Financial assistance was provided by the Executive Office of Energy & Environmental Affairs (EEA) under the FY21 Municipal Vulnerability Preparedness (MVP) Grant Program. The MVP Action Grant offers financial resources to municipalities that are seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts.

**Fuss & O’Neill Team**
- Julianne Busa, PhD
- Sean Arruda, PE
- Erik Mas, PE
- Michael Soares
- Sarah Hayden, MSc
- Derek Newhall
- Liz Isenstein, EIT
- Jon Allard, PLA
- Daniel Turgeon, PLA
- Katy Carroll

**City of Easthampton Project Team**
- Nicole LaChapelle, Mayor
- Diane Rossini, City Project Lead, Staff Engineer
- Jamie Webb, Assistant Planner
- Greg Nuttelman, DPW Director
- Jeff Bagg, City Planner
- Dan Murphy, City Engineer

Document photos and graphics produced by Fuss & O’Neill unless otherwise noted.
INTRODUCTION

The City of Easthampton has developed this City-Wide Green Infrastructure Master Plan using funding through the Executive Office of Energy and Environmental Affairs Municipal Vulnerability Preparedness (MVP) Action Grant program. The purpose of the plan is to identify opportunities to address stormwater-driven flooding hazards and improve water quality through the use of nature-based, green infrastructure practices. This nature-based approach looks at “end of the pipe” problems such as nutrient-impaired waters and known problem areas at stormwater outfalls and seeks to create long-term solutions by providing improved stormwater management in the corresponding upgradient drainage areas. The proposed green infrastructure improvements encompass a range of parcel-specific practices, linear green infrastructure in the municipal right of way, and also more centralized approaches to manage stormwater, increase flood storage, and restore ecosystems on public lands.

Green infrastructure, also referred to as “green stormwater infrastructure” and “low impact development (LID),” is an alternative approach to traditional stormwater management. The green infrastructure approach encourages the infiltration of stormwater into the ground close to where precipitation falls, similar to what naturally occurs in undeveloped areas. By using natural materials including vegetation and soils, these practices restore natural groundwater recharge and filtration processes while reducing downstream flooding. Additionally, green infrastructure can be constructed in stages, as funding and resources become available and as roads or City buildings undergo repaving, renovation, or other upgrades. Unlike traditional underground drainage that needs to be constructed in whole to provide any benefit, green infrastructure solutions can provide incremental benefits as they are implemented, allowing them to be phased in over time.

In addition to reducing polluted runoff and improving water quality, green infrastructure can improve flow conditions in streams and rivers by infiltrating water into the ground, thereby reducing peak flows during wet weather events and sustaining or increasing stream base flow during dry periods, which can be important for aquatic habitat, fisheries, and groundwater supplies. When applied throughout a watershed, green infrastructure can help mitigate flood risk and increase flood resiliency. At a smaller scale, green infrastructure can also reduce erosive velocities and streambank erosion. Green infrastructure and LID are the preferred approach for stormwater management in Massachusetts.

Easthampton is undergoing significant economic development and redevelopment, so there is an imminent need for sound future-focused solutions to guide development in ways that consider future climate conditions, ongoing maintenance needs, and the needs of the City’s Environmental Justice and climate vulnerable populations. The Green Infrastructure Master Plan is intended to help our City officials and other local decision-makers think more strategically about ways to utilize nature-based solutions to make our City more resilient to future climate impacts—from flooding to extreme heat and drought—and to recognize key leverage points where projects can effectively benefit water quality and ecological health while simultaneously communicating proactive, climate resilient development strategies to residents.

This plan is the culmination of a year-long process of assessing potential green infrastructure sites and project ideas throughout the City. It includes:

- Prioritized site-specific and City-wide recommendations,
- 21 concept-level designs to support future implementation projects
- Standard engineering details for low-maintenance green infrastructure stormwater controls tailored to the needs of Easthampton that could be implemented by the City Department of Public Works (DPW) in a variety of locations
- Potential funding sources for design, permitting, and implementation of recommended projects

A key objective of this project is to promote long-term planning and resiliency measures that consider both existing and ongoing infrastructure needs and natural system solutions and form the basis of a climate resiliency vision and implementation strategy for the City of Easthampton.
What is Green Infrastructure?

Green infrastructure refers to systems and practices that reduce stormwater runoff through use of vegetation, soils, and natural processes to manage water and create healthier urban and suburban environments. These practices capture, manage, and/or reuse rainfall close to where it falls, reducing stormwater runoff and keeping it out of drainage systems and receiving waters.

**Green Infrastructure:**
- Improves water quality
- Reduces pollutants in stormwater runoff
- Reduces peak flows during storms
- Helps sustain stream flow during droughts
- Mitigates flooding & increases flood resiliency
- Reduces streambank erosion
- Is more cost-effective than traditional drainage
- Improves air quality
- Sequesters carbon
- Helps reduce energy consumption
- Adds aesthetic interest
- Improves property values
- Contributes to overall economic vitality
- Promotes adaptation to climate change

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Treebox Filters  
Curbed Bioretention Planters  
Curb Bumpouts  
Rain Gardens  
Curb Bumpouts
CURRENT WATER INFRASTRUCTURE AND WATER RESOURCE CONDITIONS

Easthampton’s Aging Stormwater Infrastructure

The City of Easthampton operates an extensive drainage network to collect and convey stormwater, consisting of over 2,800 catch basins (inlets from the roadway into the underground drainage system), over 70 miles of drainage pipe, and nearly 200 outfalls where stormwater is ultimately conveyed to streams and wetlands. Much of this infrastructure is past its intended design lifespan, and in some cases, the drainage network is beginning to fail. To address water infrastructure needs, the City invested in a 5-year process of developing an Integrated Water Resources Management Plan (IWRMP). That planning process, which culminated in 2018, tallied the costs of stormwater management (including upkeep and operations of the system and compliance with federal regulations) as approximately $1.3 million annually.

The IWRMP also identified a list of priority stormwater projects, ranked according to the immediacy of need, environmental impact, and other factors. Identification of municipal properties for green infrastructure retrofits is listed among the top priorities. The overall five-year capital improvements plan for water infrastructure (including stormwater, drinking water, and wastewater infrastructure) includes repair and replacement of aging pipes and structures as roads are repaired or repaved. Specific project callouts also reference replacement and repair of two failed stormwater outfalls—one at the end of Cherry Street, and one at the end of Industrial Parkway.

In addition to the impacts of age alone, older drainage systems are frequently undersized to accommodate the more intense storms that we have been experiencing in recent years, which are expected to continue to increase in frequency due to climate change. With this in mind, as repairs and upgrades are considered, the City aims to future-proof its infrastructure by ensuring that it is sized to accommodate future precipitation events and that stormwater can be infiltrated into the ground wherever possible.
Failed Stormwater Outfalls
Cherry Street and Industrial Parkway

In recent years, both Cherry Street and Industrial Parkway have experienced significant erosion and damage at stormwater outfalls due to the increasing frequency of heavy precipitation events that surpass the design capacity of outdated pipe networks, and are now at the top of the DPW’s list of priorities. At Industrial Parkway, the headwall to the outfall now stands approximately 30 feet forward of the slope, and sections of pipe continue to break away as the erosion of the slope into the stream below continues with each major storm. The roadway itself floods when stormwater backs up through the drainage system and onto the roadway during major storm events. When this occurred during a 3 inch rain event associated with Hurricane Florence in September 2018, access to the western end of the roadway was blocked off.

The situation at Cherry Street is similar, with the headwall completely collapsed and several sections of pipe laying in or near Brickyard Brook where they have broken away. At the Cherry Street site, the siltation of the brook and degradation of the surrounding ecosystem is especially evident due to the site’s proximity to the frequently-used recreational trail.
Cherry Street
A Green Infrastructure Makeover

In tandem with the development of this plan, the City’s MVP grant also funded design and permitting of green infrastructure for Cherry Street. The designs respond to predicted increases in precipitation due to climate change by providing treatment and infiltration for the first inch of rain within the neighborhood. This will effectively infiltrate runoff from most precipitation events directly into the ground for groundwater recharge. By infiltrating at least the first inch of rain during larger events, green infrastructure practices will also provide treatment for the “first flush” - collecting sediment and nutrients that are mobilized in heavy precipitation events and treating them through bioretention planters and tree box filters rather than allowing these pollutants to be carried directly into Brickyard Brook and ultimately to the City’s impaired waterbodies. The green infrastructure practices will also decrease peak flows and help to desynchronize peak runoff from the neighborhood from flows entering the brook at other outfalls. This in turn helps to limit the overall velocity and erosive forces acting on the stream channel and limit storm damages.

Targeting improvements in the upgradient neighborhood to reduce overall stormwater runoff in the contributing drainage areas will ultimately improve water quality and help to reduce velocities during high flow events and thereby limit erosion and scour throughout.
How Stormwater Leads to Water Pollution

When rain falls from the sky, it is generally clean. However, as soon as a raindrop hits the ground and starts flowing across surfaces, it begins collecting other materials. Stormwater runoff picks up surface pollutants-like sand and road grit, excess herbicides or fertilizers, broken down bits of leaves and grass clippings—and carries these into natural waterbodies, often without an opportunity for effective treatment and/or filtration. This can lead to degraded water quality, also referred to as “impairments,” resulting from excessive levels of phosphorus, nitrogen, sediments and solids, salts, bacteria, and other pollutants.

The Massachusetts Department of Environmental Protection tracks water quality in streams, ponds, and lakes around the Commonwealth. Within Easthampton, the Manhan River, which flows across the City from its western boundary with Southampton to its eastern boundary where it joins the Connecticut River Oxbow, is listed as impaired due to high levels of bacteria; Nashawannuck Pond is listed as impaired due to high levels of phosphorus and nutrients/eutrophication. In 2019, these water quality problems contributed to a harmful algal bloom and public health advisories at Nashawannuck Pond which prevented any recreational use of the pond for several weeks.
As time goes on, Easthampton’s climate will begin to look more like the climate in the mid-Atlantic. By the end of the century, our climate here in Western Massachusetts will feel like that of the Carolinas today— in other words, we’re looking at a hotter, wetter future.

The Northeast Climate Science Center at the University of Massachusetts Amherst projects that, given a medium to high future emissions scenario, Easthampton will see as much as 8.3 inches of additional rainfall per year by the end of the century. More critically in terms of flood potential, the City could see up to 4.35 additional days with precipitation over one inch. Similarly, the Massachusetts Department of Transportation (MassDOT)\(^1\) projects that by 2070 the 100-year, 24-hr rainfall event in the Connecticut River Basin, will increase up to 20% under a medium emissions scenario (RCP6.0) and up to 30% under a high emissions or business-as-usual scenario (RCP8.5). This is consistent with the broader findings of the 4th National Climate Change Assessment that identified a 55% increase in the total annual precipitation falling in the heaviest 1% of events in the period 1958-2016 and anticipates an up to 40+% change by late century under a high emissions scenario. With higher annual temperatures and warmer winters, more precipitation will be falling in the form of rain, generating more runoff.

What Climate Change Means for Stormwater

As precipitation events become more intense and less predictable, undersized and aging stormwater infrastructure is expected to pose a greater threat of failure and flooding. Catch basins can be overwhelmed, and even where drainage pipes are of adequate size, high volume stormwater flows can result in powerful erosive forces and scouring at outfalls, with corresponding impacts to natural streams. High volumes of stormwater runoff also increase peak flows through downstream

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\(^1\) https://gis.massdot.state.ma.us/cpws/
Figure 1
Observed and Predicted Extreme Precipitation (4th National Climate Assessment; https://nca2018.globalchange.gov/chapter/2/)

Water Quality and Climate Change
Harmful algal blooms and public health advisories are expected to become increasingly frequent as climate change leads to more extreme heat conditions and drought periods. The Connecticut River Basin is expected to see increases in days over 90°F of up to 67 additional days by the 2090s, and consecutive dry days between rain events are predicted to increase to 17.14 days annually by the end of the century. Increased frequency and intensity of precipitation events also increases nutrient loads in stormwater runoff. Together with increasing temperatures, this creates the conditions for cyanobacteria to grow and reproduce to dangerous levels. A nationwide screening-level assessment of climate impacts on cyanobacteria harmful algal bloom prevalence (Chapra et al. 2017) determined that the largest increases in harmful algal bloom occurrence were likely to occur in the Northeast.


PRIORITIZED GREEN INFRASTRUCTURE CONCEPTS

EASTHAMPTON, MASSACHUSETTS
CITY-WIDE GREEN INFRASTRUCTURE MASTER PLAN

KEY MAP

LEGEND
1. Parsons Street Park
2. New City Parcel
3. New City Right of Way
4. Pleasant Green Park
5. Terrace View Right of Way
6. Edward Dwyer Conservation Area
7. Industrial Parkway
8. Former Boy Scout Camp Parcel - Highland Ave
9. East Street at Old Pascommuck Conservation Area
10. Council on Aging
11. Community Center
12. Sunrise Manor / Clark Street
13. Cottage Street Parking Lot
14. Williston Avenue
15. Williston Avenue / Lownds Avenue
16. Brookside Cemetery at Nashawannuck Pond
17. Nashawannuck Neighborhoods
18. Plain and Strong Street Playground
19. Millside Park Parking Area
20. Brittany Lane and Hendrick Street
21. Loverfield Street
Site Selection and Assessment Process

Sites throughout Easthampton were screened for green infrastructure opportunities or other nature-based solutions to increase flood resiliency and improve or protect water quality. A desktop screening process was initially performed using GIS data layers to identify areas with the greatest risk from flooding and potential for water quality benefits from stormwater retrofits. This screening-level review considered the following factors:

- Utility information (particularly existing drainage infrastructure)
- Soil infiltration capacity
- Municipal ownership (parcels and right of ways)
- Open space priorities
- MS4 regulated areas
- Flood-prone areas
- Water quality impairments
- The City’s Aquifer Protection District and Floodplain and Manhan River Protection Zoning District.

Information from City staff and other stakeholders was incorporated to identify additional areas of known flooding or drainage concerns. The list of potential sites was also examined relative to ongoing planning and capital projects in the City to identify project sites where green infrastructure could be incorporated in a cost-effective manner as part of a larger project (e.g., planned future redevelopment projects or repaving).

Field inventories were then performed at sites identified by the screening-level review to further evaluate the feasibility of implementing green infrastructure retrofits or nature-based solutions at each location. Field assessments focused on adjacent land use and development characteristics, areas of impervious surfaces, drainage patterns and approximate drainage areas, the presence of utilities, locations for potential stormwater retrofits, and site constraints such as evidence of shallow groundwater or bedrock that could limit the feasibility of infiltration-based practices.

The 21 concepts presented in this master plan were determined to be the most promising candidates for green infrastructure improvements that would yield significant benefits in terms of flooding and climate resilience as well as improved water quality. Many of the selected sites are also priority areas for either DPW or Planning for future improvements within the next several years.

Each concept includes preliminary calculations of the volume and depth of stormwater runoff that could be captured by the proposed green infrastructure practices. Calculations of potential pollutant load reductions for total suspended solids (sand, grit, etc.), nutrients (phosphorus and nitrogen) and bacteria were calculated for each practice based on BMP performance curves published by the University of New Hampshire Stormwater Center and the U.S. Environmental Protection Agency. Order of magnitude costs were also calculated based on the assumed volume of water to be treated at each side and typical unit costs for constructing green infrastructure practices. A more detailed summary of cost calculations and assumptions is provided after the concepts.

1. Parsons Street Park
Site Description

The existing park at the corner of Federal Street and Parsons Street has traditionally been underutilized. The ¾th acre lot currently contains a metal swing set and two benches, and a bike share station was recently installed and formally opened in April, 2021. The property is operated by the Easthampton Parks and Recreation Department. Stormwater runoff from both Federal and Parsons Streets flows toward catch basins at the intersection, making the park an ideal location to capture and infiltrate rainwater before it enters the storm drainage system.

Proposed Green Infrastructure Concept:

- Expanded amenities at this neighborhood park to include an upgraded playground area and additional seating
- ADA accessible concrete path winds through the park
- Three rain gardens with native plantings add interest and beauty to the landscape and create a visual and sound buffer between the playground and neighborhood.
- Rain gardens receive stormwater drainage from curb cuts capturing stormwater runoff from Federal Street and Parsons Street; stormwater flows are conveyed under the sidewalk via ADA-approved grates to convey water into the rain gardens where it can infiltrate into the ground.
- New trees provide shade and cooling for the playground and help to reduce urban heat island effects.

Concept Summary

- Impervious Area Treated: 0.26 acres
- Design Storage Volume: 930 cubic feet
- Runoff Capture Depth: 1 inch

Long-Term Pollutant Load Reduction:
- Total Suspended Solids (TSS): 100%
- Phosphorus: 92%+ (dependent on specific infiltration rates)
- Nitrogen: 98%+ (dependent on specific infiltration rates)
- Bacteria: 93%+ (dependent on specific infiltration rates)

Estimated Cost: $130,000
1. Parsons Street Park Rendering
2. New City Parcel
Site Description

The approximately 1.2-acre site located at 10 Lincoln Street was originally part of the larger Parsons Street School property. When the school building was sold in 2015 for private redevelopment into apartments, the City retained the remaining parcel with the intent of ultimately creating a green space within New City for use by the community. The site is currently unused and consists of a circular drive around a central grass island. Entrance to the site from Lincoln Street is via a broad, paved driveway. Informal connectors consisting of degraded asphalt and gravel/dirt exist between the vacant parcel and the neighboring Parsons Place apartments and are used as a vehicle cut-through. A section of degraded pavement lies between the Parsons Place parking area and the circular drive at 10 Lincoln Street. Stormwater runoff from the apartments is directed to a catch basin within this degraded paved area. Stormwater runoff from the driveway currently flows toward the center of the site, into existing catch basins.

Proposed Green Infrastructure Concept:

- Remove degraded pavement at east edge of lot to reduce impervious surfaces on the site and convert to a bioretention area or rain garden.
- Install a small parking area at the entrance to the parcel, adjacent to Lincoln Street, with downgradient bioretention areas to receive stormwater flows from the newly paved parking spaces.
- Narrow the entrance drive and remove excess pavement adjacent to Lincoln Street to decrease impervious surface on the site.
- Preserve the central space within the site for development of walkable community green space amenities within the New City neighborhood; possible ideas for this space have included community garden space, communal gathering areas, and a nature-based community playground.
- Vehicle access connection between Parsons Place apartments and 10 Lincoln can be maintained if desired, depending on ultimate future use.

Concept Summary

- **Impervious Area Treated**: 0.62 acres
- **Design Storage Volume**: 2,210 cubic feet
- **Runoff Capture Depth**: 1 inch

Long-Term Pollutant Load Reduction:

- **Total Suspended Solids (TSS)**: 100%
- **Phosphorus**: 92%+ (dependent on specific infiltration rates)
- **Nitrogen**: 98%+ (dependent on specific infiltration rates)
- **Bacteria**: 93%+ (dependent on specific infiltration rates)

**Estimated Cost**: $136,000
3. New City Right of Way
3. New City Right of Way Rendering
**Site Description**

Originally created as a residential housing area for workers in Easthampton’s mills, the New City neighborhood is one of the City’s most densely-developed areas. New City has a high concentration of low to moderate income residents, and a significant renter population. The interior streets of the neighborhood are primarily residential, with scattered commercial businesses located on Lincoln Street and Parsons Street. While most streets are narrow, Lincoln Street is wide and frequently used as a cut-through route connecting Everett Street to Ferry Street, which contributes to speeding and safety concerns in the neighborhood. Most residences lack off-street parking. On-street parking is the norm on the roadways, as well as at the top of slope above Lower Mill Pond along much of the length of Emerald Place. Parking along Emerald Place has caused a loss of vegetation contributing to ongoing erosion and gullying which has repeatedly undermined the slope, leading to a need for repairs and management by the Department of Public Works.

**Proposed Green Infrastructure Concept:**

- Dual curb extension planters are proposed at the mid-block crosswalk on Lincoln Street. In addition to managing stormwater runoff from Lincoln Street, the planters will create a pinch-point where the road narrows. This results in traffic calming and also shortens the distance of the crosswalk, adding extra protection for pedestrians. The crosswalk is conveniently located adjacent to 10 Lincoln Street for access to the proposed community green space to be developed at that location.

- Re-establishment of a vegetated buffer and installation of vegetated swales are proposed along Emerald Place to provide nature-based stabilization of the slope above Lower Mill Pond. In addition to slowing stormwater runoff to reduce slope erosion, native vegetation provides filtration of stormwater pollutants to help protect the water quality of the pond.

- Reduced pavement width is proposed for the connector road between Emerald Place and Glen Cove Place. Vegetated swales are proposed where pavement is removed.

- Tree box filters can be a useful practice in tight spaces like these; proposed locations should be selected in conjunction with private owners, since they may require use of private property. Tree box filters would also introduce additional tree cover and shade into the neighborhood, reducing urban heat island effects.

**Concept Summary**

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**Long-Term Pollutant Load Reduction:**

- **Total Suspended Solids (TSS):** 100%
- **Phosphorus:** 92%+ (dependent on specific infiltration rates)
- **Nitrogen:** 98%+ (dependent on specific infiltration rates)
- **Bacteria:** 93%+ (dependent on specific infiltration rates)

**Estimated Cost Range:**

$520,000 to $1.1 million for green infrastructure retrofits (does not include utility upgrades or overall road/streetscape reconstruction)
4. Pleasant Green Park
**Site Description**

Pleasant Green Park lies at the center of the Terrace View Neighborhood, a densely-populated, predominantly low-income and renter-occupied neighborhood that is a priority investment area for resilience and community improvements in the City. The neighborhood surrounding the park lacks off-street parking; the park’s edges are therefore used both formally and informally for resident parking, with cars often parked on makeshift asphalt pads and in adjacent unpaved areas, including wedged in between existing trees at the park’s edge. The south end of the park adjacent to Pleasant Street contains playground equipment; the remainder of the park space is currently a large expanse of mowed lawn with few trees and little shade and a few isolated benches limited to the perimeter of the space. The lawn is used for various pick-up sports games and informal gathering.

**Proposed Green Infrastructure Concept:**

- The City seeks to engage neighborhood residents in a community-led design process to further refine a vision for the park and surrounding neighborhood streets to reimagine the park to reflect the needs and wants of the community while incorporating green stormwater management and increased tree cover to counter urban heat island effects.

- The flexible concept for stormwater management design allows for further input and collaboration with residents while focusing on the following core elements:
  
  - Utilize grade change at the middle of the park to create a bioretention area with native plantings that draws stormwater from surrounding streets into the center of the park for infiltration and simultaneously establishes a division between the upper and lower park spaces for multiple simultaneous uses.
  
  - Provide increased tree cover for shade and greater water uptake within the park.
  
  - Integrate pathways and native plantings to create pleasant walking spaces, increase noise/visual buffers, and encourage water uptake.
  
  - Provide increased seating with shade cover.
  
  - Maintain existing parking and seek to formalize additional spaces in locations that are already being utilized informally.

**Concept Summary**

- **Impervious Area Treated:** 0.71 acres
- **Design Storage Volume:** 2,875 cubic feet
- **Runoff Capture Depth:** 1.1 inch

**Long-Term Pollutant Load Reduction:**

- **Total Suspended Solids (TSS):** 100%
- **Phosphorus:** 97%+
- **Nitrogen:** 100%
- **Bacteria:** 99%+

**Estimated Cost:** $230,000
5. Terrace View Right of Way
5. Terrace View Right of Way

Site Description
The Terrace View Neighborhood is one of the City’s most densely-populated residential neighborhoods, with a predominantly low-income or fixed income resident population. The neighborhood is largely renter-occupied. Terrace View is a priority investment area for resilience and community improvements in the City. Like New City, Terrace View was developed as housing for workers in the adjacent mills. Homes have little setback from the street or sidewalks and parking is almost exclusively on-street. The majority of the Terrace View neighborhood drains to a single stormwater outfall located above the Manhan River within the adjacent Edward Dwyer Conservation Area. Due to the high degree of impervious cover in the neighborhood, drainage problems and severe erosion at the outfall are a persistent problem.

Proposed Green Infrastructure Concept:
• Implement green infrastructure practices neighborhood-wide to limit stormwater runoff and pollutants discharged to the Manhan River and add vegetation, shade, and infiltration capacity along neighborhood streets.

• Repeating stormwater management practices are proposed on a street-by-street basis for neighborhood streets, depending on the available space, varying road widths and character of individual streets, and observed parking practices. Proposed practice types include varying configurations of curbside bioretention planters and treebox filters. Due to space limitations and to increase vegetation and improve aesthetics of the streetscape, a larger number of small practices is proposed for each street, rather than concentrating green infrastructure at fewer locations.

• At the end of Ridgewood Terrace, expansion of the existing grassed island is proposed with conversion of the central space into a bioretention area for stormwater capture and infiltration.

• At the crosswalk along Pleasant Street, convert a portion of the existing wide concrete sidewalk into a series of bioretention planters, maintaining access to adjacent parallel parking with walk-through areas.

• Create a vegetated swale along the top of the retaining wall along Pleasant Street to slow stormwater runoff from the raised drive and parking that parallels the street.

Concept Summary
- Impervious Area Treated: 3.7 acres
- Design Storage Volume: 12,750 cubic feet
- Runoff Capture Depth: 1 inch

Long-Term Pollutant Load Reduction:
- Total Suspended Solids (TSS): 100%
- Phosphorus: 97%+
- Nitrogen: 100%
- Bacteria: 99%+

Estimated Cost Range: $300,000 to $650,000 for green infrastructure retrofits (does not include utility upgrades or overall road/streetscape reconstruction)
6. Edward Dwyer Conservation Area
**Site Description**

The 35-acre Edward Dwyer Conservation Area is an underutilized conservation area located between the Terrace View neighborhood and the Manhan River. The property is managed by Pascommuck Conservation Trust and contains an existing trail. Access is via a narrow opening in a chain link fence at the top of slope along Terrace View; no formal parking is available. An existing City stormwater outfall within the conservation area drains most of the upgradient Terrace View neighborhood and has become badly eroded, creating a deep gully. Scour has left the outfall pipe perched approximately 8 feet above the ground surface within a gully approximately 25 feet wide. Trash and debris surround the outfall, much of which is likely legacy material that was once buried and is now being exposed by the ongoing erosion. This trash includes glass and rusty metal that pose a safety hazard to visitors or animals who venture off the marked trail. Below the outfall, the Manhan River winds through floodplain forest. Invasive vegetation is frequent, but the property offers valuable habitat for kingfishers, turtles, fish, and invertebrate species.

**Proposed Green Infrastructure Concept:**

- Implement a regenerative stormwater conveyance at the eroded outfall— a series of step pools designed to accommodate forecasted stormwater runoff volumes from the upgradient neighborhood that account for both increased precipitation due to climate change and decreased runoff due to the proposed implementation of green infrastructure on upgradient neighborhood streets within the contributing drainage area.

- Integrate green infrastructure design with a larger stream and forest restoration project to stabilize eroded banks, remove debris and trash, remove invasive species, and install native plantings.

- Extend the existing trail network by developing a secondary trail along the restored areas and regenerative stormwater conveyance feature with educational signage and access to the Manhan River. Coordinate with Pascommuck Conservation Trust and residents of the Terrace View neighborhood to enhance river access and recreation and education opportunities immediately adjacent to the underserved Terrace View community.

- Provide formalized parking and improved trailhead signage within the City right of way along Terrace View to welcome visitors to the conservation area. Install bioretention to manage stormwater from the newly paved parking area.

**Concept Summary**

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**Long-Term Pollutant Load Reduction:**

- Total Suspended Solids (TSS): 90%
- Phosphorus: 76%
- Nitrogen: 74%

**Estimated Cost:** $675,000

* to be refined based on future drainage modeling of neighborhood with upgradient green infrastructure improvements
6. Edward Dwyer Conservation Area Rendering
7. Industrial Parkway

[Diagram of Industrial Parkway with details on green infrastructure features such as rain gardens, swales, and bioretention areas.]
**Site Description**

Industrial Parkway is a 35-foot wide paved roadway located off of O’Neil Street, just southeast of Route 10. The roadway provides access to about a dozen commercial or institutional properties, including the Hilltown Cooperative Charter Public School and All About Children Daycare. Tractor trailer traffic and school pick-up traffic are both common. The roadway ends in a cul-de-sac, beyond which the City owns a 30-foot wide utility easement that leads into the woods and culminates at a rapidly failing stormwater outfall. The headwall to the outfall now stands approximately 30 feet forward of the slope, and sections of pipe continue to break away as the erosion of the slope into the stream below continues with each major storm. Flooding associated with drainage backups in large storms has been a problem at Industrial Parkway. Water backs up through the drainage system near the middle of Industrial Parkway and causes road flooding due to the accumulation of heavy rain and stormwater runoff, blocking access to the western end of the roadway. All About Children Day Care is located at the cul-de-sac, and during flooding events parents have been unable to reach their children. Flooding also affects business operations along the road, making closures at this location a considerable concern. This level of flooding is a recurring problem, and such flooding events are expected to become more common as climate change impacts increase.

**Proposed Green Infrastructure Concept:**

- Reduce impervious cover and convey stormwater runoff from the roadway into a vegetated swale to promote infiltration and reduce the volume of water entering the storm drainage pipes. Narrow roadway width from 35 feet to 30 feet, using 5 feet to create space for vegetated swales with check dams along north side of roadway; connect swales under driveways as necessary. Repave street to drain to the north. Maintaining 30 foot road width will continue to allow for use by large trucks and provide necessary turning radius.

- After reducing the pavement width, model the existing drainage system to understand specific conditions contributing to the erosion problems and roadway flooding and properly size green infrastructure practices.

- To reduce contributions of stormwater runoff from private sites into the City drainage system, work with private owners to integrate bioretention into unused front lawn areas or other spaces at sites where on-site stormwater practices are not already in place.

- Intercept existing drainage network at end of cul-de-sac and create linear bioretention in City easement before overflowing to existing outfall.

- Coordinate with private owners to install track-off grates at ends of driveways to limit sediment being tracked onto road and reduce clogging of catch basins. Establish operation and maintenance for cleaning of grates to remove and dispose of captured material.

- Optional: install dry wells along roadway for additional distributed infiltration if required based on modeling of drainage from all contributing sites.

- Repair the failing stormwater outfall and restore and stabilize the slope with native plantings to limit further erosion around the outfall.
7. Industrial Parkway Rendering
Concept Summary

Impervious Area Treated: 11.6 acres
Design Storage Volume: 24,990 cubic feet
Runoff Capture Depth: 0.6 inches

Long-Term Pollutant Load Reduction:
Total Suspended Solids (TSS): 98%
Phosphorus: 82%
Nitrogen: 92%
Bacteria: 78%+

Estimated Cost Range: $830,000 (does not include road repaving or practices on private property)
8. Former Boy Scout Camp Parcel
Site Description

The site of a former Boy Scout camp, the 10.2-acre parcel is located at the end of Highland Avenue, off of Northampton Street/Route 10. The site is currently unused, and access to the interior of the site must pass close to the adjacent residence. At the north edge of the property, a steep slope leads down to a tributary stream that feeds the Manhan River -- this is the same stream that receives stormwater runoff from the outfall at the end of Industrial Parkway and additional stormwater drainage from properties along Route 10. The City operates the parcel as open space and wishes to maintain flexibility for a variety of potential future uses.

Proposed Green Infrastructure Concept:

- Utilize the old road into the property to provide improved access to the interior of the parcel for future uses. Create a small parking lot in the parcel interior to avoid visual/noise impacts to the adjacent private residence.

- Create a bioretention area adjacent to the new parking area to receive stormwater runoff from the increased impervious cover created by the new access road and parking area.

- Coordinate with owners upstream and across the stream to implement a low-tech (no significant earthwork), process-based stream restoration and nature-based bank stabilization project in the stretch between Northampton Street/Route 10, behind Industrial Parkway, and along the northern edge of the Boy Scout Parcel to address ongoing erosion and reduce downstream sediment contributions to the Manhan River.

Concept Summary

- Impervious Area Treated: 0.2 acres
- Design Storage Volume: 630 cubic feet
- Runoff Capture Depth: 1 inch
- Estimated Cost: $198,000

- Create a trail and overlook to provide a view of the stream and restoration project from the top of slope, with interpretive signage providing explanation of the techniques at use.

- Develop ongoing site monitoring to measure effectiveness of the restoration approaches and evaluate potential for applying similar approaches at other locations in the City.

- Note that this project should be implemented in tandem with upgradient green infrastructure improvements in the catchment area, particularly at Industrial Parkway, to slow and infiltrate as much stormwater as possible before it enters the stream, thereby reducing the potential for future and ongoing erosion.
9. East Street at Old Pascommuck Conservation Area
Site Description

East Street is a major route into and out of Easthampton, connecting Route 5 with Route 141 (Mountain Road), and several smaller neighborhood streets in between. The road is also used as a detour for large trucks as necessary during construction projects in other parts of the City. East Street follows the toe of slope of Mt. Tom. Because of stormwater runoff coming off of the mountain, drainage has historically been an issue at certain areas along the roadway. The proposed site is located immediately across from the Old Pascommuck Conservation Area, on the south side of East Street. At this location, stormwater runoff from the roadway is conveyed via a stormwater outfall into a tributary stream that passes under East Street, under the Manhan Rail Trail, and then under an access road before emptying into the Manhan River, all within approximately 350 feet. Each of these crossings consists of an old, undersized stone culvert which constricts flow. Erosion caused by the force of water passing through these culverts during storm events has resulted in ongoing failures and maintenance problems for the City, which are exacerbated by the significant inputs of stormwater runoff from the roadway.

Proposed Green Infrastructure Concept:

- Install a vegetated swale with check dams in the City right of way along the south side of East Street to intercept stormwater runoff that would otherwise flow to two existing catch basins before draining to the stormwater outfall above the first stone culvert. The swale and check dams will slow water and allow for infiltration, lessening the contribution of stormwater to the stream and/or desynchronizing stormwater contributions from the roadway and other surrounding land uses to put less stress on the undersized culverts.

- Plant trees adjacent to the swale to provide additional shade and promote water uptake. (Note that overhead power lines are located along the north side of the road and trees will therefore not interfere with power lines.)

- In the long-term, consider replacement and upsizing of the culverts to accommodate the larger flows associated with current and future storm events.

Concept Summary

Impervious Area Treated: 0.4 acres  
Design Storage Volume: 1,875 cubic feet  
Runoff Capture Depth: 1.3 inches

Long-Term Pollutant Load Reduction:
Total Suspended Solids (TSS): 100%  
Phosphorus: 92%+ (depending on specific infiltration rate)  
Nitrogen: 98%  
Bacteria: 97%

Estimated Cost: $63,000 (does not include culvert replacements)

- Installation of similar practices may be possible at other locations along East Street.
10. Council on Aging
Site Description
The Easthampton Council on Aging and Enrichment Center (ECOAE) is located at 19 Union Street, across the street from Big E’s Supermarket. The ECOAE provides information and services for Easthampton residents 55 and older. The ECOAE facility is located in the downtown area, and both the site and surrounding area consist primarily of impervious surfaces. A small perennial garden is located between the building’s front and the sidewalk along Union Street. Access to the parking area is via High Street and is located primarily at the south of the building, with parking for the ECOAE’s vans and limited additional parking spaces located on the north side of the building.

Proposed Green Infrastructure Concept:
• Reconfigure driveway access/layout to create a semi-circular bioretention/rain garden in the driveway along High Street to break up pavement and capture stormwater runoff from the ECOAE parking and High Street while maintaining driveway and parking access. Utilize the existing catch basin in High Street as an overflow structure to convey excess stormwater to the existing drainage system.
• Convert one parking space in the southeast corner of the lot to a bioretention area or rain garden to capture stormwater runoff from the side driveway and parking area and formalize the division between the ECOAE and an adjacent parking lot, which is currently demarcated by traffic cones to prevent cars from driving between the lots. Utilize the existing catch basin located in the parking space as an overflow structure to convey excess stormwater to the existing drainage system.
• Optional: Install a rain barrel to collect roof runoff from the small portion of the building roof that has gutters. Water collected in the rain barrel can be used for irrigation of the existing perennial garden.

Concept Summary
- Impervious Area Treated: 0.2 acres
- Design Storage Volume: 745 cubic feet
- Runoff Capture Depth: 1 inch

Long-Term Pollutant Load Reduction:
- Total Suspended Solids (TSS): 100%
- Phosphorus: 97%
- Nitrogen: 100%
- Bacteria: 97%

Estimated Cost: $26,000
11. Easthampton Community Center
Site Description

The Easthampton Community Center is located at 12 Clark Street and provides services and assistance to residents of the greater Easthampton area. In addition to providing meeting spaces and classes, the community center operates a Food Pantry, Community Care Kitchen, and Clothing Closet. The center is located within a densely developed, mapped environmental justice neighborhood within the City, putting it in easy walking distance for some of the City’s more vulnerable residents. The community center parcel is largely impervious, with a parking area taking up most of the eastern half of the parcel; most of this area drains to the east edge of the site, rather than toward Clark Street. Along Clark Street, the building has both an asphalt walkway connecting the building to the parking area, as well as a section of concrete sidewalk within the City right of way. This sidewalk connects via a crosswalk to a continuous sidewalk on the north side of Clark Street; however, the sidewalk does not continue in either direction on the south side of Clark Street. Use of an unpaved area between the parking lot and Clark Street as an overflow parking space has resulted in this area being devoid of vegetation and developing ruts which collect ponded water during rain events, causing further erosion and undermining of the parking lot edge. At the east edge of the parking area, an informal berm has built up, likely as a result of repeated plowing, which has scraped up material from the uncurbed edge of the lot. The Community Center is one of the few public spaces along Clark Street, a main thoroughfare connecting East Street to the center of the City. Combined with its visible nature and high utilization of the center, this makes it an ideal location to capture and infiltrate stormwater along Clark Street and simultaneously provide an opportunity to showcase a green infrastructure demonstration site.

Proposed Green Infrastructure Concept:

- Remove the existing concrete sidewalk in the City right of way and replace with curbed bioretention planters to reduce impervious cover and capture stormwater runoff from Clark Street and the front walk of the Community Center. Maintain crosswalk access via an ADA-accessible pedestrian pass-through between the two sides of the planter. The planters can also be used to establish visual separation between the road and the community center and prevent parking on the sidewalk, which is sometimes a problem.
- Collaborate with the Community Center to replace the asphalt walkway with pervious pavers to reduce impervious surface and enhance the aesthetics of the building entrance.
- Install a second bioretention area at the northeast corner of the lot, in the City right of way, to prevent further rutting and erosion of this unofficial parking space where water ponds and provide additional capacity for infiltration of stormwater runoff from Clark Street.
- Remove the built-up berm and install a vegetated swale along the east edge of the Community Center parking area. Curb the lot and install curb cuts to convey stormwater runoff through to the swale. Install a wooden guardrail to prevent plowing of/into the swale. (Note that plowed snow is stored on the opposite side of the lot, behind the building.)

Concept Summary

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Long-Term Pollutant Load Reduction:

- Total Suspended Solids (TSS): 100%
- Phosphorus: 92%
- Nitrogen: 98%
- Bacteria: 97%

Estimated Cost: $46,000
12. Sunrise Manor/Clark Street
Site Description
Sunrise Manor was constructed in 1959 as Easthampton’s first subsidized housing complex for elderly residents and is operated by the Easthampton Housing Authority. The development has frontage along Clark Street and is framed by Laura Avenue to the west and Paradise Drive to the east and south. The complex consists of thirty units distributed among six buildings. A number of large shade trees were recently removed from the perimeter of the property, leaving the buildings and grounds without any shade. Stormwater currently ponds along Clark Street at the intersections with both Paradise Drive and Laura Avenue, as well as at the center front of the lot, which is the low point along Clark Street. An existing paved swale runs along the south edge of the property, draining toward an existing catch basin at the center rear of the lot. As with the Community Center, located a few properties to the west, Sunrise Manor is one of the few properties along Clark Street that offers significant frontage within which to install green infrastructure to capture water from the roadway.

Proposed Green Infrastructure Concept:
• Coordinate with the Housing Authority to install a bioretention practice along frontage on Clark Street in both the City right of way and unused front lawn of the property to receive stormwater runoff from Clark Street, incorporating trees to provide shade to the residences and replacing several trees that were recently lost on this parcel. Utilize curb cuts along Clark Street to direct stormwater into the bioretention area and/or shallow surface swales that lead to the bioretention area.

Concept Summary

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<th>Description</th>
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<tr>
<td>Total Suspended Solids (TSS):</td>
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<tr>
<td>Phosphorus:</td>
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<td>Nitrogen:</td>
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<td>Bacteria:</td>
<td>97%</td>
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<tr>
<td>Estimated Cost:</td>
<td>$82,000</td>
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• Extend the existing green island at the corner of Laura Avenue and Paradise Drive westward and convert to a curbed bioretention planter that encompasses the existing catch basin and captures and infiltrates stormwater runoff from both streets. Use the existing catch basin as an overflow structure to return excess stormwater to the City drainage system.

• Convert existing partially-paved swale at rear edge of parcel into a vegetated swale to promote infiltration along the back fence line.

• Optional: Install a bioretention area or rain garden between the two eastern-most buildings on the parcel. This location would likely not receive significant stormwater runoff, but may provide additional gardening space or aesthetic benefits for residents if desired.

• Optional: With input from residents, consider integrating small rain gardens with trees into the central courtyard area to provide shade and gardening opportunities to residents.
13. Cottage Street Parking Lot
Site Description
The Cottage Street Parking Lot is located across from the old theater marquis at the heart of the City’s Cottage Street Cultural District and is one of the few off-street parking options in the downtown area. The parking lot is accessed via one-way entrance/exit driveways along Cottage Street, or via a two-way drive that connects through to Maple Street. The lot offers approximately 26 parking spaces, with two designated handicapped spaces. Because of the diagonal parking configuration of the lot, there are several unusable wedge-shaped areas at the end of the parking rows which are currently paved. A stamped concrete, brick-look area along the center of the lot links to the sidewalk along Cottage Street where a wide crosswalk provides pedestrian access to the shops on the south side of the street; there is an existing curbed, grass island at the north end of this strip. Along the front of the lot, stamped concrete areas made to look like brick separate the roadway from the concrete sidewalk.

Proposed Green Infrastructure Concept:
- Adjust parking spacing and narrow the existing one-way travel lane slightly to provide additional central space between the center parking rows to incorporate a curbed bioretention area with curb cuts to direct stormwater runoff from the parking area into the planter.
- Convert un-parkable wedge-shaped areas to pervious planting areas or small rain gardens to reduce impervious area and provide additional space for infiltration.
- Convert unused space at the north edge of lot to pervious planting area to reduce impervious area and lessen stormwater runoff.
- Convert adjacent stamped brick areas on either side of the Cottage Street crosswalk to curbside bioretention planters to capture stormwater from Cottage Street and enhance the aesthetics of the Cottage Street Cultural District.
- Note that the proposed concept incorporates green infrastructure into the un-parkable areas of the lot; all existing parking spaces are maintained.

Concept Summary

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<tr>
<td>Total Suspended Solids (TSS):</td>
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<tr>
<td>Nitrogen:</td>
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<td>Bacteria:</td>
<td>99%</td>
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<td>Estimated Cost:</td>
<td>$168,000</td>
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13. Cottage Street Parking Lot Rendering
14. Williston Avenue Right of Way
Site Description

Williston Avenue begins at the four-way intersection of Williston Avenue/Payson Avenue/Cottage Street/Union Street and travels southward, along Nashawannuck Pond and Brookside Cemetery to the east, and residential neighborhoods to the west. Williston Avenue provides access to Easthampton High School and Nonotuck Park. A sidewalk runs along the west side of the road, separated from the roadway along most of its length by a grass strip of varying width. The City intends to ultimately implement a complete streets approach that would provide for both pedestrian and bicycle access between the downtown area and the High School and park. The existing roadway is approximately 32 feet wide.

Proposed Green Infrastructure Concept:

- Reconfigure the streetscape to create two 10 foot-wide travel lanes and two 5-foot wide bike lanes within the existing roadway footprint.

- Incorporate the remaining 1-2 feet of existing road width along with the existing grass strip between the sidewalk and roadway to create sufficient space to install curbside bioretention planters along the west side of Williston Avenue.

- Along the east side of Williston Avenue, install treebox filters with mitered sides that allow them to be set flush into the adjacent slope along the cemetery.

- Toward the north end of the street, as Williston slopes toward Nashawannuck Pond, utilize the empty lawn area at the northern tip of Brookside Cemetery to construct tiered vegetated swales that follow the contour of the slope and convey runoff from the roadway into the parcel, with a rain garden at the lowest tier and northern-most tip of the parcel.

- At intersections with the side streets of Ward Avenue and Garfield Avenue, install bioretention bumpouts as shown to narrow the roadway at the intersection while maintaining the availability of on-street parking within the neighborhood and capture stormwater runoff from the respective streets.

- Install a bioretention area at south edge of driveway into the high school to manage runoff from the driveway, mimicking the style of existing stormwater practices within the high school parcel that currently capture stormwater from the school building and parking areas.

Concept Summary

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Long-Term Pollutant Load Reduction:

- Total Suspended Solids (TSS): 100%
- Phosphorus: 94%
- Nitrogen: 98%
- Bacteria: 97%

Estimated Cost: $414,000 (does not include lane reconfiguration)
15. Williston Avenue/Lownds Avenue

GENERAL NOTES:
- STABILIZE ERODED BANKS WITH ROOTWADS/
  NATIVE PLANTINGS
- LIMIT SEDIMENT TRANSPORT TO WHITE BROOK/
  NASHAWANNUCK POND

EXISTING TRAIL

REGENERATIVE STORMWATER
CONVEYANCE SYSTEM

WILLISTON AVE

LOWNDS AVE

NASHAWANNUCK
POND
Site Description
Williston Avenue becomes Lownds Avenue as it takes a ninety-degree turn westward toward the entrance to Nonotuck Park. Surface drainage from both roadways is conveyed toward this corner, and the catch basins along Lownds Avenue and on Williston Avenue from approximately the school southward are conveyed to a stormwater outfall located just beyond the roadway at this corner. At the outfall, significant erosion has created a steep-sided gully. Over time, concrete slabs and stone riprap have been used to try to limit erosion at the outfall. The gully conveys stormwater into the wetlands at the bottom of the slope and from there directly into Nashawannuck Pond, just beyond the point at which White Brook flows into the pond. Significant amounts of eroded sediment are carried toward the pond as the slope continues to erode below the outfall. Nashawannuck Pond is state-listed as water quality impaired due to phosphorus and nutrients/eutrophication. In 2019, these water quality problems contributed to a harmful algal bloom and public health advisories at Nashawannuck Pond. Nutrient impairments related to phosphorus and nitrogen are typically attributable to stormwater runoff carrying excess fertilizers and yard and pet waste from maintained lawn areas within the watershed.

Proposed Green Infrastructure Concept:
- Implement recommendations for green infrastructure improvements along the length of Williston Avenue (see detailed concept for Williston Avenue Right of Way) to reduce stormwater runoff within the catchment to the existing stormwater outfall and provide upgradient opportunities for infiltration and filtration/pre-treatment of stormwater pollutants.
- At the outfall, implement a regenerative stormwater conveyance within the eroded gully at the outfall – a series of step pools designed to accommodate stormwater runoff volumes from the upgradient neighborhood that account for both increased precipitation due to climate change and decreased runoff due to the proposed implementation of green infrastructure on neighborhood streets.
- Stabilize eroded banks with native plantings and natural materials such as rootwads from fallen trees or other large woody debris.

Concept Summary

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Long-Term Pollutant Load Reduction:
- Total Suspended Solids (TSS): 90%
- Phosphorus: 76%
- Nitrogen: 74%

Estimated Cost: $422,000

* to be refined based on future drainage modeling of neighborhood with upgradient green infrastructure improvements

Remove accumulated sediment at the toe of slope to prevent its further transport into White Brook or Nashawannuck Pond.

- Install interpretive signage along the existing foot trail to provide education about the regenerative stormwater conveyance, its role in preventing pollution of the pond and maintaining healthy waterbodies, and the importance of the green infrastructure practices in the upgradient neighborhood.
16. Brookside Cemetery at Nashawannuck Pond
Site Description

Brookside Cemetery is operated by the Easthampton Parks and Recreation Department. The 33-acre parcel encompasses the entire area between Nashawannuck Pond to the east and Williston Avenue to the west. The cemetery parcel abuts the end of the existing Promenade along Nashawannuck Pond. An internal cemetery drive parallels the pond from Williston Avenue southeast through the site; at the north end of the cemetery, there are no burial plots located between this driveway and the pond, and people frequently pull off the drive and park underneath the existing large conifers to enjoy the view of the pond. Over time, this practice has resulted in compacted soil surfaces and exposed dirt which erodes toward the pond during rain events. Closer to the pond, mowed lawn extends almost to the water’s edge, with a narrow strip of weedy vegetation providing minimal opportunity to anchor the slope against erosion or provide filtration of pollutants from stormwater runoff before it enters the pond. This is particularly important, as Nashawannuck Pond is listed as impaired due to nutrient pollution, particularly phosphorus. This impairment contributes to the potential for algal blooms which limit enjoyment of the pond both in terms of aesthetics and safe access to the water for recreation.

Proposed Green Infrastructure Concept:

- Enhance aesthetic value and water quality protections by providing an enhanced buffer to Nashawannuck Pond. Pull back the limit of mowed lawn to create space for native plantings along the water’s edge. Discourage foot traffic at pond edge with a low wooden guardrail or railing matched to the style of the promenade boardwalk and creation of an upgradient pathway that functions as an extension of the adjacent Promenade and John Bator Park nature trail. Install benches along the trail.
- Create formalized parking to replace the unofficial parking that occurs under the existing trees, paving the area to end ongoing erosion and directing stormwater runoff from the new impervious surface and adjacent cemetery drives to new rain garden areas for infiltration and pre-treatment before the runoff enters the pond.
- Install a series of step pools at the south edge of the walkway to slow and filter runoff from the steeply sloped cemetery drive that drains toward the pond and eliminate ongoing erosion caused by this drainage pattern.

Concept Summary

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<td>Runoff Capture Depth:</td>
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**Long-Term Pollutant Load Reduction:**

- Total Suspended Solids (TSS): 100%
- Phosphorus: 97%
- Nitrogen: 100%
- Bacteria: 99%

**Estimated Cost:** $215,000
16. Brookside Cemetery at Nashawannuck Pond Rendering
17. Nashawannuck Neighborhoods
17. Nashawannuck Neighborhoods
Site Description

This neighborhood is framed by Cottage Street to the north, Nashawannuck Pond to the west, and Holyoke Street/Route 141 to the east. Like many of the City’s other downtown neighborhoods, housing and infrastructure in this neighborhood is typically quite old, with many homes dating to the late 1800s or early 1900s. Lots are small and there is a high degree of impervious cover. The streets in this neighborhood all slope toward Nashawannuck Pond, and drainage is conveyed through the City stormwater network to one of several stormwater outfalls into the pond. Many properties in the neighborhood have off-street parking, but on-street parking is still common; more so on some streets than on others. The character of each street varies widely. Fairfield Avenue has a 12-foot wide grass strip between the sidewalk and roadway, while on most streets there is little if any divider between the sidewalk and road. Most streets have sidewalks on one side only, while Pine Street has sidewalks on both sides. Widths of existing roads and sidewalks vary as well, with sidewalks ranging from 4 feet or narrower to as wide as 7 feet in places, and road widths varying from 20 feet to 29 feet. Properties along the pond frequently lack a vegetative buffer to provide filtration of stormwater runoff, with lawns extending to or very near the water’s edge. The pond provides a scenic backdrop as well as recreational opportunities for residents who make use of boating and fishing opportunities in the summer and skating, hockey, and ice fishing in the winter. However, the water quality of the pond is impaired by nutrient pollution from nitrogen and phosphorus conveyed by stormwater runoff into the pond.

Concept Summary

- Impervious Area Treated: 8.5 acres
- Design Storage Volume: 30,300 cubic feet
- Runoff Capture Depth: 1 inch

Long-Term Pollutant Load Reduction:
- Total Suspended Solids (TSS): 100%
- Phosphorus: 97%
- Nitrogen: 100%
- Bacteria: 99%

Estimated Cost: $700,000 to $1.5 million for green infrastructure retrofits (does not include utility upgrades or overall road/streetscape reconstruction)
17. Nashawannuck Neighborhoods

Proposed Green Infrastructure Concept:

- Widespread implementation of green infrastructure in this neighborhood has the potential to significantly improve water quality in Nashawannuck Pond by infiltrating stormwater runoff from smaller events and providing treatment for the first inch of rain or “first flush” during larger storms. Proposed green infrastructure practices should be optimized for collecting sediment and nutrients that are mobilized and filtering them out before excess stormwater is released to Nashawannuck Pond.

- As in the City’s other densely developed neighborhoods, repeating stormwater management practices are proposed on a street-by-street basis for neighborhood side streets, particularly those that slope toward the pond, depending on the available space, character of individual streets, and observed parking practices. Green infrastructure practices such as curbed bioretention planters and treebox filters take advantage of narrow, linear space available in the road right of way and can be integrated with other streetscape improvements for improved walkability, ADA accommodations, and improved neighborhood aesthetics. These practices also provide opportunities to introduce additional tree cover and shade into the neighborhood, reducing urban heat island effects.

- Space is particularly limited on the streets that parallel the pond. Take advantage of locations where the road widens or the City has utility easements over the existing drainage pipes to create surface green infrastructure and provide infiltration.
  - Narrow the roadway at the ninety-degree bend in Water Lane to reduce impervious surface and install curbed bioretention planters along the west side of the road.
  - At the Nashawannuck Pond Boat Launch on Water Lane, remove the existing remnant concrete slab and dead tree in the grass island adjacent to the sidewalk and install a bioretention area with a curb cut and grate leading under the sidewalk to capture stormwater runoff from Water Lane.

- Encourage private homeowners to implement additional runoff reduction practices within their own properties through programming designed to help residents establish rain gardens, rain barrels/rain harvesting systems, etc.

- Where residents are willing, re-establish vegetated buffers along the pond’s edge to provide additional filtration of pollutants and help to stabilize and anchor the bank against erosion.
18. Plain and Strong Street Playground
**Site Description**

The Plain and Strong Street Playground is located at the southeast corner of the intersection of Plain Street and Strong Street. The playground is a popular destination for families but currently lacks sidewalk access or a formal parking area. An existing gravel lot and drive accessed from Strong Street provide some parking within the parcel at the south end of the site. Stormwater runoff from the interior lawn area down the slope and across this gravel parking area has created rutting and erosion that is channeling gravel and sediment toward a stream at the south end of the site. Parking also occurs at an informal pull off along the road right of way on Strong Street closer to the intersection. Playground equipment is the only feature currently offered at the site.

**Proposed Green Infrastructure Concept:**

- Redirect parking to a formalized, paved lot; direct stormwater runoff from this lot into a rain garden for treatment before it is ultimately conveyed down the slope to the stream.

- Establish a vegetated buffer/rain garden between the parking area and play area to slow runoff down the slope onto the parking surface and provide a visual and noise barrier that separates the play space from the parking area.

- Install a sidewalk and vegetated swale along Strong Street at the area currently used as a parking pull off, with potential additional bioretention areas at one or more corners of the Plain Street/Strong Street intersection.

**Concept Summary**

- Impervious Area Treated: 0.8 acres
- Design Storage Volume: 2,745 cubic feet
- Runoff Capture Depth: 0.95 inches

**Long-Term Pollutant Load Reduction:**

- Total Suspended Solids (TSS): 100%
- Phosphorus: 100%
- Nitrogen: 100%
- Bacteria: 99%

**Estimated Cost:** $147,000
19. Millside Park
Site Description

Millside Park is located at 2 Ferry Street along the Manhan Rail Trail. The park features a band shell and serves as a host location for City events such as Arts in the Park and Millside Live, sometimes attracting upwards of 2,000 attendees. The park is bordered by Lower Mill Pond to the south, and the Manhan Rail Trail and redeveloped Easthampton mills to the north. The large parking area at the back of the mills was recently renovated and stormwater from the mills is conveyed to two large detention basins within the park. One of these basins has not been functioning properly; it holds water rather than draining after storms, and the slope between the basin and the pond is destabilizing, with a large crevice and erosion channel opened up in the slope. An additional City-owned parking area lies between the park and Ferry Street at the top of a steep slope down to the pond.

Proposed Green Infrastructure Concept:

- Redesign the City-owned parking area to incorporate green infrastructure into a series of landscaped islands, with overflow and stormwater runoff from the southern side of the parking area directed to rain gardens at the southeast and southwest corners of the lot. Include trees in the landscape islands for shade and improved water uptake.

- Implement nature-based bank stabilization and buffer enhancement plantings along failing/cracking slope at edge of pond.

- Repair improperly functioning detention basin.

Concept Summary

<table>
<thead>
<tr>
<th>Impervious Area Treated:</th>
<th>0.6 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Storage Volume:</td>
<td>2,100 cubic feet</td>
</tr>
<tr>
<td>Runoff Capture Depth:</td>
<td>1 inch</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Long-Term Pollutant Load Reduction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Suspended Solids (TSS):</td>
</tr>
<tr>
<td>Phosphorus:</td>
</tr>
<tr>
<td>Nitrogen:</td>
</tr>
<tr>
<td>Bacteria:</td>
</tr>
<tr>
<td>Estimated Cost: $138,000</td>
</tr>
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</table>
20. Brittany Lane and Hendrick Street
**Site Description**

Brittany Lane is a residential cul-de-sac located on the north side of Hendrick Street, approximately 1,500 feet west of the intersection of Hendrick Street and Mountain Road/Route 141. As such, Brittany lane is located at the base of Mt Tom, where the slope levels out before dropping again to Broad Brook. Broad Brook Meadows Conservation Area, owned by Pascommuck Conservation Trust, is accessed from the end of the cul-de-sac; the parcel also wraps around the houses on the north side of the road. The conservation area parcel includes approximately 60 feet of frontage on Hendrick Street and 200 feet of frontage along Brittany Lane. This area is currently primarily mowed lawn contiguous with the adjacent residential property. Some plantings exist further within the parcel as the lawn slopes down toward a City stormwater outfall that conveys drainage from Brittany Lane and Hendrick Street along a gully and ultimately into Broad Brook. Further downstream, where Broad Brook flows into Nashawannuck Pond, a sedimentation basin traps excess sediment transported along Broad Brook. This sediment likely originates in part from stormwater runoff and/or due to erosive forces at stormwater outfalls like the one at Brittany Lane.

**Proposed Green Infrastructure Concept:**

- Install bioretention/rain garden practices on both corners at intersection of Brittany Lane and Hendrick Street to slow and infiltrate runoff from both streets and lessen volume/velocity at outfall. Right of way space is limited on the west side of Brittany Lane, but the conservation area on the east side of the road provides significant surface space that could be utilized in collaboration with Pascommuck Conservation Trust as a partner.

- In addition to directing surface runoff into bioretention areas, utilize the drop in slope within the conservation area parcel to intercept existing drainage pipes, providing pre-treatment and stormwater infiltration for water conveyed to the outfall from catch basins along the entirety of Brittany Lane.

- Consider implementing a regenerative stormwater conveyance/step pool system at, or leading to, the existing stormwater outfall to address erosion at the outfall and limit sediment transport to Broad Brook from this drainage catchment.

**Concept Summary**

- **Impervious Area Treated:** 1.75 acres
- **Design Storage Volume:** 3,960 cubic feet (excluding regenerative stormwater conveyance)
- **Runoff Capture Depth:** 0.6 inches (excluding regenerative stormwater conveyance)

**Long-Term Pollutant Load Reduction:**

- **Total Suspended Solids (TSS):** 98%
- **Phosphorus:** 82%
- **Nitrogen:** 92%
- **Bacteria:** 93%

**Estimated Cost:** $322,000

*The Regenerative Stormwater Conveyance would be designed to manage higher flows and provide additional pollutant removal*
21. Lovefield Street Right of Way
Site Description
Lovefield Street crosses the Manhan River just south of a City wastewater pump station. At this location, the roadway parallels the Manhan Rail Trail, with a wide vegetated strip separating the two. Two City stormwater outfalls are located within the vegetated strip and convey runoff into the Manhan River from drainage systems that flow toward the river from both the north and south directions. Existing native plantings installed several years ago exist in the vegetated strip at the top of slope on both sides of the river.

Proposed Green Infrastructure Concept:

• To the north of the river, utilize the green space framed by both branches of Lovefield Street, the Manhan Rail Trail, and the pump station driveway to create a bioretention area. (Note that utility conflicts may limit available space and need to be further investigated). Convey stormwater from Lovefield Street and O’Neil Street into the bioretention area via curb cuts and a shallow surface swale. Link the primary bioretention area to a secondary bioretention area via an outlet pipe under the pump station driveway.

• On the south side of the river, install a vegetated swale along the roadway with native plantings to promote infiltration and pre-treatment.

Concept Summary

<table>
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<tr>
<th>Impervious Area Treated:</th>
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<td>Runoff Capture Depth:</td>
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Long-Term Pollutant Load Reduction:
- Total Suspended Solids (TSS): 100%
- Phosphorus: 92%
- Nitrogen: 98%
- Bacteria: 93%

Estimated Cost: $40,000
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<tr>
<th>Site Number</th>
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<th>Construction</th>
<th>Planning and Design</th>
<th>Cost Range</th>
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<td>New City Right of Way</td>
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<td>Pleasant Green Park</td>
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<td>Terrace View Right of Way</td>
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<td>Edward Dwyer Conservation Area</td>
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<td>Industrial Parkway</td>
<td>Parking and trail upgrades</td>
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<td>Vegetated Swale w/ Check Dams</td>
<td>$12.75</td>
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<td>Bioretention Basin (East End of Street)</td>
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<td>Bioretention Basins (At Cul-de-sac)</td>
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<td>Bioretention Basin in City Utility Easement</td>
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<td>Former Boy Scout Parcel</td>
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<td>East Street and Old Pascommuck</td>
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<td>Rain Barrel</td>
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<td>Pervious Pavers</td>
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<td>Vegetated Swale</td>
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**Notes:**
*Estimate includes 10% general conditions and mobilization, 15% design contingency, and 30% construction contingency.

**Costs are based on screening-level evaluations of site characteristics and should be used for planning purposes only. Construction costs could vary significantly. Planning level opinion of costs include estimated costs for engineering design, permitting, and construction.**

**Cost formula and adjustment factors are based on EPA guidance:** [https://www3.epa.gov/region19/Stormwater.htm#green-infrastructure-stormwater-bmp-cost-estimation.pdf](https://www3.epa.gov/region19/Stormwater.htm#green-infrastructure-stormwater-bmp-cost-estimation.pdf)

**Unit Cost sources are as follows:**
<table>
<thead>
<tr>
<th>Site Number</th>
<th>Location and BMP Type</th>
<th>Construction</th>
<th>Planning and Design</th>
<th>Cost Range</th>
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<td></td>
<td>Unit Cost</td>
<td>Unit</td>
<td>Adjustment Factor</td>
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<td>12</td>
<td>Sunrise Manor/Clark Street</td>
<td>Bioretention Area (Clark Street)</td>
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<td>Curbed Bioretention Planter (Laura Ave)</td>
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<td>CF design storage volume</td>
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<td></td>
<td>Courtyard Rain Gardens</td>
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<td>CF design storage volume</td>
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<td></td>
<td>Vegetated Swale at Rear of Property</td>
<td>$12.75</td>
<td>CF design storage volume</td>
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<td>13</td>
<td>Cottage Street Parking Lot</td>
<td>Parking Lot Reconstruction with Green Infrastructure</td>
<td>--</td>
<td>project-specific estimate*</td>
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<td>14</td>
<td>Williston Avenue Right of Way</td>
<td>Curbed Bioretention Planters</td>
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<td></td>
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<td>Bioretention Area at High School Driveway</td>
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<td></td>
<td>Rain Garden/Bioretention with On-Contour Vegetated Swales</td>
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<td>Tree Box Filters</td>
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<tr>
<td>16</td>
<td>Brookside Cemetery at Nashawannuck Pond</td>
<td>Pedestrian Elements/Parking Area/Green infrastructure</td>
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<td>project-specific estimate*</td>
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<tr>
<td>17</td>
<td>Nashawannuck Neighborhoods Right of Way</td>
<td>Distributed Neighborhood Bioretention Practices</td>
<td>$12.75</td>
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<td>18</td>
<td>Plain and Strong Street Playground</td>
<td>Playground Improvements, Parking and Green infrastructure</td>
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<td>19</td>
<td>Millside Park</td>
<td>Parking Lot Reconstruction with Green Infrastructure</td>
<td>--</td>
<td>project-specific estimate*</td>
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<td>20</td>
<td>Brittan Lane and Hendrick Street</td>
<td>Bioretention Areas</td>
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<td>CF design storage volume</td>
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<tr>
<td></td>
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<td>Regenerative Stormwater Conveyance</td>
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<tr>
<td>21</td>
<td>Lovefield Street Right of Way</td>
<td>Bioretention Areas and Vegetated Swale</td>
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<tr>
<td><strong>Total</strong></td>
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</table>
## ADDITIONAL GREEN INFRASTRUCTURE PROJECT IDEAS

<table>
<thead>
<tr>
<th>Location</th>
<th>Project Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Street at Mutter’s Field</td>
<td>• Collaborate with Pascommuck Conservation Trust to create a bioretention area in the ~15 ft space between the roadway and the existing trailhead parking. East Street is 30 feet wide at this point—consider possibility of reducing width to accommodate larger swale and decrease impervious surface.</td>
</tr>
<tr>
<td>Taft Avenue</td>
<td>• Install bioretention bumpouts at intervals along both sides of the roadway. Consider reducing overall pavement width—roadway is currently 30 to 40 feet wide.</td>
</tr>
<tr>
<td>Post Office</td>
<td>• Investigate viability of installing bioretention at front of property in lawn to capture runoff from Rte. 10. Note that utility conflicts may be extensive at this location.</td>
</tr>
<tr>
<td>Katherine Root Wayside Park/Florence Road</td>
<td>• Install vegetated swale along inside of semi-circular parking pull-out. Install raingardens in open area of park to intercept flows to existing catch basins/create visual interest. Incorporate a vegetated swale in the right of way along west side of Florence Road (across from park). Note: intersection layout may change in future; incorporate green infrastructure design into future roadway project.</td>
</tr>
<tr>
<td>S0 Payson/Payson Avenue</td>
<td>• Consider installing bumpouts/curbside bioretention planters along Payson Ave, creating separation between sidewalk and roadway. Note that coordination with Police and Fire would be necessary, as installation of green infrastructure would potentially narrow the roadway near the Police/Fire Station. Consider converting catch basin(s) receiving roof drainage to infiltrating catch basins and/or direct roof drains to dry wells. Utilize extra width at main entrance driveway to install curved bioretention planter between sidewalk and parking spaces, pushing parking spaces adjacent to main entrance 5 feet towards the police station.</td>
</tr>
<tr>
<td>Highway Department</td>
<td>• Investigate viability of bioretention at driveway entrance in grassed area – would need to verify engineering feasibility of promoting infiltration at this location given proximity to bridge and slope. Utilize nature-based slope stabilization to treat erosion of adjacent slopes and limit sediment transport into the river.</td>
</tr>
<tr>
<td>Water Division</td>
<td>• Replace current paved swale along west side of driveway with vegetated swale with check dams.</td>
</tr>
<tr>
<td>City Parcel 170-3 (adjacent to Water Division)</td>
<td>• Install bioretention island at bottom of slope (in mowed area) to intercept and infiltrate before outfall. Include a forebay with weirs to slow flow from system above slope. Note: Design feasibility would need to verify proximity to wetlands, pipe depths/velocity/volume. Construct vegetated swales along Hendrick Street (both sides) to slow flow before it reaches the drainage system and is conveyed down the slope. Install bioretention practice at corner of Brook Street/Hendrick Street.</td>
</tr>
<tr>
<td>Gladacres</td>
<td>• Collaborate with Housing Authority to install varied green infrastructure practices throughout the property: ◦ Install bioretention bumpouts at four corners of intersection of Sunset Ave. and John Street, with existing catch basins serving as overflow structures. ◦ Install bioretention bumpouts at intersection with Ely Ave (two corners). ◦ Install bioretention bumpouts along South Street in front of Housing Authority properties to slow traffic as it approaches bike path. ◦ Install tree box filters along Ely Ave, Sunset Ave, and John St.</td>
</tr>
<tr>
<td>Cliffview Manor</td>
<td>• Collaborate with Housing Authority to install green infrastructure/upgrade existing stormwater structures on the property: ◦ Modify existing stormwater basin to raise outlet and provide stormwater retention/treatment/infiltration, rather than just detention. ◦ Install curbside bioretention planters along Echo Lane and Lussier Circle (all travel is currently one-way, leaving excess road width to utilize). ◦ Expand existing grass island at end of Lussier Circle for bioretention/raingarden. ◦ Enhance stream buffer at back of property with native plantings.</td>
</tr>
<tr>
<td>Housing Authority Office/Special Needs Housing</td>
<td>• Create bioretention swales/planters at front of property along Holyoke Street. Install bioretention area at south side of driveway in grassy area to receive stormwater from the parking area and driveway.</td>
</tr>
</tbody>
</table>
STANDARD ENGINEERING DETAILS
CONVENTIONAL BIORETENTION BASIN NOTES:

1. Engineered soil media shall have a loamy sand soil texture per USDA textural triangle. The soil mixture shall be 80 - 70% of sand by volume; 15 - 25% of topsoil, or loam by volume; and 15 - 25% of organic matter (consisting of partially decomposed sphagnum peat with 100% passing a 2” sieve, and a pH of 3.4 to 4.8, or ground pine bark mulch) by volume, with a maximum silt and clay content of 8%.

2. Engineered soil media shall have a depth of 24 inches to 48 inches as required to accommodate the water quality volume (WQV) and subsurface conditions.

3. Engineered soil media and associated subgrade shall not be compacted.

4. The top of the engineered soil media layer must be at least 36” above the seasonal high groundwater table (SHT) on the surface of the engineered soil media (including the pea gravel, sump and crushed gravel sump if present) must be at or above the SHT; whichever is greater.

5. The surface of bioretention area/rain garden shall be level or have a maximum slope of 0.5% to promote infiltration and even flow distribution. Bioretention installed in sloped areas may be terraced to achieve a level surface. Bioretention may be designed with surface slopes greater than 0.5% if designed with check dams.

6. In-situ infiltration rates must exceed 0.17 inches/hour as designed as an infiltration basin with no underdrain system. If in-situ infiltration rates are less than 0.17 inches/hour, install underdrain system and design basin to achieve partial infiltration. Impermeable liners (not shown) are required when adequate separation to SHT/bedrock cannot be achieved, soils are contaminated, or horizontal setback requirements cannot be achieved.

7. Perforated underdrain, pea gravel, and crushed gravel sump are optional for infiltration basins but are required for flow-through basins.

8. When bioretention basin is installed with an underdrain, the underdrain must be installed with a minimum of 2" of pea gravel above and below the underdrain for a distance of 12" on both sides.

9. Pea gravel, if required, shall consist of 3” to 5” size clean, washed gravel, conforming to the gradation of subsection M2.01.4 of the MassDOT Standards. Additionally, D85 (of pea gravel) ≤ 80pa (of engineered soil media) and D30 (of pea gravel) ≤ 250ps (of engineered soil media).

10. Crushed gravel sump stone material, if required, shall be clean, washed stone and shall meet the gradation of subsection M2.01.4 of the MassDOT Standards.

11. Impermeable liner, if required, shall be a 30 mil (minimum) HDPE or PVC liner.

12. The minimum width of the bioretention area/rain garden shall be 2 feet.

13. The ponding depth for the water quality volume may vary between 6” and 12”. The maximum ponding depth during overflow events shall be 3 feet.

14. Every bioretention basin must have an inlet opening for inflow. Inlet opening options include inlet curb cut openings, inlet structures, piping, flow entrances, flow diversion structures, sediment basins, and swales/channels.

15. Raised overflow structure option is shown. Every bioretention basin must have a provision for overflow. Options may include outflow curb cut openings, single-stage or multi-stage raised overflow structures, stabilized spillways/berms/overflow weirs, or outlet pipe/curblets.

16. Sediment forebay pretreatment option shown. Pretreatment options include: sediment forebays, vegetative filter strips, pretreatment swales, deep-sump catch basins, proprietary flow-through treatment devices, and grass channels.

17. Sediment forebay berm options include: gabion baskets, concrete or granite curbing, and precast or cast-in-place concrete weirs.

18. Sediment forebay surface shall consist of a hardscaping surface such as concrete, grooved stone, or other material subject to department approval in order to facilitate maintenance. Provide at least 2 weep holes (2.5 inches in diameter) for every 25 square feet of surface area in the surface of the forebay to facilitate low level drainage. Extend hardscape up sideslopes of basin to elevation equivalent to top of forebay berm.

19. Vegetation installed within bioretention basins in medians, near intersections, or near pedestrian crossings shall reach a mature height of no greater than 24" above the surrounding sidewalk or pavement surface.

20. 3 (horizontal) to 1 (vertical) side slopes or flatter are preferred. If site topography does not allow for 3 (horizontal) to 1 (vertical) slopes, slopes greater than 3 (horizontal) to 1 (vertical) stabilized with turf reinforcement matting or equivalent (included on the MassDOT qualified construction materials list) may be used or vertical concrete walls with a minimum height of 30 inches when the slopes are greater than 2 (horizontal) to 1 (vertical) may be used to create the side walls of the bioretention basin.

21. Filter fabric shall be non-woven, be on the MassDOT qualified construction materials list as a fabric suitable for subsurface drainage applications.
CITY OF EASTHAMPTON

BIORETENTION PARKING LANE ADJACENT PLANTER
TYPICAL PLAN AND SECTION VIEWS

D-201

Easthampton Green Infrastructure Master Plan
BIORETENTION PARKING LANE ADJACENT PLANTER NOTES:

1. ENGINEERED SOIL MEDIA WILL HAVE A LOAMY SAND SOIL TEXTURE PER USDA TEXTURAL TRIANGLE. THE SOIL MIXTURE SHALL BE 30% LOAMY SAND BY VOLUME; 15% TO 25% OF TOPSOIL OR LOAM BY VOLUME, AND 15% TO 25% OF ORGANIC MATTER (CONSISTING OF PARTIALLY DECOMPOSED SPHAGNUM PEAT WITH 10% PASSING A 4 INCH CIRCLE, AND A PH OF 3.4 TO 4.8, OR GREEN BARN MULCH) BY VOLUME, WITH A MAXIMUM Silt AND ClAY CONTENT OF 20%.

2. ENGINEERED SOIL MEDIA WILL HAVE A DEPTH OF 24 INCHES TO 48 INCHES AS NECESSARY TO ACCOMMODATE THE WATER QUALITY VOLUME (WQV) AND SUBSURFACE CONDITIONS.

3. ENGINEERED SOIL MEDIA AND ASSOCIATED SUBGRADE SHALL NOT BE COMPACTED.

4. THE TOP OF THE ENGINEERED SOIL MEDIA LAYER MUST BE AT LEAST 36 INCHES ABOVE THE SEASONAL HIGH GROUNDWATER TABLE (SHOT) OR THE SURFACE OF THE ENGINEERED SOIL MEDIA (INCLUDING THE PEA GRAVEL SUMP AND CRUSHED GRAVEL SUMP IF PRESENT) MUST BE AT OR ABOVE THE SHOT, WHICHERSOEVER IS GREATER.

5. THE SURFACE OF BIORETENTION PARKING LANE ADJACENT PLANTERS SHALL BE LEVEL OR HAVE A MAXIMUM SLOPE OF 0.5% TO PROMOTE INFILTRATION AND EVEN FLOW DISTRIBUTION.

6. IN-SITU INFILTRATION RATES MUST EXCEED 0.17 INCHES PER HOUR TO BE DEEMED AS AN INFILTRATION PLANTER WITH NO UNDERDRAIN SYSTEM. IF IN-SITU INFILTRATION RATES ARE LESS THAN 0.17 INCHES PER HOUR, INSTALL UNDERDRAIN SYSTEM AND DESIGN PLANTER TO ACHIEVE PARTIAL INFILTRATION. IMPERVIOUS LINERS (NOT SHOWN) ARE REQUIRED WHEN ADEQUATE SEPARATION BETWEEN SEASONAL HIGH GROUNDWATER TABLE (SHOT)/BEDROCK CANNOT BE ACHIEVED, SOILS ARE CONTAMINATED, OR HORIZONTAL SETBACK REQUIREMENTS CANNOT BE ACHIEVED.

7. PERFORATED UNDERDRAIN, PEA GRAVEL, AND CRUSHED GRAVEL SUMP ARE OPTIONAL FOR INFILTRATION BIORETENTION PLANTERS BUT ARE REQUIRED FOR FLOW-THROUGH BIORETENTION PLANTERS.

8. PEA GRAVEL, IF REQUIRED, SHALL CONSIST OF 2" TO 4" SIZE CLEAN, WASHED GRAVEL IN CONFORMING TO THE GRADING OF M2.01.4 OF THE MASSDOT STANDARDS.

9. CRUSHED GRAVEL SUMP STONE MATERIAL, IF REQUIRED, SHALL BE CLEAN, WASHED STONE AND SHALL MEET THE GRADING OF M2.01.4 OF THE MASSDOT STANDARDS.

10. WHEN PLANTER IS INSTALLED WITH AN UNDERDRAIN, THE UNDERDRAIN MUST BE INSTALLED WITH A MINIMUM OF 2" OF PEA GRAVEL ABOVE AND BELOW THE UNDERDRAIN FOR A DISTANCE OF 12" ON BOTH SIDES.

11. IMPERVIOUS LINER, IF REQUIRED, SHALL BE A 30 MIL (MINIMUM) HOPE OR PVC LINER.

12. THE PREFERRED WIDTH OF THE BIORETENTION PARKING LANE ADJACENT PLANTER SHALL BE 4.0 FEET. HOWEVER, NARROWER PLANTERS MAY BE ALLOWED WITH WIDTHS LESS THAN 2.5 FEET. ONLY INSTALL TREES IN PLANTERS WITH WIDTHS OF 4 FEET OR GREATER.

13. THE PONDING DEPTH FOR THE WATER QUALITY VOLUME (WQV) MAY VARY BETWEEN 6" AND 12".

14. EVERY BIORETENTION PLANTER MUST HAVE AN INLET OPENING FOR INFLOW. INLET OPENING OR MULTI-STAGE RAISED INFLOW STRUCTURES, THROUGH SUMP FLOW ENTRANCES, INLET STRUCTURES, PIPE FLOW ENTRANCES, AND FLOW DIVERSION STRUCTURES.

15. PRETREATMENT PRETREATMENT OPTION SHOWN. PRETREATMENT OPTIONS INCLUDE: SEDIMENT FOREBAYS, DEEP-SUMP CATCH BASINS, PROPRIETARY FLOW THROUGH TREATMENT DEVICES, AND GRASS CHANNELS.

16. SEDIMENT FOREBAY BERM OPTIONS INCLUDE: CARBON BASKETS, CONCRETE OR GRANITE CURBING, AND PRECAST OR CAST-IN-PLACE CONCRETE WERDS.

17. SEDIMENT FORBAY SURFACE SHALL CONSIST OF A HARDSCAPE SURFACE SUCH AS CONCRETE, GRANITE CURBING, OR MILLER MATERIAL SUBJECT TO DEPARTMENT APPROVAL IN ORDER TO MEET STORMWATER DISCHARGE REQUIREMENTS.

18. PROVIDE AT LEAST TWO WEEP HOLES (2.5 INCHES IN DIAMETER) FOR EVERY 25 SQUARE FEET OF SURFACE AREA IN THE SURFACE OF THE FORBAY TO FACILITATE LOW LEVEL DRAINAGE.

19. RAISED INFLOW STRUCTURE OPTIONS ARE SHOWN. EVERY BIORETENTION PLANTER MUST HAVE A PROVISION FOR INFLOW. OPTIONS MAY INCLUDE OUTFLOW CURB CUT OPENINGS, SINGLE-/MULTI-STAGE RAISED INFLOW STRUCTURES, STABILIZED SPILLWAYS/OVERFLOW MERS, OR OUTLET PIPES/CULVERTS.

20. PLANTERS EXCEEDING 12" IN DEPTH BETWEEN ADJACENT SIDEWALK/GROUND SURFACE MUST BE DESIGNED WITH LOW-BARRIER MATCHING SUCH AS RAISED 4" INCH CURB CIRRUS EDGE, EDGING, OR LOW FENCING LESS THAN 24" IN HEIGHT. PLANTERS WITH ANGLED MORE THAN 30" MUST BE DESIGNED IN ACCORDANCE WITH ADA STANDARDS FOR RAILING SYSTEM/BARRIER.

21. LEVEL, STEP-OUT ZONE SHALL BE A MINIMUM OF 35 HOE LEVEL, STEP-OUT ZONE MAY BE REDUCED TO 12"-18" WHERE PLANTERS ARE LESS THAN 20 FEET LONG AND REGULAR 5 FOOT PEDESTRIAN CUT-THROUGH PATHS ARE PROVIDED, AND THE STEP-OUT ZONE IS NOT PART OF AN ADA ACCESSIBLE ROUTE.

22. PEDESTRIAN CUT-THROUGHS SHALL HAVE A MINIMUM WIDTH OF 5 FEET.

23. VEGETATION INSTALLED WITHIN BIORETENTION PLANTERS IN MEDANS, NEAR INTERSECTIONS, OR NEAR PEDESTRIAN CROSSINGS SHALL REACH A MATURE HEIGHT OF NO GREATER THAN 24 INCHES ABOVE THE SURROUNDING SIDEWALK OR PAVEMENT SURFACE.

24. CURB SHALL BE IN ACCORDANCE WITH SECTION 501 OF THE MASSDOT STANDARD SPECIFICATIONS. CURB BURIAL DEPTH, NEED FOR OUTER BRACING, OR CURB FOUNDATION SHALL BE DETERMINED THROUGH SITE SPECIFIC DESIGN AND EVALUATION OF EXISTING SOIL CONDITIONS.

25. CONCRETE CURB LOCK SHALL BE IN ACCORDANCE WITH SECTION 501 OF THE MASSDOT STANDARD SPECIFICATIONS.

26. FILTER FABRIC SHALL BE NON-WOVEN, ON THE MASSDOT QUALIFIED CONSTRUCTION MATERIALS LIST, AND INSTALLED IN ACCORDANCE WITH THE MANUFACTURER’S RECOMMENDATIONS.

27. LIGHTWEIGHT STEEL DECKING/DECKERS FOR SNOW REMOVAL SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS. MATERIALS SHALL CONFORM TO SECTION 629 OF THE MASSDOT STANDARD SPECIFICATIONS AND THE LATEST EDITION OF THE MANUAL UNIFORM TRAFFIC CONTROL DEVICES (MUTCD).
BIORETENTION CURB EXTENSION PLANTER NOTES:

1. ENGINEERED SOIL MEDIA SHALL HAVE A LOAMY SAND SOIL TEXTURE PER USDA TEXTURAL TRIANGLE. THE SOIL MIXTURE SHALL BE 60 – 70% BY VOLUME OF SAND, 15 – 25% OF TOPSOIL OR LOAM BY VOLUME, AND 15 – 25% OF ORGANIC MATTER (CONSISTING OF PARTIALLY DECOMPOSED SPHAGNUM PEAT WITH 100% PASSING A 2" SIEVE, AND A PH OF 3.4 TO 4.8, OR GROUND PINE BARK MULCH) BY VOLUME, WITH A MAXIMUM SILT AND CLAY CONTENT OF 3%.

2. ENGINEERED SOIL MEDIA SHALL HAVE A DEPTH OF 24 INCHES TO 48 INCHES NECESSARY TO ACCOMMODATE THE WATER QUALITY VOLUME (WQV) AND SUBSURFACE CONDITIONS.

3. ENGINEERED SOIL MEDIA AND ASSOCIATED SUBGRADE SHALL NOT BE COMPACTED.

4. THE TOP OF THE ENGINEERED SOIL MEDIA LAYER MUST BE AT LEAST 36" ABOVE THE SEASONAL HIGH GROUNDWATER TABLE (SHGT) OR THE SURFACE OF THE ENGINEERED SOIL MEDIA (INCLUDING THE PEA GRAVEL SUMP AND CRUSHED GRAVEL SUMP IF PRESENT) MUST BE AT OR ABOVE THE SHGT, WhICHERsoever is greater.

5. THE SURFACE OF THE BIORETENTION PLANter SHALL BE LEVEL OR HAVE A MAXIMUM SLOPE OF 0.5% TO PROMOTE INFILTRATION AND EVEN FLOW DISTRIBUTION. PLANTERS INSTALLED IN SLOPED AREAS MAY BE TERRACED TO ACHIEVE A LEVEL SURFACE. BIORETENTION PLANTERS MAY BE DESIGNED WITH SURFACE SLOPES GREATER THAN 0.5% IF DESIGNED WITH CHECK DAMS.

6. IN-SITU INFILTRATION RATES MUST EXCEED 0.17 INCHES/HR TO BE DESIGNED AS AN INFILTRATION PLANTER WITH NO UNDERDRAIN SYSTEM. IF IN-SITU INFILTRATION RATES ARE LESS THAN 0.17 INCHES/HR, INSTALL UNDERDRAIN SYSTEM AND DESIGN PLANTER TO ACHIEVE PARTIAL INFILTRATION. IMPERMEABLE LINERS (NOT SHOWN) ARE REQUIRED WHEN ADEQUATE SEPARATION TO SEASONAL HIGH GROUNDWATER TABLE (SHGT)/BEDROCK CANNOT BE ACHIEVED, SOILS ARE CONTAMINATED, OR HORIZONTAL SEAT AlK REQUIREMENTS CANNOT BE ACHIEVED.

7. PERFORATED UNDERDRAIN, PEA GRAVEL, AND CRUSHED GRAVEL SUMP ARE OPTIONAL FOR INFILTRATION BIORETENTION PLANTERS BUT ARE REQUIRED FOR FLOW-THROUGH BIORETENTION PLANTERS.

8. PEA GRAVEL, IF REQUIRED, SHALL CONSIST OF #3 TO #8 SIZE CLEAN, WASHED GRAVEL CONFORMING TO THE GRADATION OF SUBSECTION M2.01.4 OF THE MASSDOT STANDARDS. ADDITIONALLY, D50 (OF PEA GRAVEL) ≤ 500 (OF ENGINEERED SOIL MEDIA) AND D60 (OF PEA GRAVEL) ≤ 250 (OF ENGINEERED SOIL MEDIA).

9. CRUSHED GRAVEL SUMP STONE MATERIAL, IF REQUIRED, SHALL BE CLEAN, WASHED STONE AND SHALL MEET THE GRADATION OF SUBSECTION M2.01.4 OF THE MASSDOT STANDARDS.

10. WHEN PLANTER IS INSTALLED WITH AN UNDERDRAIN, THE UNDERDRAIN MUST BE INSTALLED WITH A MINIMUM OF 2" OF PEA GRAVEL ABOVE AND BELOW THE UNDERDRAIN FOR A DISTANCE OF 12" ON BOTH SIDES.

11. IMPERMEABLE LINER, IF REQUIRED, SHALL BE A 30 MIL (MINIMUM) THEPE OR PVC LINER.

12. THE PREFERRED WIDTH OF THE BIORETENTION CURB EXTENSION PLANTER SHALL BE 40 FEET. HOWEVER, NARROWER PLANTERS MAY BE ALLOWED WITH WIDTHS NO LESS THAN 2.5 FEET. ONLY INSTALL TREES IN PLANTERS WITH WIDTHS OF 4 FEET OR GREATER.

13. THE PONDING DEPTHS FOR THE WATER QUALITY VOLUME (WQV) MAY VARY BETWEEN 6" AND 12".

14. NO CURB CUT OPENING SHOWN. EVERY BIORETENTION PLANTER MUST HAVE AN INLET OPENING FOR INFLOW. INLET OPENING OPTIONS MAY INCLUDE INLET CURB CUT OPENINGS, INLET STRUCTURES, PIPELINED FLOW ENTRANCES, AND FLOW DIVERSION STRUCTURES. IF CURB CUT OPENING IS SELECTED, PROVIDE WITH AN 12-INCH MINIMUM WIDTH FOR CURB EXTENSION PLANTERS AND 18-INCH MINIMUM WIDTH FOR OTHER PLANTER TYPES.

15. SEDIMENT FOREBAY PRETREATMENT OPTION SHOWN. PRETREATMENT OPTIONS INCLUDE: SEDIMENT FOREBAYS, DEEP-SUMP CATCH BASINS, PROPRIETARY FLOW THROUGH TREATMENT DEVICES, AND GRASS CHANNELS.

16. SEDIMENT FOREBAY BEIN OPTIONS INCLUDE: GABION BASKETS, CONCRETE OR GRANITE CURBING, AND PRECAST OR CAST-IN-PLACE CONCRETE WORK.

17. SEDIMENT FOREBAY SURFACE SHALL CONSIST OF A HABITAT SURFACE such as CONCRETE, GROUNDED STONE, OR OTHER MATERIAL SUBJECT TO DEPARTMENT APPROVAL IN ORDER TO FACILITATE MAINTENANCE.

18. PROVIDE AT LEAST TWO WEEP HOLES (2.5 INCHES IN DIAMETER) FOR EVERY 25 SQUARE FEET OF SURFACE AREA IN THE SURFACE OF THE FOREBAY TO FACILITATE LOW LEVEL DRAINAGE.

19. RAISED OVERFLOW STRUCTURE OPTION IS SHOWN. EVERY BIORETENTION PLANTER MUST HAVE A PROVISION FOR OVERFLOW. OPTIONS MAY INCLUDE OUTFLOW CURB CUT OPENINGS, SINGLE-STAGE OR MULTI-STAGE RAISED OVERFLOW STRUCTURES, STABILIZED SPILLWAYS/OVERFLOW WEIRS, OR OUTLET PIPES/CULVERTS.

20. PLANTERS EXCEEDING 12" IN DEPTH BETWEEN ADJACENT SIDEWALK/GROUND SURFACE MUST BE DESIGNED WITH LOW-HEIGHT BARRIERS SUCH AS RAISED 4-INCH HIGH CURBING, EDGING, OR LOW FENCING LESS THAN 24-INCHES TALL. PLANTERS WITH DROP OF MORE THAN 36" MUST BE DESIGNED IN ACCORDANCE WITH ADA STANDARDS FOR RAILING SYSTEMS/BARRIERS.

21. VEGETATION INSTALLED WITHIN CURB EXTENSION PLANTERS NEAR INTERSECTIONS OR NEAR PEDESTRIAN CROSSINGS SHALL REACH A MATURE HEIGHT OF NO GREATER THAN 24-INCHES ABOVE THE SURROUNDING SIDEWALK OR PAVEMENT SURFACE.

22. CURB SHALL BE IN ACCORDANCE WITH SECTION 901 OF THE MASSDOT STANDARD SPECIFICATIONS. CURB BURIAL DEPTH, NEED FOR LATERAL BRACING, OR CURB FOUNDATION SHALL BE DETERMINED THROUGH SITE SPECIFIC DESIGN AND EVALUATION OF EXISTING SOIL CONDITIONS.

23. CONCRETE CURB LOCK SHALL BE IN ACCORDANCE WITH SECTION 901 OF THE MASSDOT STANDARD SPECIFICATIONS.

24. FILTER FABRIC SHALL BE NON-WOVEN, ON THE MASSDOT QUALIFIED CONSTRUCTION MATERIAL LISTS, AND INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

Plan View

SECTION VIEW

City of Easthampton

Bioretention Curb Inlet Planter
Typical Plan and Section Views

D-401

Easthampton Green Infrastructure Master Plan
BIORETENTION CURB INLET PLANTER NOTES:

1. Engineered soil media shall have a loamy sand soil texture per USDA textural triangle. The soil mixture shall be 60 – 70% of sand by volume, 15 – 25% of topsoil or loam by volume, and 15 – 20% of organic matter (consisting or partially decomposed sphagnum peat with 100% passing a 4" sieve, and a pH of 3.4 to 4.8, or ground pine bark mulch) by volume, with a maximum silt and clay content of 8%.

2. Engineered soil media shall have a depth of 24 to 72 inches as necessary to accommodate the water quality volume (WQV) and subsurface conditions.

3. Engineered soil media and associated subgrade shall not be compacted.

4. The top of the engineered soil media layer must be at least 26" above the seasonal high groundwater table (SHGT) or the surface of the engineered soil media (including the pea gravel sump and crushed gravel sump if present) must be at or above the SHGT, whichever is greater.

5. The surface of bioretention curb inlet planters shall be level or have a maximum slope of 0.5% to promote infiltration and even flow distribution. Bioretention parking lane adjacent planters installed in sloped areas may be terraced to achieve a level surface. Bioretention planters may be designed with surface slopes greater than 0.5% if designed with check dams.

6. In-situ infiltration rates must exceed 0.17 inches/hour to be designed as an infiltration planter with no underdrain system. If in-situ infiltration rates are less than 0.17 inches/hour, install underdrain system and design planter to achieve partial infiltration. Impermeable liners (not shown) are required when adequate separation to seasonal high groundwater table (SHGT)/bedrock cannot be achieved, soils are contaminated, or horizontal setback requirements cannot be achieved.

7. Perforated underdrain, pea gravel, and crushed gravel sump are optional for infiltration bioretention planters but are required for flow-through bioretention planters.

8. Pea gravel, if required, shall consist of 2 to 4" sieve clean, washed gravel conforming to the gradation of subsection M-2.01.4 of the MassDOT standards. Additionally, D50 (of pea gravel) ≤ 250 (of engineered soil media).

9. Crushed gravel sump stone material, if required, shall be clean, washed stone and shall meet the gradation of subsection M-2.01.4 of the MassDOT standards.

10. When planter is installed with an underdrain, the underdrain must be installed with the drain line of the underdrain for a distance of 12" on both sides.

11. Impermeable liner, if required, shall be a 30 mil (minimum) HDPE or PVC liner.

12. The preferred width of the bioretention curb inlet planter shall be 4.0 feet. However, narrower planters may be allowed with widths no less than 2.5 feet. Only install trees in planters with widths of 4 feet or greater.

13. The ponding depth for the water quality volume (WQV) may vary between 6" and 12".

14. Every bioretention planter must have an inlet opening for inflow. Inlet opening options may include inlet curb cut openings, inlet structures, piped flow entrances, and flow diversion structures.

15. Sediment forebay pretreatment option shown. Pretreatment options include: sediment forebays, deep-sump catch basins, proprietary flow through treatment devices, and glass channels.

16. Sediment forebay berm options include: gabion baskets, concrete or granite curbling, and precast or cast-in-place concrete works.

17. Sediment forebay surface shall consist of a hardscape surface such as concrete, grooved stone, or other material subject to department approval in order to facilitate maintenance.

18. Provide at least two weep holes (2.5 inches in diameter) for every 25 square feet of surface area in the forebay to facilitate low level drainage.

19. Raised overflow structure option shown. Every bioretention planter must have a provision for overflow. Options may include outlet curb cut openings, single-stage or multi-stage raised overflow structures, stabilized spillways/overflow weirs, or outlet pipes/culverts.

20. Planters exceeding 12" in depth between adjacent sidewalk/ground surface must be designed with low-height barriers such as raised 4-inch high curbing edging, or low fencing less than 24"-inches tall. Planters with drops of more than 30" must be designed in accordance with ADA standards for railing systems/barrier.

21. Pedestrian cut-throughs shall have a minimum width of 8 feet.

22. Vegetation installed within bioretention planters in medians, near intersections, or near pedestrian crossings shall reach a mature height of no greater than 24"-inches above the surrounding sidewalk or pavement surface.

23. Curb shall be in accordance with section 501 of the MassDOT standard specifications. Curb burial depth, need for lateral bracing, or curb foundation shall be determined through site specific design and evaluation of existing soil conditions.

24. Concrete curb lock shall be in accordance with section 901 of the MassDOT standard specifications.

25. Filter fabric shall be non-woven, on the MassDOT qualified construction materials list, and installed in accordance with the manufacturer's recommendations.

26. Left over from the final design may be used for snow removal. All remaining snow shall be installed in accordance with the manufacturer's recommendations. Materials shall conform to section 828 of the MassDOT standard specifications and the latest edition of the manual uniform traffic control devices (MUTCD).
BIORETENTION SWALE WITH CHECK DAM(S) NOTES:

1. Engineered soil media shall have a loamy sand soil texture per USDA textural triangle. The soil mixture shall be 60 – 70% sand by volume; 15 – 25% topsoil or loam by volume; and 15 – 25% organic matter (consisting of partially decomposed sphagnum peat with 100% passing a 4" sieve, and a PH of 3.4 to 4.8; or ground pine bark mulch) by volume, with a maximum silt and clay content of 5%.

2. Engineered soil media shall have a depth of 24 inches to 48 inches as required to accommodate the water quality volume (WQV) and subsurface conditions.

3. Engineered soil media and associated subgrade shall not be compacted.

4. The top of the engineered soil media layer must be at least 36" above the seasonal high groundwater table (SGT) or the surface of the engineered soil media (including the pea gravel sump and crushed gravel sump if present) must be at or above the SGT; whichever is greater.

5. Bioretention swales shall have a maximum longitudinal slope of 2% without check dams, provided that flow velocities are non-erodive. Bioretention swales shall have a maximum slope of 6% with check dams. Check dams must be designed to reduce the effective slope of the bottom of the bioretention swale to 2.0% or less.

6. In-situ infiltration rates must exceed 0.17 inches/hour to be designed as an infiltration bioretention swale with no underdrain system. If in-situ infiltration rates are less than 0.17 inches/hour, install underdrain system and design swale to achieve partial infiltration. Improvable liners (not shown above) are required when adequate separation to shot/bedrock cannot be achieved, soils are contaminated, or horizontal setback requirements cannot be achieved.

7. Perforated underdrain, pea gravel, and crushed gravel sum are optional for infiltration swales but are required for flow-through swales.

8. When bioretention swale is installed with an underdrain, the underdrain must be installed with a minimum of 2" of pea gravel above and below the underdrain for a distance of 12" on both sides.

9. Pea gravel shall consist of 1/3 to 4" size clean, washed gravel conforming to the gradation of Subsection M2.01.4 of the MassDOT Standards. Additionally, D50 (of pea gravel) ≤ 50% (of engineered soil media) and D90 (of pea gravel) ≤ 250% (of engineered soil media).

10. Crushed gravel, sump stone material shall be clean, washed stone and shall meet the gradation of Subsection M2.01.4 of the MassDOT Standards.

11. Impermeable liner, if required, shall be a 30 mil (minimum) TPO or PVC liner.

12. The minimum width of the bioretention swale bottom shall be 2 feet; the maximum width shall be 8 feet.

13. The maximum ponding depth for the water quality volume is 12" at the longitudinal mid-point of the swale and 18" at the downstream end of the swale.

14. The maximum vertical depth of the swale shall be 6" above the 10-year storm water surface profile.

15. Every bioretention swale must have an inlet opening for inflow. Inlet opening options include inlet curb cut openings, inlet structures, piped flow entrances, flow diversion structures, overflow land, and swales/channels.

16. Raised overflow structure option is shown. Every bioretention swale must have a provision for overflow. Options may include outflow curb cut openings, single-stage or multi-stage raised overflow structures, stabilized spillways/overflow weirs, or outlet pipes/culverts.

17. Sediment forebay pretreatment option shown. Pretreatment options include: sediment forebays, vegetative filter strips, pretreatment swales, deep-sump catch basins, proprietary flow-through treatment devices, and grass channels.

18. Sediment forebay basin options include: gabion baskets, concrete or granite curbing, and precast or cast-in-place concrete weirs.

19. Sediment forebay basin shall consist of a hard-scape bottom such as concrete, gravel stone, or other material subject to department approval in order to facilitate maintenance. Provide at least two weep holes (2.5 inches in diameter) every 25 square feet of surface area in the bottom of the forebay to facilitate low level drainage. Extend hard-scape up side slopes of swale to elevation equivalent to top of forebay weir.

20. Vegetation installed within bioretention swales in medians, near intersections, or near pedestrian crossings shall reach a mature height of no greater than 24 inches above the surrounding sidewalk or pavement surface.

21. 3 (horizontal) to 1 (vertical) side slopes or flatter are preferred. If site topography does not allow for 3 (horizontal) to 1 (vertical) slopes, slopes greater than 3 (horizontal) to 1 (vertical) stabilized with turf reinforcement matting or equivalent (incorporated in the MassDOT qualified construction materials list) may be used or vertical concrete walls with a minimum height of 30 inches when the slopes are greater than 2 (horizontal) to 1 (vertical) may be used to create the side walls of the sand filter.

22. Filter fabric shall be non-woven, be on the MassDOT qualified construction materials list as a fabric suitable for subsurface drainage applications.

23. Gabion basket check dam shown. Check dams may consist of gabion baskets, concrete or granite curbing, or precast concrete weirs and shall be designed by engineer.
SUBSURFACE INFILTRATION NOTES:

1. UNDERGROUND INFILTRATION SYSTEM SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
2. SUBGRADE SHALL NOT BE COMPACTED.
3. THE BOTTOM OF THE INFILTRATION SYSTEM (E.G. CRUSHED STONE RESERVOIR) MUST BE AT LEAST 36" ABOVE THE SEASONAL HIGH GROUNDWATER TABLE (SHG/Bedrock).
4. IN-SITU INFILTRATION RATES MUST EXCEED 0.17 INCHES/HOUR TO BE SUITABLE FOR INFILTRATION.
5. CRUSHED STONE RESERVOIR SHALL CONSIST OF CLEAN, WASHED STONE MEETING THE GRADATION LISTED IN SUBSECTION M2.01.1 & M2.02.2 OF THE MASSDOT STANDARD SPECIFICATIONS.
6. TOP OF CRUSHED STONE SHALL BE BELOW PAVEMENT STRUCTURE OR A MINIMUM OF 1'-0" BELOW PAVEMENT.
7. CRUSHED STONE SHALL ENCOMPASS INFILTRATION CHAMBERS/STRUCTURES BY A MINIMUM OF 5 INCHES ON ITS TOP AND BOTTOM AND A MINIMUM OF 12 INCHES ON ITS SIDES.
8. THE SURFACE OF INFILTRATION SYSTEM SHALL BE LEVEL TO PROMOTE INFILTRATION AND EVEN FLOW DISTRIBUTION. INFILTRATION SYSTEMS INSTALLED IN SLOPED AREAS MAY BE TERRACED TO ACHIEVE A LEVEL SURFACE.
9. CLEAN-OUT OR INSPECTION PORT SHALL BE IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND/OR SECTION M5.03.7 AND ALL APPLICABLE INFORMATION FROM SECTION 260 OF THE MASSDOT STANDARD SPECIFICATIONS.
10. FILTER FABRIC SHALL BE WRAPPED AROUND CLEAN-OUT 6" ABOVE THE CRUSHED STONE, TIED TO THE CLEAN-OUT WITH STAINLESS STEEL CLAMP.
11. FILTER FABRIC SHALL BE NON-WOVEN, BE ON THE MASSDOT QUALIFIED CONSTRUCTION MATERIALS LIST AS A FABRIC SUITABLE FOR SUBSURFACE DRAINAGE APPLICATIONS. FABRIC SHALL ENCOMPASS THE TOP AND SIDES OF STONE (AT MINIMUM). INSTALL FABRIC ON BASE OF SYSTEM IF RECOMMENDED BY SUBSURFACE INFILTRATION SYSTEM MANUFACTURER.
12. ROAD BOX SHALL BE IN ACCORDANCE WITH MANUFACTURER'S INSPECTION PORT INSTALLATION DETAILS.
13. CONCRETE COLLAR SHALL BE IN ACCORDANCE WITH SECTIONS 901 AND M4.02.00 OF THE MASSDOT STANDARD SPECIFICATIONS AND MANUFACTURER'S RECOMMENDATIONS.
14. INLET OPTIONS MAY INCLUDE: INLET STRUCTURES CONNECTED TO UNDERGROUND INFILTRATION SYSTEMS BY EXISTING, PROPOSED INLET FLOW ENTRANCES, OR OTHER STRUCTURES AS RECOMMENDED BY MANUFACTURER'S SUBSURFACE INFILTRATION SYSTEMS.
15. PRETREATMENT OPTIONS MAY INCLUDE: SEDIMENT FOREBAYS, VEGETATIVE FILTER STRIPS, PRETREATMENT SWALES, DEEP-SPUMP CATCH BASINS WITH HOODS, PROPRIETARY FLOW-THROUGH TREATMENT DEVICES, AND GRASS CHANNELS (ALTHOUGH DEEP-SPUMP CATCH BASINS WITH HOODS AND PROPRIETARY FLOW-THROUGH TREATMENT DEVICES ARE THE TWO MOST COMMON FOR SUBSURFACE INFILTRATION).
16. OVERFLOW/OUTLET PIPE (CONNECTED TO AN EXISTING DRAINAGE SYSTEM) OPTION IS SHOWN. EVERY IN-LINE UNDERGROUND INFILTRATION SYSTEM MUST HAVE A PROVISION FOR OVERFLOW/BYPASS SIZE TO ACCOMMODATE THE 10-YEAR STORM EVENT (AT MINIMUM). OPTIONS MAY INCLUDE SINGLE-STAGE OR MULTI-STAGE OUTLET PIPES/CULVERTS CONNECTING TO AN EXISTING OR PROPOSED CLOSED-CONDUIT STORM DRAIN NETWORK OR CREATING A NEW OUTFALL THAT DAYLIGHTS TO EXISTING GRADE. IF ADDING A NEW OUTFALL THAT DAYLIGHTS TO EXISTING GRADE, THE OUTLET SHALL NOT DISRUPT EXISTING SITE USES; SHALL NOT RESULT IN INCREASES IN PEAK FLOW RATES AND VOLUMES TO OFF-SITE PROPERTIES; AND SHALL NOT CAUSE SCOUR, EROSION, OR FLOODING.
CITY OF EASTHAMPTON

TREE BOX FILTER
TYPICAL PLAN AND SECTION VIEWS

ISSUE DATE:
JUNE 2021

SCALE:
NOT TO SCALE

DRAWING NUMBER
D-701
TREE FILTER NOTES:

1. Engineered soil media shall have a loamy sand soil texture per USDA textural triangle. The soil mixture shall be 60 – 70% of sand by volume, 15 – 25% of topsoil or loam by volume, and 15 – 25% of organic matter (consisting of partially decomposed sphagnum peat or 100% passing a 2” sieve, and a pH of 3.4 to 4.8, or ground pine bark mulch) by volume, with a maximum silt and clay content of 8%.

2. Engineered soil media shall have a depth of 24 inches to 48 inches as necessary to accommodate the water quality volume (WQV) and subsurface conditions.

3. Engineered soil media and associated subgrade shall not be compacted.

4. The top of the engineered soil media layer must be at least 36” above the seasonal high groundwater table (SHGT) bedrock or at the bottom of the engineered soil media (including the drainage layer if present) must be at or above the SHGT/bedrock, whichever is greater, at least 12” of the drainage layer, if used, shall be above the SHGT.

5. The bottom slope of the tree filter shall be level or have a maximum slope of 0.5% to promote infiltration and even distribution.

6. If tree filters are installed within existing sidewalk or walkway areas, access around the tree filters shall meet ADA requirements or ADA compliant grating must be installed atop the filters to facilitate access.

7. If the tree filter is located adjacent to a sidewalk or in an area subject to pedestrian traffic and the height from the top of the tree filter media to the sidewalk elevation is greater than 12 inches, use grating above the filter or design with low-height barriers such as raised curbs.

8. If required, grate shall be galvanized metal or cast iron.

9. In-situ infiltration rates must exceed 0.17 inches/hour to be designed as an infiltration planter with no underdrain system. If in-situ infiltration rates are less than 0.17 inches/hour, install underdrain system and design tree box filter to achieve partial infiltration. Impermeable liners (not shown) are required when adequate separation to seasonal high groundwater table (SHGT)/bedrock cannot be achieved. Soils are contaminated, or horizontal setback requirements cannot be achieved.

10. Perforated underdrain, pea gravel, and crushed gravel sump are optional for infiltration tree box filters but are required for flow-through tree box filters.

11. The maximum depth of ponding for the water quality volume shall be 6 inches. The maximum depth of ponding during overflow events shall be 9 inches (preferred) to 12 inches (maximum).

12. Ponded water shall drain from the tree filter within 48 hours or less. Underdrains may be added, as necessary, to meet the drain time requirement if needed.

13. pea gravel shall consist of 3” to 4” size clean, washed gravel conforming to the gradation of subsection M2.01.4 of the MassDot standards. Additionally, C64 (of pea gravel) ≤ 300 (of engineered soil media) and D64 (of pea gravel) ≤ 250 (of engineered soil media).

14. Crushed gravel sump stone material shall be clean, washed stone and shall meet the gradation of subsection M2.01.4 of the MassDot standards.

15. Every tree filter must have an inlet opening for inflow. Inlet opening options may include inlet curb cut openings, drop inlets, or a piped inlet.

16. Every tree filter must have a provision for overflow. Overflow options may include outlet curb cut or a combined inflow/outflow curb opening (shown in detail).

17. Pretreatment options include: Interconcrete sediment collection chambers (shown) or deep sump catch basins. Sump holes shall be provided along base of pretreatment wall to facilitate drainage of pretreatment chambers.

18. Concrete sediment collection chamber shall be in accordance with section 201 of the MassDot standard specifications.

19. The concrete sediment collection chamber shall have a minimum bottom surface area of 6 sq. feet with no dimension less than 2 feet.

20. Crest elevation of pretreatment overflow wall/mer shall be no more than 2" above surface of engineered soil media.

21. Tree filters shall have a soil volume of 600 cubic feet for small trees, 1,000 cubic feet for medium trees, and 1,500 cubic feet for large trees.

22. Filter fabric shall be non-woven, be on the MassDOT qualified construction materials list as a fabric suitable for subsurface drainage applications.

23. Filter fabric shall extend a minimum of 1’-0” from the edge of sump hole.

24. Install tree well wall around tree box filter when installed in sloped area. The wall shall be constructed to provide a 2-foot minimum (4-foot preferred) separation to the outside perimeter filter box/vault.

25. In no case shall there be less than 4-feet between the tree well wall and the tree trunk.

26. Tree wall, gravel base, and associated drain piping and aggregate shall be designed by engineer and shall be in accordance with wall manufacturer recommendations if applicable.
PERMEABLE PAVER NOTES:

1. Permeable pavers shall be in accordance with the manufacturer’s recommendations.
2. Surface slope shall be a minimum of 1% and a maximum of 5%.
3. The permeable paver joint material shall consist of a permeable open-graded, crushed angular stone, granite chips, or coarse aggregate material in accordance with size requirements of ASTM No. 8 or less than opening width of joints, whichever is smaller, if chips used, chips shall consist of 1/8" to 3/16" granite chips.
4. The permeable bedding course shall consist of open-graded, crushed angular stone conforming to the size requirements of ASTM No. 8.
5. The choker course shall be in accordance with ASHTO No. 57 clean, washed stone.
6. The filter/base course shall be in accordance with Section M4.02.02 of the Mass DOT standard specifications for fine aggregate for concrete or ASTM C-33 surcharge material with a hydraulic conductivity of 10 to 60 feet per day at 95% standard proctor density.
7. Filter blanket shall be in accordance with Section M4.01.15 of the Mass DOT standard specifications. Filter blanket shall have a D15 (of filter blanket) ≤ 5 D5 (of filter course) and D50 (of filter blanket) ≥ 25 D50 (of filter course).
8. Reservoir course shall be washed and in accordance with Section M4.01.3 of the Mass DOT standard specifications.
9. Filter fabric shall be placed along sidewalls of excavation. Filter fabric shall be non-woven, be on the MassDOT qualified construction materials list, and installed in accordance with the manufacturer’s recommendations.
10. Subgrade shall not be compacted.
11. In-situ infiltration rates must exceed 0.17 inches/hour to be suitable for infiltration. If in-situ infiltration rates are less than 0.17 inches/hour, increase the filter course thickness to 18 inches (min.) and install porous pavement system with an underdrain system.
12. When the permeable pavers system is installed with an underdrain system, the reservoir course shall have a minimum thickness of 8" and the underdrain shall be elevated a minimum of 2" from the reservoir course surface. The invert of the underdrain must also be 4" (minimum) above the seasonal high groundwater table.
13. The ratio of contributing impervious area does not exceed three times the surface area of the permeable pavers (referred to as a 3:1 run-on ratio).
14. For an unlined system: the bottom of the reservoir layer shall be at or above shgt/bedrock and the bottom of the filter course shall be at least 3 feet above shgt/bedrock. If an underdrain system is required, the surface of the underdrain shall not be less than 4 inches above shgt.
Inlet Curb Cut Opening (Typ.)

Sediment Forebay Pretreatment Option Shown

Granite Curb Forebay Berm

Inlet Curb Opening (For Curb Extension Planter)

Inlet Curb Opening (Typ.)

Inlet Screen Cover (Optional for added litter/debris protection)

Stainless steel (Grade 304 or 316) bolts to secure wheel guard plate to top of roadside granite curbing

Granite Curbing Along Roadway

New Planter Curb

Existing Roadway Curb

Inlet Curb Opening (For Curb Extension Planter)

Section A-A

Inlet Curb Cut Opening - Option 1

NOT TO SCALE

Section B-B

Inlet Curb Cut Opening - Option 2

NOT TO SCALE

Notes:
1. Wheel guards shall be a steel plate rated for H-20 loading. Bolts and attachments shall be stainless steel (Grade 304 or 316).
2. Internal curb inlet debris screen shall be attached to inside of granite curb inlet opening such that it does not protrude into roadway. Screen shall be a manual retractable curb inlet screen cover as manufactured by United Storm Water, Inc. or approved equal.

CITY OF EASTHAMPTON

GREEN INFRASTRUCTURE INLET OPTIONS

TYPICAL DETAILS

ISSUE DATE: JUNE 2021

SCALE: NOT TO SCALE

DRAWING NUMBER: D-901
NOTES:
1. THIS BATTLED DIVERSION STRUCTURE REPRESENTS AN OPTION FOR Sending WATER QUALITY TREATMENT FLOW TO THE PROPOSED GREEN INFRASTRUCTURE PRACTICE. DIVERSION STRUCTURES MAY BE DESIGNED WITHOUT BAFFLES. BY ENGINEER IF TOP OF PIPE TO GREEN INFRASTRUCTURE, WHICH IS SUED TO PASS THE WATER QUALITY TREATMENT FLOW, IS SET EQUAL TO THE INVERT OF THE OUTLET FOR FLOOD FLOWS OR FLOWS IN EXCESS OF THE WATER QUALITY TREATMENT FLOW.

2. FOR A BATTLED DIVERSION STRUCTURE, THE TOP OF BATTLE WALL SHALL BE SET EQUIVALENT TO THE TOP OF THE PIPE DISCHARGING TO THE GREEN INFRASTRUCTURE PRACTICE.

3. THE BATTLE WALL SHALL BE MADE OF A MATERIAL RESISTANT TO CORROSION (MINIMUM 4-INCH THICK REINFORCED CONCRETE, TYPE 302 OR TYPE 316 STAINLESS STEEL PLATE, OR AN ALUMINUM, FRP, OR HDPE PANEL/PLATE) AND SECURED/ANCHORED TO THE MANHOLE WALLS.

DIVERSION STRUCTURE INLET OPTION
NOT TO SCALE

CITY OF EASTHAMPTON
GREEN INFRASTRUCTURE INLET OPTIONS
TYPICAL DETAILS

ISSUE DATE: JUNE 2021
SCALE: NOT TO SCALE
DRAWING NUMBER: D-903
SOIL SUITABILITY DETERMINATION FOR GREEN INFRASTRUCTURE PRACTICES

1. Site Suitability for Green Infrastructure Practices

In order to determine if areas being considered for the application of green infrastructure practices are suitable for infiltration, an assessment of in-situ soils is necessary by a “Competent Soils Professional.” Consistent with the Massachusetts Stormwater Handbook, a “Competent Soils Professional” is an individual with demonstrated expertise in soil science, including, but not limited to, a Massachusetts Registered Professional Engineer, Engineer in Training (EIT certificate) with a concentration in civil, sanitary or environmental engineering, or Bachelor of Arts or Sciences degree or more advanced degree in Soil Science, Geology, or Groundwater Hydrology from an accredited college or university.

- Existing infiltration rates and in-situ conditions will determine if the green infrastructure practice can be designed to achieve infiltration, partial infiltration, or require an underdrain.
- Complete in-situ soil investigations and testing in accordance with this document and the Massachusetts Stormwater Handbook.
- Infiltration rates can be determined by in-situ infiltration testing (when sizing BMPs using the ‘Static Method’ or ‘Simple Dynamic Method.’) If infiltration testing is performed, the design infiltration rate used for design shall be half the field-derived value of the most restrictive in-situ soil layer below the base of the practice. In either case, soil testing must be performed to determine the texture of soils in the location of the proposed green infrastructure practice.
  - If in-situ infiltration rates of underlying soils exceed 0.17 inches per hour (but ideally 0.52 inches per hour) and adequate separation to SHGT/bedrock exists, the green infrastructure practice can be designed for infiltration without the need of an underdrain system.
  - If in-situ infiltration rates of underlying soils are less than 0.17 inches per hour (or ideally 0.52 inches per hour) and adequate separation to SHGT/bedrock exists, design green infrastructure practice with an underdrain system. If adequate separation to SHGT/bedrock does not exist or horizontal setbacks cannot be met, install practice with a liner.

2. On-Site Investigation

The first step in determining if in-situ soils are suitable for infiltration is identifying soils and their corresponding hydrologic soil groups based on a review of soil survey information developed by the Natural Resources Conservation Service (NRCS). This information can be accessed on-line at the following location: Web Soil Survey- Home (usda.gov). Previous field test pit, boring log, or septic system data may also be reviewed, if available, to determine whether infiltration is feasible and/or to screen for unsuitable sites. It should be noted, however, that septic percolation testing is not an acceptable test for estimating saturated hydraulic conductivity at specific locations where infiltration is proposed because percolation tests tend to overestimate the saturated hydraulic conductivity rate.

If the results show that infiltration is feasible, the next step includes a site visit and investigation to confirm consistency with soil survey or to determine if subsurface conditions vary from the soil survey or if the soils have been disturbed, filled, or altered. During this investigation, the texture of the soils at the depths where infiltration will be proposed must be determined by a Competent Soils Professional. The depth to bedrock or seasonal high groundwater shall also be observed/noted. The depth of test pits must be deep enough to confirm that both bedrock and seasonal high groundwater are greater than 2 feet from the bottom of the proposed practice (although 4 feet is preferred if practical). Test pits must be advanced at the location and within the soil layer where infiltration is being considered/proposed.

In-situ infiltration rates can then be determined based on the proposed BMP sizing approach: the ‘Static/Simple Dynamic Method’ or the ‘Dynamic Field Method.’ Native soils should have a minimum field infiltration rate of 0.52 inches per
hour (Hydrologic Soil Group A and B soils) at the actual location and soil layer where infiltration is being proposed. However, stormwater infiltration may be proposed at locations having field infiltration rates of between 0.17 and 0.52 inches per hour (Hydrologic Soil Group C soils) provided that field infiltration rates are field-verified by saturated hydraulic conductivity testing (or the Dynamic Field Method). Green infrastructure practices that are designed for infiltration shall not be sited in soils with in-situ infiltration rates lower than 0.17 inches/hour (Hydrologic Soil Group D soils) due to the potential for failure unless designed with an underdrain or liner system.

2.1 Static or Simple Dynamic Method Approach to Estimating Infiltration Rates
When “Static” or “Simple Dynamic” Methods are used to size the recharge practice, the infiltration rate used to design the green infrastructure practice shall be determined based on the soil textural analysis performed by the Competent Soils Professional and the rates specified by Rawls 1982 (refer to Table 1 below).

2.2 Dynamic Field Method Approach to Estimating Infiltration Rates
When the “Dynamic Field” method is used for sizing the BMP, the following field test methods shall be used by a Competent Soils Professional to assess the saturated hydraulic conductivity of the soil, which must simulate the “field-saturated” condition:

- Double ring permeameter or infiltrometer - ASTM D3385-03 (for double-ring infiltrometer), D5093-02 (for double-ring infiltrometer with a sealed-inner ring), D5126-90 Methods
- Guelph permeameter - ASTM D5126-90 Method
- Falling head permeameter – ASTM D5126-90 Method
- Amoozemeter or Amoozegar (constant head) permeameter – Amoozegar 1992

The design of the green infrastructure practice shall be based on 50% of the actual in-situ saturated hydraulic conductivity rate. A Title 5 percolation test is not an acceptable test as it tends to overestimate the saturated hydraulic conductivity rate. The number of test locations is dependent on the type and size of the green infrastructure practice being considered. Refer to Volume 2, Chapter 2 of the Massachusetts Stormwater Handbook to determine the number of test locations needed.

<table>
<thead>
<tr>
<th>USDA Soil Texture Class</th>
<th>NRCS Hydrologic Soil Group (HSG)</th>
<th>Infiltration Rate (inches/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>A</td>
<td>8.27</td>
</tr>
<tr>
<td>Loamy Sand</td>
<td>A</td>
<td>2.41</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>B</td>
<td>1.02</td>
</tr>
<tr>
<td>Loam</td>
<td>B</td>
<td>0.52</td>
</tr>
<tr>
<td>Silt Loam</td>
<td>C</td>
<td>0.27</td>
</tr>
<tr>
<td>Sandy Clay Loam</td>
<td>C</td>
<td>0.17</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>D</td>
<td>0.09</td>
</tr>
<tr>
<td>Silty Clay Loam</td>
<td>D</td>
<td>0.06</td>
</tr>
<tr>
<td>Sandy Clay</td>
<td>D</td>
<td>0.05</td>
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<tr>
<td>Silty Clay</td>
<td>D</td>
<td>0.04</td>
</tr>
<tr>
<td>Clay</td>
<td>D</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 1: 1982 Rawls Rates (Rawls, Brakensiek and Saxton, 1982)
As another option, a borehole infiltration test (NHDES, 2008) may be performed. To do this:

- Install casing (solid 4-6 inch diameter, 30” length to 12” below proposed bottom of the practice.

- Remove any smeared soil surfaces and provide a natural soil interface into which water may percolate. Remove all loose material from the casing. Upon the tester’s discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill casing with clean water to a depth of 24” and allow to pre-soak for 24 hours.

- 24 hours later, refill casing with another 24 inches of clean water and monitor water level (measured drop from the top of the casing) for 1 hour. Repeat this procedure (filling the casing each time) three additional times, for a total of 4 observations. The observations should be averaged. The average should be reduced by factor of 2 to determine the field infiltration rate for design purposes.

- May be done through a boring or open excavation.

- Upon completion of the testing, the casings should be immediately pulled, and the test pit should be back-filled.

### 2.3 Approximate Depth to Seasonal High Groundwater

In accordance with the *Massachusetts Stormwater Handbook*, the depth to seasonal high groundwater may be identified based on redox features in the soil. When redox features are not available, installation of temporary push point wells or piezometers should be considered if it cannot be confidently determined by a Competent Soils Professional that seasonal high groundwater is not a concern. Ideally, such wells should be monitored in the spring when groundwater is highest and results compared to nearby groundwater wells monitored by the USGS to estimate whether regional groundwater is below normal, normal or above normal (see: [http://ma.water.usgs.gov](http://ma.water.usgs.gov)).

### 2.4 Design Approach if Fill Materials Exist in Location of Green Infrastructure Practice

In accordance with the *Massachusetts Stormwater Handbook*, a soil textural analysis must be conducted in both the fill material and the underlying parent materials when fill materials are present or are added prior to construction of the green infrastructure practice if infiltration is desired. The Hydrologic Soil Group of the more restrictive layer must be used to size the green infrastructure practice. If fill is present that is composed of asphalt, brick, concrete, construction debris, or if materials classified as solid or hazardous waste are identified at the specific location where infiltration/recharge is proposed, a different site should be considered. Alternatively, the debris or waste may be removed in accordance with all applicable Solid and Hazardous Waste Regulations and replaced with clean material suitable for infiltration. Any solid or hazardous wastes present on the site must be managed in strict accordance with *MassDEP Solid Waste Regulations, 310 CMR 19.000, Hazardous Waste Regulations, 310 CMR 30.00, and the Massachusetts Contingency Plan Regulations, 310 CMR 40.000.*
FUNDING STRATEGIES

When properly designed and maintained, green infrastructure and other nature-based approaches have the benefit of lower maintenance costs and effort over time. Managing stormwater through on-site infiltration reduces the need to dig up, repair, or extend pipe networks. If it becomes necessary over the life of a green infrastructure installation, the infiltration capacity of these practices can be ‘refreshed’ by replacing media and plantings without major construction effort. A shift toward green infrastructure thus promotes resilience benefits at lower future cost and is a smart long-term investment for the City. However, like any construction improvement, the initial investment in green infrastructure can be costly.

Fortunately, as climate resilience and nature-based solutions continue to gain traction throughout Massachusetts and the wider United States, a variety of funding programs have become available to fund green infrastructure and other resilience solutions. The Commonwealth of Massachusetts has been at the forefront of prioritizing climate adaptation actions through an expanding set of funding opportunities, and both state and federal opportunities exist to help fund green infrastructure projects. Easthampton anticipates pursuing an array of grant funding to help offset capital costs as the City gradually begins to incorporate green infrastructure into its future capital projects.

STATE FUNDING SOURCES

Executive Office of Energy and Environmental Affairs Planning Assistance Grants

EEA Planning Assistance grants are available to support projects that are consistent with state priorities for land conservation, reduction of natural resource consumption, and climate mitigation and resilience building. Actions implementing the results of climate vulnerability assessments or priorities identified during a community’s MVP process are eligible for funding, as are Low Impact Development, and other related projects. Up to $50,000 is available per municipality, with the option of pursuing a multi-jurisdictional regional project. Projects must include a minimum non-state match of 25%. Approximately $1M to $1.3M has been awarded each year.

Website: https://www.mass.gov/service-details/planning-assistance-grants

Chapter 90 Program

The Chapter 90 program is administered by the Massachusetts Department of Transportation. The program provides 100% reimbursement for approved roadway projects, including projects such as road resurfacing, roadside drainage structures, bridges, side road approaches, and landscaping and tree planting.

Website: https://www.mass.gov/chapter-90-program

Clean Water Act, Section 319 Nonpoint Source Implementation Grants

Section 319 Grants are available for projects that promote restoration and protection of water quality through reducing and managing nonpoint source pollution. These grants are made possible by federal funds provided to MassDEP by the USEPA under Section 319 of the Clean Water Act. Eligible applicants include municipal, state, or regional governments, quasi-state agencies, public schools and universities, and non-profit watershed, environmental, or conservation organizations. Pursuant to federal guidelines for Section 319 funding, projects can only be funded in those areas in which a Watershed-Based Plan has been completed. MassDEP created the Massachusetts Watershed-Based Plan (WBP) for all watersheds in the state that can be used to develop proposals for 319 grants.

Clean Water Act Section 319 grants may be used for green stormwater infrastructure projects (if not mandated by a stormwater permit) and certain restoration activities such as dam removal. The EPA’s guidance, “Nonpoint Source Program and Grants Guidelines for States and Territories,” includes hydrologic modification as a type of nonpoint source pollution and therefore projects that address hydrologic modification such as dam removal are potentially eligible for funding. Dam removal or river restoration projects need to be consistent with a state’s written Nonpoint Source Management Program Plan. Dam removal projects that are included in local watershed-based plans that are consistent with EPA Guidelines would also be eligible for 319 funds.
Division of Ecological Restoration (DER) Project Grants
The DER offers small grants to fund wetland, river, and flow restoration projects that are high-priority and provide significant ecological and community benefits to the Commonwealth. The DER considers funding for several types of “priority projects,” including dam removal and culvert replacements. In addition to small grants, eligible projects also receive technical services (data collection, engineering, design work, and permitting) and project management and fundraising help.

DER Website: https://www.mass.gov/how-to/become-a-der-priority-project

Dam Removal Website: https://www.mass.gov/river-restoration-dam-removal

Culvert Replacement Website: https://www.mass.gov/river-restoration-culvert-replacements

MassWorks Infrastructure Program
The MassWorks Infrastructure Program is administered by the Executive Office of Housing and Economic Development, the Department of Transportation, and the Executive Office for Administration and Finance. The program provides public infrastructure funding to support sustainability in Massachusetts, as well as job creation and economic development. Although the program is not specifically for hazard mitigation, the infrastructure improvements covered under MassWorks could help protect communities from natural disasters such as flooding.

Website: https://www.mass.gov/service-details/massworks-infrastructure-grants

Municipal Vulnerability Preparedness (MVP) Action Grant Program
The MVP Action Grant Program is administered through the Executive Office of Energy and Environmental Affairs. To be eligible for funding, communities must complete the MVP Planning Grant process. The MVP Action Grant offers financial assistance to municipalities that are interested in implementing climate adaptation actions to address the impacts of climate change (extreme weather, sea level rise, inland and coastal flooding, severe heat, etc.). The program funds projects relating to planning, assessments, and regulatory updates; nature-based solutions for ecological and public health; and resilient redesigns and retrofits for critical facilities and infrastructure. The MVP program also emphasizes robust engagement of the public and benefits for environmental justice communities or climate vulnerable populations. In past funding rounds, applicants were able to request $25,000 to $2,000,000 in funding (up to $5,000,000 available for regional projects). A 25% match, either through cash or in-kind services, is required.

Website: https://www.mass.gov/service-details/mvp-action-grant

State Revolving Fund (SRF) Loan Program
The SRF provides a low-cost financing option for communities through two programs: the Clean Water Program and the Drinking Water Program. The Clean Water Program provides loans to help municipalities comply with federal and state water quality requirements by focusing on watershed management priorities, stormwater management, and green infrastructure. The Drinking Water SRF Program provides loans to communities to improve water supply infrastructure and drinking water safety.

SRF Clean Water Program Website: https://www.mass.gov/service-details/srf-clean-water-program

SRF Drinking Water Program Website: https://www.mass.gov/service-details/srf-drinking-water-program

Water Management Act (WMA) Grant Program
The WMA grant program is available to WMA permit holders. The program provides aid for planning assistance, demand management, and withdrawal impact mitigation projects in local communities. Grants are reimbursed at 80% and require a 20% match through in-kind services or cash. The Commonwealth awards approximately 10 grants per year. Both planning and implementation projects are eligible.

Website: https://www.mass.gov/info-details/water-management-act-grant-programs-for-public-water-suppliers
FEDERAL FUNDING SOURCES

Army Corps of Engineers Aquatic Ecosystem Restoration Program
Under Section 206 of the Water Resources Development Act of 1996 (33 U.S.C. 2330), the Army Corps of Engineers can participate in the study, design and implementation of ecosystem restoration projects. Projects conducted in New England under this program have included eelgrass restoration, salt marsh and salt pond restoration, freshwater wetland restoration, anadromous fish passage and dam removal, river restoration, and nesting bird island restoration. Projects must be in the public interest and cost effective and are limited to $10 million in Federal cost.

Non-Federal project sponsors must be public agencies or national non-profit organizations capable of undertaking future requirements for operation, maintenance, repair, replacement and rehabilitation (OMMR&R), or may be any non-profit organization if there are no future requirements for OMMR&R. The Corps of Engineers provides the first $100,000 of study costs. A non-Federal sponsor must contribute 50 percent of the cost of the feasibility study after the first $100,000 of expenditures, 35 percent of the cost of design and construction, and 100 percent of operation and maintenance costs.

Website:
http://www.nae.usace.army.mil/Missions/Public-Services/Continuing-Authorities-Program/Section-206/

Community Rating System (CRS) under National Flood Insurance Program (NFIP)
The Community Rating System is a voluntary program under the NFIP that encourages municipalities to participate in flood management activities that exceed the minimum requirements of the NFIP. There are three goals of the CRS: reduce flood damage to insurable property, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management. Communities participating in the CRS receive reduced insurance premiums as a result of their compliance.

Website:
https://www.fema.gov/media-library/assets/documents/181241

FEMA Hazard Mitigation Assistance Grant Programs
The Federal Emergency Management Agency (FEMA) administers two major programs related to hazard mitigation: the National Flood Insurance Program (see Section 3.1 of this plan) and the Hazard Mitigation Assistance Program. FEMA’s hazard mitigation assistance grant programs provide funding to protect life and property from future natural disasters. In Massachusetts, these programs are administered by the Massachusetts Emergency Management Agency (MEMA). FEMA flood hazard mitigation assistance funding is available to Massachusetts communities through the following programs:

- Building Resilient Infrastructure and Communities (BRIC) BRIC provides funds to support public infrastructure projects that increase a community’s resiliency to reduce the effects of future disasters. The program replaced the former Pre-Disaster Mitigation (PDM) program in 2020. The goal of the BRIC program is to reduce overall risk to the population and structures, while at the same time, also reducing reliance on Federal funding from actual disaster declarations. A 25% non-federal share (local government or other organization) is required.

- Flood Mitigation Assistance (FMA) provides funds for projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis. These are cost share grants for pre-disaster planning and projects, with a federal share (up to 100%) and non-federal share (local government or other organization).

- Severe Repetitive Loss (SRL) is designed to reduce flood damages to residential properties that have experienced SRLs under flood insurance coverage. The program provides funds so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the NFIP. Funding is available on an annual basis (as available). SRL provides up to 90% Federal funding for eligible projects.

- Hazard Mitigation Grant Program (HMGP) assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement plans or projects in accordance with State, Tribal, and local priorities. HMGP grants are post-disaster cost share grants consisting of 75% federal share and 25% non-federal share (local government or other organization).
• Public Assistance (PA) Grants provide assistance to local, tribal and state governments and certain types of Private Non-Profit (PNP) organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President. Through the PA Program, supplemental Federal disaster grant assistance is provided for debris removal, emergency protective measures, and the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain PNP organizations. The PA Program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process.

Website: https://www.fema.gov/hazard-mitigation-assistance

National Fish and Wildlife Foundation (NFWF) New England Forests and Rivers Fund

The National Fish and Wildlife Foundation (NFWF) New England Forests and Rivers Fund is dedicated to restoring and sustaining healthy forests and rivers that provide habitat for diverse native bird and freshwater fish populations in the six New England states. This program annually awards competitive grants ranging from $50,000 to $200,000 each. Since its creation in 2015, the Fund has awarded 48 grants to restore early successional habitat, modify and replace barriers to fish movement, restore riparian and instream habitat, and engage volunteers in forest habitat restoration and stream connectivity projects. Major funding for the New England Forests and Rivers Fund is provided by Eversource Energy, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture’s Natural Resources Conservation Service and Forest Service.

Website: http://www.nfwf.org/newengland/Pages/home.aspx

US Department of Housing and Urban Development (HUD) Community Development Block Grants

Title 1 of the Housing and Community Development Act of 1974 authorized the Community Development Block Grant program. The program is sponsored by the US Department of Housing and Urban Development. The Massachusetts program is administered through the Massachusetts Department of Housing and Community Development.

CDBG-DR (disaster recovery) funds may be used to restore public facilities and infrastructure, rehabilitate or replace housing, acquire property, promote economic revitalization, and support Hazard Mitigation Planning. CDBG-DR funds are intended to support long-term recovery from a specific natural disaster and may not be applied to recovery activities associated with other disasters. Annual CDBG Program funds may also be used for certain eligible hazard mitigation and disaster recovery activities (Commonwealth of Massachusetts, n.d.). Implementation of green stormwater infrastructure and drainage system upgrades to mitigate drainage-related flooding is potentially eligible for CDBG funding.

Website: https://www.mass.gov/service-details/community-development-block-grant-cdbg

US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Funding Programs

The USDA Natural Resources Conservation Service (NRCS) works with land owners in Massachusetts to improve and protect soil, water, and other natural resources. NRCS has several funding programs in Massachusetts that help property owners address flooding and water quality issues.

• The Emergency Watershed Protection (EWP) Program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. EWP is an emergency recovery program, which responds to emergencies created by natural disasters. It is not necessary for a national emergency to be declared for an area to be eligible for assistance. EWP is designed for installation of recovery measures. Activities include providing financial and technical assistance to remove debris from stream channels, road culverts, and bridges, reshape and protect eroded banks, correct damaged drainage facilities, establish cover on critically eroding lands, repair levees and structures, and repair conservation practices.

Website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/
• The Emergency Watershed Protection - Floodplain Easement Program (EWP-FPE) provides an alternative measure to traditional EWP recovery, where it is determined that acquiring an easement in lieu of recovery measures is the more economical and prudent approach to reducing a threat to life or property. The easement area is restored to the maximum extent practicable to its natural condition using structural and nonstructural practices to restore the flood storage and flow, erosion control, and improve the practical management of the easement. Floodplain easements restore, protect, maintain and enhance the functions of floodplains while conserving their natural values such as fish and wildlife habitat, water quality, flood water retention and ground water recharge. Structures, including buildings, within the floodplain easement must be demolished and removed, or relocated outside the 100-year floodplain or dam breach inundation area.

Website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/programs/financial/ewp/?cid=stelprdb1244478

• The Watershed and Flood Prevention Operations Program provides technical and financial assistance to states, local governments and Tribes to plan and implement watershed project plans for the purpose of watershed protection, flood mitigation, water quality improvement, fish and wildlife enhancement, wetlands and wetland function creation and restoration, groundwater recharge, and wetland and floodplain conservation easements.

Website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/

American Rescue Plan Act

In 2021, Congress passed and President Biden signed the American Rescue Plan Act, which includes $1.9 trillion dollars in funding to individuals, schools, businesses, and areas suffering from the COVID-19 pandemic. $130 billion is directed to municipal and county governments for the purpose of replacing revenue lost or reduced as a result of the pandemic, funding COVID-related costs, providing support to aid households and businesses impacted by the crisis, investing in economic recovery and renewal, and funding investments in water, sewer and broadband infrastructure. Green infrastructure and stormwater projects can be funded under the sewer infrastructure category. As of June 1, 2021, Easthampton’s total allocation through ARPA was anticipated to be approximately $4.7 million. The funds will be provided in two blocks, in 2021 and 2022, and will be available for use through 2024.
OTHER FUNDING SOURCES

Healthy Watersheds Consortium Grant Program - U.S. Endowment for Forestry and Communities, USEPA, USDA NRCS

The goal of the Healthy Watersheds Consortium Grant Program is to accelerate strategic protection of healthy, freshwater ecosystems and their watersheds. The program supports:

- Developing funding mechanisms, plans, or other strategies to implement large-scale watershed protection, source water protection, green infrastructure, or related landscape conservation objectives.

- Building the sustainable organizational infrastructure, social support, and long-term funding commitments necessary to implement large-scale protection of healthy watersheds.

- Supporting innovative or catalytic projects that may accelerate funding for or implementation of watershed protection efforts, or broadly advance this field of practice.

Eligible applicants include non-profit organizations, for-profit companies, tribes, intertribal consortia, interstate, state, and local government agencies including water utilities and wastewater facilities, and colleges and universities. Funding amounts range from $50,000 to $300,000.

Website: https://www.epa.gov/hwp/healthy-watersheds-consortium-grants-hwcg

Resilient Communities Program

Wells Fargo, in partnership with the National Fish and Wildlife Foundation, launched the Resilient Communities Program in 2017. The program is designed to prepare for future environmental challenges by enhancing community capacity to plan and implement resiliency projects and improve the protections afforded by natural ecosystems by investing in green infrastructure and other measures. The program focuses on water quality and quantity declines, forest health concerns, and sea level rise. The program emphasizes community inclusion and assistance to traditionally underserved populations in vulnerable areas. In the northeast, eligible project types include wetland restoration and aquatic organism passage. The program awarded approximately $2 million in grants to projects in 2019. Each grant will range from $100,000 to $500,000 depending on category and will be awarded to eligible entities working to help communities become more resilient. This program has one round of applications per year and awards approximately three to six grants annually.

Website: http://www.nfwf.org/resilientcommunities/Pages/home.aspx