SUBWATERSHED RESTORATION PLAN FOR MILFORD, MA

PREPARED BY

The Town of Milford and Charles River Watershed Association (CRWA)

2020

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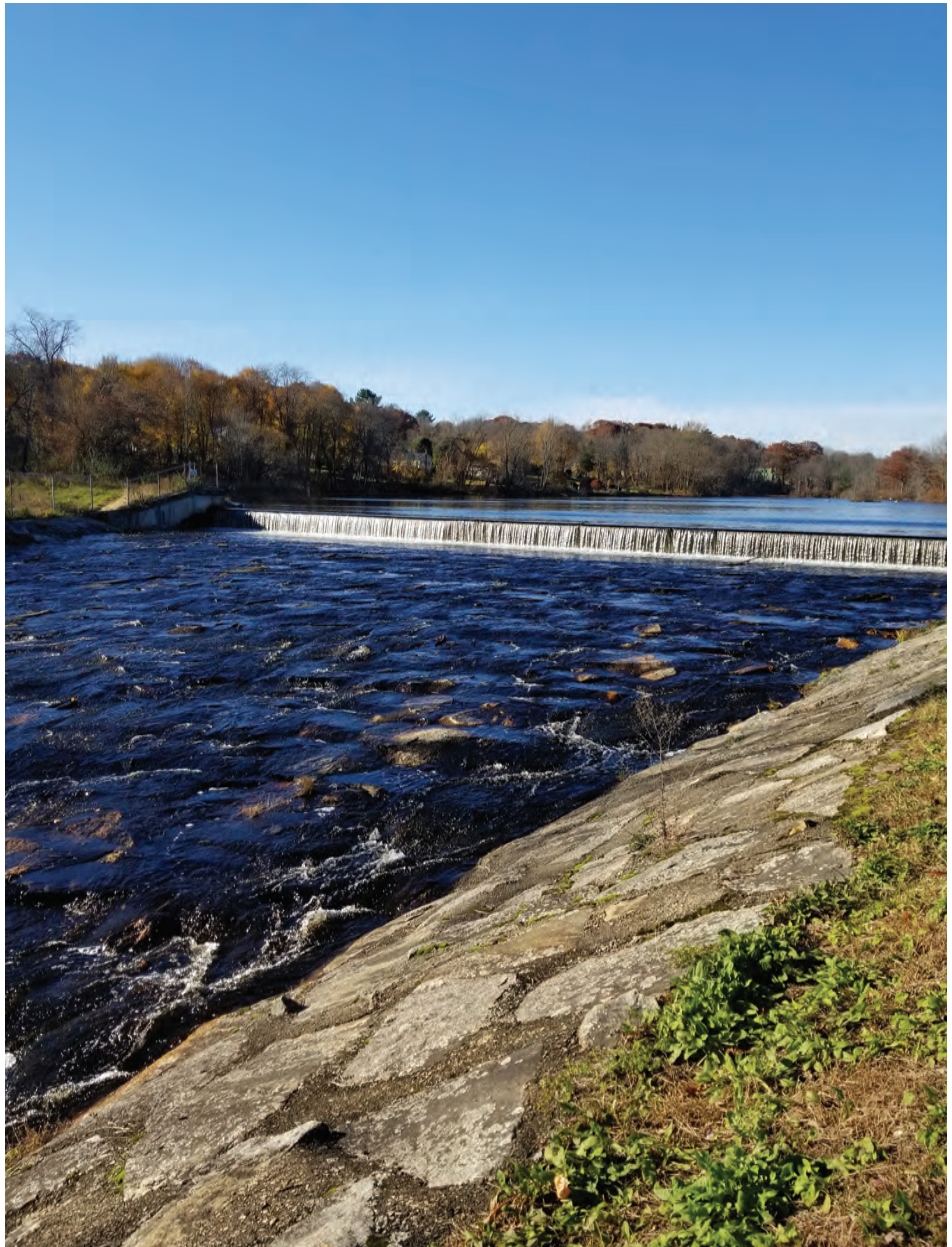

Acknowledgements

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Many Town staff members worked hard to develop this subwatershed restoration plan including Town Engineer, Michael Dean and Parks and Recreation Administrator, James Asam. We are grateful for the input of the Milford Water Company as well. Charles River Watershed Association developed the subwatershed plan conceptual designs and contributed greatly to this report. CRWA also supported the Town in securing funding to conduct this planning work and to begin implementation. Horsley Witten Group developed the designs for the proposed green stormwater infrastructure (GSI) at Milford Town Park. GSI renderings by Inside Out Communications. Report layout by AMW Marketing.

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Summary

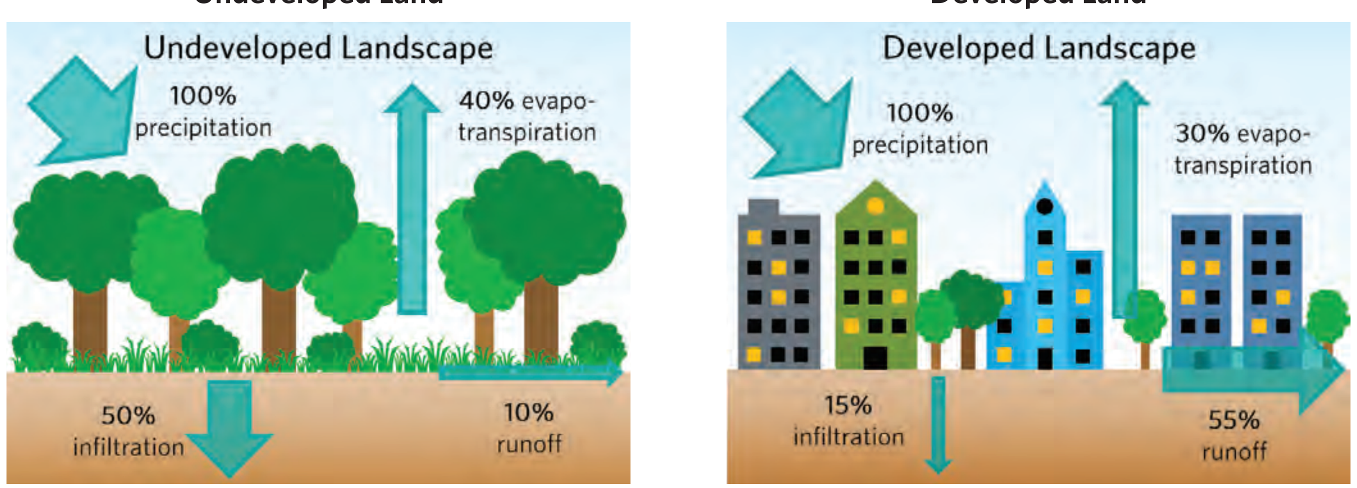
The Town of Milford (Town) partnered with Charles River Watershed Association (CRWA) to create this restoration plan for the Milford Pond subwatershed. The Town of Milford is facing many environmental challenges including high demand for groundwater, low river flows in the headwater section of the Charles River, stormwater runoff pollution, and climate change.

This restoration plan:

1. Identifies opportunities for infiltrating stormwater runoff to increase groundwater levels and consequently flow in the Charles River
2. Proposes stormwater treatment systems across the subwatershed to comply with the Town's stormwater permit (known as the MS4 permit)
3. Prioritizes key natural areas for protection and conservation to promote healthy land and river use in Milford
4. Identifies strategies to help the Town adapt to some expected impacts of climate change including: flooding, increased temperatures, and drought

Development of the restoration plan spanned approximately 14 months, and included a thorough analysis of the study area, development of pollution reduction and groundwater recharge goals, identification of numerous restoration opportunities, and quantification of their co-benefits. Proposing locations and types of green stormwater infrastructure treatment systems is a key component of this plan. As described below, some of these systems will move into the implementation phase in the near term and others can and will be implemented in years to come, as properties and roadways undergo redevelopments and improvements. This restoration plan can guide development and redevelopment across the subwatershed and also serve as a model for actions and strategies that can be used across the entire Town.

Undeveloped Land | Developed Land



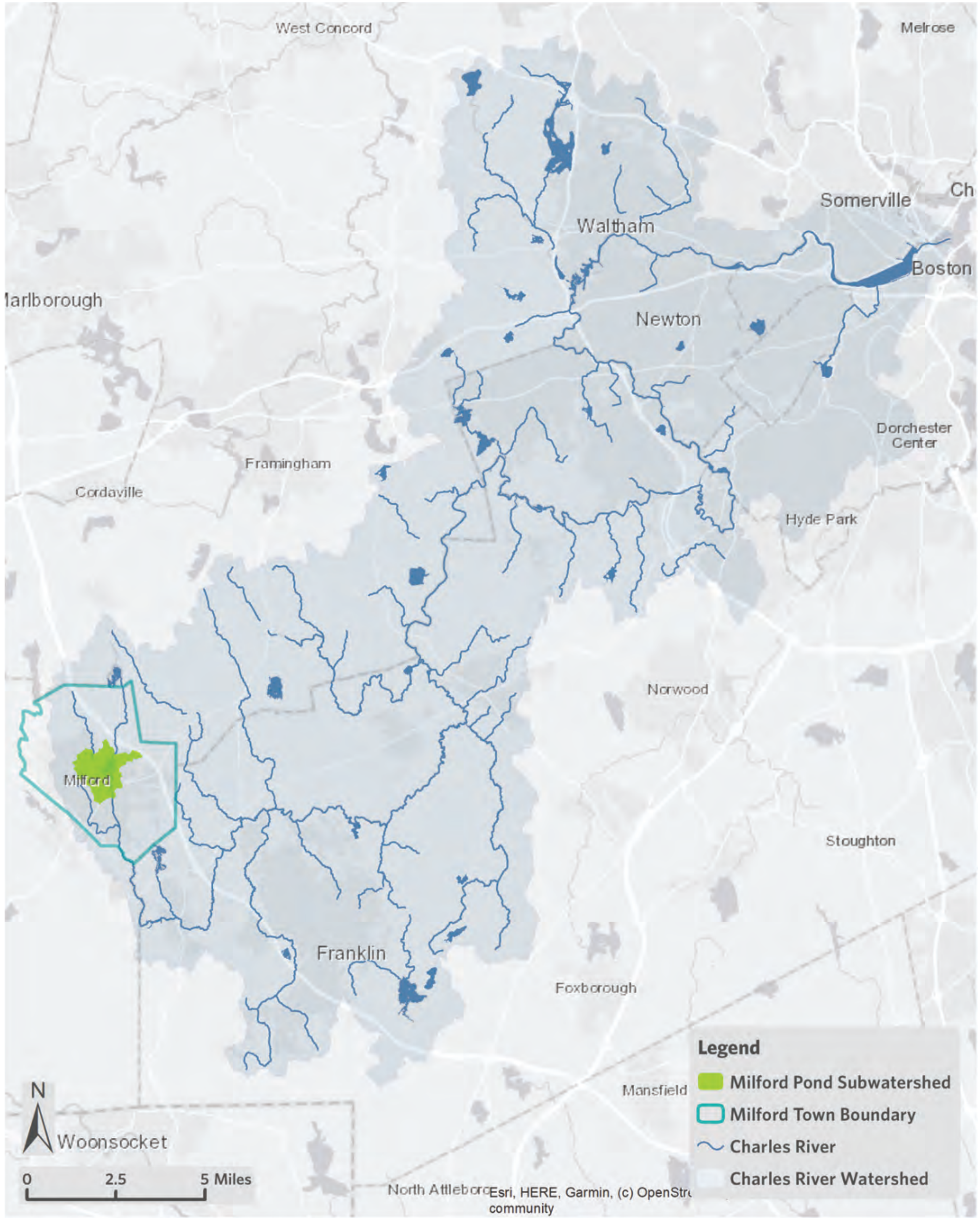
Developing land changes the local water cycle. The balance of impervious surface and vegetative cover affects the amount of precipitation that is infiltrated into the ground, evapotranspirated back into the atmosphere, and runs off into rivers. These changes often make flooding and drought more extreme in developed landscapes.

Introduction

The Town of Milford and Charles River Watershed Association partnered to develop this comprehensive subwatershed restoration plan for the Milford Pond subwatershed. The Town of Milford is facing multiple environmental challenges including stormwater pollution, drought, and climate change. Traditional development practices have considerable impacts on local rivers, streams, and other natural environments because they fundamentally alter the natural water cycle. Paving over or building on a natural landscape reduces the amount of water that can infiltrate into the ground to recharge local aquifers and increases the amount of water that becomes polluted stormwater runoff. Removing trees and other vegetative cover reduces the amount of runoff captured by plants and released back into the atmosphere.

Development all across the Charles River watershed has severely impacted the River, and stormwater runoff is the primary source of pollution to the river. Nutrient pollution, particularly phosphorus, is a major issue in the Charles River. The Town has phosphorus reduction requirements in their Municipal Separate Storm Sewer System (MS4) permit that requires the reduction of 809 lbs of phosphorus from stormwater runoff. The Town relies on local groundwater to supply water to all residents and businesses, including a power plant that relies on both the public water supply and an onsite private well. Finally, the town has identified both flooding and drought as challenges that are likely to become more pressing as the climate changes. Increased infiltration of stormwater may ameliorate some of the deleterious effects of stormwater.

The proposed plan identifies numerous strategies to help the Town address these challenges. Each of the strategies suggested, such as filtration by soils and plants, incorporates natural functions into the developed landscape to increase groundwater recharge and restore our rivers and streams. The plan includes detailed suggestions for locating stormwater treatment systems to reduce phosphorus pollution in stormwater runoff and to significantly increase groundwater recharge. CRWA and the Town identified a target of reducing about 300 lbs of phosphorus in stormwater runoff and 200 million gallons of groundwater recharge annually. The proposed stormwater treatment systems will also help reduce the impacts of stormwater flooding and add green spaces to help cool the landscape in a warming climate.



The Milford Pond Subwatershed is a 1.5 mi^2 area in the Upper Charles Watershed located in the Town of Milford and is the study area of this plan.

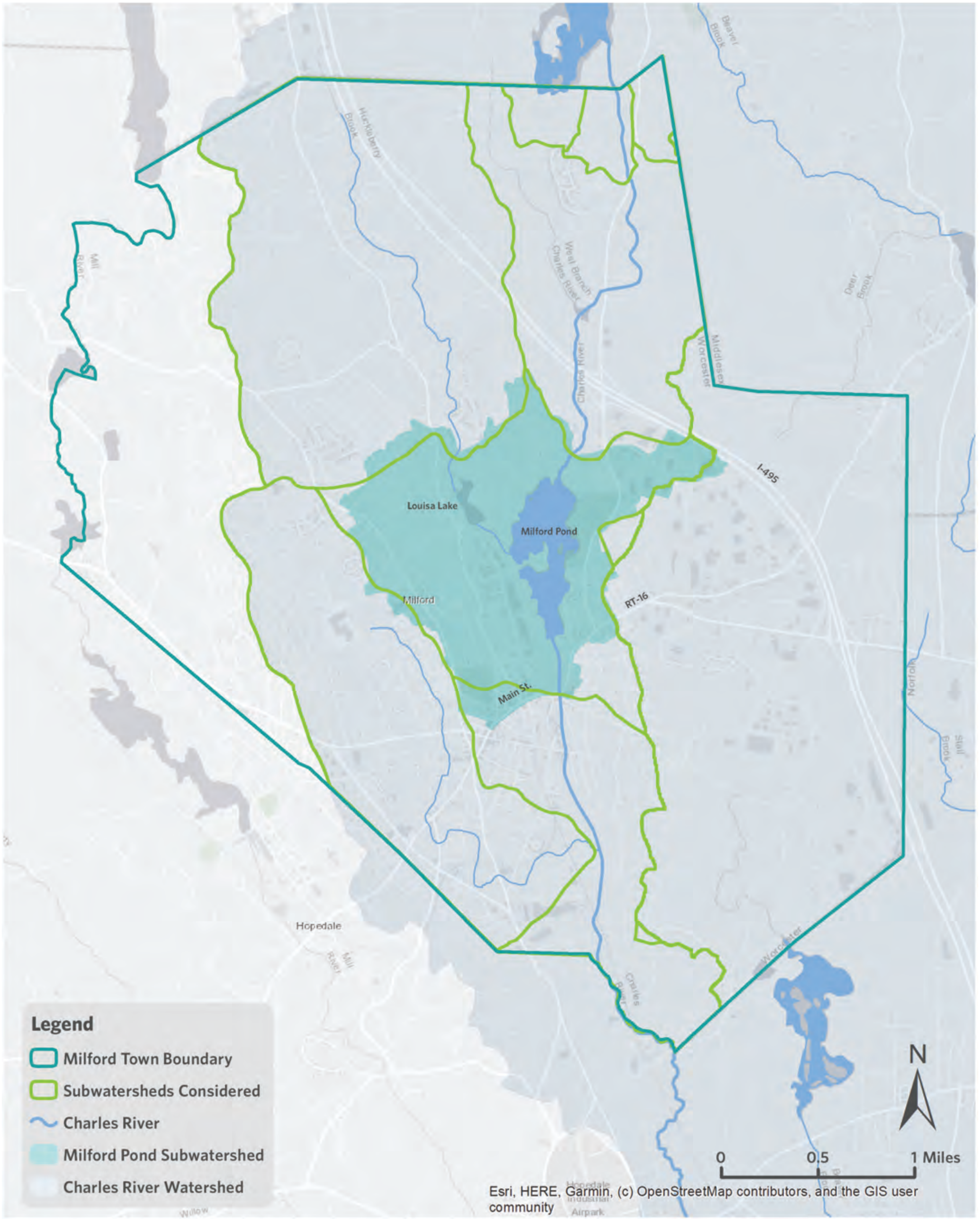
This plan also recommends areas that should be conserved to maintain tree canopy, valuable habitat, and critical groundwater recharge. Additionally, the plan identifies areas for larger scale river restoration opportunities to improve water quality and reestablish habitat in this important headwaters section of the river. This plan focuses on the subwatershed around Milford Pond, however, all of these strategies could be implemented throughout the Town and across the Charles River watershed.

Subwatershed Selection

CRWA's first task was to select a subwatershed within Milford for which we would develop a stormwater management plan. Our goal was to select an area that met the following criteria:

- Fell within the subbasin representing the headwaters of the Charles River (SWMI subbasin 21029);
- Less than two square miles in area to allow for detailed planning based on available resources;
- Contains mixed land uses, representative of the Town of Milford as a whole;
- Includes public property and open space;
- Has a significant amount of impervious cover;
- Provides retrofit design opportunities of varying types and at different scales;
- Has opportunities to engage youth and stakeholders.

This task was completed using geographic information systems (GIS) to assess how various subwatersheds matched the selection criteria. Maps for each possible subwatershed displayed geographic size, soil types, land use, parcels within the subwatershed, open space, and impervious area. CRWA assessed each parameter and narrowed down the list of potential subwatersheds. Site visits and consultation with the Town Engineer allowed CRWA to further evaluate existing conditions, restoration potential, and challenges. The Milford Pond Subwatershed was ultimately selected as the study area because it closely matched the selection criteria.



Subwatersheds considered for study area within Milford. Referenced locations and features labelled.

Existing Conditions Analysis

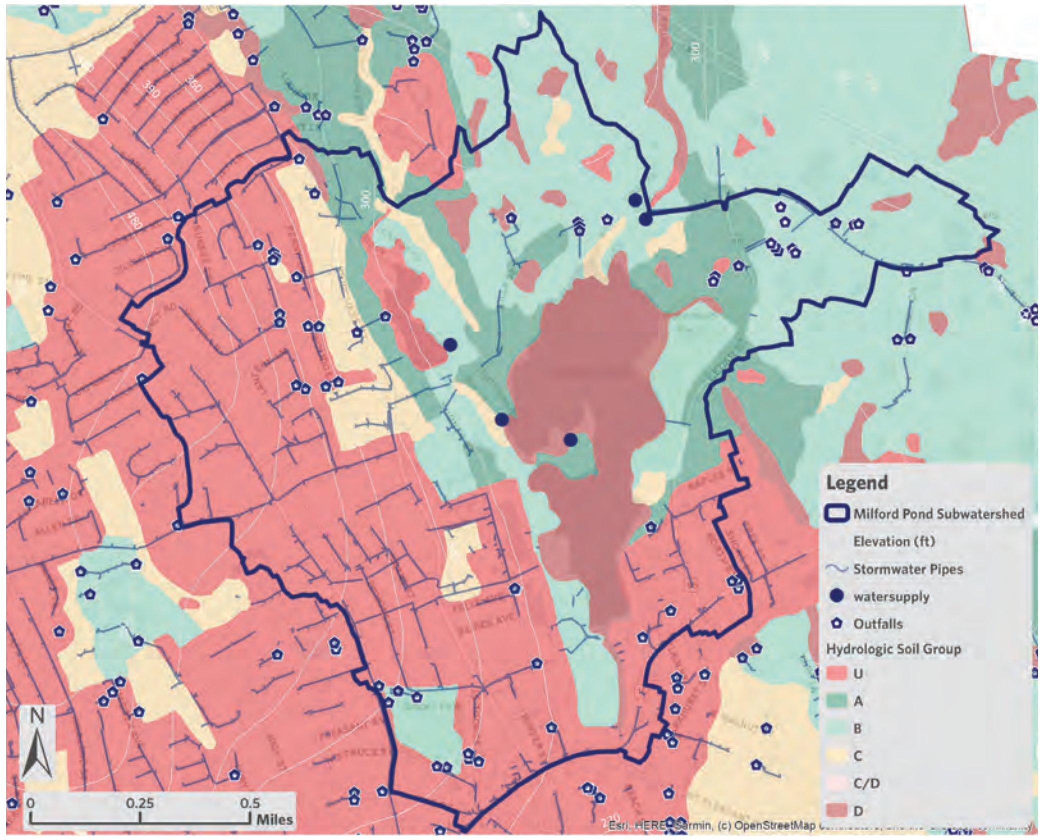
Methodology

After selecting the Milford Pond Subwatershed as our study area, CRWA collected detailed information on this subwatershed to help select, locate, and design environmental restoration techniques and stormwater controls. This assessment included analysis of the following parameters:

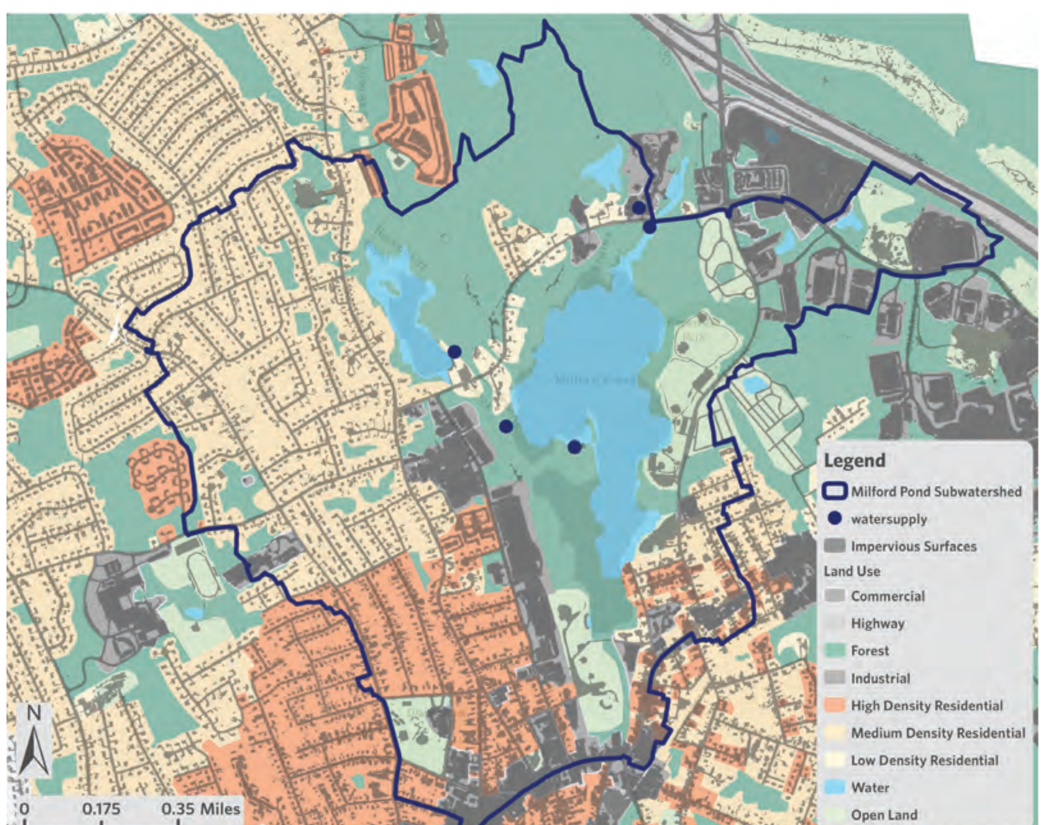
- Topography
- Land use
- Hydrological features
- Stormwater infrastructure (Town of Milford)
- Drinking water resource areas
- Hydrological soil type (NRCS dataset)
- Groundwater depth (NRCS dataset)
- Open space
- Public parcels
- Existing Best Management Practices (BMPs)
- Recreational opportunities
- Historical water resources and land uses
- Water quality data
- Water quantity data
- Estimated existing phosphorus load
- Target phosphorus load reduction based on MS4 permit requirements
- Target groundwater recharge based on water use permits, anticipated uses, and recharge potential

CRWA also reviewed recent Town and regulatory documents including the Milford's 2018 Municipal Vulnerability Preparedness (MVP) Planning report, the Milford's 2018 Multi-Hazard Mitigation Plan report, Milford's 2003 Comprehensive Plan, and the Town's MS4 Stormwater permit.

Existing Conditions Maps



Water infrastructure and hydrological soil groups in Milford Pond Subwatershed.



Land use and impervious surfaces in the subwatershed.

Project Area Description

Milford Pond Subwatershed is 1.5 square miles (970 acres) in area, and is located to the south and west of Route 495, near the center of Milford. The southern portion of the subwatershed includes Milford Town Center, which is located along Main Street (Route 16). The original sub-watershed area was based on USGS subwatershed areas, which are defined by topography and tributary positions. The boundary was modified based on stormwater infrastructure drainage.

The Charles River flows into the study area from the north and is impounded by a dam within the subwatershed. This dam forms a pond behind it, known as Milford Pond or Cedar Swamp Pond. Water drains into the Pond from a hill to the west, through underground stormwater drain pipes. Another smaller impoundment, Louisa Lake, is also located within the subwater-shed and drains into Milford Pond from the northwest. The northeastern branch of the Milford Pond Subwatershed has large commercial buildings and parking lots which drain to three large retention ponds. Multiple water supply wells are located within the subwatershed.

Overall, 46% of the subwatershed is residential and 30% is forested and impervious surfaces cover 33% of the subwatershed. The northwestern and southeastern sections of the subwatershed are mainly residential, ranging from low density to high density/ multifamily housing. The southwestern portion of the subwatershed is more developed and includes the Town Center area, with some commercial and industrial areas located close to the Pond and the River. These areas also contain some large open space parcels, including Fino Field and Milford Town Park. The northern part of the subwatershed is less developed, and this area contains forested land with a bike and pedestrian trail system. To the northeast, large commercial buildings and industrial areas are developed and include extensive impervious surface cover. Public areas such as Plains Park and multiple cemeteries are located near Milford Pond, which is lined by non-forested wetland.

CRWA calculated the current phosphorus load in the subwatershed in order to determine the target reduction, based on requirements of the MS4 permit. The baseline phosphorus load was calculated using 2005 land use data from MassGIS and the methods laid out in the MS4 stormwater permit which requires phosphorus reduction based on land use. From these calculations, the goal phosphorus reduction was 58%, or reduction of 303 lbs of phosphorus per year.

Land Use Category	**Area** (ac)	**% Area**	**Phosphorus Loading** (lbs/ac/yr)	Baseline **Phosphorus Load** (lbs/yr)	**% Reduction Required**	**Phosphorus Load Reduction** (lbs/yr)	**Target Phosphorus Load** (lbs P/yr)
Medium Density Residential	293.4	30.2%	0.49	143.8	62%	89.2	54.6
Forest	288.9	29.7%	0.12	34.7	0%	0.0	34.7
High Density Residential	129.8	13.4%	1.04	134.9	62%	83.7	51.3
Open Land	88.8	9.1%	0.26	23.1	62%	14.3	8.8
Industrial	76.8	7.9%	1.27	97.6	62%	60.5	37.1
Commercial	68.5	7.0%	1.13	77.4	65%	50.3	27.1
Low Density Residential	23.5	2.4%	0.30	7.1	62%	4.4	2.7
Highway	1.9	0.2%	0.73	1.4	62%	0.9	0.5
Total	**971.6**			**519.9**		**303.2**	**216.7**

Calculations of existing and target phosphorus loads in the Milford Pond Subwatershed.

Increasing groundwater recharge to this portion of the watershed was another major goal of this project, as the river suffers from groundwater depletion. In 2018, the Milford Power Plant made technological upgrades to the facility that necessitated additional water use. As both local groundwater and the effluent from Milford's wastewater treatment facility provide flow to the Charles River, the increased use of water at the power plant has the potential to significantly impact flow in the Charles River. Considering the current and expected additional water use at the power plant as well as the subwatershed size, the project team set a recharge goal of 200 million gallons per year (MGY).

"The Town of Milford is facing multiple environmental challenges including stormwater pollution, drought, and climate change."

Charles River Watershed Association

Treatment System Type	Number Proposed
Rain Garden	30
Biofiltration	29
Infiltration Trench	9
Constructed Wetland	1
Total	69

Number of stormwater treatment systems (BMPs) proposed in the Milford Pond Subwatershed.

Subwatershed Restoration Design

Methodology

CRWA employed an iterative process to identify sites for stormwater treatment systems across the subwatershed. CRWA conducted a thorough desktop analysis using ArcGIS. Town-owned sites were assessed first, as they often present good implementation opportunities because there is no need to involve a third-party owner when constructing the designs. Other criteria used to identify properties where treatment systems could be placed included:

- Properties with high stormwater loads (commercial, industrial and high-density residential)
- Low lying properties where stormwater is currently draining to or collecting
- Properties with favorable soil conditions for groundwater infiltration
- Roadways, especially overly wide roadways and cul-de-sacs
- Heavily used areas such as parks and town center areas
- Properties slated for development or redevelopment

After identifying potential sites, CRWA used the following characteristics to determine whether or not it was a good fit for stormwater infrastructure placement:

- Available space
- Amount of impervious surface in drainage area
- Ability to route stormwater to the site for treatment
- Presence or lack of existing stormwater infrastructure
- Underlying soil and groundwater conditions
- Proximity to known soil contamination
- Any unique property characteristics
- Potential for nutrient pollution removal and groundwater infiltration

For sites that were determined to be good candidates for stormwater treatment systems, CRWA identified a specific location and specific treatment system type. Four types of treatment system were considered: biofiltration systems, infiltration trenches, rain gardens, and constructed wetlands. Rain gardens, which infiltrate and add surface greening, were the default option and suggested for any site where conditions would support an above-surface infiltration system. Biofiltration systems were used for sites suspected of having poor soil or high groundwater conditions. Infiltration trenches were proposed for sites with good soil conditions but space constraints. Finally, constructed wetlands were proposed for sites with ample space where a wetland feature would be considered an amenity. Treatment systems were proposed to be as large as space constraints would reasonably allow. For ease of tracking, the study area was divided into three sections (west, north, and east of Milford Pond), and each treatment system was assigned a unique ID code based on which section of the study area it was located in. Pollution removal and rechange volumes were calculated for each proposed treatment system.

The site selection process was repeated until sufficient system locations were identified to meet target pollution reduction and groundwater recharge goals. With each iteration, CRWA expanded our criteria to include possible opportunity sites that may present slightly higher technical or logistical challenges. These more challenging sites with limited stormwater drainage, private ownership, and limited space can still benefit from stormwater treatment. After using ArcGIS to identify opportunity properties and possible treatment system sites, CRWA conducted site visits to verify that current conditions on the ground supported initial conceptual designs and made adjustments as needed based on these site visits. CRWA then calculated the potential pollution removal from each treatment system using the methods detailed in the MS4 stormwater permit, Appendix F. The potential recharge was calculated using a stormwater calculator tool developed by CRWA in support of Water Management Act regulations.

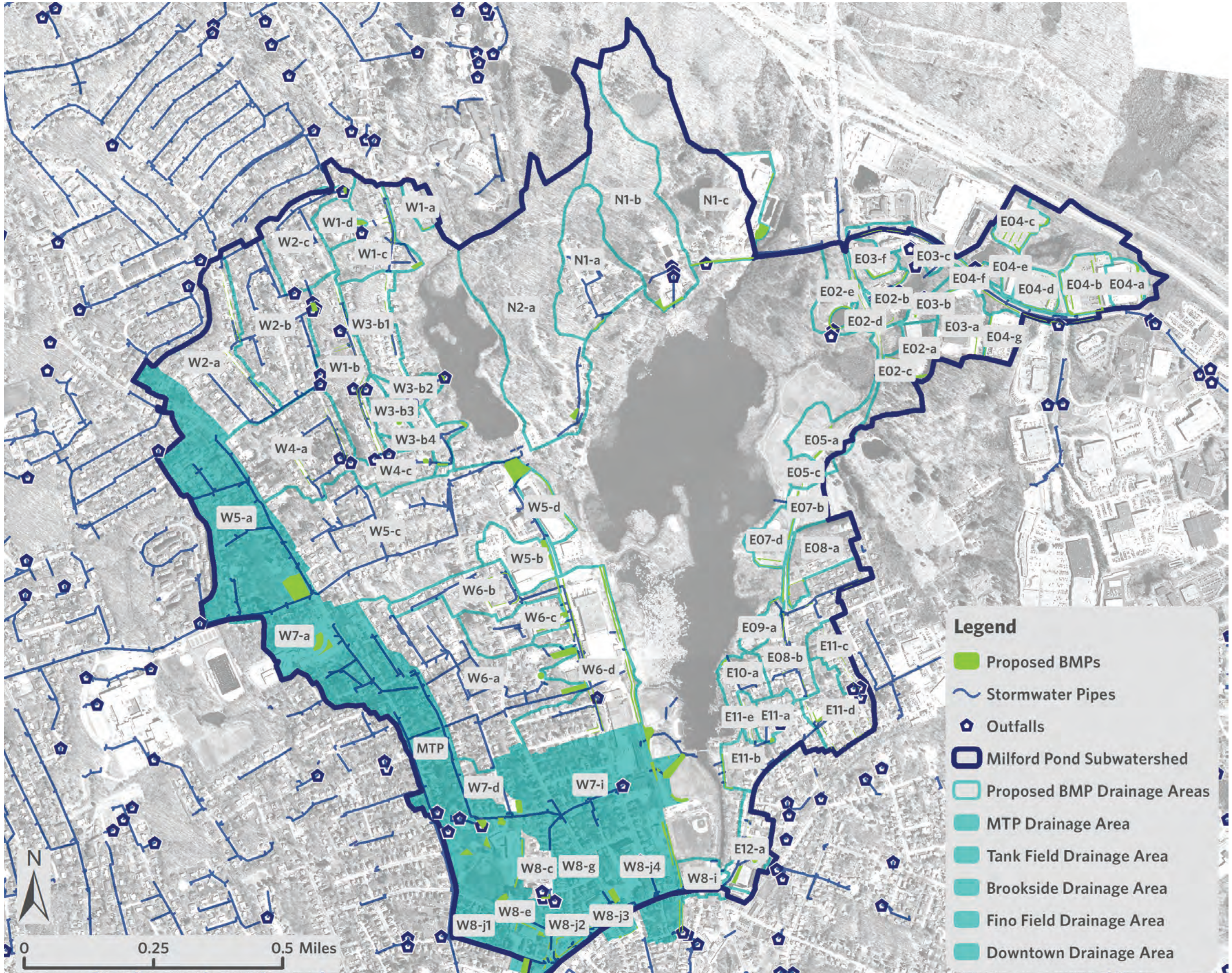
Results

CRWA identified 69 possible locations for stormwater treatment systems. As described above, soil and groundwater conditions were assessed for the entire subwatershed. Sections of the study area subwatershed with good infiltration and limited groundwater conflicts were prioritized for rain gardens and infiltration trenches. This includes most of the Eastern (E) and Northern (N) sections of the subwatershed. The Western (W) section includes a mix of some rain gardens and biofiltration systems as there were gaps in the soil characteristic data in this section of the subwatershed. One constructed wetland is proposed in the Western section. In some drainage areas, multiple treatment systems are proposed. These could likely all be implemented in a single redevelopment project. This includes systems on one property or along one street.

Treatment systems are proposed to treat varying design storm sizes, ranging from 0.1″ to 2.0″. Fourty-two systems, or 61%, are sized to treat a 1″ or greater design storm. The total phosphorus reduction for the subwatershed from the proposed plan is 650 lbs per year. The total annual infiltration estimated from the proposed plan is approximately 240 million gallons (Appendix A).

	Goal	Planned
Phosphorus Reduction (lbs/yr)	303	650
Groundwater Recharge (MGY)	200	240

Phosphorus reduction and groundwater recharge goals and results of planned stormwater treatment systems in the project area.



Planned treatment systems (BMPs) and drainage areas in the Milford Pond Subwatershed. Drainage areas and systems labelled with letters based on their relative location to Milford Town Pond: W to the west of the Pond, E to the east, and N to the north.

Restoration Priorities

Stakeholder Engagement

Throughout the course of the project, CRWA consulted with the Town to better understand on-the-ground conditions, verify assumptions, and gather input. Meetings were primarily between CRWA and the Town Engineer, but CRWA engaged other stakeholders later in the process. Once the subwatershed restoration design was robust and calculations showed that the proposed treatment systems met the recharge and phosphorus reduction goals, the project team began to prioritize the restoration sites.

In December 2019, CRWA and the Town Engineer presented restoration designs at a meeting with both the Manager and the Operations Manager at the Milford Water Company. Discussion revolved around the parcels where interventions were proposed on Water Company lands, including Tank Field and the Milford Water Company facility. The on-the-ground observations allowed CRWA to revise the footprints and drainage areas of the proposed BMPs at those sites. In general, the Water Company expressed interest and support of the project, as it would provide for groundwater recharge, which is a growing concern.

The team then assembled a subcommittee of Town employees to give input on the designs. The subcommittee was comprised of the following members, in addition to the CRWA team:

- Michael Dean, Town Engineer, Town of Milford
- James Asam, Parks and Recreation Administrator, Town of Milford
- Scott Crisafulli, Highway Surveyor, Town of Milford
- Rob Quinn, Facilities Director, Town of Milford Public Schools
- David Condrey, Manager, Milford Water Company

This group met in January 2020 and narrowed down the proposed BMPs to five priority sites. Overall, prioritization of the sites included consideration of parcel ownership, restoration potential for groundwater infiltration and pollution reduction, and visibility by the public for educational opportunities. The Town, in accordance with their MS4 permit requirements, saw large properties with high potential for phosphorus removal as the greatest priority.

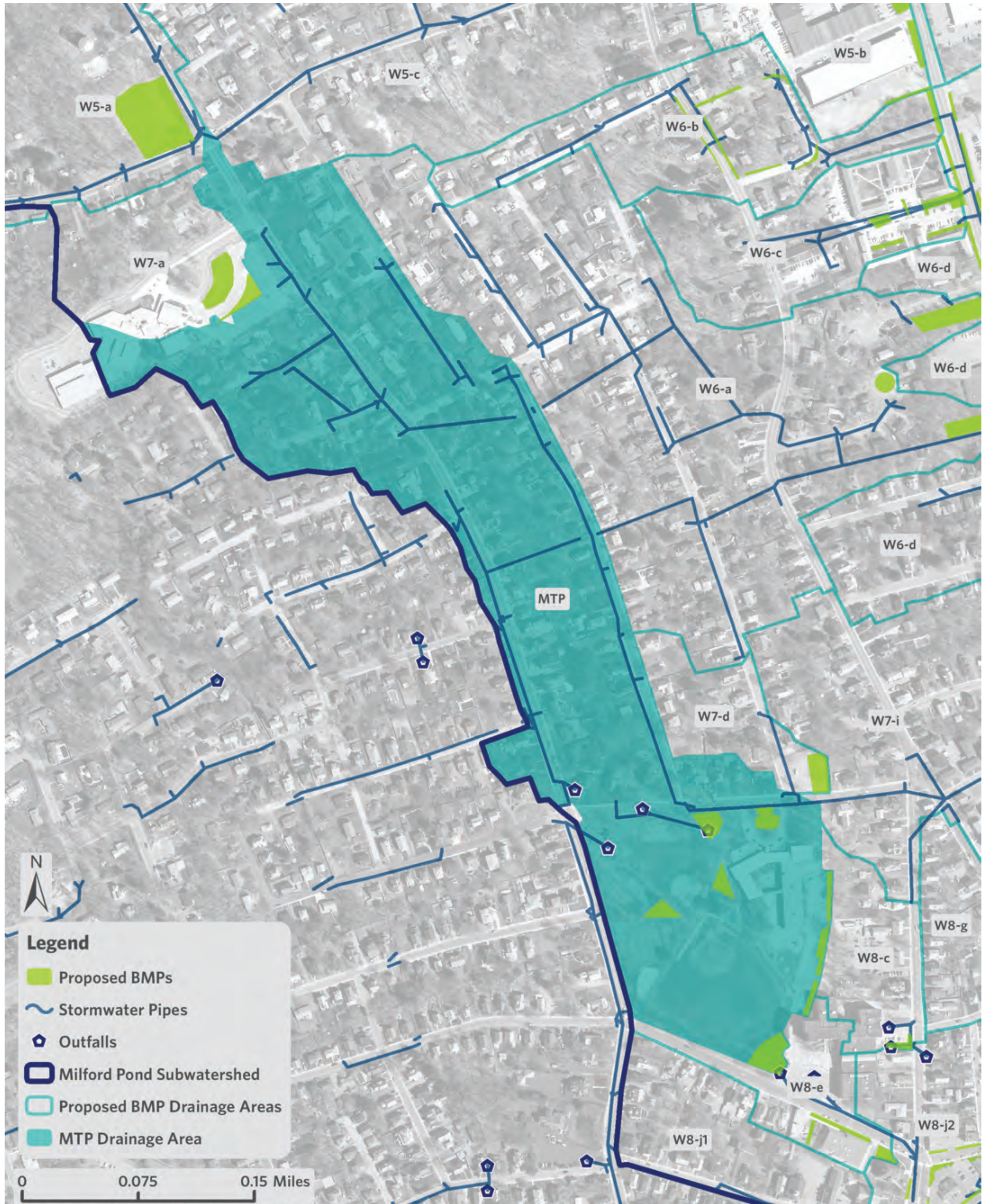
Priority Green Stormwater Treatment Sites

The following sites were selected as priorities for the Town to pursue engineering design and construction in the coming years:

1. Milford Town Park
2. Fino Field
3. Downtown Milford
4. Tank Field
5. Brookside Elementary School

A summary of the existing conditions, reasons for prioritization, proposed stormwater interventions, and benefits on each site are provided below.

> ***"Prioritization of the sites included consideration of parcel ownership, restoration potential for groundwater infiltration and pollution reduction, and visibility by the public for educational opportunities."***
>
> **Charles River Watershed Association**



Proposed BMPs and drainage area in Milford Town Park.

Milford Town Park

Milford Town Park was selected as a priority site in part for its large available spaces, good underlying soils for infiltration, and gentle grade to collect runoff from surrounding streets. The Town-owned park contains baseball fields, basketball courts, tennis courts, open grassy areas, and walking paths which are utilized for a variety of recreational activities including concerts and festivals. The park is also centrally located and adjacent to Memorial Elementary School and Stacy Middle School. Its frequent use, proximity to schools, and location near the Town center were major factors in prioritizing this area.

Six individual BMPs were proposed within the park. One rain garden was placed in the southeast corner of the park, a location which currently requires frequent maintenance due to drainage issues. Additional rain gardens were placed along the east side of the property to simultaneously alleviate drainage issues and collect runoff from the parking lot. The final proposed rain gardens repurposed unutilized spaces throughout the park between paths and roadways. All of the aforementioned BMPs are sized as rain gardens. Together, the proposed BMPs would treat stormwater runoff collected from Congress, Emmons, and Walnut Streets to the north, as well as overland flow from the park and Memorial Elementary School's parking lot.

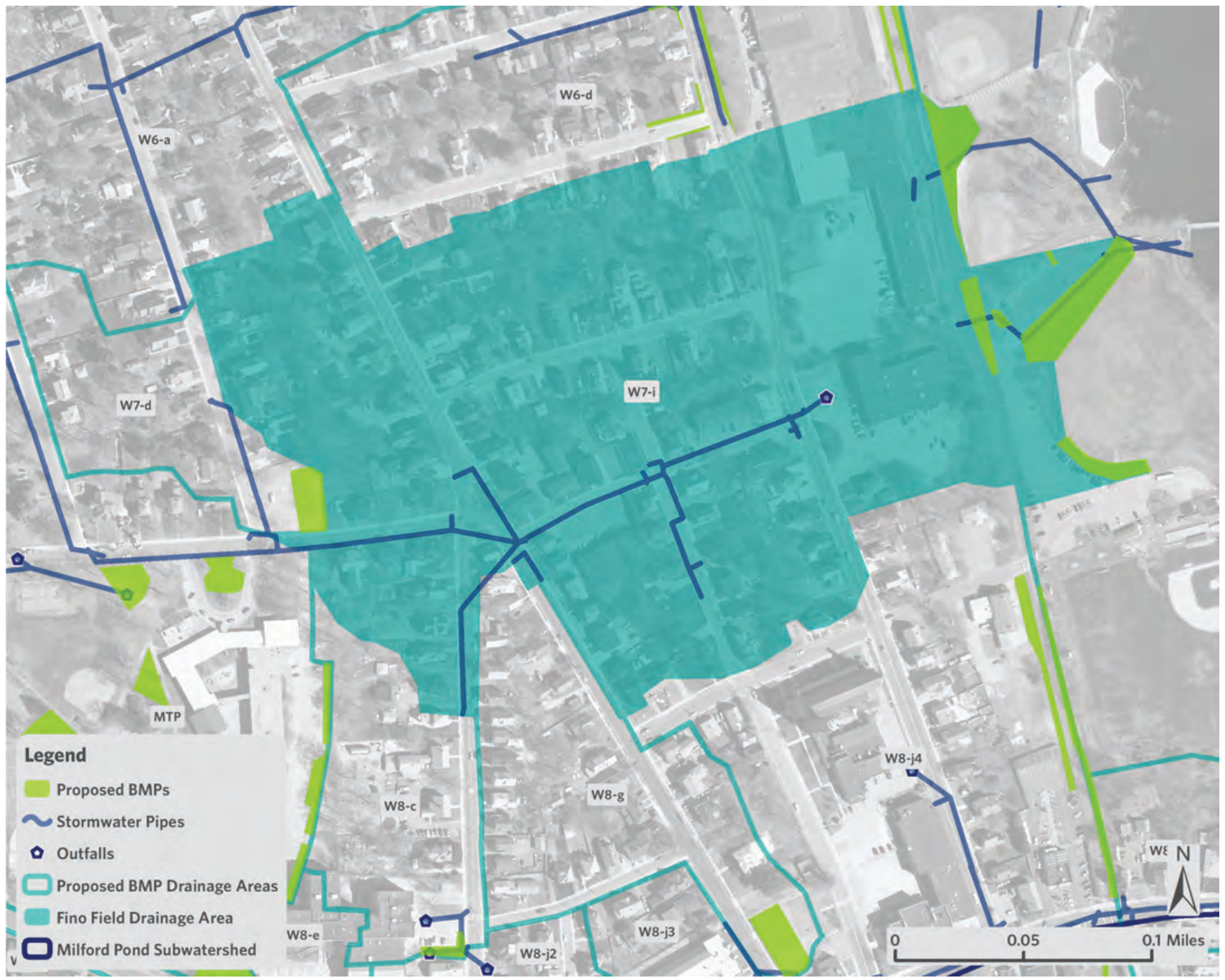

School parking lot with drainage problems.

Drainage Area ID	MTP
Drainage Area (acres)	89.0
Drainage Area Impervious Cover (acres)	29.6
Dominant Land Use	Participation Recreation
Dominant Soil Type	B
System Types	Rain Gardens
Treated Runoff (in)	1.0
Existing Phosphorus Load (lbs/yr)	58.3
Percent Reduction (%)	96%
Phosphorus Load Reduction (lbs/yr)	55.9
Recharge Credit (MGY)	26.7

Fino Field

Fino Field was selected as a priority site for its large available spaces, potential to intercept and treat significant amounts of runoff, and the fact it is Town owned. This site also offered an opportunity to reduce a significant amount of phosphorus from the subwatershed. A large drain pipe runs under Fino Field's parking lot and field, making this site a critical location to capture and treat stormwater runoff from a 61 acre drainage area before it drains into the Charles River. In addition, the Town already has plans to improve the field and pool area, making it an ideal location for additional restoration. Lastly, the proposed area is located next to the Upper Charles Bike Trail, further increasing visibility of any interventions.

Four major BMPs were proposed for the Fino Field area. One runs parallel to the drain pipe that outfalls directly into the Charles River and would treat a significant amount of stormwater from this drainage system. The other BMPs would provide treatment for runoff from Fino Field's parking lots, the bike trail, and from another small stormwater pipe. All of the BMPs were sized as rain gardens because of the potentially good soils for drainage. However, high groundwater may require conversion of these BMPs to biofiltration cells, pending future evaluation.



Proposed BMPs and drainage area in Fino Field.

Rendering of rain garden in Fino Field.

Drainage Area ID	W7-i
Drainage Area (acres)	61.6
Drainage Area Impervious Cover (acres)	29.0
Dominant Land Use	Participation Recreation
Dominant Soil Type	B
System Types	Rain Gardens
Treated Runoff (in)	1.3
Existing Phosphorus Load (lbs/yr)	63.0
Percent Reduction (%)	97%
Phosphorus Load Reduction (lbs/yr)	61.1
Recharge Credit (MGY)	28.3

Space for biofiltration system near 7-Eleven parking lot.

Downtown Milford

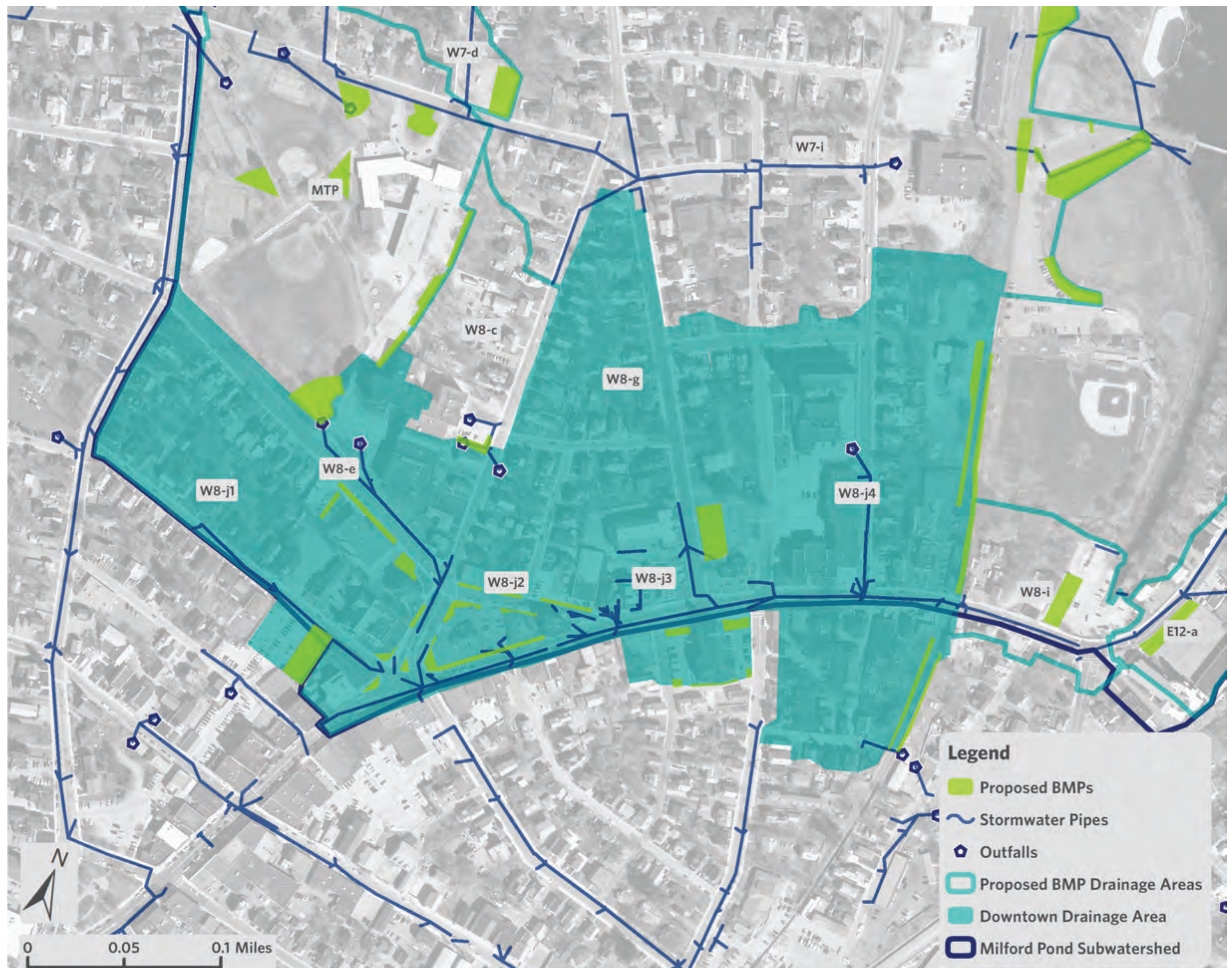
Several sites were identified for potential restoration in Downtown Milford along Main Street (Rt. 16) west of the Charles River. This area was selected as high priority because of its high visibility and the opportunities presented by interspersed Town-owned land. BMPs constructed here would demonstrate how green stormwater infrastructure can work in tight, urban spaces. If a series of these are constructed, they can have a significant impact on phosphorus reduction.

Several drainage areas were proposed for the Downtown area, including both biofiltration practices and infiltration trenches. Biofiltration practices are proposed for public areas around the library, Town Hall, and at the 7-Eleven parking lot. Underground infiltration practices are proposed on two Town-owned parcels: one at the Pine Street parking lot, and the other at the basketball courts between Pearl and Winter Streets.

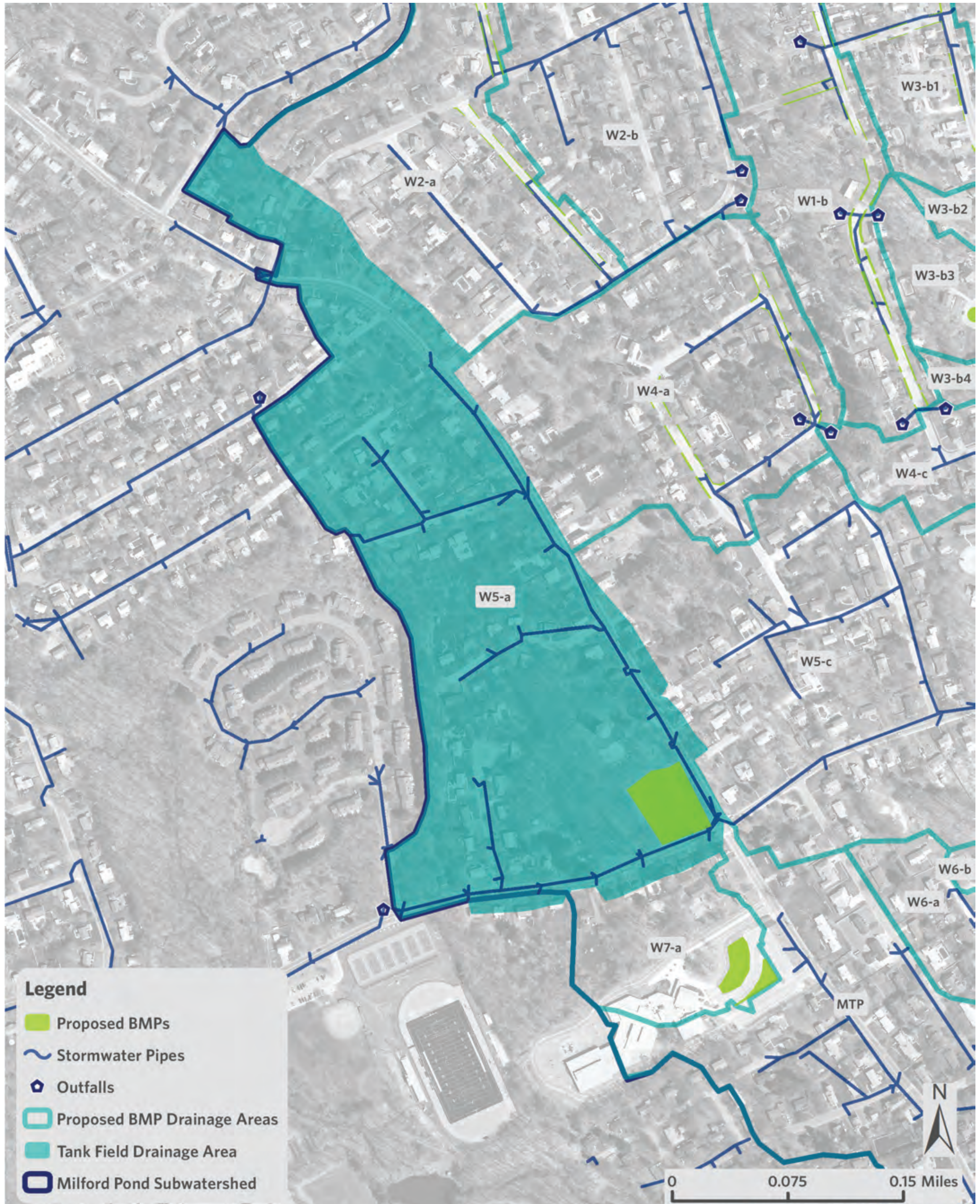
Space for biofiltration system in Library parking lot.

Space for biofiltration system next to Town Hall.

Drainage Area ID	Drainage Area (acres)	Drainage Area Impervious Cover (acres)	Dominant Land Use	Dominant Soil Type	System Type	Treated Runoff (in)	Existing Phosphorus Load (lbs/yr)	Percent Reduction (%)	Phosphorus Load Reduction (lbs/yr)	Recharge Credit (MGY)
W8-j1	13.1	6.5	Multi-Family Residential	B	Infiltration Trench	1.2	10.6	95%	10.1	6.2
W8-j2	16.2	13.0	Commercial	U	Biofiltration	0.7	8.4	68%	5.7	-
W8-j3	8.3	7.2	Urban Public/Institution	U	Biofiltration	0.5	3.8	59%	2.2	-
W8-j4	32.9	20.9	Commercial	U	Biofiltration	0.6	20.2	64%	13.0	-
W8-e	7.4	5.8	Urban Public/Institution	U	Biofiltration	0.7	3.8	68%	2.6	-
W8-g	12.1	6.5	Multi-Family Residential	B	Infiltration Trench	1.2	11.9	95%	11.3	6.2
Total	**90.1**	**60.0**					**58.8**		**44.9**	**12.5**



Proposed BMPs and drainage areas in Downtown Milford.



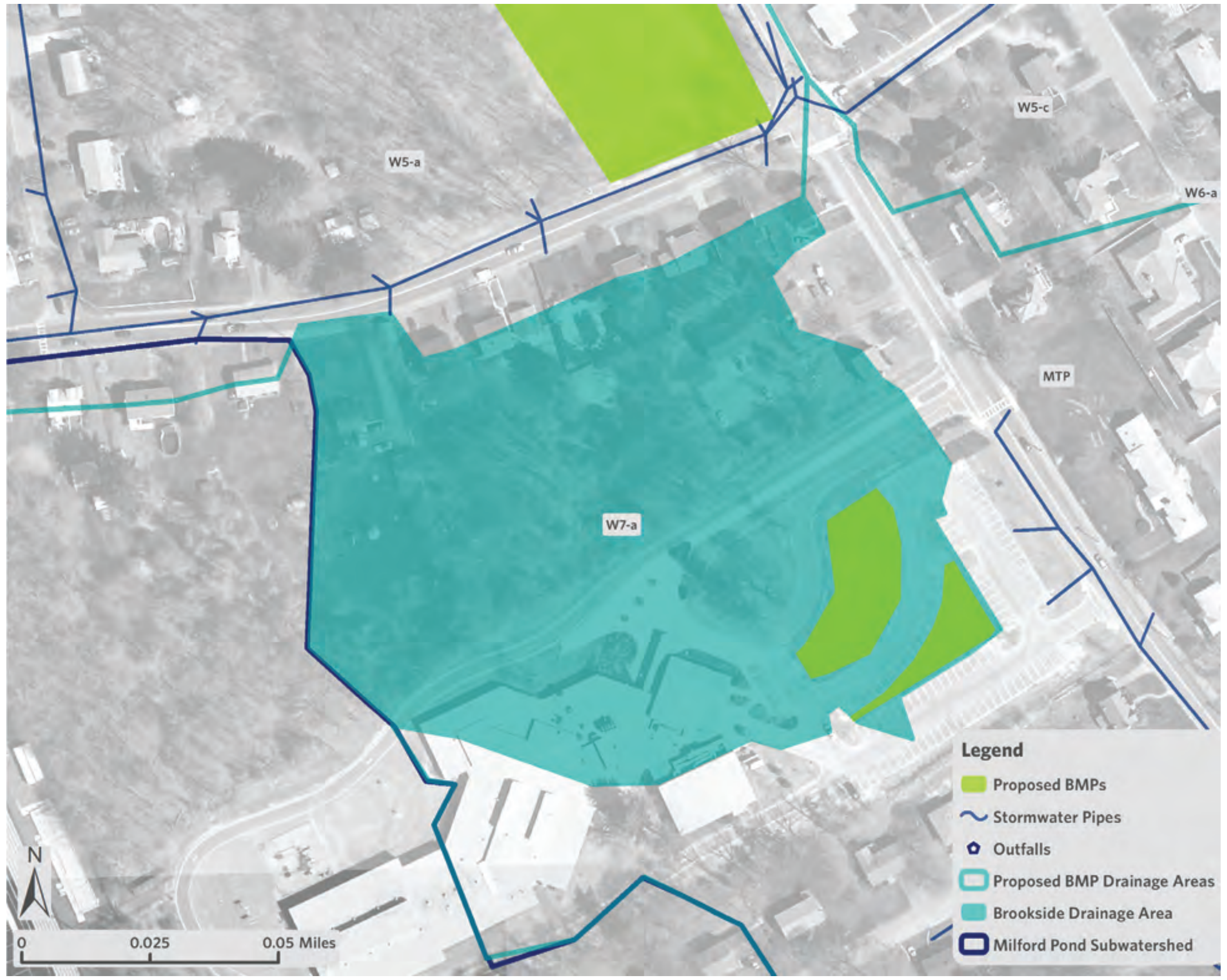
Proposed BMP and drainage area in Tank Field.

Tank Field

Tank field is a small recreational field on the west side of the subwatershed, located on Milford Water Company's property near their water tower. The field is used for passive recreation and sometimes as a practice area for neighboring schools' sports teams. Retrofitting this parcel would collect runoff from storm drain pipes on Congress and West Fountain Streets. A large rain garden or small constructed wetland is possible in this space, or a combination of surface and subsurface practices. Installation may limit the space used for active recreation, but represents a significant opportunity to both infiltrate water and reduce a significant phosphorus load from a 75 acre drainage area.

Rendering of wetland/rain garden in Tank Field.

Drainage Area ID	W5-a
Drainage Area (acres)	75.9
Drainage Area Impervious Cover (acres)	20.4
Dominant Land Use	Medium Density Residential
Dominant Soil Type	U
System Type	Rain Garden
Treated Runoff (in)	1.6
Existing Phosphorus Load (lbs/yr)	15.1
Percent Reduction (%)	98%
Phosphorus Load Reduction (lbs/yr)	14.8
Recharge Credit (MGY)	20.9



Proposed BMPs and drainage area at Brookside Elementary School.

Drainage Area ID	W7-a
Drainage Area (acres)	12.1
Drainage Area Impervious Cover (acres)	3.5
Dominant Land Use	Urban Public/Institution
Dominant Soil Type	U
System Type	Biofiltration
Treated Runoff (in)	2.0
Existing Phosphorus Load (lbs/yr)	3.6
Percent Reduction (%)	89%
Phosphorus Load Reduction (lbs/yr)	3.2
Recharge Credit (MGY)	-

Brookside Elementary School

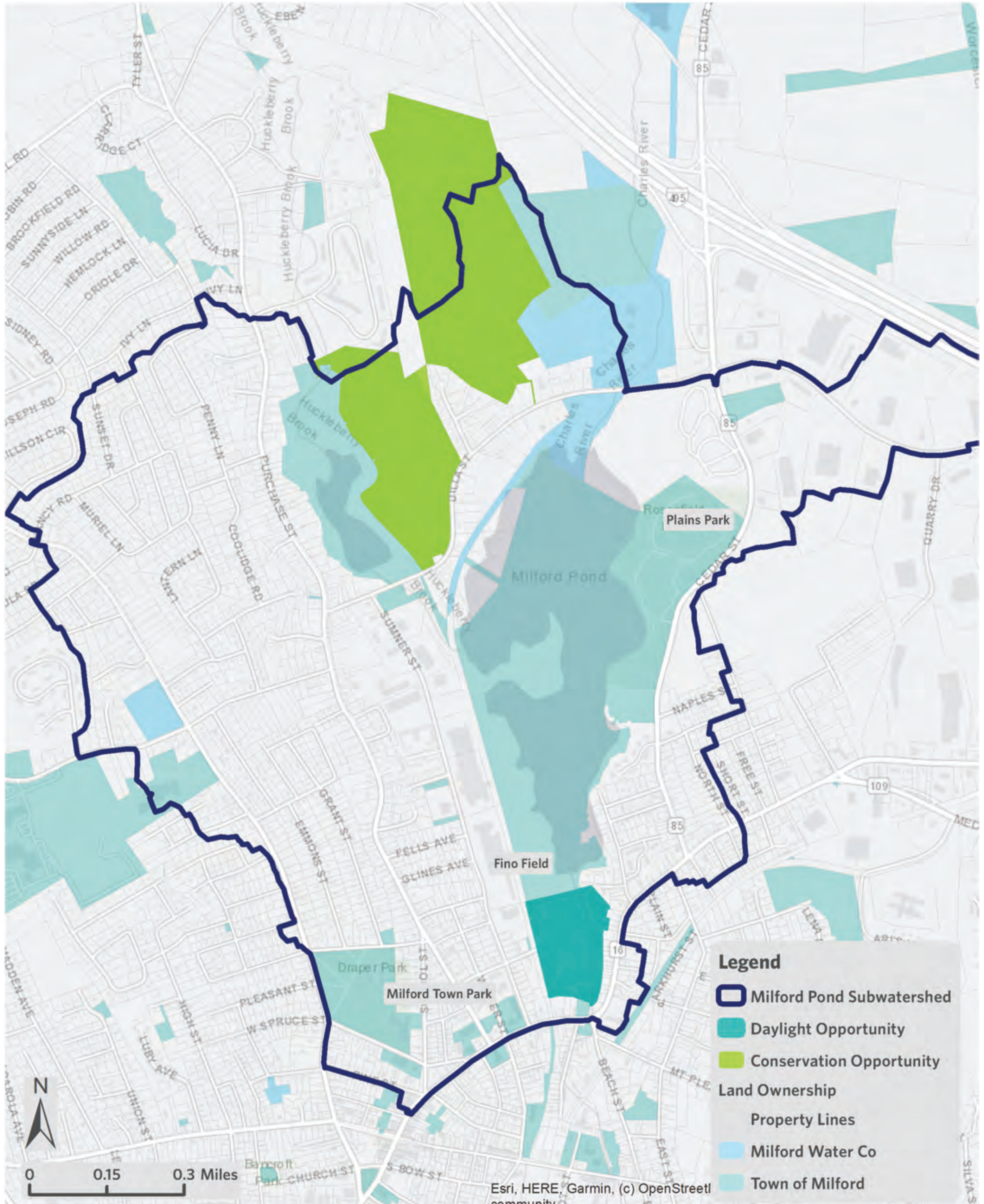
The final priority site is located on the western side of the subwatershed at Brookside Elementary School. The project would replace a defunct stormwater treatment system previously installed in their parking lot. Replacing this system with additional drainage systems throughout the parking lot would treat a larger area of runoff than the original installation and act as an educational display, creating opportunities for future collaboration and partnership with the school.

Current stormwater treatment system in front of Brookside Elementary School.

Additional Restoration Considerations

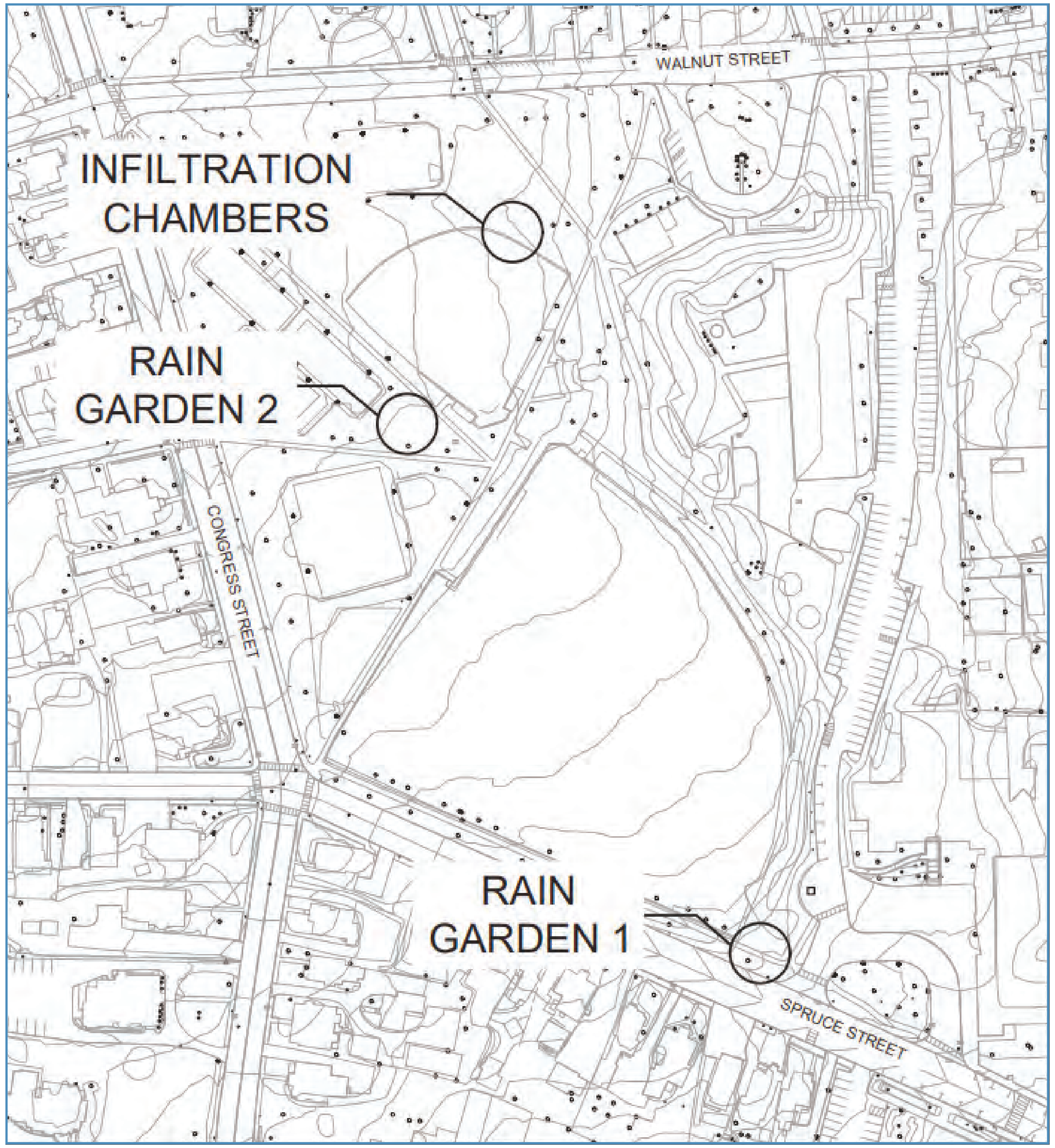
CRWA identified two additional sites for restoration and conservation in the Milford Pond subwatershed. The first is located in the northernmost part of the subwatershed, north of Dilla Street. This area is mainly forested with good soils for infiltration, and is owned by the Town and Milford Water Company. These conditions are ideal for maintaining this area as conservation land. Adding and maintaining protections to this area would in-turn protect the Town's water resources by providing high levels of natural phosphorus reduction and groundwater recharge by the soils and vegetation.

The second site is located in the southern part of the subwatershed, south of Milford Pond and north of Main Street. Located here is a Town-owned parking lot where approximately 100 ft of the river runs underground. CRWA proposes restoring the river and its surrounding banks through a process of daylighting (bringing an underground river back to the surface). Daylighting the river and restoring its banks would reduce pollutant loads, alleviate localized flooding, expand natural habitat space, and create new space for passive recreation.



Land ownership and parcels identified for additional conservation and restoration opportunities.

Municipal parking lot with possibility of daylighting a portion of the Charles River.



Location of systems with preliminary design in Milford Town Park.

Preliminary Design at Milford Town Park

Working with the internal stakeholder the Town and CRWA identified the Milford Town Park site as the first site the Town should move into the implementation phase. This site provides significant pollution reduction and groundwater recharge benefits and provides educational opportunities due to its proximity to two schools and heavy use for community events.

Methodology

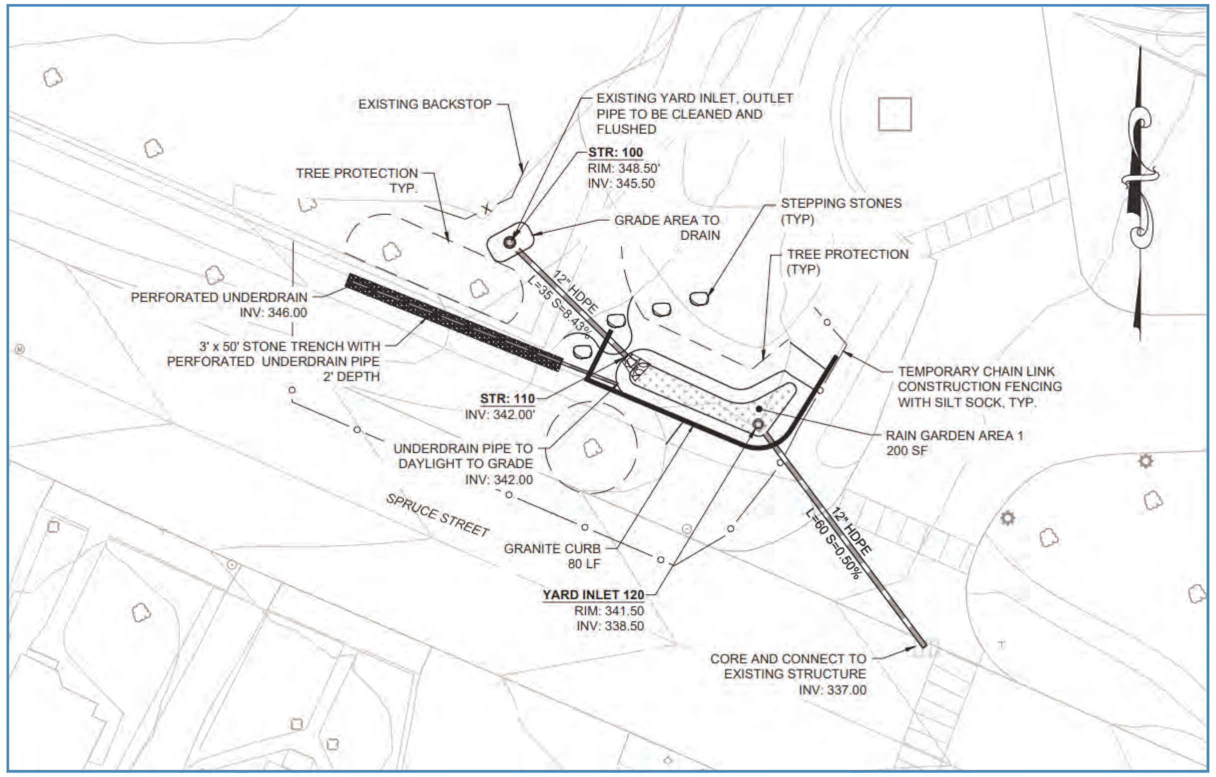
CRWA hired the engineering consulting firm Horsley Witten to develop 30% engineering designs for three proposed systems at Milford Town Park. Horsley Witten has extensive experience in the field of green infrastructure design and implementation. A soil evaluator was also retained to conduct soil assessments at the proposed treatment system sites within Milford Town Park. The soil evaluation was conducted over two days due to identification of unmapped underground utilities during the first field outing.

Results

The soil evaluation found good soils and low groundwater levels for the proposed sites for the rain gardens and infiltration chamber. A fourth site on the east side of the park's parking lot was also tested, but found to have a perched water table, making it less ideal for an infiltration system. Priority was therefore given to developing 30% design plans for two of the proposed rain gardens and one infiltration chamber at three sites in the park. This priority was based on results of the soil analysis, and advantages to each system:

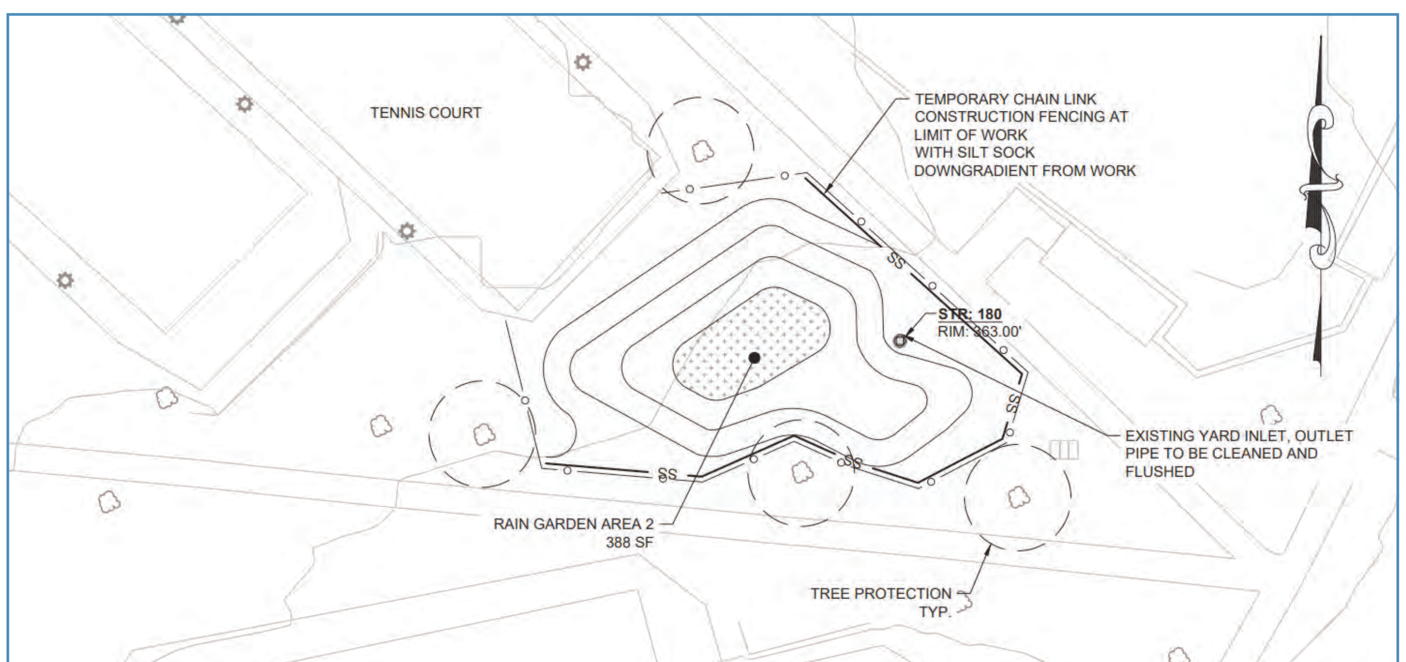
- Rain garden 1 will alleviate local drainage issues, leading to reduced maintenance over time
- Rain garden 2 is centrally located in the Park, serving to enhance education about stormwater runoff
- The infiltration chamber will treat and infiltrate a large amount of runoff from Congress, Emmons, and Walnut Streets

For the rain gardens, stormwater runoff enters the system through a pipe (rain garden 1) or by overland flow (rain garden 2), is filtered by layers of engineered soil and plants, and is infiltrated into the underlying soil through a layer of 3" pea gravel. For the infiltration chamber, stormwater is redirected from the pipe system on Walnut Street into the system of 167 subsurface chambers, is filtered and infiltrated into the underlying soil.



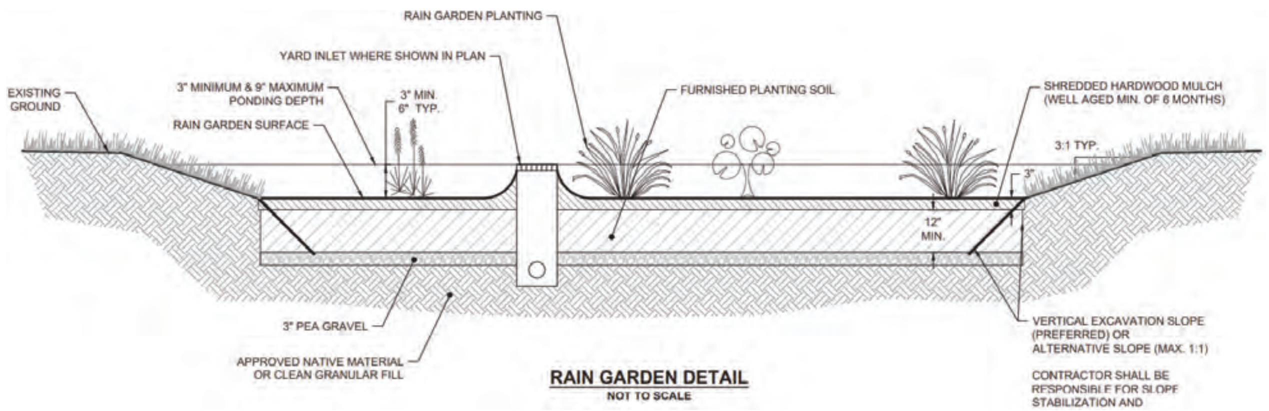
Engineering drawing of rain garden 1.

Rendering of rain garden 1.



Engineering drawing of rain garden 2.

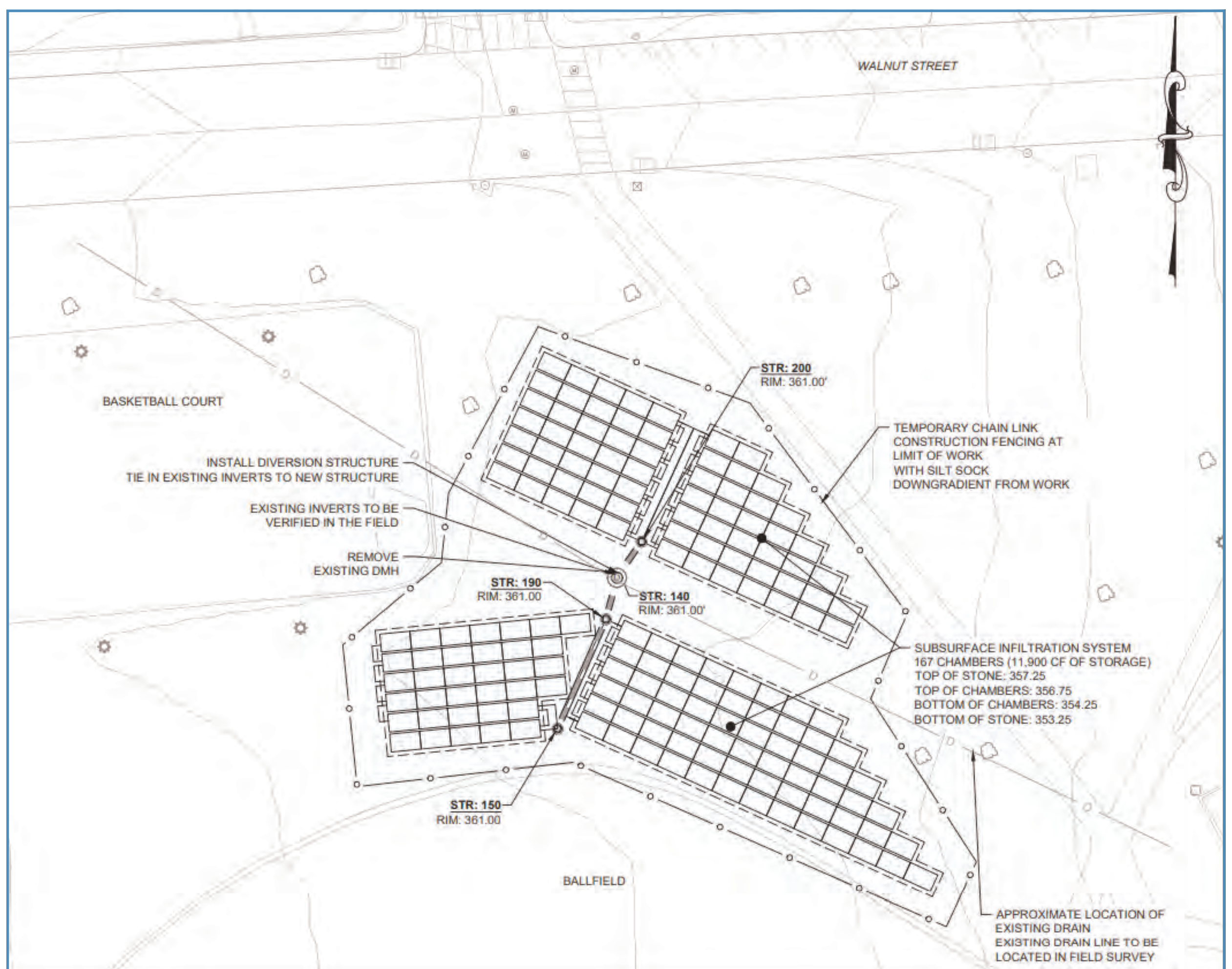
Rendering of rain garden 2.



Schematic cross section of rain garden.

Conclusions

The restoration plan identifies numerous strategies and opportunity sites for stormwater treatment, groundwater recharge, habitat protection, and water quality improvement across the study area. This restoration plan should guide development and redevelopment across the Milford Pond subwatershed for years to come. The strategies identified here should also be incorporated into planning and development projects all across the Town. This restoration plan also serves as the beginning of a phosphorus control plan (PCP) which is a requirement of the Town's MS4 permit. The Town will continue to engage in stakeholder involvement and education to further prioritize projects for investment and raise awareness about the environmental challenges the Town of Milford is facing, and how nature based solutions can help address them.



Engineering drawing of infiltration chamber.

Appendix A: Proposed BMPs

BMP Information							Phosphorous Reduction				
Drainage Area ID	**System Type**	**Soil Type**	**Infiltration Rate** (in/hr)	**Treated Runoff** (in)	**Drainage Area** (acres)	**Drainage Area Impervious Cover** (acres)	**Existing Phosphorus Load** (lbs/yr)	**Percent Reduction** (%)	**Phosphorus Load Reduction** (lbs/yr)	**Resultant Phosphorus Load** (lbs/yr)	**Recharge Credit** (MGY)
W7-i	Rain Garden	B	0.73	1.3	61.6	29.0	63.0	97%	61.1	1.9	28.3
MTP	Rain Garden	B	0.73	1.0	89.0	29.6	58.3	96%	55.9	2.3	26.7
W6-d	Biofiltration	U	0.05	1.2	54.5	33.3	63.2	80%	50.6	12.6	-
W6-a	Biofiltration	U	0.05	1.0	71.4	20.8	64.6	76%	49.1	15.5	-
N1-c	Rain Garden	B	0.73	1.7	73.0	10.7	46.7	99%	46.3	0.5	11.0
W5-c	Constructed Wetland	B	0.73	0.4	107.5	31.4	26.7	99%	26.4	0.3	17.7
N1-b	Rain Garden	B	0.73	1.1	55.4	5.3	26.1	97%	25.3	0.8	4.9
W5-b	Rain Garden	A	4.46	1.0	13.2	12.1	16.6	99%	16.5	0.2	10.9
E03-a	Rain Garden	B	0.73	0.6	14.7	8.7	17.8	89%	15.9	2.0	6.2
W5-a	Rain Garden	U	0.05	1.6	75.9	20.4	15.1	98%	14.8	0.3	20.9
E04-b	Rain Garden	B	0.73	1.8	11.3	10.7	14.3	99%	14.2	0.1	11.1
W8-j4	Biofiltration	U	0.05	0.6	32.9	20.9	20.2	64%	13.0	7.3	-
W8-g	Infiltration Trench	B	0.73	1.2	12.1	6.5	11.9	95%	11.3	0.6	6.2
N1-a	Rain Garden	A	4.46	0.3	33.8	6.3	13.4	83%	11.1	2.3	2.9
N2-a	Rain Garden	A	4.46	0.5	87.5	5.6	10.7	97%	10.4	0.3	3.6
W8-j1	Infiltration Trench	B	0.73	1.2	13.1	6.5	10.6	95%	10.1	0.5	6.2
E05-a	Rain Garden	A/B	1.80	2.0	14.7	4.2	10.0	100%	10.0	0.0	4.5
E04-a	Infiltration Trench	B	0.73	1.3	7.2	5.2	9.1	97%	8.8	0.3	5.1
E03-c	Rain Garden	B	0.73	1.1	19.4	13.9	8.5	97%	8.3	0.3	12.9
E04-g	Rain Garden	B	0.73	0.9	6.5	5.4	8.2	95%	7.7	0.4	4.7
W6-c	Biofiltration	U	0.05	1.0	16.3	6.7	10.2	76%	7.7	2.4	-
W7-d	Infiltration Trench	B	0.73	2.0	7.3	2.2	7.5	100%	7.5	0.0	2.3
E02-e	Rain Garden	A	4.46	2.0	10.1	2.0	7.2	100%	7.2	0.0	2.1
E08-b	Biofiltration	U	0.05	1.1	28.5	7.6	9.4	76%	7.2	2.3	-
W5-d	Rain Garden	B	0.73	1.6	8.7	4.8	7.1	99%	7.0	0.1	4.9
E02-a	Rain Garden	B	0.73	0.6	7.1	4.5	7.5	89%	6.7	0.8	3.2
E11-b	Biofiltration	U	0.05	0.8	17.0	5.6	8.8	71%	6.2	2.5	-
E12-a	Biofiltration	U	0.05	1.1	11.5	5.5	7.7	78%	6.0	1.7	-
E11-d	Biofiltration	U	0.05	1.0	17.6	5.5	7.9	76%	6.0	1.9	-
W8-j2	Biofiltration	U	0.05	0.7	16.2	13.0	8.4	68%	5.7	2.7	-
E02-d	Rain Garden	A	4.46	2.0	8.4	3.3	5.6	100%	5.6	0.0	3.4
E02-b	Rain Garden	B	0.73	0.8	4.8	3.0	6.0	93%	5.6	0.4	2.4
E04-c	Rain Garden	B	0.73	2.0	8.4	0.5	5.6	100%	5.6	0.0	0.5
E07-d	Biofiltration	B/C	0.40	2.0	8.3	1.9	5.9	89%	5.2	0.6	-

All planned BMP drainage areas with phosphorus reduction and groundwater recharge calculations, sorted by phosphorus load reduction. Groundwater recharge only shown for infiltrating systems.

BMP Information							Phosphorous Reduction				
Drainage Area ID	**System Type**	**Soil Type**	**Infiltration Rate** (in/hr)	**Treated Runoff** (in)	**Drainage Area** (acres)	**Drainage Area Impervious Cover** (acres)	**Existing Phosphorus Load** (lbs/yr)	**Percent Reduction** (%)	**Phosphorus Load Reduction** (lbs/yr)	**Resultant Phosphorus Load** (lbs/yr)	**Recharge Credit** (MGY)
E04-d	Rain Garden	B	0.73	2.0	6.7	3.9	4.9	100%	4.9	0.0	4.2
E07-b	Rain Garden	A	4.46	2.0	6.2	1.4	4.5	100%	4.5	0.0	1.5
W1-c	Rain Garden	A	4.46	1.2	18.4	5.2	4.6	99%	4.5	0.0	5.6
W1-c	Rain Garden	A	4.46	1.9	20.7	5.4	4.6	99%	4.5	0.0	5.6
W6-b	Biofiltration	U	0.05	1.2	19.9	6.3	5.5	80%	4.4	1.1	-
E08-a	Biofiltration	U	0.05	1.0	15.4	2.1	5.3	76%	4.0	1.3	-
W1-b	Biofiltration	U	0.05	1.5	29.5	6.3	4.6	84%	3.9	0.7	-
W1-a	Rain Garden	A	4.46	0.6	4.8	2.5	3.8	97%	3.7	0.1	1.8
E03-h	Rain Garden	B	0.73	1.2	3.7	1.7	3.5	97%	3.4	0.1	1.7
E10-a	Biofiltration	U	0.05	0.5	9.3	2.1	5.7	60%	3.4	2.3	-
E09-a	Infiltration Trench	A	4.46	1.1	4.8	3.7	3.4	97%	3.3	0.1	3.4
W7-a	Biofiltration	U	0.05	2.0	12.1	3.5	3.6	89%	3.2	0.4	-
E03-b	Rain Garden	B	0.73	0.8	4.6	1.9	3.4	93%	3.2	0.2	1.5
W8-c	Biofiltration	U	0.05	0.4	7.9	3.6	6.9	44%	3.0	3.9	-
E05-c	Rain Garden	A	4.46	2.0	4.1	0.9	3.0	100%	3.0	0.0	0.9
W2-a	Biofiltration	U	0.05	0.6	38.7	9.9	4.6	64%	3.0	1.7	-
W4-a	Biofiltration	U	0.05	0.5	39.8	8.8	4.8	59%	2.8	2.0	-
W1-d	Biofiltration	C	0.21	0.9	7.4	3.5	4.1	64%	2.6	1.5	-
W8-e	Biofiltration	U	0.05	0.7	7.4	5.8	3.8	68%	2.6	1.2	-
E11-c	Biofiltration	U	0.05	0.9	8.6	1.9	3.4	74%	2.5	0.9	-
E02-c	Rain Garden	B	0.73	1.0	2.6	1.3	2.5	96%	2.4	0.1	1.1
W8-i	Infiltration Trench	B	0.73	2.0	7.1	2.4	2.3	100%	2.3	0.0	2.6
W8-j3	Biofiltration	U	0.05	0.5	8.3	7.2	3.8	59%	2.2	1.6	-
W3-b1	Biofiltration	C	0.21	0.5	19.5	5.4	3.6	58%	2.1	1.5	-
E03-f	Rain Garden	A/B	1.80	2.0	5.5	2.6	2.0	100%	2.0	0.0	2.7
E11-e	Biofiltration	U	0.05	1.6	3.3	0.9	2.2	85%	1.9	0.3	-
W2-b	Biofiltration	C	0.21	0.2	43.2	11.9	5.1	34%	1.7	3.3	-
E04-e	Infiltration Trench	B	0.73	2.0	2.5	0.7	1.7	100%	1.7	0.0	0.8
W4-c	Biofiltration	C	0.21	0.8	11.5	3.2	1.9	71%	1.4	0.6	-
E11-a	Biofiltration	U	0.05	0.8	4.9	1.3	1.9	71%	1.3	0.5	-
W3-b4	Infiltration Trench	A	4.46	0.9	9.5	2.2	1.4	95%	1.3	0.1	1.9
W3-b3	Biofiltration	C	0.21	1.4	8.2	1.8	1.5	82%	1.2	0.3	-
E04-f	Rain Garden	B	0.73	2.0	1.5	0.0	0.7	100%	0.7	0.0	0.0
W3-b2	Infiltration Trench	A	4.46	0.7	5.4	1.7	0.7	89%	0.7	0.1	1.3
W2-c	Biofiltration	C/D	0.10	0.1	21.7	6.1	2.5	19%	0.5	2.1	-
TOTALS					**1449.5**	**481.6**	**742.1**		**650.3**	**91.8**	**239.3**

All planned BMP drainage areas with phosphorus reduction and groundwater recharge calculations, sorted by phosphorus load reduction. Groundwater recharge only shown for infiltrating systems.