TOWN OF AMENIA
TOWN BOARD

4988 Route 22, AMENIA, NY 12501
(845) 373-8860 www.ameniany.gov

Resolution #45 of 2024

RE: ADOPTING TEN MILE RIVER WATERSHED MANAGEMENT PLAN

NOW, THEREFORE, BE IT RESOLVED, that the Town Board of the Town of Amenia does hereby adopt the Ten Mile River Watershed Management Plan; and

BE IT FURTHER RESOLVED, that a copy of the Ten Mile River Watershed Management Plan shall be kept on file in the office of the Town Clerk.

Motion made by S/Blackman

Seconded by C/Rebillard

The foregoing resolution was voted upon with all councilwomen/councilmen voting as follows:

Supervisor Blackman	Aye
Councilman Rebillard	Aye
Councilwoman Hamm	Aye
Councilman Winters	Absent
Councilwoman Ahearn	Aye

Dated: Amenia, New York
March 21, 2024

DAWN MARIE KLINGNER, TOWN CLERK

Ten Mile River Watershed Management Plan

Prepared by the Housatonic Valley Association for

The Ten Mile River Collaborative

NFWF The National Fish and Wildlife Foundation's Long Island Sound Futures Fund

HVA HOUSATONIC VALLEY ASSOCIATION

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Municipalities

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Vicky Doyle, Amenia Town Council
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Christy Gast, Amenia Conservation Advisory Committee
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THANK YOU TO OUR FUNDERS!

Long Island Sound Futures Fund

THE WERTH FAMILY FOUNDATION

Honeywell

The Honeywell Foundation

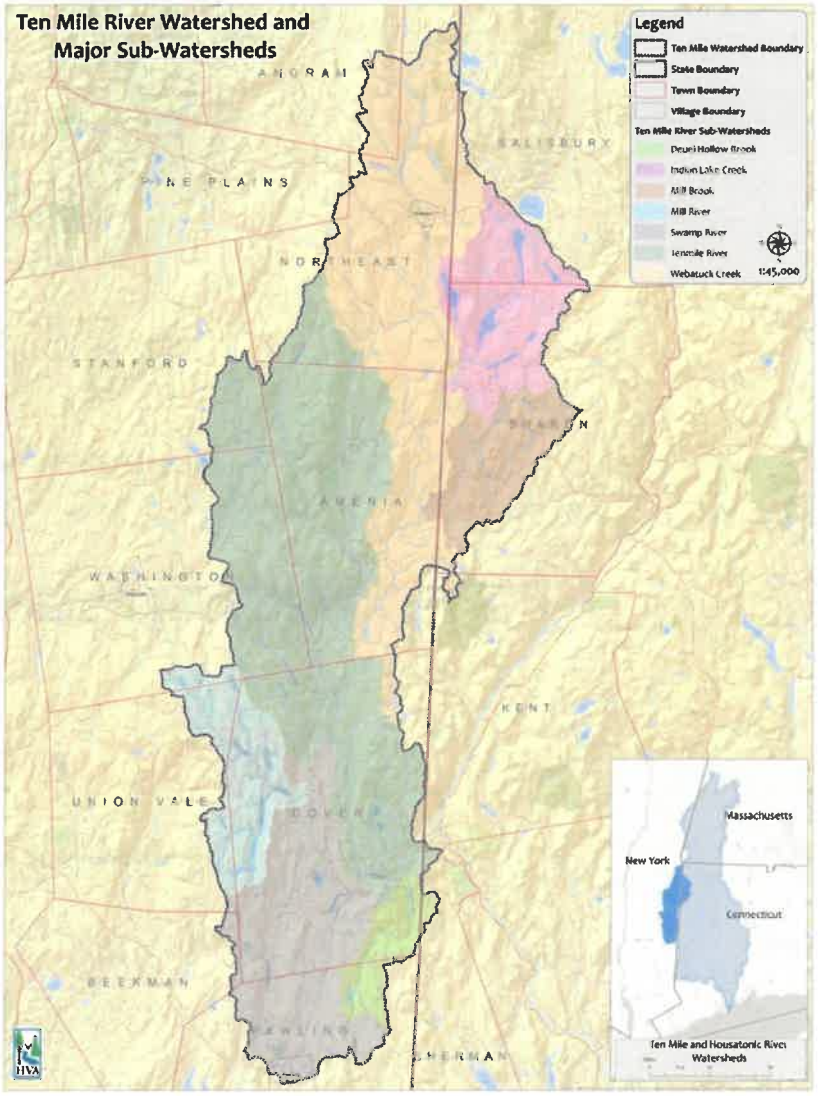
Ten Mile River Watershed Management Plan

Executive Summary

TMRC

The Ten Mile River watershed is home to clean, cold streams, rare species and habitats, productive farmland, and healthy forests.

This outstanding natural heritage is essential to the vibrancy and cultural character of watershed communities,from the headwaters in Salisbury and Sharon (Connecticut)and Ancram, North East and Millerton (New York), south through the New York communities of Amenia, Dover, Stanford, Washington, Union Vale, Beekman and Pawling. The Ten Mile River gathers the waters of Webatuck Creek, Wassaic Creek, the SwampRiver and numerous other smaller tributaries before joiningthe Housatonic River at Gaylordsville in Connecticut. Throughout the watershed, residents and visitors enjoy activities like fishing, paddling and hiking on iconic routessuch as the Appalachian Trail and the Harlem Valley Rail- Trail. The health of the Ten Mile River is what makes these experiences special.



But future health of the watershed is not guaranteed.

Habitat loss and fragmentation, pollution from sources like stormwater runoff and failing septic systems, major floods, more frequent drought and invasive species all threaten the health of the lands and waters of the Ten Mile River system. These threats are exacerbated by the effects of climate change, which is already bringing warmer air and water temperatures, more frequent extreme precipitation, and dramatic changes inseasonality to the region. These trends are expected to continue and become more pronounced.

Development in the watershed that sends untreated stormwater runoff to streams is impacting water quality in some areas, as are some agricultural operations. Major floods over the past two decades have damaged infrastructure and property. Reaches of the Ten Mile and its tributaries have excessively eroding banks, large amounts of woody debris and areas of significant sediment deposition. Continuing stream instability along these reaches threatens property, infrastructure and habitat for fish and wildlife. Large blocks of contiguous forest in

the watershed that are vital to maintaining cool, clean water and providing critical habitat remain unprotected and vulnerable to fragmentation. Undersized culverts pose a significant threat for flooding and property damage, and create barriers to fish and wildlife movement by blocking key migration routesthat will be essential for the persistence of native species as suitable habitat contracts in the warming climate. Healthy forests and stream corridors are threatened by invasive plants and pathogens that are thriving in a warming climate.

These issues transcend jurisdictional boundaries and the specific missions of agencies and organizations. The actions of individual landowners and municipalities can cause impacts far beyond the sites where work is happening- often in downstream communities. Watershed management in the Ten Mile has been complicated by the fact that the watershed encompasses portions of 15 municipalities in two states, each with considerable land-use decision making authority. It includes the service areas of two federal agency Regions (Region 1 on the CT side, Region 2 on the NY side); two state environmental agencies (NYS Department of Environmental Conservation and CT Department of Energy and Environmental Protection), two Soil and Water Conservation Districts (Dutchess County and CT Northwest) and two regional planning agencies (Dutchess County Planning Department and Northwest Hills Council of Governments). There are also a number of non-profit organizations actively working in the watershed with an interest in its management.

Building partnerships to help the Ten Mile River.

Ten Mile River Watershed Forum, 2014

Collaborative watershed-scale planning is a widely accepted and proven method for addressing issues like pollution, flooding and biodiversity conservation that transcend municipal boundaries and organizational missions. Watershed planning builds partnerships and frameworks for collaboration, gathers and interprets existing research and planning, identifies information gaps that must be filled to make management decisions and collects that information, brings diverse stakeholders together to articulate goals for watershed management, and identifies the actions that partners need to take to achieve those shared goals.

In 2014, an active and engaged group of watershed municipalities, federal, state and regional agencies and conservation non-profits came together to form the Ten Mile River Collaborative (TMRC). This group has met regularly since then to discuss watershed management issues and look for opportunities to work together to achieve shared management goals. Municipal members of the TMRC formally resolved to support collaborative management of the Ten Mile, including the development of a Watershed Management Plan. The TMRC is the driving force behind this Watershed Plan. TMRC members have collectively committed thousands of hours to assessing the state of the Ten Mile River watershed, articulating a shared vision for its future, and identifying the steps we need to take to get there.

TMRC identified five key Focus Areas for management of the Ten Mile River watershed that form the framework of this Watershed Plan:

- **Water Quality**
- **Recreation Enhancement and Promotion**
- **Climate Change Resilience and Stream Corridor Management**
- **Natural Heritage**
- **Agriculture and Producer Support**

Characterizing the Ten Mile River watershed.

With the Focus Areas identified by the TMRC as a guide, HVA and the TMRC reviewed over 200 references including but not limited to water quality studies, town planning documents and natural resource inventories. At the same time, HVA collected new information, walking 25 stream miles in the watershed to assess conditions and identify restoration opportunities to reduce pollution and flood risk, restore habitat and enhance river access.

The summary of existing research and planning and the results of HVA's field investigations were combined as the **Ten Mile River Watershed Existing Conditions Report (ECR).** HVA circulated a draft of the ECR to the TMRC and other expert stakeholders, and incorporated the comments received into the document.

A summary of the ECR's findings are below:

- Our research indicates that the Ten Mile River and its tributaries still support good water quality for the most part, although there are localized impacts in some areas. Some of these impacts can be attributed to polluted runoff (both from developed areas and agricultural operations), but there are likely other contributing sources.
- There are many reaches (particularly along the Ten Mile River mainstem) that are unstable- meaning that erosion and deposition of sediment is out of balance, and the stream is rapidly changing its shape. Unstable streams can threaten property and infrastructure, and contribute to downstream water quality degradation. More frequent large floods, removal of streamside vegetation and channel modifications (undersized bridges and culverts, filling in the floodplain, bank

Water quality monitoring on Burton Brook (Town of Dover) in 2018

armoring, etc.) all contribute to this issue.

- While there are many excellent outdoor recreation opportunities in the watershed (including the Appalachian Trail, the Harlem Valley Rail Trail and some public fishing access sites managed by NYS DEC), access to the Ten Mile and major tributaries for fishing, paddling and other water-related activities is difficult in some areas. There are also opportunities for building connectivity between existing outdoor recreation areas. Outdoor recreation is an undeveloped sector of the local economy that could be enhanced. Given the region's outstanding natural heritage and easy access from large population centers, there is potential for this.
- The Ten Mile River watershed is critically important to landscape-scale conservation of species and habitats. The intact forests and healthy waters of the region are a key part of a wildlife migration corridor running from the Hudson River Highlands and points south, through western Connecticut and western Massachusetts to the Green Mountains of Vermont and on to the Canadian border.
- Climate change is accelerating water quality degradation, increasing flood risk and reducing the extent of high-quality wildlife habitats in watershed communities. There is little that we can do to arrest global climate change and associated threats to ecosystems and communities locally in the short term, so it is critical that we take advantage of every opportunity to build climate resilience in the natural and built environments- using techniques, tools and resources that are locally available.
- Agriculture is key to the environmental health and cultural character of the Ten Mile River watershed. Agricultural producers need support to keep their operations viable in a changing economy and climate, and also in some cases to adopt Best Management Practices that protect watershed health and the long-term productivity of the land.

Duell Hollow Brook, Town of Dover

Envisioning the Future and Setting Goals.

Based on the findings of the Ten Mile River Watershed Existing Conditions Report, TMRC members developed the following Vision Statement for the Watershed:

The Ten Mile River watershed continues to be rich with healthy woods and waters, unique habitats, anddiverse species in the face of a changing climate, and these assets support vibrant and resilient communities. Streams and wetlands are an integral part of watershed communities, providing critical ecological services, opportunities to connect with the land and compelling watershed residents and visitorsto learn about and protect the natural world. All watershed residents and visitors have easy access to openspaces, regardless of background or ability. Outdoor recreation, farming and forestry are recognized as pillars of the local economy, and watershed health is understood to be essential to these economic sectors. Municipalities, conservation organizations, government agencies and other partners work collaborativelyto:

- *Protect and improve the quality of water resources.*
- *Proactively implement measures to adapt to climate change impacts and enhance the resiliencyof watershed communities.*
- *Support agricultural producers in their efforts to protect the health of woods and waters, andpromote food and other products grown or made on Ten Mile River watershed farms.*
- *Restore and protect habitats for species of conservation concern.*
- *Leverage the outstanding natural and cultural heritage of the watershed for economic development, while balancing economic growth with natural resource conservation.*
- *Ensure that all feel safe and welcome in outdoor spaces regardless of race, ethnicity, genderidentity, age, or ability.*

TMRC, 2015

Using this Vision Statement as a guide, the TMRC identified the following goals for each Key Focus Areas:

Water Quality

- *Monitor, maintain, and improve water quality of the Ten Mile River and all tributaries to support healthy, diverse populations of aquatic biota and ensure Water Quality Standards are met.*
- *Improve community connection to waterways and understanding of the importance of maintaining the health of freshwater resources and ecosystems for all living entities, including people, fish and wildlife.*
    - *Emphasize co-benefits of water protection efforts: safe drinking water, protection from flood damage, improved productivity of farms and forests, and enhanced recreation opportunities.*
    - *Support residents in adopting property management practices that protect water quality.*
    - *Create educational opportunities that communicate how diversity and quantity of macroinvertebrates are indicators of overall water quality.*
    - *Engage Watershed youth in activities related to conservation and environmental stewardship.*
- *Support adoption of water quality protection policies and programs at the municipal level.*
- *Encourage proactive intermunicipal water quality protection planning and program development.*

Climate Resilience & Stream Corridor Management

- *Restore and protect functioning floodplains to reduce flood heights in developed areas.*
- *Reconnect streams to floodplains wherever possible. Restore riparian buffers - plan for future healthy canopy cover and carbon storing.*
- *Identify channel constrictions (e.g. undersized bridges and culverts) and mitigate flood risk using future precipitation projections to help guide replacement strategies.*
- *Protect and enhance in-stream habitat for climate sensitive species.*
- *Educate community members on benefits of Green Infrastructure (GI) and Low Impact Development (LID) practices.*
- *Implement GI and LID practices wherever possible.*
- *Encourage and support intermunicipal collaboration and knowledge-sharing in planning for future hazard mitigation and building local climate resilience.*
- *Consider carbon sequestration when planning TMR Watershed Plan implementation.*

Stream instability along the Ten Mile River, Town of Dover

Agriculture

- *Support sustainable practices while supporting farmers through direct outreach.*
    - *Encourage the adoption and implementation of farm-based Conservation Plans thataddress natural resource concerns and keep productive agricultural land in use.*
- *Explore creative and flexible approaches to on-farm riparian buffer restoration.*
    - *Enhance outreach efforts through identification of demonstration project sites.*
- *Establish information and equipment sharing networks for Watershed producers.*
- *Increase access to technical support and funding opportunities for Watershed producers,particularly resources available through Farm Bill programs administered by the NaturalResources Conservation Service.*
- *Promote and demonstrate the importance of implementing Best Management Practices – including but not limited to integrated agroforestry and silvopasture, nutrient management, andthe continued use of soil erosion control methods.*
- *Increase awareness of and participation in existing programs such as the Agricultural Environmental Management program administered by Dutchess County Soil and Water Conservation District and the New York State Department of Agriculture and Markets' AgriculturalDistricts program.*
- *Create opportunities for on-farm agritourism and the promotion of local agriculture.*

Natural Heritage

- *Develop a unified biodiversity conservation strategy for the TMR watershed informed by keypartners and existing local and regional conservation planning.*
- *Promote and support the creation and maintenance of biodiversity inventories.*
- *Protect land through conservation easements or in-fee purchase in large contiguous forest blocks and other core habitats as opportunities arise.*
- *Support preservation and expansion of aquatic and terrestrial habitat connections:*
    - *In areas important to landscape-scale connectivity:*
        - *Remove barriers to fish and wildlife passage along stream corridors.*
        - *Restore and protect healthy riparian buffers.*
        - *Protect land through conservation easements or in-fee purchase.*
        - *Identify ways to make these efforts beneficial for landowners and the greater Watershed community, including finding areas where land protection and stewardship can accomplish multiple objectives (biodiversity conservation, flood damage prevention, water quality protection, recreation enhancement).*
- *Build biodiversity-focused educational outreach to raise awareness of rare and significant plant and animal populations that exist within the Watershed.*

Perry Preserve, Town of Dover

- *Use local attractions as outdoor classrooms for learning about local habitats andecosystems.*
- *Plan community events that celebrate and raise awareness of our cherished naturalresources.*

Recreation Enhancement & Promotion

- *Build strong collaboration between federal and state agencies, municipalities, and conservation organizations for planning safe, sustainable recreation opportunities.*
- *Use recreation enhancements as opportunities for job creation through:*
  - *Comprehensive monitoring of heavily trafficked areas,*
  - *Development and implementation of outdoor recreation plans targeted at protectingagainst overuse – especially in ecologically sensitive areas, and*
  - *Launching public information campaigns to educate the public on the impacts of recreation, and the relationship between recreation and the movement of invasivespecies.*
- *Foster strong partnerships with landowners to encourage public access - be supportive of land-owner concerns.*
- *Create information sharing systems that can alert the public of overuse and advise againstvisitation.*
- *Establish new outdoor recreation opportunities while increasing awareness of those that alreadyexist (e.g. create linkages between the Harlem Valley Rail Trail and new outdoor spaces).*
- *Create new opportunities to recreate outdoors and ensure connectivity between outdoor spaces(e.g. trail linkages).*

Making the Action Plan.

Once the TMRC reached consensus on the Vision and Goals, the next step in the Watershed Planning process was to identify specific Actions that must be taken to achieve a healthy, resilient Ten Mile River watershed. Actions were generally organized as **non-construction programs** (Actions like water quality monitoring and educating youth about the Ten Mile River) and **construction projects** (Actions like planting trees along a stream or capturing polluted runoff from a parking lot to filter out pollution).

The TMRC identified over 30 Actions over the five focus areas, aimed at everything from involving local youth in watershed plan implementation to enhancing river access for paddlers and anglers to encouraging streamside homeowners to use sustainable lawn management practices. The TMRC then worked collaboratively to prioritize Actions for implementation based on pollution reduction potential, existing and potential partnerships to support implementation, cost-effectiveness/feasibility and potential to address multiple Goals across the five Watershed Plan Focus Areas.

Polluted runoff draining towards Wells Brook from the CVS Plaza in Dover Plains

Examples of Construction Projects and Non-Construction Programs identified by the TMRC as priority Actions are included below. ***Note that this is a representative list; many more Actions are described in the main body of this Watershed Plan document.***

Construction Projects

Wells Brook Stormwater Retrofit- Town of Dover

Focus Areas addressed: **Water Quality, Natural Heritage, Climate Change Resilience/Stream Corridor Management, Recreation Enhancement and Promotion**

Wells Brook is generally healthy before it flows through a commercial area in Dover Plains, approximately 2500' above its confluence with the Ten Mile River. HVA has documented a variety of water quality issues downstream of this commercial area, including elevated levels of indicator bacteria and nutrients and changes to the invertebrate community that indicate chronic water quality impacts. Wells Brook is also a summer thermal refuge for Eastern Brook Trout and other coldwater species, which has been documented by HVA's warm-season temperature monitoring as well as assessment of the Wells Brook fish community conducted by NYS DEC Region 3 Fisheries. This project will use Green Infrastructure practices to capture polluted runoff currently entering Wells Brook untreated from parking lots associated the existing CVS shopping center and the McDonalds restaurant, as well as NYS Route 22. These practices will reduce the amount of nutrients, sediment, heavy metals and deicing agents entering Wells Brook and the Ten Mile River. This location also presents an excellent opportunity for public outreach around managing polluted runoff, given the large number of daily visitors. Plans will integrate a new outdoor dining area on the McDonald's side of the stream and interpretive signage.

North East Highway Garage- Village of Millerton

Focus Areas addressed: **Water Quality, Natural Heritage, Climate Change Resilience/Stream Corridor Management, Recreation Enhancement and Promotion**

Fill in the Webatuck Creek floodplain behind retaining wall at North East Highway Garage, Village of Millerton.

The Town of North East is working to decommission their Highway facility on Center Street in the Village of Millerton, which is built on fill in the Webatuck Creek floodplain. This facility has been used to store deicing salt and sand, and also has a garage building used for vehicle and equipment maintenance and a fueling station. The Town is currently constructing a new facility at a different location, and they have already moved stockpiles of deicing salt and other assets to this new site. While this has addressed an acute water quality issue, sand and other materials are still stockpiled at the Center Street facility, just above Webatuck Creek. There are also concerns about legacy pollution related to past vehicle/equipment maintenance and refueling. This site is just across Webatuck Creek from the Harlem Valley Rail Trail, and is within walking distance for hundreds of Millerton residents. This project will support the Town as they continue to transition from this site to their new facility, and explore possibilities for remediating the site and creating public access to Webatuck Creek and the Harlem Valley Rail Trail. There is also an opportunity to remove fill and reconnect Webatuck Creek to its floodplain in this location, which could help reduce flood risk on adjacent properties.

Wassaic Park Upgrades- Town of Amenia

Focus Areas addressed: **Recreation Enhancement and Promotion, Water Quality, Natural Heritage, Climate Change Resilience/Stream Corridor Management**

Retaining wall below parking area at Wassaic Park

Wassaic Park is an underused outdoor space in the unincorporated community of Wassaic. It is difficult to access by vehicle and not easy to find- visitors must travel through a commercial/industrial complex to reach the parking lot, and the park is not visible from nearby roads. Wassaic Park is the current southern terminus of the Harlem Valley Rail Trail, which connects pedestrians and cyclists with the park from the center of Wassaic and points north. Wassaic Park has extensive frontage along Wassaic Creek, with excellent opportunities for angling, wildlife-watching and launching canoes or kayaks when flows are appropriate. The Town of Amenia has plans to upgrade existing playground equipment at the park. This project will complement that work with improvements to access routes for vehicles and pedestrians meant to raise awareness of the park and make access more intuitive; redesign of the retaining wall on the left bank of Wassaic Creek below the existing parking area to prevent a potential slope failure and reduce stream instability; a creekside trail with designated access points suitable for multiple uses and visitors of all ages and abilities; restoration of native streamside vegetation; and interpretive signage to help visitors connect with Wassaic Creek.

Non-Construction Programs

Mill Brook Watershed Farm-Scale Conservation Planning – Town of Sharon

Focus Areas addressed: **Agriculture and Producer Support, Water Quality, Natural Heritage, Climate Change Resilience/Stream Corridor Management**

Mill Brook drains an approximately 11-square-mile watershed that falls almost entirely in the Town of Sharon, CT. A 1.66-mile reach of Mill Brook was assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and is listed as Impaired for recreation in the most recent (2018) State of Connecticut Integrated Water Quality Report to Congress due to elevated levels of the bacteria *Escherichia coli* (*E. coli*). Water quality monitoring conducted by HVA in 2018 at a site just downstream of the CT/NY border showed high concentrations of *E. coli* (ranging from 1732 to 2420 MPN/100 ml). *E. coli* concentrations were elevated above CT Water Quality Standards during three sampling events, suggesting that Mill Brook may not be meeting its recreational use goals as it flows from CT into NY. A Total Maximum Daily Load (TMDL) for *E. coli* was assigned to the Mill Brook watershed in 2012. Based on field assessments, agricultural activities are suspected to be a significant source of nonpoint source (NPS) pollution (including nutrients and sediment in

addition to *E. coli*) for Mill Brook. The Mill Brook mainstem flows through large tracts of row crops and pastures with unrestricted access to the stream corridor for livestock. In order to reduce agricultural NPS pollution in the Mill Brook watershed and downstream waters, HVA, CT Northwest Conservation District (NWCD), Sharon Land Trust (SLT) and the Natural Resources Conservation Service (NRCS) will build new relationships with watershed farmers, develop farm-scale Conservation Plans where there are opportunities for measurable NPS pollution reduction, and connect farmers with resources available through NRCS for Conservation Plan implementation.

2018 Still River Watershed Connections summer Stewardship Crew

Ten Mile River Watershed Connections – Entire Watershed

Focus Areas addressed: **Agriculture and Producer Support, Water Quality, Natural Heritage, Climate Change Resilience/Stream Corridor Management**

Implementing this Watershed Plan is an excellent opportunity to engage local youth in stream stewardship. Hands-on restoration work (tree planting, invasive species removal, trash cleanups, water quality monitoring, etc.) can help young people from the area learn valuable career skills while building their awareness of and respect for local streams. We envision a Ten Mile River that's healthy and resilient long into the future. Creating the next generation of stream managers and advocates is essential to realizing that vision. Ten Mile River Watershed Connections (TMR Connections) will build partnerships between restoration practitioners, public schools in the watershed and youth services agencies to connect local youth with meaningful watershed restoration projects, with the complementary goals of teaching 21st-century career skills, raising awareness of/fostering love for local streams, and providing a reliable source of volunteers for installing and maintaining restoration projects. TMR Connections will be modeled on similar successful programs developed by TMRC members, including the No Child Left Inside program administered by Cornell Cooperative Extension of Dutchess County, and the Still River Watershed Connections program administered by HVA.

Implementing the Watershed Plan.

Completing this Watershed Plan document is just the beginning of our collective effort. Implementing the Actions we've identified as essential to accomplishing our Goals is vital to realizing our shared Vision for the Ten Mile River Watershed.

Encouragingly, the TMRC has already begun Watershed Plan implementation, and resources to jump-start priority projects have been secured. Examples of this include ongoing restoration work along lower Wells Brook in the Town of Dover. Phase I of a project to address actively eroding streambanks and restore native

streamside vegetation at a site just upstream from the Wells Brook/Ten Mile River confluence was completed in fall 2020. Funding has been secured to complete Phases II and III of this project through the Natural Resources Conservation Service Regional Conservation Partnerships Program (RCPP). Altogether, this project will restore 1600' of streambank, mitigating significant pollution from bank erosion and restoring habitat for Eastern Brook Trout and other cold-water obligate species along this reach.

Volunteers planted over 500 live willow and dogwood stakes as part of the Lower Wells Brook Stream Restoration- Phase I

RCPP funding will also cover design and construction of a streambank restoration project along the Ten Mile River mainstem adjacent to Craig Lane in the Town of Dover. In this area, excessive erosion is contributing sediment and nutrients to the Ten Mile. The stream is also migrating laterally towards septic system leach fields associated with nearby homes. This project will stabilize the bank and restore native streamside vegetation, arresting the lateral migration of the stream and preventing it from reaching the leach fields and associated nutrient and pathogen pollution that would end up in the Ten Mile and downstream waters.

The Town of North East has completed the initial phases of their work to remove their highway garage and salt storage shed from the Webatuck Creek floodplain (described above). The salt storage shed and salt stockpile have been moved to another location away from the stream, removing a major source of chloride and sediment pollution. Future work on this site is planned to address legacy contamination from past uses, remove fill and reconnect the floodplain and develop passive recreation opportunities.

HVA in partnership with the CT Northwest Conservation District, CT NRCS and the Sharon Land Trust have received funding from the Clean Water Act Section 319 Nonpoint Source Grants Program to work with

farmers in the Mill Brook watershed to develop and implement on-farm Conservation Plans. This project is also described above.

Most importantly, this planning process has built and strengthened the partnerships that are crucial to addressing issues like pollution and flooding at a watershed scale. All four of the projects already underway that we describe above are identified as priorities in the Action Plan. The TMRC is hitting the ground running as this Watershed Plan document is completed, and that wouldn't have been possible without the help and support of each member.

The role of the TMRC will now shift from guiding Watershed Plan development to driving implementation and fostering continued collaboration between watershed communities, state, federal and regional agencies and non-profit groups with a stake in the way the Ten Mile River is managed. There is a long road ahead of us as we work towards realizing the TMRC's Vision for the Ten Mile River and its watershed, but we have the strength of our partnerships and the clarity of our shared purpose to see us through. **This Watershed Plan is our roadmap towards a Ten Mile River that is swimmable and fishable, that provides opportunities to connect with and learn from nature for people of all backgrounds, ages and abilities, which is resilient to the effects of climate change, and supports thriving species and habitats.** The Ten Mile River we envision is an economic driver for the region, a point of pride for watershed residents, and a reflection of the care and respect that people producing food and fiber in the watershed have for their land. Implementing this Watershed Plan, together, is how we realize that vision.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background

The Ten Mile River (TMR) watershed falls into the service area of two federal agency Regions (Region 1 on the CT side, Region 2 on the NY side); two state environmental agencies (NYS DEC and CT DEEP), two Soil and Water Conservation Districts (Dutchess County and NWCD) and two regional planning agencies (Dutchess County Planning Department and Northwest Hills Council of Governments). It encompasses portions of 15 municipalities, each with considerable land-use decision making authority. There are also a number of non-profit organizations actively working in the watershed with an interest in its management. Consequently, regional collaboration to accomplish shared goals is essential.

In recognition of this, watershed municipalities and other stakeholders have come together as the Ten Mile River Collaborative (TMRC). Since 2014, the TMRC has been working towards a community-supported Watershed-Based Plan for the TMR that is meant to restore and protect water quality, build climate resiliency, support sustainable agriculture, enhance outdoor recreation opportunities, and protect important species and habitats.

Collaborative watershed-scale planning is a widely accepted and proven method for addressing issues like pollution and flooding that transcend municipal boundaries and organizational missions. This Watershed-Based Plan builds on the momentum of the TMRC and establishes a lasting framework for collaborative management of the watershed that will be crucial to its long-term protection.

1.2 Plan Development Process

The journey towards this watershed plan started in June of 2014, when a group of watershed municipalities, conservation nonprofits, and government agencies convened the Ten Mile River Watershed Forum at the Wethersfield Estate Carriage Museum in Amenia. TMR Watershed Forum attendees agreed that the watershed's management challenges required an ongoing dialog between key stakeholders. The Ten Mile River Collaborative (TMRC) was formed out of that conversation. Core partners convened the first official meeting of the TMRC in September 2015, and this group has met regularly since then to discuss shared watershed management concerns and identify opportunities to address those concerns collaboratively.

The TMRC's first success was securing agreement from the Towns of North East, Amenia and Dover and the Village of Millerton to pursue designation of the Ten Mile River and major tributaries as New York State Designated Inland Waterways. This Designation made these communities eligible for funding available through the New York State Department of State for waterfront revitalization, including watershed planning and management. All of these communities passed resolutions articulating their commitment to collaborative watershed management in 2016, and the representatives of these communities in the NYS Senate and Assembly brought Inland Waterway Designation for the Ten Mile River, Webatuck Creek, and Wassaic Creek to those bodies for approval during the 2017 legislative session. The legislation designating these streams was signed by the Governor in June of 2017. The most important outcome of this process was the consensus achieved among TMRC members that developing a watershed-based management plan was critical to achieving shared goals for the watershed. Based on this consensus, on behalf of the TMRC the Housatonic Valley Association (HVA) applied for and received

a grant from the 2017 round of the National Fish and Wildlife Foundation's Long Island Sound Futures Fund to begin developing a watershed-based management plan for the Ten Mile River.

In June of 2018, the TMRC organized the official Watershed Planning Kickoff Meeting, which was hosted by the Wassaic Project at Maxon Mills in Wassaic. Participants in the kickoff meeting included representatives from New York and Connecticut watershed municipalities, Dutchess County and New York State agencies, conservation non-profits active in the watershed, and members of the public. Participants agreed on five key focus areas for the Watershed Plan: Water Quality, Natural Heritage, Climate Resilience and Stream Corridor Management, Recreation Enhancement and Promotion, and Agriculture/Producer Support.

The TMRC met regularly after the kickoff meeting to gather information and resources to inform the Ten Mile River Watershed Existing Conditions Report (ECR), a document that summarized existing research and planning germane to the five Watershed Plan focus areas to describe the current state of the Ten Mile River watershed.

Field assessments in support of this planning process were conducted by HVA (although data collected by other agencies and organizations were reviewed to develop the ECR). This included a season of water quality monitoring at 16 sites across the watershed, and continuous streamwalks along 36 stream reaches expected to have water quality impacts to identify restoration opportunities. HVA used a customized version of the Unified Stream Assessment (USA) developed by the Center for Watershed Protection when conducting these streamwalks. Water quality monitoring and streamwalk data were incorporated in the ECR. Please see Chapter 3 (Water Quality) for more details about field assessments.

Based on the findings in the ECR, the TMRC worked collaboratively to articulate a Vision for the future of the watershed, and a set of Goals that must be achieved to realize that Vision. The Vision and Goals then informed identification, development and prioritization of construction projects and non-construction programs compiled as the Watershed Plan Implementation Strategy (AKA Action Plan).

Finishing the Watershed Plan is just the beginning of our work to achieve the Vision articulated by the TMRC. The TMRC will now shift their focus to implementing the Actions identified in the Implementation Strategy of this plan and tracking the success of those Actions in achieving our goals for water quality, recreation enhancement, building climate resilience in the built and natural environment and supporting sustainable agriculture that protects watershed health. For more information about the planning process, please see Appendix A.

1.3 Management Plan Recommendations

This document includes a number of recommended Actions developed by the TMRC that will help to improve and protect water quality throughout the watershed. These Actions were generated from HVA's field assessments, conversations with the TMRC and watershed residents, and common practices used in similar watersheds. Tables with Actions specific to each Watershed Plan Focus Area are included at the end of each focus area chapter.

1.4 Navigating the Plan

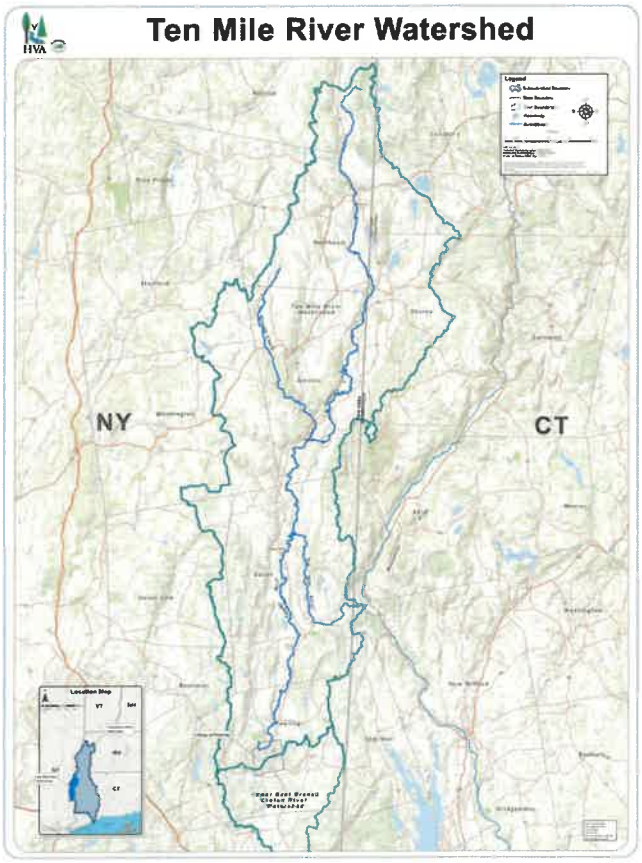
The Watershed Plan presents a wealth of information – beginning with a general description of drainage basin characteristics (chapter 2); continuing with existing conditions, goals, and recommended Actions related to each of the five Focus Areas (chapters 3-7); and finishing with the Implementation Strategy (chapter 8).

Chapters 3-7 include the extensive research and data collection that shaped the Plan, and they are each arranged in the same order: goals, existing conditions, and recommended Actions. Chapter 8 describes construction projects and non-construction programs that were identified by the TMRC as priority Actions for implementation.

2. GENERAL WATERSHED CHARACTERISTICS

2.1 Geography

The Ten Mile River drains 210 square miles in eastern Dutchess County NY and northwestern Litchfield County CT, from the Columbia County line south to the town of Pawling. The basin ranges from 5 to 8 miles wide, is 33 miles long, and has four principal watercourses: the Ten Mile River mainstem, Swamp River, Webatuck Creek, and Wassaic Creek[1]. This drainage system falls an average of 16 feet per mile as it flows from the headwaters in northwestern Connecticut, through the Harlem Valley lowlands in Amenia and Dover, and into the Housatonic River at Gaylordsville, CT.



Map 1. General map of the Ten Mile River watershed.

2.2 Geology

Everett Schist comprises the bedrock terrain of what are usually called the Taconic Mountains from Indian Mountain north along the western boundary of New England with New York. These rocks were laid down as magma along the subduction zone beneath the Iapetos Sea and then twisted and compressed in a metamorphic process and uplifted 440 million years ago during the Taconic Orogeny[2].

Pre-Cambrian pink granitic gneiss forms most of East Mountain in Amenia and Dover, New York and adjacent parts of Kent and Sharon, Connecticut. This bedrock originated far earlier (800-1,700 million years ago) than Everett Schist, and was part of a far older mountain building period. This mountain, together with much of the Hudson Highlands and the eastern Berkshire Hills, belongs to the Grenville period, although uplifted once more during the Taconic Orogeny. Locally, it is best described as part of

the Hudson Highlands and related geologically to Vermont's Green Mountains, the Adirondacks, some of the Litchfield Hills and much of the Berkshires. West Mountain, on the other hand, is a thrust fault of metamorphic Taconic sequence rock surrounded by shales[3].

The most recent event to influence the geology and soils of the TMR watershed was the advance of the Laurentide ice sheet which extended southward out of Canada down to Long Island approximately 20,000 years ago – carving and moving material along the way. As the ice sheet retreated, it left behind the surficial deposits (i.e. gravel-rich till) that we see today[4].

2.3 Hydrology

All bodies of water drain a finite amount of land, as determined by topography. These topographic and hydrologic systems are known as watersheds (also known as drainage basins and catchments). Watersheds are the fundamental spatial unit of landscapes[5], and each watershed contains subwatersheds within it. The delineation of watershed boundaries defines the separation of surface flow and accumulation.

The Ten Mile River watershed is a subwatershed of the 1,948 mi^2 Housatonic River watershed, which is in turn part of the 17,814 mi^2 Long Island Sound (LIS)[6] watershed which encompasses nearly the entire state of Connecticut; parts of Massachusetts, New Hampshire, Rhode Island, Vermont, and a small portion of Canada; as well as portions of New York City, and Columbia, Dutchess, Westchester, Nassau, and Suffolk Counties in New York State (NYS)[7]. The headwaters of the TMR watershed – where Webatuck Creek begins - are in the Taconic State Park region, near the Massachusetts/New York/Connecticut state lines.

3. WATER QUALITY

3.1 Goals

- Monitor, maintain, and improve water quality of the Ten Mile River and all tributaries to support healthy, diverse populations of aquatic biota and ensure Water Quality Standards are met.
- Improve community connection to waterways and understanding of the importance of maintaining the health of freshwater resources and ecosystems for all living entities, including people, fish and wildlife.
    - Emphasize co-benefits of water protection efforts: safe drinking water, protection from flood damage, improved productivity of farms and forests, and enhanced recreation opportunities.
    - Support residents in adopting property management practices that protect water quality.
    - Create educational opportunities that communicate how diversity and quantity of macroinvertebrates are indicators of overall water quality.
    - Engage Watershed youth in activities related to conservation and environmental stewardship.
- Support adoption of water quality protection policies and programs at the municipal level.
- Encourage proactive intermunicipal water quality protection planning and program development.

3.2 Current State of Water Quality in the TMR Watershed

3.2.1 The Hydrologic Cycle and Watersheds

The amount of water present on Earth today is a fixed quantity—meaning that, despite undergoing regular changes in form, there is no additional water created, and no existing water is ever destroyed. We directly observe the movement of water in its various forms in our day-to-day lives. We see land flood, and we observe land once rich with water begin to dry up. These fluctuations in the amount of surface water visible in our immediate landscapes represent changes in water storage. Water is stored in various "reservoirs", such as the atmosphere, oceans, lakes and ponds, rivers and streams, soils, snow and glaciers, and subterranean reserves. The capacity for each of these reservoirs to store water is spatially and temporally variable. The conceptual model known as the hydrologic cycle describes how water moves across these places of storage as it evaporates, precipitates, and flows[8]. The oceans are Earth's largest reservoir—collectively holding approximately 97% of all water. The remaining 3% of Earth's water is the only freshwater we have. Of that 3%, most (78%) is stored as ice and 21% is stored as groundwater, leaving less than 1% to flow freely through rivers, lakes, and soils. This means that all of the freshwater that we are familiar with makes up a mere 0.02% of all of the water on the planet[9].

Water enters the atmosphere following a phase change from its liquid (through evaporation and transpiration) or solid (through sublimation) state to a gas (water vapor). Once the water vapor is in the air, it rises and cools. The cooling vapor molecules attach to particulate matter and condense to form water droplets, which collectively form clouds. When the droplets become heavy enough, they fall back to Earth's surface as rain, snow, or hail[10]. This precipitation is then intercepted by vegetation or impervious surfaces and absorbed by the soil, flows overland as runoff, or falls directly into water bodies. Which water bodies precipitation from a particular cloud eventually settle in depends on the topography of the area where it lands. The amount of precipitation that reaches a given water body as runoff and the time it takes for that runoff to get there is governed primarily by soils, land use and vegetative cover.

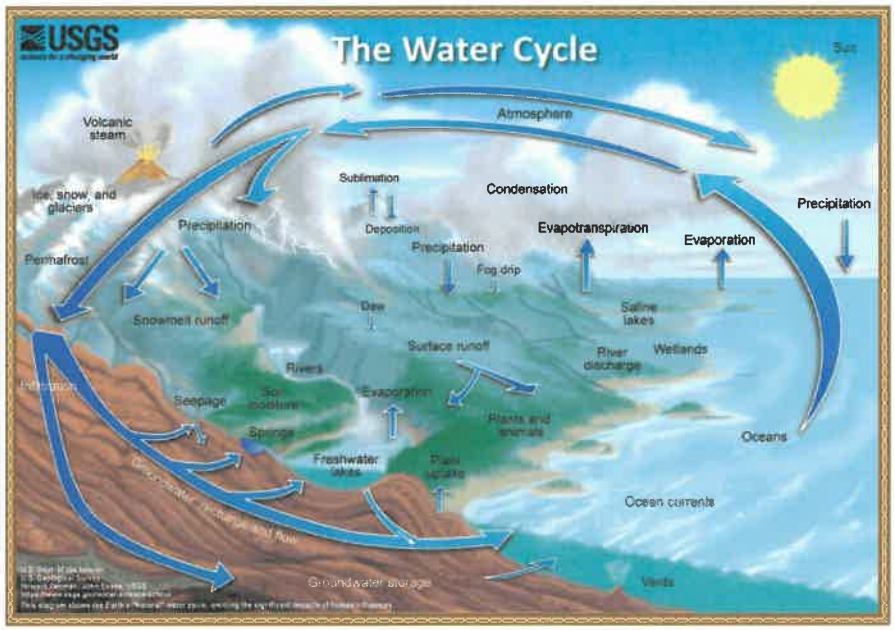
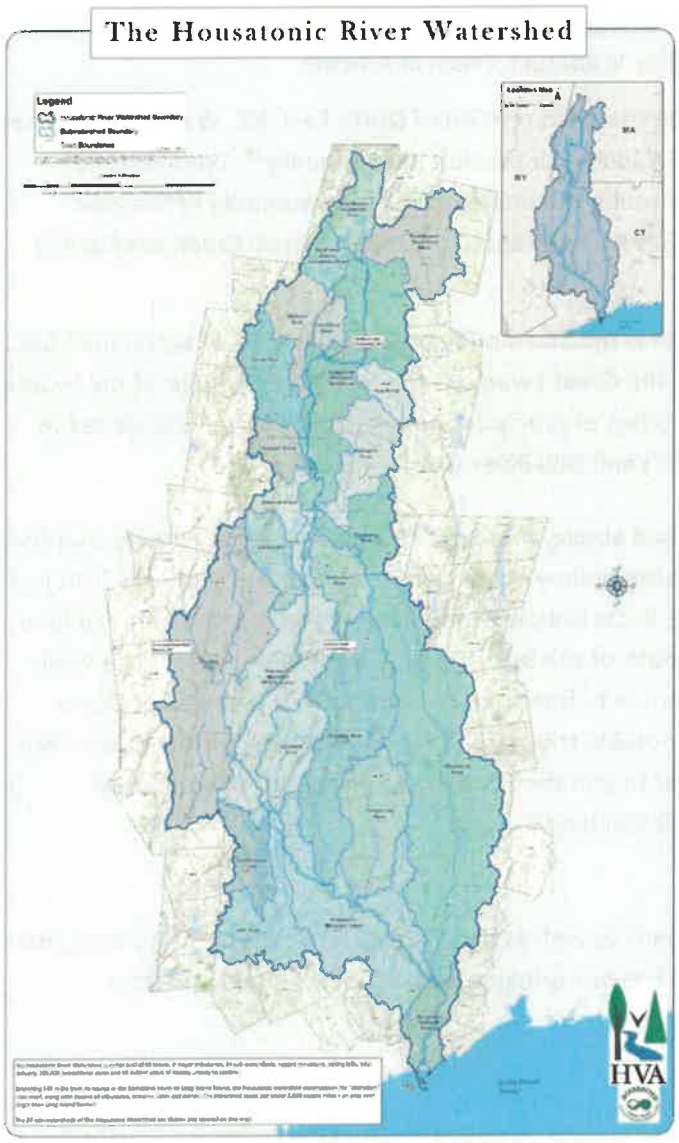


Figure 1. United States Geological Survey's diagram of the hydrologic cycle.

All bodies of water have a finite amount of land that drains to them, as determined by topography. These topographic and hydrologic systems are known as watersheds (also known as drainage basins and catchments). Watersheds are a fundamental spatial unit of landscapes[11], and each watershed contains subwatersheds within it. The delineation of watershed boundaries defines the separation of surface flow and accumulation.

3.2.2 The TMR Watershed

The Long Island Sound (LIS) watershed encompasses nearly the entire state of Connecticut; parts of Massachusetts, New Hampshire, Rhode Island, Vermont, and a small portion of Canada; as well as portions of New York City, and Columbia, Dutchess, Westchester, Nassau, and Suffolk Counties in New York State (NYS)[12]. This vast drainage basin covers a total of 17,814 mi^2.[13] The Sound is an estuary that stretches over an area of approximately 1,320 mi^2, features 600 miles of coastline, and includes more than 60 bays with beaches and harbors. It also lies in one of the most densely populated regions in the nation—with over eight million people calling the watershed home. [14] Diligent conservation efforts are necessary in mitigating the impacts of the concentrated human populations surrounding the Sound and in its watershed. Save the Sound – an organization advocating for the protection of the Sound – periodically issues a "report card" that characterizes the health of the Sound, based in large part on nutrient loading and associated dissolved oxygen levels. The report card divides the Sound into five regions: Eastern Narrows, Eastern Basin, Central Basin, Western Basin, and Western Narrows. Of these five regions, the Housatonic River primarily drains into the Central Basin[15]. The Housatonic River watershed is the second-largest source of freshwater to the Sound, second only to the Connecticut River watershed.



Map 2. The Housatonic River watershed.

The Housatonic River watershed covers 1,948 mi^2— draining lands from north of Pittsfield, Massachusetts, in the Berkshires-south to the LIS. The drainage basin covers the western third of Connecticut and extends into New York where it shares the watershed divide with the Hudson River (falling into Columbia and Dutchess Counties). Within the watershed, there are 83 towns with deep and unique histories. The river's mainstem has 8 major tributaries, and the watershed can be divided into 24 distinct subwatersheds. Of these subwatersheds, the Ten Mile River watershed is one of the most significant contributors of flow.

The Ten Mile River (TMR) watershed has a drainage area (DA) of 206 mi^2 and it encompasses portions of 15 municipalities between Connecticut and New York. The TMR mainstem has 3 major tributaries (Webatuck Creek, Wassaic Creek, and the Swamp River North Flow), but the entire watershed can be

broken up into 10 major subwatersheds (Map 1). The watershed receives an average of 46.16 inches of precipitation every year. Approximately 1.42% of the land cover within the watershed is impervious surface[16].

The headwaters of Webatuck Creek are in the Taconic State Park region, near the Massachusetts/New York/Connecticut state lines. Webatuck Creek's watershed covers a total of 83.6 mi^2 and receives an average of 44.1 inches of precipitation every year[17]. Major tributaries to the Webatuck are Indian Lake Creek (DA = 18.9 mi^2) and Mill Brook (DA = 11.9 mi^2) – both of which flow through Sharon, CT. Indian Lake Creek flows out of Indian Lake on the CT/NY state line and moves south through Sharon, before crossing back into NY and joining the Webatuck. Mill Brook originates in Sharon, flows through Hatch Pond, and eventually crosses into NY where it joins Webatuck Creek in Amenia.

The Wassaic Creek headwaters are located in the southern portion of North East, NY. Wassaic Creek has a DA of 36.1 mi^2 and it receives an average of 41.7 inches of precipitation annually[18]. Wassaic Creek flows southeast from the headwaters, passing through the unincorporated community of Wassaic before reaching its confluence with Webatuck Creek. The Webatuck Creek/Wassaic Creek confluence marks the beginning of the TMR mainstem.

The last of the three major tributaries to the TMR is the Swamp River. The Swamp River watershed has a drainage area of 49.4 mi^2. Northward flow from the Great Swamp is the headwater source of the Swamp River. The watershed receives an average 42.9 inches of precipitation annually[19]. Major tributaries to the Swamp River are Burton Brook (DA = 8.11 mi^2) and Mill River (DA = 14.8 mi^2).

In addition to the three major tributaries described above, there are several smaller tributaries that feed directly to the TMR. Notable among these are Butts Hollow Brook, which is confluent with the TMR just south of the Webatuck/Wassaic confluence. The Butts Hollow Brook watershed covers 4.38 mi^2 of land on the western side of the TMR. Immediately south of the Butts Hollow Brook watershed is the Wells Brook subwatershed. 6.11 mi^2 drain into Wells Brook before it flows into the TMR just east of Dover Plains. Duell Hollow Brook is the southernmost notable tributary to the TMR— confluent with the TMR mainstem just before it crosses the NY/CT border to join the Housatonic. The Duell Hollow Brook watershed covers 6.25 mi^2 of mostly forested (89.9%) land[20].

3.2.3 Water Quality Protection

Clean water is essential to quality of life for humans as well as fish, wildlife and plants. For humans, the health of surface and groundwaters directly impacts our drinking water supplies, food and fiber production and recreation opportunities.

Drinking Water

Municipalities within the Ten Mile River watershed largely receive their drinking water from artesian and gravel aquifers. These water sources are pumped from surficial glacial deposits, stored, and disinfected before being delivered to homes and businesses. Due to the combination of the geologic nature of these aquifers and the residential land use (and related activities) in aquifer recharge areas, many of these water supplies have been rated as having elevated susceptibility to microbial, inorganic, organic chemical, and radioactive contamination through the NYS Department of Health's source water assessments[21]. It should also be noted that aquifers provide a finite supply of water. Recharging of these

supplies is dependent on annual precipitation, as well as the water's ability to infiltrate the earth's surface.

Table 1. Drinking water supplies for major TMR watershed municipalities.

Municipality	Water Supply Description
Sharon	The majority of the Town of Sharon's "raw" water is collected in the Calkinstown Reservoir from the diversion of a small-unnamed tributary to Beardsley Pond Brook. During dry periods, water is pumped from the Beardsley Reservoir to augment this source. Both of these sources are considered "surface water" and must go through a filtration and treatment process in order to meet the safe drinking water requirements. Water from the reservoirs is piped into the Dr. Malcolm Brown Water Filtration Plant where we use multiple processes to treat the water. The first stage of treatment is the addition of a coagulating chemical to help make the size of particles in the water larger, so they can be removed in the two stage filters. Filtration is necessary to reduce turbidity, and to remove and inactivate microorganisms. After filtration, sodium hypochlorite (chlorine) is added to the finished water to assure that remaining microorganisms are destroyed, and to also provide a protective barrier to formation of bacteria in the pipes that serve the town.
Salisbury	The Town of Salisbury is provided water by the Aquarion Water Company. The water is collected in reservoirs and wells, treated, and delivered through an extensive underground piping system. This Lakeville/Salisbury System supply, which serves approximately 1,880 people, is a mixture of surface water drawn from two reservoirs (Lakeville reservoirs #2 and #3) and ground water from two well fields (the Lakeville and Salisbury wells). The reservoirs supply approximately 36% of the 310,000 gallons of water per day that customers use on average. An average of 19.3% of the demand is water drawn for firefighting, water main cleaning, water main breaks and leaks, and unauthorized use. The reservoir water is filtered at the Lakeville treatment facility, and water from the wells is filtered naturally underground. All the water is disinfected and further treated to protect the distribution system. The Salisbury wells also receive aeration treatment to remove tetrachloroethylene and radon.
North East/ Millerton	The Village supplies approximately 125,000-130,000 gallons of drinking water daily to a total of 478 water accounts which includes 110 located within the Town. At one point, the Village consistently peaked at nearly 400,000 gallons due to leaks. According to the Water Operator, the Village could comfortably distribute 150,000-200,000 gallons of water daily without impacting the Village's ample water supply or straining operating systems. The Village has two wells and a 250,000-gallon water tank. There are no issues with the quality of the water which is treated and tested regularly. The Village and Town have a 40-year water supply contract, which will expire in December 2035.
Amenia	The Town of Amenia's water supply is drawn from five wells located throughout the water district. At each of the well locations the water is treated with chlorine for disinfection purposes, it is then pumped directly into the distribution system. The unused water is stored in a 200,000 gallon storage tank located at Washington Court treatment facility. The system serves 1006 people through 305 service connections. In 2011, the total water produced was 34 million gallons with an average monthly use of 2.5 million gallons. The daily average of water treated and pumped into the distribution system was 99,000 gallons a day.

Dover	A variety of shallow and deep groundwater wells supply most of the water for residents, farms, businesses, and industry in Dover. The public water supply serving the Dover Plains hamlet is from two shallow wells tapping the valley bottom aquifer in the NYS Route 22 corridor. In 2018 (the most recent data available) the Dover Plains system served fewer than 1000 people through 225 service connections. The same aquifer is tapped for the public water supply serving the Schreiber Water District in Wingdale, which served 70 residents in 2018. Other centralized water systems (serving 25 or more people) include those of the Country Mill and Woodwinds developments in Wingdale, the High Meadows Mobile Home Cooperative on Holsapple Road, and the Olivet University campus at the former Harlem Valley Psychiatric Center in Wingdale. In 1999 the town established Aquifer Overlay Districts to protect groundwater supplies for public and private wells.
Pawling	Pawling's water supply system serves 243 people through 58 service connections. The water source is two drilled bedrock wells. One well is located on Mountainview Drive and the other well is located in the recreation area by Willow Lake. In 2013, both wells were rehabilitated. The water obtained from the wells is disinfected with sodium hypochlorite and treated to reduce iron, manganese, and radon prior to distribution.

Clean Water Act and Water Quality Standards

The Clean Water Act (CWA) is a federal law established in 1972 that regulates the discharge of pollutants into surface waters and the water quality of surface waters in the United States. The CWA made point source (or end-of-pipe) pollution discharges into navigable waters without a permit illegal through the National Pollutant Discharge Elimination System, or NPDES[22]. It also required states and tribes to adopt and revise Water Quality Standards (WQS), regularly assess waters in their jurisdiction to understand where WQS aren't being met, and take action to ensure waters not meeting WQS are restored.

Connecticut and New York's WQS represent the foundation of waterbody management across the states, including pollution discharge permits and the development of Total Maximum Daily Loads (further described below). State WQS required by federal law under section 303(c) of the CWA indicate designated uses (e.g. drinking, swimming, fishing) and water quality classifications (use goals) for surface water, groundwater, and coastal/marine surface waters. A review of the State WQS is conducted every three years by governing state agencies. Under CWA Section 305(b) the State of New York Department of Environmental Conservation (NYS DEC) and State of Connecticut Department of Energy and Environmental Protection (CT DEEP) are required to monitor, assess and report on water quality to the U.S. Environmental Protection Agency (U.S. EPA) with regard to meeting designated uses for each waterbody, as per state WQS and Classifications. These Water Quality Reports provide information on assessed waterbodies within New York and Connecticut, including those within the TMR watershed. Those waters that do not meet the State's WQS are listed as "Impaired" for designated uses (recreation, aquatic life, drinking water supply) depending on the nature of the pollution and the results of field assessments.

In the TMR watershed, Rudd Pond in North East, NY and Mill Brook in the Town of Sharon, CT are listed as Impaired. A segment of the Swamp River is listed as Stressed (an action stage before listing as Impaired used by NYS DEC) based on assessment of a battery of water quality parameters.

Water Quality Classifications and Uses

NYSDEC and CTDEEP use a similar water quality classification system for inland (fresh) surface waters. This system classifies inland surface waters on letter based system (Class AA, Class A, Class B, etc.). Each class indicates the water's designated use or best use and therefore its WQS. CT limits discharges from industrial and municipal wastewater treatment facilities to waters with a specific classification. Table 2 and 3 below outline each states' classification and designation.

Table 2. CTDEEP Inland Fresh Water Classifications[23]

Class	Designated Use	Discharges allowed
AA	Existing or proposed drinking water supply; fish and wildlife habitat; recreational use (may be restricted); agricultural and industry supply	Discharges from public or private drinking water treatment systems, dredging and dewatering, emergency and clean water discharges
A	Potential drinking water supply; fish and wildlife habitat; recreational use; agricultural and industrial supply and other legitimate uses including navigation	Same as AA
B	Recreational use; fish and wildlife habitat; agricultural and industrial supply and other legitimate uses including navigation	Same as A as well as discharges from industrial and municipal wastewater treatment facilities that practice best available treatment methods and best management practices. Other discharges allowed with a National Pollutant Discharge Elimination System (NPDES) permit (Connecticut General Statute Section 22a-430).

Table 2: NYSDEC Fresh Surface Water Classifications[24]

Class	Best Use
AA	Drinking (after treatment for naturally present impurities); culinary or food processing; primary and secondary contact recreation; and fishing. Waters are suitable for fish, shellfish, and wildlife propagation and survival.
A	Drinking (after disinfection and approved treatment, culinary or food processing; primary and secondary contact recreation; and fishing. Waters are suitable for fish, shellfish, and wildlife propagation and survival.
B	Primary and secondary contact and fishing. Waters are suitable for fish, shellfish, and wildlife propagation and survival.
C	Fishing and restricted designated recreation. Waters are suitable for fish, shellfish, and wildlife propagation and survival.
D	Fishing with restrictions. Waters are suitable for fish, shellfish, and wildlife survival but not propagation.

NYSDEC classifications can be modified by adding the standard of (T) or (TS) to any of the classes listed in Table 2—these modifiers indicate that the waters may support trout populations or trout spawning areas, respectively. Many of the stream miles within the NY portion TMR watershed have been designated the standard of (T), which means that a Protection of Waters Permit is required for any work that could potentially impact these important fisheries. DEC's Environmental Resource Mapper[25] can be used to identify these protected streams.

Water Quality Monitoring

CWA Section 305(b) requires each state to monitor the quality of surface waters in order to determine which are not meeting WQS. New York fulfills the CWA Section 305(b) water quality monitoring requirement through its Rotating Integrated Basin Studies (RIBS) program. Through RIBS monitoring NYSDEC is able to document high quality waters and identify water quality problems, understand long-term water quality trends, characterize naturally occurring or background conditions, and establish baseline conditions[26]. New York has 17 basins that RIBS monitors on a rotating basis every five years. The Ten Mile River basin (as a subwatershed of the Housatonic River) was monitored by RIBS in 2017 and will be monitored again in 2022.

The RIBS program accomplishes its goals in three ways. The Routine Trend Monitoring Network sets baseline conditions by monitoring water quality at fixed sites across the state every year[27]. The Screening Network measures biological health, acute toxicity, physical habitat and water chemistry at a large number of sites and identifies areas where follow-up screening is needed in subsequent years[28]. Finally, RIBS Special Surveys evaluate water quality to answer or provide more data on a specific habitat or water quality question[29]. Data collected through the RIBS program are used to determine which streams, rivers, lakes, and ponds end up on the CWA Section 303(d) List of Impaired Waters (see "Impairments and TMDL" section below) and help determine priority waterbodies for restoration throughout the state. Data from NYS assessments are also used to create the Waterbody Inventory/Priority Waterbodies List. This inventory allows the NYSDEC to track support (or Impairment) of designated uses, conduct an overall assessment of water quality, causes and sources of water quality impact/Impairment, and the status of restoration, protection and other water quality management activities. This information helps to identify where management will have the greatest impact and evaluate needs for funding.[30]

In addition to the RIBS program, New York collects additional monitoring data through the Water Assessments by Volunteer Evaluators (WAVE) and Professional External Evaluations of Rivers and Streams (PEERS) programs. The WAVE program is citizen-based and provides a framework for trained volunteers to collect benthic macroinvertebrate samples from wadeable streams. Samples are identified and interpreted by a WAVE coordinator, and results are ultimately used to classify stream segments into one of the following categories: no known impact, possibly impaired, or no conclusion. In addition to collecting macroinvertebrate samples, WAVE participants also complete user perception forms (data on recreational use potential of the stream) and habitat assessment forms (data on habitat conditions). HVA staff participated in the WAVE program in 2014, 2015, and 2016 at 16 sample sites in the Ten Mile River Watershed. WAVE results are used to inform further assessments under the RIBS program.

The PEERS program outfits environmental professional organizations such as watershed associations, consulting firms, other government agencies and tribes with equipment, resources, and training to support collection of professional-grade chemical and biological water quality data. To become PEERS certified, partner organizations must write a Quality Assurance Project Plan (QAPP) in collaboration with a PEERS coordinator and demonstrate competency in sample collection and data management protocols. The PEERS program's stringent certification and training requirements yield high-quality data that can be used in state and federal water quality reports. These data can expand on data collected through RIBS in order to inform local water resource management. Through the PEERS program, the

Housatonic Valley Association collected water quality data in the TMR watershed in the summer of 2018.

Similar to New York, CT-DEEP administers a number of water quality monitoring programs. The River and Stream Water Quality Monitoring and Lake and Pond Water Quality Monitoring programs conducted by CT-DEEP staff help Connecticut evaluate the impact of pollution and effectiveness of pollution control programs, track water quality trends, explore water quality problems, investigate citizen complaints, and provide data for the biannual Integrated Water Quality Report to EPA[31].
CT DEEP's citizen science programs provide training, equipment and quality control to environmental groups, nonprofits, land trusts and other volunteers monitoring water quality. The Riffle Bioassessments by Volunteers (RBV) program supports volunteer collection of benthic macroinvertebrate samples, which are used primarily to identify healthy sites along smaller streams. The Volunteer Stream Temperature Monitoring Network (V-STeM) works with local volunteers to deploy in-situ temperature loggers between May and October each year. The data collected by RBV and VSTeM Network volunteers are used to inform CT DEEP water quality assessments, help develop state water temperature standards, identify cold water habitat, and determine the impact of nonpoint source pollution mitigation projects[32].
V-STeM data is also uploaded to the Spatial Hydro-Ecological Decision System (SHEDS) Stream Temperature Database administered by the US Geological Survey, which uses the data to refine cold-water habitat distribution predictive models[33]

HVA and other organizations such as Friends of the Great Swamp (FrOGS) and Trout Unlimited's Mid-Hudson Chapter have worked with these and other programs to collect water quality data in the TMR watershed. Details on this work and subwatershed-level results are described in subsequent sections.

Impairments and TMDLs
Waters that don't meet state water quality standards are listed as "Impaired" for aquatic life and/or other designated uses, such as recreation. Under CWA Section 303(d) states are required to report the list of Impaired waterbodies under their jurisdiction to the EPA and Congress every two years.
When a water body is listed as Impaired, states must identify the pollutant(s) responsible, their source, and the amount of pollutant(s) that must be removed from the system for the water body to achieve its use goals. CWA Section 303(d) mandates that Impaired waters be placed under a Total Maximum Daily Load (TMDL), which can be thought of as a "pollution diet" for a given water body. TMDLs use water quality data and watershed modeling to calculate how much pollution needs to be reduced for a waterbody to meet its use goals, and generally describe management measures that could lead to those reductions.

Water bodies included in CWA Section 303(d) water quality reporting for the Ten Mile River watershed include Rudd Pond in North East, NY; Mill Brook in Sharon, CT; and the Swamp River in Pawling, NY. At 70 acres, Rudd Pond is one of the largest open waterbodies in the TMR watershed. There is a popular campground associated with Taconic State Park along Rudd Pond's eastern shore. Due to phosphorous and sediment runoff from the campground and upstream farms, Rudd Pond was listed as Impaired in 1998. Since then, Dutchess County Soil and Water Conservation District (DCSWCD) has worked with farmers, municipal and county officials and Taconic State Park to reduce nutrient loading and soil erosion through implementing Best Management Practices for agricultural and recreational lands[34].

Rudd Pond was removed from the Section 303(d) Impaired waters list in 2010; however, it remains on a NYSDEC "watch list". Excessive algal and weed growth at Rudd Pond indicate the persistence of phosphorus inputs to the water column, potentially from the sediment and/or upstream agricultural activities[35].

In the 2008 RIBS report for the TMR watershed (the most recent report available), a segment of the Swamp River from its confluence with the TMR to Wingdale was listed as Stressed (an action stage before listing as Impaired used by NYS DEC), based on assessment of a battery of water quality parameters. Based on this listing, HVA and other partners conducted a season of water quality monitoring along this stretch of the Swamp River. This is described in more detail below.

On the Connecticut side, a 1.66-mile segment of Class-A Mill Brook is Impaired for recreation due to elevated bacteria levels according to CTDEEP's latest *2020 Integrated Water Quality Report.* The segment between the Hatch Pond dam outlet to the confluence with Beebe Brook has a TMDL for the indicator bacteria, *E. coli*—established in September 2012. E. coli data collected by HVA to support this watershed plan downstream of this segment indicate that the Impairment is likely more extensive than has been documented by CT-DEEP. According to the Mill Brook TMDL, potential bacteria sources include agricultural activities, wildlife and domestic animal waste, failing septic systems, and stormwater runoff[36]. Nearly one third of the Mill Brook watershed is agricultural (27% of land use) including a large agricultural area just upstream of the impaired segment. Farms in this area include several large hayfields, row crops, hobby farms, and two cattle farms[37]. Manure storage, possible livestock crossings, and fertilizer from these farms likely contribute to the impaired segment downstream. Additionally, there may be other sources not listed in the TMDL that also degrade water quality in Mill Brook. The land to the east of the impaired segment is largely forested.

Water Quality Parameters and Pollution Issues:

Nutrients

The two nutrients most commonly measured in water quality monitoring are nitrogen and phosphorus. At normal levels, these nutrients are essential for biological growth, but they can be detrimental to water quality when present in excess.

The most common forms of nitrogen in streams are ammonia (NH_3) and nitrate (NO_3). Ammonia concentration that exceeds 1.0 mg/L and nitrate levels above 0.10 mg/L indicate human impact such as from sewage pollution, fertilizers from residential and agricultural stormwater runoff, or atmospheric deposition of nitrogen from gas emissions. Excessive nitrogen can lead to algal blooms, depleting the dissolved oxygen and causing fish die-offs.

Phosphorus is commonly found as phosphate (PO_4). Plants take up phosphate from water and convert to organic phosphorous. Phosphate will have an impact on aquatic life at concentrations above 0.05 mg/L and as low as 0.01 mg/L[38]. Phosphate is often the limiting factor for aquatic plant growth, therefore even in small amounts it can cause harmful algal blooms, eutrophication, and deplete dissolved oxygen levels[39]. For this reason, the EPA recommends keeping phosphate levels below 0.1 mg/L in flowing streams and less than 0.05 mg/L in stagnate water such as lakes, ponds, and reservoirs[40]. Phosphate

sources include sewage waste, animal waste, fertilizer, detergents, disturbed land, anticaking agents (as in from road salt), and stormwater runoff[41].

Dissolved Oxygen

Dissolved oxygen (DO) is the amount of oxygen dissolved in water and available to aquatic organisms. When dissolved oxygen is too low (below 3 mg/L) aquatic organisms cannot survive- thus it's an important measurement of water quality. DO comes primarily from atmospheric exchange or as a byproduct from aquatic plant photosynthesis[42]. The depletion of oxygen in surface waters can be caused by increases in organic matter, decay from sewage, or excess algal growth. Decreased DO can contribute to fish kills and the death of other aquatic organisms. In many surface waters, insufficient oxygen concentrations are a result of other impairments such as pollution and warming waters due to insufficient buffer zones upstream of the affected site. Therefore, watershed scale management is often required for mitigation.[43]

pH

The pH of water is the measure of acidity and is measured on a scale ranging from 0 (highly acidic) to 14 (highly alkaline). Aquatic life thrives in healthy freshwater systems with a pH between 6.5 and 8.0. Environments outside this range can stress or kill aquatic life and can be a sign of industrial waste[44]. The average pH of rainfall in New York is between 4.0 – 4.5 (acidic).[45] This is buffered by the calcium carbonate bedrock of Dutchess County which tends to cause ground and surface water in the area to be more alkaline.[46]

Turbidity

Turbidity measures the clarity of a water sample or how much material (sediment, algae, pollution, microbes etc.) is suspended in the sample. It is measured by the amount of sunlight that passes through a sample of water, in Nephelometric Turbidity Units (NTUs)[47]. The higher the NTUs, the less light passes through the water. Turbidity can be caused by soil erosion from eroding banks, agriculture or construction, stormwater runoff, and sometimes failing septic systems. Each of these turbidity sources involves solids (e.g., pet droppings, leaves and grass clippings, litter, sand) being transported through the water system. High turbidity blocks or absorbs sunlight, reducing the ability for plants to photosynthesis and grow, thus harming the food source for fish and other aquatic life. Moreover, suspended solids can clog fish fills, smother fish eggs, and suffocate the organisms that fish eat.

Chloride

Chloride is found in salts such as sodium chloride (NaCl), calcium chloride, or magnesium chloride. Sources of chloride include geologic formations, agricultural runoff, industrial wastewater, effluent from wastewater treatment plants, and winter road salting[48]. According to a recent study of Wappinger Creek in Millbrook, NY 90% of surface water salinity in the Dutchess County area comes from road salt[49]. Road salt was first used in New Hampshire in 1938 and quickly became a popular solution to deicing winter roads. As of 2010 it was estimated that Dutchess County New York used approximately 14 tons of road salt per lane mile[50]. The most common form of road salt is sodium chloride (NaCl), which easily dissolves with snowmelt, and ends up in nearby road ditches, culverts, and streams[51] as well as groundwater through the infiltration[52].

The impact of salt on surface water is detrimental to stream ecosystems as it can lead to acidification and increased mobilization of metals in streams. The United States Environmental Protection Agency (EPA), states that stream ecology is impacted when the four-day average concentration of chloride exceeds 230 mg/L or a one-hour average concentration exceeds 860 mg/L, more than once every three years[53].

Chloride can alter the composition of riparian and wetland plant communities, giving a competitive advantage to more salt tolerant invasive species. It can interfere with the natural mixing of lakes and alter or inhibit the microbial communities which remove nitrate and water quality[54]. Chloride in groundwater can interrupt healthy reproduction of plants and increase mortality by interrupting the ion exchange in plant root systems[55]. These impacts reach far beyond the winter salinity spike that occurs at the time of application. Scientists have found concentrations of chloride in surface waters that are sometimes higher in the summer possibly due to a release from highly concentrated groundwater releasing salt throughout the year and into the summer[56]. Moreover, it's estimated that it can take decades for salt levels to stabilize or move through a freshwater river system[57].

Temperature

Stream temperature has a significant impact on aquatic ecology. High temperature generally increases solubility of solids and decreases solubility of gases. Among other dynamics, change in temperature affects movement of molecules, fluid dynamics and the metabolic rate of aquatic organisms[58]. Chemical water quality worsens with rising temperature, namely dissolved oxygen levels drop and algae blooms occur more frequently. Algae blooms reduce dissolve oxygen further, can clog fish gills, and produce toxins harmful to animals and humans[59]. Finally, warmer waters also make fish more vulnerable to parasites and diseases[60].

There are a number of factors that influence stream temperatures: watershed land use, groundwater recharge, stream profile (i.e. depth and complexity), riparian buffer canopy density, flow velocity which can be impacted by dams, culverts or other impoundments, and air temperature[61]. Stream temperature data throughout the northeast has been compiled into the Spatial Hydro-Ecological Decision System (SHEDS) Stream Temperature Database. This dataset presents the data collected by 81 organizations at 7,612 monitoring stations through the Interactive Catchment Explorer (ICE)[62] online application. According to ICE, current average stream temperature of Ten Mile watershed surface water is 18.2°C (64.8°F)[63]. With ambient air temperature rising due to climate change surface waters will rise also. Climate change models predict air temperatures to rise between 2.0°C (with low emissions scenario) to 4.8°C (with high emissions scenario) by 2100.[64] ICE model predicts that with an increased air temperature rise of 2°C stream temperature will rise by 1.4°C to an average of 19.6°C (67.3°F).

Cold water species such as native Eastern Brook Trout (*Salvelinus fontinalis*), require thermal refuges with colder water to survive during warm summer months. Brook Trout cannot survive in stream temperatures above 25°C and prefer temperatures less than 20°C[65]. If stream temperature rise to 19.4°C many Brook Trout and other cold water obligate populations will likely decrease as fish experience stress and are forced to adapt - finding colder water, move north, change the timing of migration and spawning, and/or altering predator-prey ranges and interaction[66].

Indicator Bacteria

Eschirichia coli (E. coli) is a bacteria found in the guts of all warm blooded animals. While not necessarily harmful on its own, it is an indicator bacteria- in other words, it shows the presence of other harmful pathogens in water. Elevated indicator bacteria can be from human-generated wastewater, livestock, or wildlife such as waterfowl. Areas of the watershed with higher density of agricultural land around streams, such as Swamp River, the Webatuck Creek, and Mill Brook in Connecticut are at higher risk for elevated levels of *E. coli* (see PEERS data by watershed below).

Benthic Macroinvertebrates

Biological monitoring programs in both New York and Connecticut were initiated in 1972 with the primary objective to evaluate the health of surface waters through the analysis of benthic macroinvertebrate communities[67]. Benthic macroinvertebrates (animals that can be observed with the naked eye that spend all or part of their lives living on the bottom) have varying sensitivities to water quality impacts. They also are generally unable to travel long distances in response to habitat changes and lack the ability to detect non-chemical impacts (e.g., siltation and thermal changes), so their ability to avoid pollution is limited [68]. The composition of the benthic macroinvertebrate community at a given site is a reflection of long-term trends in water quality. Sites with episodic or chronic water quality impacts will support fewer organisms that are sensitive to pollution, and more organisms that are tolerant of pollution. Because of this, benthic macroinvertebrate assessment provides a valuable indicator of the overall health of a site that may be difficult to capture with water chemistry sampling, especially when researchers may not have the opportunity to visit a site regularly. Individual water chemistry samples deliver a snapshot of conditions at the instant the sample was taken that might not reflect the range of impacts a site experiences over time.

Benthic macroinvertebrate community metrics are regionally calibrated to account for variations in aquatic systems. In NYS, metrics used for water quality assessments include:

- *Species Richness*: the total number of species or taxa found in a sample[69];
- *Ephemora, Plecoptera, Trichoptera (EPT) Richness*: shows the total number of species of mayflies (Ephemora), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in a subsample (these pollution-intolerant taxa are considered to be an indicator of clean water) [70];
- *Hilsenhoff's Biotic Index (HBI):* calculated by calculating the number of individuals of each species by its assigned tolerance value (represents the organism's ability to tolerate impacts)- which is a scale of 0 (intolerant) to 10 (tolerant). High HBI values indicate the presence of organic pollution[71];
- *Dominance*: looks at community balance. High values indicate unbalanced communities[72];
- *Non-Chironomidae and Oligochaeta (NCO) Richness*: shows the number of species outside of the Chironomidae and Oligochaeta groups, as these two pollution-tolerant taxa are most abundant in impacted communities (this value is used in sandy streams in place of EPT richness) [73];
- *Nutrient Biotic Index (NBI) for Phosphorus*: a value that diagnoses the measure of stream nutrient enrichment. The NBI was developed by studying the frequency of taxa at varying nutrient concentrations[74].
- Percent Model Affinity: compares the sample to a model non-impacted community[75].
- Species Diversity: combines species richness with community balance. Diverse and well-balanced communities are indicative of healthy systems[76].

The metric values are combined into a scaled ranking to develop a *Biological Assessment Profile (BAP)* score. The BAP score ranges from 0 (very poor water quality) to 10 (very good water quality), and can be used to assign water bodies to one of four categories: non-impacted (10-7.5), slightly impacted (7.5-5), moderately impacted (5-2.5), and severely impacted (2.5-0)[77].

Land Use in Ten Mile River Watershed and Relationship to Water Quality

"Land use" is the term used to describe the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and open space) that are practiced at a given place. When siting and design is not carefully considered, land use can have a significant impact on water quality. In watersheds with less human disturbance, the waterbodies they supply are generally healthy. In areas that are more developed, the health of the waterbodies they supply tends to decline in proportion to the extent and degree of development.

Land cover in the TMR watershed is outlined in Table 3 and displayed in Maps 3 and 4.

Table 4. Land cover in the TMR watershed.

Land Cover Type	Acres
Barren Land	438.64
Cultivated Crops	5820.38
Deciduous Forest	69240.63
Developed, High Intensity	199.84
Developed, Low Intensity	2389.44
Developed, Medium Intensity	992.11
Developed, Open Space	5313.27
Emergent Herbaceous Wetlands	1029.50
Evergreen Forest	2785.23
Hay/Pasture	23175.10
Herbaceuous	1911.55
Mixed Forest	6041.62
Open Water	1596.52
Shrub/Scrub	421.56
Woody Wetlands	10627.88

Nonpoint Source Pollution

While both point and nonpoint sources of pollution contribute to ongoing and potential Impairments in the TMR watershed, this plan is focused specifically on nonpoint sources of pollution (NPS pollution). Watershed planning of this nature is crucial to addressing NPS pollution. By its nature, NPS pollution is a diffuse issue with many contributing sources and responsible parties across the landscape. Consequently, collaboration and strategic approaches are essential. The CWA does not provide a detailed definition of NPS pollution. Rather, NPS pollution is defined by exclusion—any pollution source not considered a point source according to the CWA and EPA regulations is NPS pollution.

Runoff from precipitation (rain and melting snow) flowing over the landscape and washing pollutants directly into nearby waterbodies is a key source of NPS pollution. NPS pollution can also come from sanitary sewage disposal issues (e.g. failing septic systems or connections between sanitary sewers and storm sewers); stream instability (excessive erosion and deposition) caused by land use changes, channel modifications or large floods; and atmospheric deposition. Note that this list is not exhaustive. Examples of NPS pollution include but aren't limited to:

- Fertilizers, herbicides and insecticides from agricultural lands and residential areas
- Hydrocarbons (oil and gas), grease and heavy metals from urban runoff
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks

- Salt from road de-icing agents
- Bacteria and nutrients from livestock, pet wastes and faulty septic systems
- Mercury from upwind power generation

Congress chose not to address NPS pollution through a regulatory approach, unlike its actions with "point" sources. However, both CT and NY issue a Municipal Separate Storm Sewer System (MS4) General Permit that essentially regulates urban stormwater systems as point sources. Communities containing designated "Urbanized Areas" (as determined by the United States Census) discharging stormwater via a separate storm sewer system to surface waters of the state are required to follow the guidelines of the MS4 General Permit. There are no MS4 communities in the TMR watershed, although the Town/Village of Pawling are required to abide by the NYS MS4 General Permit in areas discharging to the South Flow of the Swamp River.

Impervious Cover

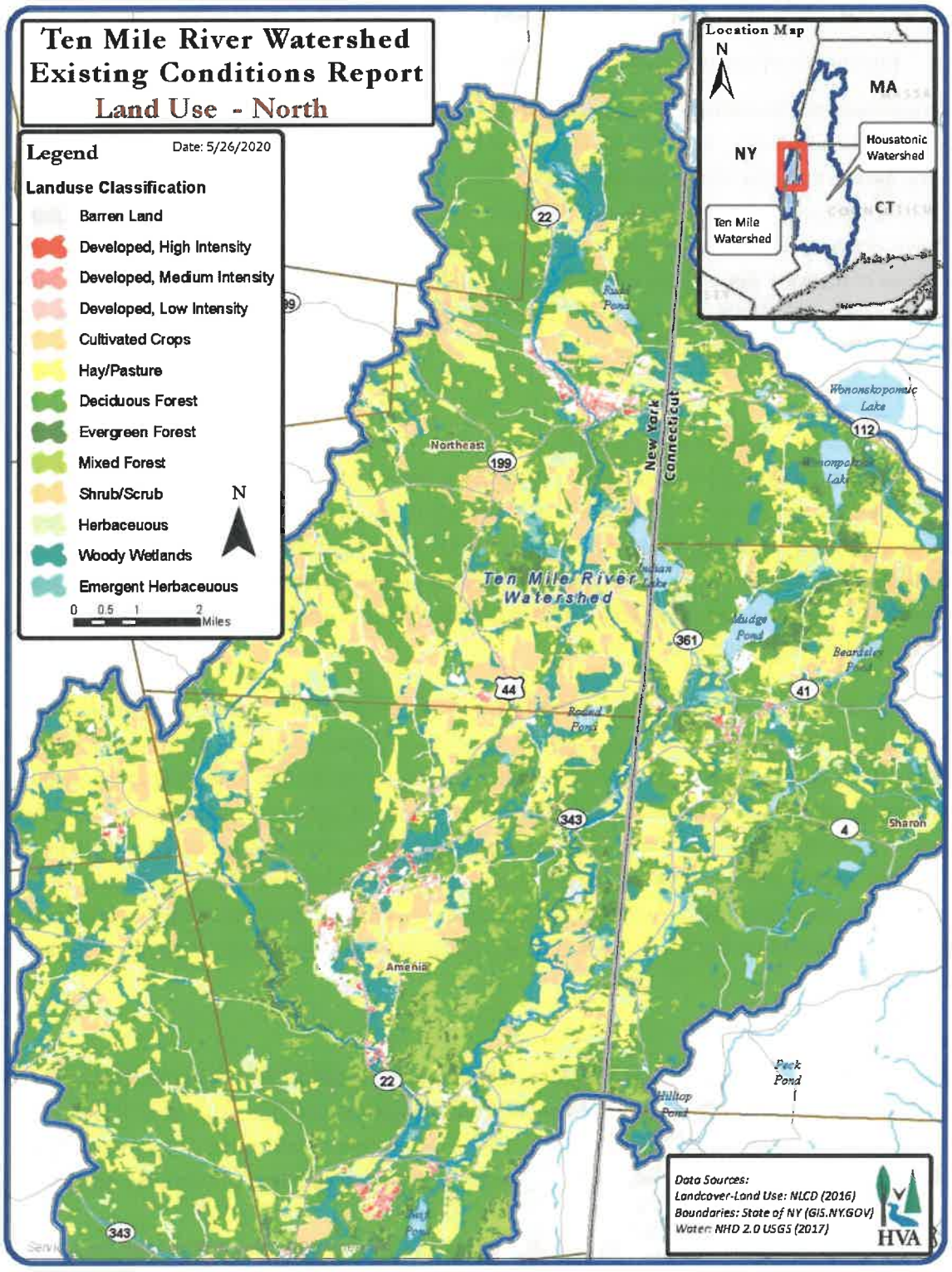
Parking lots, roads, roofs and other elements of developed landscapes that prevent rainwater from filtering through the soil are referred to as "Impervious Cover" (IC). While IC is not a constituent of water's chemical composition, the relationship between IC and stream health has been very well documented. Watersheds with greater than 11%-12% IC as a proportion of total land cover generally tend to experience water quality degradation significant enough to negatively impact aquatic life[78]. Extent of IC in a drainage area can be a useful proxy for other parameters when assessing water quality impacts and planning restoration activities.

Without careful planning and mitigation efforts, IC can contribute to NPS pollution by limiting the capacity of soils to filter runoff; increasing peak flows as water moves directly to stream channels, which can increase stream instability; decreasing summer base flows due to lack of aquifer recharge; and increasing the amount of pollutants (hydrocarbons, deicing salts, sediment, heavy metals etc.) migrating to water bodies. Impervious surfaces can raise the temperature of stormwater runoff, which in turn reduces the water's ability to hold dissolved oxygen and harms some game fish populations, while promoting excess algal growth. Field observation, research, and hydrologic modeling suggest a threshold of 10 percent impervious surface in a watershed, after which there is marked transition to degraded stream conditions

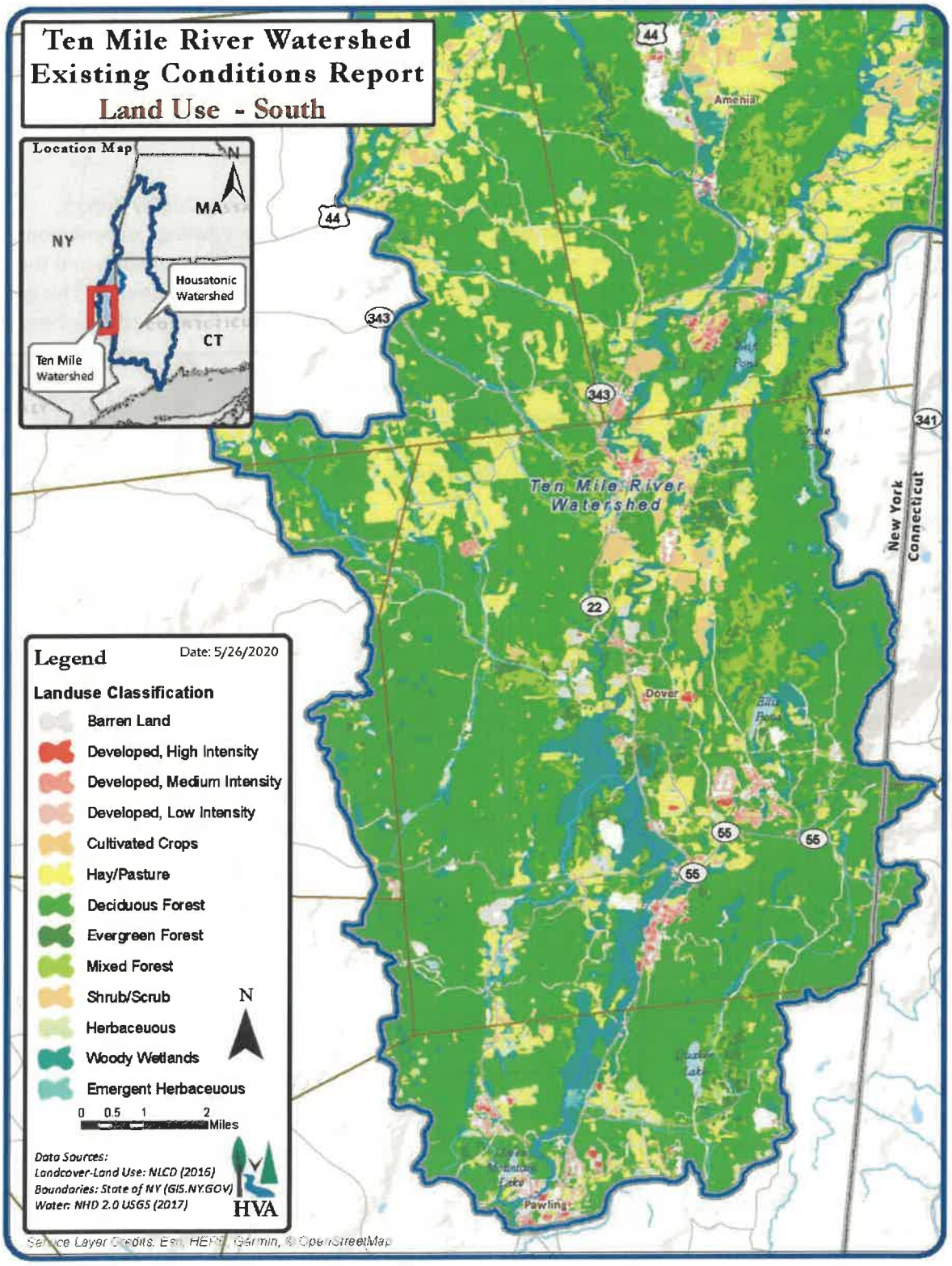
Agricultural Land Use

In the TMR watershed, agriculture is a significant land use. Approximately 22% of the total area of the watershed is in some kind of agricultural use (hay/pasture and cultivated crops, Table 3). While generally better for water quality than more intensive development, agricultural operations in a watershed can contribute to water quality degradation. Potential agricultural land uses can affect the quality of water and watersheds, including:

- The types of crops planted, tillage practices, and various irrigation practices can limit the amount of water available for other uses.
- Livestock grazing in riparian zones can change landscape conditions by reducing stream bank vegetation and increasing water temperatures, sedimentation, and nutrient levels.



Map 3. Land use in the northern half of the Ten Mile River watershed.



Map 4. Land use in the southern half of the Ten Mile River watershed.

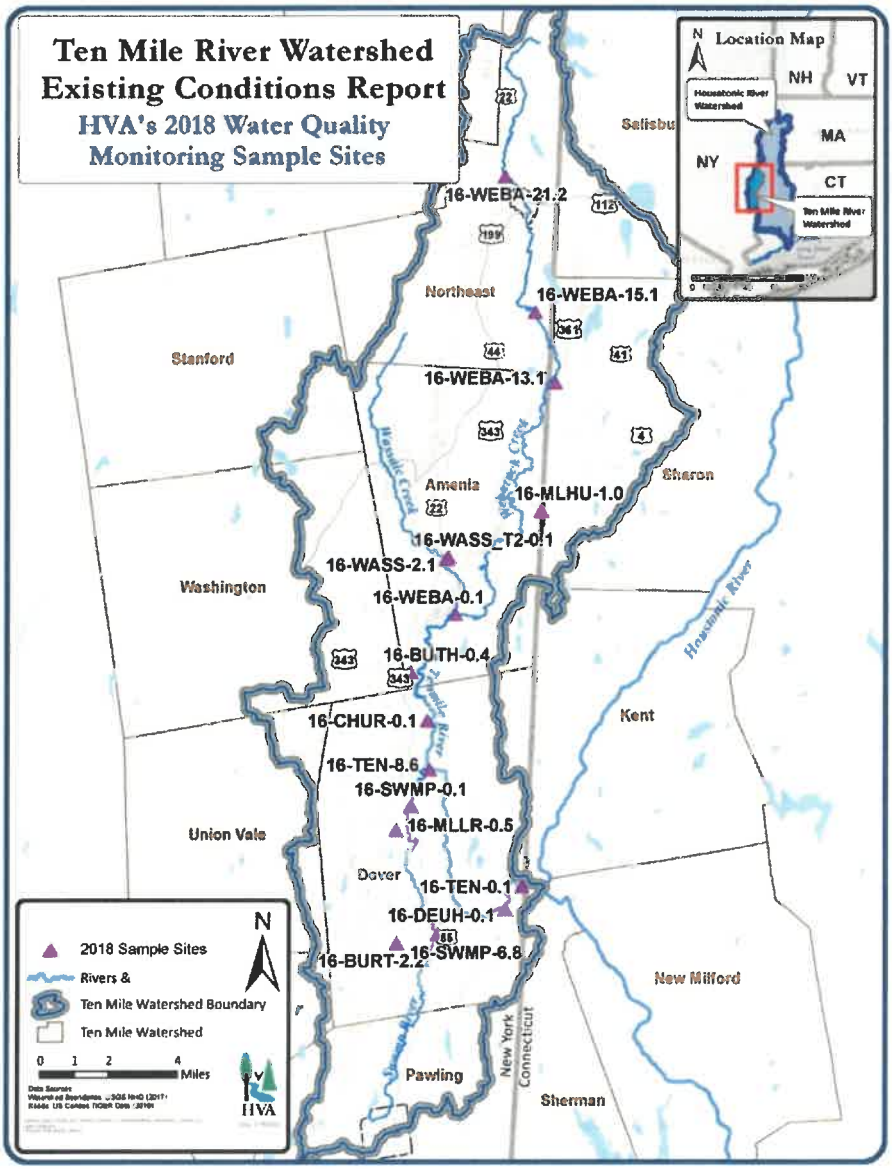
3.2.4 Water Quality Monitoring in the TMR Watershed

Over the past two decades, Ten Mile River Collaborative members have conducted biological, chemical and physical water quality monitoring across the TMR watershed. In 2003, HVA conducted chemical and physical assessments along Webatuck Creek and Wassaic Creek to document impacts and habitat conditions[79] [80]. The results of these assessments were compiled in a 2004 report titled, *"An Assessment of the Headwaters of the Ten Mile River"*.

In response to the Swamp River's listing as Threatened in NYS DEC's 2008 Water Quality Report, representatives from the Cary Institute of Ecosystem Studies, Marist College, Pawling Conservation Advisory Council, NYS DEC Region 3, Friends of the Great Swamp, Oblong Land Conservancy and the Housatonic Valley Association came together as the Swamp River Scientific Advisory Council. This group evaluated existing water quality information for the Swamp River and identified the need for a base-line assessment of water chemistry and indicator bacteria. Water quality monitoring was conducted in 2010 and results were compiled in the 2013 *"Swamp River Baseline Water Quality Assessment"*.[81]

HVA collected benthic macroinvertebrates under the NYS DEC WAVE program (detailed above) in 2014, 2015, and 2016. WAVE samples were collected at sites along Wells Brook, Webatuck Creek, the Ten Mile River, Baldwin Brook, Cascade Brook, and Flat Brook.

Each year a group of trained volunteers from Friends of the Great Swamp collects benthic macroinvertebrate and water chemistry samples from sites along the north flow of the Swamp River.[82]



Map 5. HVA Water Quality Monitoring Sites, 2018.

More recently, in 2018, HVA conducted water quality sampling at sixteen sample sites, distributed across the watershed. Data collection was done in collaboration with NYSDEC, as part of a pilot expansion of the PEERS program (detailed above) to include sampling of chemical parameters in addition to benthic macroinvertebrate sampling. The NYS DEC PEERS/WAVE Coordinator assisted HVA in developing a sampling plan that included meticulous QA/QC protocols (detailed in a

Quality Assurance Project Plan, or QAPP) and observed HVA staff in the field to confirm ability to adequately follow the protocols described in the QAPP.

HVA visited each site eight times between July 20 and September 25 of 2018 to collect chemical data (temperature, turbidity, dissolved oxygen, conductivity, and pH) and grab samples to be analyzed in a lab for the following constituents: total dissolved nitrogen, total dissolved phosphorus, nitrate, nitrite, ammonia, and *E. coli*. At the end of each sample day, lab samples were dropped off at both Smith Laboratory (a NYS certified lab in Hyde Park NY; to be tested for all constituents) and the Cary Institute for Ecosystem Studies (to be tested for nitrate and total dissolved phosphorus). Over the summer, HVA staff also collected one sample of the macroinvertebrate community from twelve of the sample sites (over 3 days: August 9, 15, and September 24), which were then sent to a certified lab for identification and interpretation. Biological samples were not collected at four of the sites due to abnormally high flows at the end of the sampling season.

3.2.4.1 Watershed Monitoring Results

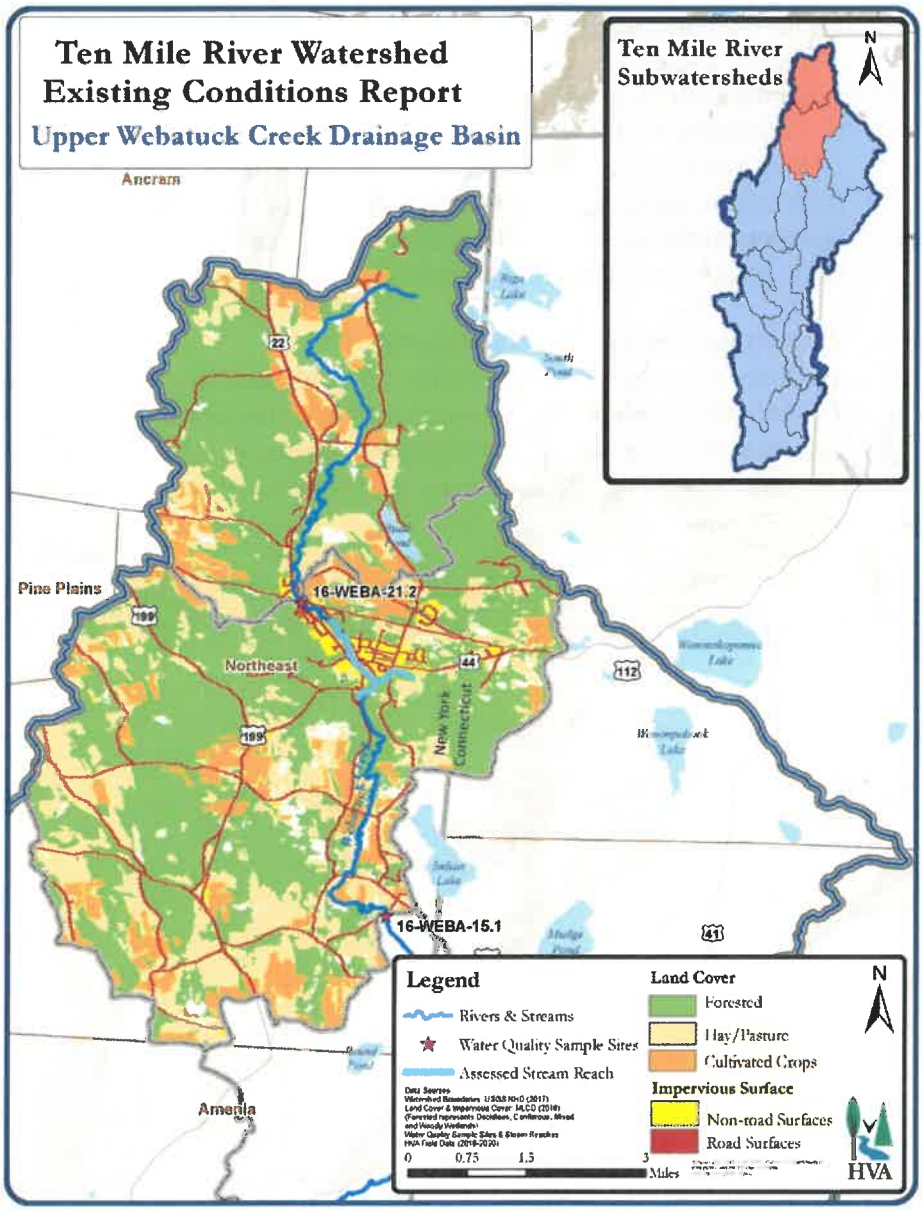
The following subsections report the results of water quality and biomonitoring studies conducted in the Ten Mile River watershed. The monitoring was conducted by both state agencies and non-profits. State agency monitoring programs are outlined previously in this chapter. On the non-profit side, both FrOGS and HVA have done extensive water quality monitoring in the TMR watershed. Results are presented by subwatershed.

Webatuck Creek Watershed

Chemical water quality sampling in the Webatuck Creek subwatershed has been conducted by NYSDEC, HVA, and CTDEEP. In 2018, HVA collected water quality samples at three Webatuck Creek sample sites, one Indian Lake Creek site, and one Mill Brook site.

Headwaters (above Millerton)

HVA data collection in the Webatuck headwaters (sample site 16-WEBA-21.2, just north of the Village of Millerton) indicate a healthy stream with no red flags. HVA macroinvertebrate sampling at this site resulted in a BAP score of 6.04, the fifth highest score of the twelve sites at which 2018 biological monitoring was conducted (Figure 7). The drainage basin of the Webatuck Creek headwaters sample site is largely forested (55%) and used for agricultural purposes (27%).[83]



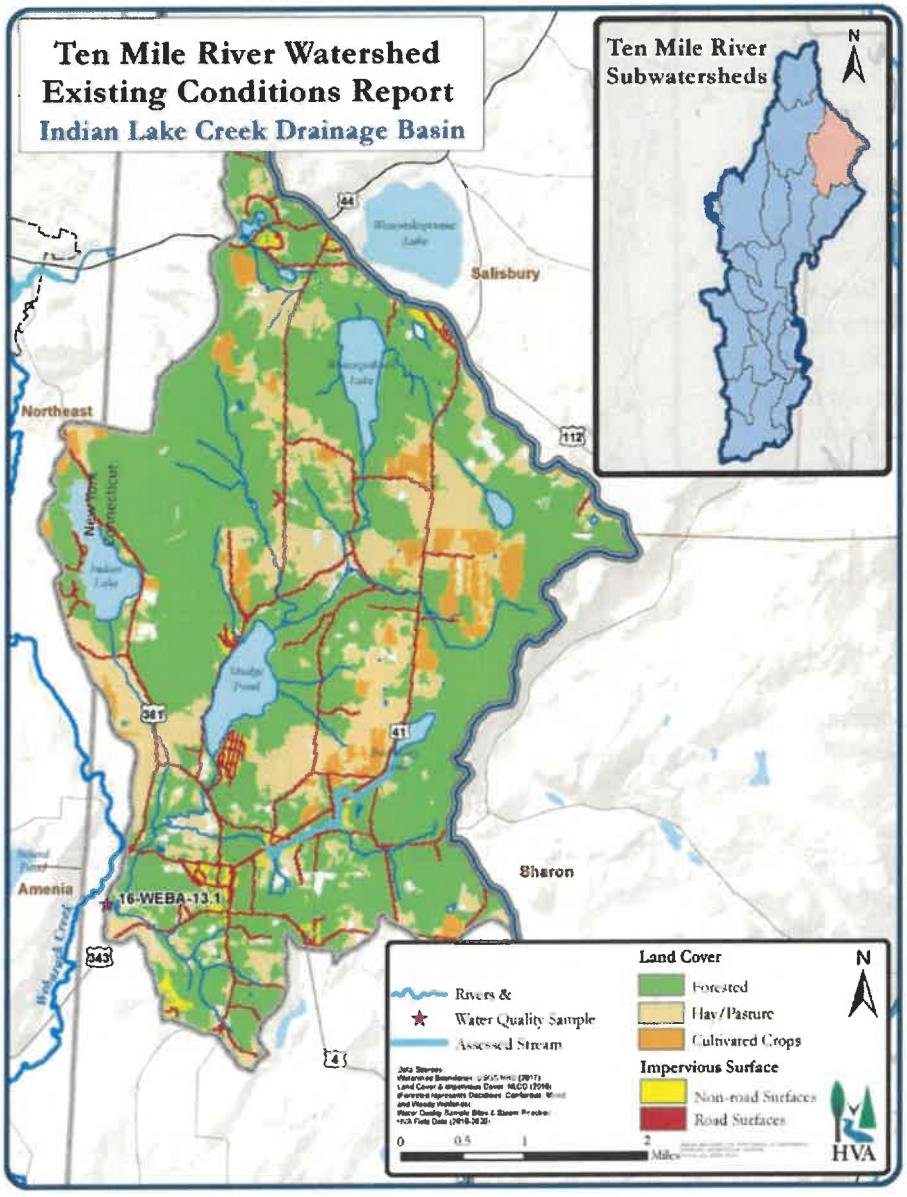
Map 6. HVA monitoring sites in the upper Webatuck Creek watershed.

Below Millerton

Further downstream, 2014 HVA WAVE data collection at a site just south of Millerton resulted in a "no conclusion" result. This result indicates that the sample did not contain at least six of the "most wanted organisms" or at least four of the "least wanted organisms". Downstream of that WAVE sample site, 2018 HVA sampling at sample site 16-WEBA-15.1 resulted in an overall slightly high nitrate average (from six sample dates), as compared to the entire watershed. Biological monitoring at this site resulted in a BAP score of 5.48 (Figure 7). This site also had a relatively high ammonia sample result as compared to other sites (Figure 6) on July 26, 2018 (0.73 mg/L). This particular sample site is adjacent to a large farm property; land use in this sample site's drainage basin is 35% agricultural and 46% forested.[84]

Indian Lake Creek

In 2018, HVA collected chemical data at an Indian Lake Creek sample site not too far above the confluence with the Webatuck (16-WEBA-13.1). This sample site's drainage basin is largely forested (47%) and agricultural (32%), and contains three larger water bodies: Indian Lake, Mudge Pond, and Wononpakook Lake. This site also had a relatively high ammonia sample result (as compared to other sites) on July 26, 2018 (0.73 mg/L). This site also had some of the highest total phosphorus (TP) sample results (overall average of 0.09 mg/L; second only to one of the Swamp River sample sites; (Figure 3). There was also a particularly high total nitrogen result at this site (7.9 mg/L on 7/26/18), again second only to the Swamp River site (Figure 4). For these reasons, HVA flagged this sample site as an area to continue evaluating.

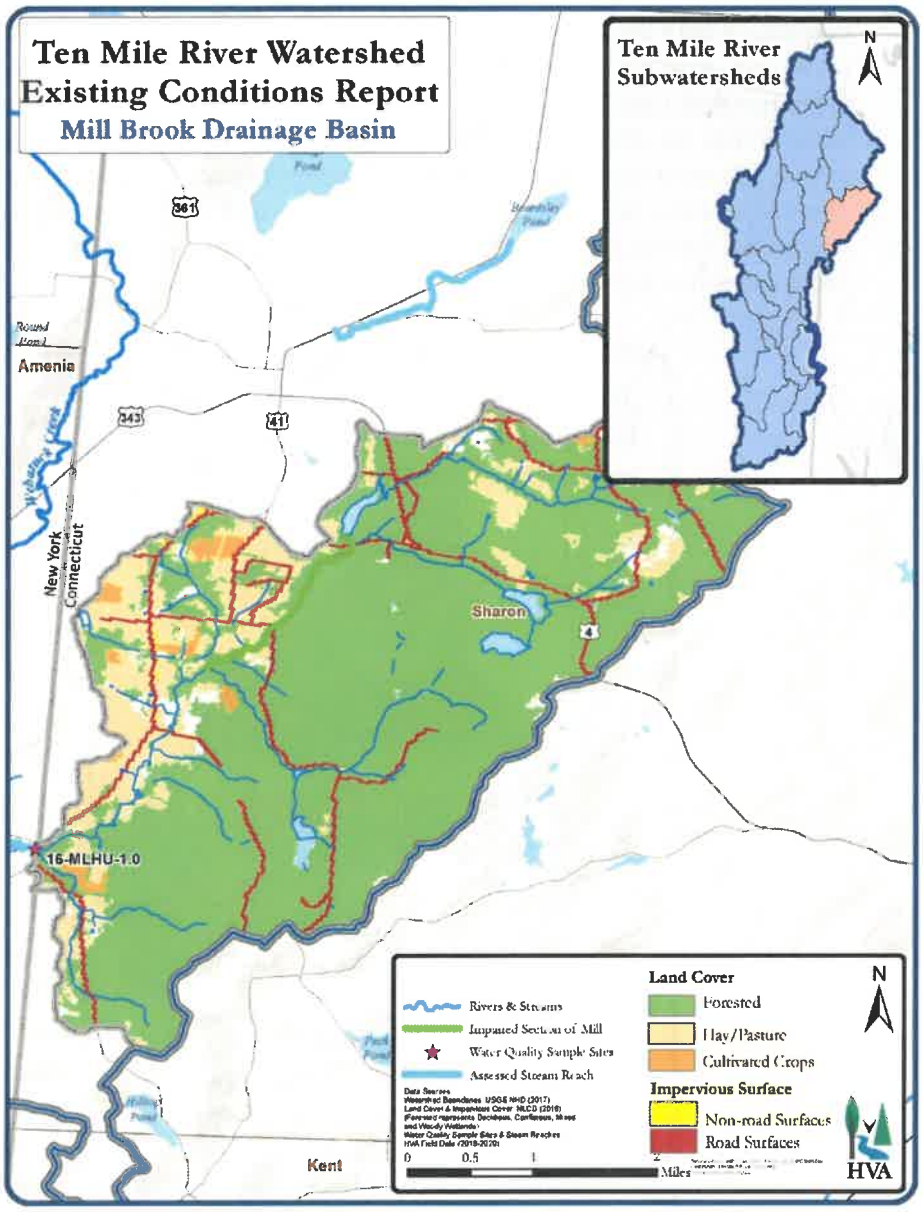


Map 7. HVA monitoring sites in the Indian Lake Creek Watershed.

Mill Brook

The Mill Brook drainage basin is mostly forested, however areas in floodplains adjacent to the mainstem are primarily agricultural.

A 1.66-mile section of Mill Brook (CT6302-00_02) is listed as Impaired for Recreational Use (non-designated swimming and other water contact related activities) due to elevated levels of the bacteria *E. coli* in the most recent (2020) State of Connecticut Integrated Water Quality Report to Congress. The segment of Mill Brook downstream of the listed reach (CT6302-00_01) has not yet been assessed. As mentioned previously, a TMDL was assigned to the Mill Brook watershed in 2012. The results from CT DEEP's sampling efforts which took place downstream of Mitchelltown Rd., at the confluence of the Hatch Pond outlet and Bog Meadow Brook are listed in Table 4.



Map 8. HVA monitoring sites in the Mill Brook watershed.

HVA's 2018 biological monitoring in this subwatershed resulted in a high BAP score (7.02), second only to Deuel Hollow Brook (Figure 7). Similarly, NYSDEC RIBS sampling at the same site in 2007 resulted in a final score of 6.96. Despite these encouraging metrics, the three HVA-collected samples that were tested for *E. coli* in 2018 resulted in the highest concentrations of all the HVA test sites (ranging from 1732 to 2420 MPN/100 ml).

The Northwest Conservation District, Natural Resources Conservation Service, Sharon Land Trust and HVA are developing strategies for producer outreach in the Mill Brook watershed, with the goal of developing farm-scale Conservation Plans that identify and develop Best Management Practices for pollution reduction.

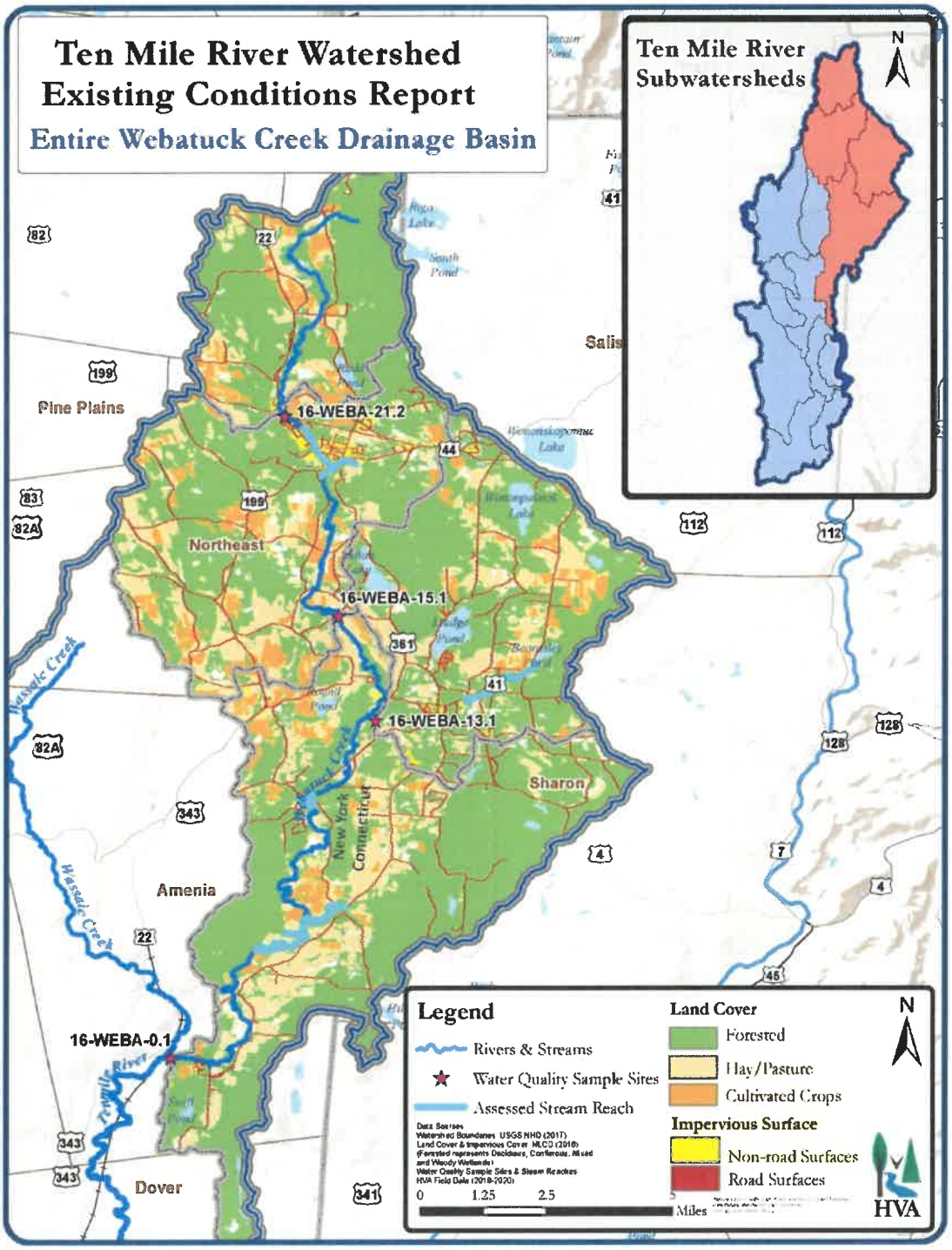
Table 4. Data from 2006-2009 CT DEEP sampling efforts, 2012 TMDL cycle.[85]

Date	Results	Wet/ Dry	Geomean	Date	Results	Wet/ Dry	Geomean
6/1/2006	390	dry	51	5/22/2008	63	wet	82
				6/5/2008	31	wet	
6/14/2006	26†	dry		6/9/2008	73	wet	
6/29/2006	410†	wet		6/19/2008	120	wet	
7/12/2006	52	dry		6/26/2008	52	dry	
7/26/2006	63	dry		7/8/2008	85	dry	
8/2/2006	41	dry		7/23/2008	120	wet	
8/9/2006	20	wet		8/4/2008	26†	wet	
8/14/2006	20	dry		8/14/2008	110	dry	
8/23/2006	10	dry		9/9/2008	530	wet	
6/6/2007	150	wet	94	6/11/2009	52	wet	98
6/12/2007	58†	dry		6/17/2009	63	wet	
6/27/2007	280	dry		7/2/2009	**1400* (71%)**	wet	
7/5/2007	110	wet		7/9/2009	58†	dry	
7/10/2007	85	dry		7/16/2009	52	dry	
7/17/2007	240	wet		7/23/2009	430	wet	
7/25/2007	20	wet		8/6/2009	63	dry	
8/2/2007	290†	dry		8/12/2009	69†	dry	
8/9/2007	41†	wet		8/19/2009	31†	dry	
8/30/2007	74	dry					
9/6/2007	20	dry					
9/13/2007	250†	wet					

Shaded cells indicate an exceedence of water quality criteria
†Average of two duplicate samples
***Indicates single sample and geometric mean values used to calculate the percent reduction**

Entire Webatuck Creek Drainage

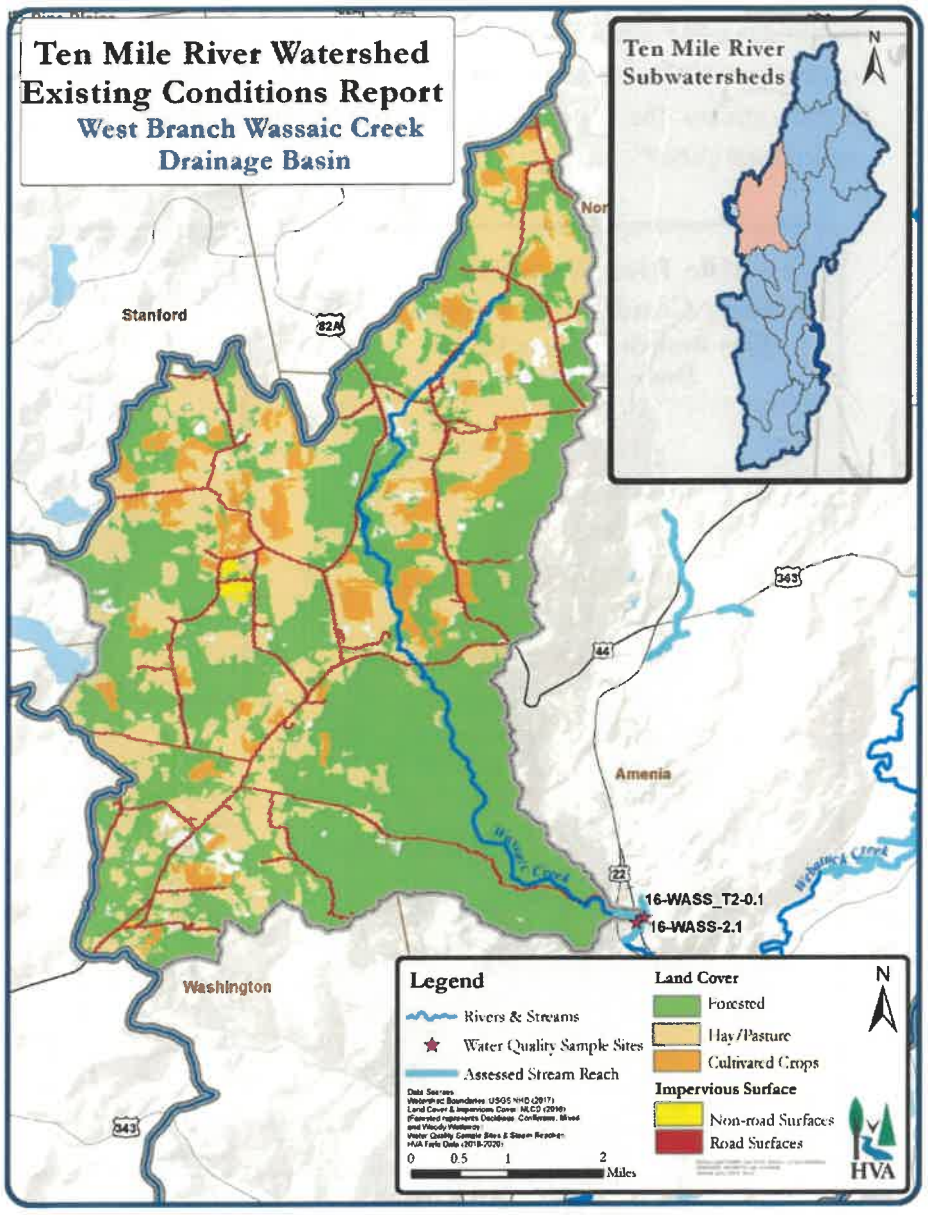
The southern-most HVA 2018 Webatuck Creek sample site is located at the bottom of the Webatuck Creek drainage basin (16-WEBA-0.1), just upstream of the confluence with the Ten Mile River. HVA's 2018 water quality monitoring results from this site reflected a healthy stream, and did not raise any red flags (Figures 2-6). Biological monitoring resulting in a BAP score of 5.64 (Figure 7). NYSDEC RIBS biological monitoring at this site in 2002 resulted in a final BAP score of 7.33.



Map 9. HVA monitoring sites throughout the entire Webatuck Creek watershed.

Wassaic Creek Watershed

WAVE sampling results from four sample sites along the Wassaic Creek and tributaries resulted in a classification of "No Known Impact" (2015 sampling), indicating a high-quality stream. The 2018 HVA sampling included two sites in the Hamlet of Wassaic: one meant to assess the west branch of Wassaic Creek (16-WASS-2.1) and one meant to assess the East Branch (16-WASS-T2-0.1). Sampling results indicated a relatively healthy stream, with no indication of urgent problems.



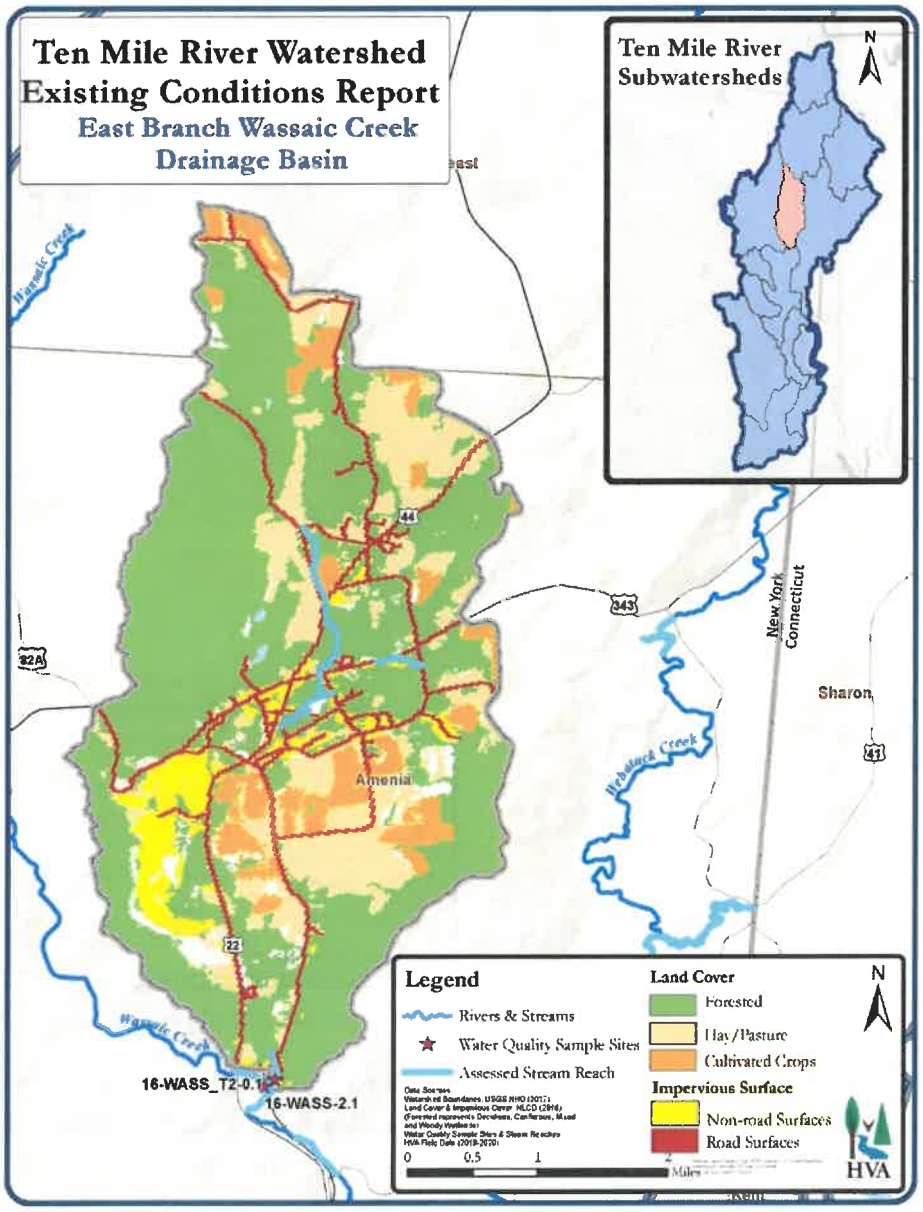
Map 10. HVA monitoring sites in the West Branch Wassaic Creek watershed.

West Branch

HVA water quality monitoring results from 2018 at sample site 16-WASS-2.1 generally indicated a healthy stream. The average nitrate value was slightly higher than averages from the other sample sites at 0.59 mg/L, and may warrant a closer look in future sampling (Figure 2). For comparison, the nitrate value from the 2008 chemical sampling at the NYSDEC site resulted in a value of 0.61 mg/L. At a RIBS biological monitoring site, just upstream from the Ten Mile River confluence (16-WASS-1.2; 100 meters above County Route 81), 2012 sampling results resulted in a final BAP score of 6.03, which was slightly lower than the 2008 final score at the same sight (6.98). Land use data for the drainage basin of the Wassaic Creek sample site indicates that land is largely used for agricultural purposes (45% in pasture/hay or cultivated crops) or is forested (40%)[86].

East Branch

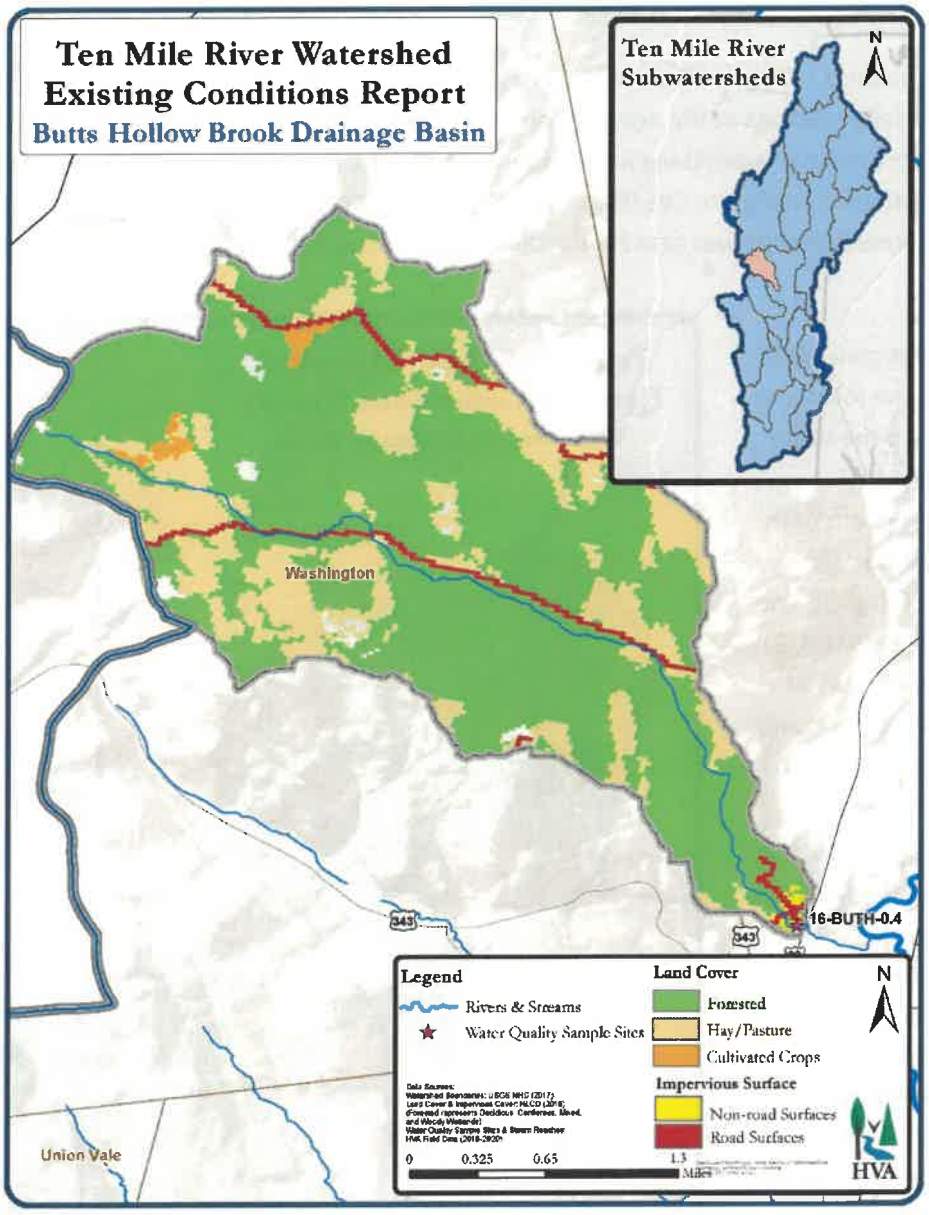
HVA's 2018 biological monitoring results for the Wassaic Creek tributary sampling site (16-WASS-T2-0.1) resulted in a BAP score of 6.18- the fourth highest of the 12 sites that were sampled (Figure 7). Other results from HVA's 2018 water quality monitoring at sample site 16-WASS-T2-0.1 generally indicated a healthy stream. The Wassaic tributary sampling site drainage basin is largely forested (46%) and agricultural (39%)[87].



Map 11. HVA monitoring sites in the East Branch Wassaic Creek watershed.

Butts Hollow Brook

HVA conducted chemical sampling in 2018 at the Route 22/Butts Hollow Brook road-stream crossing, just upstream of the TMR confluence. The drainage basin for this sample site is approximately 68% forested. Results from the 2018 sampling season contributed to HVA flagging this site as one to continue monitoring. This site had the highest overall nitrate concentrations of all the HVA sample sites, with multiple results from September 2018 sample days exceeding 1 mg/L and an average of 0.81 mg/L (Figure 2). Biological monitoring from that same season resulted in an extremely low BAP score (1.96; Figure 7), due to a sample that was dominated by Naididae worms. This stream is known to be completely dry at the NYS Route 22 crossing during times that streams of comparable size are flowing. A streamwalk to investigate potential upstream diversions or subsurface flow is recommended.



Map 12. HVA monitoring sites in the Butts Hollow Brook watershed.

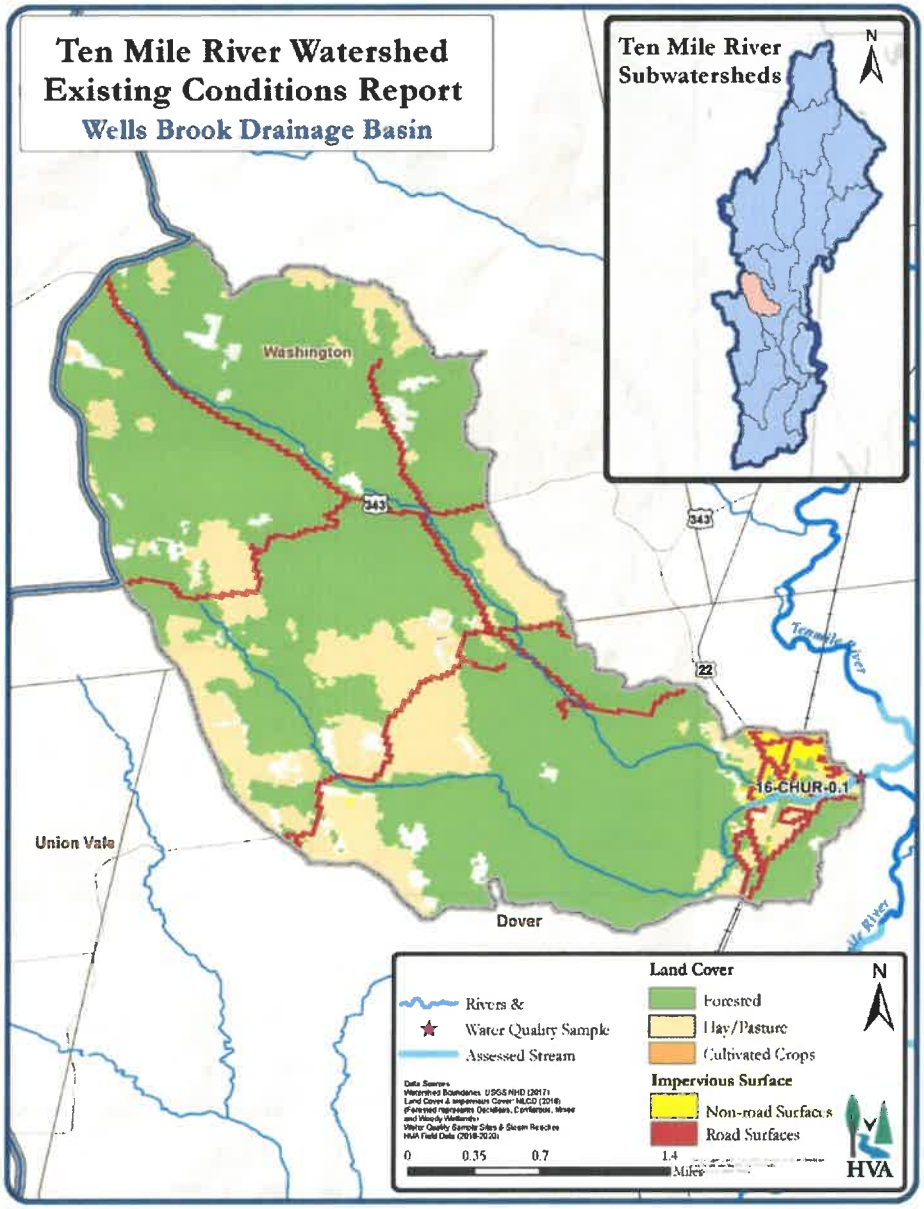
Wells Brook

The Wells Brook watershed is primarily forested (70%) and agricultural (27%)[88]. HVA has been conducting on-going monitoring and restoration activities in this watershed since 2013. In 2015, HVA released a report on the management of the Lower Wells Brook, which details threats and management strategies for the most developed Wells Brook reach: from the Seven Wells area, across the intersection with Route 22, to the confluence with Stone Church Brook[89]. This report was based on monitoring activities done in partnership with Dover High School students in 2014, and detailed recommendations for future monitoring and management. In-situ temperature monitoring using Onset HOBO temperature loggers[90] placed at two sites (just upstream of the confluence with Stone Church Brook and just below the NYS Route 22 intersection) in 2014 indicated that Wells Brook's mean summer temperatures and

maximum summer daily mean temperatures fell within the range predictive of cold water fish (data analysis done using a method developed by CTDEEP for stream thermal classification[91]).

Conductivity readings taking on five sampling days at those same two sites consistently resulted in higher conductivity readings at the downstream site (the confluence with Stone Church Brook), indicating the presence of something influencing conductivity between the two sites- potentially stormwater outfalls draining the CVS Plaza, McDonalds and Dover Village Plaza parking lots[92]. WAVE macroinvertebrate sampling was also conducted in 2014, resulting in a WAVE designation of "No Known Impact".

The 2015 report concluded by identifying the following major threats to the Wells Brook watershed: 1) polluted runoff (from both the CVS parking lot, the McDonalds parking lot, and the Dover Village Plaza), 2) invasive plants, 3) loss of streamside vegetation, and 4) floodplain encroachment/stream instability. Regarding the runoff, HVA staff visited those parking lots listed above during rain events in 2014 and noted areas of high runoff where stormwater management retrofits could be installed. The invasive plants of most concern were listed as Japanese knotweed (*Fallopia japonica*) and purple loosestrife (*Lythrum salicaria*). HVA began treating a large patch of knotweed in 2015 and continues to monitor the impacted area. To address lack of vegetated buffers, in 2014 HVA and Dover High School students planted over 300 trees and shrubs along this reach. Finally, to address stream instability, areas of excessive bank erosion were identified and marked for future actions[93].



Map 13. HVA monitoring sites in the Wells Brook watershed.

Since the 2015 report, HVA has continued monitoring and working along lower Wells Brook. HOBO temperature loggers were deployed at multiple sites along lower Wells Brook from 2016 to 2019. Results for mean summer temperatures (ranging from 16.02 to 17.77°C), mean July temperatures (ranging from 9.88 to 18.59°C), and maximum daily temperatures (ranging from 18.37 to 22.17°C) across all sites clearly indicated that Wells Brook can be considered a "cold" thermal stream classification[94]. Data from HOBO loggers deployed in the Ten Mile River just upstream of the Wells Brook confluence demonstrate that Wells Brook stays significantly colder than the Ten Mile over July and August, indicating that Wells Brook could serve as a thermal refuge for cold-water obligate species during the summer.

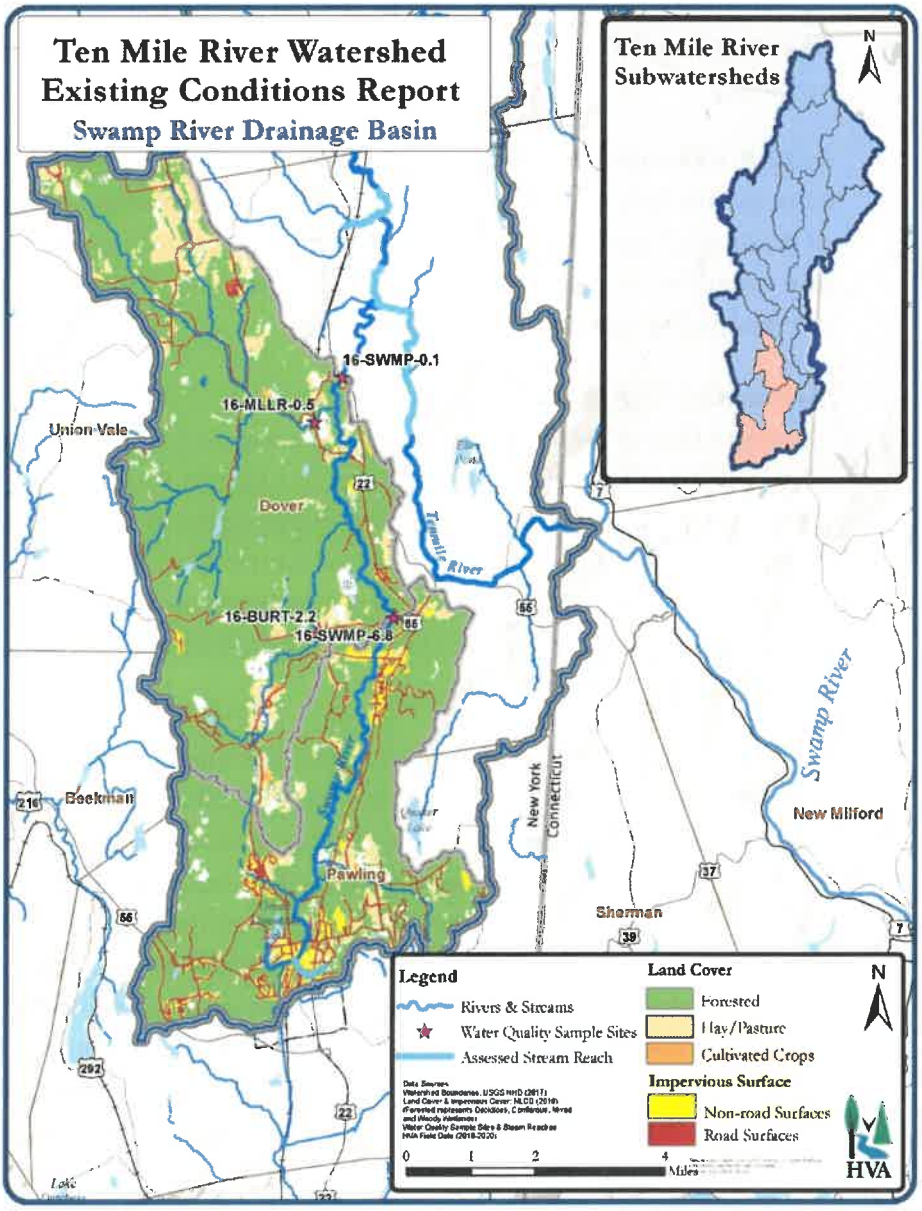
In 2018, HVA conducted water quality monitoring at a sample site on lower Wells Brook, just upstream from the Ten Mile River confluence. Results indicated relatively high overall nitrate at this site (average of 0.57 mg/L; Figure 2), and HVA flagged it as a site to continue monitoring. Macroinvertebrate sampling also conducted in 2018 at this sample site resulted in a relatively low BAP score (4.88), indicating a moderately impacted site (Figure 7).

Swamp River Watershed

The North Flow of the Swamp River is a major tributary of the TMR watershed, draining portions of the Town and Villag Ten Mile River watershed. The Swamp River drainage basin also makes up the northern half of the Great Swamp Watershed, one of the largest freshwater wetland systems in the state. Water quality has been monitored throughout the Swamp River for decades through efforts by the NYSDEC, Friends of the Great Swamp (FrOGS) and HVA. While the Swamp River drainage basin is largely forested (approximately 65%), agricultural use in the watershed and development in the Town and Village of Pawling influence water quality.

In 2007 and 2008, NYS DEC conducted an inventory and assessment of subwatersheds on the New York side of the Housatonic River watershed under the RIBS program, including the Ten Mile River drainage basin. The assessment concluded that the New York region of the Housatonic watershed was overall healthy, however 34 of 379 Housatonic-bound stream miles in New York were impacted enough to be included on the Priority Waterbodies List[95]. All 34 of these stream miles were found within the Swamp River subwatershed. The identified reaches were listed as "Stressed", meaning they were still supporting designated uses, but there were noticeable water quality impacts that had the potential to get worse. In response to these findings and the potential for further deterioration of water quality in the Swamp River, stakeholders from the region formed the Swamp River Scientific Advisory Council (SAC). The SAC held its first meeting in 2009. Participants included the Cary Institute of Ecosystem Studies, FrOGS, HVA, Oblong Land Conservancy, Marist College, NYS DEC Region 3, Pawling Conservation Advisory Council, and the Pawling Corporation. The SAC determined that further assessment to create a base-line water quality profile of the Swamp River was necessary in order to evaluate the environmental impacts of any proposed development.

The base-line water quality study occurred in 2010 and was led by HVA. Sampling was conducted at five sample sites across five randomly selected days between April and October. The following trends were noted: (1) the highest concentrations of sampled constituents (nitrogen, magnesium, ammonia, sodium chloride and calcium) were nearest the upstream urban areas and the Appalachian Trail site; (2) the Appalachian Trail site tended to have the lowest DO concentration; (3) concentrations of all sampled constituents varied seasonally; (4) sodium and chloride concentrations were near or above maximum recommended levels for freshwater organisms during several sampling events; (5) a significant number of conductivity measurements exceeded the upper values recommended for fisheries[96]. Overall, water quality appeared to decrease with increasing proximity to impervious surface and urbanization.

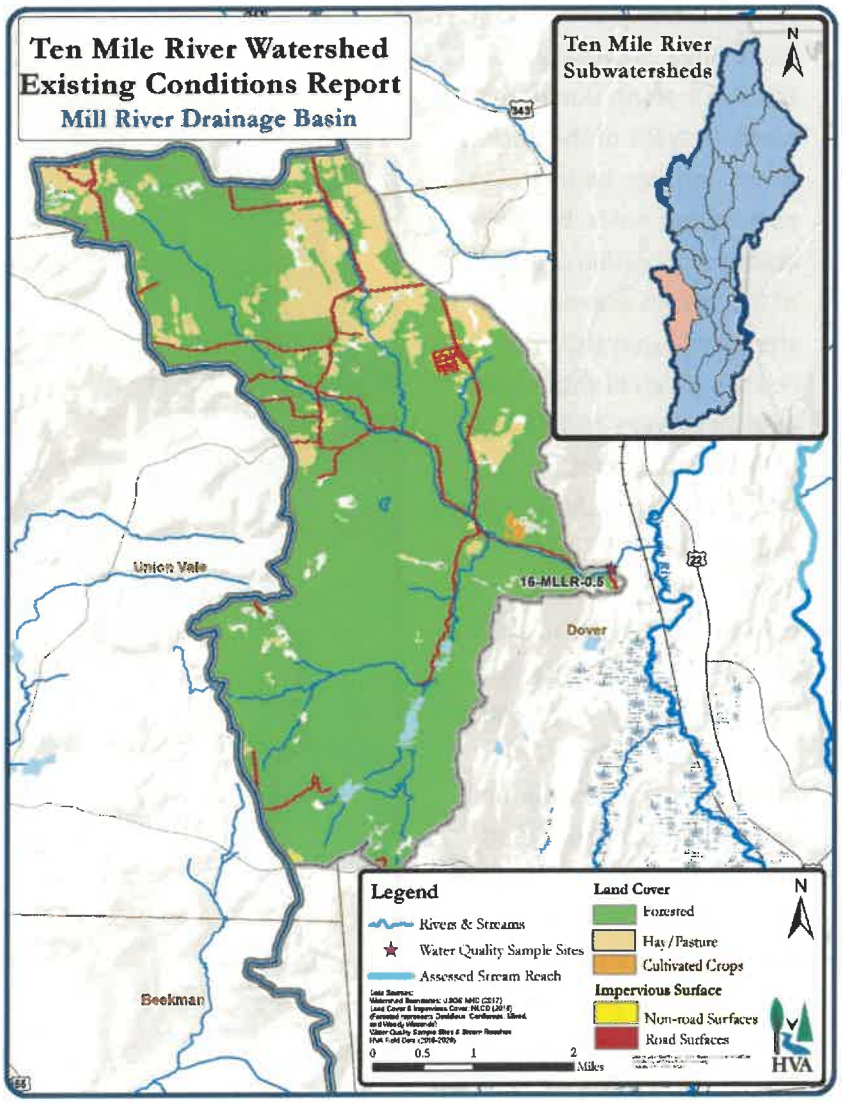


Map 14. HVA 2018 Monitoring Sites in the Swamp River watershed.

NYS DEC's listing of the Swamp River as Stressed was the impetus for additional biological monitoring coordinated by FrOGS. FrOGs hired Watershed Assessment Associates, LLC to conduct benthic macroinvertebrate sampling in 2010 and 2012. Assessments in 2010 were conducted at seven sample sites, two on the Swamp River and the remainder on its tributaries. The BAP results for the Swamp River sites indicated slightly impacted water quality (6.85 at station GRWS01 and 5.91 at GRWS02). The report noted that BAP at station GRWS01 had declined at this site since 1992, but had slightly improved from the 2008 results[97]. Both sites also had Impact Source Determination (ISD) scores that indicated that nonpoint nutrient sources may be impacting the sites. ISD scores are based on a comparison of the sample community structure to a series of benthic model communities that indicate various sources of impact. Of the tributary sample sites, Mill River and Coopertown Brook had the highest BAP scores (7.64 and 8.08, respectively), indicating non-impacted waters. Whereas, the Burton Brook BAP indicated severe

impact (2.02). The 2010 report concluded that the biotic metrics in the Swamp River have changed over the years, based on a comparison with historical data, and that agricultural runoff may be affecting water quality in this stream system[98].

In 2012, biological assessments were again conducted in the Great Swamp watershed, at 11 previously un-sampled sites, 3 of which were in the East Branch of the Croton River watershed and 4 of which were new Swamp River sample stations. To further explore Burton Brook, two new sample sites were selected downstream of the 2010 sample site. Results for the four Swamp River sample sites showed a strong upstream to downstream trend of increasing BAP scores, with the most upstream sample site score indicating severe impact (2.11) and the most downstream sample site score indicating non-impacted water quality (7.54)[99]. These results are counter to most free-flowing streams, which often become more degraded downstream, due to the compounding effects of various impacts. This strong longitudinal trend also held true for other biotic metrics among the four Swamp River sites, including species richness. This trend may be affected by agricultural and suburban land use in the upper Swamp River. For the two Burton Brook sites, the downstream station had a BAP score of 2.95, while the upstream station (approximately 1.5 miles upstream of the downstream sample station and 2.1 miles downstream of the 2010 Burton Brook sample station) had a BAP score of 6.7.



Map 15. HVA monitoring sites in the Mill River watershed.

Mill River

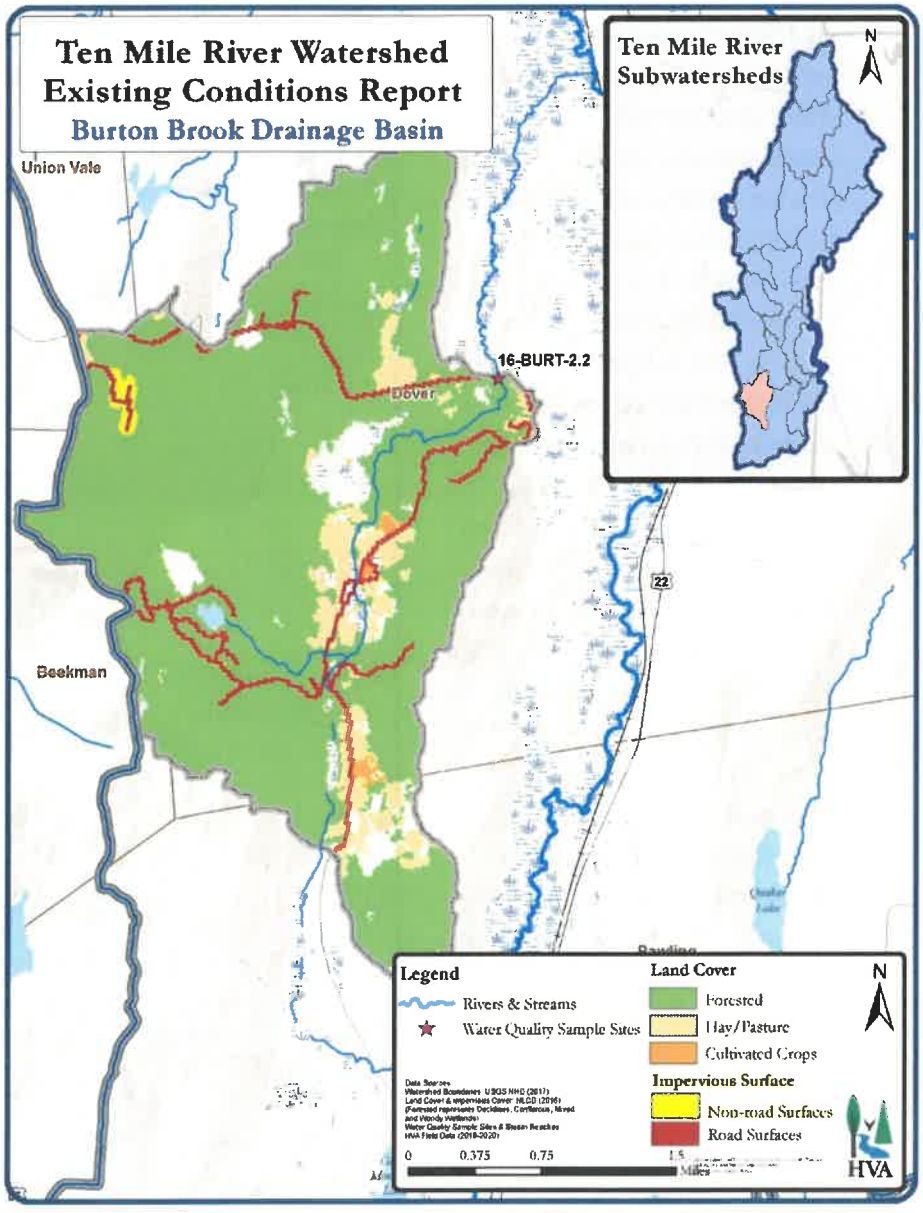
Mill River is a major tributary of the Swamp River and drains the northwestern part of the Swamp River basin. HVA conducted water quality monitoring in 2018 at a sample site approximately 0.5 miles upstream from the confluence of Mill River and Swamp River. The drainage basin above this sample site is largely forested (approximately 76%) and undeveloped. Monitoring results indicate a healthy stream system. Macroinvertebrate sampling resulted in the third highest BAP score of the 12 sites at which macroinvertebrate samples were collected (6.94; Figure 7).

HVA's other monitoring results from that sample season indicate low concentrations of nitrogen and phosphorus (Figures 4 and 3, respectively). It is worth noting that the highest ammonia measurement was from Mill River (9/25/18; 1.6 mg/L), but previous ammonia results were extremely low (Figure 6).

Prior biological metrics at Mill River show the BAP increasing from 2.85 (2002; NYS DEC), to 5.44 (2007; NYS DEC), to 7.64 (2010; Watershed Assessment Associates, LLC), indicating an overall improvement in water quality[100].

Burton Brook

In 2018, HVA sampled Burton Brook upstream of a road-stream crossing on Pleasant Ridge Road. (sample site 16-BURT-2.2; south side of the road). Only 8% of the Burton Brook drainage basin is pasture/hay fields, but these areas are all within proximity of the stream channel. This site was flagged as having relatively high nitrate levels with an average of 0.62 mg/L. HVA did not conduct biomonitoring at this site in 2018. However, biomonitoring data was collected at this site in 2007 and the resulting BAP score was 4.24. Note in the Swamp River narrative above that more recent biomonitoring data in Burton Brook (2010 and 2012) resulted in low BAP scores, indicating severe impact. Based on these results and the 2018 data, the Burton Brook sample site was flagged by HVA as one to continue monitoring.



Map 16. HVA monitoring sites in the Burton Brook watershed.

Swamp River

Upper Swamp River Mainstem

The most recent water quality monitoring data from Swamp River is from HVA's 2018 sampling. Two Swamp River sites were sampled: 16-SWMP-6.8 (upstream site, 6.8 miles from confluence with Ten Mile

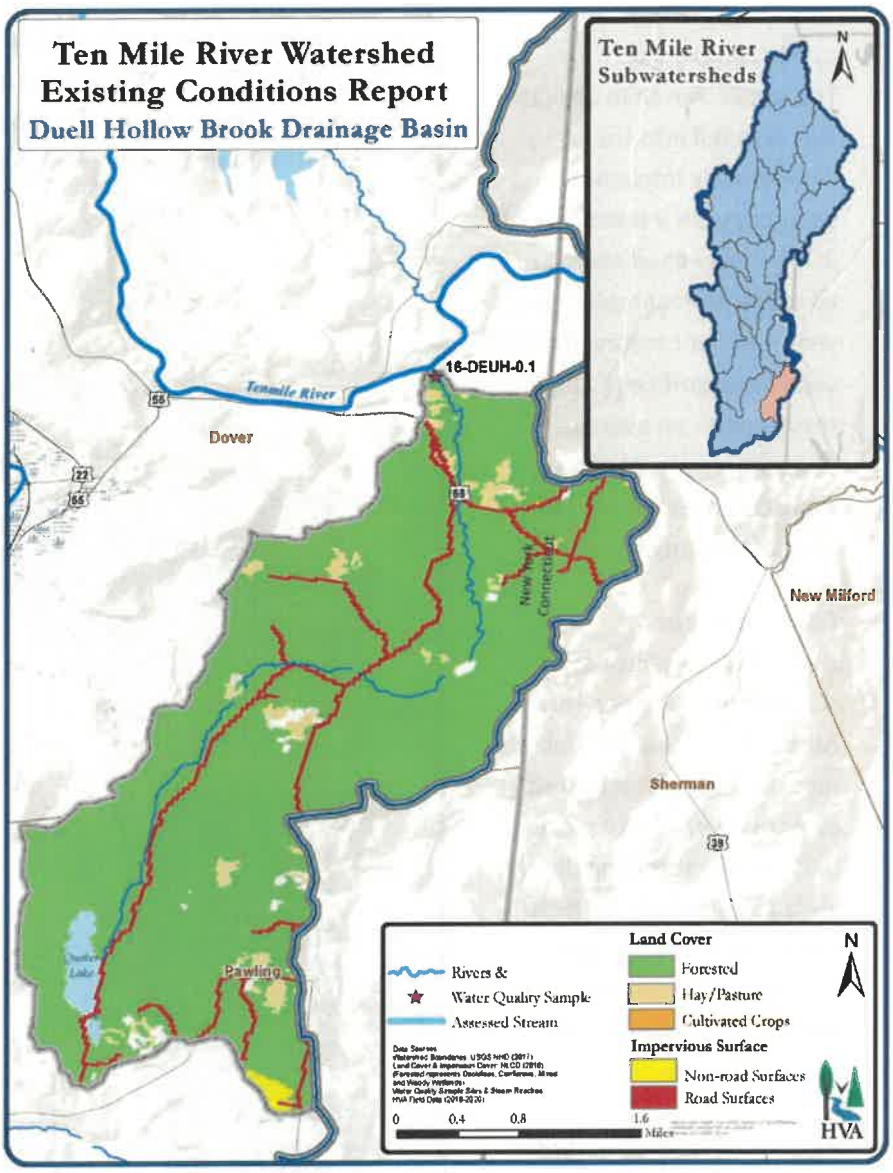
River) and 16-SWMP-0.1 (downstream site, 0.1 miles from the confluence with the Ten Mile River). The upstream site results indicated high phosphorus concentrations, relative to data from the other 16 sample sites, with an average phosphorus result of 0.75 mg/L (Figure 3). HVA 2018 biotic assessment results categorized the upstream sample site as "moderately impacted", based on a BAP score of 4.01.

Entire Swamp River Drainage

Similar to trends identified in previous Swamp River studies, phosphorus concentrations are actually lessened at the downstream sample site, with an average phosphorus result of 0.035 mg/L (Figure 3).

Duell Hollow Brook

In 2018, HVA sampled Duell Hollow Brook just above its confluence with the Ten Mile on Old Forge Rd. in Wingdale, NY (sample site 16-DEUH-0.1). The Duell Hollow drainage basin is 80% forested and 6% pasture/hay. This stream was noteworthy due to water quality results indicating a healthy and high-quality system, with low nitrate and phosphorous levels and a BAP score of 7.5 (Figure 7). This BAP result was the highest of all twelve sites where biomonitoring was conducted in 2018. This is in part due to the high EPT score of 10. According to the 2008 WI/PWL, Deuel Hollow Brook is a Class C(T) stream[101].



Map 17. HVA monitoring sites in the Deuel Hollow Brook watershed.

Ten Mile River Mainstem

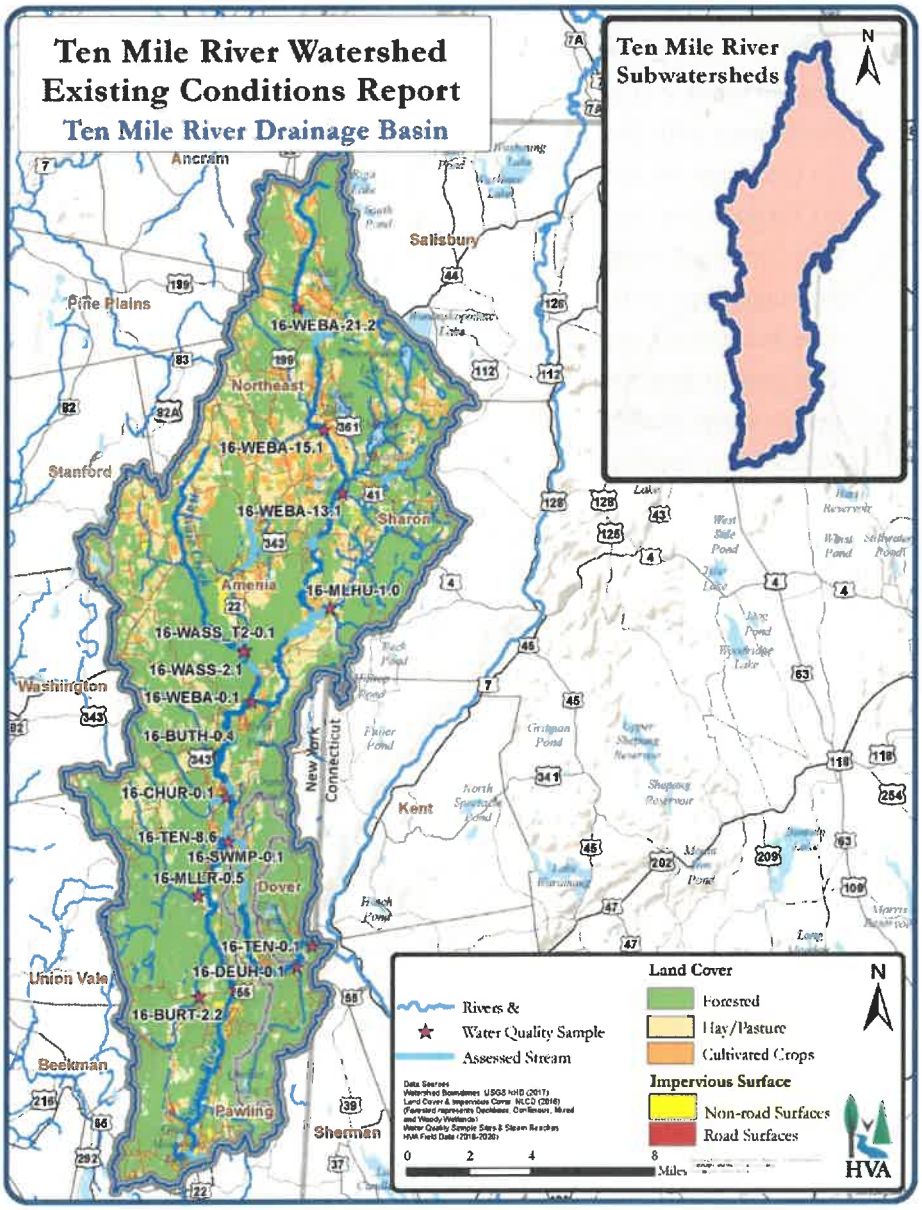
HVA sampled the Ten Mile River mainstem in two locations in 2018—one at the County Route 4 bridge in Dover (sample site 16-TEN-8.6) and the other off of Old Forge Road, just upstream of the NY/CT border (sample site 16-TEN-0.1). The latter represents water quality of the TMR system as a whole as it is the furthest downstream of all sampling sites. 16-TEN-0.1 is also included in a RIBS reach. WAVE sampling on the Ten Mile River mainstem in 2014 and 2016, just upstream of the Deuel Hollow Brook confluence, both resulted "no known impact" classifications.

Upper Sample Site

The upper Ten Mile site (16-TEN-8.6) fell into the "moderately impacted" category with a BAP score of 3.76—the second lowest of all of the sites sampled that year. Nutrient testing did not yield any significantly high results, with an average phosphorous level of 0.03 mg/L and average nitrate level of 0.44 mg/L.

Entire Drainage

HVA's 2018 monitoring resulted in the lower Ten Mile site (16-TEN-0.1) falling into the "slightly impacted" category with a BAP score of 5.19. Nutrient testing did not yield any significantly high results, with an average phosphorous level of 0.03 mg/L and average nitrate level of 0.41 mg/L.



Map 18. HVA monitoring sites throughout the Ten Mile River watershed.

As noted above, this site falls within the stretch of the Ten Mile that was included in NYSDEC's 2008 WI/PWL report which evaluated the mainstem and selected tributaries from the state line, up to Dover Plains. RIBS monitoring of this reach was completed in 2003. The biological monitoring indicated non-impacted water quality conditions. Notable concerns in coliform and iron levels were reported, although the iron contributions are

assumed to be naturally occurring. Bottom sediment sampling and toxicity testing show that the site is, overall, supportive of aquatic life. The segments of the mainstem were classified as Class B(T) from the state line to Lake Ellis Road Bridge and Class C(T) for the remainder of the reach[102].

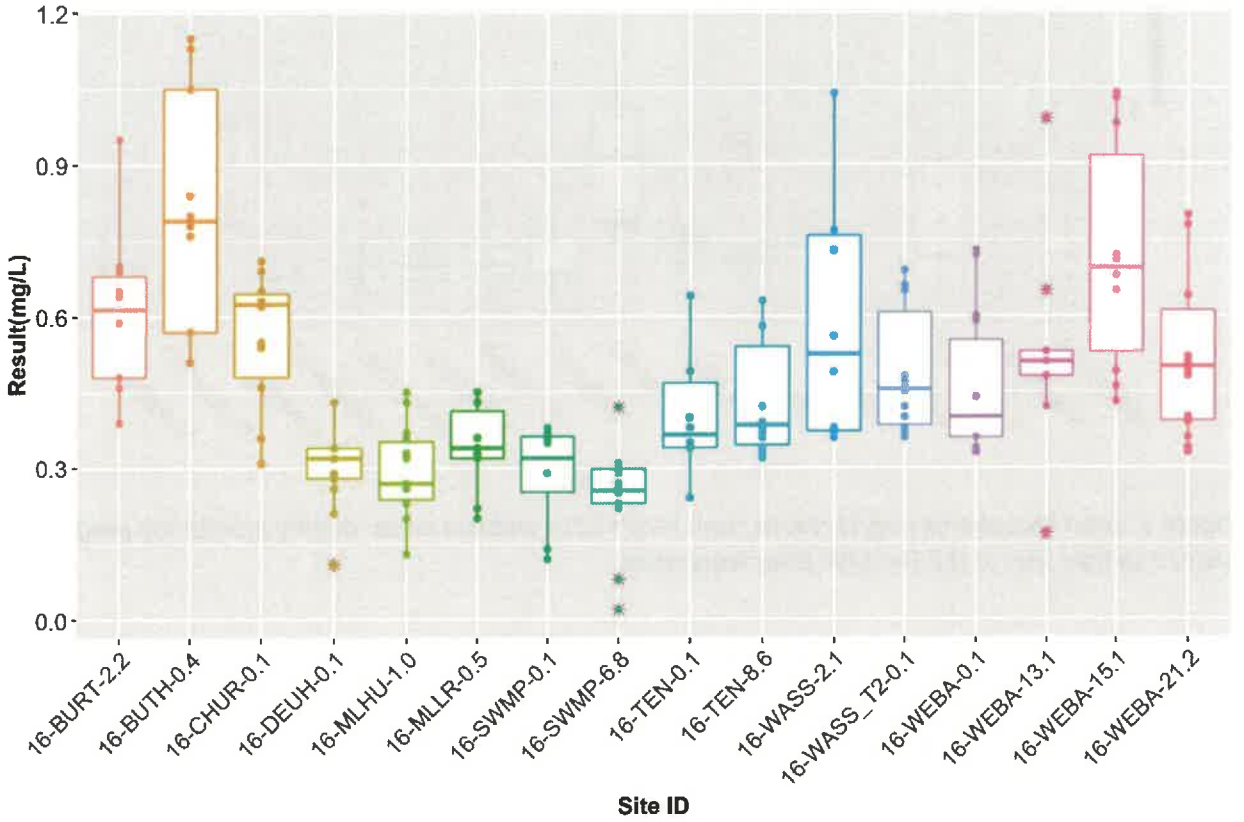


Figure 2. Nitrate (NO3; mg/L) results of HVA's 2018 ambient water quality monitoring program at sixteen sample sites in the Ten Mile River watershed.

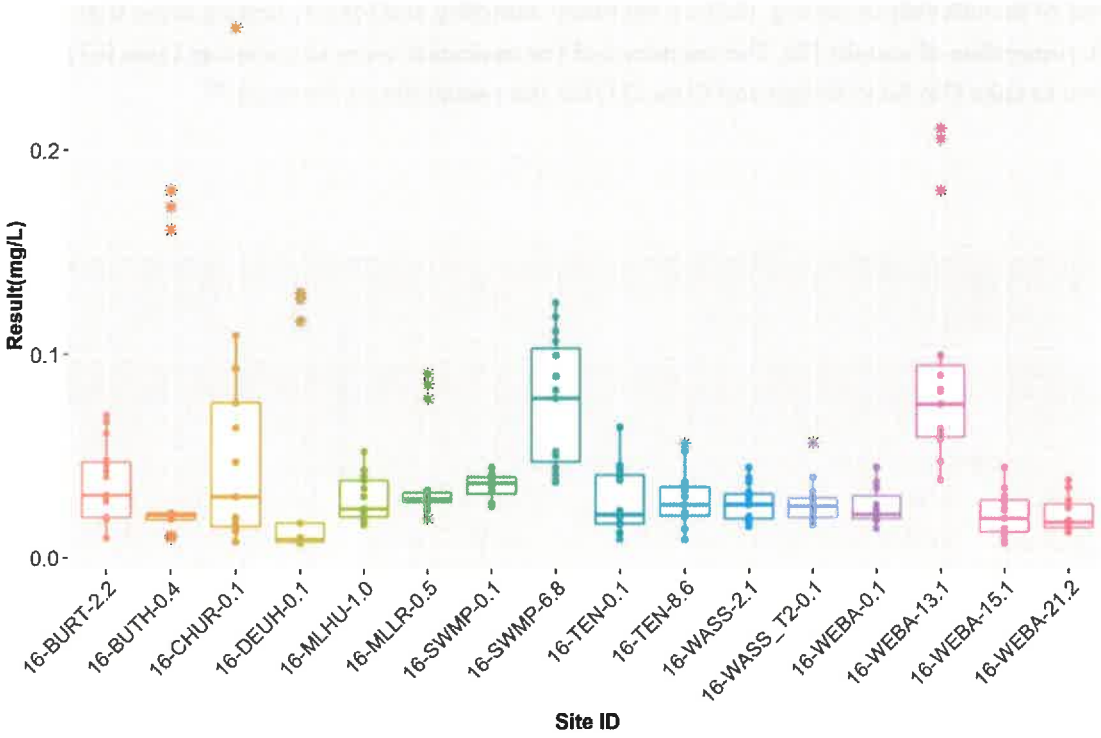


Figure 3. Total Phosphorus (mg/L) results from HVA's 2018 ambient water quality monitoring program at sixteen sample sites in the Ten Mile River watershed.

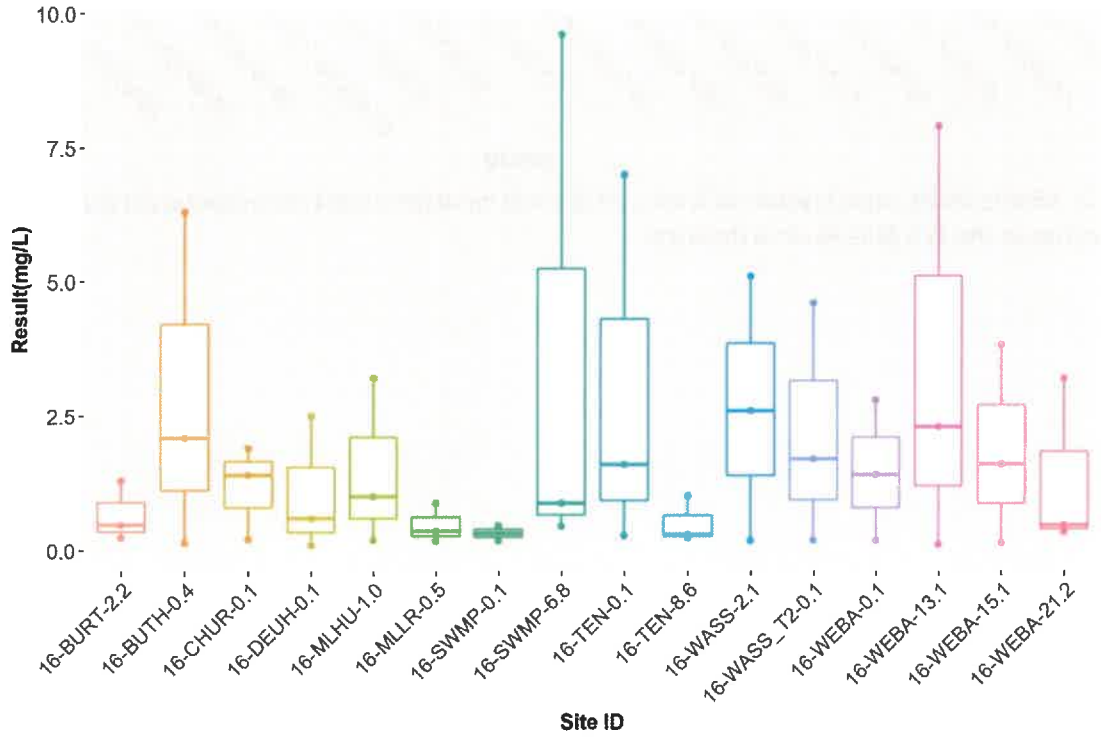


Figure 4. Total Nitrogen (TKN; mg/L) results from HVA's 2018 ambient water quality monitoring program at sixteen sample sites in the Ten Mile River watershed.

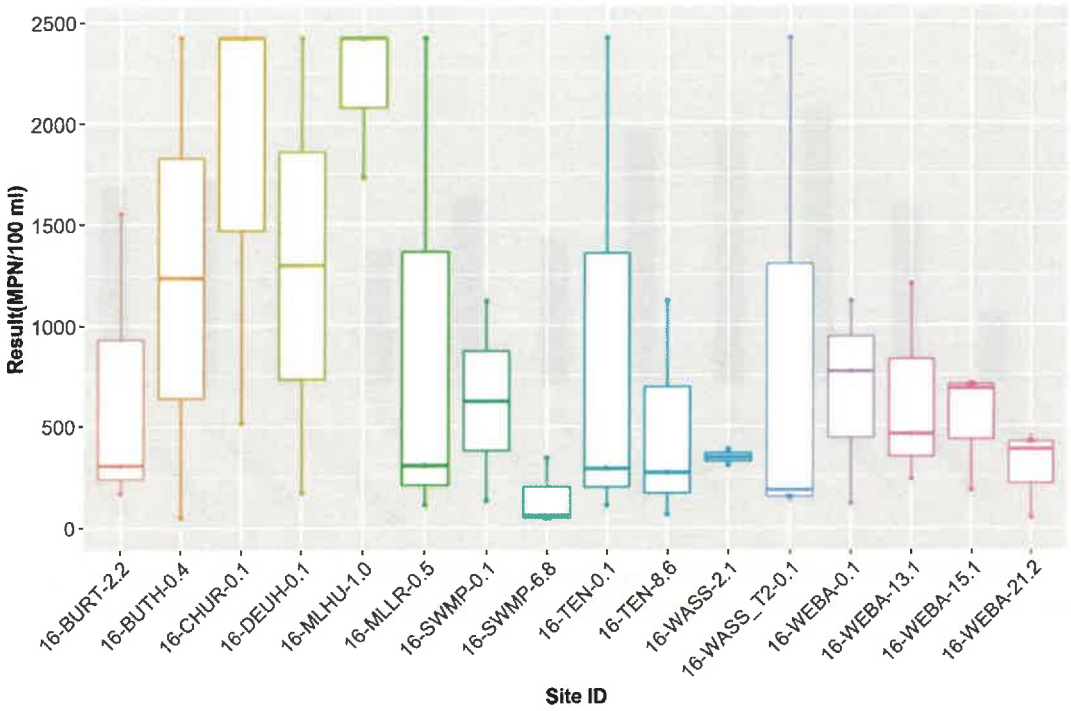


Figure 5. E. coli (MPN/100 mL) results from HVA's 2018 ambient water quality monitoring program at sixteen sample sites in the Ten Mile River watershed.

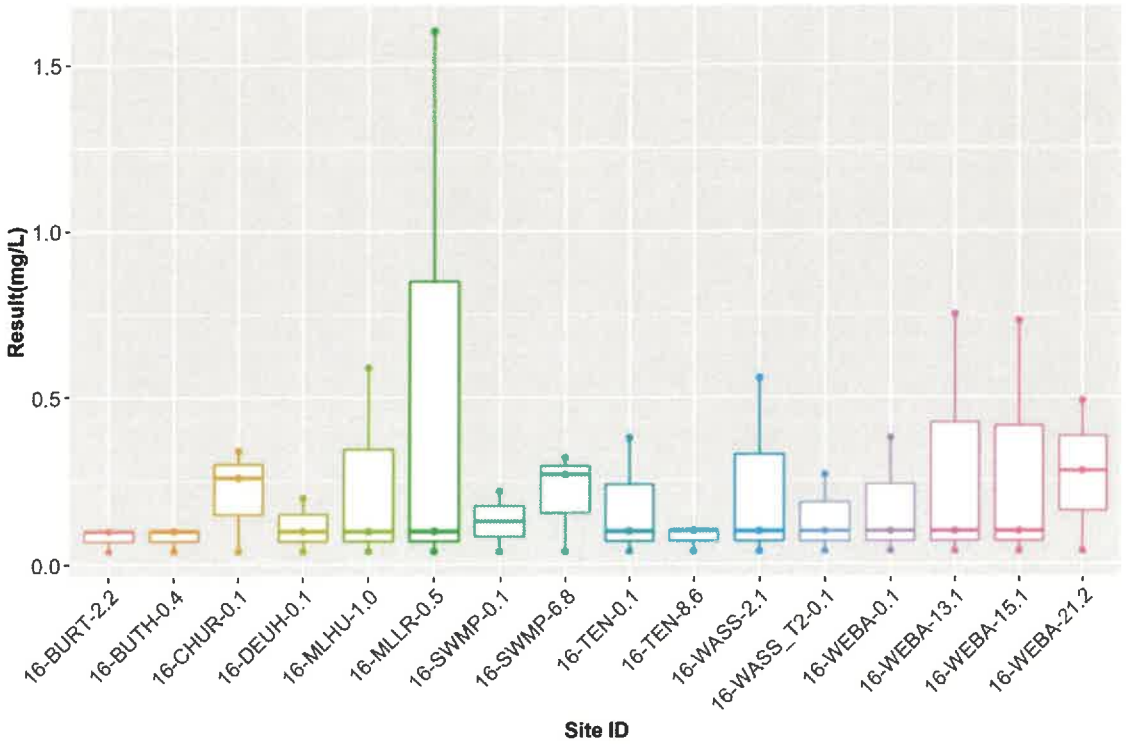


Figure 6. Ammonia (NH3; mg/L) results from HVA's 2018 ambient water quality monitoring program at sixteen sample sites in the Ten Mile River watershed.

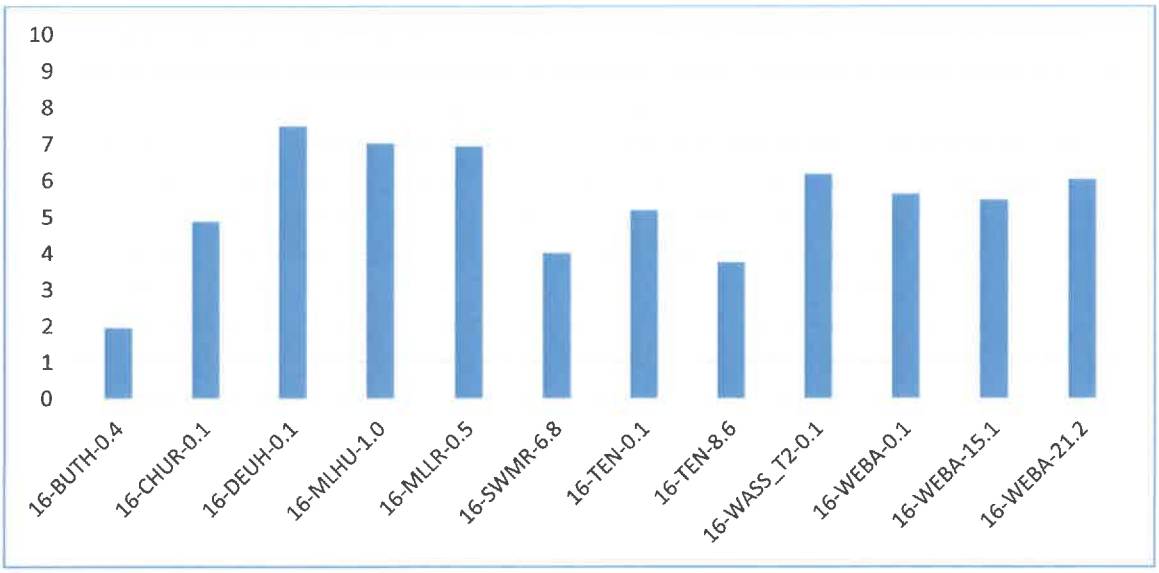


Figure 7. Biological monitoring results (Biological Assessment Profile score) from HVA's 2018 ambient water quality monitoring program at twelve sample sites in the Ten Mile River watershed.

3.3 Recommended Actions

Recommended Actions & Milestones	Who	Timeframe (Schedule)	Deliverables & Evaluation Criteria	Est
Revisit Watershed Plan on a regular basis (minimum every year Action Plan; every 5 years full plan) to: • Assess progress • Update with new data • Update with new projects Revisions to Watershed Plan will be made to improve the effectiveness of implementation efforts if monitoring shows no improvement post BMP efforts.	Ten Mile River Collaborative	Annually (Implement ation Strategy) Every 5th year (entire Watershed Plan)	• Update appendix • Revisions to plan document as necessary	
Establish and implement water quality monitoring program • Prepare QAPP • Train staff, interns, and volunteers • Conduct monitoring • Analyze samples • Compile data and create reports	TMRC with assistance from CT DEEP and NYS DEC	Establish 0-1 year Seasonal sampling (Apr – Oct)	• Approved QAPP • Staff, interns & volunteers trained • Monitoring results/reports	
Continue to do USA Streamwalks • Train any new staff and volunteers • Complete streamwalks • Compile and analyze data • Identify restoration areas and publish updated streamwalk data	TMRC	2-5 years (repeat every 5 years)	• Streamwalk assessment results published • Restoration sites identified	
Conduct outreach to streamside landowners to encourage adoption of property management practices that protect water quality	TMRC, watershed municipalities	Within 3 years	100 landowners reached	

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000

$50,000 HVA = Housatonic Valley Association, CT DEEP = Connecticut Department of Energy and Environmental Protections, Project Plan, NYS DEC= New York State Department of Environmental Conservation, NFWF = National Fish and Wildlife Foun

4. CLIMATE RESILIENCE AND STREAM CORRIDOR MANAGEMENT

4.1 Goals

- Restore and protect functioning floodplains to reduce flood heights in developed areas.
- Reconnect streams to floodplains wherever possible.
- Restore riparian buffers - plan for future healthy canopy cover and carbon storing.
- Identify channel constrictions (e.g. undersized bridges and culverts) and mitigate flood risk using future precipitation projections to help guide replacement strategies.
- Protect and enhance in-stream habitat for climate sensitive species.
- Educate community members on benefits of Green Infrastructure (GI) and Low Impact Development (LID) practices.
- Implement GI and LID practices wherever possible.
- Encourage and support intermunicipal collaboration and knowledge-sharing in planning for future hazard mitigation and building local climate resilience.
- Consider carbon sequestration when planning TMR Watershed Plan implementation.

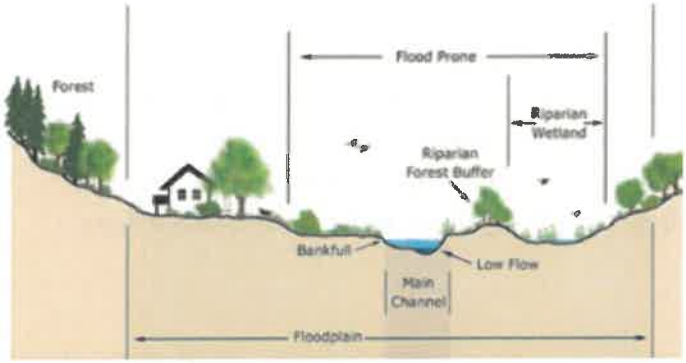
4.2 Current State of Climate and Stream Corridor Management in the TMR Watershed

Climate change is the overarching threat to the outstanding natural heritage of the TMR watershed, in addition to the litany of threats it presents to property, infrastructure and public health in watershed communities. The effects of climate change (including but not limited to more frequent and intense precipitation events, reduced winter snowpack, more frequent short-term droughts and increasing air and surface water temperatures) are exacerbating all of the other key stressors that species and habitats of the watershed face, which include habitat loss and fragmentation, stream instability, water quality degradation, and invasive species. It's important for the TMRC to recognize that climate change is global in scope, and there is not much we can do locally in the short-term to stop it.

Heavy rain from a thunderstorm, Town of Sharon. Photo source: Litchfield County Times

Given this fact, we have to focus on adapting to climate change impacts to build resilience in the natural and built environments of the TMR watershed. Climate change has become the context in which we address the things we do have influence on- water quality conservation, protection of core habitats and populations of species of conservation concern, stream habitat connectivity, stream corridor management, community land-use planning/development and the spread of invasive species. Climate change is affecting the Northeast U.S. in a variety of ways that impact water resources: sea levels are rising, snowpack is decreasing, temperatures are increasing in our air and surface waters, and precipitation patterns are changing. The seasonality of eastern NY is central to the region's sense of

place and is an important driver of rural economies. Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry. The region's rural industries and livelihoods are at risk from further changes to forests, wildlife, snowpack, and streamflow[103]. These changes in climate are also impacting native biodiversity and increasing the risk of natural disasters.



The Stream Corridor in cross-section

Many of the most severe climate change impacts and corresponding opportunities for adaptation in the TMR watershed occur along stream corridors. The term "stream corridor" refers to the stream channel and its associated riparian areas and floodplains. Climate change is increasing the frequency and magnitude of flood events in the TMR watershed, which threatens property, infrastructure and native biodiversity. Therefore, effective stream corridor management will be essential to building climate resilience in both the natural and built environments of the TMR watershed.

Increasing temperatures

According to the Northeast Climate Impacts Assessment, Eastern NY ambient air temperature has increased an average of 2-2.5° F since 1970, twice as much as the rest of the lower 48 states. By 2035, under both lower and higher scenarios (RCP4.5 and RCP8.5), the Northeast is projected to be more than 3.6°F (2°C) warmer on average than during the preindustrial era. This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone. Warmer ambient temperatures along with more frequent droughts with corresponding low flows are leading to warmer surface water temperatures[104].

Increasing precipitation

Climate change is increasing precipitation both annually and per-event in the TMR watershed, and this trend is expected to continue. Damaging flood events are becoming more frequent, threatening stream stability, property and infrastructure. Analysis of past precipitation events conducted by the National Oceanic and Atmospheric Administration to develop their most recent Precipitation Atlas for the Northeastern United States (released in 2016) shows a dramatic upward shift in per-event rainfall total predictions as compared to National Weather Service

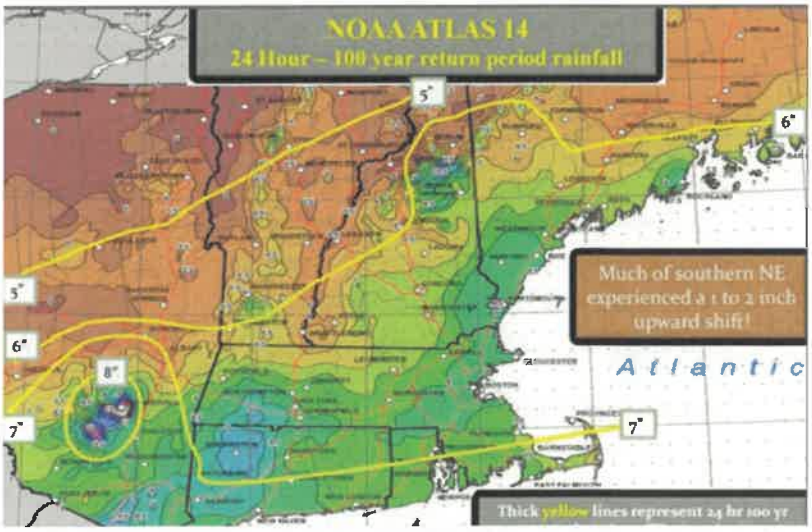


Figure 8. Comparison of TP-40 and NOAA Precipitation Atlas 14. From the proceedings of the 2017 Southeast New York Stormwater Conference, talk delivered by David Vallee, Hydrologist-in-Charge, NOAA/NWS Northeast River Forecast Center

Technical Paper 40 (TP-40), which was released in 1961. TP-40 was the most commonly used source of rainfall total predictions for designing infrastructure like bridges and culverts until the release of NOAA Atlas 14. NOAA Atlas 14 shows a roughly 2-inch increase in the amount of rain expected during the 24-hour, 1% annual chance (100-year) storm from TP-40 in the TMR watershed. This trend is expected to continue as climate change progresses.

Droughts

In 2000, 2016, and 2020, New York and New England experienced historic drought conditions not seen since the 1960s. The Northeast also frequently experiences "flash" droughts—short-term intense dry periods that can follow a period of normal to above-normal precipitation. While these flash droughts may last only 2–6 months, they can have profound impacts on a local region, resulting in shortages in public water supplies and very low streamflows. These flash droughts are expected to become more common as the climate warms[105].

Flooding

Watershed management planning is an opportunity for communities to address flood risk collaboratively. Flooding is an issue that that transcends municipal boundaries. The effects of management actions taken by one community or agency can reverberate beyond their jurisdiction and into other areas. Communities are often impacted by increased flood risks that arise outside of their jurisdiction, making it difficult or impossible for them to address the problem at its source without working together at the watershed scale.

Flooding in Dover Plains from the Ten Mile River. Photo Taken April 16, 2007.

The TMR has experienced a number of significant flood events in the past 20 years, including record flows in 2005 and major flooding in 2006, 2007 and 2011. Not only did these flood events result in significant damage to property and infrastructure, but they also caused dramatic changes to channel morphology along many stream reaches. As a stream adjusts to these changes, it can become unstable, i.e. subject to excessive erosion and deposition. Unstable channels are a source of nutrients and sediment to downstream waters, can threaten property and infrastructure, and impact fish and wildlife habitat along the stream corridor- sometimes in the next town downstream.

Stream instability

Stream instability along the TMR and its tributaries is well documented in a Section 908(d) Reconnaissance Study completed by the U.S. Army Corps of Engineers in 2008[106], and was subsequently documented by HVA's stream corridor assessments in support of this watershed plan. For an in-depth explanation of stream form and function, please refer to Appendix C. A summary of the management issues described in the 2008 USACE report are excerpted verbatim below.

- *Reduced Stream Capacity: Due to sediment aggradation throughout the watershed, erosion of streambanks and uncontrolled sediment transport, channels of the mainstem Ten Mile River and its tributaries are filling with sediment. The severe bank erosion results in changes in channel dimension as well as horizontal movement of the channels, which results in a loss of vegetation, wash-out of roadways and other infrastructure and loss of public and private lands. Erosion is the main causal agent for sediment accumulation and ecosystem degradation within the Ten Mile River and its tributaries and it contributes to flooding in the area through restriction of channel capacities. The sandbars and islands that form in the river cause changes in the hydraulic regime and result in reduced flood capacity and lead to flooding, erosion and loss of habitat. These issues are found throughout the Ten Mile River Basin, specifically along the Webatuck Creek in the Town of Northeast, the Wassaic Creek in the Town of Amenia and Hamlet of Wassaic and the mainstem of the Ten Mile River throughout the Town of Dover and Dover Plains. This condition is expected to continue and worsen in the without project future condition.*

- *Flooding is also a major concern expressed by the public - Flooding occurs throughout the Ten Mile River Basin and causes significant damages in populated areas and appears to be worsened by the reduced channel capacity discussed above. The primary commercial and residential areas damaged by flooding are in the Hamlet of Wassaic and Dover Plains. The situation would likely worsen in without project future conditions.*

- *Obstructions of the channel are found throughout the Ten Mile River Basin. These obstructions are typically in the form of debris jams, large trees, and culverts and can cause a "damming" effect upstream of the obstruction.*

- *The degradation of the Ten Mile River Basin ecosystem has also been raised as a concern by the public. Ecosystem degradation of the Ten Mile River and tributaries and the basin as a whole is significantly increased by erosion and sedimentation. As erosion driven sediment accumulates the channel dimensions and depth decrease. The erosion negatively impacts flora and fauna in the study area, especially aquatic species such as Brown Trout. The Ten Mile River is classified by NYSDEC as a Class B (Trout) stream. In accordance with §701.7 of the New York State Environmental Conservation Law, Class B fresh surface waters is defined as waters where "the best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival." By this definition, the Ten Mile River Watershed could provide the habitat for fish propagation and survival, however, anecdotal discussions indicate that Brown Trout populations have declined in recent years due to increasing river temperatures. Therefore, the erosion and sediment aggradation throughout the watershed is impacting the fishery resources in the Ten Mile River Basin. This trend is expected to continue in the without project future condition.*

Note that "project future condition" refers to continuation of the USACE process through a Feasibility Study, a stream corridor management plan that identifies and develops specific projects, and implementation of that plan. While continuing the USACE process is worth exploring, there are a number of avenues that the TMRC and other partners can use to address the stream instability issue.

As noted above, HVA observed widespread stream instability during our assessments of stream corridors in the watershed in 2018 and 2019, particularly along the Ten Mile River mainstem through the Town of Dover. The image to the right shows an area of excessive erosion threatening residential properties in the Town of Dover.

4.2.1 Floodplain Management

All TMR watershed communities participate in the National Flood Insurance Program (NFIP). The NFIP is a federal program administered by the Federal Emergency Management Agency (FEMA) that provides assessments of flood risk in the form of Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRMs), establishes minimum regulations to guide development in floodplains, and provides federally subsidized flood insurance to property owners in participating communities. Participation in the NFIP is required in order for residents to be eligible for federally subsidized flood insurance. Each NFIP community must adopt floodplain management regulations that are at least as stringent as the minimum regulations developed by FEMA (although they can be more stringent). Floodplain management regulations use the boundaries of the 1% annual chance floodplain (aka the 100-year floodplain) and the designated floodway (the area where the bulk of floodwaters are expected to flow during a 1% annual chance flood) delineated on their FIRM as a zoning overlay, within which development must meet standards meant to reduce flood risk. Participating communities must also designate a Floodplain Administrator, who reviews development proposals and issues Floodplain Development Permits.

New York State has adopted an additional floodplain development standard beyond the NFIP minimum regulations that requires structures in the floodplain to have their first floor elevated 2' above the predicted elevation of the 1% annual chance flood (the NFIP minimum is first floor at the elevation of the 1% annual chance flood).

It's important to note the limitations of FEMA's flood hazard mapping. It does not take into account changes in precipitation and corresponding floods expected from climate change. Model flood depths and extents are based on previous flood events. Flood hazard mapping is also based solely on elevation, and does not consider lateral migration of streams during floods (erosion hazards). FEMA's statistics

indicate that 30 percent of all flood insurance claims are filed in low- to moderate-risk areas outside of the 100-year floodplain.

Communities on the New York side of the TMR watershed (Towns of North East, Amenia, Washington, Beekman, Dover, Pawling and Villages of Millerton and Pawling) are covered by the Dutchess County FIS/FIRM made effective on 05/02/2012. Communities on the CT side of the TMR watershed (Towns of Sharon and Salisbury) are covered by town-scale FIS/FIRMS made effective on 08/16/1988. This mapping is quite dated, and not very helpful for understanding flood risk and planning development. FEMA flood hazard mapping is available online here, searchable by address: msc.fema.gov/portal/home

One tool that TMR watershed communities can use to supplement FEMA flood hazard mapping- especially useful in areas where FEMA mapping is older- is called Flood Factor. Flood Factor is a free web-based application created by the nonprofit First Street Foundation that makes it easy for Americans to find their property's risk of flooding and understand how flood risks are changing because of a changing environment. The Flood Factor tool is available here, also searchable by address: floodfactor.com

Major floods that impacted the TMR watershed are listed below. Federally Declared disasters include the declaration number.

- **October 28, 1995: Flash Floods**
  Heavy rains produced flash floods across several streams in Dutchess County which caused mudslides and flooded roadways in the Town of Amenia.
- **January 19-30, 1996: Flood of 1996 (1095 DR)**
  Unseasonably warm temperatures resulted in the rapid melting of one to three feet of snow. In addition to the snow melt, one to three inches of rain fell, resulting in widespread flooding across Dutchess County. Small streams flooded and many roads were washed out. In the higher elevations, there were numerous road washouts. In the Town of Pawling, 50% of the roads in the town were washed out. In the Towns of North East and Amenia, widespread and severe damage also occurred.
- **June 30, 1998: Severe Thunderstorms and Flash Flooding**
  Severe thunderstorms and flash flooding impacted Dutchess and Ulster Counties. The storms downed trees and wires and brought large hail across several locations in the counties. Torrential rains from the storms produced flash flooding across Ulster and southern Dutchess County. There was flooding of roadways in Hopewell Junction (Town of East Fishkill) and Wingdale (Town of Dover).
- **January 18-19, 1999: Heavy Rain, Flooding and Ice Jam**
  Heavy rain and an ice jam in Dutchess County resulted in Wassaic Creek overflowing its banks and flooding County Route 81 in the Town of Amenia. Several homes were evacuated in this area due to the flooding.
- **October 19, 2005: Heavy Rain and Flooding**
  Heavy rains caused flooding of the Ten Mile River which affected the Towns of Dover, Pawling, and Beekman.

- **April 16-18, 2007: Severe Storms and Inland and Coastal Flooding (DR-1692)**
  An intense coastal storm brought heavy precipitation across the lower Hudson Valley of New York State. At first, the precipitation fell as wet snow, sleet and rain and then changed to all rain. Precipitation totals ranged from three to eight inches and led to widespread flooding across the lower and mid-Hudson Valley region. In Dutchess County, small streams and creeks flooded throughout the County. Moderate flooding was recorded along Ten Mile River at Webatuck which crested at 11.23 feet. The flooding led to numerous road closures.
- **August 26 – September 5, 2011: Hurricane Irene (DR-4020)**
  In Dutchess County, flash flooding was reported in several locations. Numerous roads and bridges were closed or damaged due to flooding and downed trees. There were mandatory evacuations in the County as well. Moderate flooding was reported on the Ten Mile River at Webatuck.
- **August 9, 2013: Heavy Rain and Flash Flood**
  Strong thunderstorms and heavy rainfall led to overflowing creeks and flooding in Dutchess County. In Dover Plains, several roads were closed due to flooding.

4.2.2 NYS Climate Smart Communities program

Climate Smart Communities (CSC) is a New York State program that helps local governments take action to reduce greenhouse gas emissions and adapt to a changing climate. The program offers free technical assistance, grants, and rebates for electric vehicles. Registered communities have made a commitment to act by passing the CSC pledge. Certified communities are the foremost leaders in the state; they have gone beyond the CSC pledge by completing and documenting a suite of actions that mitigate and adapt to climate change at the local level.

TMRC member communities are enthusiastically participating in the CSC program. The Town of Dover was certified as a Bronze-level community in September of 2020, and the Town of North East, Village of Millerton and Town of Amenia are working towards certification at the time of this writing. As part of their certification activities, each of these communities has completed a Road-Stream Crossing Management Plan (RSCMP) that includes a comprehensive inventory of bridges and culverts in their jurisdiction, an evaluation of barrier status and flood risk at each structure, and the results of a collaborative prioritization of replacement projects based on conservation value, potential to reduce flood risk and maintenance need. The RSCMPs are meant to be a tool that will help communities secure financing for replacement projects through competitive grants, capital planning, or recovery operations in the wake of flood disasters.

Each community has also evaluated their existing planning, regulations and operations using the Climate Smart Resiliency Planning tool developed by the CSC program. This analysis is meant to identify opportunities for building community climate resilience, and is the first step towards a detailed climate resilience plan.

These are just two examples of many actions these municipalities have taken in pursuit of their certification as Climate Smart Communities. This program will continue to be a resource for implementing actions described in this Watershed Plan that build resilience in the built and natural environments of the TMR watershed.

4.3 Recommended Actions

Recommended Actions & Milestones	Who	Timeframe (Schedule)	Deliverables & Evaluation Criteria	Esti C
Restore and Protect functioning floodplains wherever possible, particularly in areas adjacent to densely populated areas	TMRC, Watershed Municipalities, Land Trusts	Ongoing	Important floodplains upstream and downstream of densely populated areas are restored/protected; flood risk in population centers does not increase due to loss of floodplain storage	$$$-
Consider adopting regulations that restrict development in floodplains to passive uses and prohibit loss of floodplain storage	Watershed Municipalities w/support from TMRC, NYSDEC	W/in 2 years	Town Boards take up and deliberate this issue during regular meetings	
Ensure that all communities have access to a Certified Floodplain Manager when evaluating potential development in floodplains	TMRC, Watershed Municipalities	W/in 2 years	Opportunities for sharing this service across municipalities explored and solution identified	$
Relocate critical facilities (Fire/EMS, Highway/Public works, town offices, etc.) and high-risk residential developments out of flood-prone areas	Watershed Municipalities	W/in 5 years	At-risk critical facilities and residential developments identified; opportunities for relocating out of harm's way explored	$$

Conduct geomorphic assessments along the TMR mainstem and tributaries that are currently experiencing excessive erosion and deposition to identify opportunities for stream corridor restoration	TMRC	W/in 2 years	10 stream miles assessed; 3-5 projects identified	$$
Upsize hydraulically inadequate bridges and culverts, based on results of Road-Stream Crossing Management Planning	TMRC, Watershed Municipalities	W/in 5 years	Shovel-ready designs for Priority structure in each community with an RSCMP developed	$$$
Complete RSCMPs for Washington, Pawling, Beekman	TMRC, Watershed Municipalities	W/in 5 years	RSCMPs developed, priority structures identified	$$

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000
$50,000

5. AGRICULTURE

5.1 Goals

- Support sustainable practices while supporting farmers through direct outreach.
    - Encourage the adoption and implementation of farm-based Conservation Plans that address natural resource concerns and keep productive agricultural land in use.
- Explore creative and flexible approaches to on-farm riparian buffer restoration.
    - Enhance outreach efforts through identification of demonstration project sites.
- Establish information and equipment sharing networks for Watershed producers.
- Increase access to technical support and funding opportunities for Watershed producers, particularly resources available through Farm Bill programs administered by the Natural Resources Conservation Service.
- Promote and demonstrate the importance of implementing Best Management Practices—including but not limited to integrated agroforestry and silvopasture, nutrient management, and the continued use of soil erosion control methods.
- Increase awareness of and participation in existing programs such as the Agricultural Environmental Management program administered by Dutchess County Soil and Water Conservation District and the New York State Department of Agriculture and Markets' Agricultural Districts program.
- Create opportunities for on-farm agritourism and the promotion of local agriculture.

5.2 Current State of Agriculture in the TMR Watershed

The local economy, scenic rural landscapes, and strong community character that define the Ten Mile River (TMR) watershed historically have been, and continue to be, largely influenced by agriculture as a primary industry.[107] The Wappinger and Mahican People of the Algonquin Nation first began cultivating the land in (and around) the TMR watershed approximately 2000 years ago.[108] Post-colonization, agriculture remained the dominant land-use in the watershed even as lands to the west (the eastern bank of the Hudson River) became industrialized as a result of proximity to developing cargo freight systems. Agriculture persevered as the dominant land use due to the TMR watershed's fertile floodplains and abundant sources of water.

As industrialization progressed, the lands within the TMR watershed maintained a connective support system to more populated centers, such as Poughkeepsie and New York City. This connection has been a double-edged sword for farming in the TMR watershed— while access to large markets benefits farming operations, proximity to dense populations increases the pressure for the development and conversion of arable lands. The pace of this conversion picked up in the 1990's, and that pressure continues today.

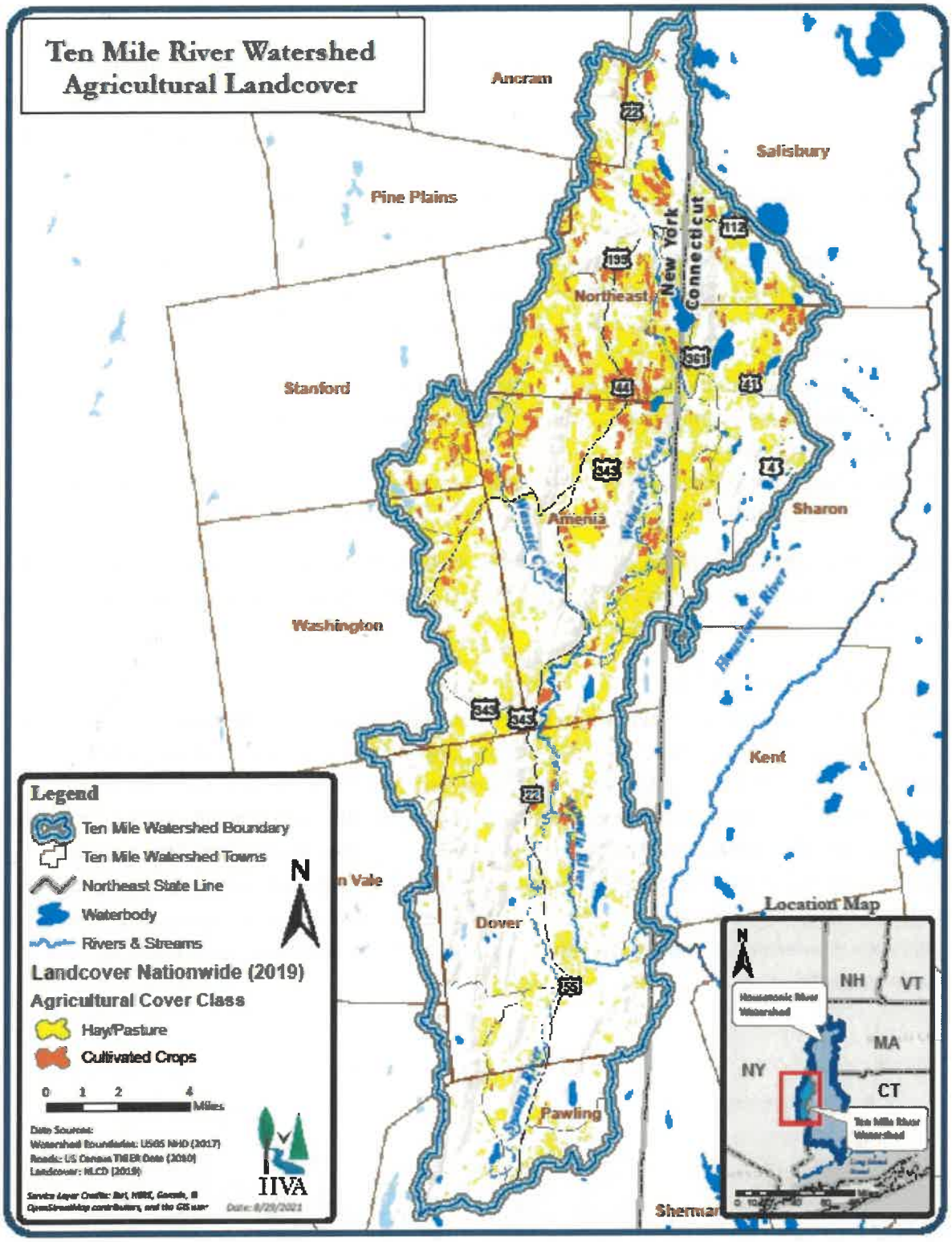
Historically, apple farms were common in this region as glacial deposits created favorable soil conditions for orchards. [109] However, dairy has been the most notable agricultural industry in the TMR watershed. Dairy became a strong economic driver following the 1861 construction of the New York Condensed Milk Company headquarters in the unincorporated community of Wassaic (Town of Amenia). The New York Condensed Milk Company became the Borden Company in 1919, which would become the nation's largest distributor of fluid milk in the 1930's. This influenced the prominence of the dairy industry that continues to this day.[110]

The combination of long-established farms and growth of new operations has kept agriculture as one of the Watershed's primary industries and community assets. Local farms provide fresh food to Watershed communities as well as more urbanized areas along the Hudson River.

Agricultural landscapes instill a strong sense of cultural identity, community pride and a connection to land, water, natural systems, and seasonal cycles – benefiting tourism and creating outdoor recreation opportunities. When managed properly, conserved open spaces on farmlands can provide habitat for wildlife, as well as a buffer between the land being worked and adjacent waterbodies – protecting the quality of surface and groundwater. Additionally, proper management of agricultural lands provides ecosystem services through soil and biodiversity conservation, carbon sequestration, and flood mitigation.

Current Agricultural and Natural Resource Production

Map 19 below shows current agriculture-related land cover. These lands and associated agricultural activities are important both for the region's economy and conservation lands network. The following sections cover regional agricultural production trends, threats to the sector, management practices, and resources available to farmers.



Map 19. Agricultural land in the TMR watershed.

Agricultural Production Groups

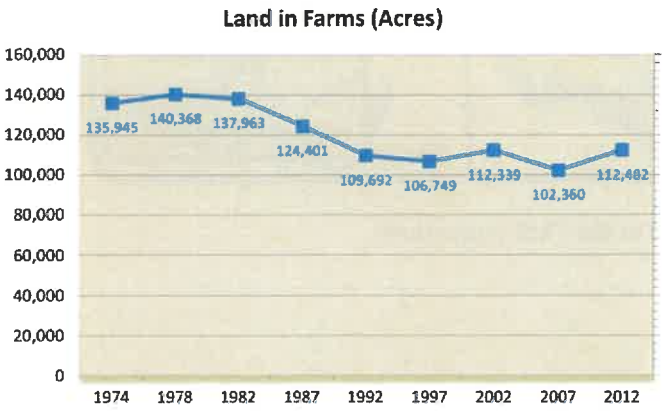
All agricultural products fall within an agricultural production group. The following prominent agricultural production groups of the Ten Mile River watershed were compiled based on a combination of information received from local land conservancies, the Dutchess County Agricultural Navigator, the 2019 Town Agricultural Profiles, and NRCS.

- **Livestock:** Data from NRCS show that the highest number of livestock on farms within the watershed were found to be dairy cows. It was found that there is an estimated 7,500 acres of pastureland associated with livestock production.[111] Dairy is a particularly large agricultural segment in Amenia (1,875 acres) and in Town of Washington (752 acres).[112] Livestock, particularly beef, sheep and goats, make up a large segment of farm operations on 4,309 acres of property in Town of Dover.[113]
- **Row crops:** Typical row crops include corn and soybeans. Many of the corn and soybeans grown in the region are planted using no-till and contour strip cropping methods.[114]
- **Vegetables:** specialty crop
- **Other Agricultural Groups (specialty crops):** Cut flowers, forestry, nurseries, greenhouse production, maple syrup, hops, Christmas trees, hemp, orchards and vineyards

The maple syrup specialty crop has a strong presence in the Town of Dover and relies on sugar maple trees for production. Madeva Farms, located in Dover, is home to Crown Maple— a nearly 800-acre tree farm devoted to production of maple syrup.

Trends in Eastern Dutchess County

Dutchess County experienced expedited loss of farms through conversion of farmland into other uses due to development pressure and a decline in profitability of farming operations in the 1990's. [115] Currently, the agricultural economy of Dutchess County (and therefore, much of the lands that encompass the TMR watershed) is making a rebound. This is due to a variety of influences such as; the implementation of the *1998 Dutchess County Agricultural and Farmland Protection Plan*; a slow in development following the 2008 recession; a renewed interest in farming by young farmers and formation of mentorship programs; "Buy Local" campaigns and "farm-to-table" trends and markets; and the utilization of information technologies and farming practices that provide opportunity for local farms to turn profit. [116]



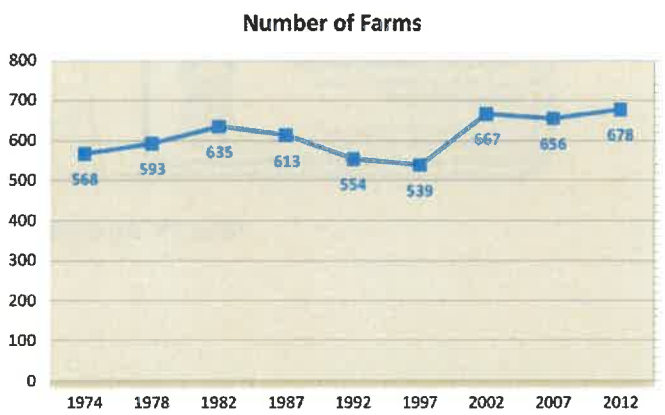


Figure 8. a) Trend in acres of farmland in Dutchess County from 1974-2012. b) Trend in number of farms in Dutchess County from 1974-2012 *(Dutchess County Agriculture and Farmland Protection Plan).*

> **"More than 70 percent of our farms are going to change hands in the next 20 years. If we want to continue to have productive farms in the foodshed, it's critical that we keep the land affordable for the next generation of farmers."**
> Lindsey Lusher Shute, Director and Co-Founder, National Young Farmers Coalition

Data show that the total number of acres in farming has been stable for the last 20 years (Figure 8a), and that total is largely comprised of smaller farming operations that are experiencing stability in sales.[117] Due in part to "Buy Local" campaigns and an uptick in farmers markets and food accessibility initiatives, there is a renewed consumer-driven interest in locally produced foods in both the Hudson and Harlem Valleys. Farms within the TMR watershed are well positioned to take advantage of the Hudson Valley name associated with farming and agricultural products. Both longstanding entities and newer groups assist farmers and wholesalers in marketing local products and developing farming infrastructure (see the "Farmer Resources" section of this chapter for more information). Proximity to New York City allows farms in Eastern Dutchess County to distribute products more broadly. Both local and broad distribution are also aided by the utilization of social media to potentially reach previously inaccessible customer bases. With a mix of multi-generational farms, active chapters of the National Young Farmers Coalition, and many resources and expertise being invested in agriculture and natural resources production, movement is trending towards a more equitable and sustainable regional system.[118]

Ongoing Threats

There are many challenges to the local agricultural sector's viability in the TMR watershed that align with those that exist throughout Dutchess County. Challenges to agricultural operations were identified in the 2015 Dutchess County Agricultural and Farmland Protection Plan at a countywide scale. In general, a lack of awareness of the general public about agricultural food systems and a disconnect between economic development initiatives and agricultural needs were identified as key challenges in the Plan. Additional issues included aging farmers combined with a lack of next generation farmers, loss of farmland due to suburban growth, and the high cost of farm operations and land.[119]

Land development pressure, competition with large-scale or national farm industries, and fragmentation of productive farmland are all challenges that extend into the TMR watershed. Farmland affordability and access is especially of concern to young farmers in the region .[120] As eastern Dutchess County is attractive amongst second-home buyers and estate properties, there is a presence of active farmland being purchased to turn into estate properties. Sometimes landowners choose to continue to have the property "actively farmed". Residential and industrial development pressure exists in the southern portion of the watershed, especially along the Route 22 corridor.[121] Localized regional innovative solutions to these issues exist in the form of landowner match programs. In the NY portion of the Watershed, the Farmer-Landowner Match Program connects landowners interested in increasing land productivity with farmers seeking land, and provides guidance needed to establish a lease structure that is fair and secure for both parties. This is an exceptional resource to both farmers and landowners, and

individuals looking to start or expand farming operations and preserve active agricultural lands in the Watershed.

Additional challenges faced by farms in the region include instability and a lack of a strong economic market for agriculture and consistent access to local marketplaces for farmers to reach customers and vendors to sell and distribute their products. There is also a need for a robust agricultural economic development program so that farmers can access the extended network of business needed to support farming such as buyers of products, transporters, veterinarians, machinery suppliers, etc. Some farmers have utilized innovative ways to engage with customers and create greater accessibility through providing Community Supported Agriculture memberships (CSAs), value added products, having a presence at farmers' markets, and utilizing social media. However, this all takes a certain skill set, time, energy and monetary investment, all of which is an additional challenge.[122] Initiatives such as the Dutchess County Tourism Farm Fresh Guide and Dutchess Farm Fresh Program, as well as, New York State Taste of NY provide support to local farms to advertise and market their products. The Dutchess County Agricultural and Farmland Protection Plan presents the development of an Agriculture Business and Retention Program as a solution to address these issues. The plan also identified County support for a regional "Agricultural Navigator" position to coordinate programming and activities that support agriculture. This position is currently active and delivered by the Cornell Cooperative Extension Dutchess County Agriculture and Horticulture Program.

In particular, with a strong presence of independent dairy farms in the TMR watershed, a current challenge is low milk prices, which make it hard for dairy farmers to turn profit.[123] One example of a solution to this is farmer owned Hudson Valley Fresh, which is dedicated to supplying accessible and high quality local dairy products regionally, while ensuring that farmers are able to secure living wages. By joining together, farmers are providing a solution to this challenge. There are four Hudson Valley Fresh participating dairy farms in the TMR watershed.[124] The lack of processing facilities for butchering and packaging is a challenge to the beef and livestock industries in the Watershed. Sometimes these challenges cause a farm to have to switch from one production type to another such as from dairy operations to producing hay and grain instead. Maintaining farmer awareness of available resources key in overcoming these challenges.

Lastly, climate change impacts are becoming more prevalent and thus are a threat and challenge to farmers and the agricultural lands they manage. Climate change vulnerabilities include irregular weather patterns, drought, increased precipitation including hail and heavy rains, flooding, frost risk, heat stress and emerging pests and diseases as the climate warms.[125] The Agricultural Environmental Management Program (AEM) and Climate Resilient Farming Program (CRF) are two NYS conservation incentive programs uniquely positioned to support climate resilient best management practices in the region.[126]

Farmland Protection

There are programs in place in both the New York and Connecticut portions of the TMR watershed that help communities to proactively preserve and protect open space and farmland, watershed health, and community vitality. Municipalities can also implement tools and techniques in their local Comprehensive and Open Space Plans and Zoning Laws to help ensure that the land that is important to their rural communities is able to continue for future generations. The 2015 Dutchess County Agricultural and

Farmland Protection Plan provides recommendations for Dutchess County to preserve farmland through a variety of ways including partnerships, programs, conservation easements and Purchase of Development Rights (PDR), and raising awareness for county and state-level farm-friendly regulations.[127] The Agricultural and Farmland Protection Plan also designates specific farmlands as being part of Agricultural Priority Areas within the county.

A key tool for protecting farmland is a conservation easement. A conservation easement permanently protects the important resources on a property while ensuring that retained development is located on less resource rich portions of the land. They help to assure that land is available for agricultural (and associated) uses in perpetuity, thus preventing inappropriate development from occurring. Overall, a conservation easement allows landowners to plan the future uses of their land so that important open space and natural resources are not compromised, but instead preserved, while still addressing landowners needs and financial goals.

Conservation Easements can be donated or sold/purchased. When they are sold/purchased, this is known as the Purchase of Development Rights (PDR) because the land trust is purchasing some or all of the landowner's rights to develop their land. Through a PDR project a landowner is compensated for giving up their right to fully develop their property in order to protect their land and keep it open for agricultural uses. Proceeds from a PDR conservation easement can help support a farmer's ability to invest in on the ground improvements to infrastructure and equipment, to purchase more land for their operation, and to facilitate transfers of ownership from one generation to the next, or to a new and beginning farmer, something that may otherwise be cost prohibitive. This assistance can help make farm operations more realistically viable and sustainable long into the future.

Conservation easements are most often held by local not-for-profit land trusts that have the experience and financial ability to hold and oversee these perpetual agreements into the future. Active land trusts in the TMR watershed include the Dutchess Land Conservancy, the Northwest Connecticut Land Conservancy (formerly the Weantinogue Heritage Trust), the Oblong Land Conservancy, Scenic Hudson Land Trust, and the Sharon Land Trust. Land trusts work directly with landowners who are considering the donation or sale of a conservation easement to help them through the process from A to Z. This includes assisting the landowner in developing a future plan for their property, determining likely funding sources, acquiring appraisals, applying for funding, all the way through closing the project.

Funding sources include the USDA Natural Resource Conservation Service (NRCS), the US Fish and Wildlife Service through the Great Thicket National Wildlife Refuge, the Connecticut Department of Agriculture, the New York State Department of Agriculture and Markets (NYSDAM), the CT Department of Energy and Environmental Protection (CT DEEP), the New York State Department of Environmental Conservation, the Dutchess County Partnership for Manageable Growth and Open Space (PMG), local municipalities through special open space funding allocations, Bond Acts and Community Preservation Funds, private foundations, other land trusts and even individuals.

Dutchess County established its Partnership for Manageable Growth Program in 1999, which helps to fund open space and farmland protection projects. The program provides matching grants to assist local municipalities and land trusts to protect agricultural and open space resources by purchasing

conservation easements. The Dutchess Land Conservancy (DLC) holds hundreds of conservation easements on tens of thousands of acres of land in the NY portion of the Ten Mile River Watershed, a good portion of which have some type of farming. The DLC has purchased the development rights on several farms within the Watershed as well. This ensures that valuable lands suitable for farming are conserved into the future. These successful PDR projects were made possible through partnerships with Dutchess County, the New York State Department of Agriculture and Markets, the Housatonic Valley Association, and Scenic Hudson. Additional lands are conserved in the TMR watershed by other organizations including the Oblong Land Conservancy, Sharon Land Trust, the Nature Conservancy, and the North American Land Trust – although these are not always farmlands.

Scenic Hudson developed a Foodshed Conservation Plan in 2019, as a means to proactively prioritize conserving farmland throughout the Hudson Valley. 255 Foodshed Priority Farms were identified within the NYS portion of the Ten Mile River Watershed by Scenic Hudson in 2020. Within the Watershed, 5,440 acres of the total 23,475 acres identified as Foodshed Priority Farms are protected to date in the New York portion.

Dutchess County Agricultural Districts Program

In order to encourage the continued use and preservation of farmland for agricultural production, Dutchess County implemented an Agricultural Districts Program. The Program is based on a combination of landowner incentives and protections with an objective to preemptively forestall conversion of farmland to non-agricultural uses. Dutchess County has four Agricultural Districts with over 5,000 parcels of land.[128] There are 1,042 Agricultural District parcels within the New York portion of the Ten Mile River watershed (HUC-10). Agricultural District land acreage within the New York portion of the Watershed totals 60,076 acres. An important benefit of the Program is the opportunity for farmland owners to receive real property assessments based on the value of their land for agricultural production rather than on its development value. Farmers that receive an agricultural assessment collectively save over $70 million annually throughout New York State.

In 2015, Dutchess County created Town Agricultural Profiles for each of the 20 towns within the County. A new round of profiles is completed annually. The purpose of the profiles is to provide a short narrative and summary of details on the state and trends of agriculture in each community including statistics of farmland acreage, types of farming production and percentage of type, and economic statistics. Relevant information from Town Agricultural Profiles of each eastern Dutchess County town within the TMR watershed is included in Appendix D.

5.2.1 Agriculture and Watershed Management

Agricultural production activities require significant amounts of ground and surface waters, which speaks to the proximity of farmlands to water resources. This close relationship between the two can negatively impact waters if farmland is not carefully managed. Impacts in the TMR watershed include pollution from livestock with unrestricted access to streams, inadequate riparian buffers in combination with manure spreading and and the destabilization of stream banks. Allowing livestock to directly drink from streams accelerates the destruction of stream banks, as the vegetation is trampled, and the bank material is eroded. Animal access can also create a direct path for animal waste to enter the water. Farming practices that extend all the way to water edge ultimately impact water quality through the lack

of a healthy riparian buffer. Issues related to insufficient buffer areas are excess nutrients and sediment entering waterways.[129] Agricultural runoff can impact water quality through increased nitrogen and phosphorus loads (nutrient loading) from manure or fertilizers that enter the system as non-point or point source pollution. Nutrient loading can cause algal blooms, which in turn lead to low dissolved oxygen levels and hypoxic conditions, limiting aquatic life. Additionally, this manure-related runoff contributes pathogenic bacteria and pharmaceuticals to waterways.

It is clear that local farms and agricultural operations play an important role in the stewardship of the TMR watershed. The USDA Natural Resource Conservation Service (NRCS) works to ensure that conservation practices and management strategies are implemented on agricultural lands, so that water quality and watershed health are maintained, and benefit from restoration and conservation efforts.[130] This is accomplished through implementation of best management practices (BMPs), many of which help to reduce erosion and improve water quality. In NY, the Dutchess County Soil and Water Conservation District (DCSWCD) works with regional NRCS, to offer technical as well as financial assistance to implement BMPs on local farms. The Northwest Conservation District partners with NRCS to offer similar support in the CT portion of the TMR watershed. BMP focus areas include barnyard runoff control, stream protection, cropland erosion control and nutrient management.[131] Through its Agricultural Environmental Management Program (AEM), the DCSWCD helps farmers identify and address natural resource (animal, farmland, forest, plant, soil, wetland, wildlife, water, air) concerns in areas being actively farmed.

NRCS works with agricultural landowners to protect lands and waterbodies and preserve farmland through the Wetland Reserve Easements (WRE) Program assists landowners to protect wetland ecosystems. Wetlands are extremely important for watershed health because they help catch and filter pollutants before they enter waterbodies, waterways, and groundwater storage areas. This ability to capture overland flow also allows wetlands act as a sponge—assisting in the storage and slowing of floodwaters. Lastly, wetlands provide critical habitat for a unique variety of wildlife. Eligible lands for this program include converted or farmed wetlands that can successfully be restored, agricultural lands that are subject to repeated flooding, and riparian areas that may provide a linkage to protected wetland areas.

Climate Resilience and Flood Damage Prevention

Climate change brings serious vulnerabilities to agricultural lands and operations in the TMR watershed region, threats of which are previously identified in "Ongoing Threats" section of this chapter. In New York State, average temperatures have been increasing slowly (2° F in summer, 4° F in winter) since 1970. This change results in climatic effects, many of which are costly and damaging to New York State communities and infrastructure.[132] In particular, irregular weather patterns prove to be a challenge to farmers. Increased temperatures and significant weather events bring drought, flooding, pests, and pathogens—all of which stress soils, crops, and livestock. Farmers are well experienced in being adaptable to new challenges, and many recognize the need to address climate change impacts proactively. There are resources, strategies, tools and funding assistance available through supportive regional organizations to assist farmers in mitigating risk and ensuring that agricultural lands and production are not diminished in the face of these emerging vulnerabilities (see the "Farmer Resources" section of this chapter).

Cornell University College of Agriculture and Life Sciences (CALS) supports a Climate Smart Farming program that aids farmers with decision making tools and strategies for climate resilience. A Cornell publication, *Farming Success in an Uncertain Climate,* provides examples of strategies to address drought and heat stress including; increasing irrigation capacity for high-value crops, shifting to drought-tolerant crop varieties, and being more cognizant of seasonal changes to shift plant dates and avoid dry periods. Strategies to adapt to increased heavy rainfall events and flooding include; increasing soil organic matter for better drainage, investing in drainage systems for repeatedly flooded fields, shifting to flood-tolerant crop varieties, and being cognizant of seasonal changes to shift planting dates during wet periods. Climate change challenges specific to the dairy and livestock industry include improving barn ventilation, minimizing heat exposure and maximizing shade, and increasing water availability for livestock. High-cost strategies include improving cooling capacity of enclosures with appliances and insulating under barn roofs to save on cooling costs and buffer heat. Lastly, strategies to address pests and diseases such as introduced, ecologically-destructive insects and weeds include regional monitoring efforts by organizations such as Cornell Cooperative Extension Dutchess County and the Lower Hudson Partnership for Regional Invasive Species Management (PRISM), and enhanced monitoring and implementation of integrated pest management (IPM). Investing in climate change resilience through proactive measures brings benefit to farmers and the integrity and value of agricultural lands throughout the TMR watershed.[133] By collaborating and learning from each other, and sharing strategies and BMPs, collectively, the farming community, and the watershed itself, will benefit from increased resilience.

Farming and Carbon Sequestration

In considering climate change impacts, agricultural producers should also recognize how their work helps to mitigate climate change effects through the carbon sequestration potential of the plants on their land. This carbon sequestration process pulls carbon dioxide out of the air and releases it into the soil which acts as "sink" and traps the carbon—keeping it from contributing to the growing levels of greenhouse gases in the atmosphere. The movement in farming to specialize in soil restoration and "trapping" carbon is known as "regenerative agriculture."

In 2019, a pilot program was proposed to be included in the state budget to experiment with carbon sequestration techniques on Dutchess County farms. The proposed legislation and budget passed to create a two-year soil health pilot project for carbon farming to be administered by local Soil and Water Conservation Districts in Columbia and Dutchess Counties. The project's goal is to help farmers restore soil on their farms while reducing greenhouse gas emissions and mitigating climate change. Simultaneously, it serves as a model for other agricultural operations at a local, regional and national level.[134]

Preservation of Natural Heritage and Biodiversity

Both healthy biodiversity and agricultural production rely on fertile soils and clean water; therefore, sustainable agricultural practices also assist in the preservation of the TMR watershed's rich and unique natural heritage. Zoning regulations and easements that prevent farmlands from being converted and developed ultimately allow for the viability of important habitat linkages— connections between habitat types (see the Natural Heritage chapter of this Report for more information on biodiversity in the TMR watershed and habitat linkages).

NRCS assists in preserving natural heritage by offering the Agricultural Land Easements (ALE) Program, which provides funding to partners such as land trusts to purchase conservation easements on working lands. Eligible land categories include cropland, rangeland, grassland, pastureland and forestlands. Through this program, the NRCS will work with the agricultural landowner or producer to develop a restoration and maintenance plan and ensure that BMPs are used to properly manage and conserve the land.[135]

Recreation and Agritourism

The Harlem Valley (and therefore, the TMR watershed) has long been an attractive destination for people living in the more populated areas of NY and surrounding states. While the unique landscapes of the region have traditionally been a driving force in drawing in visitors, today it also benefits from the increased visibility of the Appalachian Trail- which runs though the southern portion of the watershed. With information being more widely available and accessible through internet advertising and networking, hikers and visitors are increasingly likely to discover more of the region's offerings while passing through.

The *Harlem Valley Outdoor Recreation Economic Assessment Research Summary,* conducted by the Appalachian Trail Conservancy (ATC) found that farm-based event venues, local food restaurants, and farm experiences add to the strength of the agricultural sector of the economy.[136] The ATC found - through the Harlem Valley Visitor Survey - that there is significant interest in locally-produced foods among those visiting for outdoor recreation. The Survey also showed farm stores ranking fourth on a list of 8 Frequently Used Visitor Services (Figure 9).

Given this connection between agricultural production and tourism, it could prove to be economically beneficial for farm operators to build connections within the outdoor recreation sector through secondary business models. This could include utilizing some of the land and infrastructure for commercial use that may not necessarily be farming-related (e.g. wedding venues, corn mazes, breweries, etc).

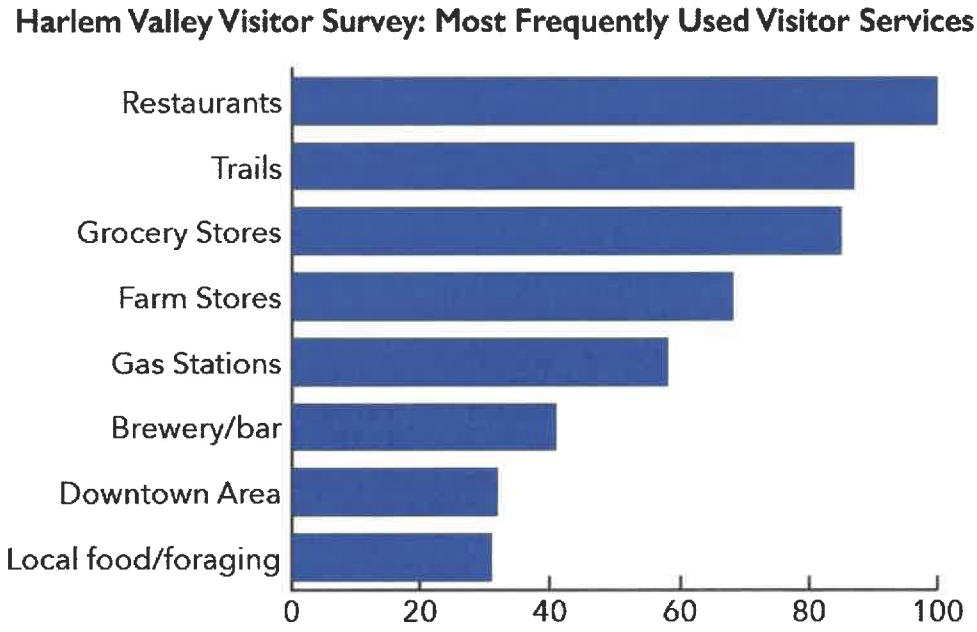


Figure 9. Results from the Harlem Valley Visitor Survey: Frequently Used Visitor Services.

5.2.2 Resources for Farmers

There are a number of agencies and organizations that can provide programmatic support for on-farm natural resource management. The following is a list of resources available to communities within the Ten Mile River watershed.

Resources Available: Ten Mile River Watershed

- **USDA Farm Service Agency (FSA)-** The FSA was developed to serve farmers and ranchers by providing financial safety nets to ensure economically viable production; increasing stewardship of natural resources while enhancing the environment; ensuring effective and efficient procurement of commodities to increase food security; and managing people and service capabilities (i.e. investing in the workforce). These goals are accomplished through the availability of Available (operating, ownership, and guaranteed), Targeted (legislatively set aside for youth, minority, and women farmers), and Specialty (reserved for Native American Tribal farmers and emergencies) Loans.
- **Natural Resource Conservation Service (NRCS)**- NRCS is an agency of the Department of Agriculture that provides assistance to farmers, landowners, and others, with an emphasis on sustainability. NRCS does
- **NRCS Farm Bill-** Enacted on December 20, 2018, the NRCS Farm Bill strives to support the conservation efforts of farmers. The service offers both financial and technical assistance that helps to make and maintain improvements on the land. Each state has region-specific service centers (NY is broken up by county, CT has one state office and five field offices). This is accomplished through the following core programs:
    - The Environmental Quality Incentives Program (EQIP): addresses natural resource concerns to deliver environmental benefits.

- The Conservation Stewardship Program (CSP): maintains and improves existing conservation systems and adopts additional activities to address priority concerns.
- The Agricultural Management Assistance (AMA): assists in managing financial risk. NRCS administers conservation provisions while Risk Management Agency and Agricultural Marketing Services assist in product diversification and marketing.
- The Agricultural Conservation Easement Program (ACEP): supports landowners and land trusts in protecting, restoring, and enhancing wetlands, grasslands, and active farms through Agricultural Land Easements and Wetland Reserve Easements.
- The Healthy Forests Reserve Program (HFRP): supports restoring, enhancing, and protecting private and tribal forestland resources through easements and financial assistance.
- The Regional Conservation Partnership Program (RCPP): unites NRCS and its partners to provide conservation assistance to producers and landowners through partnership agreements and RCPP conservation program contracts.

- **National Young Farmers Coalition-** The National Young Farmers Coalition is a national network that advocates for changes in policy, builds networks, and provides business services to ensure the success of young farmers. The Hudson Valley Young Farmers Coalition is a chapter been organizing since 2012 to address challenges related to beginning careers in farming. The New Connecticut Farmer Alliance (the CT chapter of the Coalition) has been was formed in 2010 as a social network of support and resource sharing.
- **Northeast Sustainable Agriculture Research and Education Program (SARE)-** SARE offers grants and education to farmers and educators in the 13 northeastern states, including NY and CT.
- **Housatonic Valley Association (HVA)-** HVA is dedicated to preserving, protecting, and utilizing the land and waterways of the Housatonic Valley Watershed.

Resources Available: New York

- **New York State Department of Environmental Conservation (NYSDEC)-** The department guides and regulates the conservation, improvement, and protection of New York's natural resources. NYSDEC also issues permits for Concentrated Animal Feeding Operations (CAFOs), irrigation, and stormwater from construction.
- **New York State Energy Research and Development Authority (NYSERDA)-** NYSERDA supports eligible farms in identifying electric and gas energy efficiency measures. Funding may be provided for solar or wind system installs, and the construction or renovation of commercial and industrial buildings. NYSERDA also offers a Food Waste Management program where they partner with farmers who are under pressure to control contaminants from manure to explore possible technological solutions and business structures.
- **Dutchess County Soil and Water Conservation District (DCSWCD)-** DCSWCD's primary goal is to protect and improve water quality and enhance and preserve natural resources. They offer technical and financial assistance for the design and installation of soil and water conservation practices, including barnyard runoff control, stream protection, cropland erosion control, and nutrient management. DCSWCD implements the AEM in Dutchess County.
- **Agricultural Environmental Management Program (AEM)-** AEM is a cooperative, interagency program developed through the NY Soil and Water Conservation Committee that supports the identification of risks on farm lands. The program is voluntary and incentive-based— designed to help farmers to make science-based, cost-effective decisions to further protect water and soil

quality as well as other important natural resources. Farmers work with local AEM resource professionals to develop comprehensive farm plans using a tiered process:

  - Tier 1 – Inventory current activities, future plans, and potential environmental concerns.
  - Tier 2 – Document current land stewardship while assessing and prioritizing areas of concern.
  - Tier 3 – Develop conservation plans addressing concerns and opportunities tailored to farm goals.
  - Tier 4 – Implement plans utilizing available financial, educational, and technical assistance.
  - Tier 5 – Evaluate to ensure the protection of the environment and farm viability.

- **Agricultural Non-point Source Abatement and Control Grant Program-** The Agricultural Non-point Source Abatement and Control Program is a competitive grant program with funds awarded through NY county Soil and Water Conservation Districts. The program uses funds from the NYS Environmental Protection Fund to support water quality protection projects that focus on environmental planning and best management practice systems. Projects include conservation measures, such as nutrient management through manure storage, vegetative buffers along streams, and conservation cover crops.
- **Cornell Cooperative Extension of Dutchess County (CCEDC)-** CCEDC offers agricultural education, resource-based information, and farm business management assistance to farmers. Strategic initiatives in agricultural sustainability and economic development.
- **Dutchess County Department of Planning and Development-** The Dept. of Planning and Development is responsible for a wide variety of comprehensive, county-wide, land-related planning and preservation. The Agriculture and Farmland Protection Board (AFPB), Agricultural Advisory Committee, and Right-to-Farm Resolution Committee operate within the Department to report to the County Legislature, advise the County Executive and address complaints related to farming activities, respectively. The AFPB also funds projects and activities that help meet the goals outlined in the DC Agricultural & Farmland Protection Plan, and the Department provides relevant data and maps.
- **Dutchess Land Conservancy-** The DLC works with the County Farmland Protection Board to leverage numerous federal, state, county, town, and private funding sources to secure millions of dollars for farmland protection in Dutchess County.
- **Hudson River Valley Greenway-** The Greenway Compact Program is a voluntary partnership between the Greenway Council and local communities within the Hudson River watershed, but it includes all of Dutchess County. Participating municipalities work together to ensure that land use decisions are consistent with the goals and policies of the program, and in turn receive incentives and long-term benefits.
- **Harlem Valley Farm and Food Alliance-** This Harlem Valley Farm and Food Alliance was formed by next-generation farmers and natural resource-focused entrepreneurs to provide support for each other and their community. They work together in product promotion, resource exchange, and advocacy.
- **The Local Economies Project's Hudson Valley Farm Hub-** Hudson Valley Farm Hub is involved in testing practices and models for farms and natural businesses, which can then be shared with people involved in agriculture throughout the area. They also host the multi-year farmer training program, ProFarmer, that provides hands-on instruction in ecologically regenerative, economically viable, and equitable farm practices that are integrated with food justice and community.

- **Hudson Valley Agribusiness Development Corporation (HVADC)-** The HVADC provides expertise and resources for agriculture-related businesses in the Hudson Valley, from analysis and start-up assistance for new ventures to market expansion and improved distribution networks for existing agricultural businesses.
- **Hudson Valley FARMLINK Network (HVFN)-** HVFN is an exceptional resource for farmers and farmland owners who seek guidance in finding or starting their farm, transferring their farmland, connecting with a farmer or stewarding their farm property. The program was created in response to farmland loss and additional challenges faced by farmers. The network includes 17 partner organizations that provide match services, trainings and networking events, and one-on-one assistance.
  The Farmer-Landowner Match Program is an affiliated program formed through a partnership between Dutchess and Columbia Land Conservancies.

Resources Available: Connecticut

- **Connecticut Department of Agriculture-** The CT Department of Agriculture seeks to effectively develop, promote, and regulate agricultural businesses in order to foster a healthy economic, environmental, and social climate. The Department offers numerous resources and programs, such as the Farmland Preservation Program—developed to ensure that lands remain available for agricultural use.
- **Connecticut Farmland Trust (CFT)-** The CFT was founded by the Hartford Food System, "Celebration of Connecticut Farms, Food and Art", and others as a land trust to protect the State's working lands. The Trust accepts donations of, and purchases, conservation easements and agricultural lands. They also work with towns and land trusts to identify threats to farmland, and connect with communities to encourage local farmland preservation through support and engagement.
- **Connecticut FarmLink-** CT FarmLink is a program funded by the Community Investment Act and the CT Department of Agriculture, in partnership with the CFT. FarmLink acts as a clearinghouse that connects both prospective farmers and farmers looking to expand with available farmland, in order to continue the area's agricultural legacy.
- **Connecticut Farm Bureau (CFBA)-** The CFBA is a statewide non-profit organization with an assigned farm bureau for each of the eight counties. Each bureau acts as a separate entity with their own Board of Directors and work plan. The CFBA works to elevate the agricultural sector through education, market promotion, and legislative advocacy.
- **University of Connecticut (UConn) Farm Risk Management and Crop Insurance Program-** This UConn-supported Program provides farmers and agribusinesses with tools and information to improve financial management and reduce risk. The Program provides one-on-one sessions that can help develop a risk management plan, understand crop insurance, inform on labor issues and regulations, and direct toward stress support services.
- **The Northeast Organic Farming Association of Connecticut (CT NOFA)-** CT NOFA seeks to support the growth of organic agriculture, food, and land care in CT to encourage a healthy relationship with the natural world.

5.3 Recommended Actions

Recommended Actions & Milestones	Who	Timeframe (Schedule)	Deliverables & Evaluation Criteria	Esti C
Encourage agricultural operations to develop and implement farm-scale Conservation Plans that include best management practices to reduce pollution caused by farm-related activities.	Dutchess SWCD, CT Northwest Conservation District, NRCS, HVA, Land Trusts	w/in 5 years	3-5 new Conservation Plans written and adopted	$$
Connect with local producers and host regular listening sessions to identify needs and build support networks.	TMRC	w/in 2 years	3-4 meet ups/year depending on availability; establish easily-accessible contact and resource lists for producers	$

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000
$50,000

6. Natural Heritage

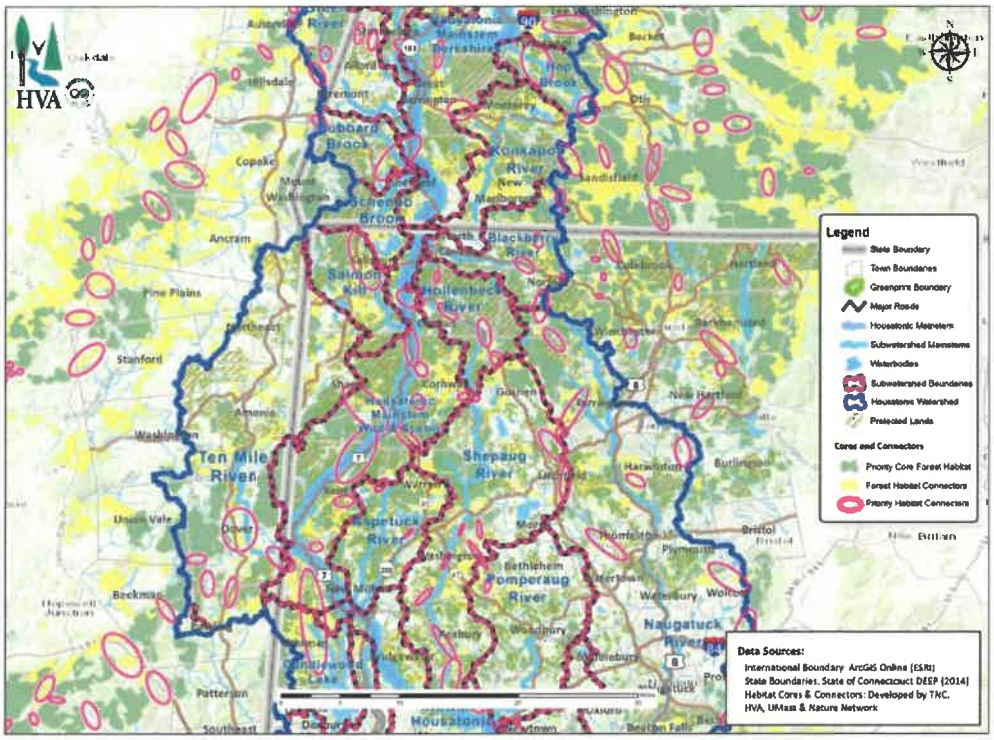
6.1 Goals

- Develop a unified biodiversity conservation strategy for the TMR watershed informed by key partners and existing local and regional conservation planning.
- Promote and support the creation and maintenance of biodiversity inventories.
- Protect land through conservation easements or in-fee purchase in large contiguous forest blocks and other core habitats as opportunities arise.
- Support preservation and expansion of aquatic and terrestrial habitat connections in areas important to landscape-scale connectivity:
    - Remove barriers to fish and wildlife passage along stream corridors.
    - Restore and protect healthy riparian buffers.
    - Protect land through conservation easements or in-fee purchase
    - Identify ways to make these efforts beneficial for landowners and the greater Watershed community, including finding areas where land protection and stewardship can accomplish multiple objectives (biodiversity conservation, flood damage prevention, water quality protection, recreation enhancement).
- Build biodiversity-focused educational outreach to raise awareness of rare and significant plant and animal populations that exist within the Watershed
    - Use local attractions as outdoor classrooms for learning about local habitats and ecosystems.
    - Plan community events that celebrate and raise awareness of our cherished natural resources.

6.2 Current State of Natural Heritage in the TMR Watershed

The 132,000 acres of land draining to the Ten Mile River support a variety of species and habitats of conservation concern. The TMR watershed overlaps closely with the region known as the Harlem Valley. Bounding the valley on either side are forested upland ridges that feature a north-south orientation and extend through the Litchfield Hills into the Taconic Range. The topography of this region yields important hydrologic linkages between the uplands, associated lowland wetlands, aquifers, and the extensive network of streams that make up the Ten Mile system. The last of which join together and meet the Housatonic River near Kent, CT, where they flow south to the Long Island Sound.

A complex series of earth-shaping events that have occurred over geologic time, combined with the region's climate and both historic and contemporary land uses, provide this area's distinctive natural heritage as it is known today. These variables intertwine in a variety of combinations to influence the size, condition, and distribution of the plants, animals, and natural habitats within the Watershed. The habitat Cores and Connectors that occur throughout the watershed are home to rare species and natural communities—both of which are dependent on the terrain as it exists now, leaving them highly vulnerable to alteration and destruction through inappropriate land use and inadequate water resource management.



Map 21. Core forests and important connections in the Housatonic River watershed.

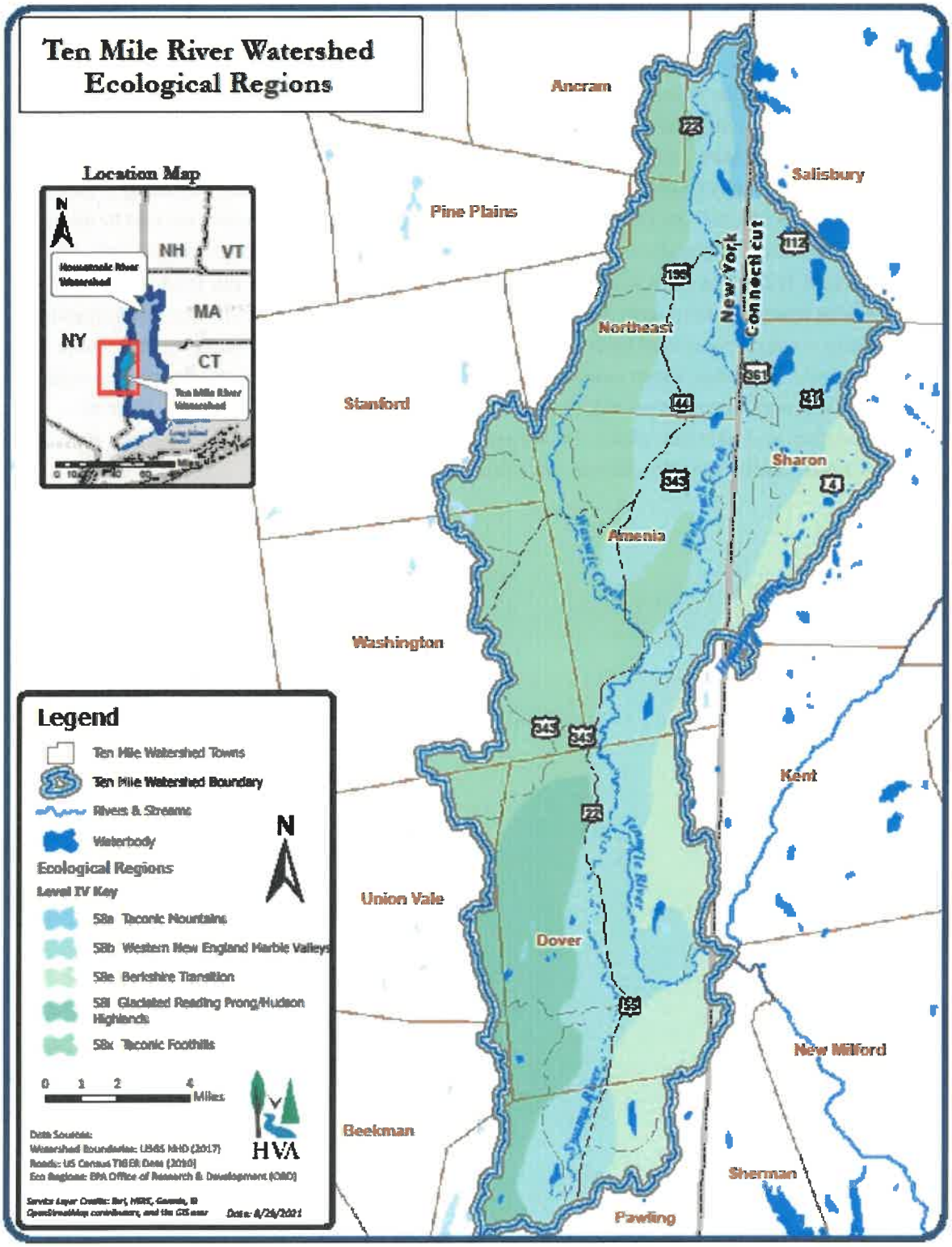
6.2.1 Ten Mile River Ecoregions

Ecological regions, or ecoregions, are areas that are generally similar in type, quality, and quantity of environmental resources present. Like watersheds, these ecoregions are delineated using a hierarchical system. The Nature Conservancy breaks New York into seven distinct ecoregions. The TMR watershed lies within the Lower New England-Northern Piedmont ecoregion—described as a limestone valley with low mountains and lakes throughout.[137] There are six different ecoregions within Dutchess County, NY, and the Watershed contains portions of five of those. Those five are the Western New England Marble Valleys, Taconic Foothills, Hudson Highlands, Berkshire Transition, and Taconic Mountains (Map 1). Brief descriptions of these are outlined below:

- **Western New England Marble Valleys:** Characterized by steep-sided valleys with floodplains, terraces, and rolling terrain, the Western New England Marble Valleys occur in the Harlem Valley. The low to moderate gradient streams are the most ubiquitous surface waters—with lakes and reservoirs being less common. Other moist habitats such as bogs and calcareous marshes are also present. Northern and transition hardwoods dominate the woodlands of the Marble Valleys.[138]
- **Taconic Foothills**: These foothills create a rounded, rolling landscape with narrow valleys and steep slopes. Surface waters are present in the form of bedrock-, boulder-, and cobble-bottomed cold-water streams, with some lakes and ponds. Woodlands are dominated with Appalachian oak-hickory forests, northern hardwoods, and hemlocks (on northern slopes and tight valleys). This ecoregion acts as a transition zone between the Hudson Valley and the Hudson Highlands to the south, and the Western New England Marble Valleys, the Berkshire Transition, and Taconic Mountains to the east and northeast.[139]
- **Taconic Mountains**: Located at the northernmost stretch of the Watershed, this ecoregion is defined by rounded low mountains and high hills, with steep slopes and narrow valleys. The

bedrock, boulder, and cobble-bottomed streams here are moderate to high gradient, and there are few to no lakes present. Forests consist of northern hardwoods with patches of spruce-fir at higher elevations. Oak and hickory are present on south-facing slopes.[140]

- **Hudson Highlands**: This ecological region extends along the boundaries of Beekman and Pawling, Union Vale, and Dover. It features hills and low mountains, with steep narrow valleys. There are some lakes, and the boulder- and cobble-bottomed streams are cool enough to support trout. Soils throughout the region are shallow and highly acidic resulting in forests with Appalachian oak-hickory communities in dry areas and northern hardwoods and hemlock in areas with more moisture; however, forests are dominated by transition hardwoods.[141]
- **Berkshire Transition**: This ecological region lies within the center of the TMR watershed. It features low mountains with narrow valleys and some steep slopes. Surface water features include moderate-gradient bedrock, boulder, and cobble-bottomed streams, with some lakes and ponds, and a few larger reservoirs present. Northern hardwoods, hemlock, and white pines are mixed with Appalachian oak-hickory forest in the warmer microclimates; northern hardwoods and hemlock-white pine forest occur in mostly north-facing slopes and ravines. Red oak-sugar maple transition forests are found on mesic midslopes.[142]



Map 22. Ecological Regions of the Ten Mile River watershed (Source: Dutchess County Natural Resource Inventory).

6.2.2 Habitats of Conservation Concern

Contiguous Forest

Contiguous forest habitats refer to large areas of undeveloped forested land. Throughout the Ten Mile River watershed, there are pockets of contiguous forests comprised of deciduous forests (most common), evergreen forests, and mixed forests. The presence of these forests provides communities with recreational opportunities and scenic views. Additionally, the extent of the values in terms of biodiversity and ecosystem services that contiguous forest habitats provide cannot be duplicated by smaller forest patches[143].

Contiguous forest habitats provide essential habitat for birds and other wildlife, including some species of global or continental conservation concern that depend on large tracts of undisturbed forest[144]. These sites include areas for breeding, wintering, and migrating birds and large mammals. Mammals such as bobcats, black bears, and fishers and neotropical migratory songbirds which include black-throated blue warblers, and scarlet tanagers (both SGCN) are examples of animals that tend to disappear from landscapes where only small forest patches remain[145].

Additionally, forests play a part in the long-term storage of large amounts of carbon in their above-ground and below-ground biomass[146]. Therefore, there is significant value to forests in their ability to offset some of the carbon emissions of human activities. The presence of forests and other intact habitats in floodplains and adjacent areas can also help to accommodate the increasing frequency and magnitude of flood events[147].

Early Successional Grasslands/Shrublands

An early successional habitat refers to an area of vigorously growing grasses, flowering plants (forbs), shrubs, and sometimes trees. Early successional habitats provide excellent food and cover for wildlife and need disturbance to be conserved.[148] These habitats will naturally become forests over time if not maintained through mowing, burning, cutting, grazing, or some other management practice. Upland meadows, also known as grasslands, include active cropland, hayfields, pastures, abandoned fields, and similar areas. They are typically dominated by grasses and forbs with less than 20% shrub cover and their ecological values differ according to the types of vegetation present and varying disturbances (e.g., tilling, mowing, grazing, pesticide and herbicide applications).[149] These habitats support a variety of invertebrates, reptiles, mammals, and birds. Most importantly, grasslands support several species of rare butterflies and grassland-breeding birds who use these habitats for nesting and foraging. It is important to note that the value of these habitats can differ significantly depending on the frequency and intensity of grazing and maintenance. Development around meadows can promote increased predation on grassland-breeding bird nests by predators such as raccoons and domestic cats. These animals are "human-subsidized," or often increase their presence when humans are around.[150] Therefore, it is important to take these valuable species into consideration while planning management strategies for these habitats.

Shrublands are habitats in transition between meadows and young forests. They also may occur along utility corridors and are maintained by cutting or herbicides in recently cleared areas.[151] Similar to grasslands and meadows, they also provide a suitable habitat for bird species of conservation concern and rare butterflies.

Floodplains

Floodplains are the low-lying areas adjacent to streams and rivers. These areas have a significant hydrologic role as they directly influence the amount of discharge in the downstream areas of a river during episodes of flooding. In extreme precipitation events, runoff from the watershed enters a river faster than it can be removed from the system, therefore, the excess water that overtops the channel banks is stored on the floodplain surface. [152] The water storage and processing done by these habitats is especially important to conserve considering the increased flooding events that are happening and predicted to worsen due to climate change. Floodplains also contain deep, nutrient-rich sediments which makes them some of the most fertile and biologically productive areas of the landscape.[153] Protecting these habitats can help maintain groundwater recharge, reduce the risk for downstream flooding and erosion, increase wildlife habitat resources and connectivity, maintain or improve water and habitat quality, and support human recreational activities.[154]

Human development within floodplain habitats can have a major impact on the benefits these areas provide. Development can disrupt connectivity between the water body and the floodplain which reduces the ability for floodwaters to spread out and tends to exacerbate downstream flood damage to property and infrastructure.[155] Additionally, any stored materials such as household cleaners, paints, solvents, oil, gasoline, pesticides, and fertilizers within development on the floodplain can contaminate floodwaters resulting in toxic conditions downstream.[156]

Vernal Pools

An intermittent woodland pool, or vernal pool, is a small wetland partially or entirely surrounded by forest, with standing water during winter and spring that dries up in the summer during a normal year[157]. Despite their small size, they have a significantly positive ecological role as they provide a vital, fishless habitat for the various amphibians (specifically frogs, toads, and salamanders) who use the pool as their breeding site. Reptiles, birds, and other mammals also derive benefits from these pools as a water source and a foraging area[158].

Unfortunately, the temporary nature of these pools can make them difficult to identify and conserve. Empty intermittent woodland pools blend in with their forested landscape, which can lead to unintentional destruction. These pools are frequently drained or filled by landowners and developers, used as dumping grounds, treated for mosquito control, and sometimes converted into ornamental ponds[159]. The surrounding forest is also important to conserve as it provides the pool with organic litter, the base of the pool's food web, and serves as an upland habitat for the amphibians after the breeding season[160].

Fens and Calcareous Wetlands

Fens and calcareous wetlands are rare wetlands that contain calcium carbonate in their soils. They are formed as water seeps upwards through limestone or dolostone—two types of bedrock that are high in calcium carbonate—forming wetlands that are basic (have a high pH) and have high concentrations of calcium and/or magnesium. These unique habitats support critically endangered species such as the bog turtle and many types of rare plants, including the handsome sedge and New England blazing star.[161]

In 1997, the US Fish and Wildlife Service published a comprehensive report (Significant Habitats and Habitat Complexes of the New York Bight Watershed) in which it highlights the Harlem Valley Calcareous Wetlands Complex. The Harlem Valley Calcareous wetlands are located in the Taconic Highlands area of New York (Putnam, Dutchess, and Columbia counties) and stretch into the Taconic Mountains area in Connecticut (Fairfield and Litchfield counties) and Massachusetts (Berkshire county). The Complex includes not only the wetland habitat, but also the surrounding uplands and ridgetops that support associated rare reptiles, waterfowl, and raptors.[162]

Crest, Ledge, and Talus

The crest, ledge, and talus habitats often occur together and are described as upland habitats. Crests and ledges typically present very shallow soils with intermittent bedrock exposures. Talus habitats are accumulations of boulders that occur at the bottom of steep ledges. Despite the fact that these habitats may present harsh conditions, they support distinct and diverse communities of rare plants and animals. Rare reptiles, for example, thrive in the ample sun-exposed surfaces. These biotic communities become even more unique with the presence of calcareous bedrock.[163]

The Ten Mile River watershed is rich with the crest, ledge, and talus habitat—nearly 50% of the Town of Dover's total area was predicted to be rocky habitat.[164]

Headwaters

Headwaters are the springs and small (first- and second-order) streams that exist throughout a watershed. As with larger streams, the climatic, geologic, and riparian settings that they occur in can be quite variable, resulting in differences in temperature, light, and hydrologic regimes.[165] When these variations occur at the smaller-scale, they provide an abundant array of habitats. Small stream habitats support primary producers, decomposers, insects, crustaceans, fish, amphibians and reptiles, and birds. Many of the species present in a headwater waterway are species that are unique to small ecosystems (do not occur in other parts of the river network), species that migrate seasonally or at specific life stages, and species that feed on benthic and emerging insects (products of headwater systems).

Ultimately, the headwaters are integral to the maintenance of the biological diversity of the entire watershed.[166] The catchments that feed these small source waterways are themselves small in size, making the systems particularly vulnerable to even small-scale disruptions.

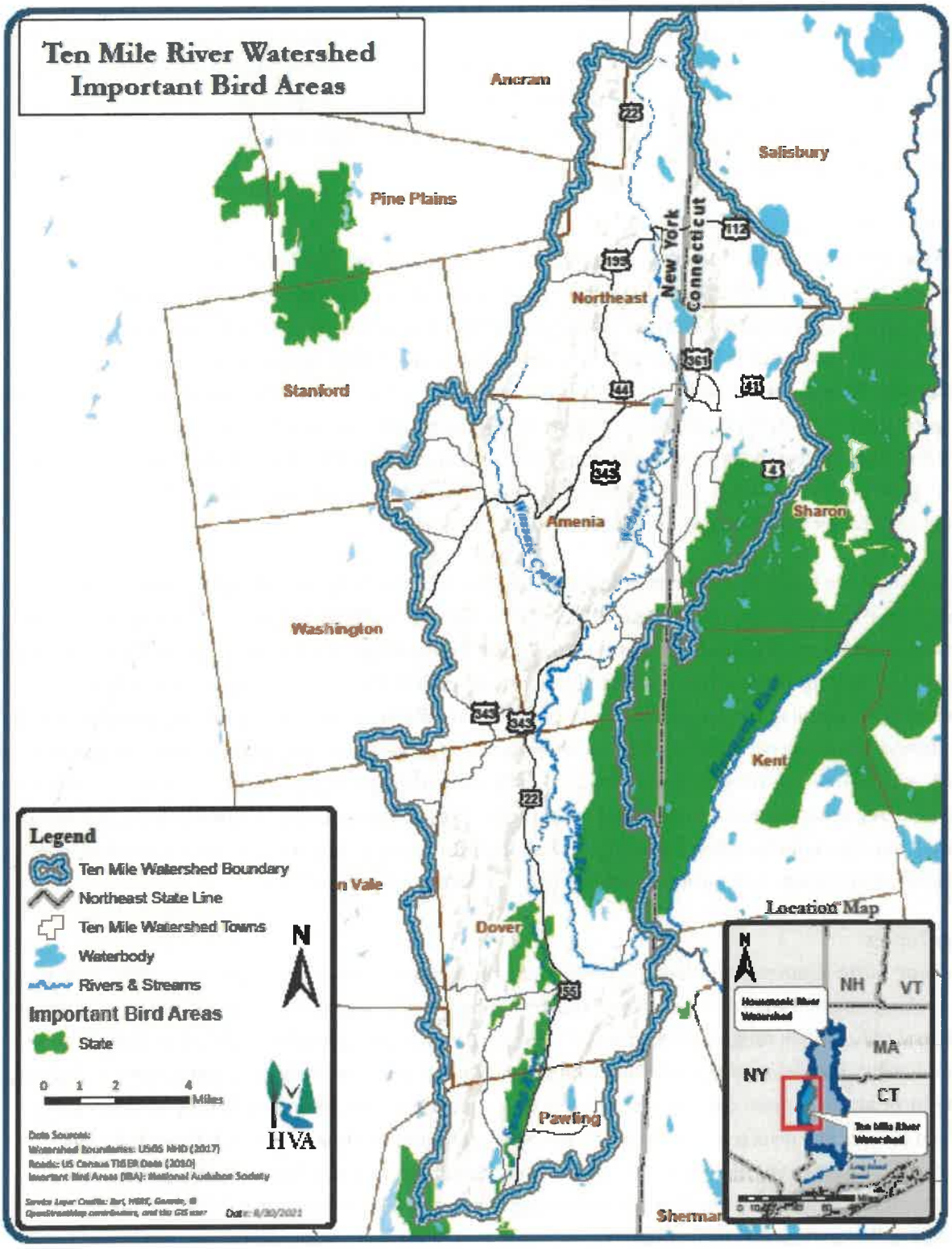
Important Bird and Biodiversity Areas

Important Bird and Biodiversity Areas (IBAs) are places deemed most significant for the conservation of the world's birds by BirdLife International and affiliated organizations, including their U.S. partner, the Audubon Society. All IBAs are also recognized by the International Union for Conservation of Nature as Key Biodiversity Areas.

- **Macedonia Block:** The Macedonia Block Important Bird and Biodiversity Area is a state priority IBA for both New York and Connecticut. The New York portion covers 9,126 acres of East Mountain in the towns of Dover and Amenia. The majority of the IBA extends into the Connecticut towns of Kent and Sharon, adding an additional 22,985 acres. The IBA overlays an area of large, intact core forest that attracts interior forest birds such as Wood Thrush and Cerulean Warbler. While there are extensive protections for the IBA in Connecticut, the vast majority of the area remains unprotected in New York. The southwestern portion of the IBA

drains into the mainstem of the Ten Mile River, while the northwestern portion in Sharon lies within the Webatuck Creek subwatershed.

- **The Great Swamp:** The Great Swamp Important Bird and Biodiversity Area is comprised of 4,549 acres that extend for 20 miles from central Dover to Brewster. Roughly half of the IBA is in the Ten Mile River Watershed. The Great Swamp is the second largest freshwater wetland in the state of New York. The wetland habitat of the IBA primarily consists of red maple swamps and hosts an exceptional array of plant and animal life. In addition to resident wetland birds, the IBA is also an important area for migrating shorebirds.
  Running parallel and in proximity to Route 22, the IBA and its associated wetlands are at risk of greater development along this commercial corridor. Fragmentation of both terrestrial habitats and the hydrologic connections that support wetlands threaten to diminish opportunities for connected plant and animal habitat.



Map 23. Important Bird Areas (IBAs) in and around the TMR watershed

6.2.3 Species of Conservation Concern

While there are only two highlighted below, there is an extensive list of plant and animal species that have been identified as species of conservation concern within the TMR watershed. The unique nature of many of the habitats present in the Watershed either currently support or have the potential to support these species and preserve biotic diversity. A more detailed report is on the list of action items to come out of this Plan.

Eastern Brook Trout

The eastern brook trout (*Salvelinus fontinalis*) is a member of the char family. Native to the Eastern United States, it is also known as a speckled trout, spotted trout, brookie, or a squaretail[167]. Their native range spans from Maine to Georgia, but biologists have long known that brook trout populations are declining[168]. Because of their need for clean, cold (preferably below 68 degrees Fahrenheit and not exceeding 77 degrees Fahrenheit), and highly oxygenated water, brook trout are known to be indicators of good water quality[169]. Therefore, a decline in the population can be a warning sign of a deteriorating habitat. Poor land management associated with agriculture including clearing streamside vegetation, over-grazing sensitive areas, and ineffectively managing nutrients was identified as the most widespread impact on brook trout habitat in the Eastern United States[170].

Brook trout are greenish-brown in color with a unique pattern of lighter yellowish color on their back and sides that fades down to incorporate scattered red dots outlined in blue[171]. The size of these fish greatly depends on the condition of their habitat but, on average, they grow to about 10 inches and weigh one pound. Some brook trout populations spend all of their life in freshwater habitats while other anadromous populations spend a majority of their adult life in salt water and return to freshwater only to spawn. Spawning occurs in the late summer or fall dependent on temperature and female trout travel upstream to find a nesting spot with loose, clean gravel and high oxygen levels. The female will prepare a nest along the shoreline and occupy it until she is ready to express eggs. Once fertilized, the female buries the eggs until they hatch in early spring. Adult brook trout will feed on worms, leeches, minors, crayfish, amphibians, and insects while young trout feed on plankton[172].

Bog Turtles

The bog turtle (*Clemmys muhlenbergii*) was federally listed as a threatened species in 1997 and is listed as endangered by New York State. Over the past 20 years, the bog turtle has experienced at least a 50 percent reduction in range and numbers[173]. The northern population of this species is limited to Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, and Pennsylvania. Typically, bog turtles occupy open-canopy, herbaceous sedge meadows and fens bordered by wooded areas which provide the diverse micro-habitat needed for foraging, nesting, basking, hibernation, and shelter[174]. The primary threats to this species include habitat loss and fragmentation. Habitat fragmentation caused by development increases the negative edge effects and limits the bog turtle's ability to find mates and new habitat[175].

The bog turtle is one of North America's smallest turtles. It is recognized by its light brown to ebony carapace and bright yellow, orange, or red blotch on each side of its head[176]. Their diet mainly consists of seeds, berries, shoots, and invertebrates. Bog turtles emerge from hibernation as temperatures warm around mid-April to early May. The warmer air temperatures trigger their emergence and basking in the

sun increases their body temperature. Females typically lay a clutch of three to four tiny, white eggs in a shallow nest located within a sunny, open area in late June to early July[177]. Hatching occurs from late August to early September and then cold temperatures in October to November will cause bog turtles to retreat to their wintering sites. Bog turtles hibernate within underground burrows where springs ensure that water will flow during the winter, preventing the turtles from freezing[178].

6.2.4 Ecological Threats

Habitat Fragmentation and Destruction: Terrestrial Habitats

Terrestrial habitat fragmentation is the breaking up of large swathes of habitat (e.g. contiguous forests) into smaller, isolated parcels that results in reduced forest health and habitat quality. Fragmentation is caused by the construction of roads or other human development through natural areas. This development process not only destroys many natural areas, but also isolates the remaining natural spaces from each other. This isolation reduces the utility of the habitat as organisms in one area are limited in their access to food, mates, shelter, and other resources—lest they risk crossing highways or through developments to access another habitat fragment and find new resources or mates. The reduction in the size of each parcel fundamentally changes the type of habitat that is available. All of the habitat is now similar to what used to only exist on the borders of the forest, and the more isolated conditions that can only occur in the center of a large forest now no longer exist anywhere. The type of forest habitat that exists in the deep interior, which is dark, quiet, cool, damp, and sheltered from wind, supports plant and animal species that cannot tolerate high levels of disturbance. Deep interior forest conditions require 200-300 feet of buffer forest between themselves and the forest border, and so this microhabitat and associated organisms are lost when the habitat becomes fragmented into plots smaller than about fourteen acres.[179]

Because isolated parcels restrict the movement and interbreeding of plants and animals, the gene pool is smaller, leading to a less-resilient forest community that is more vulnerable to invasive species and pathogens. The reduced habitat area and increased homogeneity of the habitat leads to a loss in biodiversity. Habitat fragmentation and deforestation near rivers also reduce the ability of the natural floodplain to slow down the high flows of water following a rain event, as mentioned above. Changing the floodplain's groundcover from the natural understory plants to agricultural fields, lawns, parking lots, or buildings causes water to move over the ground faster, creating faster-moving, high-volume flows that are more likely to cause erosion and flooding.

In the Ten Mile watershed, habitat fragmentation has been caused by highways, agricultural fields, construction of towns, factories, mining, and logging. Notable examples include clearcutting of much of the forest in the Amenia area for charcoal fuel in the late 1700's and early 1800's—about 600 acres of forest were clearcut each year to power just one charcoal furnace.[180] Another example is the extensive gravel mining that has occurred in Dover. Mining operations frequently impact terrestrial animal habitats. Especially important is the potential for extractive mining to destroy or degrade the dens and basking areas of endangered snakes, like the timber rattlesnake, northern copperhead, and eastern rat snake. The eastern wormsnake is especially affected because it is a burrowing snake.[181]

Habitat Fragmentation and Destruction: Aquatic Habitats

The fragmentation of aquatic habitats occurs when the movement of water and aquatic organisms through surface waters is disrupted by the construction of dams, culverts, bridges, and other manmade

structures. Fish, amphibians, macroinvertebrates and even terrestrial species require the natural connection of these waterbodies (aquatic connectivity) so that they can move to avoid danger, maintain genetic diversity, access coldwater habitats, find food, and migrate to breeding or spawning areas. Aquatic connectivity is lost when flow is interrupted.

Road-stream crossings occur anywhere where a stream intersects with a road. Most commonly, culverts and bridges are built to allow water to flow underneath a road, trail, or driveway, and they affect aquatic connectivity to varying degrees. An ideal road-stream crossing (culvert or bridge) allows all aquatic life to move upstream or downstream through the crossing as if the crossing were not there. An example of this is a bridge constructed to span both the stream channel and its banks. Ideally, there is no bottom to the structure, so the stream bed consists of natural substrate. The natural substrate or material of the streambed (e.g. silt, cobble, sand, gravel, boulders, or a mix of these) provides many microhabitats (nooks and crannies) in which macroinvertebrates such as insect larvae, small fish, and other organisms lay their eggs and take refuge. Culverts and other road-stream crossings that create an artificial streambed—such as poured concrete—overtop of the natural streambed disrupt the natural substrate and take away these microhabitats needed by marcoinvertebrates and fish. Terrestrial animals would also benefit from such a structure because they could continue to walk the riparian corridor without having to cross the road. However, these structures can be very expensive and difficult to build, so smaller culverts are much more common. Culverts can also disrupt aquatic connectivity through channel constriction (if the structure is smaller than the width of the stream), creating an unnatural drop or freefall in the stream (often occurring at the outlet of the structure), or disconnecting the banks on one side of the structure from the banks on the opposite side. Many culverts are barriers to the passage of aquatic life up- or downstream. Aquatic connectivity is especially important for species that migrate to breed, find food or other resources, or need to move from a warmer area of the stream to a cooler area.

As of February 2020, about 55% of the non-bridge road-stream crossings evaluated within the entire Housatonic River watershed evaluated using the protocol developed by the North Atlantic Aquatic Connectivity Collaborative (1,231 in total) are moderate, significant, or severe barriers to fish and wildlife passage.[182]

Aquatic habitats can also be disturbed by the channelization of stream channels. Channelization refers to the construction of walls or berms to straighten the stream's path and redirect water in a way that is more convenient for human development. Channelization increases the velocity of flows because it reduces sinuosity, increases slope, disconnects the stream from its floodplain, and sometimes reduces friction between water and banks.[183] Although channelization is generally meant for site-scale flood prevention, it often exacerbates flooding downstream. The conversion of natural stream habitat to channelized habitat also markedly reduces the varieties and quality of microhabitats available.

Invasive Species

An invasive species is a species that originated outside of the ecosystem in which it is currently existing and that has the potential to cause harm to the new environment. Introduced plants or animals can overtake native vegetation and wildlife by outcompeting them for food, space, light, or other resources. They can be a huge threat to biodiversity and offset the balance of an ecosystem. Unfortunately, there

are many aquatic and forest pests thriving within the Watershed today - including plants and insects. These numbers are likely to grow in the face of climate change, and strategic management is recommended.

Much of the brush along the Ten Mile river is made up of invasive species such as honeysuckle, multiflora rose, barberry, and Japanese knotweed. In many sections of the river, invasive plants have completely overtaken the riparian zone and made it impossible to walk.[184] In addition to these invasives, the town of Salisbury, CT has noted garlic mustard and Asiatic bittersweet as invasive terrestrial plants in the region, as well as the aquatic invasive species Phragmites (common reed), purple loosestrife, Eurasian water-milfoil, and zebra mussels.[185]

These aquatic invasive species pose additional threats to water bodies because they are easily spread downstream or between water bodies from where they are first introduced—very quickly infecting an entire stream system. Additionally, they can spread from objects that move between water bodies like the bottoms of boats, life vests, waders, and other recreation equipment.

Climate Change

Climate change has affected and will continue to influence precipitation patterns in the Ten Mile watershed. The region will experience heavier, more frequent rainstorms, warmer temperatures, flooding during the winter and spring, and droughts during the summer and fall. Warmer temperatures and droughts during the summer can cause algal blooms that harm fish and reduce water quality.[186] See chapter 4 of this report for more information on the impacts of climate change.

Pollution

There is evidence of several different types of pollution in the Ten Mile Watershed. These include both point source and non-point source pollution. Point source pollution stems from a single source and is confined to one area, while non-point source pollutants (like agricultural runoff, factory waste, or greenhouse gases) are released in a wide area, making it more difficult to identify the exact source of the pollution.

- **Dumping** is the improper disposal of trash or other waste by dumping it in large quantities in natural areas. Surveys have found piles of construction and demolition debris dumped in wetlands near the Ten Mile River, for example in Dover Plains, New York at the Ten Mile River, LLC site. This debris was found to contain several harmful pollutants, including mesityl oxide, which may be leaching into a tributary to the Ten Mile River.[187]
- **Nutrient loading**: the introduction of excess amounts of chemicals that encourage plant growth—typically nitrates and phosphates—to water bodies. This leads to an overgrowth of algae. Through a process called eutrophication, the excess algal growth reduces the amount of dissolved oxygen in the water and increases carbon dioxide levels as it dies and decomposes. Low dissolved oxygen can kill fish and other aquatic animals.
  There are many potential sources for nutrient pollution, but common ones are sewage, agricultural runoff, animal waste, and fertilizers.
- **Sewage:** There are several permitted sewer outlets into the Ten Mile, and there may also be accidental sources of sewage introduction to the water like broken sanitary sewer lines or septic failure. Sewage contamination of water bodies can be a public health concern if the water is used for recreation, and can also lead to nutrient pollution and introduce harmful bacteria to

aquatic ecosystems. Slightly elevated levels of sulfides were found in a 2002 water quality assessment of Webatuck Creek done by the Housatonic Valley Association, evidencing sewage or industrial waste pollution.

- **Light pollution:** excess light emitted by cities and other inhabited areas—disorient wildlife and disrupt their Circadian rhythms. Many animal behaviors, including mating, finding food, migration, and sleep are regulated by the day-night cycle and may be impacted by light pollution from humans.[188] Insects, frogs, bats, birds, and moths are common species to the Ten Mile watershed known to be affected by light pollution. Frogs have been found to reduce their mating calls when exposed to artificial light at night, in turn reducing their mating ability and reproduction. Artificial lights attract and disorient birds and moths and alter the feeding behaviors of bats. [189]
- **Noise Pollution:** this form of pollution can come from human development like construction, roads, all-terrain vehicles, airplanes, cities, industrial activities, and railroads affect animals' abilities to navigate, find mates and food, migrate, and avoid predators. A 2019 meta-analysis of prior experimental studies found that noise pollution has a significant effect on a wide variety of animals including amphibians, arthropods, birds, fish, mammals, mollusks and reptiles.[190]

6.2.5 Conservation Significance

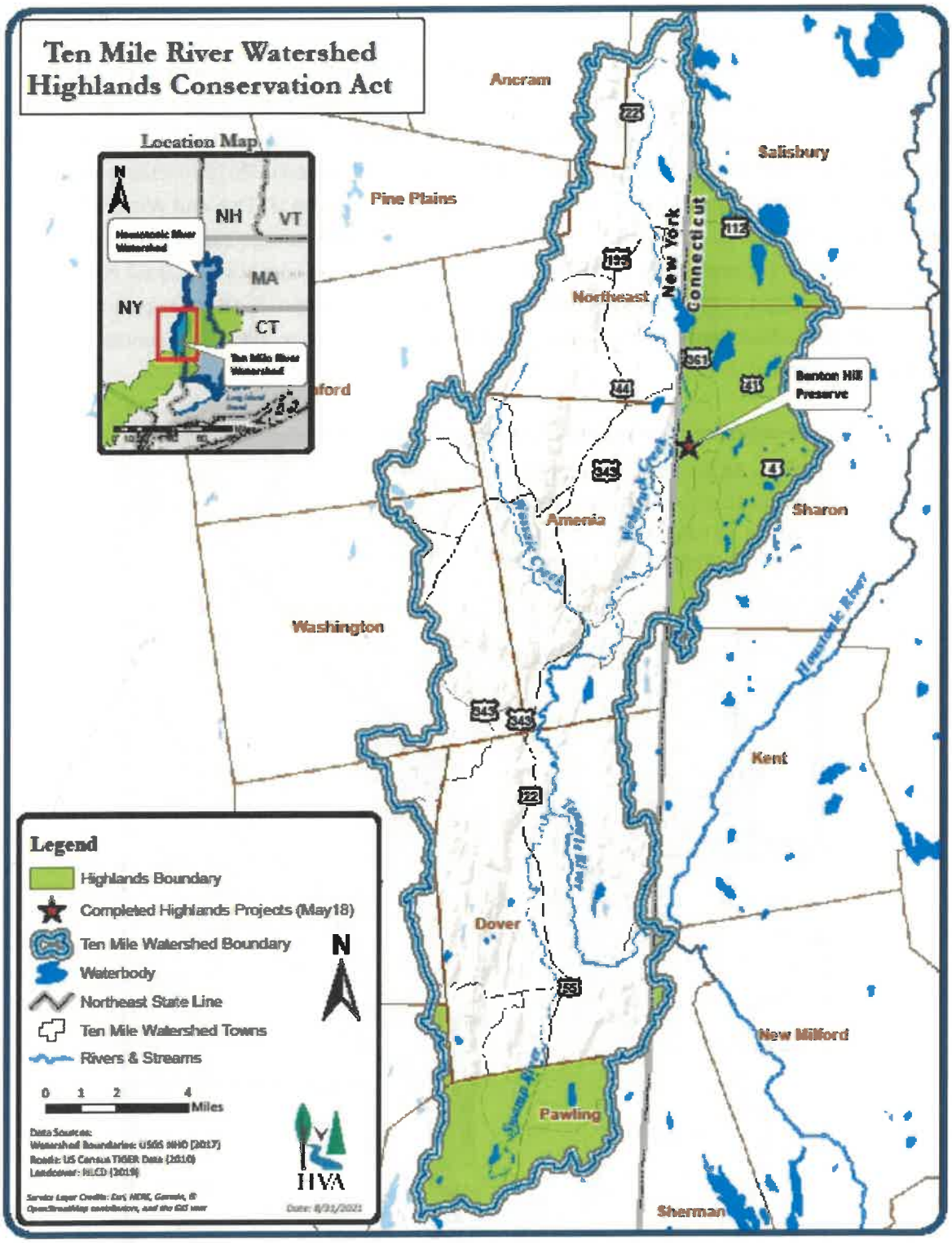
Federal, State, and Local Recognition

The Ten Mile River Watershed has been widely recognized for its ecological significance with numerous federal, state, county, municipal, and non-profit designations. In 2004, a grant program was established to support conservation efforts within the Highlands region under the federal Highlands Conservation Act. In 2006, the calcareous wetlands were once again recognized as a Significant Biodiversity Area in the NYS Department of Environmental Conservation's, *Hudson River Estuary Wildlife Habitat and Restoration Framework* , where it is described in a manner similar to the 1997 USFW publication. In 2016, the "The 2016 New York State Conservation Plan" recognized the Taconic Ridge and adjacent Harlem Valley among its regional conservation priority project areas—including the entire Ten Mile watershed. Also in 2016, the USFWS established the Great Thicket National Wildlife Refuge—forming the Northern Housatonic Refuge Acquisition Focus Area which encompasses 33,000 acres of land in portions of Sharon, CT, and Amenia and Dover, NY.

Highlands Conservation Act

As mentioned above, the Highlands Conservation Act (HCA) was passed by the US Congress in 2004 and is administered by the US Fish and Wildlife Service. The act covers 3.4 million acres in Connecticut, New York, New Jersey and Pennsylvania. The focus of the legislation and associated federal funding is to conserve plants, wildlife and habitat, while also protecting community resources such as clean drinking water and recreational opportunities.

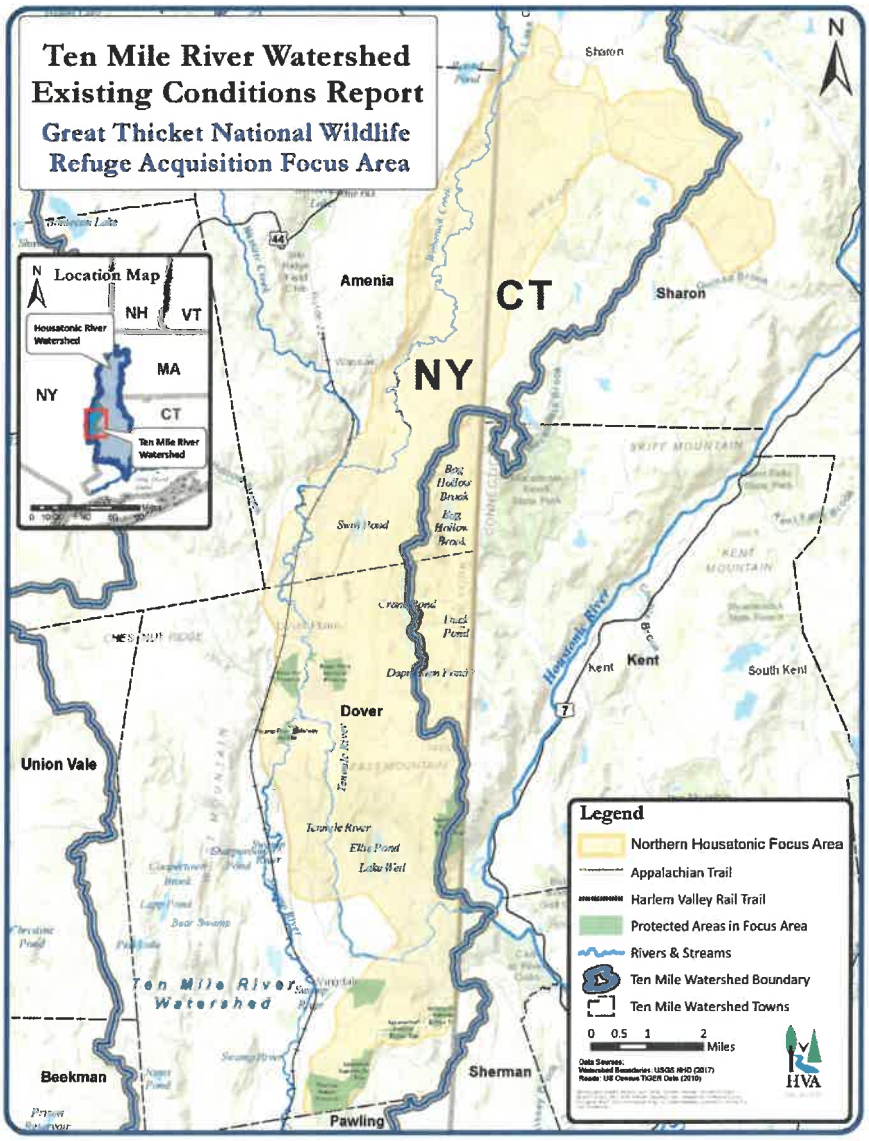
Within the Ten Mile River Watershed, the towns of Pawling, New York and Sharon, Connecticut are included in the Act's geographic focal area. Projects funded by the HCA must be acquired by state governments and federal funding from the Act is limited to 50% of the acquisition fair market value. To be eligible, land conservation projects must be in an area identified as having high conservation values as determined by the scientific studies that support the Act.



Map 24. HCA areas within the TMR watershed

Great Thicket National Wildlife Refuge

Thickets (also known as "shrublands", "early successional forests", and "young forests") are densely vegetated habitats, the establishment of which typically follows both anthropogenic and natural disturbances. Human development along with their control of natural disturbance have significantly impacted the proliferation of these habitats resulting in the decline in the associated plant and wildlife populations. The Great Thicket National Wildlife Refuge was established in 2016 following a Land Protection Plan/ Environmental Assessment (LPP/EA) conducted by the US Fish and Wildlife Service in collaboration with six states (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, and New York), the New England Cottontail (NEC) Executive and Technical committees, state NEC and shrubland management teams, state and service migratory bird biologists, and other partners. The goal of the LPP/EA and subsequent establishment of the Great Thicket was to aid in the reversal of shrubland habitat and species loss.



Map 25. Northern Housatonic Refuge Acquisition Focus Area of the Great Thicket National Wildlife Refuge.

Forest Legacy Program

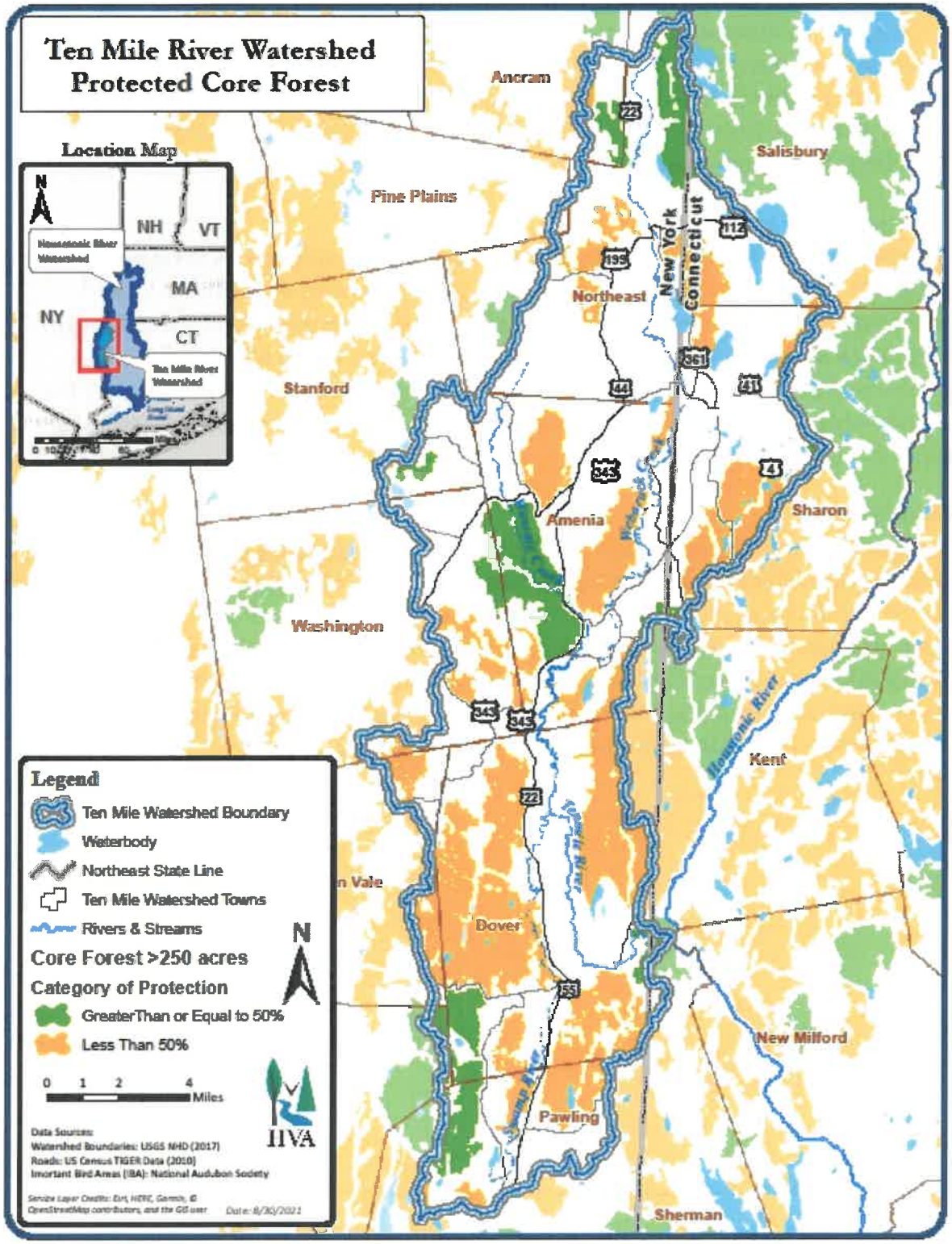
Portions of the watershed (the Taconic Ridge) are also recognized by the Forest Legacy Program. This federal program was established to protect forested land from conversion to non-forest use through conservation easements. While there have not been any Forest Legacy projects in the Ten Mile watershed, the program includes lands to the east of Route 22 from Dover northward beyond the watershed divide. The Connecticut portion of the watershed is entirely within that state's designated Western Connecticut Forest Legacy Area.

Staying Connected Initiative

The connectivity of the habitats in the Ten Mile River watershed is recognized by the Staying Connected Initiative (SCI). Through the many public and private entities partnering with state and local organizations, this binational collaboration works to conserve and restore landscape connectivity throughout the Northern Appalachian/Acadian region. As of 2018, the SCI had worked to gain permanent protection of over 500,000 acres in their wildlife movement focus areas (linkages). The collaboration has established nine priority linkage sites—one of which is the Green Mountains to Hudson Highlands Priority Linkage.

Follow the Forest

Connectivity is again highlighted as a conservation priority by the Follow the Forest Initiative lead by The Housatonic Valley Association and its local and regional partners. Follow the Forest recognizes the vital role of the wildlife linkages in Pawling, Dover and Amenia to the North/South climate corridor that runs between the Hudson River and Canada. Also recognized is the need for accelerated conservation of the forested uplands that contain the largest areas of available habitat. These areas of core forest are over 250 acres in size, are buffered by 300ft from non-forested areas, and have received relatively little conservation focus outside of the narrow Appalachian Trail corridor.



Map 26. Follow the Forest Protected Core Forest in the TMR watershed

NYS Wildlife Action Plan

The New York State Wildlife Action Plan serves as a guiding document for the management and conservation of species and habitats in New York. Created in 2002, then later updated in 2015, the plan was a response to the Federal State Wildlife Grant program. This program requires states to complete a Comprehensive Wildlife Conservation Strategy which includes a list of Species of Greatest Concern (SGCN), threats to these species and their habitats, and a description of conservation strategies, monitoring plans, and public outreach efforts[191]. The New York State Department of Environmental Conservation and its many conservation partners assessed 597 species; identifying important habitats, population trends, and the threats for each[192]. The collected information was compiled to create a SGCN list, which then served as a resource for the prioritization and organization of conservation actions. More than 600 actions to conserve SGCN were identified by DEC staff and conservation partners and listed in a database which links the actions to the species that would benefit[193]. These actions were sorted in two ways: program (broad in scope and ongoing) versus project (work to implement program action at specific locations) actions and the IUCN Conservation Action Classification system to allow comparability of actions among the northeast states. Information on readiness, durability, cost, and relative priority of each action was estimated and entered into a database for each action when possible[194].

6.2.6 Management Strategies and Actions

In areas with less development the focus is less on restoration and more on protection. Often these areas are closer to the watershed's headwaters and therefore keeping these areas natural and healthy takes on particular significance due to their impact downstream. With smart planning, the TMR watershed can continue to be a place for nature to flourish and wildlife to thrive. One of the principle ways this happens is by encouraging areas of native habitats wherever possible - namely parks, backyards, resident gardens, and business landscaping - and creating corridors for wildlife to move. Rethinking basic infrastructure to integrate habitat friendly design is an excellent place to start. For example, culverts often create barriers to fish and aquatic life and often force terrestrial animals to cross roads to move from one area to another. Replacing culverts with stream simulated design bridges allows animals to cross under a road as if the road does not exist. Mapping current infrastructure, exploring where opportunities exist, and having example redesigns seeds the ground for when failing infrastructure can be replaced with a more eco-friendly alternative.

Road-Stream Crossing Assessments and Replacement Strategies

The design and condition of road-stream crossings (typically bridges or culverts) can significantly influence whether a stream behaves naturally and whether animals (aquatic and terrestrial) can migrate along the stream corridor. Unfortunately, stream habitat continuity is often not considered during the initial design and construction of these structures and as a result, they become barriers to fish and wildlife. Even crossings that were not barriers when originally constructed may become barriers because of stream erosion, mechanical breakdown of the crossing itself, or changes in the upstream or downstream channel shape[195]. Therefore, performing road-stream crossing assessments is a useful management strategy to help identify and prioritize culverts and bridges in greatest need of replacement (or other measures) to reduce hazards to humans, infrastructure, and aquatic life[196].

Optimally, road-stream crossings should essentially be "invisible" to fish and wildlife in that they should maintain appropriate flow and substrate through the crossing and not constrict a stream[197].

In 2015, HVA began a pilot project to develop road-stream crossing management plans (RSCMPs) in 7 towns in Northwest CT; as of 2020, there are 24 plans in various stages of completion across the watershed. The primary objectives of this work are to help communities identify highest priority replacement projects based on conservation value, flood risk and maintenance need, encourage adoption of culvert design Best Management Practices, and create a new tool for securing financing for replacement projects. At the time of writing this report, HVA has completed RSCMPs for five towns in the TMR watershed: Amenia, Dover and North East (including the Village of Millerton), NY, and Sharon and Salisbury, CT.

6.3 Recommended Actions

Recommended Actions & Milestones	Who	Timeframe (Schedule)	Deliverables & Evaluation Criteria	Est (
Incorporate practices that restore/protect habitat for native species (elimination of invasive species, use of native plants in landscaping, riparian buffer protection/restoration, Green Infrastructure practices to reduce stormwater pollution) into new development or substantial upgrades to existing development	TMRC, watershed municipalities, landowners and property managers	Ongoing		$$
Replace barrier culverts with structures that restore stream habitat connectivity, using data from RSCMPs	Watershed municipalities	Ongoing		$$

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000

$50,000

7. Recreation Enhancement and Promotion

7.1 Goals

- Build strong collaboration between federal and state agencies, municipalities, and conservation organizations for planning safe, sustainable recreation opportunities.
- Use recreation enhancements as opportunities for job creation through:
    - Comprehensive monitoring of heavily trafficked areas,
    - Development and implementation of outdoor recreation plans targeted at protecting against overuse – especially in ecologically sensitive areas, and
    - Launching public information campaigns to educate the public on the impacts of recreation, and the relationship between recreation and the movement of invasive species.
- Foster strong partnerships with landowners to encourage public access - be supportive of land-owner concerns.
- Create information sharing systems that can alert the public of overuse and advise against visitation.
- Establish new outdoor recreation opportunities while increasing awareness of those that already exist (e.g. create linkages between the Harlem Valley Rail Trail and new outdoor spaces).
- Create new opportunities to recreate outdoors and ensure connectivity between outdoor spaces (e.g. trail linkages).

7.2 Current State of Recreation in the TMR Watershed

Time spent outdoors can greatly improve our physical and mental health[198]. Researchers have found that spending time in natural spaces affects our physiology, emotional well-being, and ability to think. While seeing these studies emerge, we are also witnessing a shift in more sought-after travel experiences. It is becoming abundantly clear that today's travelers prefer the exploration, experience, and discovery of unique, off-the-beaten-path places.[199]

The Ten Mile River (TMR) watershed is rich with opportunities for enhancing recreational access, while simultaneously preserving and establishing ecologically significant open spaces. For example, within the watershed, one will find a 16-mile section of the Appalachian National Scenic Trail (AT) and the northernmost station of the Metro-North Railroad's Harlem Line—the only train stop on the entire length of the famous trail. A survey of Dutchess County visitors conducted in 2018 showed that the AT was the most widely-recognized name among other outdoor attractions in the Harlem Valley.[200] But the AT is just one of many opportunities for outdoor recreation in the Ten Mile River valley, all of which could potentially be a part of a strong regional draw for outdoor enthusiast across the region and beyond.

Municipalities and community groups along the Ten Mile River express a clear desire to improve the condition, accessibility, and connectivity of their open spaces—documented, for example, as goals in both the Town of Amenia 2006 Recreation Plan and the 2019 Town of North East/Village of Millerton Comprehensive Plan. However, low awareness of outdoor recreation opportunities and natural assets remain a primary concern for community stakeholders[201]. Active public interest in building this part of the local economy, along with a growing awareness of the need to connect with natural systems,

present a unique opportunity to increase visibility, awareness, and understanding of the TMR watershed- and build local economies based on natural resource protection and appreciation.

Detailed below are some of the major existing parks, trails, and river access sites in the TMR watershed, along with outdoor recreation pursuits and their associated communities and supporters. We also include an initial list of potential outdoor recreation enhancement projects.

7.2.1 Parks and Trails

The Great Swamp

Formed over 10,000 years ago[202], this freshwater wetland covers more than 6,000 acres in Putnam and Dutchess Counties—nearly a third of which falls within the TMR watershed's boundaries. One of the five largest wetlands in New York State, the Great Swamp is a designated a Priority Wetland by the United States Fish and Wildlife Service, a Class I wetland by The NYS Department of Environmental Conservation (NYSDEC) and a Highlands Conservation Focal Area by the USDA Forest Service. It was named a National Historic Landmark by the Department of Interior, declared a Critical Environmental Area by Dutchess and Putnam Counties and an Important Bird Area by the National Audubon Society. NYSDEC recognized the Great Swamp for its habitat, diverse wildlife, scenic value, and critical function as an aquifer recharge area. [203] The Great Swamp also provides significant ecosystem services[204] – direct and indirect contributions to human well-being - including water filtration, flood control and storm protection, sediment and nutrient retention, and groundwater replenishment.

Nestled in the valley between the ridges of the Hudson Highlands, the Great Swamp collects waters from 63,000 surrounding acres, with a total watershed area of 97 square miles[205]. Water drains from the wetlands through a north flow and a south flow. The North Flow becomes the Swamp River (one of the Ten Mile's three most significant tributaries) which crosses through Pawling and Dover. Currently, beaver impoundments and the lack of established access points make recreation on the North Flow a more primitive experience than the more developed South Flow[206]. Paddling the waters can be difficult as it involves portage through much of the reach leaving the Great Swamp. Less challenging recreational opportunities include fishing, birding and wildlife viewing, and exploring areas on land.

Since 1990, Friends of the Great Swamp (FrOGS) – a volunteer non-profit organization – have worked tirelessly to preserve and protect this treasured wetland through research, education, conservation, and partnership building[207]. They host a variety of outdoor events throughout the year and are a great resource for building the awareness of recreational opportunities in the area.

Morning Mist by Julian Diamond. A foggy view of the Appalachian Trail boardwalk over the Swamp River in Pawling, NY.

Appalachian Trail

In 1921, Brenton MacKaye went public with his dream of the Appalachian Trail (AT), "A Project in Regional Planning". By 1925 he had gathered enough support to organize the Appalachian Trail Conference and began presenting specific plans for the hiking trail that would ultimately cover 2,190 miles of the Appalachian Mountain landscape—traversing 14 states from Springer Mountain, GA, north to Mt. Katahdin, ME. Known as the "Wild East", the trail was designated the first National Scenic Trail by the National Trail Systems Act of 1968.[208] Today, 99% of the AT is protected by federal or state ownership of the land or by right-of-way. The National Park Service, numerous conservation groups, and thousands of volunteers work to maintain this extensive corridor[209]. It is estimated that 3 million people visit the Appalachian Trail every year[210].

Sixteen miles of the AT cut through the TMR watershed in Dover and Pawling, NY. The trail currently carries the strongest name recognition out of all the notable natural areas in Dutchess County. Twenty-five percent of all surveyed leisure visitors have hiked at least part of it and 46% say that they have heard of it and would like to hike it in the future[211]. The Metro-North Railroad's Harlem Line provides a direct connection to the trail from the New York metropolitan area and can drop visitors at Pawling, Dover or Wassaic during regular service[212]. On weekends, the train stops directly at the AT station (the only train stop on the entire length of the trail). There is also free parking at the AT train station for those traveling by car.

July of 2012 saw the completion of the 1,600-foot Appalachian Trail boardwalk through the Great Swamp which includes a 34-foot bridge over the Swamp River (north flow out of the Great Swamp)[213]. Hikers can make their way to visit the Dover White Oak and/or Cat Rocks from here. Further east, the Appalachian Trail meets the Ten Mile in Kent, CT. Day visitors can access the trail from the parking area on Bulls Bridge Rd. All hikers can cross the TMR via a foot bridge while catching a view of the river's confluence with the Housatonic. Overnight hikers can set up camp in the Ten Mile River Lean-To.

The Appalachian Trail unites several conservation groups including the Appalachian Trail Conservancy (through which Dover and Pawling became the Harlem Valley Appalachian Trail Community), New York-New Jersey Trail Conference, and Friends of the Great Swamp. Having these notable organizations active in the watershed provides a head start in the efforts to enhance and promote the recreation opportunities available at other local treasures.

Great Thicket National Wildlife Refuge & Nellie Hill Preserve

In 2016, the U.S. Fish and Wildlife Service (USFWS) created the Great Thicket National Wildlife Refuge in response to the urgent need for permanently protected and managed lands that serve as critical wildlife habitat and contribute to the needed diversity in forest age classes. The Great Thicket's goal is to acquire up to 15,000 acres of shrublands and young forests in 10 separate Refuge Acquisition Focus Areas (RAFAs) in Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, and New York. The service works with willing and interested landowners to acquire land through conservation easements or fee-title acquisitions[214].

The Nellie Hill Preserve in Dover, NY was purchased by The Nature Conservancy (TNC) in 1991. In 2016 TNC donated the 144-acre parcel and the preserve became the Service's first land acquisition—officially establishing the Great Thicket National Wildlife Refuge[215]. The preserve lies within the Northern Housatonic RAFA in the New York/Connecticut Border Sub-Region of the Great Thicket[216]. Here, USFWS works with the NYS Department of Environmental Protection on shrubland habitat management. Nellie Hill is a hotspot for migrating birds and is home to unique wildlife and rare plant communities. The preserve features rocky cliffs, grasslands, sloping meadows, oak forests, limestone woodlands, five springs, and two ponds. With easily accessible parking off NY-22, visitors can enjoy a stroll along the 1.3-mile loop trail through the forested uplands that border the Ten Mile's floodplain and lie approximately 1000 feet east of Wells Brook.

Dover Stone Church

The Stone Church is a geologic feature located in Dover, NY. Composed of a soft garnet mica schist, this metamorphic bedrock cavern was likely once the location of a waterfall until the stream found a point of weakness and carved out the opening in the cliff as it is seen today[217]. The entrance to this opening evokes a gothic cathedral window—giving this feature its name. Stone Church Brook flows through the outcrop, heads east, joins Wells Brook, and eventually meets the Ten Mile. The lands surrounding the cavern feature natural meadows and spring-fed ponds.

Originally a land significant to the Schaghticoke Tribal Nation, this location became a popular attraction to the region's visitors in the 1800s—inspiring local lore, as well as the work of artists and naturalists. The Town of Dover, the Dutchess Land Conservancy, and the Friends of Dover Stone Church

collaboratively raised public and private funds to purchase the 58.5-acre property in 2002. Since then, neighbors of this historic right-of-way have donated a total of 113 acres to the Town allowing further protection of the site's unique natural features[218].

Visitors are welcome to explore the site's 3.5-mile loop from dawn to dusk while practicing Leave No Trace and "carry out" principles, as there are currently no garbage disposals or restrooms available. Future improvements are planned to further develop the nature trails.

Harlem Valley Rail Trail

The railbed acquisition and the construction of the Harlem Valley Rail Trail (HVRT) is the product of a joint effort between the Harlem Valley Rail Trail Association (HVRTA), NYS Office of Parks, Recreation & Historic Preservation, the NYS Department of Transportation, Dutchess County, the Towns of North East and Amenia, and the Village of Millerton. The trail is currently a 15-mile paved trail that follows the abandoned rail bed of Penn Central Railroad's Upper Harlem Line. With additional sections currently in various stages of development, the goal of the Harlem Valley Rail Trail Association is to have a path for walkers and bikers that begins at the existing Wassaic Metro-North Railroad Station trail head and extends 46 miles north to Chatham, NY[219].

The HVRT crosses small tributaries of Webatuck Creek and passes along several of the watershed's ponds and wetland areas. Along with a view of former railroad stations and other relics of the past, the thousands of annual visitors have the opportunity to observe a wide variety of wildlife and plant species (much of which is detailed in the 2005 Harlem Valley Rail Trail Botanical Guide).

Taconic State Park (Rudd Pond Area)

The Taconic State Park consists of more than 6,000 acres of forested land and covers 16 miles of the Taconic Mountain Range. The park consists of three non-contiguous tracts—the southernmost being the Rudd Pond area in Millerton, NY[220]. Rudd Pond is a 64-acre pond in the northern portion of the Ten Mile River watershed. The park has 40 campsites that are equipped with grills, fire rings, and picnic areas. The pond is open for swimming on weekends and holidays from Memorial Day weekend through the third weekend of August. Visitors can also hike, fish, and boat (a watercraft rental is available on site). According to the NYS Office of Parks, Recreation & Historic Preservation, annual attendance at Rudd Pond reached 22,171 in 2016, reflecting a 30% increase from 16,946 recorded in 2006. It is also noted that the park could use significant improvements[221].

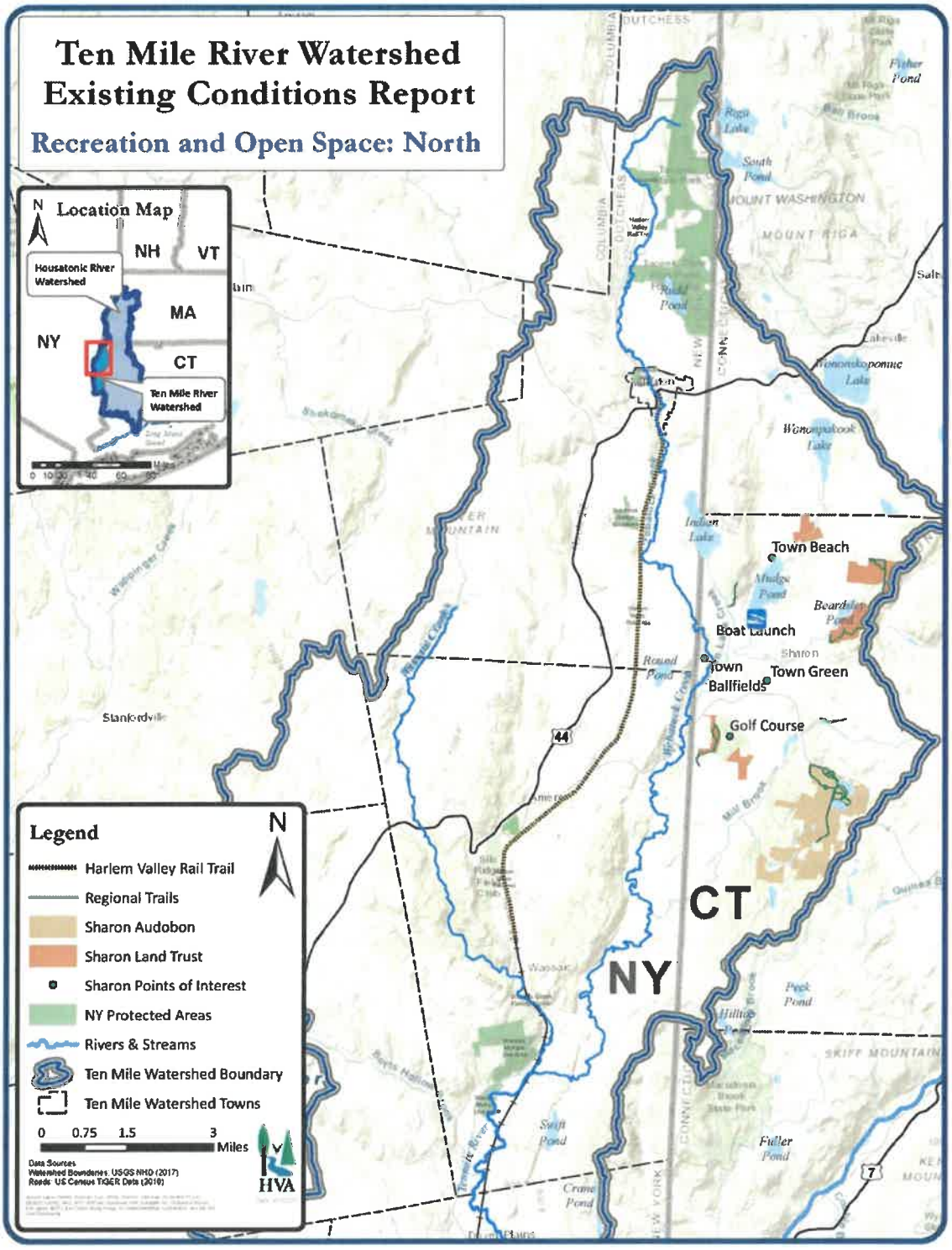
Other Parks and Trails

In addition to the large tracts of land outlined above, the Ten Mile River watershed is home to several parks that are less developed, smaller in size, or may be further away from streams, but still offer special recreational experiences. These parks are listed below:

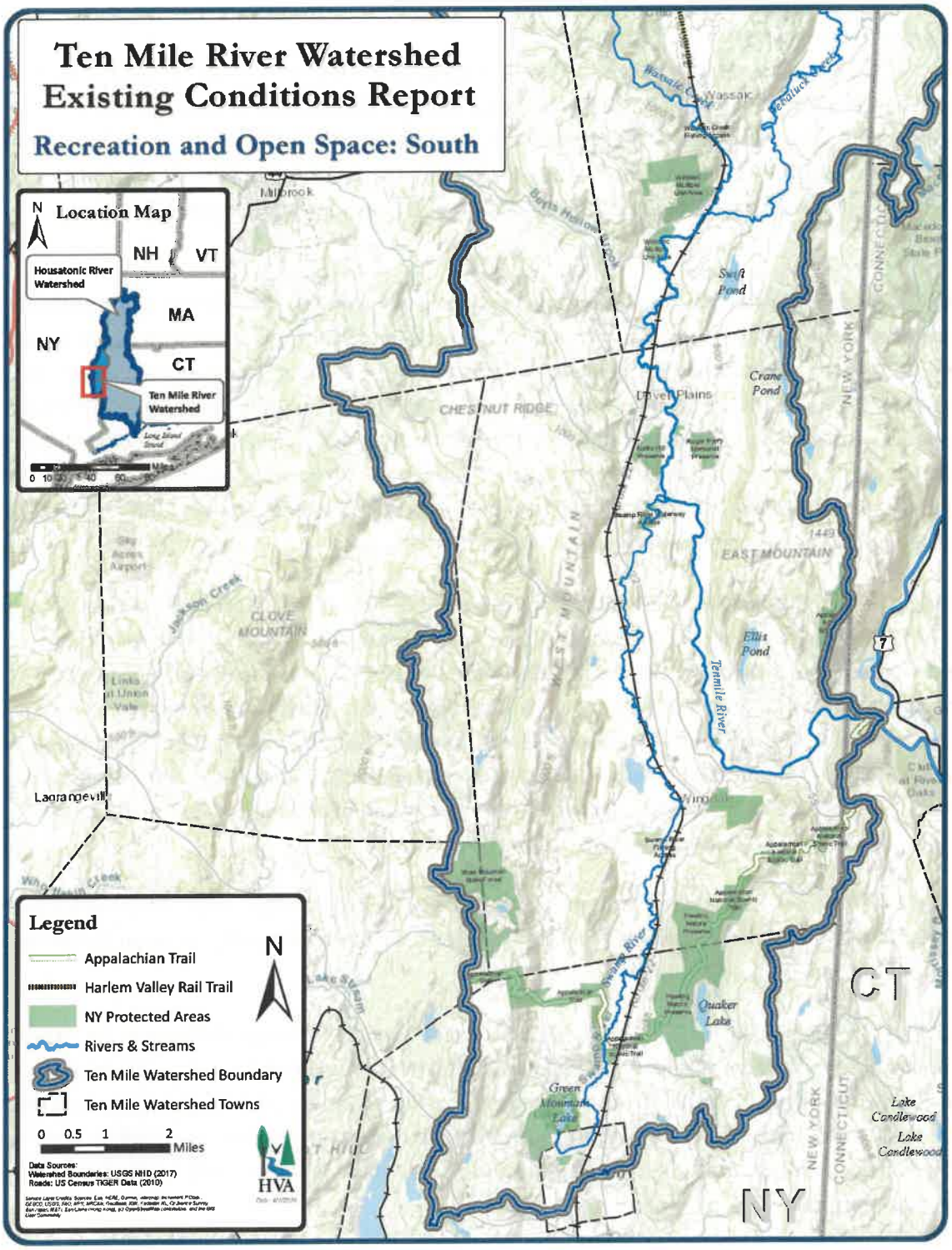
- **West Mountain State Forest** is an 830-acre forest that is managed by NYSDEC. The headwaters of Burton Brook- a Swamp River tributary- run through the state forest. The park currently features 4 miles of unmarked, multi-use trails.
- **Roger Perry Memorial Preserve** in Dover, NY is a 120-acre reserve that was donated in 2001 to The Nature Conservancy by the friends and family of Roger Perry- a devoted conservationist. A short loop trail leads visitors through land that is covered in white sand and punctuated by

limestone cliffs and wetland fens. Reptiles and amphibians, insects and birds, along with rare plants can all be observed here.

- **Thomas J Boyce Park:** Less than a mile east of the Swamp River, on Route 55 is Thomas J Boyce Park (named after the Dutchess County Post Commander of the American Legion). The park is maintained by the Town of Dover, NY[222] and serves as a hub for community recreation featuring a playground and sports fields. It can also be enjoyed by hikers who wish to walk through the large meadow and up a short, steep trail to get to the overlook—once the location of a hang glide launch ramp. A small stream drains from the park, flowing southwest to the Swamp River where it enters on the right bank of the DEC's Public Fishing Rights area.
- **John Henry Ketchem Recreation Area** is a small park on the Ten Mile in Dover, NY. The park is being redesigned by the town, but currently offers fishing access as well as opportunities for sports and picnicking[223].
- **Beekman Park:** The Town of Amenia purchased the land for Beekman Park in 1974 and officially opened this small park in 1983. Before this land became a NY designated wetland, it was the site of Lake Amenia—a popular manmade lake until its dam was destroyed by Hurricane Diane in 1955. Today locals visit the park for sports, picnics, and fishing the Wassaic Creek and its tributaries[224].
- **Wassaic Multiple Use Area:** NYSDEC's Wassaic Multiple Use Area is a 488-acre state forest that does not currently have any marked trails but is open to non-motorized recreation. A tributary to the Ten Mile runs through a cross-section of the park and enters the river just downstream of the Wassaic and Webatuck Creek confluence. Route 343 and a small residential area lie between the park and the Ten Mile mainstem.
- **Eddie Collins Memorial Park:** Adjacent to Webatuck Creak, Eddie Collins Memorial Park (Millerton Recreation Park) in the Village of Millerton is an outdoor, multi-purpose recreation park primarily used for youth athletics and the Village's six-week summer camp program. 17 acres contain a handicapped accessible playground, two baseball fields, a softball field, a basketball court, a skateboard park, a pool house building, and a pavilion. A $5,000 Hudson Valley Greenway Grant was awarded to Millerton in 2017 to develop a conceptual plan for an updated park[225].
- **Borden Park** is an open space in Wassaic, NY. Tucked between Metro-North Rail Line and Wassaic Creek behind the Pawling Corporation Architectural building, this small park is accessible by a trail that starts at the junction of Nelson Hill and Furnace Bank Rd. and runs along the Metro-North line. The park includes a small field and playground equipment[226].
- **The Railroad Ramble** is a vehicle-free path that connects Salisbury and Lakeville, CT, and offers "excellent, scenic biking"[227]. The Town of North East/Village of Millerton's 2019 Comprehensive Plan cites this path as an opportunity for creating a linkage between the communities.[228]



Map 26. Current Existing Recreation Opportunities and Open Space in Northern Half of the Ten Mile River Watershed.



Map 27. Current Existing Recreation Opportunities and Open Space in Southern Half of the Ten Mile River Watershed.

7.2.2 Outdoor Sporting/Conservation Clubs and Communities

Fish Stocking and Public Fishing Access

Every year state environmental agencies release hundreds of millions of fish into the nation's public streams, rivers, lakes, and ponds. Known as "fish stocking" this practice enhances high-quality recreational fishing and maintains healthy populations of native species[229]. The Ten Mile River is unique in that it is stocked by two state agencies, the New York State Department of Environmental Conservation (NYSDEC) and Connecticut's Department of Energy and Environmental Protection (CTDEEP).

CTDEEP's Fisheries Division has five active stocking sites on the Ten Mile River in the Bull's Bridge Trout Management Area (TMA), which spans from the New York line to the confluence with the Housatonic River[230]. TMAs were established by CTDEEP in an effort to improve trout fishing in specific reaches of rivers and streams. TMAs are stocked with more and/or larger trout in order to optimize the fishing experience in areas that experience heavy fishing pressure. They have regulations that differ from the statewide regulations on season, creel limit, and size limit, and require a special stamp to legally fish[231]. There were approximately 70,000 Trout and Salmon Stamp Inland License Sales in 2019[232]. The Trout Management Areas are open for fishing year-round.

According to the 2018 Fish Distribution Report, the Ten Mile River (Kent, Sherman) TMA was stocked with 12,000 yearlings (5-6 inches), 400 adults (9-12 inches), and 100 "specialty" trout (adults greater than 12 inches). The Brown Trout released at the Bull's Bridge TMA are reared at one or more of Fisheries Division's (FD) three fish hatcheries (Burlington State Fish Hatchery in Burlington, Quinebaug Valley State Trout Hatchery in Plainfield, and Kensington State Fish Hatchery in Berlin)[233], and are part of the over 500,000 catchable fish (adults 9-12 inches), fry, fingerlings, and eggs distributed by the state annually. Fish that are smaller than "catchable size" are stocked to provide a diversity of angling experiences and enhance naturalized populations[234].

The Ten Mile TMA can be accessed from the north by hiking on the western bank's blue blaze trail that connects to the Appalachian Trail, and from the south by hiking approximately 1 mile up the eastern bank from the First Light access gate.

NYSDEC's Fisheries Unit stocks 309 lakes and ponds and around 2,900 miles of stream every year[235]. The fish populations of the Ten Mile River, Webatuck Creek, and the Swamp River are supplemented and managed by DEC Region 3. Brown Trout are brought into these systems from one of the twelve DEC fish hatcheries located across the state. The anticipated distribution for the Spring 2020 fishing season are outlined below (numbers are subject to weather and flow conditions; contact regional fisheries office for additional information).

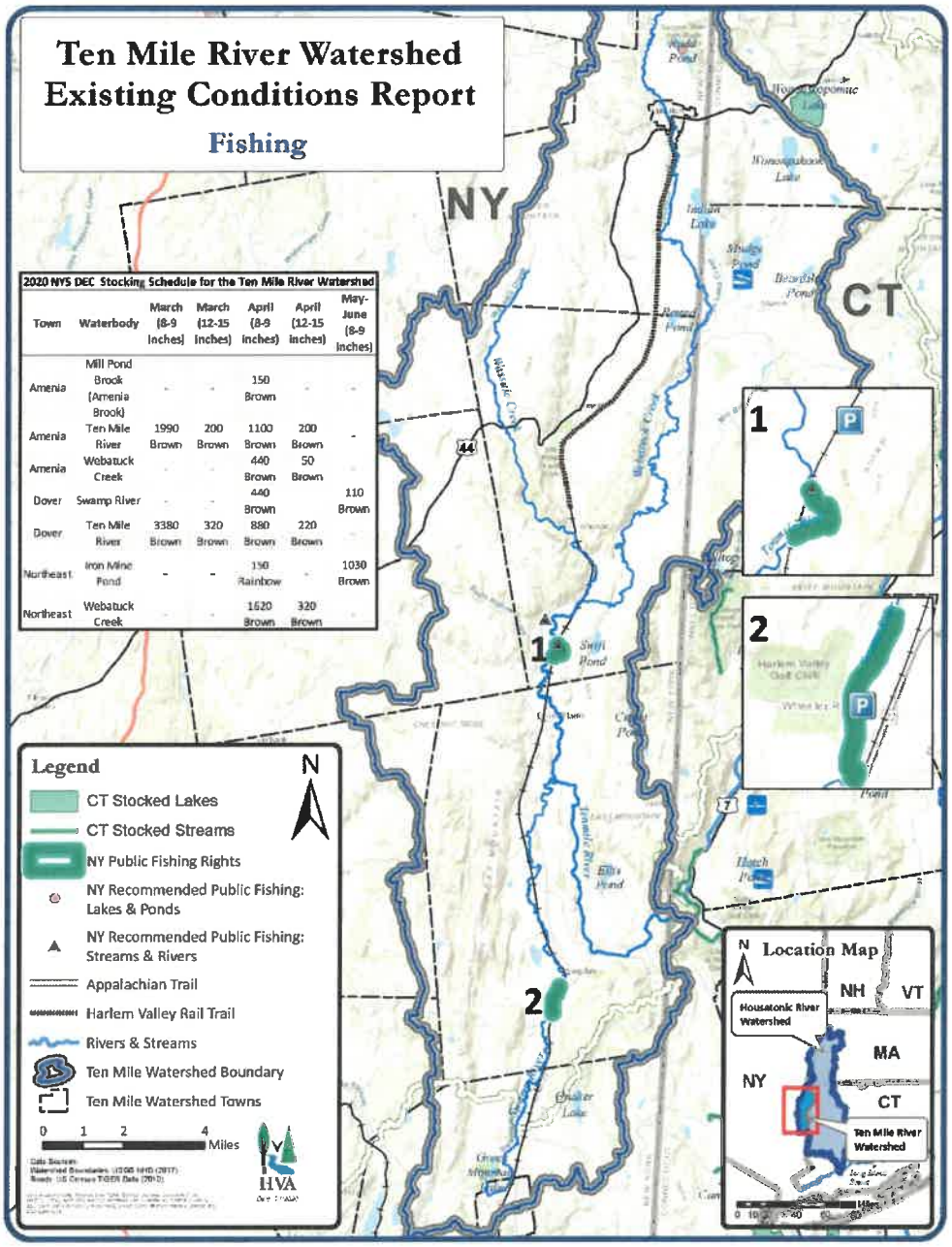
Town	Waterbody	March (8-9 inches)	March (12-15 inches)	April (8-9 inches)	April (12-15 inches)	May-June (8-9 inches)
Amenia	Mill Pond Brook (Amenia Brook)	-	-	150 Brown	-	-
Amenia	Ten Mile River	1990 Brown	200 Brown	1100 Brown	200 Brown	-
Amenia	Webatuck Creek	-	-	440 Brown	50 Brown	-
Dover	Swamp River	-	-	440 Brown		110 Brown
Dover	Ten Mile River	3380 Brown	320 Brown	880 Brown	220 Brown	-
Northeast	Iron Mine Pond	-	-	150 Rainbow	-	1030 Brown
Northeast	Webatuck Creek	-	-	1620 Brown	320 Brown	-

Table 5. 2020 NYS DEC Stocking Schedule for the Ten Mile River Watershed

Fishing in New York State and Connecticut requires a license. NYSDEC has two Public Fishing Rights (PFRs) access points in the Ten Mile River watershed[236]. The PFRs are permanent easements purchased by the state's DEC from willing landowner's that give anglers the right to fish and walk along the bank (within approximately 33 feet of water's edge)[237]. Anglers can access the right and left banks of the Ten Mile off Route 22 in Wassaic, NY. The Swamp River's PFR also features right and left bank access and is located off of Old Pawling Rd in Dover.

Boating

Beaver impoundments, strainers, and high waters can make paddling the Ten Mile River a challenging activity, but the scenery and the thrill are well sought-after by the more experienced . There is a put-in located off Route 55 (Riverview Rd.) in Dover, NY where kayakers will experience flat waters and Class I whitewater (smooth water with light riffles) for the first couple of miles. Beyond that point, there is a Class II drop at the NY/CT border. Downstream of the state line, the river briefly returns to flatwater conditions before paddlers encounter a longer stretch of Class II rapids (medium-quick water rapids with clear, open passages between rocks and ledges). These conditions can be dangerous and should be handled by those who can safely maneuver their watercraft and read the water. Kayakers are also known to put-in across from the Ten Mile River Metro-North Railroad station —at the Wassaic and Webatuck Creek confluence. From there they can enjoy a seven-hour float down to the Housatonic River—again, with caution. A slower, more primitive paddling experience (involving portage) can be found on the Swamp River where the waters leave the Great Swamp.



Map 28. Public Fishing Rights and CTDEEP trout stocking locations.

Trout Unlimited, Inc. — Mid-Hudson Chapter

Trout Unlimited, Inc. (TU) is a robust national community with over 300,000 members consisting of anglers and volunteers, all dedicated to protecting important habitats, reconnecting degraded waterways, and restoring the trout populations of North America's cold water fisheries and the watersheds that feed them. Since 1959, TU's approach to conservation has involved building partnerships between landowners, agencies, non-profits, municipalities, and other stakeholders. Their conservation efforts include land management and development, water and fisheries management, and watershed restoration. They also engage with communities through their Trout in the Classroom program for young students, "sharing the healing power of water" work with veterans, and their endorsement of local businesses[238].

Mid-Hudson Trout Unlimited supports work in the Ten Mile River watershed by participating in volunteer events, contributing to the scientific research datasets needed to improve infrastructure and stream corridors, and collaborating with municipalities, non-profits, and local officials. Public Fishing Rights Maps for Dutchess County can also be found on their website—a great resource for the prospective angler.

Ducks Unlimited

Founded by hunter-conservationists in 1937, Ducks Unlimited (DU) is the world's largest private, nonprofit waterfowl and wetlands conservation organization. Grassroots and volunteer-based, with nearly 700,000 members, DU's efforts unite conservationists and outdoor enthusiasts across the United States, Mexico, and Canada. Their work aims to conserve, restore, and manage wetlands and other habitats of North American waterfowl[239].

The Ten Mile River watershed falls within the Atlantic Flyway portion of DU's Great Lakes/Atlantic Region (GLAR)[240]. GLAR covers 21 states in the New England, Mid-Atlantic, and Mid-West sections of the United States. The GLAR office provides conservation planning, engineering services, mitigation incentives, public policy planning, and communications/outreach to their communities.

The Dutchess County chapter of Ducks Unlimited was founded in 2012 and is located at the Ten Mile River Preserve in Dover Plains, NY. This chapter serves the residents and visitors of Dutchess County through local events participation, youth and adult programming, providing direction for wetlands conservation and restoration, and highlighting recreational opportunities for the duck hunters in the Hudson and Harlem Valleys. They have been a significant partner in protecting and raising funds for the Great Swamp.

Ten Mile River Preserve

The Ten Mile River Preserve (TMRP) is a private membership club located in Dover Plains, NY. The TMRP consists of over 3,000 acres of land managed for recreational use—incorporating 200 acres of lakes, and 3.5 miles of the Ten Mile River. The club offers upland bird hunting, wild hunting, sporting clays, fishing, a shooting range, gun dog training and boarding, and lodging. The preserve hosts the Dutchess County chapter of Ducks Unlimited and, given the outdoor activities offered, they are an important member of the TMR recreation and conservation community.

Sharon Audubon Center

Situated between Hatch Pond and Ford Pond (both of which feed Mill Brook—a tributary to Webatuck Creek), Connecticut's Sharon Audubon Center hosts educational programs throughout the year and is home to the Children's Adventure Center. The Sharon Audubon Center also includes raptor aviaries, pollinator gardens, a butterfly house, hiking trails and a working sugar house.

In addition to the attractions listed above, the Center also coordinates Audubon Connecticut's Forest for Birds program—a habitat assessment program that integrates science, education, public policy, and land management expertise to protect high-quality breeding habitats for forest songbirds along the Atlantic Flyway[241].

Other Clubs and Communities

The Ten Mile River watershed is fortunate to have many active conservation communities working hard to protect its natural assets. In addition to those listed above, the following organizations and clubs are also present and are either smaller in size or highlighted in other sections of this chapter.

- The Harlem Valley Rail Trail Association (HVRTA)
- Appalachian Trail Conservancy/ Appalachian Trail Community
- Small private clubs with a presence in the watershed include Amenia Fish and Game Club, Inc and the Chestnut Ridge Rod and Gun Club, Inc. in Dover Plains.

7.2.3 Economic Importance of Outdoor Recreation and Open Spaces

As a whole, New York State welcomed a record high of 234.8 million visitors in 2017 with visitor spending exceeding $67.6 billion—generating $8.5 billion in state and local taxes[242]. Dutchess Tourism estimates per-household tax savings from tourism to be $630 annually[243]. Similarly, in 2017, the State of Connecticut saw a visitor spending increase of 3.6%, the strongest increase since 2011— a total of $9.3 billion[244].

The Recreation Supersector accounts for a large portion of visitor spending[245]. The 2020 Harlem Valley Outdoor Recreation Survey (HVORS) reported that 67% of Harlem Valley visitors were in the area to hike the Appalachian Trail, 6% were there for another trail, and 5% were there for other outdoor recreation (a large portion of responses are considered "hiker intercept surveys)[246]. Data from the HVORS Survey show that both day and night visitors spend money locally related to their travels—with the visitor spending averaging $93/day by the day visitor and $117/day by the overnight visitor[247]. The Harlem Valley Visitor Survey showed that trails come second in the list of "Most Frequently Used Visitor Spaces"—falling in between restaurants and grocery stores. The survey also showed "better information about trails" being the number one answer when visitors were asked what would encourage them to spend more time in the Harlem Valley[248].

The Litchfield Hills Region of Connecticut accounts for 11.8% of CT's visitor spending—Litchfield County makes up 4.3%[249]. While this may be a small portion of the total GDP contributions for the state, the western portion of Connecticut shows promising signs of growth that could be enhanced through enhancing recreation opportunities.

Litchfield Hills

Tourism Employment

Year	Direct	Total (Dir, Ind, Induced)	Share of State (Total)
2015	9,623	14,349	11.81%
2014	9,609	14,326	11.91%
2013	9,497	14,143	11.93%
2012	9,176	13,709	11.78%
2011	8,756	13,157	11.51%

Tourism Labor Income, (millions)

Year	Direct	Total (Dir, Ind, Induced)	Share of State (Total)
2015	$282.7	$513.5	9.83%
2014	$271.3	$498.7	9.77%
2013	$269.8	$491.8	9.79%
2012	$264.2	$483.3	9.83%
2011	$243.4	$448.5	9.65%

Total Tourism Tax Receipts (millions)

Year	Federal	State and Local	Hotel	Total
2015	$85.8	$112.7	$12.26	$198.4
2014	$83.2	$107.7	$11.59	$190.9
2013	$81.5	$104.7	$10.99	$186.2
2012	$81.0	$104.7	$10.66	$185.7
2011	$77.8	$103.2	$9.58	$181.0

Tourism Sales (millions)

Tourism Industry	Tourism Economy
$1,028.8	$1,614.4
$970.6	$1,580.7
$931.4	$1,518.7
$908.1	$1,510.3
$891.8	$1,484.6

Figure 10. Tourism impact seen in the Litchfield Hills Region.[250]

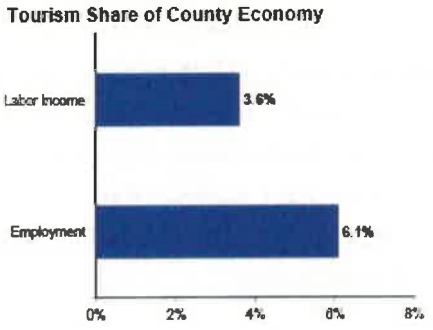
Litchfield County

Tourism Employment

Year	Direct	Total (Dir, Ind, Induced)	Share of State (Total)
2015	3,749	5,409	4.45%
2014	3,837	5,538	4.61%
2013	3,869	5,567	4.69%
2012	3,643	5,269	4.53%
2011	3,344	4,875	4.26%

Tourism Labor Income, (millions)

Year	Direct	Total (Dir, Ind, Induced)	Share of State (Total)
2015	$98.1	$161.3	3.08%
2014	$95.5	$158.5	3.10%
2013	$97.3	$159.9	3.18%
2012	$94.8	$156.0	3.17%
2011	$83.1	$137.9	2.97%



Total Tourism Tax Receipts (millions)

Year	Federal	State and Local	Hotel	Total
2015	$29.1	$36.4	$2.56	$65.5
2014	$28.7	$35.5	$2.35	$64.2
2013	$28.7	$35.6	$2.36	$64.3
2012	$28.4	$35.1	$2.33	$63.5
2011	$26.4	$33.5	$2.13	$59.9

Tourism Sales (millions)

Tourism Industry	Tourism Economy
$374.2	$584.3
$359.8	$567.9
$356.8	$567.0
$352.5	$561.0
$341.6	$542.5

Figure 11. Tourism impact seen in Litchfield County, 2015. [251]

Increases in visitor frequency not only support growing economies, but they also present employment opportunities for watershed residents. In 2016, 14.8% of jobs in Dutchess County were in the travel and tourism-related industries[252]. Visitor spending in the State of Connecticut supported 123,521 jobs through direct, indirect, and induced impacts[253].

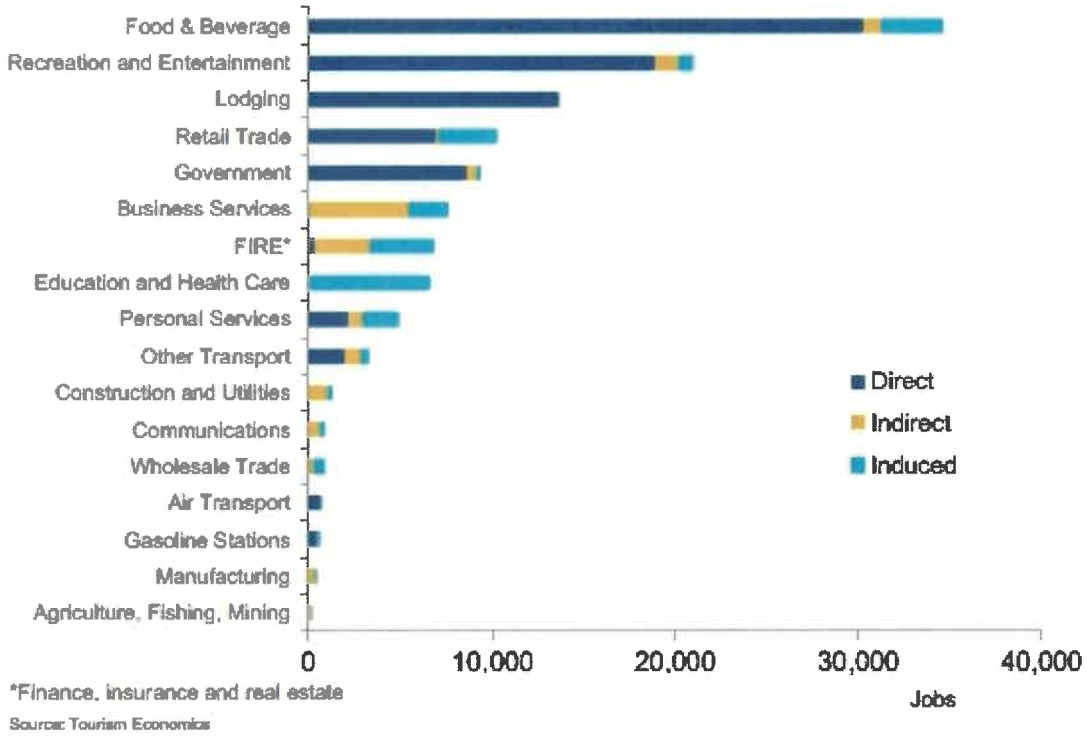


Figure 12. Tourism-related employment impacts in the State of Connecticut[254]

In addition to the economic growth opportunities available through the enhancement and promotion of outdoor recreation assets in the watershed, the natural landscapes also provide economically valuable ecosystem services (water filtration, erosion control, flood mitigation, carbon sequestration, and air purification). Using the 2011 analysis of socioeconomic value of the Delaware River Basin as a tool, the Harlem Valley's Outdoor Recreation Economic Assessment estimates the dollar value of these services to be $195.5 million each year[255]

Cover Type	Acres	$ Value/ Acre	Annual $ Value
Freshwater wetlands	10,531	$16,116	$169.7 million
Farmland	22,465	$2,949	$7.3 million
Forest	74,980	$2,330	$116 million
Open freshwa-ter	1,500	$2,292	$3.4 million
Developed	8,700	$403	$3.5 million
Other	2,674	n/a	

Figure 13. Harlem Valley land cover data with dollar value per acre[256]

7.2.4 Outdoor Recreation Promotion

With the personal and economic benefits of preserved and protected open spaces becoming so clear, it is important to begin engaging new approaches in destination and tourism services. Focusing advertising and promotion on sustainability, shifting from "product development" to "experience development", and providing more digital and online travel planning tools are all new tactics being employed by service

providers[257]. The Destination Marketing Association International recently surveyed 350 destination marketing organizations (DMOs) in over 36 countries to gain a better understanding of trends that are affecting destination marketing efforts. The study identified 20 important trends—some of which are particularly relevant to establishing the Ten Mile River watershed as a travel destination. Those highlighted in the *Harlem Valley Outdoor Recreation Economic Assessment* include social media's reach to travel markets, mobile platforms and apps as the primary engagement platform for travelers, and customers increasingly seeking personalized travel experiences[258].

Despite this growing awareness, the Ten Mile River watershed and all of its important assets still suffer from low visibility when compared to surrounding regions. The Appalachian Trail remains the watershed's most well-known feature[259].

Leisure Overnight n=775	Never heard of it	Heard of it but not interested in visiting	Heard of it and want to visit in the future	I have been there
Great Swamp	83.9%	6.2%	7.5%	2.5%
Dover Stone Church	78.1%	5.7%	13.4%	2.9%
Harlem Valley Rail Trail	62.3%	9.1%	20.6%	8.0%
Appalachian Trail	6.8%	23.9%	48.0%	21.3%

Leisure Daytrip n=1,684	Never heard of it	Heard of it but not interested in visiting	Heard of it and want to visit in the future	I have been there
Great Swamp	78.9%	6.5%	10.5%	4.2%
Dover Stone Church	73.7%	5.7%	15.7%	4.9%
Harlem Valley Rail Trail	48.5%	10.8%	28.2%	12.6%
Appalachian Trail	6.1%	20.4%	45.2%	28.3%

Bus/Conf/Mtg n=125	Never heard of it	Heard of it but not interested in visiting	Heard of it and want to visit in the future	I have been there
Great Swamp	78.3%	5.8%	10.8%	5.0%
Dover Stone Church	72.4%	11.4%	13.8%	2.4%
Harlem Valley Rail Trail	44.7%	13.0%	26.0%	16.3%
Appalachian Trail	5.7%	20.3%	52.0%	22.0%

CIA n=1,199	Never heard of it	Heard of it but not interested in visiting	Heard of it and want to visit in the future	I have been there
Great Swamp	84.0%	5.5%	7.5%	3.1%
Dover Stone Church	79.5%	4.6%	12.6%	3.3%
Harlem Valley Rail Trail	58.5%	9.1%	22.2%	10.3%
Appalachian Trail	6.1%	23.1%	46.0%	24.9%

Figure 14. Results of the Dutchess County Visitor Survey: Outdoor Asset Name Recognition [260].

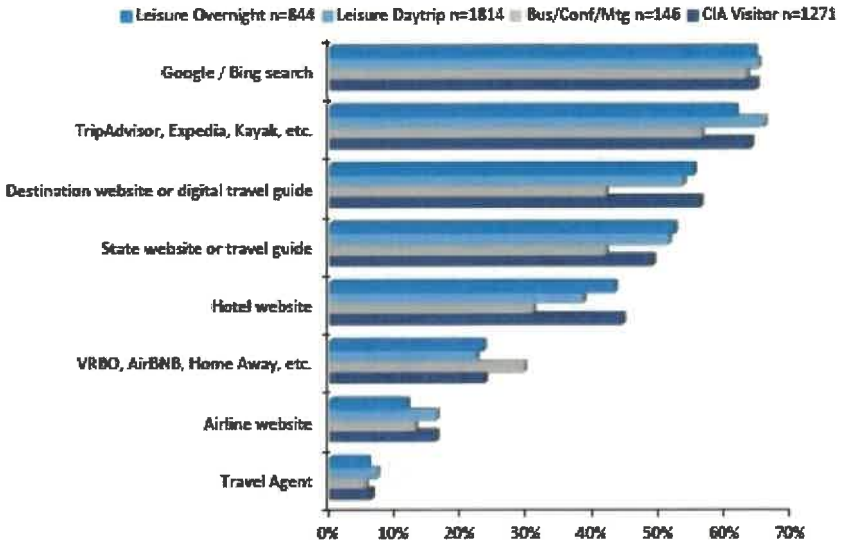


Figure 15. Preferred information sources for getaway planning[261]

As seen in Figure 15, online information sources have become the go-to in travel planning. The following is a list of some of the promotional initiatives that are active within the watershed.

Dutchess Tourism, Inc.

Dutchess Tourism, Inc's (DTI) mission is to drive visitation to Dutchess County in order to generate the maximum impact of visitor spending for the benefit of the County's community. It is Dutchess County's officially designated destination marketing and management organization—accredited by the Destination Marketing Accreditation Program (DMAP) of Destinations International. This independent 501c6 non-profit organization works to bring tourism dollars to the area through marketing and promotion of the County's assets. DTI provides in-depth analyses of Dutchess County's tourism industry, programmatic support for the area's businesses and organizations, and a user-friendly online platform for existing and prospective visitors[262]. The organization also supported the recent production of the Appalachian Trail Conservancy's *Harlem Valley Outdoor Recreation Economic Assessment*.

Appalachian Trail Conservancy's AT Communities

The Appalachian Trail Conservancy's Appalachian Trail Community program recognizes communities that promote and protect the AT in addition to acting as a welcoming hub for those who hike the trail. The program seeks to engage citizens and visitors, recognize the communities for their service, act as a catalyst for enhancing sustainable economic development, assist municipalities with conservation planning, and increase recognition of the trail as a community resource and asset[263]. The towns of Dover and Pawling combined their efforts to form the Harlem Valley Appalachian Trail Community (HVATC) in 2013 with the help of the Appalachian Trail Conservancy and New York-New Jersey Trail Conference. They have since committed to celebrating the Trail's beauty, cultural heritage, and value through outreach and education, and advocating for large landscape conservation in the Harlem Valley. Guided by the Schaghticoke Tribal Nation to understand the land and rivers, the HVATC is working to develop a cultural conservation project to showcase the diversity of populations that make up the Harlem Valley[264].

Harlem Valley Rail Trail Botanical Guide

The Harlem Valley Rail Trail Association's Botanical Guide is an extensive botanical survey that was conducted by local ecologists and published as a brochure in August of 2005. Available at kiosks along the trail and for download online, the guide serves as exciting tool for both the professional and the beginner plant enthusiasts.

Harlem Valley Geotourism

Appalachian Trail Conservancy's geotourism initiative is an online travel guide created with the goal of "building the Harlem Valley's synergy of outdoor recreation, farm and food, hospitality, arts and culture, history and conservation". The project is currently ongoing.

Federation of Dutchess County Fish and Game Clubs, Inc

As a membership organization committed to representing the interests of the outdoors sporting communities of Dutchess County, the Federation of Dutchess County Fish and Game Clubs, Inc. works closely with sportsmen's clubs, NYSDEC, elected representatives, and other interested communities to conserve wildlife and natural resources. Through partnering with these entities, communications with sportsmen and sportswomen, and their Conservation Awareness Fund, the Federation ensures the continuation of the legacy and traditions of outdoor sports[265].

Services offered by the Federation include: "Hunters Helping the Hungry" a program through which wild game is processed and donated to local food kitchens who serve hot meals to those in need, trout stocking in lakes throughout the county, maintenance of fishing access points, and conservation promotion and public awareness at the Dutchess County Fair and through their *Outdoor Journal* newspaper.

7.3 Recommended Actions

Recommended Actions & Milestones	Who	Timeframe (Schedule)	Deliverables & Evaluation Criteria	Est
Establish a Ten Mile River Recreation Subcommittee that will collaborate across municipalities to: • pool resources • seek and secure funding • coordinate efforts to develop and maintain a network of recreational opportunities throughout the watershed.	TMRC	w/in 2 years	•	
Incorporate educational signage, workshops, activities, and materials into recreation projects that inform users about the Ten Mile River - and greater Housatonic River - watersheds, their history, and ongoing restoration.	TMRC, watershed municipalities, landowners	Ongoing	•	$
Create linkages between open space, parks, trails, public transportation, sidewalks, pathways, river access points and other forms of transportation infrastructure where possible.	TMRC, NYSDEC, watershed municipalities	Ongoing		$
Increase accessibility to people of all ages, abilities, and backgrounds. • Promote the accessibility of recreation such as hiking, boating, fishing, etc. to low-income people of color, those with disabilities, children and the elderly.	TMRC, watershed municipalities, land trusts	Ongoing		

• Study the connectivity and impact of public transit and municipal infrastructure on recreation accessibility in the watershed. Institute programming that cater to and excite these audiences in creative and engaging ways to encourage use of recreation infrastructure. • Examine and create messaging, branding and design of watershed recreation that pulls these audiences in, engages them in creative ways, and generates a sense of belonging.				

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000
$50,00

8. IMPLEMENTATION STRATEGY

Once the TMRC reached consensus on the Vision and Goals for the TMR Watershed, the next step in the Watershed Planning process was to identify specific Actions that must be taken to achieve a healthy, resilient Ten Mile River watershed. Actions were generally organized as **non-construction programs** (Actions like water quality monitoring and educating youth about the Ten Mile River) and **construction projects** (Actions like planting trees along a stream or capturing polluted runoff from a parking lot to filter out pollution).

The TMRC identified over 30 Actions over the five focus areas, aimed at everything from involving local youth in watershed plan implementation to enhancing river access for paddlers and anglers to encouraging streamside homeowners to use sustainable lawn management practices. The TMRC then worked collaboratively to prioritize Actions for implementation based on pollution reduction potential, existing and potential partnerships to support implementation, cost-effectiveness/feasibility and potential to address multiple Goals across the five Watershed Plan Focus Areas.

More detailed descriptions of priority projects and programs are included below.

8.1 Site-Specific Projects

8.1.1 Wells Brook Stormwater Retrofit

Address:	3078 Rt. 22, Dover Plains, NY 12522
Coordinates:	41.734605, -73.580714
Sub watershed:	Wells Brook
Location:	Dover, NY
Impervious Area:	47,736 SF

Site description: Wells Brook is generally healthy before it flows through a commercial area in Dover Plains, approximately 2500' above its confluence with the Ten Mile River. HVA has documented a variety of water quality issues downstream of this commercial area, including elevated levels of indicator bacteria and nutrients and changes to the invertebrate community that indicate chronic water quality impacts. Wells Brook is also a summer thermal refuge for Eastern Brook Trout and other coldwater species, which has been documented by HVA's warm-season temperature monitoring as well as assessment of the Wells Brook fish community conducted by NYS DEC Region 3 Fisheries. This project will use Green Infrastructure practices to capture polluted runoff currently entering Wells Brook untreated from parking lots associated the existing CVS shopping center and the McDonalds restaurant, as well as NYS Route 22. These practices will reduce the amount of nutrients, sediment, heavy metals and deicing agents entering Wells Brook and the Ten Mile River.

Reducing existing nutrient loads and preventing future increases in nutrient loading from the TMR to the Housatonic River and LIS is a central goal of HVA's TMR watershed management work. Ultimately the TMR WBP will bring more resources into the watershed to implement strategies that minimize NPS Nitrogen pollution from the TMR, which will help meet the goals being developed for the LIS Nitrogen Reduction Strategy and reduce eutrophication-related impairments in LIS embayments. To that end, HVA, in partnership with Rennia Engineering Design, PLLC, has assessed three separate sections (Drainage Area 1, Drainage Area 2, and Drainage Area 3 on Survey/Existing Conditions Map) of the directly connected impervious area associated with the CVS Plaza and McDonalds, and designed GI practices that will intercept and filter runoff from each of these areas before it enters Wells Brook.

Drainage Area 1 (DA-1):

DA-1 encompasses a portion of the McDonalds driveway and parking lot, and a section of NYS Rte. 22. This area will be treated with a bioretention cell (BR-1). Bioretention uses native vegetation, compost and sand as filtering mechanisms. The stormwater first enters a grassed filter strip, where the majority of the larger contaminates are removed by and retained in the grass. The stormwater then pools up above the main filtration cell, which contains native shrubs and herbaceous species selected based on their filtration effectiveness and ability to handle inundation as well as drought periods. Salt tolerance is also an important characteristic of plants chosen for bioretention. The rhizosphere (roots and associated microorganisms) absorbs water and absorbs or attenuates contaminates. The water then travels through a filtration medium comprised of layers of compost, topsoil and sand, during which additional contaminates are removed. Treated water is then piped out of the bioretention area to Wells Brook.

In addition to improving water quality, the bioretention structures will also provide aesthetic interest in the form of flowering plants, hardscapes and water features. Our partners at McDonalds are very interested in taking advantage of this with an informal seating area for customers. This also creates an excellent opportunity for active and passive public outreach (i.e. public presentations and interpretive signage- more on this below).

Drainage Area 2 (DA-2):

DA-2 encompasses a portion of NYS Rte. 22, and also includes what was an informal pull off for larger vehicles (i.e. tractor-trailers) visiting Dunkin Donuts or McDonalds. This area has since been blocked off by NYS DOT after consultation with landowners and HVA, but the area is severely compacted and acts essentially as impervious cover. DA-2 will be treated by a Dry Swale (DS-1). Dry swales work in a similar manner to the bioretention, but are less complex. Water is directed to the swale, which is grass lined. The grass acts as pretreatment removing some contaminates. The water is then filtered through a sand, topsoil and compost mixture to remove additional contaminates. Finally, the treated water is piped out of the practice to Wells Brook. The Dry Swale practice was chosen for this location in order minimize maintenance.

Drainage Area 3 (DA-3):

DA-3 encompasses a significant amount of the directly connected impervious cover associated with the CVS plaza. DA-3 will be treated by two Dry Swales (DS-2 and DS-3), which is critical in this location- due to its proximity to Rte. 22, taller vegetation could interfere with sightlines required by NYS DOT. Our intention is for the Dry Swale practice to look essentially identical to existing conditions, once installed, and require essentially the same maintenance regime (i.e. periodic mowing or string-trimming).

A summary of nutrient reduction estimates for the proposed Gi practices, is below:

Phosphorous Removal	
Practice	Amount Removed (lbs/yr)
BR-1	0.50
DS-1	0.17
DS-2 & DS-3	2.18
Total	**2.84**

Nitrogen Removal	
Practice	Amount Removed (lbs/yr)
BR-1	2.10
DS-1	1.05
DS-2 & DS-3	14.14
Total	**17.28**

Education and Outreach: In addition to reducing nonpoint source pollution through this reach of the Wells Brook, this project will be an excellent tool for teaching the community about the connection between their home river- the TMR- and the health of the Long Island Sound. This area gets lots of visitors, and adjacent property owners have expressed an interest in creating opportunities for the public to access Wells Brook and the restoration work HVA and our partners have completed, including a seating area adjacent to BR-1 and trails through the restored riparian zone. The large number of daily visitors to this location also presents an ideal opportunity to create passive outreach, such as interpretive signage. Potential messaging could include a background on the project and the associated

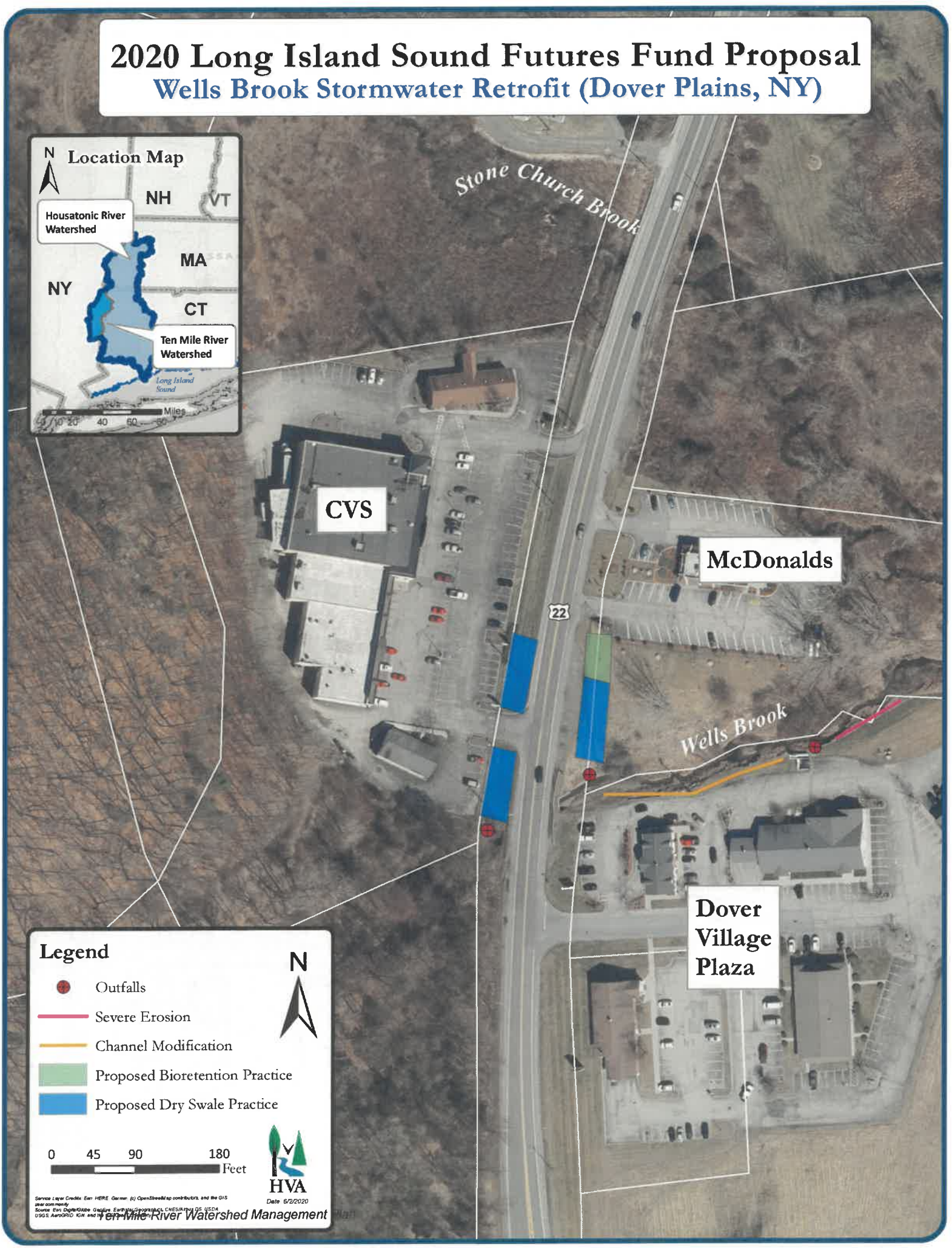
ecological and water quality benefits, a summary of the watershed and its geographical context, and a description of the importance of native plant communities and healthy riparian zones.

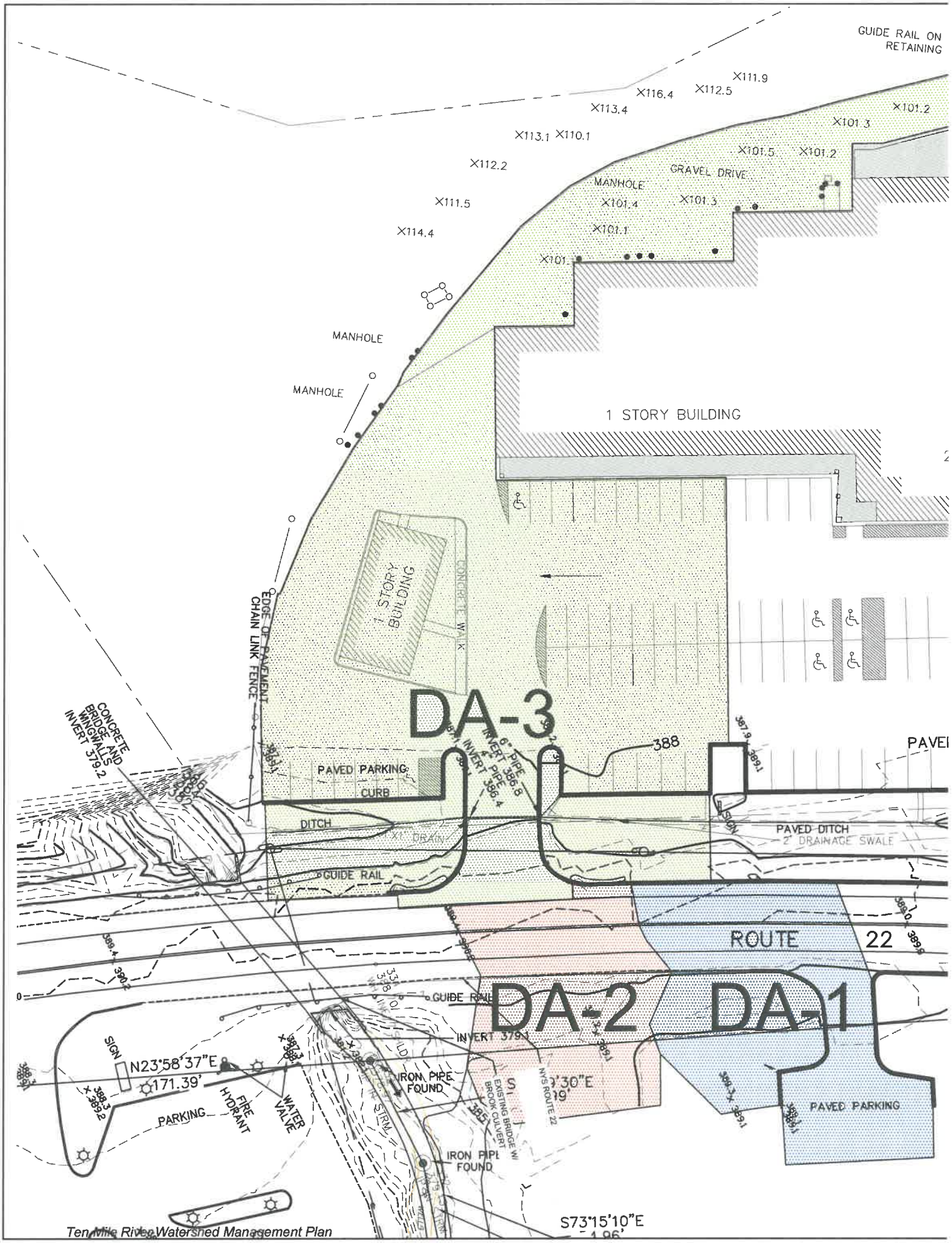
The project also has great potential as a demonstration site/case study to be used in public presentations and workshop development. The Green Infrastructure practices we describe will be the first of their kind locally, and we intend to use them as a flagship for encouraging municipal staff and officials to incorporate similar practices into development and redevelopment project.

Photos (clockwise from top left): Stormwater accumulating in the parking lot and beginning to flow into Wells Brook; Stormwater flow heading for Wells Brook; Downstream end of stormwater flow entering Wells Brook; Stormwater on upstream side (CVS parking lot)

2020 Long Island Sound Futures Fund Proposal

Wells Brook Stormwater Retrofit (Dover Plains, NY)




GUIDE RAIL ON RETAINING
X111.9
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MANHOLE
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MANHOLE
MANHOLE
1 STORY BUILDING
1 STORY BUILDING
CONCRETE WALK
EDGE OF PAVEMENT
CHAIN LINK FENCE
DA-3
CONCRETE BRIDGE WINGWALLS INVERT 379.2
PAVED PARKING
CURB
DITCH
6" PIPE INVERT 386.8
4" PIPE INVERT 386.4
388
PAVED DITCH
2' DRAINAGE SWALE
GUIDE RAIL
ROUTE 22
DA-2
DA-1
SIGN
N23°58'37"E
171.39'
INVERT 379.1
IRON PIPE FOUND
PARKING
FIRE HYDRANT
WATER VALVE
EXISTING BRIDGE W/ BROOK CULVERT
NYS ROUTE 22
PAVED PARKING
IRON PIPE FOUND
S73°15'10"E
1.96'

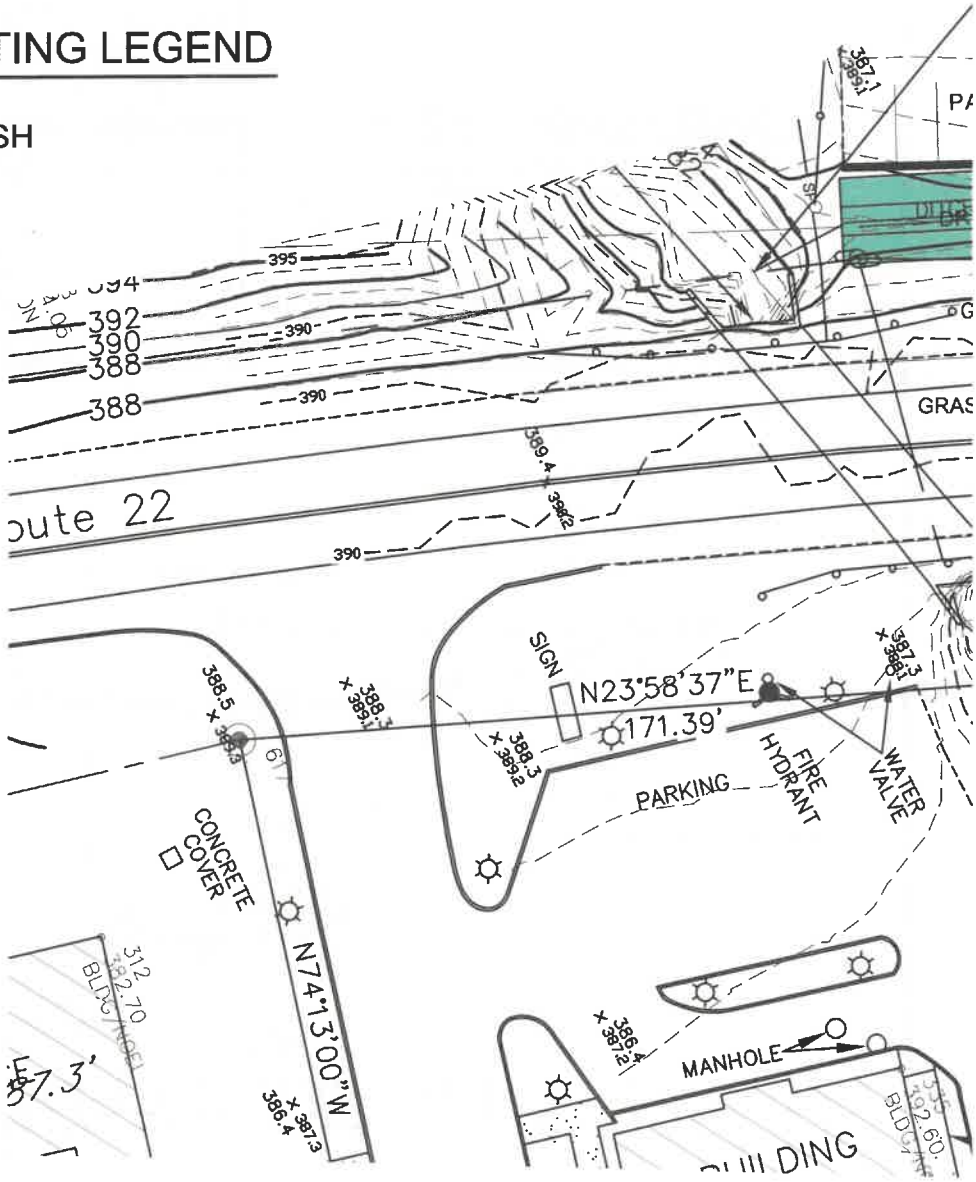
BIORETENTION PLANTING SCHEDULE

MARK	QTY.	BOTANICAL NAME	COMMON NAME	SIZE	REMARKS
SP	4	CLETHRA ALNIFOLIA 'HUMMINGBIRD'	SWEET PEPPERBUSH, SUMMER SWEET	18" HGT.	5 GALLON
HA	3	ASTER 'BLUE AUTUMN'	HARDY ASTER	12" HGT.	2 GALLON
*R	4	JUNCUS EFFUSUS	SOFT RUSH	8" HGT.	1 GALLON
*S	7	CAREX FLACCA	BLUE SEDGE	8" HGT.	1 GALLON

* PLANT RUSH AND SEDGE PLANTS IN A RANDOM PATTERN WITHIN THE LOWEST CENTRAL PORTIONS OF THE BIORETENTION BED. MAINTAIN AN AVERAGE SPACING OF 12" - 18".

BIORETENTION PLANTING LEGEND

- (SP) SWEET PEPPERBUSH
- (HA) HARDY ASTER
- (R) SOFT RUSH
- (S) BLUE SEDGE



DATE	REVISION

2' x 2' YARI

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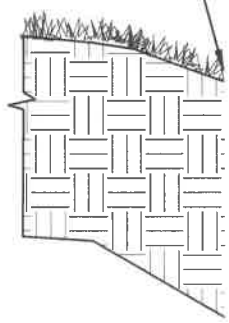
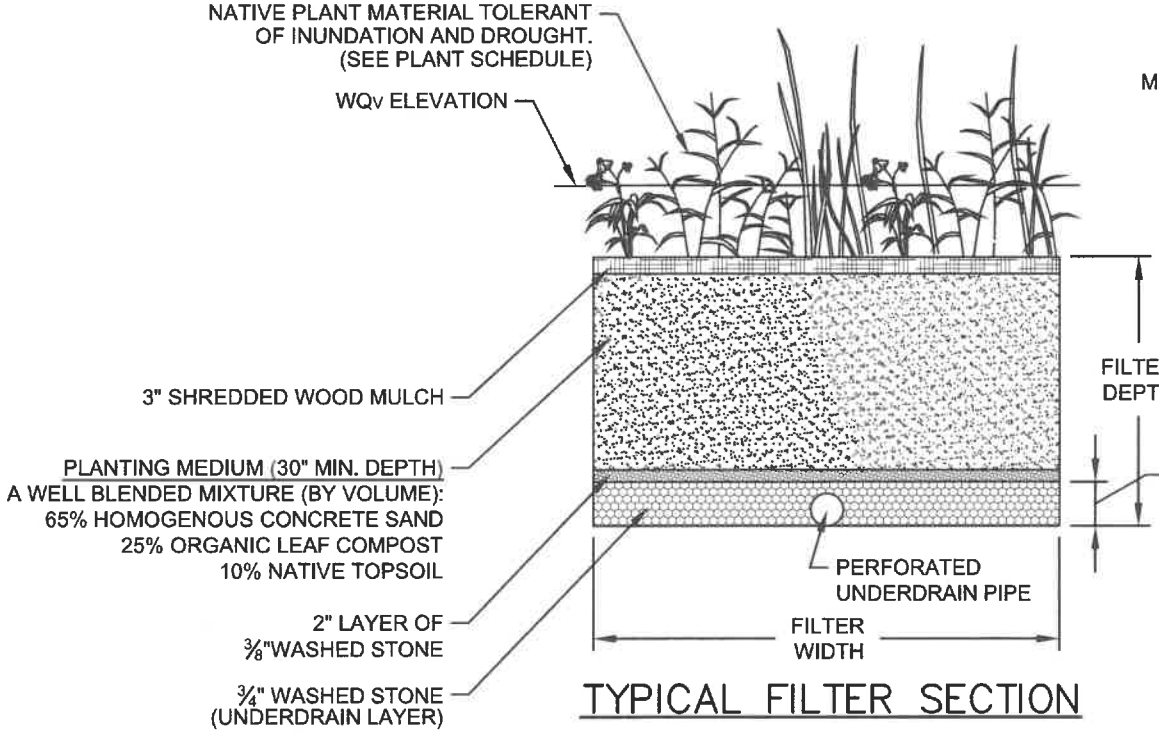
WQv ELEV

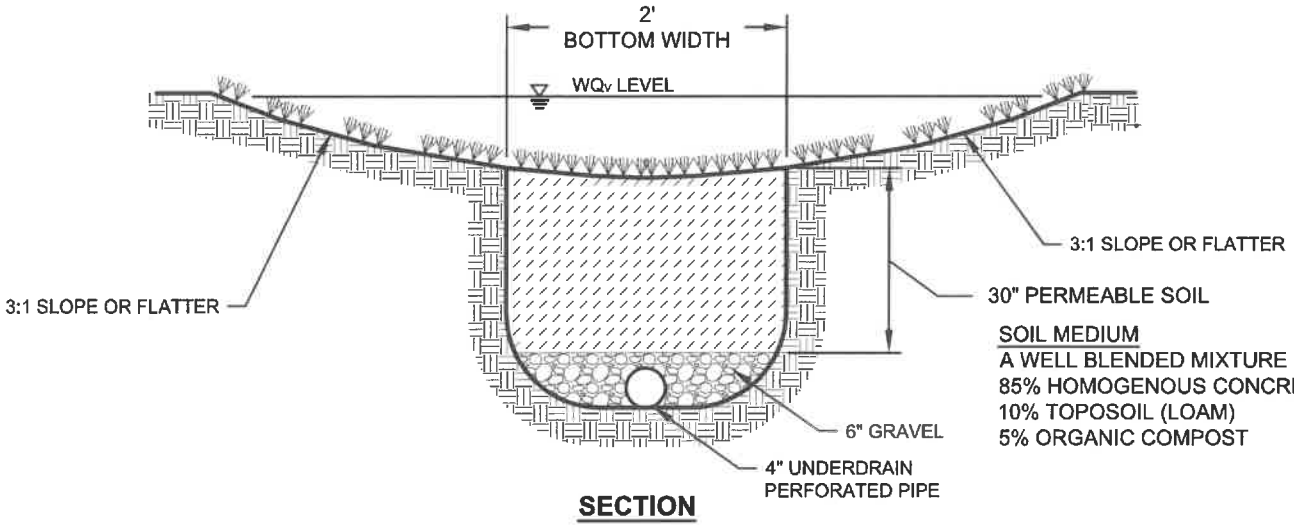
MAX. 3:1 SIDE SLOPES





TYPICAL FILTER SECTION

BIO RETENTION



SECTION

DRY SWALE DETAIL

NTS

DATE	REVISION

Wells Brook
Typical Bioretention Practice
Cost Estimate

Bioretention Area (BR-1)	Units	Quantity	Unit Cost	Total Estimated Price
Site Preparation				
Site Formation				
Excavation	CY	100	$22.00	$2,200.00
Hauling on-site	CY	100	$22.00	$2,200.00
Structural Components				
Yard Drain	Each	1	$1,000.00	$1,000.00
Pretreatment pea gravel trench	CY	4	$68.00	$251.85
4" perforated Underdrain	LF	64	$15.00	$960
Pea gravel Underdrain	CY	17	$50.00	$833
Filter Fabric (10' wide roll)	LF	100	$8.00	$800
Sand / Filter Media	CY	83	$70.00	$5,833.33
Site Restoration				
Planting	SF	900	$9.00	$8,100.00
Mulch	SY	100	$7.50	$750.00
			Subtotal	$22,928.52
			Cost per SF of Bio-retention Area	$25.48

Notes:

900 ft^2 bioretention area.

100 % of excavated material to be moved onsite.

15% Prevailing wage increase to total project budget.

Wells Brook
Typical Dry Swale Practice
Cost Estimate

Dry Swale (DS-22-1A)	Units	Quantity	Unit Cost	Total Estimated Price
Site Preparation				
Excavation	CY	278	$22.00	$6,116
Excavation Material Hauling on site	CY	278	$22.00	$6,116
Structural Components				
Pretreatment pea gravel trench	CY	11	$68.00	$756
4" perforated Underdrain	LF	300	$15.00	$4,500
Pea gravel Underdrain	CY	33	$50.00	$1,667
Sand / Filter Media	CY	167	$65.00	$10,833
Filter Fabric (10' wide roll)	LF	600	$8.00	$4,800
Inlet structure (Yard Drain)	Each	1	$1,000.00	$1,000
			Subtotal	$35,788
			Cost per SF of Dry Swale Area	$19.88

Notes:

1,800 ft^2 Treatment Area, 4,200 ft2 overall dry swale surface area.

Excavated material to be moved on site.

10% estimate for contigencies.

15% Prevailing wage increase to total project budget

8.1.2 Wells Brook Stream Restoration

Address: Dover Plains, NY 12522

Sub watershed: Wells Brook

Location: Dover, NY

Site description: This particular reach of Wells Brook is highly sinuous and low gradient, with no existing riparian buffer. The banks are actively eroding - introducing sediment to this important coldwater system and degrading Eastern Brook Trout habitat. HVA began assessing the water quality and ecological conditions of Wells Brook in 2014. The monitoring that was completed identified the following as root causes of degradation within the catchment:

- Floodplain Encroachment/Stream Instability
- Loss of Streamside Vegetation
- Invasive Plants
- Stormwater Runoff

This Project will initially address the floodplain encroachment and stream instability. The post-construction planting of a dense riparian buffer will address vegetation issue- allowing for native plant species to further stabilize the banks and preventing the spread of invasives. This buffer will also provide protection from potential stormwater-related inputs.

The Project's intent is to preserve and enhance the character of the cold-water habitat by reconstructing actively eroding banks and installing erosion control structures. The installation of rootwads and rock vanes will provide shaded pools and will greatly improve the conservation value of Wells Brook.

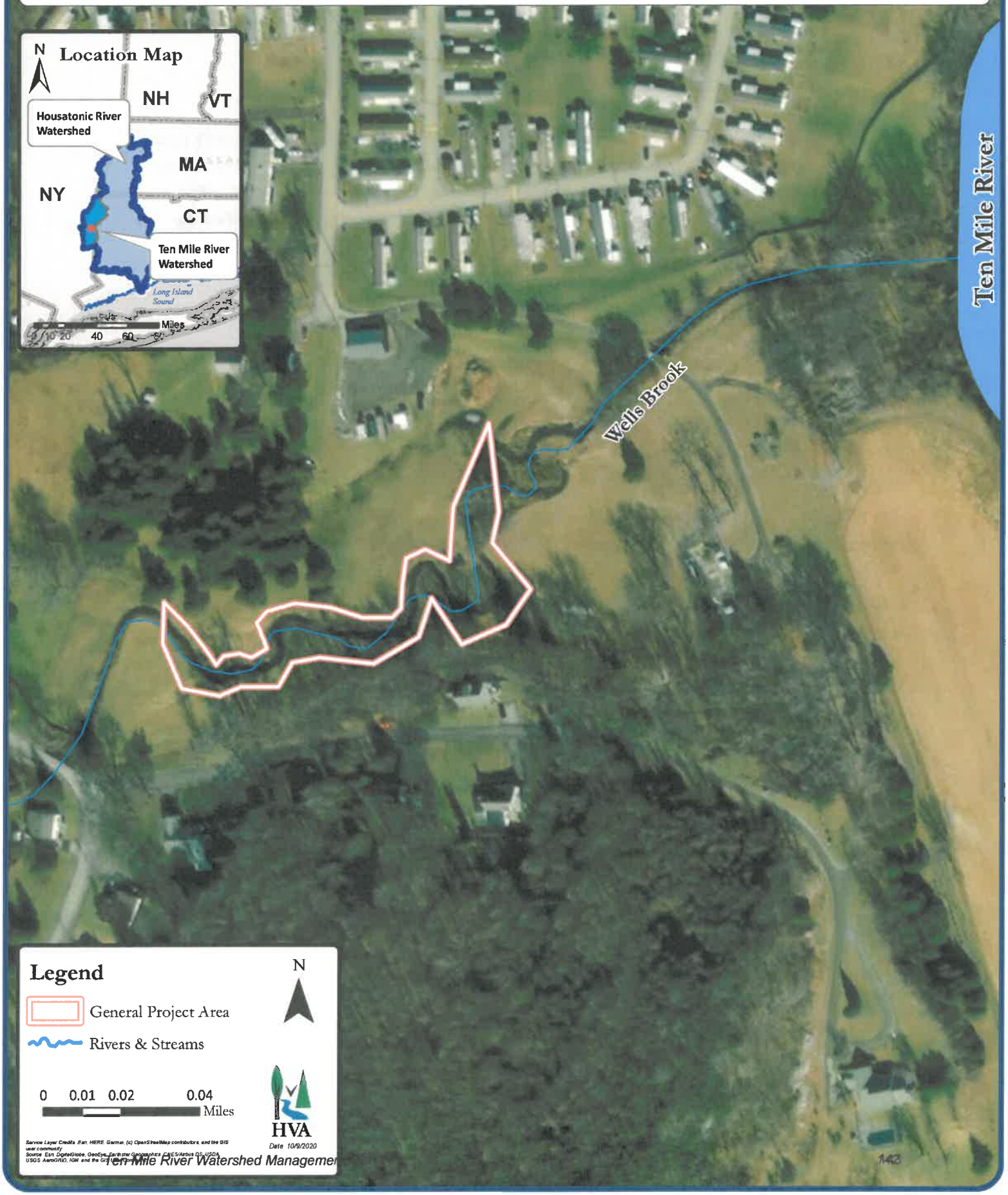
The project's location just upstream of the Wells Brook/Ten Mile River confluence ensures that this site will be utilized by coldwater obligate species that are seeking cold waters during the heat of the summer and traveling toward upstream tributary headwaters, from the Ten Mile River. The proposed enhancements will provide immediate coldwater pools and cover, once trout enter Wells Brook.

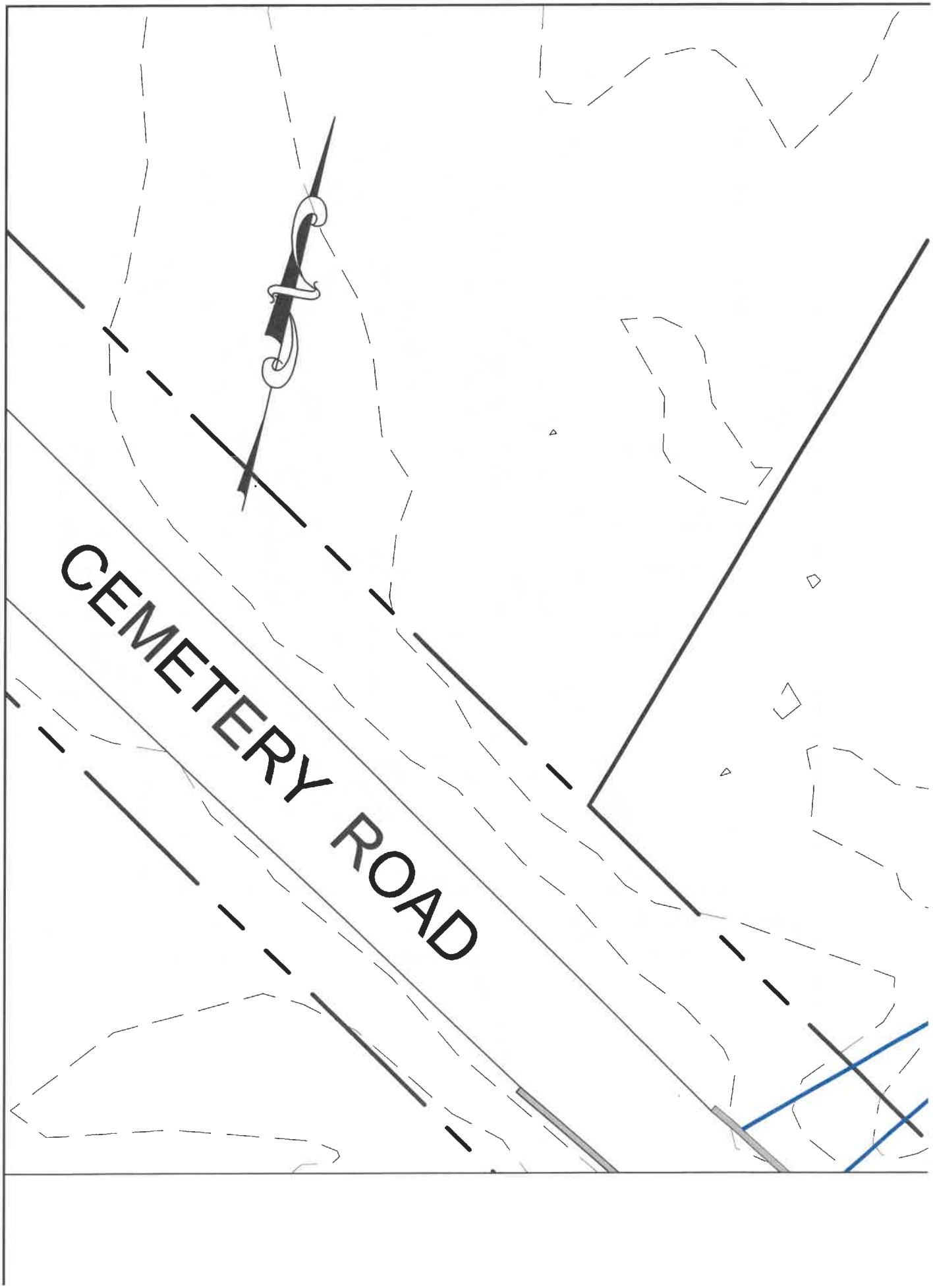
The preliminary designs on the following pages have been completed by property owner and project partner, Rennia Engineering.

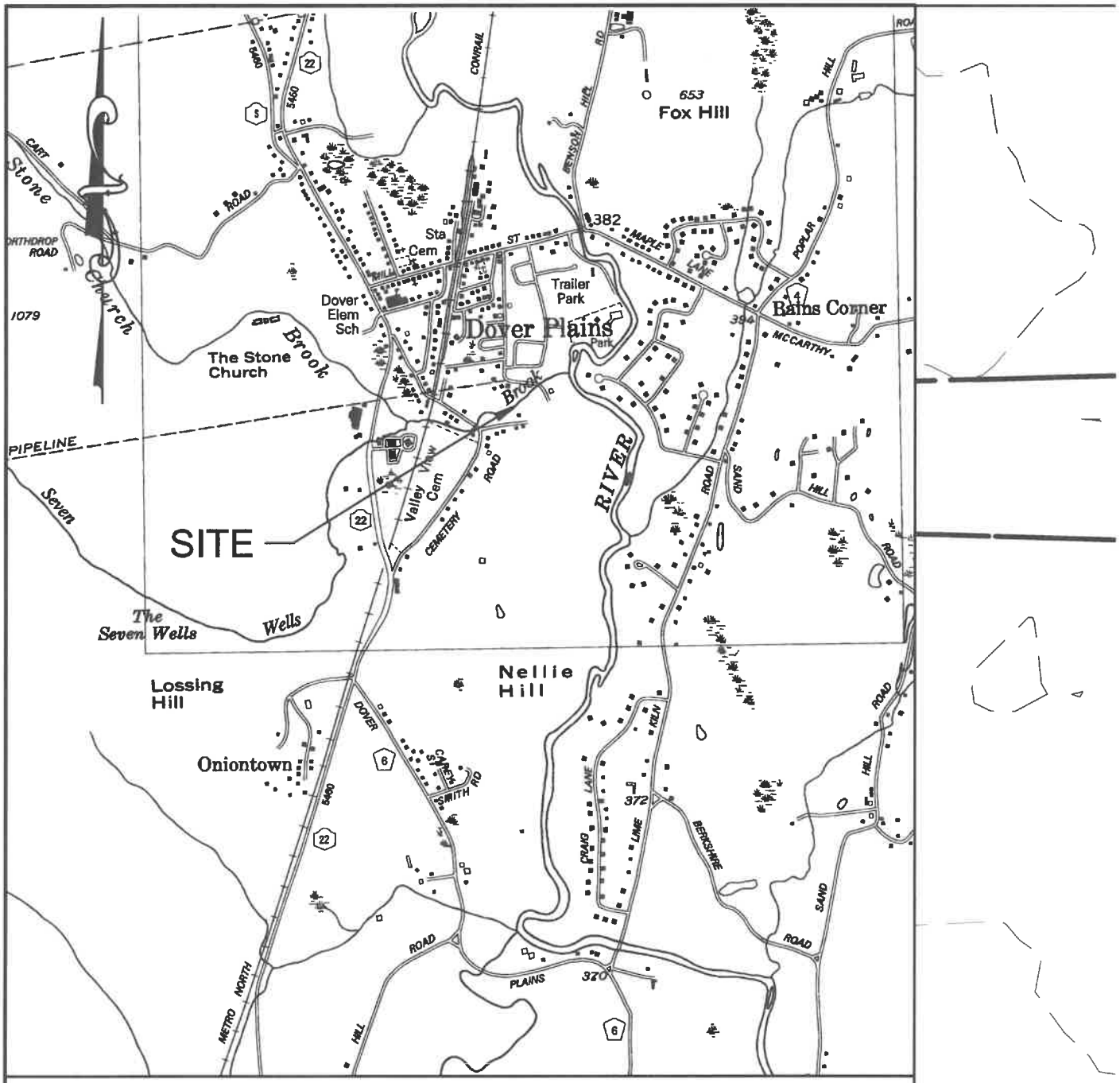
Goals:

- Reconstruct the stream channel and stabilize the banks.
- Preserve the ecologically important cold water habitat.
- Install a pollinator-friendly and diverse riparian buffer throughout the length of the reach.
- Conduct long-term monitoring of the site to track project success.

Lower Wells Brook Stream Restoration
Dover Plains, NY

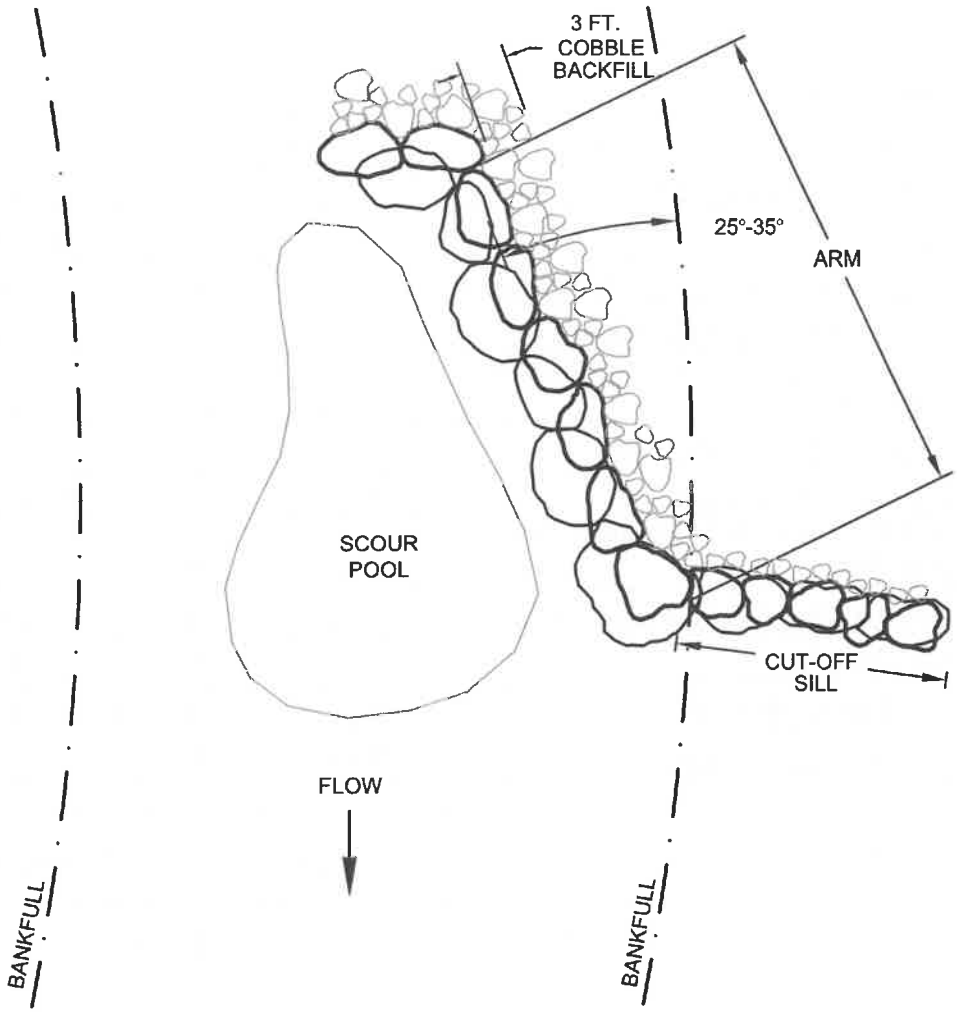



CEMETERY ROAD

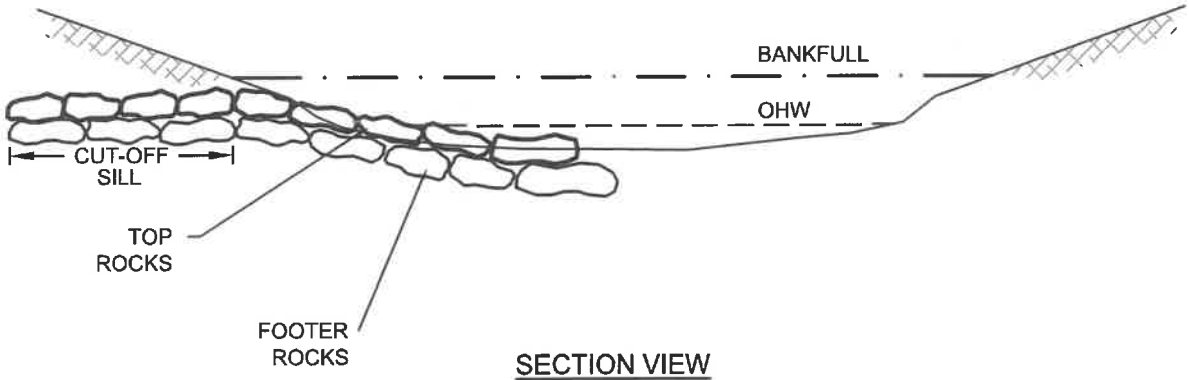


VICINITY PLAN

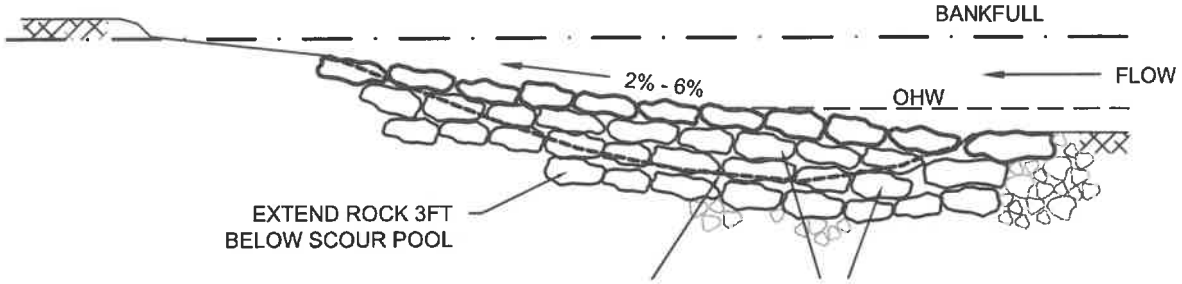
SCALE: 1" = 2,000'



PLAN VIEW



SECTION VIEW



Wells Brook Streambank Restoration
Project Cost Estimate

Item No.	Primary Items	Units	Estimated Qty.	Unit Cost	Total Cost
1	Mobilization & Demobilization	LS	1	$12,000	$12,000
2	Construction De-Watering	LS	1	$8,000	$8,000
3	Survey Control	LS	1	$5,000	$5,000
4	Temporary Erosion & Sediment Control	LS	1	$4,500	$4,500
5	Site Clearing (stockpile topsoil)	Cu Yd	400	$4	$1,600
6	Removal of Gravel Fill Material from Streambed	Cu Yd	444.7	$6	$2,668
7	Gravel Fill Borrow Material	Cu Yd	517	$8	$4,138
8	Root wads / toe wood	Each	5	$1,500	$7,500
9	Boulder Toe & Misc. Stabilization Stone (2'-4' DIA)	Ton	275	$40	$11,000
10	3 - Rock Vane Structures (4'-6' DIA)	Ton	305	$60	$18,300
11	Top Soil & Seed	SY	833	$3	$2,083
12	Live Stakes (Willow)	Each	160	$4	$640
13	Live Stakes (Dogwood)	Each	160	$4	$640
				Sub-Total Construction:	$78,069
				10% Construction Contingency	$7,807
				10% Engineering Design & Inspection:	$7,807
				Total Project Cost	**$93,683**

8.1.3 Mill Road

Address:	Mill Rd., Millerton, NY 12546
Coordinates:	41.917829, -73.517524
Sub watershed:	Webatuck Creek
Location:	North East, NY

***Site description*:** A tributary to Webatuck Creek flows through a wetland complex and under Mill Rd. before pinching up between the road and Harlem Valley Rail Trail (HVRT) bridge abutment (HVRT bridge does not otherwise interact with stream channel). There is significant scour along the road embankment and the concrete blocks that are leaning over the channel could fail in the future. There is some scour along the base of the HVRT bridge abutment. The site is reported to flood during large precipitation events - shutting down road and leaving at least one household stranded.

The site was documented during the 2019 road-stream crossing assessments, but only as a note in the record for the culvert upstream (xy4191837473518146 – replaced in 2019).

Goals:

- Engineer a solution that would allow the water to pass under the road.
- Maintain channel connectivity and integrity of the wetland area.

Above: Tributary channel being pinched between road and bridge abutment

Below: Significant scour of structures and leaning concrete blocks

Ten Mile River Watershed Management Plan

8.1.4 Amenia Highway Salt and Sand Storage

Address:	8 Borden Ln., Wassaic, NY 12592
Coordinates:	41.801901, -73.561159
Sub watershed:	Wassaic Creek
Location:	Amenia, NY

***Site description*:** The Town of Amenia Highway Department's stockpile of road salt and sand are currently located on Borden Lane in Wassaic (behind Pawling Corp) along with the salt storage shed. The site is inappropriate for salt due to its proximity to Wassaic Creek. Additionally, a mix of fill and piles of sediment disrupt connectivity between the stream and its floodplain.

This project will work to address nonpoint source pollution (hydrocarbons, deicing agents, and heavy metals being the principal pollutants of concern), while restoring the natural functions of the floodplain. At the time that this plan was written, there were no conceptual designs or cost estimates available.

Goals:

- Assist Town of Amenia Highway Department in moving the salt pile and salt shed to the newly acquired 5-acre site on Route 22 in Wassaic where a new highway garage will be built.
- Eliminate salt input and reduce unnatural sediment supply.
- Floodplain to stream channel reconnection.

Left: Large sand and gravel pile stored on right bank of Wassaic Creek

Above: Other end of sand and gravel pile with storm-water drainage channel to the right

Left: Piles of debris along right bank of Wassaic Creek—cutting off access to floodplain

Right: Salt shed surrounded by large piles of sediment within floodplain

8.1.5 North East Highway Garage and South Center Street Bridge

Address:	11 S Center St., Millerton, NY 12546
Coordinates:	41.949999, -73.509170
Sub watershed:	Webatuck Creek; Kelsey Brook
Location:	North East, NY

***Site description*:**

The Town of North East is working to decommission their Highway facility on Center Street in the Village of Millerton, which is built on fill in the Webatuck Creek floodplain. This facility has been used to store deicing salt and sand, and also has a garage building used for vehicle and equipment maintenance and a fueling station. The Town is currently constructing a new facility at a different location, and they have already moved stockpiles of deicing salt and other assets to this new site. While this has addressed an acute water quality issue, sand and other materials are still stockpiled at the Center Street facility, just above Webatuck Creek. There are also concerns about legacy pollution related to past vehicle/equipment maintenance and refueling. This site is just across Webatuck Creek from the Harlem Valley Rail Trail, and is within walking distance for hundreds of Millerton residents. This project will support the Town as they continue to transition from this site to their new facility, and explore possibilities for remediating the site and creating public access to Webatuck Creek and the Harlem Valley Rail Trail. There is also an opportunity to remove fill and reconnect Webatuck Creek to its floodplain in this location, which could help reduce flood risk on adjacent properties.

Just downstream of the garage, the Webatuck Creek meets Kelsey Brook. Kelsey Brook runs parallel to the southern end of the Center St. before making a 90° turn to enter the bridge on S. Center St. where it joins Webatuck Creek. The creek then flows under Mill Rd. through a double-celled culvert just downstream of the confluence.

- xy4194997673508970- Kelsey Brook bridge allows for full aquatic organism passage but is geomorphically incompatible (not aligned with channel and moderate channel constriction). Highway personnel report regular debris accumulation and severe scouring of the structure.
- xy4194977273509210- Webatuck Creek culvert is noted to reduce organism passage but is an insignificant barrier. A large pool has formed at the inlet and is likely due to location of confluence of Kelsey Brook and Webatuck Creek.

Goals:

- Assist Town of North East Highway Department in removing the existing garage and sediment piles from the floodplain. Secure funding for new garage.
- Prepare the site for transition to recreational open space.
- Floodplain to stream channel reconnection.
- Design geomorphically compatible structure for the confluence of Webatuck Creek and Kelsey Brook. Replace existing structures.

Aerial view of the North East Highway Garage project site. Red arrows show locations of tures and sediment storage in Webatuck Creek floodplain.

Left: Sand storage in Wassaic Creek floodplain

Right: Piles of gravel stored on left bank of Wassaic Creek. Narrow buffer with invasives

Left: Highway garage to be removed

8.1.6 Century Boulevard

Address:	Century Blvd., Millerton, NY 12546
Coordinates:	41.954206, -73.507374
Sub watershed:	Webatuck Creek
Location:	North East, NY

***Site description*:** Century Blvd. in the Village of Millerton was originally used by trains and later used mainly for parking – it is still known by some as "parking street." It is extremely wide, with no marked lanes or parking spaces (except at the east end), and no sidewalks except for a short segment from the northeast corner to the post office. Town Hall, the post office, and the fire department all sit along this corridor. The road sits at the base of a slope and stormwater currently flows directly into various drains located throughout the area.

In January of 2018, the Dutchess County Transportation Council completed a Pedestrian Plan for the Village with partial funding from the Federal Highway Administration and Federal Transit Administration, U.S. Department of Transportation, under the State Planning and Research Program. A key goal of this project would be to incorporate GI practices into these preliminary plans.

Goals:

- Incorporate Green Infrastructure (GI) practices into the current streetscaping plans.
- Improve walkability and use the heavily trafficked zone as a GI demonstration area.
- Protect Kelsey Brook and Webatuck Creek from stormwater inputs.

Above: Steep slope leading to impervious surface on Century Blvd.

Below: Vegetated storm drain on opposite side of road

8.1.7 Millerton Storm Drain Enhancements

Address:	Millerton, NY 12546
Coordinates:	41.954206, -73.507374
Sub watershed:	Webatuck Creek
Location:	North East, NY

Site description: Storm drains throughout the Village of Millerton are reported to regularly fill with debris and sediment. Sediment includes sand and salt used on roads throughout the cold-weather months. These congested drains lead to inadequate drainage and increased stormwater runoff being introduced to the Village's surface waters.

While this has been widely recognized as an issue, initial studies and conceptual plans have yet to be completed.

Goals:

- Assess where and how sediment-carrying runoff is impacting the Village's waterways.
- Explore mitigation strategies, including the installation of hydrodynamic separators and/or grate filters.

Village of Millerton—the most developed portion of the Town of North East

8.1.8 Nellie Hill Bridge

Address:	Nellie Hill Rd., Dover Plains, NY 12522
Coordinates:	41.734930, -73.575660
Sub watershed:	Wells Brook
Location:	Dover, NY

***Site description*:** The Nellie Hill bridge crosses Wells Brook in Dover and has been flagged for replacement since 2011 and was identified as a priority structure in HVA's 2016 assessment of the Town's road-stream crossings. The road on northwest side of the bridge is approximately 4ft too high and prevents emergency vehicles from passing beneath the Metro North Railroad crossing. Flooding and/or bridge failure at this site would cut off access to approximately 10 households.

The Town had previously received a grant, but lost the opportunity.

Goals:

- Replace existing bridge with geomorphically compatible structure that has the ability to pass high flows - design based off of future precipitation projections.
- Ensure emergency vehicle access to vulnerable neighborhood.

Left: View of rail trail crossing over Nellie Hill Rd. Large emergency response vehicles are unable to pass beneath this crossing.

Right: Inlet of the current structure.

Left: Structure outlet.

8.1.9 Ketcham Park

Address:	Dover Plains, NY 12522
Coordinates:	41.739030, -73.568726
Sub watershed:	Ten Mile River Mainstem
Location:	Dover, NY

Site description: J. H. Ketcham Memorial Park is an 11.1-acre parcel in the Town's Dover Plains hamlet, on the right bank of the Ten Mile River, and the location of a popular community pool from the mid-1960s to 2010. When the pool was decommissioned in 2016 due to age and disrepair, it was restored as open space and a public walking track is set to be installed in 2021. The waterfront land includes a vegetated riparian buffer (with some invasive species present), a children's playground, regulation-size baseball field, a small parking lot, and a community meeting space with kitchen facilities. The park's proximity to the hamlet provides walkable public recreation close to apartment-dwelling residents and families in the Railroad Square area of town, a 100-unit senior citizen mobile home park, and nearby neighborhoods of single-family homes.

In the 1993 Master Plan, it stated, "the hamlet of Dover Plains lacks a centrally located recreational area which is within walking distance of the higher density development located around the hamlet center" (p. 68). In 2018 and 2021, the Town received county development block grants to renovate the former pool's concession building in to meeting space and to construct a ¼-mile walking track. A 2017 residents' survey found a community center and a sports/recreation facility were ranked at 69% and 67% as the town resources that would most improve the overall quality of life in Dover.

Continued redevelopment of J. H. Ketcham Memorial Park in an environmentally and ecologically-thoughtful manner will provide access to public open space and recreation especially for low and fixed-income residents and families who live in the Dover Plains hamlet. Additionally, the following new offerings are recommended to help utilize and expand recreational opportunities for the park that might complement and augment existing facilities and programs presently offered at Thomas Boyce Park in Wingdale:

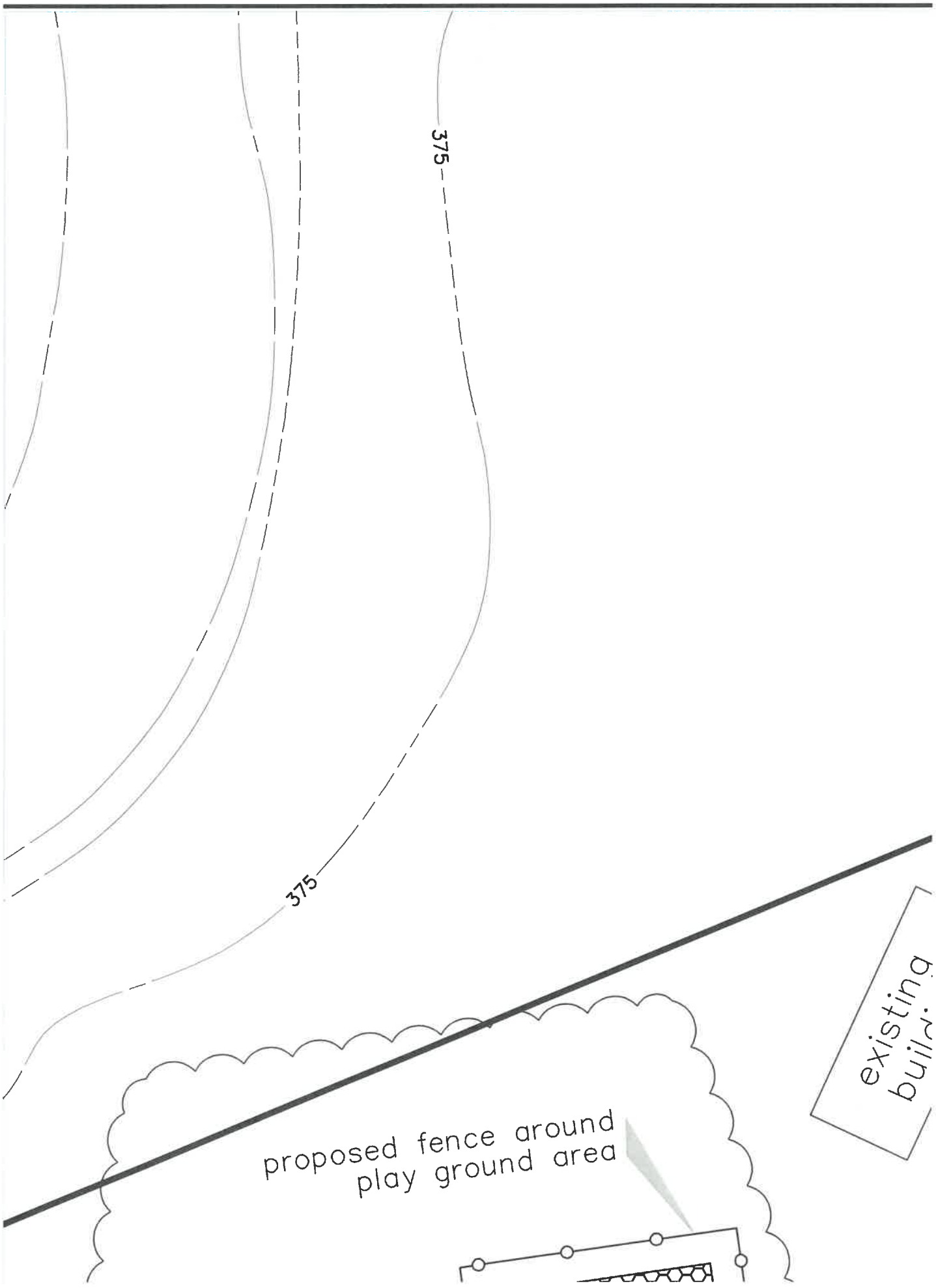
- car-top boat launch
- streamside trails
- new recreation programs targeted to residents of adjacent communities
- addition of outdoor fitness equipment in and around the ¼-mile walk track
- construction of an open air pavilion for community events
- addition of a sensory garden to the children's playground
- after school and adult education programs and

Goals:

- Increase river access for fishing, boating, and wildlife observation.
- Utilize the space as an outdoor educational center.
- Remove invasives and create ecologically-friendly trail system through riparian zone.
- Create paths through pollinator gardens - incorporate fruit and nut- bearing trees and shrubs.

Aerial view of JH Ketcham Park showing proximity to the Ten Mile River. The yellow circle indic
location of a future car-top boat launch. The yellow rectangle indicates an area of the park th
an outdoor classroom.

Clockwise from bottom left: Riparian zone—potential site of platform for outdoor classroom; Potential site for car-top boat launch (behind old pump house with old stream modification); Aerial view of park; Old site of pool and future walking track


375
375
existing
proposed fence around
play ground area

8.1.10 Wassaic Park

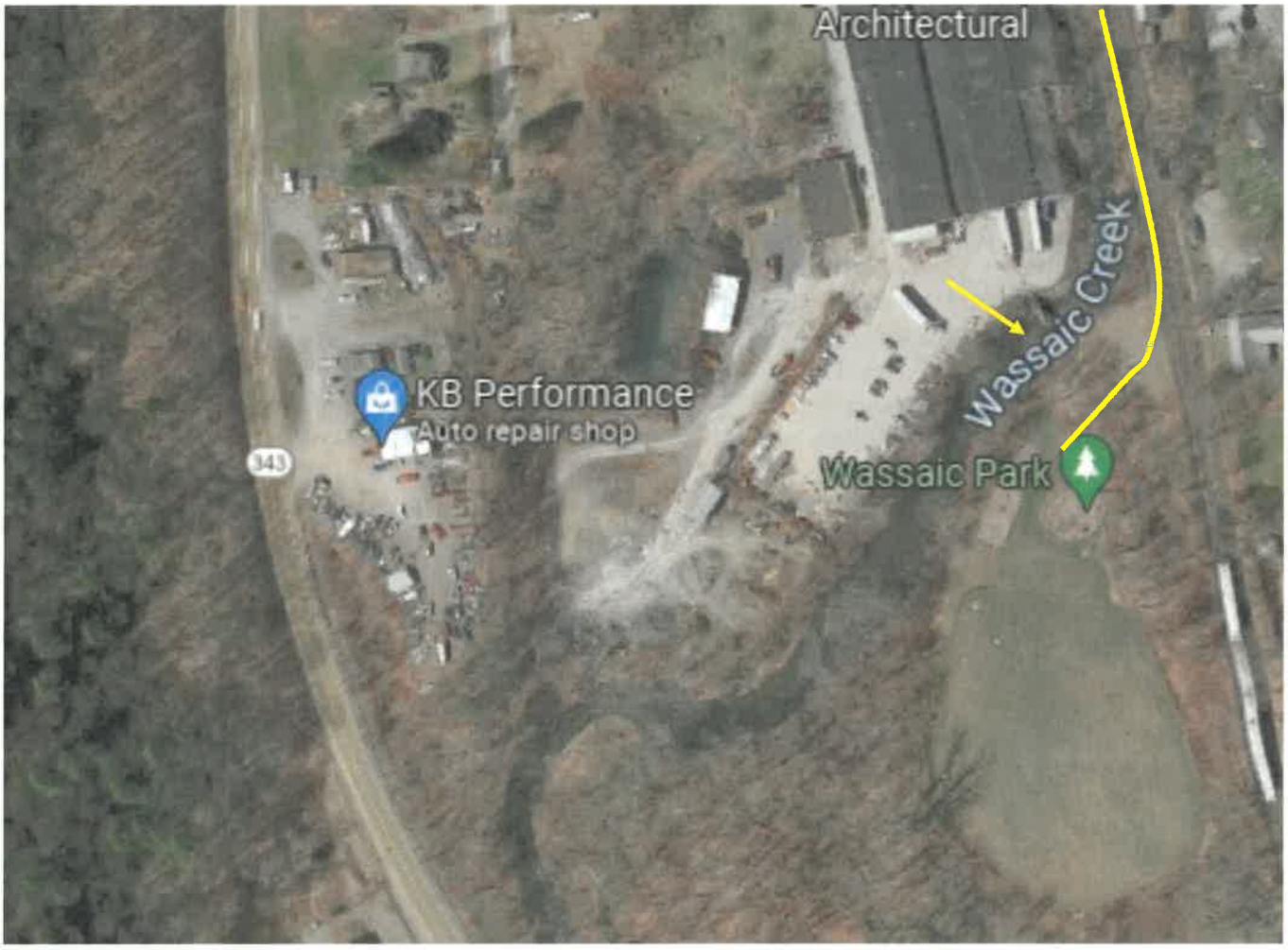
Address:	203 Old Rt. 22, Wassaic, NY 12592
Coordinates:	41.802468, -73.560144
Sub watershed:	Wassaic Creek
Location:	Amenia, NY

***Site description*:** Wassaic Park is an underused outdoor space in the unincorporated community of Wassaic. It is difficult to access by vehicle and not easy to find- visitors must travel through a commercial/industrial complex to reach the parking lot, and the park is not visible from nearby roads. Wassaic Park is the current southern terminus of the Harlem Valley Rail Trail, which connects pedestrians and cyclists with the park from the center of Wassaic and points north. Wassaic Park has extensive frontage along Wassaic Creek, with excellent opportunities for angling, wildlife-watching and launching canoes or kayaks when flows are appropriate. The Town of Amenia has plans to upgrade existing playground equipment at the park. This project will complement that work with improvements to access routes for vehicles and pedestrians meant to raise awareness of the park and make access more intuitive; redesign of the retaining wall on the left bank of Wassaic Creek below the existing parking area to prevent a potential slope failure and reduce stream instability; a creekside trail with designated access points suitable for multiple uses and visitors of all ages and abilities; restoration of native streamside vegetation; and interpretive signage to help visitors connect with Wassaic Creek.

With creative and welcoming upgrades to the paths into the park, the space presents an opportunity to become a valued resource for community members, as well as an additional attraction for Rail Trail visitors.

Goals:

- Regrade the land at the entrance to the park and establish ADA compliant river access. Upgrade existing park features.
- Stabilize existing retaining wall on the left bank of Wassaic Creek.
- Create a safe and welcoming path to the park - incorporate spaces for sitting.
- Remove invasives and create ecologically-friendly trail system through the riparian zone.



Aerial view of Wassaic Park showing proximity to Wassaic Creek and underutilized land. The y row indicate the existing access points to the park. The arrow is a bridge on the southern side al parking lot. The yellow line is the trail that runs parallel to the Metro North Railroad line.

Clockwise from bottom left: Bend in Wassaic Creek hitting retention wall on left bank; Retention wall leaning into Wassaic Creek; Steep, unpaved path into park; Small path to the creek with sidecast berm; Large open field in Wassaic Creek floodplain

8.1.11 Amenia Landfill

Address:	4541 Rt. 22, Amenia, NY 12501
Coordinates:	41.825851, -73.566148
Sub watershed:	Wassaic Creek
Location:	Amenia, NY

***Site description*:** Previously home to the Town of Amenia landfill where toxic materials (including PCB's) were dumped, this reclaimed superfund site has been designed for passive recreation by the NYSDEC, Town of Amenia, and Town of Sharon. It is currently fenced along Route 22, has a paved entrance with a gate and "parking pad" that can be made suitable for a parking spaces, and a 1.5 mile paved road along a wetland. The road is suitable for a nice, flat, scenic walking path and the park, as a whole, could serve as a way to educate the community on the negative impacts of pollution on our natural resources. Additionally, the site could potentially host a small solar field.

Goals:

- Installation of park amenities including a welcome kiosk, educational signage, dog clean up areas, picnic space, etc.
- Establish pollinator gardens and phenology trails.
- Ensure that the path becomes ADA compliant.

Aerial view of the Amenia Landfill project site showing the existing walking path to the

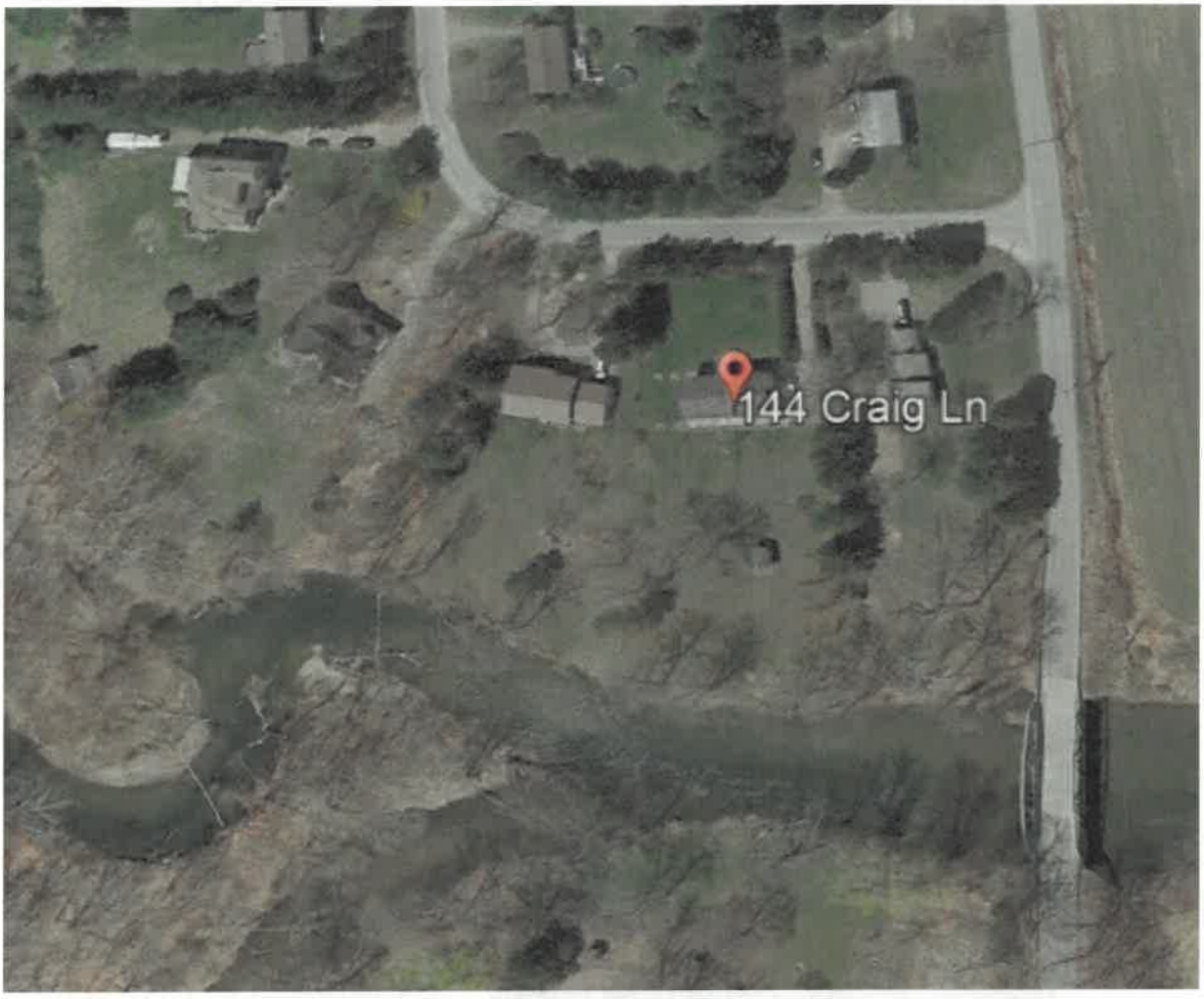
8.1.12 Craig Ln. Stream Restoration

Address:	144 Craig Ln., Dover Plains, NY 12522
Coordinates:	41.716735, -73.569835
Sub watershed:	Ten Mile River Mainstem
Location:	Dover, NY

***Site description*:** This section of the Ten Mile River was walked during HVA's stream assessments and identified as a candidate for a bank stabilization project. Following conversations with landowners, HVA learned that the erosion was triggered by shifts in the hydraulic geometry following major flood events. The rapid erosion occurring here currently threatens the septic areas of two households.

Goals:

- Reconstruct the stream channel and stabilize the banks.
- Protect water quality by preventing septic inputs.
- Install a pollinator-friendly and diverse riparian buffer throughout the length of the reach.
- Conduct long-term monitoring of the site to track project success.



Aerial view of the Craig Ln project site located between the confluence of Swamp Creek and tl and the bridge downstream

Above: Shed in neighbor's yard—near edge of the eroding bank. Neighbors report that material has recently calved off of the bank.

Left: Slumping material and actively eroding left bank at Craig Ln project site.

Below: View of channel upstream of the property with in-stream wood deposits.

8.1.13 Village of Millerton - Wastewater Infrastructure Upgrades

Sub watershed: Webatuck
Location: Village of Millerton

Project Description: The Village of Millerton has completed a Preliminary Engineering Report and identified wastewater needs that results from poor on-site conditions leading to failing septic systems. They are currently in the district formation stage, and seeking funding to support the final design and construction of a sanitary sewer system for the Village hamlet and properties immediately adjacent to it including those in the Town of Northeast. The total project budget, estimated by professional engineers at Tighe & Bond is $13,434,000.

The Village is in the northeastern corner of Dutchess County within the Town of North East, near the border of Connecticut. The Village is approximately 1.0 square mile including residential and commercial uses. The entire study area is approximately 1.7 square miles. The Town of North East had a total population of 2,971 at the time of the 2020 census. The population of the Village of Millerton according to the 2020 census is 921, representing approximately 31% of the Town population. The Village is currently served by individual (residential/commercial) subsurface wastewater disposal systems (primarily septic tanks with leachfields) and is un-sewered. The study area boundary for the Tighe & Bond evaluation is the water service area which encompasses portions of the Town of North East and the entire Village of Millerton.

The following tasks were performed as part of the evaluation:

1. Service Area Delineation
2. Wastewater Flow Estimates
3. Evaluation of Collection, Treatment, and Disposal Alternatives
4. Cost Estimates for the Developed Alternatives
5. Recommendations & Implementation Procedures

Goals:

- Protect the water quality of the Webatuck, which passes directly through the Village center impacting the life quality of all residents and provide a system that permits water resource recovery
- Return our most valuable resource as an asset to the hydrologic cycle rather than a waste product
- Alleviate contributing pollution from untreated human effluent on the Ten Mile watershed, Housatonic watershed and its ultimate receiving body, Long Island Sound

8.2 Programs

8.2.1 Ten Mile River Watershed Connections

Location: Watershed-wide

***Program description*:** The Ten Mile River Watershed Connections (Connections) program will connect local youth to the watershed restoration projects identified in the in this Plan to provide hands on environmental education, teach about environmental careers, provide job skills training, and raise awareness of the Ten Mile River and its tributaries in watershed communities.

The Program will seek to engage underserved communities and will be modeled on and similar successful programs developed by TMRC members, including the No Child Left Inside program administered by Cornell Cooperative Extension of Dutchess County, and the Still River Watershed Connections program administered by HVA.

The Connections program will with be designed to accomplish the following goals:

- Cultivate a sense of river stewardship amongst local youth by engaging them in river restoration and management projects such as riparian buffer restoration, trash clean-ups, water quality monitoring, and public outreach
- Provide classroom-based and on-the-job training in 21st century skills relevant to a wide variety of potential academic and career paths, with an emphasis on applied, hands-on experience in the growing field of environmental science
- Implement projects identified in the Ten Mile River Watershed Plan
- Provide opportunities for participating youth to share their personal connection to the Ten Mile River and communicate the importance of their work with the public
- Build public support for the implementation of the Ten Mile River Watershed Plan.

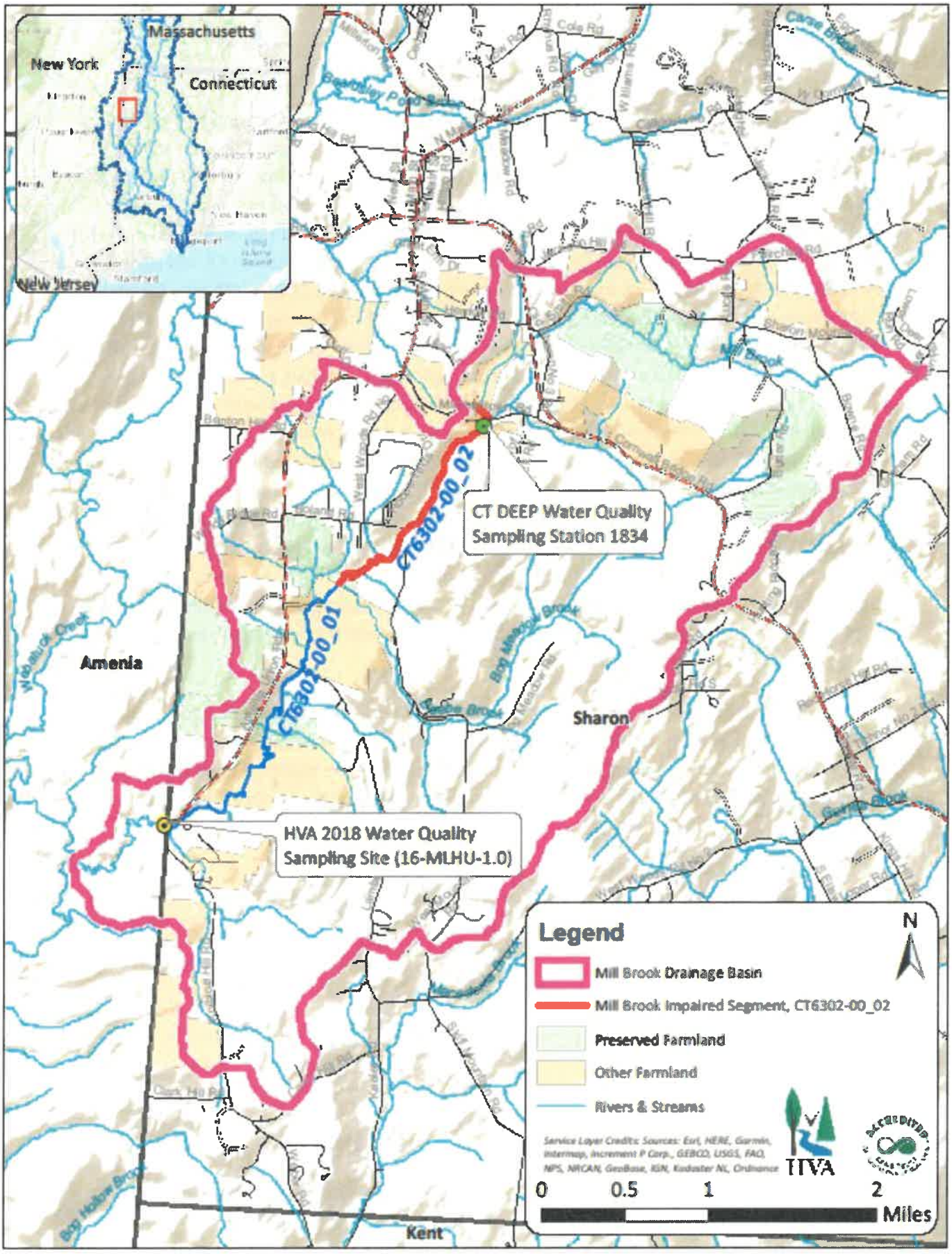
We envision a Ten Mile River that's healthy and resilient long into the future. Creating the next generation of stream managers and advocates is essential to realizing that vision. Connections will build partnerships between restoration practitioners, public schools in the Watershed and youth services agencies to connect local youth with meaningful watershed work, with the complementary goals of teaching 21st-century career skills, raising awareness of/fostering love for local streams, and providing a reliable source of volunteers for installing and maintaining restoration projects.

8.2.2 Mill Brook Basin

Location: Mill Brook Watershed

Program description: Mill Brook drains an approximately 11-square-mile watershed that falls almost entirely in the Town of Sharon, CT. A 1.66-mile reach of Mill Brook was assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and is listed as Impaired for recreation in the most recent (2018) State of Connecticut Integrated Water Quality Report to Congress due to elevated levels of the bacteria *Escherichia coli* (*E. coli*). Water quality monitoring conducted by HVA in 2018 at a site just downstream of the CT/NY border showed high concentrations of *E. coli* (ranging from 1732 to 2420 MPN/100 ml). *E. coli* concentrations were elevated above CT Water Quality Standards during three sampling events, suggesting that Mill Brook may not be meeting its recreational use goals as it flows from CT into NY. A Total Maximum Daily Load (TMDL) for *E. coli* was assigned to the Mill Brook watershed in 2012. Based on field assessments, agricultural activities are suspected to be a significant source of nonpoint source (NPS) pollution (including nutrients and sediment in addition to *E. coli*) for Mill Brook. The Mill Brook mainstem flows through large tracts of row crops and pastures with unrestricted access to the stream corridor for livestock. In order to reduce agricultural NPS pollution in the Mill Brook watershed and downstream waters, HVA, CT Northwest Conservation District (NWCD), Sharon Land Trust (SLT) and the Natural Resources Conservation Service (NRCS) will build new relationships with watershed farmers, develop farm-scale Conservation Plans where there are opportunities for measurable NPS pollution reduction, and connect farmers with resources available through NRCS for Conservation Plan implementation. This partnership provides the solid foundation needed to support the producers through this process and presents the opportunity for projects to be implemented with no out-of-pocket cost to the farmer.

This work will set an example for our NY partners as we work with them to prevent contributing pollution that may flow from the TMR, into the Housatonic River and ultimately the Long Island Sound. It's essential that the waters flowing from CT into NY are healthy as we make the case to our partners in NY that they should be doing more to ensure that the TMR is healthy when it flows over the border into CT.


Massachusetts
New York
Connecticut
New Jersey
CT DEEP Water Quality Sampling Station 1834
CT6302-00_02
CT6302-00_01
HVA 2018 Water Quality Sampling Site (16-MLHU-1.0)
Amenia
Sharon
Kent
Mill Brook
Legend
Mill Brook Drainage Basin
Mill Brook Impaired Segment, CT6302-00_02
Preserved Farmland
Other Farmland
Rivers & Streams
N
0
0.5
1
2
Miles
HVA

8.2.3 In-Stream Wood Management

Location: Watershed-wide

Program description: Multiple towns throughout the Ten Mile River watershed have expressed concerns over large deposits of wood (downed trees, tree limbs, and branches) in streams and noted that the amount has increased following several major flood events. In-stream wood can increase flooding by creating hazardous jams at road-stream crossings during higher precipitation, and large accumulations can become snags that can be dangerous for people to navigate through while boating, fishing, etc. In-stream wood can also provide many benefits to river ecosystem function.

Studies around the subject of in-stream wood have led to the proposition of developing decision-making processes and protocols for management, and particularly for assessing the relative benefits and hazards associated with the wood. Decisions to keep, remove, or modify wood depend greatly on the specific context, and any decisions made should be coupled with monitoring and continued refinement of the practice.

Goals:

- Ensure the safety of our communities and people enjoying the waterways through effective management of in-stream wood.
- Research existing In-Stream Wood Management protocols and establish a protocol that is specific to the Ten Mile River watershed.

8.2.4 Stream Cleanups

Location: Watershed-wide

Program description: Many Watershed residents have communicated that they do not have enough opportunities to connect with their local waterways. Community cleanups have proven to be a great way to get residents and visitors to discover new sections of streams while allowing participants to feel as though they are playing an active role in the protection of their natural resources. These events are a great way to build friendships while keeping trash out of the stream networks and the TMR Watershed-Wide Clean Up day will be modeled on other similar and successful programs that are hosted by watershed groups across the country.

The TMRC will be used to identify cleanup site leads throughout the Watershed and develop partnerships with municipal waste collection facilities for proper waste disposal.

Goals:

- Establish an annual watershed-wide cleanup day to build community and foster an appreciation for the local waterways.
- Identify a central meeting place for an end-of-day celebration.

8.2.5 Stream Corridor Assessments

Location: Watershed-wide

***Program description*:** While HVA has walked approximately 20 miles of stream using the Unified Stream Assessment (USA) protocol (See Appendix B for more details on the USA protocol), the TMRC has identified the need for more assessments as a priority plan implementation project. Further assessments will continue to help identify areas for restoration, locate pollution sources, and help develop a more detailed action plan.

HVA and other stakeholders (TMRC) plan to revisit this Watershed Plan on a regular basis. Each year they will evaluate progress toward the recommended actions and goals in the Action Plan. Every five years the full plan will be updated based on progress made, results achieved, and new priorities set. This update will include an assessment of progress made, update with new data, and an update with new projects. Revisions to the Watershed Plan will be made to improve the effectiveness of implementation efforts if monitoring shows no improvement post BMP efforts. Data collected during the stream corridor assessments will provide baselines and guides for these revisions.

Goals:

- Increase the miles of assessed streams throughout the Watershed.
- Establish a robust dataset of stream corridor conditions.

8.2.6 Water Quality Monitoring

Location: Watershed-wide

***Program description*:** The Ten Mile River watershed - as a whole - is known for its generally healthy surface waters. Performing water quality monitoring and tracking any changes in condition is key in our efforts to preserve (and improve where necessary).

The TMRC aims to launch two main monitoring programs: one led by professional staff and one for trained community scientists. These two programs will serve as a way to build a robust dataset and foster a sense of responsibility for water health amongst watershed residents.

Goals:

- Create a community science water quality monitoring program where community volunteers collect grab samples throughout a pre-determined sampling season and bring to HVA staff for lab delivery.
- Form a water quality monitoring collaborative that will determine process for collecting a more robust dataset.
- Create a publicly accessible water quality dataset (interactive map).

8.2.7 Temperature Studies

Location: Watershed-wide

Program description: The importance of our cold water systems has become increasingly clear in the face of shifting climate patterns. Temperature monitoring conducted throughout the Watershed has identified streams that should be preserved for their cold water habitat, and monitoring conducted above the Ten Mile/Housatonic River confluence shows a significant increase in mean annual temperatures over the past 20 years. Now is the time for a concerted effort to identify, preserve, and expand our Watershed's cold water resources.

Goals:

- Deploy temperature loggers at pre-determined locations throughout the Ten Mile River watershed and conduct multiyear studies.
- Identify cold water inputs (i.e. springs, seeps, etc.) and enhance the plumes to expand cold water refuge.

[1]

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