



WEST RIVER

WATERSHED MANAGEMENT PLAN

prepared by  FUSS & O'NEILL

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Project Steering Committee

Chelsea Auerback, West River Watershed Coalition, New Haven Resident, Student, Yale Law
Lynne Bonnett, Greater New Haven Waterworks Coalition, New Haven Environmental Justice Network
Frank Cochran, New Haven, Friends of Edgewood Park
Frank Deleo, Woodbridge Resident, West River Watershed Coalition Member
Kathy Fay, Neighborhood Housing Services, New Haven
Chris Malik, Connecticut Department of Energy and Environmental Protection
Adam Marchand, Alderman, Ward 25, New Haven
Courtney McGinnis, Hamden Resident, Assistant Professor of Biology at Quinnipiac University
Mary Mushinsky, River Advocates of South Central Connecticut (formerly with Mill River Watershed Association)
Stacy R. Spell, West River Community Member, Civic Leader
Ron Walters, South Central Connecticut Regional Water Authority
Giovanni Zinn, City Engineer, City of New Haven
Gary Zrelak, Greater New Haven Water Pollution Control Authority

Other Involved Stakeholders

City of New Haven – Karyn Gilvarg, Executive Director, City Plan Department; Rebecca Bombero, Director New Haven Parks, Recreation and Trees
City of West Haven – Gail Burns, City Council Member, 10th District; Rob Librandi, Assistant City Planner
Common Ground High School – David Edgeworth, Joel Toleman and the Common Ground West River Stewards
Friends of Beaver Ponds Park – Nan Bartow and William Bidwell
Friends of Edgewood Park – Stephanie Fitzgerald
Neighborhood Housing Services
Solar Youth – Joanne Sculli
Town of Hamden – Robert Brinton, City Engineer; Tom Vocelli, Inland Wetlands Enforcement Officer
Town of Woodbridge – Ellen Scalettar, First Selectwoman
Urban Resources Initiative – Collen Murphy Dunning, Executive Director
West River Watershed Coalition
Westville Village Renaissance Alliance – Chris Heitman, Executive Director

Save the Sound/Connecticut Fund for the Environment

Kendall Barbery, Green Infrastructure Program Manager
John Champion, Director of Green Projects
Gwen Macdonald, Director of Habitat Restoration
Annalisa Paltauf, Green Projects Administrative Assistant
Brian Holdt, Green Projects Administrator

Consultant – Fuss & O'Neill, Inc.

Erik Mas, P.E.; Diane Mas, Ph.D.; Meghan Flanagan, EIT; Kristine Baker, P.E.; Jonathan Allard, PLA; David Askew, CPESC

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1 Introduction

1.1 Background

The West River and Its Watershed

The 25-mile long West River originates north of Lake Bethany near Route 42 and flows south through Bethany, Woodbridge, New Haven, and West Haven, eventually discharging into New Haven Harbor. Wintergreen Brook and Sargent River are the major tributaries of the West River. The tidally-influenced portion of the river, which contains the approximately 62-acre West River Tidal Marsh, extends from New Haven Harbor to Edgewood Park.



West River Memorial Park, New Haven (Source: CTDEEP).

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.



The West River watershed encompasses approximately 35 square-miles of land located primarily in the municipalities of New Haven, West Haven, Bethany, Hamden, Prospect, and Woodbridge, Connecticut (Figure 1-1). The southern portion of the watershed is highly urban, while the northern portion of the watershed is much more rural with significant areas of forest and protected water supply land (Figure 1-2). The Maltby Lakes and associated drainage area (Figure 1-3) are considered part of the West River watershed, despite CTDEEP basin mapping that incorrectly depicts the Maltby Lakes within the Cove River watershed and South Coastal Basin.

The West River watershed is home to approximately 75,000 residents. Land use is characterized by a mix of residential areas, commercial and industrial uses, open space, and other land uses. Several major state roads pass through the watershed, including Interstate 95 and Routes 1 and 34 in the lower watershed, Routes 10 and 15 in the middle portion of the watershed, and Routes 63 and 69 in the upper watershed. West Rock Ridge is the

most prominent topographic feature in the watershed, at an elevation of approximately 600 feet above the surrounding valley, separating Wintergreen Brook from the West River.

The existing physical, land use, and water quality characteristics of the West River watershed are further described in the document entitled *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a) (Appendix A).

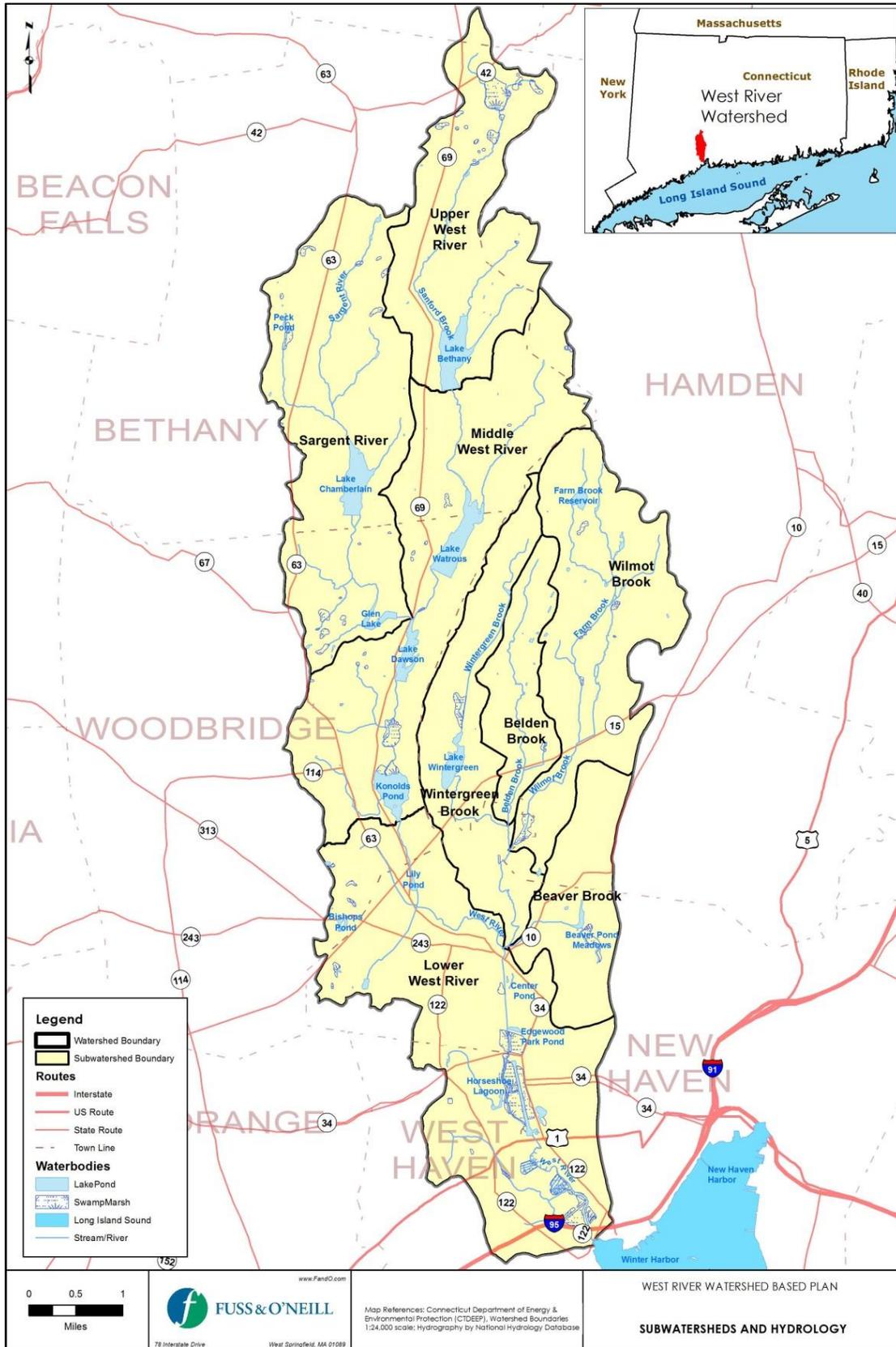


Figure 1-1. West River Watershed

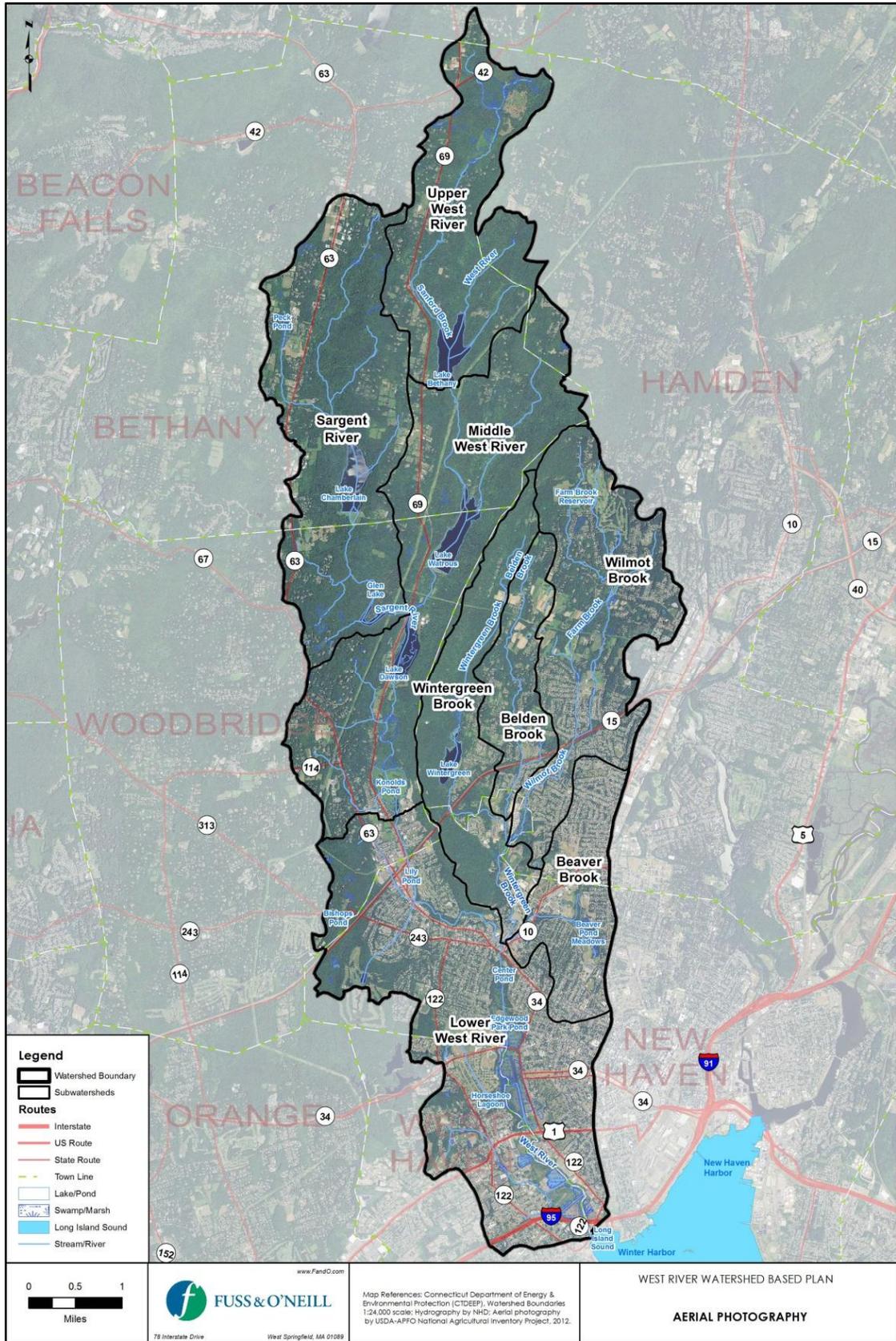


Figure 1-2. Aerial View of West River Watershed

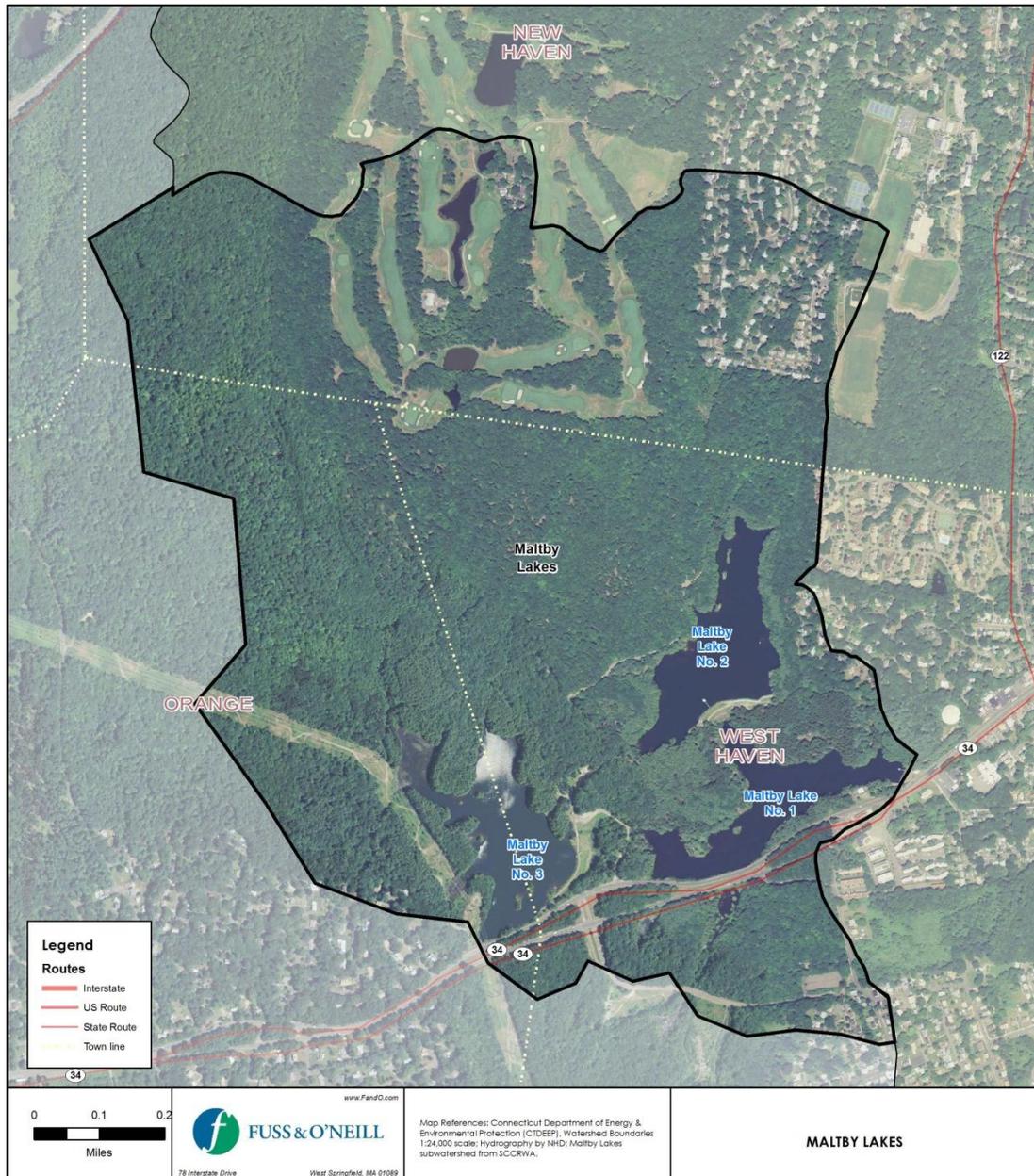


Figure 1-3. Maltby Lakes Subwatershed¹

¹ The Maltby Lakes subwatershed is 1.2 square miles in size and comprises roughly 3.5% of the overall West River watershed area. The outlet from Maltby Lake No. 1 flows easterly to Horseshoe Lagoon and eventually the West River. According to the South Central Connecticut Regional Water Authority (SCCRWA), the Cove River was diverted and is hydrologically separated from Maltby Lakes. The Trout Brook/Indian River watershed has the potential to be diverted to the Maltby Lakes. Since the Maltby Lakes are not currently used for water supply, the Trout Brook/Indian River watershed is not considered part of the West River watershed system. Approximately 70 percent of the Maltby Lakes subwatershed is owned and managed by SCCRWA, while the remainder is privately owned including a portion of the Golf Course at Yale.

Issues Facing the Watershed

Degraded Water Quality

The West River, like many suburban and urban rivers and streams in Connecticut, has been impacted by historical development and land use activities in its watershed. Water quality in the lower reaches of the West River is degraded due to elevated bacteria levels resulting from stormwater runoff, agriculture, combined sewer overflows, illicit discharges, pets, wildlife, and other sources. This has resulted in water quality “impairments,” which means that the waterbodies cannot support certain types of uses such as recreation or habitat for aquatic life. In contrast, the water quality in the upper portions of the watershed is very good, supporting surface drinking water supplies and cold water fisheries, which reflects the large areas of forested land and sparse development in the upper watershed.

A 3.2-mile segment of the West River stretching from the outlet of Konolds Pond to Edgewood Park Pond has been identified as impaired for recreation due to bacteria and impaired for aquatic life due to unknown causes (*Figure 1-4*). The estuary portions of the West River south of Edgewood Park Pond are impaired for recreation due to bacteria; marine life due to dissolved oxygen saturation, nutrients, oils and grease, dissolved oxygen, and PCBs; and shellfish due to bacteria. Edgewood Park Pond is impaired for recreation due to bacteria. The southern portion of Wintergreen Brook where it joins the West River is also impaired for recreation due to bacteria (CTDEEP, 2012).

In 2012, the Connecticut Department of Energy and Environmental Protection (CTDEEP) developed a Total Maximum Daily Load (TMDL) – essentially a “pollution budget” – for bacteria-impacted waterbodies statewide, including the West River, to begin addressing the bacteria impairments. The TMDL identified reductions in fecal indicator bacteria loads to the West River that are necessary for the impaired segments to meet State water quality standards and once again support contact recreation and provide suitable aquatic habitat.

The Statewide Bacteria TMDL for the West River can be achieved by implementing actions that will reduce bacterial loads using a watershed framework. This watershed-based plan therefore provides a framework for implementing the TMDL. Ultimately, the goal of both the watershed plan and the TMDL is to improve the water quality of the West River.

The West River – A Contrast in Water Quality

The water quality in the lower reaches of the West River is degraded due to elevated levels of bacteria and other pollutants resulting from combined sewer overflows, illicit discharges, and nonpoint sources such as stormwater runoff from developed areas. The poor water quality in the lower West River cannot support contact recreation or habitat for aquatic life.

In contrast, the water quality in the upper portions of the watershed is very good, supporting surface drinking water supplies and cold water fisheries.

The difference in water quality between the upper and lower portions of the West River highlights the strong influence of watershed land use activities on water quality and the importance of watershed management to address the water quality problems in the lower watershed.

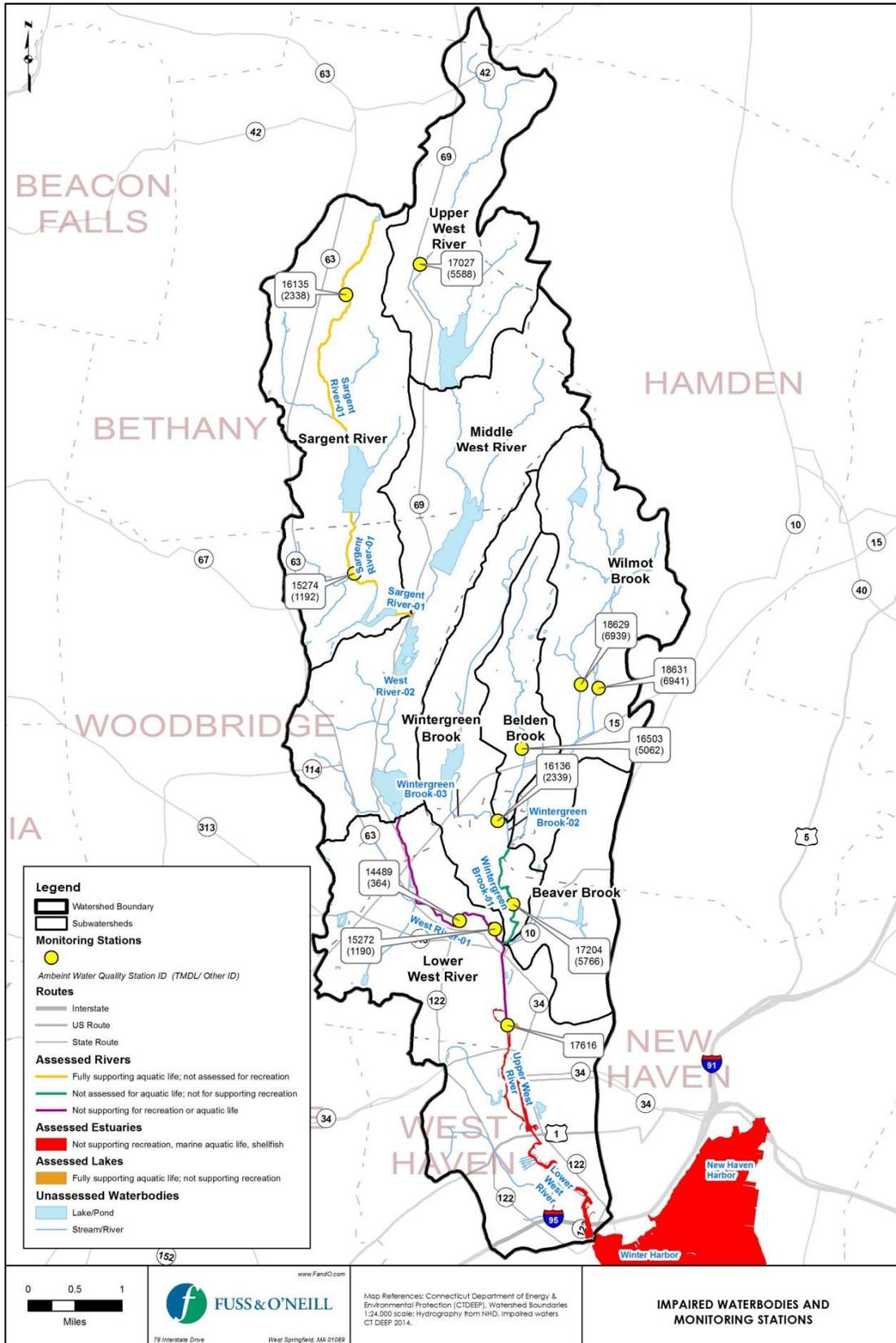


Figure 1-4. Water Quality Impairments in the West River Watershed

Urban stormwater runoff is a significant source of pollutants and a leading cause of water quality impairments in the West River. Stormwater runoff from developed areas and other nonpoint sources of pollution in the watershed are major contributors of bacteria, sediment, and nutrients. Stormwater runoff collected by the combined sanitary and storm sewer system in the City of New Haven also contributes to Combined Sewer Overflow (CSO) discharges to the West River during periods of heavy rainfall, when the combined sewer system becomes overwhelmed and untreated sewage is discharged directly to the river.

The Greater New Haven Water Pollution Control Authority (GNHWPCA) is in the process of implementing a long-term plan to reduce CSOs to the West River, which includes traditional gray infrastructure and green infrastructure² approaches. In addition to GNHWPCA, the City of New Haven, private development, and other groups are implementing green infrastructure in the West River watershed, which will reduce CSO discharges, runoff volumes, and wet weather pollutant loads.

Loss of Habitat

Historical development in the watershed and other factors are also responsible for loss of important habitats including inland wetlands, tidal marsh, natural vegetation along stream corridors, aquatic habitat, and forests. The West River and its tributaries were once important habitat for anadromous³ fish species, although urban development and flood control projects have diminished the quality and extent of fisheries in the watershed. The lower portions of the West River (e.g., West River Memorial Park and Edgewood Park) have been the focus of efforts by various groups over the past decade to restore lost or degraded habitat.

Limited River Access

Access to many portions of the West River is limited due to development along the river and the presence of major roads that cut-off the river from the surrounding neighborhoods (e.g., Ella T. Grasso Boulevard). Improved access to the West River and its tributaries is needed to enhance recreational opportunities as well as public appreciation and stewardship of the river.

Flooding

Portions of the West River and its tributaries have a long history of flooding as a result of historical development in the watershed. The U.S. Army Corps of Engineers spent much of the 1900s redirecting the West River to suit industrial and flood control needs. Urban flooding is common in some of the more urbanized areas of the watershed where storm drainage systems are over-capacity during some storms. Riverine flooding is also a significant and frequent problem in some areas, particularly near Blake Street, the Woodbridge Flats area, and along Wilmot Brook (also known locally as Farm Brook).

² Green infrastructure refers to systems and practices that reduce runoff through the use of vegetation, soils, and natural processes to manage water and create healthier urban and suburban environments (EPA, 2014). When applied to sites or neighborhoods, green infrastructure includes stormwater management practices such as rain gardens, permeable pavement, green and blue roofs, green streets, infiltration planters, trees and tree boxes, and rainwater harvesting. These practices capture, manage, and/or reuse rainfall close to where it falls, thereby reducing stormwater runoff and keeping it out of receiving waters.

³ Anadromous fish begin life in freshwater, migrate to the sea to reach maturity, and return to freshwater to spawn.

1.2 Why Develop a Watershed Plan?

Save the Sound, the West River Watershed Coalition, the watershed communities, and the CTDEEP recognize the need to address the water quality issues of the West River and its tributaries using a watershed-based approach. A primary way to do this is by developing and implementing a comprehensive watershed management plan. The watershed plan provides a blueprint to help groups within the watershed work across municipal boundaries to better protect and restore water resource conditions throughout the watershed.

Watershed Management

Watershed planning is a process that identifies ways to protect and restore the water quality and other natural resources in a watershed. The outcome of the watershed planning process is documented in a watershed management plan.

The major objectives of developing a watershed-based management plan for the West River are to:

- Characterize current watershed conditions and issues
- Identify specific actions to protect and improve water quality, but also address related issues such as habitat restoration, land use planning, open space protection, public access and recreation, and flooding
- Incorporate ongoing and planned stewardship efforts in the watershed
- Facilitate capacity-building and engage the watershed municipalities and other stakeholder groups in the watershed planning process and future plan implementation
- Promote collaboration across municipal boundaries, bringing the watershed communities and groups together to cooperate around shared issues of concern and objectives without compromising their “home rule” principles
- Create a plan that satisfies EPA and CTDEEP requirements for watershed-based plans to better position the West River for future grant funding from certain State and Federal sources.

1.3 Plan Development Process

Save the Sound partnered with the West River Watershed Coalition, CTDEEP, the watershed municipalities, and other groups to develop a watershed management plan for the West River. Funding for this project was provided by the CTDEEP through a U.S. EPA Clean Water Act Section 319 grant. Fuss & O’Neill, Inc. was retained by Save the Sound to lead the development of the watershed management plan.

This plan has been developed consistent with EPA and CTDEEP guidance for watershed-based plans. The guidance outlines nine key elements (see text box on the following page) that 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 this approach will enable implementation projects under this plan to be considered for funding under Section 319 of the Clean Water Act and improve the chances for funding through other State and Federal sources.

Development of the watershed management plan consisted of the following tasks.

Project Steering Committee

A Project Steering Committee was formed to guide the plan development. The Steering Committee consisted of representatives from the watershed municipalities, government organizations, educational institutions, non-profit organizations, and others who live and work within the watershed.

A series of workshop meetings were held with the Steering Committee and other invited stakeholders to discuss issues of concern in the watershed and to identify watershed planning goals and objectives that would form the basis of the plan recommendations. The Steering Committee and other stakeholders also provided review comments on draft deliverables. The watershed plan reflects the combined efforts of Save the Sound, the West River Watershed Coalition, the watershed municipalities, CTDEEP, other stakeholders, and the Fuss & O'Neill project team. Members of the Project Steering Committee and other individuals involved in the plan development process are listed in the Acknowledgments section at the beginning of this document.

EPA Nine Key Elements of a Watershed-Based Plan

- a. Identify causes and sources of pollution
- b. Estimate pollutant loading to the watershed and the expected load reductions
- c. Describe management measures that will achieve load reductions and targeted critical areas
- d. Estimated amount of technical and financial assistance and the relevant authorities needed to implement the plan
- e. Develop and information/education component
- f. Develop a project schedule
- g. Describe the interim, measurable milestones
- h. Identify indicators to measure progress
- i. Develop a monitoring component

State of the Watershed Assessment

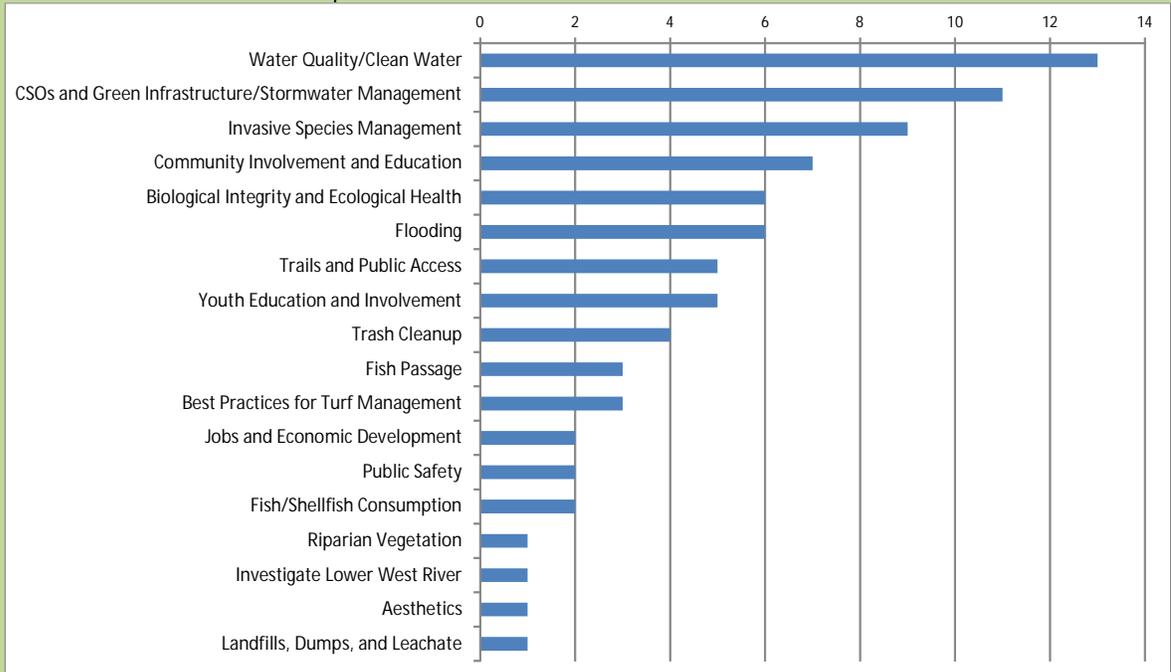
A baseline assessment was performed to document the existing physical, land use, and water quality characteristics of the West River watershed. The project team reviewed existing watershed data, studies, and reports; compiled and analyzed GIS mapping of the watershed and various subwatersheds; and developed pollutant loading and impervious cover estimates for the watershed. The document entitled *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a) serves as a basis for the watershed plan recommendations and also provides a background reference document to support future implementation activities within the watershed. A copy of the technical memorandum is provided on CD in *Appendix A* of this plan.

Watershed Survey

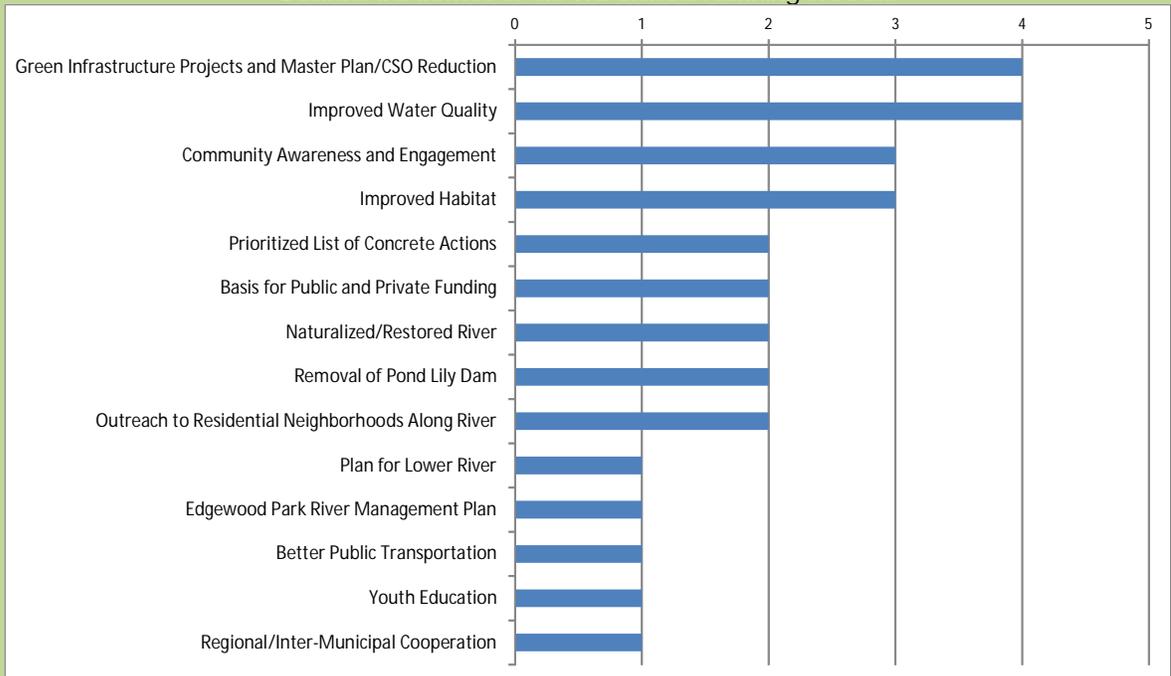
A survey was conducted to obtain early feedback from the Project Steering Committee and other stakeholders regarding the top concerns and issues in the West River watershed and the desired outcomes of the watershed planning process. The survey was completed on-line using Constant Contact and by filling out paper forms in some cases. The survey results are provided in *Appendix B* of this plan. The following text box summarizes key responses to the watershed survey.

West River Watershed Survey Responses

Top Issues/Concerns in the West River Watershed



Desired Outcomes of the Watershed Planning Process



Green Infrastructure Assessment

An assessment was performed to identify opportunities and develop concepts for site-specific green infrastructure retrofits in the West River watershed. The assessment included a screening evaluation to quickly identify areas of the watershed with the greatest feasibility for and potential benefits from green infrastructure retrofits, field inventories of the most promising green infrastructure retrofit opportunities in the watershed identified from the screening step, and green infrastructure concept designs for selected retrofit sites. The site-specific project concepts are intended to serve as future implementation projects and examples of the types of projects that could also be implemented for other similar land uses and locations in the watershed. The methods and findings of this assessment are documented in *Technical Memorandum #2: Low Impact Development and Green Infrastructure Assessment* (Fuss & O'Neill, 2015b). A copy of the technical memorandum is provided on CD in *Appendix C* of this plan.

Plan Goals and Objectives

The project team developed a series of goals and objectives for the watershed plan. The goals and objectives were further refined by the Project Steering Committee and other watershed stakeholders and are presented in *Section 2* of this document.

Plan Recommendations

Potential management actions were identified for each of the plan goals and objectives and subsequently refined based upon input from the Project Steering Committee and other stakeholders, culminating in the management recommendations that are presented in *Section 3* of this document.

1.4 Public Participation and Outreach

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. The following public outreach activities occurred during the watershed planning process:

- October 2014 – A Project Steering Committee was formed in October 2014. An initial project kickoff meeting was held with the Steering Committee and other invited stakeholders on October 16, 2014 at Neighborhood Housing Services of New Haven. The watershed survey was circulated to the stakeholders at this meeting to identify issues of concern and watershed planning priorities. A meeting summary is included in *Appendix D* of this plan.
- November 2014 – A Project Steering Committee workshop meeting was held on December 16, 2014 at Neighborhood Housing Services of New Haven. The purpose of the meeting was to review the watershed survey responses, baseline watershed conditions, and the watershed plan goals. *Appendix D* contains a summary of the meeting.
- April 2015 - A second Project Steering Committee workshop meeting was held on April 22, 2015 at Neighborhood Housing Services of New Haven. The purpose of the meeting was to review updates to Technical Memorandum #1 and the draft Technical Memorandum #2 (Green Infrastructure Assessment).

- May 2015 – Two community workshop meetings open to the public were held on May 13 and May 27, 2015. The May 13 meeting was held at the Edgewood Park Coogan Pavilion, while the May 27 meeting was held at the West River Memorial Park Barnard Nature Center. The workshops consisted of a presentation on the current watershed conditions and major issues facing the West River watershed, followed by group discussion of local issues of importance and desired outcomes of the watershed planning process. Summaries of the meetings (main concerns, desired outcomes of the watershed plan, and project recommendations) and questionnaires completed by the workshop participants are included in *Appendix E* of this plan.
- June 2015 – Fuss & O'Neill and staff from the Connecticut office of the Natural Resources Conservation Service (NRCS) conducted streamwalk assessment training on June 22, 2015 for Save the Sound, members of the West River Watershed Coalition, and other volunteers, including students and faculty of the Common Ground High School in New Haven. The training provided volunteers with basic information on conducting stream assessments of the West River and its tributaries following the NRCS protocols for performing visual stream assessments in Connecticut. Further details of the stream assessments are discussed later in this plan.
- August 2015 – The watershed plan was presented to the public on August 18, 2015. Questions and comments were received during and following the meeting. Public comments have been incorporated into the final watershed management plan.

Other related watershed outreach activities led by Save the Sound have included:

- Monthly participation in West River Watershed Coalition meetings
- West River watershed streamwalks with volunteers
- Coordination/outreach with Common Ground High School including general watershed education, streamwalk training, and streamwalk surveys
- Consulting with Edgewood School on Urban Oasis Program rain garden and erosion prevention activities (with Audubon Connecticut)
- Presentation to New Haven Parks Commission seeking permission to install rain gardens in the median island on Edgewood Avenue - permission granted
- Coordination with New Haven Engineering Department on Edgewood Avenue rain garden
- Coordination with the New Haven City Plan Department regarding development of the watershed plan.

2 Watershed Management Goals and Objectives

This section presents management goals and objectives for the West River watershed. The goals and objectives were developed in conjunction with the Project Steering Committee, with input from the public and other watershed stakeholders during the planning process. *Section 3* of this plan presents recommended actions to achieve these goals and objectives.

- Goal #1 – Capacity Building. Strengthen and build local capacity to implement the watershed management plan.

Capacity Building Objectives

- Establish a framework and lead entity for implementation of the watershed management plan
- Identify and pursue funding to implement the recommendations outlined in this plan.
- Promote inter-municipal coordination to formally adopt the watershed plan and coordinate and oversee watershed management plan implementation activities.
- Promote regional collaboration to share ideas and strengthen regional watershed management efforts, particularly with groups representing the neighboring Mill River and Quinnipiac River watersheds.
- Conduct streamwalks in priority subwatersheds to assess the condition of the streams and riparian corridors, identify retrofit opportunities and problem areas, and involve the public and volunteers as a form of outreach.
- Prepare and implement subwatershed action plans for priority subwatersheds.



West River watershed management goals.

- Goal #2 – Water Quality. Improve the water quality of the impaired segments of the West River and its tributaries by reducing loadings of bacteria and other pollutants. Consistently meet water quality standards for recreation and aquatic habitat. Protect and enhance high quality and unimpaired waterbodies.

Water Quality Objectives

- Continue water quality monitoring to identify pollution sources, follow long-term trends in water quality, and track the progress of the watershed plan.
- Eliminate Combined Sewer Overflow (CSO) discharges to the West River.
- Reduce the impacts of subsurface sewage disposal systems through proper homeowner inspection and maintenance.
- Expand the use of green infrastructure throughout the watershed.
- Implement municipal stormwater management programs to comply with state and federal permit requirements.

- Protect and restore natural streamside vegetation in the watershed to protect and improve water quality.
 - Reduce bacteria loads from wildlife and pet waste.
 - Identify and remove illicit connections and non-stormwater discharges to the West River and its tributaries.
 - Promote sustainable lawn care practices to reduce the use of water, fertilizer, and toxic chemicals.
 - Reduce the threats to water quality from commercial and industrial land uses.
 - Protect public drinking water supplies in the upper watershed through ongoing source water protection and open space acquisition.
- Goal #3 – Habitat Protection and Restoration. Protect and restore terrestrial, streamside, and aquatic habitat.

Habitat Objectives

- Protect and restore in-stream habitat for resident and migratory fish species in the West River and portions of Wintergreen Brook by removing barriers to fish passage.
 - Protect and restore natural vegetated buffers along the West River, its tributaries, and other water bodies.
 - Protect and restore high-priority wetland and open water habitat including the West River Tidal Marsh and reflecting pool, Pond Lily, Konolds Pond, and Beaver Ponds.
 - Manage invasive plant species that threaten local biodiversity and ecosystem function in the watershed.
 - Protect and restore forested areas and tree canopy within the watershed.
- Goal #4 – Sustainable Land Use, Open Space, and Public Access. Promote sustainable land use and appropriate development in the watershed while protecting and improving water quality and natural resources, enhancing public access to and connectivity of waterbodies and open space, and addressing current and future flooding problems.

Land Use, Open Space, and Public Access Objectives

- Preserve existing open space and prioritize additional lands for open space conservation.
 - Increase public access to and connectivity of water bodies and open space to improve public use, appreciation, and stewardship.
 - Strengthen municipal land use policy and regulations for broader implementation of low impact development and green infrastructure.
 - Increase flood resilience through a watershed approach.
- Goal #5 – Education and Stewardship. Promote stewardship of the watershed through education and outreach, improved access to the West River and its tributaries, and citizen involvement in science, conservation, and restoration activities.

Education and Stewardship Objectives

- Implement a green infrastructure public outreach campaign focused on citizens, businesses, and communities.
- Provide incentives for residential “green” practices.
- Conduct homeowner education and outreach on animal waste, sustainable lawn care and landscaping practices, streamside buffers, and septic system maintenance.
- Promote, publicize, and support existing community engagement events that focus on the West River and its watershed such as the annual “West River Water Festival”.
- Conduct education and outreach for the watershed business community on pollution prevention.
- Conduct municipal education and outreach on animal waste, parks and open space maintenance, green infrastructure, storm sewer system and BMP maintenance, and identification and removal of illicit connections.
- Enhance youth education, community service, and environmental stewardship programs.
- Conduct outreach to public and private institutional property owners in the watershed such as Yale University, Southern Connecticut State University, University of New Haven, and others.
- Increase watershed stewardship signage in targeted areas.
- Address homeless encampments near the West River through support of City shelters and services to reduce homelessness, periodic cleanups, providing public restrooms, and partnering with non-governmental organizations to address homelessness.

3 Management Recommendations

This section describes recommended actions to meet the watershed management goals and objectives outlined in *Section 2*. The recommendations include watershed-wide and targeted actions:

- Watershed-wide Recommendations are recommendations that can be implemented throughout the West 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 subwatersheds or 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.

Due to the large size of the West River watershed and limited field assessment scope of the watershed planning process, additional field assessments are recommended to further characterize pollutant sources and potential site-specific restoration projects. An objective of the proposed stream assessments is to help identify additional site-specific projects and develop action plans for targeted subwatersheds, which is more effective at the subwatershed scale.

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 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.
- Mid-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 5 and 10 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 programs and mechanisms.

The remainder of this section describes the recommended actions presented in this watershed management plan. The recommended actions are categorized according to the five major goals of this plan – (1) capacity building, (2) water quality, (3) habitat protection and restoration, (4) sustainable land use, open space, and public access, and (5) education and stewardship.

3.1 Capacity Building

Goal Statement: Strengthen and build local capacity to implement the watershed management plan.

The success of this watershed plan will depend on effective leadership, active participation by the watershed stakeholders, and local “buy-in” of the plan recommendations by the watershed municipalities, in addition to funding and technical assistance. Fortunately, significant local support and “capacity” for watershed protection and restoration already exists within the West River Watershed, led by the West River Watershed Coalition and other stakeholder groups. Strengthening local capacity for implementing this watershed plan, by building on the existing network of volunteers and programs, is a critical early 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 Establish a Framework and Lead Entity

Recommended Actions

- The West River Watershed Coalition has limited capacity to implement the watershed plan without a funded watershed coordinator position. Secure funding for and hire a watershed coordinator to assist the WRWC and to lead watershed management plan implementation activities such as:
 - Coordinating the efforts of plan implementation sub-committees
 - 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 public outreach activities
 - Hosting public meetings to celebrate accomplishments, recognize participants, review lessons learned, and solicit feedback on plan updates and next steps.

An example of a funded watershed coordinator position is the Niantic River Watershed Coordinator, which has been funded through a series of Section 319 Nonpoint Source Pollution program grants awarded to the Eastern Connecticut Conservation District.

- Form watershed plan implementation sub-committees around the watershed plan goals – water quality, habitat restoration, land use/open space, and education/outreach. The sub-committees would ideally consist of volunteers with a particular interest or area of expertise in each topic.
- Hold regular meetings/forums for citizen input.
- Create and maintain a website dedicated to the West River watershed to serve as a centralized source of information on the watershed and management plan implementation activities.

3.1.2 Promote Inter-Municipal Coordination

Many of the recommendations in this watershed management plan can 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.

Table 3-1. Capacity Building Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Secure funding for and hire a watershed coordinator	WRWC, STS, SWCD	0-2 years	Funded watershed coordinator position	\$\$\$	Grants
2. Form watershed plan implementation sub-committees or work groups <ul style="list-style-type: none"> Recruit members Develop work plans Hold regular forums for citizen input 	WRWC	0-2 years	Committee membership and work plans	\$	Grants
3. Create and maintain a West River watershed website	WRWC and consultant	0-2 years	Dedicated website	\$\$\$	Grants
4. Obtain municipal endorsement of the watershed plan	STS and WRWC	0-2 years	Memorandum of Agreement (MOA), inter-municipal agreement, compact or similar mechanism	\$	
5. Engage and involve local, state, and regional organizations. Promote grassroots involvement.	WRWC and groups listed in Table 3-2	Ongoing	Active participation in watershed plan activities by organizations	\$	
6. Identify and pursue funding <ul style="list-style-type: none"> Review and prioritize funding sources Prepare and submit grant applications 	STS and WRWC	0-2 years Ongoing	List of funding sources and funding pursued	\$\$	See Section 5 and Appendix H of this plan for funding sources
7. Conduct streamwalk assessments <ul style="list-style-type: none"> Complete streamwalks Compile and analyze data Plan and conduct "track down" surveys 	STS and volunteers	0-2 years (repeat streamwalks every 5 yrs)	Streamwalk assessment and track down survey findings and recommendations	\$\$	
8. Prepare and implement subwatershed action plans	WRWC and consultant	0-2 years	Subwatershed action plans prepared and implemented	\$\$\$	

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

STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition SWCD = Southwest Conservation District

Additionally, a watershed partnership permits the sharing of technical and human resources, volunteers, equipment, and materials. Endorsement of the watershed management plan by the watershed municipalities is an important first step in implementing the plan recommendations.

Recommended Actions

- The West River Watershed Coalition, with the assistance of Save the Sound, should seek endorsement of the watershed management plan by the watershed municipalities through a Memorandum of Agreement (MOA), inter-municipal agreement, compact or similar mechanism to encourage inter-municipal coordination and accountability and to formalize the municipalities' agreement to support the watershed planning effort 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, particularly groups representing the neighboring Mill River and Quinnipiac River watersheds, 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.

Recommended Actions

- Engage and involve the following local, state, and regional organizations with an interest in the West 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).

Table 3-2. Local, Regional and State Organizations

Local Organizations	Regional Organizations	State Organizations
<ul style="list-style-type: none"> • Municipal Staff and Land Use Commissions • West River Watershed Partnership • West River Watershed Youth Council • West River Neighborhood Services Corporation • New Haven Environmental Justice Network • The Elm City Parks Conservancy • Neighborhood Housing Services of New Haven • New Haven Land Trust • Local Conservation Trusts • Local Schools and Universities • Urban Resources Initiative • New Haven Bioregional Group • Friends of Edgewood Park • Friends of Beaver Ponds Park • Solar Youth 	<ul style="list-style-type: none"> • Greater New Haven Water Pollution Control Authority • South Central Connecticut Regional Water Authority • South Central Regional Council of Governments • Southwest Conservation District • Quinnipiac River Watershed Association • Mill River Watershed Association of South Central Connecticut • River Advocates of South Central Connecticut • Greater New Haven Green Fund • Greater New Haven Waterworks Coalition 	<ul style="list-style-type: none"> • Rivers Alliance of Connecticut • American Rivers • CT Audubon Society • The Nature Conservancy • CT Forest and Park Association • Trout Unlimited • CTDEEP • CT Coalition for Environmental Justice • Bikewalk CT • Natural Resources Conservation Service (NRCS-CT) • Save the Sound/CT Fund for the Environment

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*). High-priority funding sources that should be considered include:
 - CTDEEP/EPA Section 319 Nonpoint Source Grants
 - National Fish and Wildlife Foundation Long Island Sound Futures Fund
 - Connecticut Clean Water Fund
 - HUD Community Development Block Grants for green infrastructure and coastal resilience
 - Community Foundation for Greater New Haven
 - Stormwater utilities and other innovative stormwater program financing mechanisms
- 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.
- Explore EPA designation of the West River, Mill River, and Quinnipiac River watersheds (i.e., “Greater New Haven Watershed”) as an eligible geographic location (co-located with 18 existing Urban Waters Federal Partnership locations nation-wide) under the EPA Urban Waters Small Grants program. At some point in the future, eligible geographic location/Federal Partnership designation will be re-evaluated by EPA.

3.1.5 Conduct Streamwalk Assessments

Visual stream assessments or streamwalks are a simplified assessment protocol to evaluate the condition of aquatic ecosystems associated with streams. They help to evaluate the overall condition of the stream, riparian buffer, and floodplain based on a consideration of in-stream habitat, vegetative protection, bank erosion, floodplain connection, vegetated buffer width, floodplain vegetation and habitat, and floodplain encroachment. Visual stream assessments also help to identify problem areas and provide a basis for further detailed field investigation and potential restoration opportunities. Streamwalks also provide an ideal opportunity to involve the public and volunteers as a form of outreach.

Fuss & O'Neill and staff from the Connecticut office of the Natural Resources Conservation Service (NRCS) conducted streamwalk assessment training on June 22, 2015 for Save the Sound, members of the West River Watershed Coalition, and other volunteers. The classroom and field training provided information on conducting stream assessments of the West River and its tributaries following the NRCS protocols for performing visual stream assessments in Connecticut
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/water/?cid=nrcs142p2_011198.

Appendix F of this plan contains materials from the streamwalk assessment training.

Save the Sound, members of the West River Watershed Coalition, students and faculty from the Common Ground School, and other volunteers conducted streamwalk assessments of selected reaches of the West River and its tributaries during the summer of 2015. The selected reaches are primarily within the lower impaired sections of the West River and Wintergreen Brook subwatersheds. A reach on the Sargent River with documented high-quality water is also included as a reference reach for comparison. Initial results from the streamwalks are presented in *Appendix F*.

Recommended Actions

- Complete streamwalk assessment surveys of all selected reaches in the watershed using the Connecticut NRCS protocols and field data collection sheets.
- Compile and analyze the collected data.
- Following the streamwalks and evaluation of the assessment results, plan and conduct subwatershed visual “track down” surveys of identified or suspected pollution sources. 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.
- Subwatershed 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.

3.1.6 Prepare and Implement Subwatershed Action Plans

Development and implementation of site-specific restoration and protection strategies is most effective at the subwatershed scale for larger watersheds such as the West River watershed. Although this watershed plan identifies a number of site-specific recommendations and green infrastructure 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 West River and its entire watershed. Additional targeted watershed assessment and planning is recommended for various subwatersheds, including streamwalk assessments, track down surveys, and volunteer monitoring. These additional assessments will help to better characterize current conditions within specific reaches of the West River, its tributaries, and upland areas of the subwatersheds. The goal of the streamwalks and track down surveys is to develop action plans for each priority subwatershed and identify additional site-specific restoration projects.

Recommended Actions

- Prepare and implement more detailed subwatershed action plans for priority subwatersheds based on the findings of streamwalk assessments and associated track down surveys (see recommendations in previous section).
- Target subwatersheds, including major tributaries and municipalities located within each subwatershed, are summarized in *Table 3-3*. The municipalities located within each subwatershed should be encouraged to participate in development and implementation of the respective subwatershed action plans. *Table 3-3* also includes the average percent reductions in bacterial loads to meet water quality standards, as reported in the statewide bacteria TMDL for the West River. Higher priority subwatersheds are those watersheds containing water bodies with bacterial impairments listed in the TMDL. Lower priority subwatersheds include other West River tributaries with listed water quality impairments, but for which a TMDL has not yet been developed.

- Subwatershed action plans could be maintained as an appendix to the overall West River Watershed Management Plan, relying on watershed background information, goals, and objectives contained in the larger watershed plan. A recommended framework for a simplified subwatershed action plan is as follows:
 - Subwatershed Pollutant Sources
 - Load Reductions Needed
 - Recommended Actions

Table 3-3. Target Subwatersheds for Development of Subwatershed Action Plans

Subwatershed	Waterbody Segment	Municipalities Located within Subwatershed	Required Percent Reduction in Bacterial Loads (TMDL)
Higher Priority (Bacteria Impairment with Approved TMDL)			
Lower West River	West River from Konold's Pond Outlet to Chapel Street crossing CTDEEP Waterbody ID CT5305-00_01	New Haven Woodbridge	86% (geomean) 88% (single sample)
Lower West River	Edgewood Park (Duck) Pond Outflow CTDEEP Waterbody ID CT5305-00-3-L1_01	New Haven	62% (geomean) 94% (single sample)
Lower Priority (Impaired and TMDL Required)			
Lower West River – Tidal/Estuary	West River downstream of Chapel Street crossing CTDEEP Waterbody ID CT5305-00_01	New Haven West Haven	Not Applicable
Wintergreen Brook	Wintergreen Brook from mouth on West River, downstream of Blake Street crossing, upstream to confluence with Wilmot Brook, upstream of Wilmot Road crossing	New Haven	Not Applicable
Beaver Brook	Beaver Brook	New Haven Hamden	Not Applicable
Wilmot Brook	Wilmot Brook Farm Brook	Hamden	Not Applicable
Belden Brook	Belden Brook	Hamden New Haven	Not Applicable

3.2 Water Quality

Goal Statement: Improve the water quality of the impaired segments of the West River and its tributaries by reducing loadings of bacteria and other pollutants. Consistently meet water quality standards for recreation and aquatic habitat. Protect and enhance high quality and unimpaired waterbodies.

3.2.1 Water Quality Monitoring

Ongoing water quality monitoring is recommended for the West River watershed to refine the understanding of water quality impacts from potential point and non-point pollution sources in the watershed, to measure the progress toward meeting watershed management goals and TMDL pollutant load reductions, and ultimately support removal of the impaired segments of the West River and its tributaries from the CTDEEP impaired waters list. Water quality monitoring recommendations are summarized in *Table 3-4*.

Recommended Actions

- Consider establishing a volunteer water quality monitoring program for the West River. Volunteer monitoring promotes citizen awareness, involvement, and environmental stewardship. Volunteer monitoring can also help to identify ambient water quality and trends, fill in gaps in statewide monitoring data, and provides data for regulatory and land use decision-making. Many examples of successful volunteer monitoring programs exist around Long Island Sound. Additional information about the CTDEEP Volunteer Monitoring Program is available online at <http://www.ct.gov/deep/streamvolmon>.
- Consistent with the bacteria TMDL for the West River watershed, the monitoring program should be designed to accomplish two objectives: (1) source detection to identify specific sources of bacterial loading and (2) fixed station monitoring to track water quality improvements.
 - Bacteria Source Detection – Source detection monitoring may include visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient (in-stream) conditions at closely spaced intervals to identify “hot spots” for more detailed investigations leading to specific sources of high bacteria loads. Source detection monitoring should be informed by the findings of streamwalk assessments and follow-up track down surveys. Source detection monitoring should also be implemented by the watershed municipalities as part of their “Illicit Discharge Detection and Elimination” efforts as required by the MS4 permit.
 - Fixed Station Bacteria Monitoring – Conduct routine bacteria monitoring at fixed sites along the impaired reaches of West River (and the Edgewood Park Pond outflow) and Wintergreen Brook to measure progress toward achieving the watershed plan and TMDL pollutant load reduction goals. Sampling should be scheduled at regularly spaced intervals during the recreational season. Therefore, the data set at the end of each season would include ambient values for both “wet” and “dry” conditions in relative proportion to the number of “wet” and “dry” days that occurred during the monitoring period. The TMDL calculations can be updated over time to compare the percent reductions needed under “dry” and “wet” conditions to the percent reductions that were needed at the time of TMDL adoption.

Recommended Fixed Station Bacteria Monitoring Locations – West River Watershed

- Konolds Pond outflow
 - West River at Pond Lily Avenue (just downstream of Route 15)
 - West River at Valley Street (CTDEEP sampling station 364)
 - Wintergreen Brook below Wintergreen Avenue
 - Wintergreen Brook at Blake Street (downstream of SCSU)
 - West River upstream of Blake Street (CTDEEP sampling station 1190)
 - West River in Edgewood Park downstream of Whalley Avenue and CSO 006
 - Edgewood Park (Duck) Pond Outflow (CTDEEP sampling station 17616)
 - West River at Derby Avenue downstream of CSO 005
 - West River Reflecting Pool near Legion Avenue and CSO 004
 - West River at Orange Avenue (Route 1) downstream of CSO 003
- Also consider implementing the Riffle Bioassessment by Volunteers (RBV) Program within the West River watershed. The RBV program is a volunteer water quality monitoring protocol developed and administered by the CTDEEP. Volunteers are trained to assess benthic macroinvertebrates in small wadeable streams to screen local stream segments for water quality. Volunteers could include students and faculty from local schools and universities. The non-tidal portions of the West River and both impaired and unimpaired segments of its major tributaries are potential candidates for RBV surveys. Information on the RBV Program is available at <http://www.ct.gov/deep/rbv>.
 - Develop and implement a centralized water quality database for historical and new water quality monitoring data for the West River watershed. The database could be made accessible to the West River Watershed Coalition, educational groups for teaching purposes, and the general public. The database could be implemented using an existing tool such as the Global Learning and Observations to Benefit the Environment (GLOBE) Program <https://www.globe.gov/home>, which is an international science and education program that provides students and the public worldwide with the opportunity to participate in data collection, data entry, and data visualization, or a custom software application such as the recently developed water quality database and web resource for the Bronx River <http://bronxriverwater.org/>.
 - Pursue dedicated funding to finance future monitoring and reporting.
 - Revive the inactive West Rock Nature Center for use as a headquarters for water quality monitoring, stream surveys, and other field-related and restoration activities in the West River watershed.
 - Prepare a periodic “Water Quality Report Card” for the West River modeled after similar report cards that have been prepared for other rivers and embayments around Long Island Sound and elsewhere in the U.S. The report card would provide a transparent, timely, and geographically detailed assessment of water quality for the West River to inform the public of water quality conditions and actions that are occurring to improve and protect water quality in the river. Report card scores are determined by comparing water quality indicators to scientifically-derived ecological thresholds or goals.

Water Quality Report Card

An example of a water quality report card developed for Hempstead Harbor on the north shore of Long Island.

<http://www.nfwf.org/whoware/mediacenter/pr/Documents/hempstead-harbor-report-card.pdf>

D+

Harbor nitrogen levels & water clarity need improvement

Overall Inner Harbor Health **D+**

Inner Hempstead Harbor scored 67% **D+**. This grade is considered poor. Dissolved oxygen scored 87% **B+** overall, a moderately good grade. Dissolved inorganic nitrogen scored 76% **C**, a moderate grade and water clarity scored 38% **F**, a very poor grade.

Outer Harbor **ID**

The Outer Harbor subregion was not scored, due to insufficient data collected in this region, with only one sampling site. Because of the importance of shellfishing in this region, new sampling sites are being considered in the future.

Glen Cove Creek **F**

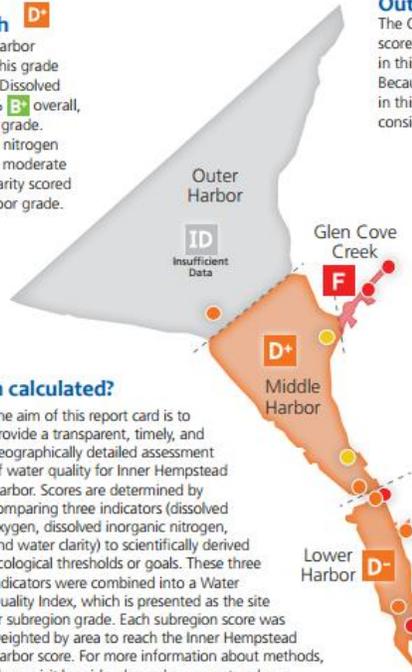
The Glen Cove Creek subregion scored 54% **F**, a very poor grade. Dissolved oxygen scored 82% **B-**, a moderately good grade. Dissolved inorganic nitrogen and water clarity had very poor grades, 52% **F**, and 27% **F**, respectively.

Middle Harbor **D+**

The Middle Harbor subregion scored 69% **D+**, a poor grade. Dissolved oxygen scored 88% **B+**, a moderately good grade and dissolved inorganic nitrogen scored 79% **C+**, a moderate grade. Water clarity scored 41% **F**, a very poor grade.

Lower Harbor **D-**

The Lower Harbor subregion scored 62% **D-**, a poor grade. Dissolved oxygen scored 83% **B**, a moderately good grade. Dissolved inorganic nitrogen scored 70% **C-**, a moderately poor grade. Water clarity scored 31% **F**, a very poor grade.



How is health calculated?

- DO**
Dissolved oxygen
- N**
Dissolved inorganic nitrogen
- Water clarity**

The aim of this report card is to provide a transparent, timely, and geographically detailed assessment of water quality for Inner Hempstead Harbor. Scores are determined by comparing three indicators (dissolved oxygen, dissolved inorganic nitrogen, and water clarity) to scientifically derived ecological thresholds or goals. These three indicators were combined into a Water Quality Index, which is presented as the site or subregion grade. Each subregion score was weighted by area to reach the Inner Hempstead Harbor score. For more information about methods, please visit longislandsound.ecoreportcard.org.

- A** 90–100%: All water quality indicators meet desired levels. Quality of water in these locations tends to be very good, most often leading to preferred habitat conditions for aquatic plants and animals.
- B** 80–90%: Most water quality indicators meet desired levels. Quality of water in these locations tends to be good, often leading to acceptable habitat conditions for aquatic plants and animals.
- C** 70–80%: There is a mix of good and poor levels of water quality indicators. Quality of water in these locations tends to be fair, leading to sufficient habitat conditions for aquatic plants and animals.
- D** 60–70%: Some or few water quality indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to degraded habitat conditions for aquatic plants and animals.
- F** 0–60%: Very few or no water quality indicators meet desired levels. Quality of water in these locations tends to be very poor, leading to unacceptable habitat conditions for aquatic plants and animals.
- ID** Insufficient Data (ID) is a designation used for areas where there is either insufficient or no data to give a grade on desired health levels.

Table 3-4. Water Quality Monitoring Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Establish and implement a volunteer water quality monitoring program <ul style="list-style-type: none"> • Identify funding sources • Identify monitoring coordinator • Develop program with CTDEEP • Recruit volunteers • Conduct training and prepare QAPP 	STS, WRWC, Harbor Watch/River Watch Program, and volunteers	2-5 years initial program development Annual monitoring	Approved QAPP, monitoring results/reports	\$\$\$	
2. Implement RBV program <ul style="list-style-type: none"> • Contact CTDEEP RBV Coordinator • Recruit volunteers • Conduct training and surveys 	WRWC, CTDEEP, and volunteers	0-2 years and annually thereafter	Survey results/reports	\$\$	
3. Develop and implement a centralized water quality database	WRWC and consultant	2-5 years	Functional database	\$\$\$	
4. Revive the West Rock Nature Center for use as a headquarters for water quality monitoring and other field activities	City of New Haven Parks and Recreation Department and WRWC	0-2 years	Use of Nature Center for watershed field activities	\$	
5. Prepare a periodic "Water Quality Report Card"	WRWC and consultant	2-5 years	Report cards	\$\$\$	

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

STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition CTDEEP = Connecticut Department of Energy and Environmental Protection

3.2.2 Combined Sewer Overflows

As described in *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a), during wet weather portions of the combined sanitary and storm sewer system in the City of New Haven become overwhelmed and combined sewage overflows to nearby receiving waters. These discharges are referred to as Combined Sewer Overflows (CSOs). There are four permitted CSO outfalls to the West River – CSOs 003, 004, 005, and 006. The Greater New Haven Water Pollution Control Authority (GNHWPCA) is in the process of implementing a phased plan to reduce CSOs to the West River, which includes traditional gray infrastructure and green infrastructure approaches.

GNHWPCA should continue to implement CSO abatement measures to further reduce CSO discharges to the West River consistent with its CSO abatement plan. Specific CSO-related recommendations are described below and summarized in *Table 3-5*.

Recommended Actions

- Complete the CSO wet weather capacity improvements in the West River watershed that are identified in the 2014 West River CSO Abatement Report (CH2MHILL, 2014a) and 2014 Hydraulic Model Update Report (CH2MHILL, 2015), including but not limited to:
 - Raising the overflow weir at Regulators 004 and 005 (completed in 2014)
 - Making improvements to the Truman CSO Storage Tank (completed in 2015)
 - Cleaning the lower Boulevard Trunk Sewer
 - Maximizing pumping from the Boulevard Pump Station
 - Relocating Regulator 003 off of Ella Grasso Boulevard and constructing a new mechanically controlled adjustable weir at a higher elevation
 - Relocating Regulator 004 off of Ella Grasso Boulevard and constructing a new mechanically controlled adjustable weir at a higher elevation
 - Modifying Regulator 006 by constructing a new access chamber and installing stop logs at a higher elevation.
- Implement green infrastructure projects within the Boulevard Trunk Sewer tributary areas (CSO sewersheds 003 and 004), as identified in the Green Infrastructure Suitability Pilot Study (Green Infrastructure Improvement Report) completed in August 2014 (CH2MHILL, 2014b).
- Update and implement the CSO Long Term Control Plan (2016 Update), which will identify and develop short, intermediate and long term CSO control measures to achieve zero discharges from CSO outfalls for up to a 2-year, 6-hour rainfall event by 2036.
- Continue to require the use of green infrastructure stormwater management practices (e.g., infiltrators and drywells, rain water storage tanks, bioswales and tree wells, water features) for development projects within combined sewer areas in accordance with the GNHWPCA Permitting and Design Criteria Manual (retain runoff on-site for the 2-year, 6-hour rainfall event, or approximately 2.05 inches).
- Continue to collect flow monitoring data to evaluate the effectiveness of the ongoing CSO improvements in the West River watershed (i.e., CSO events, volumes, and pollutant loads)
- Compare annual measured CSO volumes with the annual CSO volume predicted by the December 2014 hydraulic model update (14.65 million gallons). Several years of monitoring data may be needed to adequately characterize annual CSO discharges under a variety of wet weather conditions.

- Foster a partnership between the GNHWPCA and the Greater New Haven Waterworks Coalition to help promote green infrastructure within the GHNWPCA service areas with combined sewers. The Greater New Haven Waterworks Coalition would have a role in helping to establish success measures and provide some oversight and reporting back to the community.

3.2.3 Green Infrastructure and Low Impact Development

Urban stormwater runoff is a significant source of pollutants and a leading cause of water quality impairments in the West River. Stormwater runoff from developed areas and other nonpoint sources of pollution in the watershed are major contributors of bacteria, sediment, and nutrients. As discussed previously, CSOs are also a major source of pollutants to the West River during wet weather.

Green infrastructure (GI) refers to systems and practices that reduce runoff through the use vegetation, soils, and natural processes to manage water and create healthier urban and suburban environments (EPA, 2014). When applied to sites or neighborhoods, green infrastructure includes stormwater management practices such as rain gardens, permeable pavement, green and blue roofs, green streets, infiltration planters, trees and tree boxes, and rainwater harvesting. These practices capture, manage, and/or reuse rainfall close to where it falls, thereby reducing stormwater runoff and keeping it out of receiving waters.

In addition to reducing polluted runoff and improving water quality, GI has been shown to provide other social and economic benefits relative to reduced energy consumption, improved air quality, carbon reduction and sequestration, improved property values, recreational opportunities, overall economic vitality, and adaptation to climate change (Center for Neighborhood Technology and American Rivers, 2010; EPA Green Infrastructure Website http://water.epa.gov/infrastructure/greeninfrastructure/gi_why.cfm). For these reasons, many communities are exploring the use of and are adopting GI within their municipal infrastructure programs.

Green Infrastructure (GI) can be 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 that is intended to reduce development related impacts on water resources through the use of stormwater management practices that infiltrate, evapotranspire, or harvest and use stormwater on the site where it falls.

As described in *Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a), GI is being implemented by the City of New Haven, GNHWPCA, private development, and other groups working in the West River watershed. An important objective of the West River Watershed Management Plan is to reduce CSO discharges, runoff volumes, and pollutant loads through the use of GI by building on the previous and ongoing GI initiatives in the watershed and region. Additional opportunities for GI retrofits in the West River watershed were identified during the development of this watershed plan and are documented in *Technical Memorandum #2: Low Impact Development and Green Infrastructure Assessment* (Fuss & O'Neill, 2015b). *Table 3-5* contains green infrastructure recommendations for the West River watershed.

Table 3-5. Combined Sewer Overflow and Green Infrastructure Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue to implement CSO improvements identified in the GNHWPCA West River CSO Abatement Plan	GNHWPCA	Ongoing	Updated 2016 LTCP, completed projects	\$\$\$\$	GNHWPCA, CWF
2. Flow monitoring to evaluate effectiveness of CSO improvements <ul style="list-style-type: none"> Compare modeled and measured CSO events, volumes, and pollutant loads 	GNHWPCA, GNHWWC	Ongoing	Flow monitoring reports including analysis of modeled and measured parameters	\$\$\$\$	GNHWPCA, CWF
3. Implement pilot study GI projects within CSO sewersheds 003 and 004	GNHWPCA, GNHWWC	Ongoing	Completed projects	\$\$\$\$	GNHWPCA, CWF
4. Require use of GI for development projects within combined sewer areas	GNHWPCA	Ongoing	Completed projects	\$	Private
5. Implement identified GI retrofit projects on public lands <ul style="list-style-type: none"> Pursue grant funding Design and construct projects 	STS, municipalities, consultants	Ongoing 319 NPS grant application submitted in spring 2015 for first 2 projects	Completed projects	\$\$\$\$	319 NPS Grant
6. Incorporate GI into municipal projects including "green streets" projects	West Haven, Woodbridge, Hamden, Bethany	Ongoing	Completed projects	\$\$\$\$	
7. Update New Haven Complete Streets Design Manual	City of New Haven, consultant	0-2 years	Updated manual	\$\$\$	
8. Incorporate GI into Route 34 corridor redevelopment planning	City of New Haven	Ongoing	GI master plan and design concepts	\$\$\$\$	
9. Implement GI recommendations of SCSU Stormwater Master Plan	CT DAS/DCS, SCSU	Ongoing	Completed projects	\$\$\$\$	

Table 3-5. Combined Sewer Overflow and Green Infrastructure Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
10. Evaluate and modify existing municipal land use regulations and policy to require the use of GI and LID for development projects <ul style="list-style-type: none"> • Conduct land use regulatory review • Implement recommendations of land use regulatory review 	UConn NEMO (regulatory review)	0-2 years	Final project report	\$\$\$\$	Long Island Sound Study
	Municipalities, consultants (implement recommendations)	2-5 years	Amendments to local land use regulations and policies	\$\$\$\$	NFWF Long Island Sound Futures Fund, CTDEEP Supplemental Environmental Project Funds, 319 NPS Grants
11. Pursue sustainable, long-term funding sources for large-scale GI implementation	Regional collaboration of STS, SCRCOG, GNHWPCA, Municipalities	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, CWF

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

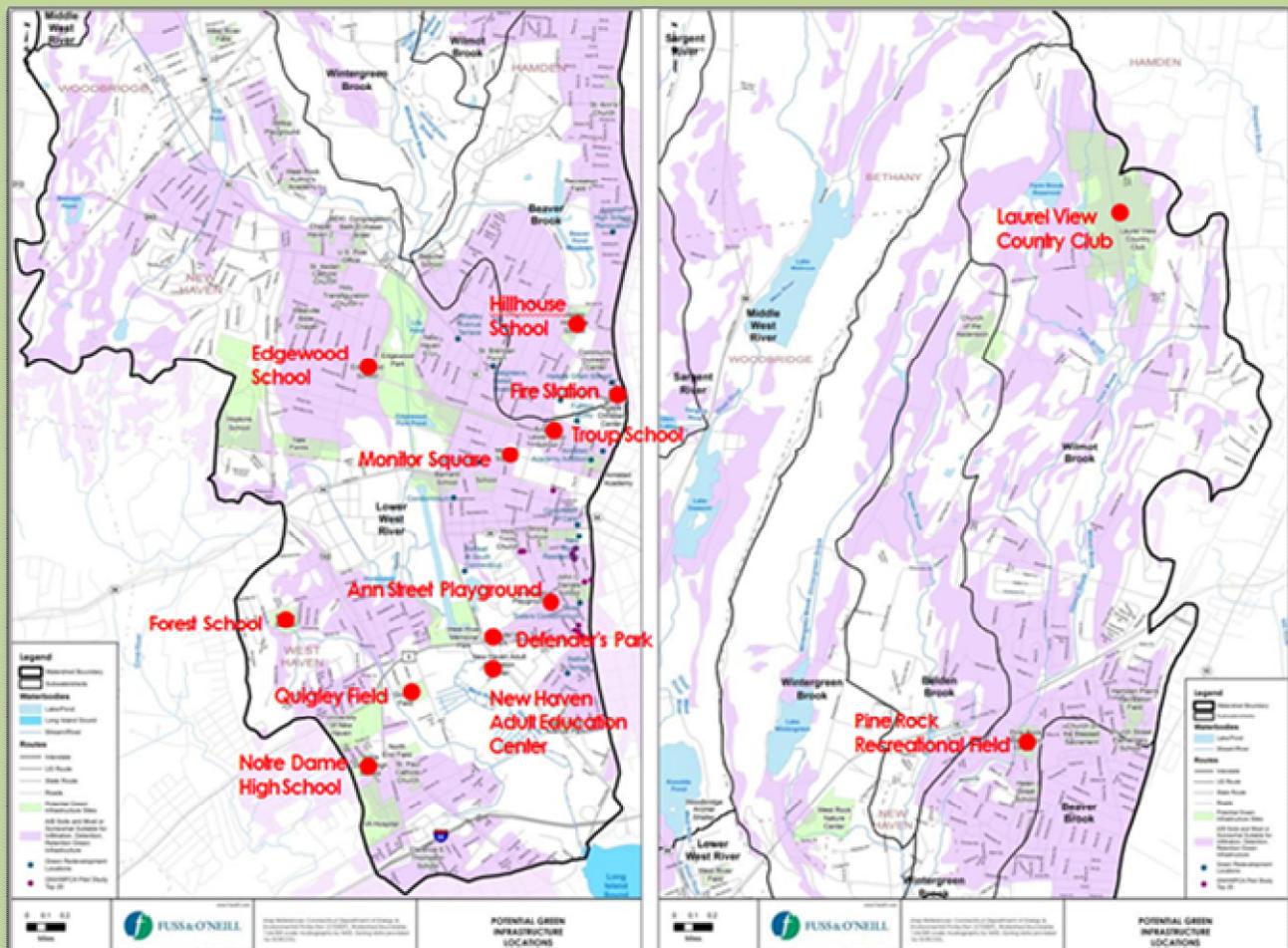
GNHWPCA = Greater New Haven Water Pollution Control Authority STS = Save the Sound/Connecticut Fund for the Environment CTDEEP = Connecticut Department of Energy and Environmental Protection SCRCOG = South Central Regional Council of Governments CT DAS/DCS = Connecticut Department of Administrative Services, Division of Construction Services CWF = Connecticut Clean Water Fund GNHWWC = Greater New Haven Waterworks Coalition

Recommended Actions

- Pursue funding for and implement identified site-specific GI retrofits on public lands based on the site-specific GI concepts identified in *Technical Memorandum #2: Low Impact Development and Green Infrastructure Assessment* (Fuss & O'Neill, 2015b) (see *Appendix C*). Other potential retrofit projects should be identified through future streamwalks, track down surveys, and subwatershed action plans, including potential retrofits of stormwater outfalls along the West River on adjacent public land such as Edgewood Park and West River Memorial Park.

Site-Specific Green Infrastructure Retrofits in the West River Watershed

An assessment was performed to identify opportunities and develop concepts for site-specific GI retrofits in the West River watershed. The assessment began with a screening evaluation of the approximately 360 publicly-owned parcels in the watershed to quickly identify areas with the greatest feasibility for and potential benefits from GI retrofits. Field inventories were then conducted at approximately 40 sites with the greatest opportunity for GI retrofits. GI concept designs were prepared for 11 of the sites visited. Details of the assessment methods, concept designs, and other GI retrofit opportunities in the watershed are provided in *Technical Memorandum #2: Low Impact Development and Green Infrastructure Assessment* (Fuss & O'Neill, 2015b) (see *Appendix C*).



- The watershed municipalities should incorporate GI into municipal projects, including roadway projects in the context of “green streets” approaches, following the City of New Haven’s “Complete Streets” initiative. The City of New Haven should update its Complete Streets Design Manual (2010) to provide urban street design standards and promote the use of GI.
- Incorporate GI into the City of New Haven’s Route 34 West economic development and planning initiatives. Future development will focus on the area from Dwight Street westward to Ella T. Grasso Boulevard. Current planning envisions a comprehensive revitalization of the area, which includes 45 parcels totaling approximately 37 acres, over the next 20 years.
- Implement the GI recommendations of the Southern Connecticut State University Stormwater Master Plan (Fuss & O’Neill, 2012) including new GI/LID stormwater management practices for individual campus master plan projects and GI/LID retrofits of the existing parking lots (Lots 5, 6, 8, 9, 10, and 12) that discharge stormwater directly to Beaver Brook and Wintergreen Brook. Implement GI as part of campus development projects and retrofits at other educational facilities in the watershed including Yale University, the University of New Haven, and public/private schools.
- Cost-effective, large-scale implementation of GI will require non-traditional financing. Possible long-term funding sources including user fees, stormwater utilities, property tax credits or rebates, green bonds and community-based public-private partnerships. The following alternative funding approaches should be considered:

- Stormwater Utilities – Previous attempts to establish a stormwater utility in New Haven were unsuccessful due to lack of political and public support. Several other Connecticut municipalities (New London and Bridgeport) are also evaluating the feasibility of establishing stormwater utilities in their communities. With the anticipated renewal of the MS4 Permit in 2016 and several major drainage/flood infrastructure projects planned, the City of New Haven and GNHWPCA should re-evaluate the feasibility of implementing a municipal or regional stormwater utility, incorporating lessons learned from previous and ongoing efforts by New Haven and other Connecticut communities. Critical to the success of such an effort is an effective public outreach and community stakeholder engagement program.
- General Fund/Property Taxes – while many issues exist with using property taxes to fund municipal stormwater management programs (e.g., property taxes are not assessed based

Green Infrastructure in New Haven

City of New Haven bioswale installed along Yale Avenue near the Edgewood School. The City plans on installing bioswales across the city to manage stormwater runoff effectively.



The Route 34 corridor, which sits above the original drainage to Long Island Sound, presents a significant opportunity for implementation of GI within the West River watershed as the area is redeveloped over the next 20 years.



on runoff generation, some significant runoff generators are tax-exempt, many competing priorities for general funds), tax credits or incentive rate structures could be explored that would incentivize the use of green infrastructure by property owners.

- Clean Water Fund – grant and loan funding from the Connecticut Clean Water Fund should continue to be focused on implementing green infrastructure projects in the combined sewer areas of the West River watershed.
- Green Bonds – Green Bonds are a growing mechanism for funding green projects, including green infrastructure and flood resilience projects. Green bonds are debt instruments issued to finance environmental projects focused on climate change initiatives. The identification and labeling of a green bond is typically based on a set of voluntary standards drafted by a consortium of investment banks that outlines the process for issuers to designate specific green projects. The guidelines specify that a bond issue qualifies as green if the issuer uses the proceeds solely for capital expenditures associated with green or climate-related environmental benefits in accordance with certain standards.
- Public Private Partnerships – A Community-Based Public Private Partnership (CBP3) is being implemented by Prince George's County, Maryland with the support of EPA Region 3 (http://www.epa.gov/reg3wapd/greeninfrastructure/GI_CB_P3_Guide_%20EPA_R3_FINAL_042115_508.pdf). A P3 is an arrangement between government and the private sector in which the private sector assumes a large share of the risk in terms of financing, constructing, and maintaining the infrastructure. Government repays the private sector over the long term if the infrastructure is built and maintained according to specifications. Prince George's County is implementing a P3 program to retrofit 2,000 acres of impervious surfaces in the public right of way. Private funds will finance 30% to 40% of the program costs upfront, enabling project construction to begin sooner and proceed more quickly.

3.2.4 Residential Low Impact Development

Residential land use accounts for approximately 36% of the land area in the West River watershed. Residential areas are a significant source of runoff and nonpoint source pollutant loads to the West River. The actions of individual homeowners can help to reduce runoff and pollutant loads to the combined and separate storm sewer systems in residential areas. The previous section describes larger-scale green infrastructure recommendations primarily targeted at municipalities, institutions, and private development. Low Impact Development (LID) management practices can also be implemented by homeowners on individual residential lots.

Residences in parts of the watershed generate significant quantities of rooftop runoff, which can also be a source of bacterial loads from birds and squirrels especially in areas with overhead tree canopy. Opportunities exist to disconnect residential rooftop runoff from the combined or storm drainage systems and reuse or redirect it to pervious areas through the use of rain barrels, rain gardens, and drywells.

Downspout disconnection can be a cost-effective option, in certain residential settings⁴, for reducing the volume and cost of stormwater that requires public management. The use of pervious materials for patios, walkways and driveways, as well as pavement removal and planting new yard trees, can also reduce impervious surfaces on residential lots and the contribution of runoff and pollutant loads to waterbodies.

Residential LID retrofits 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 LID practices therefore requires homeowner education and incentive programs.

Recommendations for implementation of residential LID practices in the West River watershed are described below and summarized in *Table 3-6*.

Recommended Actions

- Encourage disconnection of rooftop runoff from the storm drainage system by redirecting exterior roof leaders to pervious lawn areas and through the use of dry wells, rain barrels or rain gardens.
- The watershed municipalities, together with the GNHWPCA, should consider developing residential LID incentive programs to encourage implementation of LID practices by homeowners, which will help reduce the burden on municipal stormwater and wastewater infrastructure for managing runoff from residential lots. 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 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

⁴ In densely developed urban areas with combined sewer systems, such as parts of the West River watershed in New Haven, downspout disconnection (i.e., roof leader separation) can be extremely expensive and less cost-effective than other BMPs since disconnecting roof leaders from the combined sewer system often requires costly interior plumbing modifications.

Disconnecting Roof Downspouts

Disconnecting roof downspouts is one of the easiest things homeowners can do to help reduce stormwater runoff. Disconnecting downspouts will reroute the runoff into rain barrels or permeable areas like lawns or rain garden instead of the sewer.

<http://reducerunoff.org/downspout.htm>
(Save the Sound).



Reroute your downspout so your yard or rain garden absorbs and filters the runoff from your roof.



Disconnecting your downspout is a simple and effective way of reducing stormwater runoff. (Photo from grandbuilding.ca)

- Municipal sponsored public workshops on how to build rain gardens emphasizing the increase in property value and curb appeal of LID landscaping

Incentive programs can also serve as a mode of public outreach. Several examples of successful residential LID incentive programs are highlighted in the following text box.

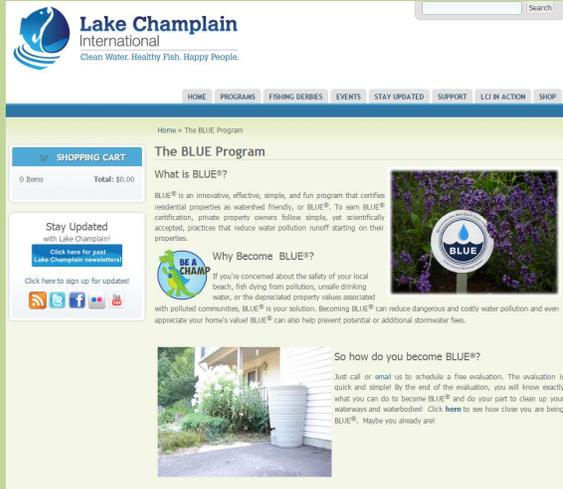
Residential LID Incentive Programs

Lake Champlain BLUE® Certification Program Program developed by Lake Champlain International that certifies residential properties as watershed friendly, or BLUE®, if they follow simple, yet scientifically accepted, practices that reduce water pollution runoff starting on their properties. Certified homeowners receive a BLUE certification lawn sign, increased property values, and the satisfaction of improving local water quality.

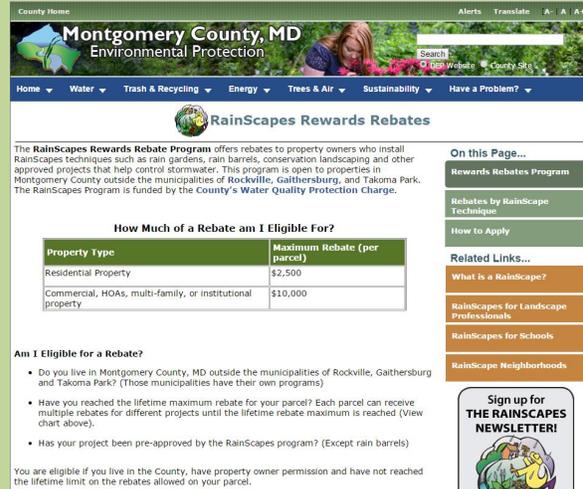
<http://www.mychamplain.net/blue-program>

Montgomery County, MD RainScapes Rewards Montgomery County coordinates RainScapes Rewards, a rebate program used to meet part of its municipal separate storm sewer system (MS4) permit goals. The county provides rebates based on the amount of runoff captured. Residential properties are capped at \$2,500.

<https://www.montgomerycountymd.gov/DEP/water/rainscapes-rebates.html>



The screenshot shows the Lake Champlain International website. The main heading is "The BLUE Program". Below it, there is a section titled "What is BLUE?" which describes the program as an innovative, effective, simple, and fun program that certifies residential properties as watershed friendly, or BLUE®. To the right of this text is a photograph of a blue lawn sign with a water drop icon and the word "BLUE". Below the sign, there is a section titled "Why Become BLUE?" which explains that if you're concerned about the safety of your local beach, fish dying from pollution, unsafe drinking water, or the devalued property values associated with polluted communities, BLUE® is your solution. At the bottom, there is a section titled "So how do you become BLUE?" which encourages users to call or email to schedule a free evaluation.



The screenshot shows the Montgomery County, MD RainScapes Rewards Rebates website. The main heading is "RainScapes Rewards Rebates". Below it, there is a section titled "How Much of a Rebate am I Eligible For?" which contains a table with two columns: "Property Type" and "Maximum Rebate (per parcel)".

Property Type	Maximum Rebate (per parcel)
Residential Property	\$2,500
Commercial, HOAs, multi-family, or institutional property	\$10,000

Below the table, there is a section titled "Am I Eligible for a Rebate?" which lists three bullet points: "Do you live in Montgomery County, MD outside the municipalities of Rockville, Gaithersburg and Takoma Park?", "Have you reached the lifetime maximum rebate for your parcel?", and "Has your project been pre-approved by the RainScapes program?".

- Provide education and outreach to homeowners, neighborhood groups, and roofing contractors on disconnecting roof downspouts and installing and maintaining residential rain gardens and rain barrels. The Connecticut NEMO web site provides a wealth of information about residential rain gardens: http://nemo.uconn.edu/tools/stormwater/rain_garden.htm
- Additional homeowner education and outreach recommendations are discussed in *Section 3.5* of this plan.

Table 3-6. Residential Low Impact Development Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Evaluate and implement residential LID incentive programs <ul style="list-style-type: none"> • Identify and build upon existing programs (e.g., The Sound School and GNHWPCA rain barrel program) • Evaluate feasibility of alternative programs • Pursue funding • Implement program(s) 	STS, WRWC, GNHWPCA, NHS	0-2 years establish program Ongoing implementation thereafter	Program(s) identified, funding secured, program established, number of homeowners participating	\$\$\$\$	Grants, future stormwater fees, property tax credits
2. Provide homeowner education and outreach on using LID	Municipalities, STS, UConn NEMO, NHS, GNHWWC, WRNSC, WRWP	Ongoing	Outreach materials disseminated	\$\$	Municipal, grants

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

GNHWPCA = Greater New Haven Water Pollution Control Authority STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition NHS = Neighborhood Housing Services of New Haven NEMO = Nonpoint Education for Municipal Officials GNHWWC = Greater New Haven Waterworks Coalition WRWP = West River Watershed Partnership WRNSC = West River Neighborhood Services Corporation

3.2.5 Municipal Stormwater Management Programs

The stormwater collection and drainage systems within the watershed consist of drainage infrastructure operated and maintained by the watershed municipalities and the Connecticut Department of Transportation. Each of these entities is a regulated small Municipal Separate Storm Sewer System (MS4) under the CTDEEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit).

Through their MS4 Permit stormwater management programs and other planning initiatives, the watershed municipalities have developed and implemented a variety of Best Management Practices to address stormwater quality and quantity issues associated with municipal activities as well as land development and redevelopment projects.

Construction sites that disturb one or more acres of land are regulated by the CTDEEP under the General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Municipalities also have jurisdiction over construction sites that disturb 0.5 or more acres of land.

Reissuance of CTDEEP MS4 Permit

CTDEEP is working with the Connecticut Conference of Municipalities, the Council of Small Towns, and the Connecticut Fund for the Environment to finalize the MS4 Permit, which is expected to be re-issued in early 2016. The new permit is anticipated to contain more stringent requirements relative to storm system mapping, illicit discharge detection and elimination, monitoring, and more prescriptive requirements for discharges to impaired waters, such as the West River. The re-issuance of the MS4 Permit will require the watershed municipalities to review and update their municipal stormwater management programs to meet the new permit requirements.

Municipal stormwater management recommendations are summarized in *Table 3-7*.

Recommended Actions

The watershed municipalities should continue to implement municipal stormwater management programs for their regulated MS4s, as required by the MS4 Permit. The six minimum control measures of the MS4 Permit include public education, public involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention and good housekeeping. Specific recommendations include:

- The South Central Regional Council of Governments (SCRCOG), together with the Capitol Region Council of Governments (CRCOG), has expressed interest in forming a regional coalition of regulated MS4s to facilitate sharing of resources to more cost-effectively comply with the new MS4 Permit. SCRCOG and CRCOG should take the lead in forming a regional coalition, borrowing from the successes of similar regional stormwater coalitions in Massachusetts such as the Central Massachusetts Regional Stormwater Coalition (<http://centralmastormwater.org/Pages/index>).
- The municipalities should consider requesting approval from CTDEEP for an alternative MS4 Permit monitoring program to more effectively address the bacteria impairments in the West River watershed. Monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. The program must include sampling to address both objectives (source detection and progress quantification). Source detection monitoring may include such activities as visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient (in-stream) conditions at closely spaced

intervals to identify “hot spots” for more detailed investigations leading to specific sources of high bacteria loads.

3.2.6 Subsurface Sewage Disposal Systems

Approximately one-half of the watershed area, but less than 5 percent of the watershed population, is served by on-site subsurface sewage disposal systems, also referred to as septic systems. Most of these systems are located in the upper portion of the West River watershed, although there is a residential area near the impaired segment of the West River in Woodbridge where residents rely on 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 West River. The Quinnipiack Valley Health District (QVHD), which serves Bethany, Woodbridge, and Hamden, regulates the installation of subsurface sewage disposal systems and is responsible for site inspections, plan review, the issuing of permits and inspections of all new, repair and replacement systems.

Recommendations regarding subsurface sewage disposal systems are summarized in *Table 3-8*.

Recommended Actions

- Strengthen state and local regulations in Woodbridge and Bethany to require regular septic system inspection and maintenance and upgrades to sub-standard systems, such as requiring systems to pass an inspection or be upgraded upon the sale of a property.
- Continue to encourage regular maintenance of septic systems by providing homeowners in Woodbridge and Bethany educational materials on how to identify improperly functioning systems and procedures to have systems inspected, cleaned, and repaired or upgraded. Septic system educational materials offered by QVHD should be disseminated by these towns to homeowners in their respective communities, which could also be used to meet the public outreach/education minimum control measure of the MS4 Permit and the related municipal stormwater management plans.

Septic System Educational Materials for Homeowners in Woodbridge and Bethany

The Quinnipiack Valley Health District regulates the installation, maintenance, and repair/replacement of septic systems in Woodbridge and Bethany, according to the Connecticut Public Health Code. QVHD also provides septic system educational materials to homeowners on their website <http://www.qvhd.org/>.



Table 3-7. Municipal Stormwater Management Program Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Form a regional stormwater coalition to cost-effectively comply with the new MS4 Permit	SCRCOG, CRCOG, municipalities, consultant	0-2 years	Regional coalition established	\$\$\$\$	SCRCOG/CRCOG
2. Consider alternative MS4 Permit monitoring to more effectively address bacteria impairments	Municipalities	After re-issuance of the MS4 General Permit	Approved alternative monitoring program consistent with monitoring objectives of this watershed plan and West River bacteria TMDL	\$	

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

SCRCOG = South Central Regional Council of Governments CRCOG = Capitol Region Council of Governments

Table 3-8. Subsurface Sewage Disposal Systems Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Strengthen municipal regulations regarding septic system inspection, maintenance, and repair/upgrade	Woodbridge, Bethany, West Haven	0-2 years	Amended regulations	\$\$\$	NFWF Long Island Sound Futures Fund, CTDEEP Supplemental Environmental Project Funds, CTDEEP 319 NPS Grants
2. Provide homeowner outreach on septic systems	Woodbridge, Bethany, West Haven	2-5 years	Outreach materials provided or made available to homeowners	\$	Same as above

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

3.2.7 Illicit Connections and Discharges

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

All of the watershed municipalities are subject to the requirements of the CTDEEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit). The MS4 Permit regulates the quality of discharges from municipal storm drainage systems. The permit requires 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 its municipal separate storm sewer system and implement procedures to prevent such discharges.

Recommendations relative to eliminating illicit connections and discharges to the West River and its tributaries are summarized in *Table 3-9*.

Recommended Actions

- The watershed municipalities should implement IDDE programs as required by the existing and future re-issued MS4 Permit, including an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the regulated municipal separate storm sewer system and an IDDE program to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.
 - Educate municipal staff and the public about illicit discharges and the importance of eliminating or avoiding such discharges.
 - Implement priority stream cleanups identified by streamwalks and track down surveys.
 - Conduct follow-up illicit discharge investigations at priority outfalls identified during stormwater outfall monitoring, streamwalks, and track down surveys.

Table 3-9. Illicit Connections and Discharges Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Implement IDDE program consistent with new MS4 Permit <ul style="list-style-type: none"> • 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 	Watershed Municipalities, SCRCOG/CROG, consultants	2016-2021 (5-year permit term)	Ordinance/legal mechanism, outfall map IDDE Plan, outfall screening and sampling results	\$\$\$\$	Municipal funds (permit requirements not eligible for state/federal funding) Cost efficiencies can be realized through participation in a regional stormwater coalition

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

SCRCOG = South Central Regional Council of Governments CROG = Capitol Region Council of Governments

3.2.8 Commercial and Industrial Land Use

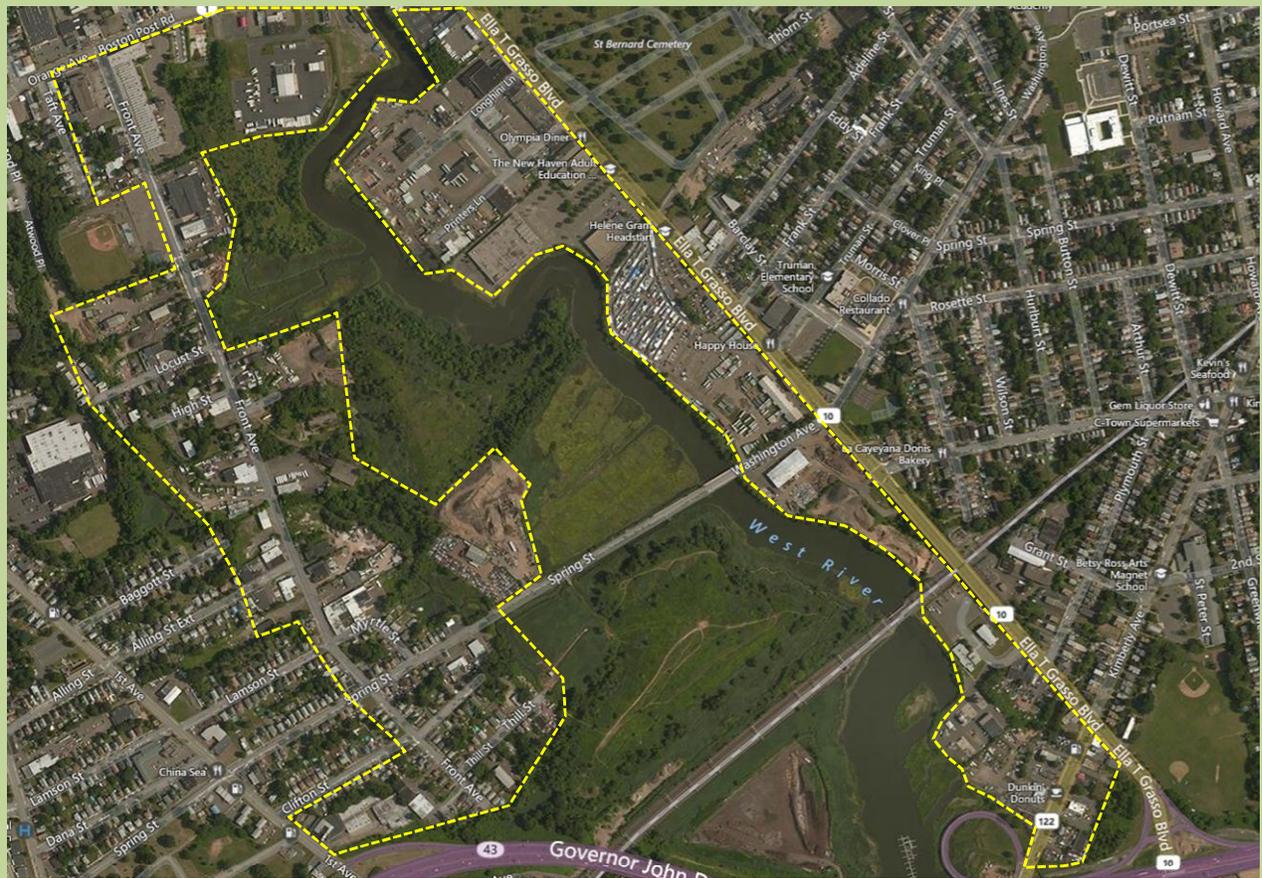
Commercial and industrial land uses have the potential for higher potential pollutant loads due to the pollutant sources associated with commercial and industrial activities and the significant runoff generated from these highly impervious sites. Most of the commercial development in the watershed is located along the major transportation corridors including Route 15 and 63, Route 10 (Whalley Avenue), and Route 34 in the middle and lower watershed, and along Route 63 and 69 near the headwaters of the West River. Industrial land use is primarily concentrated along the lower West River and tidal marsh south of Route 1, as well as isolated industrial properties such as the industrial park southeast of Konolds Pond.

Commercial and Industrial Land Uses in the Lower West River

The commercial and industrial areas along the lower West River south of Route 1 (highlighted in yellow below) are a source of stormwater runoff and associated pollutant loads to the impaired section of the river.

The commercial and industrial sites on the west side of Ella T. Grasso Boulevard in New Haven have large amounts of impervious cover and discharge stormwater directly to the West River, with little or no natural vegetation along the river. These public and privately-owned sites should be the focus of green infrastructure (GI) retrofits, or large-scale GI implementation during future redevelopment, and stream buffer restoration. GI recommendations for the site of the New Haven Adult Education Center and Helene Grant School are provided in *Appendix C*.

The industrial sites on the west side of the river in West Haven, as well as other industrial facilities in the watershed, should implement good housekeeping and source control best management practices to reduce exposure of materials and activities to stormwater runoff.



Recommendations related to reducing the impacts from commercial and industrial land uses are summarized in *Table 3-10*.

Recommended Actions

- Conduct outreach to commercial and industrial property owners in the watershed explaining how their activities contribute to the water quality impairments of the West River.
- Consider establishing or strengthening municipal ordinances requiring covered trash enclosures and frequent cleaning to reduce the bacteria load associated with dumpsters, consistent with the good housekeeping requirements in the CTDEEP industrial and commercial stormwater permit programs, which apply to certain categories of industrial facilities and to larger commercial sites such as shopping centers (e.g., Whalley Commons). Leaking dumpsters can be a major source of fecal indicator bacteria during wet weather. Include dumpster and trash management issues in commercial and industrial outreach.
- Strengthen CTDEEP inspection and enforcement of commercial and industrial facilities in the watershed that are regulated under the CTDEEP industrial and commercial stormwater permit programs, particularly those facilities that are located adjacent to that discharge directly to the West River or its tributaries.
- Review the commercial and industrial facilities in the watershed to identify sites that are subject to the CTDEEP industrial and commercial stormwater permit programs, but that are not currently registered.
- Ensure that reissued NPDES industrial water discharge permits in the watershed contain provisions for TMDL implementation, LID, runoff volume reduction, and water quality protection.
- Promote green infrastructure and stream buffer restoration during redevelopment of large commercial and industrial sites such as the properties along the east side of the lower West River south of Route 1 and west of Ella T. Grasso Boulevard.
- Cleanup and promote sustainable re-use of contaminated sites including the use of green infrastructure.

Table 3-10. Commercial and Industrial Land Use Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Conduct outreach to commercial and industrial property owners	Municipalities (as part of MS4 Permit outreach)	2016-2021 (5-year permit term)	Outreach completed as documented in MS4 annual Reports	\$\$	Municipal funds (permit requirements not eligible for state/federal funding) Cost efficiencies through participation in a regional stormwater coalition
2. Establish or strengthen municipal ordinances requiring covered trash enclosures and frequent cleaning	Municipalities (as part of MS4 Permit IDDE Ordinance)	2016-2021 (5-year permit term)	New or modified ordinance or other enforceable regulatory mechanism	\$\$	
3. Strengthen CTDEEP inspection and enforcement of commercial and industrial facilities covered under the CTDEEP stormwater general permit programs	CTDEEP	2-5 years	Facility compliance reviews/ inspections and followup actions to address deficiencies	\$\$\$	CTDEEP
4. Review commercial and industrial facilities to identify sites that need coverage under the CTDEEP stormwater permit programs	STS, CTDEEP	2-5 years	Non-compliant sites identified and notified	\$\$	
5. Ensure reissued NPDES industrial water discharge permits contain provisions for TMDL implementation, LID, runoff volume reduction, and water quality protection	WRWC, STS	Ongoing as draft permits are reissued	Comments submitted on CTDEEP draft permits	\$	
6. Promote green infrastructure for redevelopment of commercial and industrial sites, including contaminated sites	City of New Haven and other watershed municipalities	Ongoing	GI requirements for large-scale commercial and industrial development parcels	\$\$\$	

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

GNHWPCA = Greater New Haven Water Pollution Control Authority STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition CTDEEP = Connecticut Department of Energy and Environmental Protection

3.2.9 Wildlife and Pet Waste

Wildlife and domesticated animals within the West River watershed are a source of fecal indicator bacteria that can significantly impact stream water quality and be extremely difficult to control. 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 (ASCE, 2014). Domesticated animals (dogs and cats) and wildlife such as birds, raccoons, and rodents can be significant contributors, particularly in urban areas where open space corridors have been preserved along waterways, such as Edgewood Park and West River Memorial Park in the lower West River, as well as other parks, golf courses, commercial areas, and cemeteries near waterbodies in the watershed.

Most of the watershed communities have existing bans on feeding of waterfowl and pet waste (i.e., “pooper scooper”) ordinances. However, enforcement of such regulatory controls is difficult. Furthermore, there are no easy solutions to nuisance waterfowl problems. Canada geese are persistent when they have become habituated to an area (CTDEEP, 2011). A more effective nuisance waterfowl control strategy is needed, focusing on education and outreach and other proven control methods.

Recommendations related to wildlife and pet waste are summarized in *Table 3-11*.

Recommended Actions

- Continue waterfowl deterrent efforts – habitat modification and barriers/exclusion methods – to reduce feeding of waterfowl by the public, waterfowl nesting, and terrestrial waterfowl habitat in the watershed. Creation of a vegetated buffer along ponds or 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.
- Existing regulatory controls prohibiting the feeding of waterfowl should be augmented through additional and/or more effective signage in public parks including the potential for fines. Signage should emphasize that feeding of waterfowl such as ducks, geese, and swans is harmful to their health. People feed geese and other waterfowl because they love them; emphasizing protection of waterfowl health is often the most effective strategy.
- Provide pet waste bag dispensers and disposal cans at high-use areas and conveniently spaced intervals on trails and in open space areas. Provide park and trail 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 (e.g., Poo Free Parks®). Allow natural vegetated buffers to grow alongside streams to deter pet access. Provide educational materials regarding the impact of improperly disposed pet waste. These materials should be made available in locations such as pet stores, animal shelters, veterinary offices, and other sites frequented by pet owners.

Geese Deterrent Methods (CTDEEP, Wildlife Division, 2009)

Habitat Modification: As long as favorable habitat is available, geese will be attracted to an area. Plant unpalatable vegetation, such as pachysandra to replace some of the mowed lawn. Allow grass to grow tall which makes it unpalatable to the geese. Plant hedges, shrubs, or visual barriers between feeding areas and water. Be sure the geese are not being fed artificially by people.

Barriers and Exclusion Methods: Low fences are very effective at keeping geese from lawns especially during June and July when geese have molted their flight feathers and are unable to fly. A 3-foot high chicken wire or weld wire fence should be used. Soft or hard nylon fences are also potential barriers.

Table 3-11. Wildlife and Pet Waste Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue waterfowl deterrent efforts <ul style="list-style-type: none"> • Physical barriers • Regulatory controls • Signage • Educational programs 	Municipalities (as part of MS4 Permit compliance)	2016-2021 (5-year permit term)	Waterfowl programs implemented	\$\$	Municipal funds (permit requirements not eligible for state/federal funding) Cost efficiencies through participation in a regional stormwater coalition
2. Implement and enforce pet waste programs <ul style="list-style-type: none"> • Provide bag dispensers and disposal cans • Provide park and trail signage • Allow natural buffers to grow • Provide educational materials • Provide and maintain off-leash dog parks 	Municipalities (as part of MS4 Permit compliance)	2016-2021 (5-year permit term)	Pet waste programs implemented	\$\$	
3. Implement stormwater Best Management Practices (BMPs) at New Haven and Woodbridge animal shelters	Municipalities (as part of MS4 Permit compliance)	2016-2021 (5-year permit term)	Review of facility operations and BMPs implemented	\$	

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

- Providing and properly maintaining off-leash dog parks, preferably at locations that do not directly drain to receiving waters. Improperly maintained dog parks can become a source of bacteria if not properly managed.
- Work with New Haven and Woodbridge to ensure that stormwater best management practices are being implemented at the New Haven and Woodbridge animal shelters on Beaver Ponds and Konolds Pond. Animal waste, animal washing, or other animal handling activities can introduce bacteria, excess nutrients, soaps, chemicals, or sediment into waterbodies.

3.2.10 Natural Stream Buffers

Stream buffers are naturally vegetated areas adjacent to streams, ponds, and wetlands. Stream buffers help encourage infiltration of rainfall and runoff, and provide absorption for high stream flows, which helps reduce flooding and drought. The buffer area provides a living “cushion” between upland land use and water, protecting water quality, the hydrologic regime of the waterway and stream structure. Naturally vegetated buffers filter out pollutants, capture sediment, regulate stream water temperature and process many contaminants through vegetative uptake. The vegetative community of stream buffers provides habitat for plants and animals, many of which are dependent on riparian habitat features for survival. Changes to the natural riparian buffer zone can reduce the effectiveness of the buffer and contribute to water quality impairment.

As discussed in *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O’Neill, 2015a), the high degree of stream buffer encroachment along the lower main stem West River, Beaver Brook, Belden Brook, Wilmot Brook, and Wintergreen Brook has affected water quality and overall stream and habitat conditions.

An objective of this plan is to protect and restore degraded stream buffers in the watershed to enhance water quality. Recommendations related to stream buffers for water quality purposes are summarized in *Table 3-12*. Related recommendations for protection and restoration of riparian habitat, including in-stream habitat, are addressed in *Section 3* of this plan.



Examples of degraded stream buffers along the lower West River (top) and Wilmot Brook (bottom).

Table 3-12. Stream Buffer Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Encourage backyard stream buffers <ul style="list-style-type: none"> Provide homeowner education by building on existing materials and programs 	Municipalities (as part of MS4 Permit compliance), WRWC, STS	Ongoing	Educational materials disseminated	\$\$	Municipal funds (permit requirements not eligible for state/federal funding) Cost efficiencies through participation in a regional stormwater coalition
2. Implement priority buffer restoration projects	Municipalities, WRWC, STS	Ongoing	Priority projects identified, funding secured, projects completed	\$\$\$	
3. Aggressively implement and enforce 100-foot setback zones in local Inland Wetlands and Watercourses regulations	Municipalities	Ongoing	Modified or updated land use regulations	\$\$\$	
4. Encourage stream buffers on hobby farms and agricultural lands in upper watershed	Bethany, Woodbridge, and Hamden, Southwest Conservation District, NRCS, private land owners	Ongoing	Priority projects identified, funding secured, projects completed	\$\$\$	NRCS-EQIP

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

STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition NRCS = Natural Resources Conservation Service EQIP = Environmental Quality Incentives Program

Recommended Actions

- Encourage the creation of backyard buffers in residential areas near stream corridors, including the importance of maintaining healthy vegetated buffers to streams, ponds, and wetlands, and recognize the efforts of the public.
 - Educate homeowners about the value and importance of stream buffers by building on existing stream buffer outreach and educational programming (e.g., public recognition programs for cooperating landowners, *Streamside Landowners' Guide to the Quinnipiac Greenway*, Audubon's backyard program, and programs from the EPA- Long Island Sound Study and Connecticut Sea Grant).

- Implement priority buffer restoration projects identified during streamwalks and watershed field inventories.
 - Focus efforts on publicly-owned, high-profile sites such as existing parks along the West River, as well as smaller tributaries, ponds, and lakes. *Technical Memorandum #2: Low Impact Development and Green Infrastructure Assessment* (Fuss & O'Neill, 2015b) (*Appendix C*) identifies several potential stream buffer restoration candidates based on limited field inventories, including site-specific concepts for several of these potential opportunities. Future streamwalks and track down surveys will help to identify additional stream buffer restoration candidates.
 - Potential buffer restoration approaches for the watershed include installation of new buffers, widening existing buffers, invasive species removal/management, and tree planting/reforestation.
 - Preserve and enhance stream buffers that provide public access to the West River and its tributaries.
 - Engage volunteers in riparian buffer implementation projects.
 - Further evaluate the feasibility of buffer restoration at specific sites based on consideration of site-specific factors including site access, available land area, land ownership, soil conditions, appropriate buffer width, and native plant species.

- Provide stream buffer protection through aggressive implementation and enforcement of 100-foot setback zones in local Inland Wetlands and Watercourses regulations. Consider modifying existing land use regulations to incorporate incentives for developers to restore or establish vegetative buffers as part of new development or redevelopment.

- Ensure there are sufficient stream buffers along agricultural lands in the upper portion of the West River watershed (Bethany, Woodbridge, and Hamden), including farms along Wilmot (Farm) Brook, Belden Brook, and Sargent River. Priority should be given to farms where agricultural operations such as fields and pastures are in close proximity to the streams, including hobby farms. Focusing agricultural BMPs to improve buffer areas around streams will reduce the volume and improve the quality of stormwater runoff from the farm before it enters the stream. Other related conservation practices that should be considered for these farms include vegetated filter strips, stream habitat improvement and protection, and streambank protection projects. The USDA Natural Resources Conservation Service (NRCS) National Water Quality Initiative offers financial and technical assistance to farmers and forest landowners interested in improving water quality and aquatic habitats in priority watersheds with impaired streams.

3.3 Habitat Protection and Restoration

Goal Statement: Protect and restore terrestrial, streamside, and aquatic habitat.

Table 3-13 summarizes habitat protection and restoration recommendations for the West River watershed.

3.3.1 Protect and Restore In-Stream Habitat

The West River and its tributaries are home to a variety of resident fish species were once important habitat for anadromous fish species. Numerous man-made impoundments, flood control projects, and other development along the stream corridor have altered in-stream and riparian habitat and restricted fish migration. Several projects have been completed along the West River to restore anadromous and freshwater fish migration.

A fishway was installed on Pond Lily Dam in the early 2000s to aid fish passage of anadromous and resident fish species. Self-regulating tide gates were installed at the Route 1 bridge in 2012, allowing both spawning and nursery fish to migrate through the West River Tidal Marsh and up to Pond Lily Dam and potentially over the fishway at the dam. Removal of Pond Lily Dam is planned to begin in summer 2015.

Reaches of the West River upstream of Pond Lily Dam, including Konolds Pond, are potential habitat for spawning and nursery river herring. There is also some potential for fish passage restoration along Wintergreen Brook, although portions of the Wintergreen Brook tributary system (Beaver Brook) have little potential for fish passage restoration since the downstream portion of Beaver Brook flows through an underground conduit.

Pond Lily Dam Removal

Removal of Pond Lily Dam is proposed to improve fish passage and ecological function of the area near the dam as well as channel and floodplain restoration through the riparian corridor (Milone & MacBroom, 2011). Removal of the dam will restore about 2.6 miles of stream to migratory fish including herring, eel and shad (FWS, 2014).



Table 3-13. Habitat Protection and Restoration Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
In-Stream Habitat					
1. Conduct stream crossing surveys	WRWC, STS, TNC	2-5 years	Completed surveys with prioritized recommendations	\$\$\$	Grant funding – NFWF, Hurricane Sandy Disaster Recovery
2. Revise local design standards for stream crossings	Municipalities	2-5 years	Revised standards	\$\$	
3. Remove Pond Lily Dam	STS	0-2 years	Construction completed	\$\$\$\$	Hurricane Sandy Disaster Recovery Funds
4. Add a fishway to Konolds Pond Dam	CTDEEP, STS, WRWC	5-10 years	Funding secured, design completed, fishway installed	\$\$\$\$	Grant funding – NFWF
5. Implement priority stream restoration projects	WRWC, STS, municipalities	5-10 years	Completed projects	\$\$\$\$	Grant funding – NFWF
Forested Areas and Tree Canopy					
6. Establish a tree canopy goal in New Haven	New Haven, URI	5-10+ years	Numeric or qualitative tree canopy goal and implementation criteria	\$\$\$	
7. Implement sustainable management practices in woodlands along utility corridors	United Illuminating, UConn	Ongoing	Use of BMPs for tree cutting along utility lines	\$\$\$\$	
8. Amend site development regulations and zoning	Municipalities, consultants	5-10 years	Amendments to local land use regulations and policies	\$\$\$	
9. Implement tree canopy demonstration projects	Municipalities, URI	5-10 years	Completed projects	\$\$\$	
10. Protect forested land through land acquisition and conservation easements	Municipalities	Ongoing	Area of forest land acquired or preserved	\$\$\$\$	
Invasive Plant Species					
11. Implement priority invasive species management projects identified during	WRWC, CFE, Municipalities, URI	Ongoing	Completed projects	\$\$\$	

Table 3-13. Habitat Protection and Restoration Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
streamwalks and track down surveys					
12. Educate residents, facility maintenance personnel, landscapers and local nurseries, and land use commissions about non-native invasive species	WRWC	5-10 years	Education events and materials, number of participants and audiences reached	\$\$	
13. Involve volunteers and neighborhood groups in invasive species removal	WRWC, CFE, Schools	Ongoing	Invasive species removal, number of sites or areas restored	\$\$\$	
High-Priority Wetland and Open Water Habitat					
14. Re-evaluate the feasibility of connecting the north end of the reflecting pool to the West River	CFE, NOAA, City of New Haven, consultants	2-5 years	Feasibility study recommendations and implementation plan	\$\$\$\$	
15. Re-evaluate the feasibility and benefits of targeted dredging and Floating Treatment Wetlands in the reflecting pool	CFE, NOAA, City of New Haven, consultants	2-5 years	Feasibility study recommendations and implementation plan	\$\$\$	
16. Continue post-restoration monitoring of water quality, vegetation, and fish communities in the lower West River	CFE, URI, WRWC	Ongoing	Funding secured, monitoring reports	\$\$\$	
17. Advocate and pursue funding for re-location of the shooting range near Beaver Pond Park	FOBPP, New Haven	Ongoing	Funding secured and shooting range re-located	\$\$\$\$	
18. Secure funds to construct a nature trail along Beaver Pond with educational signage	FOBPP, New Haven	2-5 years	Funding secured, trail and signage constructed	\$\$\$\$	
19. Implement other habitat and water quality-related management recommendations from 2007 Beaver Pond Park Management Plan	FOBPP	Ongoing	Various	\$\$\$\$	

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

STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition TNC = The Nature Conservancy URI = Yale School of Forestry and Environmental Studies Urban Resources Initiative FOBPP = Friends of Beaver Pond Park

Other issues that affect in-stream habitat in the West River watershed include elevated stream temperatures due to a lack of stream shading and inputs of stormwater runoff, abnormally low flows during dry weather, and numerous culverts on smaller streams that impede resident fish migration.

Recommended Actions

- Conduct a stream crossing (culvert and bridge) survey of the West River watershed for anadromous and resident fish species to identify and prioritize barriers to fish passage and opportunities for restoring fish passage. The survey should focus on areas of the watershed that have not yet been assessed, including the West River upstream of Konolds Pond and Wintergreen Brook, Wilmot Brook, and Belden Brook. The survey should follow standardized protocols recently developed by the North Atlantic Aquatic Connectivity Collaborative <https://www.streamcontinuity.org/>.
- Revise local storm drainage design standards such that new or modified stream crossings are designed following the *Connecticut Stream Crossing Guidelines* (CTDEEP, 2008).
- Complete the planned removal of Pond Lily Dam and associated ecological restoration project.
- Following the removal of Pond Lily Dam, CTDEEP should initiate a community-based effort to add a fishway to Konolds Pond Dam to increase fish migration into Konolds Pond. CTDEEP has identified Konolds Pond as critical habitat for spawning and nursery river herring. The spillway is very low and gently sloped, and CTDEEP believes that some fish can enter Konolds Pond at certain flow levels.
- Implement priority stream restoration projects identified during streamwalks and track down surveys. Address areas of stream erosion and sedimentation using appropriate bioengineering and habitat-sensitive measures.
 - Explore the feasibility of daylighting portions of the roughly ¼-mile culverted section of Beaver Brook that flows beneath a residential and commercial area starting upstream of Blake Street to approximately 50 yards upstream of the confluence with Wintergreen Brook.

3.3.2 Protect and Restore Forested Areas and Tree Canopy

Forest cover, including natural forest soils with irregular topography, provides numerous benefits at both the site and watershed scales. In addition to providing habitat for terrestrial and aquatic wildlife, watershed forest cover also reduces stormwater runoff and flooding, improves regional air quality, reduces stream and channel erosion, improves soil and water quality, and reduces summer air and water temperatures (USDA Forest Service, 2005).

Forested areas comprise approximately 50% of the West River watershed. Most of this forestland is located in the northern portion of the watershed, with much lower levels of tree canopy in the lower watershed. The following recommendations (summarized in *Table 3-13*) will help protect existing forested areas and enhance the tree canopy in the more urban areas of the watershed.

Recommended Actions

- In 2009, the City of New Haven and Yale's Urban Resources Initiative (URI) began a tree planting program with a goal of planting 10,000 public trees in five years (aka "Tree Haven 10K Pledge"). Consistent with its Draft Comprehensive Plan Update (New Haven Vision 2025), the City should continue to partner with URI to establish a goal for enhancing tree canopy in New Haven, focusing on parcels with no or little existing tree canopy, large amounts of impervious surfaces (such as former commercial and industrial sites), and proximity to the West River and its tributaries.
- Implement sustainable management practices in woodlands along utility corridors. Utility companies statewide, including The United Illuminating Company (UI), continue to implement tree and forest management programs to reduce the risk of tree-related storm damage to power lines. UI should implement Best Management Practices and strategies for storm-related utility line tree cutting. The "Stormwise" vegetation management initiative and research program led by UConn and the CT Agricultural Experiment Station, partnered with various stakeholders including UI and other utility companies, is identifying management strategies to reduce the risk of tree-related power and transportation disruptions during storms while sustaining trees and forested areas and protecting wetlands and water quality.
- Amend site development regulations and zoning to encourage tree retention and maintenance, restrict tree removal, and require landscaping and parking lot shading. Consider developing a tree ordinance, especially for canopy protection along the river corridor.
- Demonstrate the importance of trees and vegetation as a critical component of green infrastructure and the related water quality benefits through local tree canopy demonstration projects.
- Protect existing forested land through land acquisition and conservation easements.

3.3.3 Manage Invasive Plant Species

Native vegetation plays an important role in ecosystem biodiversity. Invasive plant species, which are mostly non-native plant species that successfully out-compete native plants, are prevalent throughout the watershed. The most common invasive plant species observed in the watershed include multiflora rose, Japanese knotweed, Norway maple, purple loosestrife, common reed, and Oriental or ornamental bittersweet. A number of organizations have been involved in invasive species control efforts at targeted locations in the watershed such as Edgewood Park, Beaver Ponds Park, and the West River Tidal Marsh.

Recommended Actions

- Focus invasive species management efforts on site-specific and targeted stream corridor improvements identified during streamwalks and track down surveys. Focus on properties that are actively maintained with opportunity and interest for control since it is impractical to successfully control or eradicate invasive plant species on unmaintained sites.
- Educate residents, facility maintenance personnel, landscapers and local nurseries, and land use commissions about the negative effects of non-native invasive species, pathways of introduction, and alternatives to invasive ornamental plants.
- Involve volunteers and neighborhood groups in invasive species removal and stream corridor improvements.

3.3.4 Protect and Restore High-Priority Wetland and Open Water Habitat

The West River Tidal Marsh has been the focus of extensive study and habitat restoration efforts. In 1994, the West River Memorial Park was listed by the CTDEEP as a potential salt marsh restoration site. A preliminary engineering study was conducted for the restoration of West River Memorial Park. Potential restoration activities that were investigated include expanding an existing pond area in the southeastern section of the park; dredging an existing sediment bar in the reflecting pool; connecting the West River with the head of the reflecting pool; constructing a bridge at the connection between the West River and Horseshoe Lagoon; expanding the southern confluence of the West River and reflecting pool; opening one or two tide gate flaps; and excavating the existing marsh along Ella Grasso Boulevard to encourage tidal flooding (Milone & MacBroom, 2002b).

The tidal marsh and channel restoration was completed in 2012, which involved replacing three of the old timber tide gates with self-regulating gates to enable better exchange of tidal waters with the lower portion of West River and provide flushing of stagnant portions of the dredged channel. The alteration was found to improve water quality in the river and restore portions of the tidal marsh. As part of the restoration project, invasive species were removed from Edgewood Park and public access was improved with a raised walkway (Milone & MacBroom, 2012).

Although the West River tide gate project has had an immediate, positive impact on the West River and surrounding marsh, the reflecting pool does not receive as much tidal flushing as the main stem of the river, and the duck pond and main stem of the West River above Chapel Street receive little saline influence. Dissolved oxygen levels in the lower West River continue to fluctuate above and below safe levels for fish populations due to impacts from combined sewer overflows and other pollutant sources (CFE, 2013).

There has also been significant interest by local groups, led by the Friends of Beaver Pond Park, in protecting and restoring Beaver Pond Park. Owned by the City of New Haven, Beaver Pond Park is approximately 107 acres and contains athletic fields and an approximately 86-acre wetland and pond system that consists of two distinct ponds with dense shoreline vegetation, a red maple swamp, the Sherman Forest, and two small cattail marshes. Southern Connecticut State University abuts the ponds. The ponds receive stormwater from an urban watershed of approximately 1,200 acres (Bates et al., 2007). The *Management Plan for Beaver Pond Park* (Bates et al., 2007) developed recommendations for the park and ponds.

Lastly, Pond Lily and Konolds Pond are the focus of ongoing and planned fish passage restoration efforts to open up additional reaches of the West River to fish migration and breeding habitat.

Recommended Actions

West River Tidal Marsh

- Re-evaluate the feasibility of connecting the north end of the reflecting pool to the West River. The reflecting pool is currently connected to the West River at its southern end and at its mid-point across from the intersection of Legion Avenue and Ella Grasso Boulevard. A public boat launch is located at the northern, stagnant end of the pool. A newly created channel at the northern end of the pool would facilitate flushing and flow circulation within the reflecting pool and marsh complex, thereby improving water quality in the pool, reducing public exposure to bacteria, and enhancing ecological functions of the marsh.

CFE had previously evaluated the feasibility of excavating a channel to connect the northern end of the reflecting pool to the West River, but the feasibility evaluation identified two issues that put the plan on hold. The material in the proposed excavation area was sampled and determined to be classified as “polluted soil,” prohibiting its reuse on the site and making the project cost-prohibitive due to hauling and disposal costs. There was also concern that a new channel would potentially divert too much flow from the main stem of the West River. Additional hydrologic and hydraulic analyses were recommended following several years of tidal inundation monitoring to observe the effects of the self-regulating tide gates.

The following actions are recommended to re-evaluate the feasibility of connecting the north end of the reflecting pool to the West River:

- Identify and evaluate alternative locations and configurations for a proposed channel connecting the pool and the river. Other locations or configurations may be better suited in terms of soil quality and river hydraulics.
- Conduct additional soil sampling for the potential channel alternatives to better characterize soil contaminant levels relative to the Connecticut Remediation Standards Regulations and potential for on-site reuse of the excavated material.
- Re-model the anticipated flow impacts and water quality benefits of the potential channel alternatives using post-restoration tidal and water quality monitoring data.

West River Reflecting Pool Enhancements

The feasibility of connecting the north end of the reflecting pool to the West River should be re-evaluated. A new channel would facilitate flushing and flow circulation within the reflecting pool and marsh complex, thereby improving water quality in the pool and enhancing ecological functions of the marsh. The feasibility and benefits of targeted dredging and installation of Floating Treatment Wetlands in the reflecting pool should also be considered.



- Update project costs and pursue funding for the project.
- Complete design, permitting, and construction.

- Re-evaluate the feasibility and benefits of targeted dredging in the reflecting pool. A previous engineering study by Milone & MacBroom (2002b) recommended dredging of a sand bar in the reflecting pool immediately downstream of the Legion Avenue CSO and storm drain discharge locations, which is an obstacle to canoe passage and limits flushing of the reflecting pool. Sediments in the reflecting pool in the vicinity of the CSO discharge may also be a significant source of fecal indicator bacteria since sediments often function as a reservoir in which microorganisms can persist. Dredging of existing sand bars and bacteria-rich sediment near the Legion Avenue CSO and storm drain discharges should be considered.

- Evaluate the feasibility of installing Floating Treatment Wetlands (FTWs) in the West River reflecting pool in the vicinity of the CSO and stormwater outfalls. FTWs could potentially be used to treat stormwater and CSO discharges. Also evaluate the feasibility of bioremediation of contaminated sediments in the reflecting pool and Horseshoe Lagoon as an alternative to dredging.

- Continue post-restoration monitoring of water quality (salinity, dissolved oxygen, and tidal range), vegetation, and fish communities in the lower West River to evaluate the effectiveness of the completed and ongoing habitat restoration efforts within and upstream of the West River tidal marsh. CFE and Yale professor Gaboury Benoit, who has a permanent data logger stationed in the West River, should continue to seek funding for ongoing post-restoration monitoring.

Beaver Ponds

- Continue to advocate and pursue funding for re-location of the existing active shooting range that operates on the grounds of the Police Academy in Beaver Pond Park, just east of the South Pond and north of Sherman Forest. The shooting range is a source of significant negative sentiment in the adjacent neighborhoods and is an environmental concern if best management practices are not employed.

- Secure funds to construct a nature trail along the pond with educational signage.

- Implement other habitat and water quality-related management recommendations from the 2007 Beaver Pond Park Management Plan, including:
 - Evaluate through further study and planning the “marsh restoration” alternative presented in the 2007 management plan, which would allow the ponds to revert back to marshland, which is what existed at the site prior to human intervention.
 - Continue educational and engineering-based trash management options in the park including school-based trash cleanups, storm drain stenciling programs, regular maintenance of storm drains and catch basins, and installation of forebays at selected storm drain inlets to the ponds.

Pond Lily and Konolds Pond

- Complete the planned removal of Pond Lily Dam and associated ecological restoration project.

- Following the removal of Pond Lily Dam, CTDEEP should initiate a community-based effort to add a fishway to Konolds Pond Dam to increase fish migration into Konolds Pond. CTDEEP has identified Konolds Pond as critical habitat for spawning and nursery river herring. The spillway is very low and gently sloped, and CTDEEP believes that some fish can enter Konolds Pond at certain flow levels.

3.4 Sustainable Land Use, Open Space, and Public Access

Goal Statement: Promote sustainable land use and appropriate development in the watershed while protecting and improving water quality and natural resources, enhancing public access to and connectivity of waterbodies and open space, and addressing current and future flooding problems.

Table 3-14 summarizes land use, open space, and public access recommendations.

3.4.1 Strengthen Land Use Regulations

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.

The Nonpoint Education for Municipal Officials (NEMO) Program of the UConn Center for Land Use Education and Research (CLEAR) is conducting a land use regulatory review of the municipalities in the West River watershed. The project will facilitate adoption of green infrastructure and low impact development (LID) within the West River watershed municipalities through recommended changes to land use plans, ordinances and regulations. The UConn review will build upon a previous review by the Mill River Watershed Association of municipal land use regulations in the West River, Mill River, and Quinnipiac River watersheds, which found that most of the municipalities surveyed require some form of green infrastructure or LID for new construction but few, if any, require retrofits for existing development (Mushinsky, 2015).

Recommended Actions

- The watershed municipalities should implement the recommendations of the UConn/NEMO land use regulatory review.
- The other watershed municipalities should adopt green infrastructure and LID stormwater requirements, including runoff reduction standards, following the lead of the City of New Haven and GNHWPCA, particularly for new development and redevelopment of sites with large amounts of existing or proposed impervious surfaces. Projects completed by a number of Connecticut communities (Plainville, Newington, Tolland, Vernon, and East Granby) to remove barriers to and implement LID can serve as a model for implementation of similar LID recommendations in the West River watershed municipalities.

Table 3-14. Land Use, Open Space, and Public Access Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
Land Use Regulations					
1. Implement the recommendations of the UConn/NEMO land use regulatory review	Municipalities	2-5 years	Adopted or revised land use regulations or policies	\$\$\$	
2. Watershed municipalities should adopt green infrastructure and Low Impact Development stormwater requirements	Municipalities	2-5 years	Adopted or revised land use regulations or policies	\$\$\$\$	
3. Reference the West River Watershed Management Plan in updated municipal Plans of Conservation and Development	Municipalities	Ongoing	Updated POCDs	\$	
Flood Resilience					
4. Implement flood protection recommendations in City of New Haven's Comprehensive Plan Update	City of New Haven	0-2 years	Updated Comprehensive Plan	\$\$\$\$	
5. Adopt a policy of no-net-loss of flood storage capacity or flood conveyance	Municipalities	2-5 years	Revised flood hazard regulations	\$\$\$	
6. Update design storm rainfall amounts and assess the vulnerability of public and private infrastructure to climate change	Municipalities	2-5 years	Revised design storms in regulations, climate change vulnerability assessments	\$\$\$\$	
7. Implement coastal resilience measures for the tidally influenced portion of the West River	New Haven and West Haven	5-10 years	Coastal resilience plans prepared and implementation projects completed	\$\$\$\$	Grant funding – FEMA, HUD, NOAA, CIRCA
8. Address current flood problems using federal and state agency assistance and resources	Municipalities	Ongoing	Pursue federal grants and technical assistance	\$\$\$	FEMA, HUD, NOAA, CIRCA, CTDEEP
Open Space					
9. Develop/update municipal open space conservation plans	Municipalities, land trusts	2-5 years	Open space planning document updates	\$\$\$	
10. Acquire unprotected open space	Land trusts,	Ongoing	Protected land	\$\$\$\$	Federal (USDA Forest

Table 3-14. Land Use, Open Space, and Public Access Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
	municipalities, SCCRWA				Service and NRCS), State (CTDEEP and CTDOA), CT Land Conservation Council, and private organizations
11. Provide for public access to open space areas	Municipalities	Ongoing	Completed projects and number of sites	\$\$\$	
12. Perform an evaluation of undeveloped and underdeveloped parcels in the watershed	WRWC	2-5 years	Evaluation report with recommendations	\$\$\$	
Public Access					
13. Implement the recommendations of the West River Mobility Study	City of New Haven	2-10+ years	Projects completed	\$\$\$\$	
14. Expand and link the existing trail system in the watershed. Plan and create new trails to connect existing trails and open space.	New Haven, Woodbridge, West Haven, Hamden	5-10 years	Continuous and inter-connected network of trails within the West River watershed	\$\$\$\$	
15. Update the Plan for Greenways and Cycling Systems	City of New Haven	2-5 years	Updated plan	\$\$\$	
16. Consider creating/designating a water trail along the lower West River and reflecting pool	New Haven, West Haven	5-10+ years	Feasibility study with recommendations for phased implementation; signage and trail guide	\$\$\$\$	
17. Develop a public access area inventory for the West River and its tributaries. Identify and acquire new access points.	WRWC	2-5 years	Map and listing of the areas summarizing location, size, current and potential uses, and ownership	\$\$\$	
18. Introduce educational signage, interpretive stations, maps and online resources for new or modified public access points	WRWC, municipalities	Ongoing	Public access locations with signage	\$\$\$	

Table 3-14. Land Use, Open Space, and Public Access Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
19. Promote public access to the Regional Water Authority public water supply land	SCCRWA	Ongoing	Increase in public access permits issued by SCCRWA	\$\$	

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

STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition FEMA = Federal Emergency Management Agency HUD = U.S. Department of Housing and Urban Development NOAA = National Oceanic and Atmospheric Administration CIRCA = Connecticut Institute for Resilience and Climate Adaptation CTDOA = Connecticut Department of Agriculture USDA = U.S. Department of Agriculture NRCS = Natural Resources Conservation Service

- The watershed municipalities should reference the West River Watershed Management Plan in their updated 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.

3.4.2 Increase Flood Resilience Using a Watershed Approach

Portions of the West River and its tributaries have a long history of flooding as a result of historical development in the watershed. The U.S. Army Corps of Engineers spent much of the 1900s redirecting the West River to suit industrial and flood control needs. Urban flooding is common in some of the more urbanized areas of the watershed where storm drainage systems are over-capacity during some storms. Riverine flooding is also a significant and frequent problem in some areas, particularly near Blake Street, the Woodbridge Flats area, and along Wilmot Brook (also known locally as Farm Brook).

Water quality is the primary focus of this watershed management plan, although water quality and quantity (i.e., flooding) issues are closely related in terms of watershed resource management. This watershed plan, although not intended as a flood mitigation plan, also addresses flooding due to the prevalence of flooding and significant attention that flood mitigation has received in the watershed communities, particularly in the face of climate change and the potential for more frequent and intense storms in the future.

The flooding-related recommendations in this watershed plan are intended to enhance flood resilience⁵ by supplementing previous and ongoing flood mitigation efforts in the watershed. These recommendations focus on an integrated, watershed-based approach to addressing flooding, water quality, and habitat restoration. The emphasis is on restoring the functions, and often the forms, of the resources provided by natural riverine, wetland, and estuarine systems, which is a change from past, conventional approaches to watershed development and traditional flood control. This plan also recognizes the critical importance of wetland/marsh protection and restoration for flood resilience.

The recommendations include elements of the National Flood Insurance Program for planning and restoration of riverine corridors (insurance claims, adaptation-avoidance by elevating structures, discouraging future development activities within flood prone areas, floodplain easements, etc.), as well as other approaches such as green infrastructure, which recognize that flooding damage in urban and suburban areas is not confined to floodplains (Center for Neighborhood Technology, 2013).

Use of Green Infrastructure and Other Innovative Approaches to Urban Flooding

Green infrastructure and other techniques are recommended to address urban flooding problems in the watershed. These recommendations focus on an integrated, watershed-based approach to addressing flooding, water quality, and habitat restoration. The emphasis is on restoring the functions, and often the forms, of the resources provided by natural riverine, wetland, and estuarine systems, which is a change from past, conventional approaches to flood control.

⁵ "Flood resilience" is a community's ability to plan for, respond to, and recover from flooding.

Recommended Actions

- Implement the flood protection recommendations in the City of New Haven's Comprehensive Plan Update:
 - Continue to restrict land clearing activities and development in low-lying areas through the enforcement of the city's floodplain ordinances
 - Encourage flood proofing of structures in areas prone to repetitive floods. Identify and seek pre-disaster mitigation funding and other sources of funding available at the state and federal level to implement flood proofing measures within the city.
 - Review, assess, and revise the floodplain ordinances of the city periodically to protect the health, safety, and welfare of residents.
 - Delineate Base Flood Elevations (BFEs) at the parcel level, as designated by FEMA, on official City maps and publish them on City webpage so that they can be used by residents and potential developers.
 - Continue to update and adopt the City's Natural Hazard Mitigation Plan (updated in 2010).

- Adopt a policy of no-net-loss of flood storage capacity or flood conveyance within the watershed. Preserve and protect existing wetlands that provide flood storage and attenuation.

- Remove, redesign and reduce in-channel and in-floodway structures and restore channels, floodways and floodplains. Restore floodplain storage by excavating fill and removing flood-prone structures.

- Emphasize infiltration using green infrastructure techniques, which provides water quality and other benefits in addition to flood mitigation.

- Incorporate updated design storm rainfall amounts into local land use regulations and policies to account for the influence of climate change.

- Ensure that future flood mitigation projects and designs include provisions for water quality and riparian/aquatic habitat restoration. Provide or maintain vegetated buffers around all watercourses and wetlands where feasible.

- Assess the vulnerability of public and private infrastructure (e.g., utilities, transportation, structures) to climate change and increased frequency of extreme storms, sea level rise, etc. and develop adaptation strategies.

- Implement coastal resiliency measures, including protection of marshland, for areas along the tidally influenced portions of the lower West River to mitigate adverse impacts of sea level rise and storm surge.

- Engage federal and state agencies on available assistance and resources to develop and implement engineering solutions to address flood problems.

Updated Design Storm Rainfall

The National Oceanic and Atmospheric Administration National Weather Service is updating precipitation frequency data (i.e., design storm rainfall amounts). A similar tool for updated extreme precipitation data was developed as a joint collaboration between the Northeast Regional Climate Center and the USDA Natural Resources Conservation Services, <http://precip.eas.cornell.edu>, for New York and New England. The design storm rainfall amounts provided by this web tool offer significant advantages over previous products (e.g., "Rainfall Frequency Atlas of the United States", Technical Paper No. 40, U.S. Department of Commerce, Weather Bureau and NOAA Technical Memorandum "NWS Hydro-35", June 1977, U.S. Department of Commerce, National Weather Service) since the design storm rainfall amounts are based on a much longer period of record, including future updates as new rainfall data is available.

3.4.3 Preserve and Protect Open Space

An objective of this plan is to manage, maintain, and promote existing open space and continue to protect and acquire open space that meets resource protection and recreational goals. Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious coverage, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as farmland preservation, community preservation, and passive recreation. Open space is also important as habitat for native and migratory species and protection of public water supply, both significant uses of open space in the West River watershed.

Open space in the West River watershed includes preserved natural areas (e.g., West Rock Ridge State Park and Regional Water Authority public water supply land) as well as lightly developed parks, playgrounds, and cemeteries. The watershed communities have identified open space protection goals and priorities primarily through their Plans of Conservation and Development.

Recommended Actions

- The watershed municipalities should develop or update existing municipal open space conservation plans. Update open space planning documents at least every five years.
- Work closely with land owners to protect and/or acquire unprotected open space as recommended in this watershed based plan, the municipal Plans of Conservation and Development, and related open space planning efforts.
- Continue to promote conservation easements as a tool to local or regional land trusts to protect, conserve, and maintain open space. Alternative funding sources and approaches for open space acquisition include state funding (e.g., Community Investment Act - Public Act 05-228), limited market rate development on a parcel to help fund the acquisition of the remainder of the parcel as open space, and transferring development rights from sensitive locations to locations better suited for development. Regardless of the mechanism, critical to the success of protecting open space land is the ability to readily leverage financing when windows of opportunity arise to acquire or preserve significant parcels.
- Plan and provide for public access to open space areas, and connect existing open spaces to avoid open space fragmentation. Obtain public access easements from property owners to link open space areas. Partner with non-profit organizations such as the New Haven Land Trust to acquire adequate vacant lands or easements to create a linked network of trails within the West River watershed.
- Ensure that open spaces remain available for passive recreation. Promote awareness and appropriate use of existing open space by publicizing parks, trails, community gardens, and historic landscapes as well as educational events on open space parcels.
- Assess, improve, and restore parcels already acquired. Develop management plans for the use of acquired open space parcels.
- Proposed open space acquisitions should be evaluated based on a set of criteria that considers the environmental and physical characteristics of each property proposed for acquisition. In general, priority for open space protection should be given to properties that meet one or more of the following environmental criteria, in addition to multiple public benefits:

- Size – Larger parcels provide greater opportunity for contiguous undeveloped areas to benefit wildlife, water quality and provide recreation.
 - Water Resources – Parcels that provide buffers for rivers and streams and associated riparian communities, headwater streams, and coastal areas.
 - Wetlands and Wildlife Habitat – Parcels that provide upland buffers around high quality wetlands and habitat areas and that support, enhance or protect biodiversity. In addition, areas of unprotected land within threatened or endangered species habitat should be made a priority for acquisition or conservation.
 - Floodplain Protection – Parcels in floodplain areas to provide habitat, protect or improve water quality, and preserve natural flood storage or function (to the 500-year flood level).
 - Streamflow Protection – Parcels that provide protection of groundwater recharge areas and headwater streams or parcels whose protection would prevent fragmentation of large forest tracts.
 - Recreation – Parcels that provide water and land-based recreational opportunities including swimming, fishing, boating, hunting, other water-access, or could accommodate multi-use trails as part of an existing or planned greenway, trail or linear park or provide connectivity of existing trail systems.
- Evaluate undeveloped and underdeveloped parcels in the watershed based upon the above factors to help identify open space protection priorities. Consider two types of open space protection – acquisition or protection through a conservation easement or restriction. Parcels that are currently undeveloped should be assigned higher priority for acquisition, while those parcels that are partially developed but have potential for future development should be assigned higher priority for a conservation restriction.

3.4.4 Increase Public Access to the River

Access to many portions of the West River is limited due to development along the river and the presence of major roads that cut-off the river from the surrounding neighborhoods (e.g., Ella T. Grasso Boulevard). Improved access to the West River and its tributaries, including connectivity of waterbodies and open space, is needed to enhance recreational opportunities as well as public appreciation and stewardship of the river.

Recommended Actions

- Promote safe pedestrian access to the West River and other waterbodies where access is currently limited or restricted. For example, West River Memorial Park and the lower West River are currently separated from the West River neighborhood by Ella T. Grasso Boulevard, which is a four lane state highway. The City of New Haven is undertaking a mobility study to improve safety in the area prior to substantial development beginning on the underutilized parcels in the Route 34 corridor. The City of New Haven should implement the recommendations

West River Mobility Study

The City of New Haven is undertaking a mobility study to improve safety for pedestrians and bicyclists in the West River neighborhood prior to substantial development of the underutilized parcels in the Route 34 corridor. The study recommendations are anticipated to include infrastructure improvements along MLK Jr. Boulevard and Legion Avenue with safe crossing of Ella T. Grasso Boulevard to access West River Memorial Park.



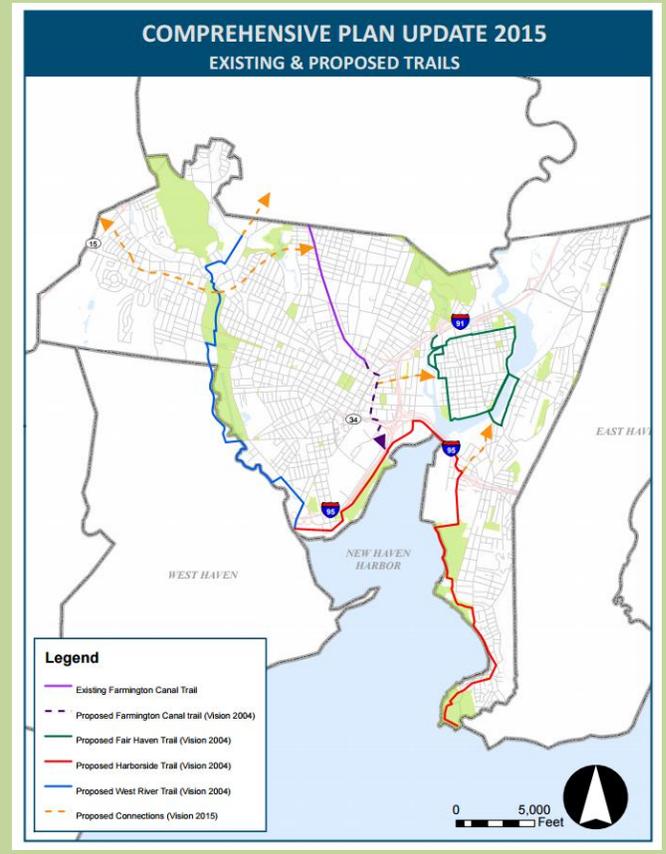
of the West River Mobility Study (draft, Fuss & O'Neill, 2015c) to improve safe crossing of Ella T. Grasso Boulevard to access West River Memorial Park.

- Building on the recent designation of the West River Greenway by the Connecticut Greenways Council, the West River Watershed Coalition and the watershed municipalities of New Haven, Woodbridge, West Haven, and Hamden should work together to:

- Expand and link existing trail systems in the West River watershed, such as the existing trail system in Woodbridge
- Plan and create new trails to connect existing trails and open space in the West River watershed. The City of New Haven should update the City's Plan for Greenways and Cycling Systems, originally prepared in 2004, to more closely reflect the current vision for a continuous and inter-connected network of trails within the city and within the West River watershed. The City's Draft Comprehensive Plan Update contains a proposed concept for a trail along the lower West River (see the blue trail line in the box at right).

Proposed West River Trail Concept

The map below depicts the concept for a trail along the lower West River as envisioned in the City's Plan for Greenways and Cycling Systems (2004) and in the City's Draft Comprehensive Plan Update (2015).

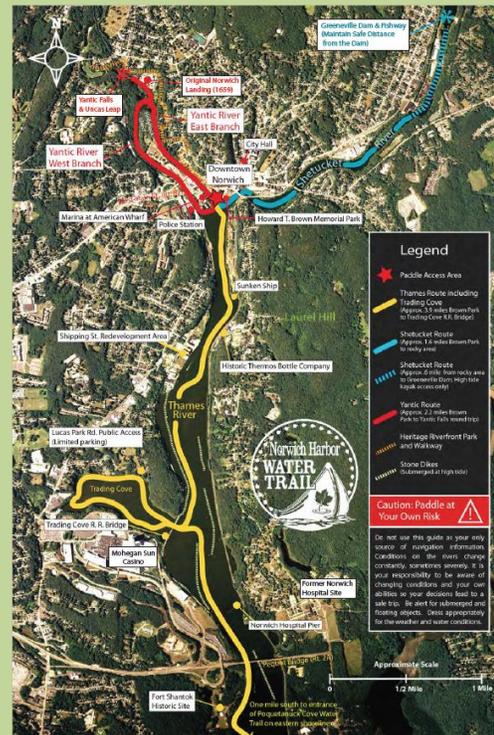


- Consider creating/designating a water trail along the lower West River and reflecting pool (between the tide gates at Route 1 and Edgewood Park) for canoes and kayaks, and potentially paddle boats in the reflecting pool. Other similar water or “blue” trails have been created along the Lower Quinnipiac River (Lower Quinnipiac Canoeable Trail), Norwich Harbor including the Thames, Yantic and Shetucket Rivers, New York Harbor, and embayments on the north shore of Long Island. Creation of a water trail would require designated river access points and signage, in addition to the existing canoe launches already in West River Memorial Park, as well as a trail guide that could describe the West River and its watershed, the tidal marsh restoration projects, and historical and recreational points of interest along the trail. Reduction in the frequency of overflows at the Legion and Derby Avenue CSO discharges is recommended prior to creation of a water trail along the lower West River or reflecting pool. A water trail would also need to be maintained regularly to remove logs, debris, and other obstructions along the river, especially in wooded sections of the river and at downstream bridges.

- Develop a public access area inventory for the West River and its tributaries that includes a map and listing of the areas summarizing location, size, current and potential uses, and ownership. Such an inventory could be used to help develop a West River water trail.
- Target acquisition of new access points or areas at locations that are underserved by open space or access to the river and with residential neighborhoods within walking distance. Public access areas should not adversely affect sensitive areas. Incorporate LID and other sensitive design elements into access area designs.
- Introduce educational signage, interpretive stations, laminated maps and guides, and online resources in the design of new or modified public access to waterways and open space areas.
- Promote public access to the Regional Water Authority public water supply land in the West River watershed as a way to educate the public about the watershed and water quality protection. The public can access the public water supply land by obtaining a permit from the Regional Water Authority.

Norwich Harbor Water Trail

The City of Norwich through its Harbor Management Commission created the Norwich Harbor Water Trail along the Thames, Yantic, and Shetucket Rivers. The trail can be accessed using the boat launch ramp at Chelsea Landing. An informative guide offers suggested routes for exploring the rivers in small paddle craft: <http://norwichct.org/DocumentCenter/View/1657>



3.5 Education and Outreach

Goal Statement: Promote stewardship of the watershed through education and outreach, improved access to the West River and its tributaries, and citizen involvement in science, conservation, and restoration activities.

A goal of this watershed plan is to modify the behaviors of individuals and the public to affect a positive change in the watershed. Often, the public is not aware of the impacts that their every-day activities can have on water quality. Public education is critical to the long-term success of watershed management because it raises awareness and reminds people of the individual actions they can take to protect and improve water quality in their watershed. This increased understanding has the additional benefit of fostering support for watershed management efforts and cultivating a long-term environmental watershed stewardship ethic, particularly with respect to the benefits of green infrastructure.

The education and outreach recommendations of this watershed plan are targeted at reaching four primary audiences, in addition to other stakeholder groups:

- Homeowners
- Municipalities and volunteer groups
- Students (K-12)/higher education
- Businesses and industry

Education and outreach recommendations that are tailored to these audiences are described in the following sections. Watershed public outreach and educational programs should build upon the successful programs and models that already exist in the watershed, elsewhere in Connecticut, and nationally.

Table 3-15 summarizes education and outreach recommendations for the West River watershed.

3.5.1 Implement a Public Outreach Campaign

The West River Watershed Coalition, working with local and regional partners including Save the Sound, CTDEEP, the watershed municipalities and GNHWPCA, should consider developing and implementing a watershed-based green infrastructure public outreach campaign⁶ for the West River (or a regional effort for the Greater New Haven watersheds including the West River, Quinnipiac River, and Mill River) focused on citizens, businesses, and communities. The public outreach campaign could be developed based on other successful models such as EPA's "Soak Up the Rain" program or the award-winning "Save the Rain" initiative in Onondaga County (Syracuse), New York. Startup funding for such a campaign may be possible through CTDEEP, particularly if the campaign is developed/designed to be transferable to other watersheds or organizations or for use statewide.

Key aspects of developing a successful outreach campaign include identifying and analyzing the target audiences, drafting an effective message and branding the program, and packaging and delivering the message through a variety of media. EPA's *Getting In Step: A Guide for Conducting Watershed Outreach Campaigns* (2010) is an excellent resource for developing and implementing a successful program.

⁶ A campaign is not a single product or event, but rather a suite of activities, materials, and distribution formats that are carefully coordinated to achieve specific goals and objectives.

Onondaga County's "Save the Rain" Initiative

The "Save the Rain" program is a comprehensive stormwater management program intended to reduce pollution to Onondaga Lake and its tributaries resulting from stormwater runoff and Combined Sewer Overflows (CSOs). The program consists of a comprehensive stormwater management program that combines green infrastructure and traditional gray infrastructure approaches, as well as a public outreach campaign that uses a variety of educational materials and media.

<http://savetherain.us/>



The screenshot shows the homepage of the "Save the Rain" website. At the top, it features the slogan "See how you can make a difference... every drop counts." and social media icons for Facebook, Twitter, and YouTube. A navigation menu includes links for ABOUT, GREEN PROJECTS, PROGRAMS, GREEN FUNDS, RESOURCES, CONTACT, and ART. Below the navigation is a search bar and an "About" section. A prominent "TIMELINE" graphic highlights key milestones: 1940 (Sewering decisions), 1949 (AECI project), 1998 (AECI redesign), 2009 (Revised AECI plan), 2011 (Onondaga County Stormwater Management Plan), 2013 (Onondaga County Green Infrastructure Plan), and 2014 (Onondaga County Green Infrastructure Plan). The main text describes the program as an award-winning initiative to improve water quality, noting that the county has advanced more than 175 distinct green infrastructure projects. A photo shows a young girl in a "Save the Rain" t-shirt. On the right, there are three vertical buttons: "GENERAL INFORMATION", "FOR THE HOME", and "FOR THE BUSINESS".

The outreach campaign should target, at a minimum, watershed residents, businesses, and municipalities, including incentive programs for residential "green" practices. The recommended website dedicated to the West River watershed (see *Section 3.1 – Capacity Building*) could also serve as the on-line home for the public outreach initiative. The website could include downloadable educational and outreach materials on green infrastructure and other residential, business, and municipal practices to protect and improve water quality, as well as project updates, funding resources, technical resources, and current events.

The outreach campaign could also be coordinated with the public education and involvement efforts of the watershed municipalities to comply with the new MS4 Permit, as well as public education efforts associated with implementation of a municipal or regional stormwater utility.

Table 3-15. Education and Outreach Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
Public Outreach Campaign					
1. Develop and implement a green infrastructure public outreach campaign, including a more formal and consistent watershed signage program	WRWC, STS, GNHWPCA, watershed municipalities, CTDEEP, URI	2-5 years	Public outreach messages developed and delivered through a variety of media	\$\$\$\$	CTDEEP 319 NPS Grants
Homeowner Education and Outreach					
2. Evaluate and implement residential LID incentive programs <ul style="list-style-type: none"> Identify and build upon existing programs (e.g., The Sound School and GNHWPCA rain barrel program) Evaluate feasibility of alternative programs Pursue funding Implement program(s) 	STS, WRWC, GNHWPCA, NHS, GNHWWC	0-2 years establish program Ongoing implementation thereafter	Program(s) identified, funding secured, program established, number of homeowners participating	\$\$\$\$	Grants, future stormwater fees
3. Provide homeowner education and outreach on using LID	Municipalities, STS, UConn NEMO, GNHWWC, NHS	Ongoing	Outreach materials disseminated	\$\$	Municipal, grants
4. Provide homeowner outreach on sustainable lawn care practices and backyard habitat	Municipalities, WRWC, STS	Ongoing	Outreach materials disseminated	\$\$	Municipal, grants
5. Provide homeowner outreach on septic systems	Woodbridge, Bethany, West Haven	2-5 years	Outreach materials provided or made available to homeowners	\$	NFWF Long Island Sound Futures Fund, CTDEEP Supplemental Environmental Project Funds, CTDEEP 319 NPS Grants

Table 3-15. Education and Outreach Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
Outreach to Municipalities and Volunteer Groups					
6. Provide education and training for municipal employees, land use boards, and building inspectors	Municipalities (as part of MS4 Permit outreach)	2016-2021 (5-year permit term)	Outreach completed as documented in MS4 annual Reports	\$\$	Municipal funds (permit requirements not eligible for state/federal funding) Cost efficiencies through participation in a regional stormwater coalition
7. Provide education and outreach to volunteers of local non-profit organizations <ul style="list-style-type: none"> • Friends of Edgewood Park • Friends of Beaver Ponds Park • Watershed associations • Greater New Haven Waterworks Coalition 	STS, URI, municipalities (as part of MS4 Permit outreach)	2016-2021 (5-year permit term)	Outreach events completed	\$\$	
Outreach to Business Community					
8. Conduct outreach to commercial and industrial property owners	Municipalities (as part of MS4 Permit outreach)	2016-2021 (5-year permit term)	Outreach completed as documented in MS4 annual Reports	\$\$	Municipal funds (permit requirements not eligible for state/federal funding) Cost efficiencies through participation in a regional stormwater coalition
Outreach to Institutional Property Owners					
9. Conduct workshops on best practices for institutional facilities for water quality protection	WRWC, STS, CTDEEP, Colleges and Universities	2-5 years	Workshops developed and conducted	\$\$\$	Grants

Table 3-15. Education and Outreach Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
10. Encourage participation in EPA's annual Campus RainWorks Challenge	WRWC, STS, Colleges and Universities	Ongoing	Student applications submitted	\$	
Community Engagement Events					
11. Engage local, state, and regional organizations in the West River watershed <ul style="list-style-type: none"> Promote, publicize, and support existing events such as the annual "West River Water Festival" 	WRWC, WRWP, NHS, ECPC	Ongoing	Ongoing coordination with groups, events publicized and held	\$\$	
Youth Education, Community Service, and Stewardship Programs					
12. Expand existing relationships and educational programs with schools	WRWC, STS, Edgewood School, Common Ground School, other schools, URI	Ongoing	Expanded or new programming and curricula	\$\$	
13. Consider implementing a watershed-based component to the curriculum in school districts where such programs are not already in place.	WRWC, STS, City of New Haven, URI	2-5 years	Expanded or new programming and curricula	\$\$\$	
14. Work with Solar Youth to develop West River-focused community service projects	WRWC, STS, Solar Youth	Ongoing	Solar Youth involvement in West River projects	\$\$	
15. Continue to recruit student volunteers to participate in water quality and benthic monitoring and streamwalks	WRWC, STS, school faculty and students, URI	Ongoing	Student participation in monitoring and streamwalks	\$	
16. Continue to collaborate with college faculty and research staff on the West River watershed	WRWC, STS, Yale/URI, and other colleges and universities	Ongoing	Collaboration with research faculty and staff on West River projects	\$\$	

Table 3-15. Education and Outreach Recommendations

Actions	Who	Timeframe	Products/ Evaluation Criteria	Estimated Costs	Potential Funding Sources
Homeless Encampments					
17. Collaboration with the City of New Haven and other agencies to develop multi-faceted approach	WRWC, STS, City of New Haven	5-10 years	Number of homeless camps reduced along lower West River	\$\$\$\$	

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

STS = Save the Sound/Connecticut Fund for the Environment WRWC = West River Watershed Coalition NHS = Neighborhood Housing Services of New Haven
 GNHWWC = Greater New Haven Waterworks Coalition WRWP = West River Watershed Partnership ECPC = Elm City Parks Conservancy URI = Yale University School of Forestry and Environmental Studies Urban Resources Initiative

3.5.2 Homeowner Education and Outreach

An objective of the watershed plan is to build awareness of land stewardship and management practices and reduce water quality impacts associated with residential land use, which comprises approximately 36% of the watershed land area. Successful homeowner outreach programs have been developed by other watershed groups, including the Norwalk River Watershed Initiative (NRWI). A number of good educational brochures for homeowners are available on the NRWI website

<http://conservect.org/southwest/Education/tabid/267/itemid/121/Default.aspx>.

Encourage the use of Residential LID Practices

Homeowners should be encouraged to implement green infrastructure or Low Impact Development (LID) practices on their properties.

- Encourage disconnection of rooftop runoff from the storm drainage system and impervious areas to reduce the quantity of runoff by redirecting the runoff to pervious lawn areas, through the use of dry wells, or through the use of rain barrels or rain gardens.
- Provide education and outreach to homeowners, neighborhood groups, and roofing contractors on disconnecting roof downspouts and installing and maintaining residential rain gardens and rain barrels. The Connecticut NEMO web site provides a wealth of information about residential rain gardens: http://nemo.uconn.edu/tools/stormwater/rain_garden.htm
- Provide residential LID incentive programs such as those described in *Section 3.2.4* of this plan.

Promote Sustainable Lawn Care Practices – Homeowners and Lawn Care Professionals

Homeowners should be encouraged to use environmentally-friendly lawn care practices such as reducing or eliminating fertilizer and pesticide usage through the use of slow release fertilizers and fertilizer application timing; utilizing alternative landscaping that decreases maintenance; soil testing and non-chemical lawn care measures. Although sustainable lawn care practices will not significantly reduce bacteria loadings, they will reduce nutrient loadings, the use of toxic chemicals, and promote water conservation.

Extensive educational materials are available on these topics, including:

- CTDEEP Organic Lawn Care website:
<http://www.ct.gov/deep/cwp/view.asp?A=2708&Q=382644>
- CTDEEP Transitioning To Organic Land Care (OLC) In Your Town
http://www.ct.gov/deep/cwp/view.asp?a=2708&q=379676&deepNav_GID=1763
- Connecticut Chapter of the Northeast Organic Farming Association
<http://www.organiclandcare.net/>
- Southwest Conservations District
<http://conservect.org/southwest/Education/tabid/267/itemid/121/Default.aspx>

Other resources include the EPA's GreenScape program, and more locally, the UCONN Cooperative Extension System's Home & Garden Education Center. The Home & Garden Education Center's web site, along with information on their soil testing services can be found at: <http://www.ladybug.uconn.edu/index.html> Recognizing the trend toward greater use of professional lawn care services by homeowners, outreach to local landscapers and lawn care companies is an essential element of a successful lawn care outreach program.

Potential outreach programs, which could be developed in partnership with local land trusts and garden clubs, could include:

- Identifying and promoting sustainable landscape provider certification programs
- Developing a placard campaign to identify lawns that implement preferred practices
- Develop a sustainable lawn care and gardening recognition and incentive program, with landscapers and homeowners highlighted on a rotating basis, or institute an alternative landscape competition. The Environmental Concerns Coalition of Milford, Connecticut, has developed a very successful organic lawn care competition and incentive program called "Freedom Lawns." A Freedom Lawn brochure developed by the Farmington River Watershed Association can be found at: <http://www.frwa.org/publications/freedomlawntips.pdf>. Another successful homeowner incentive program has been developed by Lake Champlain International called the BLUE® Certification Program, which can be found at: <http://www.mychamplain.net/blue-program>.
- Implement a public awareness campaign modeled after the City of Middletown's Project Green Lawn to encourage residents and businesses to eliminate lawn chemicals. <http://www.cityofmiddletown.com/content/117/121/167/1862/486.aspx>

Promote Backyard Habitat

As discussed in *Section 3.2.10*, encourage the creation of backyard buffers in residential areas near stream corridors, including the importance of maintaining healthy vegetated buffers to streams, ponds, and wetlands, and recognize the efforts of the public.

- Educate homeowners about the value and importance of stream buffers by building on existing stream buffer outreach and educational programming (e.g., public recognition programs for cooperating landowners, *Streamside Landowners' Guide to the Quinnipiac Greenway*, Audubon's backyard program, and programs from the EPA- Long Island Sound Study and Connecticut Sea Grant).

Provide Homeowner Outreach on Septic Systems

As described in *Section 3.2.6*, provide homeowners in Woodbridge and Bethany educational materials on how to identify improperly functioning septic systems and procedures to have systems inspected, cleaned, and repaired or upgraded. Septic system educational materials offered by The Quinnipiac Valley Health District (QVHD), which serves Bethany, Woodbridge, and Hamden, should be disseminated by these towns to homeowners in their respective communities, which could also be used to meet the public outreach/education minimum control measure of the MS4 Permit and the related municipal stormwater management plans.

Increase Watershed Stewardship Signage

Stewardship signage can increase public awareness and visibility of the West River and the connection between the community, the watershed, and the river. Watershed signage can take the form of kiosks in public areas, storm drain markers or stencils, anti-dumping signs, proper pet waste management signs, and roadside/stream side signage (examples include "adopt a stream/roadway" programs). Storm drain stenciling and other watershed signs are already present in some areas of the watershed.

The West River Watershed Coalition and local partners should consider developing a more formal and consistent watershed sign program that could be implemented as a component of the recommended green infrastructure public outreach program. The signs should incorporate a simple, yet consistent message and logo. Watershed signs are recommended in highly-visible public areas of the watershed such as municipal

facilities (schools, parks, libraries, other municipal properties, commercial areas, etc.) and public access areas along the river.

3.5.3 Outreach to Municipalities and Volunteer Groups

A key objective of this plan is to advance local government awareness, understanding, and stewardship of the West River watershed. Ongoing outreach to municipal departments, staff, and volunteer board members is an important element of municipal stormwater management programs, as required by the MS4 Permit. Suggested topics include common municipal activities and operations that can impact bacteria loads to the West River including parks and open space maintenance, green infrastructure and LID, storm sewer system and BMP maintenance, and identification and removal of illicit connections.

- Municipalities should provide annual pollution prevention and good housekeeping training for all municipal employees whose activities potentially impact stormwater and water quality. The training should include municipal personnel with responsibility for public works, parks and recreation, building maintenance, lakes and pond management, and water/wastewater.
- Provide training for municipal reviewers (municipal land use commissions and boards, planners, etc.) of land development projects and designers (developers, architects, engineers, contractors, etc.). Suggested training topics include stream buffer protection, LID and green infrastructure, and construction erosion and sediment controls.
- Building inspectors in Connecticut must earn a requisite amount of continuing education credits each year. Existing training programs often do not address stormwater, LID, green infrastructure or erosion and sedimentation control methods. Building inspectors in each watershed municipality should be required to receive regular training on these topics. Additionally, training should also be required on sanitary sewer and stormwater connection inspections.
- Continue to invite and involve the municipal staff and land use board members in West River restoration efforts, outreach events, and river clean-ups.

Ongoing education and outreach to those that work as volunteers of local stewardship groups is also important. Local volunteer-based nonprofit groups such as Friends of Edgewood Park, Friends of Beaver Ponds Park, watershed associations, and the Greater New Haven Waterworks Coalition should provide opportunities for their member volunteers to participate in seminars, presentations, and other training offered by groups such as Save the Sound/CT Fund for the Environment, Urban Resources Initiative and public education provided by the watershed municipalities to comply with the MS4 Permit.

3.5.4 Outreach to Business Community

Commercial businesses along the major transportation corridors and industrial facilities in the lower West River watershed, whether located directly adjacent to the river or in upland areas of the watershed, contribute stormwater runoff that ultimately reaches the West River. An objective of this plan is to advance local business awareness, understanding, and stewardship of the West River watershed.

- Provide outreach to commercial and industrial property owners in the watershed explaining how their activities contribute to the water quality impairments of the West River. Focus on activities that contribute bacteria to the West River, including dumpster and trash management issues.

- Continue to involve businesses in restoration efforts, outreach events, and river clean-ups.

3.5.5 Outreach to Institutional Property Owners

Management and maintenance practices at institutional facilities with large intensively managed lawn areas and expansive parking lots can have a significant impact on water quality. Many large institutional land owners are located in the West River watershed (e.g., Yale University, Southern Connecticut State University, University of New Haven, and other public and private schools) and, therefore, play an important collective role in improving and protecting water quality.

- The West River Watershed Coalition should consider partnering with STS, CTDEEP, and the colleges and universities in the watershed to conduct workshops on best practices for institutional facilities for water quality protection. Topics could include:
 - Integrated Pest Management (IPM)
 - Turf management and low fertilizer usage
 - Protection and restoration of stream buffer areas
 - Parking lot and road maintenance (deicing, snow management)
 - Drainage system inspection and maintenance (catch basins, storm drains, stormwater BMPs)
 - Water quantity and flooding issues
 - Low Impact Development and green infrastructure approaches
- Encourage the colleges and universities in the watershed (faculty, students, and facilities) to participate in EPA's annual Campus RainWorks Challenge, which is a national competition for student teams to design an innovative green infrastructure project for their campus showing how managing stormwater at its source can benefit the campus community and the environment.
http://water.epa.gov/infrastructure/greeninfrastructure/crw_challenge.cfm

3.5.6 Promote Community Engagement Events

Community events focused on the West River and its watershed are also an effective way to provide public outreach and stewardship of the West River. There are many community groups and organizations involved in environmental and watershed-related activities in the greater New Haven area, providing a strong base of local support and interest in the West River.

- The West River Watershed Coalition should continue to engage the many local, state, and regional organizations with an interest in the West River watershed, including the organizations listed in *Table 3-2* and other groups.
- Promote, publicize, and support existing community engagement events that focus on the West River and its watershed such as the annual "West River Water Festival".

3.5.7 Promote Youth Education, Community Service, and Stewardship Programs

In addition to several colleges and universities, the West River watershed is also home to numerous public and private primary and secondary schools, many of which offer environmental education and community service programs. These existing programs and resources provide an excellent opportunity to promote youth education on issues related to watersheds, water quality, and the West River.

- The West River Watershed Coalition and STS should continue and expand their existing relationships and educational programs at the Edgewood School (“Schoolyard Habitat Program”), Common Ground High School (streamwalk surveys and other programs), and other local schools. Other interested schools in New Haven and schools in other watershed communities should be identified as potential candidates for involvement in the West River watershed restoration efforts.
- Consider implementing a watershed-based component to the curriculum in school districts where such programs are not already in place. Use existing educational materials available through the EPA-Long Island Sound Study, Connecticut Sea Grant, CTDEEP, and area colleges. The curriculum could combine lessons, field activities, classroom experiments, and regional networking into learning activities that build shared scientific knowledge and stewardship experiences. The Farmington River Watershed (FRWA) has developed a place-based environmental curriculum consisting of 30 lessons for teachers to use at the elementary, secondary, and high school levels to communicate about the cultural, historical, wildlife, and water resources of the Farmington River Watershed. The lessons, training, and a cross-walk to current state curriculum standards are available for teachers in the watershed.
- Work with the New Haven nonprofit youth development and environmental education organization Solar Youth to provide teenagers with opportunities for involvement in environmental service projects related to the West River watershed. Develop West River-focused community service projects in conjunction with the Green Jobs Youth Development Program Coordinator.
- Continue to recruit student volunteers to participate in water quality and benthic monitoring and streamwalks in the West River watershed.
- Continue to collaborate with college faculty and research staff on ongoing and future research activities focused on the West River watershed, such as the long-time research by Dr. Gaboury Benoit of Yale.

3.5.8 Address Homeless Encampments

Temporary or permanent homeless encampments along waterways where human waste is disposed can be a common problem in highly urbanized areas with an urban stream corridor (ASCE, 2014). Homeless encampments along portions of the lower West River are a recognized problem and potential source of fecal indicator bacteria to the river. Homelessness is a serious social issue and sensitive public policy issue without an immediate or clear solution. Several options exist to begin to address this issue from a water quality standpoint, based on the experience of urban communities in other parts of the U.S.:

- Support of city shelters and services to reduce homelessness
- Periodic cleanup of homeless camps near streams

- Police enforcement/sweeps
- Providing public restrooms
- Partnering with non-governmental organizations to address homelessness.

The Contra Costa County Flood Control and Water Conservation District in southern California undertook an extensive research project to understand the best approaches for addressing water quality pollution from homeless encampments (DeVuono-Powell 2013). The study found that collaboration with other agencies was the most effective approach for addressing the long-term concerns of homeless encampments (ASCE, 2014).

4 Pollutant Load Reductions

Pollutant load reductions were estimated for the watershed plan recommendations for which pollutant loads can be reasonably quantified. Load reductions were calculated using the Watershed Treatment Model (WTM), a screening-level land use pollutant loading model described in *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a). Anticipated pollutant load reductions associated with ongoing and future CSO abatement efforts are based on the GNHWPCA 2014 hydraulic model update.

Annual pollutant loads were estimated for the management actions described below. Predicted load reductions were calculated relative to the existing, baseline pollutant loads, which are presented in *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a).

- **CSO Abatement.** Existing conditions (2014) pollutant loads reflect recent and ongoing improvements to the overflow weirs at CSO Regulators 004 and 005, improvements to the Truman Storage Tank, and cleaning of the lower Boulevard Trunk Sewer, based on the GNHWPCA 2014 hydraulic model update (i.e., 2014 Conditions). Two future CSO abatement scenarios were considered, consistent with the phased implementation of the GNHWPCA Long-Term Control Plan for CSO discharges to the West River. The first future scenario reflects the interim plan for additional improvements to CSO Regulators 003, 004, and 006 as described in the *West River CSO Abatement Report* (CH2MHILL, 2014a). These improvements are predicted to reduce annual CSO volumes and the number of CSO events in a typical year by approximately 60% from the 2014 model conditions and are proposed to be completed by 2018 (i.e., Short Term Control Plan – 2018 Conditions). The second future scenario reflects additional improvements, including the construction of additional CSO Storage Tanks at each of the remaining active CSO discharge locations to the West River. These improvements would eliminate CSO discharges to the West River for up to the 2-year, 6-hour rainfall event (which equates to zero discharges in a “typical year”) and would be completed by 2036 (i.e., Long Term Control Plan – 2036 Conditions). The following table summarizes the modeled West River CSO volumes and number of CSO events for typical year conditions⁷.

Scenario	West River CSO Volume (Million Gallons)	West River CSO Events
2014 Conditions (Modeled Existing Conditions)	14.65	56
Short Term Control Plan – 2018 Conditions	6.02	20
Long Term Control Plan – 2036 Conditions	0.00	0

- **Green Infrastructure.** Continued implementation of green infrastructure is recommended throughout the watershed. Green infrastructure should continue to be implemented through retrofits of existing developed sites and roads (i.e., complete streets), and as part of new public and private development and redevelopment in the watershed, as required by existing and future land use regulations and policies. Potential pollutant load and runoff reductions were estimated for the following types of green infrastructure practices and land use settings:

- Roof leader disconnection and bioretention on commercial, institutional, and industrial land

⁷ Typical year conditions are defined as 40.63 inches of total rainfall per year, peak 15-minute intensity of 3.16 inches per hour, and 114 rainfall events per year (*Hydraulic Model Update Report*, CH2MHILL, 2015).

- Rain barrels and roof leader disconnection on residential properties
- Bioswales/bioretention and/or infiltration (subsurface infiltrators or trenches) for roadways.

Multiple scenarios were modeled to estimate the effect of varying levels of green infrastructure implementation across the watershed, including estimates for retrofitting 10%, 25%, 50%, and 100% of the impervious area watershed-wide. The modeled effectiveness of the proposed retrofits was reduced to reflect system maintenance and design (system bypass during larger storms) factors.

- Stream Buffer Restoration. Potential pollutant load reductions were estimated for restoration of impacted stream buffers in the watershed. The total length of streams within each subwatershed with impacted buffers was estimated from land cover data. Under the modeled restoration scenario, a 100-foot vegetative streamside buffer was assumed for 50% of those areas currently with impacted buffers (i.e., 50% restoration scenario).
- Reforestation. The watershed plan promotes preservation and enhancement of tree canopy through various urban watershed forestry approaches. Potential pollutant load reduction benefits were estimated for a watershed reforestation scenario using recommended tree canopy goals. Based on a recommendation of American Forests, 40% forest cover is a reasonable overall threshold goal for developed watersheds, with 25% forest cover as a goal for urban areas and 50% forest cover for suburban areas (American Forests, 2009). The amount of land conversion required to achieve the recommended tree canopy goals was modeled by converting existing developed land uses to a forested condition for subwatersheds that do not currently meet these goals (i.e., Lower West River, Beaver Brook, and Belden Brook subwatersheds).
- Public Education. Nonpoint source education programs can change behaviors that affect pollutant loads. Pollutant load reductions were estimated for pet waste education programs based on the number of dwellings, average fraction of pet-owners, pet-owners who already clean up after their pets, and average fraction willing to change their behavior. Conservative model assumptions were used to avoid over-estimating the load reduction benefits of these programs.
- Illicit Discharge Detection and Elimination. Illicit stormwater connection removal was considered in each subwatershed based on the existing estimated number of illicit connections associated with commercial and residential land uses. The illicit connection removal scenario conservatively assumes that 15% of the existing illicit discharges are detected and eliminated.
- Septic System Repairs. Septic system repairs were considered in each subwatershed based on the existing estimated number of households served by septic systems. The septic system repair scenario assumes that 20% of the failing septic systems are repaired. This scenario reflects short or mid-term recommendations to address existing failing or malfunctioning septic systems.

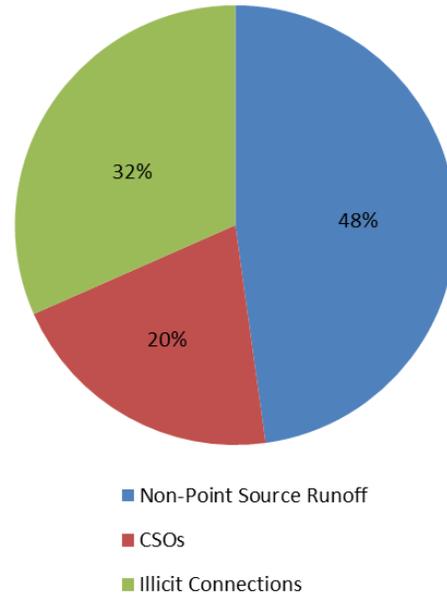
Other watershed management recommendations identified in this plan were not quantified due to the inherent limitations of screening-level pollutant load models and/or the lack of reliable information on the pollutant removal effectiveness of certain management measures.

Existing Pollutant Loads

Annual average pollutant loads for total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), total fecal coliform (FC) bacteria, and average annual runoff volume were estimated for existing conditions and future conditions assuming implementation of the watershed management plan recommendations described in the above scenarios. Existing conditions pollutant loads are described in *West River Watershed Management Plan, Technical Memorandum #1: State of the Watershed* (Fuss & O'Neill, 2015a), a copy of which is provided as *Appendix A* of this plan.

Although pollutant loads were estimated for nutrients, sediment, and fecal indicator bacteria, the focus of discussion for the remainder of this section is on fecal indicator bacteria, which is the primary cause of water quality impairments in the West River watershed.

Nonpoint source runoff accounts for approximately 48% of the modeled existing annual bacteria load to the West River, CSOs account for approximately 20%, and estimated illicit connections account for approximately 32% (see chart at right). It is important to note that these percentages reflect modeled loads based on recent and proposed CSO improvements in the West River watershed. As indicated in Section 3.2.2, continued CSO flow monitoring is recommended to verify modeled pollutant loads.



Relative composition of annual fecal indicator bacteria loads to the West River.

Pollutant Load Reductions

Table 5-1 summarizes the anticipated pollutant load reductions for the plan recommendations for which pollutant loads can be reasonably quantified. The load reduction values presented in *Table 5-1* are for the overall West River watershed. Load reduction summaries by subwatershed are provided in *Appendix G*. The bar graphs in *Figure 5-1* show modeled reductions in annual fecal indicator bacteria loads and runoff volumes, while the pie charts in *Figure 5-2* compare modeled existing (2014) and future (2036) annual fecal indicator bacteria loads and the relative composition of sources.

As indicated in *Table 5-1* and *Figures 5-1 and 5-2*, the watershed plan recommendations are predicted to result in an approximately 31% reduction⁸ in annual fecal indicator bacteria loads for the entire West River watershed under the Long Term Control Plan 2036 CSO abatement scenario and assuming implementation of green infrastructure for 10% of the impervious area in the watershed. Of this 31% reduction, 20% is attributable to CSO abatement, approximately 3% to green infrastructure, approximately 5% to elimination of illicit discharges, and the remainder to other structural and non-structural nonpoint source pollution control measures. A similar management scenario for the Lower West River Subwatershed alone is predicted to

⁸ A 34.3% "effective" reduction in annual fecal indicator bacteria loads is predicted. Effective load reductions are realistically-achievable reductions that account for the natural background pollutant load. The natural background pollutant loads reflect a fully-forested condition in the entire watershed, which represents the lowest, realistically-achievable pollutant loads for the watershed.

achieve a 49% reduction in annual fecal indicator bacteria loads to the impaired lower portion of the West River.

Varying levels of green infrastructure implementation across the watershed were modeled, including the use of green infrastructure to manage runoff from 10%, 25%, 50%, and 100% of the impervious area in residential, industrial, commercial, institutional, and transportation land uses. The results for the 10% scenario, which is considered a reasonable likely future scenario, are included in *Table 5-1*. The results for all four scenarios are presented in *Table 5-2*. The 10% retrofit scenario is predicted to result in an approximately 3% reduction in annual fecal indicator bacteria loads and 4% reduction in annual runoff volume. Higher bacteria load reductions (up to approximately 27%) could potentially be achieved by implementing green infrastructure over a larger percentage of the watershed.

Illicit discharge detection and elimination (IDDE) is also predicted to result in annual bacteria load reductions comparable to a 10% green infrastructure scenario. Even the modest 15% removal rate assumed in the model is predicted to achieve an approximately 5% reduction in annual fecal indicator bacteria loads. IDDE is significantly more cost-effective than implementing structural stormwater retrofits. Dry weather sources of fecal indicator bacteria are the most likely to be identified and effectively managed and more likely to include human sources. Wet weather bacteria sources are often very costly to address and stream standards can be difficult to attain, particularly with the presence of CSOs. IDDE and other source controls focusing on dry weather bacteria sources should be aggressively implemented through municipal stormwater management programs (as required by the MS4 permit) in conjunction with green infrastructure for wet weather sources.

Table 5-1. Modeled Annual Pollutant Load Reductions

Watershed Management Recommendation	Fecal Coliform (billion/year)	Fecal Coliform (%)	Runoff Volume (acre-feet/year)	Runoff Volume (%)
CSO Abatement (2036 levels)	548,800	20.6%	--	--
Green Infrastructure (10% of impervious area)	70,974	2.7%	801	3.7%
Riparian Buffer Restoration	10,996	0.4%	181	0.8%
Reforestation	49,513	1.9%	871	4%
Public Education	12,018	0.5%	--	--
Illicit Discharge Detection and Elimination (IDDE)	126,561	4.7%	--	--
Septic Repair	6,991	0.3%	--	--
<i>Total</i>	825,852	31.0%	1,854	8.6%

Table 5-2. Modeled Annual Pollutant Load Reductions for Varying Levels of Green Infrastructure Implementation

Green Infrastructure Implementation Scenario	Fecal Coliform (billion/year)	Fecal Coliform (%)	Runoff Volume (acre-feet/year)	Runoff Volume (%)
Retrofit 10% of Impervious Area	70,974	2.7%	801	3.7%
Retrofit 25% of Impervious Area	177,435	6.7%	2,003	9.3%
Retrofit 50% of Impervious Area	354,871	13.3%	4,007	18.6%
Retrofit 100% of Impervious Area	709,741	26.6%	8,013	37.3%

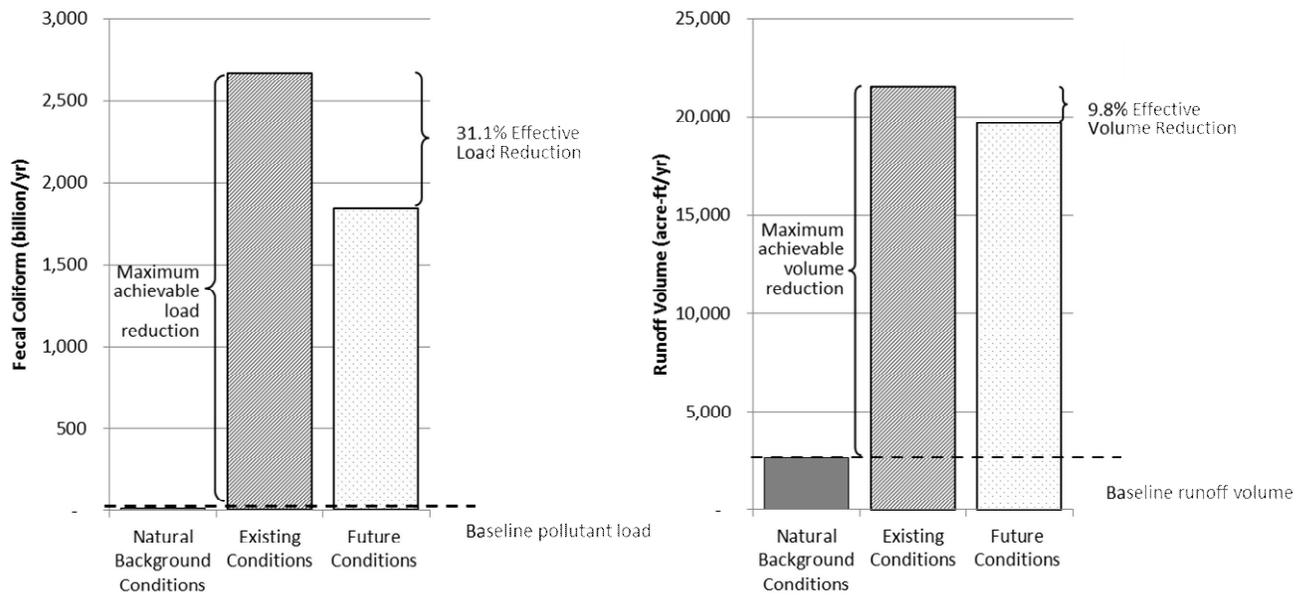


Figure 5-1. Modeled Reductions in Annual Fecal Indicator Bacteria Loads and Runoff Volumes

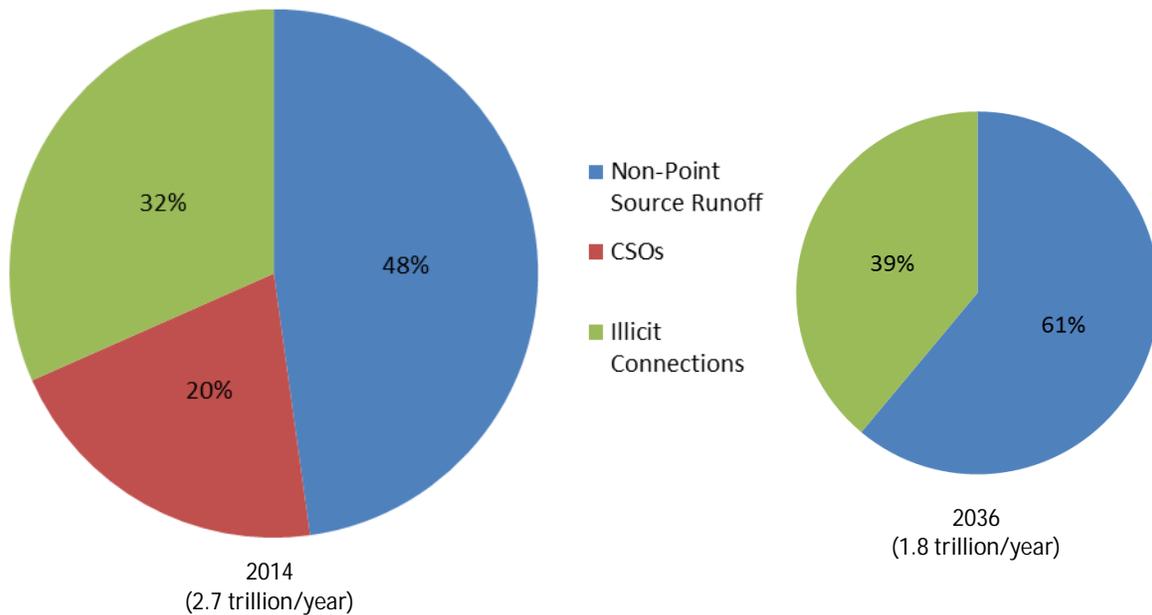


Figure 5-2. Modeled Existing (2014) and Future (2036) Annual Fecal Indicator Bacteria Loads

How Much will the Watershed Plan Recommendations Improve Water Quality?

The primary objective of this watershed plan is to address the water quality impairments in the West River and thereby restore the recreational uses and aquatic habitat that have been affected by poor water quality. The pollutant load evaluation suggests that significant pollutant load and runoff reductions could be achieved by implementing the plan recommendations. Implementation of the watershed management recommendations is predicted to result in an approximately 31% to 49% reduction in annual fecal indicator bacteria loads to the West River.

However, a logical question that arises from this evaluation is – if the watershed plan recommendations are fully implemented, will water quality in the West River consistently meet water quality standards for recreation and aquatic life?

A Total Maximum Daily Load (TMDL) analysis for fecal indicator bacteria was completed for the West River as part of CTDEEP'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. The Statewide Bacteria TMDL calls for an 86% reduction in fecal indicator bacteria loads (based on the geometric mean) to the impaired segment of the West River. The pollutant load modeling results indicate that fecal indicator bacteria load reductions of between 34% and 49% are achievable with full implementation of the watershed management plan recommendations. This suggests that additional controls or more aggressive control strategies are needed to fully achieve the load reductions specified in the TMDL. Additional load reductions may be achieved through implementation of green infrastructure over a larger portion of the watershed, additional reforestation and stream buffer restoration, increasing the public awareness in the watershed of certain programs, and increased detection and elimination of illicit discharges.

It is important to note several limitations of both the TMDL load reduction estimates and the pollutant load reduction modeling. The TMDL is based on very limited wet and dry weather monitoring data – 3 samples collected in 1998 and 8 samples collected in 2010. The samples were also collected at locations upstream of the influence of CSOs. Furthermore, the TMDL and modeled load reductions are not directly comparable since the TMDL loads are daily, seasonal (i.e., worst-case) values, whereas the modeled pollutant loads are annual values. Lastly, the load reductions anticipated from CSO abatement efforts are not directly comparable to the TMDL load reduction goal since the TMDL was developed prior to the recent upgrades to the Boulevard Trunk Sewer system, while the GNHWPCA 2014 Conditions hydraulic model accounts for these recent upgrades. Therefore, the modeled future CSO abatement load reductions are conservatively low when compared to the TMDL load reduction goals.

As indicated in the TMDL, progress in achieving TMDL-established goals through implementation of this watershed plan may be most effectively gauged through continued fixed-station ambient water quality monitoring. Routine monitoring should be performed at the same two sites used to generate the data for the TMDL calculations, as well as at additional sites along the West River (see the water quality monitoring recommendations in *Section 3.2* of this plan). Sampling should be scheduled at regularly spaced intervals during the recreational season. Therefore, the data set at the end of each season will include ambient values for both "wet" and "dry" conditions in relative proportion to the number of "wet" and "dry" days that occurred during the monitoring period. The TMDL calculations can be updated over time to compare the percent reductions needed under "dry" and "wet" conditions to the percent reductions that were needed at the time of TMDL adoption.

5 Funding Sources

A variety of local, state, and federal sources 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 H* contains a list 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.

6 References

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Appendix A

West River Watershed Management Plan
Technical Memorandum #1:
State of the Watershed (on CD)

Appendix B

Watershed Survey Responses

Appendix C

West River Watershed Management Plan
Technical Memorandum #2:
Green Infrastructure Assessment (on CD)

Appendix D

Project Steering Committee Meeting Summaries

Appendix E

Community Workshop Meeting Summaries

Appendix F

Streamwalk Assessment Training and Preliminary Results

Appendix G

Pollutant Load Reduction Model Results

Appendix H

Potential Funding Sources



FUSS & O'NEILL