Niantic River Watershed
Protection Plan Update

prepared by FUSS & O'NEILL

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List of Acronyms

APA	Aquifer Protection Area
BMP	Best Management Practice
CFU	Colony Forming Units
CIRCA	Connecticut Institute for Resilience and Climate Adaptation
CLEAR	Center for Land Use Education and Research
CT DA/BA	Connecticut Department of Agriculture/Bureau of Aquaculture
CT DPH	Connecticut Department of Public Health
CT DEEP	Connecticut Department of Energy and Environmental Protection
CT DOAG	Connecticut Department of Agriculture
CT DOT	Connecticut Department of Transportation
DCIA	Directly Connected Impervious Area
ECCD	Eastern Connecticut Conservation District
EQIP	Environmental Quality Incentives Program
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FLRP	Farmland Restoration Program
GI	Green Infrastructure
GPD	Gallons per Day
IC	Impervious Cover
IDDE	Illicit Discharge Detection and Elimination
IWQR	Integrated Water Quality Report
LID	Low Impact Development
LIS	Long Island Sound
LLHD	Ledge Light Health District
MEL	Millstone Environmental Lab (Dominion Energy)
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
NECCOG	Northeastern Connecticut Council of Governments
NEMO	Nonpoint Education for Municipal Officials
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source pollution
NRCS	USDA Natural Resources Conservation Service
NRWC	Niantic River Watershed Committee
NRWPP	Niantic River Watershed Protection Plan
NWQI	National Water Quality Initiative (NRCS)
POCD	Plan of Conservation and Development
QAPP	Quality Assurance Project Plan
RBV	Riffle Bioassessment for Volunteers
ROW	Right-of-Way
RWMP	Regional Wastewater Management Plan
SCCOG	Southeastern Connecticut Council of Governments
SLR	Sea Level Rise
STS	Save the Sound
SWMM	Storm Water Management Model

List of Acronyms

SWS	Stormwater system
TMDL	Total Maximum Daily Load
UHD	Uncas Health District
UCONN	University of Connecticut
URA	Upland Review Area
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWS	Unified Water Study

1 Introduction

1.1 Background

The Niantic River and its Watershed

The Niantic River watershed (*Figure 1-1*) covers approximately 31 square miles in southeastern Connecticut within the four towns of East Lyme, Salem, Montville, and Waterford.

The headwaters of the Niantic River are distributed among its major tributaries that originate in forested areas in Salem, Montville, and East Lyme. These freshwater streams flow southerly to tidally influenced coves in the Niantic River, a broad estuary of more than 830 acres. The mouth of the river empties through The Gut into Niantic Bay, an embayment of Long Island Sound. The major tributaries to the Niantic River include Latimer Brook, Oil Mill Brook, and Stony Brook. The subwatersheds that drain into Latimer Brook are Cranberry Meadow Brook, Silver Falls, Barnes Reservoir, and Bogue Brook Reservoir.

Figure 1.1. Municipalities located within the Niantic River watershed

Land use is varied in the Niantic River watershed. Areas of residential and commercial development are concentrated around most of the Niantic River Estuary (Estuary) and along the central and southern reaches of Latimer Brook. While pockets of development are found throughout the rest of the watershed, the majority of land (roughly 60%) is covered by core forest and fragmented forest. Approximately 18% of the watershed is developed (including turf grass), and wetlands and agriculture account for 5% and 3%, respectively. Public and private lands that have been protected as open space are approximately 25% of the watershed. Major regional transportation corridors in the watershed include Interstate 95 and Interstate 395. Other major roads are U.S. Route 1, and State Roads 156, 161, and 85.

The watershed's freshwater system (tributaries, lakes and ponds, and wetlands) drains to the Niantic River, an estuary connected to Niantic Bay and Long Island Sound. As an estuary, the Niantic River is a unique habitat in that both saltwater and freshwater processes influence the river. Certain marine species, including fish, have adapted to rely

What is a Watershed?

A watershed is the area of land that contributes runoff to a lake, river, stream, wetland, estuary, or bay. Land use activities within a watershed affect the water quality of the receiving waters.

Diagram courtesy of Arkansas Watershed Advisory Group on estuaries for shelter and nursery habitats. The Niantic River Estuary has also been a valuable natural harbor for centuries, is an important recreational and economic resource for Waterford and East Lyme, and continues to support multiple uses in commercial fishing/shellfishing, recreation, and tourism.

More information on the existing physical, land use, and water quality characteristics of the Niantic River watershed are found in *Section 2* of this Update.

Issues Facing the Niantic River Watershed

Impaired Water Quality

The Connecticut Department of Energy and Environmental Protection (CT DEEP) has documented levels of nutrients and fecal indicator bacteria in excess of State water quality standards. In its 2004 Water Quality Report to Congress, the Connecticut Department of Environmental Protection (now CT DEEP) included a 2003 fish kill in the Estuary in a summary of concerns for aquatic species in Connecticut.[1] CT DEEP completed a "Statewide Bacteria Total Maximum Daily Load" (TMDL) for 176 impaired waterbody segments based on the 2010 Impaired Waters List.[2] The TMDL sets target pollution levels and establishes a framework for restoring water quality of the impaired segments. In 2014, a TMDL was approved for the Niantic River Estuary (CT-E1_020) and for three segments of Niantic Bay (CT-E2_013, CT-E2_14, and CT-E3_006) based on past monitoring data. The TMDL identifies percent reductions in geometric mean and single sample fecal indicator bacteria concentrations required to meet water quality criteria for recreation and shellfish harvest (enterococci for recreation, fecal coliform for shellfishing). The Estuary has been identified as impaired by CT DEEP for nearly two decades. In 2018, it was listed by CT DEEP as impaired for aquatic habitat, direct consumption of shellfish and recreation due to excess nutrients and bacteria. The watershed's major tributaries were also listed that year, with two tributaries having three segments listed as impaired:

1. the lower 0.23 miles of Stony Brook (south of crossing U.S. Route 1), impaired for recreation (*E. coli*)
2. the lower 4.23 miles of Latimer Brook (south of the confluence with Cranberry Meadow Brook), impaired for recreation (*E. coli*) and aquatic life (flow regime modification)
3. the 3.43-mile segment of Latimer Brook between Beckwith Pond and the confluence with Cranberry Meadow Brook, impaired for aquatic life (flow regime modification)

Stormwater Runoff and Impervious Cover

The discharge of untreated stormwater from developed areas has impacted water quality in the watershed. Stormwater runoff and direct discharges of stormwater are known sources of pollutants (nutrients, bacteria, sediment, etc.) that impact water quality.[3] The water quality impairments in the watershed coincide with developed areas that have high levels of impervious cover and, conversely, few or no natural areas to intercept and infiltrate stormwater. Throughout the watershed, development has also altered or removed the naturally vegetated buffers along rivers/streams and the Estuary. When intact, riparian buffers create a continuous vegetative zone along the water's edge that benefit water quality in a number of ways. In response to untreated stormwater, municipalities and local groups have retrofitted some existing stormwater systems, parking lots and roadsides near the Estuary with treatment practices, although most drainage systems in the watershed still have minimal or no stormwater pollutant controls. Stormwater discharges from the municipal storm drainage systems in East Lyme, Waterford, and Montville are regulated under the CT DEEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit). Stormwater discharges associated with the state drainage system are regulated under a similar MS4 permit issued specifically to the Connecticut

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[1] Connecticut Department of Environmental Protection. 2004 Water Quality Report to Congress. Page 8-3.
[2] CT DEEP. 2010. *A Statewide Total Maximum Daily Load Analysis for Bacteria Impaired Waters*.
[3] CT DEEP. 2018 Integrated Water Quality Report.

Department of Transportation (CT DOT). Both permits establish requirements for implementing BMPs that will reduce pollutant discharges from municipal and state storm drainage systems.

Other Nonpoint Pollution Sources

In addition to stormwater runoff from impervious surfaces, nonpoint source (NPS) pollution in the Niantic River and its tributaries can be attributed to other sources and land use activities, which are distributed throughout the watershed and impact water quality to varying degrees. *Table 1-1* provides a list of the common sources, their potential origins, and the types of pollutant associated with the respective sources.

Table 1-1. Types of pollutant sources and their origins in the Niantic River watershed

Source Category	Potential Origin(s) of Source	Type of NPS Pollutant
Residential Uses	failing or inadequate septic systems	bacteria, nutrients
	lawn fertilizer	nutrients
	illicit discharges	bacteria, nutrients, organic and inorganic pollutants
Agriculture	animal manure	bacteria, nutrients
	fertilizer	nutrients
	bare ground (high-traffic areas for livestock, tilled fields)	sediment/solids
Boating/Marinas	illicit discharge of sewage	bacteria, nutrients
	leaks and spills of grease/oil/fuel, metals including heavy metals, paints, cleaning chemicals	organic and inorganic pollutants
Waterfowl & Pet Waste	fecal matter	bacteria, nutrients
Sedimentation/Siltation	construction activities, road sand, bank/shoreline erosion, etc.	sediment/solids
Commercial/Industrial/ Institutional Uses	illicit discharges	bacteria, nutrients, organic and inorganic pollutants
	runoff from large roof areas and parking lots; leaks/spills from stored materials; leaks from storm or sanitary sewer systems	nutrients, bacteria, solids, organic and inorganic pollutants

Watershed Development

Analysis by the University of Connecticut's Center for Land Use Education and Research (UCONN-CLEAR) shows that, from 1985 to 2015, an estimated 703 acres of the watershed's land area have been converted from undeveloped to developed land cover types.[4] The largest decrease is seen in forest land cover. The rate of development in the watershed has been moderate in recent years, which is likely due to the economic recession beginning in 2008 and its slow recovery. These specific market-driven dynamics do not account for other types of development in the watershed, such as the conversion of farmland or forest to large photovoltaic arrays for commercial power generation.

While development in the Niantic River watershed has been limited in recent years and a sizeable amount of land is protected open space, the potential still remains for significant future development to further impact water quality and environmental resources in the watershed. During the Stakeholder Workshops conducted to develop

[4] UCONN-CLEAR. *Connecticut and Long Island Sound Land Cover and Change – 1985 to 2015*. 2016. Available at clear.uconn.edu/projects/landscape/LIS/stats/change7dates.htm#top

this Update, attendees in nearly all of the eight focus groups listed existing and new development in the watershed as one of their top concerns. Similarly, most respondents to a stakeholder survey conducted in the fall of 2019 expressed concern about development and its effects, particularly the increase in nonpoint source pollution and the loss of open space and riparian buffers. Many workshop attendees and survey respondents voiced specific concerns about the short- and long-term impacts of the construction of large solar arrays and the possible development of Oswegatchie Hills.

Hydro-modification

Hydro-modification is the alteration of the natural flow of water through the landscape, generally in the form of channelization, dams, and streambank and shoreline erosion. Such alterations tend to diminish a stream's natural functions and exacerbate or add to sources of nonpoint source pollution by causing increases in flow rates, erosion, and water temperature.

The Niantic River Estuary is fed by numerous freshwater streams around its shoreline, and many have been channelized, disconnected from inland wetlands, or otherwise modified over the long history of development in the region. Throughout the watershed, channelization is common to segments of the major and minor tributaries in developed areas. Examples include: the upper reach of Latimer Brook east of Route 85 (Salem), Latimer Brook east of Flanders Four Corners (East Lyme), No Name Brook (Waterford), Oil Mill Brook below Interstate 95 (Waterford), and an unnamed tributary to Bogue Brook at Evergreen Land (Montville).

A broader definition of hydro-modification goes beyond physical alterations made to land under or adjacent to a waterbody. It includes changes in surrounding land use, which can degrade water quality with changes to the rate and/or volume of natural flows under all conditions. For example, a stream's peak flow after a thunderstorm is higher (volume and height) and occurs earlier in developed drainage areas than in undeveloped ones. Following the peak, developed areas retain less stormwater in the subsurface and return to a base flow more quickly. An additional long-term impact is that the accelerated drainage of stormwater reduces watershed storage and thus depresses a stream's natural base flow between precipitation events.

Last, hydro-modification can also refer to human-caused changes to the water balance of inputs and outputs in a watershed. In the Niantic River watershed, several drinking water reservoirs serve as public water supplies for New London and portions of Waterford and East Lyme, as well as municipalities outside the Niantic River watershed. In 2016, the average daily demand on these combined sources was estimated at 5.3 million gallons per day.[5] Unlike public water supplies that are utilized within the same watershed, withdrawals exported out of a watershed, in this case from Latimer Brook's drainage area, are another type of long-term flow modification that reduces natural base flow and may contribute to higher concentrations of nonpoint source pollutants and degraded aquatic habitats.

Degraded Coastal Systems and Habitat

Human activities in the Niantic River watershed have adversely impacted and continue to affect coastal processes and the unique systems they support. Perhaps the most significantly impacted resource is marine life in the Niantic River Estuary, which once supported an abundance of species. Poor water quality (high levels of bacteria, nutrients, and temperature; low levels of oxygen) and alterations to critical habitat, like eelgrass beds, have reduced shellfish and fish populations. The environmental stresses and their consequences are well known to residents and businesses, who value the Estuary as a resource for recreation, shellfishing/fisheries, and its intrinsic natural character.

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[5] Milone & MacBroom, Inc. *Coordinated Water System Plan, Part III: Final Integrated Report*. 2018. Prepared for the Eastern Region Water Utility Coordinating Committee. Pages 2-16.

Equally as valuable are those systems on or near the physical coastline of the Niantic River, where the estuarine water meets land. Environments like forested coastal uplands, barrier beaches, dunes, tidal wetlands, salt marshes, and intertidal flats are unique habitats, often functioning as nurseries for a range of marine and terrestrial species. These systems also provide valuable ecosystem services to coastal communities: a buffer to coastal flooding, water filtration, and recreation/tourism to name a few. Other than a one-mile section of shoreline north of Quarry Dock Road in East Lyme, the shoreline is almost entirely developed with dense residential or commercial uses. Development, hard engineered structures (i.e., seawalls), and land modifications have altered the shoreline to such an extent that coastal ecosystems and processes are absent or so diminished as to render them unsupportive.

Impacts of Climate Change

Climate research has identified new stresses and vulnerabilities and continues to update projections for coastal watersheds. Of primary concern to the health of the Niantic River watershed and its communities are: increases in the frequency, intensity, and duration of coastal flooding events caused by sea level rise and storm surge, and increases in inland flooding due to changing patterns in precipitation and the intensity of storms, including hurricanes. Attention to certain land use issues (new development, vegetated buffers) and developing/ implementing vulnerability assessments and recommended adaptation measures for critical infrastructure (transportation, energy, telecommunications, stormwater and sewage disposal systems, water supplies) in low-lying areas near the coast and in riparian zones and floodplains should be a priority for all stakeholders.

It also expected that documented trends in changing water quality will continue and adversely impact the watershed. Water in Long Island Sound and its embayments will continue to become warmer and more acidic, exacerbating the processes that lead to additional stresses, like hypoxia. These interdependent changes and stresses continue to alter the Estuary's environmental conditions and further degrade habitat that support shellfish, vertebrates, and other marine fauna.

Education/Outreach and Monitoring

From the beginning, providing educational programs, initiatives, and materials to the community has been at the center of management efforts in the Niantic River watershed. At the stakeholder workshops held in October 2019, attendees expressed their positive experiences with and support of projects that have raised awareness and fostered stewardship of the watershed and its natural resources (homeowner-BMP workshops, Low Impact Development (LID) checklist, BMP implementations). Their message was that educational programs are reaching the community and are well received. However, stakeholders also made it clear that more education/outreach is needed to continue to raise awareness and address the sources and impacts of nonpoint source pollution. Prioritized topics identified by stakeholders include homeowner BMPs (fertilizer use, septic system monitoring/maintenance, rain gardens and barrels), forest management planning, climate resiliency, and supporting fisheries/aquaculture.

Watershed Management Goals

The successful management of the Niantic River watershed benefits from an engaged and committed group of organizations, agencies, municipal officials and staff, and local community members. These stakeholders share a set of goals to protect, sustain, and enjoy the natural resources provided by the watershed. Sustainable management of the watershed is guided by the goals listed below (derived from the 2009 Guided Summary, see *Section 1.2 Prior Watershed Planning*):

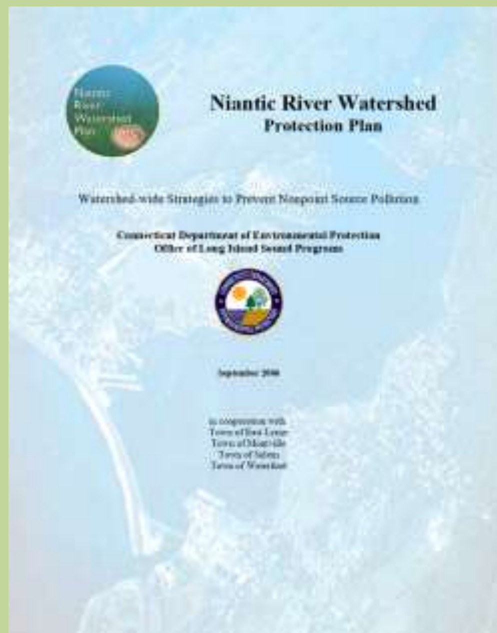
1. Raise Stakeholder Awareness and Involvement by Implementing a Watershed Management Information and Education Campaign

2. Support Designated Uses for Aquatic Life
3. Support Designated Uses for Shellfishing and Contact Recreation
4. Maintain a Sustainable Coalition of Partners to Manage the Niantic River Watershed
5. Improve Water Quality and Biological Monitoring for the Niantic River and its Tributaries
6. Protect and Restore Natural Stream Channels

1.2 Prior Watershed Planning

Watershed-based planning for the Niantic River watershed was prompted by observations of degraded habitat and reductions in marine species. Observation include biological monitoring as far back as 1976 by Millstone Environmental Laboratory (for permit compliance for constructing and operating Millstone Power Station) and water quality data collected the CT Department of Environmental Protection (now CT DEEP) in the early 2000s.[6] In response to high levels of indicator bacteria in the Estuary, the CT Department of Environmental Protection secured a one-time grant from the National Oceanic and Atmospheric Administration's (NOAA) Office of Coastal Resource Management to develop a watershed management plan according to the Nine Elements established by the U.S. Environmental Protection Agency (EPA). In 2006, the Niantic River Watershed Protection Plan (NRWPP) was developed by the consulting firm Kleinschmidt Associates to provide the initial framework and analysis needed for the management of water quality in the Niantic River watershed. Among the top priorities of the new plan were recommendations to: re-organize the NRWPP's steering committee as the entity responsible for implementing the new plan; hire a watershed management coordinator; and gain municipal support for the NRWPP. These administrative and coalition-building goals were accomplished in the following years and set the stage for addressing watershed management objectives of the NRWPP.

2006 Niantic River Watershed Protection Plan



In 2008, the Niantic River Watershed Committee (NRWC) created a summary document for the purpose of providing town officials, commission members, business owners, homeowners and the general public a shortened version of the 2006 NRWPP.[7] The NRWC was awarded funding by CT Department of Environmental Protection (now CT DEEP) through the EPA's Nonpoint Source grant program. In 2009, the NRWC and watershed stakeholders released the Guided Summary, a 34-page detailed outline of the 2006 Plan's management goals, objectives, and recommendations to provide a more accessible document and management tool for municipalities.

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[6] Dominion Energy Nuclear Connecticut, Inc. 2019. Monitoring the marine environment of Long Island Sound at Millstone Power Station. 2018 Annual Report. 201 pp.

[7] Niantic River Watershed Committee. 2009. *Guided Summary of the Niantic River Watershed Protection Plan*.

Niantic River Watershed Protection Compact


Niantic River Watershed Protection Compact

In 2011, the NRWC formed a Board of Directors. That same year, chief elected officials from the four municipalities in the watershed endorsed the Niantic River Watershed Protection Watershed Compact. Through the Compact, town leaders acknowledged the many values of the river's natural resources and that sound land-use and planning is key to protecting them. Additionally, they pledged their support of NRWPP's management goals, the NRWC, and policies and planning decisions that ensure the long-term health of the Niantic River watershed. In 2015, the NRWC was incorporated and filed as a 501(c)3 non-profit organization. As a private not-for-profit, NRWC does not receive municipal funds but has relied on funding secured from private and public grant programs to support its work.

Since 2011, the NRWC has developed biennial Plans of Work based on the summaries of goals and objectives in the 2009 Guided Summary. The Plans of Work are organized by management goals for the watershed, the actions relevant to each goal, and their status of completion. Goals and actions are prioritized and include potential partnering entities for each action. This Update to the 2006 NRWPP is the result of a prioritized goal in the 2019 Plan of Work that specified reviewing and updating the NRWPP.

1.3 Why Update the Protection Plan?

The purpose of this Update is to develop a revised framework of management recommendations for future efforts and actions taken to protect the Niantic River and its watershed. The main goals of this plan update are:

- Develop an update to the NRWPP that characterizes the causes and sources of water quality impairments, with the focus on impaired stream segments (including the Niantic River Estuary) and their subwatersheds. The original 2006 NRWPP is nearly 15 years old and should be updated to reflect current watershed conditions, issues of concern, and trends in watershed management.

- Review the status of completion of recommendations in the NRWPP, and identify current opportunities for Best Management Practices (BMPs) to reduce bacteria and nutrient sources and prioritize cost-effective implementation efforts.

- Assess the success of the NRWPP's recommendations to date to determine if those implemented have resulted in improvements in water quality, habitat, etc.

- Provide an implementation program that meets the EPA's Nine Elements criteria (see the adjacent text box). These criteria establish the structure of the plan, including specific goals, objectives, and strategies to protect and restore water quality; methods to build and strengthen working partnerships; a dual focus on addressing existing problems and preventing new ones; a strategy for implementing the plan; and a feedback loop to evaluate progress and revise the plan as necessary. Following the EPA Nine Elements framework will enable implementation projects under this plan to be considered for funding under the Section 319 nonpoint source program of the Clean Water Act and improve the chances for funding through other State and Federal sources. This updated EPA and CT DEEP watershed planning process is also the recommended approach for achieving the pollutant load reductions for the Niantic River watershed outlined in the Statewide Bacteria TMDL. *Table 1-2* summarizes the nine elements and where they are addressed in this Update to the 2006 NRWPP.

EPA Nine Elements Watershed Plan Framework

1. Impairment
2. Load Reduction
3. Management Measures
4. Technical & Financial Assistance
5. Public Information & Education
6. Schedule
7. Milestones
8. Performance Criteria
9. Monitoring

- Strengthen partnerships with key stakeholders, including the watershed committee, to produce a NRWPP update achieved by a broad collaboration and seen as valued guidance by the public and key stakeholders.

The NRWC, CT DEEP, and other stakeholders recognize the need for an updated watershed management plan to address the water quality issues in the Niantic River watershed. The updated plan will serve as a road map to return impaired waters to swimmable and fishable conditions and will be used to evaluate changes through time.

Specifically, the objectives of this Plan Update are to:

- Establish an up-to-date baseline of water quality and land use conditions in the watershed
- Evaluate contributing factors in areas of known impairments
- Identify water quality monitoring needs to support plan implementation
- Establish community buy-in through public engagement in the planning process
- Identify and prioritize actions to reduce pollutant inputs to impaired rivers, streams, and the Estuary
- Incorporate proactive measures to protect/maintain high quality streams.

This Plan is a *guidance* document that seeks to resolve surface water quality impairments and related water resource issues within the Niantic River watershed. This document is not intended to "point fingers" but is to help make all aware of how individual and collective actions are interconnected and can impact the watershed's water resources. Unless identified as a required action under an existing local, State or federal regulation or permit, the recommendations in this Plan for specific projects/actions are intended to be *voluntary* undertakings, carried out with willing, cooperative partners, working together to protect and improve water quality. Towards this end, this Plan identifies potential partners and funding sources to assist with achieving the recommendations presented herein.

Table 1-2. How this watershed based plan addresses the EPA nine key elements

EPA Nine Elements	Description	Location in Watershed Based Plan
1. Impairment	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and other goals identified in the watershed plan	• Section 2 (Watershed Characteristics)
2. Load Reduction	An estimate of the load reductions expected from management measures	• Section 5 (Management Measures and Pollutant Load Reductions)

EPA Nine Elements		Description	Location in Watershed Based Plan
			• Appendix C (Technical Memorandum – Pollutant Loading Model)
3.	Management Measures	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan	• Section 3 (Management Recommendations) • Section 4 (Site-Specific BMP Concepts)
4.	Technical and Financial Assistance	An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan	• Section 3 (Management Recommendations) recommendations tables • Section 4 (Site-Specific BMP Concepts) • Appendix D (Site-Specific BMP Concept Cost Estimates)
5.	Public Information and Education	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures	• Section 3.6 (Education and Outreach)
6.	Schedule	A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious	• Section 3 (Management Recommendations) recommendations tables
7.	Milestones	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented	• Section 3 (Management Recommendations) recommendations tables
8.	Performance Criteria	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards	• Section 3 (Management Recommendations) recommendations tables
9.	Monitoring	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the performance criteria established	• Section 3 (Management Recommendations) recommendations tables • Section 3.7 (Monitoring and Assessment)

1.4 Plan Update Process

With support from stakeholders, the NRWC pursued and secured funding for this project from the Community Foundation of Eastern Connecticut, the Connecticut Department of Energy and Environmental Protection via the Clean Water Act Section 319 Nonpoint Source program, and Kleinschmidt Foundation through the Community Foundation of Maine. In January 2019, the NRWC issued a Request For Proposals and contracted Fuss & O'Neill to develop the Update. Over approximately 18 months, the NRWC, officials and staff from the four watershed towns, and numerous stakeholder entities – including watershed residents – have actively participated in each step of the plan update process:

1. Review the 2006 NRWPP and other watershed planning documents (Sep. 2019 – Jan. 2020)
   Evaluate the status of recommendations in the 2006 Plan; review regional plans/reports on subjects related to watershed management
2. Review and summarize the watershed's existing conditions (Sep. 2019 – Jan. 2020)
   Revise conditions, descriptions, and mapping with data generated after 2006
3. Conduct stakeholder workshops (Oct. 2019)
   Identify and invite stakeholders to workshops designed to promote discussion and gather firsthand information on watershed issues and recommended actions
4. Conduct visual field assessments (December 2019-January 2020)
   Identify locations as potential candidates for water-quality improvement projects or as areas/sites of concern. Conduct field assessments to inform development of site-specific and watershed-wide recommendations.
5. Develop a draft Plan Addendum (May 2020)
   Provide full draft to NRWC and stakeholders for review
6. Complete final Plan Addendum (June 2020)
   Incorporate review comments and provide final plan update to NRWC and stakeholders
7. Watershed Summit (*location and date to be determined*)
   Present NRWPP Update and findings to stakeholders and the watershed communities

1.5 Review of 2006 Plan Recommendations

The 2006 NRWPP identified the range of primary sources, land use practices, and cultural behaviors leading to impairments within the watershed. As stated in the Executive Summary, "stormwater runoff has become the primary target for protecting the Niantic River," as "this widespread *nonpoint source pollution* is the greatest threat to the water quality and ecological health of the Niantic River."[8] The resulting recommendations made by Kleinschmidt Associates in the 2006 NRWPP were based on analysis, findings, and research compiled on the Niantic River and its watershed. Included in the Executive Summary are the Plan's Key Recommendations, organized according to one of three areas of recommended management actions: Zoning, Management & Monitoring, and Educational. The full range of management recommendations for each of these areas are discussed in subsequent sections of the NRWPP. For this Update, the NRWPP's Key Recommendations and related Actions and the NRWC's Guided Summary were reviewed for the status of their completion (*Appendix A* and *Appendix B*, respectively).

In 2009 the NRWC and watershed stakeholders released the Guided Summary, its own digest of the NRWPP. The purpose of the Guided Summary was to offer stakeholders a "concise description of the water quality impairments affecting the watershed and...a focused directory of recommendations aimed at reducing those impairments."[9] The intent was to create a condensed version of the NRWPP to be utilized by stakeholders as a tool for guidance and reference toward the decision processes embedded in identifying, prioritizing, and implementing land and watershed management projects. To that end, the Guided Summary revised the framework of the 2006 recommendations according to the following Main Goals and Objectives (page 25):

[8] Kleinschmidt Associates, Inc. 2006. *Niantic River Watershed Protection Plan*. Prepared for CT DEP (now CT DEEP).
[9] Niantic River Watershed Committee. 2009. *Guided Summary of the Niantic River Watershed Protection Plan*.

Support Designated Uses for Shellfishing and Primary Contact Recreation

- Reduce bacterial loads from stormwater outfalls, runoff and direct discharges

Support Designated Uses for Aquatic Life

- Reduce nutrient loading from stormwater outfalls and runoff

Protect and Restore Natural Stream Channels

- Minimize flooding impacts by improving peak and volume controls from impervious surfaces
- Preserve and restore critical wetland and watercourse vegetative buffers

Raise Stakeholder Awareness and Involvement by Implementing a Watershed Management Information and Education Campaign

- Educate stakeholders about the Niantic River and its tributaries and watershed management

Establish a Sustainable Coalition of Partners to Manage the Niantic River Watershed

- Create a coalition of watershed stakeholders to take a leadership role for the implementation of this plan

Improve Water Quality and Biological Monitoring for the Niantic River and its Tributaries

- Establish a comprehensive long-term water quality monitoring program for the Niantic River Watershed

To adequately review the status of completion of management recommendations stemming from the 2006 NRWPP, the recommendations contained in the 2009 Guided Summary were also summarized and reviewed for their status of completion. The full list of recommendations and their statuses of completion are in *Appendix A* (NRWPP) and *Appendix B* (Guided Summary).

Key Accomplishments

Since the completion of the 2006 NRWPP, there has been significant, measureable progress on many of the recommendations contained in both planning documents. Some of the key accomplishments are:

- **Administrative Actions** to establish a management body and hire staff have been completed. Ongoing efforts to secure funding and build capacity have successfully sustained the NRWC and its staff person, the Watershed Coordinator, since 2008.

- **Water Quality Monitoring** has expanded from the initial programs established by CT DEP (now DEEP) and Dominion Energy's Millstone Environmental Lab in the Niantic River Estuary. Through volunteer recruitment and training, NRWC, watershed towns, and other organizations monitor the Estuary and its freshwater tributaries, including the following programs:
    - Stream water quality monitoring (starting date: 2012)
    - Riffle Bioassessments (2012)
    - Stream Temperature Monitoring (2013)
    - Stream Corridor Assessments (2014)
    - Unified Water Study: LIS Embayment Research (2018) by Save the River – Save the Hills

- Additional expansions of monitoring and related research on the Niantic River watershed have been undertaken by faculty at UCONN, Save the Sound, the US Geological Survey (USGS), and the Southeastern Connecticut Council of Governments (SCCOG).

- **Stormwater Management Practices** have been implemented in developed areas, as prioritized for stormwater improvements by the 2006 NRWPP. These implementations – such as tree wells, rain gardens and other infiltration practices – have been installed in several locations since 2006:
  - East Lyme: East Lyme High School, Grand Street, Hole-in-the-Wall parking lot, Oswegatchie Hills Nature Preserve, Colony Road, Pennsylvania Avenue, Veterans Memorial Park, Pine Grove
  - Waterford: commercial properties with infiltration basins and/or swales (Harvey Industries, Charter Oak Federal Credit union), L&M Cancer Institute, Constitution Surgery Center; municipal projects at Mago Point and Oswegatchie School; BMPs in residential subdivisions (Kathryn Court, Shawandassee Road, Seaview Terrace)
  - Montville: commercial property sediment control basins and/or swales or level spreaders (Dan Jones, Wide World of Indoor Sports, Supercharged, Advanced Improvements LLC, B&W Paving, Holly Lombardi Land Holdings LLC, Daniels Construction, Double Down Gravel Excavation, Butlertown Rd subdivision)
  - Salem: stormwater management practices have been installed outside of the Niantic River watershed

- **Education and Outreach** efforts have been active since the adoption of the 2006 NRWPP. The NRWC and its partners have addressed many of the recommendations aimed at increasing the community's awareness of the watershed's conditions and providing educational opportunities to homeowners, municipal staff, and those engaged in commercial and recreational uses on the Niantic River Estuary. Additionally, the NRWC maintains the website nianticriverwatershed.org with news, supporting materials, and information on activities, projects, education and outreach. Past programs and initiatives include:
  - LID and Riparian Buffers
  - Stormwater/LID Review Checklist
  - Landscaping for Water Quality
  - Teacher Water Quality Loan Kits
  - Rain Garden Initiative
  - Rain Barrels Give-away/Workshops
  - Eastern CT Stormwater Collaborative
  - Targeted outreach to homeowners, developers, and K-12 schoolchildren
  - Annual participation in Celebrate East Lyme Day
  - Recreational Shellfishing outreach and education
  - MS4 Stormwater BMPs workshop

- **Land Use Planning** has occurred at the municipal and regional levels. Since 2006, each of the watershed towns have adopted a Plan of Conservation & Development (POCD), a 10-year master plan developed collaboratively with residents to guide land use policies and needs for the community (Waterford, 2015-2025; Salem, 2012-2022; Montville, 2010-2020; East Lyme, 2009-2019). In 2017, SCCOG released a Regional POCD for its current membership of 22 municipalities in southeastern Connecticut, which includes all town in the Niantic River watershed. The town of Waterford has incorporated Low Impact Development (LID) practices into its Subdivision Regulations (April 2018) and Zoning Regulations (July 2019) and established a district for Mago Point with specific stormwater management requirements. The town of East Lyme has officially incorporated LID practices into its Subdivision Regulations (2008). The three MS4 communities in the watershed (Waterford, East Lyme, Montville) need to implement post-construction stormwater management requirements of the current MS4 Permit in their local land use regulations by June 2021, including provisions for LID and removing barriers in the regulations to the use of LID.

Incomplete or Partially Complete Recommendations

The review of the 2006 recommendations and the status of their implementation also highlighted actions yet to be fully implemented in the watershed. Participants in the stakeholder workshops in October 2019 reiterated some of these recommendations and the related issues:

- **Coordinated Land Use Policies and Planning** may be one of the most challenging, yet productive, strategies to fully develop and implement. The NRWPP makes a number of recommendations that focus on the importance of municipal regulations in a watershed-wide management framework. While all of the watershed towns are addressing certain aspects of these recommendations, the objective is to manage the Niantic River watershed and its resources with a more uniform approach to planning and regulation. Examples include:
    - Establish an Upland Review Area in inland-wetland regulations of 100 feet or more
    - Set limits or restrict activities from steep slopes as well as all (or designated) riparian buffers
    - Incorporate Low Impact Development (LID) practices into zoning and subdivision regulations (required for MS4 Permit compliance)
    - Develop programs and share resources for Illicit Discharge Detection and Elimination (IDDE)
    - Coordinate stormwater monitoring and explore the development of stormwater utilities
    - Address conservation planning at the watershed scale; identify and prioritize areas of the watershed that are important to protect and/or restore for fresh and estuarine water quality Identify major and minor tributaries in need of protection or monitoring
    - Standardize climate resiliency/vulnerability action plans and adaptation measures; share resources and partner on competitive grant requests

- **Water Quality Monitoring** has expanded considerably in the watershed since 2006. NRWC has five years of monthly data on the three main tributaries, as well as several years of event-based sampling data on Latimer Brook only. Long-term water temperature monitoring has resulted in estimates of the volumes of water contributed by upper Latimer Brook and Cranberry Meadow Brook to the combined flow downstream of their confluence; similar monitoring was used to examine the effects of stormwater discharged from a commercial solar energy project in East Lyme on Cranberry Meadow Brook. The town of Waterford has a long record of water quality data on Stony Brook and Oil Mill Brook. Monitoring in the Estuary has expanded to include programs by Save the Sound (Unified Water Study, conducted by Save the River – Save the Hills), USGS, and UCONN. Support should continue for these programs to build the existing datasets and track changes in water quality. Baseline monitoring data collected through regular or event-based sampling, stream walks, or similar efforts may also be needed for the remaining major and minor tributaries. As mentioned above, the NRWPP recommends a broader program to monitor stormwater management systems throughout the watershed.

- **Targeted Outreach** has been achieved with some groups such as homeowners, K-12 schoolchildren, and town staff and elected officials. The NRWPP also recommended specific programs or materials for marinas, boat owners, contractors, and developers, in addition to training for municipal staff on the water quality and its improvement.

- **Building Organizational Capacity** of stakeholders and partnerships to develop the momentum to accomplish these recommendations is key. Many of the recommendations yet to be completed are hindered by the most basic resources – funding and staff time. For example, while the NRWC has a fairly comprehensive website and recently began to use social media for its outreach, the maintenance and growth of these platforms are limited by funding and staff time. While the primary Administrative Actions of the NRWPP were successfully implemented, a large proportion of the watershed management actions, including those listed above, require enhanced capacity building among the watershed's many stakeholders and across its range of issues. Specifically:

- Develop a communication platform for sharing information on BMP projects, water quality monitoring, and status of construction activities and state/federal permits.
- Pursue funding that further maintains and expands organizational capacity, staffing, programs, and implementations.

1.6 Stakeholder and Public Participation

Public participation and outreach was conducted as part of the watershed planning process to increase public understanding of issues affecting the watershed, to encourage participation in the development of the watershed plan, and to build support for implementation of the plan. Input from the broad range of public and private stakeholders has been essential to effectively managing the Niantic River watershed since the 2006 NRWPP was developed and adopted.

To succeed in incorporating the range of concerns and potential recommendations that have been identified in the watershed, two Stakeholder Workshop meetings were held in the watershed on October 29, 2019. These public information meetings were designed to update participants on the watershed's conditions and to provide opportunities to identify their top issues in and recommendations for the watershed. A memo summarizing the workshops and their outcomes is available in *Appendix H*.

Prior to the Workshops, an online survey was distributed to stakeholders and local residents to gain a better understanding of their perceptions of water quality in the Niantic River watershed and its management. Respondents shared their assessments of the current management programs/projects and water quality in the Estuary and its tributaries. The survey also asked them to list their top concerns in the watershed and the types of management recommendations that should be included in this Update.

The draft Update to the NRWPP was made available to the public on May 14, 2020 for review and comments. Questions and comments from stakeholders and the public were received in the spring of 2020, and comments have been incorporated into the final Update. The final version of the Update will be presented at the Niantic River Watershed Summit (date and location to be determined).

2 Watershed Characteristics

2.1 Watershed Description

The Niantic River watershed is a coastal drainage basin in southeastern Connecticut, covering approximately 31 square miles in the towns of East Lyme, Salem, Montville, and Waterford (*Table 2-1*). The watershed makes up approximately half of the western basin of the drainage area identified by CT DEEP as “Major Basin Southeast Coast 2,” in which three Subregional Basins comprise the Niantic River watershed: Niantic River Subregional Basin (#2204), Latimer Brook Subregional Basin (#2202), and Oil Mill Brook Subregional Basin (#2203). To aid this Update’s discussion of the watershed’s issues and its management, the three Subregional Basins can be further subdivided into a total of nine subwatersheds: Barnes Reservoir, Bogue Brook Reservoir, Silver Falls, Cranberry Meadow Brook, Latimer Brook, Oil Mill Brook, Stony Brook, Upper Niantic, and Niantic River Estuary (*Figure 2-1*).

Table 2-1. Watershed composition by municipality

Municipality	Acres	Square Miles	Percent of Watershed
East Lyme	5,804.8	9.1	29%
Salem	2,585.5	4.0	13%
Montville	4,619.6	7.2	23%
Waterford	5,913.4	9.2	30%
Watershed Total	**18,923.3**	**29.6**	**96%***

**Remaining 4% of land area is the open water surface of the Niantic River Estuary, which is approximately 832 acres or 1.3 square miles.*

The Niantic River is tidally influenced from Banning Cove at the north of the Estuary to where the mouth of the river drains to Niantic Bay, an embayment of Long Island Sound. The Estuary is approximately 1.3 square miles in area and functions as an estuary, a transition zone between marine ecosystems and freshwater ecosystems that are among nature’s most productive habitats. Numerous small streams drain directly from the uplands surrounding the Estuary. Most are unnamed and drain relatively localized areas.

Latimer Brook and its tributaries contribute the majority of freshwater to the Niantic River Estuary. The brook begins in Salem, approximately 12 miles from its mouth in Banning Cove, and drains the entire upper (northern) and most of the central and western portions of the watershed. Public water supplies for the City of New London, Waterford, and East Lyme rely on a network of reservoirs that occupy the upper Niantic River watershed. This includes Lake Konomoc, which is part of the Oil Mill Brook Subregional Basin. Oil Mill Brook begins at a dam spillway at the southwest end of Lake Konomoc and flows southwesterly for approximately three miles before draining into the northeast corner of Banning Cove.

The northern part of the Niantic River watershed, sometimes referred to in this Update as the “upper watershed,” is generally rural in character with primarily low-density residential land use, pockets of medium-density residential use, and some agricultural lands. The remainder of undeveloped land is forested, of which a significant area is conserved as open space to protect the public drinking water supply watershed. Land use in the southernmost part of the watershed is dominated by suburban residential and commercial development. In 2010, the population density was 563 people per square mile in East Lyme, 596 people per square mile in Waterford, 143

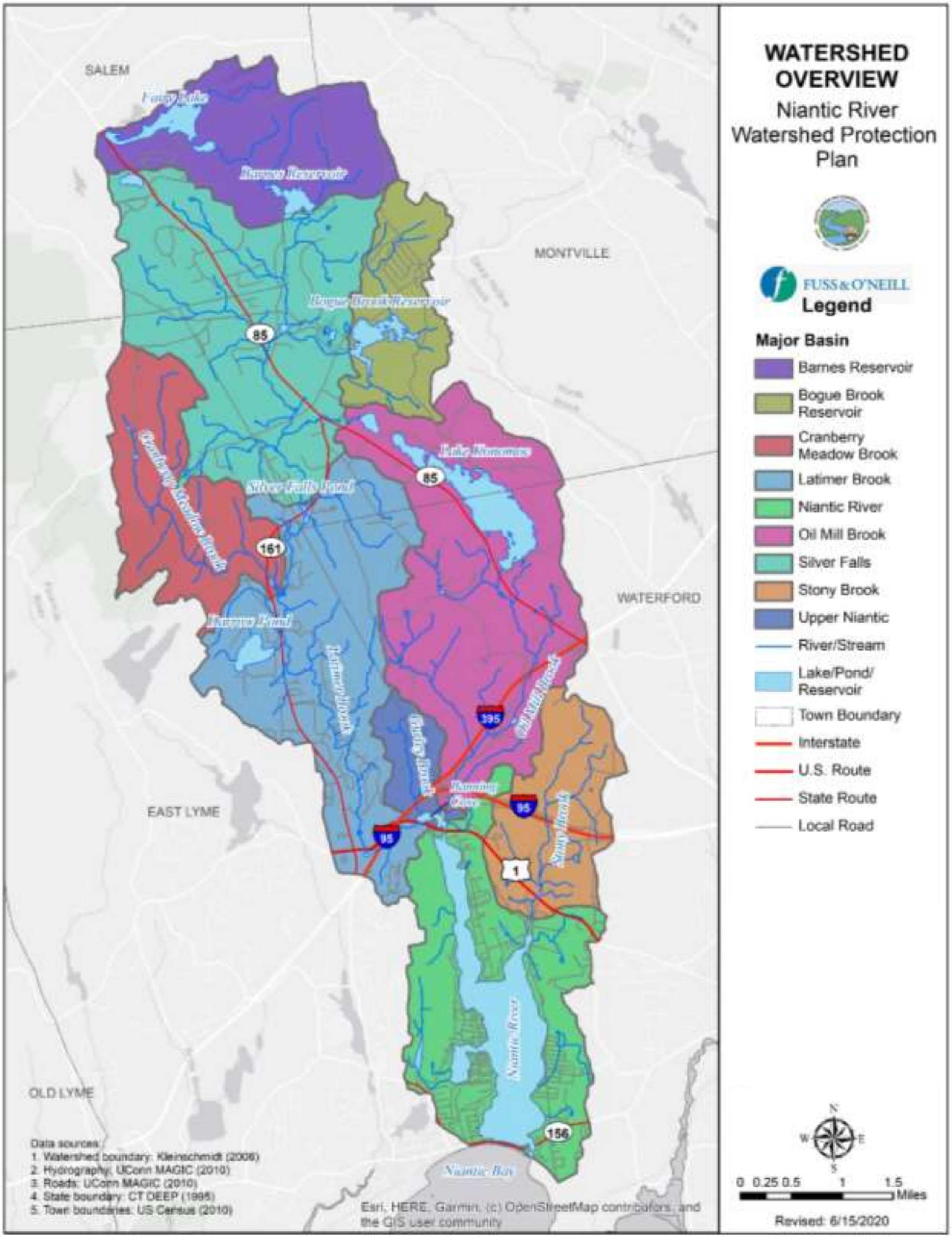

Figure 2.1. Niantic River Watershed Overview Map

people per square mile in Salem, and 465 people per square mile in Montville (within the Niantic River watershed, Montville's population density is considerably lower).[10]

Major roads located in the watershed include Interstate 95, Interstate 395, U.S. Route 1, and State Routes 85, 156, and 161. Other than the Niantic River Estuary itself, other landmarks in the watershed are the Village of Niantic, Camp Nett Army National Guard Base, Oswegatchie Hills Nature Preserve, public drinking water supply reservoirs (Barnes Reservoir, Bogue Brook Reservoir, Lake Konomoc, Fairy Lake, Beckwith Pond), Darrow Pond, part of Nehantic State Forest, Niantic River Headwaters Preserve, and the Morgan R. Chaney Sanctuary.

2.2 Water Quality

Water quality in the Niantic River watershed is mixed. In some tributaries and stream segments, water quality is good and supports healthy populations of resident fish species and macroinvertebrates. Similarly, public water reservoirs managed by New London Department of Public Utilities are well-protected by surrounding undeveloped land and maintain good water quality. On the other hand, a long history of development and certain land use activities have adversely impacted the Niantic River (and Niantic Bay) and some of its tributaries. In the Niantic River, Latimer Brook and Stony Brook, in-stream fecal indicator bacteria levels have been measured in excess of the State water quality standard for recreation in non-designated swimming areas (410 colonies/100mL maximum for a single sample, and less than 126 colonies/100 mL for the geometric mean). The Niantic River Estuary also has an excess of nutrients, namely nitrogen and phosphorus.[11] The Estuary is currently impaired for habitat for marine fish, other aquatic life including shellfish, and wildlife in general. Aquatic life has also been impacted in the Estuary and some stream segments as a result of withdrawals for public water supply, land development, and other hydro-modifications (see page 50), the last of which has contributed to reduced flow and degraded habitat in some streams.

Water Quality Impairments

One segment of the Estuary and nine stream segments within the Niantic River watershed were assessed by CT DEEP in their 2018 Integrated Water Quality Report (IWQR). Of these, the Niantic River Estuary and three stream segments are listed as impaired (i.e., do not meet water quality standards) for at least one designated use category (*Figure 2-2* and *Table 2-2*). As defined in Section 40 CFR 131.3(f) of the Clean Water Act, designated uses are "those uses specified in water quality standards for each waterbody or segment whether or not they are being attained."

- **Niantic River.** The Niantic River segment CT-E1_020 ("LIS EB Inner - Niantic River (mouth), Niantic") is a 1.3 square-mile Estuary extending from Niantic Bay north to the saltwater limit in Banning Cove to the west and the mouth of Stony Brook to the east. The Estuary is impaired for recreation; as habitat for marine fish, other aquatic life and wildlife; and harvesting shellfish. Niantic Bay, which receives flow from the Niantic River Estuary, was assessed as three segments: CT-E2_013 ("LIS EB Shore - Niantic Bay (East), Waterford"), CT-E2_014 ("LIS EB Shore - Niantic Bay (West), East Lyme"), and CT-E2_015 ("LIS EB Shore - Niantic Bay (Black Pt), East Lyme"). All are listed as impaired as habitat for marine fish, other aquatic life and wildlife and for harvesting shellfish.

- **Latimer Brook.** The lowest segment CT2202-00_01 of Latimer Brook ("Latimer Brook (East Lyme)-01") is 4.23 miles and extends north from its mouth in Banning Cove north to its confluence with Cranberry

[10] Milone & MacBroom, 2016, Coordinated Water System Supply Plan, Part I: Final Water Supply Assessment, prepared for the Eastern Region Water Utility Coordinating Committee, 231 pages. https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/drinking_water/pdf/20161214EasternWSApdf.pdf?la=en

[11] CT DEEP. *2018 Integrated Water Quality Report*.

Meadow Brook. The segment is impaired for recreation and aquatic life. Immediately upstream, the segment CT2202-00_02 ("Latimer Brook (East Lyme/Montville)-02") is 3.43 miles north to Beckwith Pond. This segment is impaired for aquatic life and has not been assessed for supporting recreation.

- **Stony Brook.** The segment CT2204-03_01 ("Stony Brook (Waterford)-01") is a 0.23 mile segment from Keeny Cove in the Estuary to the crossing at Boston Post Road (US Route 1). The segment is impaired for recreation and not assessed for support of aquatic life.

Table 2-2. Impaired waterbody segments in the Niantic River watershed*

Impaired Segment	Impaired Designated Use	Cause	TMDL Status
CT-E1_020 LIS EB Inner - Niantic River (mouth), Niantic	Habitat for Marine Fish, Other Aquatic Life and Wildlife; Shellfish Harvest; Recreation	Nutrients; Estuarine Bioassessments; Cause Unknown; *Enterococcus;* Fecal Coliform	CT Statewide Bacteria TMDL, 2014
CT2202-00_01 Latimer Brook (East Lyme)-01	Recreation; Habitat for Fish, Other Aquatic Life and Wildlife	*E. Coli*; Flow Regime Modification	No TMDL (proposed TMDL 2020)
CT2202-00_02 Latimer Brook (East Lyme/Montville)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Regime Modification	No TMDL
CT2204-03_01 Stony Brook (Waterford)-01	Recreation	*E. Coli*	No TMDL (proposed TMDL 2020)
Impaired Segments of Niantic Bay+			
CT-E2_013 LIS EB Shore – Niantic Bay (East)	Habitat for Marine Fish, Other Aquatic Life and Wildlife; Shellfish Harvest	Cause Unknown; Fecal Coliform	CT Statewide Bacteria TMDL, 2014
CT-E2_014 LIS EB Shore – Niantic Bay (West), East Lyme	Habitat for Marine Fish, Other Aquatic Life and Wildlife; Shellfish Harvest	Cause Unknown; Fecal Coliform	CT Statewide Bacteria TMDL, 2014
CT-E3_006 LIS EB Midshore – Niantic Bay	Habitat for Marine Fish, Other Aquatic Life and Wildlife; Shellfish Harvest	Cause Unknown; Fecal Coliform	CT Statewide Bacteria TMDL, 2014

** CT DEEP 2018 Integrated Water Quality Report*

+ *Niantic Bay is located outside of the Niantic River watershed and included here as reference on the status of waters downstream of the Niantic River.*

Potential sources of bacteria in the watershed include "nonpoint sources" such as diffuse stormwater runoff, failing or malfunctioning septic systems, agricultural activities including but not limited to numerous farms in the northern part of the watershed, and waste from wildlife and pets. "Point sources" of bacteria include discharges from Municipal Separate Storm Sewer Systems (MS4s), potential illicit discharges, and runoff from industrial and commercial facilities.

Total Maximum Daily Load (TMDL) Analysis and Target Load Reductions

From 2000-2011, CT DEEP collected data from targeted sampling efforts. Based on this data, a TMDL was established that the Niantic River Estuary (CT-E1_020) requires: (1) a 94% reduction in geometric mean fecal coliform levels, and (2) a 90% reduction in single sample fecal coliform levels (90% of samples having less than 31 colonies/100ml). No TMDL, and thus no recommended reductions, have been established for the remaining stream segments listed in 2018 as impaired. In lieu of a TMDL, data published by USGS in 2011 on *E. coli* densities in certain tributaries could be compared to established water quality standards for designated uses in order to guide the water quality management.[12] The *Connecticut Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters* (2012) and the Appendix *Estuary 14: Waterford/East Lyme* (2014) and are available at portal.ct.gov/DEEP/Water/TMDL/Total-Maximum-Daily-Load.

Potential sources of indicator bacteria identified in the TMDL include discharges from MS4s and industrial and commercial facilities. Additional nonpoint sources include stormwater runoff, failing septic systems, agricultural activities, and wastes from wildlife and pets. Stormwater discharges to MS4s and illicit discharges are two of the primary targets identified in the Statewide Bacteria TMDL for pollution reduction in freshwater segments. These items will be addressed through the regulatory requirements of the MS4 Permit program.

Water Quality Monitoring

The Connecticut Department of Energy and Environmental Protection (CT DEEP) routinely monitors ambient water quality, macroinvertebrate diversity, and fisheries at locations within the watershed, in addition to reviewing data collected by other agencies and organizations. These data are incorporated into the biannual IWQRs and TMDLs. Due to constrained resources, CT DEEP has a limited number of fixed stations across the state that are monitored on an annual basis. Additional assessments are conducted annually on a five-year rotating basis by major watershed throughout the state (i.e., one year the focus will be the Housatonic River Major Basin, and another it will be the Connecticut River Major Basin). As such, the TMDLs in the Niantic River watershed are based on limited water quality monitoring data.

Dominion Energy collects water quality data from the Niantic River and Niantic Bay throughout the year. Collected data includes temperature, dissolved oxygen, salinity, and dissolved organic and inorganic nitrogen. In addition, samples are macro-algae, eelgrass, and marine fish and macroinvertebrates (via fish trawls). MEL also collects water quality data at NRWC's lowermost Latimer Brook site to provide a check on other sampling results.

Save the Sound (STS) coordinates the Unified Water Study, a water quality program designed to collect standardized data in Long Island Sound and its embayments. STS developed the monitoring protocol and partnered with local groups to launch the program in 2017 in selected embayments (in New York and Connecticut). In 2018, the cooperation of the local conservation group Save the River-Save the Hills enabled the program to begin monitoring in the Niantic River Estuary. Eight stations were established (see *Figure 2-2*) in the Estuary for UWS Tier I sampling parameters: dissolved oxygen, water clarity, temperature, salinity, and chlorophyll-*a*. Additional measurements for Tier II data (continuous dissolved oxygen, nitrogen, phosphorous, macrophyte quantities) have been collected at five of these stations. All data and monitoring protocols are publicly available at www.savethesound.org/water-monitoring-ecological-health.

The **Niantic River Watershed Committee's** Monitoring Subcommittee compiles data and analysis on water quality monitoring efforts and trends in the watershed. In 2012, they initiated a water quality monitoring program in Latimer Brook and Cranberry Meadow Brook, and the program was expanded in 2014 to include Oil Mill Brook and Stony Brook. Beginning in 2017, quarterly water quality monitoring before, during and after precipitation events was begun in order to study how stormwater runoff impacts nitrogen levels in Latimer Brook. The data, used by NRWC and municipalities, rely on the observed trends in watershed data to identify opportunities and support funding requests for water quality improvements. The NRWC also participates in the Riffle Bioassessment by Volunteer (RBV) program run by CT DEEP, a state-wide program that monitors macroinvertebrates as an indicator of water quality. To monitor the effect of stormwater on water temperature, NRWC also monitors water

[12] Mullaney, J.R., 2013, Nutrient concentrations and loads and *Escherichia coli* densities in tributaries of the Niantic River estuary, southeastern Connecticut, 2005 and 2008–2011: U.S. Geological Survey Scientific Investigations Report 2013–5008, 27 pages, at http://pubs.usgs.gov/sir/2013/5008/

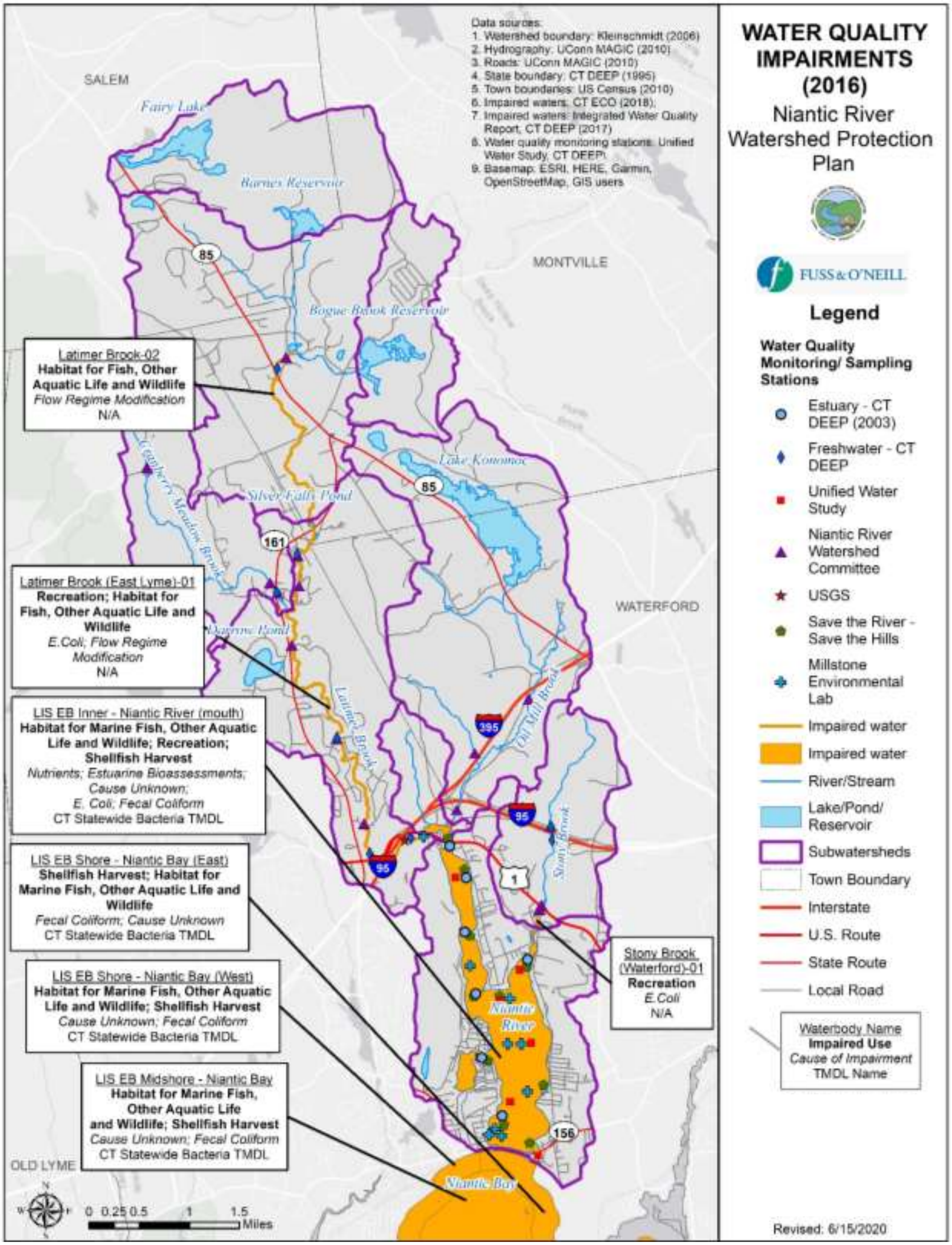

Figure 2.2. Water Quality Impairments Map

temperature in Latimer Brook, Cranberry Meadow Brook, and an unnamed tributary to Cranberry Meadow Brook, specifically as it relates to the ability of the waterbodies to support cool-cold water fish species, particularly native brook trout. Along parts of Latimer Brook, the NRWC has also conducted stream corridor assessments, utilizing the Natural Resource Conservation Service (NRCS) "Stream Walk" methodology, in which citizen scientists walk along the waterbody to identify conditions that could impact water quality.[13]

Water Quality Research in the Watershed

In 2011, the **United States Geological Survey** (USGS) published its study of water-quality sampling and survey of base flows in tributaries to the Niantic River. The project involved monitoring *E. coli* densities and nutrient concentrations at Latimer Brook, Oil Mill Brook, and Stony Brook, conducted through continuous streamflow, monthly water-quality sampling, and storm event sampling.[14] The study found that eelgrass beds – an essential habitat for shellfish and other wildlife in the Niantic River – may be adversely affected by water quality. The study also found that *E. coli* levels from single samples exceeded state standards at several waterbodies in the watershed, although the geometric means of the samples from the three waterbodies did not exceed state standards (wet weather samples more likely to exceed standards). The sources of nitrogen (nitrate) were determined to likely be from fertilizer, animal waste/sewage, or a combination of the two, with Latimer Brook representing a majority (78-80%) of the nitrogen loading in the study area. In the 2015 study, nitrogen concentrations were determined from 20 wells located near the Niantic River from 2005 to 2011 examining the effect of the 2008-09 sewering of the Pine Grove section of Niantic.[15] Concentrations of dissolved nitrogen for most wells decreased following sewer hookups. The estimated nitrogen loading before sewering was 1,675 pounds/year (lbs/yr) and 963 lbs/yr afterwards. Estimated future loading estimates ranged between 202 and 423 lbs/yr.

The **Vaudrey Lab** (Dr. Jamie Vaudrey, Dr. Jason Krumholz, and Dr. Christopher Calabretta) at the University of Connecticut conducted *Data Synthesis and Modeling of Nitrogen Effects on Niantic River Estuary*, a three-phase project that analyzed 30 years of data to understand the impacts of nitrogen in the Estuary and build upon historic water quality monitoring and analysis projects. The project focuses on "development of a model to investigate the relationship between nutrient inputs, physical flow, climatic changes, and the response of the ecosystem (oxygen, eelgrass, macroalgae)." Data included in the analysis were collected by the Kremer Lab, Dominion Energy's Millstone Environmental Lab Nitrogen Working Group, NRWC, Save the River-Save the Hills, and the Vaudrey Lab. The findings indicate that 71% of inter-annual variability in eelgrass health is related to summer air temperature and annual water temperature. Wind speed and sunlight accounted for 13%. The report emphasizes that the Niantic River Estuary has been moderately supportive of eelgrass.

In 2013, the Vaudrey Lab began an analysis of nitrogen loading to Long Island Sound from embayments in New York and Connecticut. The results from this study identified the trophic status in 2011-2014 of these embayments, estimated the nitrogen load and sources of nitrogen to all embayments of Long Island Sound, and established a list of embayments most likely to be experiencing the impacts of eutrophication.[16] The threshold for good water quality was based in part on distribution and health of eelgrass beds, established by research conclusions that eelgrass is adversely impacted by nitrogen loading in excess of 50 kilograms/hectare of an estuary/year (Latimer

[13] www.nianticriverwatershed.org/our-programs/water-quality-management/monitoring/

[14] Mullaney, J.R., 2013, Nutrient concentrations and loads and *Escherichia coli* densities in tributaries of the Niantic River estuary, southeastern Connecticut, 2005 and 2008–2011: U.S. Geological Survey Scientific Investigations Report 2013–5008, 27 p., at http://pubs.usgs.gov/sir/2013/5008/

[15] Mullaney, J.R., 2015, Evaluation of the Effects of Sewering on Nitrogen Loads to the Niantic River, Southeastern Connecticut, 2005-11, Scientific Investigations Report 2015-5-11, 42 p., at https://pubs.usgs.gov/sir/2015/5011/pdf/sir2015-5011.pdf

[16] Vaudrey, J. et al. 2016. *Comparative analysis and model development for determining the susceptibility to eutrophication of Long Island Sound embayments*. https://vaudrey.lab.uconn.edu/embayment-n-load/

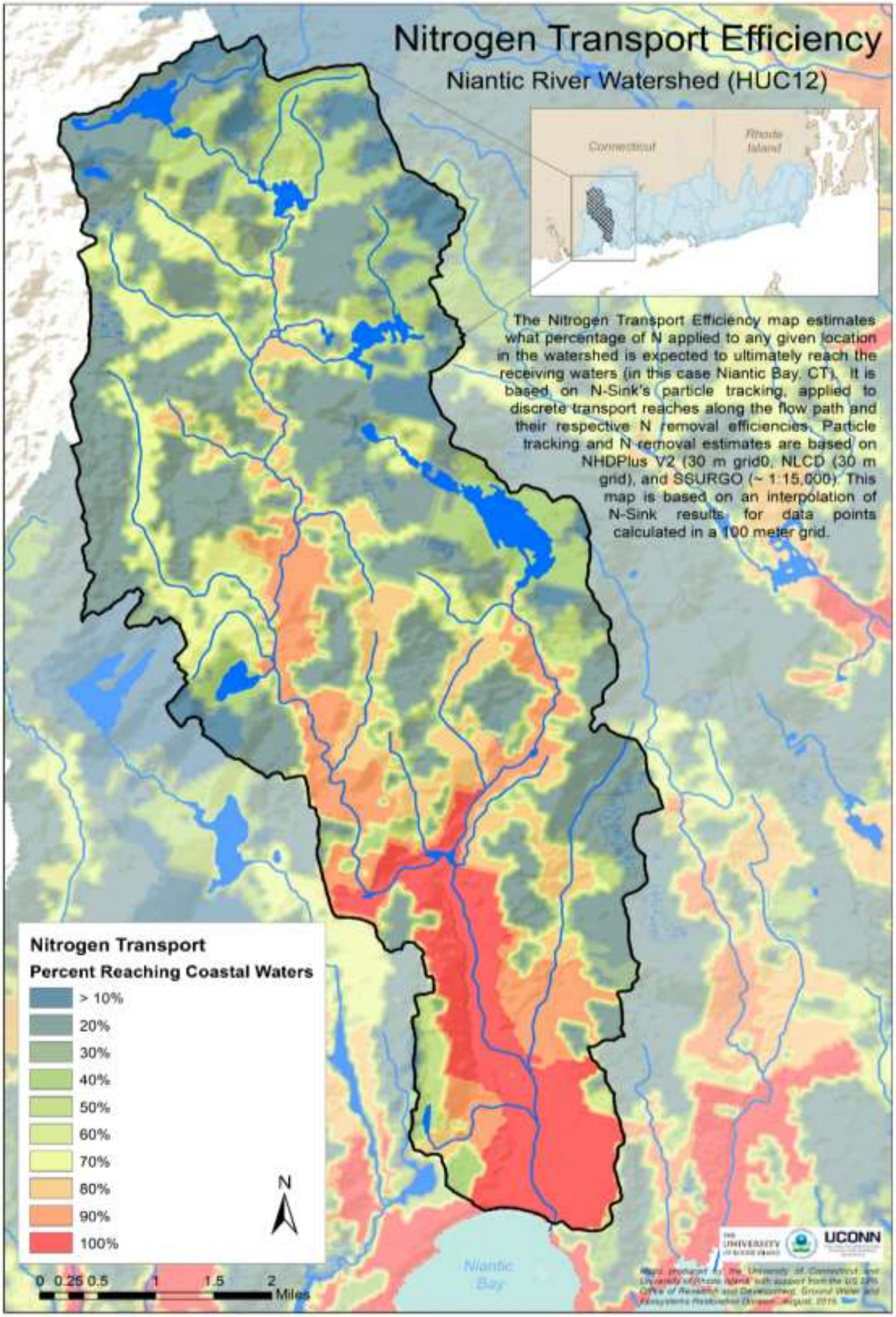

Figure 2-3. Nitrogen Transport Efficiency Map (reprinted courtesy of UCONN-CLEAR)

and Rego, 2010). Below this threshold, the presence and health of eelgrass is determined by other factors (i.e., temperature, disturbance, substrate, current speed). At the two sites analyzed in the Niantic River Estuary, rates of nitrogen loading varied and correlated with known presence/absence of eelgrass. When factoring in estuarine freshwater flushing time and assessments of eutrophic status, the project's ranking placed the Estuary at a relatively low risk for eutrophication but as a top-priority embayment for preserving existing eelgrass beds.

Currently under development by **UCONN-CLEAR and the University of Rhode Island** is the N-Sink Tool, which is a predictive model that tracks nitrogen from any point in a watershed. The tool is intended as a way for stakeholders in a watershed to examine the relationship between nitrogen pollution and land use. The tool will allow users to: choose any point in the watershed and find the percent of relative nitrogen removal; and, draw a polygon to estimate loading from a particular area (estimates are likely lower than actual loads, as they are based on soil data and do not account for the catchment/discharge of storm sewers nor their potential treatment capacity). In developing the tool, the Niantic River watershed was chosen as a pilot watershed to demonstrate the tool's outputs (nitrogen removal efficiency, nitrogen transport efficiency, and nitrogen delivery index) and applicability to prioritizing land and watershed management decisions. *Figure 2-3* shows the estimated percentages of nitrogen transported to (and percentages of nitrogen removed from) tributaries and the Niantic River Estuary.

2.3 Land Cover

The distribution of land cover (physical land type) and land use (how people make use of land) within the watershed plays an important role in shaping spatial patterns and sources of nonpoint source pollution and surface water quality. *Figure 2-4* shows the distribution of land cover across the Niantic River watershed based on the most recent (2015) land cover data available from UCONN-CLEAR. The land cover data show that the watershed is over 60% forested (*Table 2-3*). This is followed by developed land (Developed, Turf and Grass, Other Grass, and Agriculture land cover types), which accounts for approximately nearly 25% of land cover in the watershed, and open water and wetlands which make up approximately 12% of the watershed. *Table 2-4* provides a summary of land cover by subwatershed.

Table 2-3. Land cover in the Niantic River watershed

Land Cover	2006 Area (sq. mi.)	2006 Percent Cover	2015 Area (sq. mi.)	2015 Percent Cover	Change (sq. mi.)
Developed	4.1	13.3%	4.19	13.6%	+0.08
Turf and Grass	1.44	4.7%	1.43	4.6%	-0.01
Other Grass	0.78	2.5%	0.82	2.7%	+0.05
Agriculture	1.02	3.3%	1.02	3.3%	0
Deciduous Forest	17.67	57.3%	17.7	57.3%	+0.03
Coniferous Forest	1.34	4.3%	1.33	4.3%	-0.01
Water	2.27	7.4%	2.27	7.4%	0
Non-Forested Wetlands	0.1	0.3%	0.1	0.3%	0
Forested Wetlands	1.38	4.5%	1.38	4.5%	0
Barren	0.57	1.8%	0.44	1.4%	-0.13
Utility ROW (forest)	0.19	0.6%	0.19	0.6%	0
Watershed Total	**30.87**	**100%**	**30.87**	**100%**	

Table 2-4 also presents land cover data for the watershed from 2006 to evaluate the changes in land cover composition since the original NRWPP was developed. Overall, there have been modest changes in land cover in

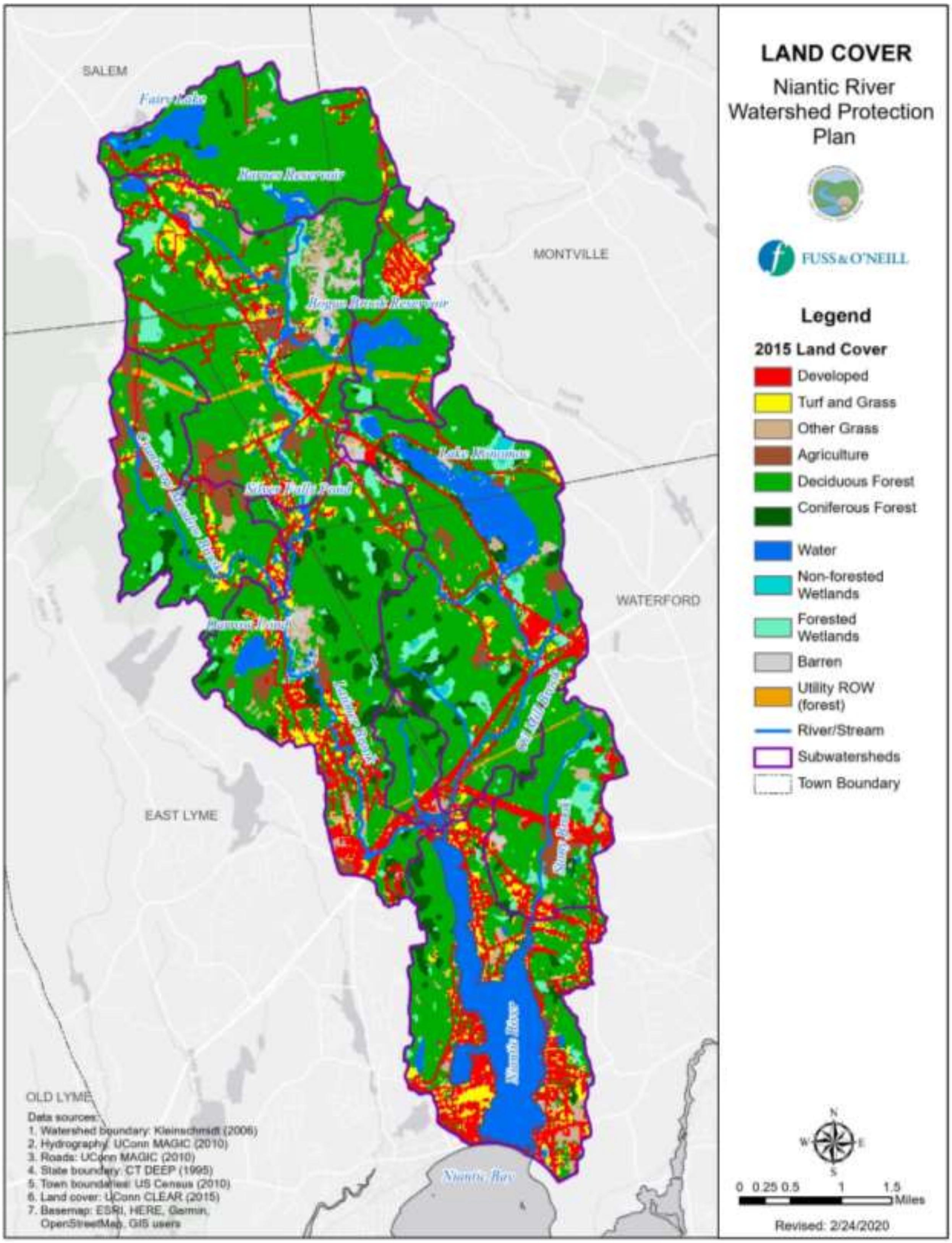

Figure 2.3-4. Land Cover Map

Table 2-4. Land cover by subwatershed

Land Cover	Silver Falls		Upper Niantic		Bogue Brook Reservoir		Cranberry Meadow Brook		Stony Brook		Niantic River		Latimer Brook		Oil Mill		Barnes Reservoir	
	Acres	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Developed	392.8	10.8%	44.3	10.8%	115.9	10.7%	111.6	6.7%	228.6	17.9%	768.8	25.5%	508.5	16.3%	414.8	11.2%	92.5	5.0%
Turf and Grass	218.8	6.0%	8.0	1.9%	48.9	4.5%	73.5	4.4%	40.6	3.2%	236.5	7.9%	163.9	5.2%	86.5	2.3%	35.8	1.9%
Other Grass	179.5	4.9%	13.5	3.3%	24.1	2.2%	25.0	1.5%	33.5	2.6%	70.5	2.3%	88.6	2.8%	63.6	1.7%	29.2	1.6%
Agriculture	190.5	5.2%	0.0	0.0%	15.6	1.4%	204.1	12.2%	66.8	5.2%	0.0	0.0%	84.9	2.7%	82.4	2.2%	9.2	0.5%
Deciduous Forest	2199.7	60.4%	280.5	68.1%	731.4	67.8%	1090.7	65.4%	725.4	56.9%	919.9	30.6%	1731.6	55.3%	2179.1	59.0%	1468.8	79.5%
Coniferous Forest	8.7	0.2%	42.0	10.2%	10.1	0.9%	68.2	4.1%	29.8	2.3%	119.6	4.0%	282.1	9.0%	253.2	6.9%	38.8	2.1%
Water	42.7	1.2%	14.2	3.5%	56.9	5.3%	4.6	0.3%	2.5	0.2%	823.7	27.4%	70.5	2.3%	296.1	8.0%	139.6	7.6%
Non-Forested Wetlands	2.1	0.1%	0.0	0.0%	2.3	0.2%	1.6	0.1%	7.6	0.6%	1.8	0.1%	0.9	0.0%	42.0	1.1%	6.7	0.4%
Forested Wetlands	241.7	6.6%	3.9	0.9%	45.2	4.2%	64.0	3.8%	112.9	8.9%	45.0	1.5%	131.1	4.2%	214.4	5.8%	25.0	1.4%
Barren	124.4	3.4%	0.2	0.1%	1.6	0.1%	2.1	0.1%	14.9	1.2%	25.0	0.8%	62.4	2.0%	47.5	1.3%	2.8	0.1%
Utility ROW (forest)	38.3	1.1%	5.3	1.3%	27.3	2.5%	23.4	1.4%	11.0	0.9%	0.0	0.0%	4.1	0.1%	12.6	0.3%	0.0	0.0%
Total	**3639.3**	**100%**	**412.1**	**100%**	**1079.4**	**100%**	**1668.7**	**100%**	**1273.9**	**100%**	**3010.8**	**100%**	**3128.8**	**100%**	**3692.4**	**100%**	**1848.2**	**100%**

the watershed since 2006, which likely reflects the limited development that occurred during the economic downturn starting in 2008. Developed land (Developed, Turf and Grass, Other Grass, and Agriculture land cover types) increased by approximately 76 acres and forested land experienced a net increase of approximately 12 acres, while Barren land cover type saw a corresponding reduction of approximately 83 acres. The majority of this reduction is attributable to the revegetation of a now inactive, privately-owned gravel mining operation in southwest Montville (effort is currently underway to permanently protect the area as open space.)

2.4 Impervious Cover

Impervious cover (IC) refers to any surface that prevents natural infiltration of stormwater into the soil, most notably buildings and pavement. Urban stormwater runoff generated in developed areas from buildings, pavement, and other impervious surfaces is a significant source of pollutants to the Niantic River Estuary and its tributaries. Stormwater flowing off of impervious surfaces typically contains pollutants associated with atmospheric deposition, vehicles, industrial and commercial operations, lawns, construction sites, and human and animal activities. Without treatment, these pollutants may be conveyed during storm events from an impervious surface directly to a nearby waterbody or to a storm drainage system that eventually discharges to a waterbody. This impact is combined with the loss of areas that infiltrate rainfall/runoff into the ground and help to filter out pollutants. In addition, impervious surfaces, especially those connected to traditional, piped storm drainage systems, increase the volume, peak flow rates, and velocity of stormwater runoff to receiving waters. This can contribute to higher flood risk, channel erosion, sedimentation, and reduced groundwater recharge and base flow to streams, particularly during dry periods.

Research has documented the effects of urbanization on stream and watershed health. More specifically, studies by CT DEEP have found a negative relationship between upstream impervious land cover and aquatic habitat in downstream, adjacent waters, with predictable, detrimental impacts to aquatic life when impervious cover exceeds 12%. However, impacts to streams can also occur before impervious cover reaches that level, particularly where sources other than piped stormwater discharges contribute to water quality impairments.

Figure 2-5 and *Table 2-5* summarize impervious cover in the Niantic River watershed based on the 2012 high-resolution impervious cover data layer released by UCONN-CLEAR in 2016. As a whole, the Niantic River watershed has an estimated 5.3% impervious cover (*Table 2-5*). All subwatersheds, as defined in this plan, are also below the 12% threshold, with the Niantic River subwatershed having the highest impervious cover at 10.1%, due to high levels of development, and the Barnes River Reservoir subwatershed with the lowest impervious cover at 1.62% due to relatively sparse development. As indicated by the orange and red shaded areas in *Figure 2-5*, several of the smaller CT DEEP Local Basins within the Niantic River and Latimer Brook subwatersheds have locally higher amounts of impervious cover (10-15% or greater), including downtown Niantic, the Avenues and Mago Point in Waterford, and the Flanders Four Corners commercial area of East Lyme. Consistent with the well-documented relationship between impervious cover and water quality, these highly-developed areas are generally where water quality impairments exist.

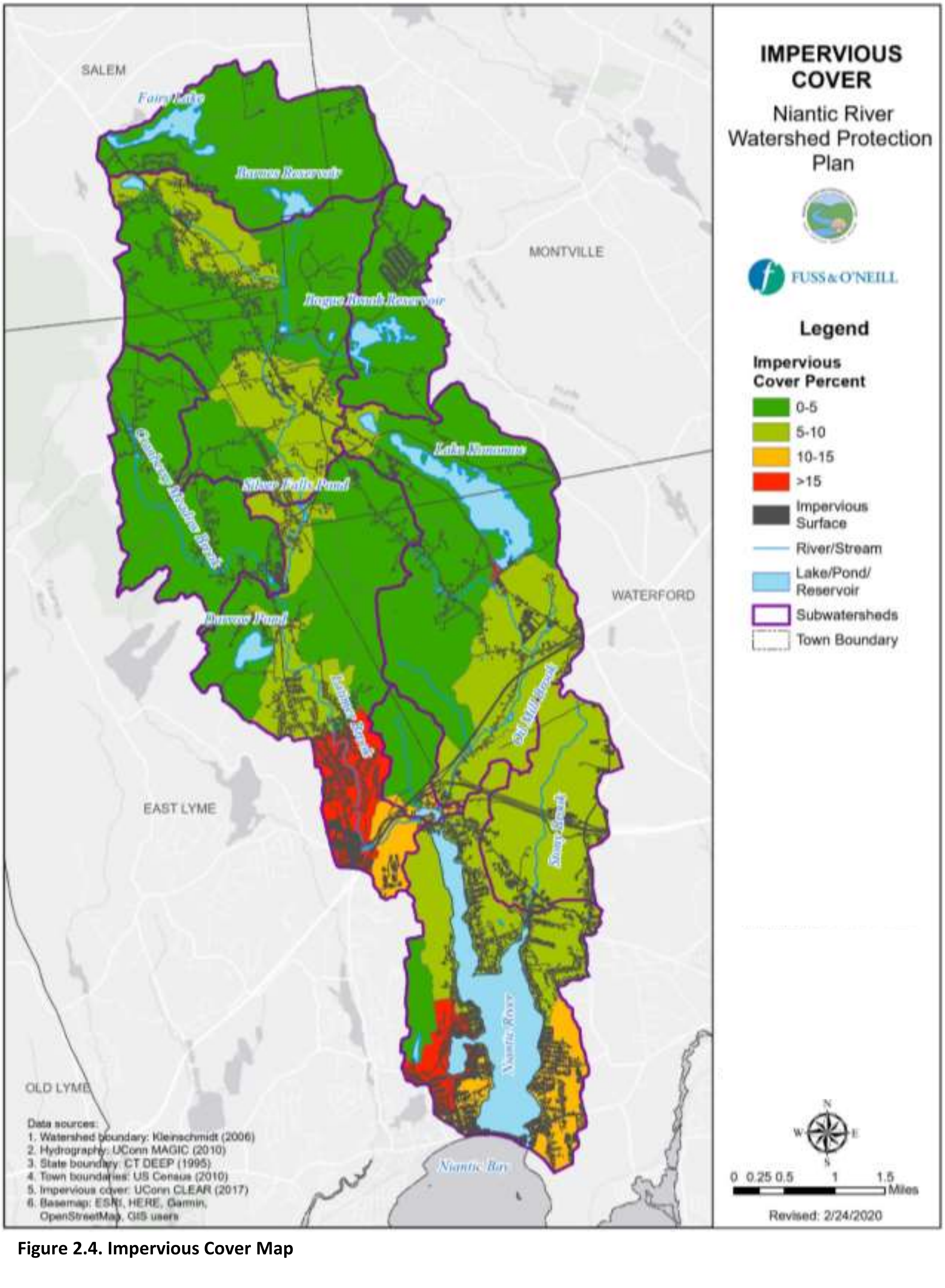

Figure 2.4. Impervious Cover Map

Table 2-5. Impervious cover statistics for the Niantic River watershed

Subwatershed	Imperious Cover (acres)	Impervious Cover (%)
Niantic River	304.7	10.1%
Upper Niantic	13.6	3.3%
Latimer Brook	213.8	6.8%
Cranberry Meadow Brook	48.5	2.9%
Silver Falls	159.4	4.4%
Stony Brook	94.7	7.4%
Oil Mill	142.1	3.9%
Bogue Brook Reservoir	41.1	3.8%
Barnes Reservoir	29.9	1.6%
Watershed Total	**1047.8**	**5.3%**

2.5 Open Space

Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious cover, preserving natural areas for pollutant attenuation, and supporting other planning objectives such as farmland preservation, community preservation, passive recreation, habitat, and water supply protection. Open space includes public open space, which is land owned by the local, state, or federal government. Public open spaces are lands that are used for recreation or other purposes and may currently be lightly developed and subject to future, more intensive development, if not protected. Permanently protected open space is land that has been set aside specifically to prevent future development through conservation easements, its purchase for the intent of conservation, or other restrictions on a property's developments. Protecting open space from development through these methods is also an effective strategy for protecting the quantity and quality of local water resources.

Approximately 22% percent of the land area in the Niantic River watershed consists of protected open space (*Figure 2-6*). A project is currently underway by Avalonia Land Conservancy, supported by CT DEEP, and the town of Montville to permanently protect 669 acres along Latimer Brook; this acquisition would increase the amount of open space in the watershed to 25%. The permanently protected open space parcels in the Niantic River watershed include town-owned parks, recreation areas, and preserves; land trust properties; State of Connecticut properties that are undeveloped; and Class A water company land. Many of the areas identified in the 2006 NRWPP as having high-priority status for conservation contain open space protected since 2006 (Conservation Priority Index (CPI), shaded green, in *Figure 2-6*). This status was determined by a land-area analysis for the NRWPP to depict the optimal areas for protection against future water quality degradation. Notable permanently protected open space in the Niantic River watershed includes:

- Oswegatchie Hills Nature Preserve (457± acres; town of East Lyme and East Lyme Land Trust)
- Nehantic State Forest (608± acres in the watershed; CT DEEP)
- Protected lands surrounding public water supply reservoirs (2,000± acres, City of New London's Department of Public Utilities)
- Niantic River Headwaters Community Forest (200± acres; New England Forestry Foundation)
- The Morgan R. Chaney Sanctuary (233± acres; Connecticut Audubon Society)

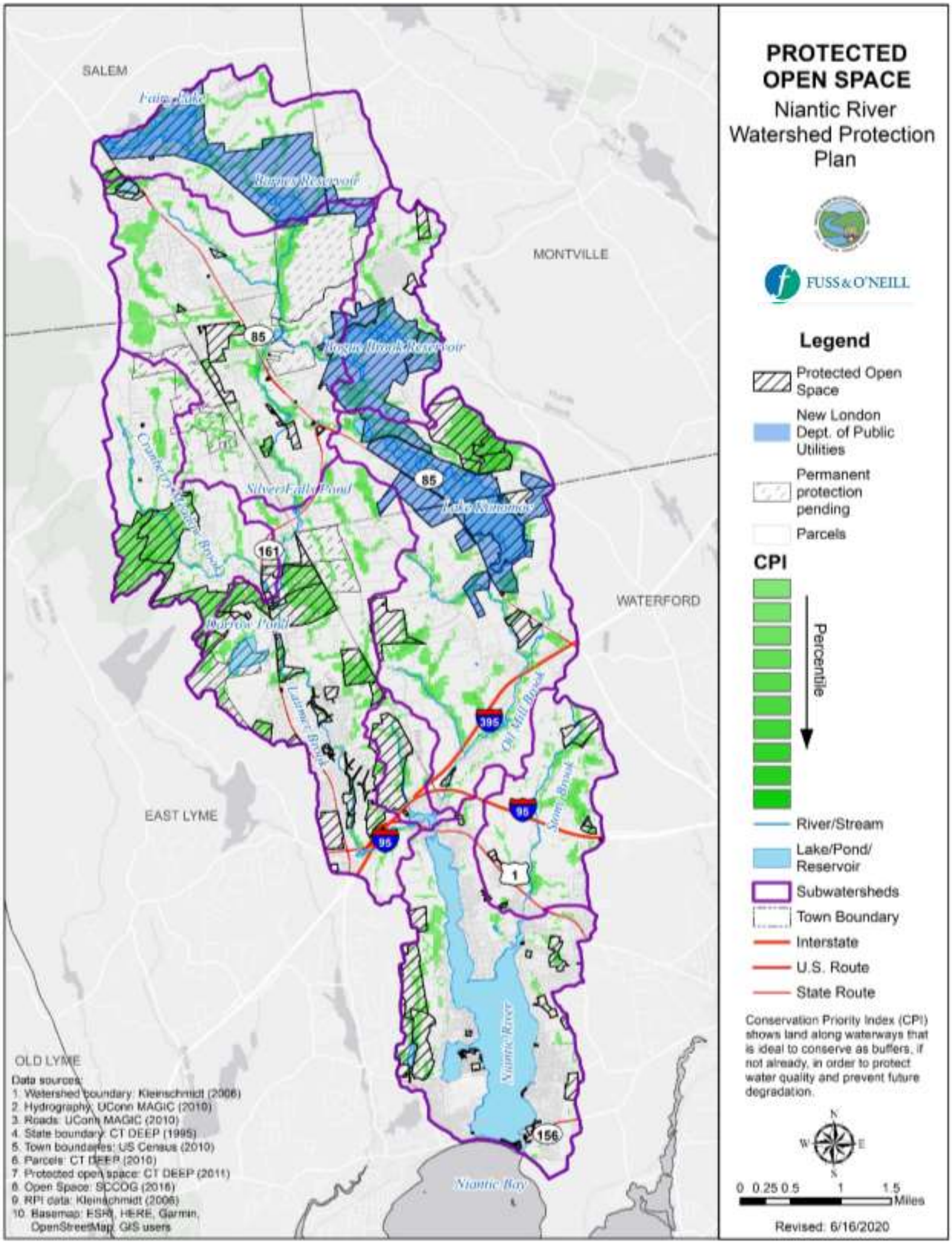

Figure 2.5. Protected Open Space Map

2.6 Geology and Soils

The Niantic River watershed has a unique geology that is comparable to other medium-sized coastal watersheds in Connecticut like the Mystic River, Hammonasset River, and Norwalk River. The topography of this watershed varies considerably in any of its parts; uplands can be relatively flat or steeply sloped with abundant outcropping bedrock ledges. Watercourses can occupy broad riparian areas with signs of relict meanders or roil through incised channels, the latter being more common in the upper watershed. The underlying bedrock formed more than 500 million years ago when the African and North American continents collided. Granitic rocks and ocean sediments were highly metamorphosed and became the formative structure that gives shape to the landscape known today. While it is more common at the higher elevations, much of the watershed has bedrock exposed at the surface or soils that are characterized as shallow or moderately shallow to bedrock.

The surficial geology of the watershed has been shaped by glaciation and is another major factor influencing topography, soils, and drainage characteristics within the watershed (USGS, 1929). Glacial advance and retreat carved rock ledges and removed existing soil, and deposited two types of glacial drift: unstratified drift, or till, and stratified drift, or glacial outwash. Till is a hard-packed and jumbled mixture of unsorted glacial sediments, which was deposited directly by the ice and forms a mantle of variable thickness that is frequently interrupted by bedrock in the higher elevations of the watershed. Stratified drift is sorted layers of sand or gravel and was deposited by glacial meltwater where many of the major tributaries flow today, particularly along Latimer, lower Oil Mill and lower Stony Brooks. Additional deposits are found around the water supply reservoirs and the Niantic River Estuary (see *Figure 2-10*). At the northeast corner of the watershed, the landscape rises to a maximum elevation of 600 feet above sea level in Montville and descends to sea level at the Estuary.

The U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS) classifies soils into Hydrologic Soil Groups that characterize a soil's runoff versus infiltration potential after prolonged wetting. Group A soils are the most well-drained, meaning that they have low runoff potential and high infiltration potential. At the other extreme, Group D soils are the most poorly-drained. Water movement through Group D soils is restricted, causing them to have high runoff potential and low infiltration potential. Group D soils are frequently either (1) high in clay content or (2) shallow soils over an impermeable layer (i.e., shallow bedrock or dense glacial till) or a shallow water table. Group B and C soils complete the continuum between these extremes. Group B soils have moderately low runoff potential and unimpeded water transmission through the soil, while group C soils have moderately high runoff potential and are somewhat restrictive of water movement.

Figure 2-7 shows the distribution of Hydrologic Soil Groups in the Niantic River watershed. Approximately 37% of the watershed is classified as either Group A/D, B/D, C, C/D, or D soils, which are characterized by poor infiltration potential. Approximately 51% of the watershed consists of areas with Group A or B soils, which have greater infiltration potential and are generally more conducive to infiltration-based Low Impact Development and green stormwater infrastructure practices.

The Bogue Brook Reservoir, Stony Brook, Oil Mill, and Barnes Reservoir subwatersheds have the highest combinations of Group A and B soils and are therefore expected to have better infiltration potential (*Table 2-6*). Additionally, some of the areas of Group A and B soils in the Niantic River subwatersheds coincide with area of denser development, making these areas potential targets for infiltration-based stormwater retrofits. Areas of the watershed with poorly-drained soils are also less suitable for septic systems and more susceptible to septic system failure, which can be a significant a source of nutrients and bacteria to the Estuary.

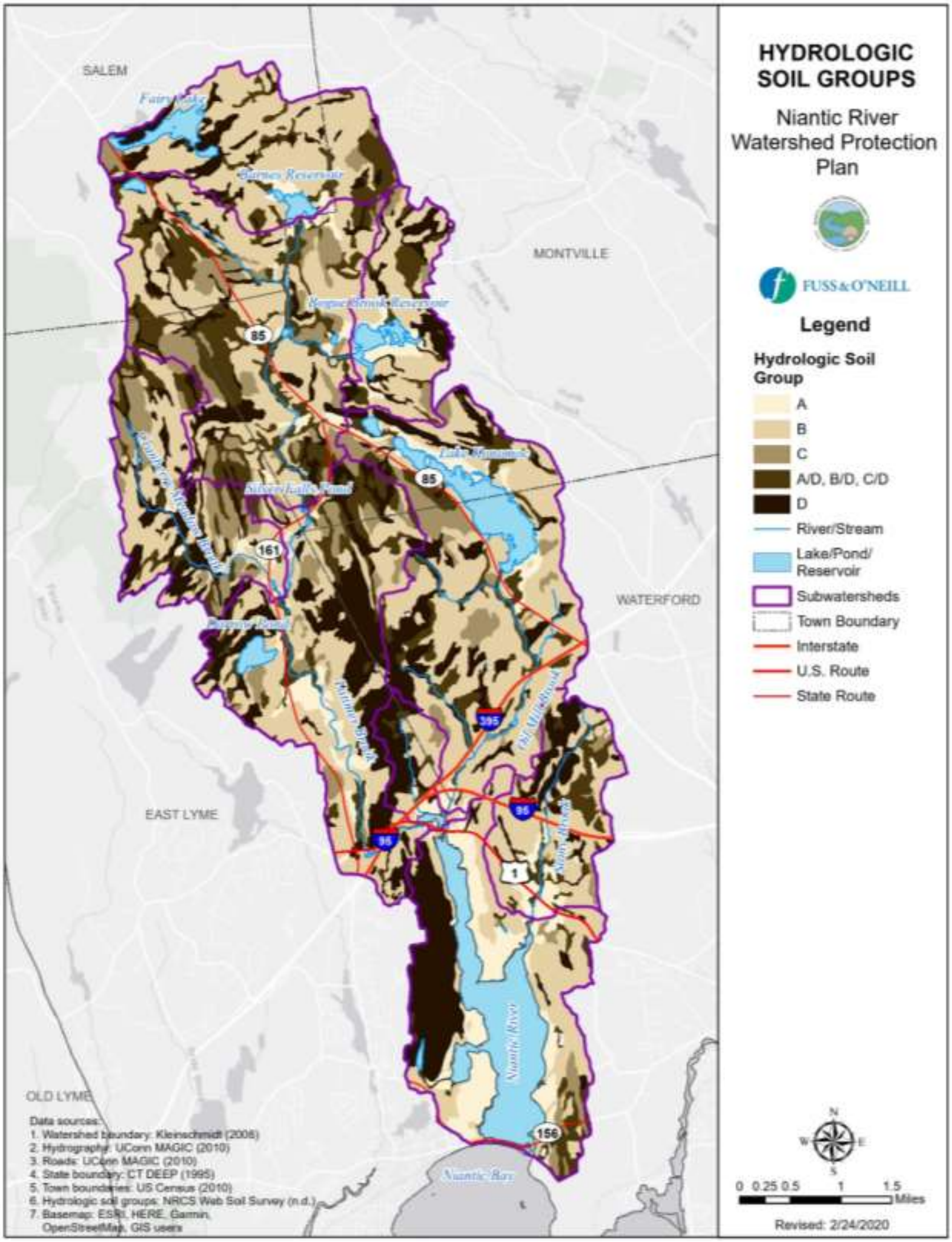

Figure 2.6. NRCS Hydrologic Soil Groups Map

Table 2-6. Distribution of hydrologic soil groups by subwatershed

	Hydrologic Soil Group				
Subwatershed	**A**	**B**	**C**	**D***	**Water**
Niantic River	19.2%	25.7%	3.1%	48.7%	3.3%
Upper Niantic	8.4%	36.4%	4.1%	51.1%	0.0%
Latimer Brook	6.0%	41.9%	8.9%	41.5%	1.7%
Cranberry Meadow Brook	2.9%	38.2%	21.1%	37.5%	0.3%
Silver Falls	3.2%	43.7%	14.6%	37.9%	0.6%
Stony Brook	10.5%	50.3%	4.3%	34.7%	0.2%
Oil Mill	4.0%	51.0%	9.5%	26.6%	8.4%
Bogue Brook Reservoir	8.9%	48.0%	4.9%	31.0%	6.9%
Barnes Reservoir	2.0%	58.0%	3.7%	28.1%	7.6%
Watershed Total	7.1%	43.4%	9.1%	36.8%	3.6%

**Includes A/D, B/D, C/D, and D Hydrologic Soil Groups*

2.7 Wetlands, Riparian Areas, and Forests

Wetlands

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and plant and animal communities living in the soil and on its surface. Wetlands can vary widely in type and characteristics and are an important feature of a watershed, providing water quality benefits by removing pollutants and mitigating flooding. The extent and distribution of wetland soils (which are the defining characteristic for inland wetlands in Connecticut) in the Niantic River watershed are shown in *Figure 2-8* and *Table 2-7*. Inland wetland soils make up approximately 12% of the watershed overall. Inland wetland soils comprise between 2% and 20% of the land area in the respective subwatersheds of the Niantic River watershed.

Table 2-7. Extent of inland wetland soils in the Niantic River watershed

Subwatershed	**Percent Wetland Soils**
Niantic River	2.2%
Upper Niantic	7.9%
Latimer Brook	11.4%
Cranberry Meadow Brook	16.2%
Silver Falls	18.7%
Stony Brook	20.3%
Oil Mill	11.9%
Bogue Brook Reservoir	11.4%
Barnes Reservoir	7.7%
Watershed Total	**12.0%**

Available mapping depicts approximately 17 acres (less than 0.001%) of tidal wetlands in the Niantic River watershed.[17] The majority are located in coves at the northern limit (Keeney Cove, Banning Cove) and western limit (Smith Cove) of the Estuary. Narrow bands of tidal wetlands are also mapped along the eastern shoreline of the Estuary south of Banning Cove, north and south of Mago Boulevard (Waterford), and a wetland approximately 500 feet east of the mouth of the Niantic River (to Niantic Bay).

Riparian Areas

Riparian area refers to the interface between land and water. Healthy riparian areas are characterized by a vegetated area along a river or stream that provides habitat to a diverse array of plants and animals. Such areas, also referred to as vegetated or stream "buffers," can also slow stormwater runoff, trap sediment and other pollutants, provide shade to the stream, and provide a food source for wildlife. On the other hand, riparian areas that are developed or that lack a natural stand of vegetation (e.g., paved or landscaped lawn areas or pasture and cropland right up to the water's edge) can be limited in their ability to filter stormwater and pollutants, leaving rivers and streams vulnerable to water quality issues. Slopes, soils, vegetation type and vegetation width all influence the effectiveness of buffers to protect water quality.

UCONN-CLEAR analyzed 2015 land cover within riparian areas in the Niantic River watershed, defined as 300 feet on both sides of mapped perennial and intermittent rivers and streams, including the areas of rivers and streams that can be mapped as open water depending on their width. For this analysis, land cover types were grouped by their effectiveness as riparian buffer. Overall, approximately three-quarters of the riparian areas in the watershed are undeveloped (forest, wetland, and open water), with the percentage of undeveloped riparian land cover ranging from 51% to 98% across the subwatersheds (*Table 2-8*). Agriculture, turf, and grass account for approximately 8% of the riparian land cover overall, while roughly 19% of the riparian areas in the watershed consist of developed land cover types. The Niantic River subwatershed has the highest amounts of developed riparian land cover, while the Silver Falls, Cranberry Meadow Brook, and Stony Brook subwatersheds have higher amounts of agricultural land cover in the riparian area (*Figure 2-9*).

Table 2-8. Land cover composition (by percent) of riparian areas within the Niantic River watershed

Subwatershed	Land Cover Category		
	Developed, Other Grasses, Barren	**Agriculture, Turf & Grass**	**Forest, Wetlands, & Water**
Upper Niantic	22.0%	3.0%	75.0%
Niantic River	39.6%	9.9%	50.5%
Latimer Brook	21.7%	7.4%	70.9%
Cranberry Meadow Brook	9.2%	12.7%	78.1%
Silver Falls	20.7%	12.8%	66.5%
Stony Brook	16.1%	11.1%	72.8%
Oil Mill	16.8%	4.6%	78.6%
Bogue Brook Reservoir	13.2%	2.3%	84.5%
Barnes Reservoir	1.8%	0.3%	97.9%
Watershed Total	**19.4%**	**8.1%**	**72.5%**

[17]Connecticut Department of Environmental Protection. Tidal Wetlands 1990's. 1999. Data available at cteco.uconn.edu/ctmaps/rest/services/Bioscience/Tidal_Wetlands_1990s/MapServer

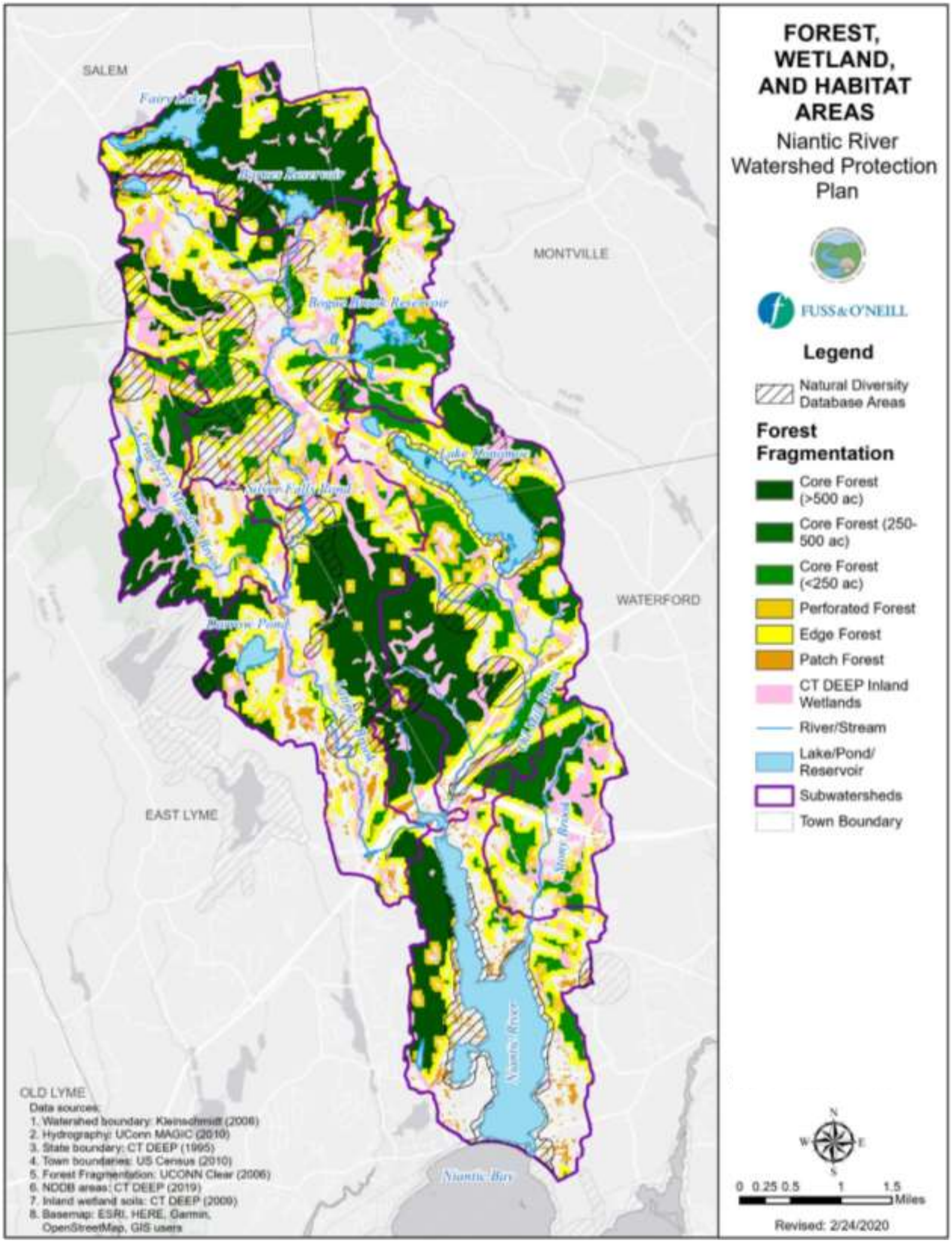

Figure 2.7. Forest, Wetlands, and Habitat Areas Map

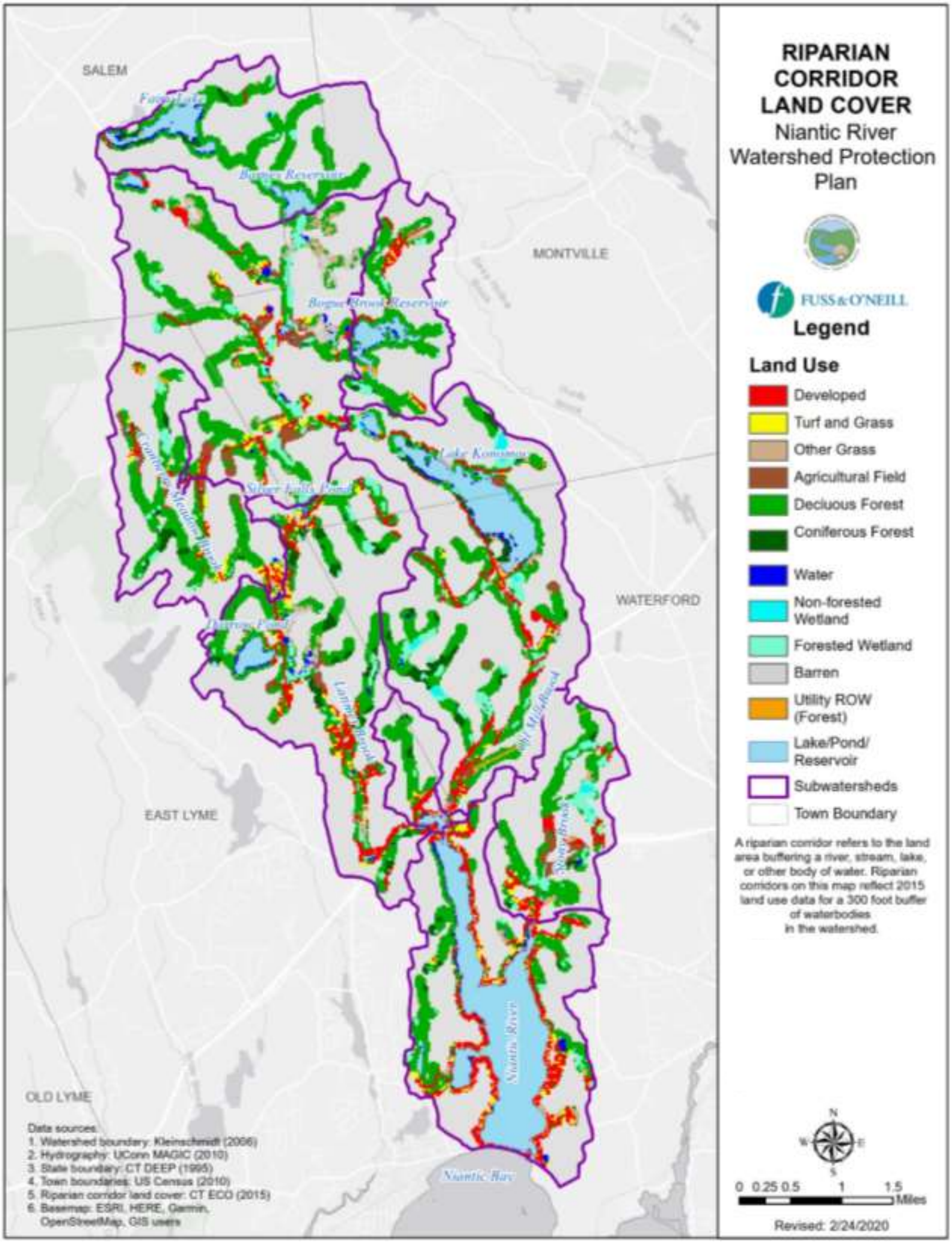

Figure 2-9. Riparian Corridor Land Cover Map

Forests

Forests provides numerous benefits including habitat for terrestrial and aquatic wildlife, improved soil and water quality, improved regional air quality, reductions in stormwater runoff and flooding, and the prevention of stream bank erosion. Large, unfragmented forested areas play a critical role in preserving the natural systems and processes that protect and improve water resources. Urbanization and fragmentation of forestland resulting from land development have been shown to adversely affect stream water quality and ecological health.

Forested land cover varies between 36% and 83% across the subwatersheds within the Niantic River watershed. Core forest, defined as intact forest located over 300 feet from non-forested areas, comprises 38.5% of the overall Niantic River watershed area (core forest includes three types: forest blocks greater than 500 acres, 250-500 acres, and less than 250 acres). Edge forest, which make up the exterior periphery of core forest tracts where they meet with non-forested areas, also accounts for approximately 4% of the area in the watershed. Patch and perforated forest areas, which are highly fragmented and often associated with residential development and subdivisions, account for approximately 23% of the area of the watershed (*Figure 2-8* and *Table 2-9)*.

Table 2-9. Forest land cover composition within the Niantic River watershed

Subwatershed	Forest Type (%)				Total Acres Core Forest
	Patch Forest	Perforated Forest	Edge Forest	Core Forest	
Niantic River	4.2%	11.2%	3.2%	17.5%	**525.5**
Upper Niantic	4.2%	5.9%	3.6%	65.6%	**270.4**
Latimer Brook	4.7%	22.5%	3.5%	37.9%	**1184.6**
Cranberry Meadow Brook	2.1%	19.9%	5.2%	46.1%	**768.6**
Silver Falls	4.2%	28.9%	5.4%	28.8%	**1046.1**
Stony Brook	1.8%	24.5%	4.6%	37.9%	**482.6**
Oil Mill	1.4%	21.5%	5.1%	43.7%	**1612.0**
Bogue Brook Reservoir	0.7%	19.8%	5.6%	46.8%	**504.6**
Barnes Reservoir	1.1%	13.9%	2.6%	65.4%	**1208.4**
Watershed Total	2.9%	20.4%	4.3%	38.5%	**7602.8**

2.8 Water Supply, Wastewater, and Stormwater

Drinking Water Supply

The sources of drinking water in the Niantic River watershed include both groundwater and surface waters. Groundwater drawn from private and public wells supplies residents in all four municipalities in the watershed. Depending on the location within the watershed, many homes rely on private wells drilled into bedrock aquifers for their water supply. In addition, six public wellfields are active in the watershed (*Table 2-10*).

Table 2-10. Public water supply systems in the Niantic River watershed

System Name	Primary Source	Population Served
New London Department of Public Utilities	Surface Water	28,025
East Lyme Water & Sewer Commission	Groundwater	15,245
Waterford Water Pollution Control Authority (WPCA)	Surface Water	16,578
SCWA Montville Division (MTV)*	Groundwater	2,174
Oakdale Heights Association Inc.	Groundwater	876
SCWA Robin Hill Division (RBN)*	Groundwater	388
Crystal Lake Condominiums	Groundwater	184
Oakridge Village*	Groundwater	33

**Mapped supply area is located primarily outside of the Niantic River watershed.*

The watershed aquifers, which are zones of fractured crystalline rock or coarse sand and gravels that store groundwater, are susceptible to contamination. Aquifers can be depleted through overuse. Aquifers can also be disconnected from replenishing rainfall and snowmelt by intensive land use development, which can increase surface runoff and reduce the amount of precipitation that infiltrates into the ground and recharges groundwater levels. As development and the demand for water increases, so does the potential for groundwater contamination, depleted wells, lower river flows, and increased stress on fish and wildlife species that rely on aquatic habitat. To protect major public water supply wells in stratified drift deposits that serve more than 1,000 people, CT DEEP requires water companies to map the boundaries for the area contributing groundwater to their well fields. These areas are called Aquifer Protection Areas (APAs). Municipalities are required, in turn, to delineate APA boundaries on local zoning (or inland wetland) maps and adopt aquifer protection regulations consistent with State regulations which restrict development of certain new land use activities involving hazardous materials and require existing regulated land uses to register and follow best management practices. In East Lyme, 823 acres of the APA "Gorton's Pond A 75" is located within the watershed (*Figure 2-10*). Preserving and protecting groundwater resources in the watershed continues to be a major focus of the watershed communities, NRWC, resource agencies, and other stakeholders.

Public drinking water is sourced from surface waters in a series of reservoirs in the northern part of the watershed: Lake Konomoc (Waterford/Montville), Bogue Brook Reservoir (Montville), Barnes Reservoir (Montville), and Fairy Lake (Salem). The City of New London owns and manages the reservoirs and the protected lands around them; the City is responsible for water treatment and for portions of the distribution system that provide some level of drinking water to all watershed towns. The most extensive distribution systems in the Niantic River watershed are located in the developed areas of East Lyme and Waterford.

In 2018, the Eastern Water Utility Coordinating Committee adopted *Part III: Final Integrated Report* of the Coordinated Water System Plan for the Eastern Public Water Supply Management Area, which includes all town in the Niantic River watershed. The report provides assessments of existing supply sources and projected supply/consumption for 5, 20, and 50 years. Analysis of supply management and related recommendations are intended to serve as a long-term planning tool for the region. Public water supplies operated by the municipalities of East Lyme, Waterford, and New London are discussed in detail. In addition, the report contains management strategies and recommended actions for public water supplies in the Niantic River watershed that are relevant to sustainable management of its water quality and quantity such as streamflow standards and regulations, projected deficits from surface and ground water sources, and developing new supply sources

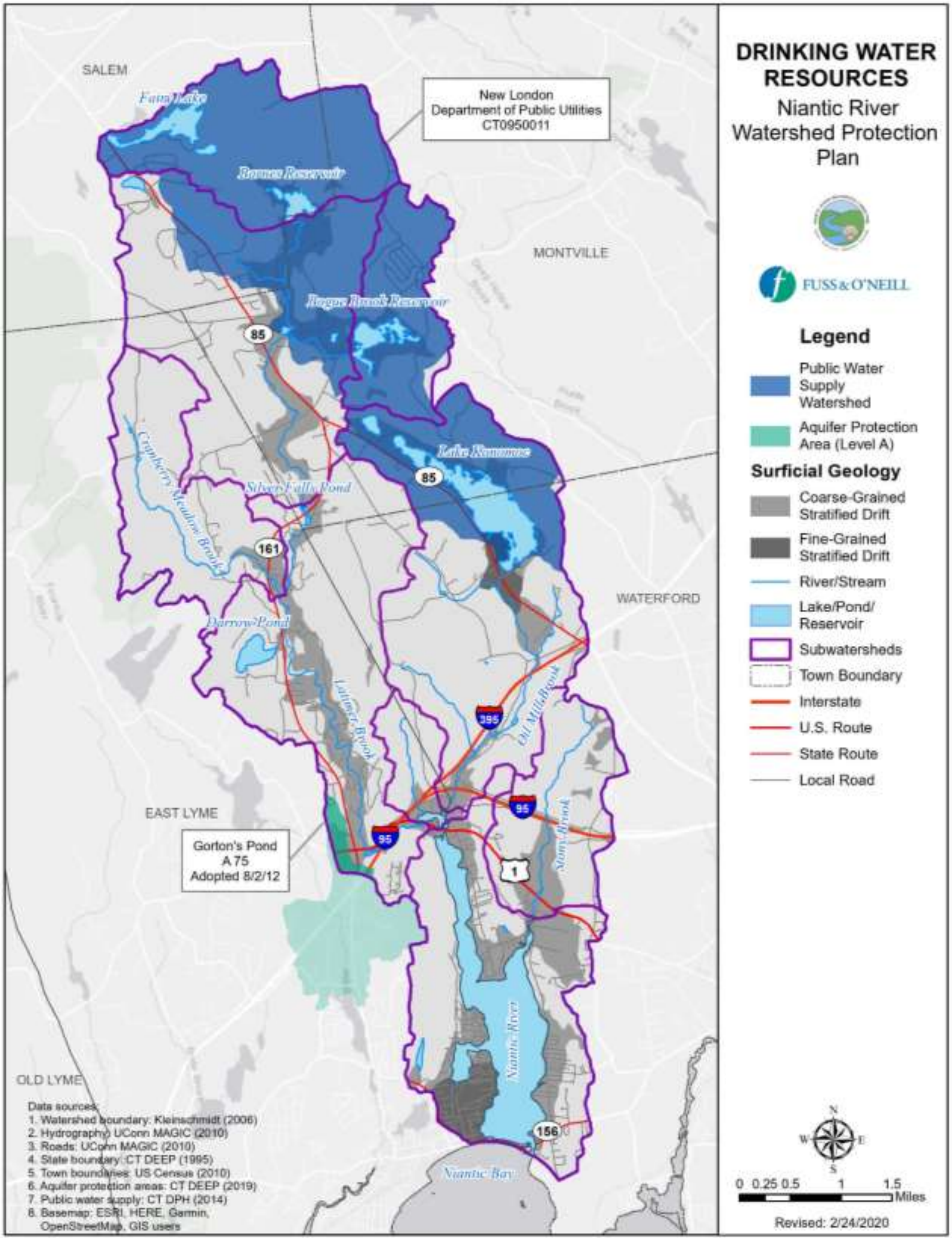

Figure 2.8. Drinking Water Resources Map

Regulated Wastewater Discharges

A relatively small portion of the Niantic River watershed is served by sanitary sewers (*Figure 2-11*). Sewer service areas have been constructed primarily in parts of the commercial/residential development south of the Interstate 95 corridor. No wastewater treatment facilities operate in the watershed. Instead, sanitary sewers in East Lyme and Waterford convey sewage to the New London Wastewater Treatment Facility under an agreement dated January 10, 1991.[18] It is expected that wastewater volumes will increase with proposed expanded service in the Niantic River watershed and projects underway in Old Lyme. Such expansions increase the net water export of water from the watershed.

The majority of the Niantic River watershed is served by private onsite subsurface sewage disposal systems, most of which are conventional septic systems. Larger subsurface disposal systems typically serve apartments, condominiums, restaurants, and other commercial buildings. Subsurface disposal systems that are properly designed, installed, and maintained provide a safe and efficient way of disposing domestic sewage. Failing or older, sub-standard systems can impact surface water and groundwater quality and can expose the public to untreated sewage and be a source of bacteria, pathogens, and nutrients to the Niantic River and other surface waterbodies. Even when properly installed, conventional septic systems do not adequately treat nitrogen, which can be a problem in fast draining coastal soils. A higher degree of treatment can be achieved in coastal communities with advanced septic systems; system design and efficacy are being evaluated by the Laboratory of Soil Ecology and Microbiology and the New England Onsite Wastewater Training Program, both at the University of Rhode Island.[19] Certain coastal areas have been designated by the state of Rhode Island as Critical Resource Areas, where new or replacement septic systems are require to reduce nitrogen in wastewater by 50% or more (as compared to a conventional system).[20] At this time, related agencies in the state of Connecticut do not have a methodology in place to approve the installation of nitrogen-treating systems or require their installation in sensitive areas.

Septic systems with design flows of 7,500 gallons per day (GPD) and less are under the jurisdiction of Connecticut Department of Public Health (CT DPH) and the Local Directors of Health. The towns of East Lyme and Waterford are part of the Ledge Light Health District (LLHD), and the towns of Salem and Montville fall under the jurisdiction of Uncas Health District (UHD). In general, systems of this size are permitted by local health directors and health districts, a process which includes: permit issuance, site investigation, plan review, approval to construct, system inspection, approval to discharge and enforcement of all newly constructed, repaired, altered or extended systems. Plans for large septic systems serving buildings with design flows of 2,000 to 7,500 GPD must be approved by CT DPH. The regulated discharge of subsurface sewage disposal has been permitted at four locations in the watershed (*Figure 2-11*). Disposal systems on sites with design flows exceeding 7,500 GPD, alternative sewage disposal systems, and community sewage systems are under the jurisdiction of CT DEEP.

Communications with the LLHD found that approximately 590 septic permits were issued since 2004 to Waterford/East Lyme addresses in the Niantic River watershed, though the applicant's reason for applying for a permit (e.g., repair, failure, expansion) could not be determined; similar data was not available for Salem or Montville. It can be assumed that older residential neighborhoods with poor soils are most likely to experience failure or have substandard performance, and such systems in close proximity to rivers and streams can potentially impact surface water quality. Subsurface systems that serve apartment complexes, condos, and commercial businesses in the watershed are a potentially more significant source of water quality impacts.

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[18] Milone & MacBroom, Inc. 2019. Regional Wastewater Management Plan. 200 pages. Prepared for the Southeastern CT Council of Governments.

[19] Lancellotti, B.V., G. Loomis, K. Hoyt, E. Avizinis, and J.A. Amador. 2017. Evaluation of Nitrogen Concentration in Final Effluent of Advanced Nitrogen-Removal Onsite Wastewater Treatment Systems (OWTS). *Water, Air & Soil Pollution* 228:383-298.

[20] Rhode Island Department of Environmental Management, Office of Water Resources. 2010. Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems, 123 pages.

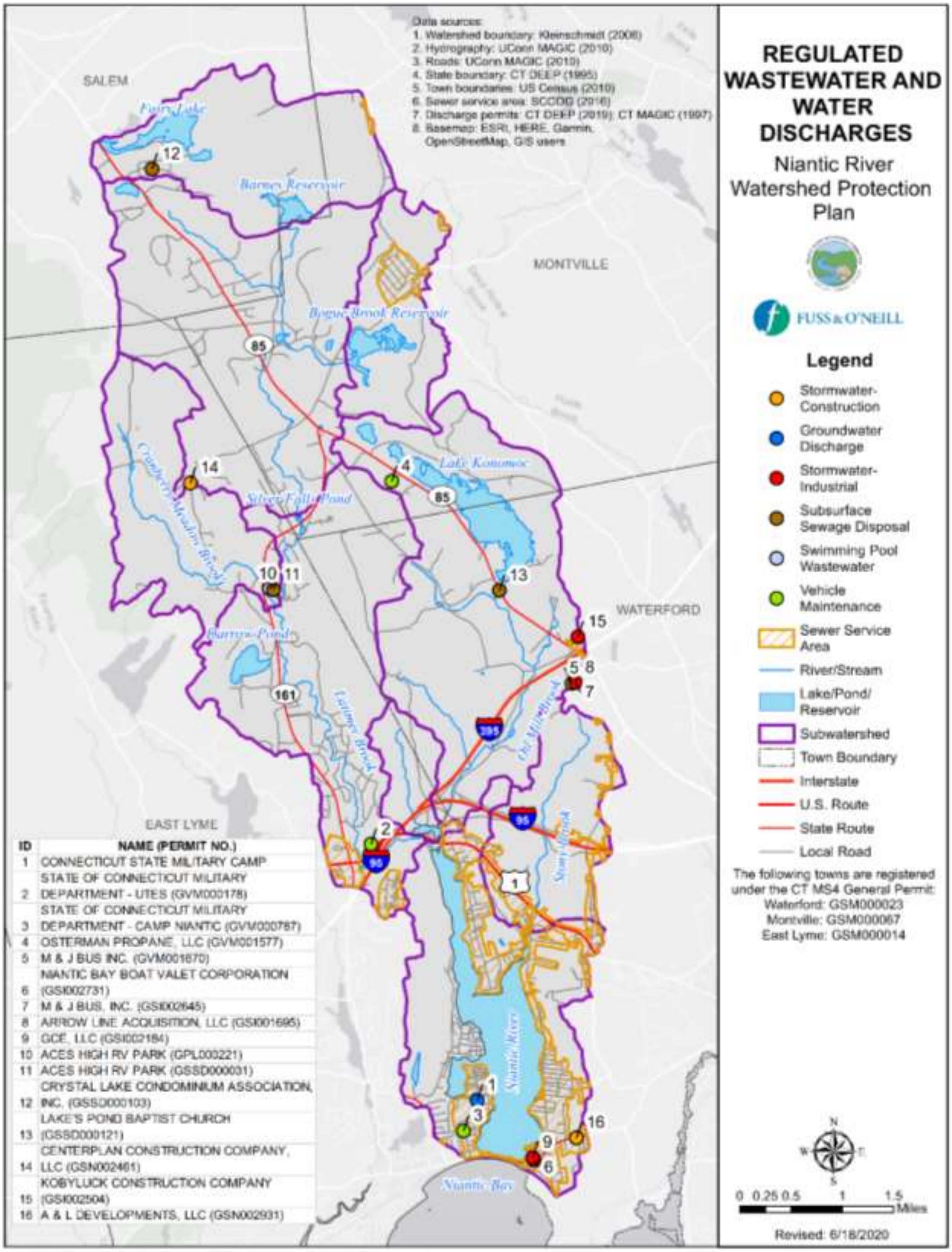

Figure 2.8. Regulated Wastewater and Water Discharges Map

Facilities with new or existing subsurface systems (>7,500 GPD) are required to obtain a CT DEEP permit, which requires oversite/maintenance of the system by the facility owner. If the facility owner does not operate or maintain the system in accordance with their permit, there may be a delay in action by CT DEEP due to limited State resources for inspection and enforcement, which could increase the water quality impact.

Figure 2-11 depicts the locations of regulated wastewater and water discharges within the watershed that could potentially contribute bacteria, nutrients, and other pollutants. These include discharges from institutional, industrial and commercial facilities in the watershed, subsurface sewage disposal systems permitted by CT DEEP, and regulated stormwater discharges, described in more detail below.

Regulated Stormwater Discharges

Three of the municipalities within the watershed – East Lyme, Waterford, and Montville – are regulated under the CT DEEP General Permit for the Discharge of Small Municipal Separate Storm Sewer Systems (MS4 Permit). The revised MS4 Permit applies to all municipalities that have at least 1,000 people within an "Urbanized Area" (Urbanized Areas are determined based on the 2010 U.S. Census). Communities subject to the MS4 Permit are required to develop, implement and enforce stormwater management plans centered around six minimum control measures, including: public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management in new development or redevelopment, and good housekeeping and pollution prevention. The last two measures include requirements to consider and utilize Low Impact Development (LID) measures to reduce or disconnect impervious cover to infiltrate more runoff on site. The MS4 Permit also requires municipalities to address the source(s) of stormwater pollutants contributing to impaired waters. For example, in this case, it means that the three regulated MS4 communities in the watershed need to implement Best Management Practices (BMPs) that focus on reducing bacteria and nutrient loads to the impaired segments of Latimer Brook and the Niantic River. The Connecticut Department of Transportation is also required to address the quality of stormwater discharges from the state transportation system in the watershed through compliance with its own MS4 Permit, which became effective in July 2019.

Other regulated stormwater discharges in the watershed include industrial facilities that are registered under the CT DEEP General Permit for the Discharge of Stormwater Associated with Industrial Activity ("Industrial General Permit") and commercial facilities registered under the CT DEEP General Permit for the Discharge of Stormwater Associated with Commercial Activity ("Commercial General Permit"). The Industrial General Permit regulates industrial facilities with point source stormwater discharges that are engaged in specific activities according to their Standard Industrial Classification code, while the Commercial General Permit requires operators of large paved commercial sites such as malls, movie theaters, and supermarkets to undertake actions such as parking lot sweeping and catch basin cleaning to keep stormwater clean before it reaches waterbodies. Construction activities in the watershed are also potentially subject to the CT DEEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities ("Construction General Permit"), which requires developers and builders to implement a Stormwater Pollution Control Plan to prevent the movement of sediment from construction sites and to address impacts of stormwater discharges from a project after construction is complete.

2.9 Emerging Issues

Since 2006, the range of issues affecting the Niantic River watershed and its communities has evolved. A primary task in developing this plan update was to identify stressors impacting the watershed that were not apparent or prominent 14 years ago when the NRWPP was developed. The most pressing new challenges have resulted in impacts to the watershed that fall into one of two categories: climate change and hydro-modification.

Climate Change

Air Temperature

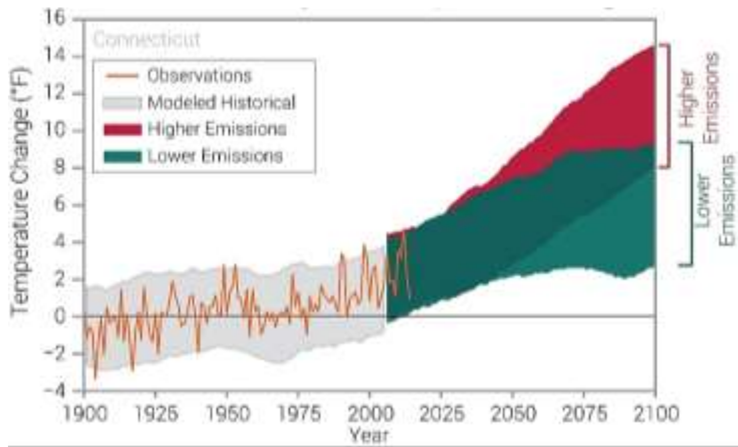

Figure 2.9. Observed and projected changes in near-surface air temperature in Connecticut. Observations 1900-2014, projections are 2006-2100 (Source: NOAA, State Climate Summaries, 2017).

Since 1900, air temperatures in Connecticut have increased about 3° F, and projections for the best-case scenarios for future emissions of greenhouse gasses show that average annual temperatures are likely to exceed historical record level by 2050. Under a high-emissions scenario, average temperatures by 2100 could increase 8-12°F above historical levels in winter and 6-14°F in summer (*Figure 2-12*). Under a low-emissions scenario increases would be about half as much (NECIA, 2006).[21] The increase is part of larger shift in climactic patterns; heat waves and drought episodes are expected to become more intense, and the intensity of cold waves is projected to decrease.[22] Warming air temperatures cause or in some way influence most of the impacts that stress species and their habitats. In the Niantic River watershed, the synthesis and analysis of research data from the Niantic River Estuary, conducted by Dr. Jamie Vaudrey (Department of Marine Sciences, University of Connecticut) and her co-authors, found that summer annual air temperature is the most powerful individual indicator to explain the variability in eelgrass health.[23] Warming summer air temperatures have also resulted in higher rates of evaporation from freshwater waterbodies, such as reservoirs, and evapotranspiration from natural vegetation and agricultural crops. Research shows that changes in species' population densities, local distributions, and behaviors (e.g., migration) are correlated to rising air temperatures.

Water Temperature

Temperatures and conditions in the Niantic River Estuary and Niantic Bay have been monitored since 1976 by MEL, and higher summer temperatures are known to impact populations of marine vertebrates, shellfish and other aquatic species, and habitat-creating species such as eelgrass (2006 NRWPP; Vaudrey et al, 2019). Higher temperatures are also directly correlated to the extent and severity of harmful algal blooms, whose decomposition depletes dissolved oxygen.[24] These monitoring programs were established in the response to declining fisheries/shellfishing in the region, and as a condition for utilizing water for cooling at the Millstone Power Station in Waterford. Since 2006, more attention is being given to the temperature of freshwater systems, particularly streams that do support or historically have supported native cold-water fish species, such as brook trout. Since

[21] Climate change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment, Cambridge, MA. Union of Concerned Scientists, 2006.

[22] Runkle, J., K. Kunkel, S. Champion, D. Easterling, B. Stewart, R. Frankson, and W. Sweet, 2017: Connecticut State Climate Summary. *NOAA Technical Report NESDIS 149-CT,* 2017.

[23] Vaudrey, J.M.P., Krumholz, J., Calabretta, C. 2019. [Eelgrass success in Niantic River Estuary, CT: quantifying factors influencing interannual variability of eelgrass (Zostera marina) using a 30-year dataset]. University of Connecticut, Department of Marine Sciences, Groton, CT. Final report prepared for the Niantic Nitrogen Work Group.

[24] Gobler, Christopher J., et al. 2017. "Ocean warming since 1982 has expanded the niche of toxic algal blooms in the North Atlantic and North Pacific oceans." *Proceedings of the National Academy of Sciences* 114, no.19. Pages 4975-4980.

2012, NRWC has been collecting a range of water quality data in Cranberry Meadow Brook and Latimer Brook. As a result of a fisheries survey conducted by CT DEEP in 2013, NRWC collected stream temperature data in 2017 in partnership with CT DEEP. From this data, it was CT DEEP's determination that Latimer Brook no longer supports cold water fish species. It is important to note that increasing water temperatures also result from warm stormwater entering the Estuary and tributaries via outfalls or direct runoff. Elevated water temperatures resulting from stormwater is a type of NPS pollution and is a distinct environmental stressor from warmer surface water caused by climate change.

Ocean Acidification

While the natural acidity of water is fairly neutral, including saltwater, warmer water can absorb greater amounts of carbon dioxide (CO_2), one of the most abundant greenhouse gases. The steady increase in absorbed CO_2 creates a chemical imbalance by lowering pH, or acidifying, our oceans. Acidification threatens all marine species, but shellfish and crustaceans (crabs, lobsters) are particularly at risk because acidification hinders their development of a healthy external shell. Other negative feedback loops exist that intensify the risks to native marine species and complicate prevention/management strategies. For example, the influx of nutrients like nitrogen into the ocean lead to further acidification and intensify harmful algal blooms, which release more carbon and deplete more oxygen upon decomposing. Hypoxia events have occurred repeatedly in the upper Estuary and bottom waters of the Niantic River.

Sea Level Rise

Sea Level Rise (SLR) has the potential to impact the water quality in the Niantic River watershed. For example, SLR can elevate the water table in coastal areas and reduce effective treatment of wastewater by septic systems. In addition, the intrusion of brackish water and more regular inundation/flooding will force transitions in plant species inhabiting fresh tidal wetlands, salt marsh, and other costal zones. Increased water levels in the Estuary and other coastal areas will also affect management planning and action prioritization that closely relate to sustainable watershed management (infrastructure, land use planning, fisheries/shellfish, recreation). A main goal of this document is to provide a comprehensive update of watershed conditions, and so, going forward, understanding the current and projected impacts of SLR will be fundamental to developing the most informed strategies and appropriate actions for protecting the watershed's natural resources and the communities who rely on them. The State of Connecticut has adopted a "planning threshold" of 20 inches for SLR above 2001 levels by 2050 (*Figure 2-13*).[25]

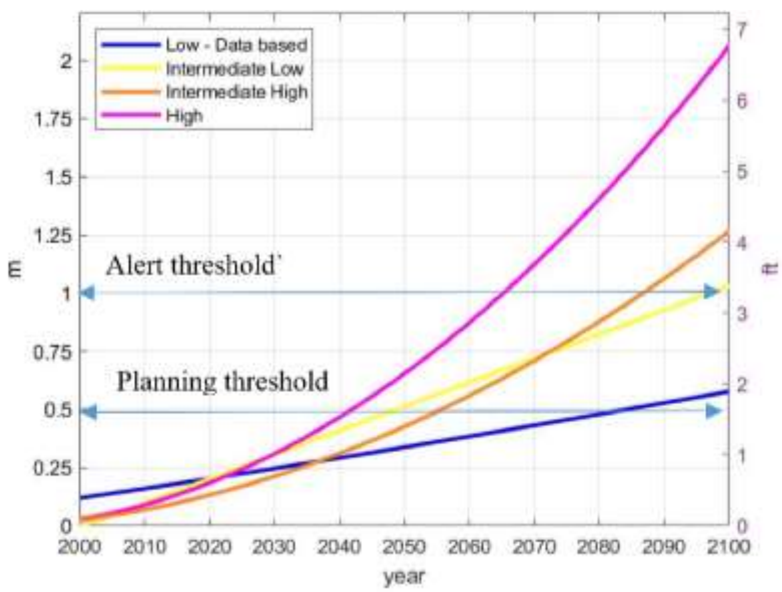

Figure 2.9. Connecticut SLR Projections, from Sea Level Rise in Connecticut, Final Report February 2019 (O'Donnell, 2019).

[25] O'Donnell, J. 2019. *Sea Level Rise in Connecticut Final Report February 2019.* Dept. of Marine Sciences and CT Institute for Resilience and Climate Adaptation, University of Connecticut. 28 pages.

As sea levels continue to rise, the frequency of regular flooding at high tides and event-based flooding will increase. In addition to the damage to property and transportation infrastructure (road/highways, railroads), coastal flooding can impact water quality by degrading or disrupting water-related infrastructure: public and private wellfields for drinking water, stormwater management systems, and sanitary sewers. Receding floodwaters then carry pollutants back into Long Island Sound and its embayments. Lower intensity flooding at regular intervals, which is already taking place in the region, has the same effect and introduces a new chronic source of NPS pollution to be investigated.

Climate adaptation and resiliency planning in the watershed is underway. Managers and residents in coastal communities can access flood projection maps, data, and planning recommendations from several federal and state agencies. The towns of Waterford and East Lyme have completed studies (2015[26] and 2018,[27] respectively) to assess vulnerabilities and develop climate resiliency plans. SCCOG has developed and compiled a range of tools to assess flood hazards and mitigating actions. It is important that the plans and tools themselves are assessed over time, as climate research leads to revised conclusions and projections for the region.

Increased Precipitation/Flooding

The total amount of precipitation and the frequency of heavy precipitation events has risen in the Northeast. Between 1958 and 2012, the Northeast saw more than a 70% increase in the amount of rainfall measured during heavy precipitation events, more than in any other region in the United States.[28] Projections indicate intense precipitation events will continue and have the potential to cause more inland floods, particularly in valleys where people, infrastructure, and agriculture tend to be concentrated. This impact can be more prominent in developed areas with higher percentages of impervious cover (i.e., less area for infiltration) or near channelized streams. In addition, increased freshwater volumes will impact saltwater species downstream in the Estuary and Niantic Bay that require specific levels in salinity (e.g., eelgrass, shellfish).

Hydro-modification

Hydro-modification refers to changes in streamflow that result from alterations to the natural physical and hydrological characteristics and processes in and around a stream. The most common alterations are channel modification and channelization, in which a stream channel is straightened, deepened, or otherwise modified to control flow in developed areas or for certain purposes (drainage, agricultural, navigation, etc.). Other forms of this type of hydro-modification[29] are:

- *Widening, deepening of channel* – manipulate width or depth variable to increase channel capacity
- *Stream relocation* – move streams, such as to the property edge to maximize land availability
- *Decreasing channel length* – reduce natural stream meanders to maximize land availability and facilitate development
- *Headwater stream and wetlands fills* – fill all or parts of headwater streams and small wetlands, route runoff into detention ponds or into ditches
- *Straightening* – steepen the gradients to increase the flow velocity
- *Levee construction* – confine floodwaters by raising the height of the channel banks

[26] Stantec. 2018. *Coastal Resilience, Climate Adaptation, and Sustainability Study*. 37 pages. Prepared for the Town of East Lyme.
[27] Kleinfelder Northeast, Inc. 2017. *Climate Change risk Vulnerability, Risk Assessment and Adaptation Study*. 119 pages. Prepared for the Town of Waterford.
[28] U.S. Global Change Research Program. Walsh, J. et *al. Chapter 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment.* Pages 19-67.
[29] Department of Natural Resources. 2000. *Ohio Coastal Nonpoint Pollution Control Program Plan*. Page 7-2.

- *Bank stabilization* – use structures and hard engineering (e.g., gabions, riprap, steel piles) to control bank erosion
- *Clearing and snagging* – remove obstructions to decrease resistance and increase flow velocity
- *Riparian encroachment* – clear banks of trees and natural vegetation
- *Bridge construction* – construct crossings that constrict flow or require structures in the river that change the flow pattern or channel slope
- *Culverting* – construct crossings with round-pipe or box culverts that constrict flow or alter stream bottom substrate and banks
- *Draining, filling* – remove water from wetlands to provide faster delivery to the river system and/or to maximize land availability

These re-engineering practices simplify habitat by removing the sinuosity and physical diversity of the channel and by preventing the further development of critical habitat types (e.g. pools, spawning gravels). Negative impacts on biological communities due to habitat simplification may occur not only within channelized reaches but at substantial distances downstream. They also disrupt the equilibrium of erosion-deposition dynamics, which increases the likelihood of more severe erosion, channel destabilization, and property loss to downstream areas. Higher stream velocity shortens the residence time during which a steam's biochemical processes may remove excess nutrients.

Hydro-modification also accounts for changes to the stream's flow itself. Flow alterations include diversions, withdrawals, and impoundments that result in an increase or a decrease downstream in the usual freshwater supply to a stream or estuary. Such decreases in supply tend to be more common and have significant, long-term impacts to aquatic species in stream habitats. Reduced natural flow amplifies the stress on species from water temperature, predation, and surviving naturally-occurring low flow episodes, typical in late summer and fall (which may be in addition to other stresses from channel modification, stormwater runoff, etc.). Further, reduced stream flows are directly related to increases in the concentration of excess nutrients, total suspended solids, and other NPS pollutants. In 2011, Stream Flow Standards and Regulations[30] were adopted to protect the ecological health of rivers and streams by establishing minimum flow standards for each of the four classes of rivers and streams:

- Class 1 - free flowing, priority given to protecting ecological health
- Class 2 - minimally altered free flowing stream system
- Class 3 - moderately altered, have intermediate balance points between ecological and human uses
- Class 4 - substantially altered, priority is given to human uses

Nearly all of Latimer Brook is classified as Class 1,[31] defined in Section 26-141b-4(a) of the Stream Flow Standards and Regulations as a stream that "shall exhibit, at all times, the depth, volume, velocity, and variation of stream flow and water levels necessary to support and maintain habitat conditions supportive of an aquatic, biological community characteristic of that typically present in free-flowing river or stream systems of similar size and geomorphic characteristics under the prevailing climactic conditions." South of the dam impounding Beckwith Pond in Montville, two segments of Latimer Brook totaling approximately 0.5 mile are classified as Class 3. This is defined as a stream that is "moderately altered form that typically present in free-flowing rivers or steams…"[32] For Class 3 streams, baseline seasonal flow standards have been established.

[30] CT DEEP. 2011. *Streamflow Standards and Regulations*. Inclusive Sections § 26-141b-1—26-141b-8.
[31] CT DEEP. 2019. Map of Final Adopted Stream Flow Classifications, available at portal.ct.gov/DEEP/Water/Stream-Flow-Standards/Connecticut-Stream-Flow-Standards
[32] CT DEEP. 2011. *Streamflow Standards and Regulations*. Inclusive Sections § 26-141b-1—26-141b-8.

3 Management Recommendations

The primary goals of the Niantic River Watershed Protection Plan Update (watershed plan) are as follows:

- Establish an up-to-date baseline of water quality and land use conditions in the watershed
- Evaluate contributing factors in areas of known impairments
- Identify water quality monitoring needs to support plan implementation
- Establish community buy-in through public engagement in the planning process
- Identify and prioritize actions to reduce pollutant inputs to impaired rivers and streams
- Incorporate proactive measures to protect/maintain high quality streams.

This section describes recommended actions to achieve these goals. The recommendations include watershed-wide and targeted actions:

- **Watershed-wide Recommendations** are recommendations that can be implemented throughout the Niantic River watershed. These basic measures can be implemented in most areas of the watershed and are intended to address nonpoint source pollution. The water quality benefits of these measures are primarily long-term and cumulative in nature resulting from runoff reduction, source control, pollution prevention, and improved stormwater management.

- **Targeted Recommendations** include site-specific projects and/or actions intended to address issues within specific subwatershed or drainage areas, rather than watershed-wide. Targeted recommendations also include actions to address common types of problems that are identified at representative locations throughout the watershed, but where additional field assessments or evaluations are required to develop site-specific recommendations. Targeted recommendations can have both short- and long-term benefits.

The recommendations presented in this section are classified according to their timeframe and implementation priority. Recommendations include ongoing, short-term, mid-term, and long-term actions:

- **Ongoing Actions** are actions that should occur annually or more frequently such as routine water quality monitoring, fundraising, and education and outreach.

- **Short-Term Actions** are initial actions to be accomplished within the first two years of plan implementation. These actions have the potential to demonstrate immediate progress and success and/or help establish the framework for implementing subsequent plan recommendations.

- **Medium-Term Actions** involve continued programmatic and operational measures, delivery of educational and outreach materials, and construction of larger retrofit and/or restoration projects between two and five years after plan adoption.

- **Long-Term Actions** consist of continued implementation of watershed projects, as well as an evaluation of progress, accounting of successes and lessons learned, and an update of the watershed management plan. Long-term actions are intended to be completed between five and ten years or longer after plan adoption. The feasibility of long-term actions, many of which involve significant infrastructure improvements, depends upon the availability of sustainable funding or financing mechanisms.

As discussed in *Section 1*, this watershed plan is a *guidance* document that seeks to address surface water quality impairments and related water resource issues within the Niantic River watershed. Unless identified as a required action under an existing local, state or federal regulation or permit, the recommendations in this plan for specific projects/actions are intended to be *voluntary* undertakings, carried out with willing, cooperative partners, working together to protect and improve water quality. The plan identifies potential partners and funding sources to assist with achieving the recommendations presented herein. While some potential funding sources for specific management measures are suggested in the subsections and associated tables that follow, a more extensive list of potential funding opportunities is provided in *Appendix F*.

3.1 Capacity Building

The success of any watershed based plan depends on effective leadership, active participation by the watershed stakeholders, and local "buy-in" of the plan recommendations by the watershed communities, in addition to funding and technical assistance. Fortunately, significant local support and "capacity" for watershed protection and restoration already exists within the Niantic River watershed, through the leadership of the Niantic River Watershed Committee, the four watershed towns, and other stakeholders. Strengthening local capacity for implementing this watershed plan, by building on the existing network of volunteers and programs, is a critical and ongoing part of the watershed plan implementation process. *Table 3-1* summarizes capacity building recommendations, which are described below in greater detail.

3.1.1 Support Management Framework and Lead Entity

Recommended Actions

- The Niantic River watershed currently benefits from watershed management coordination and project implementation by the Niantic River Watershed Committee (NRWC). Comprised of volunteers from the four watershed towns, NRWC includes shellfish and harbor management commissioners, municipal staff and land-use board members, and environmental professionals. In addition, a CT DEEP (non-voting) *ex officio* representative fills an important two-way advisory role to and for the Committee, bringing Committee goals, achievements, and concerns to the appropriate DEEP divisions and staff, while highlighting priorities that advance the state agency mission and work plans. In pursuit of its mission to restore and preserve the Niantic River and its tributaries to fully support all uses, NRWC should:
    - Continue to manage efforts and pursue opportunities to build their capacity through new or expanded partnerships, programs, and implementations
    - Maintain support for the Watershed Coordinator staff person and pursue funding to support and expand their role
    - Develop and implement work plans according to the recommendations of adopted watershed planning documents
    - Form new implementation sub-committees and manage existing ones according to plan of work and the watershed plan goals
    - Develop educational materials, campaigns, and public events with a primary goal of creating regular and ongoing outreach opportunities to inform the public and/or gain their input on watershed management

- The Watershed Coordinator position, currently funded for 20 hours/month, should be tasked with leading implementation activities such as:
    - Identifying funding sources, as well as pursuing grant funding for projects
    - Periodically reviewing and updating action items in the plan

  - Developing annual work plans (i.e., specific "to-do" lists)
  - Coordinating and leading outreach activities
  - Hosting public meetings to celebrate accomplishments, recognize participants, review lessons learned, and solicit feedback on plan updates and next steps
  - Maintaining and updating the website www.nianticriverwatershed.org to serve as a centralized source of information on the watershed and implementation activities

- Stakeholders should use the recommendations in this Plan Update as a springboard to stimulate participation in watershed management planning activities (project planning, development, and implementation). Stakeholders should:
  - Formalize the watershed agreement. Have municipal leaders from the four watershed towns formally endorse the Plan Update to renew their support of watershed planning efforts through funding, staff, or other resources. Like the Niantic River Watershed Compact (see *Section 1.2*), endorsement of the Plan Update by the watershed municipalities is an important first step in implementing its recommendations.
  - Participate in existing implementation sub-committees and form new ones around the watershed plan goals – water quality, habitat restoration, land use/open space, coastal issues, and education/outreach. The sub-committees should ideally consist of volunteers with a particular interest or area of expertise in each topic.

3.1.2 Promote Inter-Municipal Coordination

Many of the recommendations in this plan will benefit from a partnership among the watershed municipalities. For example, applying jointly for grants to fund the implementation of these activities allows the sharing of grant-writing assistance, and the leveraging of match and in-kind services. Additionally, a watershed partnership permits the sharing of technical and human resources, volunteers, equipment, and materials. Endorsement of the watershed plan by the watershed municipalities is an important first step in implementing the plan recommendations.

Recommended Actions

- The Niantic River Watershed Committee should seek endorsement of the watershed Plan Update, similar to the endorsement of the 2006 NRWPP with the Niantic River Watershed Compact (*Section 1.2*) or a similar mechanism. Such an endorsement will encourage inter-municipal coordination and accountability and formalize the municipalities' agreement to support implementation of the watershed plan through funding, staff, or other resources.

3.1.3 Promote Regional Collaboration

Many watershed organizations and municipalities in Connecticut are involved in watershed management planning to meet common resource protection objectives and are faced with similar water quality issues. Lessons learned from other watershed planning efforts in Connecticut and throughout Long Island Sound can help to improve the effectiveness of this watershed plan. This objective is to coordinate water quality planning with other watershed groups to share ideas and strengthen regional watershed management efforts.

Increasingly, neighborhood groups with focuses and missions that are not specifically environmentally-focused are recognizing the synergies between their goals and watershed and ecosystem health. Pursuing partnerships with these organizations can greatly expand the scope and reach of watershed management efforts.

Table 3-1. Capacity building recommendations

Actions & Milestones	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue to support NRWC activities and projects, including a dedicated Watershed Coordinator position	NRWC	Ongoing	• Funded Watershed Coordinator position	$$$	Grant funding
2. Obtain endorsement of the watershed Plan Update by municipal leaders in the four watershed towns	NRWC Coordinator	0-1 year	• Niantic River Watershed Compact or similar mechanism	$	
3. Engage and involve local, state, and regional organizations. Promote grassroots involvement.	NRWC	Ongoing	• Active participation in watershed plan activities by organizations	$	
4. Identify and pursue funding • Review and prioritize funding sources • Prepare and submit grant applications	NRWC Coordinator, ECCD, other local stakeholders municipalities	Ongoing	• List of funding sources and funding pursued	$$	See Section 6 and Appendix F of this plan for funding sources

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee

Recommended Actions

- Engage and involve the following local, state, and regional organizations with an interest in the Niantic River watershed and other neighboring regional watershed initiatives. These groups should work together to implement this plan. Implementation is most effective when municipalities work together with volunteers and local stewards (i.e., grassroots involvement).
    - Niantic River Watershed Committee
    - Municipalities in the watershed: East Lyme, Montville, Salem, Waterford (and New London, as owner/manager of Public Water Supply Areas in the watershed)
    - U.S. Environmental Protection Agency, Region 1
    - U.S. Department of Agriculture – Natural Resources Conservation Service
    - U.S. Geological Survey
    - Long Island Sound Study
    - University of Connecticut – Center for Land Use Education and Research
    - Connecticut Department of Energy and Environmental Protection
    - Connecticut Department of Agriculture/Bureau of Aquaculture (CT DA/BA)
    - Connecticut Department of Transportation
    - Southeastern Connecticut Council of Governments
    - Save the Sound
    - Eastern Connecticut Conservation District
    - Waterford-East Lyme Shellfish Commission
    - Save the River – Save the Hills
    - Friends of the Oswegatchie Hills Nature Preserve
    - Salem Land Trust
    - Waterford Land Trust
    - East Lyme Land Trust
    - New England Forestry Foundation
    - Connecticut Audubon Society
    - Avalonia Land Conservancy
    - Dominion Energy
    - Rivers Alliance of Connecticut

3.1.4 Identify and Pursue Funding

Many actions in this plan are only achievable with sufficient funding and staffing. A variety of funding opportunities should be pursued to implement the recommendations outlined in this plan.

Recommended Actions

- Review and prioritize potential funding sources that have been preliminarily identified in this watershed plan (see *Section 6*).
- Prepare and submit grant applications for projects identified in this plan on an ongoing basis.
- Pursue funding for ongoing, long-term water quality monitoring within the watershed.
- Advocate for state and federal funding, working jointly with other watershed organizations in the region and state.

3.2 Stormwater and Nonpoint Source Runoff

Stormwater, whether discharged directly to a waterbody or to a storm drainage system, is the most widespread and one of the top contributors of NPS pollution in the Niantic River watershed. This issue has been identified by stakeholders since the outset of the watershed's management, and many projects have been implemented to mitigate impacts, educate communities, and retrofit existing storm drainage systems with treatment practices. Nevertheless, additional improvements are needed to address a range of factors that allow untreated stormwater to enter the Estuary and its tributaries. Reducing untreated stormwater should include, but is not limited to, updating land use regulations and other policies, evaluating existing and new stormwater systems for treatment practices, and expanding outreach through targeted and watershed-wide campaigns. To maximize success and resources, these efforts should be coupled with water quality monitoring (*Section 3.7*) to prioritize projects and evaluate the outcomes of implemented programs and treatment practices.

A number of tools and resources are available to stakeholders to effectively reduce the impacts of stormwater on water quality. The following recommendations are organized into topics that vary in their scope (targeted vs. watershed-wide) and how they are implemented (on-the-ground projects, regulatory/planning, outreach).

3.2.1 Green Infrastructure and Low Impact Development

Green infrastructure (GI) and Low Impact Development (LID) refer to systems and practices that reduce runoff through the use of vegetation, soils, and natural processes to manage and cleanse water and create healthier urban and suburban environments (EPA, 2014). GI/LID includes stormwater management practices such as rain gardens, permeable pavement, green and blue roofs, green streets, infiltration planters, trees wells and tree box filters, and rainwater harvesting. These practices capture, filter, manage, and/or reuse rainfall close to where it falls, to remove pollutants, reduce stormwater runoff volume, recharge ground water supplies, and control flows to receiving surface waters. GI/LID practices can remove bacteria in stormwater through filtration, sedimentation, and inactivation by exposure to sunlight. GI/LID practices can also remove nitrogen in stormwater runoff through treatment mechanisms involving vegetation and soil.

Green Infrastructure (GI) is defined as the natural and man-made landscapes and features that can be used to manage runoff. Examples of natural green infrastructure include forests, meadows and floodplains. Examples of man-made green infrastructure include green roofs, rain gardens and rainwater cisterns.

Low Impact Development (LID) is a land development approach intended to reduce development related impacts on water resources through the use of small-scale stormwater management practices that rely on vegetation and soils.

In addition to reducing runoff and improving water quality, GI/LID has been shown to provide other social and economic benefits such as reduced energy consumption, decreased urban heat island effects, better air quality, increased carbon reduction and sequestration, higher property values, new recreational opportunities, improved economic vitality, greater adaptation to climate change, and enhanced human health and well-being (Center for Neighborhood Technology and American Rivers, 2010; EPA Green Infrastructure Website http://water.epa.gov/infrastructure/greeninfrastructure/gi_why.cfm; Oregon Health and Outdoors Initiative, 2018). For these reasons, many communities are exploring the use of and are adopting GI/LID within their municipal infrastructure programs.

Although conventional stormwater drainage systems are prevalent in the more developed areas of the watershed, several examples of GI/LID stormwater treatment practices exist in the watershed. An example is the installation of tree wells in Downtown Niantic and along Colony Road, both in East Lyme.

As with all stormwater management practices, regular maintenance is required for the successful operation of GI/LID practices. Accumulated sediment and debris can reduce treatment effectiveness, hydraulic performance, and infiltration capacity. Some GI/LID practices such as infiltration and bioretention systems require more intensive or frequent maintenance. Below-ground practices such as subsurface infiltration systems are generally more susceptible to maintenance issues, as compared to surface practices such as bioretention systems, swales, and surface infiltration basins, since subsurface practices are less visible and may suffer from an "out-of-sight, out-of-mind" mentality by property owners.

There are additional opportunities for GI/LID practices throughout the Niantic River watershed, though the opportunities vary depending on the available land area and soil permeability. Good candidates for GI/LID retrofits include public rights-of-way, municipal and commercial parking lots, and parking lots and roads associated with residential development, such as in the neighborhoods north of Flanders Four Corners (East Lyme) and The Avenues (Waterford). Candidate stormwater retrofit sites exist in virtually all of the Niantic subwatersheds but are most prevalent in the Niantic River and Latimer Brook subwatersheds and the lower sections of the Stony Brook and Oil Mill Brook subwatersheds.

Table 3-2 summarizes GI/LID recommendations for the Niantic River watershed.

Recommended Actions

- Pursue funding for and implement site-specific GI/LID retrofits on public lands based on the BMP concepts identified in *Section 4* and *Appendix D* of this watershed plan. Other potential retrofit projects could be identified through streamwalks, track down surveys, and future retrofit assessments. The MS4-regulated communities in the watershed (East Lyme, Waterford, and Montville) are also required to develop municipal stormwater retrofit plans and implement retrofit/disconnection projects to meet the impervious area disconnection requirements of the MS4 Permit.

- The watershed municipalities should continue to incorporate GI/LID into municipal projects, including parking lot upgrades and roadway projects using "green streets" approaches. Use of GI/LID in municipal projects will allow the MS4-regulated communities in the watershed (East Lyme, Waterford, Montville) to satisfy the stormwater retrofit and impervious area disconnection requirements of the MS4 Permit.

- Develop and implement targeted GI/LID master plans for high-priority areas in the watershed. The master plans could include GI/LID retrofits of municipal and commercial properties and within the municipal right-of-way, incorporating the retrofit concepts illustrated in *Section 4* of this plan. For example, through its Zoning Regulations the Town of Waterford has established the Mago Point District, which requires LID for stormwater treatment per the *Connecticut Stormwater Quality Manual* and established setbacks from the Niantic River. An alternative approach to identifying high-priority areas could be based on the subwatersheds of impaired waters. Potential high-priority areas for GI/LID master plans include:
    - Downtown Niantic, East Lyme
    - Flanders Four Corners, East Lyme
    - Banning Cove and Interstate 95/395 interchange, East Lyme
    - Niantic River Road, Waterford
    - Chesterfield Village, Montville

Table 3-2. Green Infrastructure and Low Impact Development recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Implement GI/LID retrofit projects on public lands • Identify candidate sites • Pursue and obtain funding • Design and construct projects	NRWC, ECCD, municipalities, consultants	Ongoing implementation	• Funding obtained • Projects designed and constructed	$$$$	Municipal funding, 319 NPS Grant, NFWF Long Island Sound Futures Fund, UCONN Stormwater Corps (technical assistance)
2. Incorporate GI into municipal projects including parking lot upgrades and "green streets" projects • Complete municipal stormwater retrofit plans (MS4 Permit) • Identify capital projects • Pursue and obtain funding • Design and construct projects	ECCD, municipalities	0-2 years (complete retrofit plans and identify capital projects) Ongoing implementation	• Retrofit plans completed • Projects identified • Funding obtained • Projects designed and constructed	$$$$	Municipal funding, 319 NPS Grant, NFWF Long Island Sound Futures Fund, STEAP Grant
3. Develop and implement GI/LID master plans for high-priority areas in the watershed • Develop master plan and design concepts • Pursue and obtain funding • Design and construct projects	Municipalities	2-5 years (develop plan) 5-10 years (plan implementation)	• Master plan completed • Funding obtained • Projects designed and constructed	$$$$	Municipal funding, 319 NPS Grant
4. Incorporate GI/LID into potential future re-use or redevelopment of commercial, state-owned, and municipal properties	State of Connecticut, municipalities, commercial businesses	5-10 years	• Redevelopment plan and completed projects	$$$$	

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
5. Pursue sustainable, long-term financing sources for large-scale GI implementation	NRWC, Regional Planning Agencies, ECCD	5-10 years	• Framework and action plan to evaluate and implement stormwater infrastructure financing	$$$$	Stormwater utilities, property tax credits and incentive rate structures, green bonds, public private partnerships, Connecticut Clean Water Fund

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee
ECCD = Eastern Connecticut Conservation District
319 Nonpoint Source (NPS) Grant Funding can be used for projects that exceed MS4 Permit minimum requirement

- Incorporate GI/LID approaches into redevelopment projects, such as the potential redevelopment of commercial properties at Flanders Four Corners, Mago Point (including the boat launch and parking lots managed by CT DEEP), or the current campus of the Dual Language & Arts Magnet Middle School in Waterford.

- Large-scale implementation of GI/LID may require non-traditional financing. Explore possible long-term financing sources including user fees, stormwater utilities, property tax credits or rebates, green bonds and community-based public-private partnerships. New London's recently adopted stormwater utility fee is the first stormwater utility in Connecticut and a potential model for the Niantic watershed communities (once enabling state legislation is adopted allowing municipalities to establish municipal stormwater utilities).

- Bioretention systems and other filtration/infiltration-based stormwater control measures with underdrains should be designed with an internal water storage layer by raising the underdrain outlet to enhance removal of nitrogen and other pollutants. The internal water storage layer improves exfiltration, thereby reducing pollutant loads to the receiving waterbody, and creates an anaerobic environment that enhances the process of denitrification, a biological reaction that converts nitrate into atmospheric nitrogen gas.

3.2.2 Homeowner Best Management Practices

Residential land use accounts for a large percentage of the developed land in the watershed, and these areas are a significant source of runoff and nonpoint source pollutant loads to the Niantic River and its tributaries. The actions of individual homeowners can reduce runoff and pollutant loads that flow overland and directly into waterbodies or into the storm sewer systems that discharge at outfall pipes into waterbodies. The previous section describes larger-scale green infrastructure recommendations primarily targeted at the watershed municipalities, institutions, and private development. However, LID and other small-scale best practices can also be implemented by homeowners on individual residential lots.

Residential BMPs on individual lots target small areas, requiring the participation of many homeowners to make a measurable difference across a watershed. A coordinated effort is required for widespread participation in such a program, which typically includes a combination of targeted education, technical assistance, and financial subsidies to homeowners. Successful implementation of residential/small-scale practices therefore requires homeowner education and incentive programs.

Recommendations for implementation of homeowner BMPs in the Niantic River watershed are described below and summarized in *Table 3-3*.

Recommended Actions

- Continue to offer programs to develop residential BMPs and to educate homeowners about them, including programs focused on how to:
    - Nurture native trees, shrubs, and flowers, especially near rivers, streams, ponds, and wetlands
    - Keep wetlands and streams free of yard waste and litter
    - Limit the amount of paved areas and reduce the size of grass lawns
    - Create rain gardens and similar places to intercept and infiltrate runoff into the ground
    - Plant or grow natural buffers at along the edges of rivers/streams, lakes/ponds, and wetlands
    - Reduce or eliminate use of fertilizers and pesticides, especially near waterbodies

- Dispose of pet waste in the trash or a pet-waste processor
    - Have septic tanks pumped and inspected regularly
    - Check and fix all the taps on sinks, baths, toilets, and hoses for leaks and drips
    - Dispose of unused and unwanted medications in the trash; dispose of any materials (cleaners, paint, gasoline/oil, etc.) only at hazardous waste collection locations

- Continue to encourage the disconnection of rooftop runoff from storm drainage systems by redirecting roof leaders from rain gutters to pervious lawn areas and through the use of dry wells, rain barrels or rain gardens. Downspout disconnection can be a cost-effective option for municipalities looking to reduce the volume of untreated stormwater and the cost of its management. Pavement removal and pervious materials for patios, walkways and driveways should be encouraged and demonstrated as additional homeowner BMPs that reduce runoff and pollutant loads to waterbodies.

- Given the age and location of many septic systems, it is recommended that a program be developed to assist homeowners in evaluating these systems. The program should begin with homes (and businesses) closest to waterbodies currently listed as impaired by CT DEEP: the Niantic River Estuary, Latimer Brook, and Stony Brook. This scope can be refined further through discussions with Ledge Light Health District or Uncas Health District on their records of repairs/replacements to homes of a certain age and/or locations in the community.

- Consider residential BMP incentive programs to encourage implementation of LID practices by homeowners, which will help reduce the burden on municipal stormwater infrastructure for managing runoff from residential lots. Other incentives to encourage residential property owners to use LID include:
    - Stormwater Fee Discounts or Credits – reduced fees or utility bills by installing LID practices; requires a stormwater utility or similar fee-based system
    - Rebates and Installation Financing – funding, property tax credits (i.e., reduction in property taxes), or reimbursements to property owners who install green infrastructure
    - Workshop and Give-Away Programs - rain barrel workshops for homeowners that provide a free (or reduced cost) rain barrel to each participating household, along with training on how to install and maintain the rain barrel
    - Certification and Recognition Programs – certification of residential properties as watershed-friendly by implementing LID practices
    - Municipal sponsored public workshops on how to build rain gardens emphasizing the increase in property value and curb appeal of LID landscaping

Table 3-3. Homeowner recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Promote residential BMPs by homeowners (see Education and Outreach recommendations)	NRWC, municipalities	Ongoing	• Materials disseminated • Number of homeowners participating	$$	
2. Encourage disconnection of rooftop runoff • Integrate disconnection BMPs in outreach materials • Incorporate disconnection as a BMP in local land use regulations	NRWC, ECCD, municipalities	0-2 years 2-5 years (land use regulations)	• Updated outreach materials • Updated land use regulations • Volume of runoff diverted	$ $	
3. Evaluate and implement other residential BMP incentive programs • Build upon existing pledge • Evaluate feasibility of alternative programs • Implement program(s)	NRWC and other local stakeholders	2-5 years (establish program) Ongoing implementation thereafter	• Program(s) identified, funding secured • Program established • Number of homeowners participating • Volume of runoff diverted	$$ (initial program implementation) $ (individual residential actions)	Grants, future stormwater fees, property tax credits

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee

3.2.3 Municipal Stormwater Management Programs (MS4)

Stormwater discharges from the municipal storm drainage systems in East Lyme, Waterford, and Montville are regulated under the CT DEEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit).[33] Stormwater discharges associated with the state drainage system are regulated under a similar MS4 permit issued specifically to the Connecticut Department of Transportation (CT DOT). Both permits establish requirements for implementing BMPs that will reduce pollutant discharges from municipal and state storm drainage systems.

Through their MS4 Permit stormwater management programs and other planning initiatives, the watershed municipalities have developed and are implementing a variety of BMPs to address stormwater quality issues associated with municipal activities as well as land development and redevelopment projects.[34 35 36]

Compliance with the illicit discharge detection and elimination (IDDE) program requirements of the permit can help to significantly reduce bacteria loadings where illicit connections are present and particularly where they contribute to the recreational impairments in the watershed. Outfall screening for bacteria is required where a MS4 discharges to an impaired water for which bacteria is the pollutant of concern. Other minimum control measures apply to municipal operations, such as reducing road sanding or increasing street sweeping. The permit also requires reduction in Directly Connected Impervious Area (DCIA) through the use of green infrastructure and Low Impact Development practices that retain/infiltrate stormwater runoff from impervious surfaces, either through private or municipal redevelopment projects or retrofits.

Compliance with MS4 Permits

Connecticut's revised MS4 General Permit went into effect on July 1, 2017. The watershed communities of East Lyme, Waterford, and Montville are regulated under the MS4 General Permit. These communities have developed Stormwater Management Plans that outline steps that each town will take to comply with the 6 minimum control measures in the permit, which include:

1. public education
2. public involvement
3. illicit discharge detection and elimination
4. construction site runoff control
5. post-construction runoff control
6. pollution prevention and good housekeeping

Stormwater discharges associated with the state drainage system are regulated under a similar MS4 permit issued specifically to the Connecticut Department of Transportation, which became effective July 1, 2019.

Reduction of bacteria and nutrient loads in stormwater discharges from the municipal and state storm drainage systems will be a focus of efforts by the Niantic River watershed municipalities and CT DOT in complying with their MS4 permits.

Municipal stormwater management program recommendations are summarized in *Table 3-4.*

Recommended Actions

- The Towns of East Lyme, Waterford, and Montville and CT DOT should continue to implement stormwater management programs for their regulated MS4s, as required by the MS4 Permit. Ensure that the

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33 The Town of Salem is not a regulated MS4 community based on its population density.

34 Anchor Engineering Services, Inc. *Final 2019 Annual Report, General Permit for the Discharge of Stormwater from Small MS4*. 33 pages. Prepared for the Town of Waterford.

35 Town of East Lyme, Engineering Department. *Annual Report – 2019 (DRAFT), General Permit for the Discharge of Stormwater from Small MS4*. 29 pages.

36 Town of Montville. *MS4 General Permit, Town of Montville 2019 Annual Report*. 20 pages.

Table 3-4. Municipal stormwater management program recommendations

Action & Milestones	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue to implement municipal Stormwater Management Programs • IDDE Program Implementation – July 2020 through June 2022 • Stormwater Retrofit Planning – July through December 2020 • Implementation of DCIA Reduction Projects – July 2020 through June 2022 • Post-Construction Stormwater Management Land Use Regulations Update – July 2021 • Annual Reporting and Employee Training – Annually • Good Housekeeping and Pollution Prevention - Ongoing	East Lyme, Waterford, Montville, CT DOT	Ongoing	• Compliance with permit deadlines for mapping, outfall monitoring, regulatory updates, etc.	$$$$	Municipal and state funds (permit requirements not eligible for federal 319 NPS Grant funding)
2. Continue participation in Eastern Connecticut Stormwater Collaborative	NRWC, municipalities, CT DOT, SCCOG	Ongoing	• Attendance at regular meetings; use of templates, tools, training materials, etc.	$$	Municipal and state funds
3. Encourage and support Town of Salem (not a regulated MS4 community) to develop and implement a stormwater management program	Salem, NRWC, ECCD, Eastern CT Stormwater Collaborative	0-1 year	• Stormwater management plan, attendance at Eastern CT Stormwater Collaborative meetings	$$$$	Municipal and state funds

Action & Milestones	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
4. Provide regional training and outreach materials for MS4 Permit	Eastern CT Stormwater Collaborative, SCCOG, and UCONN CLEAR/ NEMO	0-2 years	• Training materials developed • Number of municipalities receiving training	$$$	Community Foundation of Eastern Connecticut, NFWF Long Island Sound Futures Fund, member communities

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

NRWC = Niantic River Watershed Committee

CT DOT = Connecticut Department of Transportation

SCCOG = Southeastern Connecticut Council of Governments

NEMO = Nonpoint Education for Municipal Officials (a program of UCONN CLEAR) stormwater management programs focus on the Niantic River watershed and its water quality impairments as "Priority Areas." Specific actions relevant to the impairments in the Niantic River watershed include:

- Dry weather screening of outfalls in "priority areas" (defined by the MS4 permit) for evidence of illicit discharges
- Catchment investigations for outfalls known or suspected of having illicit discharges
- Elimination of illicit discharges identified
- Wet weather monitoring of stormwater outfalls that discharge directly to impaired waterbodies
- Update of local land use regulations to reflect more stringent stormwater retention and treatment standards and promote the use of green infrastructure and LID practices
- Development of a stormwater retrofit plan to identify opportunities for LID retrofits on municipal properties and within the municipal right-of-way, such as the site-specific BMP concepts presented in *Section 4* of this watershed plan
- Tracking and disconnection of impervious area through private or municipal redevelopment projects and stormwater retrofits
- Implementation of a maintenance plan that ensures the effective, long-term operation of stormwater management structures that are owned or managed by the municipality

- The NRWC, watershed municipalities, and CT DOT should continue to participate in and use resources provided by the Eastern Connecticut Stormwater Collaborative. The Collaborative was formed to provide municipalities with a regional approach and shared resources to address the management of pollution from municipal stormwater discharges. Member towns of the Eastern Connecticut Stormwater Collaborative include member towns in SCCOG and the Northeastern Connecticut Council of Governments with support from SCCOG, the Eastern Connecticut Conservation District, CT DEEP, and others.

- While the Town of Salem is not currently subject to the MS4 Permit, staff and officials from Salem are encouraged to develop and implement a stormwater management program similar to those of the regulated MS4 communities in the Niantic River watershed and to participate in the Eastern Connecticut Stormwater Collaborative. Salem may be designated a regulated MS4 community in the near future based on the 2020 U.S. Census.

3.2.4 Wastewater Disposal Systems

Most of the Niantic River watershed is served by on-site subsurface sewage disposal systems, also referred to as septic systems. Failing or older, sub-standard septic systems can impact surface water and groundwater quality and can be a source of bacteria to the Niantic River and its tributaries. The Ledge Light Health District (LLHD), which serves the watershed communities of East Lyme and Waterford, and the Uncas Health District (UHD), which serves Salem and Montville, regulate the installation of subsurface sewage disposal systems and are responsible for site inspections, plan review, issuing permits and the inspections of all new, repair and replacement systems. Plans for septic systems serving buildings with design flows of 2,000 to 7,500 GPD must be approved by the Connecticut Department of Public Health. Disposal systems on sites with design flows exceeding 7,500 GPD, alternative sewage disposal systems, and community sewage systems are permitted by the Connecticut Department of Energy and Environmental Protection.

Approximately 6% of the land area in the Niantic River watershed is served by sanitary sewers, most of which is located south of the Interstate-95 corridor. In 2019, a Regional Wastewater Management Plan (RWMP) was prepared on behalf of SCCOG for its membership of 22 municipalities and two tribal nations in eastern

Connecticut, including the four towns in the Niantic River watershed.[37] The RWMP includes: a description of the existing centralized collection and treatment systems, projected changes in wastewater volumes through 2040, and infrastructure vulnerable to coastal or inland flooding due to climate change. Additionally, potential system expansions are assessed and discussed. Section 6.0 of the RWMP outlines specific recommendations and options for existing and proposed wastewater collection systems in the Niantic River watershed.

Recommendations regarding wastewater disposal systems in the watershed are summarized in *Table 3-5*.

Recommended Actions

- Promote the implementation of the RWMP recommendations for the Niantic River watershed. The Plan contains valuable assessments and prioritized recommendations for the successful management of wastewater collection systems in the watershed. The information pertinent to the management goals in the Niantic River watershed should be summarized and highlighted and made available to stakeholders.

- Implement wastewater pump station recommendations from the Waterford and East Lyme coastal resilience planning studies. The 2017 Waterford study assessed three pump stations (Mago Point Pump Station, Niantic River Road Pump Station, Oil Mill Brook Pump Station) as currently at high risk and an additional seven at medium risk to coastal flooding.[38] Similarly, East Lyme's 2018 Outcomes Report recommended several resilience options to protect seven pump stations located within the 1%-annual-chance-storm flood zone, one of which is located in the Niantic River watershed (141 Main Street).[39]

- Explore the feasibility of expanding sewer service in targeted areas that are densely developed, currently served by outdated subsurface sewage disposal systems, have soils with poor infiltration capacity, or are consistent with municipal land use planning objectives. These include Saunders Point, Golden Spur, and residential areas along Latimer Brook, Stony Brook, and the Niantic River Estuary. New or expanded sewer service areas that are located in the drainage area of a public water supply, Aquifer Protection Area, or tributaries with good water quality should be assessed for direct and indirect (i.e., induced development) impacts to water quality.

- Continue to encourage regular maintenance of septic systems by providing homeowners with educational materials on how to identify improperly functioning systems and procedures to have systems inspected, cleaned, and repaired or upgraded. Health Districts should develop and disseminate septic system educational materials for homeowners in their respective communities. Regulated MS4 communities that support such efforts could use these actions to meet the public outreach/education minimum control measure of the MS4 Permit and the related municipal stormwater management plans.

- Explore options for offering group discounts to homeowners to regularly pump and repair septic systems.

- Inventory and map the larger, State-regulated subsurface sewage disposal systems in the Niantic River watershed. Coordinate with CT DPH and/or CT DEEP to review records related to system performance and

[37] Milone & MacBroom. 2019. *Regional Wastewater Management Plan*. 200 pages. Prepared for SCCOG.
[38] Kleinfelder Northeast, Inc. 2017. *Climate Change Risk Vulnerability, Risk Assessment, and Adaptation Study.* Prepared for the Town of Waterford. 119 pages.
[39] Stantec. 2018. *Coastal Resilience, Climate Adaptation, and Sustainability Report: Outcomes Report*. Prepared for the Town of East Lyme. 37 pages.

Table 3-5. Wastewater disposal system recommendations

Actions & Milestones	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Promote the implementation of SCCOG's Regional Wastewater Management Plan, and summarize its findings regarding service in the Niantic River watershed	NRWC	0-2 years	• Summary report of RWMP's assessments and recommendations	$	
2. Implement wastewater pump station recommendations from the Waterford and East Lyme coastal resilience planning studies	Waterford and East Lyme	5-10 years	• Pump station improvements constructed	$$$$	Connecticut Clean Water Fund
3. Consider expanding sewer service in targeted portions of the watershed	NRWC, municipalities, Ledge Light and Uncas Health Districts	Ongoing	• Sewers constructed in priority areas	$$$$	
4. Provide homeowner outreach on septic systems and explore options for group discounts to homeowners to pump and repair septic systems	NRWC, Ledge Light and Uncas Health Districts	2-5 years	• Outreach materials provided or made available to homeowners	$$	
5. Inventory, review, and prioritize larger, State-regulated subsurface sewage disposal systems in the watershed	NRWC, CT DPH, Ledge Light and Uncas Health Districts	2-5 years	• List and map of high priority systems for additional oversight	$$	
6. Strengthen state and municipal regulations regarding septic system inspection, maintenance, and repair/upgrade	CT DPH, CT DEEP, municipalities, Ledge Light and Uncas Health Districts	5-10 years	• Amended regulations	$$$$	CT DEEP Supplemental Environmental Project Funds, CT DEEP 319 NPS Grants

Actions & Milestones	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
7. Require the use of innovative alternative septic system designs and denitrification standards	Municipalities, CT DPH, CT DEEP, Ledge Light and Uncas Health Districts	5-10 years	• Amended regulations and requirements	$$$$	CT DEEP Supplemental Environmental Project Funds, CT DEEP 319 NPS Grants

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee
CT DPH = Connecticut Department of Public Health
CT DEEP = Connecticut Department of Energy and Environmental Protection

corrective actions taken to resolve prior performance issues. Identify high-priority systems for ongoing oversight based on consideration of system size, soils, proximity to waterbodies, and performance history.

- Consider strengthening state and local regulations in the watershed to require regular septic system inspection and maintenance and upgrades to sub-standard systems, such as requiring systems to pass an inspection upon the sale of a property and be upgraded if necessary.

- Require the use of innovative alternative septic system designs for lots that are too small or too constrained by groundwater and setbacks to be suitable for a standard system.

- Consider implementing a denitrification standard for new and replacement subsurface sewage disposal systems in Aquifer Protection Areas and areas near surface waters.

3.2.5 Illicit Discharges

Illicit discharges are non-stormwater flows that discharge or leak into the stormwater system or discharge directly into surface waters. Wastewater connections to the storm drain system, sanitary sewer overflows, and illegal dumping or improper disposal of wastes down storm drains are among the types of illicit discharges that may exist in residential and commercial areas within the watershed. Identifying and eliminating these discharges is an important means of pollution source control for the watershed. The sources of dry weather discharges of bacteria and nutrients such as illicit connections are the most likely to include human sources and need to be identified and effectively managed. Controlling dry weather discharges of bacteria and other pollutant sources is typically more cost-effective than trying to address pollutant sources in wet weather conditions.

As MS4-regulated communities, East Lyme, Waterford, and Montville are subject to the requirements of the CT DEEP MS4 Permit. The permit requires these municipalities to implement an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the municipal storm drainage system, as well as sanctions to ensure compliance. This includes developing and implementing an Illicit Discharge Detection and Elimination (IDDE) program to systematically find and eliminate sources of non-stormwater discharges to the municipal separate storm sewer system and implement procedures to prevent such discharges. CT DOT is also subject to similar IDDE requirements under its own MS4 Permit.

Recommendations relative to illicit discharges in the Niantic River watershed are summarized in *Table 3-6.*

Recommended Actions

- The Towns of East Lyme, Waterford, and Montville and the CT DOT should continue to implement IDDE programs as required by the MS4 Permit. This includes an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the MS4 and an IDDE program to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.
  - Educate municipal/state staff and the public about illicit discharges and the importance of eliminating or avoiding such discharges.
  - Conduct follow-up illicit discharge investigations at priority outfalls identified during the outfall screening process.

- Although not currently subject to the MS4 Permit, the Town of Salem is encouraged to develop and implement a program to identify and eliminate illicit discharges

Table 3-6. Illicit discharge recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Implement IDDE program consistent with MS4 Permit requirements • IDDE legal authority • Outfall mapping • IDDE Plan • Outfall screening and sampling • Catchment investigations and discharge removal projects • Education and outreach to municipal staff and the public	East Lyme, Waterford, Montville, CT DOT, Eastern CT Stormwater Collaborative	2017-2022 (5-year permit term)	• Compliance with permit deadlines for mapping, outfall monitoring, regulatory updates, etc. • Refined data for identifying BMP priority areas	$$$$	Municipal funds (permit requirements not eligible for federal 319 NPS Grant funding) State funds (CT DOT)
2. Encourage the non-MS4 community in the watershed to set up and implement a program to identify and address illicit discharges to stormwater systems in their communities	Salem	2-5 years	• Voluntary IDDE Program in place, number of illicit discharges identified and eliminated	$$$	Municipal funds. Non-MS4 communities in the watershed may be eligible for 319 NPS Grant funding.

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
CT DOT = Connecticut Department of Transportation

3.2.6 Commercial Business and Industrial Facilities

Commercial and industrial land uses have the potential for higher pollutant loads due to the contaminant sources associated with these activities and the significant runoff generated from these often highly impervious sites. Much of the commercial development in the watershed is concentrated along the major transportation corridors of interstates and state roads. Several commercial properties, such as marinas and the commercial district of Flanders Four Corners, are located in the southern part of the watershed. While many of these facilities may be subject to the CT DEEP General Permit for the Discharge of Stormwater associated with Commercial Activity (Commercial General Permit) or General Permit for the Discharge of Stormwater associated with Industrial Activity (Industrial General Permit), smaller facilities or certain activities may fall outside of the applicability of these general permits. However, even entities that are not subject to these general permits should identify and implement practices that address potential point and nonpoint pollutant sources. Recommendations related to reducing the impacts from commercial and industrial land uses are summarized in *Table 3-7*.

Recommended Actions

- Conduct outreach to commercial business owners in the watershed explaining how their activities can contribute to the water quality impairments of the Niantic River and its tributaries.

- Consider establishing or strengthening municipal ordinances that require covered trash enclosures, setback distances from streams and catch basins, and frequent cleaning to reduce bacteria and nutrient loads associated with dumpsters. This is consistent with the good housekeeping requirements in the CT DEEP industrial and commercial stormwater permit programs, which apply to certain categories of industrial facilities and to larger commercial sites such as shopping centers. Leaking dumpsters can be a major source of fecal indicator bacteria and nutrients during wet weather. Include dumpster and trash management issues in commercial and industrial outreach.

- Review the commercial and industrial facilities in the watershed to identify sites that are subject to the CT DEEP industrial and commercial stormwater permit programs and the APA program, but that are not currently registered.

- Continue to promote the programs that celebrate and support businesses that commit to environmental stewardship. Example programs are :
  - Clean Marina Program – marinas implementing specific BMPs can be certified as a Connecticut Clean Marina. The program is currently managed by the Connecticut Marine Trades Association.
  - Connecticut Green Lodging Program – With respect to water quality, the program emphasizes water conservation and encourages the minimized use of fertilizer in landscaping and installing stormwater BMPs (buffers, pervious pavement). The programs is managed by CT DEEP's Pollution Prevention program.

- Promote green infrastructure stormwater control measures and vegetated buffer restoration as retrofits or during the redevelopment of large commercial or industrial sites. Potential projects sites are:
  - Commercial properties at Flanders Four Corners (East Lyme)*
  - Commercial properties at Mago Point (Waterford)*
  - Marinas and associated properties (East Lyme, Waterford)
  - Dinosaur Crossing, and The PAST Antiques (Montville)*
  - Aces High RV Park (East Lyme)

Table 3-7. Commercial business and industrial facility recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Conduct outreach to commercial and industrial business owners • See Education and Outreach recommendations	Municipalities (as part of MS4 Permit outreach)	2017-2022 (5-year permit term)	• Outreach completed as documented in MS4 annual Reports	$$	
2. Establish or strengthen municipal ordinances requiring covered trash enclosures and frequent cleaning • Review existing regulations/ordinances • Amend regulations or adopt new ordinances	Municipalities (as part of MS4 Permit IDDE Ordinance)	2016-2021 (5-year permit term)	• New or modified ordinance or other enforceable regulatory mechanism	$$	
3. Review commercial and industrial facilities to identify sites that need to be registered under the CT DEEP stormwater general permit programs • Develop list of facilities in watershed • Identify which facilities are not registered • Notify unregistered facilities of need for permit coverage	CT DEEP	2-5 years	• Non-compliant sites identified and notified	$$	
4. Promote green infrastructure stormwater control measures and vegetated buffer restoration as retrofits or during redevelopment of commercial sites	NRWC, ECCD, municipalities	Ongoing	• Outreach to comm. property owners • Updated land use regulations to require GI/LID for commercial redevelopment	$$$	

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

NRWC = Niantic River Watershed Committee   CT DEEP = Connecticut Department of Energy and Environmental Protection

- Double Down, LLC (rock-processing facility in Montville)
- New London-Waterford Speedbowl (Waterford)
- Burnett's Country Gardens (Salem)*
- Eversource (right-of-way in East Lyme and Montville)

* Visual field assessments conducted by Fuss & O'Neill in January 2020. See *Appendix D* for site descriptions and site-specific recommendations.

3.2.7 Vegetated Buffers

Vegetated buffers are naturally vegetated areas adjacent to streams, ponds, lakes, and wetlands that are not routinely or extensively landscaped. Also referred to as riparian or stream buffers, vegetated buffers help encourage infiltration of rainfall and runoff and reduce flooding. The buffer area provides a living "cushion" between upland land use and surface water resources, protecting water quality, the hydrologic regime of the waterway and stream structure. Vegetated buffers filter out pollutants, capture sediment, protect streambanks from erosion, regulate stream water temperature, and process many contaminants through vegetative uptake. Vegetated buffers can also provide habitat and travel corridors for animals, many of which are dependent on riparian features for survival. A reduction to buffer width or degradations to vegetative cover can reduce the water quality and other benefits of vegetated buffers and contribute to water quality impairments. In general, vegetated buffers are more effective along small streams than large streams since most water delivered to stream channels from uplands enters along small streams.

The stream corridors in many areas of the Niantic River watershed are characterized by limited or no vegetated buffer due to residential and commercial development and farming practices. Commercial developments, residential properties, and some agricultural practices extend down to the banks in many areas of the Niantic River and its tributaries.

Recommendations related to vegetated buffers in developed areas are summarized in *Table 3-8*. Additional recommendations for restoration of vegetated buffers and filter strips for agricultural operations are addressed in *Section 3.2.9*.

Recommended Actions

- Encourage the creation and protection of backyard buffers in residential areas near stream corridors.
  - Educate homeowners about the value and importance of vegetated buffers by building on existing vegetated buffer outreach and educational programming (e.g., River Smart program, public recognition programs for cooperating landowners, *Streamside Landowners' Guide to the Quinnipiac Greenway,* Audubon's backyard program, and others).
  - Develop programs to educate and incentivize private landowners and homeowners to restore and maintain vegetated buffers, particularly those adjacent to waterbodies listed as impaired (Niantic River, Latimer Brook, Stony Brook). Outreach can include buffer restoration workshops or developing resources (brochures, websites, etc.) on buffer management, recommended native plants, and water quality benefits. Additional streams to prioritize: segments of Cranberry Meadow Brook, Oil Mill Brook, and upper Latimer Brook; No Name Brook (*Section 4.9*); and an unnamed stream at Evergreen Lane in Montville (*Section 4.7*). Recognize the efforts of homeowners and other land owners.

- Engage the participation of volunteers in buffer implementation projects.

Table 3-8. Vegetated buffer recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Encourage backyard vegetated buffers • Provide homeowner education by building on existing materials and programs (see Education and Outreach recommendations)	Municipalities (as part of MS4 Permit compliance), NRWC	2017-2022 (5-year permit term)	• Educational materials disseminated	$$	Municipal funds
2. Implement priority buffer restoration projects • Conduct more detailed assessment to identify priority restoration project sites • Pursue and obtain funding • Design and construct projects	NRWC, ECCD, municipalities	Ongoing	• Priority projects identified • Funding secured • Projects designed and constructed	$$$	Section 319 NPS Grant Program and other grants NFWF; CT Open Space Grants (Greenway Program); Trout Unlimited; America the Beautiful tree grant program
3. Consider the adoption of setback zones in priority areas. Continue to enforce municipal regulations that protect wetlands, watercourses, and adjacent upland buffers. • Review existing regulations • Amend regulations	Municipalities	Ongoing	• Modified or updated land use regulations	$$$	Municipal funds

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee
ECCD = Eastern CT Conservation District

- Implement priority buffer restoration projects based on streamwalks and track down surveys. Potential buffer restoration approaches for the watershed include installation of new buffers, widening of existing buffers, invasive species removal/management, and tree planting/reforestation.

- Pursue restoration projects on publicly-owned sites that can also serve as high-profile demonstration buffer restoration sites. Such sites may be utilized for long-term studies to monitor water quality or other characteristics in restored areas. Potential sites include:
    - East Lyme: Veterans Memorial Park; Darrow Pond property; several parcels owned or protected by easements near Latimer Brook
    - Montville: Latimer Brook, and associated ponds/wetlands to be protected by Avalonia Land Trust and its partners
    - Salem: Horse Pond; Fairy Lake along New London Road (Route 85)
    - Waterford: Mago Point

- Target the acquisition of riparian parcels as protected open space to preserve vegetated buffers and, if possible, provide public access to the Niantic River and its tributaries.

- Prioritize vegetated buffer protection through establishing setback zones in municipal inland-wetland/watercourse regulations or the adoption of riparian overlay zones (see recommendation in *Section 3.5*). As part of the regulatory updates required by the MS4 Permit, consider amending land use regulations to incorporate incentives for developers to restore or establish vegetated buffers as part of new development or redevelopment projects. Continue to enforce municipal regulations that protect wetlands, watercourses, and adjacent upland buffers.

3.2.8 Wildlife and Pet Waste

Wildlife and domesticated animals within the Niantic River watershed are a source of nutrients and fecal indicator bacteria that can impact stream water quality. Fecal material can be deposited directly into waterbodies, as well as from stormwater and dry-weather washing of feces deposited on the ground into storm sewers and receiving waters. Domesticated animals (dogs and cats) and wildlife such as birds, raccoons, and rodents can be significant contributors, particularly in parks (including dog walking parks), golf courses, and commercial areas in the watershed. Flocks of waterfowl are observed in coastal areas as well as public parks and playing fields close to watercourses.

Most of the watershed communities have existing bans on feeding waterfowl and ordinances on pet waste disposal (i.e., "pooper scooper" laws). However, enforcement of such regulatory controls is difficult. Furthermore, there are no easy solutions to nuisance waterfowl problems. Like most wildlife, Canada geese are persistent when they become habituated to an area that is considered safe and has a reliable food source.

A more effective nuisance waterfowl control strategy is needed, focusing on education and outreach and other proven control methods. Creation of vegetated buffers consisting of tall grasses, shrubs, or trees, along ponds or streams is a recommended form of habitat modification. Geese prefer to feed on short grass in areas that are open and within sight of a body of water. Tall grasses, shrubs, and trees can serve as a deterrent and cause them to relocate. Vegetated buffers can also reduce nonpoint source pollution. Recommendations related to wildlife and pet waste are summarized in *Table 3-9*.

Table 3-9. Wildlife and pet waste recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue waterfowl deterrent efforts • Physical barriers • Regulatory controls • Signage • Educational programs	MS4 muni-cipalities (as part of MS4 Permit compliance) and non-MS4 municipalities on a voluntary basis	2017-2022 (5-year permit term)	• Waterfowl programs implemented • Number of municipalities participating	$$	Municipal funds, NFWF
2. Implement and enforce pet waste programs • Provide bag dispensers and disposal cans at parks, trails, and dog parks • Provide park and trail signage • Provide educational materials	MS4 municipalities (as part of MS4 Permit compliance) and non-MS4 municipalities on a voluntary basis Local veterinarians, pet stores, dog kennels, pet supply and feed stores, etc. to help educate the public and encourage participation	2017-2022 (5-year permit term)	• Pet waste programs implemented • Number of municipalities participating • Number of businesses and other partners participating	$$	Municipal funds, contributions from businesses

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

Recommended Actions

- Continue nuisance waterfowl deterrent efforts – habitat modification, barriers/exclusion and other methods – to reduce feeding of waterfowl by the public, waterfowl nesting, and terrestrial waterfowl habitat in the watershed. Creation of vegetated buffers along ponds and streams as a form of habitat modification (to disrupt travel and sight lines) is the preferred deterrent method since it also provides water quality benefits.

- Develop and provide information to the public that discourages the feeding of wildlife, including brochures, websites, and additional signage in public parks. Materials should emphasize that feeding of waterfowl such as ducks, geese, and swans can be harmful to their health; emphasizing the protection of waterfowl health is often the most effective strategy.

- Existing regulatory controls that prohibit the feeding of waterfowl should be expanded, including the potential for fines.

- Provide pet waste bag dispensers and disposal cans at high-use areas and conveniently spaced intervals on trails and in open space areas. At municipal parks and trailheads, provide signs regarding pet waste disposal requirements and leash laws at the disposal cans. Consider allowing advertising on signs placed at pet waste bag dispensers and disposal cans to partially offset the cost. Provide educational materials regarding the impact of improperly disposed pet waste in pet stores, animal shelters, veterinary offices, and other sites frequented by pet owners.

3.2.9 Agricultural Lands

Agricultural lands can be a source of pollutants to surface waters and groundwater. Water quality contaminants associated with agricultural operations include excess nutrients (nitrogen and phosphorus primarily from fertilizers and animal wastes), bacteria/pathogens and organic materials (primarily from animal wastes), sediment (from field erosion), pesticides (applied to crops), salts (from evaporation of irrigation water), and petroleum products (from farm equipment). These pollutants enter watercourses through direct surface runoff or through seepage to groundwater that discharges to surface water.

A variety of agricultural BMPs can be implemented to reduce the potential water quality impacts of agricultural nonpoint source runoff, including:

- Livestock exclusion fencing
- Manure collection and storage
- Nutrient management (remove, reuse, land application)
- Cover crops
- Contour planting
- Vegetated buffers, filter strips
- Filter berms
- Covered heavy use areas
- Diverting clean water
- Soil health management (disturbing the soil as little as possible, growing as many different species of plants as practical, keeping living plants in the soil as often as possible, and keeping the soil covered).

The plan recommendations include descriptions of several of these practices, which can be effective for reducing sediment, bacteria, and nutrient loads from the type of smaller farms and agricultural operations that are common in the Niantic River watershed.

Recommended Actions

The parcel-level visual assessments and site-specific BMP recommendations described in *Section 4* of this plan focused on stormwater and nonpoint source runoff in residential and commercial areas of the watershed since these comprise the majority of the developed land uses in the Niantic River watershed. Field assessments were attempted for several of the agricultural properties in the watershed, although lack of access to privately-owned agricultural lands limited the assessments to windshield surveys and review of aerial imagery.

As described in the site-specific recommendations in *Appendix D* of this plan, the following agricultural operations are located directly adjacent to or in close proximity to the Niantic River tributaries and have the potential to impact water quality, and are therefore candidates for more detailed follow-up assessment and BMP implementation:

- Lower Cranberry Meadow Brook – a number of small agricultural producers and operations west of Route 161 with agricultural use in areas proximate to the brook
- Oil Mill/Stony Brook – family farm in Waterford south of Interstate 395/95 stockpiling manure in fields close to the stream

An inventory of agricultural lands within the watershed should be developed and the sites assessed for nonpoint source pollution and implementation of BMPs, in cooperation with the land owners and agricultural producers. *Table 3-10* summarizes recommendations relative to agricultural lands in the watershed.

Manure Management

Livestock waste is a source of bacteria (and associated pathogens) and excess nutrients that requires ongoing management. Farms in the watershed contain different types of livestock including cows, horses, domestic fowl (chickens, ducks, geese), goats, donkeys, and llamas. All produce wastes that vary in bacteria and nutrient concentration.[40] [41] Poor manure management can allow bacteria, nutrients and sediment to be transported to waterbodies by stormwater runoff and when livestock have direct access to waterbodies. Bacteria and phosphorus can also attach to soil particles that are washed into streams during a storm.

Manure management practices depend on the type and scale of the agricultural operation. For example, dairy operations and equestrian facilities typically collect and store manure. In these scenarios, manure piles should, at minimum, be located away from wetland and waterbodies and drain away from catch basins. To reduce exposure to rain, manure piles should be covered and, if feasible, stored in a containment structure. Containment structures also reduce the potential for bacteria and nutrients to impact groundwater. The scale of the operation would dictate the size and scope of these management practices.

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[40] Ruddy, B.C., Lorenz, D.L., and Mueller, D.K. 2006. County-Level Estimates of Nutrient Inputs to the Land Surface of the Conterminous United States, 1982–2001: U.S. Geological Survey Scientific Investigations Report 2006-5012, 17 p.

[41] Wagner, K. and Moench, E. 2009. Education Program for Improved Water Quality in Copano Bay: Task Two Report. Texas Water Resources Institute Technical Report No. 347. Texas A&M University System.

Table 3-10. Agricultural lands recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Provide outreach to farm owners on the water quality impacts of agricultural operations and agricultural BMPs	NRWC, ECCD	0-2 years Ongoing	• Outreach materials disseminated	$$	USDA/NRCS, USDA Farm Service Agency, CT Dept. of Agriculture, University of Connecticut Cooperative Extension System, Connecticut Agricultural Experiment Station
2. Work with farm owners and operators to implement site-specific agricultural BMPs • Inventory agricultural operations and producers in the watershed • Reach out to owners and operators • Conduct site assessments with owner/operator permission • Develop concept-level recommendations for site-specific agricultural BMPs • Partner with owners and operators to identify projects and financial/technical assistance • Design and construct projects	NRWC, USDA/NRCS, land owners, ECCD	2-5 years Ongoing	• Inventory of agricultural operations completed • Farm owners and operators contacted • Site assessments completed and recommendations provided • Technical & financial assistance provided • Projects completed • Number of partners participating	$ to $$$$	USDA/NRCS, USDA Farm Service Agency, Connecticut Dept. of Agriculture, University of Connecticut Cooperative Extension System, Connecticut Agricultural Experiment Station, Eastern Connecticut Conservation District, CT DEEP 319 NPS Grants

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee   USDA/NRCS = U.S. Department of Agriculture, Natural Resources Conservation Service
CT DEEP = Connecticut Department of Energy and Environmental Protection   ECCD = Eastern Connecticut Conservation District

Small farms and equestrian operations with few head appear to be common in the watershed and may not have the resources to implement the most stringent manure management practices. Educational outreach may be more effective in these cases, where the management solutions can be tailored to the scale and specific needs of each operation.

Vegetated Buffers and Filter Strips

As described in *Section 3.2.7*, vegetated buffers are vegetated areas adjacent to streams, ponds, and wetlands that can provide a variety of water quality and other benefits. Filter strips, similar to vegetated buffers, are small strips or areas of vegetated land, often used at the edges of fields, to reduce agricultural nonpoint source pollution.

In the Niantic River watershed, agricultural operations are commonly located close to streams and often have intermittent or perennial streams flowing through them. On these sites, providing vegetated buffers and filter strips is effective at decreasing velocity of runoff, which allows for trapping sediment and infiltrating water and potential dissolved inorganic pollutant loads (i.e., nitrogen, phosphorus) into the soil for uptake by vegetation.

Farm operations in the watershed have animal grazing areas through which intermittent streams or drainage channels flow. In these cases, exclusion fencing should be used to keep animals out of the stream and out of the vegetated buffer or filter strip. Fencing vegetated buffers and filter strips from pastures is often necessary to protect water quality. Exclusion fencing (board, barbed, high tensile or electric wire) is commonly used to exclude livestock from streams and vegetated buffers and filter strips to improve or protect water quality and reduce soil erosion and sedimentation. Where a stream or pond serves as a source of drinking water for livestock, provisions for an alternative water supply for livestock (off-channel watering hole or groundwater well) may be necessary.

Filter Berms

Filter berms are structural BMPs that consist of a stable, permeable berm such as gravel or compost, placed at the downgradient edge of an agricultural field, manure storage and composting facilities, and areas with high livestock use. The filter media in the berm serves to both filter the runoff from the fields and provide some opportunity for cation exchange of dissolved pollutants. Filter berms are designed to follow an elevation contour and are turned up at the ends, resembling a horseshoe, to provide runoff storage. Runoff temporarily pools behind the berm, then filters through it and infiltrates into the ground. For this reason, berms are best located downgradient from sources of bacteria and nutrients. Filter berms are best suited to treating small, frequent storms, where water is captured and infiltrated. In larger storms, the berm reduces flow velocity and stores some stormwater, allowing sediment-bound pollutants to settle before the treated stormwater is slowly released.

Filter berms typically have a small constructed footprint and represent simple and cost-effective solutions to runoff management and pollutant reduction. When properly designed and sited, they blend into the landscape. Maintenance requirements are also low: stored sediment must be periodically removed and the grass on the filter berm mowed, if desired.

Farm Financial and Technical Assistance

Implementing improvements on farms requires some capital investment that is often beyond the means of the individual farmer. The State of Connecticut and U.S. Department of Agriculture both recognize this challenge and administer programs to support farmers in conservation efforts. Outreach and technical assistance programs provided by federal and state agencies include the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), USDA Farm Service Agency, Connecticut Department of Agriculture, University of

Connecticut Cooperative Extension System, Connecticut Agricultural Experiment Station, Connecticut Conservation Districts, and CT DEEP.

Connecticut farmers can receive support from NRCS, which provides financial and technical assistance to agricultural producers to: address natural resource concerns; maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns; manage financial risk through diversification, marketing or natural resource conservation practices; protect, restore, and enhance wetlands, grasslands, and working farms and ranches through conservation easements; restore, enhance and protect forestland resources on private and tribal lands through easements and financial assistance; promote the recovery of endangered or threatened species, improve plant and animal biodiversity and enhance carbon sequestration through a variety of programs authorized through the 2018 Farm Bill.

As part of the National Water Quality Initiative (NWQI), the USDA NRCS offers financial and technical assistance to farmers and forest landowners interested in improving water quality and aquatic habitats in priority watersheds with impaired streams. The NWQI directs technical assistance to farmers as part of the Environmental Quality Incentives Program (EQIP). This is a voluntary conservation program to assist agricultural producers with implementing structural and management conservation practices to their farms that promote agricultural production and environmental quality as compatible goals. Through EQIP, agricultural producers receive financial and technical assistance to implement practices on working agricultural land.

The Connecticut Department of Agriculture provides funding through its Farmland Restoration Program (FLRP) that may support the goals of this plan. This program provides support to projects that include installation of fencing to keep livestock in reclaimed pasture areas and/or out of riparian areas, as well as funding to clear and remove trees, stumps, stones and brush to create or restore agricultural use.

3.3 Coastal and Estuarine Issues

The 2006 Niantic River Watershed Protection Plan provided a detailed summary and assessments of the impact of land use and nonpoint source pollution on the degradation of coastal systems and habitats in the Niantic River Estuary. These factors remain major concerns for many stakeholder groups, and impacts to the Estuary's water quality and diminished vigor and extent of marine species have been extensively documented and studied. In stakeholder workshops, participants identified the need for more resources to support local fisheries and shellfishing via education/outreach, state and local regulations, and restoration projects (e.g., eelgrass beds). Additionally, water quality improvements are needed to maintain the appropriate recreational uses valued by residents and visitors to the region.

As discussed previously under Emerging Issues in *Section 2.9*, climate change has introduced a range of issues that require active planning and management. While the challenges stemming from climate change can be seen as distinct from water quality, the environmental changes attributed to it – sea level rise, ocean acidification, changes in precipitation patterns – can contribute to water pollution (e.g., infrastructure compromised by flooding) or intensify the magnitude of existing sources or processes (e.g., increased runoff, warmer temperature promotes hypoxia). The communities in the Niantic River watershed should consider these issues and their management strategies when identifying mitigating actions to address water quality.

Recently, the towns of Waterford and East Lyme completed coastal resilience planning studies to assess the potential impacts of sea level rise, storms and increased rainfall on public infrastructure and natural resources. The studies also identify adaptation recommendations to prioritize capital projects and increase resiliency, including recommendations that align with the management objectives of this watershed plan. These include policy changes, education/outreach initiatives, and site-specific recommendations that address climate resiliency and water quality in the watershed.

The *Coastal Resilience, Climate Adaptation, and Sustainability Study* prepared for East Lyme discusses the following "Priority Projects" in town and recommendations in the Niantic River watershed:

- **Roadway alterations** to build resilience and maintain access and egress. Pine Grove neighborhood is located on a peninsula that has only one road for evacuation or emergency access. This is due to the restricted access at Camp Nett Army National Guard Base. The study recommends that the "Town should be prepared to elevate Pine Grove Road if it cannot negotiate a deal with Camp Nett for emergency access."

- **Drainage improvements** to poor drainage in upland and coastal areas. Specific locations or recommendations in the watershed were not discussed in the study. However, the study's *Figure 14* on Priority Projects shows areas along Latimer Brook (FEMA Flood Hazard Zone AE) containing "repetitive loss properties." The study's recommendations are made in a separate section for the town of East Lyme to consider funding land acquisition in such areas through FEMA programs focused on this problem.

- **Living shorelines** as an alternative to hardened shorelines (seawalls, bulkheads, jetties, etc.) enhance natural habitats and processes. The study does not discuss specific locations or recommendations in the watershed but does recommend that "native plantings along the shoreline can replace grassy lawns that extend to the water's edge."

- **Critical infrastructure flood protection.** This assessment for the study was specific to municipal buildings and facilities, which noted that seven pump stations in town are located in FEMA Flood Hazard Zone AE (1% annual chance storm). One pump station at 141 Main Street is located in the watershed (elevation 8 feet). Options presented are "to include construction of permanent or temporary barriers to flooding; to elevate or relocate instrumentation, electrical controls, computers and records; and to ensure backup power for pumps."

- **Communication campaign.** The study recommends that the town launch a campaign to educate the general public and property owners impacted by current and future flood risks. As with many education initiatives, the study makes the important point that "tools such as a communication packet are recommended to increase awareness of hazard mitigation and vulnerabilities at the sub-community level, as the threats from climate change are often hyperlocal."

- **Land use change, acquisition, and conservation.** General recommendations were outlined to use the upcoming revisions to the Plan of Conservation and Development, to suggest new policies that limit development in flood-prone areas and provide incentives to develop upland areas. Land acquisition, funded potentially through federal disaster-response or mitigation programs, is recommended by the study as an option for areas experiencing reoccurring flooding.

Waterford's *Coastal Resilience, Climate Adaptation, and Sustainability Study* identifies the following "Adaptation Strategies" in town and recommendations in the Niantic River watershed:

- **Buildings/Facilities.** Establish a Design Flood Elevation to determine the height of flood protection needed to protect infrastructure. For sanitary sewer pump stations, three of which were assessed as currently at high risk and seven at a medium risk of coastal flooding, specific guidelines from the New

England Interstate Water Pollution Control Commission's *Technical Report-16* should be followed.[42] Three adaptation strategies are described in the study as options for floodproofing the Mago Point Pump Station as well as one each for Oil Mill Pump Station and Stony Brook Pump Station. The study also assessed and prioritized waterproofing wastewater manholes located in the 100-year and 500-year FEMA floodplains.

- **Roadways.** A 130-foot section of Oswegatchie Road is vulnerable to flooding, which would significantly reduce access and egress at Sandy Point. The study presents three options: improve the road, reinforce embankments, or construct a new emergency road. On Niantic River Road, several locations are at a low elevation and vulnerable to flooding. Due to the length of road and challenges presented by existing development, the study recommends that embankments are reinforced to prevent further erosion.

- **Natural Resources.** The study recommends that a marsh assessment be conducted on Mago Point Marsh to understand the processes affecting the wetland (the marsh is partially located in the Niantic River watershed but drains primarily to Niantic Bay). Potential restoration may include improving tidal exchange, thin-layer deposition to accelerate accretion in the wetland, and minimizing edge erosion with oyster/clam shell bags.

The watershed communities should incorporate **nature-based solutions** (stormwater green infrastructure, living shorelines, marsh restoration, dunes, oyster beds, floodplain restoration, land acquisition, etc.), whenever possible, into climate adaptation implementation strategies. Nature-based solutions are projects that protect, restore, and/or manage an existing ecological system, and/or mimic natural processes, to safeguard public health and clean water, increase natural hazard resilience, and sequester carbon. Incorporating nature-based solutions in planning and design projects results in long-term, cost-effective strategies that benefit both human and natural systems. Nature-based solutions offer the following additional benefits to communities[43] as compared to traditional gray infrastructure solutions:

- Enhancing public safety by reducing risks from flooding, erosion, drought, and heat risks to vulnerable populations and community assets.
- Avoiding infrastructure costs of unplanned repairs and improving safety due to flooding and failure from intense rain events.
- Promoting biodiversity, which is important for our overall health and safeguarding natural resources like food, shelter, and water.
- Fostering ecosystem services, such as improving air and water quality, flood protection, groundwater recharge, carbon sequestration, and human health and well-being.

Table 3-11 summarizes recommendations relative to coastal and estuarine issues in the Niantic River watershed. Other recommendations in this watershed plan (e.g., stormwater and nonpoint source runoff, septic systems, vegetated buffers, etc.), whether implemented in upland areas or close to the Estuary, will also benefit water quality and support healthy aquatic ecosystems in the Niantic River Estuary.

[42] https://neiwpcc.org/learning-center/tr-16-guides-design-wastewater-treatment-works/

[43] Municipal Vulnerability Preparedness Program, Massachusetts Executive Office of Energy and Environmental Affairs, 2020.

Table 3-11. Coastal and estuarine recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Implement site-specific climate adaptation recommendations identified in the East Lyme and Waterford coastal resilience planning studies • Incorporate nature-based solutions into climate adaptation implementation strategies to benefit water quality and habitat	East Lyme and Waterford	5-10 years	• Assessments and/or Implementation projects completed	$$$$	NFWF Long Island Sound Futures Fund, FEMA funding programs, CIRCA (future funding programs), 319 NPS Grants, NRCS Watershed and Flood Prevention Operations Program and Regional Conservation Partnership Program
2. Determine if an assessment of Mago Point Marsh is needed to determine what restoration alternatives would benefit the Niantic River watershed	Private land owner, Waterford, CT DEEP, NRWC, ECCD, Consultant	2-5 years	• Feasibility study report and recommendations for implementation	$$$$	NFWF Long Island Sound Futures Fund, NOAA Coastal Resilience Grants Program
3. Preserve properties landward of marsh areas along the Niantic River Estuary to allow for marsh migration resulting from sea level rise	East Lyme, Waterford, land trusts	Ongoing	• Properties acquired or conservation easements obtained	$$$$	Local funds, land trusts, CT DEEP Open Space and Watershed Land Acquisition, USFWS National Coastal Wetlands Conservation Grant

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
					Program, NRCS Floodplain Easement Program
4. Increase support for shellfishing in the Niantic River (and Niantic Bay) through a combination of outreach, policy/regulations, and targeted restoration projects (e.g., eelgrass beds)	WELSCO, East Lyme, Waterford, CT DA/BA, NRWC	Ongoing	• Policy and/or regulatory changes, restoration projects implemented	\$ to \$\$\$\$	CT DOAG Farmland Restoration Program
5. Partner with CT DEEP Boating Division, local businesses, trade associations, and other stakeholders to explore how to reduce the impacts of water-based recreation in the Estuary. Consider: o Implementing BMPs for marinas and boaters (e.g., Clean Marinas Program, Clean Boaters Program) o enforcing boating speed limits and/or moving traffic farther offshore o limiting the number of moorings/boat slips in the Niantic River	CMTA, CT DEEP, Harbor Management Commission, East Lyme, Waterford, marina operators	2-5 years Ongoing (Marina BMP implementation)	• Policy changes and BMPs implemented with ongoing enforcement	\$\$	

\$ = \$0 to \$5,000   \$\$ = \$5,000 to \$10,000   \$\$\$ = \$10,000 to \$50,000   \$\$\$\$ = Greater than \$50,000
NRWC = Niantic River Watershed Committee   CT DA/BA = Connecticut Department of Agriculture/Bureau of Aquaculture
WELSCO = Waterford-East Lyme Shellfish Commission   CMTA = Connecticut Marine Trades Association
CIRCA = Connecticut Institute for Resilience and Climate Adaptation

3.4 Land Use Policy and Planning

Municipal land use plans and regulations help shape the development patterns within a watershed and can play a significant role in protecting water quality and other natural resources at the watershed scale. These commonly include municipal plans of conservation and development, zoning regulations, subdivision regulations, inland wetlands and watercourses regulations, and stormwater regulations, all of which influence the type and density of development that can occur within a watershed. Local land use regulations often vary by municipality within a watershed, and regulations are periodically revised in response to development pressure, shifts in attitude toward natural resource protection, and political and socioeconomic factors. Because a watershed management plan encompasses multiple municipalities, a watershed-based regulations review also provides an opportunity for towns or cities to compare their regulatory mechanisms to those of neighboring municipalities. By doing so, they can evaluate the relative merits of different approaches, adopt the best models, and improve region-wide consistency in how the common water resource is managed.

In 2009, the Nonpoint Education for Municipal Officials (NEMO) Program of the UCONN Center for Land Use Education and Research (CLEAR) reviewed land use regulations of 85 Connecticut towns. Recommendations for LID-friendly land use policies were identified for the four towns in the Niantic River watershed. The Town of Waterford's Zoning Regulations and Subdivision Regulations were recently revised to incorporate new stormwater management regulations.

Recommended Actions

- The Niantic River Watershed Protection Plan Update should be referenced by the watershed municipalities in future updates to municipal Plans of Conservation and Development (POCDs). The POCDs should emphasize that municipal land use agencies (i.e., inland wetlands and watercourses, planning and zoning, conservation) should consider the long-term protection and use of the watershed when implementing their statutory abilities to balance resource protection and development.

- Review land use regulations in the watershed towns for consistency in requiring/incentivizing sustainable development practices and protecting water quality. High priorities are to:

    - Review and update existing municipal land use policy and regulations to require and eliminate barriers to the use of green infrastructure and LID for new development and redevelopment projects and to meet MS4 Permit requirements. Evaluate the land use regulations in the four watershed towns for consistent application of GI/LID requirements for new development and redevelopment projects, especially in zoning districts of certain density or uses(s) and near the Niantic River and major tributaries. Incorporate the recommendations of the 2009 UCONN NEMO review, as applicable.

    - Support efforts to revise local wetland regulations for uniformity in the regulations and their enforcement throughout the watershed. For example, watershed towns currently regulate Upland Review Area (URA) at three separate distances from the edge of wetlands and watercourses (East Lyme and Waterford, 100 feet; Salem, 75 feet; Montville, 50 feet). It is recommended that all towns establish URA with a minimum width of 100 feet, as recommended by CT DEEP.

    - Ensure that all four watershed towns have an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the MS4 and an illicit discharge detection and elimination program to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.

- Expand on the existing efforts to develop watershed-wide planning and project management that brings together leaders, staff, business owners, and residents from the four watershed towns. Such focused coordination has already begun with the NRWC's Open Space Planning Workshop (February 2020) and, at a more regional scale, with the ECCD's Eastern Connecticut Stormwater Collaborative. For the Niantic River watershed, additional opportunities for cultivating inter-town cooperation and resource-sharing (i.e., funding) are MS4 compliance, buffer protection/restoration, tracking of water-quality monitoring data and installed BMPs, and outreach campaigns. Scheduling regular meetings, drafting a work plan, and identifying a "point person" are key to the success of coordinated planning.

- Prioritize planning, policies, and land use regulations to increase climate resilience. East Lyme and Waterford recently completed climate resilience planning studies that assessed vulnerabilities to present and future coastal flooding and recommended climate adaptation options. Climate adaptation strategies should incorporate nature-based solutions such as stormwater green infrastructure, floodplain restoration, land conservation, culvert upsizing, etc. Land use regulations should complement such plans by limiting development (and promoting mitigation) in high-risk areas and requiring vegetated buffers and setbacks along wetlands and watercourses. The Connecticut Institute for Resilience & Climate Adaptation (CIRCA) at UCONN has begun a coastal planning project, Resilient Connecticut. The planning tools and resources developed in this project should be tracked by stakeholders in the Niantic River watershed, and CIRCA's recommendations for plans, projects, and research should be incorporated in future plans and regulations.

    - Review the existing land use policies, plans, and regulations of the municipalities in the Niantic River watershed relative to climate change issues. Recommend new or modified land use policies and/or regulations that could be implemented by the watershed municipalities to enhance flood resilience, water quality, and ecological health in the Niantic River watershed with a focus on preserving undeveloped land, siting development in locations less vulnerable to flooding, and promoting designs that reduce runoff and are less likely to be damaged in a flood.

    - Conduct a watershed-wide road-stream crossing assessment to identify and prioritize culverts and bridges in the watershed for replacement and upsizing based on consideration of hydraulic capacity, geomorphic risk, structural condition, stream connectivity and aquatic passage, flood impact potential, and climate change. Upgrade existing vulnerable stream crossings by replacing crossings with more resilient and ecologically-friendly designs.

    - Update design storm precipitation amounts in local land use regulations and policies to promote more resilient storm drainage system and road crossing designs. At a minimum, stormwater and drainage-related infrastructure should be designed with storm intensities based on NOAA Atlas 14 (or the Northeast Regional Climate Center atlas) to represent current precipitation conditions. For more resilient water infrastructure design, including improved stream crossings, consider designing for a 20% increase in design rainfall intensity, which is consistent with climate change projections for extreme precipitation under a medium to high emissions scenario and a 50- to 100-year planning horizon.

    - Salem and Montville are encouraged to conduct climate change vulnerability assessments and adaptation planning to address vulnerable infrastructure, homes and businesses, water supplies, and natural resources, including policy recommendations.

- Consider re-establishing East Lyme's Aquifer Overlay Zones, which would include a zone along the lower reach of Latimer Brook. These regulations were removed from the municipality's Zoning Regulations in 2013. When active, the "recharge districts" provided protection areas needed for groundwater recharge of public drinking water supplies beyond the four Aquifer Protection Areas designated by CT DEEP in East Lyme. As an initial step in this implementation, a recommendation should be included in the East Lyme Plan of Conservation and Development being revised in 2020.

- Evaluate the feasibility of adopting overlay zones along river corridors, known as riparian overlay zones or streambelt zoning. These zones are designed to protect the natural systems adjacent to rivers, streams, ponds, etc. to protect water quality and mitigate flood risk, among other benefits. An Upland Review Area regulates activities but does not consistently protect riparian areas. As of 2017, 34 Connecticut towns had adopted river corridor protections through zoning, with some towns forming regional partnerships among several towns to protect major rivers (Farmington, Housatonic, and Shepaug Rivers) and estuaries (Connecticut River). For the Niantic River watershed, successful streambelt zoning could be modeled on these existing regulations and should consider the following components:
  - Focus the overlay zone by including the names or descriptions of wetlands and watercourses in the regulatory language.
  - Establish a setback of a specific distance, or phased setback. For example, a setback of 50 feet can be chosen, or a phased setback (e.g., 20'/30') can be established with greater protection required closer to the waterbody.
  - Limit disturbance by restricting designated activities from the zone, such as septic systems, timber harvest, excavation, and new structures.
  - Require vegetative cover that is natural and not landscaped or extensively managed (turf, garden beds). This includes limiting the removal of tree canopy, unless trees are identified by a qualified individual as a public safety hazard.

Table 3-12 summarizes land use policy and planning recommendations for the Niantic River watershed.

3.5 Open Space and Land Conservation

The value of open space to maintaining and improving water quality cannot be overstated. Undeveloped land, especially forest, provides the soils, vegetation, and the natural processes in terrestrial or aquatic ecosystems to collect, filter, and slowly release precipitation to groundwater and surface water. These functions are most effective when protected open spaces are well distributed in a watershed and occupy areas that protect waterbodies from stormwater originating in developed areas.[44] While the term open space can include buffers and public properties like athletic fields and parks, the management recommendations in this section concentrate primarily on undeveloped areas whose natural character and processes benefit water quality.

Elements of a number of open space planning documents in the four watershed towns have addressed land conservation in the Niantic River watershed. The analysis and recommendations of earlier open space plans in Salem and East Lyme were revised and incorporated into plans of conservation and development (all four towns have POCDs; East Lyme is currently drafting a POCD for 2020-2030, and Waterford expects to begin its next POCD update in 2022). Regional planning was completed by SCCOG in 2017, followed closely by CT DEEP's Connecticut

[44] Open Space Institute. 2018. *Literature Review: Forest Cover & Water Quality – Implication for Land Conservation*. 19 pages. s3.amazonaws.com/osi-craft/Forest-Cover-Water-Quality-Report-2018-6-30-Final.pdf?mtime=20181024125329

Table 3-12. Land use policy and planning recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Seek NRWC review on municipal Plans of Conservation and Development (POCD) and reference the Niantic River Watershed Protection Plan Update in future POCD updates	NRWC, municipalities	During next 10-year update	• Updated POCD	$	
2. Review and update existing municipal land use policy/regulations: to require green infrastructure and LID, to eliminate barriers to its use in new development and redevelopment projects, and to meet MS4 Permit requirements	Municipalities	2-5 years	• Adopted or revised land use regulations or policies	$$$	
3. Review municipal land use regulations in all four watershed towns for consistency and effectiveness for protecting water quality: • Promote the adoption of regulations that require GI/LID and minimum setbacks for areas of certain density, uses(s), and near the Niantic River and major tributaries • Revise wetland regulations for consistency in regulated areas (e.g., URA width) and enforcement • Ensure that all four towns have an illicit discharge ordinance or other regulatory mechanism	NRWC, SCCOG, municipalities	0-2 years	• Recommendations for consistent application of GI/LID stormwater requirements, wetlands regulations/Upland Review Area, and illicit discharge regulatory mechanisms	$$$	

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
4. Expand inter-town coordination of watershed-wide planning, project management, and communication	NRWC, SCCOG, ECCD, muni-cipalities, town commissions/ committees, CT DEEP, consultants	2-5 years and Ongoing	• Identification of a point person for each town and regular participation by all four watershed towns	$$	
5. Prioritize planning, policies, and land use regulations to increase climate resilience • Review existing land use policies, plans, and regulations. Recommend new or modified land use policies and/or regulations • Conduct a watershed-wide road-stream crossing assessment • Update design storm precipitation amounts in local land use regulations and policies • Conduct climate change vulnerability assessments and adaptation planning (Salem & Montville)	Municipalities, CIRCA (UCONN), consultants	2-5 years	• Policy review and recommendations • Road-stream crossing assessment results, including prioritized list of crossings for replacement • New policy or regulations requiring consideration of updated design storm precipitation • Climate resilience plans completed	$$$ $$$$ $$ $$$$	NFWF Long Island Sound Futures Fund
6. Consider re-establishing the aquifer overlay zones on the lower reach of Latimer Brook in East Lyme	East Lyme Planning & Zoning	2-5 years	• Feasibility evaluation recommendations	$$$	
7. Evaluate the feasibility of creating a riparian overlay zone (aka, "streambelt zoning") along the Niantic River and major tributaries	Municipalities	5-10 years	• Feasibility evaluation recommendations	$$$$	

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

NRWC = Niantic River Watershed Committee   CIRCA = Connecticut Institute for Resilience and Climate Adaptation

State Open Space 2018 Annual Report. Existing municipal POCDs address the need to protect riparian buffers (Salem), directly link land conservation to water quality (Montville), include thorough inventories of current and future open space (East Lyme), and stress the recreational value of open space (Waterford). In addition to public initiatives, the following private land trusts and organizations have current or future interests in land conservation in the Niantic River watershed: East Lyme Land Trust, Waterford Land Trust, Salem Land Trust, Avalonia Land Conservancy, New England Forestry Foundation, Save the River-Save the Hills, Friends of Oswegatchie Hills, Connecticut Audubon Society, and Woodsmen Land Trust.

In February 2020, NRWC organized a workshop for these stakeholders. The goal was to launch a collaborative approach among the various public and private entities working on open space preservation to identify the strategies needed and begin developing a framework for open space planning in the Niantic River watershed. Open space planning focused at the watershed level is an important step. Existing plans are defined by political boundaries larger than the watershed and generally contain objectives broader than improving water quality in the Niantic River watershed. Open space planning should be coordinated across the watershed, emphasizing the role of open space in protecting water quality and the ecological health of the Niantic River Estuary and its tributaries.

Table 3-13 summarizes open space and land conservation recommendations for the Niantic River watershed.

Recommended Actions

- Continue to build a coalition of Open Space Preservation Stakeholders focused on conservation of undeveloped land in the Niantic River watershed. As already defined during the February 2020 meeting, short-term actions are to identify and prioritize strategies (including funding), formalize communication among partners, and develop criteria or methodology for identifying parcels to protect. Medium- and long-term actions may include data collection related to other recommendations, and engaging community members through outreach programs or invitations to volunteers on site-specific projects or watershed-wide efforts for open space planning. Other partners may include public and private entities preserving farmland (and prime farmland soils).

- Develop goals and actions in future open space plans that are specific to improving and maintaining water quality in the Niantic River watershed. Conservation planning can be implemented at the watershed or sub-watershed scale to envision growth/conservation scenarios and make recommendations that identify undeveloped areas important to protecting water quality in tributaries and the Niantic River Estuary. For example, preservation can be recommended for: regions containing the headwaters of major tributaries, certain floodplains (e.g., Latimer Brook) and coastal buffers and uplands (e.g., Oswegatchie Hills) listed as high-priority acquisitions, and areas susceptible to coastal or inland flooding. In addition to targeting stormwater management and surface water quality, open space planning should emphasize the value of protecting stratified drift deposits and other areas known to recharge groundwater aquifers.

- Identify funding opportunities: work with town leaders to provide a line item for open space funding in municipal budgets; research grant programs offered by public agencies and private grantors to conserve land; consider localized fundraising campaigns for specific land acquisition projects.

- Identify protected open space for green infrastructure assessments, and conduct assessments for potential projects to install BMPs or restore/enhance streams and riparian areas. Parcel identification and assessments should be done with equal attention to the strategies and recommendations for climate resiliency in the watershed.

Table 3-13. Open Space and land conservation recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. **Continue to build a coalition focused on land conservation in the Niantic River watershed, and implement planning strategies**	NRWC, land trusts, CT DEEP, CT Audubon	2-5 years	• Planning framework, acquisition criteria; funding pursued/secured	$$$	Local funds, land trusts, CT DEEP Open Space and Watershed Land Acquisition, CT DEEP Recreation and Natural Heritage Trust Program
2. **Develop open space plans and planning goals that are specific to improving and maintaining water quality in the Niantic River watershed and/or its subwatersheds**	NRWC, land trusts, ECCD, municipalities, SCCOG	2-5 years	• Adopted planning goals/actions address water quality	$$	
3. **Identify funding opportunities, and secure funding for land acquisition**	Land trusts, municipalities, CT DEEP	Ongoing	• Funding sources identified, funding pursued/secured	$$	Same as above
4. **Identify open space for green infrastructure assessments, and conduct assessments**	NRWC, ECCD, consultants municipalities,	5-10 years	• Assessments conducted	$$$	
5. **Ensure conservation restrictions or similar mechanisms are in place on all public open space lands**	Municipalities, land trusts, NRWC	2-5 years	• Conservation restrictions secured	$$$$	Same as above
6. **Support the (CLCC) New London County Regional Land Trust Advancement Initiative and Regional Mapper tool**	NRWC, land trusts, SCCOG, municipalities	0-3 years	• Use of mapper tool to support open space programs	$	

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee
ECCD = Eastern CT Conservation District

- Ensure that public lands considered to be open space, including municipal lands and the New London Public Watershed Supply Areas, are in fact permanently protected by a conservation restriction or other type of legal instrument.

- Support the Connecticut Land Conservation Council (CLCC) in its three-year *New London County Regional Land Trust Advancement Initiative*, to provide training and technical assistance to land trusts in the county. The initiative includes the development of the Regional Mapper tool, compiling the most current digital parcel data from the towns and identifying both protected parcels and high priority unprotected parcels.

3.6 Education and Outreach

The successful management of the Niantic River watershed benefits from an informed, engaged and committed group of organizations, agencies, municipal officials and staff, and local community members. From the beginning, providing educational programs, initiatives, and materials to the community has been at the center of management efforts in the Niantic River watershed. Successful community education and engagement fosters a sense of stewardship that results in the adoption of behaviors that are supportive of natural resources provided by the watershed.

Existing Education and Outreach Programs

Existing education and outreach programs have been structured on recommendations in the 2006 NRWPP. The 2006 Plan recommended the education of "key stakeholders about watershed management issues and good housekeeping responsibilities ….by implementing a watershed management information and education campaign."[45]

Recommended outreach topics included the following goals:
- Increase stakeholder awareness about the link between public health (i.e., beach closures, shellfish closures) and sources of bacterial pollution in the Niantic River.
- Increase stakeholders' level of knowledge about nutrient loading and the health of the Niantic River Estuary.
- Educate stakeholders about the watershed management approach and the Niantic River watershed.
- Educate land use decision makers about the value of vegetated riparian buffers in the protection of water quality.

Water quality and the effects of nonpoint source (NPS) pollution on the Niantic River have formed the backbone of outreach efforts by NRWC. In 2010 NRWC launched a website, www.nianticriverwatershed.org, to provide information and useful resources about the watershed and water quality and to promote Committee programs and projects. The Committee attends Celebrate East Lyme Day each summer to raise public awareness and educate the public about the link between pollutants in stormwater (primarily nitrogen and bacteria) and the health of the Niantic River, and to promote current and ongoing projects and programs. NRWC also participates each year in the Outdoor Stormwater Classroom. The event, organized by the East Lyme School District and Department of Public Works, brings third-grade students from throughout the watershed to the Hole-in-the-Wall stormwater demonstration site for a day-long exploration of water quality concepts. NRWC Board members and the Watershed Coordinator have also presented the findings of the Committee's water quality monitoring program

[45] Niantic River Watershed Protection Plan, September 2006, Kleinschmidt & Associates (for CT DEP).

at regional and statewide conferences, including the 2014 and 2019 Connecticut Volunteer Water Monitoring Conferences.

Outreach activities and programs that NRWC has initiated since its inception in 2008 include:

2009:
- Partnered with the Children's Museum of Southeastern Connecticut in East Lyme to install Low Impact Development (LID) practices at the Museum.

2010:
- Niantic River Watershed Summit – The Watershed Summit introduced the NRWPP and the newly formed Niantic River Watershed Committee to municipal leaders, staff, commissions and committees, local, state and federal agency partners and the general public.
- Riparian Buffers – NRWC conducted a series of workshops with CT Sea Grant to introduce the NRWPP to the four watershed town land use commissions and staff, and promote the benefits of riparian buffers.
- Low Impact Development (LID) Workshop – NRWC invited CT DEP (now CT DEEP) to present a program to educate municipal land-use commissioners about low impact development as recommended in the Niantic River Watershed Protection Plan, and also to promote the use of the Stormwater/LID Review Checklist (developed by the NRWC in 2009) in municipal site plan review.

2011:
- Teacher Water Quality Loan Kit – NRWC developed a water quality loan kit, with simple water quality test kits for use by watershed teachers to teach watershed and water quality concepts in conformance with Connecticut Science Curriculum Standards.
- Landscaping for Water Quality – NRWC initiated a social marketing campaign to promote easily adopted residential yard care practices that are good for water quality, the Niantic River and Long Island Sound.
- Rain Barrel Sale – In support of the Landscaping for Water Quality social marketing program, NRWC held a rain barrel sale to encourage homeowners to re-use rainwater and reduce stormwater runoff.

2012:
- Oswegatchie Hills Nature Preserve Riparian Buffer Restoration – NRWC partnered with the Friends of the Oswegatchie Hills Nature Preserve and the Town of East Lyme to restore the riparian buffer along the shore of Clark Pond.

2014:
- Mago Point Demonstration Coastal Riparian Buffer – In partnership with the Town of Waterford, NRWC and local partners installed a demonstration coastal riparian buffer at Mago Point Park.

2017:
- Rain Garden Initiative – NRWC launched a Rain Garden Initiative to encourage homeowners to plant rain gardens to reduce stormwater runoff. The Initiative provides technical assistance and reimburses homeowners for a portion of the rain garden installation costs.
- Niantic River Community-Based Social Marketing Fertilizer Reduction Pilot Project – NRWC participated in a pilot project led by the Long Island Sound Study to encourage watershed residents living near or on the Niantic River to reduce the amount of fertilizer they apply to their lawns in order to improve water quality.

2018:
- 100 Rain Gardens in Eastern CT - Partnered with the Eastern Connecticut Conservation District (ECCD) to conduct a rain barrel workshop and install rain gardens at the Oswegatchie Hills Nature Preserve and Pine Grove to reduce stormwater runoff.

2019:
- Niantic River Watershed Behavior Change Public Outreach and Pump It Up Campaigns – Participated in Save the River – Save the Hills behavior change public outreach campaign to engage high school science

students to develop outreach messages and information in order to create behavior change that will result in a reduction of excess nitrogen and other pollutants to the Niantic River and Long Island Sound.

Future Goals and Core Outreach Messages

Core outreach messages should remain focused around water quality and the health of the Niantic River. Outreach messages should increase stakeholder awareness about nutrient loading and the health of the Niantic River Estuary and the link between shellfish closures and sources of bacterial pollution in the Niantic River. Education and outreach efforts to raise awareness of and address the sources and impacts of nonpoint source pollution should remain a priority. Additionally, outreach should address new challenges, such as the impacts of climate change, which may include sea level rise, storm surge, inland flooding, infrastructure, and water quality impacts.

At the stakeholder workshops held in October 2019, stakeholders prioritized outreach topics including homeowner BMPs (fertilizer use, septic system monitoring/maintenance, rain gardens and barrels), forest management planning, climate resiliency, and supporting fisheries/aquaculture. Future outreach should address the core messages surrounding nitrogen and bacterial pollution, while targeting these stakeholder-prioritized outreach topics. Future outreach topics should include:

- lawn fertilizer use reduction
- homeowner BMPs
- septic system maintenance
- use of nitrogen-treating septic systems in coastal areas
- preventing the feeding of waterfowl
- open space land acquisition, particularly of headwaters to the Niantic River
- support of shellfish restoration/aquaculture in the Niantic River and Bay
- impacts of climate change

Primary Audiences, Media Formats, and Tailored Messages

The NRWPP identifies a broad spectrum of audiences, from municipal staff and commissioners to watershed residents and students.

A variety of formats are available to deliver outreach messages. Electronic media such as organization websites, Facebook, Instagram, and Twitter deliver messages to a broad audience. Workshops, webinars and presentations deliver tailored messages about specific outreach topics and/or projects and programs to target audiences. Brochures and flyers passively impart both targeted and general information. News media, including local daily, weekly and monthly publications, have the capability to disseminate outreach information to a large audience.

Additional Education and Outreach Strategies

As it has done in the past, NRWC will continue to look for opportunities to expand outreach opportunities through collaboration with partner organizations in the watershed and throughout southeastern Connecticut.

3.7 Monitoring and Assessment

Continued monitoring and assessment is recommended to support implementation of the Niantic River Watershed Protection Plan Update, including water quality monitoring, streamwalk assessments, and track down surveys. The continued water quality monitoring program and related assessments will help to provide a baseline of water quality conditions, further characterize pollutant sources and problem areas, and develop more detailed action plans and site-specific restoration projects. *Table 3-14* summarizes monitoring and assessment recommendations, which are described in the following sections.

3.7.1 Water Quality Monitoring

As described in *Section 2.2*, the NRWC began implementing a comprehensive long-term water quality monitoring program for the Niantic River watershed based on recommendations in the 2006 Niantic River Watershed Protection Plan:

- In April 2012, NRWC initiated a monthly water quality monitoring program in Latimer Brook and Cranberry Meadow Brook, and the program was expanded in 2014 to include Oil Mill Brook and Stony Brook. This sampling recorded data on water quality parameters, including temperature, dissolved oxygen, pH, specific conductance, and nitrate concentrations.
- The monthly sampling concluded in March 2017. Beginning in 2017, quarterly wet weather monitoring was begun to study how stormwater runoff impacts nitrogen levels and other water quality parameters in Latimer Brook (samples taken at the Latimer Brook Pond Dam in East Lyme).
- Riffle Bioassessment for Volunteers (RBV) sampling, a voluntary citizen sampling program for aquatic macroinvertebrates administered by the CT DEEP, was performed during the fall from 2012 through 2019 at various stations in Latimer, Cranberry Meadow, and Stony Brooks. Sampling by NRWC was done in East Lyme in conjunction with the East Lyme Commission for the Conservation of Natural Resources and in Waterford with the town's Environmental Planner.
- Other groups including CT DA/BA, Dominion Energy, Save the River – Save the Hills (Unified Water Study, in partnership with Save the Sound), and the town of Waterford conduct regular water quality monitoring of the Niantic River Estuary, Niantic Bay, and inland tributaries to the estuary (sampling is also conducted per MS4 Permit requirements by East Lyme, Waterford, and Montville). The data, used by NRWC and municipalities, rely on the observed trends in watershed data to identify opportunities and support funding requests for water quality improvements.
- In 2021, NRWC will initiate the water quality monitoring of storm drain outfalls that discharge directly to the Niantic River. The purpose of this program is to document the pollution levels in specific storm drain systems, trace pollution to its source in the storm drainage area, and adopt actions to reduce or eliminate the pollution source.

Additional and ongoing water quality monitoring is recommended for the Niantic River watershed to address four objectives:

1. Improve the understanding of water quality impacts from pollution sources
2. Expand water quality monitoring or introduce new programs to tributaries not monitored previously
3. Measure the progress toward meeting watershed management goals and TMDL pollutant load reductions
4. Support the removal of the Niantic River and impaired segments of its tributaries from the CT DEEP impaired waters list.

Recommended Actions

- Consider expanding the current NRWC stream monitoring program to include bacteria (*E. coli* at freshwater locations and Enterococcus at saltwater locations) monitoring at stream sampling stations to measure progress toward achieving the watershed plan and TMDL pollutant load reduction goals for fecal indicator bacteria. Sampling should be conducted during the recreation season (April – October) under both wet and dry weather conditions.

- Expand the current NRWC stream monitoring program to include sampling of direct storm drain system outfalls to the Niantic River. Partner with municipal departments of public works to track documented pollution back to source in the storm drainage area and adopt actions to reduce and/or eliminate the pollution source.

- Prepare a periodic "Water Quality Report Card" for the Niantic River and its tributaries, modeled after similar report cards that have been prepared for other rivers and embayments around Connecticut and elsewhere in the U.S. The report card would provide a transparent, timely, and geographically detailed assessment of water quality to inform the public of water quality conditions as well as actions that are occurring to improve and protect water quality in the estuary and its tributaries. Report card scores are determined by comparing water quality indicators to scientifically-derived ecological thresholds or goals. The report card for the Niantic River watershed could integrate the results from the NRWC and other ongoing monitoring programs in the watershed.

- Work with CT DEEP and other partners to investigate why Latimer Brook has good to very good water quality (based on RBV macroinvertebrate samples), yet fish populations appear diminished.

3.7.2 Streamwalk Assessments and Track-Down Surveys

NRWC has conducted streamwalk assessments in the Niantic River watershed along sections of Latimer Brook. Additional streamwalk assessments are recommended along with visual track down surveys of actual or suspected pollutant sources identified during the streamwalks.

Recommended Actions

- Conduct streamwalk assessments within the Niantic River watershed following previously established Connecticut NRCS streamwalk protocols or alternate methodology. Future streamwalks should be conducted on a rotating basis along Latimer Brook, Cranberry Meadow Brook, Oil Mill Brook, and Stony Brook. Visual shoreline surveys are also recommended along the Niantic River Estuary to look for visual evidence of pollutant sources in developed areas of the shoreline. Future programs could include working with entities such as CT DA/BA, which conduct shoreline surveys for identifying pollutant sources and classifying shellfish growing areas.

- Following the streamwalks/shoreline surveys and evaluation of the assessment results, plan and conduct subwatershed visual track-down surveys of identified or suspected pollution sources, generally located in upland areas that drain to streams or the estuary. Visual track down surveys are a tool commonly used by the Connecticut Conservation Districts to help identify conditions responsible for water quality impairments in streams. The goals of the track down survey are to collect information on the possible causes of impairment and recommend and implement solutions to address the identified issues of concern. Watershed stream assessments and track down surveys should be updated every five to ten years to monitor changing watershed conditions and the progress of plan implementation.

3.7.3 Subwatershed Action Plans

Development and implementation of site-specific restoration and protection strategies is most effective at the subregional watershed scale for larger, regional watersheds such as the Niantic River watershed. Although this watershed plan identifies a number of site-specific recommendations and BMP concepts that are examples of the types of projects that could be implemented elsewhere in the watershed, the limited scope of this watershed planning effort did not allow for comprehensive field assessments of the entire watershed.

Recommended Actions

- Prepare and implement more detailed action plans for priority subregional or local basins based on the findings of water quality monitoring, streamwalk assessments, and track down surveys. Higher priority basins include those subregional and local basins associated with water quality impairments, as well as the subwatersheds known to have excellent water quality.
- Subwatershed action plans could be added and maintained as appendices to the overall Niantic River Watershed Protection Plan Update, relying on watershed background information, goals, and objectives contained in the larger watershed plan.

Table 3-14 summarizes monitoring and assessment recommendations for the Niantic River watershed.

Table 3-14. Monitoring and assessment recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Consider expanding the current NRWC water quality monitoring program to include the sampling at storm outfalls and bacteria monitoring at stream sampling stations	NRWC	Establish within 0-2 years, Seasonal sampling (Apr - Oct)	• Modified QAPP, volunteers trained, bacteria monitoring results/reports	$$ (annually)	Local businesses, NFWF, private foundations
2. Prepare a periodic "Water Quality Report Card"	NRWC	2-5 years	• Report card disseminated to stakeholders and the public	$$$	
3. Work with CT DEEP and partners to investigate causes of reduced fish populations in Latimer Brook	CT DEEP, NRWC, Trout Unlimited, consultant		• Report on analysis or research conducted	$$	NFWF
4. Conduct streamwalk assessments and track down surveys	NRWC and volunteers	0-2 years (repeat streamwalks every 5 years)	• Streamwalks and track down surveys conducted, survey results and recommendations	$$$	
5. Prepare and implement subwatershed action plans, or amend existing plans as needed	NRWC and consultant	2-5 years	• Subwatershed plans prepared/ amended and implemented	$$$	
6. Conduct field assessments of other areas considered important to water quality: • Wetlands • Lakes and ponds • Open Space. Assess protected lands and identify potential BMP projects.	Municipalities, NRWC, consultant, volunteers	5-10 years or as needed	• Assessments completed	$ to $$$	Local businesses, NFWF, private foundations

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
NRWC = Niantic River Watershed Committee   NFWF = National Fish and Wildlife Federation

4 Site-Specific BMP Concepts

Fuss & O'Neill conducted visual field investigations in January 2020 to assess potential sources of water quality impairments in the Niantic River watershed and to identify possible restoration opportunities. The assessments focused on identifying potential projects that would reduce bacteria and nitrogen loads in areas of the watershed with documented water quality impairments. Concepts for site-specific Best Management Practices (BMPs) were developed at priority sites based on the results of the visual assessments and input from the Niantic River Watershed Committee.

Site-specific Best Management Practice (BMP) opportunities were identified for a total of 24 sites in the Niantic River watershed based on the findings of the visual field assessments. The table in *Appendix D* contains information on pollution sources and potential BMP opportunities for the sites visited during the field assessments.

The site-specific BMP concepts presented in this section and indicated on the accompanying map (*Figure 4-1*) are intended to serve as potential on-the-ground projects for future implementation. They also provide examples of the types of projects that could be implemented at other sites throughout the watershed. It is important to note that the concepts presented in this section are examples of potential opportunities, yet do not reflect site-specific project designs. Individual project proponents (e.g., municipalities, private property owners, developers) are responsible for evaluating the ultimate feasibility of, as well as design, permitting, and maintenance of these and similar site-specific concepts.

Preliminary, planning-level costs were estimated for the site-specific concepts presented in this section, including operation and maintenance costs. These estimates are based upon unit costs derived from published sources, engineering experience, and the proposed concept designs. A range of likely costs is presented for each concept, reflecting the inherent uncertainty in these planning-level cost estimates. A more detailed breakdown of estimated costs is included in *Appendix E*.

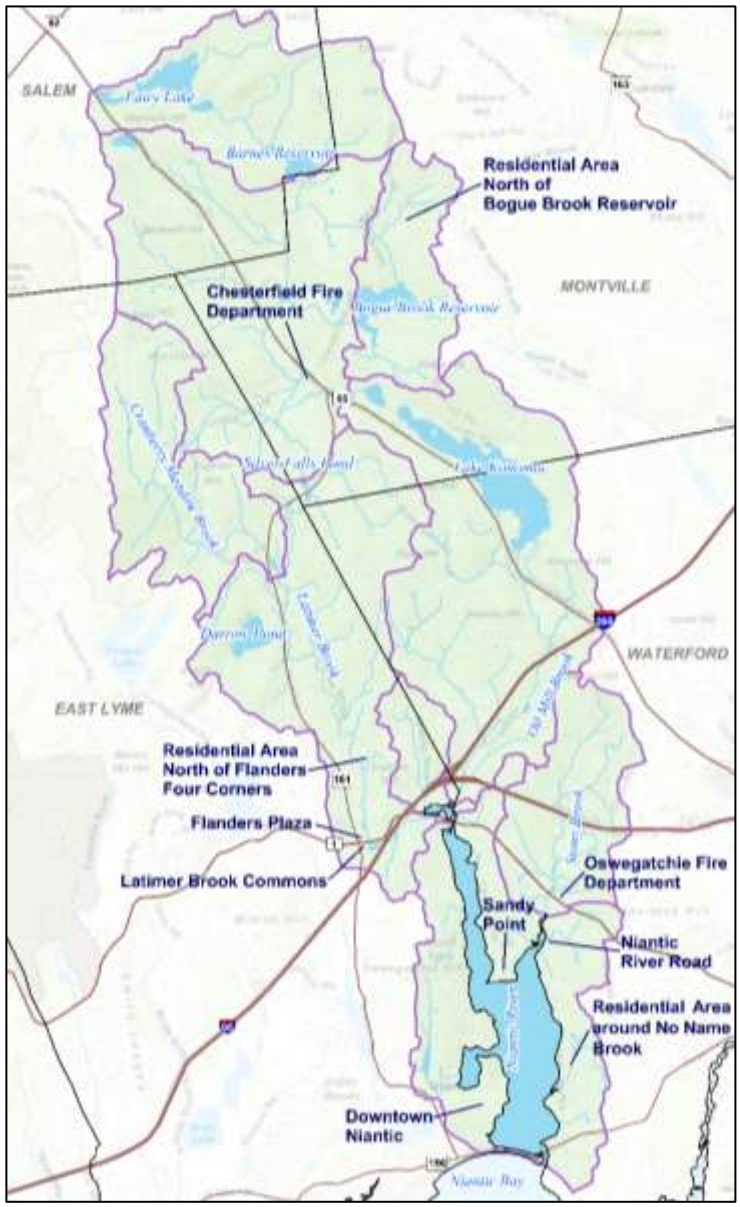


Figure 4-1. Locations of the 10 proposed site-specific BMP project concepts in the Niantic River watershed.

4.1 Flanders Plaza (Flanders Four Corners, East Lyme)

Located at 15 Chesterfield Road in East Lyme, Flanders Plaza is a privately-owned commercial development at the northeast corner of Boston Post Road (U.S. Route 1) and Chesterfield Road (State Route 161). The site lies immediately west of Latimer Brook-01 segment and contains approximately 5.2 acres of impervious cover (four separate buildings and parking). The site is nearly level with a moderate to gentle slope to the east towards Latimer Brook. As a result, the existing stormwater management system, which collects parking lot runoff and building roof drainage, discharges untreated stormwater at three outfalls near Latimer Brook's west bank. Available mapping shows that soils in the northern and eastern portions of the site are underlain by fine sandy loams, which are classified as having a moderate infiltration capacity (Hydrologic Soil Group B). The site's center is identified as "Urban land" and classified as having low infiltration Capacity (Group D).

At the north end of the parking lot, the existing stormwater management system appears to include a subsurface infiltration system to treat and infiltrate stormwater from the northwest portion of the developed area. At this time, only non-structural management practices are recommended to address the quality of stormwater discharges from the northern portion of the site; these recommendations are listed below.

Stormwater collected on the southern portion of the site is conveyed to the southeast corner, where it is discharged to the floodplain of Latimer Brook. Near the outfall, available land area and moderate infiltration capacity of soils (Group B) make the location a good candidate for a BMP to intercept and infiltrate stormwater. The site is visible and sufficiently accessible to utilize as a demonstration site for other commercial properties at Flanders Four Corners or similar areas in the Niantic River Watershed. This retrofit would complement existing outreach by CT DEEP at the Latimer Brook fish ladder, located about 0.1 mile to the east.

Proposed retrofit concepts for this site are shown in *Figure 4-3.*

- **Bioretention Basin.** A bioretention basin of approximately 1,600 square feet with a sediment forebay is proposed for the southeast corner of the existing parking lot. The southern catchment of the site of approximately 2.1 acres discharges near this location and can be effectively diverted to the proposed

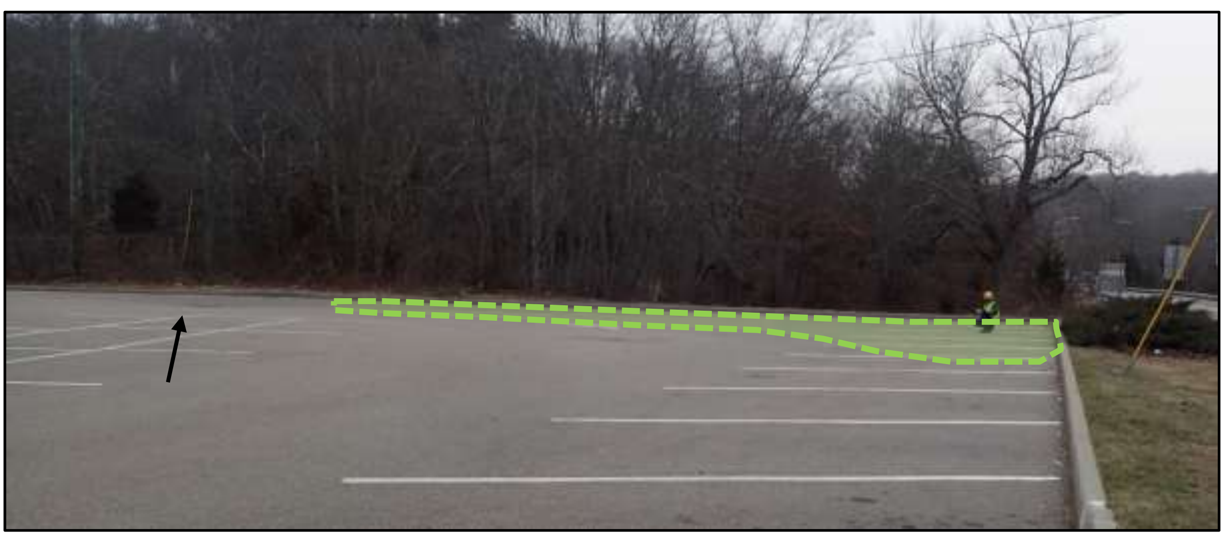


Figure 4-2. Dashes indicate approximate area of proposed bioretention basin at Flanders Plaza. Arrow indicates location of existing manhole to be retrofitted with diversion structure. Looking east.

basin. Additionally, the west edge of the basin can be designed to capture additional sheetflow from the parking lot. Access to the bank's drive-thru teller services and loading docks behind the building can be maintained by locating the basin in the corner and out of travel lanes to these areas. At the proposed size and location, four parking spaces would be lost. The basin footprint could be reduced to minimize impacts to existing parking, which would result in the capture and treatment of less stormwater from the site, or alternatively, a more costly subsurface infiltration system could be installed below the parking lot to avoid impacts to existing parking.

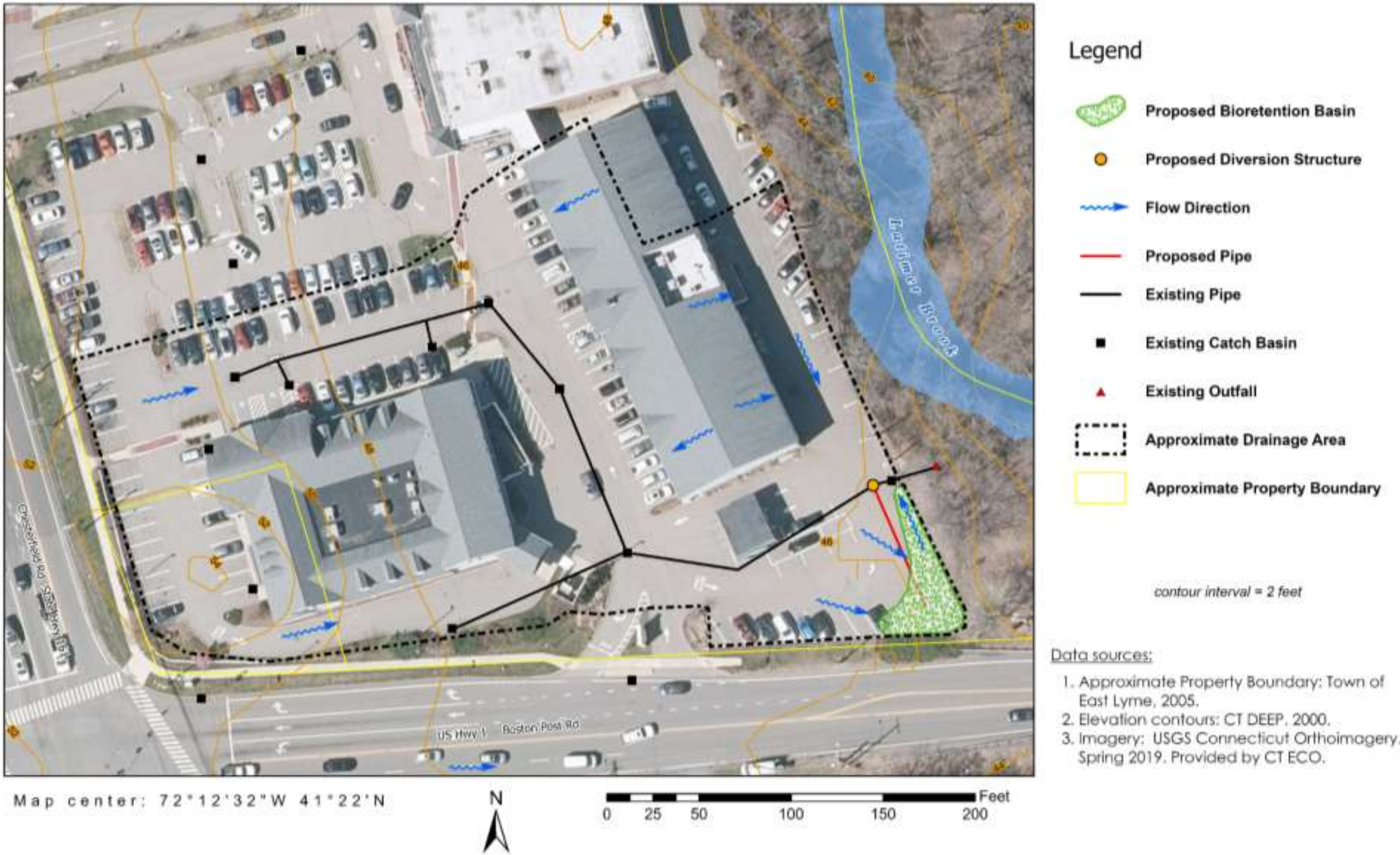
- **Diversion Structure.** An existing manhole near the proposed bioretention basin can be retrofitted with a diversion weir inside the structure. The weir would divert stormwater from routine, smaller storms to the proposed BMP. In more intense storms the initial "first flush" of stormwater would be diverted to the basin, and larger flows would go over the weir, bypassing the basin and discharging to the existing outfall.

- **Non-Structural Management Practices:**

    - **Management of Dumpster Areas.** Dumpsters are currently located: one along the parking lot's northern edge; a minimum of three behind the site's largest buildings (eastern edge); and one next to the exit to Boston Post Rd (U.S. Route 1). During the field assessment of the site, it was observed that leachate from the dumpsters has entered the stormwater system via catch basins or directly toward Latimer Brook via sheetflow off the parking lot. Dumpsters should always be kept closed to contain debris and minimize exposure to stormwater, and leaking dumpsters should be replaced. For additional protection, a containment system consisting of spill containment grooves could be incorporated into the pavement/dumpster pads to further prevent pollutants from being carried into the storm drainage system. It is recommended that dumpsters are relocated or the existing locations are improved to prevent leachate from entering the storm drainage system.

    - **Assessment of Existing BMPs.** The status of other existing source controls or structural BMPs at the site is not known. The property may have a stormwater management plan filed with the town of East Lyme or coverage under the CT DEEP Commercial Stormwater General Permit and an associated Stormwater Pollution Control Plan, which may describe the desired function of these BMPs and related maintenance tasks and schedules. Stakeholders should conduct outreach to this and other large commercial property owner(s) in the watershed regarding proper implementation and maintenance of source controls and structural BMPs.

Figure 4-3. Stormwater Retrofit Concept: Flanders Plaza
(15 Chesterfield Road, East Lyme)



Data sources:

1. Approximate Property Boundary: Town of East Lyme, 2005.
2. Elevation contours: CT DEEP, 2000.
3. Imagery: USGS Connecticut Orthoimagery, Spring 2019. Provided by CT ECO.

4.2 Latimer Brook Commons (Flanders Four Corners, East Lyme)

Latimer Brook Commons, at 339 Flanders Road, is a privately-owned commercial property located on the southeast corner of the intersection of Flanders Road (State Route 161) and Boston Post Road (U.S. Route 1). The upland portion of the property contains a large commercial building and parking, comprising approximately two acres of impervious area. Approximately 50 feet east of the developed area is a pond that connects to the impaired segment Latimer Brook-01. Soils under the developed area have been classified by USDA-NRCS as "Udorthents- Urban land complex" and "Urban land" and are rated as having moderate infiltration capacity (Hydrologic Soil Group B).

The site is gently-sloped eastward toward Latimer Brook, with its lowest elevation east of the building and closest to the brook. A storm drainage system and curbing prevent runoff from directly entering the brook, though untreated stormwater is discharged directly to the pond. Stormwater in the parking lot is intercepted by a total of four catch basins. The building's downspouts are presumed to be connected to this drainage system.

Due to the underground utilities and limited amount of usable land area for surface BMPs, the concept proposed for Latimer Brook Commons relies on subsurface or small-footprint BMPs to be installed strategically around the property to reduce the volume of stormwater entering the drainage system. Additional opportunities for low-cost/low-tech BMPs or more complex stormwater retrofits may exist but would require review of site plans or as-built drawings depicting the actual configuration of the existing site drainage system.

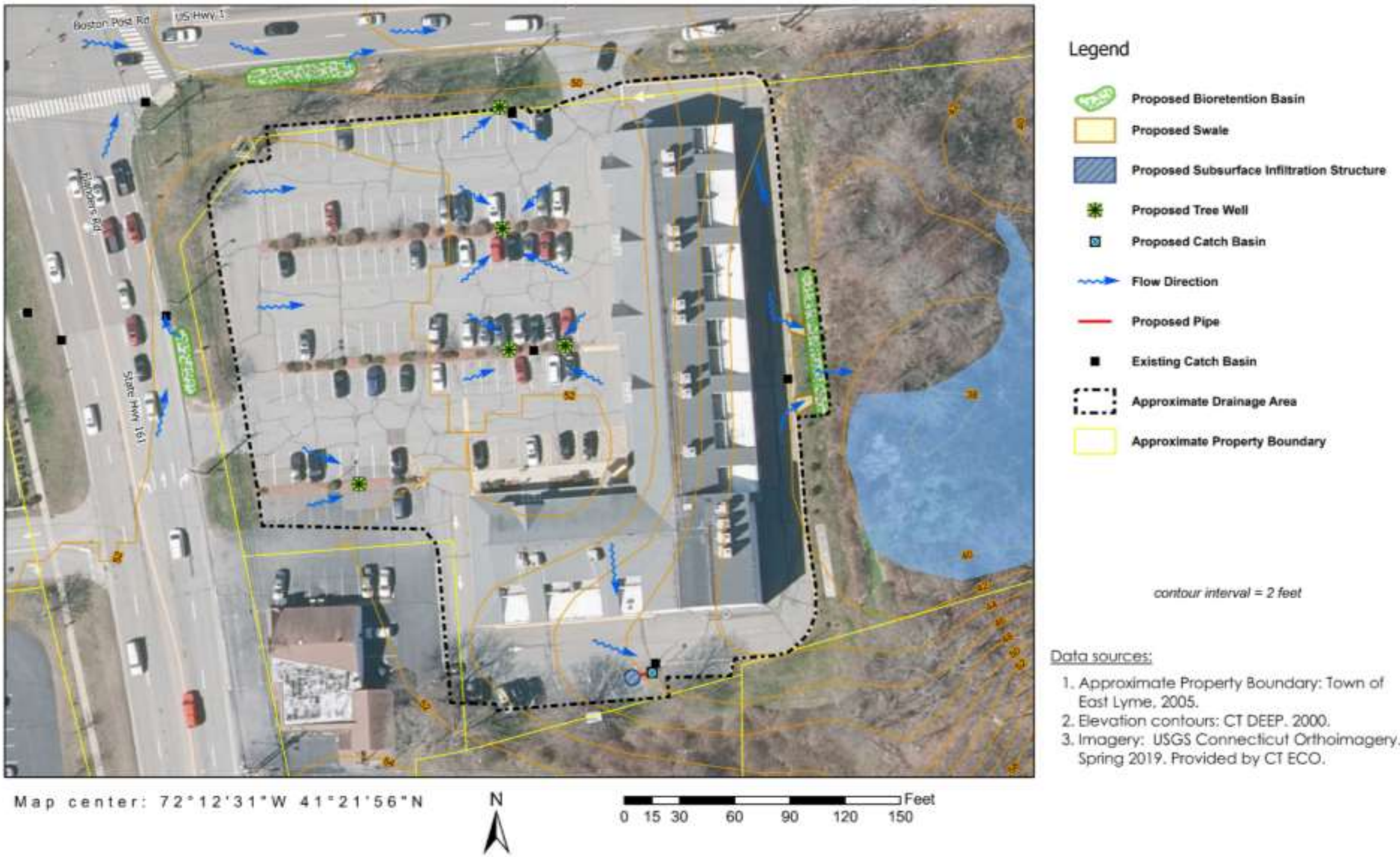
Proposed concepts for this site are shown in *Figure 4-4.*

- **Bioretention Basin.** A long and narrow bioretention basin of approximately 600 square feet is proposed for the berm that separates the parking access drive behind the building from the pond/wetland associated with Latimer Brook. Stormwater would enter the practice via curb cuts to two shallow swales to be constructed on either side of the existing catch basin. Overflow from the bioretention basin can be directed to the existing catch basin or over the swale's eastern berm to the pond.

- **Subsurface Infiltration System.** A leaching catch basin is proposed as a retrofit for the existing catch basin on the south side of the building. The leaching catch basin is a perforated concrete manhole structure that is installed below the existing grade to receive and infiltrate a relatively high volume of stormwater. To accomplish this, a new catch basin is proposed upgradient of the existing catch basin, and the existing catch basin grate would be replaced with a solid cover. The parking lot in the immediate area would be regraded to the new catch basin, which would drain to a pretreatment structure to remove solids and floatable materials, including oil, prior to the leaching catch basin. Overflow would return to the existing drainage system. While this type of implementation is more costly, it is highly effective and one of the few BMPs that is applicable to internal parking lot catch basins (i.e., catch basins surrounded by pavement as opposed to curb inlet catch basins). Similar subsurface systems have been installed by the Town of East Lyme with success at East Lyme High School.

- **Tree Wells.** Five tree wells are proposed as retrofits for the main parking lot. Tree wells are low-cost tree filters that accept pavement runoff before it enters the existing drainage system and infiltrates the runoff into the existing soils. Their locations have been selected to intercept stormwater upgradient of existing catch basins or in places where stormwater flow lines were observed.

Figure 4-4. Stormwater Retrofit Concept: Latimer Brook Commons
(339 Flanders Road, East Lyme)



Data sources:

1. Approximate Property Boundary: Town of East Lyme, 2005.
2. Elevation contours: CT DEEP, 2000.
3. Imagery: USGS Connecticut Orthoimagery, Spring 2019. Provided by CT ECO.

Also depicted in this design concept in *Figure 4-4* are two bioretention basins along the public roads adjacent to Latimer Brook Commons. While the rights-of-way along these roads are outside of the property's drainage area, the southeastern and southwestern corners of the intersections contain roadside areas that are large enough to support a number of linear bioretention basins within the State right-of-way. The locations shown in *Figure 4.4* were selected for the apparent absence of underground utilities.

4.3 Residential Area North of Flanders Four Corners (East Lyme)

This suburban residential development is located primarily east of Chesterfield Road (State Route 161) between East Lyme High School and Darrow Pond. At approximately 0.9 square mile, the area of interest for this concept extends from Egret Road to the south to Greentree Drive to the north. Beginning in the late 1950's, these neighborhoods were constructed in woodlands and farmland along the east and west side of Latimer Brook-01 segment. Most of the roads are served by storm drainage systems, which discharge untreated stormwater to Latimer Brook or wetlands and unnamed tributaries in the brook's watershed. The majority of upland adjacent to Latimer Brook contains developed areas consisting of impervious surfaces (structures, roads, driveways) and turfgrass. All homes rely on individual septic systems for wastewater disposal, and it is possible that the age and proximity of some systems contribute to the impairment of Latimer Brook. Fertilizer use is likely another contributor.

The goal of this retrofit concept is to utilize areas within the municipal or private rights-of-way for surface infiltration systems, mainly tree wells and bioretention basins. These efforts will build upon the work already begun in this area on Colony Drive, where ECCD and the NRWC partnered to install five tree wells. Colony Road is representative of a number of "priority streets" identified that have drainage systems that discharge untreated stormwater to Latimer Brook or connected waterbodies. Priority streets in these neighborhoods are:

- Bobwhite Lane
- Brookfield Drive
- Cavasin Drive
- Cedarbrook Lane
- Colony Road
- Goldfinch Terrace
- Greentree Drive
- Irvingdell Place
- Latimer Drive
- Joval Street
- Mayfield Terrace
- Qualicrest Road
- Sandpiper Lane

A number of factors (e.g., available land area, private ownership, available roadside right-of-way) will determine the feasibility of installing BMPs, as well as their specific placement and type. As such, the design concept provided here depicts three examples of neighborhoods that are representative of the recommendations that should be pursued throughout this area, with a focus on the priority streets listed previously. Most of the area contains soils mapped by USDA-NRCS as sandy loam and loamy sand with high to moderate infiltration capacity (Hydrologic Soil Groups A and B).

Proposed retrofit concepts for this site are shown in *Figure 4-5.*

- **Bioretention Basins.** Cul de sacs are common in this area, and a number of them have, at their terminus, a circular island containing turfgrass. Not all are suitable for BMPs due to the configuration of the existing drainage system and surface runoff flow patterns, but many are. The retrofit concept shows how these cul de sac islands can be used for bioretention basins whether drainage is towards the terminus, as on Bluebird Circle and Mallard Circle (*Figure 4-5* left), or away from the terminus, as on Tern Court and Meadowlark Lane (right). When runoff drains toward the terminus, there is often a drainage system and associated outfall to consider. In the latter situation, a bioretention basin may be effective but flow patterns and other site conditions should be evaluated to determine if a bioretention basin is the best BMP. For example, the island and road surface at Tern Court is crowned, directing stormwater to the cul de sac's outer curb. In this case, tree wells at the intersection are preferred. The median on Meadowlark Lane, on the other hand, has potential to intercept stormwater from the steep slopes and residential properties before it enters the drainage system.

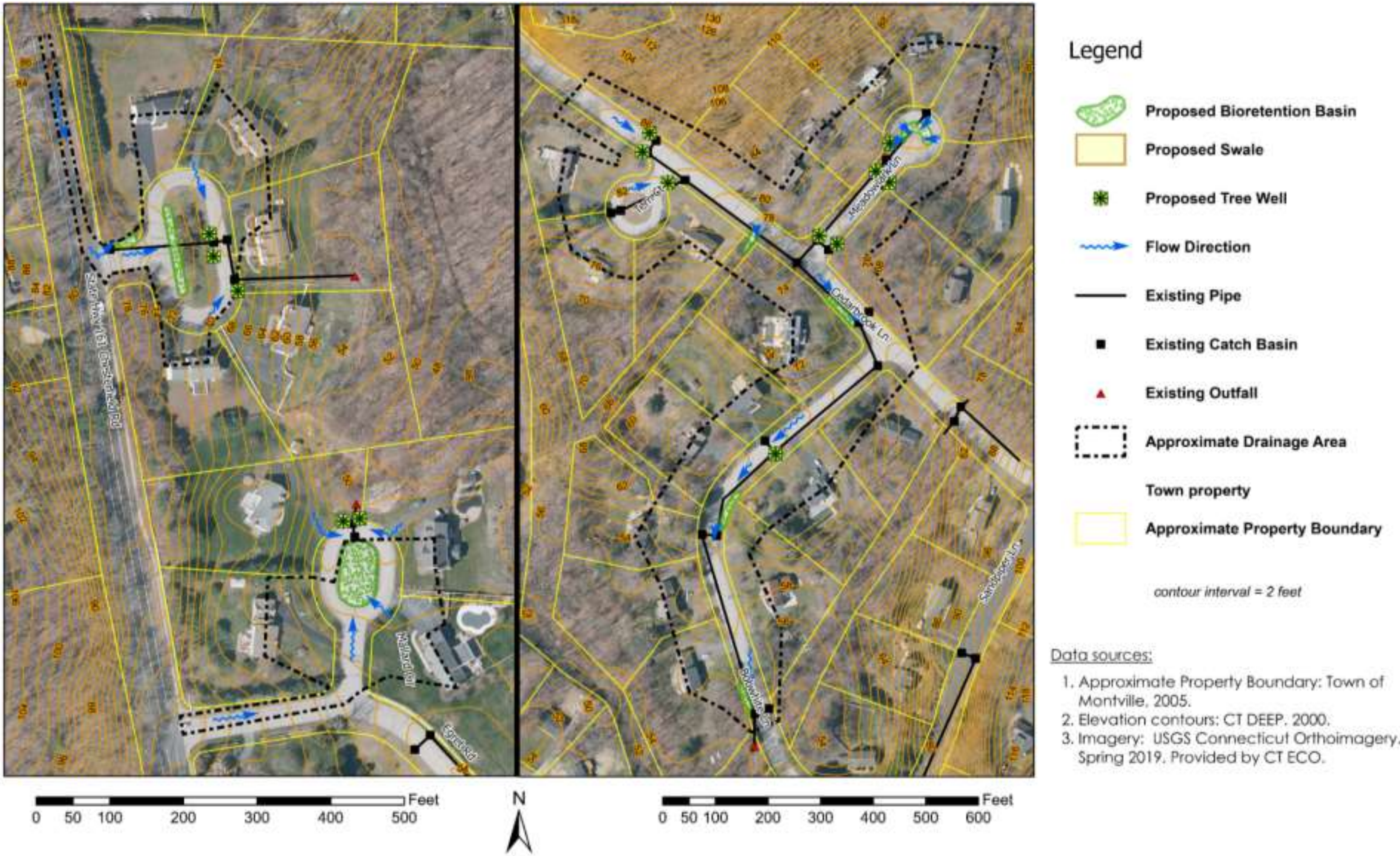
  In addition, three bioretention basins are proposed for roadside rights-of-way applications on Cedarbrook Lane and Bobwhite Lane. The basin closest to Tern Court is proposed to be located on municipal property and the right-of-way.

- **Tree Wells or Tree Filters.** In the two areas shown in *Figure 4-5*, a total of 14 tree wells are proposed for locations upgradient of existing catch basins and along the roads. Like the design concept for the Residential Area around No Name Brook in Waterford (S*ection 4.9*), the network of drainage systems mean that, pending homeowner support and funding, up to 50 additional tree wells could be installed in these areas.

- **Homeowner Best Management Practices.** These neighborhoods should be targeted for outreach on homeowner and residential BMPs to improve water quality. Due to the number of land owners involved, each recommendation should be thought of as a two-phase approach, requiring initial and ongoing outreach to homeowners (phase 1) in order to build awareness and support to implement best practices (phase 2). See Section 3.6 for recommendations regarding education/outreach opportunities for residential areas. See Section 3.2.2 for recommendations that would continue support for homeowners to disconnect impervious areas and adopt other non-structural BMPs. In summary, these recommendations are:

  - Evaluation, repair, and maintenance of septic systems
  - Restoration of riparian buffers to Latimer Brook and associated streams and wetlands. Priority streets for this recommendation are: Brookfield Drive, Cavasin Drive, Cedarbrook Lane, Colony Road, Latimer Brook Drive, Quailcrest Road, Sandpiper Lane, and Sylvan Glen Drive.
  - Installing rain gardens and rain barrels and other low-cost methods for disconnecting impervious surfaces (roofs, driveways, etc.) from the storm drainage system
  - Reducing the application of fertilizer

Figure 4-5. Stormwater Retrofit Concept: Residential Area North of Flanders Four Corners
(East Lyme)



Data sources:

1. Approximate Property Boundary: Town of Montville, 2005.
2. Elevation contours: CT DEEP, 2000.
3. Imagery: USGS Connecticut Orthoimagery, Spring 2019. Provided by CT ECO.

4.4 Sandy Point (Park Drive, Konomoc Drive, Shawandassee Road, Waterford)

Sandy Point is a coastal residential area, located between Keeney Cove and the narrowed portion of Niantic River Estuary east of the Oswegatchie Hills in East Lyme. Most roads are served by storm drainage systems that discharge to the estuary, although some outfalls discharge to the undeveloped woodlands and wetlands central to Sandy Point. The Town of Waterford has retrofitted at least two drainage systems with hydrodynamic separators to treat stormwater discharging west of Riverside Drive. As indicated by its name, upland soils on Sandy Point where BMPs are recommended are described by USDA-NRCS as fine sandy loams with high infiltration capacity (Hydrologic Soils Group A).

This design concept focuses on retrofits to the storm drainage system that drains the southernmost portion of Sandy Point, an approximate drainage area of 7 acres. The southern ends of Park Drive, Konomoc Avenue, and Shawandassee Road have separate drain lines that come together between 21 and 25 Park Drive near a 30-foot wide public walking path to a small beach. The main storm drain line is located beneath this undeveloped path and discharges at the beach. The objective of this concept is to take advantage of municipal property with high infiltration capacity in addition to retrofitting the catchment area with tree wells in strategic locations.

Proposed concepts for this site are shown in *Figure 4-7.*

- **Subsurface Infiltration System.** The limited area within the public right-of-way makes subsurface infiltration chambers the most feasible BMP for infiltrating moderate to large volumes of stormwater. As shown in *Figure 4-6*, approximately 350 square feet of potential space for subsurface infiltration is available under the existing beach access alongside the main drain line. A pre-treatment structure, similar to those already installed on Riverside Drive, should be considered for the most down-gradient manhole on Park Drive.

- **Tree Wells.** A total of 13 tree wells are proposed for Park Drive, Konomoc Drive, and Shawandassee Road. These would be placed upgradient of existing catch basins, thereby decentralizing the infiltration through the drainage area. In this application, tree wells are separate from the storm drainage system. If property owners are supportive or rights-of-way are large enough, bioretention basins and/or bioswales along the road could be added or replace the proposed tree wells.

- **Pavement Replacement with Pervious Surface.** Pavement at the southern end of the municipal right-of-way could be replaced with a pervious surface, native vegetation, or turfgrass. Currently, the location is fairly steep and allows stormwater, including its load of sediments and dissolved pollutants, to flow directly into the existing catch basin which then immediately discharges to the Estuary.

- **Homeowner Best Management Practices.** These neighborhoods should be targeted for outreach on homeowner and residential BMPs to improve water quality. Due to the number of land owners involved, each recommendation should be thought of as a two-phase approach, requiring initial and ongoing outreach to homeowners (phase 1) in order to build awareness and support to implement best practices (phase 2). See Section 3.6 for recommendations regarding education/outreach opportunities for residential areas. See Section 3.2.2 for recommendations that would continue support for homeowners to disconnect impervious areas and adopt other non-structural BMPs. In summary, these recommendations are:
    - Evaluation, repair, and maintenance of septic systems

- Restoration of vegetated buffers along the Niantic River Estuary. Depending on the location, buffers may be effective for stormwater management or deterring waterfowl.
- Installing rain gardens and rain barrels and other low-cost methods for disconnecting impervious surfaces (roofs, driveways, etc.) from the storm drainage system
- Reducing the application of fertilizer
- Disposal of pet waste

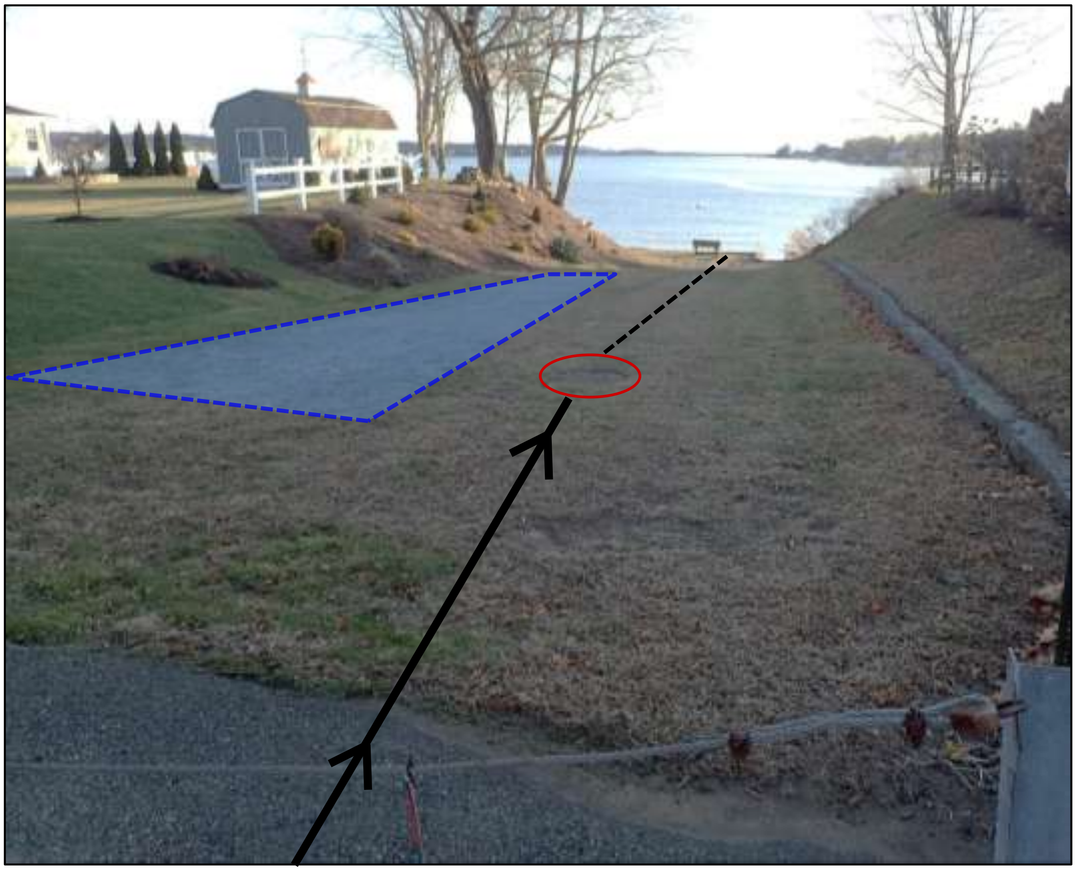


Figure 4.46. Beach access from Park Drive in Waterford. The dashed polygon represents the approximate area for a subsurface infiltration system. The solid black line is the main drain line, and dashed black line depicts the presumed path of the main drain line to the outfall.

Figure 4-7. Stormwater Retrofit Concept: Sandy Point
(Waterford)

4.5 Oswegatchie Fire Department (441 Boston Post Road, Waterford)

This complex is home to the Oswegatchie Fire Company #4, one of five fire companies that serve the Town of Waterford. It is located in the watershed of Stony Brook-01 segment, currently listed by CT DEEP as impaired for recreation due to elevated bacteria levels. Stony Brook crosses under Boston Post Road (U.S. Route 1) approximately 850 feet northwest of this site. Less than 40 feet from the rear edge of the fire department's parking lot, an unnamed tributary to Stony Brook flows northwesterly and joins Stony Brook in 0.3± mile. The site slopes moderately toward this stream, and no storm drainage system or curbing is present to prevent runoff from leaving the parking lot (it is unknown if an old catch basin, near the rear entrance of the garage, is functioning). Two catch basins in front of the complex appear to drain to the drainage system in the road. While a few downspouts drain subgrade or connect to the on-site drainage system, most drain onto the parking lot and small landscaped areas at the department's main entrance.

Existing site conditions allow for a straightforward and low-cost design for this retrofit concept. The parking lot, garage entrance, and driveway along the northern boundary are sloped to the rear edge of the pavement, which has no curbing. Along this edge, enough land area is available to construct infiltration practices to adequately treat the site's drainage area. The soils here are described as sandy loam and classified by USDA-NRCS as Hydrologic Soils Group B/D, meaning that drained areas (i.e., upland) have moderate infiltration capacity while undrained areas (i.e., low elevation) have very low infiltration capacity. The property boundary is mapped as being between the parking lot and the tributary, which would require the support of the landowner of the adjacent property (450 Boston Post Road).

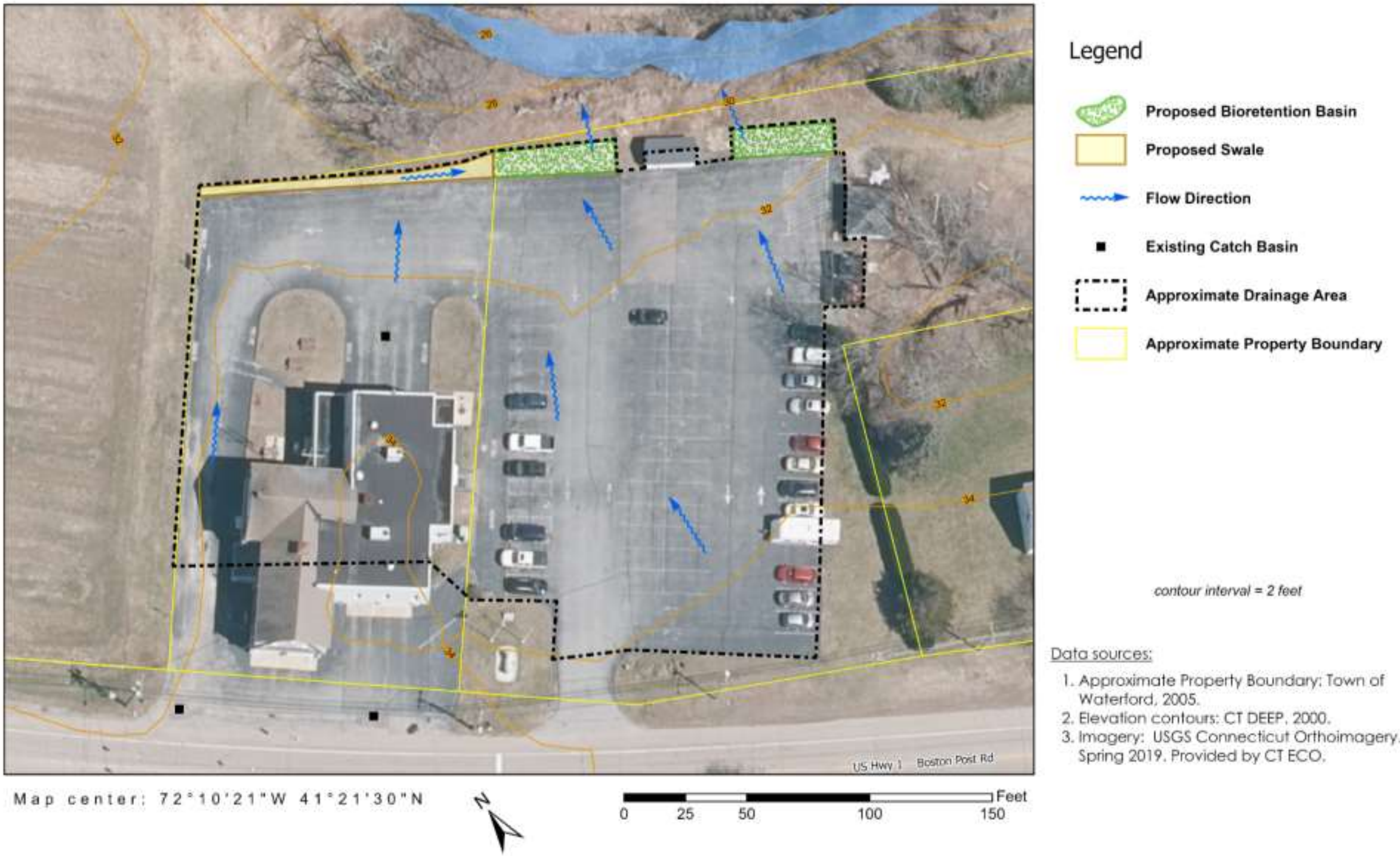
If the parking lot or the entire complex are renovated in the future, such a large-scale redevelopment of the site would be an ideal opportunity to implement more comprehensive, integrated LID strategies.

Proposed retrofit concepts for this site are shown in *Figure 4-9.*

- **Bioretention Basins and Swale.** Two bioretention basins are proposed for the flat upland between the parking lot and the tributary. The basins measure approximately 45 feet long and 15 feet wide and would be located on either side of an existing shed. This placement is preferred in order to intercept runoff from the parking lot. To treat runoff from the garage entrance and driveway, a vegetated swale of approximately 120 feet long would be constructed along the remainder of the parking lot's edge to convey stormwater to the closest basin for treatment (*Figure 4-8*). Overflow from either basin would be directed northward toward the tributary. If the existing shed is considered for removal or replacement, this concept should be amended to construct one continuous bioretention basin along the rear edge of the parking lot.

Figure 4.5. Parking lot at Oswegatchie Fire Department looking southeast. Area in foreground indicates the location of a proposed swale to convey stormwater to a proposed bioretention basin (dashes).

Figure 4-9. Stormwater Retrofit Concept: Oswegatchie Fire Department
(441 Boston Post Road, Waterford)



4.6 Chesterfield Fire Department (1606 Hartford-New London Turnpike, Montville)

Located at the intersection of Grassy Hill Road and Hartford-New London Turnpike (State Route 85), this complex houses the Chesterfield Fire Company, a volunteer company that has served the town of Montville since 1947. The site occupies a small upland area of 1.5± acres, which was likely expanded with fill for its development. This drainage area is bordered to the west by a large wetland associated with Latimer Brook-02 segment; Latimer Brook is 400± feet west of the edge of the parking lot, and wetlands are located down an embankment within 20 feet. West of the parking lot and facilities is a fire pond, constructed between 1986 and 1995. Access to the pond's hydrant is in the western corner of the parking lot.

The land use and site characteristics are similar to those at the Oswegatchie Fire Department in Waterford (*Section 4.5*). No undeveloped or undisturbed area is present, as impervious surfaces and a small amount of landscaped areas – mainly turfgrass – comprise the entire site. A moderate slope across all driveways and parking areas conveys runoff to the undeveloped edge of the pavement, where runoff can drain to the surrounding wetland. Additionally, stormwater on the south side of Route 85 appears to flow onto Grassy Hill Road and into the fire department's rear parking lot. A significant difference from Oswegatchie Fire Department is the lack of a storm drainage system here for the paved areas or building's roof drainage. All downspouts drain at the surface and exit the site as sheetflow to the adjacent wetland.

Soils where proposed BMPs are located are classified by USDA-NRCS as Hydrologic Soils Groups A/D and B/D. This split classification means that drained areas (i.e., upland) have moderate infiltration capacity while undrained areas (i.e., low elevation) have very low infiltration capacity. However, this mapping is not intended to apply at this small scale, and soils may have been modified or material added to construct the facility. For the following recommendations, soils should be investigated to determine their composition and evaluate infiltration capacity. A soil investigation can be done simply with soil auger or a shovel. Infiltration rates can be estimated based on soil textural classifications and typical infiltration rates for different soil types (see the do-it-yourself infiltration estimation method used by USDA-NRCS[46]), although field-measured infiltration rates using a double-ring infiltrometer or similar methods in accordance with the *Connecticut Stormwater Quality Manual* are preferred.

Proposed retrofit concepts for this site are shown in *Figure 4-12.*

- **Linear Bioretention Basin.** The primary BMP for the site is a linear bioretention basin/bioswale that extends across the western edge of the parking lot (*Figure 4-10*). The basin would measure approximately 110 feet long and 12 feet wide and would effectively intercept the majority of runoff from the parking lot and building. A water quality swale would be retrofitted along the remaining edge of the parking lot and convey stormwater to the bioretention basin. To gain the space needed for this retrofit, it is recommended that the basin be installed within the footprint of the existing parking lot. Moving the basin slightly upgradient and away from the wetland would have the added benefit of improving infiltration capacity. This would result in a small reduction in parking area but would not alter the parking plan or affect access for the fire equipment. Overflow could be a specific point at the north end of the basin or be distributed to the wetland along the basin's west side.

- **Bioretention Basin.** A second bioretention basin could be constructed on a small upland area along the site's northern edge. Stormwater at the front of the complex flows around the building to the northwest

[46] Soil Quality Institute, USDA-NRCS. 2001. *Soil Quality Test Kit Guide*. Section I, Chapter 3: Infiltration Test. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050956.pdf

and southeast. While ultimately most of this runoff could be intercepted by the proposed linear basin described previously, some runoff enters the wetland north of the fire pond. Currently, this area is grass and would support a teardrop-shaped bioretention area of approximately 700 square feet. Where the embankment is too close to the pavement to extend the basin southward, a small swale 25± feet in length would intercept runoff and convey it to the bioretention basin. Overflow would exit the basin at its northwestern edge to the wetland.

- **Roadside Bioretention Basin.** A third surface infiltration BMP of approximately 600 square feet is recommended for the right-of-way on Grassy Hill Road that is immediately west of the intersection (*Figure 4-11*). A basin at this location would treat stormwater from Route 85 in front of the fire department and a portion of the intersection, all of which appears currently to enter the parking lot via two existing driveways. Overflow from this basin would be directed into the parking lot where it can then be intercepted by the proposed linear bioretention basin down-gradient.

Figure 4.6. Parking lot at Chesterfield Fire Department. The green shaded area shows the approximate location of the proposed linear bioretention basin. Looking southwest.

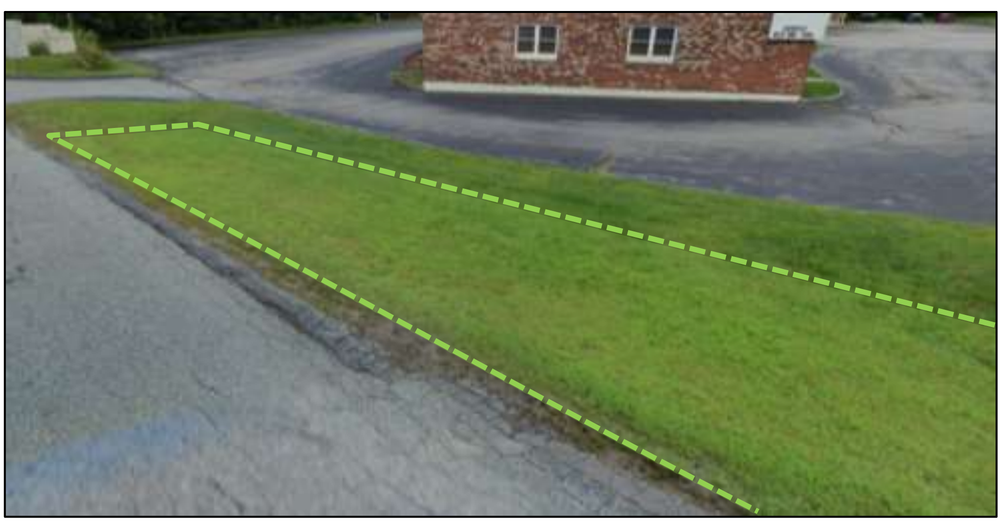


Figure 4.6. Grass shoulder between Grassy Hill Road and the Chesterfield Fire Department. The dashed area shows the approximate location of a proposed roadside bioretention basin. Looking west.

Figure 4-12. Stormwater Retrofit Concept: Chesterfield Fire Department
(1606 Hartford-New London Turnpike, Montville)

Legend

- Proposed Bioretention Basin
- Proposed Swale
- Proposed Curbing
- Flow Direction
- Existing Catch Basin
- Approximate Drainage Area
- Approximate Property Boundary

contour interval = 2 feet

Data sources:

1. Approximate Property Boundary: Town of Montville, 2005.
2. Elevation contours: CT DEEP, 2000.
3. Imagery: USGS Connecticut Orthoimagery, Spring 2019. Provided by CT ECO.

Map center: 72°13'5"W 41°25'46"N

N

0 25 50 100 150 Feet

4.7 Residential Area North of Bogue Brook Reservoir (Chapel Hill Road to Glendale Road, Montville)

This collection of neighborhoods is located at the intersection of Chapel Hill and Chesterfield Roads, near the northeastern boundary of the Niantic River watershed. It includes from Chapel Hill Road southwest to Glendale Road, and from Oak Hill Road southeast to Chesterfield Road. The area can be described as dense suburban development; there are over 220 homes within an area of 90± acres, and lot size for most of the homes, built in the mid-1960's, averages less than 0.5 acre. Overall, the terrain of the area is moderately sloped toward the northwest, where a tributary to Bogue Brook flows southwesterly through a dozen or more properties. Most of the area contains soils mapped by USDA-NRCS as fine sandy loams with low infiltration capacity (Hydrologic Soil Group C/D). However, soils are also classified as moderately well drained and designated as prime farmland soils, which suggest sufficient infiltration capacity. Prior to implementing the infiltration BMPs recommended below, proposed sites should be evaluated for adequate infiltration capacity.

All roads are served by storm drainage systems, most of which discharge untreated stormwater to the unnamed tributary at four road crossings. Behind residences on Glendale Road, a fifth outfall discharges stormwater collected from Glendale Road, Laurel Drive, and Hickory Drive to the tributary. Field assessments of the area found the tributary was in poor condition. Certain reaches were choked with yard waste, litter, or invasive species. In others, the channel was deeply incised into the land, leaving steep banks that are actively eroding. Perhaps most importantly, the tributary does not have an adequate vegetated buffer. Typically, the riparian area has been partially or entirely cleared of natural vegetation and maintained as lawn or landscaped gardens. The Town of Montville has documented potential illicit discharges at three outfalls. All homes in the area are served by sanitary sewers and rely on private wells for drinking water.

While the focus of this retrofit concept shown in *Figure 4-13* is the northern half of the residential area, most of the recommendations could be applied throughout these suburban neighborhoods. The three main objectives are (1) to raise the awareness of homeowners about improving and maintain good water quality, (2) to retrofit roadsides with infiltration BMPs to reduce the volume of untreated stormwater, and (3) to restore the tributary's vegetated buffer where feasible.

Proposed retrofit concepts for this site are shown in *Figure 4-13.*

- **Bioretention Basins.** In the concept, two bioretention basins are proposed near the tributary. These sites were selected primarily because they offer the available land area to construct a surface BMP. The basin at the intersection of Chapel Hill Road would intercept stormwater from Chapel Hill and the adjacent intersection. The larger basin at the intersection of Oak Hill Road and Evergreen Lane would be located on a private property that appears to be undevelopable due to the tributary. This intersection is a low spot on the way to the tributary, and a basin receiving runoff from both streets would effectively treat stormwater from this intersection.

  Another good candidate for a bioretention basin that is not shown in the design concept is the northern corner of the intersection of Grassy Hill Road and Chesterfield Road. The corner behind the guardrail is nearly level and appears to be within the municipal right-of-way. Two sets of curb cuts and swales under the guardrail would connect to the proposed basin of 700 square feet.

- **Tree Wells.** This area could be retrofitted with up to 21 tree wells, all of which are located upgradient of existing catch basins and function separately from the drainage system. It is estimated that an additional 20-25 tree wells could be installed on the roads not shown in the design concept. This does not include

Chapel Hill, which has a sidewalk that prevents roadside BMPs. If the road or sidewalk is improved, bioretention basins or tree wells could also be incorporated into the improvements.

- **Restoration of Riparian Buffer.** Starting at the crossing at Chapel Hill Road, 0.4± mile of the tributary is within or in close proximity to the residential development. The most impacted reach is the first 0.25 mile from the Chapel Hill Road to Beechwood Road. At a minimum, a naturally vegetated buffer of 10 feet from the bank is recommended to protect water quality and, in some areas, stabilize eroding banks. Once established, the buffer should be left alone to naturalize. Since restoration will require buy-in from at least 13 landowners whose property abuts the tributary, an outreach component is also recommended. While the initial fundraising and implementation of the restoration work would fall to stakeholders, the homeowners' support is essential to starting the project and maintaining the buffer over time.

- **Evaluation of Potential Illicit Discharges.** Personnel conducting outfall mapping by the Town of Montville observed potential illicit discharges at three outfalls located at the following road-stream crossings: Chapel Hill Road, Evergreen Lane, and Oak Hill Road. According to the Connecticut MS4 Permit, "illicit discharges include nearly anything that isn't stormwater such as illegal dumping in storm drains, animal wastes, fertilizers, industrial and commercial waste, sewage, leaves, etc."[47] The MS4 Permit requires that municipalities prohibit, investigate, and eliminate illicit discharges.

- **Homeowner Best Management Practices.** These neighborhoods should be targeted for outreach on homeowner and residential BMPs to improve water quality. Due to the number of land owners involved, each recommendation should be thought of as a two-phase approach, requiring initial and ongoing outreach to homeowners (phase 1) in order to build awareness and support to implement best practices (phase 2). See Section 3.6 for recommendations regarding education/outreach opportunities for residential areas. See Section 3.2.2 for recommendations that would continue support for homeowners to disconnect impervious areas and adopt other non-structural BMPs. In summary, these recommendations are:

    - Evaluation, repair, and maintenance of septic systems
    - Restoration of riparian buffers to the unnamed tributary and associated wetlands. Priority streets for this recommendation are: Chapel Hill Road, Utz Drive, Oak Hill Road, Evergreen Lane, Beechwood, Road, and Laurel Drive.
    - Installing rain gardens and rain barrels and other low-cost methods for disconnecting impervious surfaces (roofs, driveways, etc.) from the storm drainage system
    - Reducing the application of fertilizer

[47] https://nemo.uconn.edu/ms4/implement/idde.htm

Figure 4-13. Stormwater Retrofit Concept: Residential Area North of Bogue Brook Reservoir (Montville)

4.8 Niantic River Road (Waterford)

Niantic River Road is a major town road in Waterford along the eastern shoreline of the Niantic River Estuary. It begins at Boston Post Road (U.S. Route 1), near its crossing of Stony Brook, and travels south for 2.4± miles to Mago Point. Historical imagery from 1934 shows the road to be well-established through a patchwork of farmland. Current land use along the road is primarily residential development (i.e., single family homes), which transitions to more of a commercial district at Mago Point. Undeveloped areas tend to be wetlands or areas where development has been discouraged by steep terrain and shallow bedrock. At three locations, the road is approximately 10 feet above the water surface of the Estuary, and there is no land between the road's shoulder and the Estuary.

A storm drainage system serves Niantic River Road and receives stormwater drainage from portions of local roads such as Locust Court and Fulmore Drive. All drainage systems on Niantic River Road discharge to the Estuary. To the east, smaller drainage systems discharge into wetlands or local streams in the Niantic River subwatershed.

This retrofit concept focuses on a 0.4-mile section of Niantic River Road that discharges at a single outfall 200± feet north of Kidde Beach. From just north of Locust Court, the drainage area extends southward to beyond the most upgradient catch basins near the residence of 192 Niantic River Road. Most soils within the drainage area are described by USDA-NRCS as sandy loam and have been classified as having a high infiltration capacity (Hydrologic Soil Group A). Similar to other moderately developed regions in the watershed, the recommendations for this drainage area rely on a decentralized system of infiltration practices to reduce the volume of untreated stormwater discharged to the Estuary. Although land area is available on the east side of Niantic River Road, an existing sidewalk and buried utilities limit retrofit opportunities on this side of the road.

Proposed retrofit concepts for this site are shown in *Figure 4-15.*

- **Linear Bioretention Basins.** Two linear bioretention basins are proposed for the west side of the road near Fulmore Drive. Both should be constructed so that they are upgradient of existing catch basins and would allow overflow to return to the drainage system. These locations were selected because, according to parcel maps from the Town of Waterford, this appears to be the only area within the municipal right-of-way that provides enough land area for such BMPs. Another option may be the privately-owned parcel immediately north of the pump station. This area could be utilized for a larger bioretention basin that is designed as combined open space and stormwater control measure. Two parcels owned by the Town of Waterford are located here, but the slope of one and current use of the other (pump station) limit the use of this area for a retrofit.

- **Subsurface Infiltration System.** The limited area within the public right-of-way makes subsurface infiltration a suitable BMP for infiltrating moderate to large volumes of stormwater. From an inspection of existing utilities, elevations, and available land area in this drainage area, a potential site was selected along Niantic River Road (see *Figure 4-14*). Along the roadside, the land owner has a small paved parking area, which is immediately upgradient from a catch basin. A subsurface infiltration system, such as infiltration chambers or a drywell/leaching catch basin system, could be installed below grade with overflow returning to the existing storm drainage system in the road. A pre-treatment structure prior to the infiltration system is also recommended.

- **Tree Wells.** A total of 7 tree wells are proposed for Niantic River Road, Locust Court, and Fulmore Drive. Road. These would be located upgradient of existing catch basins and are separate from the storm drainage system. Depending on the width of the right-of way at most of these locations, BMPs may be located on private property and may require land owner approval. If homeowners are supportive and space is available, roadside bioretention basins could be included in the concept or replace the proposed tree wells. Again, land area is available on the east side of Niantic River Road, but a more detailed site evaluation is needed to determine if BMPs can be installed given the existing sidewalk and buried utilities.

- **Homeowner Best Management Practices.** These neighborhoods should be targeted for outreach on homeowner and residential BMPs to improve water quality. Due to the number of land owners involved, each recommendation should be thought of as a two-phase approach, requiring initial and ongoing outreach to homeowners (phase 1) in order to build awareness and support to implement best practices (phase 2). See Section 3.6 for recommendations regarding education/outreach opportunities for residential areas. See Section 3.2.2 for recommendations that would continue support for homeowners to disconnect impervious areas and adopt other non-structural BMPs. In summary, these recommendations are:

    - Evaluation, repair, and maintenance of septic systems
    - Restoration of vegetated buffers along the Niantic River Estuary and associated streams and wetlands. Depending on the location, buffers may be effective for stormwater management or deterring waterfowl.
    - Installing rain gardens and rain barrels and other low-cost methods for disconnecting impervious surfaces (roofs, driveways, etc.) from the storm drainage system
    - Reducing the application of fertilizer

Figure 4.8. Proposed location for subsurface infiltration system along Niantic River Road, Waterford. Looking northwest.

- **Climate Change and Coastal Resiliency**. Portions of Niantic River Road and the Town of Waterford's Niantic River Pump Station are located in areas vulnerable to coastal flooding resulting from sea level rise and storm surge associated with climate change projections. The Town of Waterford's *Climate Change Risk Vulnerability, Risk Assessment and Adaptation Study* (Kleinfelder Northeast, Inc., 2017) recommends an adaptation strategy to provide long-term protection of the pump station. Climate change adaptation strategies for this and other coastal areas within the Niantic River watershed are addressed in the Town's climate resilience plan and more generally in *Section 3.3* of this watershed plan.

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Figure 4-15. Stormwater Retrofit Concept: Niantic River Road
(Waterford)

Legend

- Proposed Bioretention Basin
- Proposed Subsurface Infiltration Structure
- Proposed Tree Box Filter
- Proposed Catch Basin
- Flow Direction
- Proposed Pipe
- Existing Pipe
- Existing Catch Basin
- Existing Outfall
- Sanitary Sewer Pump Station
- Approximate Drainage Area
- Approximate Property Boundary

contour interval = 5 feet

Data sources:

1. Approximate Property Boundary: Town of Waterford, 2005.
2. Elevation contours: CT DEEP, 2000.
3. Imagery: USGS Connecticut Orthoimagery, Spring 2019. Provided by CT ECO.

4.9 Residential Area around No Name Brook (The Avenues, Waterford)

The center of this residential area, known as "The Avenues," is located just east of Niantic River Road and approximately 1.3 miles south of the area described in *Section 4-8*. A grid of local roads contain moderately dense residential development that extends eastward from the shoreline of the Niantic River Estuary. The terrain is fairly level at first and then increases considerably east of No Name Brook, a small perennial stream (0.4± mile). This brook is a tributary to the Estuary, flowing south-southwesterly through the center of The Avenues to its mouth near 1st Avenue. The brook passes through 7 culverts between its headwater and mouth and is fed by a regularly flooded, freshwater wetland of 5.5± acres north of 7th Avenue. The eastern boundary of the Niantic River watershed is approximately 0.5 mile east of the shoreline, and natural drainage directs most surface water in the area to the wetland, No Name Brook, Niantic River, and the existing storm drainage systems.

Soils between the Niantic River Estuary and No Name Brook are described by USDA-NRCS as fine sandy loam with high infiltration capacity (Hydrologic Soil Group A). East of the brook, infiltration capacity decreases to moderate (Hydrologic Soil Group B) and then to low (Group C) as the slope increases between Middle Street and High Street. The changes in slope and infiltration capacity are likely due to the underlying bedrock that becomes increasingly shallower when heading eastward. Prior to implementing the infiltration BMPs recommended below, proposed sites should be evaluated for adequate infiltration capacity.

A network of separate storm drainage systems convey stormwater and discharge without treatment at separate outfalls. Most of the outfalls discharge to No Name Brook and the Estuary. One of the largest drainage systems, on Daniels Avenue, also receives stormwater from the Dual Language & Arts Magnet Middle School at 51 Daniels Avenue. From Circle Drive to the north to Bishop Road to the south, the area of interest in this design concept comprises over 100 acres along the Niantic River.

Proposed retrofit concepts for this site are shown in *Figure 4-17.*

- **Bioretention Basins.** There are 12 sites proposed for bioretention basins in the design concept. Due to the lack of public property and narrow roads in this neighborhood, some of the proposed basins are located on private property. The remainder are sited along public roads within the municipal right-of-way. With focused outreach efforts to the community, it is possible that additional homeowners would support BMP retrofits and additional sites, such as those selected for tree wells, could be identified for roadside bioretention basins/bioswales. The 12 proposed basins total approximately 5,300 square feet. For each basin, the following list provides a brief location description (sites are listed roughly from north to south):

    1. west side of Circle Street, south of 9th Avenue and north of the catch basin
    2. 5th Avenue, at the intersection with Niantic River Road
    3. 4th Avenue, south side of road, approximately 240 feet east of Middle Street
    4. Middle Street, at the intersection with 3rd Avenue (southeastern corner)
    5. Middle Street, at a culvert that drains existing swale; overflow structure (e.g., standpipe) may be required.
    6. Middle Street, at the intersection with Daniels Avenue (northeastern corner)
    7. Daniels Avenue, in an existing swale on town property that conveys roof drainage to drainage system on Daniels Avenue
    8. Niantic River Road, just south of its intersection with Beach Street; linear basin proposed, with a swale to also intercept runoff from Beach Street
    9. Niantic River Road, at intersection with 2nd Avenue (southeastern corner)

10. Middle Street, at the intersection with 1st Avenue (northwestern corner)
11. 1st Avenue, at intersection with Middle Avenue (northeastern corner)
12. East Bishop Street, at the intersection with Niantic River Road (northeastern corner)

- **Tree Wells.** In the area shown in the design concept, 79 potential sites were selected for tree wells. Each location was chosen for its potential to reduce the volume of stormwater entering the drainage system. In most instances, the tree well is sited adjacent or relatively close to an existing catch basin due to the high density of development and limited land area for surface BMPs, combined with a network of storm drainage systems discharging to the Estuary and its tributary, No Name Brook. In consideration of the cost-per-unit installation (or cost-per-volume of stormwater treated), several sites were evaluated for retrofitting the larger storm drainage systems with a subsurface infiltration BMP. However, existing conditions such as other buried utilities, low soil infiltration capacity, and private ownership limit the feasibility of larger subsurface infiltration systems in this area.

- **Recommendations for No Name Brook.** Due to the direct discharges of stormwater and dense residential development surrounding the brook, this tributary and its drainage area are believed to contribute significant nonpoint source pollutant loads to the Niantic River Estuary.

    - **Water Quality and Natural Resource Assessments.** Further study of the brook and its headwater wetland are recommended to better understand its potential contribution to NPS pollution in the Estuary, which would subsequently inform mitigating action. Water quality monitoring or field assessments should, at some point, be integrated with an evaluation of adjacent land use, activities, or issues (e.g., illicit discharges) related to improving water quality. Finally, an analysis of the small wetlands below 4th Avenue is recommended to determine the feasibility of larger ecological restoration projects for the benefit of water quality and coastal resiliency. Below 4th Avenue, the brook transitions from a defined, incised channel to a series of vegetated wetlands with diffuse stream flow. Currently, some of the wetlands are full of the invasive plant common reed (*Phragmites australis*), and all are located on private property. As with most projects in this area, full support of landowners would be needed to study the sites or implement a restoration plan. Going downstream (north to south), the wetlands are located between 4th and 3rd Avenues, 2nd and 1st Avenues, and west of the intersection of Niantic River Road and 1st Avenue.

    - **Vegetated Buffer.** The entire length of the tributary is affected by residential development and its associated uses and infrastructure (network of local roads, turfgrass, driveways, etc.) (*Figure 4-16*). At a minimum, a naturally vegetated buffer of 10 feet from the bank is recommended to protect water quality and, in some areas, to stabilize eroding banks. Once established, the

Figure 4.9. No Name Brook between Daniels and 3rd Avenues. Looking north (upstream) from Daniels Avenue.

buffer should be left alone to naturalize. Since restoration will require cooperation from many private landowners whose property abuts the tributary, an outreach component is also recommended. While the initial fundraising and implementation of the restoration work would be led by stakeholders, support from homeowners is essential for initiating the project and maintaining the buffer over time.

- **Homeowner Best Management Practices.** These neighborhoods should be targeted for outreach on homeowner and residential BMPs to improve water quality. Due to the number of land owners involved, each recommendation should be thought of as a two-phase approach, requiring initial and ongoing outreach to homeowners (phase 1) in order to build awareness and support to implement best practices (phase 2). See Section 3.6 for recommendations regarding education/outreach opportunities for residential areas. See Section 3.2.2 for recommendations that would continue support for homeowners to disconnect impervious areas and adopt other non-structural BMPs. In summary, these recommendations are:

    - Evaluation, repair, and maintenance of septic systems
    - Restoration of riparian buffers to No Name Brook and associated wetlands. Priority streets for this recommendation are (north to south): Circle Street, 7th Avenue, 6th Avenue, 5th Avenue, 4th Avenue, 3rd Avenue, Daniels Avenue, 2nd Avenue, Niantic River Road, Beach Street, and Wood Street.
    - Restoration of vegetated buffers along the Niantic River Estuary. Depending on the location, buffers may be effective for coastal resiliency, stormwater management or deterring waterfowl.
    - Installing rain gardens and rain barrels and other low-cost methods for disconnecting impervious surfaces (roofs, driveways, etc.) from the storm drainage system
    - Reducing the application of fertilizer

- **Climate Change and Coastal Resiliency.** The Avenues is one of the most vulnerable residential areas in Waterford to coastal flooding under projected climate change scenarios, according to the Town of Waterford's *Climate Change Risk Vulnerability, Risk Assessment and Adaptation Study* (Kleinfelder Northeast, Inc., 2017). Climate change adaptation strategies for this and other coastal areas within the Niantic River watershed are addressed in the Town's climate resilience plan and more generally in *Section 3.3* of this watershed plan.

Figure 4-17. Stormwater Retrofit Concept: Residential Area around No Name Brook
(Waterford)

Data sources:

1. Approximate Property Boundary: Town of Montville, 2005.
2. Elevation contours: CT DEEP, 2000.
3. Imagery: USGS Connecticut Orthoimagery, Spring 2019. Provided by CT ECO.

4.10 Downtown Niantic (East Lyme)

Located within the Town of East Lyme, the Village of Niantic is a historic coastal community beginning in the mid-17th century. The Village occupies the western shoreline of the Niantic River Estuary from Saunders Point in the north down to The Gut, a now-reinforced spit of land that forms the southernmost boundary of the Niantic River watershed and separates the Estuary from Long Island Sound. Downtown Niantic is a dense commercial and residential area along the shores of Long Island Sound and the Estuary. The watershed boundary of the Niantic River divides the downtown area roughly along Pennsylvania Avenue (State Route 161). Just north of the downtown area is Camp Nett, an Army National Guard Base of over 60 acres along the Estuary's shoreline. Most of the Village of Niantic, including the eastern portion of the eastern downtown area and Camp Nett, are within the Niantic River watershed.

East of Pennsylvania Avenue, most roads are served by storm drainage systems that discharge to the Estuary. The eastern ends of a series of cul de sacs off Pennsylvania Avenue (Pencove Road to Luce Avenue) drain stormwater eastward, ultimately to a large, State-owned detention basin between Pine Grove Road and Camp Nett. It is presumed that some portion of the military base's drainage system discharges to this basin; however, access to the basin is restricted, and Camp Nett was not assessed for this project. Soils mapped by the USDA-NRCS are well-suited to infiltration-based stormwater retrofits. Native soils are described as loamy sands and have been classified as having high to moderate infiltration capacity (Hydrologic Soil Groups A and B). While existing mapping shows some soils as urban land, it is likely that more occurrences of fill material associated with development are in the area. Prior to implementing the infiltration BMPs recommended below, proposed sites should be evaluated for adequate infiltration capacity.

Since 2012, nearly 40 infiltration BMPs, such as tree filters, tree wells, rain gardens, and restored buffers, have been installed by the Town of East Lyme in the downtown area. These projects have retrofitted many of the downtown roads east of Pennsylvania Avenue and south of Smith Street. As a result, the recommendations here are focused on two areas where additional retrofit opportunities were identified: the drainage area near Shore Drive, including the eastern portions of Smith Street and Morton Street; and Pine Grove Road from Smith Street north to South Street. The recommendations for each area of interest are discussed below and shown on the retrofit concepts in *Figure 4-18.*

Recommendations for the Shore Drive Area

- **Bioretention Basins.** Three bioretention basin are proposed on Smith Street and Smith Street Extension. From west to east, they are:
    1. A bioretention basin of approximately 200 square feet, located in the right-of-way in front of 48-50 Smith Street (not shown in *Figure 4-18*). There is no storm drainage on Smith Street, and stormwater runoff from the north side of the road appears to flow east to catch basins near Shore Drive. Depending on the location of existing utilities and the support of homeowners, sites for additional bioretention basins or tree wells may be found on Smith Street.
    2. A bioretention basin of approximately 350 square feet, located on private property at 81 Smith Street. This would be a good location to intercept stormwater before it flows either east or west down fairly steep gradients to the Estuary (as runoff from Smith Street Extension or directly discharging at the southern end of Shore Drive). A swale is proposed at the intersection to direct runoff into the basin.
    3. A linear bioretention basin, approximately 120 feet long on Smith Street Extension. If vehicle access east of the residential driveway is unnecessary, it is recommended that the pavement is replaced with this linear basin and a pervious surface (see the following recommendation). The

pervious surface would maintain the public access and could be designed to drain into the linear basin, which could be designed to intercept stormwater from the existing drainage system.

- **Pavement Replacement with Pervious Surface.** Depending on their respective uses, pavement at the eastern end of Smith Street Extension and the southern end of Shore Drive could be replaced with a pervious surface, native vegetation, or turfgrass. Currently, each location is fairly steep and allows stormwater and associated pollutant loads to discharge directly into the Estuary. Removal or replacement of the impervious surface on Smith Street Extension could be integrated with a new linear bioretention basin while still maintaining access to the shoreline (see the previous recommendation). It is recommended that the pavement providing access to residents' driveways be undisturbed.

- **Subsurface Infiltration System.** The limited area within the public right-of-way makes subsurface infiltration the most feasible BMP for infiltrating moderate to large volumes of stormwater. The preferred location for such a BMP is at the intersection of Shore Drive and Morton Street. Three catch basins are located here, and it is recommended that the most down-gradient catch basin is replaced with a diversion structure to direct stormwater to a subsurface infiltration system such as a drywell or infiltration chambers. Space for subsurface infiltration is potentially available below-grade at this intersection. A pre-treatment structure prior to the infiltration system is also recommended.

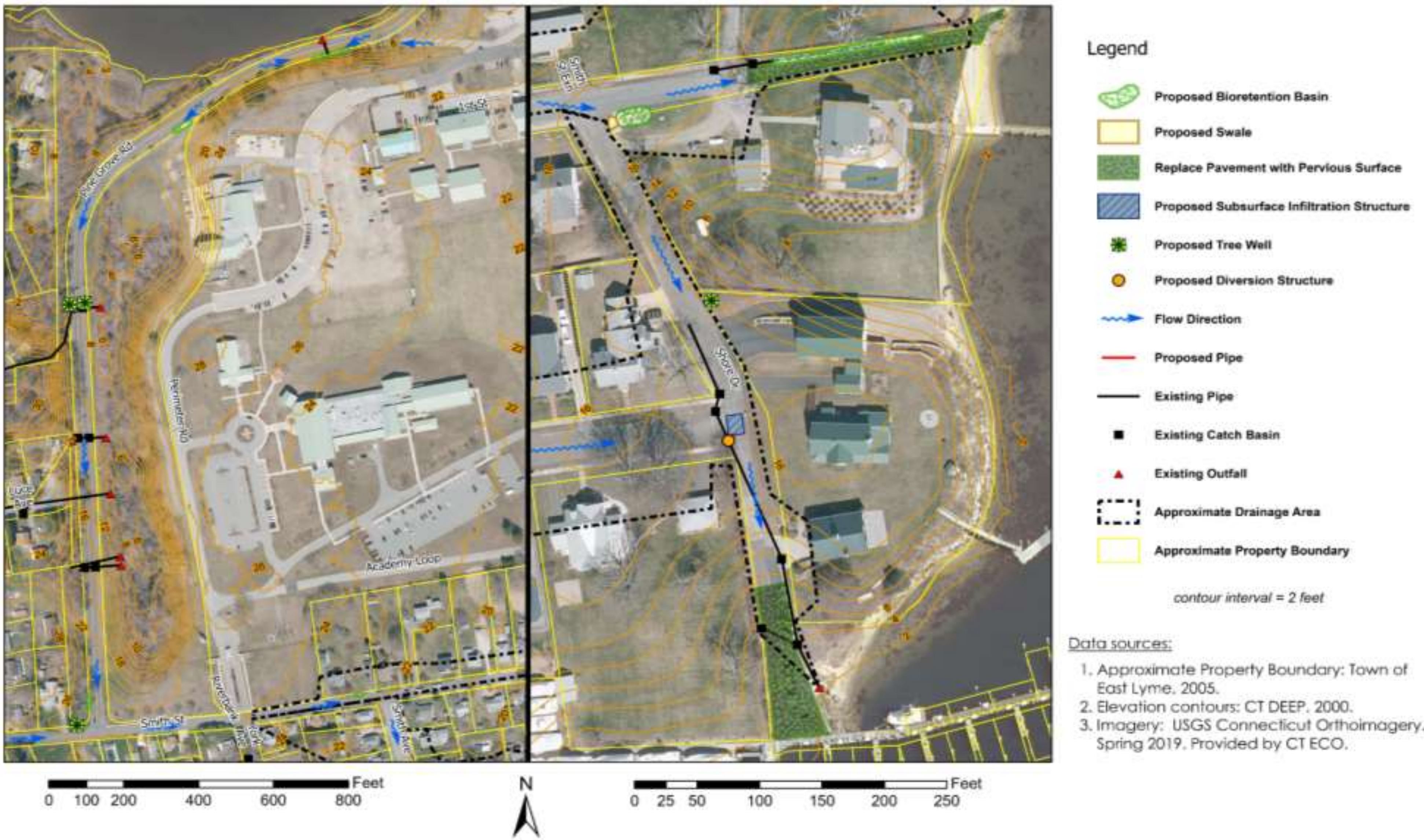
- **Tree Wells.** Two tree wells are proposed, at 2 Shore Drive and 8 Morton Street (latter not shown in *Figure 4.18*). Depending on the location of existing utilities and the support of homeowners, sites for additional tree wells (or bioretention basins) may be possible.

Recommendations for Pine Grove Road

- **Bioretention Basins.** Three bioretention basins are proposed on Pine Grove Road. The northernmost basin, approximately 900 square feet, would be an improvement to the existing swale that delivers runoff to a culvert passing under the road and discharges to Smith Cove. Currently the swale offers limited infiltration and should be reconstructed as a bioretention basin with overflow discharging to Smith Cove. The two bioretention basins farther south (750 and 400 square feet, respectively) would intercept stormwater before it reaches the storm drainage systems on Pine Grove Road or Smith Street.

- **Tree Wells.** Two tree wells are proposed to intercept runoff upgradient (north) of the existing catch basins connected to the drainage system on Clark Street. These would treat approximately 600 linear feet of Pine Grove Road down-gradient of one of the proposed bioretention basins.

Figure 4-18. Stormwater Retrofit Concept: Downtown Niantic
(East Lyme)



5 Management Measures and Pollutant Load Reductions

5.1 Pollutant Loads

Loads from Surface Inputs

Pollutant Load refers to the quantity or mass of a pollutant originating from point sources (permitted outfalls) and nonpoint source runoff that is delivered to a surface waterbody, via surface inputs or groundwater, in a specified amount of time. Surface runoff pollutant load estimates for the Niantic River watershed were developed as part of the 2006 Niantic River Watershed Protection Plan.

Pollutant Load Reductions are reductions in pollutant loads than can be expected as a result of implementing structural controls and non-structural management practices in a watershed (collectively referred to as Best Management Practices or "BMPs"). Pollutant load reduction targets for the watershed have been established in the 2012 statewide bacteria TMDL document and by the nitrogen synthesis report prepared by Dr. Jamie Vaudrey of UCONN.

The 2006 Niantic River Watershed Protection Plan included pollutant loads estimated using the EPA Storm Water Management Model (SWMM). The pollutant load modeling considered baseline (2006) conditions and future buildout with general implementation of Best Management Practices (BMPs) throughout the watershed. Relative contributions or loads of total suspended solids, nitrogen, phosphorus, and biochemical oxygen demand associated with surface water inputs were estimated on a sub-watershed basis for a hypothetical storm event. (Pollutant loads resulting from groundwater contributions to surface waterbodies were not modeled.) Baseline pollutant loads and estimated loading increases (under a future development scenario with generalized BMPs), both expressed as on a per acre basis, are summarized in *Table 5-1* for the three major receiving waterbodies in the Niantic River watershed – Niantic River, Latimer Brook, and Oil Mill Brook.

Table 5-1. Summary of estimated pollutant loads and pollutant load increases for major waterbodies in the Niantic River watershed (NRWPP 2006)

Pollutant	Load Estimate (lbs/acre)	Receiving Waterbody*		
		Niantic River	Latimer Brook	Oil Mill Brook
Total Nitrogen (TN)	Baseline Load	4.30	5.60	0.90
	Load Increase	1.23	1.65	0.30
Total Phosphorus (TP)	Baseline Load	0.66	0.98	0.17
	Load Increase	0.12	0.093	0.014
Biochemical Oxygen Demand (BOD)	Baseline Load	12.2	11.7	1.8
	Load Increase	22.76	35.71	6.66
Total Suspended Solids (TSS)	Baseline Load	166.0	552.8	61.2
	Load Increase	142.4	-101.7	16.4

**Receiving waterbody load estimates presented in the above table are calculated as the sum of load estimates for individual subwatersheds: Niantic River (Niantic River, Stony Brook, and Upper Niantic subwatersheds), Latimer Brook (Lower Latimer Brook, Silver Falls, Barnes Reservoir, Cranberry Meadow Brook, and Bogue Brook Reservoir subwatersheds), Oil Mill Brook (Oil Mill Brook subwatershed).*

Estimated surface baseline pollutant loads from the Niantic River and Latimer Brook subwatersheds are significantly higher than baseline loads from the Oil Mill Brook subwatershed for all of the pollutants modeled, which generally follows the patterns of development (developed land use and impervious cover) in the watershed.

The pollutants load estimates from the 2006 NRWPP are based on a hypothetical storm event and therefore only allow for relative comparison of surface loads from different land uses and subwatersheds. More recent nitrogen load modeling of the Niantic River watershed (2016) was completed by Dr. Jamie Vaudrey of the UCONN Department of Marine Sciences as part of a larger project to model nitrogen loads associated with various Long Island Sound embayments. The model accounted for surface and groundwater nitrogen loads to the Niantic River Estuary based on 2010 land cover data from UCONN CLEAR. The estimated annual nitrogen load to the Niantic River Estuary is approximately 22,000 kg-N/yr, with approximately 53% of the load coming from atmospheric deposition, 27% from fertilizer, and 20% from septic systems. Within the watershed, approximately 10% of the nitrogen load is estimated to originate from within 200 meters of the shore of the embayment, while 90% of the load comes from areas beyond a 200-meter buffer. Lawns (52%) and agriculture (45%) account for the vast majority of fertilizer sources in the watershed.[48]

Groundwater Nitrogen Loads

While pollutant load reduction efforts have focused on point sources and surface-transported nonpoint sources, groundwater as a pollutant transport mechanism has been relatively under-studied and may be a long-term source of nitrogen to coastal estuaries. USGS is working collaboratively with CT DEEP and the EPA Long Island Sound Study to develop a regional-scale model to simulate groundwater flow in watersheds along the Connecticut coast. As part of their study, the project team is simulating groundwater nitrogen loads to the Niantic River Estuary to answer the following questions:

1. How much groundwater is discharging directly to coastal waters?
2. Where is it from?
3. How long did it travel?

Nitrogen sources in the model include atmospheric deposition (wet and dry), fertilizers from agriculture and turf/grass, and septic systems.

Preliminary modeling results indicate that the total groundwater nitrogen load to the Niantic River watershed is approximately 21,000 kg-N/yr. Atmospheric deposition accounts for approximately 43% of the estimated groundwater nitrogen load in the Niantic River watershed, followed by fertilizer (36%), and septic systems (22%). Approximately 90% of the total groundwater nitrogen load discharges to tributaries prior to reaching coastal waters, while approximately 10% of the load is contributed directly to the Estuary. Groundwater nitrogen loads to surface waters are highest near higher nitrogen sources, which include residential and commercial areas along Latimer Brook, Silver Falls Brook, Cranberry Meadow Brook, Stony Brook, and Oil Mill Brook. Most groundwater nitrogen discharges to surface waters in less than five years, and travel times are shorter for near-stream sources and longer for distant sources.

The preliminary groundwater modeling findings are generally consistent with the 2005-2011 USGS stream water quality monitoring study, which calculated annual total nitrogen loads to the Niantic River Estuary from the three major tributaries in the range of 41,400 to 60,700 pounds (18,800 kg-N/yr to 27,500 kg-N/yr). The 2005-2011 USGS study also found that the source of nitrogen (nitrate) was likely due to fertilizer, animal waste/sewage, or a

[48] Vaudrey, J.M.P., C. Yarish, J.K. Kim, C.H. Pickerell, L. Brousseau, J. Eddings, M. Sautkulis. 2016. Long Island Sound Nitrogen Loading Model. University of Connecticut, Groton, CT.

combination of the two, with Latimer Brook representing a majority (78-80%) of the nitrogen loading in the study area.[49] Although the various estimates are from different studies using different methods and data sources, the similarity in estimated surface water nitrogen loads from the 2005-2011 USGS monitoring study (18,800 kg-N/yr to 27,500 kg-N/yr), the 2016 nitrogen modeling study by Dr. Jamie Vaudrey (22,000 kg-N/yr), and the ongoing USGS groundwater nitrogen load estimate (21,000 kg-N/yr) suggests that groundwater likely accounts for a large percentage of the nitrogen load to the Niantic River Estuary.

Nitrogen contributions from the Niantic River and Latimer Brook subwatersheds, whether from surface inputs or groundwater flows, are also more likely to reach the Niantic River Estuary and Niantic Bay based on the results of the N-sink Tool developed by UCONN-CLEAR and the University of Rhode Island (see *Section 2.2* of this watershed plan update).

Collectively, the modeled surface and groundwater pollutant loads highlight the importance and potential effectiveness of distributed source controls and structural stormwater control measures located close to the pollutant sources (i.e., small-scale retrofit and restoration projects) throughout the watershed, not just focused on the area immediately surrounding the Niantic River Estuary.

5.2 Pollutant Load Reductions Targets

Consistent with the EPA nine element watershed planning guidance, this watershed plan update includes an estimate of the load reductions required to restore impaired waterbodies and to protect/maintain high quality waterbodies. Since the plan update does not include new modeling (pollutant load or receiving water quality modeling), existing available data were used to establish numeric targets to meet these watershed goals and management objectives, and the load reductions needed to meet the targets. The numeric targets and required pollutant load reductions for the watershed are derived from the following information sources:

- Statewide Bacteria Total Maximum Daily Load (TMDL) (CT DEEP 2012)
- UCONN Nitrogen Synthesis Report (UCONN, Vaudrey 2019)
- USGS Monitoring Study (2013)

Niantic River Estuary and Niantic Bay

A TMDL analysis for fecal indicator bacteria was completed for the Niantic River Estuary and Niantic Bay as part of CT DEEP's Statewide Bacteria TMDL. A TMDL is a "pollution budget" that identifies the reductions in point and nonpoint source pollution that are needed to meet Connecticut Water Quality Standards for a particular waterbody and a strategy to implement those reductions to restore water quality.

For the Niantic River Estuary (CT-E1_020), the Statewide Bacteria TMDL calls for a 94% reduction in geometric mean fecal coliform levels and a 90% reduction in single sample fecal coliform levels (such that 90% of samples have less than 31 colonies/100 ml) to meet shellfishing criteria, and a 90% reduction in geometric mean Enterococci levels and a 75% reduction in single sample Enterococci levels to meet water quality criteria for recreation.

For the assessed portions of Niantic Bay along the coastal areas of East Lyme (CT-E2_014) and Waterford (CT-E2_013), the Statewide Bacteria TMDL calls for a 72% to 84% reduction in geometric mean fecal coliform levels and

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[49] Mullaney, J.R., 2013, Nutrient concentrations and loads and *Escherichia coli* densities in tributaries of the Niantic River estuary, southeastern Connecticut, 2005 and 2008–2011: U.S. Geological Survey Scientific Investigations Report 2013–5008, 27 p., at http://pubs.usgs.gov/sir/2013/5008/

a 40% to 56% reduction in single sample fecal coliform levels (such that 90% of samples have less than 31 colonies/100 ml) to meet shellfishing criteria.

The data synthesis report prepared by UCONN (Vaudrey et al., 2019) documents a statistical analysis of water quality data for the Niantic River Estuary, with a focus on the relationship between environmental factors and eelgrass health in the estuary. The report includes recommended threshold values for water quality conditions to support eelgrass health in the Niantic River Estuary. For dissolved inorganic nitrogen (DIN), a maximum annual average surface concentration of 0.15 mg/L is recommended, which corresponds to the maximum observed concentration for the period 1999-2016. For total dissolved nitrogen (TDN), a maximum annual average surface concentration of 0.34 mg/L is recommended, which also corresponds to the maximum value observed during the study period.

It is important to note that the Niantic River Estuary has been supportive of eelgrass and continues to support eelgrass, indicating water quality is sufficient for this purpose. Although current water quality in the estuary is supportive of eelgrass, reducing nutrient inputs, macroalgae, phytoplankton, and suspended sediments in the water column will make eelgrass more resilient to the pressures it faces from rising summer air temperature and annual water temperature, which are the primary factors responsible for eelgrass health in the Niantic River Estuary.

UCONN's ongoing research into the linkage between nitrogen inputs and ecological conditions within the Estuary includes: 1) development of recommendations for a target nitrogen load from the watershed which is supportive of eelgrass and ecosystem integrity, taking into account the predicted changes in climate (e.g., rising temperatures and sea levels); and 2) utilizing a land-use based nitrogen loading model recently developed by Vaudrey et al. for Long Island Sound embayments, including the Niantic River, to evaluate nitrogen mitigation strategies. Preliminary results presented to the Niantic River Estuary Nitrogen Working Group in 2019 suggest a target nitrogen load of approximately 18,000 ± 4,000 kg N/yr, which is equivalent to 56 ± 12 kg N/ha-yr, to support eelgrass in the estuary. The current estimated nitrogen load to the estuary is within this range. The land-use based nitrogen loading model will provide refined estimates of existing and future nitrogen loads, as well as nitrogen load reduction targets and load reduction estimates to help guide future watershed management decisions, including implementation of this watershed plan update.

Latimer Brook and Stony Brook

A TMDL has not been established for the impaired tributaries of the Niantic River Estuary (see *Section 2.2 Water Quality*). The 2005-2011 USGS monitoring study measured *E. coli* densities and nutrient concentrations in Latimer Brook, Oil Mill Brook, and Stony Brook. A total of 51 samples were collected in each stream during the study period. The study found that the geometric means of *E. coli* densities in samples from the three Niantic River tributaries were less than the State of Connecticut water quality standard of 126 colony-forming units (cfu) per 100 milliliters; however, individual samples from all three tributaries had densities as high as 2,400 to 2,900 cfu per 100 milliliters (exceeding water quality standards for designated swimming, non-designated swimming, and other water recreation), and high densities of *E. coli* were more likely to be present in samples collected during wet weather events.[50] Based on the maximum *E. coli* densities measured in all three streams, Fuss & O'Neill calculated that reductions in single sample *E. coli* levels of 76% to 86% are necessary to meet the water quality standards for non-designated swimming (410 cfu per 100 milliliters) and other recreation (576 cfu per 100 milliliters).

[50] Mullaney, J.R., 2013, Nutrient concentrations and loads and *Escherichia coli* densities in tributaries of the Niantic River estuary, southeastern Connecticut, 2005 and 2008–2011: U.S. Geological Survey Scientific Investigations Report 2013–5008, 27 p., at http://pubs.usgs.gov/sir/2013/5008/

5.3 Plan Implementation – Tracking Progress towards Load Reductions

Progress in achieving pollutant load reductions through implementation of this watershed plan will be measured and tracked through:

- **Continued Water Quality Monitoring.** A key recommendation of this watershed plan is to continue the current NRWC water quality monitoring program, but also consider expanding the program to include bacteria (*E. coli* at freshwater locations and Enterococci at saltwater locations) monitoring at stream sampling stations to measure progress toward achieving the watershed plan and TMDL pollutant load reduction goals for fecal indicator bacteria. The monitoring program will provide an updated baseline of water quality in the Estuary and its major tributaries, as well as updated bacteria load reduction targets, to support implementation of the watershed based plan and to measure progress toward achieving pollutant load reduction goals.

- **NPS Project Tracking Tool.** A nonpoint source (NPS) project tracking tool has been developed for use by NRWC and other watershed stakeholders to document nonpoint source pollution restoration projects (those identified in this watershed plan and others) and associated load reduction estimates as projects are completed. The tracking tool can help track overall pollutant load reductions and the progress of plan implementation, as well inform adjustments to the plan implementation timelines. The tool uses a simple spreadsheet interface and is based on a similar tool being developed by the New England Interstate Water Pollution Control Commission and UCONN-CLEAR for Long Island Sound. A static version of the NPS project tracking tool for the Niantic River watershed is provided in *Appendix C* of this plan.

6 Funding Sources

A variety of local, state, and federal sources and private foundations are potentially available to provide funding for implementation of this watershed management plan, in addition to potential funds contributed by local grassroots organizations and concerned citizens. *Appendix F* contains a summary of potential funding sources and mechanisms. The table is not intended to be an exhaustive list but can be used as a starting point to seek funding opportunities for implementation of the recommendations in this watershed plan. The table of potential funding sources is intended to be a living document that should be updated periodically to reflect the availability of funding or changes to the funding cycle, and to include other funding entities or grant programs. Potential funding sources for specific recommendations are also listed in the tables in *Section 3* of this plan.

7 Formal Adoption of the Niantic River Watershed Protection Plan Update

The Niantic River Watershed Committee Board of Directors voted unanimously to formally adopt the Niantic River Watershed Protection Plan Update at its Board of Directors meeting on August 6, 2020.




Funding for this project was provided by the Community Foundation of Eastern Connecticut, the Connecticut Department of Energy and Environmental Protection via the Clean Water Act Section 319 Nonpoint Source program, and Kleinschmidt Foundation through the Community Foundation of Maine.

Community Foundation of Eastern Connecticut | Connecticut Energy Environment | Kleinschmidt | Maine Community Foundation

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Front

Row 1: Judy Rondeau, Niantic River Watershed Committee | Row 2: Eric Kanter | Row 3: Save the River-Save the Hills; Suzanne Thompson

Back

Row 1: (left and center) Niantic River Watershed Committee; Eric Kanter | Row 2: Chris Tomichek

FUSS & O'NEILL