completed, Figure 2-2 was produced to identify thirty-six (36) areas; twenty three (23) of which are located in the Blackstone basin and thirteen (13) in the SuAsCo basin. These areas represent the permittable areas overlying mapped sand and gravel aquifers within the Town. Given the Water Management Act permit limitations for the Town of Shrewsbury, a specific focus on the thirteen areas in the SuAsCo Watershed was emphasized for this report. The thirteen areas are shown on Figure 2-2, with the Site ID numbers 1 – 13 used to distinguish each site. In order to understand if any of the sites are viable potential groundwater withdrawal sites, site specific studies would be required, however the list can be prioritized to determine the most favorable from the standpoint of potential recharge to a well in these locations and from a water management perspective. Table 2-1 below lists each of the thirteen sites identified in the SuAsCo basin along with their respective upgradient drainage basin areas, areas of stratified

drift, and a calculated potential recharge value in million gallons per day (MGD). Additionally, the Subbasin ID was used with the Water Management Act permitting tool to determine the estimated August depletion condition and groundwater category (GWC) to understand if the basin that the Site is located in has any additional withdrawal volume before backsliding (declining in GWC rating towards a less favorable score).

Table 2-1: SuAsCo Surficial Deposit Sites

Site ID	Drainage Basin (mi^2)	Stratified Drift Area (mi^2)	Potential Recharge (MGD)	Subbasin ID	SWMI GWC	Volume to Backslide 1 GWC (MGD)	Volume to Backslide 2 GWC's (MGD)	CFR
11	1.71	0.68	0.82	12017	2	0.01	0.0146	YES
10	1.64	0.65	0.78	12017	2	0.01	0.0146	YES
9	1.6	0.61	0.73	12017	2	0.01	0.0146	YES
2	2.17	0.53	0.64	12037	4	0.209	NA	YES
8	1.23	0.39	0.47	12017	2	0.01	0.0146	YES
7	0.88	0.23	0.28	12017	2	0.01	0.0146	YES
6	0.87	0.22	0.26	12017	2	0.01	0.0146	YES
12	0.58	0.12	0.14	12017	2	0.01	0.0146	YES
13	0.58	0.12	0.14	12017	2	0.01	0.0146	YES
3	0.15	0.0945	0.11	12017	2	0.01	0.0146	YES
4	0.15	0.0945	0.11	12017	2	0.01	0.0146	YES
5	0.36	0.0202	0.02	12017	2	0.01	0.0146	YES
1	0.0479	0.0202	0.02	12037	4	0.209	NA	YES

As shown by Table 2-1 above, the most favorable Sites are located in a GWC 2 basin, however only 0.01 MGD (10,000 GPD) is available in the basin before it backslides to a GWC 3. Additionally, only 0.0246 MGD (24,600 GPD) total is available before the basin would backslide to a GWC 4. As a result, a majority of any large groundwater withdrawal (>100,000 GPD) would need to be mitigated with offsetting recharge flows under the new Water Management Act regulations in the two subbasins identified herein (12017, 12037). If backsliding was acceptable and mitigatable, the volume 'allowable' from the two basins collectively (0.2246 MGD) is not a significant volume and may not satisfy future deficits for Shrewsbury. These groundwater withdrawal sites would have to be supplemented with additional sources in other basins to meet system needs.

2.3 Potential Bedrock Aquifer Well Sites

Using the 159 permittable areas described in Section 2.1, an overlay map was also created to understand if any of the Sites delineated were coincident with mapped bedrock contacts or fault systems. Characterizing and estimating the recharge and ultimately the potential yield of a bedrock well using regional bedrock data would not be a valid method to rank the favorability of one site over another. A town-wide fracture trace analysis, followed by surface geophysics and

site specific test well drilling program would be required to accurately identify and subsequently quantify the potential safe yield from these sites.

A look at the intersection of each site within the 59 sites identified in the SuAsCo basin that contain a geologic formation contact or brittle fault structure was used as a first pass to prioritize the sites. Eleven sites (Figure 2-3) were ultimately identified that intersected a formation contact or fault zone in the SuAsCo basin. Information such as bedrock type and number of contacts or faults in each site area was used to develop a geologic feature rank for each site. Additional factors such as land ownership by the Town further assisted in ranking each site. Two of the sites (Sites 7 and 11) are municipally owned. The results of this ranking are provided below in Table 2-2.

Table 2-2: SuAsCo Bedrock Sites

Site ID	Geo-Feature Rank	Municipal Owned	Subbasin	SWMI GWC	Volume to Backslide 1 GWC (MGD)	Volume to Backslide 2 GWC (MGD)	CFR
8	1	NO	12017	2	0.01	0.0146	YES
1	2	NO	12020 / 23030	5	0 / 0	0 / 0	YES / NO
2	2	NO	12018 / 12020	2 / 5	0.015 / 0	0.07 / 0	NO / YES
3	2	NO	12020	5	0	0	YES
5	2	NO	12017	2	0.01	0.0146	YES
6	2	NO	12018 / 12020	2 / 5	0.015 / 0	0.07 / 0	NO / YES
7	2	YES	12017	2	0.01	0.0146	YES
9	2	NO	12037	4	0.209	0	YES
10	2	NO	12037	4	0.209	0	YES
11	2	YES	12037	4	0.209	0	YES
4	3	NO	12018	2	0.015	0.07	NO

Note: Some sites identified were located in two subbasins, therefore the GWC, associated backslide volumes, and CFR information is provided for both subbasins.

Finally, a statistical approach was used by taking advantage of existing data in the DEP SearchWell database. The database was used to parse out bedrock well yields queried from a list of 219 domestic and irrigation bedrock well records in the Town of Shrewsbury. The query resulted in an average well yield of 18.61 gpm, with a range from 0.25 to 125 gpm. From this data, a probability of success at any particulate site shown on Figure 2-3 for the 11 sites identified in the SuAsCo basin was factored into the costs associated with investigating a favorable bedrock location. Given the average yield in the Town of Shrewsbury is on the order of 20 gpm, 14 to 21 bedrock wells may be needed to achieve between 0.4 to 0.6 MGD.

2.4 Summary

Given the need for multiple sources to meet the current deficit, a combination of both surficial groundwater wells and bedrock groundwater wells would be required. Multiple sites, if proven favorable with site specific aquifer testing, would require significant costs for land, infrastructure (wells, distribution system, and chemical addition), permitting, and mitigation prior to successful development. This is true even without factoring in treatment for iron or manganese which is a

common problem throughout the region. Long term operational costs would also be associated with the multiple withdrawal points of this size and the costs to treat a variety of groundwater sources. Due to these complications and costs, the viability of developing additional groundwater supplies within the town boundaries of Shrewsbury ranks very low in the list of alternatives identified in this study.

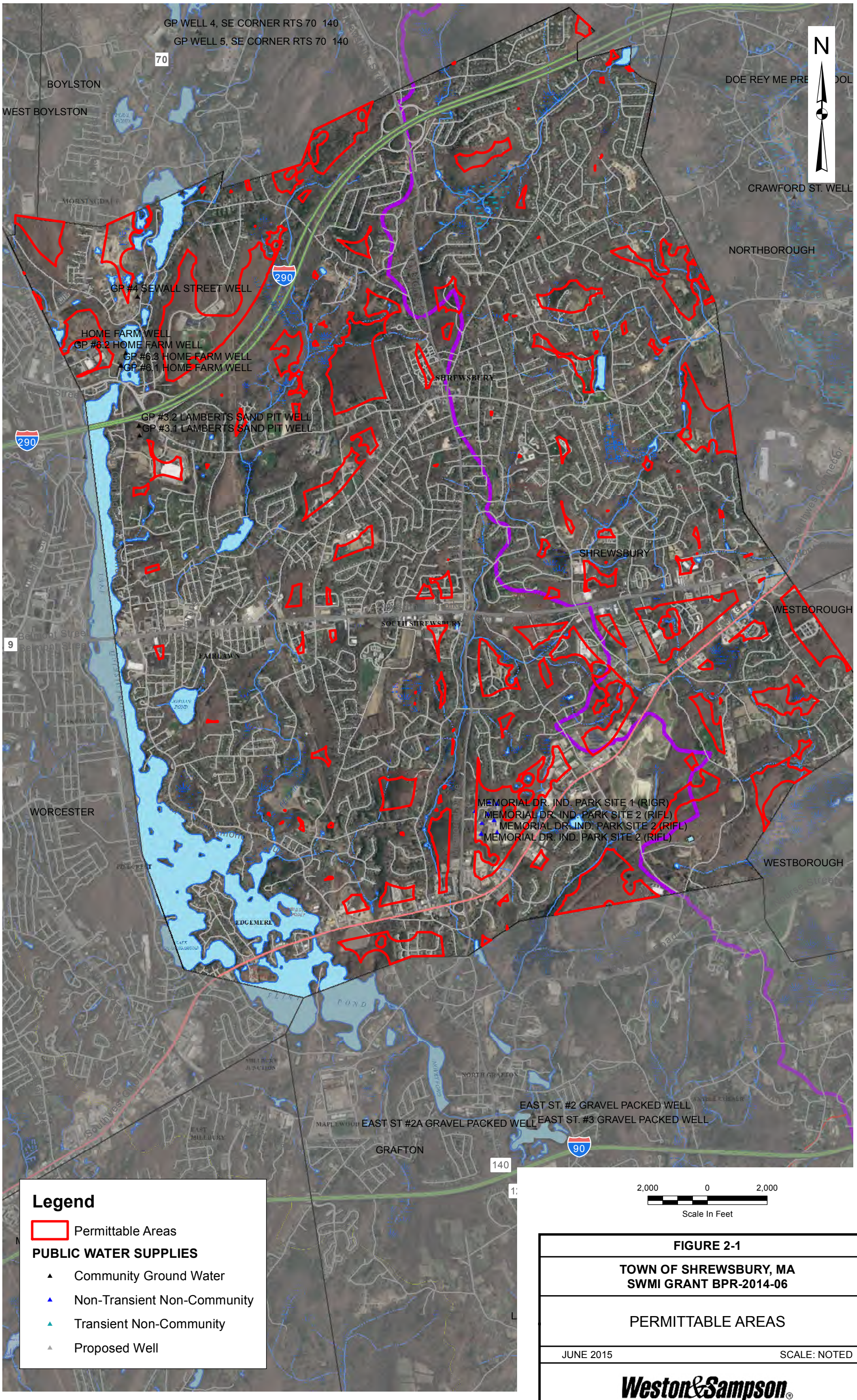


FIGURE 2-1

TOWN OF SHREWSBURY, MA
SWMI GRANT BPR-2014-06

PERMITTABLE AREAS

JUNE 2015 SCALE: NOTED

Weston&Sampson

Path: O:\SWMI Grants\2014\Shrewsbury SWMI grant\GIS\MapFiles\Final Rpt\Figure 1 - Permittable Areas.mxd **User:** mackinnk **Saved:** 6/25/2015 1:24:19 PM **Opened:** 8/13/2015 1:59:22 PM

GP WELL 4, SE CORNER RTS 70 140
GP WELL 5, SE CORNER RTS 70 140
70
23008
12037
BOYLSTON
WEST BOYLSTON
Main Street
Shrewsbury Street
DOE REY ME PRESCHOOL
Church Street
CRAWFORD ST. WELL
NORTHBOROUGH
West Main Street
Clinton Street
GP #4 SEWALL STREET WELL
290
Boylston Street
23007
GP #6.3 HOME FARM WELL
GP #6.1 HOME FARM WELL
23001
12017
SHREWSBURY
Lincoln Street
GP #3.2 LAMBERTS SAND PIT WELL
GP #3.1 LAMBERTS SAND PIT WELL
Main Street
Maple Avenue
North Quinsigamond Avenue
Grafton Street
Southwest Connector
Belmont Street
SHREWSBURY
WESTBOROUGH
Boston Turnpike
SOUTH SHREWSBURY
Boston Turnpike
Belmont Street
Belmont Street
Harrington Avenue
12018
Hartford Turnpike
23023
Lake Street
Memorial Drive
MEMORIAL DR. IND. PARK SITE 1 (RIGR)
MEMORIAL DR. IND. PARK SITE 2 (RIFL)
MEMORIAL DR. IND. PARK SITE 2 (RIFL)
MEMORIAL DR. IND. PARK SITE 2 (RIFL)
WORCESTER
Lake Avenue
South Quinsigamond Avenue
12020
WESTBOROUGH
23002
23030
Nourse Street
Westboro Road
Grafton
23031
EAST ST. #2 GRAVEL PACKED WELL
EAST ST. #3 GRAVEL PACKED WELL
EAST ST #2A GRAVEL PACKED WELL
GRAFTON
90
23037
140
122
23036
23045

Legend

- Permittable Aquifer Areas

Basin Outlines

- 8-digit (Subbasin)
- 10-digit (Watershed)
- 12-digit (Subwatershed)

PUBLIC WATER SUPPLIES

- Community Ground Water
- Non-Transient Non-Community
- Transient Non-Community
- Proposed Well
- Coldwater Fisheries Resources (CFR)

Groundwater Category

- 1. 0 - 3 %
- 2. >3 -10%
- 3. >10 - 25%
- 4. >25 - 55%
- 5. >55%

N

2,000 0 2,000
Scale In Feet

FIGURE 2-2

TOWN OF SHREWSBURY, MA
SWMI GRANT BPR-2014-06

PERMITTABLE AREAS
SURFICIAL GEOLOGY

JUNE 2015 SCALE: NOTED

Weston&Sampson

Path: O:\SWMI Grants\2014\Shrewsbury SWMI grant\GIS\MapFilesFinal Rpt\Figure 2-2 - Surficial Geology Sites.mxd User: mackinnk Saved: 8/13/2015 3:18:30 PM Opened: 8/13/2015 3:18:55 PM

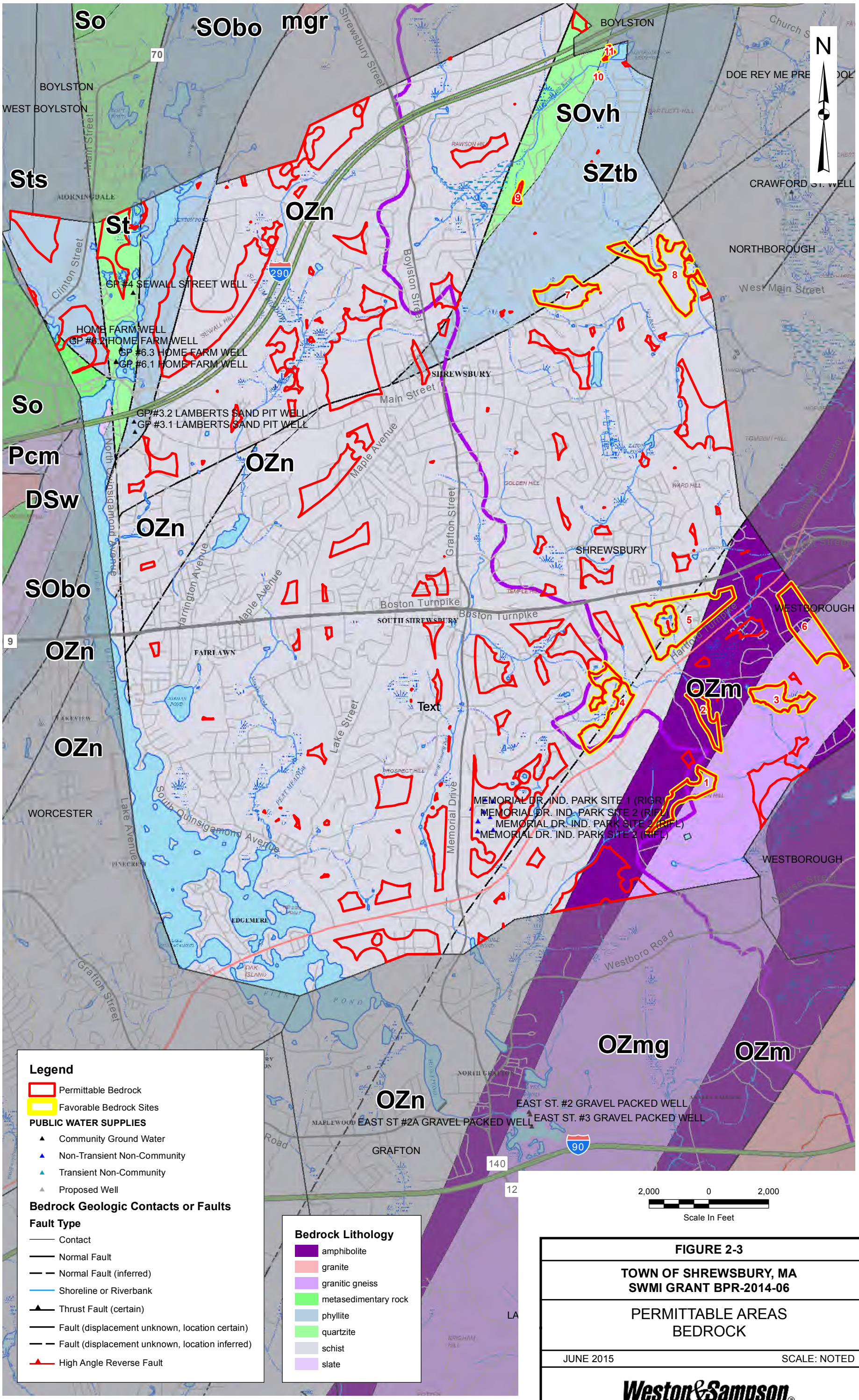


FIGURE 2-3

TOWN OF SHREWSBURY, MA
SWMI GRANT BPR-2014-06

PERMITTABLE AREAS
BEDROCK

JUNE 2015 SCALE: NOTED

Weston&Sampson

Path: O:\SWMI Grants\2014\Shrewsbury SWMI grant\GIS\Mapfiles\Final Rpt\Figure 2-3 - Permittable Bedrock Areas.mxd **User:** mackimk **Saved:** 8/13/2015 3:20:52 PM **Opened:** 8/13/2015 3:21:07 PM

3.0 EXTERNAL ALTERNATIVES

External alternatives require the involvement of other local municipalities, permitting under DEP, and occasionally the involvement of Regional Agencies such as the MWRA (for interconnections) or the WRC (for IBTA issues). These alternatives require importing water to the Shrewsbury Water infrastructure but can vary in terms of the source basin and the final discharge basin. The alternatives can also range in magnitude and implementation period based on the projected need or water demand in Shrewsbury.

The following discussion divides the alternatives into 4 general categories for external water supply source alternatives. These are:

A. Connection to add supply from nearby Towns
B. Connection to or source water from, the MWRA via Northborough
C. Connection to the City of Worcester
D. Viable hybrid alternatives including a combination of internal and external sources

Each option listed above has various engineering, political, regulatory and economic considerations. Conceptual descriptions and planning level discussions of each option are presented below and discussed in a comparative fashion in Section 4.0 of this report.

3.1 Connections to Neighboring Municipalities

Towns surrounding Shrewsbury include those that directly abut Shrewsbury and those that are within the general region. These include Boylston, Grafton, and Northborough. Interconnections with municipal systems in each of these towns are discussed below.

3.1.1 Connection to Grafton

Grafton Water District maintains four gravel packed wells, 68 miles of water mains, two booster stations and three water storage tanks. Interconnects exist with Worcester, Millbury, Upton and Wilkinsonville Water District. Former interconnections with Shrewsbury have been removed from service due to the age and condition of the infrastructure (personal communication – Matt Pearson, Grafton Water District). The other interconnections are designed to provide water to Grafton in the event of emergency. The current lack of excess source capacity and the infrastructure improvements needed to allow the Grafton system to be a reliable long term source of supply for Shrewsbury relegate this as a poor alternative.

3.1.2 Connection to Boylston

Similar to Grafton the Boylston Water District operates a total of five gravel packed wells. Of these wells only the gravel packed well #3 the Scar Hill Bluff well is located in the Nashua River Basin. Although this well has historically provided up to 104 MGY, reliance on the other four wells in the Blackstone Basin is common. The Blackstone Basin wells fall within subbasin 23008 which is listed as having a GWC level of 5 and a Biological Category (BC) level of 5 as well. The Scar Hill Well #3 is located in subbasin 11010 and has a GWC level of 3 and a BC

level of 4. In addition to insufficient capacity, further withdrawals from these wells would require mitigation. Mitigation requirements enacted by Boylston on behalf of Shrewsbury make this alternative effectively impractical. In addition, significant infrastructure upgrades would be required for a viable interconnection and to manage existing system hydraulics.

Mitigation for additional Blackstone River Basin withdrawals are effectively the same as the requirement for Shrewsbury if it were to increase withdrawals north of Lake Quinsigamond.

3.2 Connections through Northborough

Northborough was historically supplied by groundwater sources located within the town boundaries. Recently, Northborough has utilized an interconnection with the MWRA to replace all local sources. The groundwater wells remain as inactive emergency supplies but are not intended to be reactivated due to low yield and poor water quality (elevated iron and manganese). In addition to the proximity of the John J. Carroll Water Treatment Facility, raw water from the Quabbin Reservoir passes through Northborough via an aqueduct. The aqueduct and a potential route for a water distribution system upgrade connecting to the finished water source from the MWRA are shown in Figure 3-1.

The presence of both the raw water supply and the finished water supply from MWRA provide a variety of alternatives. Water supply alternatives relative to Shrewsbury's needs include the following:

1. Interconnection with Shrewsbury allowing MWRA supply to "wheel" through Northborough
2. Dedicated supply line from MWRA (John J. Carroll WTF) to Shrewsbury through Northborough.
3. Raw water supply from MWRA aqueduct to a new water treatment plant located in Northborough or Shrewsbury.
4. Utilize groundwater supplies in Northborough and treat or pump to the water treatment plant in Shrewsbury.

Each of these scenarios is considered in greater detail below.

3.2.1 Connection to MWRA, Wheel Water through Northborough

This concept appears to provide an ample long-term supply. Excess capacity at the John J. Carroll WTF could be utilized to feed all or part of Shrewsbury's current demand and future increases to average day demands. This alternative would require:

a. Entrance into MWRA by Shrewsbury.
b. Improvements to infrastructure including Northborough distribution and any necessary booster systems to meet Shrewsbury hydraulic grade lines.
c. Resolution of water quality concerns due to mixing (if any sources from Shrewsbury are maintained).
d. Inter-municipal agreements covering fees, operation and maintenance, etc.
e. Permitting under the WMA and IBT requirements.

Conceptually, this alternative would require distribution system improvement costs. Upgrades to water mains would likely include increasing water main diameters from about 12-inches to 20-

inches along the major route between John J. Carroll WTF and the Shrewsbury System on Main Street with approximately 29,000 LF of improvements. Design and construction costs could range between 6 and 8 million. Additionally, improvements in the Shrewsbury system could include booster stations and water main upgrades to feed both the high pressure zone and the reduced high pressure zone within Shrewsbury.

In addition to system hydraulic issues, blending MWRA water at a pH of 8-8.5 with Shrewsbury sources would add a level of complexity. Currently MWRA water is blended with existing sources in the communities of Stoughton, Weymouth, Reading and Woburn. Chemical addition for pH reduction is generally sufficient but increases the initial capital costs and longer term operation and maintenance costs. Elimination of Shrewsbury sources and reliance fully on MWRA supply would eliminate the chemical addition but may require additional capital costs for infrastructure redundancy and piping improvements

3.2.2 Direct Connection to MWRA

Within Shrewsbury town boundaries, the reversal of existing hydraulic gradients and system reconfiguration will likely have a significant cost. Further engineering analysis is warranted. Direct connection to finished water from the John J. Carroll WTF is also an option. Construction of a dedicated pipeline through Northborough would be required and significant increases in the pump output at the plant are likely. Approximate distances from such a pipeline, connecting to the Shrewsbury system at Main Street, could be approximately 26,000 LF as shown in Figure 3-2. A more direct route can be designed. Permitting, easement acquisition, and agreements from Northborough place the costs for this close to 9 million dollars. Like the previous option, chemical addition and a booster pump station would likely be needed. Entrance into MWRA and associated water rates would be part of this concept as well. Again, elimination of Shrewsbury sources and reliance on MWRA would eliminate chemical addition but additional infrastructure costs may be required within the Shrewsbury system. A dedicated line also significantly increases the risk level as redundancy is not maintained if the Home Farm wells and treatment system are eliminated from use. Reliance on a single dedicated pipeline is not optimum as breaks, leaks or failures would be costly and difficult to respond to. Long-term maintenance issues outside of Shrewsbury also increase costs. Like the option above, the dedicated line represents one portion of the problem. Again , internal system hydraulics within Shrewsbury would require substantial engineering study and design modifications.

3.2.3 MWRA Raw Water Source, WTP in Northborough or Shrewsbury

Discussions with Northborough and MWRA indicated that this option existed. As the Wachusett-Marlborough Aqueduct and the Wachusett Aqueduct both cross through Northborough, a spur off on or the other aqueduct could carry raw water to a new facility for treatment and subsequent distribution. Locating a plant within Northborough would allow the simplest raw water connection to MWRA. Locating a plant in Shrewsbury would require a longer initial connection from the aqueduct to a possible plant location near Shrewsbury's existing wellfield.

The largest cost for this option would be the construction of a treatment facility. Locations in Northborough would have been suggested close to the center (personal communique Dan Nason). Northborough would benefit from this additional source by having a separate

connection to MWRA and the shared costs for that connection born by Shrewsbury. Presumably costs would be apportioned by demand from each municipality. Shrewsbury would currently require approximately 4.35 MGD average day demand with peak demands closer to 6.0 MGD. Northborough demand is approximately 1.2 MGD. While Northborough is currently an "MWRA community", Shrewsbury would be required to become a member community. Both communities could benefit significantly if MWRA establishes a lower entrance fee for a "raw" or untreated connection along with lower rate structure for raw water from MWRA.

Long-term inter-municipal agreements (IMA) would be required for such a collaborative approach to work. The IMA would need to clearly specify ownership, operational conditions, an equitable fee structure and ongoing administrative governance rules. Generally the complexity and uncertainty in these agreements presents a formidable obstacle to completing such a "marriage".

Permitting requirements for this option would include the IBT issues that MWRA faces, local permitting, MEPA and state drinking water approvals through MADEP.

3.2.4 Utilize groundwater sources in Northborough to augment Shrewsbury supplies

Groundwater sources in Northborough fall within the Assabet River Basin. As Shrewsbury's wastewater discharges through the Marlborough plant to this basin, limited additional withdrawals may be permitted. Current well yield and water quality data suggest treatment will be required for these existing sources. However, the sources reportedly consist of a total available capacity of less than 400,000 gpd (personal communique, Don Bunker, PE, Fay Spofford & Thorndike). Treatment could be accomplished at a central location in Northborough or more likely at a facility near Poor Farm Brook wells in Shrewsbury, A facility in Shrewsbury would allow the inclusion of Shrewsbury's existing wells into a combined plant.

Transmission mains, pumping costs, IMA's and long-term operation and maintenance of sources within Northborough must be considered. Direct transmission would likely require 3-5 miles of 8-12-inch water main. In addition, permitting requirements including potential mitigation for these withdrawals under the new WMA regulations makes this alternative extremely expensive and marginally viable. Compounding this issue is the low total water volume offered by these sources. Anticipated withdrawals of 200-300 GPM would be insufficient to meet Shrewsbury's long-term demand.

3.3 City of Worcester Alternatives

The City of Worcester represents a significant viable partner for the Town of Shrewsbury. As previously described, the city currently has an average day demand of 24-26 MGD. Under its current registered WMA volume, the City can withdraw up to 32MGD from all of its sources.

The variety of alternatives including the City of Worcester is highly varied but can be relegated to the following discussed options.

A. Shaft 3 to Kendall Reservoir - This option includes utilizing a current emergency connection to the MWRA maintained by Worcester. Pumps currently installed in Shaft 3

could be used to transfer raw water to the Kendall Reservoir, treated at the existing WTF and as needed volumes provided to Shrewsbury.

B. Shaft 3 direct distribution to Shrewsbury – Again utilizing Worcester's current emergency pumping station, a dedicated main to Shrewsbury would provide MWRA water to Shrewsbury. Treatment within Shrewsbury is undoubtedly required.

C. Worcester Wells – The city of Worcester has previously tested what is known as the Shrewsbury well site. Development of these wells and possibly other wells in Worcester could provide source water to Shrewsbury.

D. Direct Connection to Worcester's distribution system – A direct connection of treated drinking water is also considered an option. Connections could be undertaken in a variety of locations with an obvious location being along Rte. 20 and/or Lincoln Street.

3.3.1 Shaft 3 to Kendall Reservoir

Although this alternative has been suggested, a closer look indicates serious potential flaws in this option. The shaft 3 pumps require a significant amount of energy to lift water to the hydraulic grade line of the Kendall Reservoir. Treatment capacity is not an apparent issue but the wisdom of pumping water from a contained system into an open air reservoir must be questioned. The additional flow into the reservoir may not be required for the bulk of the year. During low flow periods flow augmentation may be necessary. However, quantifying how much water is needed, how much water is lost to evaporation and a fair payment for such intermittent water use is unduly complex and certainly a potential huge waste of energy and operating costs.

3.3.2 Shaft 3 Direct Distribution to Shrewsbury

Eliminating the surface water reservoir from the previous alternative would require exorbitant transmission costs. Additional treatment costs for a facility in Shrewsbury are also necessary. Although this alternative theoretically provides an abundant source, other alternatives are simpler, more efficient, and far less costly.

3.3.3 Worcester Wells

Historical efforts to develop a well site for the City of Worcester were abandoned due to water quality issues (potential contamination threats). The wells exist within the same valley train deposits as the existing Shrewsbury system, although they are significantly deeper. Reactivation of these wells face similar mitigation requirements and water quality threats as the existing Shrewsbury sources

3.3.4 Direct Connection to Worcester

Full reliance on the sale of water from Worcester to Shrewsbury has regulatory limitations if mitigation for this use/withdrawal is required. Unless the permitting issues under the WMA and

the Interbasin Transfer Act can be resolved, the transfer of 4-6 MGD will not be politically or economically viable. From an infrastructure perspective (see Figure 3-3) the hydraulic grade lines between the Worcester system and Shrewsbury's low pressure zone are fairly similar with Worcester being roughly 30-40 feet higher. Thus, flow into Shrewsbury could be realized at the Rte. 20 interconnection. As this area is also a projected growth area, having an additional supply or connection to Worcester in this area is ideal. An alternate connection is highly recommended with the most viable option being a water main extension along Lincoln St. West to Main St. in Shrewsbury. This short pipeline improvement and metered/valved connection would help with balanced flow. Piping upgrades to Rte. 20 will need to be evaluated. Water quality similarities and comparable rate structures do not represent an impediment to this alternative.

3.4 Hybrid Alternatives

Previous sections have discussed singular solutions to long-term demand increases or to Shrewsbury's entire demand. A number of hybrid solutions or combination solutions exist. These alternatives are discussed in general below with one hybrid alternative discussed in greater detail, Aquifer Storage and Recharge. The variety of hybrid solutions includes:

A. Purchase from Worcester. Utilize current Shrewsbury wells with a new WTF.

B. Development of Worcester ground water supply wells, ground water treatment plant, aquifer storage and recharge from Wachusett.

3.4.1 Maintain Shrewsbury Wells, WTF, Augment Wells with Supply from Worcester

Ongoing pilot testing must confirm that treatment for manganese is achievable with an economically viable method. Indications are that a WTF can be constructed for 12-14 million dollars. While this does not provide additional capacity without mitigation within the Blackstone River Basin, increased system demand could be obtained from the City of Worcester. Again, withdrawals from the City of Worcester must be achieved without significant mitigation costs or changes to the City's current registration or allowances.

3.4.2 Aquifer Storage and Recharge (ASR)

This hybrid alternative would consist of the following items:

- Possible actuation of ground water supplies / aquifer identified between 1992 and 1996 by City of Worcester.
- Retrofit of Worcester intake into Wachusett with agreements needed from the City of Worcester and MWRA.
- Construction of a pipeline and ASR system along Poor Farm Brook area.

The aquifer conditions north of Lake Quinsigamond identified by previous studies undertaken by the City of Worcester indicate the potential for significant withdrawals. These withdrawals could potentially be mitigated with recharge from surface waters. While the obvious surface water

appears to be the nearby lake Quinsigamond, there are watershed protection and water quality issues surrounding this surface water feature. Instead, the Wachusett reservoir represents a substantial water asset within a reasonable distance. The intake structure would require assessment, designed improvements and environmental permitting efforts. In addition, transmission of raw water would require the construction of a pipe line to a satisfactory discharge location (see Figure 3-4). Discharge systems would require a detailed hydrogeologic evaluation prior to selection of a final design. However, aquifer recharge in this area would require one or more of the following methods:

a. Rapid Infiltration Basins
b. Injection Wells
c. Subsurface infiltration trenches or manufactured infiltrators.

The type of system, design requirements and permitting through Massachusetts DEP would need to be taken in a step by step fashion. Currently, although several working sessions have been held with DEP, interested consultants and stakeholders have not developed a methodology for approving ASR systems, Subsurface discharges are currently regulated under the Underground Injection Control (UIC) program or the Ground Water Discharge Permit guidelines assuming the surface water source is sufficiently disinfected and generally free of sediment and turbidity, the ability to recharge subsurface deposits is dependent on soil conductivity and the hydraulic grades that any given system can develop. Each type of system is discussed briefly below.

3.4.2.a Rapid Infiltration Basins (RIBS)

Although more commonly used for the discharge of treated wastewater or in residuals drying beds for water treatment plants, Rapid Infiltration Basins represent a method to recharge water to subsurface deposits. RIBS generally consist of a larger bermed area with an internal sand bed. The sand bed is generally constructed near or at existing grade. RIB construction includes the removal of topsoil or loam and shallow impermeable deposits allowing a direct hydraulic connection between the artificial sand bed and lower permeable geologic deposits (e.g. sand and gravel). Internally, lateral dispersion piping or conduits can be constructed to allow even distribution of discharge water over the entire bed. RIB infiltration rates are generally considered to be 10 gpd/sqft although infiltration of clean, low turbidity waters can often maintain rates greater than 10 gpd/sqft. Infiltration rates are most often restricted by the subsurface deposits, depth to saturation and depth of overall saturated permeable deposits below and surrounding the RIBS. Most RIBS are sighted and designed following a mounding analysis to determine the assimilative capacity of the surrounding aquifer and the local watershed.

RIBS located upgradient of the existing Shrewsbury well fields would benefit from the available permeable deposits and the extensive and deep aquifer deposits. Environmental impacts and design issues related to potential break out would require a site specific investigation under the state's Ground Water Discharge Permit program. Groundwater flow modeling would be a likely requirement for large volumes of flow.

In general RIBS require a significant land area if large flow volumes are to be realized. For planning purposes, approximately 1- 2 acres of land would be required for the construction of a RIB system.

3.4.2.b Injection Wells

ASR wells are more common in the coastal plain deposits of Southern NJ and along the Mid-Atlantic states. Many ASR projects were identified to eliminate saltwater intrusion where over withdrawals from fresh water aquifers were occurring. Within New England injection wells have been used in Westport, MA for treated wastewater although these wells were not specifically designed to mitigate water withdrawals or create additional storage of water resources in subsurface deposits.

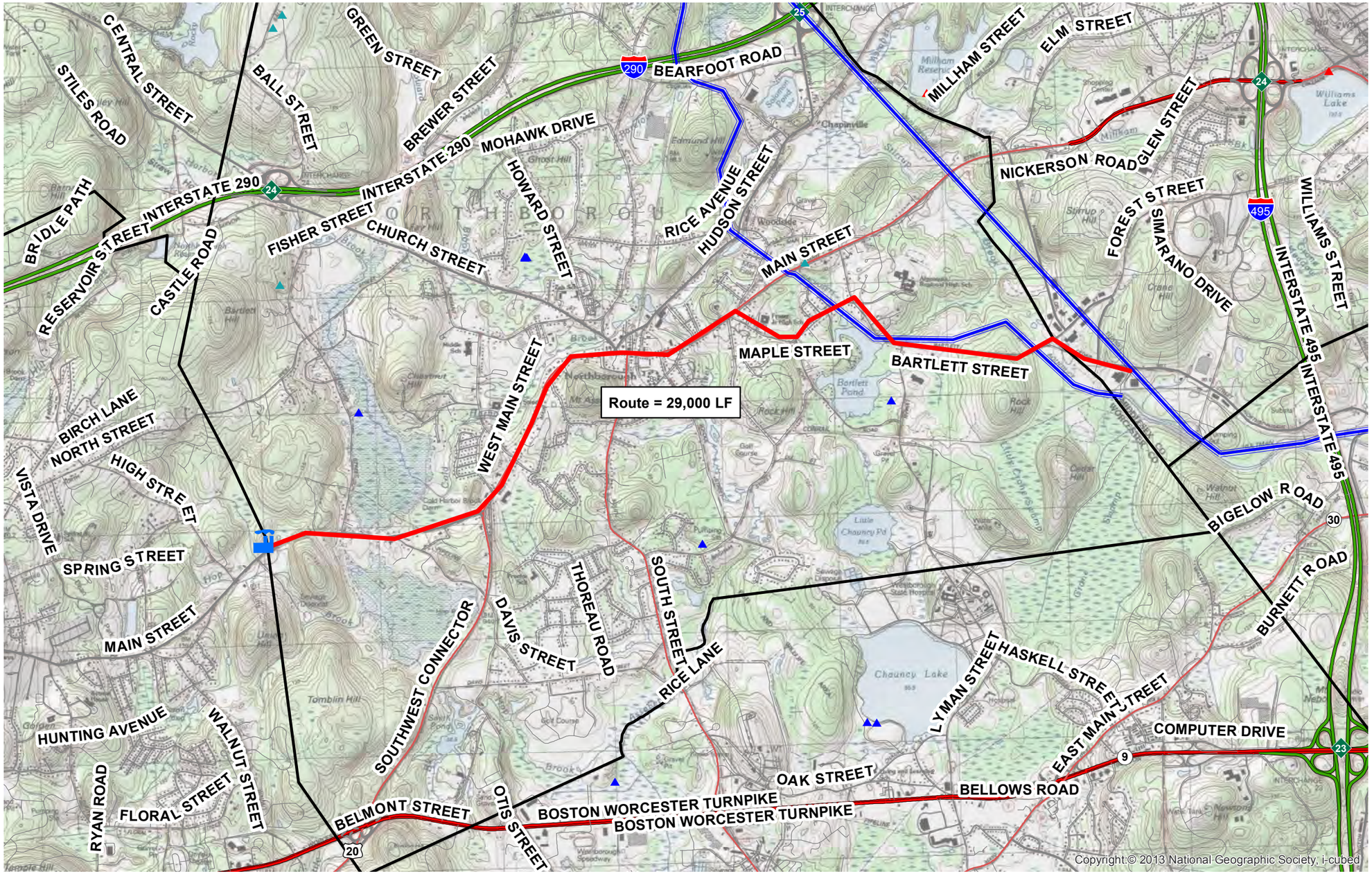
In general, injection wells can be limited by the aquifer characteristics and the resulting well hydraulics. Again, depth to the water table from ground surface can limit the amount of hydraulic head available for injection. Similarly size of well and construction characteristics are important for long-term flow characteristics. In general injection wells are constructed like municipal production wells with longer screens and an associated gravel filter peak between the screens and the natural formation. Injection volumes are generally 20-30% of a similarly designed extraction well, often due to local hydraulic conditions. For planning purposes, injection rates of 500-600 gpm within the aquifer deposits north of the current Shrewsbury / Worcester well system would require 5-7 injection wells with an installed price of $80,000-$100,000. Using $700,000 as an estimated well construction cost, additional costs for testing, modeling and permitting could readily add $250,000 to the well cost. Reinjection of surface waters would undoubtedly require treatment to remove sediment and deactivation of bacteria. Although no clear permitting process exists for ASR injection well projects, likely permitting requirements will include a UIC permit and a Groundwater Discharge Permit.

3.4.2.c Infiltration Trenches or Chambers

A commonly used technique for recharging stormwater is the use of infiltration trenches or manufactured infiltration chambers. These systems also used in septic system design or leaching fields can be utilized for groundwater recharge. Varying capacities exist dependent on design however, unitized recharge rates fall between 2 and 5 gpd/sqft of surface area for these subsurface systems. At these rates the overall footprint of a 400-500,000 gpd system could range between 1 to 2 acres of subsurface field size. Construction costs for this range between $10 and $20/sqft creating a planning level cost of $800,000 – $1,600,000 dependent on site conditions and depth of bury.

Water quality concerns would need to be addressed in both the design and permitting efforts. Similar to injection wells disinfection/deactivation and TSS removal is recommended to eliminate fouling. However, subsurface systems tend to be significantly more robust or less susceptible to fouling when compared to injection wells. Open RIB systems remain the least costly or difficult to maintain but concerns for freezing may create periods of shutdown during extremely cold weather.

Permitting requirements would include a comprehensive hydrogeologic evaluation to characterize subsurface mounding under the state's Groundwater Discharge Permit requirements.



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Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

PUBLIC WATER SUPPLIES

- Community Ground Water
- Community Surface Water
- Surface Distribution Site
- Non-Transient Non-Community
- Transient Non-Community
- Proposed Well

MWRA Aquaducts

- Aquaducts
- Pump Station
- Pipeline Route

FIGURE 3-1

Routing from MWRA through Northboro Streets
Shrewsbury, Massachusetts

Weston&Sampson®

Route = 26,000 LF

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Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

PUBLIC WATER SUPPLIES

- Community Ground Water
- Community Surface Water
- Surface Distribution Site
- Non-Transient Non-Community
- Transient Non-Community
- Proposed Well

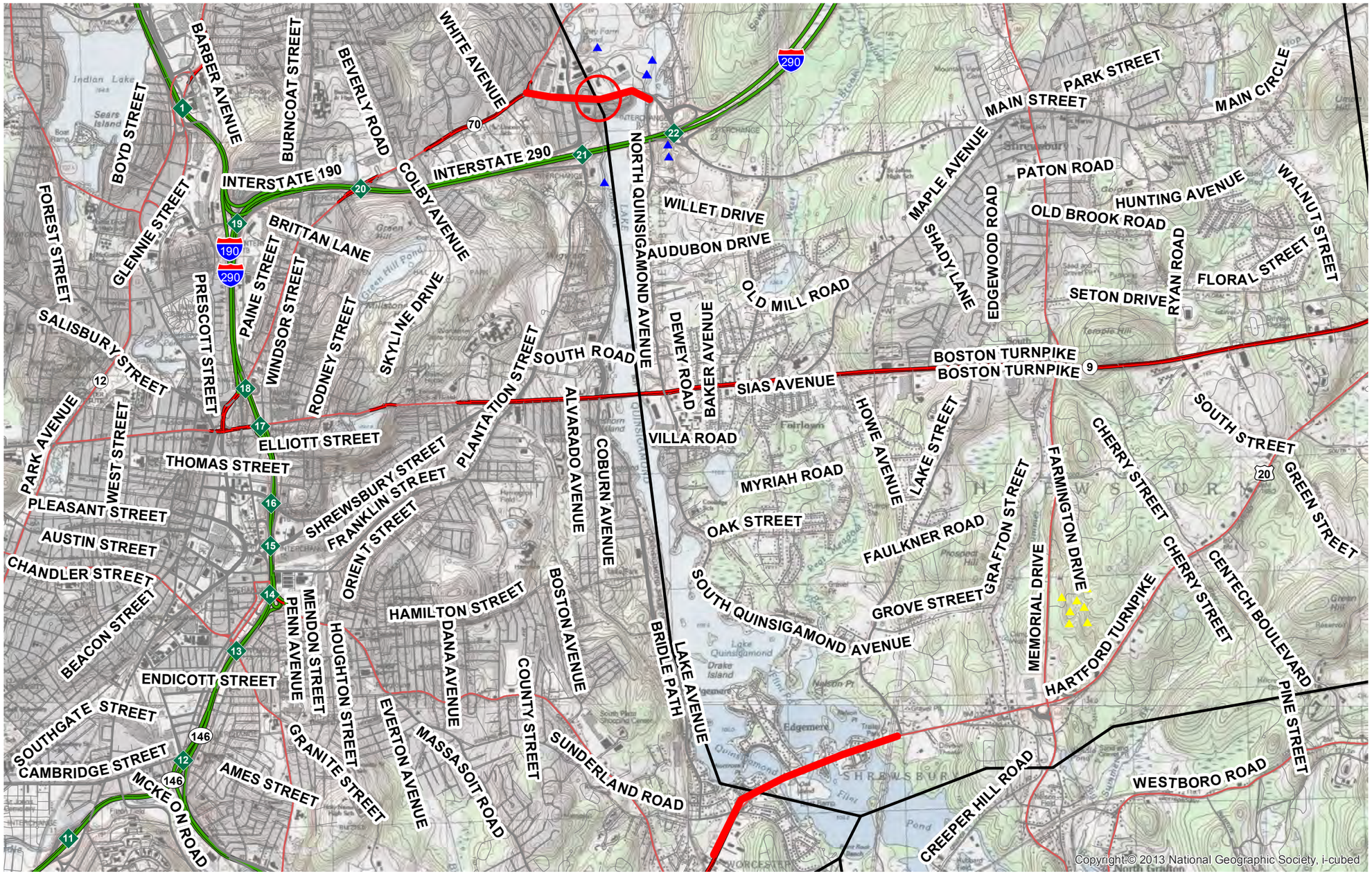
MWRA Aquaducts

- Aquaducts
- Pump Station
- Booster Pumps
- Pipeline Route

FIGURE 3-2

Routing from MWRA
Cross Country
Shrewsbury, Massachusetts

Weston&Sampson®



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Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

PUBLIC WATER SUPPLIES

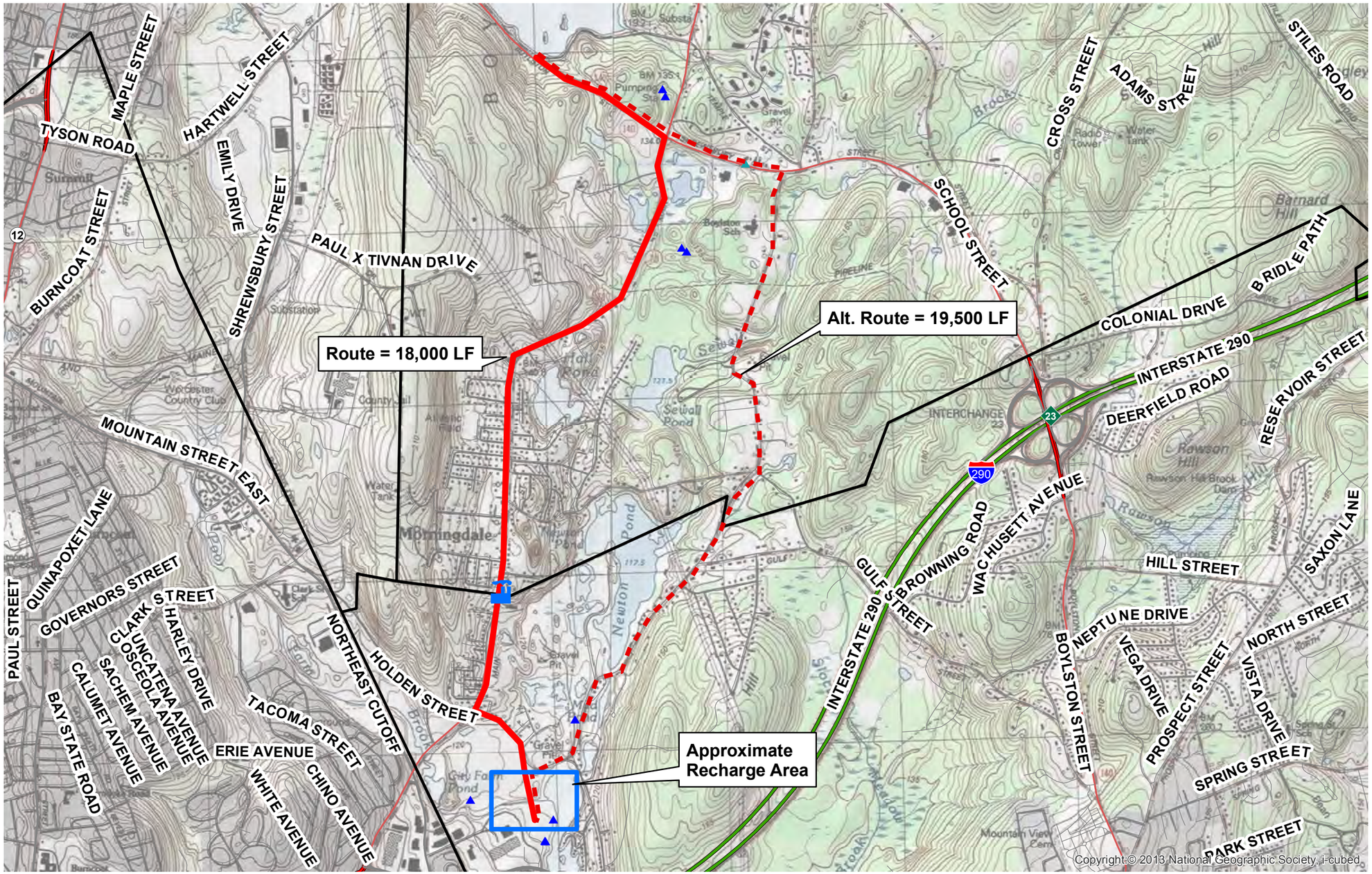
- Community Ground Water
- Community Surface Water
- Surface Distribution Site
- Non-Transient Non-Community
- Transient Non-Community
- Proposed Well
- Pipeline Upgrades
- Alt. Connection Pt.

FIGURE 3-3

Routing through
Worcester
Shrewsbury, Massachusetts

Weston&Sampson®

Path: O:\SWMI Grants\2014\Shrewsbury SWMI grant\GIS\3-4wachusett route.mxd **User:** zerillia **Saved:** 8/14/2015 1:29:07 PM **Opened:** 8/14/2015 1:29:53 PM



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Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

PUBLIC WATER SUPPLIES

- Community Ground Water
- Community Surface Water
- Surface Distribution Site
- Non-Transient Non-Community
- Transient Non-Community
- Proposed Well

MWRA Aquaducts

- Aquaducts
- Pump Station
- Pipeline Route
- Alternate Pipeline Route

FIGURE 3-4

Routing from
Wachusett Intake for Aquifer
Storage and Recharge
Shrewsbury, Massachusetts

Weston&Sampson®

4.0 MATRIX EVALUATION

An evaluation matrix can often provide clarity and objectivity to an alternatives analysis. Alternatives discussed in previous chapters are summarized in Table 4-1 below. Multiple criteria for each source alternative are provided. These include:

- Yield - Potential source of production
- Environmental – Environmental impacts and difficulty in obtaining permits
- Evaluation / Design – Costs and schedule for implementation
- Capital Costs – Total infrastructure costs
- Operational Costs – Increase in variable costs effecting water rates, not including capital funding
- Political – Political acceptance

Each of the factors is defined in greater detail below. All scores were designated to range between values of 1 to 5 with 1 being the least favorable or highest cost and 5 being the most favorable or least costly to implement.

4.1 Yield

The alternative selected must be carefully considered for its overall yield. Yield considerations for Shrewsbury can be divided into short-term, low volume solutions sufficient to meet increases above their current source capacity versus long-term, high volume sources capable of providing a full replacement capacity for the foreseeable future. These sources generally have predicted yields between .010 and .15 MGD. Those alternatives which had an unknown yield or poor capacity were ranked as a 1. Sources that provided full replacement capacity and had redundant production capacities were ranked as a 5. Where source alternatives had sufficient capacity to augment current supplies or mitigate their withdrawal effects these options were scored a median value of 3. These options can generally be considered not full capacity replacements as they may be subject to future political or regulatory hurdles.

4.2 Environmental

Although this can be a broad based category, environmental considerations are broken into three overall areas: potential impacts, difficulty of obtaining permits (including estimates of potential mitigation), and long-term energy increases for the selected alternative. Permitting and mitigation have direct impacts on schedule and overall project costs. Widespread mitigation measures can be costly and difficult to implement. Temporary environmental impacts due to construction were not included in the scoring as these impacts assumed to be handled under current requirements of local and state regulatory agencies (e.g. wetlands crossings, etc.). In general, local development of additional groundwater sources sufficient to meet demand were viewed as requiring extensive mitigation under the changes to the Water Management Act. Bedrock well sources are viewed as having slightly less impact on surface water resources although detailed site specific investigations would be required. MWRA supplies are considered to be of sufficient capacity that the impact of required withdrawal volumes has already been assessed. Where there is a transfer of raw water requiring a new

additional surface water treatment facility, the increased energy for operating and maintaining another WTF is recognized through a lower score. Environmental scorings are intended to show relative rank within the category and are useful as a comparative tool rather than an absolute value.

4.3 Evaluation / Design

Both the length of time and the difficulty of the study/design process generally impact the costs. All alternatives were constrained to available or proven technologies. The treatment of groundwater sources with elevated iron or manganese was assumed to be pressure filtration using catalytic oxidation or an equivalent process. Surface water treatment was assumed to require either conventional methods or membrane filtration. Extensive pipeline development for cross country transmission or distribution piping was ranked less favorably than upgrades to existing piping although further work needs to be accomplished relative to the Northborough options as system hydraulics may be disrupted by assumed upgrades.

4.4 Capital Costs

Capital costs were significantly impacted by alternatives where new treatment facilities are required. Additional groundwater wells and even the ongoing use of existing supplies may require filtration. Multiple smaller plants, if required to treat disperse groundwater supply locations would result in elevated capital costs. Connection to the Worcester system appears to have the lowest capital costs with the assumption that costs for any required mitigation under the WMA is not included. Including mitigation costs if Worcester were used as a full replacement source, would significantly modify the score or rank for this alternative.

4.5 Operational Costs

Distribution of treated water provided by an external system has the least operation costs for Shrewsbury's water department. Water rates for purchased water are assumed to include operational costs for the system where the supply originates. Options where Shrewsbury must construct and operate a new WTF will rank lower due to increased expenses for manpower, chemicals, energy, and maintenance. Multiple treatment facilities and multiple sources generally create operational cost increases over a centrally located facility. Costs are further analyzed in Section 5.0.

4.6 Results

The matrix scoring provides a segregation of primary alternatives from lower tier considerations. These results are shown in Table 4.1

Table 4-1: Alternatives Analysis Matrix Comparison

Alternatives Matrix	Yield	Environmental	Evaluation/ Design	Capital Costs	Operational Costs	Political	Total Score	Rank
In-Town Alternatives								
A. Bedrock Well Supplies	1	2	3	2	4	4	16	**B**
B. Additional Gravel Wells	1	1	2	4	3	1	12	**C**
C. Surface Water Supply	1	1	1	1	3	1	8	**C**
Other Municipal Alternatives								
Northborough								
D. MWRA through Northborough	5	5	3	2	5	2	22	**A**
E. MWRA dedicated line through Northborough	5	5	2	2	5	3	22	**A**
F. Raw Water tap to MWRA, WTF in Northborough	5	5	1	1	1	3	16	**B**
G. Re-establish Northborough Ground Water Supplies		1	2	1	1	1	6	**C**
Boylston								
H. Ground Water Supplies	1	1	4	1	1	1	9	**C**
Grafton / Millbury								
I. Ground Water Supplies	1	1	4	1	1	1	9	**C**
Worcester								
J. Shaft 3 Connection to Kendall Reservoir	5	5	3	2	1	1	17	**B**
K. Shaft 3 direct to Shrewsbury	5	5	1	1	5	1	18	**B**
L. Develop Ground Water wells, sell to Shrewsbury	2	2	2	3	2	1	12	**C**
M. Connect to existing system (no new MWRA use)	3	5	5	5	5	4	27	**A**
Regional / Agency Alternatives								
MWRA								
N. Direct Connection to Aqueduct, WTF in Shrewsbury	5	3	2	2	2	2	16	**B**
O. Wachusett Reservoir Intake WTF in Shrewsbury	5	1	4	1	2	3	16	**B**
Hybrid Alternatives (combination approaches)								
P. Maintain Existing Shrewsbury Wells, WTF, Augment with Worcester Supplies	3	3	4	3	3	4	20	**A**
Q. ASR using Wachusett Reservoir for recharge to Shrewsbury Wells	3	2	3	4	4	4	20	**A**
+20 = A 15-19 = B 0-1 4= C								

A distinct scoring split can be seen for alternatives scoring above 20 total points. These alternatives are relegated to an A class of alternatives. A second tier exists for those alternatives scoring between 15 and 19 with a B classification. Class C alternatives score below 15.

The highest ranking/scoring alternatives, in no assigned order of preference are:

- MWRA connection through Northborough Infrastructure
- MWRA connecting through Northborough with a dedicated line
- Connection to Worcester
- Maintain existing wells and augment with Worcester
- ASR to wells/aquifer located in Shrewsbury

5.0 COSTING ANALYSIS

Cost Comparisons for each of the 5 highest scoring alternatives can provide insight into implementation requirements, cost variables, and even risk associated with each alternative. The following breakdown of conceptual project specifics and associated costs is meant for planning and comparison purposes. Detailed evaluations and extended design efforts are necessary for all options in order to develop any given alternative beyond conceptual stages and to maintain water quality and quantity requirements for Shrewsbury.

The alternatives, their description and a description of the costing assumptions are provided below.

5.1 MWRA Connection via Northborough Infrastructure

The connection to finished water from MWRA's John J. Carroll Treatment Facility would originate at the Marlborough – Northborough town line. Currently a 16-inch water main leaves the plant changing to a 12-inch main within 1000 feet. From here a variety of 10 and 12-inch water mains transmit flow towards a possible connection point with Shrewsbury along Main Street. Upgrades to this pipe would assume a minimum of 20-inch water main would be installed at an estimated cost of 5.8 million dollars. As an interconnection does not exist, metering and a booster station would be required to meet hydraulic pressures of the Shrewsbury system. An estimated booster station cost of $580,000 assumes no land acquisition costs. Miscellaneous distribution upgrades may be necessary in Northborough to maintain hydraulic balance with a budget estimate of $1,000,000 dollars. As Shrewsbury would most likely eliminate use of its own sources (possibly keeping them as back-up supplies) the entrance fees for the MWRA would reflect the 4.35 MGD demand and are estimated at 20.88 Million Dollars ($4.8 Million / 1 MGD).

Permitting and design costs can be estimated together at approximately 15% of capital construction costs based on these budget estimates.

Operating costs for this alternative are not considered as the deactivation of operating Shrewsbury's current sources of supply could be offset by any increases to run, maintain and administer the new system. Similarly, the operation of a booster pump station may be offset by the discontinuance of the well pumps. Infrastructure operation within Shrewsbury should continue in a similar fashion as it is today.

Transferring water through Northborough is generally associated with a "wheeling" fee. Typical costs for wheeling water are 10-20 percent premium to the base rate. MWRA projected rates are provided in Appendix B.

For comparison purposes, initial capital costs are shown as an annual loan payment with a finance cost of 2% over the 20 year borrowing period.

Table 5-1: MWRA Connection via Northborough Infrastructure Cost Estimate

Water Main Improvements	$7,800,000
Booster Pump Station	580,000
Design & Permitting @ 15%	957,000
MWRA Connection Fee	20,880,000
Total Estimate	**$30,217,000**
Distributed Capital Costs (20 years at 2% interest)	**1,834,356/year**

Note: Plant / Upgrades to MWRA are unknown and therefore not included.
Connection fee costs are based on $4.8 million/MGD demand.
Demand set at permit limit of 4.35 MGD

5.2 Connection to MWRA with Cross Country Pipeline Route

In order to avoid impacts to Northborough's Water System a dedicated water main to Shrewsbury could be constructed from the MWRA. At first glance multiple routes exist from Marlborough, however, detailed property analysis and design efforts would need to be undertaken prior to final selection. Construction costs would be lower due to the more direct route (26,000 LF) and the absence of road reparation and utility conflicts. However, costs of $4,680,000 are estimated for land easements / purchase and must be factored into this effort. A planning level cost between $100 and $200 / LF easily drives this cost upwards. A booster pump station or significant improvements to the MWRA finished water piping system is also anticipated for this alternative. Design and permitting costs are assumed to increase dramatically to allow for increased difficulty (i.e. local wetlands permitting etc.). Again an entrance fee to MWRA is needed.

Table 5-2: Connection to MWRA with Cross Country Pipe Line Route Cost Estimate

Water Main Construction (dedicated 20-inch main)	$7,400,000
Land Costs (estimated)	5,000,000
Booster Pump Station	800,000
Design / Permitting @ 15%	1,485,000
MWRA Connection Fee	20,880,000
Total Estimate	**$35,565,000**
Distributed Capital Costs (20 years at 2% interest)	**2,159,000/year**

5.3 Connection to Worcester

System connections to Worcester allowing Worcester to provide all of Shrewsbury's demand with an uninterrupted supply may require multiple connections. Currently connections will feed into Shrewsbury's low pressure zone, and boosted pressure is likely to be satisfied by the existing system pumps and storage tanks. Capital costs for interconnections and Infrastructure improvements are estimated at $1.8 – 2.4 million based on 2 system connections. Design and permitting at 15% does not reflect the need to complete an Interbasin transfer Act application and to develop and implement potential mitigation requirements in Worcester. Assuming the full cost for mitigation measures equivalent to Shrewsbury's demand is paid for by Shrewsbury, SWMI Pilot Study results indicate for 4.5 MGD flows could be as much as $25 million dollars. Although the timing for implementing mitigation may be entirely unrealistic, this alternative is dependent on mitigation and regulatory requirements.

Table 5-3: Connection to Worcester Cost Estimate

Infrastructure Improvements (mains, connections, booster pump station)	$2,400,000
Design & Permitting @ 15%	360,000
Premium for IBTA, WMA	500,000
Mitigation Measures	25,000,000
Total Estimate without Mitigation/offsets	**3,260,000**
Total Estimate including Mitigation/offsets	**28,260,000**
Distributed Capital Costs (20 years)	**144,600**
Distributed Capital Costs with Mitigation/offsets	**1,253,448**

Note: SWMI Pilot Studies indicated total costs for offset approximately 25 million dollars.

5.4 Maintain Wells, Construct WTF and Augment Supply from Worcester

Although the results of the current plot testing effort for manganese removal is not complete, preliminary cost estimates for a Water Treatment Facility range between 12.8 and 13.5 million dollars with favorable results being shown by Biologically Activated Carbon technology (BAC). The recent Water Management Act Permit places the baseline system demand at 3.91 MGD with an additional withdrawal allowed from the Blackstone River Basin of .44 MGD. The combined demands are within the capacity of the current sources barring any significant changes in the watershed. Peak day demands and possible future demand from growth in Shrewsbury would be satisfied in this alternative by purchase from the City of Worcester. This alternative requires further definition of any required mitigation, if any for use of capacity from Worcester sources. Additionally, permitting requirements are assumed to be in the range of $250,000 should MEPA and IBTA issues arise. As these issues are dependent on the volume transferred significant future work needs to be completed to identify these costs and requirements. Table 5-4 provides estimated costs for this alternative, As Worcester finished

water rates are comparable to Shrewsbury it is conceivable that wholesale water sales could be set at a rate that has little effect on Shrewsbury's retail customer rates.

Table 5-4: Maintain Wells, Construct WTF, Augment Supply from Worcester Cost Estimate

Design, Construct WTF	$12,800,000
Miscellaneous infrastructure	800,000
Design @ 15%	2,040,000
IBTA, WMA	250,000
Mitigation Measures	0
Total Estimate	**$15,890,000**
Distributed Capital Costs (20 years)	960,000/yr.

5.5 Aquifer Storage and Recharge to Shrewsbury Wells

This alternative represents the most unique solution to the long-term supply issues faced by Shrewsbury. The opportunity to provide mitigation for potential withdrawal impacts within the Blackstone River Basin by transferring raw, untreated water from the Wachusett reservoir will require significant further analysis and agreement from regulators and suppliers. However, assuming that the current Worcester intake system can be refurbished and a raw water pipeline constructed, the overall costs are within the ranges seen for other alternatives.

The most important variable appears to be both the connection fee and the unit cost for untreated water. Assuming the MWRA entrance fee could be diminished by 30 to 50%, and the recharge volumes could be maintained below 2 MGD on an annual basis, the initial costs might range between 4.8 and 6.7 million dollars. Similarly, the rate for raw water, although not determined could reflect a discount over finished or treated water costs from the MWRA. Using a 20 percent reduction from the current rates charged for the Chicopee Valley Aqueduct service area (i.e. $1,800/million gallons or $1.80/1000 gallons).

Table 5-5 provides estimated capital costs including pipeline costs and recharges beds.

Table 5-5: Aquifer Storage and Recharge via Wachusett Reservoir Cost Estimate

MWRA Entrance Fee	$6,700,000
Intake Modifications/Booster Pump	600,000
12-inch diameter Transmission Main (18,000 ft.)	2,700,000
Recharge Beds	1,200,000
Engineering Design @ 15% (construction only)	675,000
Total Estimate	**$11,875,000**
Distributed Capital Costs (20 years)	**720,888**

6.0 SUMMARY

The feasibility analysis for alternate sources of supply revealed a much greater variety of alternatives than originally anticipated within Shrewsbury. The development of additional sources is unrealistic. Both bedrock well sites and sand and gravel aquifers suffer from marginal yield, potential water quality problems, and poorly quantified mitigation costs under the current WMA process.

In addition, capital and operating costs are excessive for water utilities with numerous low yield sources. Similarly, relying on groundwater resources from surrounding communities is also unrealistic for many of the same reasons.

The matrix analysis ranking indicates clearly that alternative sources with sufficient capacity to replace the current groundwater wells rank favorably. Infrastructure costs to connect to treated sources from MWRA are a significant drawback to those options. Additionally, the entrance fee represents a significant financial impediment. Utilizing Worcester as a full replacement has significant costs unless permitting issues and/or mitigation hurdles can be overcome. Costs for mitigation indicate that Worcester may represent only a partial supply source. The resultant cost effective options therefore reflect the continued use of the existing wells with either supplemental supply from Worcester or a possibly robust mitigation plan for aquifer recharge allowing current and future increased withdrawals from the current aquifer.

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APPENDIX A

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Central Regional Office • 8 New Bond Street, Worcester MA 01606 • 508-792-7650

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

July 2, 2015

Town of Shrewsbury
Attn: Daniel J. Morgado, Town Manager
100 Maple Avenue
Shrewsbury, MA 01545

Town: Shrewsbury
PWS Number: 2271000
Program: Water Management Act (WMA)
WMA Permit #: 9P4-2-12-271.01
Final Modified WMA Permit

Dear Mr. Morgado:

Please find the attached documents:

- Findings of Fact in Support of the Final Modified WMA Permit Decision;
- Final Water Management Act Permit 9P4-2-12-271.01 for the Town of Shrewsbury in the Blackstone River Basin;
- Unaccounted For Water Compliance Plan; and
- Mitigation Plan – Including Appendices A and B.

If you have any questions regarding this permit, please contact Duane LeVangie at (617) 292-5706, or me directly at (508) 767-2827.

Sincerely,

Marielle Stone
Deputy Regional Director
Bureau of Water Resources

ecc: Robert Tozeski, Shrewsbury Water Dept. (rtozeski@th.ci.shrewsbury.ma.us)
T. Philip Leader, Shrewsbury Town Counsel (leader.law@verizon.net
Jeff Howland, Shrewsbury Engineering Dept. (jhowland@shrewsburyma.gov)
Blackstone Headwaters Coalition (peter.coffin@zaptheblackstone.org)
Margaret VanDeusen, Petitioner's representative (mvandeusen@crwa.org)
Deidre Menoyo, Petitioner's representative (dmenoyo@mac.com)
Rivers Alliance (JuliaBlatt@massriversalliance.org)
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Larry Freed (larryfreed1@charter.net)
Massachusetts Audubon Society (hricci@massaudubon.org)
Rhode Island Audubon Society (emarks@asri.org)
OARs (alisonfieldjuma@oars3rivers.org)
MWWA (MWWA@verizon.net)

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Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Central Regional Office • 8 New Bond Street, Worcester MA 01606 • 508-792-7650

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July 2, 2015 - Findings of Fact in Support of Decision on Final Modified Permit
Town of Shrewsbury, Water Management Permit # 9P4-2-12-271.01

The Massachusetts Department of Environmental Protection (MassDEP, or the Department) has completed its review of the Town of Shrewsbury's (Shrewsbury's) Water Management Act (WMA) Permit application in the Blackstone River Basin. In preparing the draft permit, the following was taken under consideration: WMA application review, Shrewsbury's February 4, 2013 response to MassDEP's Order to Complete issued on November 6, 2012, Sustainable Water Management Initiative pilot project discussions, written comments received from the Blackstone River Coalition dated April 2, 2013, and meetings with the Town of Shrewsbury and the impacted watershed groups (Blackstone River Coalition, Mass Rivers Alliance, and OARs; the Assabet, Sudbury, and Concord Rivers). Comment letters were received on the draft permit and a summary of the changes incorporated into the permit is provided following the Findings of Fact.

MassDEP issues this Findings of Fact in support of the attached permit, and includes herewith its reasons for approving the permit and for the conditions of approval imposed, as required by M.G.L. c21G, s.11, and the "Massachusetts Water Resources Management Program", 310 CMR 36.00 ("the Regulations").

Town of Shrewsbury's Withdrawal History

Shrewsbury holds a registration statement (2-12-271.01) for an average annual daily withdrawal volume of 2.64 million gallons per day (MGD) from sources in the Blackstone River Basin. Shrewsbury was first issued a Water Management Act permit in November 1990 to increase the total authorized withdrawal volume from the registered sources.

MassDEP issued a new Water Management Act permit to the Town of Shrewsbury dated September 8, 2005 allowing an increase in the permitted withdrawal volume (by applying Shrewsbury's authorized withdrawal volume previously allocated in the Concord River Basin) and to add Home Farm Well #6.2 as an authorized withdrawal location. The WMA Permit issued in September 2005 was appealed by the Town of Shrewsbury. The WMA Permit was subsequently upheld by the Administrative Magistrate and the Recommended Final Decision (RFD) was issued November 23, 2007. The MassDEP Commissioner at the time, Laurie Burt, adopted the RFD in her decision dated March 21, 2008 with the exception of the Administrative Magistrate's findings regarding the requirement to retrofit municipal buildings. Commissioner Burt upheld the permit requirement to complete the retrofit of all municipal buildings within 27

months of the final permit dated May 28, 2008. On March 1, 2010, MassDEP issued a 20-Year Permit Renewal to the Town of Shrewsbury in response to its permit renewal application.

The current permit application by the Town of Shrewsbury included a request for an increase in permitted withdrawal volume of 1.37 MGD for a total authorized withdrawal volume of 5.28 MGD through the end of the 20-year basin cycle in 2033. The following permit includes an additional allocation of up to 0.44 MGD for a total authorized withdrawal volume of 4.35 MGD, until the Department of Conservation and Recreation (DCR) has adequate information to prepare a revised Water Needs Forecast for Shrewsbury and until completion of the Long-Term Safe Yield analysis. The additional authorized withdrawal volume of 0.44 MGD is the remaining volume within the Blackstone River Basin under the Interim Safe Yield. The additional volume being allocated in this permit is contingent upon Shrewsbury demonstrating to the MassDEP's satisfaction that they have evaluated and mitigated the impacts associated with the additional permitted withdrawal volumes.

MassDEP issued Water Management Act permit on January 21, 2014 to the Town of Shrewsbury. Subsequently, the January 21, 2014 WMA permit #9P4-2-12-271.01 was appealed by the Blackstone River Coalition, the Blackstone Headwaters Coalition, the Blackstone River Watershed Association and a 12 Citizens' Group (collectively, the Petitioners) on February 11, 2014. The appeal was docketed with MassDEP's Office of Administrative Appeals and Dispute Resolution (OADR) as Matter of Town of Shrewsbury – WMA Permit, OADR Docket No. 2014-002. This Final Modified Permit and Special Conditions, the attached Unaccounted-for Compliance (UAW) Plan and Mitigation Plan (including Appendices A and B) are a result of a Settlement Agreement reached between the parties to the appeal: MassDEP, the Petitioners and the Town of Shrewsbury. The Final Decision approving and incorporating the Settlement Agreement and Modified Water Management Act Permit (Permit #9P4-2-12-271.01) was signed and issued by Gary Moran, Deputy Commission of MassDEP on June 17, 2015.

Inter Basin Transfer Act (IBTA)

Shrewsbury's water supply wells are located in the Blackstone River Basin and the Town's wastewater is transported to the Westborough wastewater treatment facility in the Concord River Basin. Under the IBTA, an action that increases the capacity to transfer water across municipal and basin boundaries is subject to the IBTA. Prior to 1983, Shrewsbury had grandfathered capacity to transfer 7.8 MGD from the Blackstone River Basin to the Concord River Basin based on Shrewsbury's historical pumping capacity. Shrewsbury's Home Farm Well #6.2 was constructed after 1983; therefore, its use was not grandfathered under the IBTA. The Water Resource Commission (WRC) decision dated September 9, 2004 stated that the total withdrawal volume from the Home Farm Wells site must be restricted to no more than 5.4 MGD to remain consistent with the IBTA.

Understanding that Shrewsbury's current maximum daily pumping volumes at the Home Farm Wells site approach 5.4 MGD, increasing annual system-wide volumes would appear to exacerbate the likelihood that maximum daily volumes from the Home Farm Wells would rise as well. Prior to any exceedence of 5.4 MGD, Shrewsbury should obtain the appropriate IBTA approvals. Contact DCR's Water Resources program staff for guidance regarding the IBTA process should withdrawals necessitate an increase in maximum daily pumping rate above 5.4 MGD at the Home Farm Wells site.

The Water Management Act

Permit Factors

Section 7 of the Act requires that MassDEP issue permits that balance a variety of factors including:

- Reasonable protection of existing water uses, land values, investments and enterprises;
- Reasonable conservation consistent with efficient water use;
- Reasonable protection of public drinking water supplies, water quality, wastewater treatment capacity, waste assimilation capacity, groundwater recharge areas, navigation, hydropower resources, water-based recreation, wetland habitat, fish and wildlife, agriculture, flood plains; and
- Reasonable economic development and job creation.

Safe Yield Permit Factor

Among the minimum permit factors Section 7 requires is a determination by MassDEP that permitted water withdrawals are within the safe yield of the water source from which they are made. Section 2 of the Act defines "safe yield" as: "the maximum dependable withdrawal that can be made continuously from a water source including ground or surface water during a period of years in which the probable driest period or period of greatest water deficiency is likely to occur; provided however, that such dependability is relative and is a function of storage and drought probability".

For the purposes of the Water Management program, MassDEP considers a water source to be any one of Massachusetts' 28 major river basins. A map of the 28 major river basins has been developed by the Department of Conservation and Recreation and can be viewed in their guidance document "A Guide to the Interbasin Transfer Act and Regulations".

On December 14, 2009, MassDEP, with the assistance and concurrence of a group of stakeholders, identified a methodology for determining an Interim Safe Yield while a final Long-Term Safe Yield is developed. The Interim Safe Yield methodology is described in the document "Interim Safe Yield Determinations for Water Management Act Permits" available on MassDEP's website.

This permit is being issued under the Interim Safe Yield methodology. Pursuant to MGL c 21G, section 11 MassDEP cannot issue permits when the combined existing, permitted, and proposed withdrawal volumes exceed the safe yield of the water source. If MassDEP determines that the Long-Term Safe Yield is less than the Interim Safe Yield calculated for this basin, the volumes authorized in all Water Management permits in this basin shall be reviewed and the permitted volumes adjusted downward accordingly. MassDEP is using its best efforts to develop the final Long-Term Safe Yield for the Blackstone River Basin.

Under the Permit Extension Act, which was created by Section 173 of Chapter 240 of the Acts of 2010, and amended by Sections 74 and 75 of Chapter 238 of the Acts of 2012 to promote job growth and long-term economic recovery, expiration dates for WMA permits were extended by four years. Therefore, WMA permits for withdrawals in the Blackstone River Basin expire on February 28, 2033. Permit review in accordance with the Long-Term Safe Yield shall be no later than the next 5-year review of this permit. Note the 5 Year Review schedule for this permit has been altered to account for the additional time added because of the Permit Extension Act. The

reviews scheduled for this permit are in 2017 for Period One, 2023 for Period Two, and 2028 for Period Three (See Special Condition #1).

This permit will also enable MassDEP to incorporate the latest scientific information and to consider recommendations (including but not limited to stream flow criteria) from the currently ongoing Executive Office of Energy and Environmental Affairs' Sustainable Water Management Initiative (SWMI), along with United States Geological Survey (USGS) investigative studies, particularly, *Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins* (USGS SIR 2009-5272) which can be viewed at *http://pubs.usgs.gov/sir/2009/5272/* ; *Preliminary Assessment of Factors Influencing Riverine Fish Communities in Massachusetts (USGS OFR 2010-1139),* and *Factors Influencing Riverine Fish Assemblages in Massachusetts* (USGS SIR 2011-5193), and other pertinent studies or site-specific analyses that become available. Access to water volumes authorized beyond Period One of this permit is contingent upon all permitted withdrawals in the basin being within the Long-Term Safe Yield, implementation of any required mitigation, and on MassDEP completing a 5-year review modification or a permit amendment incorporating the Long-Term Safe Yield determination.

Using the December 14, 2009 "Approach to Interim Safe Yield (ISY) Determinations for Water Management Act Permits" the ISY for the Blackstone River Basin is 41.76 MGD. The ISY approach is available on the internet at http://www.mass.gov/eea/agencies/massdep/water/watersheds/tools-resources.html:

ISY = EA+0.01((NDB+FY)-EA)

Where,

EA = Existing Allocation
NDB = Net Drought Baseflow[1]
FY= Firm Yield of drinking water supply reservoirs within the watershed

Blackstone River EA = 40.7MGD
Blackstone River NDB = 131.87 MGD
Blackstone River FY = 14.75 MGD

Blackstone River ISY = 41.76 MGD

The water volume remaining for allocation by permitting (RAP) is the difference between the ISY and the withdrawals already allocated by registrations or permits (EA).

RAP = ISY-EA=1.06 MGD

RAP is equal to 1.06 MGD for the existing Blackstone River Basin withdrawals (41.76 MGD-40.7 MGD=1.06 MGD). An additional 0.62 MGD was allocated to the Riverdale Water Co. in a permit dated December 19, 2012; therefore 0.44 MGD is available for allocation until the Long Term Safe Yield is determined.

[1] Net Drought Baseflow was estimated by MassDEP Boston WMA staff by calculating the annual groundwater recharge over the area of the basin during the drought of record.

Findings of Fact for the Performance Standards

MassDEP has determined that there is documented evidence that water withdrawals and an increase in development and impervious area, combined with the out-of-basin export of wastewater, substantially contribute to low flow in the Commonwealth. These low flows impact the ability of rivers and tributaries to adequately serve all of the competing uses described in the Act. To better achieve the balance of competing water uses mandated by the Act, the MassDEP refers to the Water Conservation Standards adopted by the Water Resources Commission. Specific performance standards are applied to new Water Management permits and to existing permits at the time they are amended, during 5-year permit review, or permit renewal.

Consistent with Section 3 of the Act, the performance standards of 65 gallons per day or less for residential per capita water use and 10% or less of unaccounted for water, summer limits on withdrawals, and efforts to offset the impacts of increasing withdrawal volumes are consistent with the Massachusetts Water Conservation Standards approved by the Water Resources Commission in July 2006 and revised June 2012.

MassDEP believes these standards are reasonable based on studies and data developed throughout the country, the 1996 AWWA Leak Detection and Water Accountability Committee report on water accountability (AWWA Journal; July 1996; pp. 108-111), and the fact that the average values in 2012 for Massachusetts were 59 RGPCD, and 13% UAW. While these performance standards represent the minimum standards required for compliance with the Permit, MassDEP believes that through the implementation of all the terms and conditions of Water Management permits, municipalities can meet the performance standards for RGPCD and UAW.

Shrewsbury was required to meet the 65 residential gallons per capita day (RGPCD) and 10% unaccounted-for-water (UAW) performance standards beginning in calendar year 2010. MassDEP will consider any permittee that has been unable to meet the 65 RGPCD or 10% UAW performance standard within 5 years of receiving its permit to be achieving functionally equivalent compliance with the performance standards, if they:

- are complying with the Water Conservation requirements included in the permit,
- have implemented the required limits on nonessential outdoor water use, and
- are making demonstrable efforts to finance, implement and enforce a MassDEP-approved compliance plan.

Because circumstances vary, a permittee may present an analysis of the cost effectiveness of implementing certain conservation measures required by MassDEP and offer alternative measures. The analysis must explicitly consider environmental impacts and must produce environmental benefits. MassDEP will allow permittees to:

- Document economic hardship and present an analysis demonstrating that implementation of specific measures will cause or exacerbate significant economic hardship;
- Present reasons why specific measures are not cost effective because the cost would exceed the costs of alternative methods of achieving the appropriate standard; and
- Propose specific conservation measures that would result in equal or greater system-wide water savings or equal or greater environmental benefits than the conservation measures included in the MassDEP Functional Equivalence Plan(s) (See Appendix A & B).

Findings of Fact for Shrewsbury's Special Permit Conditions

In issuing permits, MassDEP looks primarily at site-specific impacts and other issues specific to the system, such as impacts to nearby streams, wetlands, or other water users, justification of long-term demand projections and the capacity of permitted withdrawal points. The conditions are intended to ensure the efficient use of water and to mitigate the potential impact of withdrawals.

The summary of permit conditions, as part of MassDEP's findings of fact, is not intended to, and should not be construed as, modifying any of the Permit conditions. In the event of any ambiguity between the summary and the actual permit conditions, the Permit language shall be controlling.

The existing permit included a condition that Shrewsbury complete Zone II delineations for all sources. MassDEP records indicate that all of Shrewsbury's sources have approved Zone II delineations. Public Water Systems are required to obtain MassDEP approval of Zone II delineations during the new source approval process and prior to activating any new sources; therefore this condition has been removed as a condition of the permit renewal.

Special Condition 1, Maximum Authorized Annual Average Withdrawal Volume, reflects an additional allocation of up to 0.44 MGD, for a total authorized withdrawal not to exceed 4.35 MGD. The additional withdrawal volume of 0.44 MGD is the remaining allocation for the Blackstone River basin under the Interim Safe Yield (ISY) Determination.

The permit authorizes an additional 0.26 MGD, with the potential to increase that by another 0.18 MGD (4.35 MGD total allocation) should demands increase and Shrewsbury meets the 65 RGPCD and 10% UAW standards, or is determined to be functionally equivalent (See Appendix A& B) if not meeting the standards. As noted earlier these volumes are also contingent upon Shrewsbury implementing the Mitigation Plan developed in consultation with MassDEP that feasibly mitigates impacts of their additional permitted withdrawals.

Massachusetts Department of Conservation and Recreation (DCR), Office of Water Resources prepared a water needs forecast for Shrewsbury dated November 20, 2008. The Water Needs Forecast (WNF) was prepared based on the Water Resources Commission's policy for developing water needs forecasts, which is available at: http://www.mass.gov/eea/docs/eea/wrc/090501-waterneedsforcast-policymethod.pdf. DCR developed Shrewsbury's WNF using 2000 census data and projected growth information obtained from the Town. Shrewsbury's was notified of DCR's final projections on November 20, 2008. Those projections identified a 2018 demand of 4.17 MGD with an additional five percent buffer available if Shrewsbury met the 65 rgpcd and 10% UAW standard. That additional 5% buffer potentially increased the allocation through 2018 to 4.38 MGD. However because the ISY is less than that value, the allocation volume is capped at 4.35 MGD.

DCR has begun using the 2010 census data when preparing WNF for communities requesting an increase in withdrawal volume or for those approaching expiration of the 20-year basin permit. The 2010 census data indicates Shrewsbury will have fewer residents and a slower rate of growth than previously predicted. The 2010 census data reported that Shrewsbury actually had 1,844 less residents in 2010 than predicted in 2008. By 2030, the slower rate of growth predicts a population of 6,242 fewer residents than previously predicted. As a result the revised WNF

prepared by DCR will likely be less than the WNF prepared in 2008. The methodology to prepare a WNF also requires the PWS to report UAW less than 15%. At the time DCR prepared the 2008 WNF, Shrewsbury's Unaccounted for Water (UAW) was 12-19%. Shrewsbury's UAW has been more than 20% since 2007. DCR must have three consecutive years of UAW of 15% or less to prepare a WNF.

Also as noted previously, volumes beyond the Period One allocation (February 28, 2017) are contingent upon the authorized withdrawals being within the Long-Term Safe Yield, and MassDEP completing a 5-Year Review or a permit amendment that incorporates the Long-Term Safe Yield determination into this permit.

Shrewsbury will be required to file and obtain a new Water Management Act Permit to receive authorization to withdraw more than 4.35 MGD. As noted above due to the lower population growth identified in the 2010 census and Shrewsbury's high UAW %, any additional allocations will be based on a revised WNF prepared by DCR.

Special Condition 2, Maximum Authorized Daily Withdrawal from each Withdrawal Point, reflects the maximum daily withdrawal rate by source, according to MassDEP approved Zone II rates.

Special Condition 3, Ground Water Supply Protection, requirements have been met for the Zone II areas within Shrewsbury's municipal boundary for the permitted sources. Additionally, Shrewsbury has submitted copies of letters dated January 28, 2013 to Boylston, West Boylston and Worcester requesting protection of Shrewsbury's Zone II areas that extend into those municipalities. Until each of those municipalities pass Ground Water Supply Protection requirements that satisfy the Regulations and include Shrewsbury's Zone II areas, MassDEP's Best Effort Requirement must be met for new source approvals (including replacement wells); monitoring waiver applications; WMA water withdrawal permit reviews or amendments; Zone II re-delineations; and Sanitary Survey stipulations. Shrewsbury will be required to repeat the "Best Effort" requirement during the next 5-Year Review.

Special Condition 4, Groundwater and Streamflow Monitoring data was collected in the summers of 2009 and 2010 to evaluate the potential impacts from pumping the Home Farm Wells on water levels near Poor Farm Brook. The MassDEP approved a monitoring plan that consisted of collection of monthly water level data from all available monitoring wells from April to November. Data was collected from six monitoring wells and three drive points. Pressure transducers and a data logger were used to record water levels in two monitoring wells during the month of July (a peak summer water use month).

MassDEP's review of the data submitted by Shrewsbury indicates that the pumping of the Home Farm Wells may be reducing baseflow to Poor Farm Brook. Pressure transducers recorded water level fluctuations of up to 0.5 feet in OBS-6 and 1.2 feet in TW-4. Monitoring well OBS-6, is approximately 315 feet west and north of Home Farm Well 6.2 and approximately 200 feet south of Poor Farm Brook. Monitoring well TW-4 is located approximately half-way between OBS-6 and Home Farm 6.2. Fluctuations appeared to correlate to the daily cyclic pumping of the Home Farm Wells. Precipitation was below normal in 2010 and water levels declined 5.4 feet in OBS-6, between April and October.

Shrewsbury's application for an increase in withdrawal volume from the Home Farm well site, necessitates a more comprehensive groundwater level monitoring program. Additional water level monitoring is required to confirm and quantify the impacts to the brook. Within 60 days of the issuance of the final permit, Shrewsbury is required to submit a revised groundwater and surface water monitoring plan for MassDEP's review and approval.

Special Condition 5, Performance Standard for Residential Gallons Per Capita Day Water Use, discussed previously. Shrewsbury reported an RGPCD of 61 in the 2014 Annual Statistical Report. If Shrewsbury's residential water use increases above 65 gallons per person, non-essential outside watering will be reduced to one day per week.

Special Condition 6, Performance Standard for Unaccounted for Water (UAW), discussed previously. The MassDEP adjusted percentage of unaccounted for water for Shrewsbury in 2014 was 22%. Shrewsbury provided an update regarding UAW compliance in a letter dated December 19, 2013. While useful, this update did not satisfy all aspects of the UAW Compliance Plan as outlined in Appendix B. Shrewsbury's UAW according to its 2014 ASR and reviewed by MassDEP, is 22%. Shrewsbury's UAW Compliance Plan resulted from settlement of the appeal docketed as Matter of Town of Shrewsbury – WMA Permit, OADR Docket No. 2014-002 and is attached hereto and incorporated as a requirement of the Modified Permit.

Special Condition 7, Seasonal Limits on Nonessential Outdoor Water Use is based upon Shrewsbury's RGPCD for the preceding year, and will be implemented according to either: 1) calendar triggered restrictions; or 2) streamflow triggered restrictions. The restrictions have been modified from the prior permit based on both technical and policy decisions by the Department. Due to groundwater depletion in the subbasins in which the Town's sources are located, this permit will require that more stringent restrictions than your existing permit be imposed, regardless of compliance with the RGPCD Standard for the preceding year. In addition, the Drought Trigger has been replaced with a new Low-Flow statistic that triggers tighter restrictions during unusually dry weather.

1. **Calendar triggered restrictions:** Restrictions shall be implemented from May 1st through September 30th. Many public water suppliers will find this option easier to implement and enforce than the streamflow triggered approach.

2. **Streamflow triggered restrictions:** Restrictions shall be implemented at those times when streamflow falls below designated flow triggers measured at an assigned, web-based, real-time U.S. Geologic Survey (USGS) stream gage from May 1st through September 30th. At a minimum, restrictions shall commence when streamflow falls below the trigger for three consecutive days. Once implemented, the restrictions shall remain in place until streamflow at the assigned USGS local stream gage meets or exceeds the trigger streamflow for seven consecutive days.

The basis for streamflow triggers is derived from Aquatic Base Flow (ABF) values calculated by the Sustainable Yield Estimator (SYE)[2] for simulated natural flow applied to

[2] Archfield, S.A., Vogel, R.M., Steeves, P.A., Brandt, S.L., Weiskel, P.K., and Garabedian, S.P., 2010, The Massachusetts Sustainable-Yield Estimator: A decision-support tool to assess water availability at ungaged stream locations in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2009–5227, 41 p. plus CD-ROM. See http://pubs.usgs.gov/sir/2009/5227/

the assigned local USGS stream gage. The two-tiered trigger values are based on flow levels that are protective of aquatic habitat for fish spawning during the spring bioperiod, designated with the June ABF; and protective flows for fish rearing and growth during the summer bioperiod, designated with the August ABF trigger. Protective flow levels are derived from index gage flow data which represent the least altered stream flows in Massachusetts, and are further described in the Department of Conservation and Recreation (DCR)[3] and USGS Index Reports[4].

If Shrewsbury selects the streamflow approach, it has been assigned the USGS local stream gage of 01110000 – Quinsigamond River at Grafton, MA. The June ABF estimated using SYE is 0.94 cfsm and the August ABF value is 0.44 cfsm. These cfsm units translate to your local gage streamflow triggers as 24 cubic feet per second (cfs) for May and June, and 11 cfs for July, August and September.

Should the reliability of flow measurement at the Quinsigamond River gage be so impaired as to question its accuracy, Permittee may request MassDEP's review and approval to transfer to another gage to trigger restrictions. MassDEP reserves the right to require use of a different gage.

The Low-flow statistic being applied replaces the Massachusetts Drought Management Task Force Declaration previously used for triggering more stringent restrictions on seasonal limits on nonessential outdoor water use. This value referred to the as "7-day low-flow statistic" is the median value of the annual 7-day low flows for the period of record for the Quinsigamond River gage. That value for the Quinsigamond River gage is 1.9 cfs and will limit non-essential outdoor watering to no more than 1 day per week as outlined in Special Condition #7. This value is expected to be more responsive of actual hydrologic conditions in our rivers and streams than the Drought Management Task Force Declaration.

Special Condition 8, Water Withdrawals that Exceed Baseline Withdrawal Volumes
Baseline withdrawal for Shrewsbury in its previous permit was 3.76 MGD (1372.4 MGY), as previously outlined in the May 28, 2008 permit amendment and March 1, 2010 permit renewal. This was Shrewsbury's average volume withdrawn in compliance with the Act from 2001 to 2003.

As part of the Sustainable Water Management Initiative (SWMI), Baseline withdrawal volumes will be adjusted to the volume of water withdrawn during 2005 plus 5% or the average volume withdrawn from 2003 through 2005 plus 5%, whichever is greater, provided that Baseline cannot exceed the maximum volume authorized for 2005.

Shrewsbury's adjusted Baseline will be 3.91 MGD (1427.15 MGY). Shrewsbury's maximum authorized volume for 2005 was 3.91 MGD. The actual withdrawal volume in 2005 was 3.81 MGD. 3.81 MGD plus 5% would be 4.00 MGD. Because Baseline cannot exceed the maximum

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[3] Massachusetts Department of Conservation and Recreation (DCR), 2008 Index Streamflows for Massachusetts, May 2008, Prepared by Office of Water Resources for the Massachusetts Water Resources Commission, 45 p., plus CD-ROM.

[4] Armstrong, D.S., Parker, G.W., and Richards, T.A., 2008, Characteristics and classification of least altered streamflows in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2007-5291, 113 p., plus CD-ROM.

volume authorized for 2005, Shrewsbury's baseline is limited to 3.91 MGD. Shrewsbury's recent withdrawals, as reported on the ASR, have been 3.66 MGD in 2012, 3.69 MGD in 2011 and 3.64 MGD in 2010.

Shrewsbury's Mitigation Plan (inclusive of Appendices A and B), resulted from settlement of the appeal docketed as Matter of Town of Shrewsbury – WMA Permit, OADR Docket No. 2014-002, and is attached hereto and incorporated as a requirement of the Modified Permit. The Mitigation Plan offsets increased water use over Baseline. The Mitigation Plan provides Shrewsbury with mitigation credit as shown on Table A at the end of the Mitigation Plan. The Mitigation Plan includes evaluation of offsets to be conducted within the sub-basin of the Home Farm Wells withdrawal, such as improvements to the stormwater outfall to Poor Farm Brook located within Shrewsbury's municipal boundaries.

Permittees are required to consult with MassDEP staff and other Executive Office of Energy and Environmental Affairs (EEA) staff deemed appropriate by MassDEP in developing the Mitigation Plan. However, having participated in the SWMI Piloting, Shrewsbury has already consulted with EEA Agency staff to identify potential mitigation options. Activities completed since 2005, such as storm water retrofits, I/I repairs, and bylaw adoption may be considered retroactively for mitigation credits.

The City of Worcester received $139,000 through the SWMI Grant Program (FY 2012) to study the feasibility of removing the Poor Farm Dam. Removal of the dam may provide benefits over the long term to the aquatic health of Poor Farm Brook through habitat and instream flow improvements. Contributing to the removal of the dam may be a creditable mitigation activity for both Worcester and Shrewsbury.

Special Condition 9, Requirement to Report Raw and Finished Water Volumes, ensures that the information necessary to evaluate compliance with the conditions included herein is accurately reported.

Special Condition 10, Water Conservation Requirements, incorporates the Water Conservation Standards for the Commonwealth of Massachusetts reviewed and approved by the Water Resources Commission in July 2006. Shrewsbury completed the retrofit of its municipal buildings with low flow fixtures by February 1, 2015.

Response to Comments on the Draft Permit Dated November 8, 2013:

***Note: The settlement agreement documents attached hereto address some of the comments below. However, these responses to comments are those MassDEP made at the time that the comments were received and therefore do not reflect the settlement.**

Comments on the draft permit were received by:

- The Town of Shrewsbury
- Blackstone River Coalition
- Massachusetts Rivers Alliance and Charles River Watershed Association
- Massachusetts Audubon Society
- Rhode Island Audubon Society
- Lawrence Freed (concerned citizen)
- City of Worcester, Dept of Public Works and Parks

Several of the comment letters stated opposition to the increase in authorized withdrawal volume provided to the Town of Shrewsbury. The Water Management Act permit for Shrewsbury allocates up to an additional withdrawal volume of 0.44 MGD, which is 32% of the 1.37 MGD volume that the Town requested in their permit application. The 0.44 MGD volume is also conditionally allocated at the Department's discretion based upon Shrewsbury meeting the 65 RGPCD and 10% UAW standard or the functional equivalence requirements. Should Shrewsbury fail to meet the performance standards that volume is limited to the 0.26 MGD projected through 2018, which is 19% of what was requested. In addition, access to any volumes above 3.91 MGD is contingent upon Shrewsbury's implementation of the MassDEP Mitigation Plan to offset withdrawals above the existing permitted volume. The Mitigation Plan considered offsets to be conducted within the sub-basin of the Home Farm Wells withdrawal such as improvements to the stormwater outfall to Poor Farm Brook located within Shrewsbury's municipal boundaries. The list of potential mitigation measures provided in Table 5 is not intended to be entirely comprehensive and the mitigation plans for each permit will be reviewed individually.

Shrewsbury has Water Needs Forecasts (WNF) developed by DCR in 2008, using the methodology approved by the Water Resources Commission, which predicted a demand of 5.03 MGD in 2028 assuming the standards of 65 RGPCD and 10% UAW were met. That number could potentially be increased at the Department's discretion by a 5% buffer (0.25 MGD), thus increasing the total allocation to 5.28 MGD. At the time the WNF's were prepared, the Town's UAW was within a range acceptable to DCR for preparing the WNF. However, since that time Shrewsbury UAW has increased significantly and the 2010 census identified a slower rate of growth than was originally expected. For those reasons and the Interim Safe yield cap discussed previously, the Department has not authorized the volume predicted by the existing WNF. Shrewsbury will be required to file a new WMA permit application to request an increase in authorized withdrawal volume above 4.35 MGD. The final permit reflects an additional authorization of 0.26 MGD, with the potential to increase that by another 0.18 MGD (4.35 MGD total allocation) should demands increase and Shrewsbury meets the 65 rgpcd and 10% UAW standards, or is determined to be functionally equivalent (See Appendix A& B) if not meeting the standards.

Shrewsbury's high unaccounted for water is a concern to all parties, including MassDEP and the Town of Shrewsbury. The Town of Shrewsbury is actively pursuing improvements to reduce unaccounted for water . The UAW Compliance Plan developed as a result of the settlement negotiations is attached. The UAW Compliance Plan includes annual leak detection surveys, water audits, and repair, replacement and calibration of meters. Shrewsbury's high UAW may in part reflect unreported water due to faulty, older meters and therefore the water is in use, not lost to the ground. Full cost pricing is required in Special Condition 10 of this permit.

Shrewsbury Water Department provided an update to MassDEP dated December 19, 2013 summarizing work completed in the last 12 months to address UAW. A full leak detection survey was completed in June 2013. Leaks were detected at 36 hydrants, three residential connections and one water main. The water main loss was estimated to be 150,000 to 185,000 gpd. Shrewsbury is continuing to proceed with its residential and commercial meter replacement program and reports that the water rates have been established to fully cover all operational and capital costs.

Several of the comments were directed to the question of the usefulness of additional water level and streamflow monitoring. The preliminary water level monitoring confirmed that the area of influence of the Home Farm Wells extends north towards Poor Farm Brook. However, additional data collection is intended to answer the question of the lateral extent of Poor Farm Brook that is impacted by pumping and possible impacts to Poor Farm Pond. The results of the additional monitoring may provide an understanding of the relationship of summer withdrawals and the duration of low flows, recovery times and the presence of a delayed response to pumping, which could lead to modification or optimization of the pumping schedule of the Home Farm Wells. This condition (Special Condition #4, Groundwater and Streamflow Monitoring) was modified based on the comments received. Item #7 of this condition had "additional monitoring required" inserted clarifying that the Department could require such work.

Public comments were requested at several points within the Water Management Act permit application review process. When the permit application is received, MassDEP posts a notification of receipt of the application in the MEPA Environmental Monitor with a 30-day comment period. The applicant notifies the primary and secondary abutters and posts a notification of the availability of the permit application for review in a local newspaper. Local watershed groups and the Massachusetts Water Works Association are copied on the Order to Complete (request for additional information on the permit application) issued to the applicant. MassDEP customarily provides a 30-day comment period on the draft permit, which is not required by the statute or the regulations.

The Town of Shrewsbury is required to comply with the municipal retrofit requirement of the permit. The Administrative Magistrate's Recommended Final Decision dated November 23, 2007 did not support the retrofit requirement. However, Commissioner Laurie Burt's rejected this recommendation in her Final Decision and outlined her reasons for doing so in the Decision dated March 21, 2008. Shrewsbury reports that 100% of its municipal buildings have been retrofit with water saving devices were completed by February 1, 2015 and confirmed in a letter to MassDEP dated April 9, 2015.

The Town of Shrewsbury's Water Conservation Bylaw restricts non-essential outside watering. The Town's current Water Conservation Bylaw bylaw as amended in May 2015 by Town Meeting vote, specifies two day per week watering by address. The attached permit allows only two day per week watering using the Calendar approach and one day per week for the Streamflow approach.

Comments received also suggested using the less impacted USGS Stillwater Gage near Sterling MA for triggering non-essential outside watering restrictions. The Department decided not to change the gage used as the triggering mechanism because the summer monthly ABF triggers are intended, where available and appropriate, to be local gages that could be affected by upstream pumping impacts. The ABF values are based on SYE-estimated unimpacted flows at the local gages, so that if the local gage downstream of the permittee's withdrawal goes below that, outdoor water use would be curtailed. The 7-day low flow statistics are calculated using actual local gage statistics. Based on our review it appears for the Quinsigamond River Gage at North Grafton that the 11 cfs and 24 cfs triggers will be hit, approximately between 50 and 75 percent of the time June through September (using historic data).

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Central Regional Office • 8 New Bond Street, Worcester MA 01606 • 508-792-7650

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

FINAL MODIFIED WATER WITHDRAWAL PERMIT
MGL c 21G

This permit is approved pursuant to the Massachusetts Water Management Act for the sole purpose of authorizing the withdrawal of a volume of water as stated below and subject to the following special and general conditions. This permit conveys no right in or to any property beyond the right to withdraw the volume of water for which it is issued.

PERMIT NUMBER: 9P4-2-12-271.01 **RIVER BASIN:** Blackstone

PERMITTEE: Town of Shrewsbury

EFFECTIVE DATE: July 2, 2015

EXPIRATION DATE: February 28, 2033

NUMBER OF WITHDRAWAL POINTS: Groundwater: 7

USE: Public Water Supply

DAYS OF OPERATION: 365

LOCATIONS:

Table 1: Withdrawal Point Identification

Source Name	PWS Source Code ID
Sewell Street Well #4	2271000-02G
Lamberts Sand Pit Well 3.1	2271000-04G (abandoned)
Lamberts Sand Pit Well 3.2	2271000-05G
Lamberts Sand Pit Well 3.3	2271000-011G
Home Farm Well 6.1	2271000-07G
Home Farm Well 6.2	2271000-08G
Home Farm Well 6.3	2271000-09G
Home Farm Well 6.4	2271000-10G

SPECIAL PERMIT CONDITIONS

1. Maximum Authorized Annual Average Withdrawal Volume

This permit authorizes the Town of Shrewsbury to withdraw water from the Blackstone River Basin at the rate described below in Table 2. The volume reflected by this rate is in addition to the 2.64 million gallons per day previously authorized to Shrewsbury under Water Management Act Registration #2-12-271.01 for withdrawal from the Blackstone River Basin. The permitted volume is expressed both as an annual average daily withdrawal rate (million gallons per day or MGD), and as a total annual withdrawal volume (million gallons per year or MGY) for each five-year period of the permit term.

The Department of Environmental Protection (MassDEP) bases these withdrawal volumes on the raw water withdrawn from the authorized withdrawal points, and will use the raw water amount to assess compliance with the registered and permitted withdrawal volumes.

Table 2: Maximum Authorized Annual Withdrawal Volumes

5-Year Periods		Total Raw Water Withdrawal Volumes			
		Permit		Permit + Registration	
		Daily Average (MGD)	Total Annual (MGY)	Daily Average (MGD)	Total Annual (MGY)
Period One*	3/1/2009 to 1/21/2014	1.27	463.6	3.91	1427.2
	1/21/2014 to 2/28/2017	1.53 (1.71**)	558.45 (624.2**)	4.17 (4.35**)	1522.05 (1587.8**)
Period Two*	3/1/2017 to 2/29/2023	***	***	***	***
Period Three*	3/1/2023 to 2/28/2028	***	***	***	***
Period Four*	3/1/2028 to 2/28/2033	***	***	***	***

*This permit is issued under the Interim Safe Yield methodology adopted by MassDEP on December 14, 2009. Under MGL c21G, §11 MassDEP cannot issue permits when the combined existing, permitted and proposed withdrawal volumes exceed the safe yield of the water source. If MassDEP determines that the Long-Term Safe Yield is less than the Interim Safe Yield calculated for this basin, the volumes authorized in all Water Management permits in this basin shall be reviewed and the permitted volumes adjusted accordingly. MassDEP is currently developing the final Long-Term Safe Yield for the Blackstone River Basin. Access to water volumes authorized beyond Period One of this permit is contingent upon all permitted withdrawals in the basin being within the Long-Term Safe Yield, and on MassDEP completing a 5-Year review or a permit amendment incorporating the Long-Term Safe Yield determination. In addition, these volumes are contingent upon their being mitigated to the extent feasible. Shrewsbury will be required to file and obtain a new Water Management Act Permit to receive authorization to withdraw more than 4.35 MGD.

** Permitted volumes may be increased by an additional 5% buffer to accommodate uncertainty in the growth projections used by the Department of Conservation and Recreation in the water needs forecasts, and/or to accommodate the water demand of a community that has not met the 65 RGPCD and 10% UAW performance standards, but has met the functional equivalence requirements included in this permit.

***This permit includes up to an additional allocation of 0.44 MGD. Shrewsbury will need to provide Annual Statistical Reports in sufficient detail to allow the Department of Conservation and Recreation (DCR) to prepare Water Needs Forecasts for Shrewsbury after three consecutive years of 15% or less UAW are reported.

2. Maximum Authorized Daily Withdrawals From Each Withdrawal Point

Withdrawals from individual withdrawal points are not to exceed the approved maximum daily volumes listed below (Table 3) without specific advance written approval from MassDEP. The authorized maximum daily volume is the approved rate of each source. In no event shall the combined withdrawals from the individual withdrawal points exceed the withdrawal volumes authorized above in Special Condition 1.

Table 3: Maximum Daily Withdrawal Rates

Source Name	PWS Source Code ID	Maximum Daily Rate (MGD)
Sewell #4	2271000-02G	1.14
Lamberts Sand Pit Well 3.1	2271000-04G	**
Lamberts Sand Pit Well 3.2	2271000-05G	0.58
Lamberts Sand Pit Well 3.3	2271000-11G	0.75**
Home Farm Well 6.1	2271000-07G	4.32*
Home Farm Well 6.2	2271000-08G	3.02*
Home Farm Well 6.3	2271000-09G	*
Home Farm Well 6.4	2271000-10G	*

* The total pumping volume from all of Shrewsbury's sources is not to exceed a daily maximum of 7.8 MG and the total pumping from Home Farm Wells 6.1, 6.2, 6.3 and 6.4 is not to exceed a daily maximum of 5.4 MG in accordance with the Water Resource Commission Decision concerning Inter-Basin Transfer dated September 9, 2004. Home Farm Well 6.3 and 6.4 were installed as back-up wells for Home Farm 6.1; therefore the combined withdrawal rate for Home Farm Wells 6.1, 6.3 and 6.4 shall not exceed the approved pumping rate for Home Farm Well 6.1 of 4.32 MGD.

** Lamberts Sand Pit Well 3.3 was installed as a replacement well for Lamberts Sand Pit Well 3.1. Lamberts Sand Pit 3.1 will be abandoned in accordance with the abandonment permit dated April 22, 2015.

3. Groundwater Supply Protection

MassDEP records indicate that Shrewsbury's permitted ground water sources meet MassDEP's wellhead protection requirements of the Drinking Water Regulations at 310 CMR 22.21(2), including a floor drain regulation, for the portion of the Zone II areas within its municipal boundaries. The Best Effort Requirement will need to be repeated, at MassDEP's direction, for WMA water withdrawal permit reviews or amendments; new source approvals (including replacement wells); monitoring waiver applications; Zone II re-delineations; and Sanitary Survey stipulations, until Worcester, Boylston and West Boylston adopt the appropriate controls. The Best Effort requirement was last satisfied in January 2013.

4. Groundwater and Streamflow Monitoring

Shrewsbury must develop and conduct, a more thorough groundwater and surface water monitoring plan and include analysis of the data. The purpose of the monitoring is to confirm

and quantify the impacts to Poor Farm Brook from groundwater withdrawals at the Home Farm well site and to determine what portion, or reach, of the stream is impacted. Shrewsbury must submit a monitoring plan for MassDEP's review and approval within sixty (60) days of the issuance date of the final modified permit.

Monitoring of groundwater and surface water in the vicinity of Poor Farm Brook and the Home Farm Wells must, at a minimum, include the following:

1. Collect water level measurements in at least two locations within Poor Farm Brook with a pressure transducer and data logger. Data must be recorded at a minimum of one hour intervals, from May 1 through September 30. One data collection location must be near the mouth of the brook, before it enters Lake Quinsigamond. The second location should be placed upstream, at a location considered outside the area of influence of the pumping wells.

2. Collect water levels from a sufficient number of monitoring wells on the site to develop groundwater contour maps. Prepare hydrographs (water level elevation versus time) for each monitoring well and prepare monthly groundwater contour maps. Measurements must be collected on a weekly basis from May 1 to September 30. Installation of additional monitoring wells may be required to obtain sufficient areal coverage.

3. Install a series of piezometers/staff gages along the length of Poor Farm Brook to help assess the potential that the brook is a "losing" stream and if so, where does it transition from a gaining to a losing stream. Determine the length of the stream reach that is impacted by the pumping of the Home Farm wells.

4. Present water level data from the Home Farm well site in graphic format with precipitation, pumping periods and pumping rate from each of the Home Farm Wells clearly defined.

5. Provide a profile of Poor Farm Brook streambed elevations between the dam and the outlet to Lake Quinsigimond.

6. Provide the data in electronic format.

7. Provide a written summary and analysis of the data collected by an engineer or hydrogeologist.

8. Submit annual reports to MassDEP by December of each year. MassDEP will evaluate the data and determine if additional information is needed, additional monitoring is required, or if monitoring may be terminated.

The results of the additional monitoring may provide an understanding of the relationship of summer withdrawals and the duration of low flows, recovery times and the presence of a delayed response to pumping, which could lead to, including without limitation, modification of the permit or of the pumping schedule of the Home Farm Wells and/or optimization to reduce environmental impacts.

5. Performance Standard for Residential Gallons Per Capita Day Water Use

Permittee's performance standard for residential gallons per capita day (RGPCD) is 65 gallons. Permittee shall be in compliance with the performance standard by December 31, 2010 and each year thereafter. Shrewsbury has been in compliance with this performance standard (<65 RGPCD) as required since 2006. In the event that Shrewsbury's RGPCD increases, non-essential outside watering will be restricted to one day per week (see Condition 7). Shrewsbury's RGPCD may increase as a result of improvements in metering to address the high unaccounted for water as discussed in Condition 6 below.

Permittee shall report its RGPCD and the calculation used to derive that figure as part of its ASR including, without limitation, the source of the data used to establish the service population and the year in which this data was developed. See Appendix A for additional information on the requirements if the performance standard for RGPCD is not met.

6. Performance Standard for Unaccounted for Water

Shrewsbury's performance standard for unaccounted for water (UAW) is 10% of overall water withdrawal. Shrewsbury's WMA Permit has required compliance with the performance standard of 10% UAW since 2010. Shrewsbury reported UAW of 17.5% in 2012, however, MassDEP recalculated UAW to be 27%. Shrewsbury reported a number of large main breaks that were repaired in 2012. However, the volume of water lost through main breaks cannot be considered "Confidently Estimated Municipal Use". The volume of water saved due to leak detection and repair will be reflected in subsequent reporting. Shrewsbury's UAW has shown a steady increase since reporting 21% in 2007. Shrewsbury reported (and MassDEP approved) 22% UAW in its 2014 Annual Statistical Report (ASR) and completion of a leak detection survey of 77% of the Town. Shrewsbury's UAW Compliance Plan has been approved by MassDEP as part of the settlement of the appeal docketed as Town of Shrewsbury – WMA Permit, OADR Docket No. 2014-002 and is attached hereto. The requirements of the UAW Compliance Plan are incorporated herein.

Shrewsbury is required to report its UAW annually in its Annual Statistical Report (ASR) and the ASR shall include the calculation used to derive that figure as part of its ASR including, without limitation, the source of data used, the methodology for calculating UAW and any assumptions used in making the calculation. Any adjustment in the calculation of UAW made as a result of confidently estimated uses shall be fully documented as required in the ASR. See Appendix B for information on requirements if the performance standard for UAW is not met.

7. Seasonal Limits on Nonessential Outdoor Water Use

Permittee shall limit nonessential outdoor water use through mandatory restrictions from May 1st through September 30th as outlined in Table 4 below.

Permittee shall be responsible for tracking streamflows and drought advisories and recording when restrictions are implemented if streamflow triggered restrictions are implemented. See *Accessing Streamflow and Drought Advisory Website Information* in Table 4 for instructions.

Permittee shall document compliance with the summer limits on nonessential outdoor water use annually in its Annual Statistical Report (ASR), and indicate whether it anticipates implementing calendar triggered restrictions or streamflow triggered restrictions during the next year.

Nothing in this permit shall prevent Permittee from implementing water use restrictions that are more restrictive than those set forth in this permit.

Water Use Restrictions

Nonessential outdoor water uses that are subject to mandatory restrictions include:

- irrigation of lawns via sprinklers or automatic irrigation systems;
- washing of vehicles, except in a commercial car wash or as necessary for operator safety; and
- washing of exterior building surfaces, parking lots, driveways or sidewalks, except as necessary to apply surface treatments such as paint, preservatives, stucco, pavement or cement.

The following uses may be allowed when mandatory restrictions are in place:

- irrigation to establish a new lawn and new plantings during the months of May and September;
- irrigation of public parks and recreational fields by means of automatic sprinklers outside the hours of 9 am to 5 pm; and
- irrigation of lawns, gardens, flowers and ornamental plants by means of a hand-held hose.

Water uses NOT subject to mandatory restrictions are those required:

- for health or safety reasons;
- by regulation;
- for the production of food and fiber;
- for the maintenance of livestock; or
- to meet the core functions of a business (for example, irrigation by golf courses as necessary to maintain tees, greens, and limited fairway watering, or irrigation by plant nurseries as necessary to maintain stock).

To the extent feasible, all summer outdoor water use should take place before 9 am and after 5 pm when evaporation and evapotranspiration rates are lower.

Table 4: Seasonal Limits on Nonessential Outdoor Water Use

For Permittees meeting the 65 RGPCD Standard for the preceding year RGPCD ≤ 65 as reported in the ASR and accepted by MassDEP	
Calendar Triggered Restrictions	Nonessential outdoor water use is allowed: a) **two (2) days per week** before 9 am and after 5 pm; **and** b) **one (1) day per week** before 9 am and after 5 pm when USGS stream gage 01110000 - Quinsigamond River at North Grafton, MA falls below **1.9 cfs** for three (3) consecutive days. Once streamflow triggered restrictions are implemented, they shall remain in place until streamflow at the gage meets or exceeds 1.9 cfs for seven (7) consecutive days.
Streamflow Triggered Restrictions	Nonessential outdoor water use is allowed: a) **two (2) days per week** before 9 am and after 5 pm when USGS stream gage 01110000 - Quinsigamond River at North Grafton, MA falls below: • May 1 – June 30: **24 cfs** for three (3) consecutive days • July 1 – September 30: **11 cfs** for three (3) consecutive days b) **one (1) day per week** before 9 am and after 5 pm when USGS stream gage 01110000 - Quinsigamond River at North Grafton, MA falls below **1.9 cfs** for three (3) consecutive days. Once implemented, the restrictions shall remain in place until streamflow at the gage meets or exceeds the trigger streamflow for seven (7) consecutive days.
For Permittees NOT meeting the 65 RGPCD standard for the preceding year RGPCD > 65 as reported in the ASR and accepted by MassDEP	
Calendar Triggered Restrictions	Nonessential outdoor water use is allowed **one (1) day per week** before 9 am and after 5 pm
Streamflow Triggered Restrictions	Nonessential outdoor water use is allowed **one (1) day per week** before 9 am and after 5 pm when USGS stream gage 01110000 - Quinsigamond River at North Grafton, MA falls below: • May 1 – June 30: **24 cfs** for three (3) consecutive days • July 1 – September 30: **11 cfs** for three (3) consecutive days Once implemented, the restrictions shall remain in place until streamflow at the gage meets or exceeds the trigger streamflow for seven (7) consecutive days.

Instructions for Accessing Streamflow and Drought Advisory Website Information

Streamflow information is available at the USGS National Water Information System (NWIS): Web Interface. The USGS NWIS default shows Massachusetts streamflows in real time, i.e., the most recent, usually quarterly hourly, reading made at each USGS stream gage.

Seasonal Limits on Nonessential Outdoor Water Use are implemented when the mean daily streamflow falls below the designated trigger. The mean daily flow is not calculated until after midnight each day when the USGS computes the hourly data into a mean daily streamflow. As a result, permittees must use the mean daily streamflow from the preceding day when tracking streamflows.

Mean daily streamflow gage readings are available at the USGS NWIS Web Interface at http://waterdata.usgs.gov/ma/nwis/current/?type=flow.

- Scroll down to 01110000 – Quinsigamond River at North Grafton, MA.
- Click on the gage number.
- Scroll down to "Provisional Date Subject to Revision – Available data for this site" and click on the drop down menu.
- Click on "Time-series: Daily data" and hit GO.
- Scroll down to the "Available Parameters" box. Within the box, be sure "Discharge (mean)" is checked, then, under "Output Format" click "Table" and hit GO.
- Scroll down to "Daily Mean Discharge, cubic feet per second" table and find the current date on the table.
- Compare the cubic feet per second (cfs) measurement shown on the table to the cfs shown under Streamflow Triggered Restrictions above.

Public Notice of Water Use Restrictions

Permittee shall notify its customers of the restrictions and the consequences of failing to adhere to the restrictions.

- For calendar-triggered restrictions, customers shall be notified by April 15th each year.
- For streamflow-triggered restrictions, when streamflow at the assigned USGS local stream gage falls below a streamflow trigger for three consecutive days, customers shall be notified as soon as possible, but within three days of implementing the restrictions.

Notice to customers shall include the following:

- A detailed description of the restrictions and penalties for violating the restrictions;
- The need to limit water use, especially nonessential outdoor water use, to ensure a sustainable drinking water supply and to protect natural resources and streamflow for aquatic life; and
- Ways individual homeowners can limit water use, especially nonessential outdoor water use.

Notice that restrictions have been put in place shall be filed each year with MassDEP within 14 days of the restriction's effective date. Filing shall be in writing on the form "Notification of Water Use Restrictions" available on MassDEP's website.

Notice to customers and MassDEP need not be provided if Permittee has already implemented water use restrictions that conform to the applicable restrictions and those restrictions are still in force.

8. Water Withdrawals that Exceed Baseline Withdrawal Volumes

Shrewsbury's baseline withdrawal volume (Baseline) is 3.91 MGD or 1,427.2 MGY. This Permit authorizes withdrawals for up to 4.35 MGD upon implementation of the MassDEP approved Mitigation Plan (attached with Appendices A and B) developed to credit measures to mitigate the impacts of withdrawals in excess of Baseline.

Shrewsbury's Mitigation Plan (inclusive of Appendices A and B) is attached hereto and incorporated herein. The Mitigation Plan was developed to reflect a three step process: 1.) Describe demand management measures that can be undertaken to postpone the need for withdrawals over Baseline; 2.) Calculate system-wide local wastewater returns through septic systems and groundwater discharge; and 3.) Describe those activities that can directly return water to the basin impacted by the withdrawals or provide other environmental benefits. Future revisions to the Mitigation Plan that involve new projects not described in the existing Mitigation Plan, shall make a written evaluation of the feasibility of adopting and implementing each of the following measures and any other measures identified by Shrewsbury or through consultation with MassDEP and other agencies of the Executive Office of Energy and Environmental Affairs (EEA).

Future revisions to the Mitigation Plan that involve new projects not described in the existing Mitigation Plan shall follow the mitigation hierarchy set forth in MassDEP's "Water Management Act Permit Guidance" (as amended). At the time that such proposed future revisions to the Mitigation Plan are submitted to MassDEP, Shrewsbury shall also forward a copy of the Plan to the Blackstone River Coalition.

Shrewsbury shall implement approved feasible mitigation measures commensurate with withdrawals in excess of Baseline and in accordance with a schedule to be developed in the Mitigation Plan.

Table 5: Mitigation Plan Components

1. Demand Management Demand management measures, in addition to the requirements of Special Condition 10, are included in mitigation planning as a means to control demand, and possibly lessen the volume of water that requires mitigation, and control the timing of implementation	• Adopt one day/week nonessential seasonal water use restrictions • Adopt a ban on nonessential seasonal water use
	Adopt a water bank • Traditional water and/or sewer bank • Institute "hook-up" fee for all new development with revenues to be dedicated to conservation and mitigation programs
	Increase billing frequency based on actual meter readings
	Install radio-read (remote) water meters
	Adopt a "best available technology" bylaw for irrigation systems
	Provide water saving devices (faucet aerators & low flow showerheads)
	Provide rebates for water efficient appliances
	Industrial, commercial or institutional water conservation programs
	Other measures to reduce demand and conserve water

Table 5: Mitigation Plan Components (continued)	
2. Calculate Local Wastewater Recharge Returns	Provide documentation in the Mitigation Plan of the portion of withdrawals over Baseline that will be returned to groundwater within the Blackstone River Basin via septic or permitted groundwater discharge
3. Mitigation Planning	
Wastewater improvements	Quantifiable I/I removal program
	Additional wastewater recharge through septic or treated groundwater discharge
Stormwater Management and Recharge	Adopt a stormwater utility or dedicated stormwater fees used to build and maintain stormwater infiltration facilities
	Adopt and implement MS4 requirements for municipality not subject to MS4 • Municipality subject to MS4 requirements can be considered for mitigation credits for successfully implemented MS4 measures
	Remove or retrofit and infiltrate targeted areas of impervious cover
Development Guidelines and Bylaws	Adopt a bylaw to extend water use restrictions to private wells
	Adopt Low Impact Development, Conservation Development and Smart Growth bylaws or regulations in addition to those implemented through the November 2001 Best Development Practices Guidebook
	Adopt land clearing/development bylaws (loan, native vegetation, site clearing limitations, lawn size limitations) in addition to those implemented through the November 2001 Best Development Practices Guidebook
Instream Flow Improvements - applicable to surface waters	Measures to be determined as applicable
Habitat Improvement	Install and maintain a fish ladder
	Remove a dam or other flow barrier
	Acquire/protect water supply or high quality natural resource lands
	Replace/resize identified culverts to improve habitat connectivity
	Restore stream buffers
	Establish and/or contribute to a mitigation fund for aquatic habitat restoration

9. Requirement to Report Raw and Finished Water Volumes

Shrewsbury shall report annually on its Annual Statistical Report the raw water volumes and finished water volumes for the entire water system and the raw water volumes for individual water withdrawal points.

10. Water Conservation Requirements

At a minimum, Shrewsbury shall implement the following conservation measures forthwith and shall be in compliance with these measures on or before February 28, 2017. Compliance with the water conservation requirements shall be reported to MassDEP upon request or by February 28, 2017, unless otherwise noted below.

Table 6: Minimum Water Conservation Requirements

System Water Audits and Leak Detection
1. At a minimum, conduct a full leak detection survey every three years. The first full leak detection survey shall be completed no later than 3 yrs from the date of last documented leak detection survey.
2. Perform a leak detection survey of those sections of the distribution system that have not been surveyed within the last year whenever the percentage of unaccounted for water increases by 5% or more (for example an increase from 3% to 8%) over the percentage reported on the ASR for the prior calendar year. Within 60 days of completing the leak detection survey, Permittee shall submit to MassDEP a report detailing the leak detection survey, any leaks uncovered as a result of the survey or otherwise, dates of repair and the estimated water savings as a result of the repairs.
3. Conduct field surveys for leaks and repair programs in accordance with the *AWWA Manual 36.*
4. Permittee shall have repair reports available for inspection by MassDEP. Permittee shall establish a schedule for repairing leaks that is at least as stringent as the following: • Leaks of 15 gallons per minute or more shall be repaired as soon as possible but not later than one month after leak detection.* • Leaks of less than 15 gallons per minute, but greater than 5 gallons per minute, shall be repaired as soon as possible but not later than two months after leak detection.* • Leaks of 5 gallons per minute or less shall be repaired as soon as possible but not later than six months after leak detection, except that hydrant leaks of one gallon or less per minute shall be repaired as soon as possible.* • Leaks shall be repaired in accordance with the priority schedule including leaks up to the property line, curb stop or service meter, as applicable. • Have water use regulations in place that require property owners to expeditiously repair leaks on their property. The following exceptions can be considered: • Repair of leakage detected during winter months can be delayed until weather conditions become favorable for conducting repairs;* and • Leaks in freeway, arterial or collector roadways may be coordinated with other scheduled projects being performed on the roadway.** *Reference: MWRA regulations 360 CMR 12.09 **Mass Highway or local regulations may regulate the timing of tearing up pavement on roads to repair leaks.
Metering
1. Calibrate all source and finished water meters at least annually and report date of calibration on the ASR.
2. Ensure that the system is 100% metered, including all water use at municipal facilities (schools, school athletic fields, etc.).

Metering (continued)
3. All water distribution system users shall have properly sized service lines and meters that meet AWWA calibration and accuracy performance standards. AWWA References: AWWA Manual M22 – Sizing Water Service Lines and Meters AWWA Manual M6 – Water Meters, or as amended
4. Permittee shall have an ongoing program to inspect individual service meters to ensure that all service meters accurately measure the volume of water used by your customers. The metering program shall include regular meter maintenance, including testing, calibration, repair, replacement and checks for tampering to identify and correct illegal connections.
5. Ensure placement of sufficient funds in the annual water budget to calibrate, repair, or replace meters as necessary.
Pricing
1. Implement a water revenue structure that includes the full cost of operating the water supply system in compliance with state and federal requirements by 3 years from permit issuance. Evaluate revenues every three to five years and adjust rates as needed. Full cost pricing factors all costs - operations, maintenance, capital, and indirect costs (environmental impacts, watershed protection) - into the revenue structure. AWWA References for Additional Information on Pricing: AWWA Manual 1- Principals of Water Rates, Fees and Charges AWWA Manual 29- Fundamentals of Water Utility Financing
2. Permittee reports using an increasing block rate structure and shall continue to do so.
Residential and Public Sector Conservation
1. Permittee shall meet the standards set forth in the Federal Energy Policy Act, 1992 and the Massachusetts Plumbing Code.
2. Meter or estimate water used by contractors using fire hydrants for pipe flushing and construction.
3. Municipal buildings • Shrewsbury has confirmed in writing to MassDEP that it has completed retrofitting its municipally owned public buildings with water saving devices (faucet aerators, low flow shower heads and low flow toilets) as of February 1, 2015.
Industrial and Commercial Water Conservation
1. Permittee shall review the use records for its industrial, commercial and institutional water users and develop an inventory of the largest water users. Permittee shall develop and implement an outreach program designed to inform and (where appropriate) work with its largest industrial, commercial and institutional water users on ways to reduce their water use. Such outreach plans can include, but are not limited to: information on water audits, meter sizing, water reuse, low-flow plumbing fixtures, mandatory outdoor water use restrictions, suggestions for contacting trade

Industrial and Commercial Water Conservation (continued)

associations for process specific information on water use reductions, and information on contacting the Executive Office of Environmental Affairs Office of Technical Assistance for Toxics Use Reduction (OTA) which offers a range of assistance and information to help facilities improve water use efficiency and reduce wastewater discharge. OTA can be contacted at (617) 626-1060 or at www.mass.gov/envir/ota.

2. Upon request by MassDEP, Permittee shall report on industrial, commercial and institutional water conservation including the results of its review of water use records for industrial, commercial and institutional water users, the inventory of the largest water users, copies of any outreach materials distributed to industrial, commercial and institutional water users, and to the extent practical, a summary of water use reductions or savings that have resulted. Upon receipt of this report, MassDEP will take whatever action it deems appropriate to promote the interests of the Water Management Act, including without limitation requiring Permittee to take additional actions to reduce industrial, commercial and institutional water use.

Lawn and Landscape

1. Shrewsbury adopted a water use restriction bylaw in May 2014 consistent with the requirements of this permit.

Public Education and Outreach

1. Develop and implement a Water Conservation Education Plan. Permittee's Water Conservation Education Plan shall be designed to educate Permittee's water customers of ways to conserve water. Without limitation, Permittee's plan may include the following actions:
    - Annual work sheets, included in water bills or under separate cover, to enable customers to track water use and conservation efforts and estimate the dollar savings;
    - Public space advertising/media stories on successes (and failures);
    - Conservation information centers perhaps run jointly with electric or gas company;
    - Speakers for community organizations;
    - Partner with garden clubs, or other private and non-profit organizations, to promote efficient water use;
    - Provide information on water-wise landscaping, gardening, efficient irrigation and lawn care practice;
    - Public service announcements; radio/T.V./audio-visual presentations;
    - Joint advertising with hardware stores to promote conservation devices;
    - Water conservation workshops for the general public
    - Use of civic and professional organization resources;
    - Special events such as Conservation Fairs;
    - Develop materials that are targeted to schools with media that appeals to children, including materials on water resource projects and field trips; and
    - Make multilingual materials available as needed.

References and additional information available through the USEPA Water Sense Program at http://www.epa.gov/watersense.

2. Upon request of MassDEP, Permittee shall report on its public education and outreach effort, including a summary of activities developed for specific target audiences, any events or activities sponsored to promote water conservation and copies of written materials.

GENERAL PERMIT CONDITIONS (applicable to all permittees)

No withdrawal in excess of 100,000 gallons per day over the registered volume (if any) shall be made following the expiration of this permit, unless before that date MassDEP has received a renewal permit application pursuant to 310 CMR 36.00.

1. **Duty to Comply** The permittee shall comply at all times with the terms and conditions of this permit, the Act and all applicable State and Federal statutes and regulations.

2. **Operation and Maintenance** The permittee shall at all times properly operate and maintain all facilities and equipment installed or used to withdraw water so as not to impair the purposes and interests of the Act.

3. **Entry and Inspections** The permittee or the permittee's agent shall allow personnel or authorized agents or employees of MassDEP to enter and examine any property for the purpose of determining compliance with this permit, the Act or the regulations published pursuant thereto, upon presentation of proper identification and an oral statement of purpose.

4. **Water Emergency** Withdrawal volumes authorized by this permit are subject to restriction in any water emergency declared by MassDEP pursuant to MGL c 21G ss 15-17, MGL c 150 ss 111, or any other enabling authority.

5. **Transfer of Permits** This permit shall not be transferred in whole or in part unless and until MassDEP approves such transfer in writing, pursuant to a transfer application on forms provided by MassDEP requesting such approval and received by MassDEP at least thirty (30) days before the effective date of the proposed transfer. No transfer application shall be deemed filed unless it is accompanied by the applicable transfer fee established by 310 CMR 36.37.

6. **Duty to Report** The permittee shall complete and submit annually, on a form provided by MassDEP, all of the information required by said form including, without limitation, a certified statement of the withdrawal. Such report shall be received by MassDEP by the date specified on the form each year. Such report must be mailed or hand delivered to:

   Department of Environmental Protection
   Water Management Program
   One Winter Street, 5th Floor
   Boston, MA 02108

7. **Duty to Maintain Records** The permittee shall maintain withdrawal records and other information in sufficient detail to demonstrate compliance with this permit.

8. **Metering** The withdrawal point(s) included within this permit are metered and shall be calibrated annually. Meters shall be maintained and replaced as necessary to ensure the accuracy of the withdrawal records.

APPEAL RIGHTS AND TIME LIMITS

The January 21, 2014 Water Management Act permit issued by MassDEP was appealed and docketed with OADR as In the Matter of the Town of Shrewsbury – WMA Permit, OADR Docket No. 2014-002. That appeal has been settled by all of the parties, resulting in issuance of this Modified Permit. Consequently, no further appeal may be filed, not only because the appeal period has passed but because the sole appeal filed has been settled and that settlement has been accepted by the Commissioner of DEP, who is the final agency decision-maker for administrative appeals. The Final Decision approving and incorporating the Settlement Agreement and Modified Water Management Act Permit (Permit #9P4-2-12-271.01) was signed and issued by MassDEP on June 17, 2015.

Issuance Date: July 2, 2015

By: Marielle Stone

Marielle Stone
Deputy Regional Director – CERO
Bureau of Water Resources
8 New Bond Street
Worcester, MA 01606

Appendix A – Residential Gallons Per Capita Day (RGPCD)

I. Compliance Plan Requirement

If the permittee fails to achieve and document compliance with the RGPCD performance standard in its Annual Statistical Report (ASR), then the permittee must file with that ASR a Residential Gallons Per Capita Day Compliance Plan (RGPCD Plan) which shall:

a. meet the requirement set forth below in Section II;
b. include measures to be implemented to meet the performance standard); and
c. include the schedule for implementing such measures.

The filing of an RGPCD Plan shall not constitute a return to compliance, nor shall it affect MassDEP's authority to take action in response to the permittee's failure to meet the performance standard.

If an RGPCD Plan is required, the permittee must:

a. submit information and supporting documentation sufficient to demonstrate compliance with its RGPCD Plan annually at the time it files its ASR; and
b. continue to implement the RGPCD Plan until it complies with the performance standard and such compliance is documented in the permittee's ASR for the calendar year in which the standard is met.

II. Contents of an RGPCD Plan

A permittee that does not meet the 65 RGPCD performance standard within 2 years, has the choice to file an RGPCD Plan containing measures that the permittee believes will be sufficient to bring the system into compliance with the performance standard (Individual RGPCD Plan) or may adopt the MassDEP RGPCD Functional Equivalence Plan that includes mandated Best Management Practices (BMPs).

A permittee that has been unable to meet the 65 RGPCD performance standard within 5 years must implement the MassDEP RGPCD Functional Equivalence Plan to be considered functionally equivalent with the performance standard.

At a minimum, all RGPCD Compliance Plans must include a detailed:

a. description of the actions taken during the prior calendar year to meet the performance standard;
b. analysis of the cause of the failure to meet the performance standard;
c. description and schedule of the actions that will be taken to meet the performance standard; and
d. analysis of how the actions described in c. will address the specific circumstances that resulted in the failure to meet the performance standard.

RGPCD Plans may be amended to revise the actions that will be taken to meet the performance standard.

Individual RGPCD Plan

Individual RGPCD Plan will document a plan to adopt and implement measures tailored to the specific needs of the water supply system that the permittee believes will be sufficient to bring the system into compliance with the performance standard within three years.

At a minimum, all Individual RGPCD Plans for failure to meet the RGPCD performance standard must include implementation of at least one of the following residential conservation programs:

a. a program that provides water saving devices such as faucet aerators and low flow shower heads at cost;
b. a program that provides rebates or other incentives for the purchase of low water use appliances (washing machines, dishwashers, and toilets); or
c. the adoption and enforcement of an ordinance, bylaw or regulation to require the installation of moisture sensors or similar climate related control technology on all automatic irrigation systems.

If the permittee is already implementing one or more of these programs, it must include in its Individual RGPCD Plan the continued implementation of such program(s), as well as implementation of at least one additional program. All programs must include a public information component designed to inform customers of the program and to encourage participation in the program.

Without limitation, the Individual RGPCD Plan for failure to meet the RGPCD performance standard may include any of the actions set forth in the MassDEP RGPCD Functional Equivalence Plan below.

MassDEP RGPCD Functional Equivalence Plan

In order to be considered functionally equivalent with the RGPCD performance standard, the permittee must adopt and implement the MassDEP RGPCD Functional Equivalence Plan that requires all the following residential conservation programs:

a. a program that provides water saving devices such as faucet aerators and low flow shower heads at cost;
b. a program that provides rebates or other incentives for the purchase of low water use appliances (washing machines, dishwashers, and toilets);
c. the adoption and enforcement of an ordinance, bylaw or regulation to require the installation of soil moisture sensors or similar climate related control technology on all automatic irrigation systems;
d. the use of an increasing block water rate or a seasonal water rate structure as a tool to encourage water conservation;
e. the adoption and enforcement of an ordinance, bylaw or regulation to require that all new construction include water saving devices and low water use appliances; and
f. the implementation of monthly or quarterly billing.

Hardship

A permittee may present an analysis of the cost effectiveness of implementing certain conservation measures included in the MassDEP RGPCD Functional Equivalence Plan and offer alternative measures. Any analysis must explicitly consider environmental impacts and must produce equal or greater environmental benefits. Suppliers will be able to present:

a. Reasons why specific measures are not cost effective because the cost would exceed the costs of alternative methods of achieving the appropriate standard;
b. Alternative specific conservation measures that would result in equal or greater system-wide water savings or equal or greater environmental benefits than the conservation measures included in the MassDEP RGPCD Functional Equivalence Plan; and
c. When applicable, an analysis demonstrating that implementation of specific measures will cause or exacerbate significant economic hardship.

Appendix B – Unaccounted for Water (UAW)

UAW is defined as the residual resulting from the total amount of water supplied to a distribution system as measured by master meters, minus the sum of all amounts of water measured by consumption meters in the distribution systems, and minus confidently estimated and documented amounts used for certain necessary purposes.

UAW shall include, without limitation: unavoidable leakage, recoverable leakage, meter inaccuracies (unless they fall under the category of source meter calibration which allows for adjustment per results of source meter calibration); errors in estimation of stopped meters, unauthorized hydrant openings, illegal connections, stand pipe overflows, data processing errors; and undocumented fire fighting uses. The need for water main flushing and the use of water in construction or meter calibration shall be metered or estimated as appropriate to assist in determining actual demand. Volumes flushed to waste shall be reported on permittee's ASR.

Uses that can be confidently estimated and documented in writing include: storage tank overflow and drainage; water main flushing and flow testing; fire fighting; bleeding or blow-offs; sewer and storm water system flushing; and cleaning and street cleaning. Any adjustments made as a result of the properly documented source meter calibration shall be provided as required by the ASR. Any adjustment in the calculation of UAW made as a result of confidently estimated uses shall be fully documented as required in the ASR.

I. Compliance Plan Requirement

If the permittee fails to document compliance with the UAW performance standard in its Annual Statistical Report (ASR), then the permittee must file with that ASR an Unaccounted for Water Compliance Plan (UAW Plan) which shall:

a. meet the requirements set forth below in Section II;
b. include measures to be implemented to meet the performance standard; and
c. include the schedule for implementing such measures.

The filing of a UAW Plan shall not constitute a return to compliance, nor shall it affect MassDEP's authority to take action in response to the permittee's failure to meet the performance standard.

If a UAW Plan is required, the permittee must:

a. submit information and supporting documentation sufficient to demonstrate compliance with its UAW Plan annually at the time it files its ASR; and
b. continue to implement the UAW Plan until it complies with the performance standard and such compliance is documented in the permittee's ASR for the calendar year in which the standard is met.

II. Contents of a UAW Compliance Plan

A permittee that does not meet the 10% UAW performance standard within 2 years, has the choice to file a UAW Plan containing measures that the permittee believes will be sufficient to bring the system into compliance with the performance standard (Individual UAW Plan) or may adopt the MassDEP UAW Functional Equivalence Plan that includes mandated Best Management Practices (BMPs).

A permittee that has been unable to meet the 10% UAW performance standard within 5 years must implement the MassDEP UAW Functional Equivalence Plan to be considered functionally equivalent with the performance standard.

At a minimum, all UAW plans must include a detailed:

a. description of the actions taken during the prior calendar year to meet the applicable performance standard;
b. analysis of the cause of the failure to meet the performance standard;
c. description and schedule of the actions that will be taken to meet the performance standard; and
d. analysis of how the actions described in c. will address the specific circumstances that resulted in the failure to meet the performance standard.

UAW plans may be amended to revise the actions that will be taken to meet the performance standard.

Individual UAW Compliance Plan

Individual UAW Plan will document a plan to adopt and implement measures tailored to the specific needs of the water supply system that the permittee believes will be sufficient to bring the system into compliance with the performance standard within three years. Individual UAW compliance plans may include any of the actions set forth in the MassDEP UAW Functional Equivalence Plan compliance plan below.

MassDEP UAW Functional Equivalence Plan

In order to be considered functionally equivalent with the UAW performance standard, the permittee must adopt and implement the MassDEP UAW Functional Equivalence Plan that, at a minimum, requires all the following measures:

a. within one year of filing the MassDEP UAW Functional Equivalence Plan, complete a water audit and leak detection survey of the entire system and submit completed audit and survey to MassDEP;
   within one year of completing the audit and leak detection survey, conduct sufficient repairs to reduce by 75% (by water volume) all leaks detected in the survey;
   within one year of completing such repairs, conduct additional repairs of leaks detected in the survey as may be necessary to reduce permittee's UAW to 10% or the minimum level possible;
b. if UAW remains above 10%, repeat the steps outlined in paragraph a.;
c. implementation of a program that ensures the inspection and evaluation of all water meters and, as appropriate, the repair, replacement and calibration of water meters in accordance with the following schedule:
   Large Meters (2" or greater) - within one year of filing the MassDEP UAW Functional Equivalence Plan
   Medium Meters (1" or greater and less than 2") - within two years of filing the MassDEP UAW Functional Equivalence Plan
   Small Meters (less than 1") - within three years of filing the MassDEP UAW Functional Equivalence Plan;
d. implementation of monthly or quarterly billing within three years of fling the MassDEP UAW Functional Equivalence Plan; and
e. within one year of filing the MassDEP UAW Functional Equivalence Plan, implementation of a water pricing structure that achieves sufficient revenues to pay the full cost of operating the system including, without limitation, the costs of repairs under paragraph a.,

the costs of meter repairs, replacements and calibrations under paragraph c., the costs of employees and equipment, and ongoing maintenance and capital costs.

Hardship

A permittee may present an analysis of the cost effectiveness of implementing certain conservation measures included in the MassDEP UAW Functional Equivalence Plan and offer alternative measures. Any analysis must explicitly consider environmental impacts and must produce equal or greater environmental benefits. Suppliers will be able to present:

a. Reasons why specific measures are not cost effective because the cost would exceed the costs of alternative methods of achieving the appropriate standard;
b. Alternative specific conservation measures that would result in equal or greater system-wide water savings or equal or greater environmental benefits than the conservation measures included in the MassDEP UAW Functional Equivalence Plan; and
c. When applicable, an analysis demonstrating that implementation of specific measures will cause or exacerbate significant economic hardship.

APPENDIX B

MWRA METRO-SYSTEM ASSESSMENT HISTORY: FY85 THROUGH FINAL PFY16 CEB

Year	Adopted Water Charges	Yearly % Increase	Cost Per Million Gallons[2]	Adopted Sewer Charges	Yearly % Increase	Adopted Total Charges	Yearly % Increase
FY85[1]	$21,085,915			$24,942,796		$46,028,711	
FY86	$24,846,758	17.8%	$269.00	$33,922,203	36.0%	$58,768,961	27.7%
FY87	$30,350,802	22.2%	$325.00	$60,337,195	77.9%	$90,687,997	54.3%
FY88	$33,381,878	10.0%	$357.00	$66,809,000	10.7%	$100,190,878	10.5%
FY89	$45,241,735	35.5%	$469.00	$92,518,378	38.5%	$137,760,113	37.5%
FY90	$49,265,228	8.9%	$511.00	$121,798,694	31.6%	$171,063,922	24.2%
FY91	$50,626,466	2.8%	$565.00	$134,724,802	10.6%	$185,351,268	8.4%
FY92	$58,338,045	15.2%	$664.00	$184,951,898	37.3%	$243,289,943	31.3%
FY93	$60,298,678	3.4%	$700.00	$230,205,027	24.5%	$290,503,705	19.4%
FY94	$63,877,477	5.9%	$792.00	$240,481,314	4.5%	$304,358,791	4.8%
FY95	$63,380,742	-0.8%	$801.00	$240,978,049	0.2%	$304,358,791	0.0%
FY96	$65,484,268	3.3%	$829.00	$242,951,330	0.8%	$308,435,598	1.3%
FY97	$65.533,762	0.1%	$852.68	$256,371,324	5.5%	$321,905,086	4.4%
FY98	$71,978,645	9.8%	$949.99	$265,013,192	3.4%	$336,991,837	4.7%
FY99	$74,005,347	2.8%	$964.29	$271,489,393	2.4%	$345,494,740	2.5%
FY00	$82,097,061	10.9%	$1,074.20	$281,594,845	3.7%	$363,691,906	5.3%
FY01	$93,184,298	13.5%	$1,205.72	$283,157,893	0.6%	$376,342,191	3.5%
FY02	$102,347,359	9.8%	$1,395.64	$287,171,112	1.4%	$389,518,471	3.5%
FY03[3]	$112,507,564	9.9%	$1,492.69	$304,151,791	5.9%	$416,659,355	6.97%
FY04[4]	$123,140,011	6.8%	$1,629.74	$308,626,801	1.5%	$431,766,812	2.9%
FY05	$133,043,167	8.0%	$1,794.17	$311,225,479	0.8%	$444,268,646	2.9%
FY06	$156,535,681	17.7%	$2,168.56	$315,684,120	1.4%	$472,219,801	6.3%
FY07	$163,124,954	4.2%	$2,216.72	$332,233,810	5.2%	$495,358,764	4.9%
FY08	$168,292,702	3.2%	$2,398.98	$349,505,130	5.2%	$517,797,832	4.5%
FY09	$180,249,266	7.1%	$2,514.49	$360,569,734	3.2%	$540,819,000	4.4%
FY10	$179,090,225	-0.6%	$2,660.73	$382,340,775	6.0%	$561,431,000	3.8%
FY11	$180,219,815	0.6%	$2,786.89	$389,580,185	1.9%	$569,800,000	1.5%
FY12	$183,885,531	2.0%	$2,760.96	$405,814,469	4.2%	$589,700,000	3.5%
FY13	$196,001,401	6.6%	$3,032.39	$411,510,599	1.4%	$607,512,000	3.0%
FY14	$203,216,774	3.7%	$3,124.91	$425,504,226	3.4%	$628,721,000	3.5%
FY15	$210,233,607	3.5%	$3,239.66	$440,082,175	3.4%	$650,315,782	3.4%
FY16	$226,372,877	7.7%	$3,488.04	$450,622,123	2.4%	$676,995,000	4.1%
Projected							
FY17	$230,477,203	1.8%	$3,551.28	$472,847,690	4.9%	$703,324,893	3.9%
FY18	$251,879,846	9.3%	$3,881.06	$480,000,752	1.5%	$731,880,598	4.1%
FY19	$256,637,351	1.9%	$3,954.37	$507,249,173	5.7%	$763,886,524	4.4%
FY20	$271,552,492	5.8%	$4,184.18	$542,072,303	6.9%	$813,624,794	6.5%
FY21	$289,994,704	6.8%	$4,468.35	$538,387,304	-0.7%	$828,382,008	1.8%
FY22	$306,870,243	5.8%	$4,728.37	$561,824,720	4.4%	$868,694,964	4.9%
FY23	$323,411,844	5.4%	$4,983.25	$516,661,740	-8.0%	$840,073,584	-3.3%
FY24	$322,903,519	-0.2%	$4,975.42	$502,709,950	-2.7%	$825,613,469	-1.7%
FY25	$311,543,934	-3.5%	$4,800.39	$493,083,625	-1.9%	$804,627,559	-2.5%
Average - all years		7.1%			8.6%		7.9%
Average - FY06-PFY16		5.1%			3.4%		3.9%
Average - FY17-FY25		3.7%			1.1%		2.0%
Average - FY17-FY20		4.7%			4.7%		4.7%

[1] The Commonwealth of Massachusetts subsidized $5.9 million in water and sewer costs in FY85.

[2] The projected FY16-FY24 cost per million gallons of water based on CY2013 community water use.

[3] Includes the FY03 mid-year assessment adjustment. Does not include Southborough or Marlborough which were added to the rate base in FY04.

[4] FY04 increase based on estimated FY03 water charges for Southborough and Marlborough. Includes debt service assistance (DSA).

MASSACHUSETTS WATER RESOURCES AUTHORITY
100 First Avenue, Charlestown Navy Yard, Boston, MA 02129

WATER QUALITY UPDATE

An Analysis of March 2015 Sampling Data

For more information, please contact MWRA at (617) 242-5323, or visit www.mwra.com.

March 2015 Highlights

•**In March, MWRA met all regulatory targets for pathogen inactivation at Brutsch Water Treatment Facility and Carroll Water Treatment Plant**, achieving greater than 99% *Cryptosporidium* inactivation and 99.9% *Giardia* inactivation at all times. Less than 5% Off-Spec water was produced. See pages 5 and 6.

•**Carroll Water Treatment Plant has completed winter maintenance.** During this period, half the plant is removed from service. Train A was off-line from Jun 5, 2015 through March 13, 2015. Train B was off-line from October 29, 2014 through December 20, 2014. All scheduled maintenance was successfully completed.

•**MWRA met all regulatory targets for the month**. No community violated the Total Coliform Rule criteria. See Page 7.

•**Did you know** that MWRA's web site has an archive of Monthly Water Quality Updates from 2001 onward at **http://www.mwra.com/monthly/wqupdate/qual3wq.htm**?

•**To reduce printing and postage costs and also to provide the most detailed version, starting in 2015 MWRA has switched to an electronic distribution of the report**. If you still receive the a printed copy of the report and would like to switch, please call (617) 242-5323 or email Joshua.Das@mwra.com.

We are continually updating the report. Let us know what you think *(617) 242-5323*

Call *(617) 242-5323 or email Joshua.Das@mwra.com*

Release Date: April 20, 2015

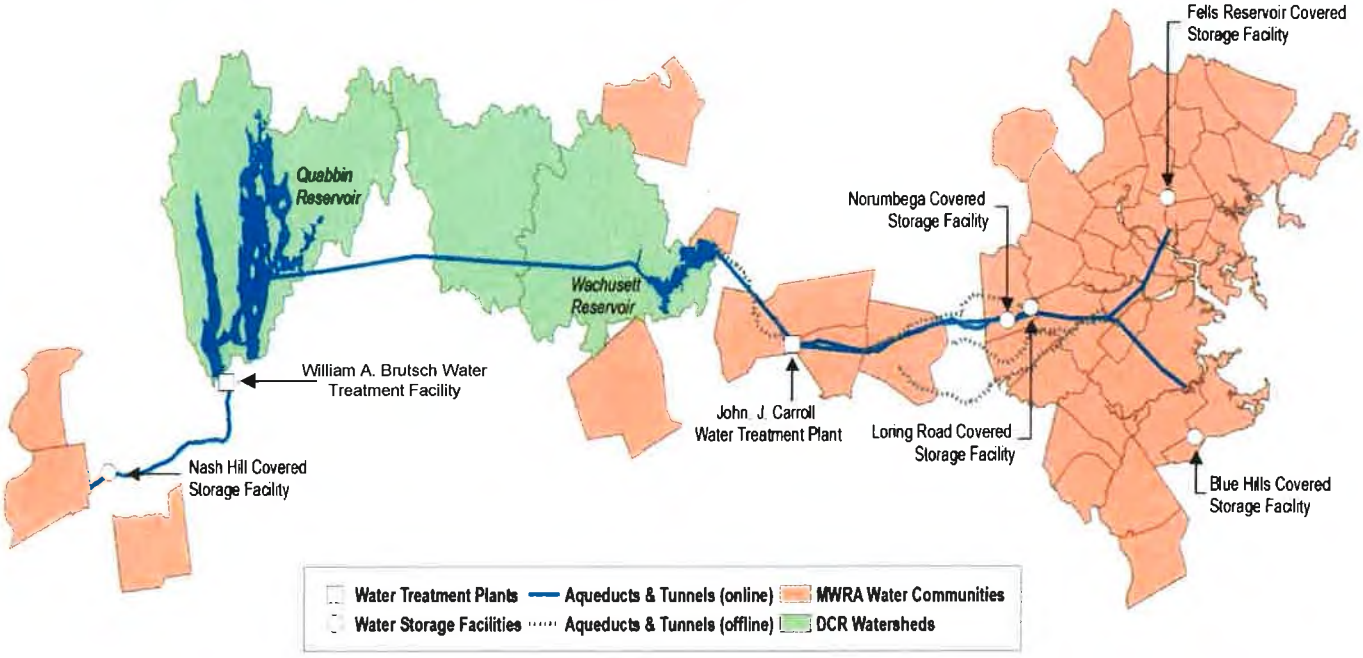
Water Quality Update
This is a monthly report containing information about the quality of water supplied by MWRA. It provides a more detailed review of water quality than the annual water quality report that is mailed each June to customers in our service area. The report is available at www.mwra.com. Note that some data listed within this report is provisional and subject to verification and correction

The Water System
The MWRA supplies wholesale water to local water departments in 51 communities, 45 in greater Boston and MetroWest, three in Western Massachusetts, and as a back-up supply for three others. Each municipality is responsible for distributing the water within its own community. More than two million people are served by the MWRA water supply system, and about 200 million gallons are supplied each day.

Quabbin Reservoir is the primary source of water for our system and one of the country's largest water supply impoundments, with a capacity of 412 billion gallons. Quabbin water represents source water for the Chicopee Valley Aqueduct (CVA) system. Water is transferred from Quabbin Reservoir to the 65 billion gallon Wachusett Reservoir in Clinton via the Quabbin Aqueduct. Wachusett water represents source water for MetroWest and Metropolitan Boston communities.

The 401-square mile watershed areas of the Quabbin and Wachusett Reservoirs are naturally protected with over 85% of the watersheds covered in forest and wetlands. The Department of Conservation and Recreation (DCR), which manages the watersheds, and MWRA are committed to safety of the water supply through intensive watershed protection as the first line of defense against water contamination.

The map below indicates the location of reservoirs, treatment facilities, and service communities.



Indicators of Water Quality

Tests are conducted on water sampled at the source reservoirs (source or "raw water") and also on water after treatment ("treated water"). MWRA routinely monitors for a variety of parameters that tell us about the disinfection, corrosivity, and the organic and inorganic constituents in the water. The Federal Safe Drinking Water Act (SDWA) sets standards for source and treated water quality. The standards relate to coliform, turbidity, watershed protection, disinfection and disinfection by-products, pathogens, and over 120 potential chemical contaminants. Testing frequencies vary by parameter.

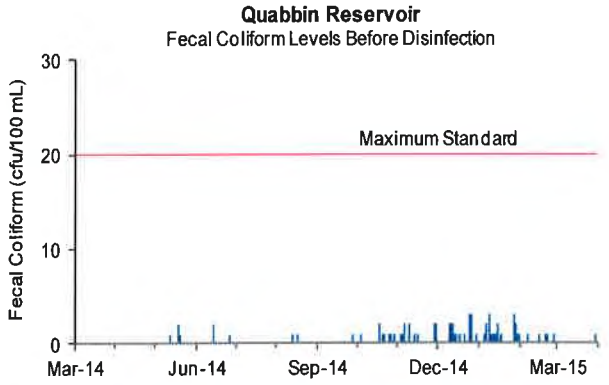
Customer communities must also meet certain standards under the SDWA concerning distribution of treated drinking water. The Total Coliform Rule (TCR) helps to alert communities to possible microbial contamination as well as the adequacy of residual disinfection within the local distribution system. MWRA tests over 2,000 samples per month. Under the SDWA, a violation of the TCR occurs when greater than 5% of the samples in a community are positive for total coliform during a month.

Source Water – Microbial and UV Results
March 2015

Source Water - Microbial Results
Total coliform bacteria are monitored in both source and treated water to provide an indication of overall bacteriological activity. Most coliforms are harmless. However, fecal coliform, a subclass of the coliform group, are identified by their growth at temperatures comparable to those in the intestinal tract of mammals. They act as indicators of possible fecal contamination. The Surface Water Treatment Rule for unfiltered water supplies allows for no more than 10% of source water samples prior to disinfection over any six-month period to have more than 20 fecal coliforms per 100mL.

Sample Site: Quabbin Reservoir
Quabbin Reservoir water is sampled at the William A. Brutsch Water Treatment Facility raw water tap before being treated and entering the CVA system.

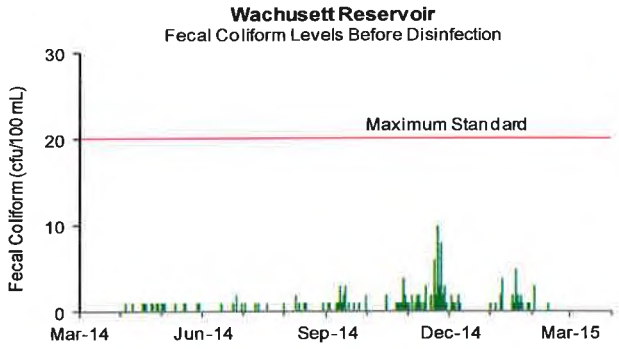
One of the 31 samples was positive during March. None of the samples exceeded a count of 20 cfu/100mL. **For the current six-month period, 0.0% of the samples have exceeded a count of 20 cfu/100mL.**



Sample Site: Wachusett Reservoir
Wachusett Reservoir water is sampled at the CWTP raw water tap in Marlborough before being treated and entering the MetroWest/Metropolitan Boston systems.

In the wintertime when smaller water bodies near Wachusett Reservoir freeze up, many waterfowl will roost in the main body of the reservoir - which freezes later. This increased bird activity tends to increase fecal coliform counts. DCR has an active bird harassment program to move the birds away from the intake area.

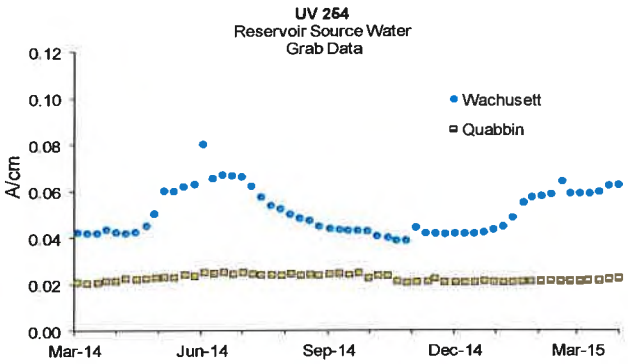
None of the 31 samples were positive during March. None of the samples exceeded a count of 20 cfu/100mL. **For the current six-month period, 0.0% of the samples have exceeded a count of 20 cfu/100mL.**



Source Water - UV Absorbance
UV Absorbance at 254nm wavelength (UV-254), is a measure of the amount and reactivity of natural organic material in source water. Higher UV-254 levels cause increased ozone and chlorine demand resulting in the need for higher ozone and chlorine doses, and can increase the level of disinfection by-products. UV-254 is impacted by tributary flows, water age, sunlight and other factors. Hurricanes can have a significant and long lasting impact.

Quabbin Reservoir UV-254 levels are currently around 0.023 A/cm.

Wachusett Reservoir UV-254 levels are currently around 0.063 A/cm.



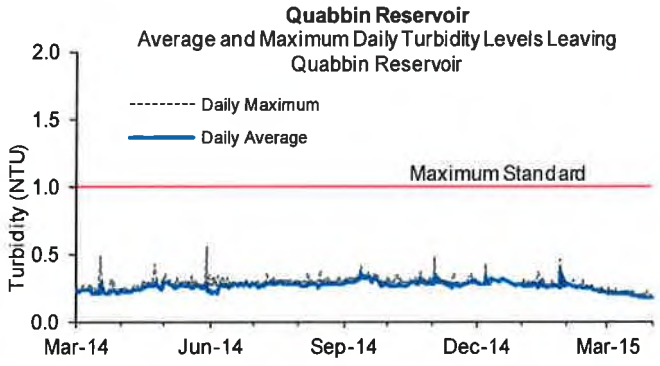
Source Water – Turbidity and Algae Results
March 2015

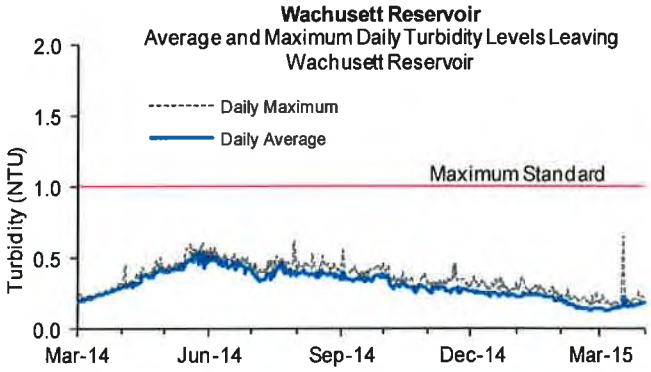
Source Water - Turbidity Results

Turbidity is a measure of suspended and colloidal particles including clay, silt, organic and inorganic matter, algae and microorganisms. The effects of turbidity depend on the nature of the matter that causes the turbidity. High levels of particulate matter may have a higher disinfectant demand or may protect bacteria from disinfection effects, thereby interfering with the disinfectant residual throughout the distribution system.

There are two standards for turbidity: all water must be below 5 NTU (Nephelometric Turbidity Units), and water can only be above 1 NTU if it does not interfere with effective disinfection.

Turbidity of Quabbin Reservoir water is monitored continuously at the William A. Brutsch Water Treatment Facility (WABWTF) before chlorination. Turbidity of Wachusett Reservoir is monitored continuously at the Carroll Water Treatment Plant (CWTP) before ozonation. Maximum turbidity results at Quabbin and Wachusett were within standards for the month.



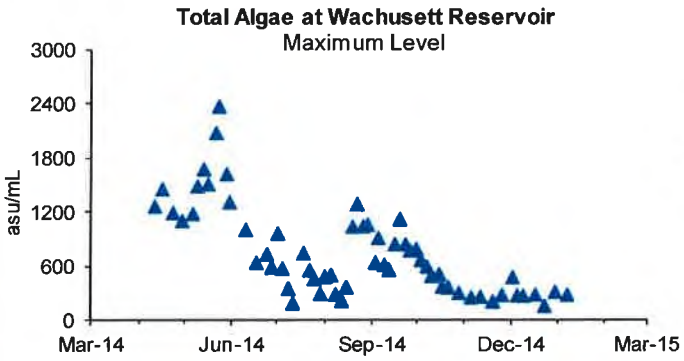


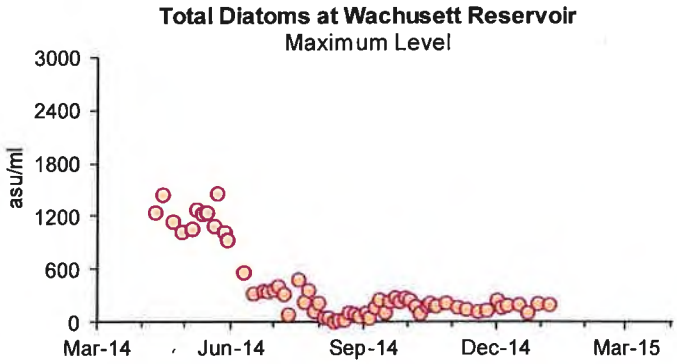
Source Water - Algae Levels

Algae levels in Wachusett Reservoir are monitored by DCR and MWRA. These results, along with taste and odor complaints, are used to make decisions on source water treatment for algae control.

Taste and odor complaints at the tap may be due to algae, which originate in source reservoirs, typically in trace amounts. Occasionally, a particular species grows rapidly, increasing its concentration in water. When *Synura*, *Anabaena*, or other nuisance algae bloom, MWRA may treat the reservoir with copper sulfate, an algaecide. During the winter and spring, diatom numbers may increase. While not a taste and odor concern, consumers using filters may notice more frequent changing of the filters is needed.

No complaints which may be related to algae were reported during March from local water departments. There have been no samples collected since January 6, 2015 as significant ice cover on the reservoir prevents safe algae sampling.



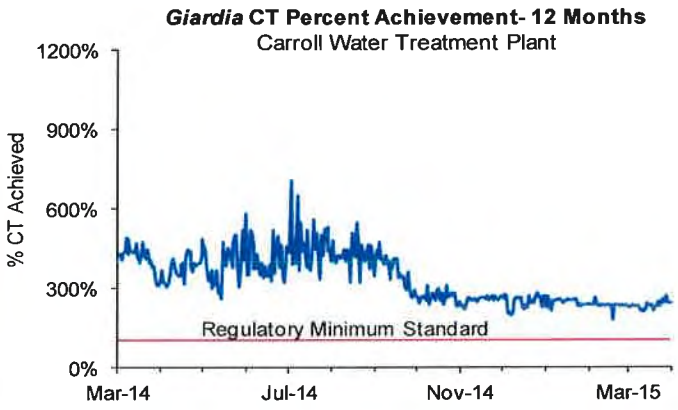


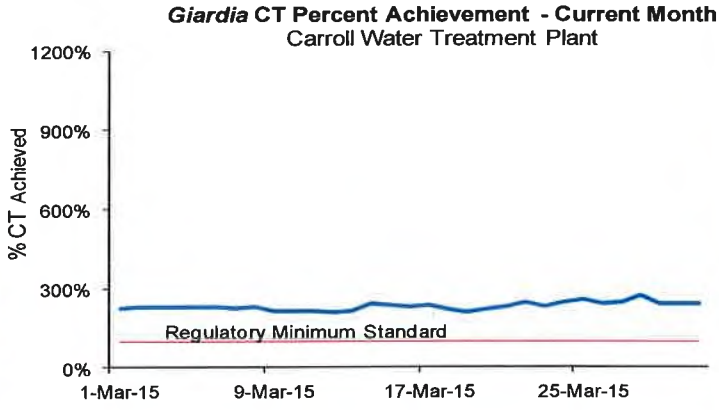
Treated Water – Disinfection Results
March 2015

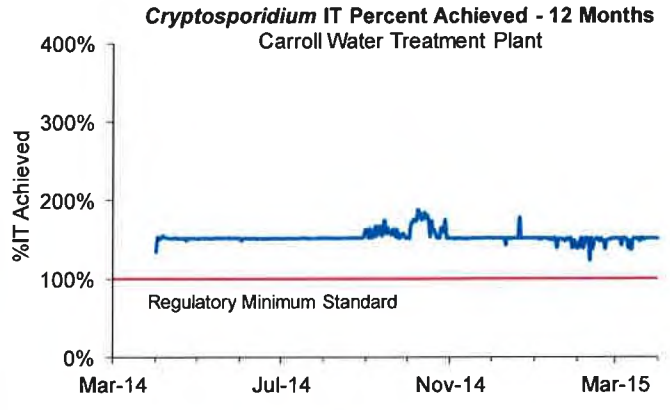
Treated Water - Primary Disinfection
At the Carroll Water Treatment Plant (CWTP), MWRA meets the required 99.9% (3-log) inactivation of *Giardia* using ozone (reported as CT: concentration of disinfectant x contact time) and the required 99% (2-log) inactivation of *Cryptosporidium* using UV (reported as IT: intensity of UV x time). MWRA calculates inactivation rates hourly and reports *Giardia* inactivation at maximum flow and *Cryptosporidium* inactivation at minimum UV dose. MWRA must meet 100% of required CT and IT.

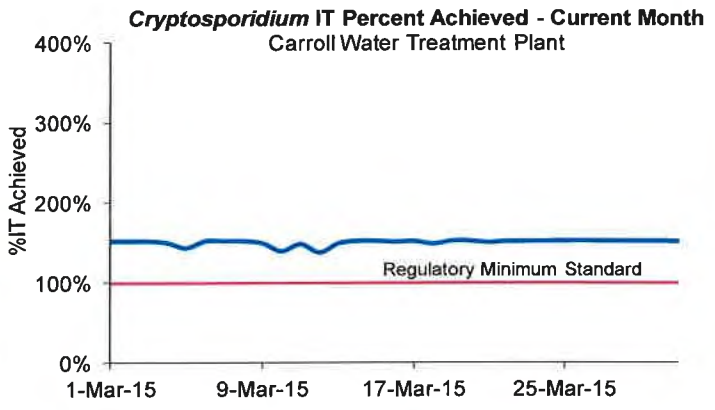
CT achievement for *Giardia* assures CT achievement for viruses, which have a lower CT requirement. For *Cryptosporidium*, there is also an "off-spec" requirement. Off-spec water is water that has not reached the full required UV dose or if the UV reactor is operated outside its validated ranges. No more than 5% off-spec water is allowed in a month.

Wachusett Reservoir - MetroWest/MetroBoston Supply:
- Ozone dose at the CWTP varied between 1.5 to 1.7 mg/L for March.
- *Giardia* CT was maintained above 100% at all times the plant was providing water into the distribution system for March.
- *Cryptosporidium* IT was maintained above 100% during the month. Off-spec water was less than 5%.





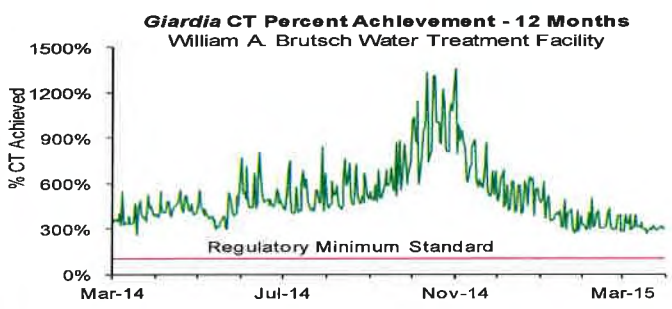


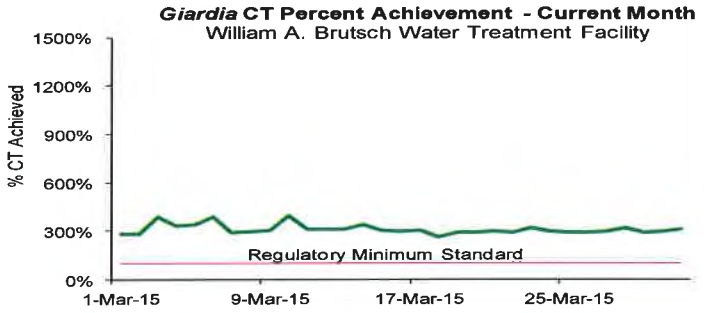


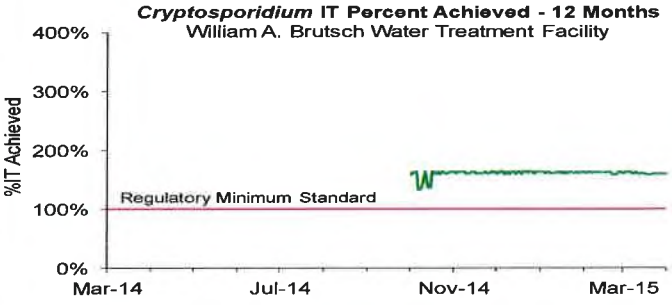
Treated Water – Disinfection, pH and Alkalinity Results
March 2015

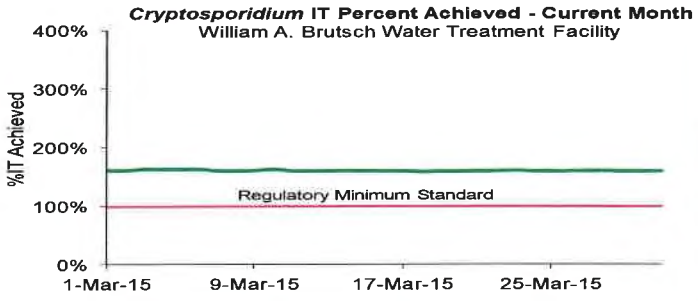
Quabbin Reservoir at William A. Brutsch Water Treatment Facility (WABWTF) (CVA Supply):

- The chlorine dose at WABWTF is adjusted in order to achieve MWRA's seasonal target of >0.75 mg/L (November 01 – May 31) and >1.0 mg/L (June 1– October 31) at Ludlow Monitoring Station.
- The chlorine dose at WDF was 1.3 mg/L for March.
- *Giardia* CT was maintained above 100% at all times the plant was providing water into the distribution system for March.
- *Cryptosporidium* IT was maintained above 100% during the month. Off-spec water was less than 5%.





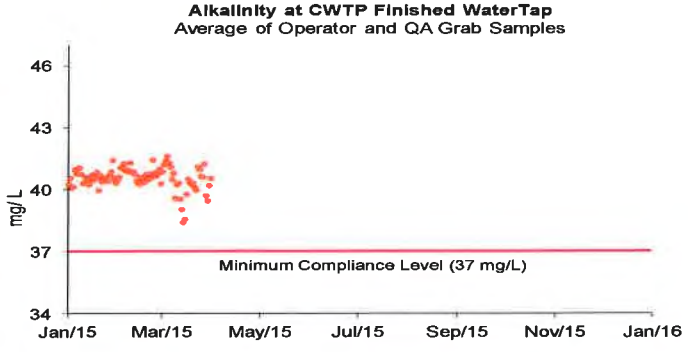


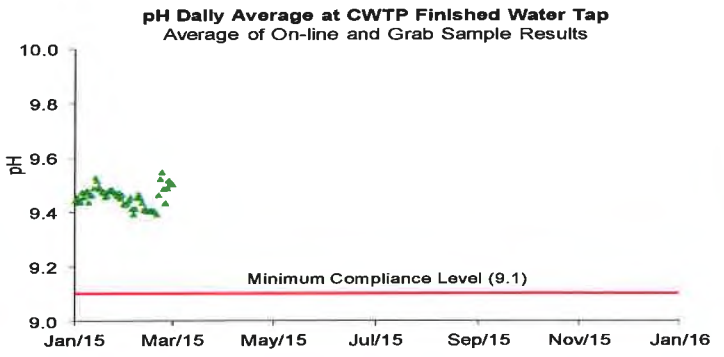


Treated Water - pH and Alkalinity Compliance:

MWRA adjusts the alkalinity and pH of Wachusett water to reduce its corrosivity, which minimizes the leaching of lead and copper from service lines and home plumbing systems into the water. MWRA's target for distribution system pH is 9.3; the target for alkalinity is 40 mg/L. Per DEP requirements, samples from the CWTP Fin B tap have a minimum compliance level of 9.1 for pH and 37 mg/L for alkalinity. Samples from 27 distribution system taps have a minimum compliance level of 9.0 for pH and 37 mg/L for alkalinity. Results must not be below this level for more than 9 days in a six-month period. MWRA tests finished water pH and alkalinity daily at the CWTP Fin B sampling tap. When CWTP undergoes winter maintenance, samples are collected at the CWTP Fin A sampling tap. Distribution system samples are collected in March, June, September, and December.

Distribution system samples were collected on March 11 and 12, 2015. Distribution system sample pH ranged from 9.4 to 9.7 and alkalinity ranged from 30 to 43 mg/L. In March and over the past six months, no sample results were below the target levels.





Bacteria & Chlorine Residual Results for Communities in MWRA Testing Program
March 2015

While all communities collect bacteria samples and chlorine residual data for the Total Coliform Rule (TCR), data from the 44 systems that use MWRA's Laboratory are reported below.

The MWRA TCR program has 142 sampling locations. These locations include sites along MWRA's transmission system, water storage tanks and pumping stations, as well as a subset of the community TCR locations.

The TCR requires that no more than 5% of all samples in a month may be total coliform positive (or that no more than one sample be positive when less than 40 samples are collected each month). Public notification is required if this standard is exceeded.

Escherichia coli (*E.coli*) is a specific coliform species whose presence likely indicates potential contamination of fecal origin. If *E.coli* are detected in a drinking water sample, this is considered evidence of a critical public health concern. Public notification is required if follow-up tests confirm the presence of *E.coli* or total coliform.

A disinfectant residual is intended to maintain the sanitary integrity of the water; MWRA considers a residual of 0.2 mg/L a minimum target level at all points in the distribution system.

Highlights
None of the 2,154 community samples (0.0%) system-wide tested positive for total coliform during the month of March. None of the 674 MWRA samples (0.0%) tested positive for total coliform. No community violated the TCR for March. No sample tested positive for *E.coli*. Only 3.5% of the samples had chlorine residuals lower than 0.2 mg/L.

						Chlorine Residuals (mg/L)					
			# Coliform Samples (a)	Total Coliform # (%) Positive	E.coli # Positive	Public Notification Required?	2015 Minimum	2014 Minimum	2015 Average	2014 Average	2015 % <0.2	2014 % <0.2
MWRA		MWRA Locations	116	0 (0%)	0		1.80	1.88	2.14	2.19	0.0%	0.0%
	d	Shared Community/MWRA sites	558	0 (0%)	0		0.06	0.07	1.90	1.88	0.7%	0.6%
		Total: MWRA	674	0 (0%)	0		0.06	0.07	1.94	1.94	0.6%	0.5%
Fully Served		ARLINGTON	52	0 (0%)	0		0.12	0.01	1.70	1.62	3.8%	9.6%
		BELMONT	40	0 (0%)	0		1.45	1.76	1.94	2.10	0.0%	0.0%
		BOSTON	270	0 (0%)	0		1.80	1.49	2.02	1.93	0.0%	0.0%
		BROOKLINE	85	0 (0%)	0		0.06	0.51	1.91	1.96	3.5%	0.0%
		CHELSEA	65	0 (0%)	0		1.20	1.20	2.11	1.95	0.0%	0.0%
		DEER ISLAND	20	0 (0%)	0		1.71	1.80	1.82	1.95	0.0%	0.0%
		EVERETT	65	0 (0%)	0		1.01	0.90	1.11	1.18	0.0%	0.0%
		FRAMINGHAM	72	0 (0%)	0		1.28	1.14	1.97	2.18	0.0%	0.0%
		LEXINGTON	45	0 (0%)	0		1.79	1.93	2.03	2.11	0.0%	0.0%
		LYNNFIELD	6	0 (0%)	0		0.65	0.98	1.38	1.53	0.0%	0.0%
		MALDEN	90	0 (0%)	0		0.82	1.62	1.96	1.75	0.0%	0.0%
		MARBLEHEAD	24	0 (0%)	0		0.21	0.25	1.71	1.72	0.0%	0.0%
		MEDFORD	85	0 (0%)	0		1.21	0.89	1.86	1.83	0.0%	0.0%
		MELROSE	45	0 (0%)	0		0.09	0.02	1.65	1.03	4.4%	17.8%
		MILTON	34	0 (0%)	0		0.87	1.38	1.93	1.78	0.0%	0.0%
		NAHANT	10	0 (0%)	0		1.42	0.81	1.78	1.57	0.0%	0.0%
		NEWTON	92	0 (0%)	0		0.68	1.08	1.95	2.01	0.0%	0.0%
		NORTHBOROUGH	16	0 (0%)	0		1.02	1.17	1.87	1.89	0.0%	0.0%
		NORWOOD	33	0 (0%)	0		0.83	0.80	1.82	1.79	0.0%	0.0%
		QUINCY	93	0 (0%)	0		0.23	0.38	1.74	1.83	0.0%	0.0%
		READING	50	0 (0%)	0		0.87	0.74	1.59	1.68	0.0%	0.0%
		REVERE	60	0 (0%)	0		1.13	1.70	1.98	2.17	0.0%	0.0%
		SAUGUS	32	0 (0%)	0		1.41	1.41	1.82	1.89	0.0%	0.0%
		SOMERVILLE	106	0 (0%)	0		1.13	1.09	1.79	1.93	0.0%	0.0%
		SOUTHBOROUGH	10	0 (0%)	0		0.45	0.93	1.87	2.05	0.0%	0.0%
		STONEHAM	28	0 (0%)	0		1.44	1.60	1.81	1.93	0.0%	0.0%
		SWAMPSCOTT	18	0 (0%)	0		1.14	1.66	1.79	1.90	0.0%	0.0%
		WALTHAM	72	0 (0%)	0		1.65	1.71	2.10	2.15	0.0%	0.0%
		WATERTOWN	40	0 (0%)	0		1.73	1.40	1.97	2.05	0.0%	0.0%
		WESTBORO HOSPITAL	5	0 (0%)	0		0.04	0.08	0.77	0.36	20.0%	80.0%
		WESTON	16	0 (0%)	0		0.87	1.80	1.86	2.19	0.0%	0.0%
		WINTHROP	24	0 (0%)	0		0.22	0.29	1.80	1.80	0.0%	0.0%
		Total: Fully Served	*1703*	*0 (0%)*								
CVA & Partially Served	b	BEDFORD	18	0 (0%)	0		1.09	0.19	1.56	1.04	0.0%	10.0%
	b	CANTON	29	0 (0%)	0		0.03	0.03	0.91	1.02	20.7%	13.8%
	b	HANSCOM AFB	9	0 (0%)	0		1.69	1.10	1.83	1.66	0.0%	0.0%
	b	MARLBOROUGH	42	0 (0%)	0		0.61	1.34	1.90	2.33	0.0%	0.0%
	b	NEEDHAM	41	0 (0%)	0		0.13	0.07	0.52	0.47	4.9%	7.3%
	b	PEABODY	90	0 (0%)	0		0.09	0.05	1.15	1.05	31.7%	42.6%
	b	WAKEFIELD	44	0 (0%)	0		0.76	0.45	1.43	1.43	0.0%	0.0%
	b	WELLESLEY	38	0 (0%)	0		0.06	0.03	0.78	0.61	10.5%	7.9%
	b	WILMINGTON	29	0 (0%)	0		1.77	1.55	2.07	2.02	0.0%	0.0%
	b	WINCHESTER	35	0 (0%)	0		0.16	0.23	1.02	1.12	2.9%	0.0%
	b	WOBURN	60	0 (0%)	0		0.46	0.13	1.21	0.91	0.0%	6.7%
	c	SOUTH HADLEY FD1	16	0 (0%)	0		0.30	0.21	0.50	0.50	0.0%	0.0%
		Total: CVA & Partially Served	*451*	*0 (0%)*								
		Total: Community Samples	*2154*	*0 (0%)*								

(a) The number of samples collected depends on the population served and the number of repeat samples required.
(b) These communities are partially supplied, and may mix their chlorinated supply with MWRA chloraminated supply.
(c) Part of the Chicopee Valley Aqueduct System. Free chlorine system.
(d) MWRA total coliform and chlorine residual results include data from 125 community pipe locations as described above. In most cases these community results are accurately indicative of MWRA water as it enters the community system; however, some are clearly strongly influenced by local pipe conditions. Residuals in the MWRA system are typically between 1.0 and 2.8 mg/L.

Treated Water - Disinfection By-Product (DBP) Levels in Communities
March 2015

Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s) are by-products of disinfection treatment with chlorine. TTHMs and HAA5s are of concern due to their potential adverse health effects at high levels. EPA's running annual average (RAA) standard is 80 µg/L for TTHMs and 60 µg/L for HAA5s. For the MetroBoston system, effective Q2 2013, under the Stage 2 DBP Rule, compliance is based on locational running annual averages (LRAA). Sampling locations have increased from 16 to 32 each quarter. Data prior to Q1 2013 reports the running annual average, and since Q1 2013, the maximum LRAA is reported (in addition to min and max values).

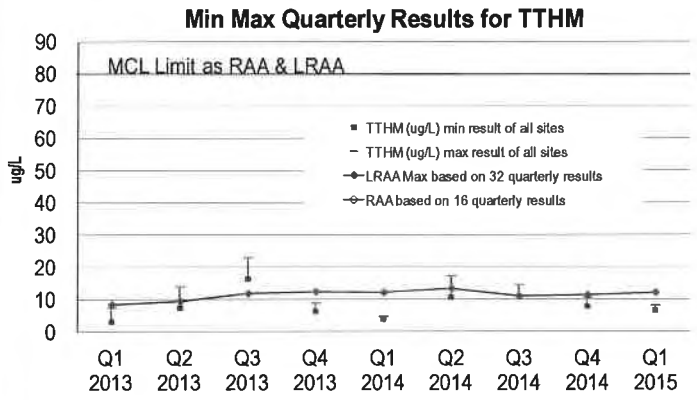
For the CVA communities, effective Q3 2013, under the Stage 2 DBP Rule, compliance is based on a LRAA for each community. Sampling locations have increased from 12 to 14 each quarter. Prior to Q3 2013, the running annual average is reported, and since Q3 2013, the maximum LRAA is reported (in addition to min and max values). The chart below combines all three CVA communities data.

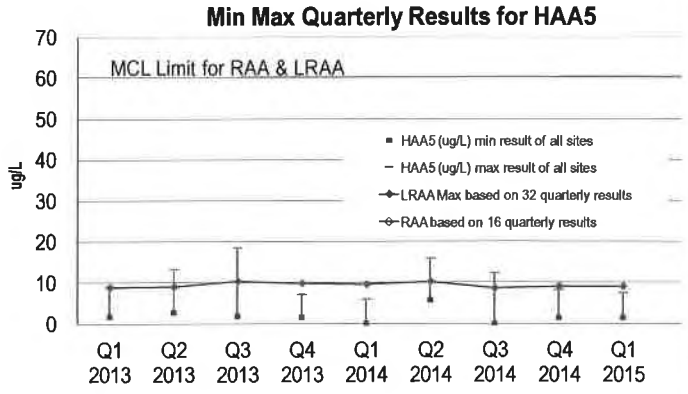
Partially served and CVA communities are responsible for their own compliance monitoring and reporting, and must be contacted directly for their individual results.

Bromate is tested monthly per DEP requirements for water systems that treat with ozone. Bromide in the raw water may be converted into bromate following ozonation. EPA's RAA Maximum Contaminant Level (MCL) standard for bromate is 10 µg/L.

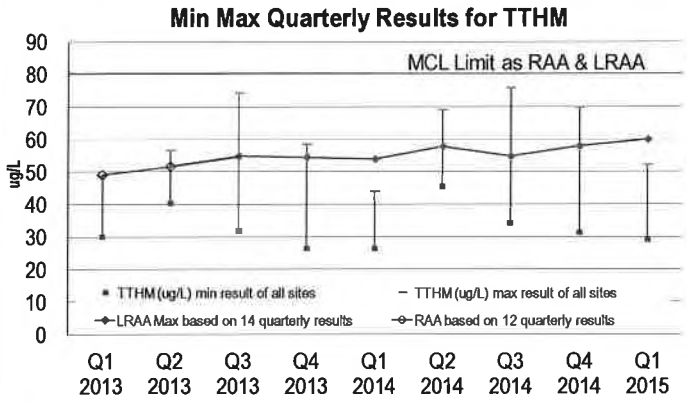
The RAA for TTHMs and HAA5s for MWRA's Compliance Program (represented as the line in the top two graphs below) remain below current standards. The Max LRAA in the first quarter for TTHMs = 12.1 µg/L; HAA5s = 9.0 µg/L. The current RAA for Bromate = 0.0 µg/L. CVA's DBP levels continue to be below current standards.

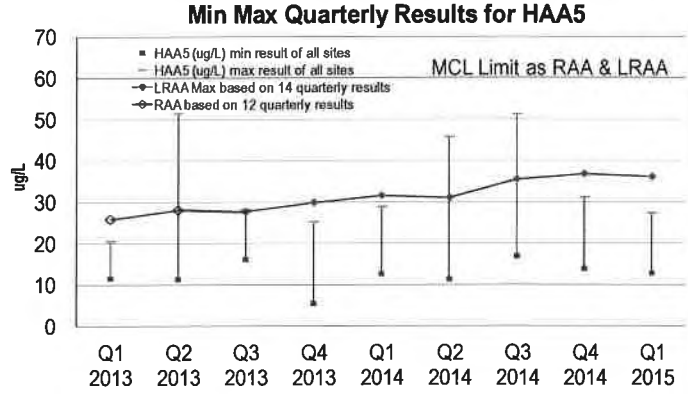
MetroBoston Disinfection By-Products





CVA Disinfection By-Products





MWRA Monthly Water Quality Analysis
March 2015

This page provides information on water quality at four locations in the MWRA transmission system. Results reflect a "snapshot" in time and may not represent typical conditions. Monitoring for parameters indicated in regular font is quarterly as they either have minimal variability or are always below detection limits. The "Wachusett System" locations represent raw water from the Wachusett Reservoir (CWTP inlet) and finished water leaving the treatment plant (CWTP Finished water tap). The "CVA System" locations represent raw water from the Quabbin Reservoir (William A. Brutsch Water Treatment Facility) and finished water after all treatment (Ludlow Monitoring Station). See www.mwra.com for additional information on other parameters which are monitored less frequently. All samples are analyzed by MWRA and contract laboratories.

	CVA System		Wachusett System Metro-Boston		Standards			
Component	Brutsch Water Treatment Facility (Raw)	Ludlow Monitoring Station (Treated)	Carroll Water Treatment Plant Inlet (Raw)	Carroll Water TP Fin. Water Tap (Treated)	Health Standard	Aesthetics or Other Standards	Units	Method Reporting Limit
Alkalinity	*3.2*	*4.2*	*6.0*	*40.8*			MG/L	0.05
Aluminum	U	U	U	U		50-200 (c)	UG/L	15.0
Ammonia-N, Total	0.01	U	0.01	0.38			MG/L	0.005
Antimony	U	U	U	U	6 (b)		UG/L	0.4
Arsenic	U	U	U	U	10 (b)		UG/L	1.0
Barium	6.2	6.1	7.9	7.9	2000 (b)		UG/L	2.0
Beryllium	U	U	U	U	4 (b)		UG/L	0.3
Bromate	*U*	*U*	*U*	*U*	10 (b)		UG/L	5.0
Bromide	*9.9*	*6.4*	*14.1*	*13.9*			UG/L	5.0
Cadmium (1)	U	U	U	U	5 (b)		UG/L	0.5
Calcium	2030	2060	3880	4030			UG/L	50
Chloride	7.6	9.0	21.5	23.5		250 (c)	MG/L	0.5
Chlorine, Free		*0.81*			4 (b)(d)		MG/L	0.02
Chlorine, Total				*2.33*	4 (b)(d)		MG/L	0.02
Chromium, Total	U	U	U	U	100 (b)		UG/L	1.0
Coliform, Fecal, MF Method	*U*		*U*		20 (a)		CFU/100 mL	1
Coliform, Total, Colilert Method	*1*	*U*	*U*	*U*	100 (a) 0 (b)		MPN/100 mL	1
Copper **	U	U	U	U		1300 (e) 1000 (f)	UG/L	3.0
Cyanide	U	U	U	U	0.2 (b)		MG/L	0.01
Fluoride (3)	U	U	U	*1.00*	4 (b)		MG/L	0.02
Hardness (2)	7.2	7.3	12.9	13.6			MG/L	0.194
Iron **	11.2	13.1	13.2	14.7		300 (c)	UG/L	6.0
Lead	0.05	0.06	U	U		15 (e)	UG/L	0.05
Magnesium	522	527	777	848			UG/L	35
Manganese	3.60	2.07	6.01	5.86		50 (c) 300 (g)	UG/L	0.1
Mercury (1)	U	U	U	U	2 (b)		UG/L	0.05
Nickel	U	U	U	U			UG/L	0.5
Nitrate-N	0.007	0.007	0.036	0.039	10 (b)		MG/L	0.005
Nitrite	U	U	U	0.005	1 (b)		MG/L	0.005
Orthophosphate	0.008	0.006	0.008	0.009			MG/L	0.0025
pH	*6.6*	*7.1*	*7.0*	*9.7*			S.U.	
Potassium	479	486	830	875			UG/L	200
Selenium	U	U	U	U	50 (b)		UG/L	1.0
Silica (SiO2)	2050	1990	2340	2800			UG/L	200.0
Silver	U	U	U	U		100 (c)	UG/L	1.0
Sodium	5.1	6.1	13.1	32.0			MG/L	0.2
Specific Conductance	*47*	*52*	*116*	*194*			UMHO/cm	0.3
Standard Plate Count, HPC	*3*		*8*	*U*	500 (b)		CFU/mL	1
Sulfate (SO4)	4.3	4.4	5.9	6.2		250 (c)	MG/L	1.0
Thallium	U	U	U	U	2 (b)		UG/L	0.3
Total Dissolved Solids	31.0	43.0	57.0	97.0		500 (c)	MG/L	13
Total Organic Carbon	*1.7*	1.8	*2.3*	2.4			MG/L	0.3
Total Phosphorus	U	U	U	U			MG/L	0.05
UV-254	*0.022*	0.016	*0.059*	*0.039*			A/cm	0.000965
Zinc **	2.0	1.7	U	U		5000 (c)	UG/L	1.5

(a) = Primary MCL standard (health related), applies to source (raw) water only. DEP "Drinking Water Regulations", 310CMR 22.00. Fecal standard takes precedence when both fecal and total coliform are tested.

(b) = Primary MCL standard (health related). DEP "Drinking Water Regulations", 310CMR 22.00. Applies to samples of treated water downstream of Wachusett and Quabbin Reservoirs. Most based on annual average.

(c) = Secondary MCL standard (aesthetic related). DEP "Drinking Water Regulations", 310CMR 22.00.

(d) = Maximum Residual Disinfectant Level. DEP "Drinking Water Regulations", 310CMR 22.00. Based on annual average.

(e) = Refers to 90th percentile Action Level. Lead results will vary at your home dependent on household plumbing.

(f) = Refers to a single sample, secondary MCL.

(g) =DEP Advisory Level, reference *www.mass.gov/eea/docs/dep/water/drinking/alpha/i-thru-z/mangfactsheet.pdf*

U = Less than method reporting limit
MCL = Maximum Contaminant Level
[ ] = Not Applicable
S.U. = Standard Units

CFU = Colony Forming Unit
NTU = Nephelometric Turbidity Unit
MG/L = milligrams per liter = parts per million
UG/L = micrograms per liter = parts per billion

MPN = Most Probable Number
HPC = Heterotrophic Plate Count (48 Hrs @ 35 °C)
** = Metal results may be elevated due to local plumbing at the sample tap.
Bold Italics = Samples from March
Regular Font = Quarterly results from January samples

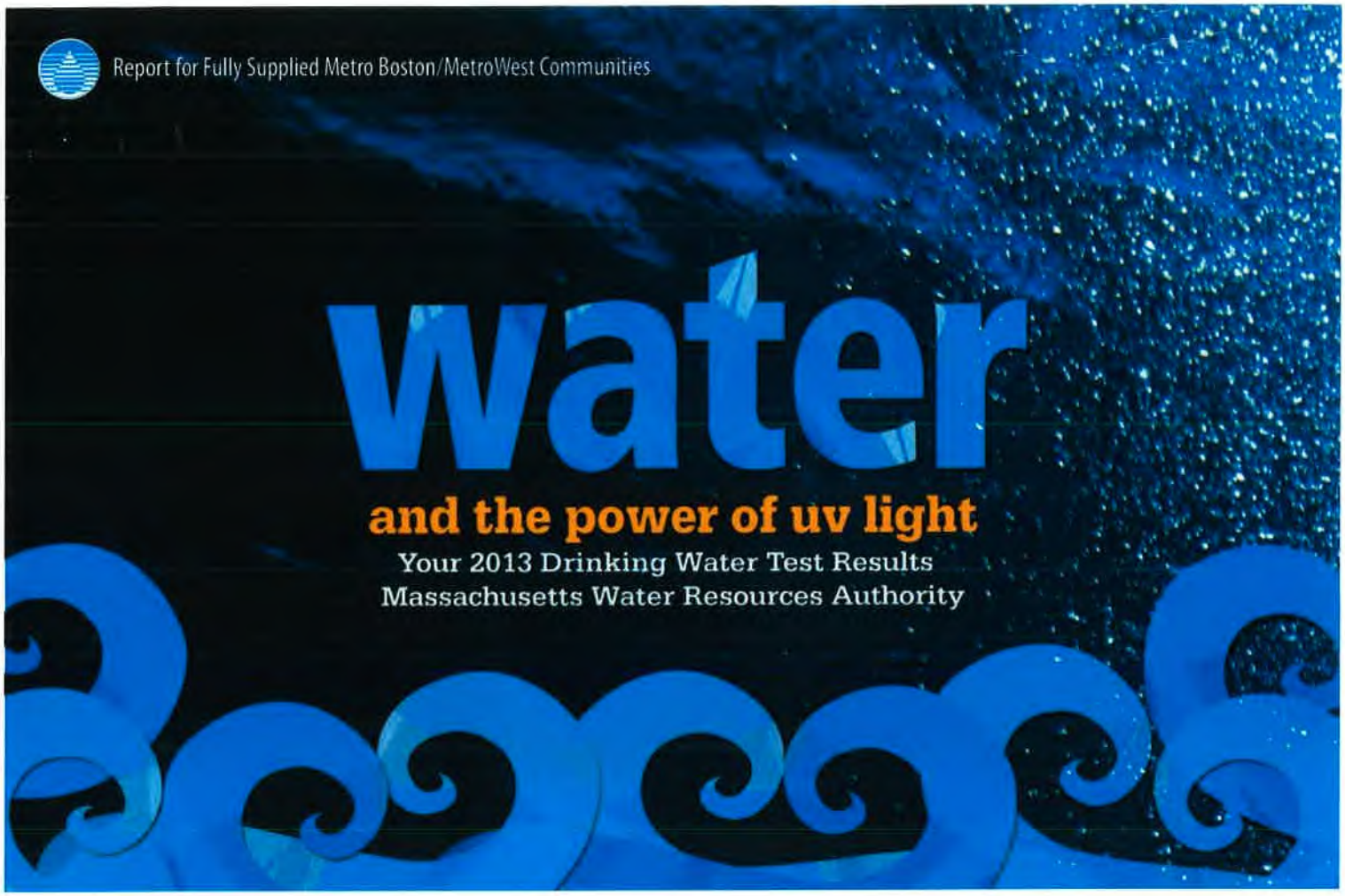
Samples listed are monthly samples taken from single grab samples on MArch 2 and 3, 2015.

NOTES:

(1) Due to MWRA lab equipment having higher sensitivity, MWRA's tests for several parameters are more sensitive than the EPA-set levels of detection and reporting. For example, the EPA minimum detection limit for cadmium is 1 ug/L and 0.2 ug/L for mercury, and MWRA lab tests and reports at lower than these detection limits.

(2) MWRA water is considered soft. Water hardness is characterized by the amount of dissolved minerals in the water, in particular calcium and magnesium. MWRA water has a hardness of about 15-20 mg/l or about 1 grain/gallon (1 grain/gallon = 17.1 mg/L). For comparison, hard water would have greater than 75 mg/l hardness.

(3) Fluoride dose is 1.0 mg/L with a desired range of 0.8 to 1.2 mg/L.



This report contains very important information about your drinking water. Please translate it, or speak with someone who understands it.	Im Bericht steht wichtige Information über die Qualität des Wassers Ihrer Gemainschaft. Der Bericht soll übersetzt werden, oder sprechen Sie mit einem Freund, der ihn gut versteht.
Si usted desea obtener una copia de este reporte en español, llamenos al telefono 617-788-1190.	这份报告中有些重要的信息，涉到关于您所在社区的水的品质。请您找人翻译一下，或者请能看得懂这份报告的朋友给您解释一下。
La relazione contiene importanti informazioni sulla qualità dell'acqua della Comunità. Tra-durlo o parlarne con un amico che lo comprenda.	この資料には、あなたの飲料水についての大切な情報が書かれています。内容をよく理解するために、日本語に翻訳して読むか説明を受けてください。
O relatório contém informações importantes sobre a qualidade da água da comunidade. Tra-duza-o ou peça a alguém que o ajude a entendê-lo melhor.	इस रिपोर्ट में पानी के बारे में बहुत महत्वपूर्ण जानकारी दी गई है। कृपया इसका अनुवाद करवाएँ, या किसी जानकार से इस बारे में पूछें।
Sprawozdanie zawiera ważne informacje na temat jakości wody w Twojej miejscowości. Poproś kogoś o przetłumaczenie go lub porozmawiaj z osobą która je dobrze rozumie.	របាយការណ៍នេះមានព័ត៌មានសំខាន់អំពីទឹកនៅតាម ។ សូមបកប្រែឬពិគ្រោះជាមួយមនុស្សដែលយល់របាយការណ៍នេះ ។
يحتوي هذا التقرير على معلومات هامة عن نوعية ماء الشرب في منطقتك يرجى ترجمته، أو ابحث التقرير مع صديق لك يفهم هذه المعلومات جيدا.	이 보고서는 귀하가 주목하고 지역의 수질에 관한 중요한 정보가 들어 있습니다. 이것을 번역하거나 충분히 이해하시는 친구와 논의하십시오.
Η εκτενέν ενοφορα παρουσιαζη σεουσάσες πληροφορίες για το ποσιμο νερο σας. Προκειλει να το μεταφρασετε η να το αξιολησετε με κάποιον που το καταλαβαινη απολητως.	Bản báo cáo có ghi những chi tiết quan trọng về phẩm chất nước trong cộng đồng quý vị. Hãy nhờ người thông dịch, hoặc hỏi một người bạn biết rõ về vấn đề này.

Massachusetts Water Resources Authority
and Your Local Water Department

This report is required under the Federal Safe Drinking Water Act. MWRA PWS ID# 6000000

Where To Go For Further Information

Massachusetts Water Resources Authority (MWRA)	www.mwra.com	617-242-5323
Massachusetts Dept. of Environmental Protection	www.mass.gov/dep	617-292-5500
Department of Conservation and Recreation	www.mass.gov/dcr/watersupply.htm	617-626-1250
Massachusetts Dept. of Public Health (DPH)	www.mass.gov/dph	617-624-6000
US Centers for Disease Control & Prevention (CDC)	www.cdc.gov	800-232-4636
List of State Certified Water Quality Testing Labs	www.mwra.com/04water/html/testinglabs.html	617-242-5323
Source Water Assessment and Protection Reports	www.mwra.com/sourcewater.htm	617-242-5323
Information on Water Conservation	www.mwra.com/conservation.html	617-242-SAVE

Public Meetings

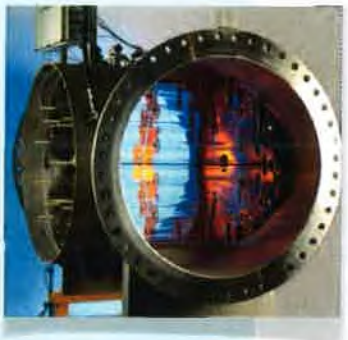
MWRA Board of Directors	www.mwra.com/02org/html/boardofdirectors.htm	617-788-1117
MWRA Advisory Board	www.mwraadvisoryboard.com	617-788-2050
Water Supply Citizens Advisory Committee	www.mwra.com/02org/html/wscac.htm	413-213-0454

For a large print version, call 617-242-5323.

Dear Customer,

I am pleased to share with you the results of our water quality testing. MWRA takes hundreds of thousands of tests each year, and for 2013, we again met every federal and state drinking water standard. System-wide, we have been below the Lead Action Level for the past ten years. Please read your community's letter on page 4 for more information on your local water system.

The big news this year is that we have completed the start-up of a new ultraviolet (UV) disinfection facility at the John J. Carroll Water Treatment Plant in Marlborough, improving the quality of the drinking water we deliver to you.



UV light is essentially a more potent form of natural disinfection from sunlight. UV enables MWRA to inactivate the most difficult to kill pathogens - which could potentially be in the source water - without the use of additional chemicals and any associated disinfection by-products. The UV process and MWRA's high quality source water allow MWRA to meet new regulatory requirements cost effectively.

Since 2005, your water has been treated with ozone - produced by applying an electrical current to pure oxygen. Ozone has ensured strong protection against microbes and viruses, improves water clarity, and has actually made the water taste better. The addition of the UV to the ozone process provides additional assurance that any pathogens potentially in our reservoirs will be rendered harmless.

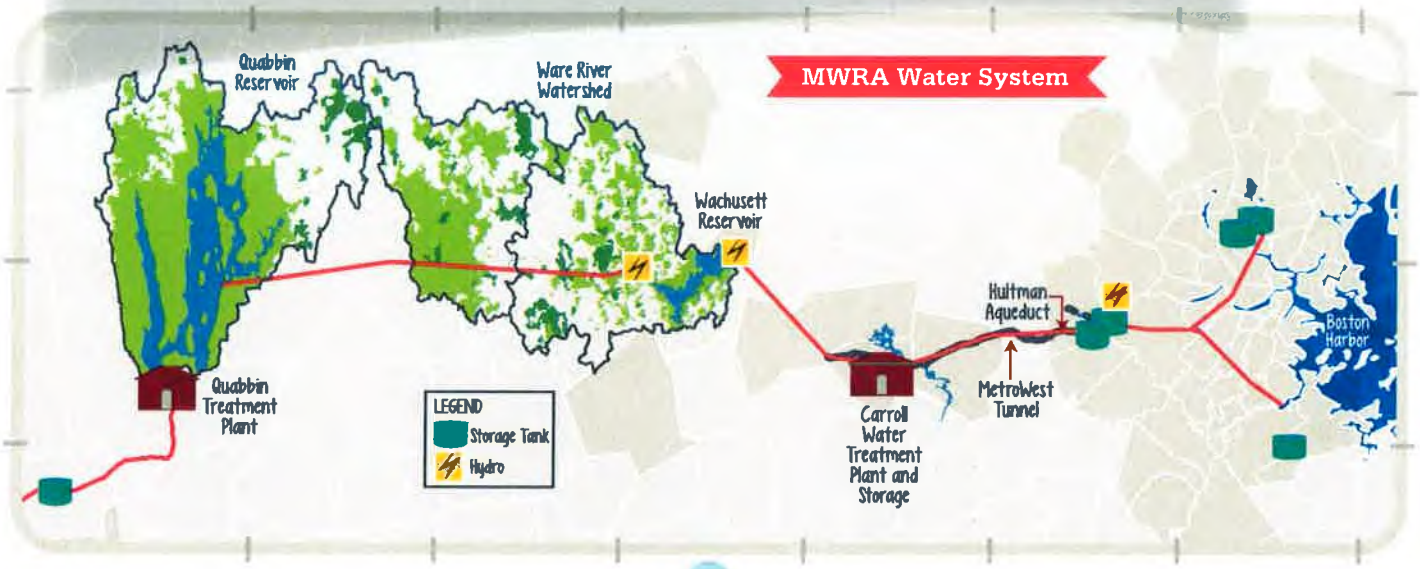
In addition, fluoride is added to promote dental health and the water chemistry is adjusted to reduce corrosion of lead and copper from home plumbing. Last, we add monochloramine, a mild and long-lasting disinfectant combining chlorine and ammonia to protect the water as it travels through miles of pipelines to your home.

In a few short years, water treatment has gone from chlorine with its taste and odor issues, to ozone and now ultraviolet – with no additional chemicals and no disinfection by-products. Just better, safer water.

I hope you will take a few moments to read this report. We want you to have the same confidence we have in the water we deliver to over 2 million customers. Please contact us if you have any questions or comments about your water quality, or any of MWRA's programs.

Sincerely,

Frederick A. Laskey
Executive Director



Where Does Your Water Come From?

Your water comes from the Quabbin Reservoir, about 65 miles west of Boston, and the Wachusett Reservoir, about 35 miles west of Boston. These reservoirs supply wholesale water to local water departments in 51 communities. The two reservoirs combined supplied about 200 million gallons a day of high quality water to consumers in 2013.

The Quabbin and Wachusett watersheds are naturally protected with over 85% of the watersheds covered in forest and wetlands. To ensure safety, the streams and reservoirs are tested often and patrolled daily by the Department of Conservation and Recreation (DCR).

Rain and snow falling on the watersheds - protected land around the reservoirs - turn into streams that flow to the reservoirs. This water comes in contact with soil, rock, plants, and other material as it follows its natural path to the reservoirs. While this process helps to clean the water, it can also dissolve and carry very small amounts of material into the reservoir. Minerals from soil and rock do not typically cause problems in the water. But, water can also transport contaminants from human and animal activity. These can include bacteria and viruses - some of which can cause illness. The test data in this report show that these contaminants are not a problem in your reservoirs' watersheds.

The Department of Environmental Protection (DEP) has prepared a Source Water Assessment Program report for the Quabbin and Wachusett Reservoirs. The DEP report commends DCR and MWRA on the existing source protection plans, and states that our "watershed protection programs are very successful and greatly reduce the actual risk of contamination." MWRA follows the report recommendations to maintain the pristine watershed areas using existing watershed plans.

Testing Your Water – Every Step of the Way

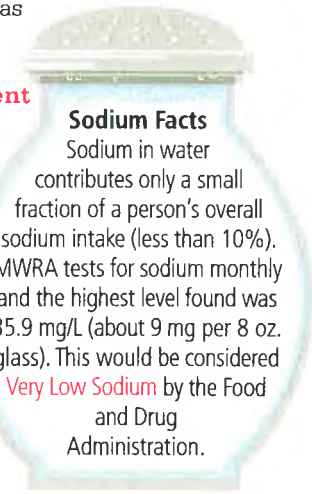
Test results show few contaminants are found in the reservoir water. The few that are found are in very small amounts, well below EPA's standards.

Turbidity (or cloudiness of the water) is one measure of overall water quality. All water must be below 5 NTU (Nephelometric Turbidity Units), and water can only be above 1 NTU if it does not interfere with effective disinfection. Typical levels at the Wachusett Reservoir are 0.3 NTU. In 2013, turbidity was below 1 NTU over 99.99% of the time, with the highest level at 1.17 NTU. This did not interfere with effective disinfection.

MWRA also tests reservoir water for pathogens such as fecal coliform, bacteria, viruses, and the parasites *Cryptosporidium* and *Giardia*. They can enter the water from animal or human waste. No *Cryptosporidium* or *Giardia* was found in the water in 2013.

Test Results – After Treatment

EPA and state regulations require many water quality tests after treatment to check the water you are drinking. MWRA conducts hundreds of thousands of tests per year on over 120 contaminants (a complete list is available on www.mwra.com). Details about 2013 test results are in the table below. The bottom line is that water quality is excellent.



Sodium Facts

Sodium in water contributes only a small fraction of a person's overall sodium intake (less than 10%). MWRA tests for sodium monthly and the highest level found was 35.9 mg/L (about 9 mg per 8 oz. glass). This would be considered Very Low Sodium by the Food and Drug Administration.

Water Quality Test Results for 2013

Compound	Units	(MCL) Highest Level Allowed	(We found) Detected Level-Average	Range of Detections	(MCLG) Ideal Goal	Violation	How it gets in the water
Barium	ppm	2	0.008	0.007-0.009	2	No	Common mineral in nature
Monochloramine	ppm	4-MRDL	1.8	0.01-4.0	4-MRDLG	No	Water disinfectant
Fluoride	ppm	4	1.04	0.37-1.1	4	No	Additive for dental health
Nitrate^	ppm	10	0.08	0.01-0.08	10	No	Atmospheric deposition
Nitrite^	ppm	1	0.005	ND-0.005	1	No	Byproduct of water disinfection
Total Trihalomethanes	ppb	80	10.1	3.0-13.9	ns	No	Byproduct of water disinfection
Haloacetic Acids-5	ppb	60	9.0	1.4-13.2	ns	No	Byproduct of water disinfection
Total Coliform	%	5%	0.5% (Nov)	ND-0.5%	0	No	Naturally present in environment

KEY: MCL=Maximum Contaminant Level. The highest level of a contaminant allowed in water. MCLs are set as close to the MCLGs as feasible using the best available technology. **MCLG**=Maximum Contaminant Level Goal. The level of contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety. **MRDL**=Maximum Residual Disinfectant Level. The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants. **MRDLG**=Maximum Residual Disinfectant Level Goal. The level of a drinking water disinfectant below which there is no known or expected health risk. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination. **ppm**=parts per million **ppb**=parts per billion **ns**=no standard
^As required by DEP, the maximum result is reported for nitrate and nitrite, not the average.

Tests in Community Pipes

MWRA and local water departments test 300 to 500 water samples each week for total coliform bacteria. Total coliform bacteria can come from the intestines of warm-blooded animals, or can be found in soil, plants, or other places. Most of the time, they are not harmful. However, their presence could signal that harmful bacteria from fecal waste may be there as well. The EPA requires that no more than 5% of the samples in a month may be positive. If a water sample does test positive, we run more specific tests for *E.coli*, which is a bacteria found in human and animal fecal waste and may cause illness. No *E.coli* was found in any MWRA community in 2013. If your community found any total coliform, it will be listed within the community letter on page 4.

Research for New Regulations

MWRA has been working with EPA and other researchers to define new national drinking water standards by testing for unregulated contaminants. To read more about this testing, and to see a listing of what was found, please visit **www.mwra.com/UCMR/2013.html**.

Drink Local and Be Green

Tap water is delivered straight to your home without trucking or plastic waste. Bottled water produces over 10,000 times the amount of greenhouse gases compared to tap water. Half of our energy needs for water and wastewater treatment are met with green power including hydro-energy, wind turbines, and solar panels.

Drink local! Drink tap water! Be green!

Drinking Water and People with Weakened Immune Systems

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/CDC guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the EPA's Safe Drinking Water Hotline (1-800-426-4791).

Contaminants in Bottled Water and Tap Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (1-800-426-4791) or MWRA. In order to ensure that tap water is safe to drink, the Massachusetts DEP and EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. Food and Drug Administration (FDA) and the Massachusetts Department of Public Health regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Information About Cross Connections

Massachusetts DEP recommends the installation of backflow prevention devices for inside and outside hose connections to help protect the water in your home as well as the drinking water system in your town. For more information on cross connections, please call 617-242-5352 or visit **www.mwra.com/crosscon.html**.

Your Tap Water – Award Winning and Affordable!

In 2013, we won New England's Best-Tasting water award from the New England Water Works Association and the National Sustainability Award from the American Council for an Energy-Efficient Economy. Great tasting, green, and also cheap! Tap water costs less than a penny per gallon delivered straight to your home, while bottled water can cost from $1 to $8 a gallon.

Make the smart choice and drink tap water.

UV treatment units

How to Find Leaks

Dripping, trickling, or leaky faucets, showerheads and toilets can waste up to several hundred gallons of water a week, depending on the size of the leaks. Worn-out washers are the main causes of leaks in faucets and showerheads. That trickling sound you hear in the bathroom could be a leaky toilet, but sometimes toilets leak silently. TRY THIS: Crush a dye tablet and carefully empty the contents into the center of the tank and allow it to dissolve or use a few drops of food coloring. Wait about 10 minutes. Inspect the toilet bowl for signs of dye indicating a leak. If the dye has appeared in the bowl, your flapper or flush valve may need to be replaced. Parts are inexpensive and fairly easy to replace. If no dye has appeared after 10 minutes, you probably don't have a leak.

Install a Low-Flow Showerhead and Faucet Aerator

Some showerheads may still use over 5 gallons of water per minute. A low-flow showerhead can use up to 50% less and can save you over 20 gallons per 10 minute shower. In one year, that's over 7,000 gallons. Faucets can use 2 to 7 gallons per minute – a low-flow aerator can reduce the flow by about 25%.

The Inch Rule For Water Saving Outdoors

Most lawns, shrubs, vegetables, and flowers need just one inch of water per week. If there has been an inch of rainfall during the week, you don't have to water at all.

Overwatering can actually weaken your lawn by encouraging shallow roots that are less tolerant of dry periods and more likely to be damaged by insects.

Wasting water can add up quickly

On average, each person in the MWRA region uses about 60 gallons of water each day. More efficient water use can reduce the impact on the water supply and on your wallet. For ways to make your home and your habits more water efficient, contact the MWRA at 617-242-SAVE or visit www.mwra.com for tips on saving water indoors and in your backyard.

Follow Outdoor Water Saving Ground Rules

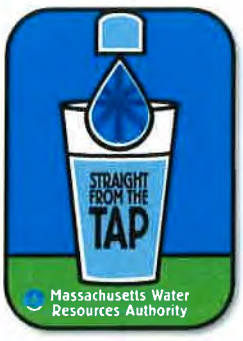
Water your lawn (and other landscaping) in early morning or evening to avoid evaporation.

Be sure sprinklers water only your lawn, not the pavement.

Never water on a windy day.

Never use the hose to clean debris from your driveway or sidewalk. Use a broom.

Apply mulch around plants to reduce evaporation, promote plant growth, and control weeds.



Promote Tap Water!

Let everyone know that you are drinking some of the best water in the world. Put a sticker on your reusable water bottle and fill it with tap water. Contact MWRA if you would like to receive a free sticker.

For more water saving ideas and devices, call 617-242-SAVE or go to www.mwra.com.

What You Need to Know about Lead in Tap Water

MWRA water is lead-free when it leaves the reservoirs. MWRA and local pipes that carry the water to your community are made mostly of iron and steel and do not add lead to the water. However, lead can get into tap water through pipes in your home, your lead service line, lead solder used in plumbing, and some brass fixtures. Corrosion or wearing away of lead-based materials can add lead to tap water, especially if water sits for a long time in the pipes before it is used.

In 1996, MWRA began adding sodium carbonate and carbon dioxide to adjust the water's pH and buffering capacity. This change has made the water less corrosive, thereby reducing the leaching of lead into drinking water. Lead levels found in sample tests of tap water have dropped by almost 90% since this treatment change.

MWRA Meets Lead Standard in 2013

Under EPA rules, each year MWRA and your local water department must test tap water in a sample of homes that are likely to have high lead levels. These are usually homes with lead service lines or lead solder. The EPA rule requires that 9 out of 10, or 90%, of the sampled homes must have lead levels below the Action Level of 15 parts per billion (ppb).

All 18 sampling rounds over the past ten years have been below the EPA standard. Results for the 452 samples taken in September 2013 are shown in the table. 9 out of 10 houses were below 6.3 ppb, which is below the Action Level of 15 ppb. Only two communities had more than one home test above the Action Level for lead. If you live in either of these communities, your town letter on page 4 will provide you with more information.

September 2013 Lead and Copper Results

	Range	90% Value	(Target) Action Level	(Ideal Goal) MCLG	% Home Above AL/# Homes Tested
Lead (ppb)	0-46.9	6.3	15	0	8/452
Copper (ppm)	0-0.3	0.1	1.3	0	0/452

KEY: AL=Action Level-The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow. Definition of MCLG available on page 2.

Important Information from EPA about Lead

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. MWRA is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. If your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline at 1-800-426-4791 or **www.epa.gov/safewater/lead**.

90th Percentile Lead Levels for MWRA Communities 2004-2013 (ppb)

How do I reduce my exposure to lead in drinking water?

- Run the tap until after the water feels cold. To save water, fill a pitcher with fresh water and place in the refrigerator for future use.
- Never use hot water from the faucet for drinking or cooking, especially when making baby formula or other food for infants.
- Ask your local water department if there are lead service lines leading to your home.
- Check your plumbing fixtures to see if they are lead-free. Read the labels closely.
- Test your tap water. Call the MWRA Drinking Water Hotline (617-242-5323) or visit our website for more tips and a list of DEP certified labs that can test your water.
- Be careful of places you may find lead in or near your home. Paint, soil, dust and some pottery may contain lead.
- Call the Department of Public Health at 1-800-532-9571 or EPA at 1-800-424-LEAD for health information.