ENVIRONMENTAL PARTNERS

April 8, 2020

Mr. Robert B. Worthley, Superintendent
Department of Public Works
70 Elm Street
Foxborough, MA 02035

**RE: Water Storage Tank Assessments – Foxborough, MA**

Dear Mr. Worthley,

The purpose of this memorandum is to evaluate the Town of Foxborough's water storage needs and evaluate alternatives for supplementing the Hill Street tank in the Main Service Zone (MSZ).

# Background

The Town of Foxborough maintains two water storage tanks (Table 1) with a total volume of approximately 4.4 million gallons (MG). The Hill Street Tank is a ground level storage tank located in the MSZ with a total volume of 3.26 MG. The Washington Street Tank is an elevated storage tank located in the High Service Zone (HSZ) with a total volume of 1.15 MG. A third storage facility, the Main Street Standpipe, was recently abandoned as part of the 12-inch water main extension and PRV Station on Main Street.

**Table 1: Existing Storage Facilities**

| Tank Name | Type | Zone | Year of Installation | Dia. (ft) | Overflow Elevation (NGVD) | Height to Overflow (ft) | Capacity (gallons) |
|---|---|---|---|---|---|---|---|
| Hill Street | Reservoir | MSZ | 1961 | 126 | 443 | 35 | 3.26 |
| Washington Street | Elevated Storage Tank | HSZ | 2002 | 70 | 508 | 40 | 1.15 |

During the summer of 2019, there were disruptions to the Town's water supplies that lowered tank levels to approximately 15 feet below overflow and caused pressures in the Hill Street neighborhood to drop as low as approximately 22 psi. The Hill Street tank is required to be taken offline for preventative maintenance in accordance with the Town's maintenance agreement with Suez and the Town has no current storage alternative in the MSZ. To mitigate future supply issues and ensure that quality service continues to be provided to the Town's consumers, an additional storage facility is recommended.

*Hill Street Tank*

*Main Street Tank (Abandoned)*

# Water System Storage Volume Evaluation

In 2018, Stantec Consulting Services completed a Water System Master Plan Study for the Town, including water storage recommendations. Environmental Partners (EP) reviewed the Master Plan and utilized the information as a basis for supplemental storage recommendations. Water usage projections from the Master Plan were not evaluated or revised for the purpose of this memorandum.

## Water Storage Requirements

The 2018 Master Plan bases storage requirements on equalization and fire protection. The future equalization volume for the Town was determined to be 713,000 gallons, or 20 percent of the projected 2037 maximum day consumption of 3.56 MG. Fire storage was calculated using the largest fire flow requirement in Foxborough at the intersection of Chestnut Street and Payson Road. This largest ISO fire flow of 7,000 GPM for three hours results in a fire storage volume of 1.26 MG. The total storage requirement of 1.97 MG is summarized in Table 2 below.

**Table 2: Water Storage Requirements (2018 Master Plan)**

| Equalizing Storage (MG) | Fire Flow Storage (MG) | Total Storage Required (MG) |
|---|---|---|
| 0.71 | 1.26 | 1.97 |

To verify storage requirements, EP applied an alternative method using fire flow, peak hourly demand, and max daily demand. The results are summarized in Table 3.

**Table 3: EP Water Storage Requirements Calculation (2037)**

| | **Required Storage Volume (MG)** |
|---|---|
| Maximum Day Demand | 3.56 |
| (1) Depletion of Storage due to Peak Hour Demands (3 Hrs @ 2 x MDD) | 0.89 |
| (2) Fire flow Requirement (7,000 gpm for 3 hours) | 1.26 |
| (3) Usage during 3 hour event at maximum day rate | 0.45 |
| Total Volume Required (1 + 2 + 3) | 2.60 |
| Supply Available During Fire (2.3 MGD for 3 hours)[1] | 0.29 |
| Storage Required | 2.31 |

1. Assumes the Oak Street WTP is offline.

As shown, EP's storage requirement is approximately 340,000 gallons greater than the total calculated in the Master Plan. The American Water Works Association (AWWA) Manual of Water Supply Practices requires 30 percent of the maximum day demand for equalization storage if pumping capacity is equal to or greater than the maximum day demand. If 30 percent of MDD is used in the Master Plan calculation for equalization storage, the total volume requirement increases to 2.33 MG. This memorandum applies a required volume of 2.3 MG.

### Available Water Storage

Usable storage is considered all storage between the tank overflow and minimum elevation required to provide 20 psi pressure at all points in the system. The highest property elevation in the Town's system is 374 feet. In order to maintain 20 psi, the minimum required hydraulic grade line (HGL) elevation is 420 feet. MSZ usable storage at the Town's existing storage facilities is summarized in Table 4.

**Table 4: Existing MSZ Usable Storage**

| Tank | Ground Elevation (NGVD88) | Overflow Elevation (NGVD88) | Usable Water Depth (ft) | Usable Storage (MG) |
|---|---|---|---|---|
| Hill Street | 408 | 443 | 23 | 2.15 |
| Washington Street | 468 | 508 | 40 | 1.15 |
| | | | Total with Washington Street | 3.30 |
| | | | Total without Washington Street | 2.15 |

Table 4 shows that the existing MSZ usable storage volume exceeds the storage requirement if the Washington Street elevated tank is utilized. While the Washington Street tank could be used in an emergency to supply water to the MSZ, the MSZ would likely experience water quality issues due to flow direction reversals in the western area of Town, including Main Street and downtown. Without the Washington Street tank, the Town currently has a storage deficit of approximately 180,000 gallons.

### Storage Redundancy

In addition to the water quality problems that would result from using the Washington Street tank for storage in the MSZ, the Washington Street tank cannot serve as redundant storage for the MSZ. The maximum fill rate of 1,500 gpm from the Ashcroft Booster Station is approximately equal to system wide average day demand and would not be able to sustain tank levels in the Washington Street tank. The only other operational option without the Hill Street tank is to pump into a closed system by varying pump output at each supply to match consumption. This type of operation can be utilized in smaller systems but is not practical for the Town of Foxborough. In order to take the Hill Street tank offline for maintenance, a new tank is required.

It is not recommended that a new redundant tank contain the required usable storage volume of 2.33 MG calculated above. Except during periods of maintenance, having 100% volume redundancy would significantly reduce tank turnover, increase average water age and result in water quality issues. In order to balance between redundancy and excess volume, EP recommends that equalization storage and fire flow storage volume requirements be reduced for the redundant storage volume calculation as show in Table 5.

**Table 5: Recommended Redundant Water Storage Tank Volume**

| | Required Storage Volume (MG) |
|---|---|
| Average Day Demand[1] | 2.19 |
| (1) Depletion of Storage due to Peak Hour Demands (3 Hrs @ 2.5 x ADD) | 0.68 |
| (2) Fire flow Requirement (3,500 gpm for 3 hours)[2] | 0.63 |
| (3) Usage during 3 hour event at average day rate | 0.27 |
| Total Volume Required (1 + 2 + 3) | 1.45 |
| Supply Available During Fire (3.0 MGD for 3 hours) | 0.38 |
| Washington Street Tank Storage Available (Fire Storage Only) | 0.63 |
| Storage Required | 0.57 |

1. ADD for 2037
2. 3,500 gpm = Fifth Largest Required Fire Flow in 2014 ISO

With the addition of a new tank containing a usable volume of 0.6 MG, the total usable volume would increase to 2.75 MG.

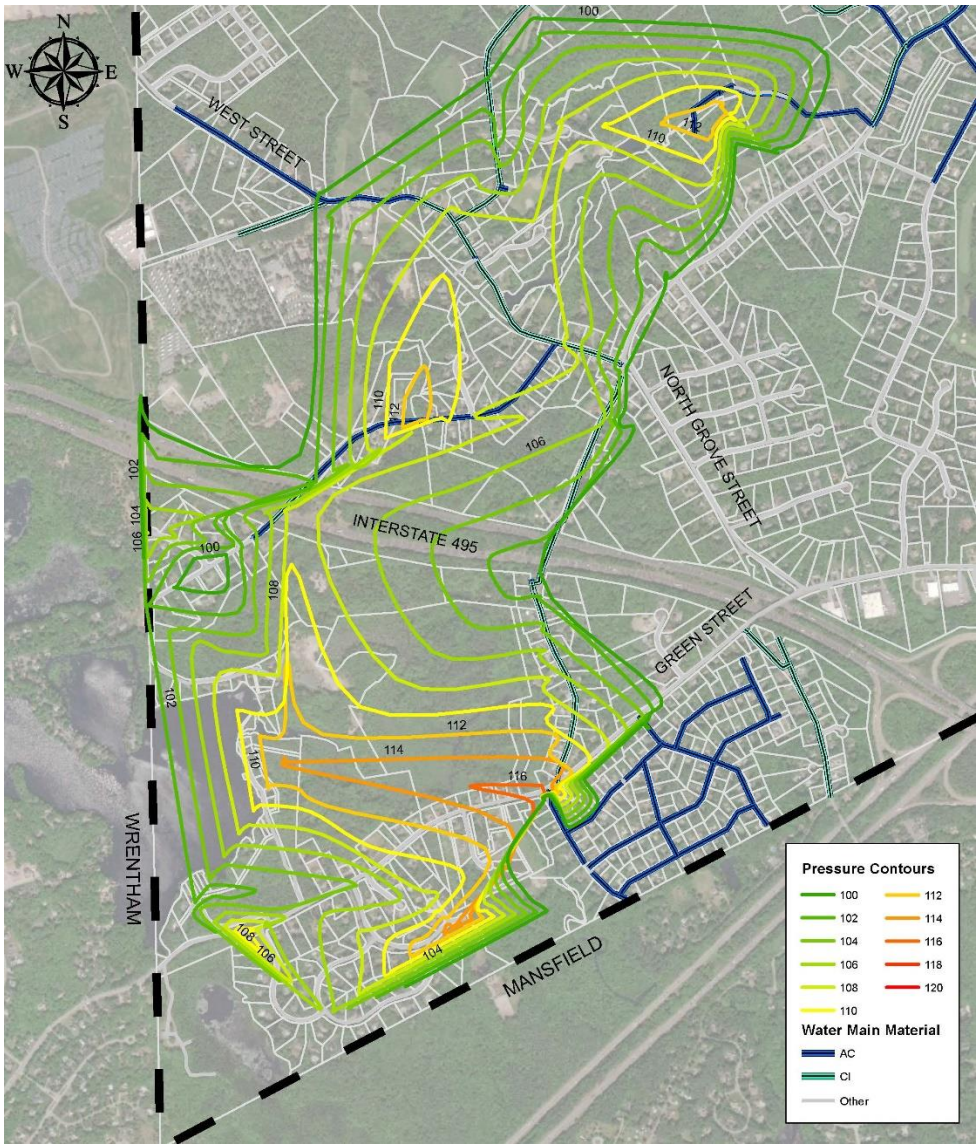
# Hydraulic Grade Line Evaluation

## Main Service Zone

The MSZ hydraulic grade line (HGL) was evaluated to determine the feasibility of increasing its elevation to obtain a wider range of usable storage in a new tank. Review of the water distribution system shows that current static pressures in the southwest area of Town are currently in the range of 100 psi to 110 psi. MassDEP Guidelines for Public Water Systems recommend that pressure reducing valves be installed for all service connections in excess of 100 psi. In addition to the high pressures in the southwest area of Foxborough, many of the water mains in this area are asbestos cement (AC) and cast iron (CI) and prone to breaks and leaks. Figure 1 shows the highest pressure areas of Town and locations of AC and CI water main.

The life of the existing Hill Street tank is anticipated to extend at least another 10 years and the tank has a fixed overflow elevation of 443 ft. If a new tank were constructed in the MSZ with an overflow elevation higher than 443 ft, the existing tank would require a control valve to close whenever water elevations in the new tank exceeded 443 feet. If the new tank operating range was always above 443 ft, the existing Hill Street tank control valve would remain closed and convert the Hill Street tank into “dead” storage. A recirculating pump between the two tanks would be required to keep water from stagnating in the existing tank. Turnover of the Hill Street Tank at the DEP recommended minimum of 5 days would require continuous recirculation at approximately 450 gpm. This option is only feasible at the Hill Street tank site where two tanks can be located in close proximity.

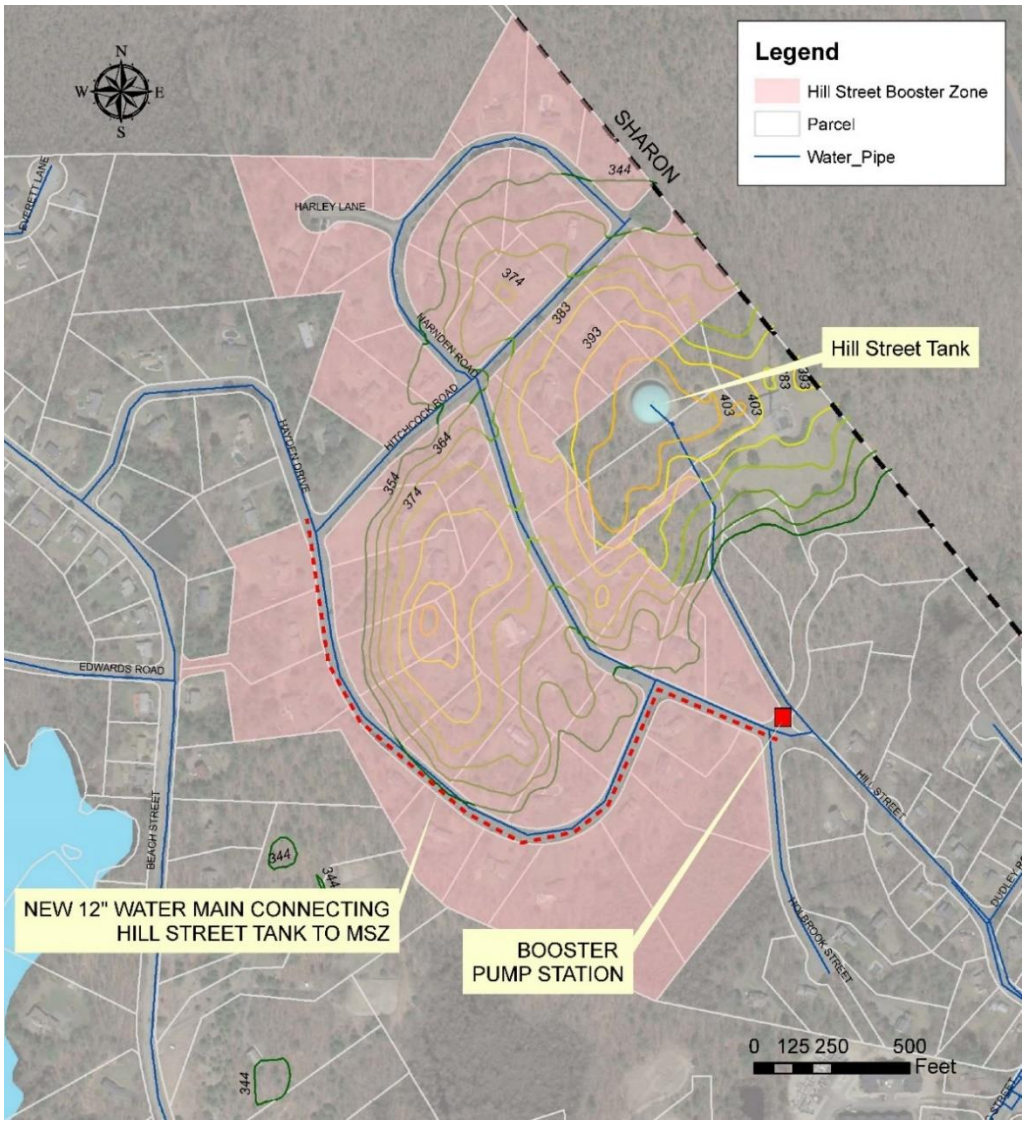
**Figure 1: MSZ Locations > 100 psi Static Pressure**




## Hill Street Area HGL

Usable storage in the Main Service Zone is driven by the highest water service elevation of 374 feet on Hill Street. The surrounding area (Dudley Hill Estates) including Hill Street, Hayden Drive, Hitchcock Road and Harnden Road ranges in elevation from the high point of 374 ft down to approximately 340 ft. Outside of the Hill Street area, the highest MSZ service elevation is approximately 360 feet at the end of Bragg Road. Elevating the HGL of the Hill Street area by constructing a Booster Pump Station would convert the entire Hill Street tank to usable volume. A conceptual plan of a Hill Street Booster Zone is shown below in Figure 2.

**Figure 2: Hill Street Booster Zone Conceptual Layout**




## New Tank Site Evaluation

Environmental Partners identified four potential tanks sites based on land availability (Town owned) and topography (minimum elevation 340 ft). The sites were then evaluated based on access, approximate construction costs, and proximity to the distribution system. The following five sites were assessed and are shown in Figure 3:

- Hill Street Tank Site
- Main Street Tank Site
- East Belcher Road Site
- Messenger Avenue Site
- High Rock Road

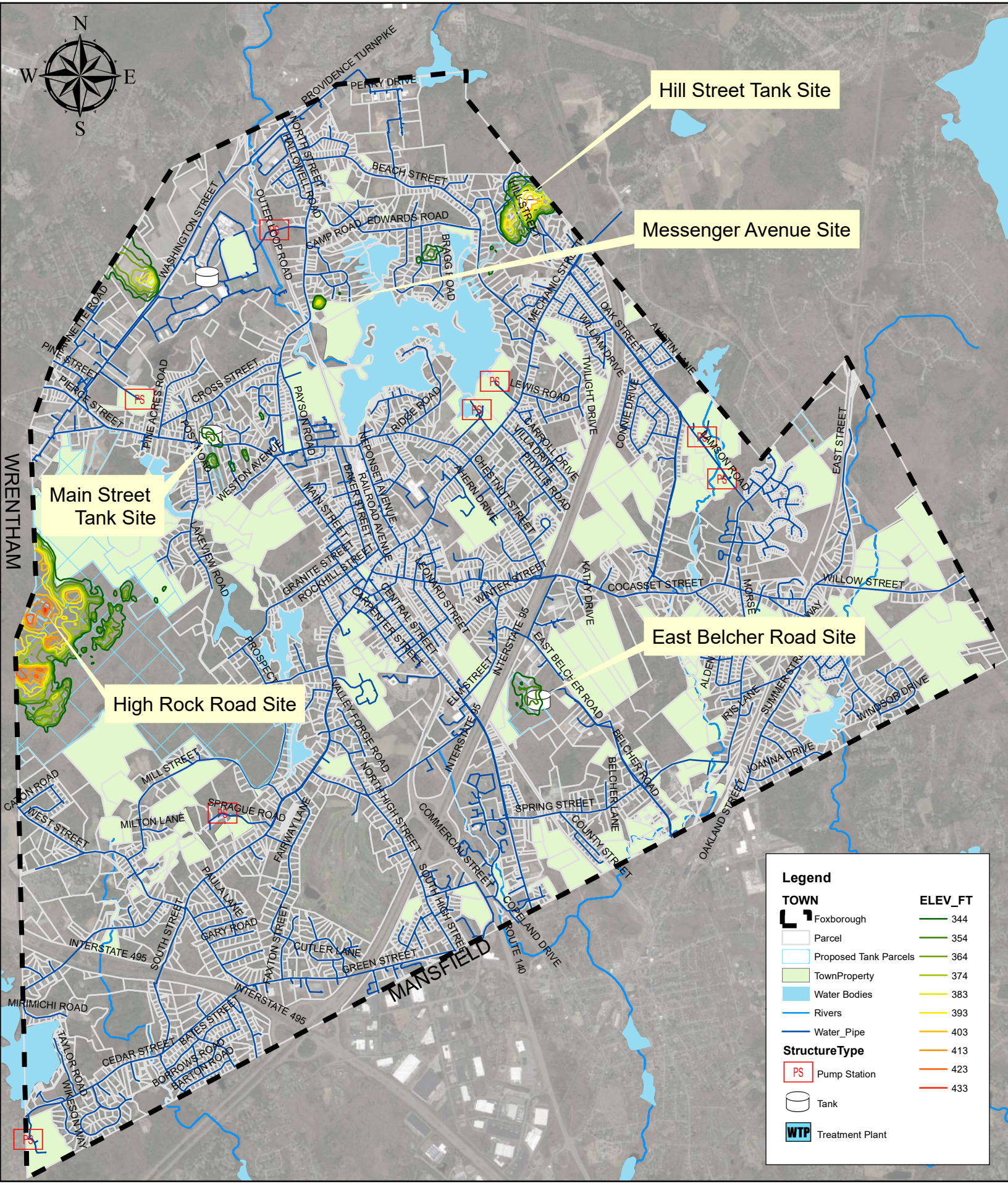



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***Figure 3: Evaluated Water Storage Tank Sites***
***Town of Foxborough, MA***
***March 2020***

0 3,600
Feet

### Hill Street Tank Site

There is sufficient space for an additional tank in the Town-owned parcels at the site of the existing 3.26 MG ground level storage tank. Clearing and grading of approximately 0.75 acres and improvements to site access would be required. This site is already configured for transmission of water to the rest of the distribution system. Distribution system improvements would not be required to implement a tank at the Hill Street site.

The ground elevation at the Hill Street site is approximately 408 feet resulting in a tank height of 35 feet. A steel or concrete reservoir similar to the existing tank would be suitable for this site.

A disadvantage to adding another tank at the Hill Street site is that it would offer no hydraulic improvements to the distribution system. It is desirable to have storage facilities spread out in the system to stabilize pressures and maximize available flows. Additionally, a contamination issue at the Hill Street site would likely affect both tanks if a new tank were constructed.

### Main Street Tank Site

The decommissioned 0.87 MG standpipe is still located at this site and would have to be demolished to install a new tank. Minimal improvements would be required to the existing access driveway. This site is already configured for transmission of water to the rest of the distribution system. Distribution system improvements would not be required to implement a tank at the Main Street site.

The ground elevation at the Main Street site is approximately 355 feet resulting in a tank height of 88 feet. An elevated tank would be suitable for this site. Although a standpipe is feasible, the total volume required (>5 MG) to attain a usable volume of 1.3 MG is excessive.

### East Belcher Road Site

This site is located off East Belcher Road and currently contains a storage facility for the Town of Mansfield. There is an existing access driveway to the Mansfield Tank that could be utilized. Additional access would need to be provided to a new Foxborough tank site. There is no infrastructure at the site and no distribution piping on East Belcher Street at the access driveway. In addition to the access road utilities, a 2,600 lf water main extension would be required to connect to the nearest 12-inch water main on Elm Street.

The ground elevation at this site is approximately 350 feet resulting in a tank height of 93 feet. An elevated tank would be suitable for this site.

### North Street Site (Neponset Reservoir)

This site is located between North Street and the Messenger Avenue cul-de-sac within Town Conservation Land associated with the Neponset Reservoir. The site is currently wooded and does not contain any infrastructure. Significant grading and site work would be required to locate a tank on this site. Additionally, 2,000 linear feet of 12-inch water main would be required on North Street to replace the existing 6-inch cast iron main and connect to the 12-inch on Cross Street.

The ground elevation at this site is approximately 370 feet resulting in a tank height of 73 feet. An elevated tank or standpipe would be suitable for this site.

### High Rock Road Site

This site is located within the F. Gilbert Hills State Forest at the location of the recently constructed regional dispatch center. Although an access road already exists to this site, approximately 2.8 miles of 12-inch or 16-inch water main would be required to connect to the MSZ.

The ground elevation at this site is approximately 425 feet resulting in a tank height of 18 feet. A standpipe would be suitable for this site to service the MSZ. This site is also suitable for an elevated tank (83 feet height) to service the HSZ.

### New Tank Site Recommendations

The East Belcher Road, North Street Site and High Rock Road sites require significantly more site and utility work than the Hill Street and Main Street sites. Costs in addition to the tanks themselves are estimated at $2.5 – $5M. Additionally, both the East Belcher Road and North Street Site contain 3rd party challenges (Town of Mansfield, Conservation, DCR) that the Main Street and Hill Street sites do not. Only the Main Street and Hill Street sites were considered viable and evaluated further.

## New Tank Alternatives Analysis

### Tank Construction Alternatives

EP evaluated four replacement tank options for the 2 viable sites as shown in Figures 4 – 7.

**Figure 4: Spheroid Tank**

Spheroid tanks are constructed of welded steel, with a narrow pedestal and bulbous storage. Spheroid tanks are distinguished by their smooth contours, gentle transitions and typically have a smaller footprint than other elevated tanks. Spheroid tanks require repainting approximately every 15-20 years.

**Figure 5: Glass-Fused-to-Steel (GFTS) Tanks**

Glass-fused-to-steel tanks are constructed of bolted panels made of an integrated glass and steel material fused together. The hard, inert barrier on both the interior and exterior tank surfaces guards against corrosion and does not require painting.

**Figure 6: Composite Elevated Tank**

Composite elevated tanks (CET) are comprised of a concrete pedestal and cylindrical welded steel tank. Pedestal diameters are constructed of cast-in-place concrete and offer lower maintenance costs by reducing surface areas that require painting. The steel bowl requires painting every 15-20 years.

**Figure 7: Pre-stressed Concrete Tank**

Prestressed concrete tanks are constructed with precast concrete walls, an embedded steel diaphragm, and wire-wound prestressing. The tanks are placed into permanent compression for strength and are built with a flexible floor wall connection allowing for water tightness without an interior coating or sealant. These tanks do not require coating or painting and therefore have minimal maintenance costs. There is no steel to steel contact within these tanks preventing corrosion of the tank.

Environmental Partners contacted tank manufacturers to determine any limiting factors based on the tank height and storage requirements. Spheroid tanks head ranges are predetermined and available storage capacities vary slightly from recommendations. Similarly, the standard head range for a composite welded steel tank in the 1.0 – 2.0 MG range is 40 feet. A custom bowl with reduced head range can be produced at a premium cost for additional engineering.

### Main Street Tank Site

A spheroid and composite welded steel tank are viable options to replace the existing abandoned standpipe. A replacement standpipe was not considered due to excessive volume.

**Table 6: Main Street Tank Selection Analysis**

| | Spheroid | CET |
|---|---|---|
| Tank Storage Volume (gallons) | 1,250,000 | 1,000,000 |
| Usable Storage | 574,000 | 662,000 |
| Head Range (feet) | 45 | 40 |
| Total Volume per Foot (gallons) | varies | varies |
| Bowl Diameter (feet) | 79 | 70 |
| Anticipated Tank Cost | $2.6M | $2.5 |
| Tank Site Work Cost | $0.5M | $0.5M |
| 25% Contingency | $0.8M | $0.8M |
| 20% Engineering | $0.6M | $0.6M |
| Total Budget Estimate (Rounded) | $4.5M | $4.4M |

### Hill Street Tank Site

A glass-fused-to-steel tank and prestressed concrete standpipe are viable options for additional storage at the Hill Street site.

**Table 7: Hill Street Tank Selection Analysis**

| | Prestressed Concrete | Glass-Fused–to-Steel |
|---|---|---|
| Tank Storage Volume (gallons) | 1,000,000 | 1,170,000 |
| Usable Storage | 660,000 | 770,000 |
| Head Range (feet) | 35 | 35 |
| Total Volume per foot (gallons) | 28,570 | 33,430 |
| Diameter (feet) | 70 | 76 |
| Anticipated Tank Cost | $0.9M | $1.0M |
| Tank Site Work Cost | $1.0M | $0.8M |
| 25% Contingency | $0.5M | $0.5M |
| 20% Engineering | $0.4M | $0.4M |
| Total Budget Estimate (Rounded) | $2.8M | $2.7M |

### Life Cycle Costs

A life-cycle cost analysis determines the most cost-effective option among different alternatives over a period of time. The analysis takes into account inflation for future costs, initial project costs, and the frequency of tank rehabilitation. Costs associated with routine inspections and maintenance are assumed to be consistent between the alternatives and are excluded. The analysis calculates the present value, which is the total future cost in 2020 dollars.

Environmental Partners conducted a life cycle cost analysis over a 50 year period for the four tank options. The analysis assumes a 4 percent inflation rate for future costs and a 5 percent discount rate to obtain the present discounted value.

**Table 8: New Water Storage Tank 50-Year Life Cycle Analysis**

| | Main Street Spheroid | Main Street Composite | Hill Street Prestressed Concrete | Hill Street Glass-Fused-to-Steel |
|---|---|---|---|---|
| Tank Capital Cost | $4.5M | $4.4M | $2.8M | $2.7M |
| Inflation Rate | 3% | 3% | 3% | 3% |
| Discount Rate | 4% | 4% | 4% | 4% |
| Rehabilitation Period | 20 years | 20 years | 20 years[1] | 20 years[2] |
| Estimated Rehabilitation Cost (2020 dollars) | $18/sf | $18/sf | 20 Years: $75k<br>40 Years: $200k | $20/lf |
| Present Discounted Value | $5.6M | $5.3M | $3.0M | $2.9M |
| $ Differential | $2.7M | $2.4M | $0.1M | - |

1. Surficial rehab in year 20 and concrete joint rehab in year 40.
2. Assumes 50% of interior and exterior seem resealing in years 20 and 40.

## Recommendations

### General

The Town of Foxborough recently abandoned its redundant tank in the MSZ leaving its tank on Hill Street to provide storage for the majority of the Town. Although there is another tank in the HSZ with significant usable storage, it is impractical for the distribution system to operate without storage in the MSZ for an extended period of time. EP recommends that a new tank with a usable volume of 0.6 MG in the MSZ be constructed as soon as possible to allow for maintenance of the existing Hill Street tank. A usable volume of 0.6 MG will allow the Town to take either tank offline for maintenance while minimizing excess storage volume. This represents a usable storage volume increase in the MSZ of approximately 30 percent.

It is not recommended to significantly increase the HGL of the MSZ as part of the new tank project. Pressures in the southwest area of Town are currently at the maximum pressures recommended by DEP guidelines and are also located in areas of asbestos cement and cast iron water mains. It is

likely that a significant increase in pressure to this area would increase the frequency of water main breaks and leaks.

EP recommends that the Town consider creation of a new service zone for the Dudley Hill Estates area. A new booster zone would increase the level of service to approximately 50 customers that currently have marginal static pressures. A new Dudley Hill booster zone would also convert all storage at the Hill Street tank to usable volume. A preliminary budget level opinion of probable cost for the new booster zone is $1.7M. This cost assumes that no land purchase is required.

### Tank Site

There are several parcels in Town that a tank could be sited on without land purchase. However, only the two existing tank sites on Main Street and Hill Street are within close proximity to large diameter water mains. Capital costs for access and extension of utilities to the potential tank sites on East Belcher Road and North Street would more than double the project costs and these sites should only be pursued if construction at the Hill Street and Main Street sites become untenable.

Cost is the primary advantage of the Hill Street site. The ground elevation is approximately 53 feet higher than the Main Street site and capital costs for tank construction are approximately 60% lower as a result. Recoating requirements for the tanks at the Main Street site also increase total lifecycle costs relative to Hill Street.

The Main Street site offers two significant advantages over the Hill Street site because it is in a different location than the existing tank.

1. **Pressure stabilization in the northeastern area of Town** - An intermediate pressure zone was created in response to low pressure complaints in the Main Street area after the standpipe was abandoned. It is possible that the intermediate zone could be eliminated with a new elevated tank at the Main Street site.
2. **Reduced risk of storage contamination** - If a contamination event (bacteriological or other) occurred at the Hill Street site, it would likely affect both tanks and leave the Town without any storage while the event is resolved. The risk of contamination in both tanks is greatly reduced if the second tank is located on Main Street.

EP recommends the Town consider construction of the second tank at the Main Street site if available funding allows. In addition to the primary project goals of additional usable storage and a redundant tank, the Main Street site offers hydraulic benefits and greatly reduces the risk for contamination at both tank sites simultaneously.

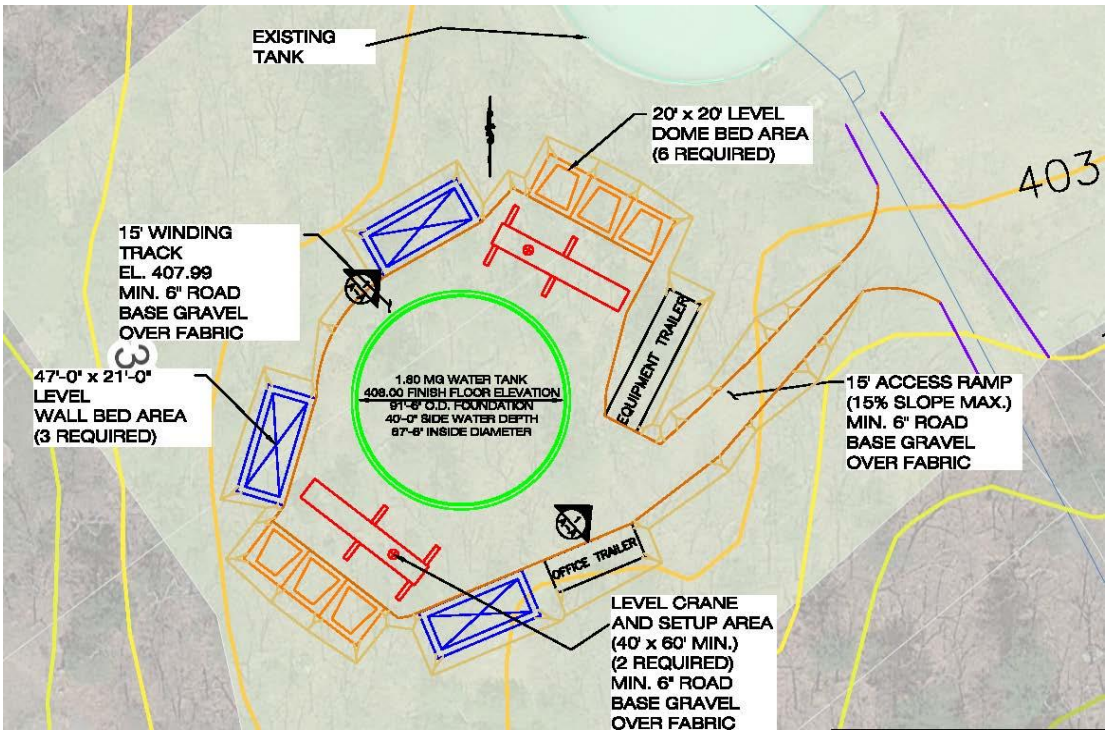
### Main Street Tank Recommendation

EP recommends that a 1.0 MG composite elevated tank be pursued for the Main Street site. Life-cycle costs between the CET and waterspheroid are comparable. The CET tank offers the required usable storage volume at a 20% reduction of total volume. The concrete pedestal can also provide the Town with storage space for vehicles and equipment.

## Hill Street Tank Recommendation

Capital and lifecycle costs for the Glass-Fused–to-Steel and Prestressed Concrete Tank at the Hill Street site are comparable. Because GFTS tanks are a newer type of construction (35 Years) and long term maintenance costs are not yet known compared to prestressed concrete, it is recommended that the Town pursue a 1.0 MG prestressed concrete storage tank adjacent to the existing tank if funding does not allow for a tank on the Main Street site. A preliminary site layout for construction of a prestressed tank is shown below in Figure 8.

**Figure 8: Hill Street Construction Layout – Prestressed Concrete Tank**




We look forward to discussing the Town of Foxborough's storage needs based on the information presented herein. If you require additional information or have any questions, please contact me at (617) 657-0281.

Sincerely,

Ryan Allgrove

Environmental Partners Group, Inc.

Ryan J. Allgrove, PE
Principal
P: 617.657.0281
E: rja@envpartners.com