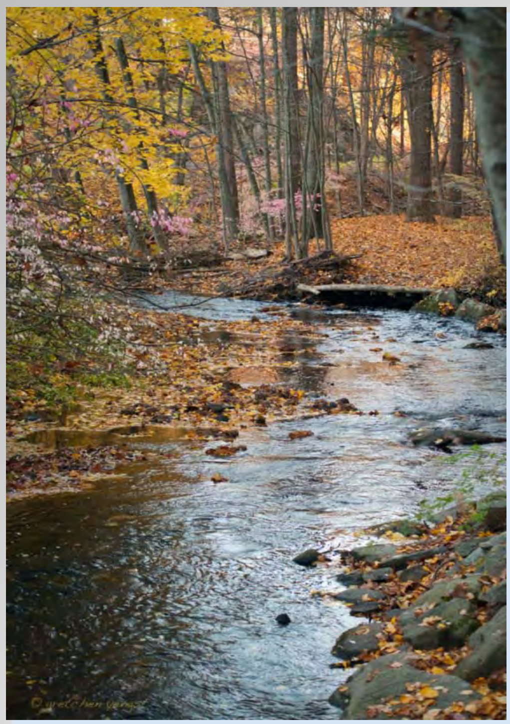
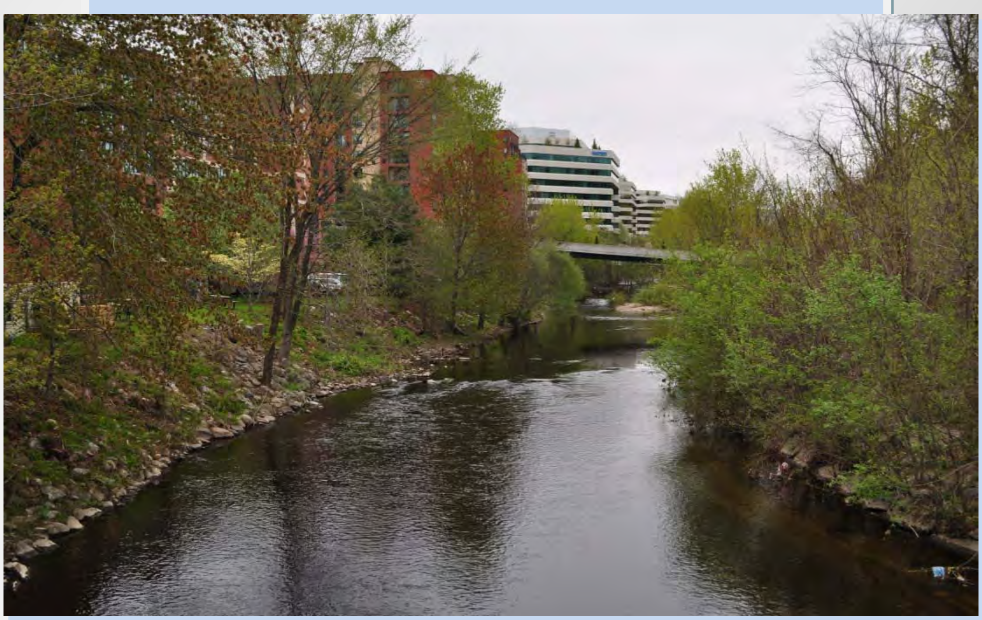


Norwalk River Watershed Based Plan

2011 Update to the 1998 Plan

The Norwalk River Watershed Action Plan

It's Our Watershed – Let's Take Care of It



Prepared by:
The Norwalk River Watershed Initiative Committee, HDR|HydroQual and the South Western Regional Planning Agency

Prepared for:
Connecticut Department of Energy and Environmental Protection

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Cover Photographs: Upper - courtesy of Gretchen Yengst – Loving Focus Photography; Lower – Alexis Cherichetti.

HDR | HydroQual

SWRPA
South Western Regional Planning Agency

Vision Statement of Norwalk River Watershed Initiative Committee, 1998

"We envision a restored Norwalk River Watershed system:
one that is healthy, dynamic and will remain so for generations to come;
one that offers clean water and functioning wetlands;
one in which a diversity, of freshwater and diadromous fish as well as other wildlife and plants are once again sustained;
one in which the river system is an attractive community resource that enhances quality of life, education, tourism and recreation; and above all one in which growth respects this vision and all people participate in the stewardship of the watershed."

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Steering Committee

Alexis Cherichetti	City of Norwalk
Kathleen Holland	Town of New Canaan
Cindy Ingersoll	Norwalk River Watershed Initiative Coordinator
Diane Lauricella	Norwalk Resident & Environmental Innovations Group, Principle
Christopher Malik	Connecticut Department of Energy & Environmental Protection
Sara da Silva Quintal	Norwalk River Watershed Association
Patricia Sesto	Town of Wilton
Kitsey Snow	Norwalk River Watershed Association

Norwalk River Watershed Initiative

Alexis Cherichetti, City of Norwalk

Mark Alexander, CTDOT

Chris Malik, Connecticut Department of Energy & Environmental Protection

Tom Devine, Devine Brothers

Dick Harris, Harbor Watch /River Watch

Tony D'Andrea, Norwalk Harbor Management Commission

Richard Weisberg, Norwalk River Watershed Association

Tom Villa & Casey Cordes, South Norwalk Electric & Water

Roman Mrozinski & Chris Boley, Southwest Conservation District

Nicole Davis, South Western Regional Planning Agency

Joe Schnierlein, The Maritime Aquarium at Norwalk

Janet Andersen, Town of Lewisboro

Kathleen Holland, Town of New Canaan

David Pattee, Town of Redding

Beth Yanity, Town of Ridgefield

Fred Anderson, Town of Weston

Patricia Sesto, Town of Wilton

Patrice Gillespie, Town of Wilton

Mike Law & Dick O'Neill, Trout Unlimited

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J. Thomas Failla & Catherine Minter, Weston Conservation Commission

Technical Assistance

Connecticut Department of Energy & Environmental Protection	MaryAnn Nusom Haverstock, Chris Malik, and Terri Schnoor.
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AVGWLF	ArcView Generalized Watershed Loading Functions (GWLF) model
BMPs	Best Management Practices
CLEAR	Center for Land Use Education and Research, University of Connecticut
CT	State of Connecticut
CTDEP	Connecticut Department of Environmental Protection (changed to Department of Energy & Environmental Protection (DEEP) July 1, 2011)
CTDOT	Connecticut Department of Transportation
CWA	Clean Water Act
CWP	Center for Watershed Protection
DEEP	Connecticut Department of Energy & Environmental Protection
DO	Dissolved Oxygen
E. coli	*Escherichia Coli*
EMC	Event Mean Concentration
EPA	United States Environmental Protection Agency
FC	Fecal Coliform
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GWLF	Generalized Watershed Loading Functions
HW/RW	Harbor Watch/River Watch
HVCEO	Housatonic Valley Council of Elected Officials
IDDE	Illicit Discharge Detection and Elimination
LIDs	Low Impact Development practices
mg/L	Milligrams per liter
mgd	Million gallons per day
MS4	Municipal Separate Storm Sewer Systems
NEIWPCC	New England Interstate Water Pollution Control Commission
NEMO	Non-point Education for Municipal Officials
NMA	Norwalk Maritime Aquarium
NPS	Non-point Source
NRCS	Natural Resources Conservation Services
NRWA	Norwalk River Watershed Association
NRWI(C)	Norwalk River Watershed Initiative (Committee)
NY	State of New York
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
TMDL	Total Maximum Daily Loads
TN	Total Nitrogen
TP	Total Phosphorus
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UCONN	University of Connecticut
USGS	U.S. Geological Survey
WBP	Watershed Based Plan
WLA	Waste Load Allocation
WPCF	Water Pollution Control Facility
WQS	Water Quality Standards

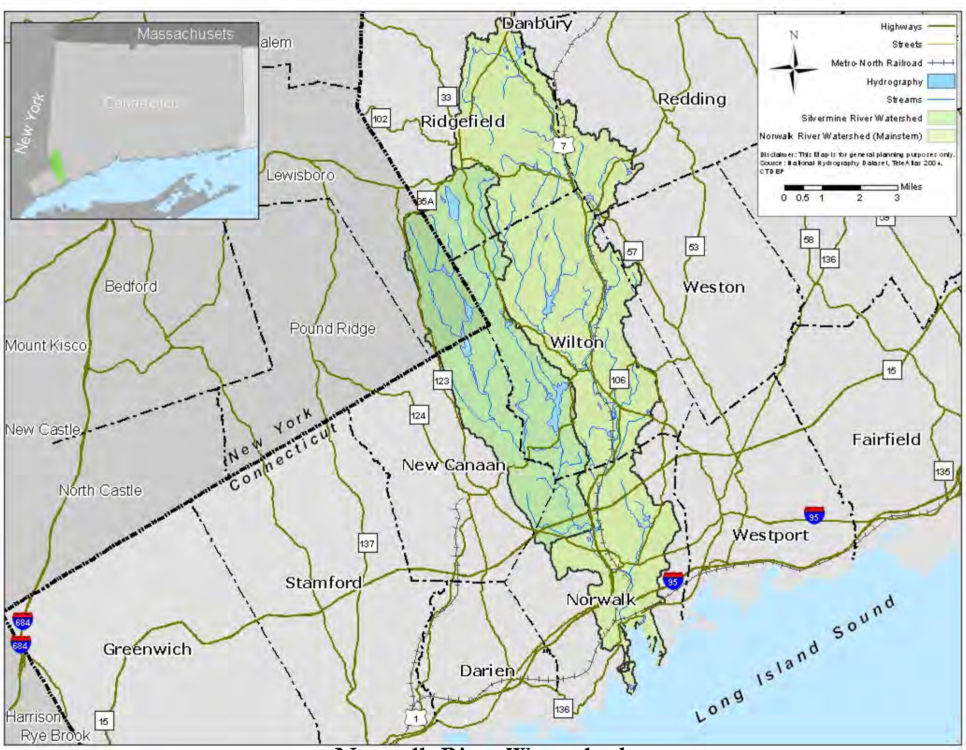
EXECUTIVE SUMMARY

E.1 Norwalk River and Tributaries

The Norwalk River watershed is a regional basin located in the southwestern portion of the State of Connecticut and Westchester County, New York. The Norwalk River Watershed is approximately 64 square miles in size, with two major tributaries: Comstock Brook and the Silvermine River. Similar to other coastal watersheds in Connecticut and New York, this watershed is heavily urbanized in the lower reaches and near the outlet into Norwalk Harbor, while the upper reaches of the watershed exhibit more forested and suburban landscapes.

The watershed extends into six municipalities in Connecticut (New Canaan, Norwalk, Redding, Ridgefield, Weston, and Wilton) and one in New York (Lewisboro). Major concerns in the watershed including flooding, streambank and channel erosion, excessive bacteria loads, nutrient loads to impoundments or the Long Island Sound (LIS), and other pollutant loads. Through an extensive and collaborative effort among watershed stakeholders, the original *Norwalk River Watershed Action Plan* published in 1998 and its update in 2004 have documented degradation in the watershed and the previous monitoring efforts such as streamwalk surveys performed by the Natural Resources Conservation Services (NRCS) in the late 1990s.

The planning efforts described in this Watershed Based Plan (WBP) cover the characterization, analysis and pollutant load calculations performed in the fresh water portion of the Norwalk River watershed, which extends from headwaters in Ridgefield southward towards Wall Street near the top of the Norwalk Harbor.



Norwalk River Watershed

E.2 History of Community Involvement

The Norwalk River watershed has a rich history of watershed planning and represents one of the earliest community-driven, locally-led initiatives in the U.S. to restore and protect watershed resources. The Norwalk River Watershed was identified as an important resource in which water quality improvements could provide benefits to LIS and the community, in the mid-1990s. A committee was formed, as a as a collaborative effort between federal, state, regional and local governments and the public to develop the 1998 *Norwalk River Watershed Action Plan* (the 1998 Action Plan).

The 1998 Action Plan represented a watershed community with a common interest in restoring and protecting the watershed and its resources. The *2004 Supplement to the 1998 Norwalk River Watershed Action Plan* (the 2004 Supplement) highlighted the accomplishments of the 1998 Action Plan and reprioritized watershed goals and recommendations.

The 1998 Action Plan and 2004 Supplement have lead to a number of successfully implemented projects and continued support and collaboration from watershed stakeholders. A successful water quality monitoring program has been established for the Norwalk River led by Harbor Watch/River Watch (HW/RW). In-stream and outfall monitoring have taken place at selected locations for more than 10 years. Regular water quality monitoring has identified and led to the detection and correction of a number of problems, including illicit discharges to stormwater sewers and failing septic systems. A summary of implementation activities has been included in Appendix A.

E.3 Water Quality Concerns

Despite significant accomplishments from watershed stakeholders, sections of the mainstem of the Norwalk River and its tributaries are categorized as impaired. Indicator bacteria levels are the primary pollutant of concern for recreational uses in the river and shellfishing in the Norwalk Harbor. A waterbody is designated as impaired when the water quality standards for the designated or existing water quality classifications are not met (CTDEP, 2008). Impairments for recreational uses due to elevated levels of indicator bacteria are well documented in the watershed (CTDEP 2008). In 2005, the Connecticut Department of Energy & Environmental Protection developed a Total Maximum Daily Load (TMDL) for indicator bacteria for the Norwalk River and various tributaries. Indicator bacteria loads were attributed to a variety of sources, including failed or improperly maintained septic systems, urban stormwater, illicit discharges to storm sewers, hobby farms, wildlife and pet waste. Targeted percent reductions in indicator bacteria pollutant loads identified as part of the TMDL ranged from 3 to 76% depending on the specific impaired segments in the mainstem of Norwalk River or the tributaries (CTDEP, 2005).

In addition to indicator bacteria loads, high levels of nutrients (both phosphorus and nitrogen) have caused water quality concerns in the tributaries and mainstem, as well as in the Long Island Sound (LIS). Localized nutrient inputs such as lawn fertilizers, failing septic systems and illicit discharges contribute to these water quality concerns. Nutrients are the primary causes for eutrophication in reservoirs/lakes/ponds (impoundments) and variations in dissolved oxygen (DO) levels that can impact aquatic life in waterways. Specific impoundment characteristics such as depth, extent of aquatic vegetation, sediments and temperature can also exacerbate water quality degradation. Several impoundments in the Norwalk River watershed, such as Great Swamp, have been identified to have excessive algal growth (NRCS, 1997).

Segments of the river have also been identified as impaired for fish and other aquatic life support, with the sources identified as "unknown" by DEEP (CTDEP, 2008). Flooding, streambank and channel erosion, restoration of fish passage, habitat protection, and adequate base flow are also concerns in the watershed, and are further discussed in 1998 *Norwalk River Watershed Action Plan* and the *2004 Supplement to the 1998 Norwalk River Watershed Action Plan*.

E.4 Development of a Watershed Based Plan

To garner continued support of watershed planning and conservation efforts the DEEP funded the update and development of this WBP containing the "Nine Elements of Watershed Planning" recommended by the U.S. Environmental Protection Agency (EPA). Funding was provided in part through an EPA Clean Water Act Section 604(b) Water Quality Management Planning Grant. The adoption and approval of the WBP by the DEEP will aid in securing necessary funding to implement recommendations of the plan. The overall goal of this WBP is to identify recommendations that can be implemented on a short to long-term basis, which will improve water quality in the Norwalk River and its tributaries, ultimately leading to segments being removed from the state impaired waters list.

Development of the WBP consisted of the following specific tasks:

i. Baseline Watershed Conditions and Natural Resource Assessment: A baseline assessment of the watershed conditions was performed to characterize the current state of the Norwalk River watershed and its tributaries. Existing data from previous studies and the HW/RW data were reviewed to support this characterization. Delineation of the watershed into smaller sub-watersheds was performed to develop pollutant loads and also to correlate the sub-watersheds and monitoring data to identify areas of the watershed that would need specific management measures for pollution control.

ii. Watershed Management Goals and Objectives: Building on the watershed goals developed previously as part of the 1998 Action Plan, water quality and non-point source runoff management were the focus of this WBP aimed at non-point source pollution reduction. The following objectives were selected to guide the development of short to long-term water quality recommendations:

Goal D: Water Quality

D-1: Eliminate illicit discharges to storm sewers
D-2: Improve solid waste and liquid waste management throughout the watershed
D-3: Reduce the impact of road sand and salt on water quality and stream habitat
D-4: Maintain adequate baseflows in the Norwalk River and its major tributaries
D-5: Eliminate or reduce the anthropogenic impacts to in-stream water quality
D-6: Reduce nitrogen loads from groundwater
D-7: Reduce nitrogen loads from atmospheric deposition
D-8: Continue water quality monitoring, data collection and assessment

Goal E: Non-point Source Runoff Management

- E-1: Reduce the cumulative impacts of development and expand efforts to promote and implement low impact development (LID) practices
- E-2: Ensure municipal regulations support the implementation of LID practices
- E-3: Advocate for a state and local permitting framework that best protects water resources from the impacts of non-point source runoff
- E-4: Adopt land use practices that reduce the impacts of non-point source runoff
- E-5: Manage bacterial contamination from waterfowl and domestic/hobby animals

Additional recommendations to support "Goal B" on Habitat Restoration, "Goal C" on Land Use, Flood Protection and Open Space and "Goal F" Stewardship and Education where also developed during the planning process to support ongoing watershed initiatives.

iii. Pollutant Loading Assessment: Pollution load assessments were conducted maximize the use of existing pollutant load characterization efforts from previous studies to support the development for this WBP. An ArcView-based Generalized Watershed Loading Functions (AVGWLF) model developed for the Long Island Sound U.S. Environmental Protection Agency was adopted and recalibrated based on recent monitoring data. This model was used to support the quantification of pollutant loads for indicator bacteria, total nitrogen, total phosphorus and total suspended solids.

iv. Watershed Recommendations: A range of potential management measures were developed to achieve the watershed goals and objectives discussed above and also based on loading calculations performed for the individual sub-watersheds. Watershed-wide, site-scale and targeted recommendations were developed and refined based on input from the steering committee.

v. Load Reductions, Implementation Schedule, Interim Milestones and Performance Criteria: For each of the key recommendations, potential reductions in both nutrient and indicator bacteria loads expected on a sub-watershed level were developed. In addition, implementation schedules for all the management measures along with interim milestones and performance criteria were identified in collaboration with the steering committee that could be used to track the progress from implementation of measures developed and presented in this plan.

E.5 Plan Recommendations

This plan recommends both structural and non-structural practices on a watershed-wide basis and at smaller scales to reduce the impacts on non-point source pollution. The watershed-wide perspective highlights the relationship between existing land uses and water quality, so that the controls envisioned at this broader level will bring consistency among various watershed municipalities in achieving an overall pollutant load reduction. Targeted and site scale recommendations focus attention on addressing impairments at selected sites or smaller geographical regions where the controls undertaken will make meaningful reductions in pollutant loads to improve water quality in the Norwalk River watershed and its tributaries. These sites are direct contributors of indicator bacteria and nutrients and will require specific investigation and implementation strategies to achieve the desired water quality goals. Additional targeted recommendations are provided to address concerns around specific sub-watersheds or stream reaches.

Recommendations were assigned an implementation priority based on both technical and financial considerations, overall benefits, as well as the extent of involvement from various watershed stakeholders needed to complete of each recommended plan element. In general, a planning element that could be completed in a few months to one to two year timeframe was designated as a short-term recommendation. Completion in three to four years was considered a mid-term recommendation, and any element that would take over four years was designated as a long-term recommendation. Table ES-1 provides a summary of pollution reductions expected with implementation of recommended management measures identified as part of the WBP. Also shown are the reduction targets set forth by the DEEP as part of the 2005 TMDL for specific segments identified as impaired for not meeting the state standards for indicator bacteria in Connecticut's 303(d) list.

Table ES-1: Summary of Pollution Reductions Achieved to Delist Impaired Segments

Impaired Segment		% Reduction Expected with 100% Implementation	TMDL Target % Reduction
CT7300-02_02	Ridgefield Brook	66%	51%
CT7300-02_01	Ridgefield Brook	66%	51%
CT7300-00_05	Norwalk River	70%	39%
CT7300-00_04	Norwalk River	73%	54%
CT7300-00_03	Norwalk River	74%	5%
CT7300-00_02	Norwalk River	75%	38%
CT7302-00_01	Silvermine River	75%	66%
CT7300-00_01	Norwalk River	76%	76%

A majority of the key management measures recommended below are necessary to achieve the targeted pollution reductions, although some of these measures will need to be achieved 100% on a watershed-wide basis and others to varying degrees depending on specific impaired segments in the Norwalk River or its tributaries.

Illicit Discharge Detection and Elimination (IDDE): With a stringent TMDL goal to reduce bacteria loading by 76% at the lower end of Norwalk River, the recommendation is to achieve 100% elimination of these dry weather sources over a period of 10 years, with an interim target of 50% to be achieved over the next five years.

Management of Septic Systems (SEP): Being another major contributor of bacterial loads at both watershed and site-scales, the recommendation is to achieve 100% in proper inspection, repairs and operation and maintenance of septic systems, so as to completely eliminate such failures over a period of 10 years. An interim target of 50% over the next five years is recommended.

Low Impact Development Adaptation (LID): With the goal of managing stormwater runoff while maintaining or restoring the natural hydrology, the recommendation is to implement LID retrofits as source control mechanisms to reduce stormwater discharge volumes and associated pollutant loads to the Norwalk River and its tributaries.

Land Use Regulations and Smart Growth (LUS): Exploration of the potential benefits is recommended from streamlining of land use regulations within the watershed municipalities and promoting smart growth in certain geographical areas can help in reducing the potential for pollutant loads.

Downspout Disconnection (DOD): A generic recommendation is made to first conduct field scale assessment of downspout connections to sewers and target areas in the watershed with high density of connections that will benefit from disconnection. Outreach and assistance can follow to help home owners with implementation.

Riparian Buffers (RBF): With high levels of targeted reductions in bacteria loads, intact riparian buffers are recommended for 100% of river miles along the low and high intensity developments, over a period of 20 years with an interim target of 50% over the next 10 years.

Management of Pollution from Waterfowl and Domestic/Hobby Animals (WAT): Connecticut DEP has developed statewide population estimates for Canadian geese and ducks to be 24,000 and 57,000, respectively, during the 2011 breeding season. Population estimates specific to the Norwalk River watershed are unavailable and these estimates include both migratory and non-migratory goose populations. The recommendation is to achieve a targeted 30% reduction in pollutant source reduction from baseline condition for the Norwalk River watershed, targeting the non-migratory goose population.

Urban Greening (UGR): Increased tree canopies and plant coverage will benefit in terms of capturing additional water through evapotranspiration and interception, reductions in thermal pollution and providing secondary environmental benefits, such as increased habitat.

Large-scale BMPs for Urban Stormwater Management (BMP): Structural BMP practices such as bioretention (with bacteria reduction effectiveness of 70%), constructed wetlands (effectiveness of 50%) and wet ponds (effectiveness of 70%) are effective in terms of reducing bacteria loads from contributing urban drainage areas. Among the targeted recommendations are the public and large-private properties that can offer potential for structural BMP implementation. About 50-60% of the urban runoff from the entire watershed will need to be treated with multiple constructed wetlands, wet ponds and bioretention, in order to meet the desired bacterial control targets for various impaired segments.

Streambank Stabilization/Restoration (STR): There is no direct benefit for bacteria load reduction from this recommendation, therefore, the stabilization can be adopted where there are specific stream segments with bank erosion and sedimentation problems.

Transportation Corridors (TRA): The Norwalk watershed is intersected by major transportation elements including parkways, national highways and boulevards/streets. The recommendation is to achieve 100% treatment of highway/roadway runoff over a period of 20 years, with an interim target of 50% over the next 10 years. Highway runoff treatment can be in the form of grass swales, wetponds, constructed wetlands, bioretention cells and buffer strips implemented based on feasibility and cost considerations along the transportation corridor to reduce bacterial and nutrient pollutant loads. In order to support the prioritization process, the subwatersheds with more than 8% (by area) of transportation corridors have been classified as high density areas for implementation of BMPs to reduce nutrients and indicator bacteria in the near term and then for the remaining areas over the long term.

Public Education and Outreach (EDU): Both lawn care practices and pet waste disposal aspects were considered in the estimation of load reductions from public education and outreach and recommended for implementation. Continued stewardship and educational opportunities are necessary for successful implementation of the WBP.

Annual average pollutant load reductions for TN, TP, TSS, and bacteria (*E. coli*) were estimated for the entire Norwalk watershed. Table ES-2 summarizes the estimated pollutant load reductions for each watershed management measure, on a watershed-wide basis.

E.6 Prioritization

Elimination of dry weather discharges through illicit discharge detection and removal, moderate control of waterfowl and the proper operation and maintenance of septic systems emerged as the most cost-effective ways to significantly reduce bacteria loads in the Norwalk River and its tributaries. Riparian buffers can also provide load reductions with moderate investments. Large-scale urban stormwater management measures can provide significant reductions; however, the associated costs are the highest in comparison to other management measures. In spite of their large costs, if specific or dedicated funding mechanisms can be pursued for projects such as wetland restoration or creation in public lands, such projects can become viable opportunities for reduction in water quality impairments. Transportation corridors also offer opportunities for large-scale treatment that provide measurable benefits. However these projects can be costly and may require collaboration among local, state and federal agencies for funding.

Distributed LIDs do require significant financial investments and extensive coordination among stakeholders to provide watershed-wide benefits. These source control practices can reduce runoff through infiltration, increase baseflow in the streams and reduce bank/channel erosion due to reduced peak flows during rainy periods. These practices can be implemented as small or large-scale projects and can also be pursued selectively based on the funding mechanisms available.

Practices such as urban greening and streambank restoration may provide limited benefits for bacteria control. However, those can be promising for controlling of other pollutants such as TSS and nutrients, reduction of thermal pollution and will provide additional habitat in the watershed.

A focused list of recommendations are included in Table 6-1, with a full list of recommendations in Appendix B. Information regarding targets/performance metrics for specific watershed management measures provided are also provide in Table 6-1 and Appendix B.

Table ES-2: Estimated Pollutant Load Reductions on a Watershed-wide Basis

Watershed Management Recommendation	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (billion/yr)	Percentages			
					N	P	TSS	*E. coli*
Existing	**266,193**	**33,669**	**13,973**	**1,552,146**	100%	100%	100%	100%
Illicit Discharge Detection & Elimination (IDDE)	5,324	673	-	491,573	2%	2%	-	32%
Management of Septic Systems (SEP)	96,437	19,855	-	231,781	36%	59%	-	15%
LID Adaptation (LID)	124	23	2	7,898	0%	0%	0%	1%
Land Use and Smart Growth (LUS)	-	-	-	-	-	-	-	-
Downspout Disconnection (DOD)	-	-	-	-	-	-	-	-
Riparian Buffers (RBF)	3,646	147	85	64,519	1%	0%	1%	4.2%
Management of Waterfowl & Animal Wastes (WAT)	11,392	1,441	-	66,426	4%	4%	-	4.3%
Urban Greening (UGR)	-	-	-	-	-	-	-	-
Large-scale BMPs for Urban Stormwater Mgmt (BMP)	8,369	916	88	296,923	3%	3%	1%	19%
Streambank stabilization/ Restoration (STR)	44	51	1,155	-	0%	0%	8%	-
Transportation Corridors (TRA)	2,315	309	16	5,354	1%	1%	0%	0%
Education & Outreach (EDU)	5,877	388	-	21,296	2%	1%	-	1%
Load Reduction Achieved	**33,528**	**23,803**	**1,346**	**1,185,770**	**50%**	**71%**	**10%**	**76%**
Remainder Pollutant Loads to Norwalk Waterways	**132,665**	**9,866**	**12,628**	**366,375**	**50%**	**29%**	**90%**	**24%**

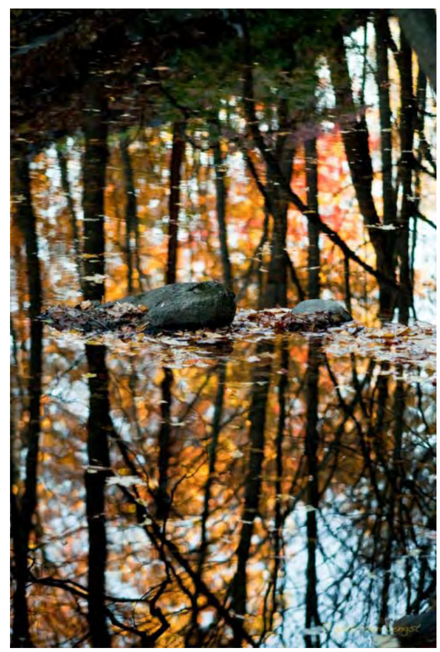
NOTE: TN – Total Nitrogen, TP – Total Phosphorus, TSS – Total Suspended Solids and *E. coli* – Escherichia Coli

1. INTRODUCTION

1.1 Need for a Watershed Based Plan

Watershed management and the methods utilized to reduce water quality impairments have continued to evolve in the 21st century, and require innovation, collaboration and local leadership. Significant progress has been made to address point sources of pollution, mainly through the National Pollution Discharge Elimination System (NPDES) program. The NPDES permitting programs strictly regulate and require advanced levels of treatment for municipal sanitary and industrial wastewater. Some urban stormwater is also regulated through the Municipal Separate Storm Sewer System (MS4) permit, which serves to establish pollution control programs (USEPA, 2002; 2010).

Despite great progress in controlling point sources, water quality problems remain. At a national level, stormwater from urban, sub-urban and non-urban land areas have been identified as major contributors to water quality impairment (NRC, 2008). These non-point sources include runoff from roads, parking lots, and lawns; leachate from septic systems; animal waste from wildlife, pets and hobby farms; and atmospheric deposition of pollutants. Non-point sources are defined as diffuse sources with multiple entry pathways into the receiving waters. Discharges from non-point sources are generally controlled through voluntary programs administered at the state and local level. Although urban stormwater conveyed through a storm sewer is regulated as a point source and permitted through the MS4 program. Stormwater runoff flowing directly form watershed lands, urban, sub-urban or rural, into a waterway is considered a non-point source. Various funding sources dedicated to non-point sources exist to help fund projects, including the 319 program.



Source: Gretchen Yengst - Loving Focus Photograph

The Norwalk River watershed (the watershed) is a regional basin predominately located in the southwestern portion of the State of Connecticut and is approximately 64 square miles in size. Comstock Brook and the Silvermine River are the major tributaries to Norwalk River (Figure 1-1). The watershed comprises approximately 40,000 acres of drainage area, extending into six municipalities in Connecticut: New Canaan, Norwalk, Redding, Ridgefield, Weston, and Wilton; and Lewisboro, New York. Similar to other coastal watersheds in Connecticut and New York, the Norwalk River is heavily urbanized in the lower reaches and near the outlet through Norwalk Harbor into the Long Island Sound (LIS), with pockets of suburban development along the Silvermine River. The upper reaches of the watershed tend to be characteristic of a more suburban landscape; however typical urban stormwater issues are still common. Historic development, economic and recreational opportunities and the proximity/accessibility of New York City are attributed to these development patterns seen throughout the LIS region.

This watershed based plan (WBP) covers the characterization, analysis and pollutant load calculations performed in the fresh water portion of the Norwalk River watershed, which extends from headwaters in Ridgefield southward to the top of the Norwalk Harbor.

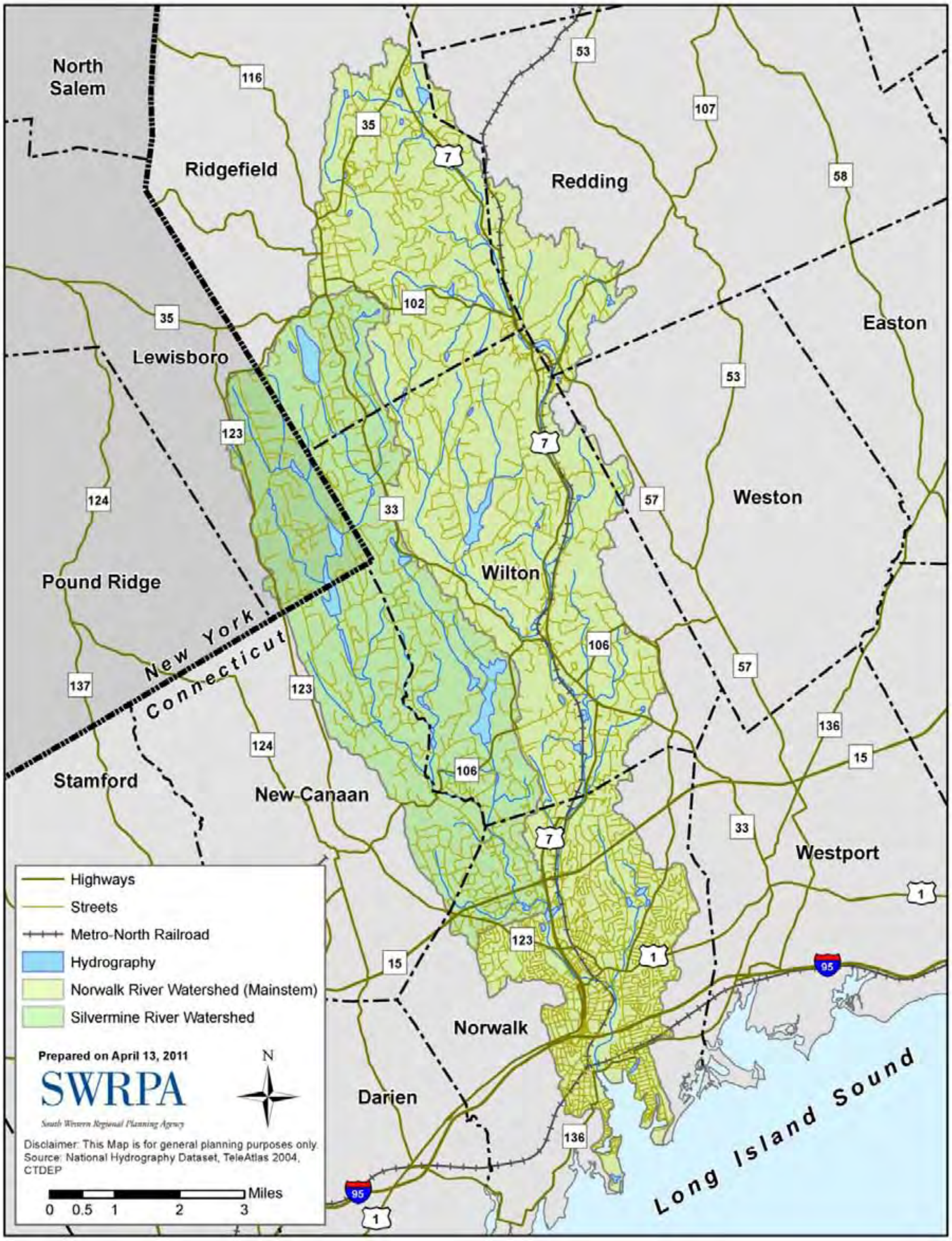


Figure 1-1. The Norwalk River Watershed

1.1.1 History of Planning Efforts in the Norwalk River Watershed

In the mid-1990s, the USDA-Natural Resources Conservation Service (NRCS), United States Environmental Protection Agency (EPA) through its Long Island Sound Office (EPA-LISO), and the Connecticut Department of Energy & Environmental Protection (DEEP) recognized the importance of a comprehensive watershed management approach to protect and restore the State's surface and ground waters, and the LIS. The Norwalk River Watershed was identified as an important resource in which water quality improvements could provide benefits to LIS and the community. As a result, the Norwalk River Watershed Initiative Committee (NRWIC) was created in early 1997 to develop a methodical framework for watershed management, as a collaborative effort between federal, state, regional and local governments and the public. Early planning focused on a "Streamwalk Assessment," which added considerably to the existing knowledge regarding the physical condition of the watershed's stream corridors. An 18-month formal planning process was undertaken by NRWIC, which resulted in the development of the 1998 Norwalk River Watershed Action Plan (the 1998 Action Plan).

This represents one of the earliest community-driven, locally-led initiatives in the U.S. to restore and protect the watershed resources. The people who live, work and recreate in the watershed are most likely to understand the problems affecting it, have the greatest stake in its health, and have the greatest incentive to affect the changes necessary to restore and protect resources. This approach assumes that the watershed is a logical, geographically defined unit, in which a wide range of environmental issues can be analyzed and assessed in a comprehensive fashion, taking into account the interactions and cumulative impacts of various pollution sources and resource impairments. The 1998 Action Plan represents a watershed community with a common interest in restoring and protecting the watershed and its resources (NRWIC, 1998). In June 2003 the NRWIC began the process to review progress in implementing the recommendations from the 1998 Action Plan. The 2004 Supplement to 1998 Action Plan (the 2004 Supplement) highlighted the accomplishments of the NRWIC and reprioritized watershed goals and recommendations for the next five years (NRWIC, 2004).

As a result of documented impairments in the Norwalk River, in 2005, the DEEP developed a Total Maximum Daily Load (TMDL) for indicator bacteria for the Norwalk River and various tributaries. The state indicator bacteria criteria are based on the protection of recreational uses such as swimming, kayaking, wading, water skiing, fishing, boating, and aesthetics. Indicator bacteria loads were attributed to a variety of sources, including failed or improperly maintained septic systems, urban stormwater, illicit discharges to storm sewers, hobby farms, wildlife and pets. A TMDL is the mechanism established by the EPA to set pollution control targets for the various contributing pollution sources (both point and non-point), accounting for the assimilative capacity of receiving waters and the anticipated growth and developments in a watershed.

Hypoxic conditions seen in the western end of the LIS and high levels of nutrient inputs from tributaries and ground water led the DEEP and New York State Department of Environmental Conservation (NYSDEC) to develop a TMDL to control Total Nitrogen (TN) inputs into the LIS from both point and non-point sources (NYSDEC and CTDEP, 2000). As documented in Mullaney et al. (2002), significant amounts of nitrogen reaches the LIS through groundwater sources. Nutrients infiltrating into the groundwater reappears in streams as base loads and Mullaney (2006) estimates the groundwater residence times can range from two to more than 50 years. Long residence times essentially move nutrients through the watershed slowly and present a long-term source of pollution loads into the LIS even when controlled from other sources with appropriate management practices.

Controlling pollution from septic systems through inspection and maintenance and removing illicit discharges to stormwater drainage systems can result in a significant reduction in pollutant loads. However, the reduction in non-point sources such as lawn fertilizers and pet/wildlife/waterfowl waste management require innovation actions for control. Developmental pressure is another major concern. With little undeveloped land in the watershed, local boards and commissions continue to see applications and requests to redevelop residential properties with larger homes or subdivisions, with increased density.

The 1998 Action Plan and 2004 Supplement have led to a number of successfully implemented projects and continued support and collaboration from watershed stakeholders. A long term water quality monitoring program has been established for the Norwalk River led by Harbor Watch/River Watch (HW/RW). In-stream and outfall monitoring has taken place at selected locations for more than 10 years and has led to the detection and correction of a number of problems, including illicit discharges to stormwater sewers and failing septic systems. A summary of implementation activities has been included in Appendix A.

1.1.2 The 2011 update to the Norwalk River Watershed Action Plan

The 2008 State of Connecticut Integrated Water Quality Report (CTDEP, 2008) designated several segments of the main stem of Norwalk River and various tributaries as impaired (further discussed in Section 3 on Watershed Characterization). Segments were considered impaired if they were unable to support designated uses. Portions of the watershed were identified as impaired for aquatic life support, recreational uses and fish consumption.

A WBP was identified as a suitable companion to the 1998 Action Plan. The development of a WBP would serve to reassess the 2004 supplement and enhance the recommended actions through the inclusion of measurable goals, milestones, evaluation criteria and identification of potential funding strategies in order to accelerate the implementation of pollution control programs. To garner continued support of watershed planning and conservation efforts the DEEP provided funding the development of a WBP containing the "Nine Elements of Watershed Planning" recommended by the EPA, through a U.S. EPA Clean Water Act Section 604(b) Water Quality Management Planning Grant. The adoption and approval of the WBP by the DEEP will help focus implementation efforts to reduce water quality impairments and aid in securing necessary funding to implement recommendations of the plan. The 2011 update to the Norwalk River Watershed Action plan will serve as a tool to reduce the impacts of the non-point source contamination and guide conservation efforts throughout the watershed.

1.2 Plan Development Process and Public Involvement

The overall goal of this WBP is to identify recommendations that can be implemented on a short to long-term basis, which will maintain and enhance water quality in the Norwalk River and its tributaries and help to eliminate water quality impairments. Key considerations for the WBP include the maintenance of water quality in upper portions of the river and restoration of waterways downstream to be able to satisfy the appropriate regulatory requirements (Clean Water Act and/ or Safe Drinking Water Act). This plan will enable implementation projects identified in the plan for consideration in the State's Section 319 process.

The DEEP and EPA provide guidance (CTDEP, 2010; EPA, 2008a) for development of WBPs following the "Nine Elements of Watershed Planning." The nine elements set forth for by the EPA include (EPA, 2008a):

- **Impairment:** An identification of the causes and sources of pollution, that will need to be controlled to achieve the load reductions estimated to fix the impairment, and to achieve any other watershed goals identified in the WBP;
- **Load Reduction:** An estimate of the load reductions expected for the management measures described. Spreadsheets and land cover mapping are typically employed in these models to estimate load reductions;
- **Management Measures:** A description of the non-point source (NPS) management measures that will need to be implemented to achieve the estimated load reductions;
- **Technical and Financial Assistance:** An estimate of the amounts of technical and financial assistance needed, and/or the sources and authorities that will be relied on, to implement this plan;
- **Public Information and Education:** An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented;
- **Schedule:** An expedited schedule for implementing NPS management measures identified;
- **Milestones:** A description of interim, measurable milestones for determining whether NPS management measures or other controls are being implemented;
- **Performance:** Criteria to determine whether loading reductions are being achieved over time, and if progress is being made towards attaining water quality standards and, if not, the criteria to determine if this plan, or a related TMDL, needs to be revised; and
- **Monitoring:** A monitoring component to evaluate the effectiveness of the implementation efforts over time.

Source: *CTDEP (2010), Accessed January 2011*.

The 1998 Action Plan and 2004 Supplement have served as the foundation for the development of this WBP. The 2011 update to the Action Plan has focused on incorporating the Nine Elements of Watershed Planning (EPA, 2008a). The WBP was developed through a collaborative process that included all identified stakeholders referred to as the Watershed Stakeholders, including but not limited to the following:

State: DEEP, NYSDEC
Federal Agencies: USGS, USDA-NRCS, EPA-LISO
Westchester County Department of Planning
Municipalities: Lewisboro, NY; New Canaan, Norwalk, Wilton, Weston, Redding and Ridgefield, CT
Non-governmental organizations: Norwalk River Watershed Initiative, Norwalk River Watershed Association, Harbor Watch/River Watch, Trout Unlimited, Norwalk Maritime Aquarium, Regional Planning Agencies (SWRPA and HVCEO), Sierra Club of Fairfield County, South Norwalk Electric and Water (SNEW), Southwest Conservation District, Connecticut Fund for the Environment/Save the Sound, Dibner Fund, Fairfield Community Foundation
Watershed residents

The planning process was led by a volunteer steering committee consisting of representatives from the DEEP, City of Norwalk, Town of New Canaan, Town of Wilton, the Norwalk River Watershed Initiative coordinator, the Norwalk River Watershed Association, a local resident and SWRPA. Two stakeholder meetings were held during the planning process to solicit input from the community. The first stakeholders meeting on June 24, 2010 reviewed the existing watershed conditions, impairments to the Norwalk River and tributaries, and the goals established by the existing plans. The first stakeholders meeting helped shape water quality objectives and recommendations.

The second stakeholders meeting held on September 29, 2010 focused on the results of the pollution load model, the status of the existing TMDL, and potential recommendations to reduce the NPS contamination that would be incorporated into the WBP. Recommended actions to address the water quality goals and objectives (Goals D and E) were developed by HDR|HydroQual and circulated to watershed stakeholders for comments, and input regarding implementation. Watershed stakeholders also developed a list of recommendations based on a survey of the action items from the 2004 supplement. As draft sections of the WBP were developed they were circulated to the steering committee for review and comment. Additional input was also received from watershed municipalities during various stages of the planning process. The final WBP reflects these discussions and the comments received.

1.3 WBP Organization

This WBP has been prepared to provide a blueprint for the watershed stakeholders to implement controls and track progress on a watershed basis. The WBP reviews the strategies for addressing water quality needs in the Norwalk River and its tributaries' along with an implementation plan. Both structural and non-structural practices are recommended on a watershed-wide basis and at smaller scales (targeted sub-watersheds and site specific). The watershed-wide perspective highlights the relationship between existing land uses and water quality, so that the controls envisioned at this broader level will bring consistency among various watershed municipalities in achieving an overall pollutant load reduction.

Site-scale recommendations focus attention on addressing impairments at selected sites or smaller geographical regions where the controls undertaken will make meaningful reductions in pollutant loads to improve water quality in the Norwalk River watershed and its tributaries. These sites are direct contributors of indicator bacteria and nutrients and will require specific investigation and implementation strategies to achieve the desired water quality goals. Additional targeted recommendations are provided, to address concerns around specific sub-watersheds or river reaches, such as transportation corridor and atmospheric deposition. Additional monitoring or investigations are suggested to improve the understanding or characterization of these sources in order to support the development of specific management measures.

The plan summarizes financial and technical considerations for best management practices (BMPs) and low impact development practices (LIDs) for indicator bacteria and nutrient controls. Based on performances and costs compiled from literature, the stakeholders can pursue specific projects and explore the necessary funding mechanisms from federal, state and municipal sources. Additional information supporting the development of the WBP has been included as appendices at the end of this document.

Source: Gretchen Yengst - Loving Focus Photograph

2. WATERSHED MANAGEMENT GOALS AND OBJECTIVES

> *We envision a restored Norwalk River Watershed system: one that is healthy, dynamic and will remain so for generations to come: one that offers clean water and functioning wetlands; one in which a diversity of freshwater and diadromous fish as well as other wildlife and plants are once again sustained: one in which the river system is an attractive community resource that enhances quality of life, education, tourism recreation: and above all, one in which growth respects this vision and all people participate in the stewardship of the watershed.*

The vision statement for the watershed was developed by the NRWIC for the 1998 Action Plan and served as the backbone for developing management goal and objectives during the 2011 update and creation of this WBP. This section presents overall management goals for the Norwalk River watershed and its tributaries and specific objectives to achieve these goals. These goals and objectives have been developed based on a review of the 1998 Action Plan, 2004 Supplement, comments received during two watershed stakeholders meeting held in 2010, and through consultation with watershed stakeholders throughout the planning process.

2.1 Management Goals

Goal A: Plan Development and Implementation
To develop an affordable and effective WBP that can be implemented collaboratively by watershed stakeholders.

Goal B: Habitat Restoration
To preserve and enhance habitat features to protect and increase diversity of floral and faunal species. The WBP must seek to improve wildlife habitat, to foster fisheries, enhance species diversity and to restore diadromous fish passage.

Goal C: Land Use/Flood Protection/Open Space
To promote balanced growth which preserves property values and protects and enhances the watershed's natural resources for future generations. This will be done by:
(1) providing that new development is within the carrying capacity of the environment,
(2) promoting economic development without adversely impacting the watershed, and
(3) creating performance standards by which all the development and renovations can be evaluated.

Goal D: Water Quality
To restore and protect surface and ground water to meet State water quality standards throughout the watershed such that the Norwalk River supports its designated and existing uses (e.g., fishing, swimming, and drinking water).

Goal E: Non-point Source Runoff Management
To reduce the cumulative impacts of development and NPS pollution on the Norwalk River and its tributaries through sustainable land use practices.

Goal F: Stewardship and Education
To educate citizens about the boundaries and functions of the Norwalk River Watershed; the specific needs for protection of and improvement to the river system, the benefits of a healthy watershed to individuals and communities, and the opportunity for the public to speak out on issues and to participate in the stewardship of the watershed.

2.2 Management Objectives

Objectives have been identified for each of the management goals to help facilitate implementation efforts. It must be emphasized that the objectives and recommendations were developed to help achieve specific goals; implementation may also serve to address other watershed management goals or objectives. The WBP focuses on improving water quality through the reduction of non point source pollution, addressed in watershed management goals D and E, with addition recommendations developed by watershed stakeholders to support the preservation and enhancement of natural resources. Generalized and specific recommendations to achieve the plan objectives, including implementation strategies' ranking, schedule, milestones, performance evaluation criteria, costs, and funding sources are presented in Section 5 on Watershed Recommendations and Section 6 on Management Measures.

Source: Gretchen Yengst - Loving Focus Photograph

Goal A: Plan Implementation

Objective A-1: Continue to work with all watershed stakeholders to undertake an implementation planning process and tracking progress over time

Objective A-2: Conduct additional field assessments to improve understanding of the watershed pollution sources and update the characterization and implementation aspects accordingly

Goal B: Habitat Restoration

Objective B-1: Control or diminish the prevalence of invasive species

Objective B-2: Minimize loss of habitat values coincident with land use practices

Objective B-3: Restore diadromous and resident fish passage

Objective B-4: Preserve and restore in-stream habitat

Objective B-5: Maintain, enhance and increase riparian buffer areas

Goal C: Land Use/Flood Protection/Open Space

Objective C-1: Identify appropriate areas for public access to the rivers and streams and increase public access where appropriate

Objective C-2: Promote inclusive land use planning for natural resource conservation

Objective C-3: Recognize the importance of maintaining and increasing open space to ensure proper functioning of the watershed.

Objective C-4: Reduce the frequency and severity of flooding

Goal D: Water Quality

Objective D-1: Eliminate illicit discharges from storm sewers

Objective D-2: Improve solid waste and liquid waste management throughout the watershed

Objective D-3: Reduce the impact of road sand and salt on water quality and stream habitat

Objective D-4: Maintain adequate baseflows in the Norwalk River and its major tributaries

Objective D-5: Eliminate or reduce the anthropogenic impacts to in-stream water quality

Objective D-6: Reduce nitrogen loads from groundwater

Objective D-7: Reduce nitrogen loads from atmospheric deposition

Objective D-8: Continue water quality monitoring and data collection and assessment

Goal E: Non-point Source Runoff Management

Objective E-1: Reduce the cumulative impacts of development and expand efforts to promote and implement LID practices

Objective E-2: Ensure municipal regulations support the implementation of LID practices

Objective E-3: Advocate for a state and local permitting framework that best protects water resources from the impacts of non-point source runoff

Objective E-4: Adopt land use practices that reduce the impacts of non-point source runoff

Objective E-5: Manage bacterial contamination from waterfowl and domestic/hobby animals

Goal F: Stewardship and Education

Objective F-1: Develop a mechanism to monitor The Action Plan, implement such a mechanism, and foster watershed stewardship

Objective F-2: Provide information and education about the Norwalk River Watershed

Objective F-3: Expand coordination and communication with watershed municipalities.

Keeping the water quality and non-point source runoff management goals in perspective (goals D and E), the work performed as part of the plan update included the following specific tasks: (a) completion of watershed characterization; (b) definition of watershed recommendations to improve water quality and protect aquatic resources; (c) identification of potential areas for implementation of best management practices and low impact development practices and also the strategies for reducing nutrient and bacteria loads to the Norwalk River and its tributary watersheds; and (d) development of an implementation program consistent with the management goals, which includes an implementation schedule, milestones, performance criteria, cost information, and estimated load reductions aimed at delisting impaired waterbodies.

Specific actions are not meant to be viewed as an assignment to any one party, but rather a community-wide effort transcending municipal boundaries and traditional jurisdictions. Measuring the success for each of the actions is important to communicate progress in terms of WBP implementation, to enable stakeholders to learn from the accomplishments and failures, and to provide a framework for tracking improvement in water quality. Recommended actions identified to help achieve the above goals and the proposed strategies for implementation are discussed in Sections 5 and 6.

3. WATERSHED CHARACTERIZATION

Information presented in this section is primarily derived from the 1998 Action Plan and 2004 Supplement (NRWIC 1998; 2004) with information updated as necessary to reflect current conditions in the watershed. Additional information on the history of the watershed can be found in 1998 Action Plan.

3.1 Watershed Description

The Norwalk River Watershed encompasses portions of seven municipalities in the States of Connecticut and New York. Six of them are located in Fairfield County (CT), namely: New Canaan, Norwalk, Redding, Ridgefield, Weston and Wilton. Lewisboro is located in Westchester County, NY. The main stem of the Norwalk River and two major tributaries, Comstock Brook and Silvermine River, constitute the primary waterways in the watershed. Watershed covers a drainage area of approximately 40,000 acres or 64.1 square miles and has a population of approximately 103,000 people (2010 census) (Table 3-1).

Table 3-1. Land Area and Percent of Municipalities

Municipalities	Town Area (in square miles)	Town Area within the Norwalk Watershed (in square miles)	% of Town within the Watershed	% of Watershed Area
New Canaan	23.3	5.9	25.3	9.1
Norwalk	27.7	12.7	45.8	19.7
Redding	32.2	3.4	10.6	5.3
Ridgefield	34.8	13.7	39.4	21.02
Weston	20.8	0.4	1.9	0.6
Wilton	26.8	24.1	90.0	37.4
Lewisboro, NY	29.3	4.3	14.6	6.7
Total	194.9	64.5	-	100.0

For this plan, the watershed boundary covers the headwaters in the Great Swamp in Ridgefield to the fresh water boundary, at Wall Street in Norwalk, approximately three miles upstream of the Norwalk Harbor. The approximate stream lengths of main stem of the Norwalk is 20 miles; main stem of the Silvermine River is eight miles, with its tributaries adding 21 miles; and the main stem of Comstock Brook is three miles, with its tributaries adding 16 miles.

The average yearly air temperature is 51 degrees Fahrenheit, with an average precipitation of 47 inches. The climate in the watershed is marked by four well-defined seasons, modified slightly by its proximity to the LIS. Breezes from the ocean tend to moderate the climate somewhat, producing cooler summers and warmer winters than are found further inland. Average temperatures in Fairfield County (CT) range from above 70° F in the warmest months to an average below 26° F during coldest months of the year, with average annual temperatures of approximately 51°F (National Climatic Data Center, 2010). Between 1990 and 2010 annual average precipitation in the areas was 49 inches; primarily in the form of rain from April through October, and in the form of rain, freezing rain, ice, sleet or snow between November and March (NOAA, 2011).

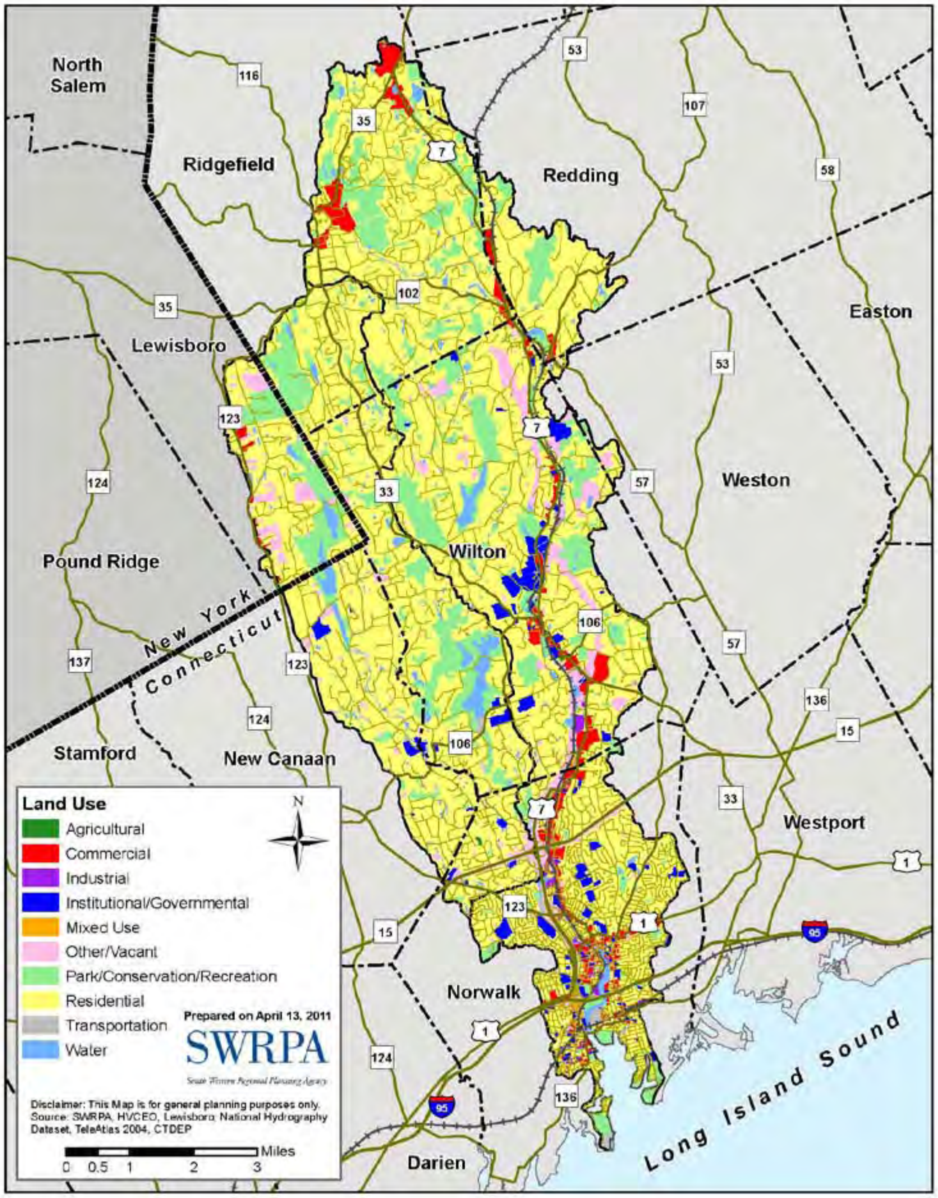


Figure 3-1. Land Use Map of the Norwalk River Watershed

Like much of New England, early development centered around navigable rivers and the coastline, with the town green and churches serving as the social and cultural centers of the community. Rivers served as both ports and commercial hubs, aiding the movement of goods and serving as a source for powering manufacturing facilities. With rivers, railroads, and later highways serving as major the economic drivers, development patterns in the watershed are primarily centered on and around this infrastructure (Figure 3-1). Transportation corridors bisecting the watershed include The Merritt Parkway (CT 15), U.S. 7, U.S. 1, I-95 and Metro North Rail Road. Approximately 67% of the watershed has been developed with commercial and light industry uses, and residential neighborhoods. Approximately 10% of the watershed is used as a transportation network and to support institutional and governmental facilities. The remaining 23% is made up of woodland, open lands, water, and wetlands. Table 3-2 summarizes the land use distribution used to support the watershed characterization.

Table 3-2. Norwalk River Watershed Land Use Type

Land Use type	Area (square miles)	Percent
Agricultural	< 1	< 1
Commercial	2.0	3
Industrial	< 1	< 1
Institutional/Governmental	1.6	2
Mixed Use	< 1	< 1
Other	3.1	5
Open Space/Recreation	10.1	16
Residential	40.3	63
Transportation	4.8	7
Water	1.5	2
Total	64.1	100

Source: SWRPA, Regional Land Use and Zoning Maps (2011), HVCOE Regional Zoning (2009), Westchester County Parcel Based Land use (2009)

Major issues in the watershed include frequent flooding, erosion and sedimentation, and water quality impairment from point and NPS pollution. Frequency and severity of storms and flooding have increased in the watershed over the past two decades. Changing weather patterns and an increase in impervious surfaces have contributed to frequent flooding in the watershed.

3.2 Demographic Profile

Proximity to the employment and cultural opportunities in Connecticut, New York City and Westchester mixed with the charm of Southern New England make the municipalities in the watershed highly desirable places to live. Table 3-3 shows the population density of towns in the Norwalk River Watershed. Norwalk is the most densely populated with a population density of 2,378 people per square mile. In comparison, Redding has the fewest people per square mile, with a population density of only 286 people per square mile (Figure 3-2). The difference in density clearly illustrates the variability of land use within the watershed, with a direct correlation between increased density and increased impervious coverage.

Table 3-3. Population Density for Municipalities of the Norwalk River Watershed

Town	Total Land Area (sq mile)	2010 Population	Population Density (persons/sq mile)	1998 Population	Population Density (persons/sq mile)	Change in Population	Change in Density (persons/sq mile)
New Canaan	23	19,738	858	17,840	776	1,898	83
Norwalk	36	85,603	2,378	78,331	2,176	7,272	202
Redding	32	9,158	286	7,920	248	1,238	39
Ridgefield	35	24,638	704	20,944	598	3,694	106
Weston	21	10,179	485	8,637	411	1,542	73
Wilton	27	18,062	669	15,993	592	2,069	77
Lewisboro	29	12,411	428	11,313	390	1,098	38

Source: U.S. Census Bureau (2010); NRWIC (1998)

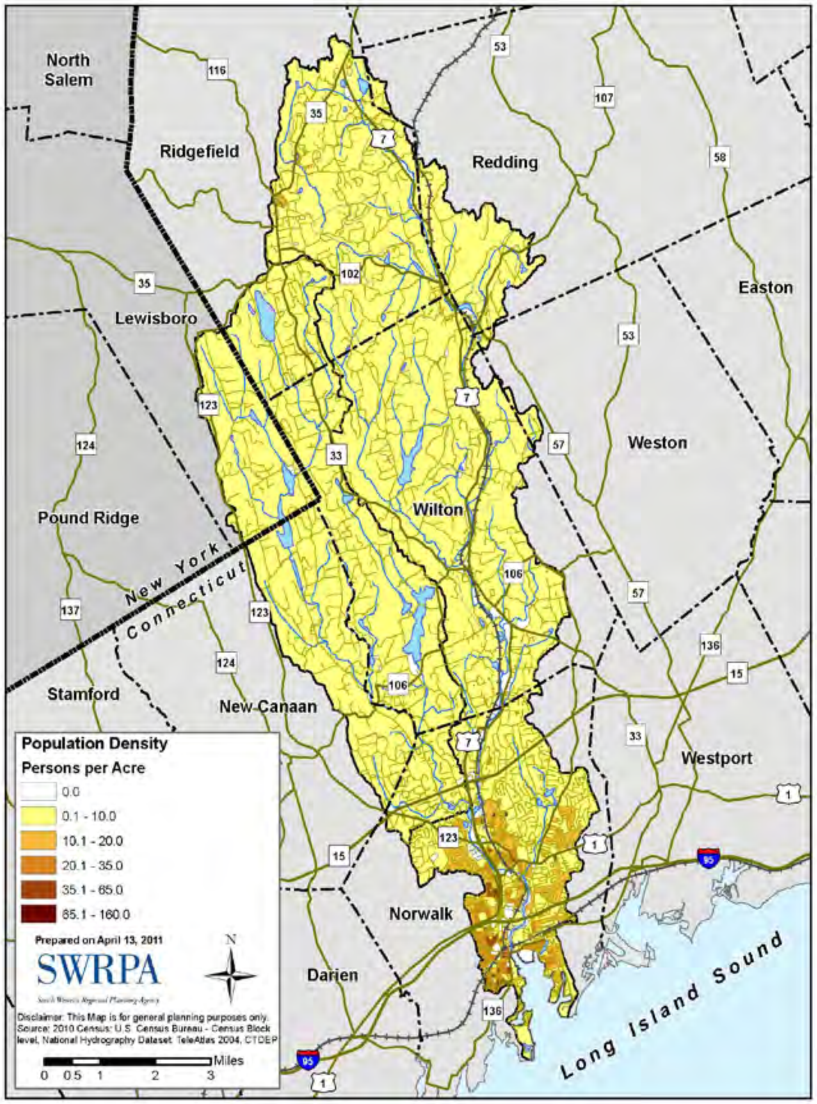


Figure 3-2. Population Density

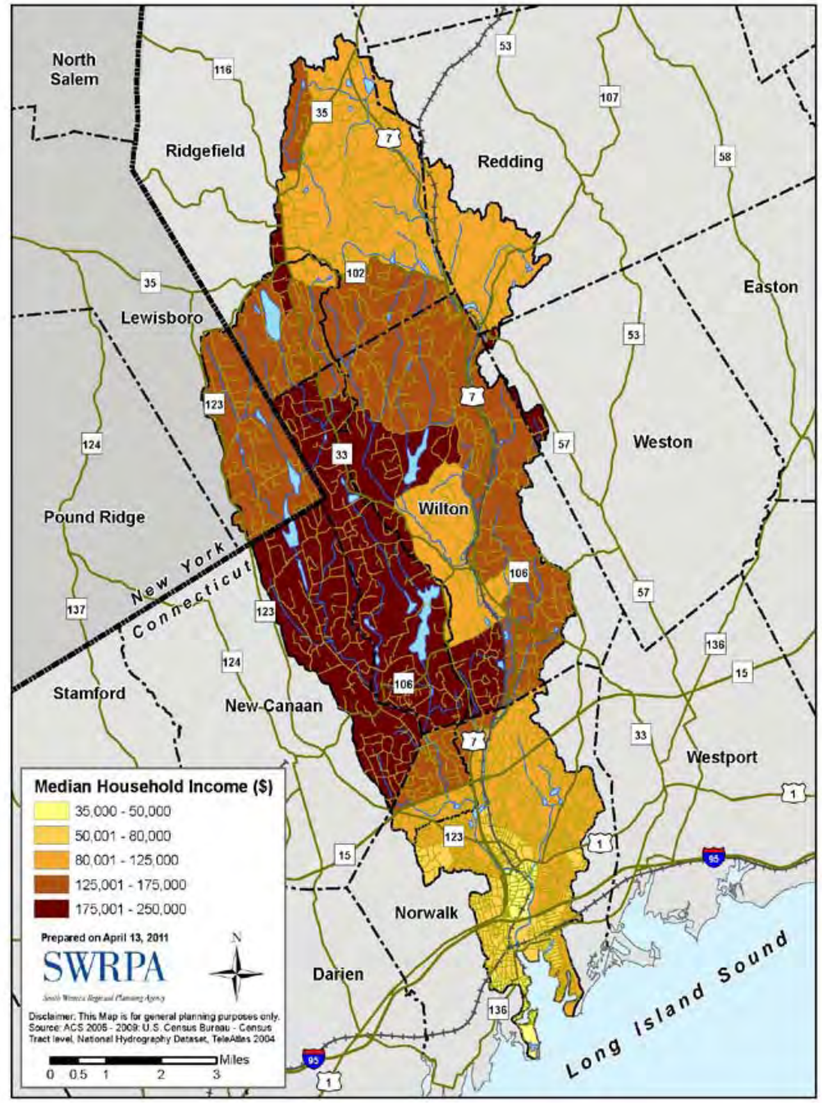


Figure 3-3. Median House Hold Income

Median family incomes for the six Connecticut communities range from $75,000 in Norwalk to $206,000 in Weston (Figure 3-3, Table 3-4). This is higher than the state median family income of $67,721 (U.S. Census Bureau, 2009). Higher levels of income have been correlated with a greater ability to manipulate the land through such activities as residential and commercial development, clearing of second growth forests, in-stream alterations, and lawn development with its associated lawn care services.

Table 3-4. Median Household Income of Municipalities in the Norwalk River Watershed

	New Canaan	Norwalk	Redding	Ridgefield	Weston	Wilton	Lewisboro
Median Household Income	$163,457	$75,695	$122,596	$128,500	$206,469	$153,179	$154,730

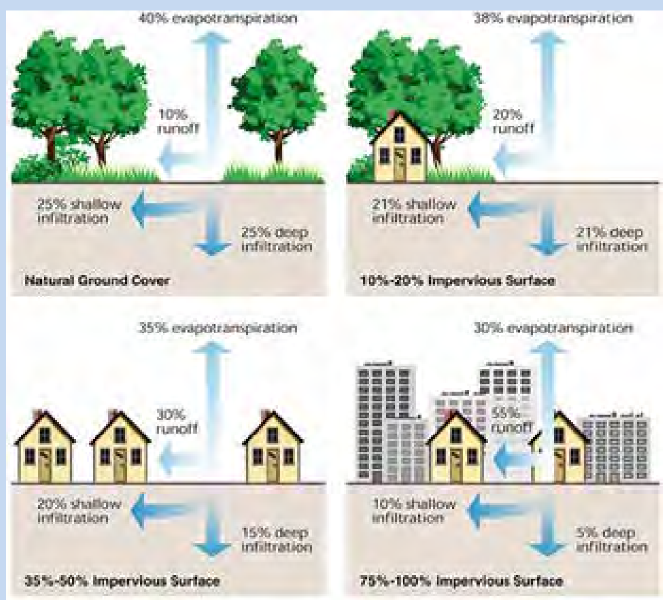
Source: 2005-2009 American Community Survey 5-year Estimates, U.S. Census Bureau

Population growth is expected to continue throughout the watershed, although at a slower pace than in the previous decade. Potential growth is limited because much of the watershed is either built out, or undeveloped parcels are designated as open space. The scarcity of developable land combined with the tremendously high real estate values has pushed developers to look toward land with steep slopes, wetlands and other unfavorable conditions that make them more vulnerable to natural hazards. As population increases, so does the level of impervious surfaces, such as roofs and roadways (Figure 3-4). As the amount of impervious coverage climbs, the level of pollutants in surface water increases, surface water temperatures rise, and erosion caused by storm flows increases. The need for cohesive watershed based planning involving watershed municipalities' is essential to ensure an overall water quality improvement in the Norwalk River watershed.

Impervious cover prevents rain water from absorbing into the ground and results in increased surface runoff. This disruption of the natural water cycle leads to a number of changes, including:

- Increased volume and velocity of runoff
- Increased frequency and severity of flooding
- Peak (storm) flows many times greater than in natural basins
- Loss of natural runoff storage capacity in vegetation, wetlands, and soil
- Reduced groundwater recharge
- Decreased base flow (the ground water contribution to stream flow). This can result in streams becoming intermittent or dry, and also affects water temperature.

As little as 10 percent impervious cover in a watershed can result impact a stream.



Source: Federal Interagency Stream Restoration Working Group

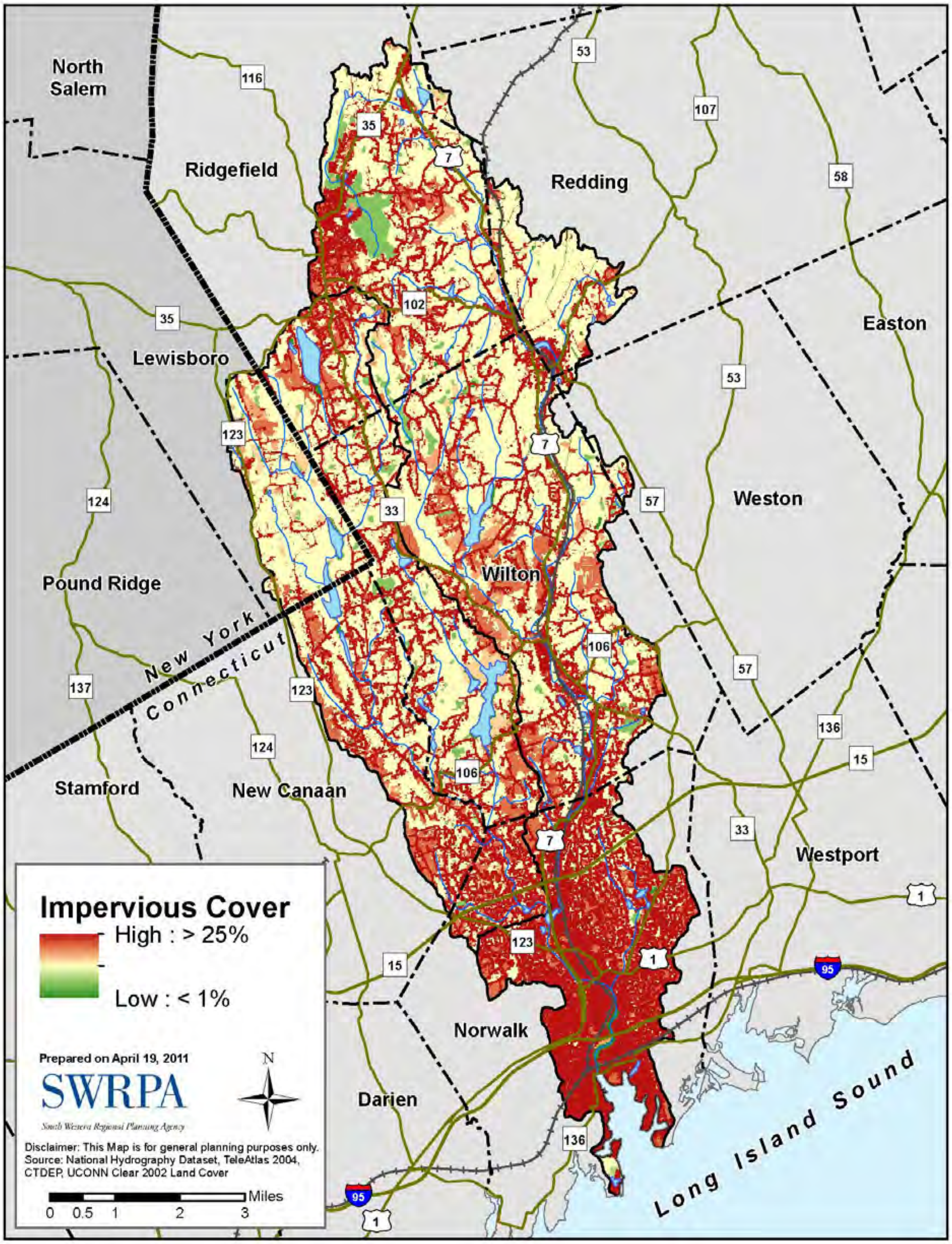


Figure 3-4. Watershed Impervious Cover

3.3 Geological Perspective

Prior to the present-day political boundaries being established, the watershed was defined solely by the geologic processes which molded it. Millions of years ago, this area was a vast open sea called Iapetus (Cappel, 1992). Sediments accumulating from the bordering highlands gradually changed into hardened sedimentary rocks, which were later transformed by heat and pressure from the intense movements of the earth's crust that occurred some 350-575 million years ago. Different degrees of folding, warping, uplift, and crystallization yielded metamorphic rock, creating the rock formations which are visible in road cuts and outcroppings in the region. Movement of glaciers southward 12,000 years ago modified the landscape, forming hills and valleys, and brought pieces of bedrock from as far away as Canada. Soils were altered, leaving glacial till as the predominant soil composition: surficially, the glacial scour created shallow soil cover over bedrock and ground water, and left the landscape strewn with boulders (Figure 3-5). Retreating ice also left behind its terminal moraine, forming Long Island and subsequently, Long Island Sound. Today's river valley shows the scars of its formation, with the river flowing through the resulting valley before discharging to the Sound.

3.4 Inland Wetland

Inland wetlands and watercourses are important for many reasons. They are essential in providing an adequate supply of surface and ground water; they promote hydrological stability and control flooding and erosion; they purify ground and surface waters; and they enable animals and plant life to exist. The role of wetlands in sediment and pollutant renovation, especially in attenuating the effects of nutrients, is an important function that protects water quality in all surface waterbodies, including the Long Island Sound. Many inland wetlands and watercourses have been destroyed or are in danger of destruction because of unregulated use. The deposition, filling or removal of material, the diversion or obstruction of water flow, and the erection of structures and other uses have despoiled, polluted, and eliminated wetlands and watercourses throughout the watershed. Such unregulated activity has had, and will continue to have, a significant, adverse impact on the environment and ecology of this watershed.

Two types of inland wetlands predominant within the Norwalk River Watershed: one is the alluvial and floodplain wetlands which are located primarily along the Norwalk River and its tributaries; and the other is the poorly drained and very poorly drained soils which are located adjacent to alluvial soils and throughout the watershed. Approximately 15% of the watershed contains wetlands. Wetlands are more common in the northern portion of the watershed with fewer wetlands in the southern portion, reflecting a more intensive use of the land over time in the southern portion (Figure 3-6).

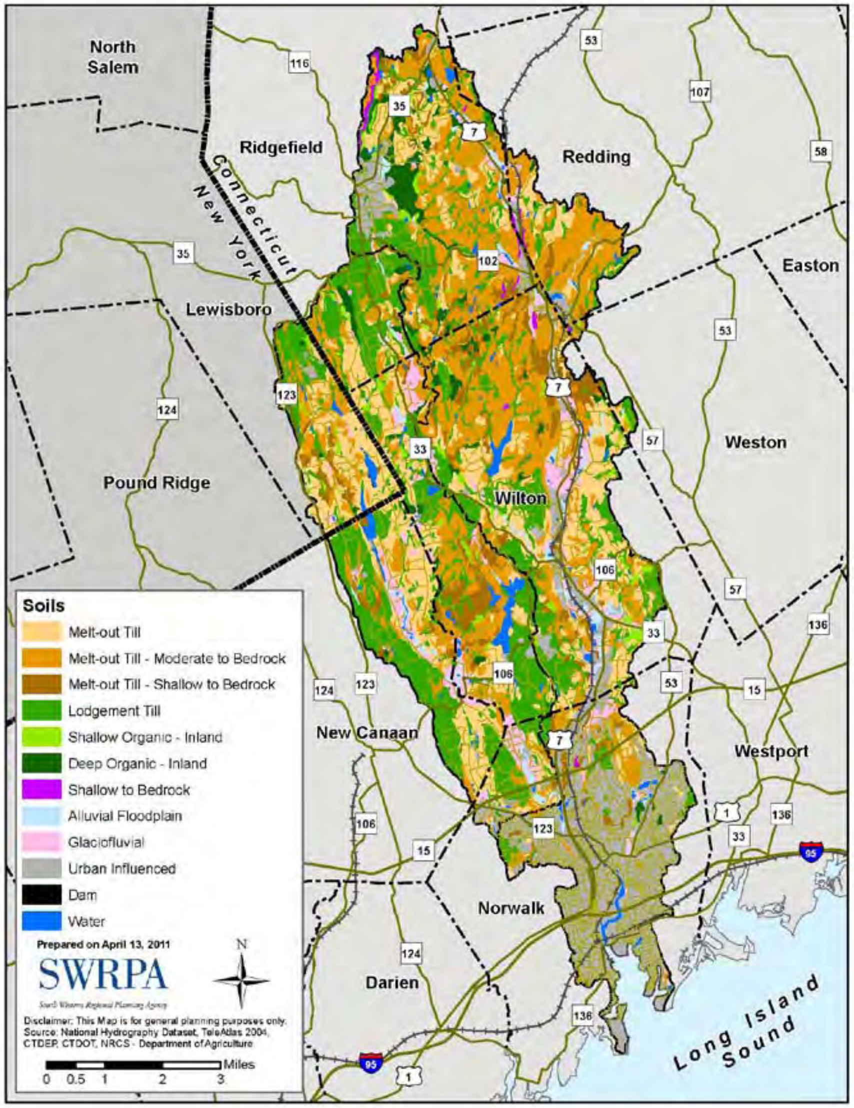


Figure 3-5. Watershed Soils

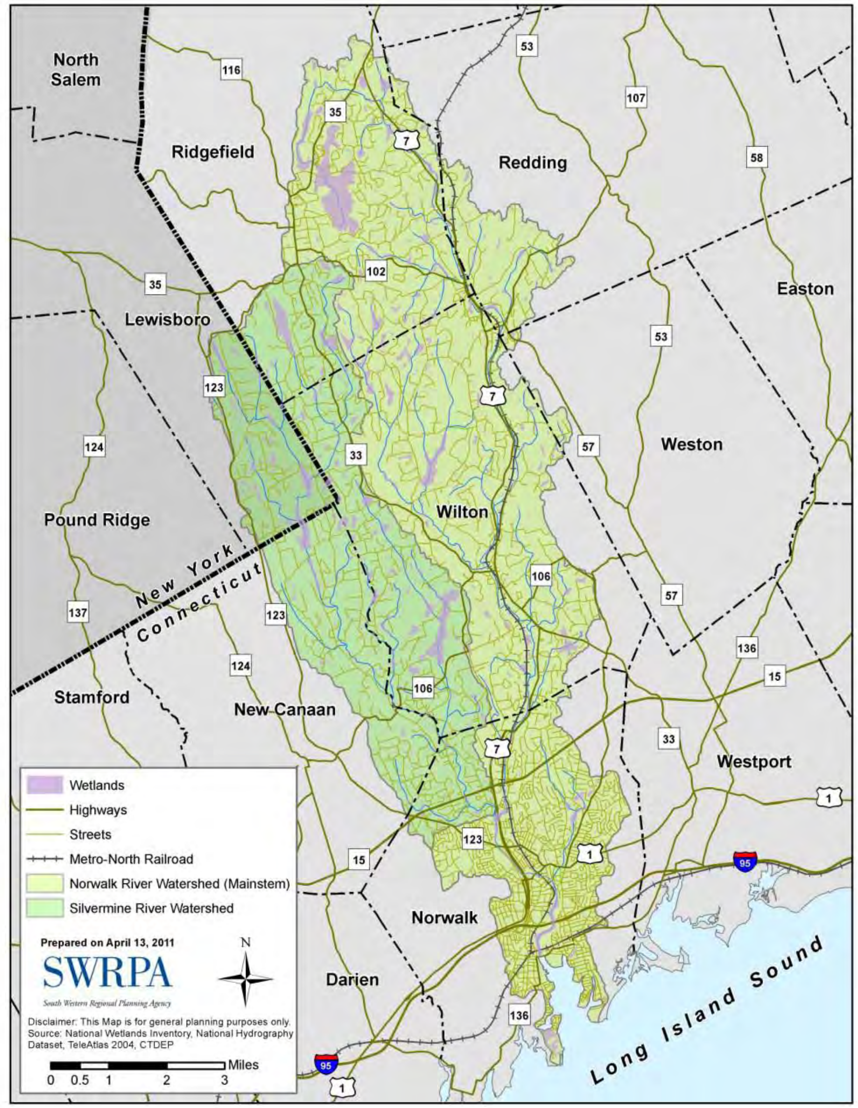


Figure 3-6. Inland Wetlands

3.5 Water Quality Considerations

Both surface and groundwater sources are used to provide water supply to the residents. Recreation is primarily limited to recreational boating at the mouth of the river and the inner harbor and fishing in the entire Norwalk River and its tributaries. The water quantity and quality aspects pertinent to the impairment of the Norwalk River or its tributaries were considered in the development of this WBP.

The watershed exhibits generally good water quality, as reviewed later in this section on ambient water quality data analysis. However, there remain portions of the watershed which are stressed. The watershed faces continuous threats and impacts to water quality from potential nonpoint sources of pollution, such as Stormwater runoff, failing septic systems, and atmospheric deposition of pollutants. The watershed is characterized by mixed land use, with urban and more commercialized and industrialized sectors in the southern portion of the watershed and a high degree of residential settlement elsewhere. Habitat conditions in the watershed vary from extremely good to severely disturbed. Impaired sites are general found along developed lands adjacent to watercourses, excessive algae growth occurs behind impoundments and dams during the summer months, water flow is restricted in certain stream segments, and streambank manipulation is common in both commercial and residential settings. These conditions, plus many others, affect the viability of fish species and populations.

About 66% of the households obtain water from three local public water supply systems: Norwalk First District Water Company, Norwalk Second District Water Company, and Bridgeport Hydraulic Company. Public surface supplies are in the form of reservoirs in Wilton (Second District) and Lewisboro (First District). Public subsurface supplies are large municipal wellfields (such as the Kellogg-Deering wellfield in Norwalk) and several smaller community systems located within the watershed. The remaining 34% of households get water from private wells.

3.5.1 Impoundments

According to the Dam Safety Inventory data collected by the DEEP, 110 registered dams are present in the watershed. Fifty-one dams have been constructed on the Norwalk River and its tributaries in the Wilton area. This inventory identified 10 dams in New Canaan, 23 in Ridgefield, 10in Redding, 16 in Norwalk, and 3 in Lewisboro, New York (Figure 3-7). However, only about seven of these dams are on the mainstem of the Norwalk River. According to the inventory, there are eight dams on the Silvermine River's mainstem. These dams on the Norwalk and Silvermine rivers are considered "run of river," which means that the inflow into the impoundment is equal to the outflow; and provide very little in terms of flood control.

Source: Alexis Cherichetti - Flock Process Dam

The 1997 Stream Walk Assessment identified 13 dams on the Norwalk River and 26 on the Silvermine. This difference may be attributable to the fact that the DEEP inventory does not record small, non-permitted dams (less than six feet in height) which are irregularly constructed out of boards and rocks.

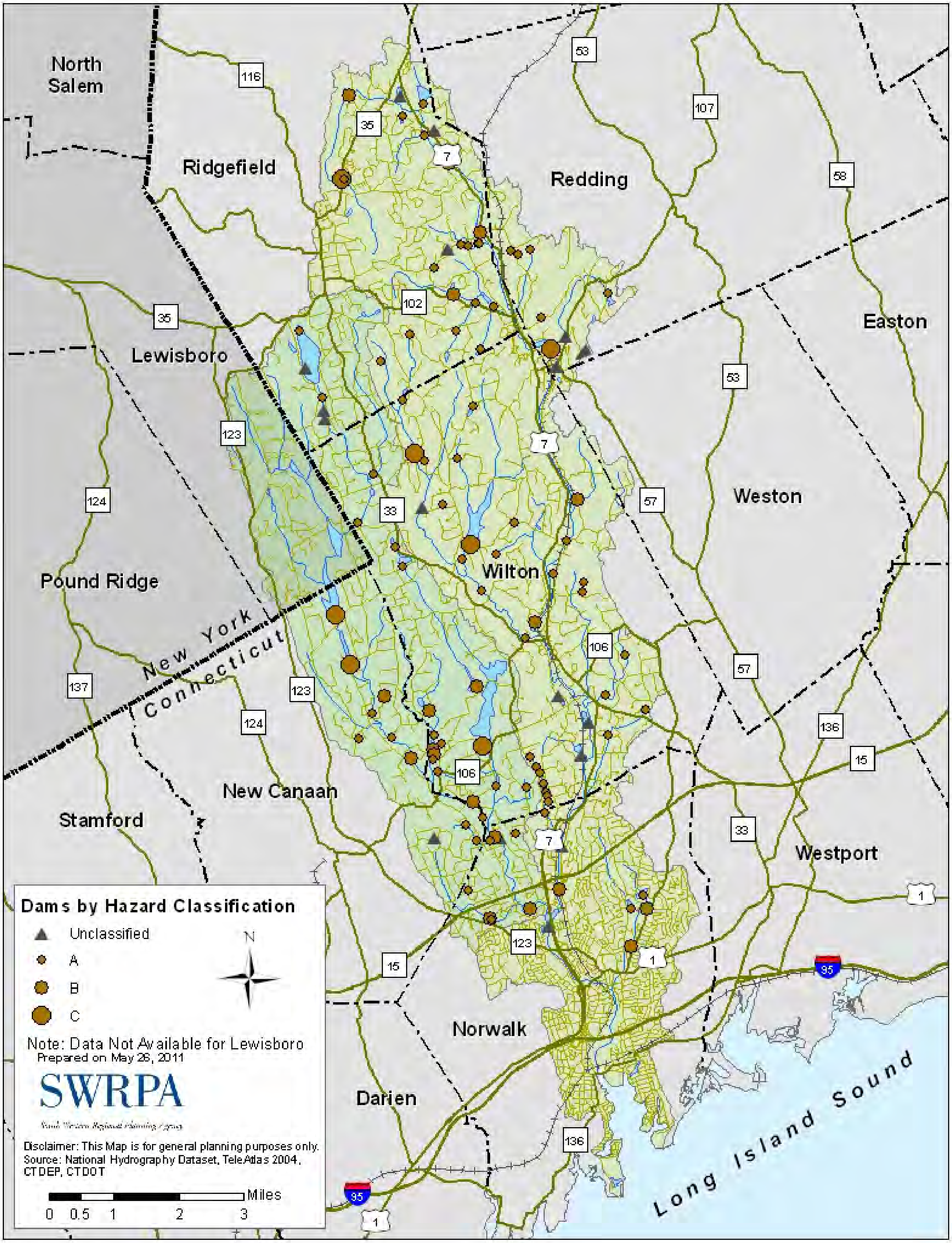


Figure 3-7. Dams in the Norwalk River Watershed

Two flood control dams are present in the watershed: one at the "Great Swamp" in Ridgefield and the other, Spectacle Brook, in Wilton. Both dams affect peak flows of the Norwalk River during flooding conditions. Each contains a wildlife pool regulated by flash boards which allows minimal storage of water for release during dry summer months.

There are eight water supply dams in the Norwalk River Watershed. These dams can provide some flood control protection during periods of heavy rainfall in the summer when they are partially empty. When full, these dams provide about 325 acre-feet of impounded water in this watershed. This type of flood control is not generally accepted because of the uncertainties of summer storms and drawdown of reservoirs.

The rest of the dams in the watershed are privately owned by homeowners and businesses. Many of these dams were constructed as impoundments for recreational or aesthetic purposes.

The presence of these dams in the watershed causes many problems. The Flock Process and Merwin Meadows Dams impeded diadromous fish migration and all seven of the dams on the Norwalk River's main stem impede local fish migration. In addition, the numerous dams located throughout the watershed also increase detention time and reduce the attenuation of nutrients. This, in turn, promotes the growth of plants and algae, resulting in eutrophication.

3.5.2 Municipal Wastewater Treatment Facilities

Fifty-six percent of the households in the Norwalk River Watershed dispose of their wastes in public sewage disposal systems. The remaining households dispose of their sewage through on-site septic systems. There are four municipal wastewater treatment plants providing wastewater treatment service in the Norwalk River Watershed: one in Norwalk (18 million gallons per day (gpd)), one in Georgetown (permitted for 245,000 gpd, currently discharging 60,000 gpd), and two in Ridgefield (1,000,000 gpd). There is also one small private sewage treatment plant in the watershed, the School Sisters of Notre Dame in Wilton, which is permitted to discharge 20,000 gallons per day to the waterway. Wastewater from the areas sewered in Wilton is piped to the Norwalk plant.

All wastewater treatment facilities are permitted through the National Pollution Discharge Elimination System (NPDES). Each of the wastewater treatment facilities are designed and/or operated to provide an advanced level of treatment.
Indicator bacteria concentrations in the Norwalk River are generally in excess of the state water quality standards in several river reaches, limiting recreational uses of the waterways. The Norwalk Harbor and the Norwalk Islands have historically been one of the most productive areas for shellfish along the Connecticut coastline. The Norwalk Harbor area has been historically "closed," classified as "Prohibited" and "Restricted-Relay," to the direct harvesting of shellfish for consumption, due to elevated indicator bacteria levels. In this WBP, the coastal waters supporting shellfish harvesting were not analyzed and discussed, although the management measures undertaken for the control of indicator bacteria in the freshwater portions will also help to benefit the coastal water quality.

3.6 Connecticut Water Quality Standards

The water quality standards (WQS) direct overall policies and actions at a local level to improve and manage the State water resources, as required by Section 303 of the federal Clean Water Act (CWA) and Section 22a-426 of the Connecticut General Statutes. Connecticut's WQS address:

- Restoration of the quality of the State's surface and groundwater resources to support a healthy aquatic environment, enable recreation uses, be suitable for industrial purposes, and provide high quality drinking water for the citizens of the State
- Protection of existing high quality surface and ground waters from degradation
- Segregation of drinking water supplies from waters used for waste assimilation
- Adoption of standards that promote State economy, while protecting the environment.

Table 3-5 summarizes the appropriate classifications assigned by the DEEP for various waterway segments in the Norwalk River watershed. The classifications are designated as either Class AA, A, B, C or D for surface waters, which are defined as below:

AA – drinking water supply, fish and wildlife habitat, recreational (may be restricted), agricultural and industrial supply;
A – potential drinking water supply, fish and wildlife habitat, recreational uses, agricultural supply and navigation
B – recreational, fish and wildlife habitat, agricultural and industrial supply, and navigation

Note that a C or D indicates that the waters are not likely to attain designated uses or meet WQS and that classifications are expressed as a water quality goal, for example as B or A.

The federal CWA requires each state to develop a prioritized list of waterbodies where existing controls on point and non-point sources of pollutants are inadequate to meet WQS and support designated uses. The CWA also mandates that States develop and adopt Total Maximum Daily Loads (TMDLs) for those waters affected by pollutants. The TMDL establishes the maximum amount of a pollutant that may be introduced into waterbody that still allows for the attainment and maintenance of WQS, after the application of technology-based or other required pollution controls.

Table 3-5. Existing Stream Reach Classifications

Waterway	Classification
Norwalk River from headwaters in Ridgefield to the Wall Street Bridge in Norwalk	B
Norwalk River below the Wall Street Bridge into the inner harbor area	SB
Lower portion of Silvermine River where it meets Belden Hill Brook to above Deering Pond in Norwalk	A
Comstock Brook	AA and A
Belden Hill Brook, Mayapple Brook and Bryant Brook in Wilton	A

Source: Compiled based on Table 3 of CTDEP (2005) on Applicable Indicator Bacteria Criteria for the Subject Waterbodies

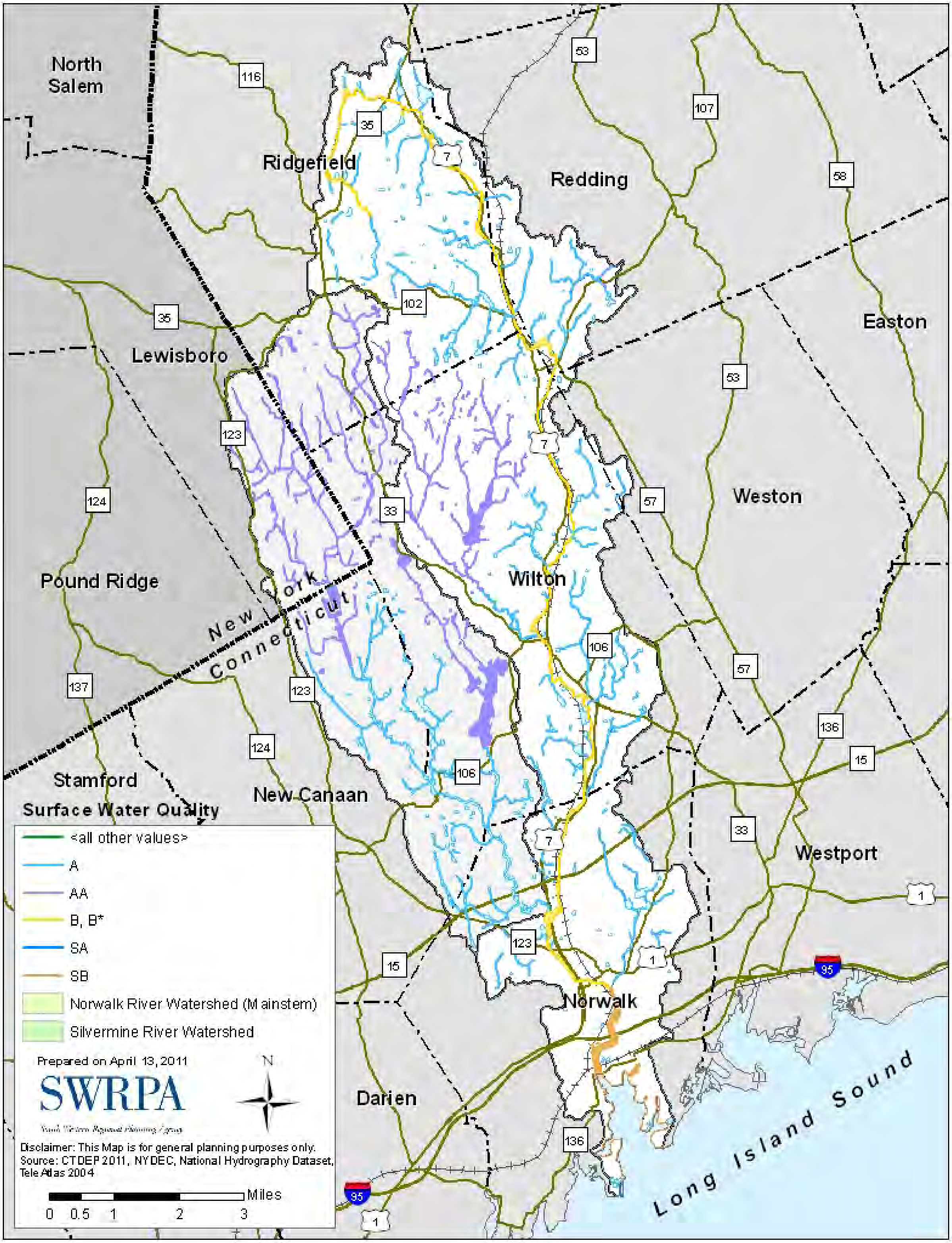


Figure 3-8. Norwalk River Water Quality Classifications

The *2008 State of Connecticut Integrated Water Quality Report* reviews the latest list of impaired waterbodies (often known as the 303(d) list), indicating surface waters in the State do not meet, or are not expected to meet (even with required pollution controls), state WQS and may require TMDLs. Table 3-6 identifies waterbodies found within the Norwalk River Watershed that are included in the 303(d) List (CTDEP, 2008). The table also provides information on the supporting designated uses.

The designations used in Table 3-6 are as follows: Y indicates that the designated use is fully supported; N reflects that the designated use is not supported and U indicates that DEEP has not assessed due to sparse or no data available for assessment. For the designated uses, AQ corresponds to the aquatic life, REC is for recreational uses, and FISH corresponds to the fish consumption.

Table 3-6. Summary of Water Quality Conditions in the Norwalk River and Tributaries

ID305B	Name	Location	River Miles	Designate Use Met AQ	REC	FISH
CT7300-00_01	Norwalk River-01	From Wall Street (Commerce Street) crossing (head of estuary/saltwater limit), Norwalk, US to confluence with Bryant Brook (DS of Wolfpit Road crossing), Wilton. (Segment includes Winnipauk Mill Pond and Deering Pond)	5.63	N	N	Y
CT7300-00_02	Norwalk River-02	From confluence with Bryant Brook (DS of Wolfpit Road crossing), US to Old Mill Road crossing (between Danbury Road (Route 7) and Railroad tracks southeast of Georgetown), Wilton.	5.61	Y	N	Y
CT7300-00_03a	Norwalk River-03a	From Old Mill Road crossing (between Danbury Road (Route 7) and Railroad track, southeast of Georgetown), Wilton, US to confluence with Georgetown WPCF outfall, Redding.	0.84	N	N	U
CT7300-00_03b	Norwalk River-03b	From confluence with Georgetown WPCF outfall, US to just US of Railroad crossing*, Redding.	0.20	U	N	U
CT7300-00_03c	Norwalk River-03c	From US of Railroad crossing*, US to Factory Pond outlet dam outlet, Redding. (Factory Pond is a separate waterbody, between segment-03c and -04).	0.11	U	U	U
CT7300-00_04	Norwalk River-04	From INLET to Factory Pond (just DS of Danbury Road (Route 7) crossing), Wilton, US to confluence with Cooper Pond Brook (DS of Branchville Road, east of intersection with Route 7), Ridgefield.	0.70	U	N	Y
CT7300-00_05	Norwalk River-05	From confluence with Cooper Pond Brook (DS of Branchville Road, east of intersection with Route 7), Ridgefield, US to headwaters at Little Pond outlet dam (US of confluence with Ridgefield Brook from west, on west side parallel to Route 7), Ridgefield.	4.85	U	N	Y
CT7300-02_01	Ridgefield Brook-01	From confluence with Norwalk River (DS of headwaters at Little Pond outlet dam, west side of Route 7), US to Taylors Pond outlet dam (US of Limestone Road crossing), Ridgefield.	1.05	U	N	Y
CT7300-02_02	Ridgefield Brook-02	From INLET to Taylor Pond (on southwest portion of pond, east of Barrow Mountain), US (south) to headwaters at outlet of Lounsebury Pond in southwest portion of Great Swamp, Ridgefield. (Segment includes outfall of Ridgefield POTW, upper Great Swamp area)	3.22	N	N	Y

* Location changed to reflect current conditions, the 'underground (pipe) section' and base of factory pond dam have been daylighted

CT7300-07_01	Cooper Pond Brook-01	From mouth at confluence with Norwalk River (DS of Ethan Allen Highway (Route 7) crossing), US to Candees Pond outlet dam, Ridgefield.	0.41	U	U	Y
CT7300-07_02	Cooper Pond Brook-02	From INLET to Candees Pond, US to headwaters at unnamed pond (on south side of Florida Hill Road, at intersection with Ivy Hill Road), Ridgefield. (Segment includes Grimes Pond and Johns Pond)	1.89	U	U	Y
CT7301-00_01	Comstock Brook (Wilton)-01	From mouth at confluence with Norwalk River (segment-02, just DS of Lovers Lane crossing), US to confluence with Barretts Brook (outlet for Popes Pond, parallel to Route 33, at intersection with Signal Hill Road), Wilton.	2.02	Y	U	Y
CT7301-00_02	Comstock Brook-02 (Wilton)	From confluence with Barretts Brook (outlet for Popes Pond, parallel to Route 33, at intersection with Signal Hill Road), US to HW (just west and parallel with Grey Rocks Road), Wilton.	2.29	U	U	Y
CT7302-00_01	Silvermine River-01	From Mouth at confluence with Norwalk River (northwest INLET to Deering Pond portion of river), US to Merritt Parkway (Route 15) crossing), Norwalk. (Segment includes Davis Pond)	0.98	U	N	Y
CT7302-00_02	Silvermine River-02	From Merritt Parkway (Route 15) crossing), Norwalk, US to Grupes Reservoir outlet dam (US of Valley Road crossing), New Canaan.	5.49	Y	N	Y

Source: Compiled from CTDEP (2008) State of Connecticut Integrated Water Quality Report, August 2008.

High levels of nutrients (both phosphorus and nitrogen) can cause water quality concerns in the tributaries and mainstem of the river and eventual delivery of nutrients into LIS. Several impoundments in the Norwalk River watershed such as Great Swamp have been identified to have excessive algal growth (NRCS, 1997; 1999). Localized nutrient inputs such as lawn fertilizers, failed septic systems and illicit discharges contribute to these water quality concerns.

Most of DEEP's assessment is based on monitoring of the water quality conditions and in-stream surveys to determine if a certain species is present or not in a waterbody. The WQS for nutrients are essentially narrative at this time in the upper drainage areas and numeric targets will need to be determined through water quality modeling of the entire system and setting appropriate targets for each segment of the mainstem and the tributaries. In the downstream end, the hypoxic conditions in the western end of LIS require a 10% reduction in TN loads from various non-point sources of pollution. This WBP suggests strategies that can help in achieving the 10% TN load reduction in the near future and also recommends that detailed water quality characterization studies be undertaken to set numeric TN and TP reduction targets for individual impoundments with eutrophication concerns.

In Connecticut's freshwaters *Escherichia Coli* (*E. coli*) is considered as indicator bacteria, which originates from the intestinal tracts of humans and other warm blooded animals. The water quality standards for *E. coli* in the fresh water portion of Norwalk River and its tributaries include: (a) not-to-exceed 235 colonies/100milliliter (mL) for bathing areas, 410/100mL for non-designated swimming areas or 576/100mL (all other water contact recreation) for single samples; and (b) not-to-exceed geometric mean of 126 colonies/100 mL for any group of samples. Since only the freshwater portions of the Norwalk River and its tributaries are covered in this WBP, the *E. coli* targets used by DEEP (CTDEP 2005) to develop load allocations for the non-point sources within the Norwalk River and its tributaries are applied without any further modifications

3.7 *Analysis of Ambient Water Quality Monitoring Data*

Available ambient water quality monitoring data indicate generally good water quality in the Norwalk River, with respect to its ability to support aquatic life. However, there are continuous threats and impacts to water quality from the following:

- Non-point sources, such as runoff from commercial and industrial areas that contains high concentrations of sediments, hydrocarbons, and metals, and direct precipitation (i.e., atmospheric deposition of nitrogen).
- High levels of indicator bacteria which can be attributed to wildlife and domestic animal sources, improperly functioning septic systems and occasional sewer overflows.
- Stormwater discharges (Stormwater runoff and permitted discharges) throughout the watershed.

In developing the TMDL for the Norwalk River DEEP reviewed the extensive ambient water quality monitoring data for *E. coli* and fecal coliform (CTDEP, 2005). Specific surveys were conducted by the Department of Agriculture/Bureau of Aquaculture in the early 1990s along the Norwalk River from the harbor northward. In addition, Harbor Watch/River Watch (HW/RW) has conducted water quality monitoring for physical/chemical parameters at more than 20 sites from Georgetown to Norwalk Harbor since 1999. These monitoring programs have identified and documented pollution sources including illegal wastewater discharges, failing septic systems, raw sewage discharges, pavement runoff and raw sewage discharges from marinas, as well as changes in wildlife species composition.

Monitoring data from HW/RW collected over the past 10 years in various reaches of the Norwalk River watershed were provided to support this study. Locations of monitoring stations are shown in Figures 3-9 and 3-10, for the upper and lower reaches of the Norwalk River watershed, respectively. The summaries of water quality data for three key parameters chosen for this analysis, namely, dissolved oxygen (DO), Fecal coliform (FC) and *E. coli* are provided in Tables 3-7 through 3-9.

Dissolved oxygen is a critical water quality parameter for characterizing the health of an aquatic system. It is a measurement of oxygen dissolved in water which is available to fish and other aquatic life. The DO content of water results from the photosynthetic and respiratory activities of the flora and fauna in the system, and the mixing of atmospheric oxygen with waters through wind and stream current action. Levels above 5 milligrams per liter (mg/L) are generally considered to be healthy for most forms of aquatic life and a level below 3 mg/l is stressful to most vertebrates and other forms of aquatic life. The overall DO levels are very good and can support most forms of aquatic life. However, in the upper reaches of Norwalk River some hotspots exist, near NR20 and NR21 (located in the upper reaches of Norwalk River in Ridgefield, as shown in Figure 3-9), where the DO levels below 5 mg/L have been observed. Table 3-7 shows the range of DO values and also lists the number of observations with less than 5 or 3 mg/L as threshold values.

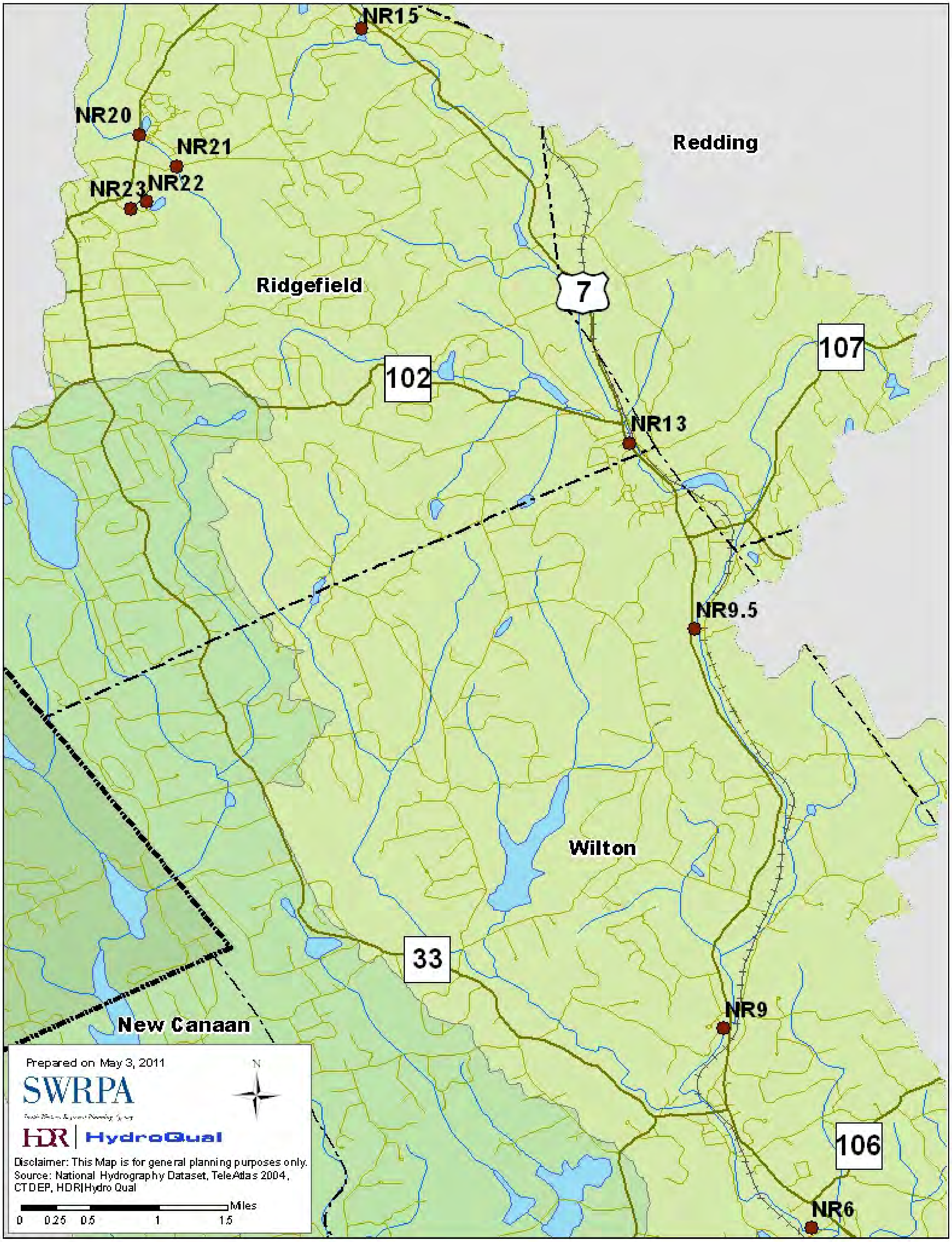


Figure 3-9. Monitoring Locations in the Upper Reaches of Norwalk River Watershed

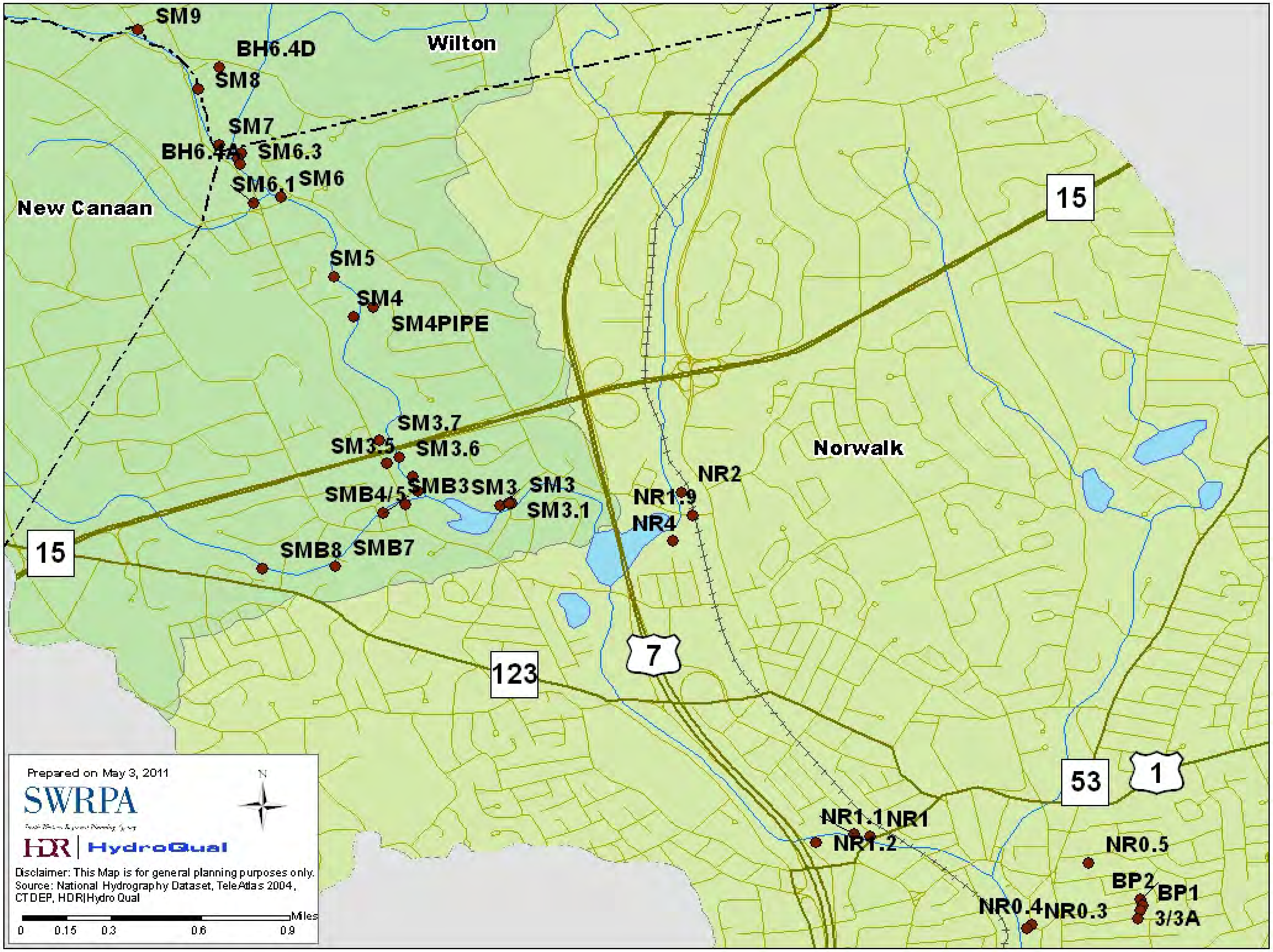


Figure 3-10. Monitoring Locations in the Lower Reaches of Norwalk River Watershed

Table 3-7. Summary of Water Quality Data: Dissolved Oxygen

Station ID	Total Number of Observations	Minimum DO Observed [mg/L]	Maximum DO Observed [mg/L]	Average DO [mg/L]	Number of Observations with DO < 5 mg/L	Number of Observations with DO < 3 mg/L
GS1	-	-	-	-	-	-
GS2	-	-	-	-	-	-
GS3	-	-	-	-	-	-
NR1	245	7.1	15.7	10.0	-	-
NR10	33	4.7	10.7	8.5	1	-
NR11	33	7.7	11.2	9.1	-	-
NR13	243	6.0	16.5	9.7	-	-
NR15	244	6.5	18.1	9.4	-	-
NR2	33	8.8	13.3	10.2	-	-
NR20	244	2.6	17.7	8.4	27	1
NR20.1	-	-	-	-	-	-
NR21	245	1.9	14.5	6.6	64	10
NR22	232	4.0	16.2	8.7	1	-
NR23	234	5.4	15.2	9.8	-	-
NR2SD	7	8.0	9.9	8.9	-	-
NR4	247	7.2	16.5	10.6	-	-
NR4.1	2	8.5	9.1	8.8	-	-
NR4.2	2	8.4	8.5	8.5	-	-
NR4pipe	8	7.5	8.9	8.2	-	-
NR6	245	6.0	17.1	10.0	-	-
NR9	245	6.4	15.8	9.8	-	-
NR9.5	245	6.4	16.1	9.6	-	-
SM3	212	6.6	15.3	9.5	-	-
SM3.1	-	-	-	-	-	-
NR4.3	1	8.4	8.4	8.4	-	-
NR4.4	1	8.3	8.3	8.3	-	-

Source: HW/RW monitoring data through Spring 2010

Although the DEEP has formally adopted *E. coli* as the indicator bacteria, FC data were also available from the HW/RW monitoring program. For the treatment plant effluents, the DEEP standards for FC comprise of a geometric mean of less than 200 CFU/100mL over a 30-day period and a single sample maximum of 400 CFU/100mL.

The DEEP standards for *E. coli* comprise of a geometric mean of 126 colonies/100mL with a single sample maximum value set based on the recreational uses: 256 colonies/100mL for swimming reaches, 410 colonies/100mL for non-swimming reaches and 576 colonies/100mL for other recreational uses.

The HW/RW data were divided into wet and dry categories using the rainfall data available at Danbury and Westchester County Airport. Tables 3-8 and 3-9 show the summaries of indicator bacteria concentrations observed during wet and dry weather periods, respectively, at the various HW/RW monitoring locations. The locations where the geometric means for FC and *E.coli* are in excess of 200 and 126 colonies/100mL are highlighted in these tables.

Table 3-8. Summary of FC/*E. coli* Data Observed During Wet Weather

Station ID	Total Number of Observations	Minimum Fecal Coliform Observed [CFUs/100mL]	Maximum Fecal Coliform Observed [CFUs/100mL]	Geometric Mean of Fecal Coliform Observed [CFUs/100mL]	Station ID	Total Number of Observations	Minimum E. coli Observed [CFUs/100mL]	Maximum E. coli Observed [CFUs/100mL]	Geometric Mean of E. coli Observed [CFUs/100mL]
GS1	1	194	194	194	**GS1**	-	-	-	-
GS2	1	140	140	140	**GS2**	-	-	-	-
GS3	1	70	70	70	**GS3**	-	-	-	-
NR1	82	45	12,300	603	**NR1**	87	42	9,600	491
NR10	13	54	1,920	300	**NR10**	13	27	1,680	185
NR11	13	74	2,760	506	**NR11**	13	60	2,500	384
NR13	86	8	20,400	294	**NR13**	86	8	18,000	245
NR15	85	30	10,200	344	**NR15**	86	18	9,100	295
NR2	13	130	18,300	877	**NR2**	13	120	11,900	671
NR20	88	14	10,600	520	**NR20**	87	12	9,800	415
NR20.1	-	-	-	-	**NR20.1**	-	-	-	-
NR21	87	4	19,000	567	**NR21**	88	2	11,000	473
NR22	84	0	146,000	76	**NR22**	46	0	9,000	25
NR23	85	4	18,000	523	**NR23**	58	2	13,000	491
NR2SD	11	250	15,800	2181	**NR2SD**	-	-	-	-
NR4	86	0	9,300	552	**NR4**	86	0	6,900	448
NR4.1	1	440	440	440	**NR4.1**	1	0	0	-
NR4.2	1	500	500	500	**NR4.2**	-	-	-	-
NR4pipe	6	0	4,200	82	**NR4pipe**	6	0	3,520	71
NR6	85	16	100,000	375	**NR6**	87	16	100,000	321
NR9	84	8	6,200	244	**NR9**	86	8	5,100	209
NR9.5	84	4	9,200	156	**NR9.5**	86	4	7,720	128
SM3	72	22	12,400	461	**SM3**	73	20	11,780	410
SM3.1	6	0	2,300	1392	**SM3.1**	6	0	2,200	1334
NR4.3	-	-	-	-	**NR4.3**	-	-	-	-
NR4.4	-	-	-	-	**NR4.4**	-	-	-	-

Source: HW/RW monitoring data through Spring 2010

Table 3-9. Summary of FC/*E. coli* Data Observed During Dry Weather

Station ID	Total Number of Observations	Minimum Fecal Coliform Observed [CFUs/100mL]	Maximum Fecal Coliform Observed [CFUs/100mL]	Geometric Mean of Fecal Coliform Observed [CFUs/100mL]	Station ID	Total Number of Observations	Minimum E. coli Observed [CFUs/100mL]	Maximum E. coli Observed [CFUs/100mL]	Geometric Mean of E. coli Observed [CFUs/100mL]
GS1	-	-	-	-	**GS1**	-	-	-	-
GS2	-	-	-	-	**GS2**	-	-	-	-
GS3	-	-	-	-	**GS3**	-	-	-	-
NR1	155	12	40,000	340	**NR1**	158	12	31,000	248
NR10	20	8	3,320	107	**NR10**	20	8	2,560	83
NR11	20	24	2,620	274	**NR11**	20	24	2,000	217
NR13	157	4	2,150	137	**NR13**	158	6	1,820	119
NR15	158	6	6,500	166	**NR15**	157	0	3,000	142
NR2	20	76	1,580	378	**NR2**	20	67	1,080	289
NR20	158	8	6,500	198	**NR20**	158	4	5,300	166
NR20.1	1	224	224	224	**NR20.1**	1	188	188	188
NR21	158	4	18,000	267	**NR21**	158	4	16,200	221
NR22	153	0	114,000	52	**NR22**	99	0	71,000	56
NR23	152	2	19,000	184	**NR23**	107	0	17,900	127
NR2SD	19	10	55,000	1254	**NR2SD**	1	340	340	340
NR4	155	12	2,800	274	**NR4**	158	12	2,200	216
NR4.1	1	570	570	570	**NR4.1**	-	-	-	-
NR4.2	1	630	630	630	**NR4.2**	-	-	-	-
NR4pipe	4	8	236	42	**NR4pipe**	4	0	8	6
NR6	154	6	3,000	175	**NR6**	158	4	2,000	145
NR9	157	0	2,380	114	**NR9**	158	0	2,200	94
NR9.5	159	0	4,000	83	**NR9.5**	159	0	3,600	67
SM3	139	16	6,800	182	**SM3**	139	12	6,700	149
SM3.1	8	160	40,000	2448	**SM3.1**	6	160	38,000	1907
NR4.3	1	570	570	570	**NR4.3**	-	-	-	-
NR4.4	1	575	575	575	**NR4.4**	-	-	-	-

Source: HW/RW monitoring data through Spring 2010

There is a general increasing trend in FC concentrations towards the downstream locations, during both wet and dry weather periods. However, there are a number of hotspots including NR21 and NR23 in the upper reaches of Norwalk River in Ridgefield and SM3.1 in the Silvermine River, with high concentrations of bacteria even during dry weather.

As shown in Tables 3-7 and 3-8, the trends in *E. coli* for not meeting the WQS are consistent with the observations made on the FC data. The upper and lower reaches of the Norwalk River and the monitoring stations SM3 and SM3.1 along the Silvermine River appear to have elevated bacteria concentrations. It must be emphasized that these datasets collected over the past 10 years may have 1-2 samples per month in some locations and very limited number of observations in other locations. Due to high variability in bacteria concentrations and suspected illicit discharges from the streamwalk surveys (NRCS, 1997; 1999) and HW/RW monitoring data, targeted additional monitoring is needed to pinpoint specific sources and pursue appropriate control measures.

A graphical visualization of the dry and wet weather monitoring results can be an effective tool to facilitate the hotspot identification and planning process. To support this, the entire Norwalk River ands its tributary watersheds were divided into smaller sub-watersheds. Targeted planning efforts could be undertaken at this sub-watershed scale involving one or more impaired segments. The sub-regional and local basin (sub-watershed) delineations developed by UCONN (http://cteco.uconn.edu/guides/Local_Basin.htm) were adopted as the starting point. Some sub-watersheds along the main stem of Norwalk River were rather large. Therefore, additional sub-watersheds were created in this project based on watershed topography. Figure 3-11 shows the sub-watersheds delineated here to support the overall watershed characterization and estimation of pollutant loads. The association between sub-watersheds and the impaired segments identified by DEEP is shown in Figure 3-12 (CTDEP, 2008).

Figure 3-13 shows the identified hotspots for indicator bacteria during dry weather. The likely sources of bacteria during dry weather include illicit discharges to storm sewers or excessive waterfowl and wildlife contributions in the impoundments that discharge into the waterways. Starting from around NR21, the high levels of indicator bacteria could be seen all the way up to NR9.5 in the Town of Wilton.

From station NR9 in the downstream end of the Town of Wilton through the Norwalk Harbor, including the lower reaches of the Silvermine River, the bacteria levels during dry weather were excessively high. The upper reaches of Silvermine River and Comstock Brook have water supply diversions and do not have sufficient data to assess the adequacy of bacterial water quality to meet the state standards. However, the failing septic systems and illicit discharges into storm sewers could be attributed to high bacterial levels in the lower reaches of Wilton, City of Norwalk, and into the Norwalk Harbor.

Bacterial water quality did not meet the state standards in every reach of the Norwalk River watershed and its tributaries during wet weather periods.

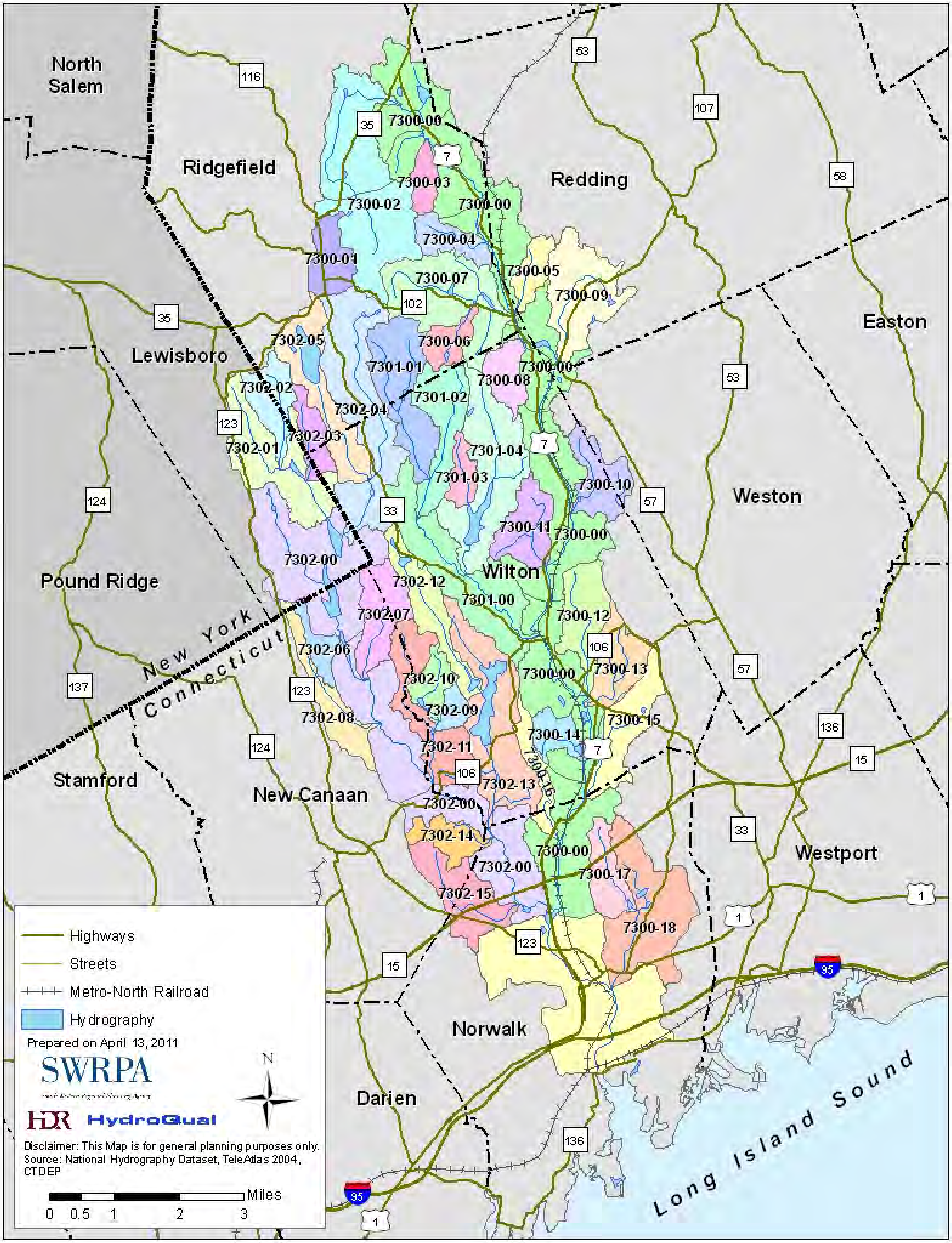


Figure 3-11. Sub-watersheds in the Norwalk River and its Tributaries

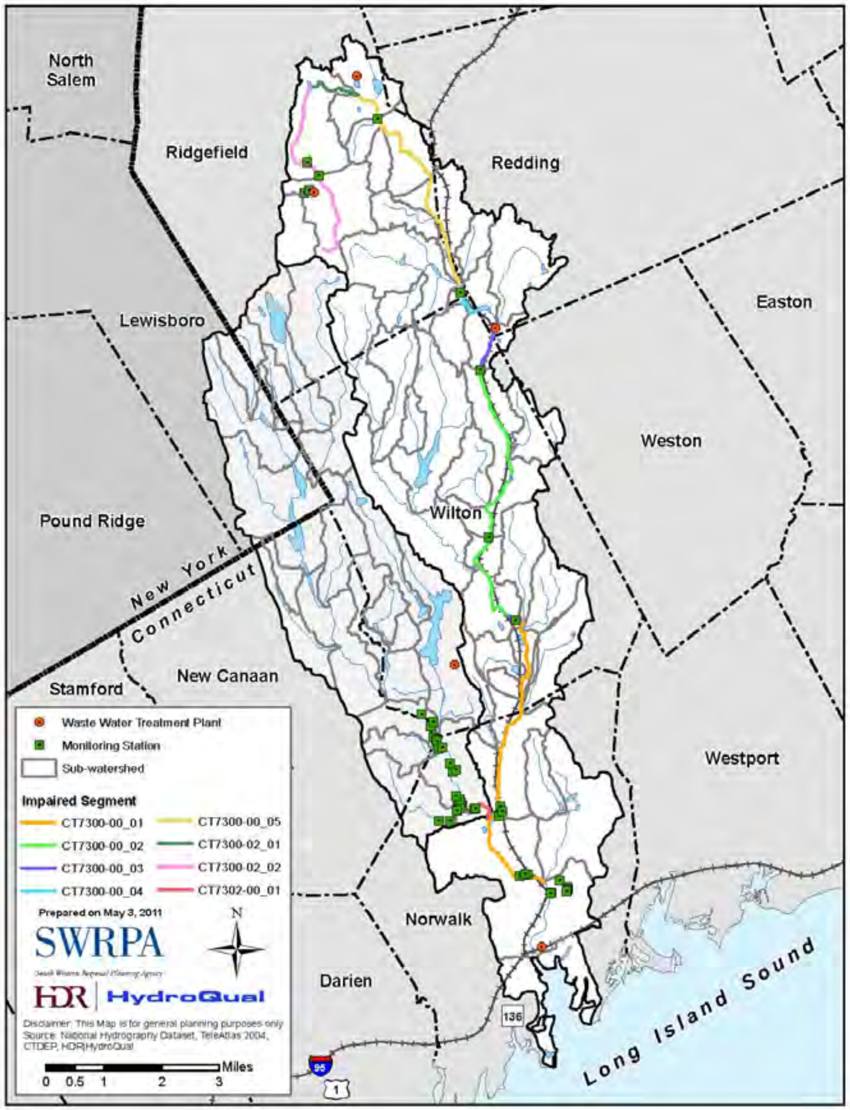


Figure 3-13: Impaired Segments

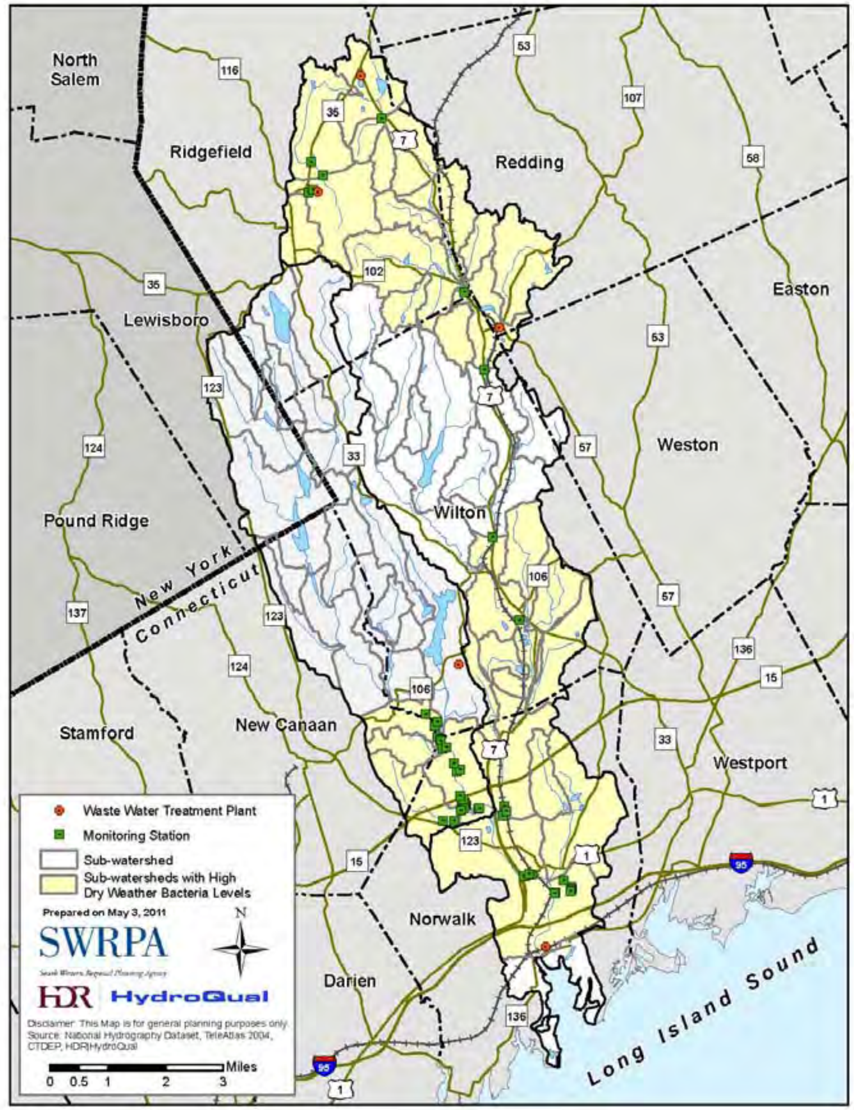


Figure 3-13: Sub-watersheds with High Bacteria Levels during Dry Weather

4. ESTIMATION OF POLLUTANT LOADS

Numerous mathematical models have been developed to characterize nutrient pollution loads for the State of Connecticut watersheds including the Norwalk River basin and its tributaries. These models have ranged from simple Rainfall-Runoff Modeling Program developed by HydroQual as part of LIS TMDL development (NYSDEC and CTDEP, 2000), to a parameter-intensive complex HSPF model developed by AQUA TERRA and HydroQual (2001). Moore et al. (2004) and Penn State (2007) developed modeling frameworks for the entire New England region that included Norwalk River watershed as a very small component. A mid-range model, in ArcView based Generalized Watershed Loading Functions (AVGWLF) framework, was developed by Farley and Rangarajan (2006) for the States of Connecticut and New York to support the tracking of pollutant load reductions from in-basin drainage areas contributing to the Sound. These models have been applied in the past to develop pollutant loads for parameters such as total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS). However, none of these models were applied to characterize pollutant loads for indicator bacteria.

Due to limited budget available in this project to support model development and calibration, the readily available mid-range AVGWLF model developed by Farley and Rangarajan (2006) was chosen to characterize the sediment (TSS is taken as surrogate parameter for sediments), TN and TP loads from the Norwalk River watershed. The goal was to resurrect this model application and update it based on available monitoring data to enable its use for pollutant load assessments. The reductions in nutrient and sediment loads can be estimated by associating expected pollutant reduction effectiveness of individual management measures. A brief description of the selected model with key assumptions and limitations is provided in the following section. Additional details on the model along with the calibration process for nutrients are provided in Appendix C.

A limitation for this approach is that the previous AVGWLF model application did not involve simulation of the indicator bacteria. This model was originally developed to support watershed planning efforts to reduce nutrient loads (Evans et al., 2002; 2003; and 2007) and has been updated very recently in 2009-10 to characterize the loads and reductions for management measures for indicator bacteria. Based on discussions with the developer (personal communications with Dr. Barry Evans, Penn State, July 2010), there were no published journal/conference articles or reports available as of July 2010 on the application of AVGWLF to indicator bacteria load estimation. In addition, the simulations performed by HDR|HydroQual with default indicator bacteria parameters (e.g., Fecal Coliform and *E. coli*) provided in the AVGWLF guidance document yielded unrealistic results (an order or two larger in magnitude in comparison to the monitored data available from HW/RW).

A simple approach has been developed in this project that uses hydrologic inputs from AVGWLF and associates event mean concentrations (EMCs) to calculate the pollutant loads for indicator bacteria. The DEEP had applied a flow-duration pollution load estimation concept (CTDEP, 2005) to quantify loads for various indicator bacteria for the different reaches identified in the 2008 list of impaired waterbodies (CTDEP, 2008). For the purposes of planning and evaluating the effectiveness of various management measures to reduce indicator bacteria loads, the procedure developed by DEEP (CTDEP, 2005) and associated load reductions for the various impaired segments were adopted in this project.

4.1 Key Model Features and Limitations

AVGWLF is a GIS-interface (in ArcView) for the Generalized Watershed Loading Functions (GWLF) model developed at Cornell University (Haith et al., 1992). For pollutant loading, the model is considered to be distributed since it allows multiple land use/cover scenarios, but each area (e.g., sub-watershed or a larger watershed) is assumed to be homogeneous in terms of the area attributes (physical slope, soil type, etc.). Loads from individual source areas (pollutant load generating areas represented by various land use/cover types) are simply aggregated to compute the total watershed loading.

Depending on the locations of the source areas with respect to a watershed outlet, the in-stream transformations can attenuate loading from these areas before reaching the outlet point. GWLF does not explicitly account for spatial routing and the in-stream transformations. This can generally lead to overestimation of loads, which is a conservative approach for the load reduction planning process.

For sub-surface (groundwater) flow and pollutant loads, the model uses a lumped parameter approach involving water balance over the entire watershed or sub-watershed. Another GWLF model limitation is that routing through reservoirs/ponds and diversions between sub-watersheds (e.g., water supply diversion from Comstock Brook) cannot be explicitly represented. Finally, the model has a rigid land use/cover categorical structure and requires consolidation of various land use categories into this specific structure. A major requirement is the specification of low and high density areas in developed areas where different loading rates for various water quality parameters are assigned, in order to compute the overall pollutant load from an urban landscape.

Daily weather data (e.g., precipitation, temperature) are used to generate the surface runoff component of stream flow using Soil Conservation Services (SCS, also known as NRCS) curve numbers. Erosion and sediment yield are computed using monthly erosion calculations based on the Universal Soil Loss Equation (USLE). Surface nutrient losses are determined by applying dissolved nitrogen (N), carbon (C) and phosphorus (P) concentrations to surface runoff for each agricultural source area. Point source discharges can also contribute to dissolved losses and are specified in terms of kilograms per month. Manured areas (including seasonal applications) and septic systems can explicitly be considered. Infiltrated components of nutrients from septic systems are tracked as part of the groundwater pollutant load, and the loads generated as a result of septic system failures are tracked separately.

All urban nutrient inputs are assumed to be solid-phase – the model uses exponential accumulation and washoff function for these loadings. Sub-surface losses are calculated using dissolved N and P concentrations for shallow groundwater contributions to stream nutrient loads, and the sub-surface model considers the entire watershed as single, lumped-parameter contributing area. A schematic of the GWLF model components is shown in Figure 4-1.

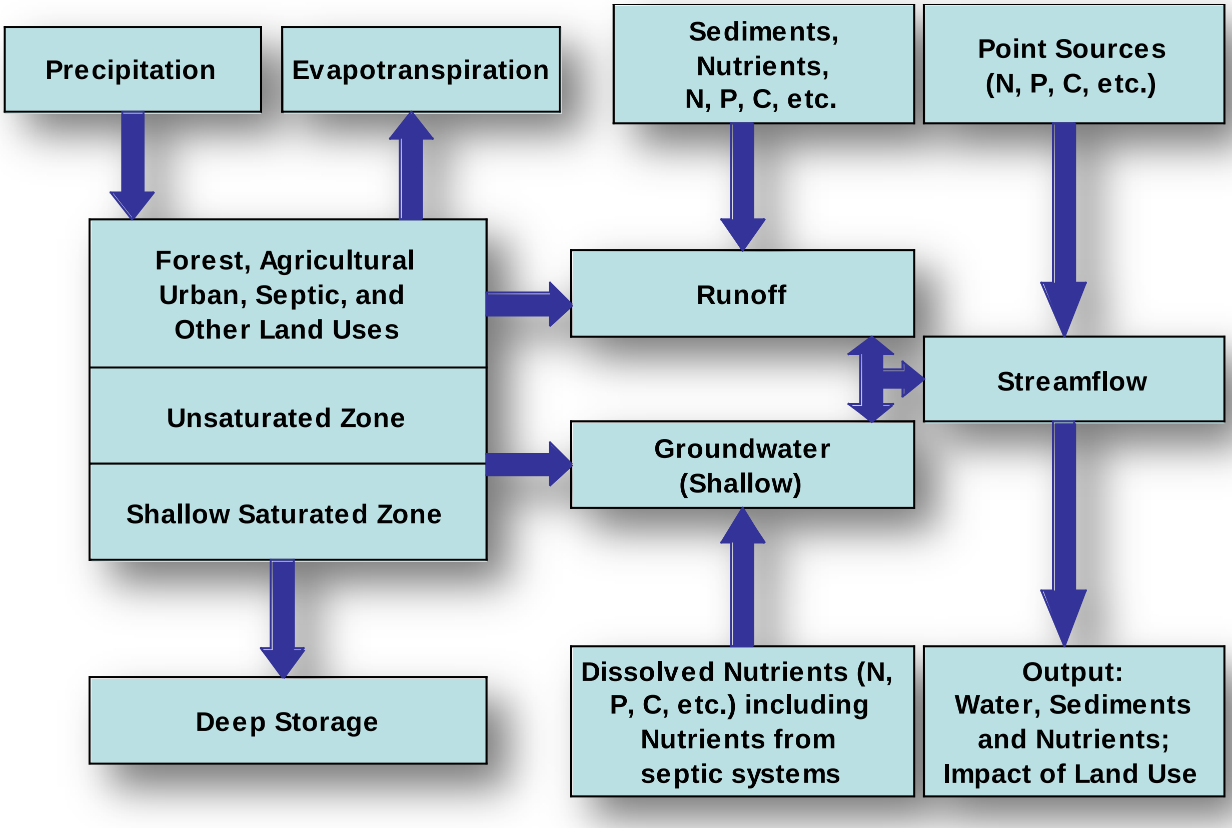


Figure 4-1. GWLF Model Components

4.2 Nutrient and Sediment Load Estimation

Land use/land cover data for the watershed were obtained from the UCONN MAGIC website (http://magic.lib.uconn.edu/) for the Connecticut portion. Data available from the GIS archive of Westchester County (New York) was obtained for the Lewisboro portion of the Norwalk watershed (http://giswww.westchestergov.com/wcgis/Data.htm). As previously indicated, the AVGWLF model explicitly requires high and low density development categories in an urban landscape so that it can associate distinct pollutant load generation factors to these two categories for computing the overall load. The 1995 land cover data distinguishes between these two categories, while the newer 2002 or 2006 land cover datasets have only one urban category.

The 1995 data was therefore used in AVGWLF to generate component pollutant loads from various sources (Figure 4-2). Data from 1995 and 2006 were reviewed to understand whether the urban land cover had changed substantially since 1995. The overall change between the 1995 and 2006 was minimal in the watershed. The developed category (which includes both low and high density residential) increased from approximately 29.5% in 1995 to about 31% in 2006, and less than 2% of forested lands were lost (Figure 4-3). Since this overall increase in developed land was relatively small (<2%), the estimates developed from 1995 were determined to be adequate for characterizing the relative contributions of various pollutant sources on a watershed basis. As discussed in Appendix C, the inter-basin water transfers by the water providing agencies were accounted for in the water balance analysis and flow calibration process. Water transfer data was obtained from the 2nd district to support the assumptions used in this study.

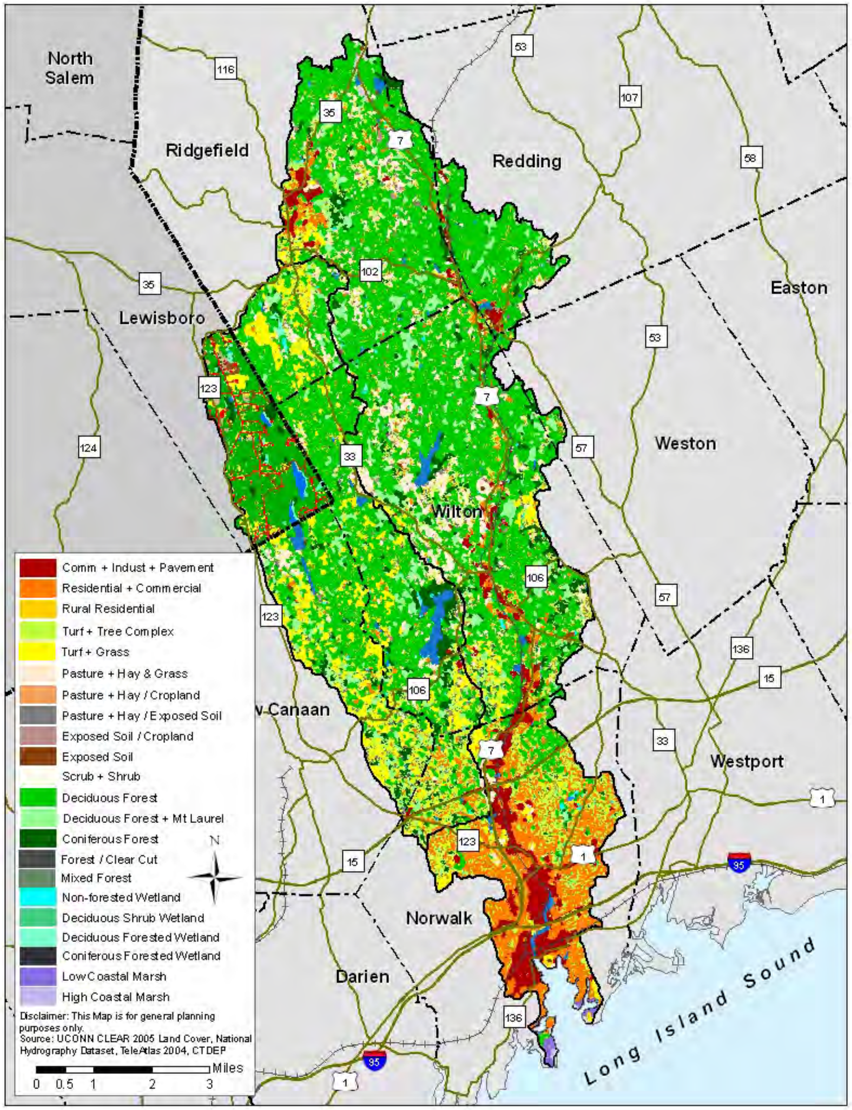


Figure 4-2. Norwalk River Watershed Landover (1995)

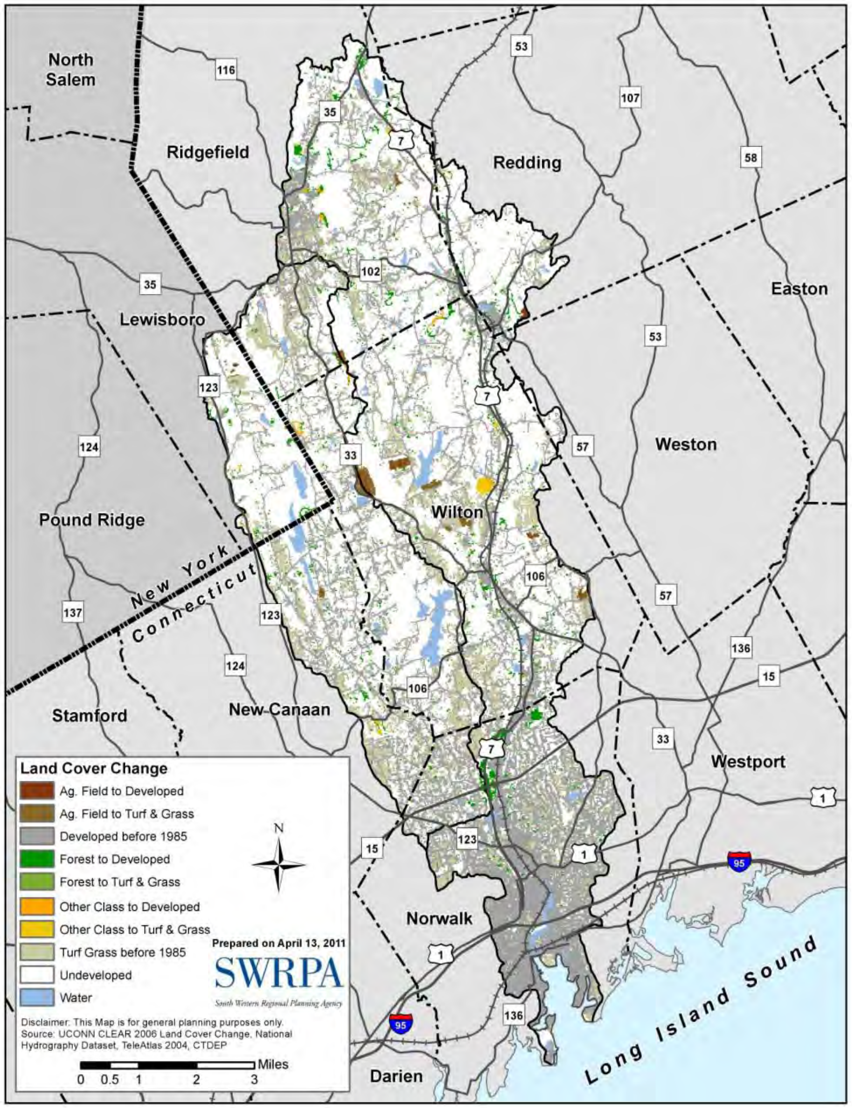


Figure 4-3. 2006 Change in Landover

Calculated annual TN, TP and TSS loads from each sub-watershed is summarized in Table 4-1. The results were calculated based on the AVGWLF model validation period (1996-2009) and an annual average is shown in this table, which excludes loading from point sources (wastewater treatment plants).

Table 4-1. Annual Pollutant Loads from Each Sub-watershed

Basin ID	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)*	Basin ID	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)*
7300-01	3761	472	199	**7300-15**	6306	816	237
7300-02-01	7007	819	382	**7300-16**	2803	375	113
7300-02-02	7033	836	344	**7300-00-07**	3035	397	123
7300-00-01	5170	582	267	**7300-17**	3421	427	153
7300-03	1438	166	77	**7302-02**	2510	235	156
7300-00-02	5106	572	262	**7302-03**	1959	222	100
7300-04	2075	233	115	**7302-01**	4442	290	343
7300-05	1530	159	96	**7302-05**	6444	769	307
7300-00-03	4591	501	261	**7302-04**	11364	1326	566
7300-06	1838	220	88	**7302-06**	1542	186	74
7300-07	8225	951	423	**7302-00-01**	8483	712	570
7300-08	2086	235	112	**7302-07**	4287	505	206
7300-09	5637	574	317	**7302-08**	3825	461	179
7300-00-04	5006	553	253	**7302-00-02**	7948	964	373
7300-10	3234	354	171	**7302-12**	3932	439	201
7300-11	3895	459	180	**7302-13**	10023	1213	450
7301-03	1473	167	77	**7302-10**	2022	247	124
7301-04	8913	1011	458	**7302-09**	966	107	49
7301-01	6464	763	322	**7302-11**	6500	797	306
7301-02	4711	539	247	**7302-00-03**	3702	459	151
7301-00	10015	1199	466	**7302-14**	2442	297	111
7300-00-05	9325	1074	445	**7302-15**	6466	856	243
7300-00-06	7099	881	301	**7302-00-04**	8793	1242	302
7300-12	4270	482	204	**7300-18**	12292	1566	476
7300-13	4007	461	191	**7300-00-08**	12697	1730	591
7300-14	2359	316	106	**7300-00-09**	22786	2460	1110

* Includes only loading from runoff

4.3 Indicator Bacteria Load Estimation

Modeling bacteria loading is more complex than modeling nutrients and sediment in a watershed. Concentrations of indicator bacteria can vary based on environmental conditions (e.g., water temperature, dry and wet weather periods, etc.) and depending on the time of travel there can be a significant decay of indicator bacteria along the waterways. To accurately account for these conditions a dynamic hydrologic, hydraulic and water quality model is needed to allow a direct comparison of monitored versus modeled values. Due to budgetary considerations a simpler method was adopted here to estimate the indicator bacteria loads.

Overall bacteria loads from the entire watershed or sub-watersheds were estimated using flows computed from the hydrology portion of the AVGWLF model for various land use categories, which were then associated with corresponding event mean concentrations (EMCs). EMCs are estimated as flow-weighted average concentrations of a pollutant from observed data collected during several wet weather periods. Table 4-2 summarizes the EMCs for specific indicator bacteria (fecal coliform or *E. coli*) compiled from literature published by the EPA, academic institutions and other organizations. Some of these references did not have values for *E. coli*, the indicator bacteria identified by the DEEP. In such cases, the fecal coliform EMC values were reviewed and a reduction was applied based on professional judgment. The final column in Table 4-2 shows the values selected for load estimation in this project.

It must be noted that some of the categories shown in Table 4-2 were clustered to match with the specific land use categories used in the AVGWLF model so as to multiply the appropriate runoff volumes with EMC values and determine the corresponding pollutant loads. A larger EMC value was assumed for the wetland category to account for the potential impacts from waterfowl and wildlife.

Table 4-2. EMC Values for Indicator Bacteria

Land Use Type	**NSQD (Pitt et al., 2004a & 2004b)**	**WTM (Caraco, 2001)**	**SCCWRP (Stein et al., 2007)**	**RUNQUAL (Evans et al., 2007)**	**NURP (EPA, 1983)**	**Selected Values**
	E. coli	Fecal coliform	*E. coli*	Fecal coliform	*E. coli*	*E. coli*
Agriculture	-	-	-	-	-	**10,000**
Low Density Residential	7,500	20,000	6,000	9,600	17,000	**8,000**
High Density Residential	7,500	20,000	6,000	9,600	17,000	**8,000**
Commercial/ Institutional	4,000	20,000	4,000	9,600	16,000	**8,000**
Open Space	8,000	-	6,000	-	-	**10,000**
Transportation	-	20,000	1,000	-	-	**2,000**
Wetland	-	-	-	-	-	**60,000**
Forest	-	-	-	-	-	**600**
Hay/Pasture	-	-	-	-	-	**10,000**
Industrial	1,500	20,000	1,500	-	14,000	**8,000**

There was no direct way of interpreting AVGWLF hydrology model outputs to develop load estimates from failing septic systems. Therefore, we used a simple approach outlined in the AVGWLF help menu (http://www.avgwlf.psu.edu/). A failure rate of 3% for the septic systems was assumed for individual households with a sewage generation rate of two billion organisms per capita per day. Information provided on Sewer Service area maps provided by SWRPA, Housatonic Valley Council of Elected Officials (HVCEO) and Westchester County (NY) was used to estimate septic system density. These septic density data were used to compute the overall load from septic system failures in individual sub-watersheds. The indicator bacteria loads generated from individual land use categories are summarized in Table 4-3 for each of the sub-watersheds within the Norwalk River watershed and tributaries.

There was no detailed calibration and validation of the model performed in this project to establish a direct correlation between load estimates and observed values, taking into account the physical and climatic aspects for the watershed. Therefore, the load estimates developed here should only be used to support a watershed-wide planning process and prioritize pollution control measures, and not interpreted in an absolute sense to pinpoint specific sources of pollution.

The targets for reductions in bacteria loads are discussed in the following section. Expected load reductions from short and long-term management strategies on a watershed-basis are discussed in Section 6 on Management Measures.

Table 4-3. Summary of *E. coli* Loads by Land Use Type (Billion organisms/year)

Basin ID	Watershed	Hay/Pasture	Agriculture	Forest	Wetland	Transitional	Low Developed	High Developed	Septic Loading	Total
7300-01	Norwalk	663	-	73	238	700	11369	12759	2383	**30185**
7300-02-01	Norwalk	699	37	572	21700	635	19604	11259	5272	**59778**
7300-02-02	Norwalk	330	24	843	15016	295	7765	10733	6343	**41350**
7300-00-01	Norwalk	314	-	681	6194	217	4414	9172	4126	**25119**
7300-03	Norwalk	614	37	196	102	74	1644	394	1221	**4281**
7300-00-02	Norwalk	1062	-	741	2027	93	5000	5515	4302	**18738**
7300-04	Norwalk	6	24	375	-	82	1343	787	1788	**4405**
7300-05	Norwalk	11	-	316	-	120	230	364	1048	**2090**
7300-00-03	Norwalk	780	36	666	4557	371	2687	7356	3109	**19563**
7300-06	Norwalk	50	-	298	509	8	937	816	1903	**4521**
7300-07	Norwalk	583	24	1232	-	275	8179	7365	7351	**25010**
7300-08	Norwalk	11	-	361	1112	85	903	1787	1786	**6045**
7300-09	Norwalk	1362	12	897	1117	151	4645	9397	3638	**21220**
7300-00-04	Norwalk	397	12	490	3048	311	6083	17429	3239	**31009**
7300-10	Norwalk	287	24	552	610	58	1763	3315	2668	**9277**
7300-11	Norwalk	1780	61	418	406	43	4820	5638	3494	**16661**
7301-03	Comstock	623	-	188	-	43	2208	1122	1220	**5404**
7301-04	Comstock	2490	231	1191	2233	217	6942	8129	7618	**29051**
7301-01	Comstock	1890	122	843	3858	171	6755	3590	6032	**23260**
7301-02	Comstock	1201	-	642	4162	206	5306	4403	3946	**19866**
7301-00	Comstock	5868	281	964	1219	326	10703	14398	8809	**42568**
7300-00-05	Norwalk	2254	73	999	4062	345	10005	23364	7374	**48476**
7300-00-06	Norwalk	474	158	569	1826	422	5816	25498	6104	**40867**
7300-12	Norwalk	2174	-	543	2327	27	2603	6427	3571	**17673**
7300-13	Norwalk	39	110	495	407	167	2470	11725	3166	**18578**
7300-14	Norwalk	231	12	244	-	194	2246	2074	2575	**7577**
7300-15	Norwalk	406	170	364	1112	259	8246	23978	6026	**40561**
7300-16	Norwalk	455	405	147	-	183	4332	7591	2795	**15908**
7300-00-07	Norwalk	-	-	243	101	201	2078	9310	3004	**14938**
7300-17	Norwalk	61	195	201	-	144	10897	8339	3130	**22968**
7302-02	Silvermine	1853	683	375	6604	4	3319	870	1297	**15004**
7302-03	Silvermine	414	73	307	305	39	1139	1798	1693	**5769**
7302-01	Silvermine	2037	597	903	25257	-	8426	3530	471	**41220**
7302-05	Silvermine	2417	85	652	12375	209	7303	8321	5813	**37176**
7302-04	Silvermine	1938	183	1365	1319	387	18824	15408	9854	**49278**
7302-06	Silvermine	352	-	158	-	54	3213	1902	1416	**7095**
7302-00-01	Silvermine	838	159	1578	6807	89	14658	9233	3549	**36912**
7302-07	Silvermine	341	24	557	-	124	4640	7062	3857	**16606**
7302-08	Silvermine	1035	219	343	-	120	7820	6643	3406	**19586**
7302-00-02	Silvermine	834	232	965	102	284	8272	12080	7485	**30252**
7302-12	Silvermine	562	134	566	-	50	2925	4629	3330	**12198**
7302-13	Silvermine	1742	634	925	4164	89	10887	15989	9677	**44106**
7302-10	Silvermine	38	12	260	-	355	2583	669	1568	**5485**
7302-09	Silvermine	-	-	171	-	-	354	1268	837	**2630**
7302-11	Silvermine	143	12	797	101	372	4355	12216	6020	**24017**
7302-00-03	Silvermine	494	73	276	-	81	6070	11290	3429	**21713**
7302-14	Silvermine	133	110	279	203	12	4774	3034	2442	**10987**
7302-15	Silvermine	975	426	455	710	23	12545	12784	7248	**35168**
7302-00-04	Silvermine	872	293	381	915	486	12327	25229	10109	**50613**
7300-18	Norwalk	149	657	329	4663	256	41577	44381	11514	**103526**
7300-00-08	Norwalk	1632	463	360	3961	2533	13352	48138	10012	**80450**
7300-00-09	Norwalk	2084	719	142	6500	2630	57495	158127	7713	**235410**
Total		**47999**	**7839**	**28488**	**153930**	**14619**	**408851**	**658639**	**231781**	**1552146**

4.4 Load Reduction Targets

Table 4-4 reviews the status of TMDLs in various impaired water segments in the Norwalk River and its tributaries, developed from a review of 305b assessment (CTDEP, 2008) and the TMDL report (CTDEP, 2005).

Table 4-4. Status of Impairment and TMDL Development

Name	ID305B	303(d) Listed	Impaired Use Cause	Applicable WQS	TMDL Status
Norwalk River	CT7300-00_01	Y	Contact Recreation Indicator Bacteria	B*	C
	CT7300-00_02	Y	Contact Recreation Indicator Bacteria	B	C
	CT7300-00_03a	Y	Contact Recreation Indicator Bacteria	B	C
	CT7300-00_03b	Y	Contact Recreation Indicator Bacteria	B	C
	CT7300-00_03c	Y	Contact Recreation Indicator Bacteria	B	C
	CT7300-00_04	Y	Contact Recreation Indicator Bacteria	B*	C
	CT7300-00_05	Y	Contact Recreation Indicator Bacteria	B*	C
Ridgefield Brook	CT7300-02_01	Y	Contact Recreation Indicator Bacteria	B	C
	CT7300-02_02	Y	Contact Recreation Indicator Bacteria	B	C
Cooper Pond Brook	CT7300-07_01	Y	Contact Recreation Indicator Bacteria	B	NC
	CT7300-07_02	Y	Contact Recreation Indicator Bacteria	B	NC
Comstock Brook	CT7301-00_01	Y	Contact Recreation Indicator Bacteria	B	NC
	CT7301-00_02	Y	Contact Recreation Indicator Bacteria	B	NC
Silvermine River	CT7302-00_01	Y	Contact Recreation Indicator Bacteria	B/A	C
	CT7302-00_02	Y	Contact Recreation Indicator Bacteria	B/A	C

NOTE: (i) C indicates a completed TMDL and NC indicates a TMDL to be developed after the CTDEP assesses the river segments for indicator bacteria water quality conditions; (ii) * *E. coli* standards for these segments include a geometric mean of 126/100mL and a single sample maximum of 410/100mL; and (iii) *E. coli* standards for other segments include a geometric mean of 126/100mL and a single sample maximum of 576/100mL.

The contributors of indicator bacteria include both point and non-point sources, such as stormwater runoff, hobby farms, pets, wildlife, waterfowl, illicit discharges, surface water base flow, and improperly functioning septic systems. Potential sources have been identified in Table 2 of the 2005 TMDL based on land-use distribution in each of the waterbodies. These sources are summarized here in Table 4-5 for reference.

Table 4-5. Potential Sources of Bacteria for Each Waterbody

Waterbody Name	Non-point Sources	Point Sources
Norwalk River	Wildlife, Waterfowl, Improperly Functioning Septic Systems, Surface Water Base Flow (Cooper Pond Brook and Gilbert and Bennett Brook)	Regulated Urban Runoff/Storm Sewers, Wastewater Treatment Plants, Illicit Discharges
Ridgefield Brook	Wildlife, Surface Water Base Flow (Steep Brook)	Regulated Urban Runoff/Storm Sewers, Wastewater Treatment Plant
Silvermine River	Horse/Pet Farms, Wildlife, Waterfowl, Improperly Functioning Septic Systems	Regulated Urban Runoff/Storm Sewers

Source: CTDEP 2005 TMDL, Table 2

The municipal wastewater treatment plant discharges are governed by the National Pollution Discharge Elimination System (NPDES) administered by the DEEP. Discussions here will therefore focus only on the non-point sources and regulated urban runoff/storm sewers.

TMDL calculations performed by DEEP (CTDEP, 2005) using the Cumulative Distribution Function Method (see Appendix B of CTDEP, 2005, for details) are summarized for reference in Table 4-6 for the various impaired waterbody segments. Note that the higher percentage reduction of 76% developed by DEEP (CTDEP, 2005) based on observations at Monitoring Site 790 has been assumed to be protective of WQS for indicator bacteria in the entire segment of CT7300-00_01 in Norwalk River.

The recent water quality monitoring data discussed in Section 3 on Watershed Characterization was analyzed in terms of the geometric mean for *E. coli* at various HW/RW monitoring sites and also on the proximity of individual sites to specific impaired waterbody segments. A statistical roll-back procedure (Ott, 1995; NYSDEC, 2003) was used to determine the percent reductions necessary in each segment. This procedure compares the geometric mean of observed values to the applicable geometric mean criterion, and determines the difference between these geometric mean values as the percent reduction in pollution loads necessary to meet the WQS (see Figure 4-4). An example for the segment CT7300-02_02 is discussed here.

The water quality monitoring stations NR20, NR21, NR22 and NR23 are located in segment CT7300-02_02. The highest geometric mean of 473/100mL for *E. coli* was observed at NR21. As a conservative planning goal, if the reductions in indicator bacteria loads could be reduced to achieve a geometric mean of 126/100mL at NR21 during wet weather, then the entire CT7300-02_02 will comply with the applicable WQS. Using the statistical roll-back procedure, an overall reduction of 74% would be needed to achieve the desired water quality goal.

In reality however, the elimination of dry weather sources such as failing septic systems or illicit discharges must also be addressed in order to improve the water quality significantly. Therefore, the percent reductions based on wet weather data developed as part of the 2005 TMDL can be used as targets for wet weather non-point sources and permitted urban stormwater discharges.

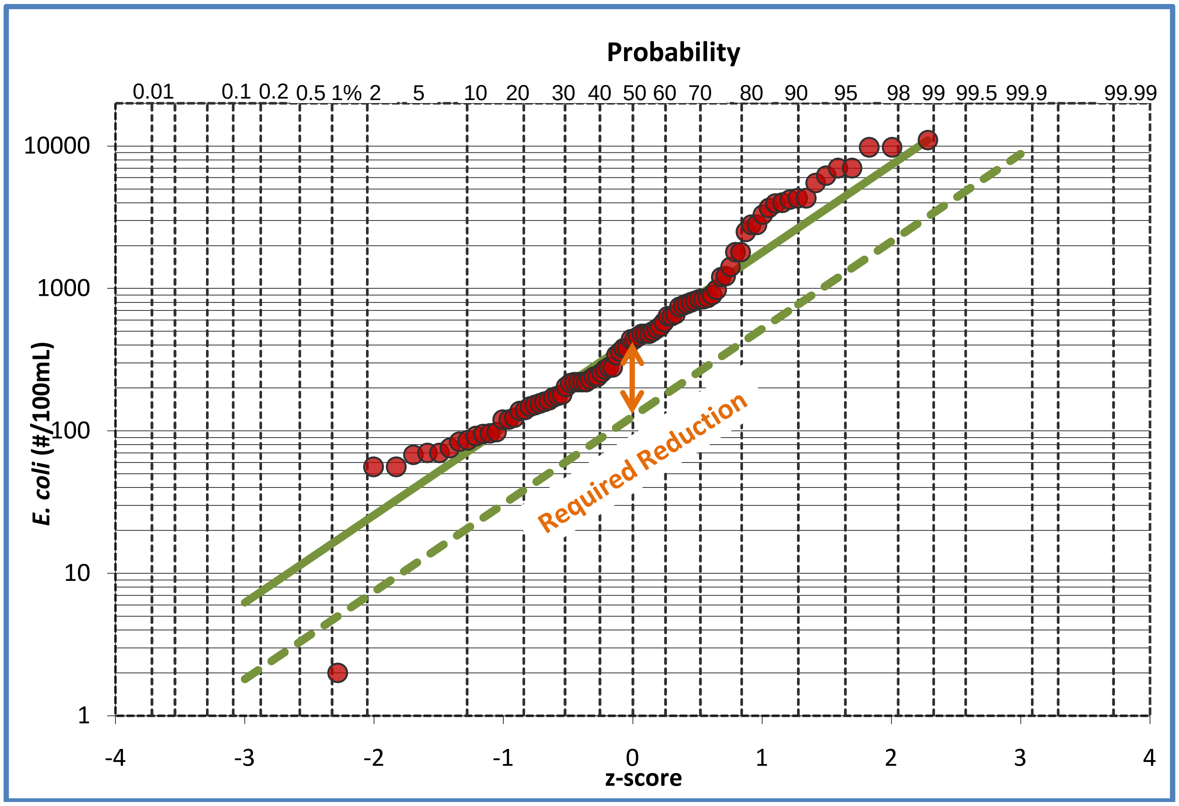


Figure 4-4. Percent Reduction in *E. coli* Loads to Meet WQS at CT7300-02_02

Short-term management measures should be undertaken for controlling indicator bacteria loads from wet weather sources and eliminate dry weather sources. This approach involves an adaptive management strategy to address dry weather sources first and continue to monitor the waterways to characterize improvements in water quality conditions. Reductions such as illicit discharges would also reduce the extent of bacterial water quality exceedances observed during wet weather. The targets for wet weather sources could then be adjusted based on this new monitoring data, which would provide the footprint for undertaking long-term management measures to further reduce the wet weather pollutant loads. Percent reductions were estimated based on wet weather data for each impaired segment derived using nearby HW/RW monitoring stations and included in Table 4-6. Also included are the TMDL load allocations for non-point sources, established by DEEP (CTDEP, 2005).

Table 4-6. Summary of TMDL Analysis

Waterbody	Impaired Segment 305B	Percent Reductions Needed to Meet Applicable WQS			
		TMDL	WLA	LA	Based on HW/RW Wet Weather Data
Norwalk River	CT7300-00_01	76	76	76	82
	CT7300-00_02	38	38	38	40
	CT7300-00_03a	5	9	3	61
	CT7300-00_03b	5	9	3	61
	CT7300-00_03c	5	9	3	61
	CT7300-00_04	54	53	55	49
	CT7300-00_05	39	42	37	58
Ridgefield Brook	CT7300-02_01	51	60	45	NC
	CT7300-02_02	51	60	45	74
Cooper Pond Brook	CT7300-07_01	ND	ND	ND	NC
	CT7300-07_02	ND	ND	ND	NC
Comstock Brook	CT7301-00_01	ND	ND	ND	NC
	CT7301-00_02	ND	ND	ND	NC
Silvermine River	CT7302-00_01	66	67	65	91
	CT7302-00_02	66	67	65	NC

NOTE: 1. Watershed Load Allocation (WLA) refers to percent reductions needed in point sources such as treatment plants; 2. Load Allocation (LA) refers to percent reductions needed in non-point sources of pollution; "ND" indicates that there were insufficient data in the 2005 TMDL analysis to support the development of pollutant reduction targets. Since the HW/RW data was also unavailable to appropriately derive percent reductions, these reaches are indicated with an "NC."

4.5 Observations on Pollution Sources and Potential Controls

Based on the extensive pollutant load modeling effort described in this section, some general conclusions were derived in order to guide the development of load reduction strategies (management measures). Specific observations made during HW/RW field visits or water quality monitoring programs are summarized in Section 5 on Watershed Recommendations with potential corrective actions. Some general conclusions about NPS pollution and the extent are summarized here.

Non-point sources include wildlife, improperly functioning septic systems, surface water base flow, urban runoff and horse/hobby farms. The BMPs for the management of non-point sources include septic system testing and maintenance, nuisance wildlife control plans, pet waste ordinances and LID practices. The contribution of bacteria from surface water base flow could be addressed by implementing non-point source BMPs in drainage areas of tributaries with known high levels of *E. coli* densities, such as Steep Brook, Cooper Pond Brook, and Gilbert and Bennett Brook.

Failing or improperly maintained septic systems contribute to DO swings and/or elevated indicator bacteria concentrations in the upper reaches of Norwalk River and in Silvermine River. As we move downstream towards densely urbanized areas, the illicit discharges into storm sewers appear to cause elevated indicator bacteria concentrations.

Based on the NRCS streamwalk surveys, several ponds in the Norwalk River watershed have been documented to have excessive algal growth and eutrophication. This occurs primarily due to phosphorus loads from contributing drainage areas such as fertilizer application in lawns. In addition to the 10% TN load reductions required by the LIS TMDL, effluent limits for TP from point sources and targeted reductions in TP from non-point sources would also need to be established to reduce eutrophication potential in these impoundments.

Waterfowl (e.g., non-migratory geese) observed near the impoundments were attributed to elevated indicator bacteria concentrations. The indicator bacteria have enhanced ability to survive in surface waters and sediment when ambient temperatures more closely approximate those of warm-blooded animals, from which the bacteria originate. In addition, the resident wildlife populations are likely to be more active during the warmer months and more migratory species are present during the summer. The DEEP has developed statewide (that includes both migratory and non-migratory) population estimates for Canadian geese and ducks to be 24,000 and 57,000 during the 2011 breeding season. No specific estimates for the Norwalk River watershed are available. These factors combine to make the summer, recreational period representative of "worst-case" conditions.

As described in Mullaney et al. (2002), groundwater contributes significant amount of TN to the sound. Septic systems are designed to infiltrate into the ground thereby transferring some of the TN loads into the groundwater that appears as baseflow in the stream at a later time. As much as 40-45% of the TN loads have been attributed to groundwater, although some of these loads could result from infiltrated TN from septic systems, natural sources may also be contributing factors. Since the residence time of TN in groundwater can be as much as 50 years, this load component becomes the most challenging to control.

Urban stormwater runoff is estimated to contribute about 20-25% of TN loads and, from a control standpoint, emerges as a source that could potentially be controlled using NPDES MS4 programs for the watershed municipalities. Some portion of this load could be attributed to manicured lawns in urban settings with varying levels of fertilizer applications (e.g., golf courses, residential and commercial property lawns, and municipal owned areas such as parks). Similarly the indicator bacteria loads could be contributed by domestic pets and hobby farm animals. These sources could potentially be reduced using public outreach and education programs aimed at reducing the overall pollutant loads to the waterways and encouraging LID practice. Under the MS4 permit, municipalities are required to implement minimum control measures in their Stormwater Management Plans to reduce the discharge of pollutants, protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act. The six minimum control measures are:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-construction Runoff Control
- Pollution Prevention/Good Housekeeping

It must be emphasized that the cost of controlling loads from urban and suburban land uses could be quite expensive and must be compared with the cost of controlling non-urban sources of pollution. On a watershed-wide basis, an offset or trading program could help in reducing the overall TN loads in the Norwalk River and its tributaries sooner.

The modeling framework used here does not explicitly account for atmospheric deposition. Most of the TN load from this source is carried to the waterways by urban runoff. Literature values compiled during the development of LIS TMDL indicated that the atmospheric deposition could contribute about 13% of the TN loads (NYSDEC and CTDEP, 2000). Similar large fractions have been reported in other large drainage areas such as Savannah Harbor and Chesapeake Bay. Again, this source is among the most challenging ones to control or at least cost prohibitive in terms of frequent street sweeping and treatment of stormwater using process-based BMPs/LIDs such as bioretention, grass swales or natural/constructed wetland systems (for additional information see Table 6-2).

5. WATERSHED RECOMMENDATIONS

This section summarizes the generalized and specific management measures developed in order to achieve the goals and associated objectives discussed in Chapter 2, with a primary focus on goals D and E. Management measures for Goals B, C and F are included in Table 6-1 and Appendix C. Management measures were initially developed based on impairments in the Norwalk River, information provided in the 1998 Action Plan, the 2004 Supplement, and current literature. Management measures were then refined through discussions with stakeholders during the course of the project. Bacteria and nutrient load reduction needs identified by the pollutant load model, 2005 TMDL and data analyses presented in Sections 3 and 4 were integrated into these recommendations. The potential load reduction associated with the major recommendations are estimated and presented in Section 6 on Management Measures.

The management measures include watershed-wide strategies that can be implemented throughout the Norwalk River and its tributary watersheds. Recommendations were developed for watershed-wide application as well as those targeting specific sub-watersheds or reaches. Site-scale strategies have also been recommended to address impairments at selected sites or smaller geographic regions where the controls undertaken will make meaningful reductions in pollutant loads to improve water quality in the Norwalk River watershed and its tributaries.

Successful implementation of the plan recommendations requires a strong foundation with committed organizational capabilities and the ability to secure funding for projects. For the Norwalk River and its tributaries, a number of stakeholder groups have been active since mid 1990s, and have worked collaboratively to address watershed goals and objectives and to lead fundraising efforts to accomplish specific activities. The WBP developed here can be used as a blueprint for setting implementation priorities, schedule, anticipated benefits, potential costs, funding sources, implementation responsibilities, and a framework to track progress from specific implementation projects.

5.1 Watershed-wide Recommendations

Watershed wide management measures were developed for implementation throughout the Norwalk River watershed and its tributaries. These usually require overarching measures that would need extensive coordination among watershed municipalities and other stakeholders, and are applicable to most of the watershed drainage area. Both structural and non-structural recommendations are presented here to address non-point source pollution through municipal land use regulations, code changes and planning, LID adaptation, smart growth, public education and outreach, and watershed monitoring to track progress.

5.1.1 Illicit Discharge Detection and Elimination

Illicit discharges are improper discharges to the stormwater drainage systems or directly into streams. Common types of illicit discharges include sanitary sewer connections to storm drains or illegal dumping of domestic or industrial wastewater. The streamwalk report (NRCS, 1997; 1999) and annual field reconnaissance and monitoring work conducted by HW/RW have documented numerous illicit discharges along the Norwalk River and tributaries that contributed to elevated bacteria levels in the waterways. Based on data analysis and high bacterial concentrations presented in Figure 3-5, there appears to be watershed-wide presence of illicit discharges that add bacterial load during dry weather. Specifically, the upper and lower reaches of the Norwalk River and the Silvermine River exhibit impaired water quality during dry weather. The DEEP General Permit for MS4 requires individual municipalities to inspect and eliminate the discharge sources. This includes developing an Illicit Discharge Detection and Elimination (IDDE) Plan to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.

Plan Recommendations:

- Review and update municipal stormwater management plans to ensure that IDDE efforts of the watershed municipalities (required by the MS4 General Permit) are undertaken.
- Continue the illicit discharge investigations and follow-up for all hotspots identified during annual HW/RW field reconnaissance/monitoring. The hotspots exhibit continuous discharges during dry weather periods and also involve exceedances of indicator bacteria water quality criteria in the waterways during such periods.
- Continue work to eliminate illicit discharges.

5.1.2 Management of Septic Systems

Infiltration of septic system effluent with high levels of nutrients can contaminate the groundwater, thereby, increase nutrient concentrations in the stream baseflows. On the other hand, improperly functioning or inadequately maintained septic systems also contribute bacteria and nutrient loads during rain events to the surface waters. A properly designed and maintained septic system may last 20 to 30 years before needing replacement. Septic systems are among the major sources of indicator bacteria and nutrient pollution (EPA, 2001; 2003).

Septic systems near steep slopes or adjacent to waterways typically have higher potential to contribute pollutants if inadequately maintained. Proper maintenance will keep the environment healthy and prolong the life of the systems, thereby reducing replacement costs and the need for sewer extensions. The USEPA has developed extensive literature over the past 10 years in association with other federal and research agencies for the design, operation and maintenance and performance requirements for septic systems (EPA, 2003; 2005) and also has developed guidelines on watershed-wide alternatives such as clustered wastewater collection/treatment/dispersal systems (also known as decentralized wastewater systems) and disinfection or nitrogen removal requirements for systems in the high contribution areas.

Plan Recommendations:

- Establish criteria to identify poorly functioning on-site septic systems in the watershed to facilitate implementation of inspection and operation and maintenance programs.
- Conduct an inventory of areas in each watershed municipality where the greatest potential for a concentration of poorly-functioning on-site septic systems are located and include a brief description of the primary factors that contribute to these problems.
- Develop a combination of GIS-based and advanced technologies such as infrared photography to identify hotspots that are affected by septic system failures.

- Adopt a targeted program to correct pollution from the hotspot areas identified in the previous step, including but not limited to field inspections, technical guidance, and monitoring and enforcement.
- Explore the use of a unified tracking system that can assist with watershed-wide monitoring of septic systems within each municipality in terms of their periodic failures and maintenance records, similar to the Rhode Island Wastewater Information System (RIWIS.org). Several onsite wastewater tracking programs are available at little to no cost.
- Work with watershed municipalities to develop a program to address potential environmental issues with poorly functioning septic systems.
- Publicize and Promote adequate maintenance of on-site septic systems through various media sources.
- Evaluate the cumulative effects of discharges permitted by CT and NY on in-stream habitat and water quality.

5.1.3 Low Impact Development Adaptation

Stormwater discharges, as discussed in Section 4, contribute nutrient and bacteria loads to the Norwalk River and its tributaries, and therefore, must be reduced or treated to realize water quality improvements in the waterways. LID practices are increasingly being recommended by federal and state regulatory agencies for stormwater management in urban and suburban areas. LID practices are among the major recommendations of recent National Research Council report on stormwater management (NRC, 2008). LID elements use or mimic natural processes to infiltrate, evapo-transpire, or store and reuse stormwater. On a regional scale (involving a larger footprint), these elements can include the preservation and restoration of natural landscape features such as forests, floodplains and wetlands. At the site-scale, LID elements can include rain gardens, permeable pavements, green roofs, green streets, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing, seasonal cooling tower makeup and landscape irrigation. These elements reduce the amount of runoff discharging to surface waters thereby reduce the potential water quality impairments.

Source: CT NEMO LID Inventory - Site with reduce road widths, no curbing, vegetated infiltration island and pervious pavement

The LID elements are designed to reduce the overall volume and peak rate of stormwater runoff, and pollutant loads. When implemented to capture volumes generated up to a design storm (e.g., 1-year return period), these elements can also reduce the frequency of runoff reaching the receiving waters, in comparison to the existing conditions with no stormwater controls. They also offer a number of other environmental, economic, and human health benefits, which often lead to higher quality of living in urban and suburban areas.

Plan Recommendations

- On a watershed-scale, all the seven watershed municipalities in CT and NY, as part of their Municipal Separate Storm Sewer System (MS4) permits, should consider integrating LID elements into their capital improvement planning process to further reduce runoff volume, peak flow rates and stormwater pollution from their respective drainage areas. (see Section 5.3.2 for additional recommendations)

Source: Center for Watershed Protection

- Since the LIS receives significant nitrogen input from groundwater, process-based LIDs that promote nutrient uptake should be considered (e.g., vegetated swales and bioretention).
- A planning-level estimate of the potential benefits from incorporation of LID elements has been developed in Section 6 on Management Measures. A comprehensive study, expanding on the planning-level analysis and cost estimation provided in this WBP, should be conducted on a watershed-basis by the watershed municipalities. Elements of the study can include:
    - A detailed inventory and mapping of existing and potential conditions that will support LID adaptation including natural resources, social and economic resources. Example actions can include infiltrometer tests to characterize soil infiltration potential, surveys to understand the willingness of citizens to maintain LIDs in their properties, etc.
    - Demonstration of project types (specific technology or a combination of technologies) with clear water quality benefits can be implemented in high visibility areas (e.g., ball fields, public parking lots and community gardens or parks). Controlled (with LIDs) and uncontrolled drainage area monitoring (similar to the Jordan Cove project) can provide comparisons useful for stakeholder communications.
    - Detailed evaluation of LID build-out scenarios and their implementation cost/feasibility analysis, similar to the approaches undertaken by other cities such as Washington DC, Philadelphia (PA) and Portland (OR).
- Evaluate long-term program costs and financing alternatives for LID implementation, including incentives for private property implementations (e.g., rain barrel giveaway program). Watershed municipalities can explore the feasibility of a stormwater utility (a fee assessed for stormwater flows generated from a property and discharged to sewers), borrowing lessons learned from the recent DEEP stormwater utility pilot projects and the ongoing work by the DEEP to incorporate LID into state permits and policy. www.ct.gov/dep
- Encourage upstream watershed municipalities to embrace aggressive LID implementation projects with the goal of not transferring the stormwater problems to downstream areas.

5.1.4 Land Use Regulations and Smart Growth

Both DEEP and NYSDEC have established land use regulations and requirements for stormwater volume and/or runoff control and included in their respective guidance documents. Implementation of such regulations still lies in the jurisdiction of individual municipalities, which is commonly referred to as "home rule." Consistency or unification of regulations can lead to accelerated pollutant reductions and enhance cooperation among various watershed municipalities.

Smart growth is a broad term used to guide watershed municipalities in developing guidelines to focus growth with certain geographical areas, where the infrastructure currently exists to support increased population density. In a water quality context, the growth may be focused or encouraged in areas with existing water and sewer infrastructure with upgrades as necessary (thereby reducing the need for building new infrastructure) and also be limited in areas that have existing water quality problems such as streambank/bed erosion, nutrient loads to impoundments with eutrophication issues, and bacteria pollution from failing septic systems.

Plan Recommendations:

- Promote watershed planning, smart growth, open space protection, and LID principles in the regulations and modify appropriate ordinances that reflect adoption of recommendations from this WBP.
- Consider modifying the zoning regulations to promote smart growth in urbanized areas including compact and preferred development areas based on availability of existing sewer, water and stormwater infrastructure. This will maximize the use of existing infrastructure with minor upgrades as necessary, while minimizing any new infrastructure investment needs.
- Modify the Stormwater Runoff section of municipal zoning regulations to include a set of stormwater management standards. Development of stormwater management standards would allow watershed municipalities to establish clearer, specific performance standards for projects. Such standards can include LID practices that recognize stormwater as a resource rather than a waste to be conveyed to the waterways instantaneously.
- Adopt regulations or make specific recommendations concerning the use of pesticides or fertilizers on municipal property (e.g., Nassau County in New York prohibits application of fertilizers on County owned parks and open areas).
- Consider multiple targets for stormwater control for new or redevelopment projects (e.g., runoff volume in addition to the traditional pre vs. post construction peak flow). Also consider indicators in receiving waterways as surrogate for increasing the extent of stormwater controls in upland areas, such as bank or bed erosion (geomorphology).
- Strengthen the landscape provisions of the Zoning Regulations by requiring maximum tree preservation, replacement and diversity of tree species.
- Modify parking regulations to reduce the effective impervious cover and encourage implementation of porous or permeable pavers in parking lots.

5.1.5 Downspout Disconnection

It is a common practice for rooftops to be directly connected to storm sewers in older residential and commercial areas. This practice essentially reduces the time of travel through the drainage area and impacts the receiving waterways in terms of erosion and channel stability. Redirection of runoff from rooftops to pervious areas such as lawns can reduce the volume and peak flow rate reaching the storm sewers. In addition, LID opportunities such as rain barrels/cisterns or rain gardens can reduce discharges and enhance sustainability through beneficial reuse of stored water. An indirect benefit is the reduced demand on potable water supply for non-potable uses. Downspout disconnection is ideal in neighborhoods where roof leaders are directly connected to the storm drainage system and in medium to high density residential areas with lot sizes in the 0.25 to 1.0 acre range (CWP, 2007).

Plan Recommendations:

- Conduct a GIS-based inventory of medium to high density areas (e.g., 0.25 to 1.0 acre lots) that can provide significant benefits from roof leader disconnection programs. The medium to high density neighborhoods will offer opportunities for disconnecting a large number of roof leaders into pervious areas, thereby, reduce the volume and peak runoff rate from roof areas significantly. Supplement this with targeted visual inspection program to quantify the percentage of households with roof leaders directly connected to sewers. The goal will be to determine the extent of directly connected impervious areas and reduce direct connections through a phased disconnection program.
- Establish a program to track the implementation of rooftop disconnection programs on a watershed-wide scale will help to monitor success of disconnection and quantify the benefits.

Encourage disconnection of rooftop runoff and reuse stormwater using rainbarrels or rain gardens. Watershed municipalities should demonstrate the use of rain barrels and other forms of downspout disconnection at public facilities and parks, and offer incentives for downspout disconnection on private property through rain barrel rebates and similar programs. This can be accomplished through a municipal rain barrel giveaway/incentive program such as the one recently conducted through Bridgeport's Conservation Corps or the Aquarion Water Company.

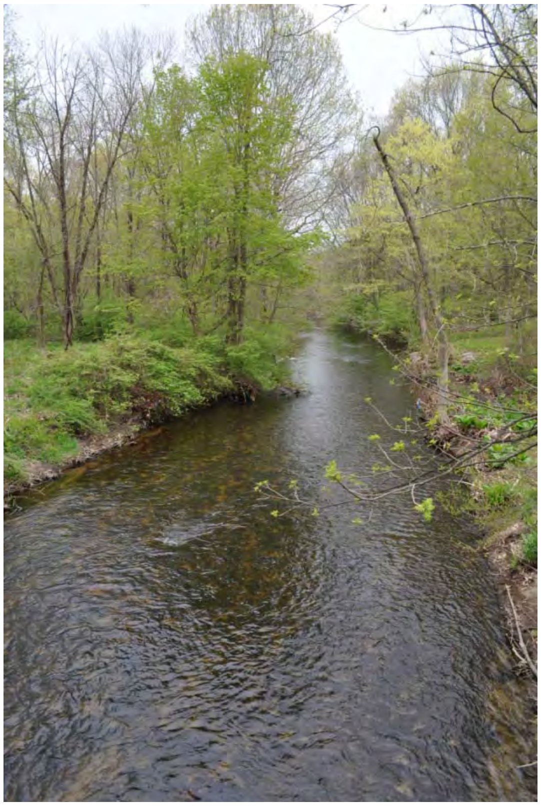
Source: Trumble Patch - Rainbarrel Installation

5.1.6 Riparian Buffers

Riparian buffer areas provide treatment for nutrients and, to some extent, bacteria. Buffers help to filter polluted overland runoff before it reaches the waterways. The Action Plan (1998) refers to extensive loss of riparian vegetation along the Norwalk River and its tributaries, thereby increasing water quality degradation. The EPA-LISO has developed a Riparian Buffer toolbox to assist with the identification of potential buffer zones, model ordinances, and expected effectiveness of these buffers in improving water quality. Figure 5-1 shows forested areas with 100 feet of a watercourse in watershed.

<u>Plan Recommendations:</u>

- Expand existing public education program about the value of riparian buffers and improvement of regulations to protect them.
- Conduct a detailed inventory of the riparian corridors to assess conditions and identify areas for restoration and where BMPs would be most effective. Promote maps developed as part of the assessment.
- Implement riparian restoration projects based on sites identified in the previous step.
- Promote the use of grass-lined swales and other bioretention practices along roadways.
- Review the quantified benefits of increased buffer zones from states such as New Jersey to accelerate the buy-in and establishment of appropriate regulations. Also, review the Riparian Toolbox that LISO had put together.



Source: Left - Alexis Cherichetti - Schenks Island; Right - Trout Unlimited - Cannodale restoration inital planting (top) & a year later (bottom)

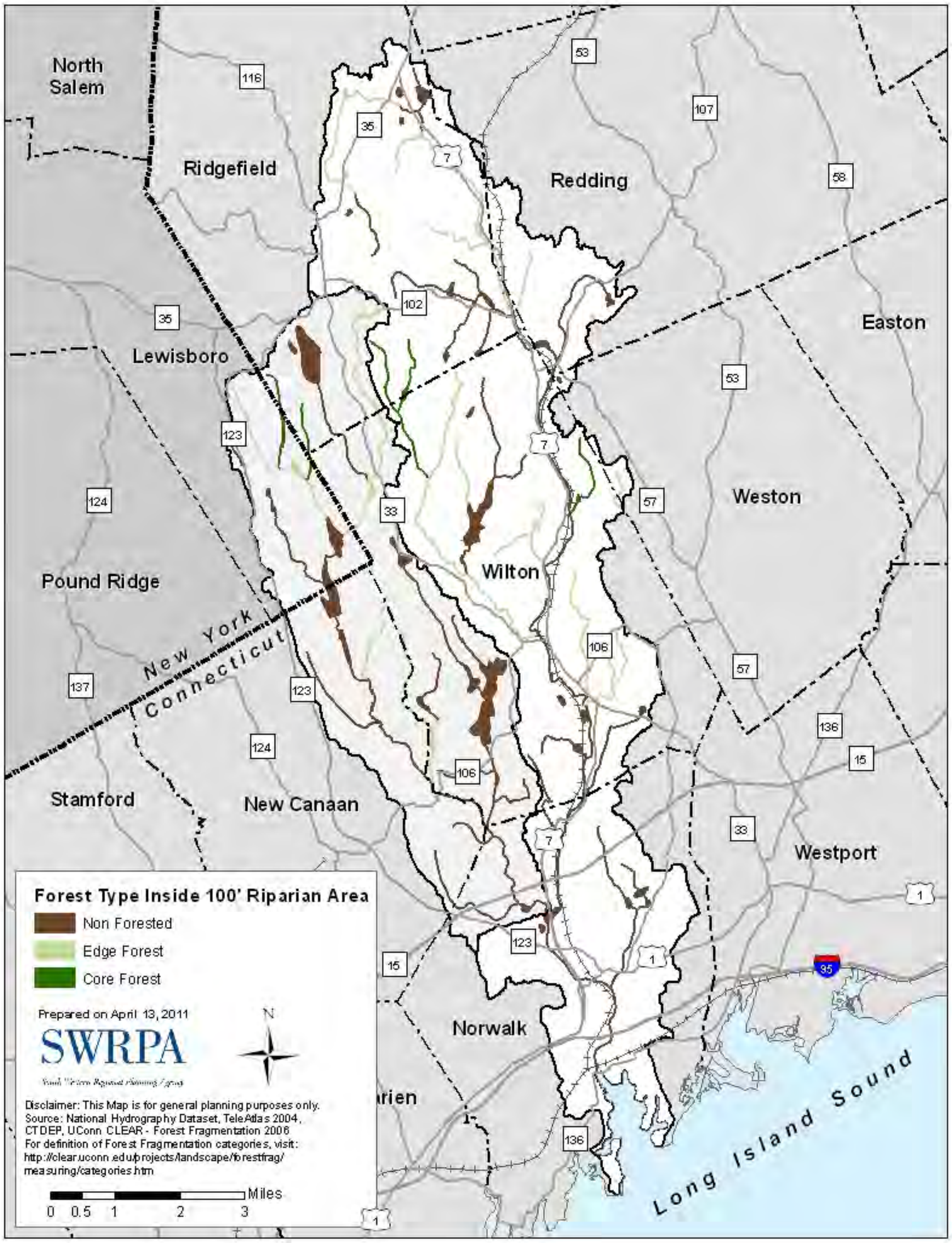


Figure 5-1. Forested Riparian Areas in the Norwalk River Watershed

5.1.7 Management of Pollution from Waterfowl and Domestic/Hobby Farm Animals

Discharges from impoundments such as Great Swamp are documented to elevate bacteria levels in the Norwalk and its tributary watersheds. Non-migratory goose populations have been observed near these ponds and the DEEP's indicator bacteria TMDL explicitly calls for active goose management. DEEP estimates the total statewide populations of Canadian geese and ducks to be 24,000 and 57,000, respectively in the 2011 breeding season (CTDEP, 2011). Specific estimates for the Norwalk River are unavailable. These statewide estimates include both migratory and non-migratory goose population. It must be noted that this recommendation addresses concerns pertinent to non-migratory goose population within the Norwalk River watershed.

All seven watershed municipalities had pursued a potential control strategy of oiling the eggs, which had yielded mixed results in terms of reduction in goose population. In addition to controlling the population, another major issue is related to feeding of goose population by residents and visitors.

Plan Recommendations:

- Adopt a local ordinance to prevent feeding of waterfowl, using New Canaan as an example.
- Post signs and conduct education programs to stop feeding using the program developed by New Canaan as a guide.
- Employ effective methods to significantly reduce the non-migratory goose population beyond egg oiling, including lethal measures as appropriate.

Source: Left - Gretchen Yengst - Loving Focus Photography; Right - Alexis Cherichetti

5.1.8 Water Quality Monitoring

The Norwalk River mainstem, the Silvermine River and Comstock Brook have long-term water quality (chemical and biological) data collected by various agencies. The USGS compiled water quality data and archived in their STORET system until the 1990s. Since 1999, the HW/RW has been monitoring the waterways and tracking hotspots such as illicit discharges in the main stem of Norwalk River as well as the Silvermine River. In addition, the DEEP had conducted short-term monitoring to support the development of indicator bacteria TMDLs for Norwalk River and tributaries. Continual monitoring of water quality is important to understand the relative contributions of various pollution sources, develop a database for the watershed to guide environmental decision-making, and to measure the progress towards achieving watershed management goals.

Plan Recommendations:

- Continue the annual water quality monitoring program and modify procedures as necessary. The results can be used to track improvements from watershed-wide and site-specific pollution control measures and understand watershed responses under different hydrologic regimes.
- Coordinate monitoring for wet and dry weather conditions to characterize potential sources of water quality impacts in specific areas of concern.
- Conduct targeted water quality monitoring to confirm the sources of conductivity and quantify the extent of this concern in the Norwalk River and its tributaries.
- Design and implement monitoring of LID practices on a demonstration basis and develop performance data to specifically support LID planning and implementation in the entire watershed. Monitoring of the LID retrofit site(s) is recommended before and after the installation of the retrofit, and also for several years in order to track their performance over time and identify specific operation and maintenance requirements.
- Perform additional field investigations to support efforts near hotspots such as Great Swamp, where HW/RW has documented highly varying DO levels and elevated indicator bacteria concentrations.
- Seek funding to evaluate Total Nitrogen (TN) and Total Phosphorus (TP) loadings in the watershed.
- Identify and pursue appropriate measures to evaluate the impact of medical waste on water quality.
- Evaluate the impact of introduced chlorides on water quality.
- Reactivate the streamwalk program to support public outreach and also use volunteers for physical, chemical and biological assessment of stream health in the watershed.

5.1.9 Urban Greening

Urban trees, shrubs and plants improve air and water quality, reduce stormwater runoff, conserve energy, and protect public health. An increasing number of U.S. cities are undertaking an urban forestry or tree canopy-based program to enhance LID opportunities. Stream temperature increases resulting from shallow water depths or an urban heat island effect can affect aquatic life, particularly the coldwater fishery. Innovative approaches have been undertaken around the country to reduce the stream temperatures, for example, Clean Water Services in Portland (OR) has developed the extent of tree canopy required to meet their temperature TMDL regulations. Urban and community forestry provides environmental, community, and economic benefits, while improving the overall quality of life within a watershed (CNT, 2011).

The tree canopies in the northeastern region are season dependent and also can contribute to additional pollutant loads during the fall season. Therefore, the direct environmental and community benefits of urban greening can be realized with additional operation and maintenance (e.g., more frequent street cleaning in the fall season) requirements.

Plan Recommendations:

- Conduct a more detailed watershed-wide tree canopy analysis, expanding on currently available data (Figure 5-2) to determine the extent of tree cover and establish baseline conditions. Aerial photographs from summer and winter seasons can be used to interpret the perennial versus seasonal cover.

- Quantify the value of urban forestry and tree programs for improving the aesthetics, energy efficiency and air quality, wildlife habitat, recreational opportunities, real estate values, and potential job opportunities. For example, the New York City has created a Million Trees program that has created significant community awareness and job opportunities to adults and youth. A simple tool such as the spreadsheet model developed by the Center for Neighborhood Technology (www.cnt.org) can be used to quantify benefits and communicate with stakeholders.
- Develop a comprehensive urban forest master plan that integrates the LID benefits and sets a watershed-wide urban tree canopy goal.
- Track progress in the implementation of tree canopy cover on a watershed-wide level.

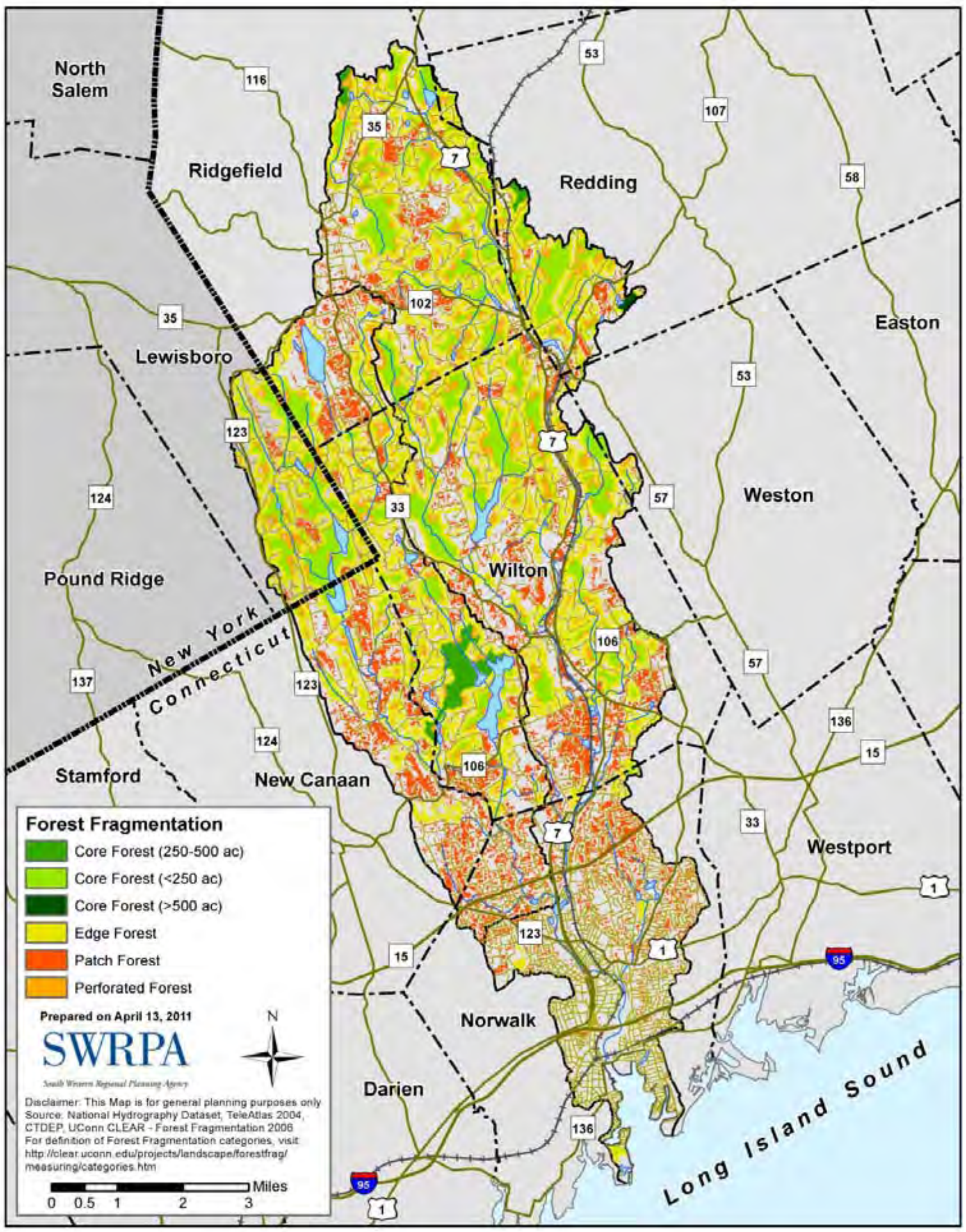


Figure 5-2. CTECO Forest Fragmentation

5.1.10 Public Education and Outreach

Public education is critical to the long-term success of watershed management, especially in managing water quality. This raises awareness about personal, community and corporate (businesses) responsibilities to environmental protection in the watershed. Stakeholders have been successful in coordinating restoration projects and hosting education programs to increase awareness throughout the watershed (e.g., NRWA sponsored River clean ups, Trout Unlimited Stream restoration projects, streamwalk program [NRCS, 1997; 1999]). The following recommendations can support or enhance the ongoing programs.

<u>Plan Recommendations:</u>

- Develop a framework for youth organizations (e.g., Boys and Girls Scout educational programs, involvement of students in World Water Monitoring Day – www.wwmd.org, etc.) that highlights the comprehensive relationships between local, regional and global water issues and builds programs for local environmental stewardship.
- Emphasize the importance of LID approaches such as the use of pervious pavement, rain gardens, and green roofs. Host hands-on workshops or field visits to demonstrate the benefits of and design considerations for LID practices.
- Develop a program to guide citizens, land use boards and businesses regarding the positive impacts of using native plants and species of concern in landscaping, and the detrimental effects of non-native invasive species.
- Increase watershed stewardship efforts (watershed, stream, stormwater pollution prevention, and catch basin markings) and create educational displays in highly visible, strategic locations throughout the watershed.
- Continue to expand coordination and communication with watershed municipalities

Source: 1998 Action Plan

5.2 Site-Specific Recommendations

Site-specific recommendations were developed based on a review of 1998 Norwalk River Action Plan, the 2004 Supplement, pollutant load estimation reviewed in Section 4, HW/RW water quality and hotspots data, and stakeholder input to address specific water quality issues within some reaches of the waterbody or sub-watersheds. Eutrophication issues documented during the last streamwalk program (NRCS, 1997; 1999) were also included here as hotspots that would benefit from localized pollution control efforts. These recommendations are presented as concepts for further refinement and application to provide guidance for the type of projects that could be undertaken to address water quality issues.

5.2.1 Identification of Public Lands for BMP/LID Implementation

Public properties, owned by the state and local governments, can offer tremendous opportunities for BMP/LID implementation. While LID elements can be implemented anywhere in a watershed, public properties can be amenable to large structural BMPs such as retention basins, wetlands and wet ponds that can provide significant reductions in nutrient and bacteria loads (EPA 2006; 2008). The public ownership offers advantages in terms of a simplified state/local permitting process as well as the elimination of land costs. In many cases public properties also offer an opportunity to engage the community and increase awareness of LID techniques. Public lands and buildings are often frequented by the community making them ideal candidates for demonstration projects, public education and community involvement.

Publicly owned properties within the watershed that may be suitable for LID retrofits and large-scale BMPs to control pollution from urban stormwater are identified in Figure 5-3 and a full list of candidate properties for further evaluation to identify appropriate BMPs are included in Appendix D.

<u>Ridgefield</u>
The municipally-owned buildings and parking lots located in Ridgefield Town Center offer a number of LID retrofit opportunities. Ridgefield Center is prone to increased stormwater runoff due to low topography and large areas of impervious surfaces. Ridgefield Center is located within the drainage area of Steep Brook, near the head waters of the Norwalk River. Steep Brook has seen consistently high counts of indicator bacteria over the years. Town parcels where opportunities for possible management measures exist include East Ridge Middle School, the public library and the Old High School. All of these areas, as well as large parking lots off Main Street, would benefit from retrofitting the existing parking areas and incorporating LID elements. In addition to the proposed projects, the area would benefit from IDDE investigation.

It should be noted that the United States Post Office in Ridgefield was also identified as a candidate property for further investigation. Although the post office is technically outside the watershed boundary, based on the modified topography of the parking lot, stormwater from the post office is directly connected to the watershed through a series of parking lots draining to Steep Brook.

- East Ridge Middle School presents the opportunity to serve as a highly visible demonstration project within the community (Figure 5-4). Retrofitting parking lots to allow for more bioretention and infiltration and the use of permeable pavement to increase the visibility of pedestrian walk ways and "no parking" areas will serve multiple purposes. The incorporation of pervious pavers, rain gardens and native plantings will highlight the school's assets while allowing for infiltration in the existing courtyards. Opportunities for stormwater disconnection also exist.

- The public library parking lot slopes directly towards Steep Brook with no vegetated buffer. Some trees are present along the brook with little to no understory or streambank vegetation. This lot has more parking space than necessary and could accommodate a vegetative buffer and bioretention basin along the brook (Figure 5-5).
- Sloping lawns in front of the Old High School could be designed to accommodate bioretention practices. The Old High School currently houses the Ridgefield Public School Offices, Ridgefield Play House, Yanity Gym and other town facilities used by the community, making this an ideal location for a variety of demonstration projects. The topography of the site makes surface bioretention difficult, but terraced gardens along the north and west lawns could be used to capture and filter runoff from parking lots, while existing vegetated parking islands could be converted to capture stormwater runoff. Different types of pervious pavement could also be integrated as walkways, driveways and parking lots are resurfaced Figure 5-6).
- Large municipal and privately owned parking lots off of Main Street on Governor and Prospect Streets would benefit from bioretention practices and a reduction of impervious area. Removing curbing from existing parking islands and the conversion of theses areas into depressed, vegetated areas for stormwater collection and infiltration would help to reduce runoff. The 2009 *Ridgefield Center Study* conducted by Milone & MacBroom contains a number of recommendations to improve vehicle and pedestrian access in Ridgefield's central business district. Recommendations from this study present a number of retrofit opportunities along with opportunities to integrate LID practices and other BMPs to reduce stormwater runoff. Figure 5-7 outlines potential retrofit opportunities. Additionally, as recommendations from Ridgefield Center Study move into design and engineering LID practices and other BMPs should be integrated wherever possible.
- Elevated levels of indicator bacteria have been documented in Great Pond and regular use of the area by non-migratory Canadian Geese has been observed. Great Pond would benefit from enhanced land care and debris management along with effective goose management practices (Figure 5-8). The use of low growing native vegetation and "no mow" areas adjacent to the beach will aid in deterring use of the park by geese. Interpretive signs may also be installed along with signs to discourage feeding waterfowl. The addition of these planted areas and increased bank side vegetation in the park areas will also help to filter stormwater draining to Great Pond. LID practices and other BMPs to reduce runoff from parking areas should also be explored along with goose management for adjacent private properties.

<u>Wilton</u>

The Norwalk River through much of Wilton flows directly adjacent to the Metro North Rail Road's Danbury Branchline and U.S. Route 7. A number of municipal and state owned properties are also directly adjacent to the Norwalk River.

- Lover's Lane has been the site of a significant streambank restoration project completed by Trout Unlimited. Unfortunately, portions of the restoration have been washed away or eroded due to two consecutive years with multiple large scale storm events. Efforts to re-stabilize and plant the streambank along these sections of river are necessary (Figure5-9).
- Several retrofit opportunities exist at the Wilton Train Station (Figure 5-10). The 2011 *Route 7*

Transportation and Land Use Study, Recommended Transportation and Land Use Plan prepared by Fitzgerald & Halliday proposes a parking structure at the train station in the existing parking lot, which would allow for the conversion of approximately 0.5 acres of parking directly adjacent to the Norwalk River to green space. As design begins for the proposed parking structure LID techniques should be used to capture all runoff from the new structure, which would reduce the total amount of stormwater currently generated at this location. Terraced Gardens installed on the hillside west of Danbury Road would filter and slow stormwater.

<u>Norwalk</u>

The lower reaches of the Norwalk and Sivermile Rivers flow through the City of Norwalk before reaching to Norwalk Harbor. Municipal properties along the River have retained buffered areas helping to stabilize the bank and filter stormwater runoff. In addition to maintaining the existing vegetative riparian buffers, retrofit opportunities have been identified at City Hall and the adjacent athletic field, Irwin Freese Park, Wolfpit Elementary School, and the Allen Road facility, all of which could also serve as demonstration projects.

- Malmquist Field and City Hall provide opportunities to capture and pre-treat stormwater runoff in a highly visible area within the City of Norwalk (Figure 5-11). Retrofitting the current parking islands with infiltration trenches and installing a stormwater basin at the south-east corner of the parking lot would help to treat and reduce runoff. The use of pervious pavement and the installation of a rain garden basin are also recommended for this site.
- Irwin Freese Park is a small pocket park directly adjacent to the Norwalk River. The installation of a new pervious foot path, diversion of runoff to a bioretention area prior to discharge to the river though an existing stormwater outfall and establishing a riparian buffer area would help to improve the quality of stormwater runoff from the park and local roads (Figure 5-12). In addition to establishing a riparian buffer planted with native grasses and forbs, native shade tress throughout the park would help to stabilize the soil and river bank, while providing needed shade.
- At Wolfpit Elementary School several opportunities exist to reduce runoff volume and use native vegetation to stabilize slopes while slowing and filtering runoff from the property (Figure 5-13). The use of a vegetated filter strip would encourage infiltration of stormwater from school parking lots, while a separate naturalized surface storage basin would collect runoff from the school's playing fields. The relocation of shade trees and areas planted with native grasses and wild flowers would provide slope stability and a buffer to wetland areas.
- Reduction of paved areas and expansion of the existing riparian buffer are recommended at the Allen Road facility, which houses the Senior Center (Figure 5-14). An underused parking area at the rear of the building could be converted to a stormwater basin. The retention basin would allow for treatment of stormwater before reaching the adjacent stream and provide water quality remediation for piped drainage from the parking areas, buildings, tennis courts and playing fields. The area would also benefit from widening and enhancing the existing vegetated riparian buffer.

<u>Plan Recommendation(s):</u>

- Specific properties among those identified in Appendix D should be explored for large-scale BMP implementation. Additional small-scale LIDs can be pursued around buildings and parking lots owned by state and municipal governments.
- Identify additional project sites that would serve as appropriate demonstration projects.

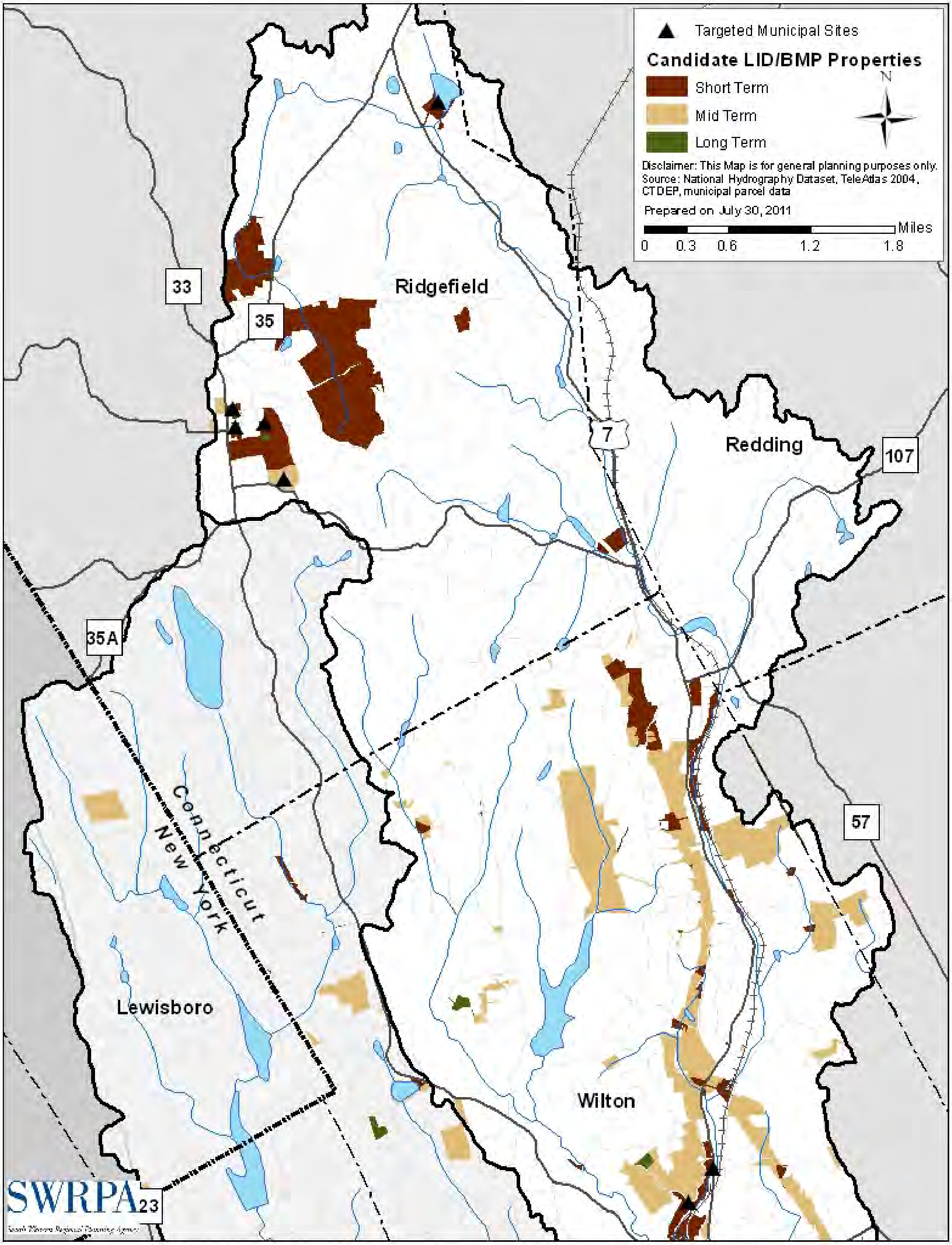


Figure 5-3a. Potential Public Lands Available for BMP/LID Implementation - Upper Watershed

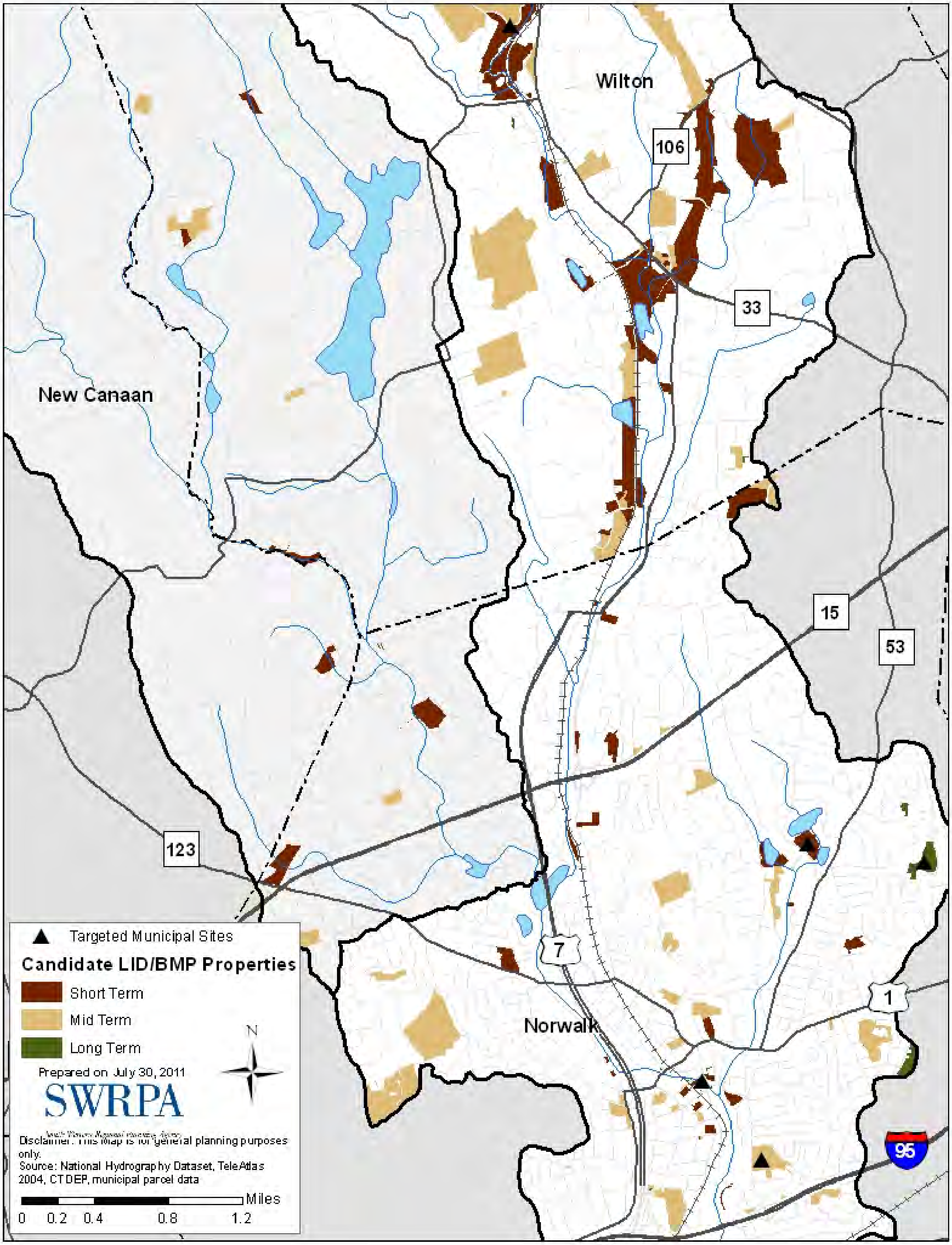


Figure 5-3b. Potential Public Lands Available for BMP/LID Implementation - Lower Watershed

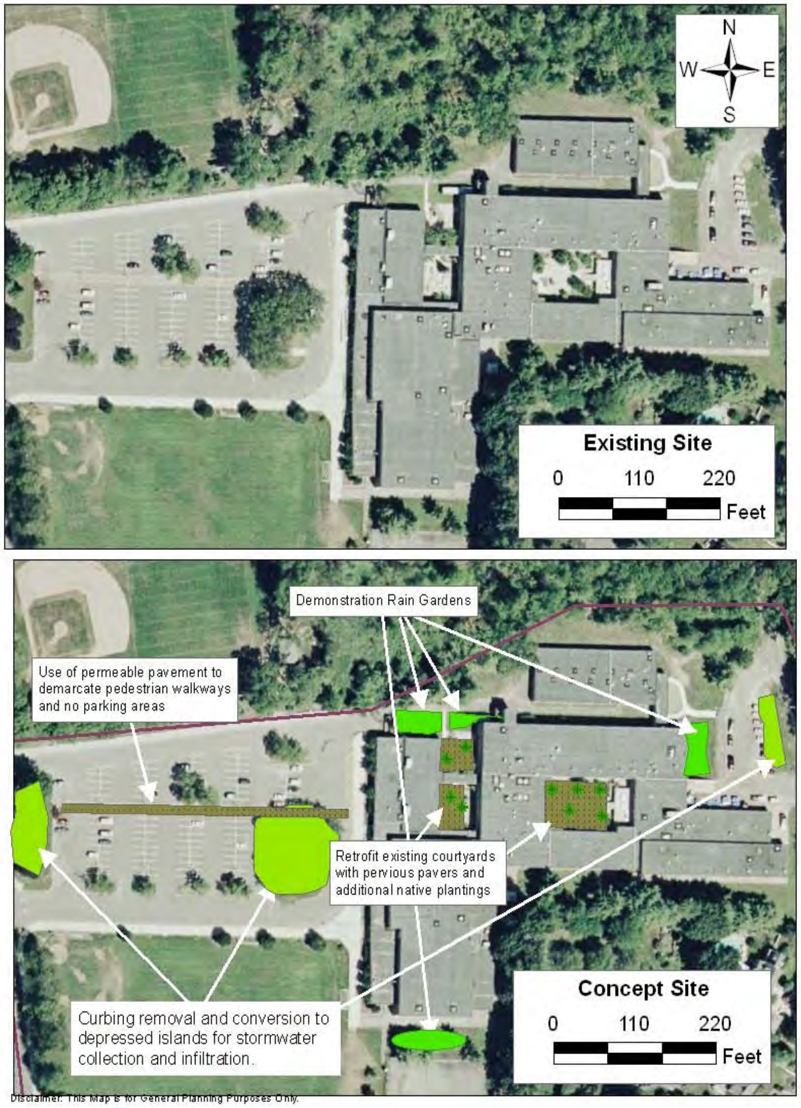


Figure 5-4. Concept Plan for East Ridge Middle School

Figure 5-5. Concept Plan for Ridgefield Public Library

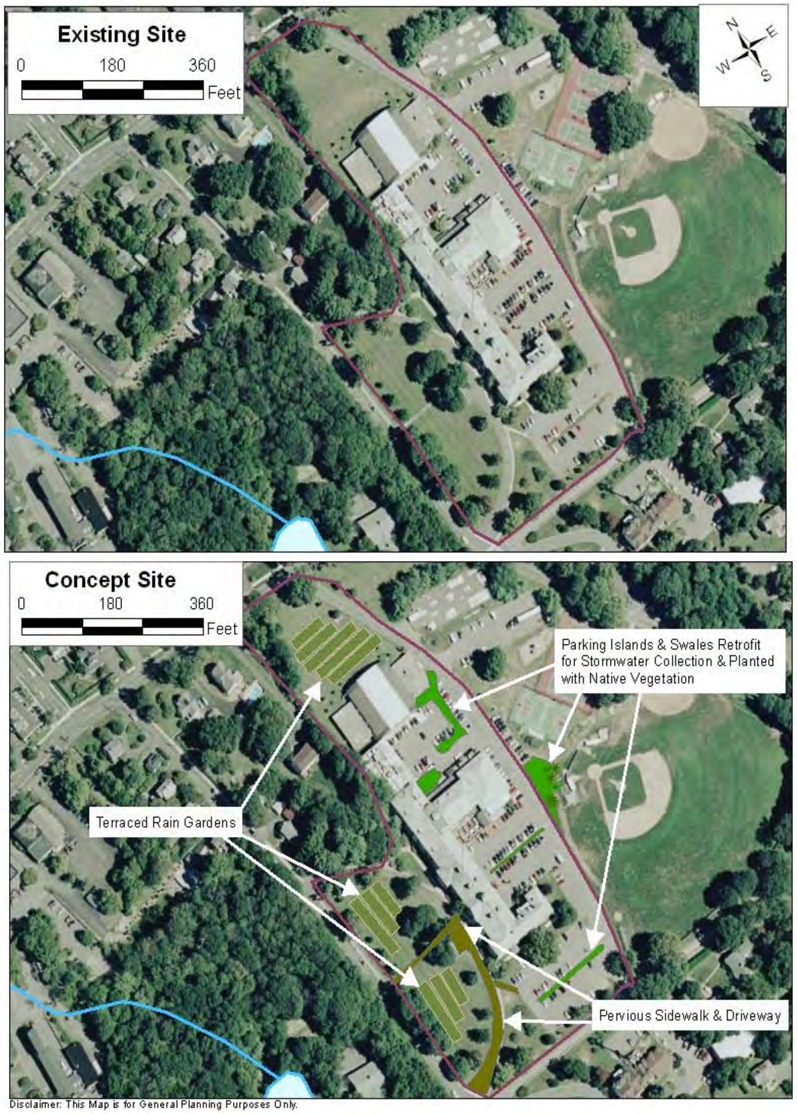


Figure 5-6. Concept Plan for the Old High School

Figure 5-7. Concept Plan for Governor and Prospect Street Parking Areas

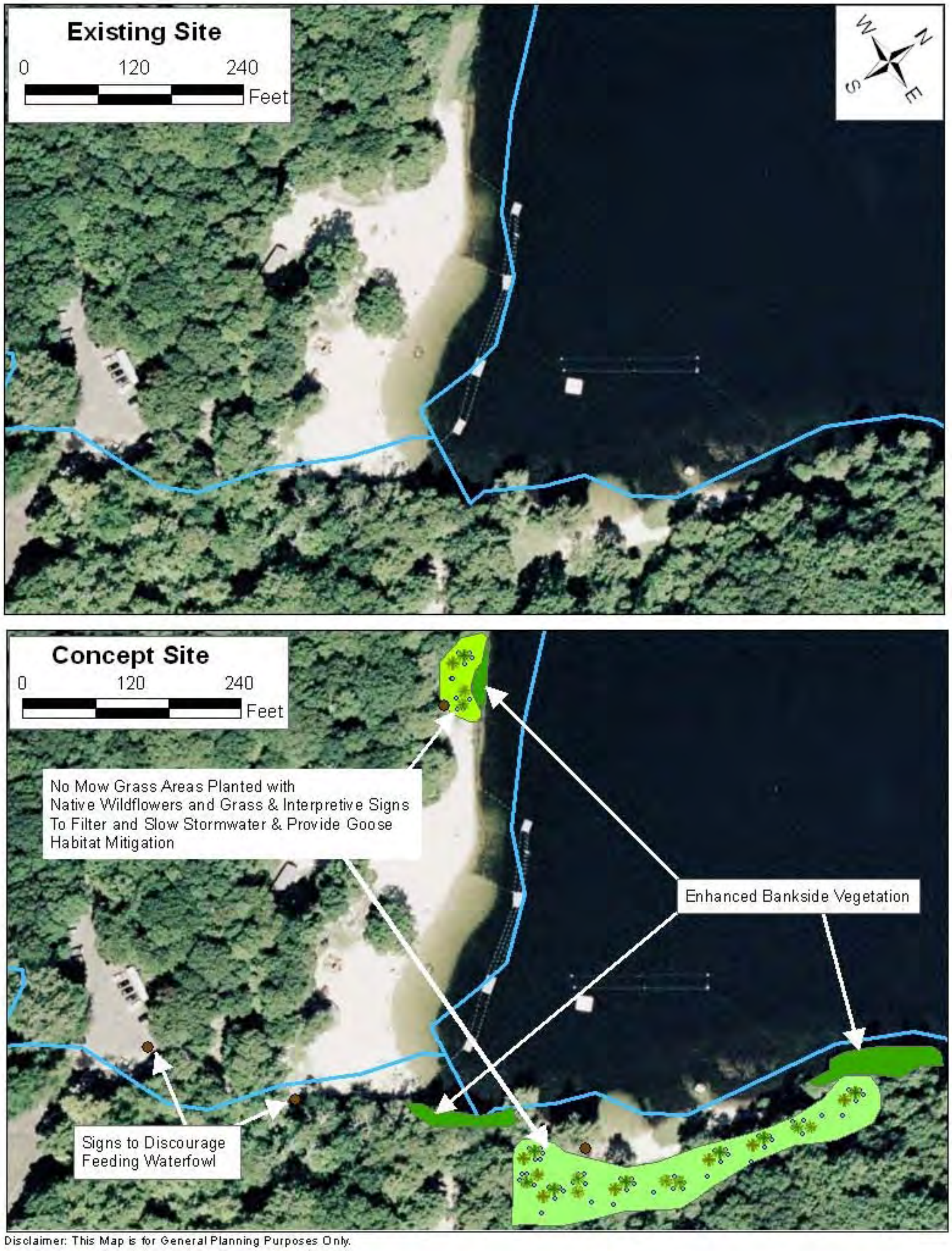


Figure 5-8. Concept Plan for Great Pond Park

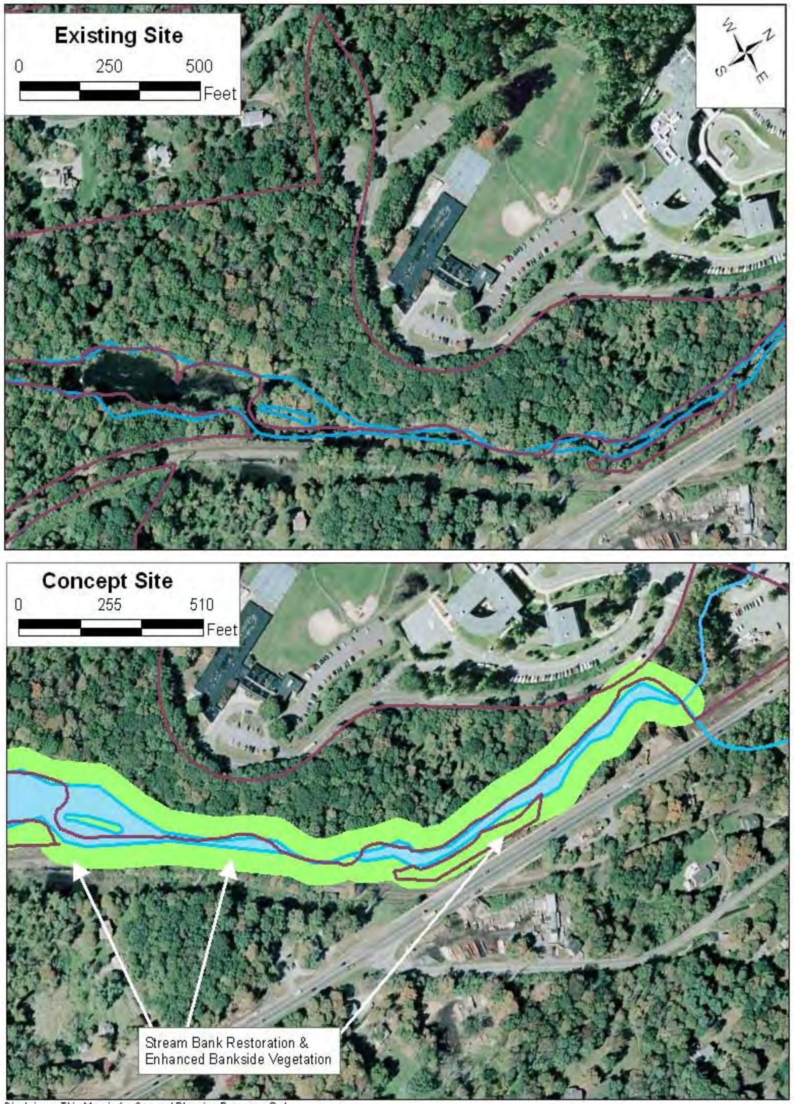


Figure 5-9. Concept Plan for Lovers Lane

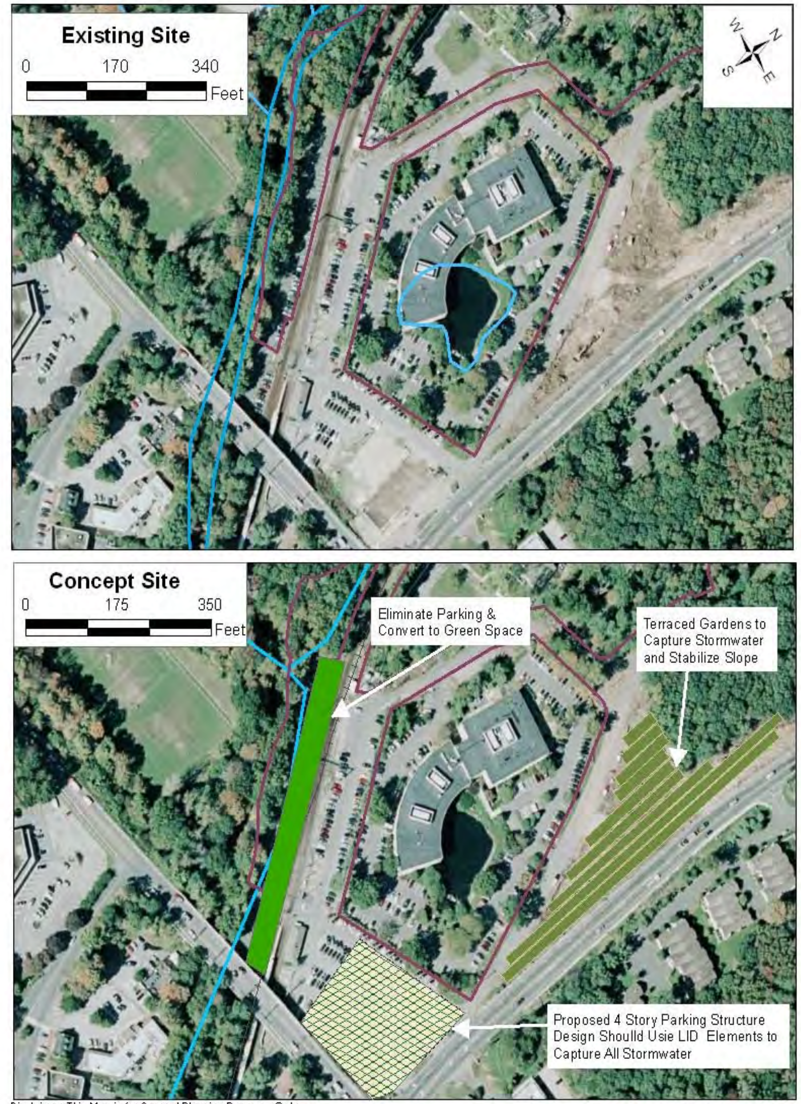


Figure 5-10. Concept Plan for Wilton Train Station

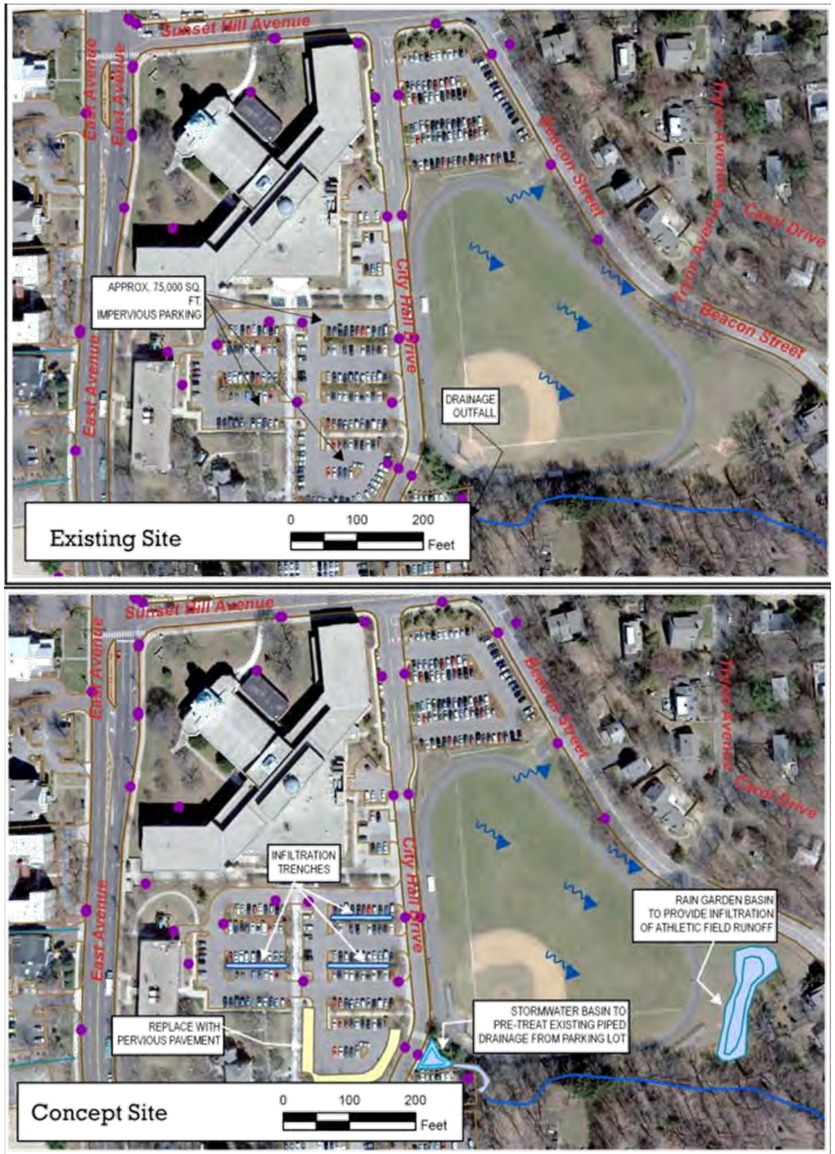


Figure 5-11. Concept Plan for Norwalk City Hall and Malmquist Field

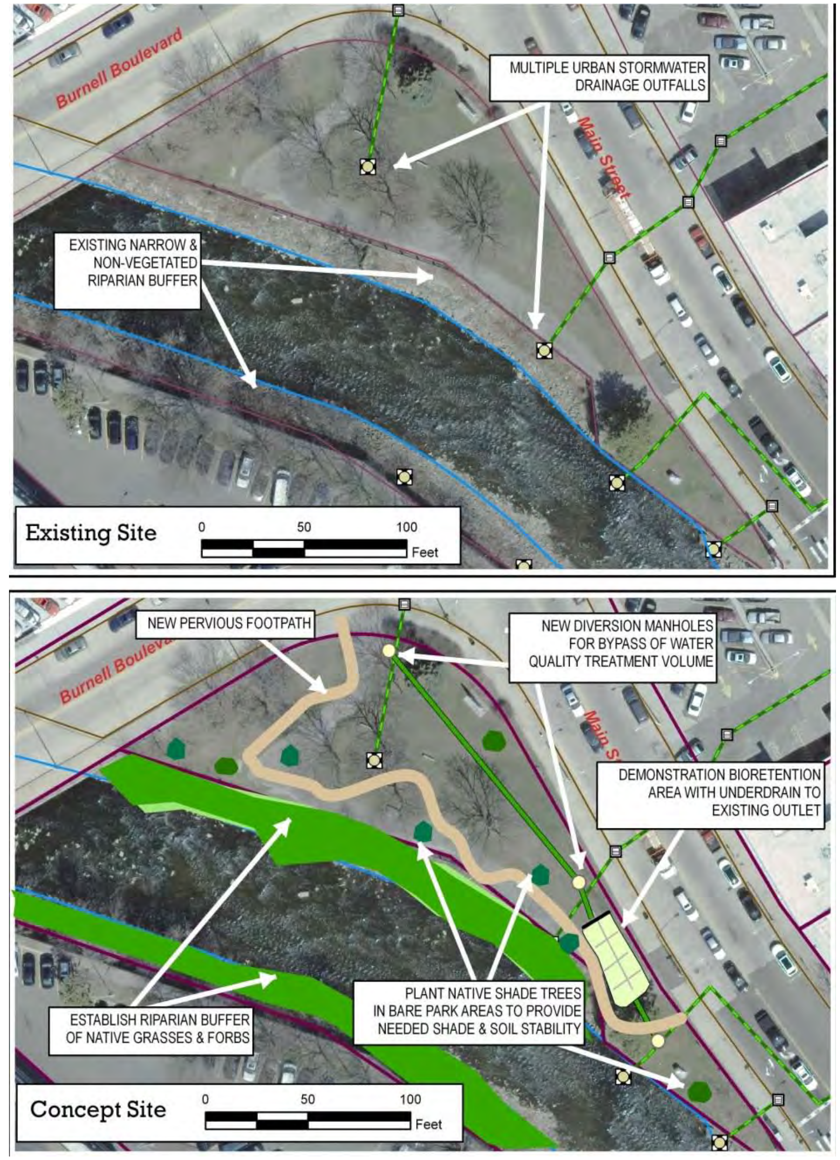


Figure 5-12. Concept Plan for Irwin Freese Park

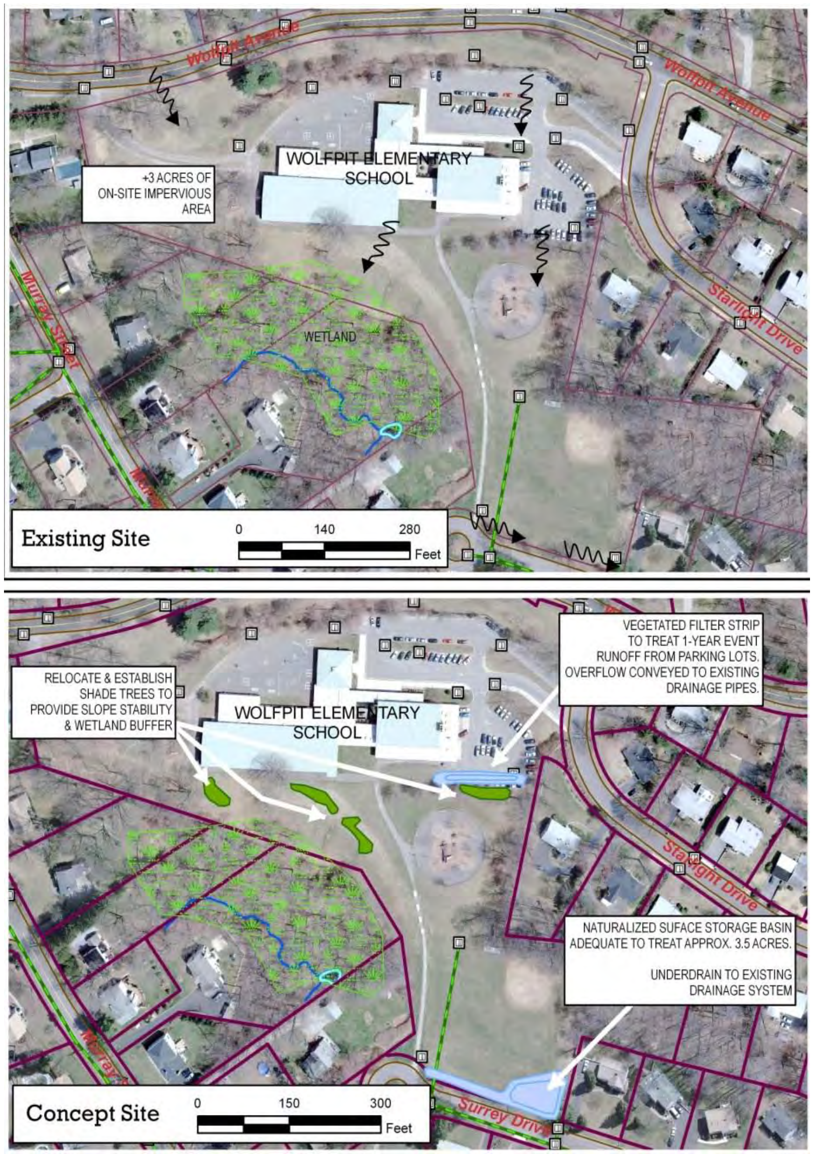


Figure 5-13. Concept Plan for Wolf Pit Elementary School

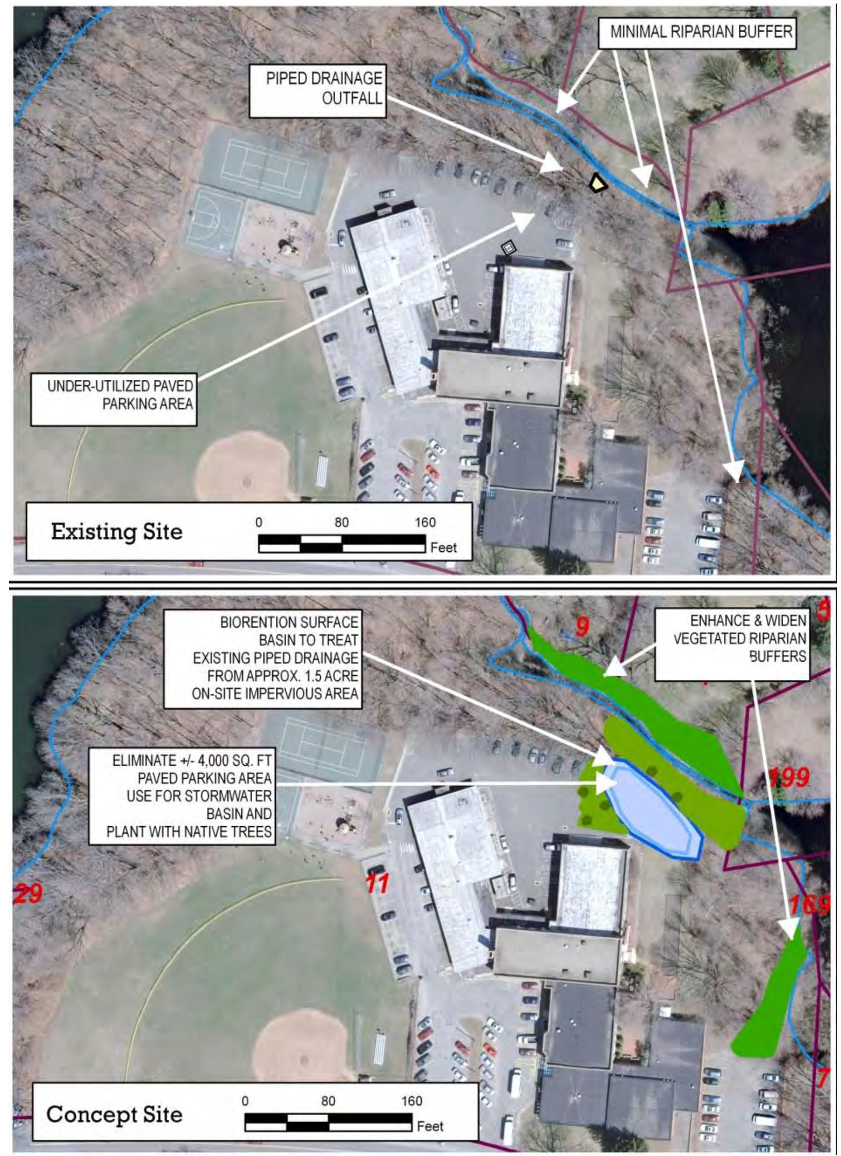


Figure 5-14. Concept Plan for Allen Road

5.2.2 Illicit Discharges

As discussed in section 5.1.1, illegal hookups to storm or sanitary sewers have been a major problem in the Norwalk River and its tributaries. The streamwalk report (NRCS, 1997; 1999) identified approximately 200 discharges into the waterways; however the actual number of illicit discharges was estimated to be much higher. Since 1997 work had been done to identify sources and eliminate discharges from illegal hook ups, with mixed success. Sources of illicit discharges could be difficult to identify.

HW/RW has been instrumental in identifying illicit discharges and working with municipalities to correct the problems. A 319 grant application was submitted by HW/RW in 2010 to conduct additional monitoring in Comstock Brook and Ridgefield Brook. Recently, HW/RW has identified the following hotspots where dry weather discharges with potential presence of sanitary flows had been observed:

- Ridgefield Brook, Ridgefield
- Washington Street, Ridgefield
- School Street, Ridgefield
- Middlebrook Farm Road/Comstock Brook, Wilton
- James Street/Silvermine River, Norwalk
- Wall Street/Norwalk River, Norwalk
- Moody's Lane/Silvermine River, Norwalk
- Cook's Nook, Norwalk
- Washington Street, Norwalk
- Marina / Norwalk Harbor, Norwalk
- Calf Pasture/ LIS, Norwalk

Further investigation is needed to identify sources for many of these hotspots and understand their impacts on the river water quality. For example, sump pumps that drain water from residential foundations are relatively clean since the source is primarily the groundwater infiltration. These are not likely to cause any significant water quality impairments, whereas the other discharges from sanitary and storm sewers can cause elevated pollutant concentrations. Sanitary sewers illegally connected to storm drains or directly into waterways can contribute excessive bacteria and nutrient loads. Similarly, the illicit storm sewer discharges to sanitary sewers can overwhelm their capacity and can result in sanitary sewer overflows (SSOs). Although diluted to some extent, the SSOs can result in excessive bacteria and nutrient loads being discharged into receiving waterways.

The six CT municipalities with boundaries within Norwalk River and its tributaries should continue to implement IDDE programs as required by the DEEP MS4 General Permit and a similar requirement for Lewisboro in accordance with the NYSDEC regulations. A range of methods or techniques are available to detect illicit discharges with varying manpower and financial resource requirements (NEIWPCC, 2003 and CWP, 2004). The following methods are commonly used by municipalities around the country for this purpose:

- Testing of Discharges during Dry Weather – Flows from stormwater outfalls during dry weather may indicate illicit sanitary sewer discharges. Tree root intrusions and leaky joints or pipe fractures can also bring groundwater during dry weather. A combination of visual inspections and monitoring on a seasonal basis and chemical analysis of dry weather discharges can help in detecting the discharge type (sanitary flow or groundwater) and quantity.
- TV Inspections – If the illicit discharges are confirmed through testing, closed-circuit television cameras can be utilized to track the pathways of these discharges. Advanced technologies can help in viewing lateral connections that may contribute flows to the storm sewers.
- Smoke Testing – Upon identifying the specific lateral sewers with illicit discharges, a non-toxic smoke can be injected from those sewers to track the pathways into individual homes or businesses.
- Dye Testing – Similar to smoke testing, this method can be used to detect sources. Appropriate colored dyes are added into the drain water of suspect piping. Appearance of the dyed water in the storm drainage system indicates an illicit discharge. Testing for anthropogenic indicators such as caffeine and optical brighteners can also confirm the presence of domestic wastewater flows.
- Infrared, Aerial, and Thermal Photography – Use of aerial, infrared, and thermal photography to locate patterns of stream temperature, land surface moisture, and vegetative growth that are emerging techniques to identify potential illicit discharges to stormwater systems.

<u>Plan Recommendations:</u>

- Perform detailed investigation for each of the identified illegal discharges to characterize the sources, and work with the watershed municipalities to correct the illicit discharges.
- Continue to perform illicit discharge monitoring and surveys.

5.2.3 DO Fluctuations

In general, the shallow sections of the rivers and creeks can exhibit low DO conditions during summer months due to high temperatures. This does not appear to be valid for the Norwalk River and tributaries where the DO levels have been in excess of 5 mg/L. However, reduced DO levels are observed at Sites NR21 and NR20 in the upper reaches of Norwalk River based on the HW/RW annual water quality monitoring data presented in Table 3-7 (Figure 5-15). It is suspected that the standing water in the Great Swamp when released into the river near Site NR21 causes this DO variation.

The approach to elimination of DO concerns for the Great Swamp location is discussed here. However, the approach will be very similar if other impoundments discussed in Section 5.3.3 on Algal Growth also exhibit DO concerns. Pollutant loads generated from individual land use types (high/low density urban, forestry, agriculture, etc.) need to be controlled, to the extent that they contribute to excessive algal growth in the impoundments or the DO fluctuations downstream of the Great Swamp. For example, the stressor identification study performed by DEEP in 2006 concluded from samples collected at location 1214 (Ridgefield Brook at Route 35 Fox Hill Condos) that urban land uses were contributing high TP loads and that there was anthropogenic enrichment from visual observations (CTDEP, 2006). Most samples exceeded 0.06 mg/L of TP, which is the 75th percentile of observations in the southwest coastal basin. Data at a location downstream of Great Swamp on the Norwalk River (Site ID 235 at Branchville) also showed similar trends. Both the Main and Route 7 wastewater treatment facilities in Ridgefield were documented in the DEEP (CTDEP, 2006) to contribute TP to the receiving waters.

Continued monitoring of DO levels at the location in the Norwalk River and the discharges from the Great Swamp are recommended. A finer scale land use analysis and pollutant load assessment model should be developed, incorporating the specific sources of nitrogen and phosphorus from contributing areas and the physical features of Great Swamp. Upon determining the numerical targets for pollution reductions necessary to improve DO levels in the Great Swamp discharges, BMP/LIDs can be accordingly planned and implemented in those drainage areas to reduce the loadings. Additional treatment technologies such as in-stream aeration or alum applications should also be evaluated for Great Swamp to determine the most effective means to increase the DO levels in the swamp.

<u>Plan Recommendations:</u>

- Perform detailed investigation for the Great Swamp discharges to determine the causes of eutrophication and associated DO variations. Conduct a comparative analysis of effluent data from the Ridgefield treatment plants and urban runoff contributions of TN and TP that get discharged into the Norwalk River.
- Conduct site-specific assessment of the Great Swamp, including the physical features and develop numerical targets for localized pollution reductions.
- Extend this methodology to other impoundments identified to have excessive algal growth in the Norwalk River watershed.

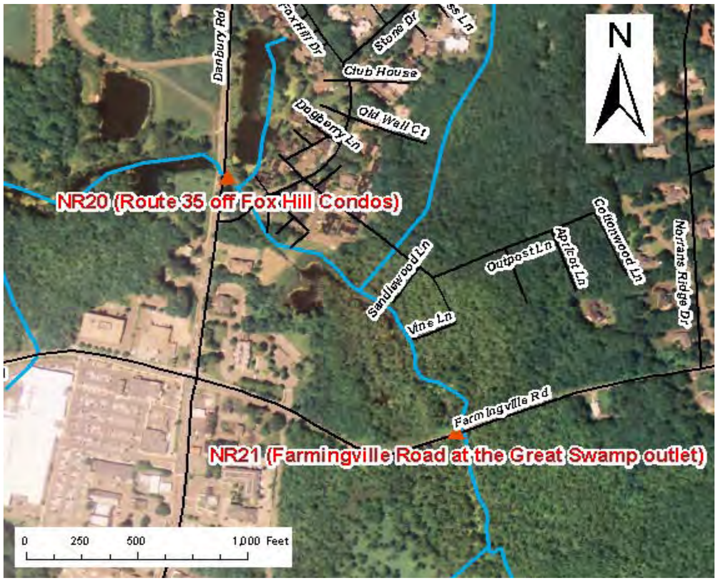


Figure 5-15. Pollutant Monitoring Site Locations: NR20 and NR21

5.2.4 Concerns on Algal Growth

Pollution control targets for nutrients, as discussed in Section 4 on the Estimation of Pollutant Loads, include: (a) 10% reduction in Total Nitrogen load from contributing non-point sources; (b) reduction in phosphorus loads from impoundments documented to have significant eutrophication and associated aesthetic concerns (see the Table below); and (c) reduction in septic system loads and nutrient loads from land practices such as fertilizer application.

Adoption of BMPs and LIDs will benefit the watershed municipalities in achieving these controls (EPA, 2008B). Since groundwater nitrogen concentrations are among the pollutant types, as recommended in the targeted strategies, process-based BMPs and LIDs that promote nutrient uptake (e.g., natural/engineered wetlands, bioretention units, and raingardens) need to be explored.

Other non-structural practices such as ordinance changes and education can be pursued to achieve reductions in nutrient loads. Based on nutrients loads reported in Farley and Rangarajan (2006) and Mullaney et al. (2001) for various Connecticut watersheds draining to the Sound, septic system failures and groundwater are the dominant sources for TN. Therefore, a combination of process-based BMP/LIDs (specifically bioretention and constructed wetlands), septic system repairs and proper operation and maintenance and public education will help in mitigating nutrient loads to eliminate this concern.

Excessive algae growth was documented during the Norwalk River streamwalk findings study (NRCS, 1997; 1999) at several sites, besides Great Swamp, distributed throughout the 26 sub-watersheds considered in that study. These are summarized in Table 5-1 grouped in terms of the watershed municipality that the sites are located in. Most of these sites involve small ponds (impoundments) and some involve stagnant sections that can promote algal growth. Based on a cursory review of these locations and adjacent land uses, septic systems and low/high density residential areas are the major sources of nutrients (specifically, phosphorus). While the percent reductions needed to eliminate eutrophication will vary from one impoundment to the other, recommendations such as restrictions on lawn fertilizers and working with homeowners to maintain septic systems will benefit all of these impoundments.

Similarly, the recent HW/RW monitoring program in the Norwalk River and Silvermine River had documented an additional hotspot (impoundment) with DO concerns, namely the outlet of a pond located on the Department of Development Services (146 Silvermine Road, Norwalk) property based on data at monitoring site SM 3.4.

Plan Recommendations:

- Additional site-specific monitoring and investigations are recommended to characterize the incoming nutrient and sediment loads, physical configurations of these impoundments (such as storage, depth, and shape), and environmental factors (temperature, leaves from trees, etc.). The overall process is identical to the procedure outlined in Section 5.2.1 for further investigation and study in the Great Swamp area, so that cost-effective controls can be undertaken.

- The local water quality monitoring data must be used to characterize the cause and effect relationships and guide the determination of numeric targets for nutrient pollution control.

- Where appropriate, explore in-stream treatment technologies (aeration or alum treatment) that can be most cost-effective for mitigating or eliminating localized eutrophication concerns.

Table 5-1: Impoundments with Excessive Algal Growth

Municipality	Impaired Site Description
Ridgefield	Stream 300 feet north of Topstone Road, adjacent to Route 7
	Small pond just southeast from the junction of Route 7 and Great Pond Road
	Small pond formed by 10 feet dam, just east of Limestone Road
	Outpost Inn pond, East side of Route 35 North of Farmingville Road
	John's Pond
	Three Road crossings. Small pond on North Cooper Pond Brook
Redding	Factory Pond
Wilton	Two ponds northwest of the Nod Road and Whipstick Road junction
	Small pond just north from Wilton Jr. High School, surrounded by athletic fields
	Small pond south of the impaired site, about 300 meters south of Cheese Spring Road to Rock Lake
	Kent Pond, off Linden Tree Road and Ridgefield Road
	Henderson Pond, south of Carriage Road and west of Ridgefield Road
	Small pond located just north from Old Highway Road
	Domenicks Pond and Trails End Pond, north from Huckleberry Hill Road
	Pond south from Gruman Hill Road
	Pond west from Grumman Road, on the west side of Route 7
	Site near water filtration plant at the outlet of the South Norwalk Reservoir
Norwalk	On the east bank of the stream, behind the courtyard of Buildings #101 and 201 on Route 7, near a stormwater outfall
	Site just north from New Canaan Avenue
	River section from the Wall Street Bridge and extending north to the railroad tracks bridge
	River section from the railroad bridge to the Route 123 overpass
	River section south of Wall Street Bridge, on the west side of river
	Small pond at 8 Shadow Lane on Woods Pond Brook
	From the north end of the harbor, extending south along the west shore to the Marina, including Sea View Park
	5 acre pond, in the Woods Pond Park

5.2.5 Bacteria Concerns

As documented in the indicator bacteria TMDL study (CTDEP, 2005), reductions from existing conditions in the range of 3 to 76% will be needed from the contributing non-point sources of pollution, in order to achieve the desired water quality improvements in the Norwalk River and tributaries. Urban stormwater was identified in the 2005 TMDL study as a major contributor to water quality impairment during wet weather. Wastes from household pets, hobby farms and wildlife are the common sources of bacteria in urban stormwater discharges.

A variety of BMPs and LIDs (e.g., vegetated swales, retention basins, and commercial filter media) have been implemented and monitored in a number of case studies from across the country to meaningfully reduce bacteria concentrations. In extreme circumstances such as Newport Bay (CA), full-scale disinfection systems, such as UV, have been built to reduce bacteria concentrations from urban stormwater prior to discharging to public beaches. None of the impairments in the Norwalk

River watershed will require such an extreme level of treatment of urban stormwater. In Norwalk River and its tributaries, leaky septic systems, illicit discharges and waterfowl are the major contributors; based on the water quality monitoring data and visual observations of stakeholders (e.g., NRCS, 1997; 1999; HW/RW monitoring data).

HW/RW has reported higher *E. coli* concentrations towards the City of Norwalk area due to storm drain runoff. Of the locations monitored only the sewage treatment plant (NR22) and Mill Road (NR9.5) exhibited acceptable levels of *E. coli*, and the remaining locations exhibited levels in excess of the state standards. Downstream of the monitoring location NR9.5, six major storm drains in Norwalk have dry weather discharges. The main river Site NR0.5 was documented to be moderately to heavily polluted, based on HW/RW data. Illicit discharge detection and elimination must be undertaken to identify the sources for these dry weather discharges and repair the sewers to eliminate the discharges.

High levels of bacteria observed near NR20 and NR21 are attributed to failing septic systems from households in this upper portion of Norwalk River. Recommendations provided earlier to address failing septic systems in terms of detection, enforcement to proper operation and maintenance, and education must be undertaken to improve water quality in this section.

High counts of *E. coli* were noted at a site in the Silvermine River (SM3.1) with counts as high as 40,000 coliform units per 100mL due to poor on-site septic system placement recently discovered by HW/RW near the James Street Bridge. Land use behavior of owners in waterfront properties including mowing land adjacent to the river, discarding of leaves and yard waste, overuse of fertilizers, feeding geese and lack of septic system maintenance have been observed in this general region shown in Figure 5-16. Specific recommendations are to fix the raw sewage hookup (using IDDE program recommendations provided earlier) to eliminate bacteria loads from this source; to work with the local community to promote proper yard maintenance adjacent to waterways; to manage waterfowl population.

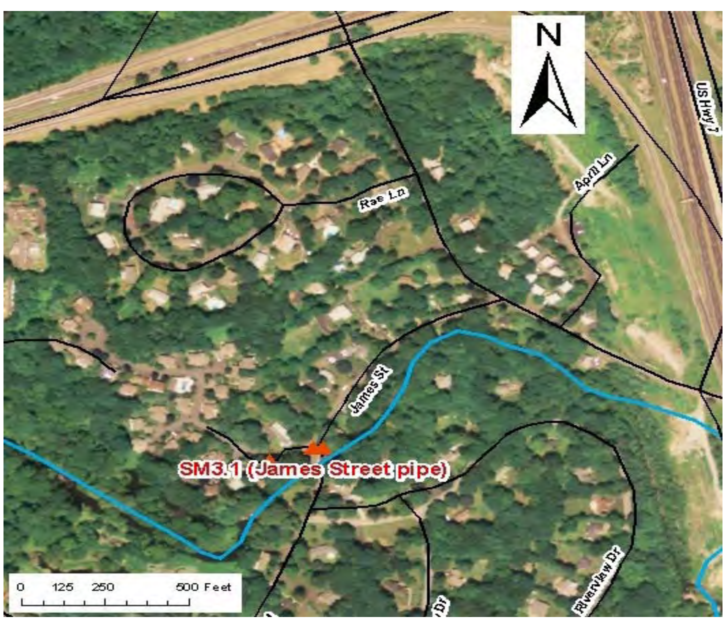


Figure 5-16. Pollutant Monitoring Site Location: SM3.1

High levels of bacteria observed at the following sites monitored by HW/RW, including SM6 (Silvermine Tavern shown on Figure 5-17) and SM3.1 (Figure 5-16) require further investigation to characterize the specific sources, so that appropriate remedial actions can be pursued.

High levels of bacteria have been observed near the confluence of Silvermine River and Belden Hill Brook and the source has been identified to be the large hobby farm located near this confluence (Figure 5-17). Water quality in the Belden Hill Brook upstream of the farm also shows exceedances. Additional monitoring and bacterial source tracking using techniques such as ribotyping and antibiotic resistance analysis can be used to demonstrate the cause-and-effects and educate/enforce to pursue remedial actions. It is recommended that the wastes from this farm are eliminated from reaching the waterways by undertaking measures such as animal waste pickup and proper disposal; and enhancement or preservation of riparian buffers.

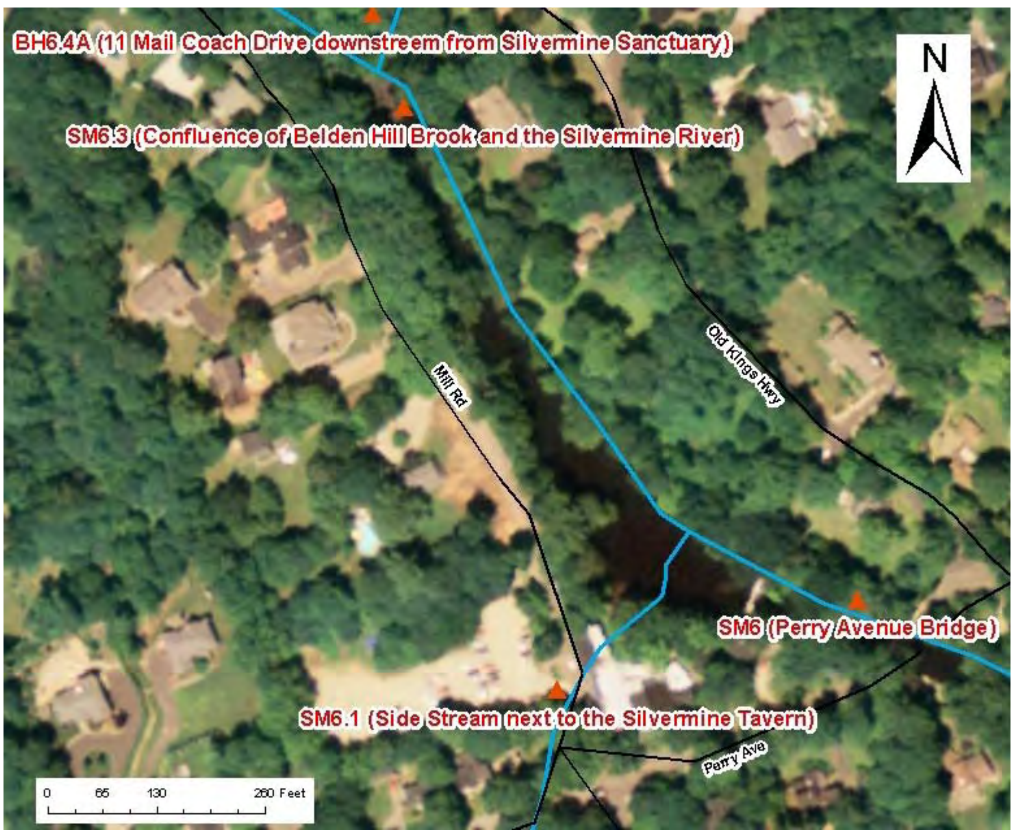


Figure 5-17. Water Quality Monitoring Sites Located at Confluence of Belden Hill Brook and the Silvermine River and Side Stream next to Silvermine Tavern

A pond alongside the Department of Mental Retardation is suspected to be a significant source of bacterial pollution (Figure 5-18). In addition, a number of impoundments including Cooper Pond Brook (Ridgefield), Factory Pond (Redding), a small pond south from Old Highway Road (Wilton) and five acre pond (Norwalk) were documented to have geese and other waterfowl population that would contribute bacteria loads. The recommendations provided earlier Section 5.1.7 for effective waterfowl management should be undertaken for each of these ponds and applied to other impoundments in watershed as appropriate. Continued water quality monitoring will aid in understanding the effectiveness of control strategies.

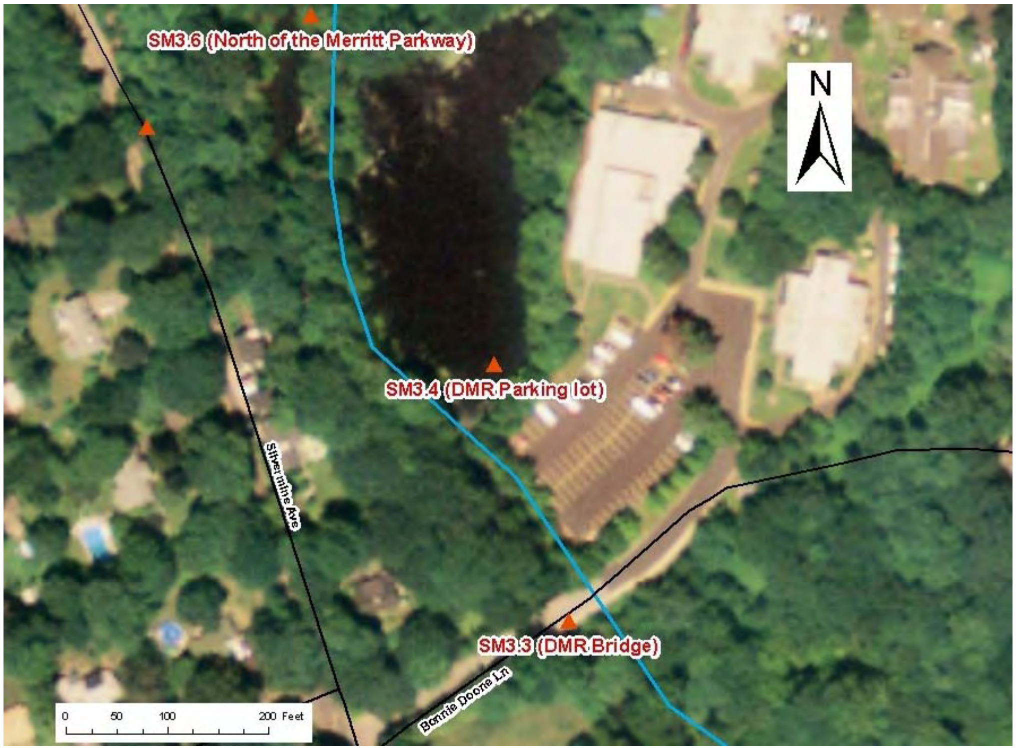
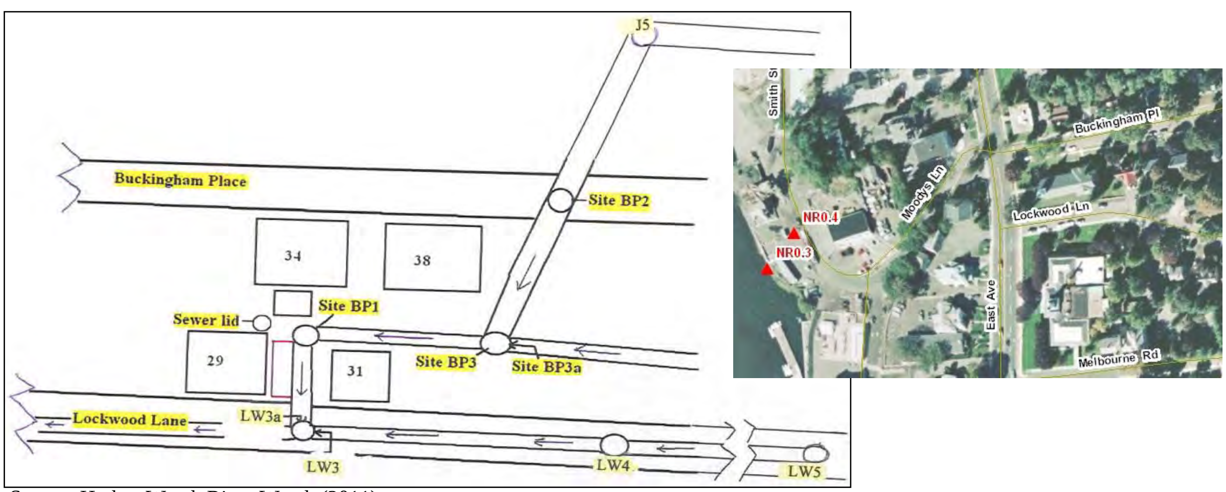


Figure 5-18. Pond alongside the Department of Mental Retardation

The storm drain system at Moody's Lane has been identified by HW/RW to have illegal hookups that need to be further inspected and verified using the DEEP IDDE procedures. Several potential illegal hookups have been identified and are shown in Figure 5-19. Based on recommendations made by HW/RW, the City of Norwalk has incorporated an investigation to verify the sources of illicit discharge sources into the pipe replacement project about to begin in the Lockwood neighborhood. Upon verification, immediate efforts to eliminate these illicit discharges should be undertaken.



Source: Harbor Watch River Watch (2011)

Figure 5-19. Potential illicit discharges to the Moodys' Lane site (HW/RW Monitoring)

Several sites along Comstock Brook showed high levels of bacteria including off of Middlebrook Farm Road in Wilton and in Ridgefield at Steep Brook near Governor Street showed high bacteria levels. Waterfowl is attributed to be the main source along with some hobby farm animals. Pet waste management and waterfowl control will help to address these impairments, which can be confirmed with subsequent water quality monitoring after implementation of these controls.

Plan Recommendations:

- Illicit discharges to storm sewers are among the primary contributors of bacteria loads to the Norwalk River and Silvermine River. Continue to monitor locations such as SM3.1, SM6 (Silvermine Tavern) and Moody's Lane and use the recommendations provided in Section 5.2.1 to track and eliminate the dry weather bacteria sources.
- Failing septic systems appear to contribute to bacteria contamination in the upper portions of Norwalk and the Silvermine River reaches. The recommendations provided for septic system operation and maintenance must be followed to eliminate this source of bacteria.

5.3 Targeted Recommendations

In addition to watershed-wide and site-specific strategies, some targeted recommendations are provided with the goal of reducing bacterial and nutrient pollutant loads to the Norwalk River or its tributaries.

5.3.1 Identification of Large Private Lands for BMP/LID from Implementation

Large private properties such as institutional, industrial, commercial and institutional buildings and lots may also offer tremendous opportunities for BMP/LID implementation based on the amount of stormwater generated within or upstream of these properties. While LIDs can be implemented anywhere in a watershed, these large properties can be amenable to large structural BMPs such as retention basins, constructed wetlands and wet ponds that can provide significant reductions in nutrient and bacteria loads. The MS4 permitting process by individual watershed municipalities can offer the permitting framework to require these large private property owners to pursue BMP/LIDs. Additional incentives such as tax breaks or cost-sharing grants can be provided to accelerate the implementation process.

The property ownership information was reviewed to identify private non-residential properties targeted for BMP and LID installations (Figure 5-20) The NRWI will identify candidate sites for suitable BMP and LID installation and work with property owners of the target properties to identify and implement projects to control pollution from urban stormwater.

Plan Recommendation(s):

- Begin to work with owners of target privately owned lands identified in Figure 5-20 to incorporate LID practices and explore opportunities for large-scale BMP implementation into their existing landscapes, rehabilitation and the future development projects.

- Work with all Stormwater General Permit Holders to begin a constructive dialog and identify and support additional to include innovative approaches, such as incorporating vegetative buffers and rain gardens, instead of or to supplement subsurface structures.
- Initiate and offer incentives and offer technical assistance through low-cost methods including, but not limited to webinars, online documents and the following websites: www.ct.gov/dep/stormwater.

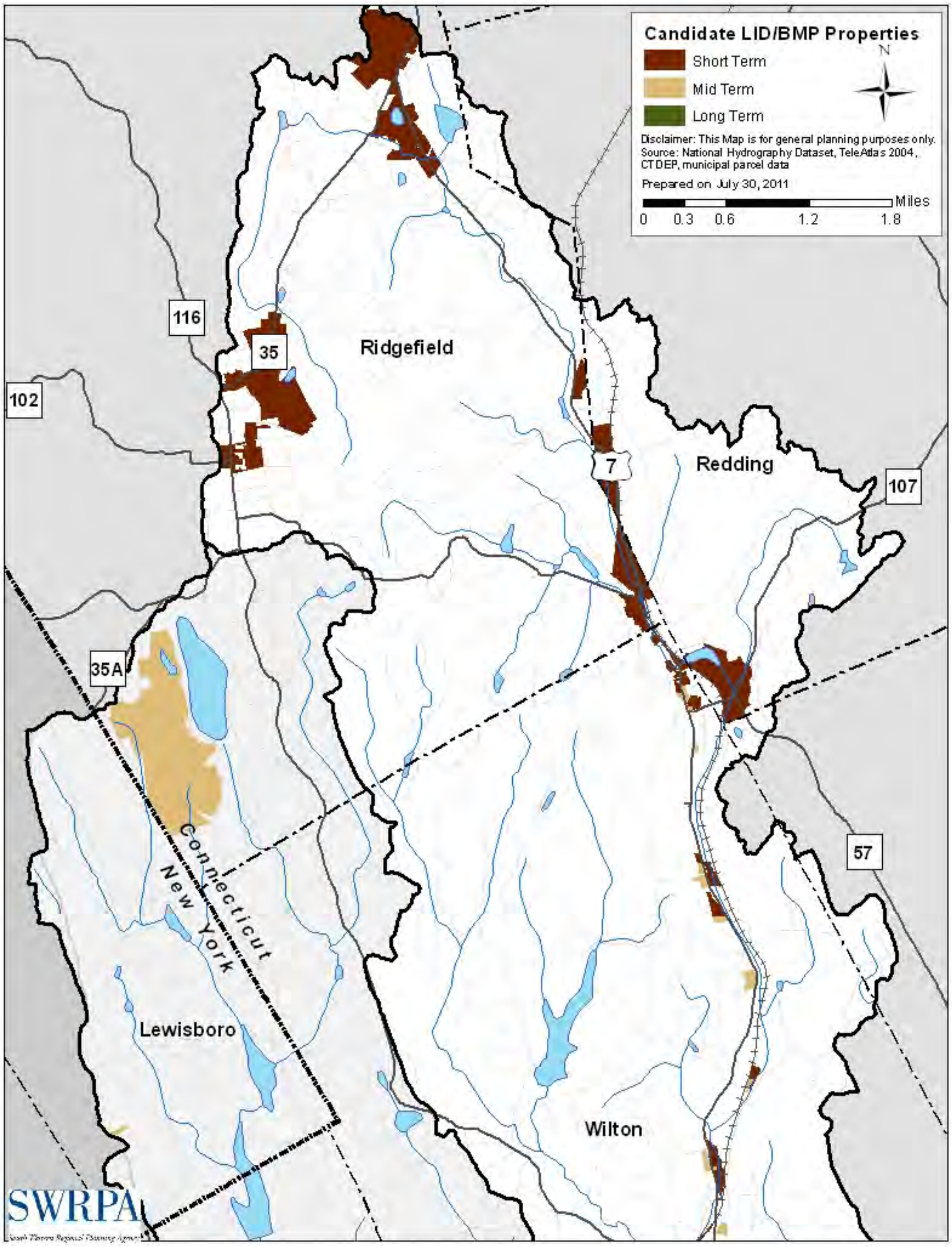


Figure 5-20a. Potential Private Lands Available for BMP/LID Implementation – Upper Watershed

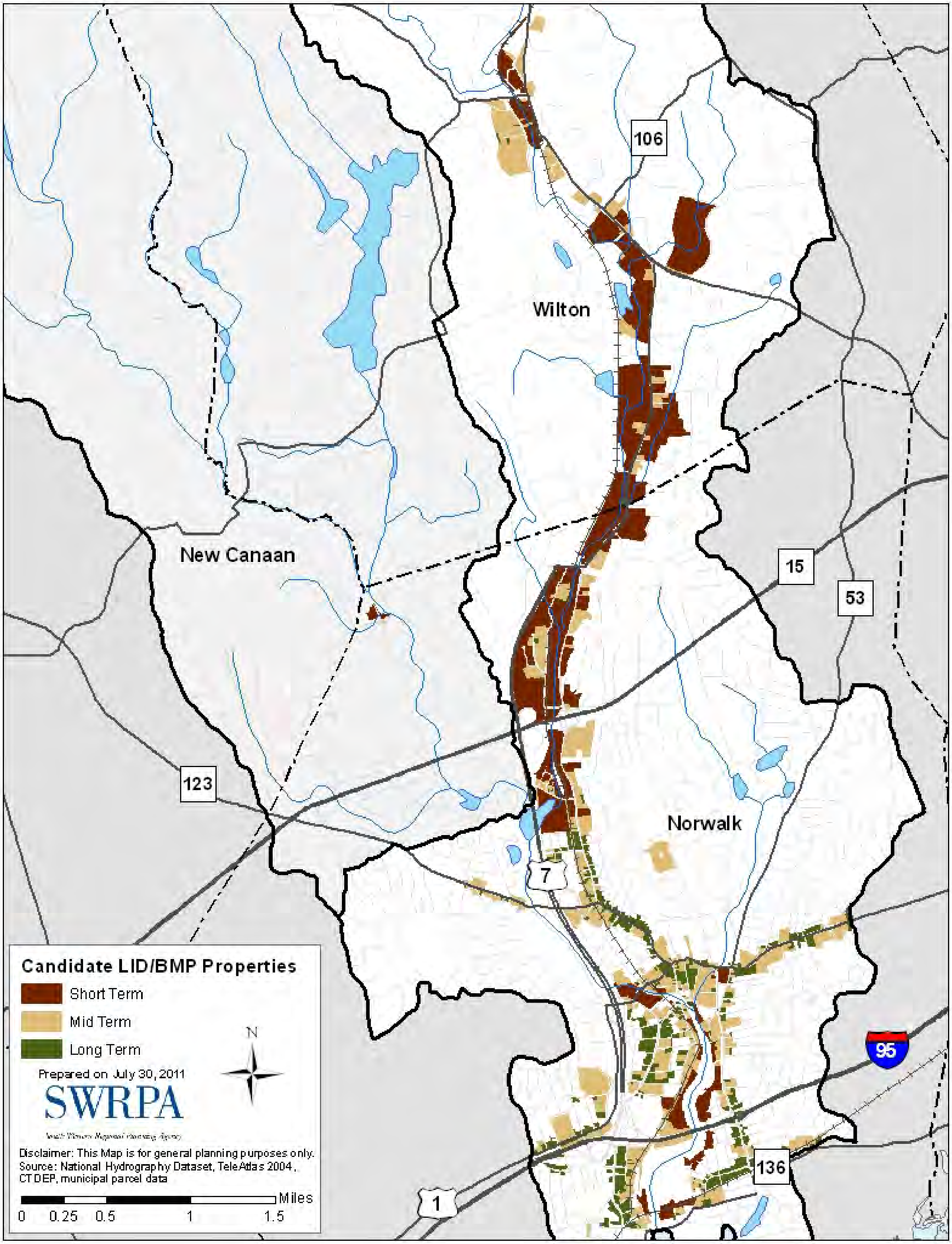


Figure 5-20b. Potential Private Lands Available for BMP/LID Implementation – Lower Watershed

5.3.2 Nutrient Loads from Groundwater

Significant amount of nitrogen reaches the Long Island Sound through groundwater sources. Nutrients infiltrating into the groundwater reappears in streams as base loads and the residence times are in the range of two to more than 50 years (Mullaney et al., 2006). This source is the most challenging from a control standpoint, as the benefits will be seen only after a long-term and after investing significant financial resources.

Plan Recommendation(s):

- Encourage adoption of process-based BMP/LIDs (e.g., raingarden, constructed wetlands, and bioretention) to uptake nutrients instead of infiltrating into groundwater.
- Evaluate the need and potential costs associated with treatment technologies for removing nitrogen from groundwater (e.g., Permeable Reactive Barrier, alternative septic systems, and STP expansions, in-stream wetland in upper reaches with high septic system density).

5.3.3 Dam Removal

In addition to potential eutrophication behind the dams that exist in the Norwalk River watershed and tributaries, impoundments also impact on fish migration. The dams along the Norwalk and Silvermine Rivers provide few benefits in terms of water storage for flood attenuation due to their "run-of-the-river" configuration. An inventory of impoundments in the watershed identified 51 dams in Wilton, 10 in New Canaan, 23 in Ridgefield, 10 in Redding, 16 in Norwalk, and three in Lewisboro, New York (Figure 3-7).

NRWIC (1998) specifically discussed three significant impoundments: the Flock Process Dam, the dam at a Wilton recreational site (Merwin Meadows) and the dam at Cannondale that had posed biggest obstacles to anadromous and coldwater fisheries. There are other dams in the watershed that are privately owned by homeowners and businesses, but for recreational or aesthetic purposes.

The presence of these dams in the watershed causes many problems. As mentioned above, a number of these dams on the Norwalk and Silvermine Rivers pose a barrier to fish migration. Dams tend to disrupt the natural flow of a river preventing the movement of sediments and nutrients, leading to a build up of sediments behind the dam, which can reduce channel depth and change the species present in a waterway. In addition, the numerous dams located throughout the watershed also provide detention time for the uptake of nutrients. This, in turn, promotes the growth of plants and algae, resulting in eutrophication.

Plan Recommendation(s):

- Develop a list of in-stream impoundments on first and second order streams and prioritize impoundments for removal based on the impacts to water quality
- Develop targeted strategies to reduce nitrogen and phosphorus inputs to the impoundments of concern, which may be more restrictive than the strategies adopted elsewhere in the watershed.

- Support connectivity through dam removal across the watershed moving forward on the removal of the Merwin Meadows (a.k.a. Dana) and Flock Process dams. Support projects for installation of fish ladders in locations where dam removal is not feasible.

5.3.4 Transportation Corridors

As discussed in Section 3, the Norwalk River and its tributaries are intersected by several major transportation corridors including I-95, U.S. 1, U.S. 7 and CT 15, also known as the Merritt Parkway, that provide east-west and north-south transportation routes. Approximately 7 square miles of the overall watershed area is covered by transportation corridors. On a national level, the impact of these corridors on water quality had not been studied well until the last decade. Several states such as California, Maryland, Texas, Florida and Delaware and the Federal Highway Administration (FHWA) have done recent and extensive research and monitoring programs to quantify the pollutant loads for constituents such as metals, suspended solids and nutrients from atmospheric deposition (Young et al., 1996; Currier et al., 2001; NCHRP, 2006; and FHWA, 2010). From water quality modeling studies performed in the Long Island Sound, about 13% of the nitrogen enrichment gets washed into the tributaries through in-basin atmospheric deposition and direct deposition on the Sound (NYSDEC and CTDEP, 2000). Some specific challenges associated with treating highway stormwater discharges for nitrogen attributed to atmospheric deposition include:

- Stormwater management vs. Highway Safety
- Limited right-of-way
- Highly impervious drainage areas
- Extensive cuts and fills
- Spill potential for hazardous material and associated cleaning/liability issues
- Use of deicing and anti-skid materials
- Higher concentrations of pollutants (e.g., metals and solids)
- Thermal impacts in summer and winter

Numerous BMPs and LIDs can be applied specifically for transportation corridors as summarized in the following documents. Process-based BMPs such as bioretention and constructed/ natural wetlands that can treat stormwater generated from road surfaces will significantly reduce nutrient and bacterial pollutant loads from this source. In major highway corridors, the existing catch-basins can be retrofitted to receive stormwater after receiving treatment from these BMPs. Availability of land may not be an issue in major corridors. For smaller road networks in dense urban areas, retrofitting of traffic triangles and areas between curbs and sidewalks may have to be retrofitted to design small-scale process-based BMPs.

In order to facilitate the prioritization of BMP implementation, Figure 5-21 provides the ratio of transportation corridor to the area of each subwatershed in the Norwalk River watershed. Similarly, Table 5-2 provides a list of subwatersheds with high density of transportation corridor areas that can be pursued in the near future to control nutrient and indicator bacteria pollutant loads. A threshold of 8% has been set as high density to support this prioritization process.

Table 5-2: Priority Subwatersheds with High Density of Transportation Corridors

Subwatershed	Municipality	Total Area (ac)	Transportation Area (ac)	Transportation Area Density (%)
7300-00-09	Norwalk	2,653	326	12.3
7300-18	Norwalk	1,370	138	10.1
7300-01	Ridgefield	421	36	8.5
7300-17	Norwalk	429	36	8.4

A number of examples and design guidance are included in the documents below.

Low Impact Development Design Manual for Highway Runoff Control (LID Design Manual) http://www.coralreef.gov/transportation/evalbmp.pdf (accessed in January 2011)

User's Guide for BMP/LID Selection (Guidelines Manual) http://www.coralreef.gov/transportation/manual.pdf (accessed in January 2011)

Evaluation of Best Management Practices for Highway Runoff Control, Transportation Research Board, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_565.pdf (accessed in January 2011)

Fact sheets, design considerations, guidance manuals, for BMPs for roads and highways, USEPA Office of Watersheds, Oceans and Wetlands, http://www.epa.gov/owow/NPS/roadshwys.html (accessed January 2011)

Plan Recommendation(s):

- Promote the use of grass-lined swales and other bioretention practices along both major highways and local roadways, using a prioritization process recommended in Table 5-2 with priority subwatersheds for immediate implementation of BMPs.
- A recent study of Route 7 completed by SWRPA recommends that LID techniques be applied to all new development in the corridor and specifically within the recommended development nodes to manage the quality and minimize the volume of added stormwater runoff to the Norwalk River, and supports the development of the Norwalk River Valley Trail.

5.3.5 Water Quantity

Flows in the waterways are generally reduced in summer months due to lower groundwater levels discharging minimal baseflows into the streams. Total flow consists of baseflow, runoff from summer rain events, interflow (runoff that leaches into the stream through soil), and in portions of the watershed, discharge from the sewage treatment plants. DEEP performed a baseflow evaluation for the Norwalk River by comparing summer flows to other similar CT watersheds such as Saugatuck and concluded that there were no baseflow concerns. There are inter-basin transfers from Comstock Brook, with flow transfer records maintained by the 2nd water district.

Plan Recommendation(s):

- In anticipation of DEEP's regulations on water quantity, the tributaries with significant water withdrawal for source water supply such as Comstock Brook and Silvermine River need to be monitored during summer months to evaluate if there were any impact on fish and other benthic communities.

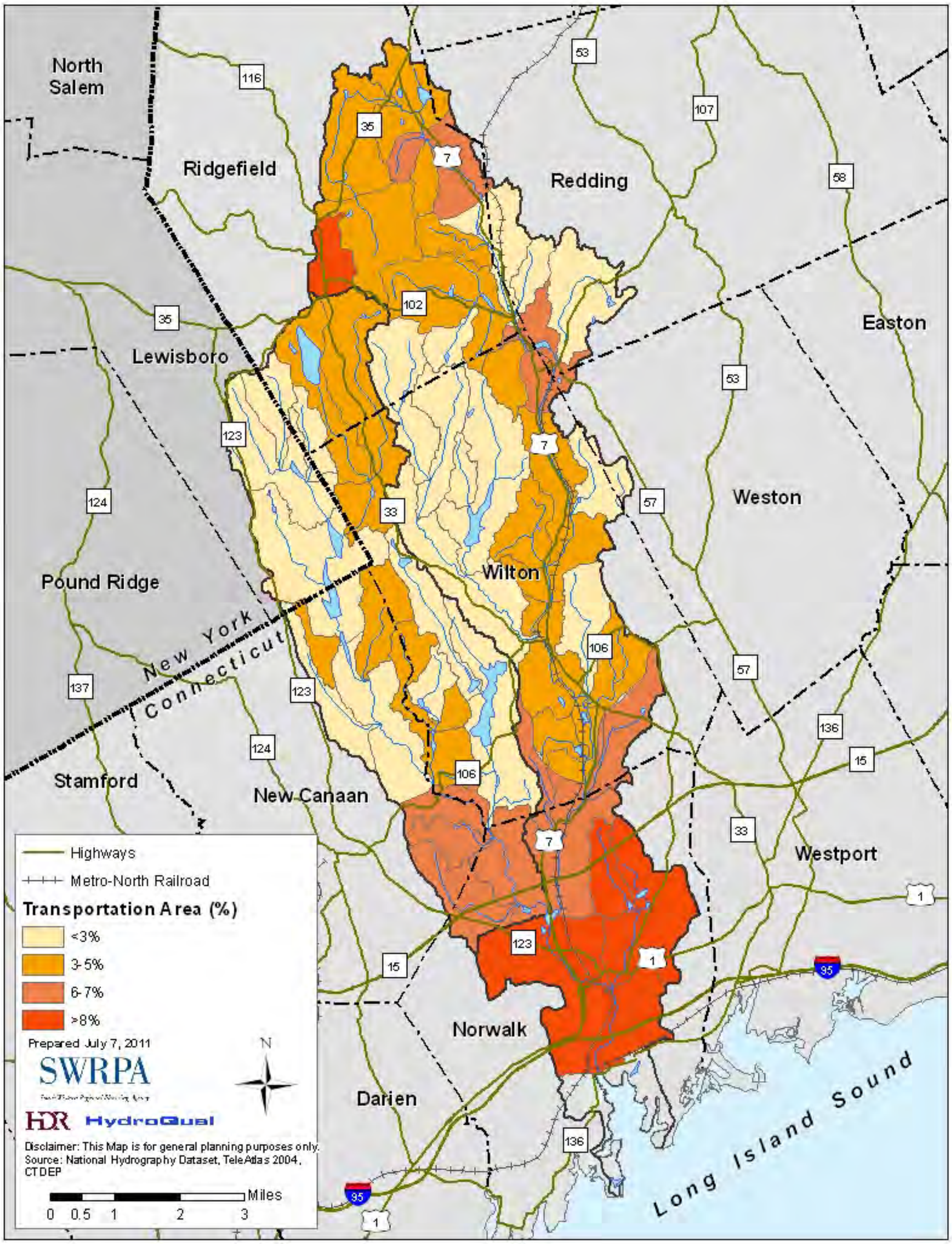


Figure 5-21. Transportation Corridor Density in Subwatersheds of the Norwalk River

5.3.6 Conductivity Concerns

HW/RW has reported high levels of conductivity at the water quality monitoring sites in Ridgefield shown in Figure 5-22, possibly due to the presence of marble and calc-silicate bedrock. Dramatic spread in conductivity at the Ridgefield sites compared to the Norwalk sites has been a concern. Conductivity is a measure of electric current which reflects the concentration of salts in the water and that conductivity testing is often used to measure salinity. Certain species of aquatic insects can be extremely sensitive to small changes in salinity which could impact the food chain.

Conductivity in a stream can vary as a function of flow. As flow decreases, the concentration of total dissolved solids (TDS) can increase, thereby increasing the conductivity. Similarly, as flows decline, water temperatures have a tendency to increase, thus affecting conductivity values.

<u>Plan Recommendation(s):</u>

- Specific additional water quality monitoring should be performed to confirm the sources as well as the extent of this concern. Literature values exist to correlate conductivity and TDS so that the load reductions can be estimated as pounds per day for to support the implementation of corrective measures.

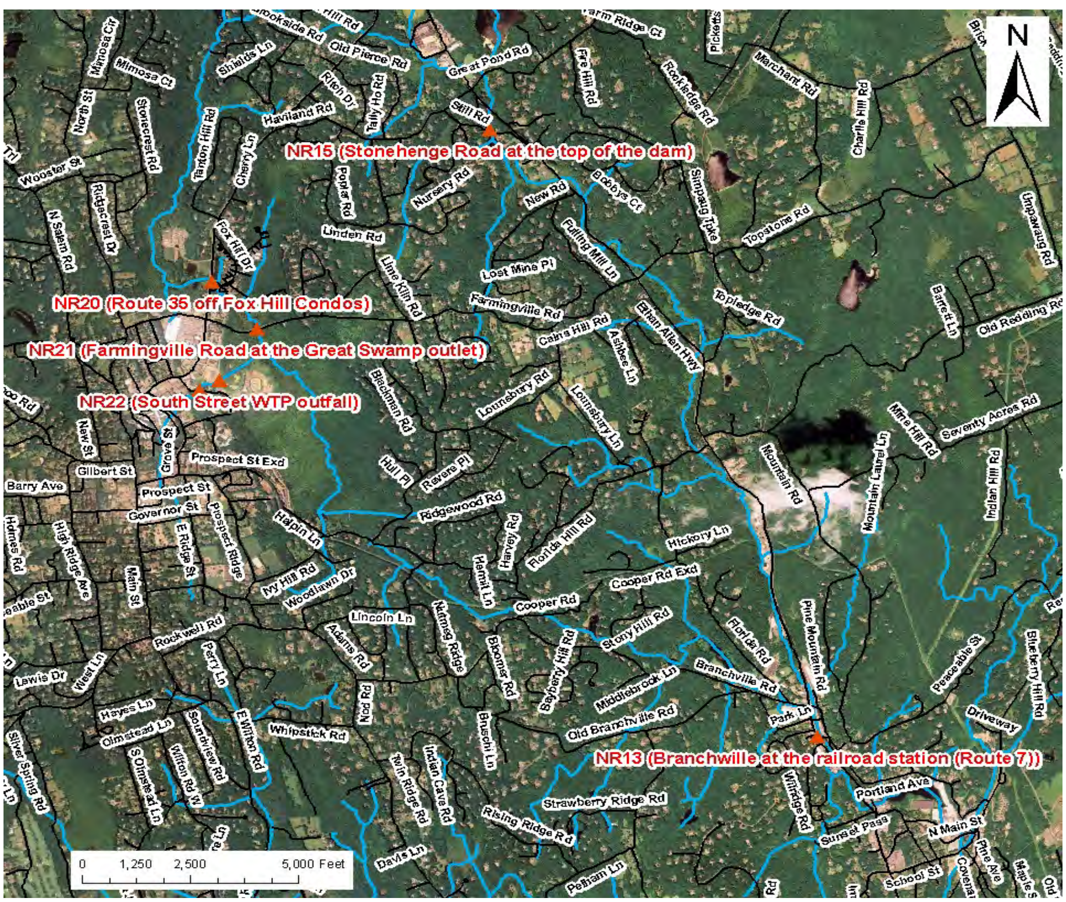


Figure 5-22. Water Quality Monitoring Sites with High Levels of Conductivity

5.3.7 Road Sand

Historically sand has been applied on roads and highways in winter to provide traction for vehicles. Road sand is transported by stormwater to the waterways and impacts water quality (e.g., sedimentation and degradation of fish habitat). NRWI completed the survey of current practices used by various municipalities and held an alternatives workshop for the watershed towns. Ridgefield, Norwalk, New Canaan and Redding have switched to pretreatment option with brine, and Wilton is in the process of switching. Sand is currently only being used in combination with salt in locations that pose a safety concern (e.g. steep hills and sharp curves).

Frequent cleaning of catch basins, capture using treatment technologies such as swirl separators or other BMPs prior to reaching the waterways, would help to reduce the impacts of road sand and other pollutants transported from roadways.

Plan Recommendation(s):

- Develop an implementable action plan through discussions with watershed municipalities' Department of Public Works (DPWs) to reduce the impacts of sediments from roadways on the river through, frequent cleaning of catch basins, capture using treatment technologies such as swirl separators or other BMPs prior to reaching the waterways and LID practices.
- Work with DPWs to develop a regular monitoring and maintenance scheduled for catch basins and drainage structures and prioritize street sweeping to maximize efforts within the watershed.
- Develop a comprehensive map of stormwater infrastructure within the watershed.
- Review deicing practices regularly and adopt practices less harmful to water quality and wildlife as appropriate.

6. PLAN IMPLEMENTATION

6.1 Management Measures

The specific set of management actions reflecting the recommendations described in Section 5 are outlined below, in order to provide a footprint for initiating and implementing projects in the Norwalk River and its tributary watersheds. The recommendations, as shown in Table 6-1, are grouped under each of the objectives identified in Section 2. It must be recognized that some specific management measures could help in achieving more than one objective, but the summarization simply reflects the closest (primary) objective that an individual action would help achieve. This summary is a living document as individual actions can be taken out once they are completed and additional actions can be added based on hotspots or priorities chosen for action based on field inspections or the focus of specific funding mechanisms sought.

Some of the implementation efforts can possibly be explored and acted on with relative ease and a shorter timeframe (months to a year or two). Typical examples are review of ordinances to develop watershed-wide consistent stormwater regulations, field inspections to verify the causes of high DO swings, etc. Some other efforts or actions will require longer timeframes for implementation due to the funding needs, coordination among watershed stakeholders, design and permitting, and construction tasks. Watershed stakeholders can use these recommended actions or measures to pursue specific funding mechanisms and undertake projects.

6.2 Interim Milestones and Schedules

Interim milestones, final outcomes and performance metrics for assessing the success of individual action items are summarized in Table 6-1, along with the stakeholders who can potentially lead the specific action items. These will also help the stakeholders in tracking the progress in watershed management efforts and achievement of watershed goals and objectives over time. Again, these can be used as guidelines and be further refined by stakeholders during the WBP implementation process.

Goal	Objective	Task	Objectives and Associated Action Items	NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				Implementing Organizations																			
B	0	0	**Goal B: Habitat Restoration** (Preserve and enhance wildlife habitat)																				
B	2	0	***Objective B-2: Minimize loss of habitat values coincident with land use practices***																				
B	2	4	Work with local open space policies to identify intact habitats and high functioning ecosystems for protections and preservation	x		x													2-4 years	–	Habitats identified in each watershed town	–	W
B	2	5	Encourage articulation of habitat restoration & protection as a goal in municipal, regional & state Plans (POCDs).	x		x	x												2-4 years	–	Habitat goal included in all POCDs	–	W
B	3	0	***Objective B-3: Restore diadromous and resident fish passage***																				
B	3	2	Press forward on the removal of the Merwin Meadows (a.k.a. Dana) and Flock Process dams			x					x			x					1-2 years	–	Restoration of fish passage and natural hydrologic regime	–	S
B	4	0	***Objective B-4: Preserve and restore in-stream habitat***																				
B	4	2	Support in-stream restoration efforts lead by local organizations	x					x										1-2 years	–	Member participation and/or letter of support for grant funding	–	W
B	4	3	Identify additional habitat restoration opportunities from stream walks and determine technical and financial assistance required	x					x										1-2 years	–	Prioritized list of detailed restoration opportunities	–	T
B	4	5	Install and maintain BMPs (i.e. sediment traps) at all discharge points to the river			x													2-4 years	Identify suitable locations for BMPs	Sediment traps installed	% of discharge points with BMPs, implemented maintenance schedule	S
B	5	0	***Objective B-5: Maintain, enhance and increase riparian buffer areas***																				
B	5	1 a	Adopt a targeted program to correct pollution from the hotspot areas identified in D-2-3a, including but not limited to field inspections, technical guidance, monitoring and enforcement	x															2-5 years	Completion of riparian corridor analysis	Maps identifying riparian areas and conditions, with prioritization shown in color-coded format	% of watershed area completed in each WM	W
B	5	1 b	Implement riparian restoration projects based on sites identified in B-5-1a			x			x					x					2-5 years	Grant award	Riparian corridors restored or rehabilitated	# of identified areas restored (Target is one project per year)	T
B	5	2	Promote the use of grass-lined swales and other bioretention practices along both major highways and local roadways, using a prioritization process recommended in Table 5-2 with priority subwatersheds for immediate implementation of BMPs.			x	x						x						1-2 years	Training (Classroom and Field)	Implementation of swales and bioretention practices with high level of effectiveness for indicator bacteria load reduction	% of transportation corridor treated by BMP/LIDs, with a target of 50% in 10 years	T
B	5	3 a	Conduct a more detailed watershed-wide tree canopy analysis, based on currently available data to determine the extent of tree cover and establish baseline conditions				x												1 year	Grant award and contractor selection	Existing tree canopy maps for various municipalities	% of watershed area completed, in each WM	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
B	5	3 b	Quantify the value of urban forestry and tree programs for improving the aesthetics, energy efficiency and air quality, wildlife habitat, recreational opportunities, real estate values, and potential job opportunities using tools such as the one developed by Center for Neighborhood Technology				x												2 years	Adoption of a valuation tool for the entire watershed	Quantified values on a watershed basis for communication with public	Completion of analysis and review in a stakeholder meeting	W
B	5	3 c	Track progress in the implementation of tree canopy cover on a watershed-wide level	x		x													Every 3 years	Grant award	Comparison of tree canopy cover to quantify benefits	% increase in canopy cover, with a target of 5% every 3 years	W
B	5	4	Develop a comprehensive urban forest master plan that integrates the LID benefits and sets a watershed-wide urban tree canopy goal			x													1-2 years	Partnership among WMs to perform this work	Urban forest master plan	Completion of the plan report	W
B	5	5	Review the quantified benefits of increased buffer zones from states such as New Jersey to accelerate the buy-in and establishment of appropriate regulations. Also review the Riparian Toolbox that EPA-LISO had put together	x															1 year	Grant award to perform this review	Compiled documentation for all stakeholders' reference	Document completion	W
B	5	6	Expand existing public education program to emphasize the value of riparian buffers and improvement of regulations to protect them		x	x								x					1 year	Curriculum expansion	Education and outreach documents	% representation from each WM, in terms of geographical coverage of the watershed	W
B	5	8	Support legislation that protects and repairs riparian zones	x	x	x													1-5 years	Letters of Support	Statewide riparian protection	Legislation Passed	W
B	5	9	Continue support of projects and programs to remove trash and debris	x					x										2-4 years	–	Member participation in clean-up projects	Member participation in clean-up projects	W
C	0	0	**Goal C: Land Use/Flood Protection/ Open Space** (Promote Balanced Growth Which Preserves Property Values and Protects and Enhances the Watershed's Resources for Future Generations)																				
C	1	0	***Objective C-1: Identify appropriate areas for public access to the rivers and streams and increase public access where appropriate.***																				
C	1	4	Support the Norwalk River Valley Trail (NRVT) Committee for greenway designation and trail development	x															1-2 years	–	Issuance of letter of support	–	S
C	2	0	***Objective C-2: Promote inclusive land use planning for natural resource conservation.***																				
C	2	1	Encourage watershed-based land use planning	x		x	x											x	1-2 years	–	Round table discussion with all noted implementing organizations	–	W
C	2	2	Develop a framework and complete a comparative review of land use, open space and zoning regulations for all watershed municipalities				x												1-2 years	–	Information collection and exchange between municipalities	–	W
C	3	0	***Objective C-3: Recognize the importance of maintaining and increasing open space to ensure proper functioning of the watershed.***																				
C	3	1	Promote balanced growth which preserves property values and protects & enhances watershed resources for the future	x		x													1-2 years	–	Local land use decisions inclusive of watershed resource protection	–	W
C	3	3	Develop an open space map for the watershed and identify key parcels beneficial for preservation			x													1-2 years	–	Watershed-wide open space planning map	–	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
C	3	4	Identify, preserve and enhance areas important for flood storage and conveyance	x		x													1-2 years	–	Development protective of flood storage	–	W
C	4	0	***Objective C-4: Reduce the frequency and severity of flooding***																				
C	4	1	Educate residents living within flood plains and flood prone areas of the vulnerability to flood damage and practices to protect and mitigate their property and families	x		x													2-4 years	–	Educational information for distribution	–	W
C	4	3	Implement strategies identified in the current Predisaster Mitigation Strategy Documents, http://www.swrpa.org/Uploads/SWR-PDM_2011-Final_reduced.pdf; and local and Regional Plans of conservation and development.			x													Ongoing	–	Reduced vulnerability and damage as a result of flooding	–	W
D	0	0	**Goal D: Water Quality** (To restore and protect surface and ground water to meet State water quality standards throughout the watershed such that the Norwalk River supports its designated and existing uses)																				
D	1	0	***Objective D-1: Eliminate illicit discharges to storm sewers***																				
D	1	2	Continue the illicit discharge investigations and follow up for all hotspots identified during field reconnaissance/monitoring. The hotspots exhibit continuous discharges during dry weather periods and also involve exceedances of indicator bacteria criteria in the waterways during such periods			x		x											1-2 years	Completion of IDDE programs	Videos, maps to confirm sources	# of sites investigated and scheduled for immediate remedial action by all WMs. Target is 100% in 10 years	S
D	1	3	Continue work to eliminate illicit discharges			x		x											Ongoing	Improved water quality	Elimination of hotspots	# of hotspots removed from the list, comparison of pre and post-removal monitoring data to show progress - Target of 100% in 5-10 years	W
D	2	0	***Objective D-2: Improve solid waste and liquid waste management throughout the watershed***																				
D	2	1	Establish criteria to identify poorly-functioning on-site septic systems in the watershed to facilitate implementation of inspection and O&M programs	x		x	x												1-2 years	Acceleration of controls for septic systems	Consistent criteria for all WMs to pursue inspection and O&M	Completion of a technical memorandum on criteria based on EPA guidance and other case studies	W
D	2	2	Conduct an inventory of areas in each municipality where the greatest potential for a concentration of poorly-functioning on-site septic systems are located and include a brief description of the primary factors that contribute to these problems	x		x	x												1-2 years	Watershed wide documentation	Documentation from all WMs with previous complaints or records on poorly functioning systems	A map of potential areas with greatest number of such systems to prioritize the subsequent inspections and actions	W
D	2	3 a	Develop a combination of GIS-based and advanced technologies such as infrared photography to identify hotspots that are affected by septic system failures			x	x												2-4 years	Grant to pursue this work	Mapping of hotspots to facilitate the control and O&M programs	# of maps created in the watershed for action by individual WMs; a report with findings	W

Goal	Objective	Task	Objectives and Associated Action Items	NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				Implementing Organizations																			
D	2	3 b	Adopt a targeted program to correct pollution from the hotspot areas identified in D-2-3a, including but not limited to field inspections, technical guidance, monitoring and enforcement			x													1-5 years	Completion of inspections and monitoring	Elimination of failed septic systems through proper O&M	# of systems brought to normal operations - Target is 100% over 5 years	S
D	2	4	Publicize and promote adequate maintenance of on-site septic systems, using a variety of media and outreach techniques	x		x													1-2 years	Outreach material	Effective communication with public on the importance of inspection and O&M aspects	% of watershed covered for public outreach - Target is 100% in 1 year; % of population that maintain their systems without failures - Target is 100% in 10 years	T
D	2	9	Work with municipalities to develop a program to address potential environmental issues with poorly-functioning septic systems	x		x												x	1-2 years	Establishment of program	Training/workshop	Completion of the program for consistent use by all WMs	W
D	8	0	***Objective D-8: Continue water quality monitoring, data collection and assessment***																				
D	8	1 a	Continue the annual water quality monitoring program and modify procedures as necessary. Results can be used to track improvements from watershed-wide and site-specific pollution control measures and understand watershed responses under different hydrologic regimes					x			x								Annually	Successful grant applications	Data collection and water quality reports	Continued Monitoring	W
D	8	1 b	Evaluate and communicate water quality trends	x				x			x								Annually	Data analysis	Historical trend and comparisons	analysis completed every 5 yrs, funding permitting and results shared with stakeholders	W
D	8	1 c	Publish a yearly water quality summary report	x				x											Annually	–	Annual monitoring reports	Completion of annual report	W
D	8	2 a	Coordinate monitoring for wet and dry weather conditions to characterize potential sources of water quality impacts in hotspots for indicator bacteria and nutrients					x			x								Ongoing	Detection of sources	Isolation of hotspots and sources contributing pollution during dry weather determined	# of hotspots recommended for immediate remedial actions	S
D	8	2 c	Continue to support 'hotspot' pollution response practices and appropriate solutions to eliminate pollution source			x		x			x								Ongoing	Detection of sources	Isolation of hotspots and sources contributing pollution during dry weather determined	remedial actions and improved water quality after remediation	S
D	8	4	Design and implement monitoring of LID practices on a demonstration basis and develop performance data to specifically support LID planning in the Norwalk River and tributary watersheds	x			x				x			x			x		1-4 years	Performance evaluation data compilation	Field monitoring and characterization results and the associated scientific report	# of pilot projects completed (goal of 6 different LID types over 4 years)	S
D	8	5	Seek funding to further evaluate TN and TP nutrient loading	x				x			x								2-4 years	Grants	Funding	Additional Nutrient Load Assessment	W
D	8	8	Reactivate the streamwalk program to support public outreach and also use volunteers for physical, chemical and biological assessment of stream health in the watershed	x															Ongoing	Grant/ volunteer sign-up	Annual Streamwalk	Annual Streamwalk held	W

Goal	Objective	Task	Objectives and Associated Action Items	NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				Implementing Organizations																			
E	0	0	**Goal E: Non-Point Source Runoff Management** (Reduce the cumulative impacts of development and non-point source pollution in runoff)																				
E	1	0	***Objective E-1: Reduce the cumulative impacts of development and expand efforts to promote and implement Low Impact Development (LID) practices***																				
E	1	1	Encourage upstream watershed municipalities to embrace aggressive BMP/LID implementation projects with the goal of not transferring the stormwater problems to downstream areas	x							x								1-2 years	Education	Watershed-wide permitting and coordination to achieve results	# of projects implemented in upper portions of the watershed	T
E	1	2 b	Begin to work with owners of large privately owned lands, to incorporate LID practices into their existing landscapes, rehabilitation and the future development projects. Targeting properties identified as suitable candidates for LID retrofits (Figure 5-11)			x					x	x							2-10 years	Outreach and buy-in from property owners, site scale evaluation and design for identified properties; funding secured; implementation; construction complete	Property owner buy-in, completed site designs, LID elements and practice incorporated into the local landscape	Number property owners contacted and met with, percent of properties in each WM, taken to design and implementation stages with appropriate grant/other financial support. Target is 1-2 properties per WM per year	T
E	1	2 c	Identity projects from E-1-2a and b that would serve as appropriate demonstration projects			x					x	x							2-10 years	Demonstration projects initiated and promotional and educational materials developed	Demonstration projects in place in each watershed municipality	# of demonstration projects completed	
E	1	3	Conduct monitoring programs to track the effectiveness of implemented LIDs. Also develop a watershed-wide database to track implementation projects undertaken and completed in municipal/state owned properties in the watershed			x													2-5 years	Performance Evaluation Data	Monitoring data, comparison to literature and statistical analyses to show effectiveness and a database to track implementation projects	Number of seasonal and continuous monitoring programs implemented. Target is 1 to 2/year	T
E	1	4	Work with municipalities to determine how best to promote smart growth in urbanized areas including compact and preferred development areas based on availability of existing sewer, water, stormwater and transportation infrastructure. Using GIS to identify preferred areas for development and incorporate into POCD recommendations			x													1-5 years	Adoption of smart growth elements in development/ redevelopment initiatives	Maps of preferred areas and associated public outreach to promote smart growth	# of Municipalities adopting smart growth elements. Target is 100% at the end of 5-years	W
E	1	6	Develop a municipal rain barrel giveaway/incentive program			x													1-2 years	Secure funding or grants	Rain barrels implementation in all WMs	Effectiveness of rain barrels and compilation of O&M needs, frequency of training programs for homeowners. Target is 200 barrels per WM over 2 years	W
E	1	7	Conduct an evaluation study of the long-term program costs and financing alternatives for developing incentives for private property owners to implement LID practices (e.g., stormwater fee discounts for the disconnected impervious area)			x					x								1-2 years	Business model LID implementation in private properties	Guidance document on program costs, barriers to implementation	# of WMs adopting LIDs to achieve MS4 permit requirements. Target is 100% in 2 years	W
E	1	9 a	Conduct a GIS-based inventory of medium to high density areas (0.25 to 1.0 acre lots) that can be targeted for roof leader disconnection programs and design visual inspections to quantify the potential benefits			x	x												1-2 years	Inventory of opportunities	Maps showing priority areas for roof leader disconnection for each WM	% watershed area completed for inventory and tracking,	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
E	1	9 b	Promote the reduction of rooftop runoff and reuse of stormwater using rain barrels, rain gardens or other LID practices	x	x	x					x								2 years	Completion of brochure/ training material	Brochures and guidance manual to public, financial incentive program for implementation	# of households and businesses adopting the reuse concept (target 25% over 10 years for each WM)	T
E	2	0	***Objective E -2: Ensure municipal regulations support the implementation of LID practices***																				
E	2	1 a	Review the municipal codes and ordinances of seven watershed municipalities and incorporate specific recommendations to embrace a watershed-wide implementation of LID elements, giving preference to process-based LID practices that promote nutrient uptake (e.g., rain garden, bioretention)	x		x	x												6 months to 1 year	Consistency in control practices in all WMs	A report reviewing all municipal ordinances and making recommended changes to codes and ordinances	Completion of the report and submission to WMs	W
E	2	1 c	Implement changes to codes and ordinances to promote process-based LID practices on a watershed-wide scale as recommended by the results of E-2-1a			x													1-2 years	Adoption of changes	Consistent codes and ordinances on a watershed basis	# of WMs formally adopting changes	W
E	2	2	Modify the Stormwater Runoff section of municipal zoning regulations to include a set of stormwater management standards, including consideration of multiple targets for stormwater control; and establish clearer, specific performance standards for projects. Such standards can include LID practices that recognize stormwater as resource rather than a waste to be conveyed to the waterways instantaneously			x					x	x							1-2 years	Modified zoning regulations	Consistent codes and regulations for the watershed	Adoption and associated revision in regulations in all WMs. Target is 100% at the end of 2-years	W
E	2	3	All the seven watershed municipalities in CT and NY, as part of their Municipal Separate Storm Sewer System (MS4) permits, should consider integrating LID elements into their capital improvement planning process to further reduce runoff volume, peak flow rates and stormwater pollution from their respective drainage areas			x													1-2 years	Guidance to WMs	Modification of protocols used within WMs to achieve this goal.	All municipalities adopting LIDs in capital improvement planning. Target is 100% over 1-2 years.	W
E	2	4	Provide education to local land use agencies regarding LID practices so that they can promote and implement these practices			x											x		1-2 years	Training Session for local board and commission members	Adoption of LID practices in regulations by all WMs	Timeframe for all WMs to adopt new regulations	W
E	2	5	Encourage revision of local land use regulations to address the impacts of new development on the natural environment including provisions that require that new construction result in a net zero increase in stormwater runoff from the site, both during and after construction	x	x	x													2-4 years	Revised land use regulations, Draft revised regulations	Consistent codes and regulations to achieve net zero increase in stormwater runoff for all watershed municipalities	CTDEP/NYSDEC stormwater regulations have this criteria. Any revisions to make sure that this is adopted by 100% of applicants in all 7 WMs	W
E	3	0	***Objective E -3: Advocate for a state and local permitting framework that best protects water resources from the impacts of non-point source runoff***																				
E	3	1	Support & recommend increased capacity for inspection and enforcement of current and future stormwater general permits in the watershed	x	x						x	x							1-2 years	Request made to CTDEP and legislators, Letters of support provided	Enforcement program developed, Streamlined permit review for all WMs	Completion of the general permit review protocol and communication with WMs	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
E	3	3	Work with state agencies and local municipalities to ensure flood plains are considered as part of the design and review of stormwater management methods, and the interactions between both systems are evaluated	x		x													2-4 years	Training held for municipal boards and commissions	Reduction of improperly functioning stormwater systems and protection of the flood plain	–	W
E	5	0	***Objective E-5: Manage bacterial contamination from waterfowl and domestic/farm animals***																				
E	5	1	Adopt a local ordinance to prevent feeding of water fowl			x													2-5 years	Adoption of ordinance	Consistent ordinance among all WMs	Ordinance adopted by all 7 municipalities	W
E	5	3	Employ <u>effective</u> methods to significantly reduce the non-migratory goose population			x					x								2 years	Testing to confirm effectiveness of methods	Guidance document for different methods and their effectiveness	Reduction in waterfowl populations/ improvement in water quality in impoundments with current waterfowl problems. Target of 30% on a watershed-basis over a period of 10 years.	W
F	0	0	**Goal F: Stewardship and Education** (Educate the community about the boundaries and functions of the Norwalk River Watershed, the specific need for protection or, and improvement to, the river system, the benefits of a healthy watershed to individuals and communities, and the opportunity to speak out on issues and to participate in the stewardship of the watershed.)																				
F	1	0	***Objective F-1: Develop a mechanism to monitor The Action Plan, implement such a mechanism, and foster watershed stewardship.***																				
F	1	1	Maintain representation and participation from watershed stakeholders including federal and state agencies, businesses, individuals, and community, environmental and educational organizations	x															Ongoing	Attendance by a representative from each identified stakeholder at a meeting at least once per year.	Increased participation for initiative group members	attendance at monthly meetings	W
F	1	2	Maintain Watershed Coordinator position to assist in monitoring plan implementation and coordination activities. Secure funding for contracting on a two-year basis	x		x					x								Ongoing	Secure funding for coordinator position	position contracted	position maintained	W
F	1	3	Hold formal annual meetings to review progress and communicate results	x															Ongoing	–	Meeting held each year	Target 100% representation from watershed stakeholders	W
F	1	4	Conduct an evaluation of the Action Plan every five (5) years	x															5 years	Plan assessment in 2016	Analysis and implementation summary	Initiation of plan update (F-1-5) or if no changes needed reassess in 2018	W
F	1	7	Develop an outline to assign implementation actions to address identified impaired segments	x															1-2 years	–	Matrix of BMPs by Segment	–	T
F	2	0	***Objective F-2: Provide information and education about the Norwalk River Watershed.***																				
F	2	1	Develop a comprehensive public relations plan/program to engage, public entities, private interest groups (i.e. local Chambers of Commerce) and professional organizations in stewardship of the watershed	x															1-2 years	Planning Committee Assembled	Formal public involvement plan developed	Increased watershed stewardship, measured through reductions in NPS targets and increased participation in meetings and activities	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
F	2	2	Create and maintain a user-friendly website for the Norwalk River Watershed to include information on the Initiative's Action Plan, updates on Implementation Activities, and information related to protecting and restoring the health of the river	x															1-2 years	Website platform and design established	Website up and running	number of 'hits' the site receives	W
F	2	3 a	Identify a means to support and fund environmental education programs outside the classroom						x	x									1 year	Grant award	Program development and location identification (e.g., NMA)	Educational curriculum and materials	W
F	2	3 b	Develop a framework for youth organizations (e.g. NRWA badge programs for scouts) and local schools (e.g. NRWA River Study Program, Roots and Shoots extracurricular program in NJ schools) that highlights the comprehensive relationships between local, regional and global water issues and builds programs for local environmental stewardship		x				x	x									1-2 years	Grant award and volunteer identification	Education materials development	Completion of the materials; # of training/outreach programs conducted (Target of 3-4 programs/year)	W
F	2	5	Identify audience and topics of interest. Coordinate workshops & public lectures and develop related resources as appropriate	x						x									1-2 years	List of topics developed, Public events organized and target audience identified	Public events held	Attendance at public events, targeting at least 1 event per year	W
F	2	6	Increase watershed stewardship efforts (watershed, stream, stormwater pollution prevention, and catch basin markings) and create educational displays in highly visible, strategic locations throughout the watershed		x	x				x									2 years	Grant award and partnerships among WMs	Publications and displays, kiosks, surveys to track awareness and stewardship among public	# of people trained # of surveys done and review of survey responses (goal of one every summer) ; # of kiosks setup and the frequency of their usage	W
F	2	7	Develop a public education campaign using the lower Silvermine watershed as a model for implementation of residential BMPs	x		x		x											1-2 years	program developed, funding identified and outreach initiated	Program developed, funding secured and campaigned completed	increased community involvement and reduction in waste and NPS runoff from residents	T
F	2	9	Develop an education program regarding BMPs for appropriate management of yard and pet waste			x													1-2 years	–	Educational materials developed and distributed	–	W
F	3	0	***Objective F-3: Expand coordination and communication with watershed municipalities.***																				
F	3	2	Encourage articulation of the Action Plan's watershed protection goals as a goal in municipal & state Plans (POCDs).			x													4+ years	–	Goals and Recommendations incorporated in to POCD updates	–	W
F	3	4	Meet with watershed town officials on an annual basis to provide an update on implementation activities and discuss issues of concern	x															1-2 years	–	Annual meeting will all watershed CEO's	–	W

Abbreviations:

Implementing Organizations: NRWI – Norwalk River Watershed Initiative; NRWA – Norwalk River Watershed Association; WM – Watershed Municipalities; RPAs – Regional Planning Agencies; DEEP –Connecticut Department of Energy & Environmental Protection; NYSDEC – New York State Department of Environmental Conservation; CTDOT – Connecticut Department of Transportation; NRCS – Natural Resources Conservation Services; TU – Trout Unlimited; HW/RW – Harbor Watch/River Watch; SWCD – Southwestern Conservation District; Publicly Owned Treatment Works; UConn – University of Connecticut; NMA – Norwalk Maritime Aquarium; USDA/USGS – U.S. Department of Agriculture/U.S. Geological Survey.

Spatial scale: W – Watershed-wide, S – Site-specific, and T – Transportation.

6.3 Urban Stormwater Controls

Urban stormwater runoff from the six CT municipalities and Lewisboro in NY are among the major sources of bacteria, as reviewed in Section 4 on Estimation of pollutant Loads. Control of pollution from this source is quite challenging due to the highly varying volume and peak runoff rates and the pollutant load generation and transport from source areas (CTDEP, 2004; NYSDEC, 2010). This sub-section provides guidance on the selection of control measures to address pollution from urban stormwater.

A number of stormwater controls can be effective in reducing indicator bacteria and nutrient loads targeted in the Norwalk River and its tributary watersheds. Table 6-2 lists control practices effective for water quality protection as suggested in the NYSDEC stormwater manual (NYSDEC, 2010), for example. Almost all of these are structural practices (e.g., filtration, infiltration, runoff peak or volume control, ponds, wetlands, and manufactured technical devices) requiring feasibility evaluation, engineering design and construction, operation and maintenance, and permitting. Capital and operations and maintenance costs of individual controls can be significant, however, they are usually designed to treat runoff volumes or pollutant loads generated from drainage areas much larger than the controls' actual footprints to make them more cost-effective. The land areas for implementation of such controls in urban areas of this watershed are very expensive and also the site selection needs to ensure that enough water can be brought to the BMP locations in order to provide treatment. Public lands can be explored first and then the large private lands for implementation of potential control measures.

Capital and operations and maintenance costs of management measures will help with project development, planning and implementation. Cost information was reviewed from multiple sources such as the EPA's Stormwater Menu of BMPs, EPA Preliminary Data Summary of Urban Stormwater BMPs, cost information from existing BMPs in the area, and the cost calculations carried out on the basis of guidelines provided by the EPA (Muthukrishnan et al., 2004). A literature search was performed to obtain region-specific cost information pertaining to the coastal Connecticut and similar areas.

Table 6-2. Stormwater Management Measures Effective for Water Quality Improvement

Group	Practice	Description
Pond	Micropool Extended Detention Pond (P-1)	Pond that treats the majority of the water quality volume through extended detention, and incorporates a micropool at the outlet of the pond to prevent sediment resuspension.
	Wet Pond (P-2)	Pond that provides storage for the entire water quality volume in the permanent pool.
	Wet Extended Detention Pond (P-3)	Pond that treats a portion of the water quality volume by detaining storm flows above a permanent pool for a specified minimum detention time.
	Multiple Pond System (P-4)	A group of ponds that collectively treat the water quality volume.
	Pocket Pond (P-5)	A stormwater wetland design adapted for the treatment of runoff from small drainage areas that has little or no baseflow available to maintain water elevations and relies on ground water to maintain a permanent pool.
Wetland	Shallow Wetland (W-1)	A wetland that provides water quality treatment entirely in a wet shallow marsh.
	Extended Detention Wetland (W-2)	A wetland system that provides some fraction of the water quality volume by detaining storm flows above the marsh surface.
	Pond/ Wetland System (W-3)	A wetland system that provides a portion of the water quality volume in the permanent pool of a wet pond that precedes the marsh for a specified minimum detention time.
	Pocket Wetland (W-4)	A shallow wetland design adapted for the treatment of runoff from small drainage areas that has variable water levels and relies on groundwater for its permanent pool.
Infiltration	Infiltration Trench (I-1)	An infiltration practice that stores the water quality volume in the void spaces of a gravel trench before it is infiltrated into the ground.
	Infiltration Basin (I-2)	An infiltration practice that stores the water quality volume in a shallow depression, before it is infiltrated it into the ground.
	Dry Well (I-3)	An infiltration practice similar in design to the infiltration trench, and best suited for treatment of rooftop runoff.
Filtering Practices	Surface Sand Filter (F-1)	A filtering practice that treats stormwater by settling out larger particles in a sediment chamber, and then filtering stormwater through a sand matrix.
	Underground Sand Filter (F-2)	A filtering practice that treats stormwater as it flows through underground settling and filtering chambers.
	Perimeter Sand Filter (F-3)	A filter that incorporates a sediment chamber and filer bed as parallel vaults adjacent to a parking lot.
	Organic Filter (F-4)	A filtering practice that uses an organic medium such as compost in the filter, in the place of sand.
	Bioretention (F-5)	A shallow depression that treats stormwater as it flows through a soil matrix, and is returned to the storm drain system.
Open Channels	Dry Swale (O-1)	An open drainage channel or depression explicitly designed to detain and promote the filtration of stormwater runoff into the soil media.
	Wet Swale (O-2)	An open drainage channel or depression designed to retain water or intercept groundwater for water quality treatment.

Source: NYSDEC Stormwater Manual (2010)

In addition, some case studies from PlaNYC (2008) were reviewed for the BMP/LIDs such as green roofs, porous pavements, and rain barrels. The suggested initial and operations and maintenance costs of BMP/LIDs that could be considered for urban stormwater treatment are summarized in Table 6-3.

Table 6-3. BMP/LID Capital and O&M Costs

BMP	Capital Cost per unit ($)	O&M Cost per unit ($)	Unit
Wet Pond	5.1 - 8.5	0.9 – 1.5	Cubic Feet
Dry Pond	2.6 – 6.8	0.4 – 1.2	Cubic Feet
Bioretention	8 - 20	2 – 5	Cubic Feet
Rain Barrel	7 - 8	-	Gallon
Porous Pavement	6.20	0.8	Square Feet
Grassed Swale	0.56	0.20	Square Feet
Green Roof	20 - 28	5 – 7	Square Feet

Another key parameter in the selection of management measures is their effectiveness to achieve the desired pollutant reduction targets. The removal efficiencies are suggested for TN, TP, TSS, and indicator bacteria in Table 6-4, compiled by reviewing various literatures and using best professional judgment based on literature values. Removal efficiencies for some practices were not suggested in cases where the performance information reported in the literature was very limited.

Table 6-4. Pollutant Removal Efficiencies of BMP/LIDs

BMP	Source*	Water quality performance - Percent removals			
		TSS	**TN**	**TP**	**Bacteria**
Bioretention	Literature Median Value	52	43	22	-
	NPRPD	59	46	5	n/a
	NYS chapter. 6	80	G (>30)	40	F (35-70)
	NYS table A.4	85	40	60	35
	MD guide	90	40	40	-
	RR memo	-	78	73	-
	Suggested Value	**52**	**43**	**22**	**70**
Constructed Wetland	Literature Median Value	58	22	45	-
	NPRPD	72	24	48	78
	NYS chapter. 6	80	G (>30)	40	G (>70)
	NYS table A.4	80	30	50	80
	MD guide	80	30	50	-
	RR memo	-	40	63	-
	Suggested Value	**58**	**22**	**45**	**50**
Dry Pond	Literature Median Value	61	25	17	
	NPRPD	49	24	20	88
	NYS chapter. 6	-	-	-	-
	NYS table A.4	-	-	-	-
	MD guide	60	30	20	-

Table 6-4 (*continued*). Pollutant Removal Efficiencies of BMP/LIDs					
BMP	**Source***	**Water quality performance - Percent removals**			
		TSS	**TN**	**TP**	**TSS**
Dry Pond *(continued)*	RR memo	-	-	-	-
	Suggested Value	**61**	**25**	**17**	**30**
Grassed Swale	Literature Median Value	-	-	-	-
	NPRPD	-	-	-	-
	NYS chapter. 6	80	-	40	-
	NYS table A.4	85	50	40	0
	MD guide	-	-	-	-
	RR memo	-	32	28	-
	Suggested Value	**85**	**32**	**28**	**0**
Green Roof	Literature Median Value	-	-	-	-
	NPRPD	-	-	-	-
	NYS chapter. 6	-	-	-	-
	NYS table A.4	-	-	-	-
	MD guide	-	-	-	-
	RR memo	-	53	53	-
	Suggested Value	**-**	**53**	**53**	**-**
Porous Pavement	Literature Median Value	93	88	48	-
	NPRPD	89	42	65	n/a
	NYS ch. 6	-	-	-	-
	NYS table A.4	90	50	70	90
	MD guide	90	50	70	-
	RR memo	-	70	70	-
	Suggested Value	**90**	**70**	**48**	**70**
Rain Barrel	Literature Median Value	-	-	-	-
	NPRPD	-	-	-	-
	NYS chapter. 6	-	-	-	-
	NYS table A.4	-	-	-	-
	MD guide	-	-	-	-
	RR memo	-	40	40	-
	Suggested Value	**-**	**40**	**40**	**-**
Wet Pond	Literature Median Value	76	30	48	90
	NPRPD	80	31	52	70
	NYS chapter. 6	80	G (>30)	40	G (>70)
	NYS table A.4	80	35	50	70
	MD guide	80	30	50	-
	RR memo	-	35	63	-
	Suggested Value	**76**	**30**	**48**	**70**

***Source** CWP (2007) National Pollutant Removal Performance Database (NRPRD): Version 3, 2007; median values. For permeable pavement, used infiltration practice data. Values are generally mass or load-based measurements of efficiency; NYSDEC Manual (2010): Just "Phosphorus" and "Nitrogen" are listed. Indicator bacteria is lumped; NYSDEC (2001) Table A.4 is from Appendix A of the 2001 manual. This appendix and table were removed in subsequent versions (2003 onward); CWP (2005) MD guide: A User's Guide to Watershed Planning in Maryland, CWP. Dry pond value assumes extended detention. For permeable pavement, used infiltration practice data; CWP (2008), Runoff Reduction Method (referred to as RR memo), CWP Runoff Reduction Method, 2008. Values are mean for Total Removal (considers change in concentration and volume).

6.4 Estimated Load Reductions

Pollutant load reductions were estimated for various watershed management measures and the suggested effectiveness values in PRedICT (Evans et al., 2007) and those reviewed in Table 6-4 were used to estimate the load reductions for these recommendations. The approaches and assumptions used for evaluating the benefits of major recommendations are discussed in the following sub-sections.

Annual average pollutant load reductions for TN, TP, TSS, and bacteria (*E. coli*) were estimated for the entire Norwalk River watershed. Table 6-5 summarizes the anticipated pollutant load reductions for each watershed management measure, based on specific impaired segments. Table 6-6 summarizes the extent of management practices needed to achieve the bacteria load reductions to enable the delisting of individual impaired segments. Abbreviations for each management measure are shown in the following list to be able to recognize them easily in the cost and pollution reduction summaries.

<u>Illicit Discharge Detection and Elimination (IDDE)</u>
Illicit discharges during dry weather are among the major sources of bacteria loads to the Norwalk River watershed and tributaries. With a stringent TMDL goal to reduce bacteria loading by 76% at the lower end of Norwalk River, the recommendation is to achieve 100% elimination of these dry weather sources over 10 years. An interim target of 50% can be used for tracking the progress over the next five years.

<u>Management of Septic Systems (SEP)</u>
Septic system failures are identified as another major contributor of bacteria loads, at both watershed and site-scales, during rainy periods. The recommendation is to achieve 100% in proper inspection, repairs and operation and maintenance of septic systems, so as to completely eliminate such failures over a period of 10 years. An interim target of 50% can be used for tracking the progress over the next five years.

<u>LID Adaptation (LID)</u>
The LID retrofits are practices to manage stormwater runoff while maintaining or restoring the natural hydrology. Examples include raingardens, vegetated swales, bioretention units, green roofs, and porous pavement. The goal is to implement LID retrofits as source control mechanisms to reduce stormwater discharge volumes and associated pollutant loads to the Norwalk River and its tributaries.

Based on a review of LID planning reports, the benefits of LIDs can be represented in terms of effective reductions in total impervious cover within urban areas. Similar to Fuss & O'Neill (2009; 2010), a conservative reduction in the amount of 1.5% of the total impervious cover was assumed to be achievable through implementation of LID techniques in the entire Norwalk River watershed. The distribution of low and high density developments in each sub-watershed was used to appropriately calculate the benefits and then summarize on an impaired segment basis.

Land Use Regulations and Smart Growth (LUS)

Streamlining of land use regulations within the watershed municipalities and promoting smart growth in certain geographical areas can help in reducing the potential for pollutant loads. In the absence of a future land use and growth scenario available on a watershed-wide basis and very sporadic literature to support any assumptions, the potential benefits and associated costs are not quantified here.

Downspout Disconnection (DOD)

Disconnection of roof area runoff from reaching storm or illicitly into sanitary sewers will reduce the peak flow reaching the sewers. The runoff diverted into pervious areas or reused for purposes such as watering of lawns and plants will reduce the overall stormwater runoff volume for small to moderate storms (say, less than one inch). One of the recommendations is to conduct field scale assessment of downspout connections to sewers and target areas in the watershed with high density of connections that will benefit from disconnection. In the absence of this information, the potential benefits and total costs are not quantified here.

Riparian Buffers (RBF)

Riparian buffer, or vegetative buffer, is a strip of grasses, shrubs, and/or trees near a stream to trap sediment and associated pollutants generated from surrounded land uses. The Watershed Treatment Model-WTM (Caraco, 2001) suggests 30% reduction efficiency for TN, 10% for TP, and 70% for TSS. No suggested value was available for indicator bacteria treatment in WTM. Lammers-Helps and Robinson (1991) developed bacteria load reductions for buffer strips. Young et al. (1980) measured bacteria in feedlot runoff. Buffer strips between 21.34 m and 27.43 m reduced total coliform and fecal coliform 69%. The bacteria reduction efficiencies were assumed to be 70% for areas that are not influenced by waterfowl and 20% for other urban areas that can be influenced by waterfowl. With high levels of targeted reductions in bacteria loads, the riparian buffers are recommended for 100% of river miles along the low and high intensity developments, over a period of 20 years. An interim target of 50% can be used to track the progress over the next 10 years.

Management of Pollution from Waterfowl and Domestic/Farm Animals (WAT)

Pollution from waterfowl and domestic/farm animals has been identified as one of the major sources from streamwalk surveys (NRCS 1997; 1999) and HW/RW monitoring programs. DEEP estimates the statewide population for Canadian geese and ducks to be 24,000 and 57,000, respectively, in the breeding season of 2011 (CTDEP, 2011). These estimates include both migratory and non-migratory goose populations and specific estimates for the Norwalk River watershed are unavailable. This management measure is targeted at the non-migratory goose population and will require performance evaluation of best technologies and adoption on a watershed basis. While the domestic/farm animal wastes can be controlled through site-scale BMPs at their sources, the wastes from waterfowl will continue to impair the water quality for bacteria. As such, it will be impossible to achieve 100% reduction in bacteria loads from this source, and the recommendation is to achieve a targeted 30% reduction from the existing conditions.

Urban Greening (UGR)

Increased tree canopies and plant coverage will benefit in terms of capturing additional water through evapotranspiration and interception and providing secondary environmental benefits. One of the recommendations is to develop and adopt an urban forestry plan that will provide a quantitative basis for calculating potential benefits using tools such as the Center for Neighborhood Technology (2011). Therefore, the potential benefits and total costs are not quantified in this report.

Large-scale BMPs for Urban Stormwater Management (BMP)

Based on new stormwater regulations at the federal and state levels, new or redevelopment projects are subjected to stormwater controls aimed at water quality and quantity improvement. However, the existing urban landscape developed over the past few decades has typically been governed by site-scale peak runoff flow reduction requirement. This indicates that a predominant portion of the urban landscape needs stormwater management measures to reduce the bacteria and nutrient loads to the waterways. As reviewed in Section 6-3 on Urban Stormwater Controls, structural BMP practices such as bioretention (with bacteria reduction effectiveness of 70%), constructed wetlands (effectiveness of 50%) and wet ponds (effectiveness of 70%) are effective in terms of reducing bacteria loads from contributing urban drainage areas.

Among the targeted recommendations are public and large-private properties that can offer potential for structural BMP implementation. For the purpose of this WBP development, constructed wetlands with a conservative 50% effectiveness for bacteria control was used to evaluate the overall load reduction on a watershed-wide basis. About 50-60% of the urban runoff from the entire watershed will need to be treated with multiple constructed wetlands, wet ponds and bioretention, in order to meet the desired bacterial control targets for various impaired segments.

Streambank Stabilization/Restoration (STR)

Streambank stabilization is a very effective method of reducing TSS loading. A planning-level evaluation of stabilizing 10% of the entire streambank length in the watershed is presented here. Reduction efficiencies of 36% for TN and 95% for phosphorus and TSS from Evans et al. (2007) were used to determine the overall load reductions. There is no direct benefit for bacteria load reduction from this recommendation, therefore, the stabilization should be adopted where there are specific stream segments with bank erosion and sedimentation problems.

Transportation Corridors (TRA)

The Norwalk watershed is intersected by major transportation elements including parkways, national highways and boulevards/streets. The modeling framework adopted here incorporates transportation corridors as part of the urban and transitional land uses evaluated for pollution control. With this, the transportation corridor-related pollutant loads were separated and structural BMPs such as wet ponds, wetlands and bioretention were evaluated (similar to the large-scale BMPs for urban stormwater management). The event mean concentrations for bacteria from transportation corridor are typically less than other urban areas. Therefore, the benefits of treating highway/roadway runoff will be realized in terms of nutrients and solids and to a much smaller extent the bacteria. The recommendation is to achieve 100% treatment of highway/roadway runoff over a period of 20 years. This indicates that all the highway runoff gets diverted to process-based BMPs/LIDs for treatment prior to being discharged into storm sewers and then into the waterways. An interim target of 50% can be used to track progress in pollutant load reductions over the next 10 years.

Education and Outreach (EDU)

Both lawn care practices and pet waste disposal aspects were considered in the estimation of load reductions from public education and outreach. The suggested reduction coefficients from Watershed Treatment Model (Caraco, 2001) were used to support the estimation of load reductions. Estimates of total lawn area and total number of households were developed using assumed lot to lawn ratios and lot acreages, and the Watershed Treatment Model coefficients were then used to develop load reductions for TSS, TP, TN and indicator bacteria.

Table 6-5. Estimated Load Reductions for Key Management Measures

Watershed Management Recommendation	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	*E. coli* (billion/yr)	Percentages			
					N	P	TSS	*E. coli*
Existing	**266,193**	**33,669**	**13,973**	**1,552,146**	100%	100%	100%	100%
Illicit Discharge Detection & Elimination (IDDE)	5,324	673	-	491,573	2%	2%	-	32%
Management of Septic Systems (SEP)	96,437	19,855	-	231,781	36%	59%	-	15%
LID Adaptation (LID)	124	23	2	7,898	0%	0%	0%	1%
Land Use and Smart Growth (LUS)	-	-	-	-	-	-	-	-
Downspout Disconnection (DOD)	-	-	-	-	-	-	-	-
Riparian Buffers (RBF)	3,646	147	85	64,519	1%	0%	1%	4.2%
Management of Waterfowl & Animal Wastes (WAT)	11,392	1,441	-	66,426	4%	4%	-	4.3%
Urban Greening (UGR)	-	-	-	-	-	-	-	-
Large-scale BMPs for Urban Stormwater Mgmt (BMP)	8,369	916	88	296,923	3%	3%	1%	19%
Streambank stabilization/ Restoration (STR)	44	51	1,155	-	0%	0%	8%	-
Transportation Corridors (TRA)	2,315	309	16	5,354	1%	1%	0%	0%
Education & Outreach (EDU)	5,877	388	-	21,296	2%	1%	-	1%
Load Reduction Achieved	**33,528**	**23,803**	**1,346**	**1,185,770**	**50%**	**71%**	**10%**	**76%**
Remainder Pollutant Loads to Norwalk Waterways	**132,665**	**9,866**	**12,628**	**366,375**	**50%**	**29%**	**90%**	**24%**

NOTE: TN – Total Nitrogen, TP – Total Phosphorus, TSS – Total Suspended Solids and *E. coli* – Escherichia Coli

Table 6-6. Summary of Management Measures Needed to Delist Impaired Segments

Impaired Segment		% Reduction Achieved with 100% Implementation	TMDL Target % Reduction	Management Measures Needed to Delist the Impaired Segments
CT7300-02_02	Ridgefield Brook	66%	51%	IDDE, SEP, LID, RBF, 30% WAT, 50% BMP, TRA, and EDU
CT7300-02_01	Ridgefield Brook	66%	51%	IDDE, SEP, LID, RBF, 30% WAT, 50% BMP, TRA, and EDU
CT7300-00_05	Norwalk River	70%	39%	IDDE, SEP, LID, RBF, 30% WAT, 50% BMP, TRA, and EDU
CT7300-00_04	Norwalk River	73%	54%	IDDE, SEP, LID, RBF, 30% WAT, 50% BMP, TRA, and EDU
CT7300-00_03	Norwalk River	74%	5%	IDDE, SEP, LID, RBF, 30% WAT, 50% BMP, TRA, and EDU
CT7300-00_02	Norwalk River	75%	38%	IDDE, SEP, LID, RBF, 30% WAT, 60% BMP, TRA, and EDU
CT7302-00_01	Silvermine River	75%	66%	IDDE, SEP, LID, RBF, 30% WAT, 60% BMP, TRA, and EDU
CT7300-00_01	Norwalk River	76%	76%	IDDE, SEP, LID, RBF, 30% WAT, 60% BMP, TRA, and EDU

6.5 *Estimated Costs*

Suggested unit cost estimates for the various watershed-wide recommendations are presented in Table 6-7. This information was compiled from several national references (Wiegand et al., 1986; Brown and Schueler, 1997; Muthukrishnan et al., 2004; and Narayanan and Pitt, 2006). If unavailable directly from literature, some estimates based on professional judgment are presented to support the watershed stakeholders in evaluating financial needs to implement the WBP and seeking funding opportunities for specific watershed-scale or site-specific initiatives. Table 6-8 and 6-9 show the initial and annual operation and maintenance costs associated with recommendations that will achieve the bacteria load reductions shown in Table 6-5. It must be noted that Table 6-8 shows the costs corresponding to management measures undertaken at each sub-watershed scale (impaired segment), in the drainage areas tributary to this impaired segment. On the other hand, Table 6-9 shows the cumulative costs from an upstream impaired segment to a downstream segment. The costs for the downstream segment, CT7300-00_01, shows the overall watershed-wide investments needed to delist that segment from the 303(d) list. These costs do not include land acquisition, remediation needed for brownfield sites if chosen for stormwater treatment or special permitting. If public lands are chosen, these costs can be really minimal as compared to the private properties.

Table 6-7. Compiled/Suggested Unit Costs for WBP Recommendations

Recommendations and/or BMP/LID	Suggested Unit Cost ($s)	Reference(s)
IDDE (for each project involving detection and elimination)	$23,300-101,200 Initial Cost; $43,000-126,500 Annual Cost; Variations are due to types of techniques and extent of planning involved	CWP IDDE Manual (2004), NEIWPCC IDDE Manual (2003); CWP (2007b)
SEP (per household)	In many cases, this is home owners' responsibility, but grant programs may be available for those needing financial support. Cost will vary significantly - $1,500 to 4,000 annually per system inspection and operation and maintenance to avoid failure	Professional judgment
LID	(summarized in Table 6-3)	Urban Stormwater Retrofit Practices, CWP (2007)
DOD per household	$150 to 400 for disconnection of downspout and drain towards pervious areas	Professional judgment

Table 6-7 *(continued)*. Compiled/Suggested Unit Costs for WBP Recommendations		
Recommendations and/or BMP/LID	**Suggested Unit Cost ($s)**	**Reference(s)**
RBF ($ per acre) - Grass/herbaceous buffer - Trees/shrubs	- $450 to 850 - $2,000 to 3,000	NRCS, Conginchaug River Watershed Based Plan (2008)
WAT	Cost will vary significantly based on evaluation of effective methods and implementation strategies	–
UGR (per 100 new trees)	$82,000 to $100,000	Greater Boston Urban Tree initiative (GBUTI, 2008)
BMP	(summarized in Table 6-3)	Urban Stormwater Retrofit Practices, Center for Watershed Protection (2007)
Site-specific Field Assessments for Impoundments, Monitoring and Load Reduction Implementation Planning	$10,000 to 25,000 per impoundment	Professional judgment; Kitchell and Schueler (2005)
STR ($/100 linear feet) - Bank Stabilization - Channel Rehabilitation	- $1,300 to 9,600 - $1,100 to 3,700	NOAA Stream Restoration Cost Estimates summarized in NRCS (2008; 2010)
TRA	(See stormwater retrofits in Table 6-3)	–
EDU (for each program)	Cost will vary significantly examples include: $2,000 for advertising campaigns to in excess of $500,000 for a full program involving brochures, advertising, surveys, etc.	–

NOTE: CWP (2007b),
http://www.ecy.wa.gov/programs/wq/stormwater/municipal/GISpresentations/09SingelisIDDEProgrammaticImplementation.pdf

Table 6-8. Costs Associated with the Management Measures to Delist Individual Impaired Segments

Watershed Management Recommendation	Cost Type	CT7300-02_02	CT7300-02_01	CT7300-00_05	CT7300-00_04	CT7300-00_03	CT7300-00_02	CT7302-00_01	CT7300-00_01
Illicit Discharge Detection & Elimination (IDDE)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-
Management of Septic Systems (SEP)	Initial	$369,000 - $984,000	-	$411,000 - $1,095,000	$376,000 - $1,003,000	$96,000 - $256,000	$1,245,000 - $3,320,000	$2,200,000 - $5,866,000	$1,024,000 - $2,730,000
	Annual O&M	$160,000 - $222,000	-	$178,000 - $246,000	$163,000 - $226,000	$42,000 - $57,000	$539,000 - $748,000	$954,000 - $1,320,000	$443,000 - $614,000
LID Adaptation (LID)	Initial	$227,000 - $3,664,000	-	$110,000 - $1,762,000	$120,000 - $1,936,000	$37,000 - $606,000	$399,000 - $6,434,000	$854,000 - $13,777,000	$906,000 - $14,644,000
	Annual O&M	$107,000 - $408,000	-	$52,000 - $195,000	$56,000 - $215,000	$18,000 - $68,000	$187,000 - $715,000	$402,000 - $1,531,000	$427,000 - $1,627,000
Land Use and Smart Growth (LUS)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-
Downspout Disconnection (DOD) [per household]	Initial	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400
	Annual O&M	-	-	-	-	-	-	-	-
Riparian Buffers (RBF)	Initial	$45,000 - $71,000	-	$69,000 - $107,000	$68,000 - $108,000	$22,000 - $34,000	$239,000 - $376,000	$443,000 - $695,000	$380,000 - $598,000
	Annual O&M	$22,000 - $34,000	-	$32,000 - $50,000	$32,000 - $51,000	$10,000 - $16,000	$113,000 - $177,000	$209,000 - $328,000	$178,000 - $280,000
Management of Waterfowl & Animal Wastes (WAT)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-
Urban Greening (UGR) [per 100 New Trees]	Initial	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000
	Annual O&M	-	-	-	-	-	-	-	-
Large-scale BMPs for Urban Stormwater Mgmt (BMP)	Initial	$3,315,000 - $5,525,000	-	$2,692,000 - $4,486,000	$2,474,000 - $4,123,000	$867,000 - $1,446,000	$11,312,000 - $18,853,000	$17,748,000 - $29,580,000	$15,987,000 - $26,645,000
	Annual O&M	$585,000 - $975,000	-	$475,000 - $792,000	$437,000 - $728,000	$153,000 - $255,000	$1,996,000 - $3,327,000	$3,132,000 - $5,220,000	$2,822,000 - $4,702,000
Streambank stabilization/ Restoration (STR)	Initial	$96,000 - $532,000	-	$146,000 - $806,000	$146,000 - $812,000	$47,000 - $257,000	$509,000 - $2,824,000	$944,000 - $5,229,000	$812,000 - $4,499,000
	Annual O&M	$46,000 - $250,000	-	$68,000 - $380,000	$69,000 - $382,000	$22,000 - $121,000	$240,000 - $1,329,000	$445,000 - $2,461,000	$381,000 - $2,117,000
Transportation Corridors (TRA)	Initial	$679,000 - $1,132,000	-	$552,000 - $919,000	$506,000 - $844,000	$178,000 - $297,000	$2,317,000 - $3,861,000	$3,636,000 - $6,059,000	$3,274,000 - $5,457,000
	Annual O&M	$120,000 - $200,000	-	$98,000 - $162,000	$89,000 - $149,000	$31,000 - $53,000	$409,000 - $681,000	$642,000 - $1,070,000	$578,000 - $962,000
Public Education & Outreach (EDU)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-

Table 6-9. Cumulative Costs Associated with the Management Measures to Delist Impaired Segments

Watershed Management Recommendation	Cost Type	CT7300-02_02	CT7300-02_01	CT7300-00_05	CT7300-00_04	CT7300-00_03	CT7300-00_02	CT7302-00_01	CT7300-00_01
Illicit Discharge Detection & Elimination (IDDE)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-
Management of Septic Systems (SEP)	Initial	$369,000 - $984,000	$369,000 - $984,000	$780,000 - $2,079,000	$1,156,000 - $3,082,000	$1,252,000 - $3,338,000	$2,497,000 - $6,658,000	$2,200,000 - $5,866,000	$5,721,000 - $15,254,000
	Annual O&M	$160,000 - $222,000	$160,000 - $222,000	$338,000 - $468,000	$501,000 - $694,000	$543,000 - $751,000	$1,082,000 - $1,499,000	$954,000 - $1,320,000	$2,479,000 - $3,433,000
LID Adaptation (LID)	Initial	$227,000 - $3,664,000	$227,000 - $3,664,000	$337,000 - $5,426,000	$457,000 - $7,362,000	$494,000 - $7,968,000	$893,000 - $14,402,000	$854,000 - $13,777,000	$2,653,000 - $42,823,000
	Annual O&M	$107,000 - $408,000	$107,000 - $408,000	$159,000 - $603,000	$215,000 - $818,000	$233,000 - $886,000	$420,000 - $1,601,000	$402,000 - $1,531,000	$1,249,000 - $4,759,000
Land Use and Smart Growth (LUS)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-
Downspout Disconnection (DOD) [per household]	Initial	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400	$150 - $400
	Annual O&M	-	-	-	-	-	-	-	-
Riparian Buffers (RBF)	Initial	$45,000 - $71,000	$45,000 - $71,000	$114,000 - $178,000	$182,000 - $286,000	$204,000 - $320,000	$443,000 - $696,000	$443,000 - $695,000	$1,266,000 - $1,989,000
	Annual O&M	$22,000 - $34,000	$22,000 - $34,000	$54,000 - $84,000	$86,000 - $135,000	$96,000 - $151,000	$209,000 - $328,000	$209,000 - $328,000	$596,000 - $936,000
Management of Waterfowl & Animal Wastes (WAT)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-
Urban Greening (UGR) [per 100 New Trees]	Initial	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000	$82,000 - $100,000
	Annual O&M	-	-	-	-	-	-	-	-
Large-scale BMPs for Urban Stormwater Mgmt (BMP)	Initial	$3,315,000 - $5,525,000	$3,315,000 - $5,525,000	$6,007,000 - $10,011,000	$8,481,000 - $14,134,000	$9,348,000 - $15,580,000	$20,660,000 - $34,433,000	$17,748,000 - $29,580,000	$54,395,000 - $90,658,000
	Annual O&M	$585,000 - $975,000	$585,000 - $975,000	$1,060,000 - $1,767,000	$1,497,000 - $2,495,000	$1,650,000 - $2,750,000	$3,646,000 - $6,077,000	$3,132,000 - $5,220,000	$9,600,000 - $15,999,000
Streambank stabilization/ Restoration (STR)	Initial	$96,000 - $532,000	$96,000 - $532,000	$242,000 - $1,338,000	$388,000 - $2,150,000	$435,000 - $2,407,000	$944,000 - $5,231,000	$944,000 - $5,229,000	$2,700,000 - $14,959,000
	Annual O&M	$46,000 - $250,000	$46,000 - $250,000	$114,000 - $630,000	$183,000 - $1,012,000	$205,000 - $1,133,000	$445,000 - $2,462,000	$445,000 - $2,461,000	$1,271,000 - $7,040,000
Transportation Corridors (TRA)	Initial	$679,000 - $1,132,000	$679,000 - $1,132,000	$1,231,000 - $2,051,000	$1,737,000 - $2,895,000	$1,915,000 - $3,192,000	$4,232,000 - $7,053,000	$3,636,000 - $6,059,000	$11,142,000 - $18,569,000
	Annual O&M	$120,000 - $200,000	$120,000 - $200,000	$218,000 - $362,000	$307,000 - $511,000	$338,000 - $564,000	$747,000 - $1,245,000	$642,000 - $1,070,000	$1,967,000 - $3,277,000
Public Education & Outreach (EDU)	Initial	-	-	-	-	-	-	-	-
	Annual O&M	-	-	-	-	-	-	-	-

6.6 Prioritization Process

Elimination of dry weather sources through illicit discharge removal; moderate control of waterfowl; and the proper operation and maintenance of septic systems emerge as the most cost-effective ways to significantly reduce bacteria loads in the Norwalk River and its tributaries. Riparian buffers can also provide load reductions with moderate investments. Large-scale urban stormwater management measures can provide significant reductions, however, the associated costs are the highest in comparison to other management measures. In spite of their large costs, if specific or dedicated funding mechanisms can be pursued for projects such as wetland restoration or creation in public lands, such projects can become viable opportunities that the watershed stakeholders can pursue. Transportation corridors can also be pursued for such large-scale opportunities for treatment.

Distributed LIDs do require significant financial investments with moderate bacteria load reductions when process-based LIDs such as raingarden or bioretention are implemented. On the other hand, these source control practices can infiltrate runoff, increase baseflow in the streams and reduce bank/channel erosion due to reduced peak flows during rainy periods. These practices may also be pursued specifically based on the funding mechanisms sought, and in some cases may be incorporated into local projects.

Practices such as urban greening and streambank restoration will provide minimal benefits for bacteria control, and may be simple and inexpensive to implement. However, those can be promising for controlling of other pollutants such as TSS and nutrients or achieving watershed management goals other than D and E. The targets/performance metrics for specific watershed management measures provided in Table 6-1 can be used as guidance for pursuing these opportunities.

6.7 Potential Funding Sources

Federal, state and local funding sources are available to pursue the implementation of recommendations included in this WBP. In addition, non-profit agencies, foundations, or conservation agencies (e.g., The Nature Conservancy, New England Interstate Water Pollution Control Commission) may provide funding opportunities targeted at specific objectives or management actions. Table 6-10 summarizes the list of potential funding sources compiled by DEEP, with assistance of NRCS. Watershed stakeholders can use this table as starting point to pursue specific actions, and can pursue multiple grant mechanisms to undertake actions that may take longer to achieve. The DEEP also maintains a list of funding sources on its website, which is referenced here:

http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335494&depNav_GID=1654&pp=12&n=1

Table 6-10. Potential Funding Sources

Funding Source	Maximum Dollar amount	Minimum Dollar amount	Required match	Applications Open	Deadline
DEP Watershed Funding Website					
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335494&depNav_GID=1654&pp=12&n=1 Index of many potential funding sources for funding watershed-based planning projects.					
DEP CT Landowner Incentive Program			At least 25%		May
http://www.ct.gov/dep/cwp/view.asp?a=2723&q=325734&depNav_GID=1655					
DEP Open Space and Watershed Land Acquisition	Up to 40-60%			Twice a year	
860-424-3016 david.stygar@ct.gov http://www.ct.gov/dep/cwp/view.asp?a=2706&q=323834&depNav_GID=1641					
DEP Recreation & Natural Heritage Trust Program					
http://www.ct.gov/dep/cwp/view.asp?a=2706&q=323840&depNav_GID=1641					
Eastman Kodak / Nat'l Geographic American Greenways Awards optional Program	$2500	$500	Optional	April	June
jwhite@conservationfund.org, Jen White					
EPA Healthy Communities Grant Program	$30,000	$ 5,000	Optional, non-federal up to 5%	March	April
617-918-1698 Padula.Jennifer@epa.gov					
Northeast Utilities Environmental Community Grant Program	$ 1,000	$ 250			15-Apr and 15-Oct
http://www.nu.com/environmental/grant.asp Cash incentives for non-profit organizations					
EPA Targeted Watershed Grants Program	$30,000	$70,000	33% of its grant award (non-federal)		April.
http://www.epa.gov/twg/ Requires Governor nomination.					
DEP CWA Section 319 NPS			40% of total project costs (non-federal)		September/ October
Non-point Source Management http://www.ct.gov/dep/nps 20-25 projects targeting both priority watersheds and statewide issues.					
DEP Section 6217 Coastal NPS			N/A		
http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323554&depNav_GID=1709 Section 6217 of the CZARA of 1990 requires the State of Connecticut to implement specific management measures to control NPS pollution in coastal waters. Management measures are economically achievable measures that reflect the best available technology for reducing non-point source pollution.					
DEP Hazard Mitigation Grant Program			75% Federal/25% Local		
http://www.ct.gov/dep/cwp/view.asp?a=2720&q=325654&depNav_GID=1654 Provides financial assistance to state and local governments for projects that reduce or eliminate the long-term risk to human life and property from the effects from natural hazards.					
NRCS Conservation Reserve Program					
http://www.nrcs.usda.gov/programs/crp/ Joyce Purcell, 860-871-4028 Available to farmers and ranchers to address natural resource concerns on their lands.					

Funding Source	Maximum Dollar amount	Minimum Dollar amount	Required match	Applications Open	Deadline
American Rivers-NOAA Community-Based Restoration Program Partnership	$100,000				December
http://www.americanrivers.org/our-work/restoring-rivers/dams/background/noaa-grants-program.html These grants are designed to provide support for local communities that are utilizing dam removal or fish passage to restore and protect the ecological integrity of their rivers and improve freshwater habitats important to migratory fish.					
Fish America Foundation Conservation Grants	$75,000	$10,000	At least 75% (non - federal)		May
703-519-9691 x247 fishamerica@asafishing.org					
Municipal Flood & Erosion Control Board	1/3 project cost	2/3 project costs			
NFWF LIS Futures Fund Small Grants	$ 10,000	$ 3,000	optional (non- federal)	Fall/Winter	March
631-289-0150 Lynn Dwyer					
NFWF Long Island Sound Futures Fund Large Grants	$ 150,000	$ 10,000	optional(non- federal)	Fall/Winter	March
631-289-0150 Lynn Dwyer					
NRCS Wildlife Habitat	$ 50,000/year	$ 1,000	25%		May
Incentives Program (WHIP)					
Joyce Purcell, (860) 871-4028 For creation, enhancement, maintenance of wildlife habitat; for privately owned lands.					
NRCS Healthy Forests Reserve Program					
http://www.nrcs.usda.gov/programs/hfrp/proginfo/index.html For restoring and enhancing forest ecosystems					
NRCS Wetlands Reserve Program					
Nels Barrett, (860) 871-4015					
USFS Watershed and Clean Water Action and Forestry Innovation Grants					
http://www.na.fs.fed.us/watershed/gp_innovation.shtm This effort between USDA FS-Northeastern Area and State Foresters to implement a challenge grant program to promote watershed health through support of state and local restoration and protection efforts.					
Corporate Wetlands Restoration Partnership (CWRP)	Typically $ 20,000	typically $5,000	3 to 1	April and August	
http://www.ctcwrp.org/9/ Can also apply for in-kind services, e.g. surveying, etc.					
River's Alliance Watershed Assistance Small Grants Program2			40% of total project costs (non-federal)		October
http://www.riversalliance.org/watershedassistancegrantrfp.cfm 860-361-9349 rivers@riversalliance.org Funding passed through River's Alliance from DEEP's 319 NPS grant program for establishing new or emerging river – watershed organizations.					

Funding Source	Maximum Dollar amount	Minimum Dollar amount	Required match	Applications Open	Deadline
USFWS National Coastal Wetlands Conservation Grant Program	$1 million		50%		
http://www.fws.gov/coastal/coastalgrants/ Ken Burton 703-358-2229 Only states can apply.					
EPA Green Infrastructure Funding Website					
http://cfpub.epa.gov/npdes/greeninfrastructure/fundingopportunities.cfm Index to funding opportunities for LID practices and pollution reduction projects.					
America the Beautiful Grant Program	$8,000		50%	May	June
USDA Forest Service funding through the DEEP Division of Forestry to support urban forestry efforts. www.ct.gov/dep/forestry					
YSI Foundation	$ 60,000		optional	March	April
937-767-7241 x406 Susan Miller Susan Miller smiller@ysi.com					
Rockfall Foundation Grants Program	$2,500	$500			Nov
Virginia R. Rollefson, Executive Director, vrr@rockfallfoundation.org (860) 347-0340					
Other Financial Opportunities					
Private Foundation Grants and Awards					
http://www.rivernetwork.org Private foundations are potential sources of funding to support watershed management activities. Many private foundations post grant guidelines on websites. Two online resources for researching sources of potential funding are provided in the contact information.					
Hartford Foundation for Public Giving - Greater Hartford's community-wide charitable endowment. Hartford Foundation for Public Giving provides financial and other support that enables people and institutions to serve the community effectively; promote informed charitable giving in order to expand the region's philanthropic resources; and participate actively in efforts to identify important community needs and opportunities, as well as the means to address them. http://www.hfpg.org/					
Congressional Appropriation - Direct Federal Funding					
State Appropriations – Direct State Funding					
http://www.cga.ct.gov/					
Membership Drives					
Membership drives can provide a stable source of income to support watershed management programs.					
Donations					
Donations can be a major source of revenue for supporting watershed activities, and can be received in a variety of ways.					
User Fees, Taxes, and Assessments					
Taxes are used to fund activities that do not provide a specific benefit, but provide a more general benefit to the community.					
Stormwater Utility Districts					
A stormwater utility district is a legal construction that allows municipalities to designated management districts where storm sewers are maintained in order to the quality of local waters. Once the district is established, the municipality may assess a fee to all property owners.					

Funding Source	Maximum Dollar amount	Minimum Dollar amount	Required match	Applications Open	Deadline
Impact Fees					
Impact fees are also known as capital contribution, facilities fees, or system development charges, among other names.					
Special Assessments					
Special assessments are created for the specific purpose of financing capital improvements, such as provisions, to serve a specific area.					
Sales Tax/Local Option Sales Tax					
Local governments, both cities and counties, have the authority to add additional taxes. Local governments can use tax revenues to provide funding for a variety of projects and activities.					
Property Tax					
These taxes generally support a significant portion of a county's or municipality's non-public enterprise activities.					
Excise Taxes					
These taxes require special legislation, and the funds generated through the tax are limited to specific uses: lodging, food, etc.					
Bonds and Loans					
Bonds and loans can be used to finance capital improvements. These programs are appropriate for local governments and utilities to support capital projects.					
Investment Income					
Some organizations have elected to establish their own foundations or endowment funds to provide long-term funding stability. Endowment funds can be established and managed by a single organization-specific foundation or an organization may elect to have a community foundation to hold and administer its endowment. With an endowment fund, the principal or actual cash raised is invested. The organization may elect to tap into the principal under certain established circumstances.					
Emerging Opportunities For Program Support					
Water Quality Trading					
Trading allows regulated entities to purchase credits for pollutant reductions in the watershed or a specified part of the watershed to meet or exceed regulatory or voluntary goals. There are a number of variations for water quality credit trading frameworks. Credits can be traded, or bought and sold, between point sources only, between NPSs only, or between point sources and NPSs.					
Mitigation and Conservation Banking					
Mitigation and Conservation banks are created by property owners who restore and/or preserve their land in its natural condition. Such banks have been developed by public, nonprofit, and private entities. In exchange for preserving the land, the "bankers" get permission from appropriate state and federal agencies to sell mitigation banking credits to developers wanting to mitigate the impacts of proposed development. By purchasing the mitigation bank credits, the developer avoids having to mitigate the impacts of their development on site. Public and nonprofit mitigation banks may use the funds generated from the sale of the credits to fund the purchase of additional land for preservation and/or for the restoration of the lands to a natural state.					

Source: NRCS (2008; 2010); Most web-links were verified for active status by HDR|HydroQual in March 2011.

7. Reference Materials

7.1 References

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APPENDIX A: Summary of Implementation Activities

The Norwalk River Watershed Initiative
Five-Year Assessment of Implementation Progress
Since 2004

I. HABITAT RESTORATION

- Redding has held invasive species removal project in open space areas through cutting and burning, then planting of native species.
- NRWA has held biannual invasive removal on the river banks on open spaces along the river.
- Ridgefield Chamber of Commerce has done invasive removal in Ridgefield.
- NRCS/USDA Wildlife Habitat Incentives Program (WHIP) has 14 acres of invasive species in Ridgefield and Wilton.
- Weston has been active in Gilbert and Bennett Development plans regarding controls on the disposal of contaminated fill.
- Weston took enforcement and legal action to preserve soils adjacent to Wampum.
- Trout Unlimited constructed and maintained a dam bypass channel at Cannondale dam to allow for up stream passage, with holding pools and native plantings.
- NRCS/USDA completed the design and permitting phase for removal of the Merwin Meadows Dam.
- Norwalk has begun the design and permitting phase for removal of the Floch Process Dam.
- Trout Unlimited completed several in-stream and bank restoration projects including in-stream and bank-placed boulders and log jams with conifer revetments and native species plantings along the river off of School Road, upstream from Old Mill Road and at Schenck's Island Park in Wilton.
- Watershed Coordinator assisted with landscaping at the Maritime Center with native plantings and butterfly garden.
- NRWI coordinated Boy Scout planting event at Silvermine School.
- Norwalk and NRCS completed the Silvermine River Streambank Restoration Project behind Silvermine School.
- Trout Unlimited, NRWA and Wilton conducted spring river cleanups each year.

II. LAND USE/FLOOD PROTECTION/OPEN SPACE

- The Norwalk River Valley Trail steering committee was formed with the support of five towns to create a 27 mile Norwalk-Danbury multiuse trail and Greenway designation which will ultimately increase exposure to the river through passive recreation. A grant from FHWA administered through DEP Recreational Trails Management has been awarded for this project.
- NRWA produced a 5 site trail guide for distribution.
- Progress was made in increasing regulated areas adjacent to wetlands:
    - Wilton increased the regulated area adjacent to a wetland from 50 to 100 ft.
    - Norwalk adopted defined regulated areas of 50ft. from wetlands.
    - Ridgefield increased regulated areas to 75 ft. from wetlands.
    - New Canaan increased regulated areas from 25 to 50 ft. from wetlands.

- Development rights to a property on Chestnut Hill in Wilton were secured to help obtain an easement on a property that is bisected by the Norwalk River.

III. WATER QUALITY

- Lewisboro initiated a septic education program, including flyers to all town residents and local cable TV show.
- NRWI sent letters to municipalities to encourage them to adopt septic ordinance.
- NRWI surveyed current municipal use of road sand.
- Ridgefield, Norwalk, New Canaan, Weston and Redding have switched to chemical de-icing
- Wilton is experimenting with a winter road mix that has less sand.
- Wilton recycling center has been revamped to include a broader spectrum of recyclables.
- Georgetown wastewater treatment plant was upgraded in 2008.
- CT DEP draft Stressor ID Report was issued.
- Norwalk, under its "The Filter Project", purchased and installed catch basins on Water Street in Norwalk.
- Lewisboro increased number of stream and lake monitoring multiple sites.
- Wilton, Norwalk and TU continue to support HW/RW & Earthplace monitoring program.
- HW/RW 's water quality monitoring program expanded testing with an additional 2 Norwalk River sites for a total of 12 and an additional 12 Silvermine River sites for a total of 20. They detected three failures at wastewater treatment plants which were resolved and identified several "hot spots" at the following locations:
  - Middlebrook Farm Road/Comstock Brook – Wilton
  - Moody's Lane/Norwalk Harbor - Norwalk
  - Calf Pasture/ LIS – Norwalk
  - School Street/Norwalk River - Norwalk
  - Washington Street/Norwalk Harbor - Norwalk
  - Rt 102-Rt 7 Intersection/Cooper Brook- Ridgefield
  - James Street/Silvermine River - Norwalk
  - Wall Street/Norwalk River- Norwalk
  - Governor Street/Ridgefield Brook- Ridgefield
  - Water Street/ Norwalk Harbor – Norwalk
- Norwalk adopted an Illicit Discharge & Detection/Elimination Ordinance
- Wilton and New Canaan held events for the collection and disposal of medications, entitled "Shed Your Meds", to raise awareness and discourage improper disposal.
- NRWI obtained and completed a grant for a goose reduction program by egg oiling including an informational brochure, workshops, and annual oiling in most watershed towns.
- New Canaan approved a "No Feeding" waterfowl ordinance.

IV. STEWARDSHIP AND EDUCATION

- NRWA maintains a website on a volunteer basis.
- Watershed Municipalities have developed greater cooperation and response to water quality issues.
- NRWI continues to support the River Study Program for 4th graders
- Maritime Aquarium has expanded its Norwalk River Watershed Exhibit.
- NRWI increased cooperation and response from municipalities to water quality issues.

- NRWI held a meeting for CEOs of watershed towns in 2006.
- Harbor Watch/ River Watch program has seen increased financial support.
- Financial support for the Coordinator position was switched from 319 to municipal funding.
- An update of the current action plan was administered by SWRPA to incorporate the Nine Elements of a Watershed Based Plan.
- NRWI had produced and distributed Informational pamphlets and brochures including a state of the Watershed report, “RiverWise: A Look at the Norwalk River Watershed”, and “Stream Corridor Restoration in the Norwalk River Watershed: Case Studies and Lesson Learned”.
- NRWI provided publicity and press releases for “The Filter Project”
- NRWI hosted a watershed event, “Restoring a River – How a Conservation Partnership Works”, at Silvermine Elementary School.
- CT DEP sponsored “Project Wet”, an educational program at Silvermine River.
- NRWI received the “Green Circle Award” in 2005 and the national award, “Clean Water Partner for 21st Century” in 2003.
- NRWI held exhibits at the Wilton Go Green Festival on topics “What Is a Watershed?”, “Non-Point Source Pollution” and “Rain Gardens” and on “Non-Point Source Pollution” annually at the Oyster festival in Norwalk.

APPENDIX B: Full List of Recommended Management Measures

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
B	0	0	**Goal B: Habitat Restoration** (Preserve and enhance wildlife habitat)																				
B	1	0	***Objective B-1: Control or diminish the prevalence of invasive species***																				
B	1	1	Identify and address problem areas with invasive species on a regular basis						x										2-4 years	–	Generation of annual list	–	S
B	1	2	Implement specific invasive species reduction/restoration projects			x													2-4 years	Identification of project sites and initiate restoration projects	Completion of projects	–	S
B	1	3	Encourage nurseries to offer more native species and discourage the sale of invasive non-native species			x													2-4 years	–	Implement seasonal campaign to educate nurserymen	–	W
B	2	0	***Objective B-2: Minimize loss of habitat values coincident with land use practices***																				
B	2	1	Support legislation regarding development that protects water resources including buffers	x		x													2-4 years	–	Issuance of a letter of support	–	W
B	2	2	Encourage standard practice of using disturbance lines and vegetative buffers			x													4+ years	–	Adoption by municipalities as standard practice	–	W
B	2	3	Encourage 'set asides' for conservation easements and open space			x													4+ years	–	Adoption by municipalities as standard practice	–	W
B	2	4	Work with local open space policies to identify intact habitats and high functioning ecosystems for protections and preservation	x		x													2-4 years	–	Habitats identified in each watershed town	–	W
B	2	5	Encourage articulation of habitat restoration & protection as a goal in municipal, regional & state Plans (POCDs).	x		x	x												2-4 years	–	Habitat goal included in all POCDs	–	W
B	3	0	***Objective B-3: Restore diadromous and resident fish passage***																				
B	3	1	Support projects for installation of fish ladders and/or dam removal throughout the watershed	x															2-4 years	–	Issuance of letter of support for implementation and grant funding	–	T
B	3	2	Press forward on the removal of the Merwin Meadows (a.k.a. Dana) and Flock Process dams			x					x			x					1-2 years	–	Restoration of fish passage and natural hydrologic regime	–	S
B	4	0	***Objective B-4: Preserve and restore in-stream habitat***																				
B	4	1	Improve water release practices from in-stream water company reservoirs																4+ years	–	Understanding of specific impacts	–	S
B	4	2	Support in-stream restoration efforts lead by local organizations	x					x										1-2 years	–	Member participation and/or letter of support for grant funding	–	W
B	4	3	Identify additional habitat restoration opportunities from stream walks and determine technical and financial assistance required	x					x										1-2 years	–	Prioritized list of detailed restoration opportunities	–	T
B	4	4	Review the existing Watershed Stream Corridor Impairment Inventory and initiate an update											x					2-4 years	–	Updated Inventory document and map	–	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
B	4	5	Install and maintain BMPs (i.e. sediment traps) at all discharge points to the river			x													2-4 years	Identify suitable locations for BMPs	Sediment traps installed	% of discharge points with BMPs, implemented maintenance schedule	S
B	5	0	***Objective B-5: Maintain, enhance and increase riparian buffer areas***																				
B	5	1 a	Adopt a targeted program to correct pollution from the hotspot areas identified in D-2-3a, including but not limited to field inspections, technical guidance, monitoring and enforcement	x															2-5 years	Completion of riparian corridor analysis	Maps identifying riparian areas and conditions, with prioritization shown in color-coded format	% of watershed area completed in each WM	W
B	5	1 b	Implement riparian restoration projects based on sites identified in B-5-1a			x			x					x					2-5 years	Grant award	Riparian corridors restored or rehabilitated	# of identified areas restored (Target is one project per year)	T
B	5	2	Promote the use of grass-lined swales and other bioretention practices along both major highways and local roadways, using a prioritization process recommended in Table 5-2 with priority subwatersheds for immediate implementation of BMPs.			x	x						x						1-2 years	Training (Classroom and Field)	Implementation of swales and bioretention practices with high level of effectiveness for indicator bacteria load reduction	% of transportation corridor treated by BMP/LIDs, with a target of 50% in 10 years	T
B	5	3 a	Conduct a more detailed watershed-wide tree canopy analysis, based on currently available data to determine the extent of tree cover and establish baseline conditions				x												1 year	Grant award and contractor selection	Existing tree canopy maps for various municipalities	% of watershed area completed, in each WM	W
B	5	3 b	Quantify the value of urban forestry and tree programs for improving the aesthetics, energy efficiency and air quality, wildlife habitat, recreational opportunities, real estate values, and potential job opportunities using tools such as the one developed by Center for Neighborhood Technology				x												2 years	Adoption of a valuation tool for the entire watershed	Quantified values on a watershed basis for communication with public	Completion of analysis and review in a stakeholder meeting	W
B	5	3 c	Track progress in the implementation of tree canopy cover on a watershed-wide level	x		x													Every 3 years	Grant award	Comparison of tree canopy cover to quantify benefits	% increase in canopy cover, with a target of 5% every 3 years	W
B	5	4	Develop a comprehensive urban forest master plan that integrates the LID benefits and sets a watershed-wide urban tree canopy goal			x													1-2 years	Partnership among WMs to perform this work	Urban forest master plan	Completion of the plan report	W
B	5	5	Review the quantified benefits of increased buffer zones from states such as New Jersey to accelerate the buy-in and establishment of appropriate regulations. Also review the Riparian Toolbox that EPA-LISO had put together	x															1 year	Grant award to perform this review	Compiled documentation for all stakeholders' reference	Document completion	W
B	5	6	Expand existing public education program to emphasize the value of riparian buffers and improvement of regulations to protect them		x	x								x					1 year	Curriculum expansion	Education and outreach documents	% representation from each WM, in terms of geographical coverage of the watershed	W
B	5	7	Identify and evaluate effectiveness of BMPs to reduce thermal pollution					x											2-4 years	Grant award to perform evaluation	Installation and monitoring of BMP installations	a detailed analysis of trends before and after installation	W
B	5	8	Support legislation that protects and repairs riparian zones	x	x	x													1-5 years	Letters of Support	Statewide riparian protection	Legislation Passed	W
B	5	9	Continue support of projects and programs to remove trash and debris	x					x										2-4 years	–	Member participation in clean-up projects	Member participation in clean-up projects	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
C	0	0	**Goal C: Land Use/Flood Protection/ Open Space** (Promote Balanced Growth Which Preserves Property Values and Protects and Enhances the Watershed's Resources for Future Generations)																				
C	1	0	***Objective C-1: Identify appropriate areas for public access to the rivers and streams and increase public access where appropriate.***																				
C	1	1	Develop a public access area inventory.						x										2-4 years	–	Documented inventory	–	W
C	1	2	Make public aware of, and promote, access to passive recreation (i.e. via signage or website)						x										2-4 years	Installation of signage	Increased use and stewardship of open areas	–	T
C	1	3	Ensure accessibility of trail maps at municipalities			x													1-2 years	–	Local trail maps at all watershed municipality town halls	% of watershed towns with local trail map guides at Town Hall, target 100% at the end of 2 yrs	S
C	1	4	Support the Norwalk River Valley Trail (NRVT) Committee for greenway designation and trail development	x															1-2 years	–	Issuance of letter of support	–	S
C	1	5	Support the creation of linear parks along the river	x															2-4 years	–	Letters of support	–	W
C	2	0	***Objective C-2: Promote inclusive land use planning for natural resource conservation.***																				
C	2	1	Encourage watershed-based land use planning	x		x	x											x	1-2 years	–	Round table discussion with all noted implementing organizations	–	W
C	2	2	Develop a framework and complete a comparative review of land use, open space and zoning regulations for all watershed municipalities				x												1-2 years	–	Information collection and exchange between municipalities	–	W
C	2	3	Work with state, regional, and municipal agencies and staff to minimize impervious surfaces	x		x	x				x	x							2-4 years	–	Reduction of impervious runoff generated in watershed	–	W
C	2	4	Ensure that land use planning for industrial and commercial uses includes consideration of adequate stormwater drainage and wastewater treatment systems			x													1-2 years	–	Revision of local regulations & policies to address BMPs stormwater and wastewater	–	W
C	2	5	Explore the feasibility and benefits of developing a Norwalk River overlay zone				x												2-4 years	–	Compiled documentation regarding feasibility	–	W
C	2	6	Support statewide legislation to mandate effective watercourse buffers	x															Ongoing	–	Issuance of letter of support	–	W
C	3	0	***Objective C-3: Recognize the importance of maintaining and increasing open space to ensure proper functioning of the watershed.***																				
C	3	1	Promote balanced growth which preserves property values and protects & enhances watershed resources for the future	x		x													1-2 years	–	Local land use decisions inclusive of watershed resource protection	–	W
C	3	2	Provide support to municipalities' and other land preservation organizations' efforts	x			x												2-4 years	–	Issuance of letter of support	–	W
C	3	3	Develop an open space map for the watershed and identify key parcels beneficial for preservation			x													1-2 years	–	Watershed-wide open space planning map	–	W
C	3	4	Identify, preserve and enhance areas important for flood storage and conveyance	x		x													1-2 years	–	Development protective of flood storage	–	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
C	4	0	***Objective C-4: Reduce the frequency and severity of flooding***																				
C	4	1	Educate residents living within flood plains and flood prone areas of the vulnerability to flood damage and practices to protect and mitigate their property and families	x		x													2-4 years	–	Educational information for distribution	–	W
C	4	2	Continue to encourage the preservation of undeveloped lands and wetlands within the 100-year flood zone with the use of Open Space purchase, donation or conservation easement			x													Ongoing	–	Additional Acquisition and protection of flood prone properties and properties beneficial for flood storage and conveyance	–	W
C	4	3	Implement strategies identified in the current Predisaster Mitigation Strategy Documents, http://www.swrpa.org/Uploads/SWR-PDM_2011-Final_reduced.pdf; and local and Regional Plans of conservation and development.			x													Ongoing	–	Reduced vulnerability and damage as a result of flooding	–	W
D	0	0	**Goal D: Water Quality** (To restore and protect surface and ground water to meet State water quality standards throughout the watershed such that the Norwalk River supports its designated and existing uses)																				
D	1	0	***Objective D-1: Eliminate illicit discharges to storm sewers***																				
D	1	1	Review and update municipal stormwater management plans to ensure that IDDE efforts are undertaken.			x													6 months	Updated stormwater plan to address IDDE requirements	Consistent IDDE program in the watershed	Effort completion in all 7 WMs	W
D	1	2	Continue the illicit discharge investigations and follow up for all hotspots identified during field reconnaissance/monitoring. The hotspots exhibit continuous discharges during dry weather periods and also involve exceedances of indicator bacteria criteria in the waterways during such periods			x		x											1-2 years	Completion of IDDE programs	Videos, maps to confirm sources	# of sites investigated and scheduled for immediate remedial action by all WMs. Target is 100% in 10 years	S
D	1	3	Continue work to eliminate illicit discharges			x		x											Ongoing	Improved water quality	Elimination of hotspots	# of hotspots removed from the list, comparison of pre and post-removal monitoring data to show progress - Target of 100% in 5-10 years	W
D	2	0	***Objective D-2: Improve solid waste and liquid waste management throughout the watershed***																				
D	2	1	Establish criteria to identify poorly-functioning on-site septic systems in the watershed to facilitate implementation of inspection and O&M programs	x		x	x												1-2 years	Acceleration of controls for septic systems	Consistent criteria for all WMs to pursue inspection and O&M	Completion of a technical memorandum on criteria based on EPA guidance and other case studies	W
D	2	2	Conduct an inventory of areas in each municipality where the greatest potential for a concentration of poorly-functioning on-site septic systems are located and include a brief description of the primary factors that contribute to these problems	x		x	x												1-2 years	Watershed wide documentation	Documentation from all WMs with previous complaints or records on poorly functioning systems	A map of potential areas with greatest number of such systems to prioritize the subsequent inspections and actions	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
D	2	3 a	Develop a combination of GIS-based and advanced technologies such as infrared photography to identify hotspots that are affected by septic system failures			x	x												2-4 years	Grant to pursue this work	Mapping of hotspots to facilitate the control and O&M programs	# of maps created in the watershed for action by individual WMs; a report with findings	W
D	2	3 b	Adopt a targeted program to correct pollution from the hotspot areas identified in D-2-3a, including but not limited to field inspections, technical guidance, monitoring and enforcement			x													1-5 years	Completion of inspections and monitoring	Elimination of failed septic systems through proper O&M	# of systems brought to normal operations - Target is 100% over 5 years	S
D	2	4	Publicize and promote adequate maintenance of on-site septic systems, using a variety of media and outreach techniques	x		x													1-2 years	Outreach material	Effective communication with public on the importance of inspection and O&M aspects	% of watershed covered for public outreach - Target is 100% in 1 year; % of population that maintain their systems without failures - Target is 100% in 10 years	T
D	2	5	Develop incentives for year-round disinfection at wastewater treatment facilities			x					x								2-4 years	Activation of disinfection	Improved plant operations	Improved water quality during dry weather	W
D	2	6	Discuss with and encourage CTDEP's Municipal Facilities Section to compose a regional fact sheet for wastewater treatment facilities	x							x								2-4 years	Meeting with CTDEP	Fact sheet developed	Fact sheet Developed	T (segments adj to POTW)
D	2	7	Encourage implementation of BMPs for phosphorous reduction at wastewater treatment facilities	x							x					x			1-2 years	Meeting with POTWs	Implementation of BMPs	100% meeting attendance within first; BMPS at each treatment plan with in 5 years	S (POTW)
D	2	8	Explore the use of a unified tracking system that can assist with watershed-wide monitoring of septic systems	x		x					x	x							2-4 years	Establishment of a tracking system	Watershed-wide database to assist the WMs in tracking improvements	% of watershed covered - Target of 100% over 5 years	W
D	2	9	Work with municipalities to develop a program to address potential environmental issues with poorly-functioning septic systems	x		x												x	1-2 years	Establishment of program	Training/workshop	Completion of the program for consistent use by all WMs	W
D	2	#	Evaluate the cumulative effect of discharges permitted by CT and NY on in-stream habitat and water quality								x	x							4-5 years	Detailed water quality assessment	Septic system loads to stream capacity analysis to quantify the impacts at small hydrological scales	Completion of the study on source and effects for both indicator bacteria and nutrients	W
D	3	0	***Objective D-3: Reduce the impact of road sand and salt on water quality and stream habitat***																				
D	3	1	Develop an implementable action plan through discussions with watershed municipalities' Department of Public Works (DPWs) to reduce the impacts of sediments from roadways on the river through, frequent cleaning of catch basins, capture using treatment technologies such as swirl separators or other BMPs prior to reaching the waterways and LID practices			x													2 years	Guidance for WMs on unified O&M procedures	Action plan document	% of catchbasins maintained per year (Target of 100% over 5 years, or 20% per year, in each municipality); estimated reductions in sediment loads based on the BMPs implemented	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
D	3	2	Work with DPWs to develop a regular monitoring and maintenance scheduled for catch basins and drainage structures and prioritize street sweeping to maximize efforts within the watershed			x													1-2 years	Unified O&M protocol	Tracking catch basin maintenance; Targeted street sweeping to reduce O&M costs for WMs	% of catchbasins monitored and maintained on a watershed-scale (goal of 100% over 5 years or 20% per year, in each municipality)	W
D	3	3	Develop a comprehensive map of stormwater infrastructure within the watershed			x	x												1-3 years	Inventory completion	Characterization report showing outfalls and drainage areas, and the collection system for each outfall	% of watershed area characterized (goal of 100% over 5 years) - this is one of the key elements of CTDEP/NYSDEC MS4 permit	W
D	3	4	Review deicing practices regularly and adopt practices less harmful to water quality and wildlife as appropriate			x													1 year	Migration to less harmful practices	Use of best available practices	100% migration by all WMs	S
D	4	0	***Objective D-4: Maintain adequate baseflows in the Norwalk River and its major tributaries***																				
D	4	1	Evaluate the potential impact of streamflow enhancement regulations from CTDEP and develop BMPs such as infiltration basins to enhance baseflows in the upper reaches of Norwalk and tributaries			x					x			x	x				2-5 years	Guidance to WMs on the impact of enhancement regulations	Maps identifying infiltration basins, and quantitative study to track improvement	Monitoring and quantification of results	T
D	5	0	***Objective D-5: Eliminate or reduce the anthropogenic impacts to in-stream water quality***																				
D	5	1	Develop a list of in-stream impoundments on first and second order streams and prioritize impoundments for removal based on the impacts to water quality	x							x								2-3 years	Basis for impoundment removal for WMs/CTDEP	Local monitoring data and site-specific assessments to characterize algal growth and nuisance aquatic plant growth	Number of priority impoundments recommended for removal of control practices	T
D	5	2	Continue to monitor the eutrophication concerns in ponds and reservoirs and evaluate the potential for in-lake treatment methods (e.g. nutrient reductions, aeration, weed removal/dredging) to improve water quality. Start with the Great Swamp and continue to other impoundments where algal growth and nuisance plants are of great concern					x			x								1-2 years	Grant solicitation to perform monitoring	Local monitoring data and site-specific assessments to characterize algal growth and nuisance aquatic plant growth	% Completion of monitoring efforts and development of site-specific recommendations for the impacted ponds and reservoirs	S
D	5	3	Develop targeted strategies to reduce nitrogen and phosphorus inputs to the impoundments of concern, which may be more restrictive than the strategies adopted elsewhere in the watershed			x													2-5 years	Action plan for individual impoundment	Education and guidance for undertaking more restrictive actions	Finalize guidance document and implement strategies - % of impoundments taken out of the hotspot list in Section 5 under Nutrient Concerns	S
D	5	4	Conduct additional investigations to determine DO fluctuations in water releases from the Great Swamp, and develop a plan to evaluate site-specific conditions and develop remedial measures					x											1 year	Pollution reduction plan	Establish mass balance to determine load to response relationships and develop target reductions in TN/TP	Completion of monitoring and targeted reductions for pollutants from areas surrounding the impaired impoundments	S
D	6	0	***Objective D-6: Reduce nitrogen loads from groundwater***																				
D	6	1	Evaluate the need and potential costs associated with treatment technologies for removing nitrogen from groundwater (e.g., Permeable Reactive Barrier, alternative septic systems, and STP expansions , in-stream wetland in upper reaches with high septic system density												x				5-10 years	Feasibility analysis of technologies and costs	Technology evaluation report, Sites for potential screening and application	Completion of the feasibility analysis and costs	T

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
D	7	0	***Objective D-7: Reduce nitrogen loads from atmospheric deposition***																				
D	7	1	Review the atmospheric deposition studies being performed by EPA/EPA-LISO to quantify the potential contributions in the watershed			x					x	x	x						1-2 years	Guidance to WMs	Correlations between vehicular traffic and nitrogen loads; estimated %reduction	Completion of the data analysis and interpretations	T
D	7	2	Conduct a GIS-based study to develop nutrient pollution load from this source and identify sites for control measures such as diversion of runoff into BMPs and LID practices including as wetlands, swales, and bioretention for treatment. Continue to implement those practices over time				x												2-3 years for study and 10-15 years for implementation	Implementation of control measures	Maps identifying locations for control measures along the transportation corridors	% of transportation corridor treated with BMPs (goal of 100% over 20 years)	T
D	8	0	***Objective D-8: Continue water quality monitoring, data collection and assessment***																				
D	8	1 a	Continue the annual water quality monitoring program and modify procedures as necessary. Results can be used to track improvements from watershed-wide and site-specific pollution control measures and understand watershed responses under different hydrologic regimes					x			x								Annually	Successful grant applications	Data collection and water quality reports	Continued Monitoring	W
D	8	1 b	Evaluate and communicate water quality trends	x				x			x								Annually	Data analysis	Historical trend and comparisons	analysis completed every 5 yrs, funding permitting and results shared with stakeholders	W
D	8	1 c	Publish a yearly water quality summary report	x				x											Annually	–	Annual monitoring reports	Completion of annual report	W
D	8	2 a	Coordinate monitoring for wet and dry weather conditions to characterize potential sources of water quality impacts in hotspots for indicator bacteria and nutrients					x			x								Ongoing	Detection of sources	Isolation of hotspots and sources contributing pollution during dry weather determined	# of hotspots recommended for immediate remedial actions	S
D	8	2 b	Perform additional field investigations and monitoring to support efforts near hotspots, e.g., Great Swamp to reduce eutrophication and algal growth. Additional site-specific monitoring and investigations should be undertaken to characterize the incoming nutrient and sediment loads, physical configurations of these impoundments (such as storage, depth, and shape), and environmental factors (temperature, leaves from trees, etc.).				x	x				x							2-5 years	Completion of investigations	Confirm suspected pollutant sources and quantify the load reductions from corrective actions	Number of sites completed (goal is 2-3 per year based on available financial resources)	S
D	8	2 c	Continue to support 'hotspot' pollution response practices and appropriate solutions to eliminate pollution source			x		x			x								Ongoing	Detection of sources	Isolation of hotspots and sources contributing pollution during dry weather determined	remedial actions and improved water quality after remediation	S
D	8	3	Conduct targeted water quality monitoring to confirm the sources of conductivity and quantify the extent of this concern in the River and its Tributaries					x			x								2-3 years	Technical basis for addressing conductivity	Scientific report for conductivity target setting	Water quality criterion for conductivity, as appropriate	T
D	8	4	Design and implement monitoring of LID practices on a demonstration basis and develop performance data to specifically support LID planning in the Norwalk River and tributary watersheds	x			x				x			x			x		1-4 years	Performance evaluation data compilation	Field monitoring and characterization results and the associated scientific report	# of pilot projects completed (goal of 6 different LID types over 4 years)	S

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations: NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
D	8	5	Seek funding to further evaluate TN and TP nutrient loading	x				x			x								2-4 years	Grants	Funding	Additional Nutrient Load Assessment	W
D	8	6	Identify and pursue appropriate measures to evaluate the impact of medical waste on water quality			x		x			x	x							4+ years	Scientific basis for medical waste management	Reviewed literature along with potential source reduction strategies and treatment methods for constituents	Completed literature and action plan for source control	W
D	8	7	Evaluate the impact of introduced chlorides on water quality					x			x	x					x		2-4 years	Toxicity evaluation	Findings of toxicity evaluation along with sensitive species in Norwalk R/tributaries	Completion of the study report	W
D	8	8	Reactivate the streamwalk program to support public outreach and also use volunteers for physical, chemical and biological assessment of stream health in the watershed	x															Ongoing	Grant/ volunteer sign-up	Annual Streamwalk	Annual Streamwalk held	W
E	0	0	**Goal E: Non-Point Source Runoff Management** (Reduce the cumulative impacts of development and non-point source pollution in runoff)																				
E	1	0	***Objective E-1: Reduce the cumulative impacts of development and expand efforts to promote and implement Low Impact Development (LID) practices***																				
E	1	1	Encourage upstream watershed municipalities to embrace aggressive BMP/LID implementation projects with the goal of not transferring the stormwater problems to downstream areas	x							x								1-2 years	Education	Watershed-wide permitting and coordination to achieve results	# of projects implemented in upper portions of the watershed	T
E	1	2 a	Evaluate the feasibility, and begin design and implementation of LID elements at identified public lands owned by state, local and county governments within the watershed (Appendix).			x					x	x	x						2-10 years	Site scale evaluation and design for identified properties; funding secured; implementation; construction complete	Completed site designs, LID elements and practice incorporated into the local landscape	Number of properties in each WM, taken to design and implementation stages with appropriate grant/other financial support. Target is 1-2 properties per WM per year	T
E	1	2 b	Begin to work with owners of large privately owned lands, to incorporate LID practices into their existing landscapes, rehabilitation and the future development projects. Targeting properties identified as suitable candidates for LID retrofits (Figure 5-11)			x					x	x							2-10 years	Outreach and buy-in from property owners, site scale evaluation and design for identified properties; funding secured; implementation; construction complete	Property owner buy-in, completed site designs, LID elements and practice incorporated into the local landscape	Number property owners contacted and met with, percent of properties in each WM, taken to design and implementation stages with appropriate grant/other financial support. Target is 1-2 properties per WM per year	T
E	1	2 c	Identity projects from E-1-2a and b that would serve as appropriate demonstration projects			x					x	x							2-10 years	Demonstration projects initiated and promotional and educational materials developed	Demonstration projects in place in each watershed municipality	# of demonstration projects completed	
E	1	3	Conduct monitoring programs to track the effectiveness of implemented LIDs. Also develop a watershed-wide database to track implementation projects undertaken and completed in municipal/state owned properties in the watershed			x													2-5 years	Performance Evaluation Data	Monitoring data, comparison to literature and statistical analyses to show effectiveness and a database to track implementation projects	Number of seasonal and continuous monitoring programs implemented. Target is 1 to 2/year	T

				Implementing Organizations																			
Goal	Objective	Task	Objectives and Associated Action Items	NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
E	1	4	Work with municipalities to determine how best to promote smart growth in urbanized areas including compact and preferred development areas based on availability of existing sewer, water, stormwater and transportation infrastructure. Using GIS to identify preferred areas for development and incorporate into POCD recommendations			x													1-5 years	Adoption of smart growth elements in development/ redevelopment initiatives	Maps of preferred areas and associated public outreach to promote smart growth	# of Municipalities adopting smart growth elements. Target is 100% at the end of 5-years	W
E	1	5	Explore the feasibility of a stormwater utility (fee assessed based on stormwater contributions from a property), borrowing lessons learned from the recent CTDEP stormwater utility pilot projects and the ongoing work by the CTDEP to incorporate LID into state permits and policy								x								2-5 years	Funding mechanism	A guidance document for the feasibility of utility fee	Establishment of a steady funding vehicle to support stormwater management efforts (utility, dedicated stormwater tax, etc.)	W
E	1	6	Develop a municipal rain barrel giveaway/incentive program			x													1-2 years	Secure funding or grants	Rain barrels implementation in all WMs	Effectiveness of rain barrels and compilation of O&M needs, frequency of training programs for homeowners. Target is 200 barrels per WM over 2 years	W
E	1	7	Conduct an evaluation study of the long-term program costs and financing alternatives for developing incentives for private property owners to implement LID practices (e.g., stormwater fee discounts for the disconnected impervious area)			x					x								1-2 years	Business model LID implementation in private properties	Guidance document on program costs, barriers to implementation	# of WMs adopting LIDs to achieve MS4 permit requirements. Target is 100% in 2 years	W
E	1	8	Publicize opportunities for engineers, architects, developers, and contractors to learn more about LID practices	x		x					x								2-4 years	Information posted online, calendar of events, Brochures & training	Workshops provided to targeted audience	% of target audience who put these practices to use in their projects. Target is 100% in 5 years	W
E	1	9 a	Conduct a GIS-based inventory of medium to high density areas (0.25 to 1.0 acre lots) that can be targeted for roof leader disconnection programs and design visual inspections to quantify the potential benefits			x	x												1-2 years	Inventory of opportunities	Maps showing priority areas for roof leader disconnection for each WM	% watershed area completed for inventory and tracking,	W
E	1	9 b	Promote the reduction of rooftop runoff and reuse of stormwater using rain barrels, rain gardens or other LID practices	x	x	x					x								2 years	Completion of brochure/ training material	Brochures and guidance manual to public, financial incentive program for implementation	# of households and businesses adopting the reuse concept (target 25% over 10 years for each WM)	T
E	1	9 c	Track the implementation of rooftop disconnection programs on a watershed-wide scale	x															5-10 years	% of disconnections over time	Monitoring program to track effectiveness, Compilation of database of installations	% of roofs with rain barrel, cistern, rain garden controls. % of households disconnected with a Target of 50% in 10-years and 100% over 40 years	W
E	2	0	***Objective E -2: Ensure municipal regulations support the implementation of LID practices***																				
E	2	1 a	Review the municipal codes and ordinances of seven watershed municipalities and incorporate specific recommendations to embrace a watershed-wide implementation of LID elements, giving preference to process-based LID practices that promote nutrient uptake (e.g., rain garden, bioretention)	x		x	x												6 months to 1 year	Consistency in control practices in all WMs	A report reviewing all municipal ordinances and making recommended changes to codes and ordinances	Completion of the report and submission to WMs	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
E	2	1 b	Review land use regulations in neighboring states to identify innovative practices appropriate for the Watershed	x															1-2 years	Summary or Regulations	Guidance or inventory of innovative practices	Completion of the review and submission of a memorandum to stakeholders	W
E	2	1 c	Implement changes to codes and ordinances to promote process-based LID practices on a watershed-wide scale as recommended by the results of E-2-1a			x													1-2 years	Adoption of changes	Consistent codes and ordinances on a watershed basis	# of WMs formally adopting changes	W
E	2	2	Modify the Stormwater Runoff section of municipal zoning regulations to include a set of stormwater management standards, including consideration of multiple targets for stormwater control; and establish clearer, specific performance standards for projects. Such standards can include LID practices that recognize stormwater as resource rather than a waste to be conveyed to the waterways instantaneously			x					x	x							1-2 years	Modified zoning regulations	Consistent codes and regulations for the watershed	Adoption and associated revision in regulations in all WMs. Target is 100% at the end of 2-years	W
E	2	3	All the seven watershed municipalities in CT and NY, as part of their Municipal Separate Storm Sewer System (MS4) permits, should consider integrating LID elements into their capital improvement planning process to further reduce runoff volume, peak flow rates and stormwater pollution from their respective drainage areas			x													1-2 years	Guidance to WMs	Modification of protocols used within WMs to achieve this goal.	All municipalities adopting LIDs in capital improvement planning. Target is 100% over 1-2 years.	W
E	2	4	Provide education to local land use agencies regarding LID practices so that they can promote and implement these practices			x											x		1-2 years	Training Session for local board and commission members	Adoption of LID practices in regulations by all WMs	Timeframe for all WMs to adopt new regulations	W
E	2	5	Encourage revision of local land use regulations to address the impacts of new development on the natural environment including provisions that require that new construction result in a net zero increase in stormwater runoff from the site, both during and after construction	x	x	x													2-4 years	Revised land use regulations, Draft revised regulations	Consistent codes and regulations to achieve net zero increase in stormwater runoff for all watershed municipalities	CTDEP/NYSDEC stormwater regulations have this criteria. Any revisions to make sure that this is adopted by 100% of applicants in all 7 WMs	W
E	3	0	***Objective E -3: Advocate for a state and local permitting framework that best protects water resources from the impacts of non-point source runoff***																				
E	3	1	Support & recommend increased capacity for inspection and enforcement of current and future stormwater general permits in the watershed	x	x						x	x							1-2 years	Request made to CTDEP and legislators, Letters of support provided	Enforcement program developed, Streamlined permit review for all WMs	Completion of the general permit review protocol and communication with WMs	W
E	3	2	Establish watershed-based permitting aimed at effectively reducing the cumulative impacts of stormwater								x	x							1-2 years	Support of watershed based permitting	watershed based permitting established	Stakeholder-driven process to issue the permit to WMs	W
E	3	3	Work with state agencies and local municipalities to ensure flood plains are considered as part of the design and review of stormwater management methods, and the interactions between both systems are evaluated	x		x													2-4 years	Training held for municipal boards and commissions	Reduction of improperly functioning stormwater systems and protection of the flood plain	–	W
E	4	0	***Objective E-4: Adopt land use practices that reduce the impacts of non-point source runoff***																				

Goal	Objective	Task	Objectives and Associated Action Items	NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				Implementing Organizations																			
E	4	1	Expand municipal commitment to use organic land care practices on municipal owned property through regulations or make specific recommendations to support an ordinance concerning the use of pesticides or fertilizers	x		x													1-2 years	Program established by municipalities Reduced use of pesticides or fertilizers	Outreach materials (pamphlets, letters to lawn mowing contractors)	Estimated load reduction from adoption of ordinances - the reductions can vary based on the acreage of public property in each sub-basin	W
E	4	2	Support statewide legislation regulating fertilizer and pesticide usage	x	x	x													1-5 years	Submission of letters	Letters of support	Legislation passed	W
E	4	3	Educate homeowners, businesses and golf course operators regarding the impact of excess fertilizer and nutrient enrichment products on water quality and communicate benefits of environmentally-sound ground keeping practices	x		x													1-2 years	Education materials developed and distributed	Outreach materials (pamphlets, letters to lawn mowing contractors)	Estimated load reduction from adoption of ordinances (reported to be in the 1-2% range watershed-wide, but can be much higher at the scale of local impoundments with eutrophication concerns	W
E	4	4	Strengthen the landscape provisions of the Zoning Regulations by requiring maximum tree preservation, replacement and diversity of tree species																2-5 years	Modified zoning regulations	Watershed-wide approach to improving urban greening	Adoption and associated revision in regulations in all WMs. Target is 100% at the end of 2-5 years	W
E	4	5	Modify parking regulations to reduce the effective impervious cover and encourage implementation of porous or permeable pavers in parking lots			x	x												2-5 years	Modified parking regulations	Watershed-wide approach to reducing impervious covers	Adoption and associated revision in regulations in all WMs. Target is 100% at the end of 2-5 years	T
E	5	0	***Objective E-5: Manage bacterial contamination from waterfowl and domestic/farm animals***																				
E	5	1	Adopt a local ordinance to prevent feeding of water fowl			x													2-5 years	Adoption of ordinance	Consistent ordinance among all WMs	Ordinance adopted by all 7 municipalities	W
E	5	2	Post signs and conduct education programs to stop feeding using the program developed by New Canaan as a guide	x		x													2 years	Education outreach program completion	Signage completion and monitoring to track progress	Reduction in waterfowl populations and associated improvement in water quality in the waterways	S
E	5	3	Employ effective methods to significantly reduce the non-migratory goose population			x					x								2 years	Testing to confirm effectiveness of methods	Guidance document for different methods and their effectiveness	Reduction in waterfowl populations/ improvement in water quality in impoundments with current waterfowl problems. Target of 30% on a watershed-basis over a period of 10 years.	W
F	0	0	**Goal F: Stewardship and Education** (Educate the community about the boundaries and functions of the Norwalk River Watershed, the specific need for protection or, and improvement to, the river system, the benefits of a healthy watershed to individuals and communities, and the opportunity to speak out on issues and to participate in the stewardship of the watershed.)																				
F	1	0	***Objective F-1: Develop a mechanism to monitor The Action Plan, implement such a mechanism, and foster watershed stewardship.***																				
F	1	1	Maintain representation and participation from watershed stakeholders including federal and state agencies, businesses, individuals, and community, environmental and educational organizations	x															Ongoing	Attendance by a representative from each identified stakeholder at a meeting at least once per year.	Increased participation for initiative group members	attendance at monthly meetings	W

Goal	Objective	Task	Objectives and Associated Action Items	NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD	Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				Implementing Organizations																			
F	1	2	Maintain Watershed Coordinator position to assist in monitoring plan implementation and coordination activities. Secure funding for contracting on a two-year basis	x		x					x								Ongoing	Secure funding for coordinator position	position contracted	position maintained	W
F	1	3	Hold formal annual meetings to review progress and communicate results	x															Ongoing	–	Meeting held each year	Target 100% representation from watershed stakeholders	W
F	1	4	Conduct an evaluation of the Action Plan every five (5) years	x															5 years	Plan assessment in 2016	Analysis and implementation summary	Initiation of plan update (F-1-5) or if no changes needed reassess in 2018	W
F	1	5	Based on evaluation results, the action plan will be revised to improve the effectiveness of implementation efforts or if monitoring shows no improvements post BMP implementation.	x															4+ years	Review summary produces as part of F-1-4, funding secured, Plan update steering committee	Plan updated by 2018 if warranted based on the results of F-1-4	Update completed following state approved watershed based planning guidance	W
F	1	6	Identify and secure appropriate funding sources for specific tasks/activities	x															Ongoing	Funding applied for, projects identified for each plan year	initiation of project implementation	target funding and initiation of 50% of recommendation strategies based on implementation schedule	W
F	1	7	Develop an outline to assign implementation actions to address identified impaired segments	x															1-2 years	–	Matrix of BMPs by Segment	–	T
F	2	0	***Objective F-2: Provide information and education about the Norwalk River Watershed.***																				
F	2	1	Develop a comprehensive public relations plan/program to engage, public entities, private interest groups (i.e. local Chambers of Commerce) and professional organizations in stewardship of the watershed	x															1-2 years	Planning Committee Assembled	Formal public involvement plan developed	Increased watershed stewardship, measured through reductions in NPS targets and increased participation in meetings and activities	W
F	2	2	Create and maintain a user-friendly website for the Norwalk River Watershed to include information on the Initiative's Action Plan, updates on Implementation Activities, and information related to protecting and restoring the health of the river	x															1-2 years	Website platform and design established	Website up and running	number of 'hits' the site receives	W
F	2	3 a	Identify a means to support and fund environmental education programs outside the classroom						x	x									1 year	Grant award	Program development and location identification (e.g., NMA)	Educational curriculum and materials	W
F	2	3 b	Develop a framework for youth organizations (e.g. NRWA badge programs for scouts) and local schools (e.g. NRWA River Study Program, Roots and Shoots extracurricular program in NJ schools) that highlights the comprehensive relationships between local, regional and global water issues and builds programs for local environmental stewardship		x				x	x									1-2 years	Grant award and volunteer identification	Education materials development	Completion of the materials; # of training/outreach programs conducted (Target of 3-4 programs/year)	W
F	2	4	Develop a program to guide citizens, land use boards and businesses regarding the positive impacts of using native plants and species of concern in landscaping and the detrimental effects of non-native invasive species	x										x				x	4+ years	–	Educational materials developed and distributed	–	W
F	2	5	Identify audience and topics of interest. Coordinate workshops & public lectures and develop related resources as appropriate	x						x									1-2 years	List of topics developed, Public events organized and target audience identified	Public events held	Attendance at public events, targeting at least 1 event per year	W

Goal	Objective	Task	Objectives and Associated Action Items	Implementing Organizations															Implementation Schedule	Milestones	Outcomes	Evaluation and Performance Criteria	Scale
				NRWI	NRWA	WM	RPAs	HW/RW	TU	NMA	DEEP	NYSDEC	CTDOT	NRCS	USDA/USGS	POTW	Uconn	SWCD					
F	2	6	Increase watershed stewardship efforts (watershed, stream, stormwater pollution prevention, and catch basin markings) and create educational displays in highly visible, strategic locations throughout the watershed		x	x				x									2 years	Grant award and partnerships among WMs	Publications and displays, kiosks, surveys to track awareness and stewardship among public	# of people trained # of surveys done and review of survey responses (goal of one every summer) ; # of kiosks setup and the frequency of their usage	W
F	2	7	Develop a public education campaign using the lower Silvermine watershed as a model for implementation of residential BMPs	x		x		x											1-2 years	program developed, funding identified and outreach initiated	Program developed, funding secured and campaigned completed	increased community involvement and reduction in waste and NPS runoff from residents	T
F	2	9	Develop an education program regarding BMPs for appropriate management of yard and pet waste			x													1-2 years	–	Educational materials developed and distributed	–	W
F	3	0	***Objective F-3: Expand coordination and communication with watershed municipalities.***																				
F	3	1	Promote information transfer between municipal boards and commissions throughout the watershed to ensure all municipalities are aware of the issues, concerns, and implementation actions occurring within the watershed			x													2-4 years	–	Summary reports/newsletter circulated to municipal boards and commission members	–	W
F	3	2	Encourage articulation of the Action Plan's watershed protection goals as a goal in municipal & state Plans (POCDs).			x													4+ years	–	Goals and Recommendations incorporated in to POCD updates	–	W
F	3	3	Educate and encourage municipal Public Works staff to employ BMP techniques regarding watercourse planning and maintenance			x													1-2 years	–	Regular meetings with appropriate municipal departments	–	W
F	3	4	Meet with watershed town officials on an annual basis to provide an update on implementation activities and discuss issues of concern	x															1-2 years	–	Annual meeting will all watershed CEO's	–	W
F	3	5	Work with the CT NEMO program to hold courses/conferences/lectures for municipal boards and commissions regarding their opportunity to regulate with watershed health in mind	x													x		2-4 years	–	Watershed courses held	–	W

APPENDIX C: Additional Information on Pollutant Load Model

As indicated in Section 4 on Estimation of Pollutant Loads and Reductions, the approach in this project was to resurrect and update the existing models to enable their use for pollutant load assessments at a sub-watershed scale and apply expected pollutant reduction performances of management practices to estimate load reductions. The Connecticut Watershed Modeling effort undertaken by Connecticut Department of Environmental Protection (CTDEP) (AQUA TERRA and HydroQual, 2001) and the recent LIS BMP effort completed by Long Island Sound Office of USEPA (Farley and Rangarajan, 2006) characterized the Norwalk River watershed and its tributaries as one of the calibration watersheds. Both of these studies focused on the quantification of TN and/or TP loads from various non-point sources of pollution. An AVGWLF modeling framework developed by Farley and Rangarajan (2006) for the Norwalk River watershed was adopted for this project, in order to minimize any new effort on model calibrations or development of pollutant load estimates for nutrients and TSS (surrogate parameter chosen for sediments). This section provides additional details on the hydrologic and pollutant estimation aspects of TN derived from previous studies and updated in this project.

C.1 Model Description and Inputs

The AVGWLF is a user-friendly interface in ArcView GIS platform for the Generalized Watershed Loading Functions (GWLF) model. Model capabilities discussed here pertain to the GWLF model developed by Cornell University (Haith et al., 1992). For estimation of the nutrient and sediment loads, the GWLF is among the mid-range watershed models that can represent the climatic and physiographic aspects better than simple spreadsheet-based tools such as the Center for Watershed Protection's Watershed Treatment Model (Caraco, 2001). On the other hand, complex models such as HSPF (AQUA TERRA and HydroQual, 2001) and Agricultural Non-point Source Pollution (AGNPS) are parameter-intensive and also require significant technical experience and resources for their successful application. A description of GWLF along with its computational aspects and input file definitions is provided here. This information is compiled from the AVGWLF 4.0 User Manual (Evans et al., 2003) and the GWLF Version 2.0 User Manual (Haith et al., 1992).

GWLF has the ability to simulate runoff, sediment, TN and TP loads from a watershed/sub-watershed for a given source area (that defines a specific land use type, namely, agricultural, forested, low density, and commercial). The built-in algorithms can account for pollutant loads from septic system failures and infiltration and point source discharges (municipal wastewater treatment plants and industries).

It is a continuous simulation model which uses daily time steps for weather data and mass balance calculations. Sediment and TN loads are estimated on a daily basis and tallied on a monthly basis, allowing monthly comparison of monitored and modeled TN loads. A GIS-interface (developed in ArcView) is AVGWLF that provides useful pre and post-processing utilities for the effective use of the GWLF model. The relevant algorithmic components used in this project are summarized below.

Hydrology: Daily weather data (e.g., precipitation, temperature) are used to generate the surface runoff component of stream flow using Soil Conservation Services (SCS) curve numbers. Evapotranspiration is computed using daily weather data and a cover factor dependent on land use and cover type. Daily water balances are computed for an unsaturated zone and the saturated sub-surface zone (see Figure 4-1 in Section 4 on Estimation of Pollutant Loads). Infiltration is calculated as the difference between precipitation and snowmelt and other hydrologic components such as initial unsaturated zone storage, maximum available zone storage, surface runoff and evapotranspiration.

Erosion: Erosion and sediment yield are computed using monthly erosion calculations based on the Universal Soil Loss Equation (USLE) with the following set of parameters: monthly rainfall-runoff coefficients, monthly composite of soil erodibility factor, topographic factor, crop management factor, and conservation practice values for each source area. A sediment delivery ratio based on the watershed size, and a transport capacity based on the average daily runoff, are then applied to estimate the sediment yield for each source area.

Nutrient Loading: Surface nutrient losses are determined by applying dissolved nitrogen (N) and phosphorus (P) concentrations to surface runoff for each agricultural source area. Point source discharges can also contribute to dissolved losses and are specified in terms of kilograms per month. Manured areas and septic systems can explicitly be considered. All urban nutrient inputs are assumed to be solid-phase – the model uses exponential accumulation and washoff function for these loadings. Sub-surface losses are calculated using dissolved N and P concentrations for shallow groundwater contributions to stream nutrient loads, and the sub-surface sub-model considers the entire watershed or sub-watershed as a lumped parameter contributing area.

Input Data Files: The model needs three input files containing weather, nutrient loading and transport-related data. The weather data file (WEATHER.DAT) specifies daily average temperature and total precipitation values for each simulation year. Multiple stations are specified for large watersheds, and the model chooses applicable weather stations based on the proximity to a watershed. The nutrient loading file (NUTRIENT.DAT) includes the loading parameters for the various source areas specified in the model such as number of septic systems, urban source area accumulation rates based on land uses, groundwater concentrations, and manure concentrations. Finally, the transport file (TRANSPORT.DAT) defines the necessary parameters for each source area being considered such as watershed size, curve number, and slope. It must be emphasized that the in-stream processes are not explicitly included.

The latest version available is AVGWLF 7.2.3 which was last modified on April 24 2009. Major changes include the incorporation of new routines for more direct simulation of loads from hobby farm animals, a indicator bacteria load estimation routine, as well as a more specialized modeling routine for heavily urbanized watersheds. Penn State had fixed errors in the LS calculation for sediment erosion calculation (version 7.2.2) and evapotranspiration calculation (version 7.2.3). The latest version 7.2.3 of the AVGWLF was used in this project.

C.2 Model Calibration

The UCONN MAGIC land use data used in this project is shown in Figure C-1. The northern portion of the watershed is dominated by forested land cover. The southern portion from downstream of the South Norwalk Reservoir to the Norwalk Harbor is highly developed. For the entire watershed, 62% of the watershed is forest, 17% is low intensity urban, and 13% is high intensity urban (Figure C-2). A portion of the forested land cover can be associated with low density residential properties (e.g., 2 to 5 acres). It is likely that only a fraction of the pervious portions of these properties are landscaped and maintained on a regular basis. Therefore, the land cover information from this dataset should be very close to how they function in reality and contribute pollutant loadings to the Norwalk River and its tributaries.

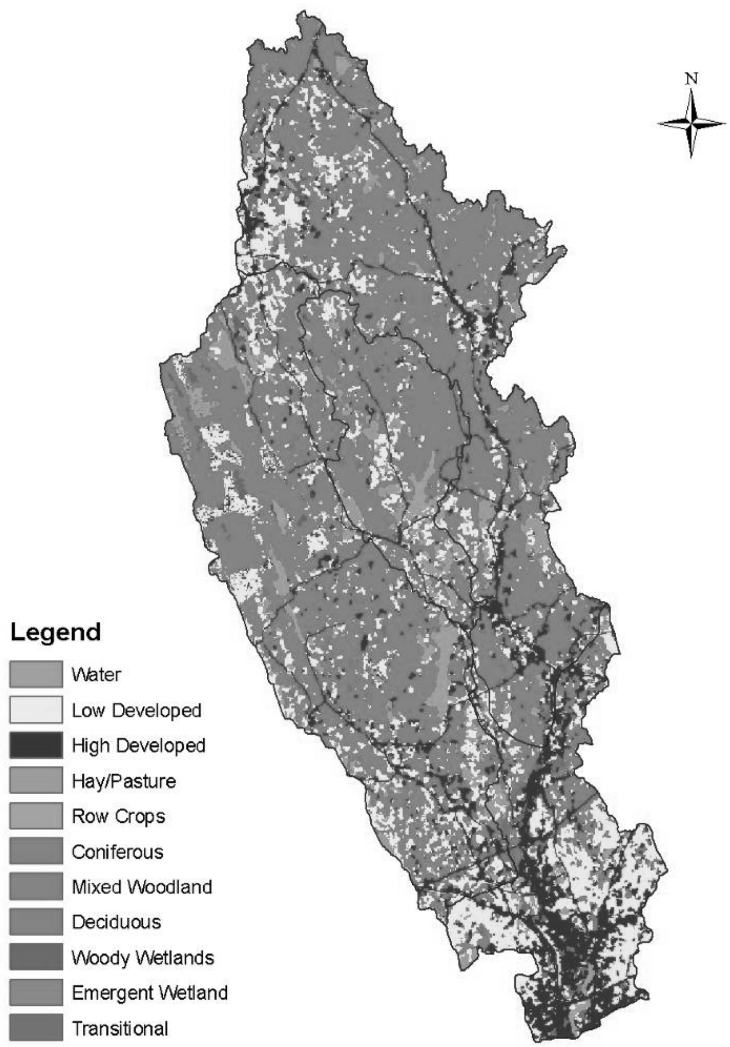


Figure C-1. Land Use Distribution in the Norwalk River Watershed

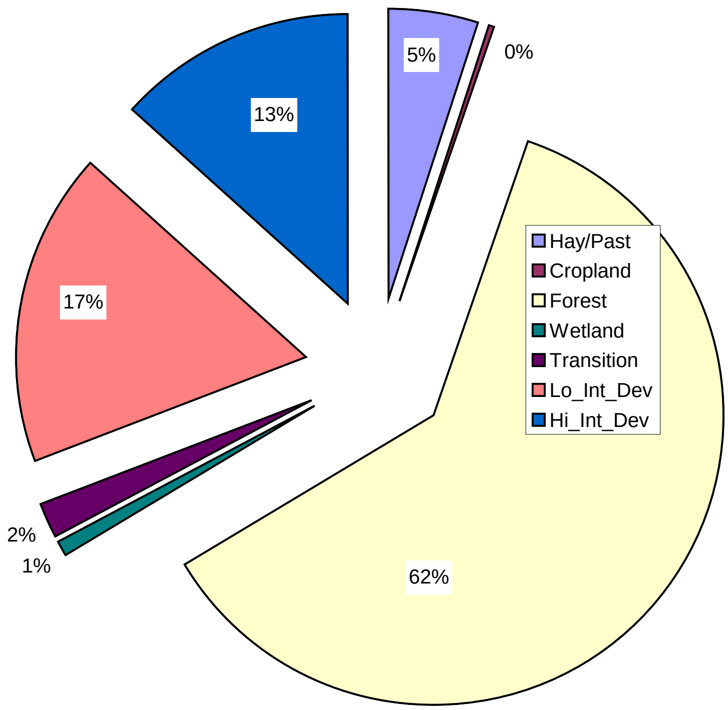


Figure C-2. Percentages of Various Land Uses in the Norwalk River Watershed

A major requirement for GWLF application to large watershed such as the Norwalk River is that each sub-watershed must be configured separately in terms of input file setup, association of model parameters and calibration. Therefore, watersheds are delineated based on where the flow or water quality data are available to support model calibration and validation. There are two United States Geological Survey (USGS) flow or water quality monitoring locations (USGS01209700 and USGS01209710) in the Norwalk River watershed. Therefore, the overall watershed was divided into four large sub-watersheds where flow or water quality calibrations can be performed in AVGWLF based on data from these two USGS gages.

Figure C-3 shows the four sub-watersheds for which the GWLF models were developed: Comstock Brook, Silvermine River, Norwalk River Upstream of the USGS gaging station, USGS01209700 (designated as Upstream Norwalk River), and the Norwalk River watershed portion downstream of this station (referred to as Downstream Norwalk River). T he detailed sub-watershed delineations shown in Figure 3-4 are sub-sets of these four major sub-watersheds used only to support the AVGWLF model calibration and validation. The pollutant loads for nutrients and TSS generated from these sub-watersheds are disaggregated to sub-watershed levels (shown in Figure 3-4) based on the relative distribution of land uses.

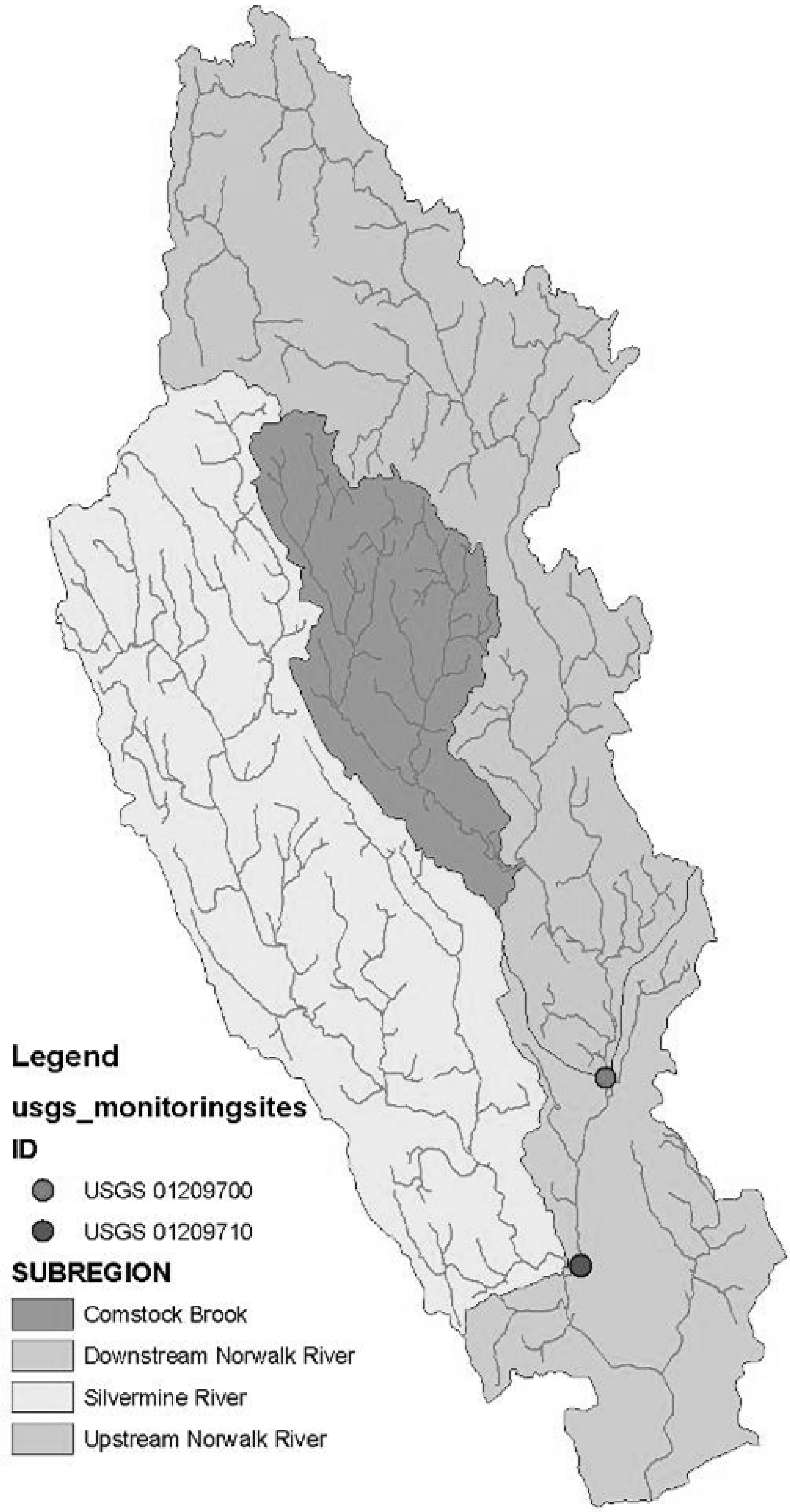


Figure C-3. GWLF Sub-watersheds of the Norwalk River Watershed

The USGS01209700 gage that records flows is located in South Wilton and the other at Winnipauk (#01209710) records water quality measurements. Both stations are on the main stem of Norwalk River and Table C-1 summarizes the historical data available at these stations. Daily flow data and water quality measurements are used here to support model calibration and validation.

Table C-1. USGS Water Monitoring Stations

USGS ID	Location	Drainage Area (mile^2)	Readily Available Data
01209700	South Wilton	30	• Real-time (Previous 120 days) • Daily Data (09/01/1962 – 06/15/2010) • Peak Streamflow (10/16/1955 – 04/16/2007) • Field/Lab water-quality samples (11/27/1962 – 08/25/2009)
01209710	Winnipauk	33	• Field/Lab water-quality samples (10/24/1980 – 06/10/2010)

Hydrologic calibration in AVGWLF was performed for a 15-year period from January 1981 through December 1995 at the South Wilton USGS monitoring station. Specific comparisons between simulated and observed flow values were prepared to assess the adequacy of calibration. These visual comparisons included: (a) time-series comparison of daily streamflow volumes (cubic feet per second, cfs); and (b) cumulative flow volumes (cfs x day). The simulated flow at this USGS location was the sum of flows from the Upstream Norwalk River and Comstock Brook sub-watersheds. The flow from Comstock Brook was reduced by 15% to take into account the amount of water diverted for use by the Norwalk Second Taxing District (based on discussions with Tom Villa with the 2nd taxing district, 2005).

For model validation, the data for a 14-year period from January 1996 through December 2009 from the South Wilton USGS monitoring station were used, and similar comparisons between modeled and monitored values were made for daily flow volumes. During this period, the flow diversions from Comstock Brook were not available, however the comparisons seem to indicate that there was little diversion during this period.

The parameters used for hydrologic model calibration are summarized in Tables C-2 and C-3. Comparisons between monitored and simulated daily flow values for the calibration and validation periods are shown in the following figures: time-series for the 1981-1995 period (Figure C-4), cumulative flow for 1981-1995 (Figure C-5), time-series for 1996-2009 (Figure C-6), and cumulative flows for 1996-2009 (Figure C-7). Simulated time-series of flows for both calibration and validation periods matched well in terms of the timing and accumulated water volume over the entire period of calibration or validation. Simulated peak flows for some storm events were much higher than the observed values. One of the major reasons for this is the lack of distributed rainfall data that can represent the spatio-temporal variations over the entire watershed. Another reason can be attributed to reservoir routing and diversion, both of which cannot be explicitly modeled using AVGWLF.

Table C-2. TRANSPORT Parameters

Land Use Type	Curve Number*	Soil Erodibility (K)	Length-Slope Factor (LS)	Cropping Management Factor (C)	Erosion Control Factor (P)
Hay/Pasture	63	0.229	0.41	0.030	0.45
Cropland	75	0.227	0.29	0.420	0.45
Forest	60	0.233	0.329	0.002	0.45
Low Intensity Urban	80	0.233	1.62	0.080	0.20
High Intensity Urban	90	0.234	2.28	0.080	0.20

Table C-3. Other TRANSPORT Parameters

Month	Evapo-transpiration Coefficient	Daylight Hours*	Growing Season*	Erosivity Coefficient
January	0.63	9.3	No	0.18
February	0.68	10.3	No	0.18
March	0.71	11.7	No	0.18
April	0.72	13.2	No	0.28
May	0.83	14.4	Yes	0.28
June	0.89	15	Yes	0.28
July	0.93	14.7	Yes	0.28
August	0.95	13.7	Yes	0.28
September	0.96	12.3	Yes	0.18
October	0.87	10.8	No	0.18
November	0.82	9.6	No	0.18
December	0.79	9	No	0.18

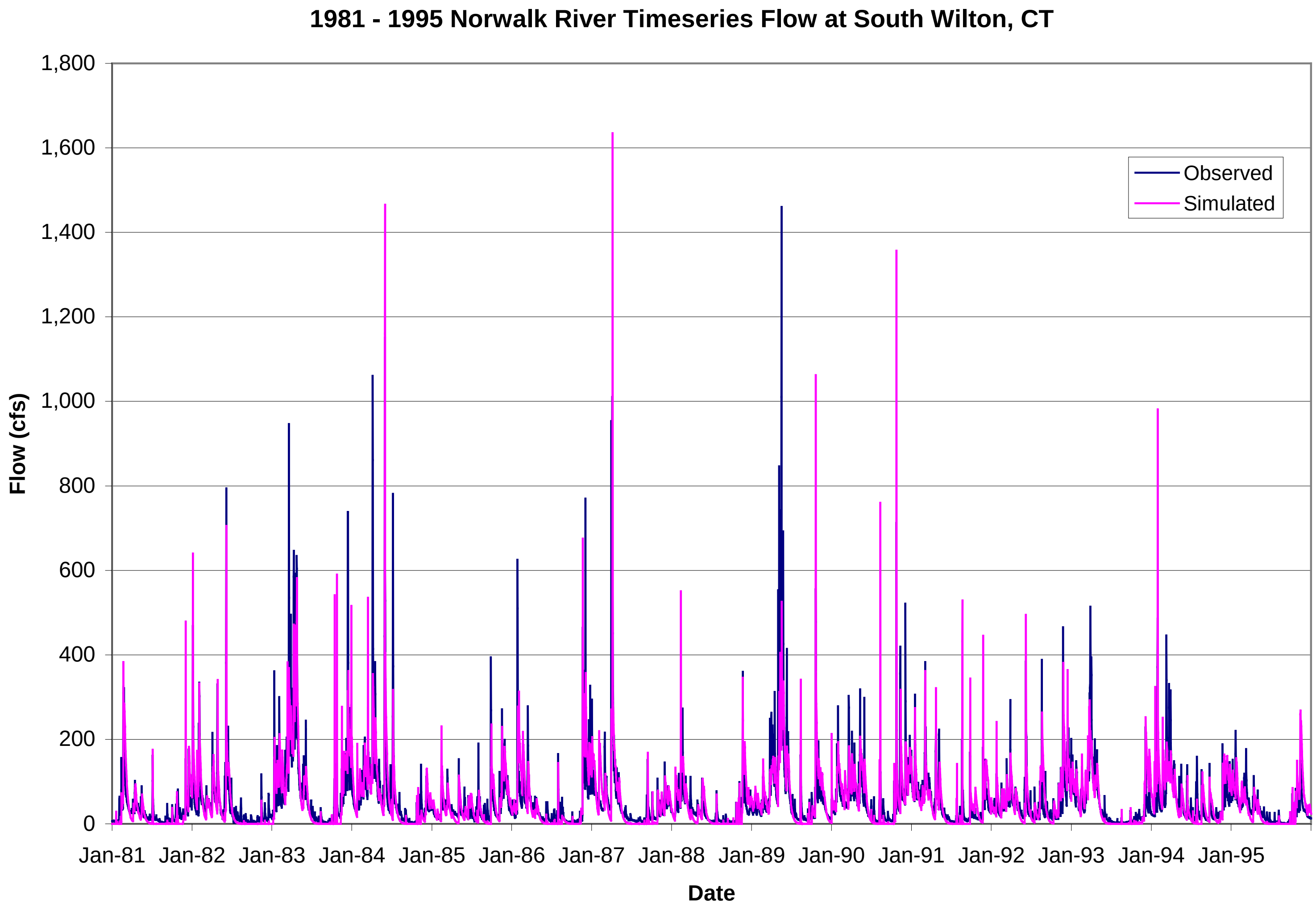


Figure C-4. Daily time-series comparison at South Wilton (1981-1995)

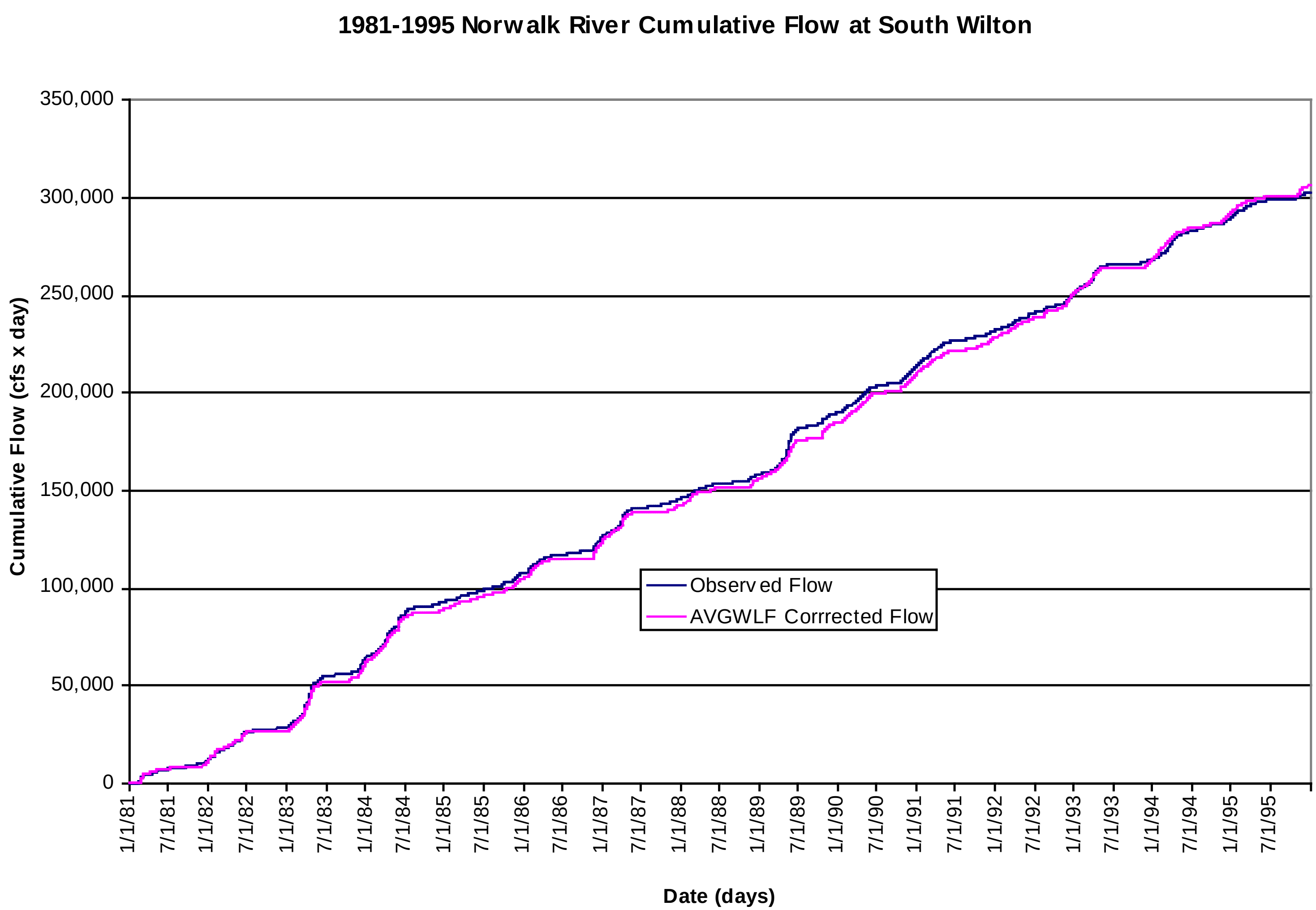


Figure C-5. Cumulative flow comparison at South Wilton (1981-1995)

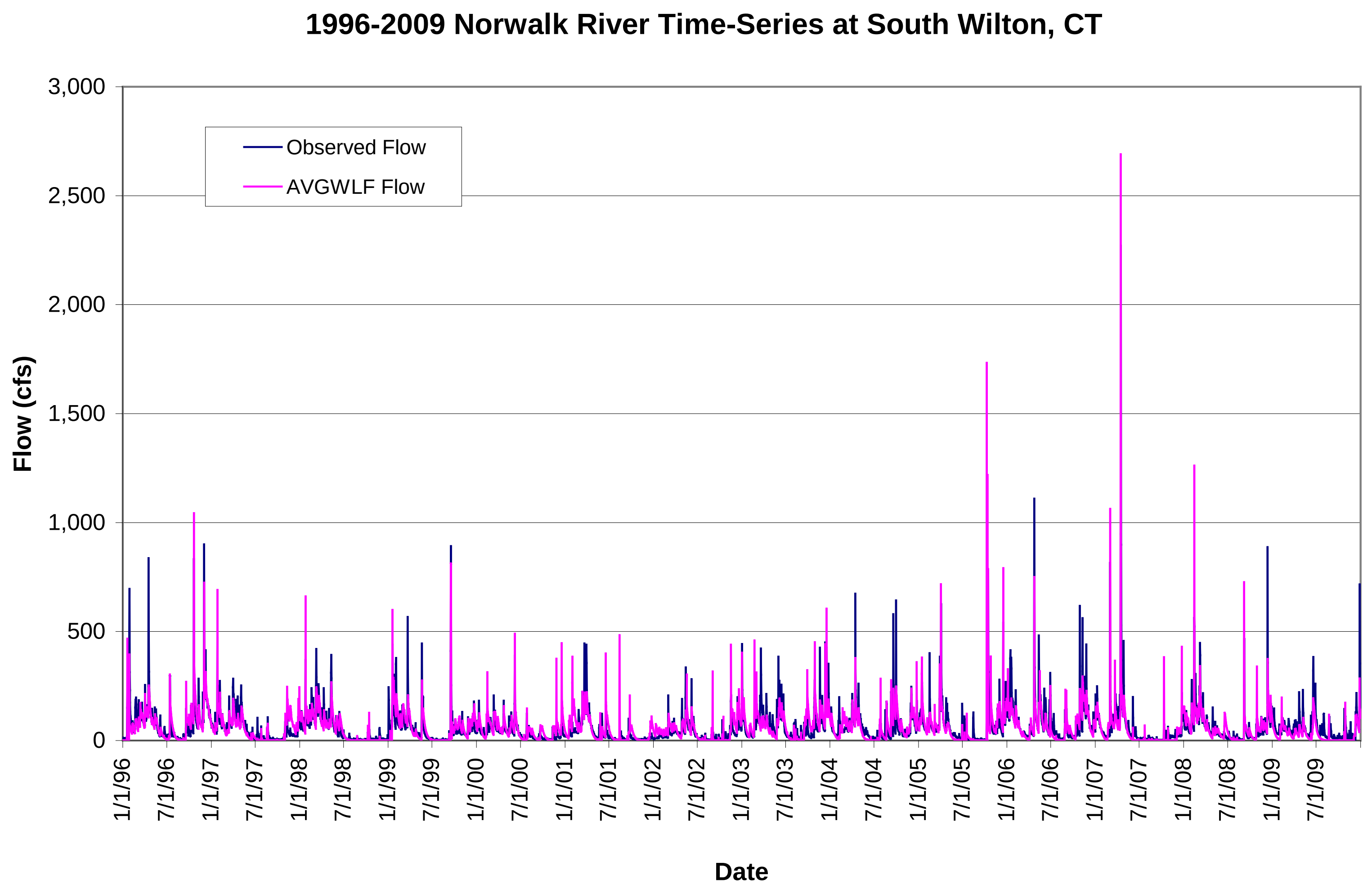


Figure C-6. Daily Time-series Comparison at South Wilton (1996-2009)

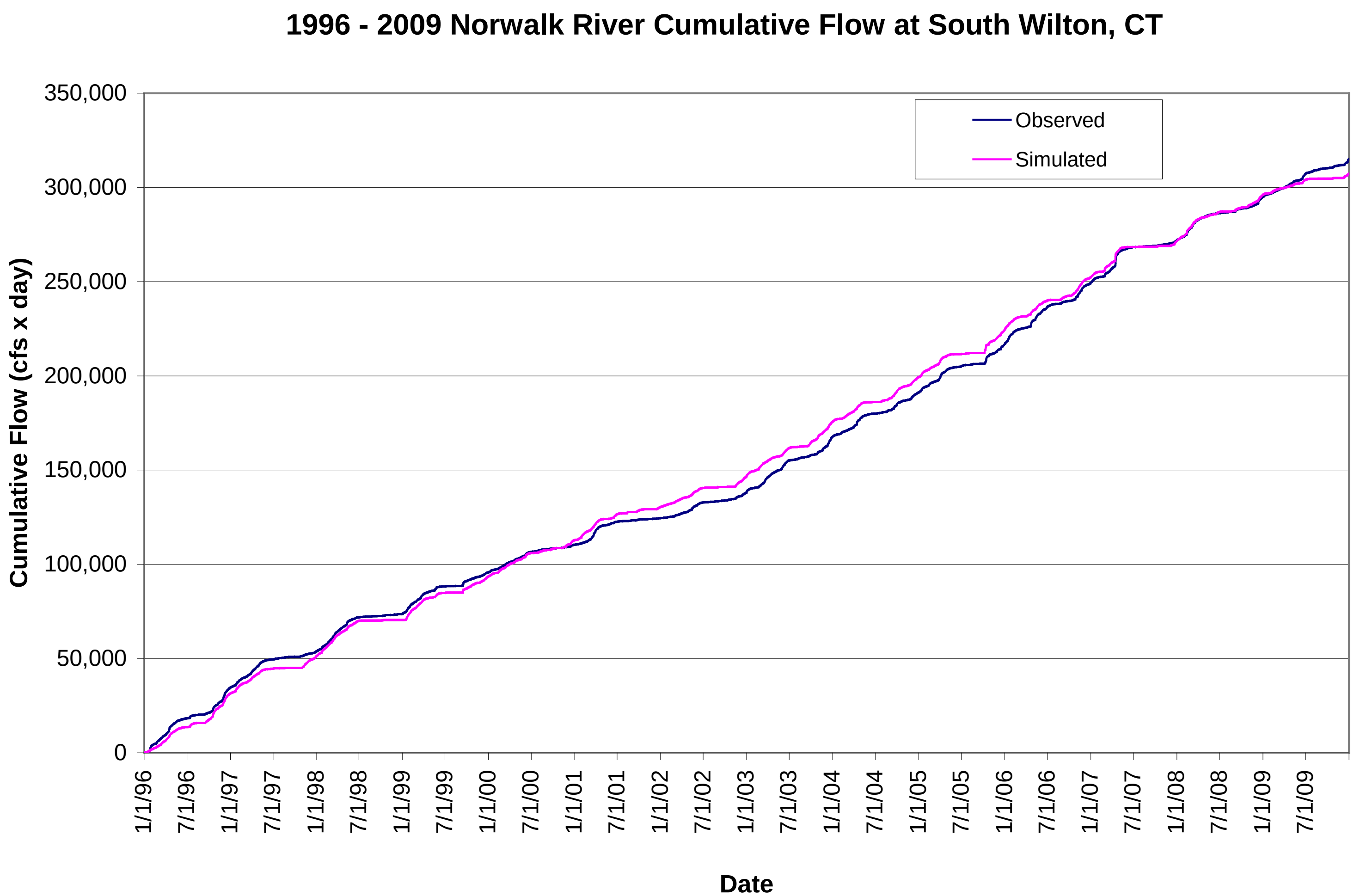
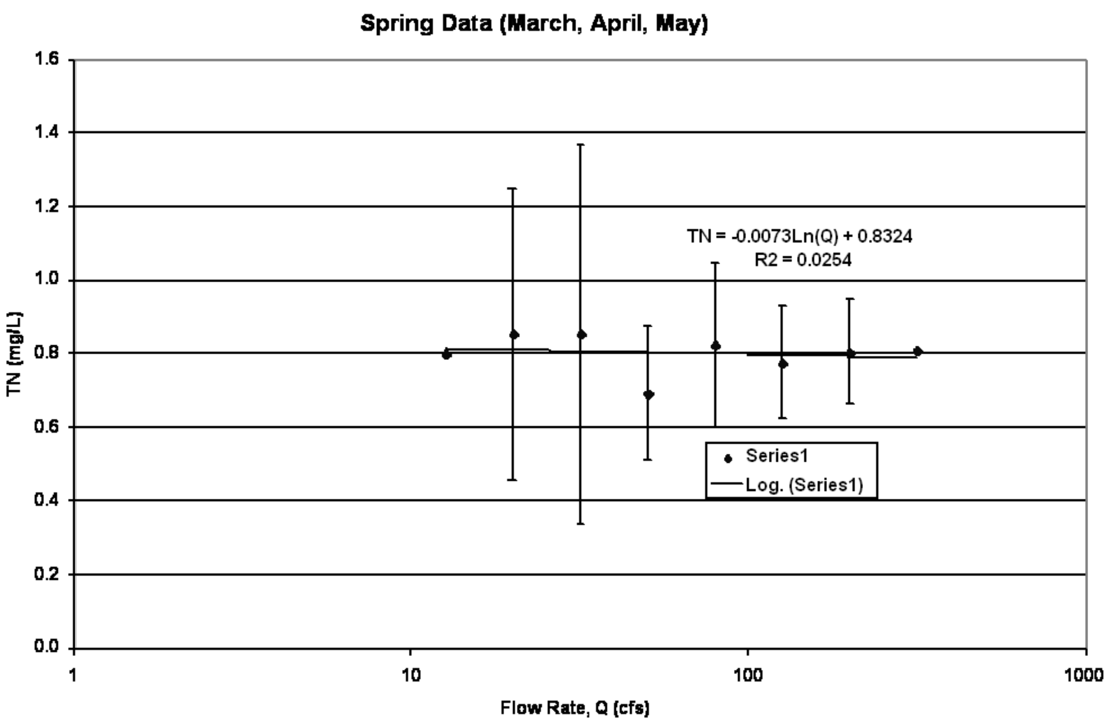
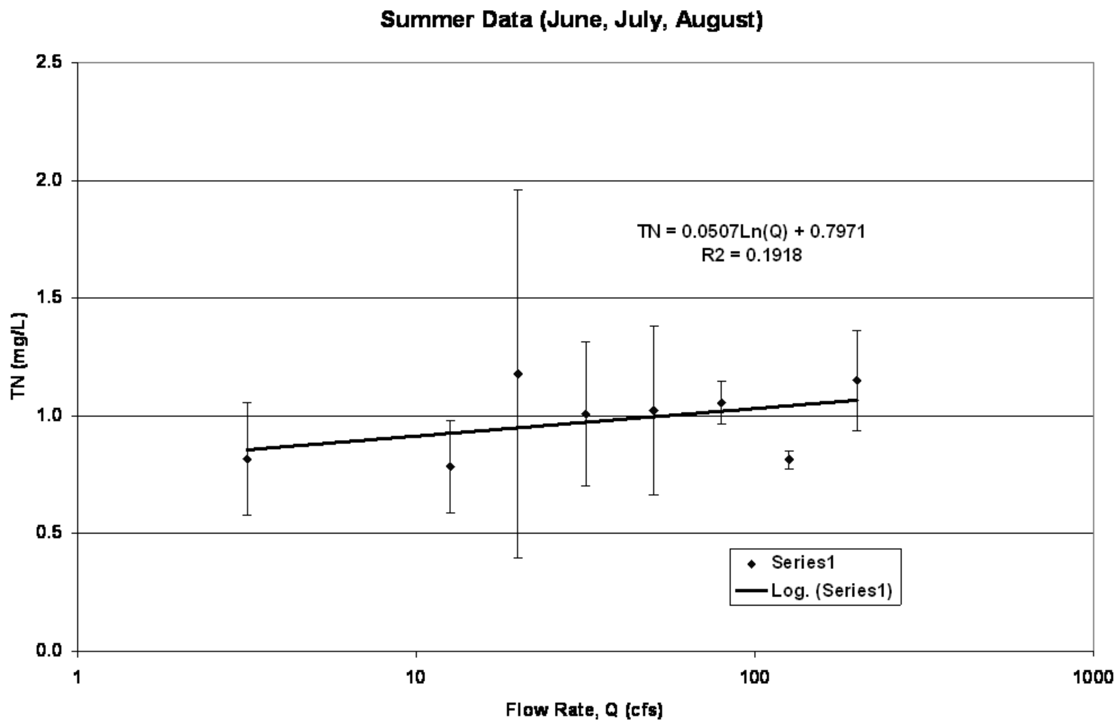
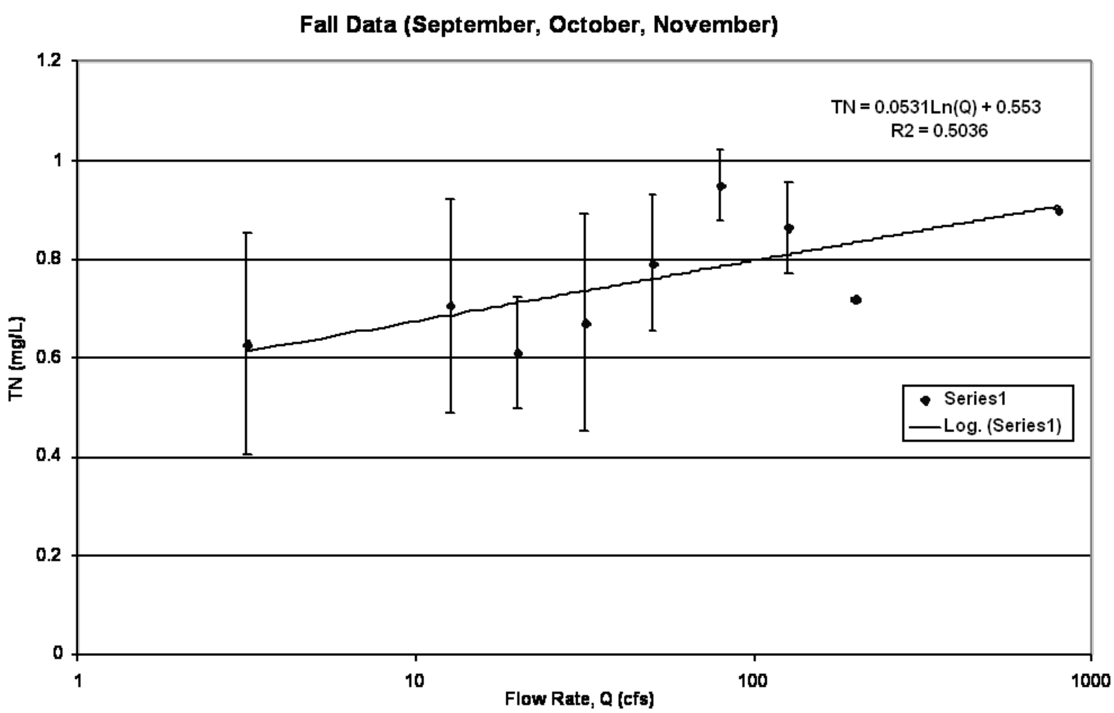


Figure C-7. Cumulative flow comparison at South Wilton (1996-2009)

Subsequent to hydrologic calibration, the AVGWLF input files were developed to support the calibration and validation for Total Nitrogen (TN). Although the model can be calibrated for TN, TP and TSS, the previous studies (AQUA TERRA and HydroQual, 2001; Farley and Rangarajan, 2006) focused on TN pollutant loads due to the LIS TMDL target of 10% for the non-point sources of pollution. Therefore, the detailed calibration and validation in this study was limited to total nitrogen. The TN concentrations were monitored at Winnipauk USGS monitoring station on a monthly basis and the monitoring frequency is not enough to use this one observation as monthly representative to estimate monthly TN loadings. In order to estimate monthly TN loading, a relationship between observed flow rate and TN concentration was developed for each season. A similar methodology was used in the LIS TMDL study performed in the late 1990s. Four seasons were used to determine the varying concentrations of TN, namely, Spring (March–May), Summer (June–August), Fall (September–November), and Winter (January–March). Observed flow at South Wilton on each TN monitoring day was categorized using ranges of flow rates (e.g., first flow range from 1-10 cfs). For each flow range and for each season, average TN concentration and standard deviation were calculated and the average TN concentration was compared with representative flow rate. The median log(Q) value for each flow range was used as representative flow rate. Figures C-8(a) through C-8(d) show the relationship between measured TN concentration and flow rate for each season.




Summer Data (June, July, August)
TN = 0.0507Ln(Q) + 0.7971
R2 = 0.1918
TN (mg/L)
Flow Rate, Q (cfs)
Series1
Log. (Series1)
2.5
2.0
1.5
1.0
0.5
0.0
1
10
100
1000


Fall Data (September, October, November)
TN = 0.0531Ln(Q) + 0.553
R2 = 0.5036
TN (mg/L)
Flow Rate, Q (cfs)
Series1
Log. (Series1)
1.2
1
0.8
0.6
0.4
0.2
0
1
10
100
1000

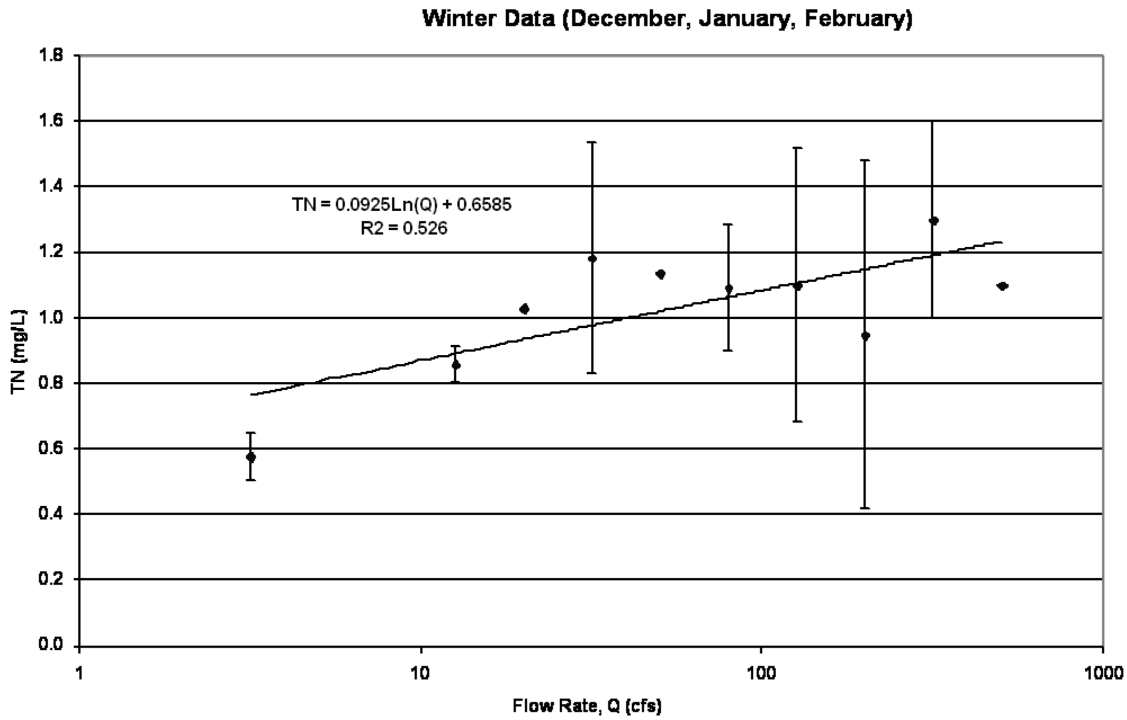


Figure C-8. Relationships between TN and flow rate for (a) spring, (b) summer, (c) fall, and (d) winter.

There is a general trend for TN concentrations to increase with the flow rates for all seasons except for spring. Seasonal regression relationships between TN and log(Q) were derived to estimate TN concentrations based on the observed daily flow rates.

Figure B-9 shows the comparison of monthly TN loads between AVGWLF and observed values. The current version of AVGWLF does not calculate the TN loads for septic systems accurately. Therefore, these loads were computed offline using the literature suggested value of 12 grams of TN unit loading value per day per capita and 1.6 grams of TN uptake by plants during the growing season (May through October). There are five known water pollution control facilities or wastewater treatment plants (WPCFs) in the Norwalk River watershed (Figure C-10). Information available or assumed for these plants is shown in Table C-4.

Calculated annual TN loading for all non-point sources (including permitted urban stormwater discharges) from each sub-watershed is summarized in Table C-5 and the loading contributions from various land uses are illustrated in Figure C-11. The results were calculated using the AVGWLF validation period (1996-2009).

There was no detailed model calibration and validation performed to characterize TP and TSS loads in the Norwalk River watershed. The default unit loading values built in AVGWLF were used to generate annual average loads summarized in Section 4 on the Estimation of Pollutant Loads.

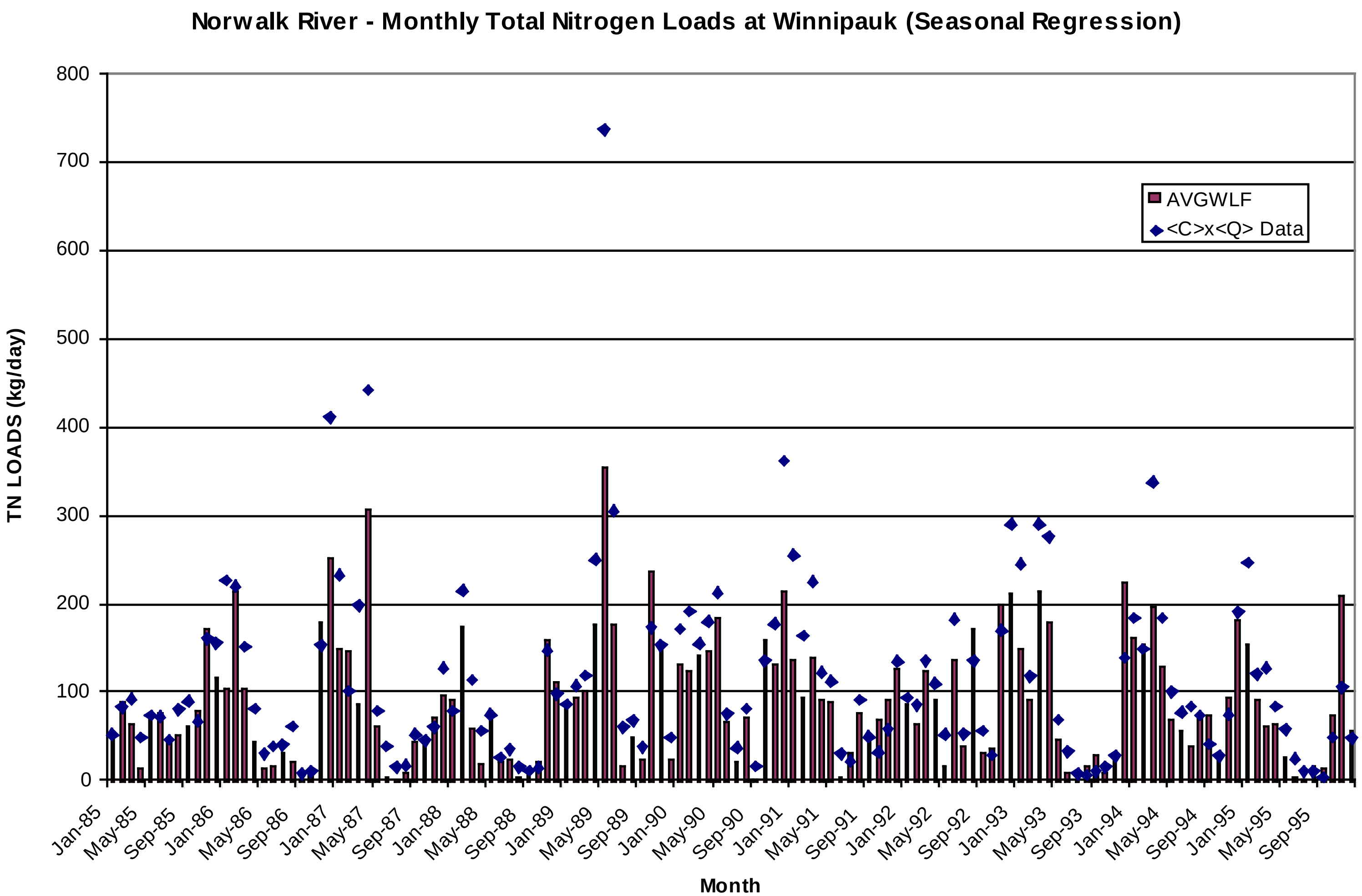


Figure C-9. Comparison of Observed and Simulated TN Loads

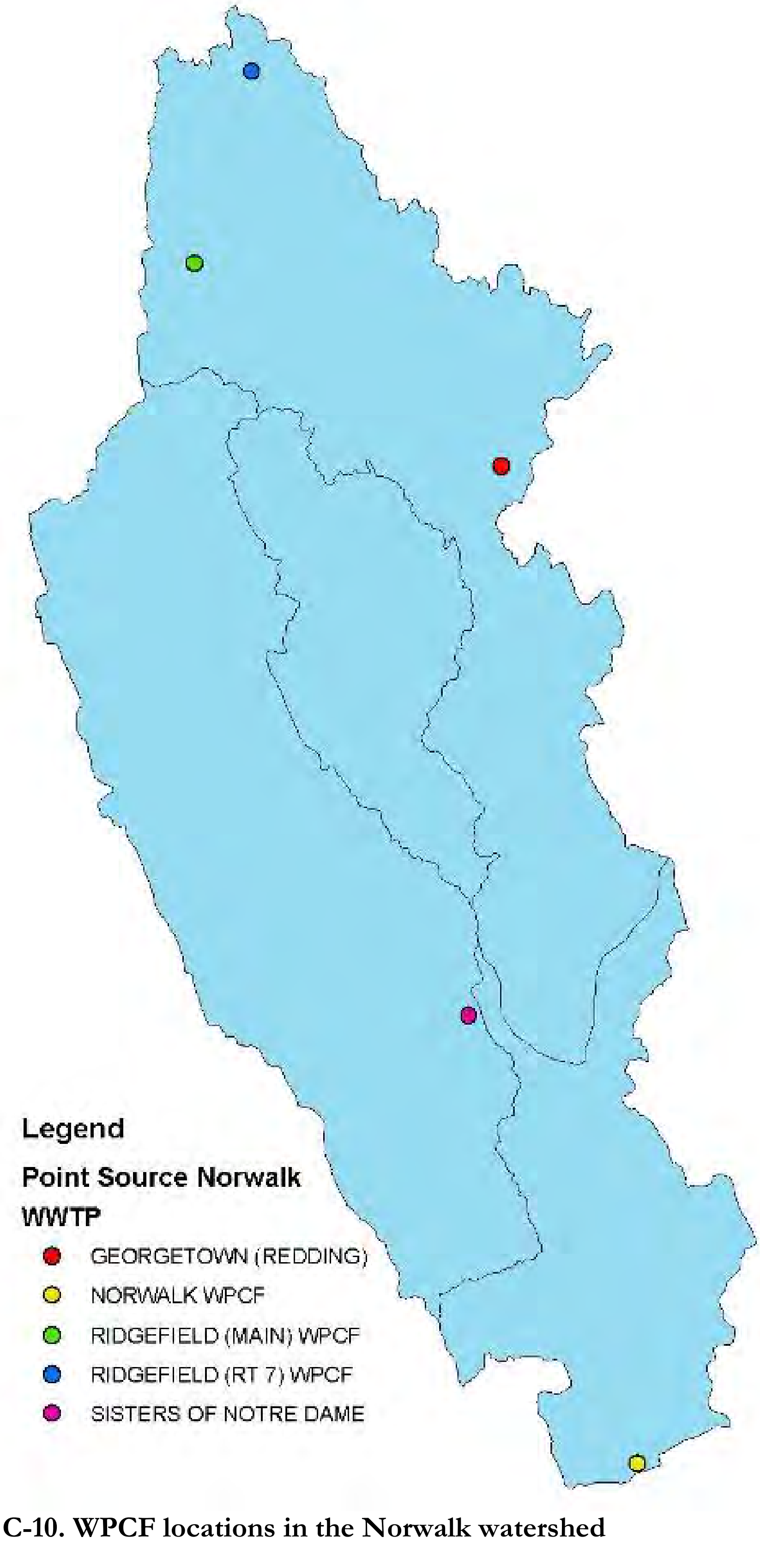


Figure C-10. WPCF locations in the Norwalk watershed

Table C-4. List of WPCFs and the reported TN concentrations

WPCF	NPDES	Design Capacity (gallons per day)	Total N (mg/L)	TN (kg/day)	TN (lb/yr)	Sub-watershed
Norwalk WPCF	CT0101249	15,000,000	6	340.2	273,509	DS of Norwalk
Sisters of Notre Dame		20,000	6 *	0.5	365	Silvermine
Georgetown (Redding)	CT0101770	17,000 (to be expanded to 75,000)	6	0.4	310	US of Norwalk
Ridgefield (Main) WPCF	CT0100854	840,000	6	19.1	15,316	US of Norwalk
Ridgefield (Route 7) WPCF	CT0101451					

* No data available, assumed to be 6 mg/L, the permit limit.

Table C-5. Annual Pollutant Loads for Each Sub-watershed

Source	US Norwalk (lb/yr)	DS Norwalk (lb/yr)	Comstock (lb/yr)	Silvermine (lb/yr)	Total (lb/yr)
Hay/Past	940	308	850	2,274	4,372
Cropland	81	254	75	394	804
Forest	965	121	312	898	2,296
Wetland	49	6	8	68	131
Transition	3,980	3,821	1,132	2,531	11,463
Lo_Int_Dev	980	1,047	294	1,235	3,556
Hi_Int_Dev	9,568	12,776	1,665	8,050	32,059
Stream Bank	416	265	65	470	1,216
Groundwater	41,039	20,186	13,092	39,542	113,859
Point Source	15,629	273,509	-	362	289,500
Septic Systems	33,066	17,139	11,490	34,743	96,437
Total	**106,712**	**329,431**	**28,983**	**90,567**	**555,693**

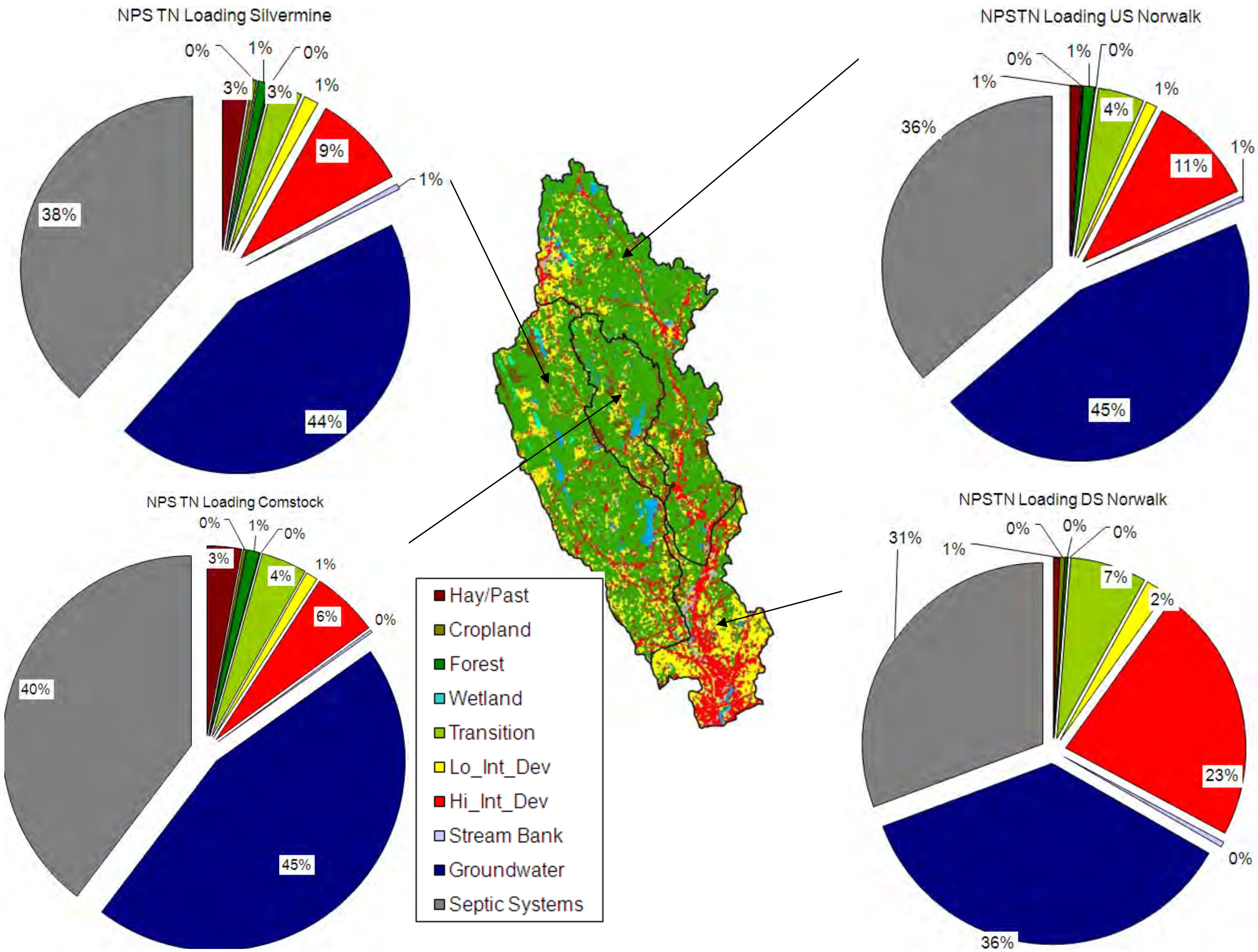


Figure C-11. Calculated TN Loads from Various Non-point Pollution Sources

APPENDIX D: Publicly Owned – LID/BMP Candidate Properties

Publicly Owned LID/BMP Candidate Properties

Town	Owner	Description	Address	Focus
Lewisboro	Lewisboro	Public Parks, Parkway Lands	111 Elmwood Rd	Mid Term
Lewisboro	Lewisboro	Public Parks, Parkway Lands	10 East St	Mid Term
Lewisboro	Lewisboro	Public Parks, Parkway Lands	500 Smith Ridge Rd	Long Term
New Canaan	Town of New Canaan		165 Heather Dr	Short Term
Norwalk	Norwalk City Of		4 North Water St	Short Term
Norwalk	Norwalk City Of	Park - Irving Freese	1 Main St	Short Term
Norwalk	Norwalk City Of	Right Of Way	Perry Av	Short Term
Norwalk	Norwalk City Of		46 Wall St	Short Term
Norwalk	Norwalk City Of	Vacant Land	Creeping Hemlock Dr	Short Term
Norwalk	Norwalk City Of	Right Of Way	85 Old Kings Hwy	Short Term
Norwalk	Norwalk City Of	Vacant Land	559 Main Av	Short Term
Norwalk	Norwalk City Of		10 Burnell Blvd	Short Term
Norwalk	Norwalk City Of		157 Perry Ave	Short Term
Norwalk	Norwalk City Of	Park - Broad River	102 New Canaan Ave	Short Term
Norwalk	Norwalk City Of	Park - Woods Pond	East Rocks Rd	Short Term
Norwalk	Norwalk City Of	Vacant Land	Margaret St	Short Term
Norwalk	Norwalk City Of		90 New Canaan Ave	Short Term
Norwalk	Norwalk City Of	School - Cava	350 Main Ave	Short Term
Norwalk	Norwalk City Of		2 South Smith St	Short Term
Norwalk	Norwalk City Of		20 Main St	Short Term
Norwalk	Connecticut State Of	Leased - Vacant Land	22 Riverside Ave	Short Term
Norwalk	Norwalk City Of	Park - Reserve	87 Burlington Ct	Short Term
Norwalk	Norwalk City Of	Vacant Land	99 Silent Grove Ct	Short Term
Norwalk	Norwalk City Of	School - Roosevelt/ Senior Center	11 Allen Rd	Short Term
Norwalk	Connecticut State Of	Armory	New Canaan Av	Short Term
Norwalk	Norwalk City Of		49 Odonnell Rd	Short Term
Norwalk	Norwalk City Of		Ann St	Short Term
Norwalk	Norwalk City Of	Housing Authority	Main Av	Short Term
Norwalk	Norwalk City Of	School - Silvermine	Perry Av	Short Term
Norwalk	Connecticut State Of	Vacant Land	36 Riverside Ave	Short Term
Norwalk	Norwalk City Of	Park - North Avenue	North Av	Short Term
Norwalk	Norwalk City Of	Parking - South Maritime	Marshall St	Short Term
Norwalk	Norwalk City Of		2 Isaacs St	Short Term
Norwalk	Connecticut State Of	DMV	542 Main Ave	Short Term
Norwalk	Norwalk City Of	Housing Authority	27 Chapel St	Short Term
Norwalk	Norwalk City Of	Housing Authority-Ft Pt	Fort Point St	Short Term
Norwalk	Norwalk City Of	Museum - Town House	30 E Wall St	Short Term
Norwalk	Norwalk City Of	Park - Reserve	325 Grumman Ave	Short Term
Norwalk	Norwalk City Of		1 Charles Marshall Dr	Mid Term
Norwalk	Norwalk City Of	City Hall	125 East Ave	Mid Term
Norwalk	Norwalk City Of	Park-Cranbury-Water Tower	357 Grumman Ave	Mid Term
Norwalk	Connecticut State Of	Courthouse	Belden Av	Mid Term
Norwalk	Norwalk City Of		31 Putnam Ave	Mid Term
Norwalk	Norwalk City Of	School - Honeyhill	50 Midrocks Drive	Mid Term
Norwalk	Norwalk City Of	Park - Mathews	300 West Ave	Mid Term
Norwalk	Norwalk City Of	Park - Mathews	295 West Ave	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Shostk-Sr	Ward St	Mid Term
Norwalk	Norwalk City Of		21 Hunters Lane	Mid Term
Norwalk	Norwalk City Of		1 Cottage St	Mid Term
Norwalk	Norwalk City Of		23 Isaacs St	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Elmwood	77 Elmwood Ave	Mid Term
Norwalk	Connecticut State Of	Parking - Commuter Lot	5 Hendricks Ave	Mid Term
Norwalk	Connecticut State Of	Right Of Way	69 Mulberry Ln	Mid Term

Town	Owner	Description	Address	Focus
Norwalk	Connecticut State Of	Vacant Land	58 Springview Ave	Mid Term
Norwalk	Norwalk City Of	Vacant Land	50 Dr Martin Luther King Jr Drive	Mid Term
Norwalk	Norwalk City Of	Fire Department	121 Connecticut Ave	Mid Term
Norwalk	Norwalk City Of		55 Dr Martin Luther King Jr Drive	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Asc Bldg	42 School St	Mid Term
Norwalk	Norwalk City Of	Housing Authority-West/Sr	West Av	Mid Term
Norwalk	Norwalk City Of	Vacant Land	Ponus Av	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Frfld Ave	38 Fairfield Ave	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Sr Ct/Sr	Union Ave	Mid Term
Norwalk	Connecticut State Of	Leased - House	62 Creeping Hemlock Dr	Mid Term
Norwalk	Norwalk City Of	Norwalk Library	1 Belden Ave	Mid Term
Norwalk	Norwalk City Of		100 Fairfield Ave	Mid Term
Norwalk	Norwalk City Of		36 Beacon St	Mid Term
Norwalk	Norwalk City Of	School - Franklin	165 Flax Hill Rd	Mid Term
Norwalk	Norwalk City Of	Vacant Land	350 West Ave	Mid Term
Norwalk	Norwalk City Of	Vacant Land	60 Dr Martin Luther King Jr Dr	Mid Term
Norwalk	Norwalk City Of	Vacant Land	93 Stuart Ave	Mid Term
Norwalk	Norwalk City Of	Vacant Land	Comstock Hill Av	Mid Term
Norwalk	Norwalk City Of	Andrew's Field	County St	Mid Term
Norwalk	Norwalk City Of		81 West Rocks Rd	Mid Term
Norwalk	Norwalk City Of	School - Jefferson	75 Van Buren Ave	Mid Term
Norwalk	Norwalk City Of	School - Tracey	24 Camp St	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Freese/Sr	Ward St	Mid Term
Norwalk	Norwalk City Of		6 Crescent St	Mid Term
Norwalk	Norwalk City Of		14 Putnam Ave	Mid Term
Norwalk	Norwalk City Of		45 West Ave	Mid Term
Norwalk	Norwalk City Of	Park - Reserve	35 Ledgewood Dr	Mid Term
Norwalk	Norwalk City Of	Vacant Land	22 Chapel St	Mid Term
Norwalk	Norwalk City Of	Vacant Land	40 Willow St	Mid Term
Norwalk	Norwalk City Of	Vacant Land	70 Stuart Ave	Mid Term
Norwalk	Norwalk City Of	Park - Cranbury	300 Grumman Ave	Mid Term
Norwalk	Norwalk City Of		180 Westport Ave	Mid Term
Norwalk	Norwalk City Of		Blake St	Mid Term
Norwalk	Connecticut State Of	Right Of Way	186 W Rocks Rd	Mid Term
Norwalk	Norwalk City Of	Housing Authority-Elmwood	71 Elmwood Ave	Long Term
Norwalk	Norwalk City Of	Park - Reserve	40 Ledgewood Ct	Long Term
Norwalk	Norwalk City Of	Vacant Land	5 Willow St	Long Term
Norwalk	Norwalk City Of		20 Washington St	Long Term
Ridgefield	Ridgefield	Branchville Station	Ethan Allen Highway	Short Term
Ridgefield	Ridgefield	Cemetery	10 Ridgefield Ln	Short Term
Ridgefield	Ridgefield	Branchville El	40 Florida Rd	Short Term
Ridgefield	Ridgefield	School	195 Danbury Rd	Short Term
Ridgefield	Ridgefield	Great Pond Beach	Ethan Allen Hwy& Great Pond Road	Short Term
Ridgefield	Ridgefield	Public Library	472 Main Street	Short Term
Ridgefield	Ridgefield	Farmingville El	324 Farmingville Rd	Short Term
Ridgefield	Ridgefield	Municipal Parking	Governor & Prospect	Short Term
Ridgefield	Ridgefield	Old High school	80 East Ridge Street	Short Term
Ridgefield	Ridgefield	Veterans Elementary	20 Governor St	Short Term
Ridgefield	Ridgefield	Undeveloped	90 Farmingville Rd	Short Term
Ridgefield	Ridgefield	East Ridge Rec Area	100 Prospect Ridge	Short Term
Ridgefield	Ridgefield	East Ridge Middle	10 East Ridge Rd	Mid Term
Ridgefield	Ridgefield	Ballard Park	480 Main St	Mid Term
Ridgefield	Ridgefield	Fire Department	6 Catoonah Street	Mid Term

Town	Owner	Description	Address	Focus
Ridgefield	United States	Us Post Office	26 Catoonah Street	Mid Term
Weston	Vacant	Other Urban/Open Space	20 Wampum Hill Rd	Mid Term
Wilton	Wilton Town Of		131 Old Mill Rd	Short Term
Wilton	Connecticut State Of		Ridgefield Rd	Short Term
Wilton	Wilton Town Of		7 Horseshoe Rd	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		15 Wolfpit Rd	Short Term
Wilton	Connecticut State Of		34 Wolfpit Rd	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Wilton Town Of		30 Ridgefield Rd	Short Term
Wilton	Wilton Town Of		Cannon Rd	Short Term
Wilton	Wilton Town Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		3 Wolfpit Rd	Short Term
Wilton	Wilton Town Of		Cannon Rd	Short Term
Wilton	Wilton Town Of		3 5 Horseshoe Rd	Short Term
Wilton	Connecticut State Of		182 Danbury Rd	Short Term
Wilton	Connecticut State Of		30 Kent Hills La	Short Term
Wilton	Connecticut State Of		408 Danbury Rd	Short Term
Wilton	Connecticut State Of		6 Wolfpit Rd	Short Term
Wilton	Connecticut State Of		Cherry La	Short Term
Wilton	Connecticut State Of		Cherry La	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		Ridgefield Rd	Short Term
Wilton	Connecticut State Of		Wolfpit Rd	Short Term
Wilton	Wilton Town Of		68 Ridgefield Rd	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		Kent Rd	Short Term
Wilton	Connecticut State Of		71 Dumplin Hill Rd	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		115 Mountain Rd	Short Term
Wilton	Wilton Town Of		91 Danbury Rd	Short Term
Wilton	Wilton Town Of		Old Ridgfld Rd	Short Term
Wilton	Connecticut State Of		184 Danbury Rd	Short Term
Wilton	Connecticut State Of		67 Cherry La	Short Term
Wilton	Wilton Town Of		45 Lovers La	Short Term
Wilton	Connecticut State Of		17 Wolfpit Rd	Short Term
Wilton	Connecticut State Of		66 Mountain Rd	Short Term
Wilton	Wilton Town Of		Old Ridgfld Rd	Short Term
Wilton	Connecticut State Of		159 Danbury Rd	Short Term
Wilton	Wilton Town Of		Danbury Rd	Short Term
Wilton	Wilton Town Of		Old Ridgfld Rd	Short Term
Wilton	Connecticut State Of		31 Wolfpit Rd	Short Term
Wilton	Wilton Town Of		52 Lovers Ln	Short Term
Wilton	Connecticut State Of		99 Cherry La	Short Term
Wilton	Connecticut State Of		48 Raymond La	Short Term
Wilton	Connecticut State Of		Westport Rd	Short Term
Wilton	Connecticut State Of		59 Dumplin Hill Rd	Short Term
Wilton	Connecticut State Of		155 Sharp Hill Rd	Short Term
Wilton	Wilton Town Of		10 Old Mill Rd	Short Term
Wilton	Connecticut State Of		Raymond La	Short Term
Wilton	Wilton Town Of		22 Linden Tree Rd	Short Term
Wilton	Connecticut State Of		178 Danbury Rd	Short Term
Wilton	Connecticut State Of		24 Wolfpit Rd	Short Term

Town	Owner	Description	Address	Focus
Wilton	Connecticut State Of		38 Wolfpit Rd	Short Term
Wilton	Connecticut State Of		95 Skunk La	Short Term
Wilton	Connecticut State Of		Gaylord Dr	Short Term
Wilton	Connecticut State Of		Sharp Hill Rd	Short Term
Wilton	Connecticut State Of		76 Mountain Rd	Short Term
Wilton	Wilton Town Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		Kent Hills La	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		Lovers La	Short Term
Wilton	Wilton Town Of		872 Danbury Rd	Short Term
Wilton	Wilton Town Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		Raymond La	Short Term
Wilton	Wilton Town Of		Old Danbury Rd	Short Term
Wilton	Connecticut State Of		Raymond La	Short Term
Wilton	Wilton Town Of		8 School St	Short Term
Wilton	Connecticut State Of		Sharp Hill Rd	Short Term
Wilton	Wilton Town Of		31 New St	Short Term
Wilton	Wilton Town Of		Borglum Rd	Short Term
Wilton	Connecticut State Of		Saunders Dr	Short Term
Wilton	Connecticut State Of		129 Sharp Hill Rd	Short Term
Wilton	Connecticut State Of		349 Olmstead Hill Rd	Short Term
Wilton	Wilton Town Of	Lovers Lane	Route 7	Short Term
Wilton	Connecticut State Of		58 Raymond La	Short Term
Wilton	Wilton Town Of		60 Lovers Ln	Short Term
Wilton	Connecticut State Of		3 Kent Hills La	Short Term
Wilton	Connecticut State Of		7 Kent Hills La	Short Term
Wilton	Wilton Town Of		Kellogg Dr	Short Term
Wilton	Wilton Town Of		Olmstead Hill Rd	Short Term
Wilton	Wilton Town Of		49 Old Danbury Rd	Short Term
Wilton	Connecticut State Of		42 Berch Ct	Short Term
Wilton	Wilton Town Of		Cherry La	Short Term
Wilton	Wilton Town Of		Scarlet Oak Dr	Short Term
Wilton	Connecticut State Of		113 Mountain Rd	Short Term
Wilton	Connecticut State Of		156 Danbury Rd	Short Term
Wilton	Connecticut State Of		186 Sharp Hill Rd	Short Term
Wilton	Connecticut State Of		40 Berch Ct	Short Term
Wilton	Connecticut State Of		48 Berch Ct	Short Term
Wilton	Connecticut State Of		63 Saunders Dr	Short Term
Wilton	Connecticut State Of		91 Mountain Rd	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		Saunders Dr	Short Term
Wilton	Connecticut State Of		Sharp Hill Rd	Short Term
Wilton	Wilton Town Of		441 Danbury Rd	Short Term
Wilton	Wilton Town Of		50 Ruscoe Rd	Short Term
Wilton	Wilton Town Of		Boulderbrook Rd	Short Term
Wilton	Wilton Town Of		Danbury Rd	Short Term
Wilton	Wilton Town Of		Mayapple Rd	Short Term
Wilton	Connecticut State Of		Sharp Hill Rd	Short Term
Wilton	Wilton Town Of		Kellogg Dr	Short Term
Wilton	Connecticut State Of		149 Sharp Hill Rd	Short Term
Wilton	Connecticut State Of		46 Berch Ct	Short Term
Wilton	Connecticut State Of		Penn Central Rr	Short Term
Wilton	Connecticut State Of		132 Mountain Rd	Short Term

Town	Owner	Description	Address	Focus
Wilton	Wilton Town Of		380 Danbury Rd	Short Term
Wilton	Connecticut State Of		20 Gilly La	Short Term
Wilton	Connecticut State Of		101 Mountain Rd	Short Term
Wilton	Wilton Town Of		31 Old Danbury Rd	Short Term
Wilton	Connecticut State Of		Penn Central Rr	Short Term
Wilton	Connecticut State Of		78 Undercliff Dr	Short Term
Wilton	Wilton Town Of		Quail Ridge	Short Term
Wilton	Connecticut State Of		101 Skunk La	Short Term
Wilton	Connecticut State Of		17 Kent Rd	Short Term
Wilton	Connecticut State Of		22 Gilly La	Short Term
Wilton	Connecticut State Of		Kent Rd	Short Term
Wilton	Wilton Town Of		Walnut Pl	Short Term
Wilton	Connecticut State Of		121 Mountain Rd	Short Term
Wilton	Connecticut State Of		410 Danbury Rd	Short Term
Wilton	Connecticut State Of		Gaylord Dr	Short Term
Wilton	Connecticut State Of		419 Danbury Rd	Short Term
Wilton	Connecticut State Of		151 Sharp Hill Rd	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Connecticut State Of		127 Mountain Rd	Short Term
Wilton	Connecticut State Of		153 Danbury Rd	Short Term
Wilton	Wilton Town Of		Middlebrook Farm	Short Term
Wilton	Wilton Town Of		44 Wild Duck Rd	Short Term
Wilton	Connecticut State Of		14 Kent Hills La	Short Term
Wilton	Connecticut State Of		21 Chipmunk La	Short Term
Wilton	Connecticut State Of		Danbury Rd	Short Term
Wilton	Wilton Town Of		Lovers La	Short Term
Wilton	Wilton Town Of		Olmstead Hill Rd	Short Term
Wilton	Wilton Town Of		Wolfpit Rd	Short Term
Wilton	Wilton Town Of		Danbury Rd	Mid Term
Wilton	Connecticut State Of		Olmstead Hill Rd	Mid Term
Wilton	Connecticut State Of		24 Gilly La	Mid Term
Wilton	Connecticut State Of		41 Arrowhead Rd	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Connecticut State Of		64 Dumplin Hill Rd	Mid Term
Wilton	Wilton Town Of		Millstone Rd	Mid Term
Wilton	Wilton Town Of		404 Danbury Rd	Mid Term
Wilton	Connecticut State Of		4 Wolfpit Rd	Mid Term
Wilton	Wilton Town Of		18 Linden Tree Rd	Mid Term
Wilton	Connecticut State Of		17 Winton Terr	Mid Term
Wilton	Connecticut State Of		23 Winton Terr	Mid Term
Wilton	Connecticut State Of		27 Chipmunk La	Mid Term
Wilton	Connecticut State Of		117 Mountain Rd	Mid Term
Wilton	Connecticut State Of		Skunk La	Mid Term
Wilton	Connecticut State Of		Spectacle La	Mid Term
Wilton	Connecticut State Of		Mountain Rd	Mid Term
Wilton	Wilton Town Of		Linden Tree Rd	Mid Term
Wilton	Connecticut State Of		425 Danbury Rd	Mid Term
Wilton	Wilton Town Of		248 Danbury Rd	Mid Term
Wilton	Connecticut State Of		1 Gaylord Dr	Mid Term
Wilton	Connecticut State Of		109 Mountain Rd	Mid Term
Wilton	Connecticut State Of		164 Danbury Rd	Mid Term
Wilton	Connecticut State Of		19 Winton Terr	Mid Term
Wilton	Connecticut State Of		2 Gaylord Dr	Mid Term

Town	Owner	Description	Address	Focus
Wilton	Connecticut State Of		2 Kent Hills La	Mid Term
Wilton	Connecticut State Of		21 Winton Terr	Mid Term
Wilton	Connecticut State Of		249 Danbury Rd	Mid Term
Wilton	Connecticut State Of		4 Gaylord Dr	Mid Term
Wilton	Connecticut State Of		78 Westport Rd	Mid Term
Wilton	Connecticut State Of		Brother Davids Trl	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Connecticut State Of		Fawn Pl	Mid Term
Wilton	Connecticut State Of		Gaylord Dr	Mid Term
Wilton	Connecticut State Of		Off Cannon Rd	Mid Term
Wilton	Wilton Town Of		19 Banks Dr	Mid Term
Wilton	Wilton Town Of		Banks Dr	Mid Term
Wilton	Wilton Town Of		Hurlbutt St	Mid Term
Wilton	Wilton Town Of		Raymond La	Mid Term
Wilton	Connecticut State Of		Mountain Rd	Mid Term
Wilton	Wilton Town Of		Partrick La	Mid Term
Wilton	Wilton Town Of		32 Old Danbury Rd	Mid Term
Wilton	Wilton Town Of		Branch Brook Rd	Mid Term
Wilton	Wilton Town Of		240 School Rd	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Connecticut State Of		Mountain Rd	Mid Term
Wilton	Wilton Town Of		Wren Thicket	Mid Term
Wilton	Wilton Town Of		32 Vista Rd	Mid Term
Wilton	Connecticut State Of		154 Sharp Hill Rd	Mid Term
Wilton	Connecticut State Of		8 Chipmunk La	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Wilton Town Of		Partrick La	Mid Term
Wilton	Connecticut State Of		20 Winton Terr	Mid Term
Wilton	Connecticut State Of		42 Arrowhead Rd	Mid Term
Wilton	Connecticut State Of		4 Chipmunk La	Mid Term
Wilton	Wilton Town Of		13 Dumplin Hill Rd	Mid Term
Wilton	Wilton Town Of		125 Honey Hill Rd	Mid Term
Wilton	Wilton Town Of		430 Danbury Rd	Mid Term
Wilton	Connecticut State Of		39 Chipmunk La	Mid Term
Wilton	Connecticut State Of		418 Danbury Rd	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Connecticut State Of		Gaylord Dr	Mid Term
Wilton	Wilton Town Of		Honey Hill Area	Mid Term
Wilton	Wilton Town Of		Hurlbutt St	Mid Term
Wilton	Connecticut State Of		653 Danbury Rd	Mid Term
Wilton	Connecticut State Of		18 Gilly La	Mid Term
Wilton	Wilton Town Of		Old Farm Rd	Mid Term
Wilton	Connecticut State Of		2 Chipmunk La	Mid Term
Wilton	Wilton Town Of		Olmstead Hill Rd	Mid Term
Wilton	Connecticut State Of		Skunk La	Mid Term
Wilton	Wilton Town Of	Millbrook School	170 Ridgefield Rd	Mid Term
Wilton	Connecticut State Of		18 Chipmunk La	Mid Term
Wilton	Connecticut State Of		46 Chipmunk La	Mid Term
Wilton	Wilton Town Of		Tamarack Pl	Mid Term
Wilton	Connecticut State Of		70 Undercliff Dr	Mid Term
Wilton	Wilton Town Of		School Rd	Mid Term
Wilton	Connecticut State Of		24 Chipmunk La	Mid Term
Wilton	Connecticut State Of		Undercliff Dr	Mid Term

Town	Owner	Description	Address	Focus
Wilton	Connecticut State Of		Twin Oak La Ext	Mid Term
Wilton	Connecticut State Of		14 Chipmunk La	Mid Term
Wilton	Wilton Town Of		34 Whipple Rd	Mid Term
Wilton	Wilton Town Of		217 Wolfpit Rd	Mid Term
Wilton	Connecticut State Of		140 Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		Sharp Hill Rd	Mid Term
Wilton	Connecticut State Of		50 Berch Ct	Mid Term
Wilton	Wilton Town Of		19 Charter Oak Dr	Mid Term
Wilton	Connecticut State Of		148 Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		161 Spectacle La	Mid Term
Wilton	Connecticut State Of		168 Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		34 Chipmunk La	Mid Term
Wilton	Connecticut State Of		420 Danbury Rd	Mid Term
Wilton	Connecticut State Of		64 Undercliff Dr	Mid Term
Wilton	Connecticut State Of		Gaylord Dr	Mid Term
Wilton	Connecticut State Of		Gaylord Dr	Mid Term
Wilton	Connecticut State Of		Sharp Hill Rd	Mid Term
Wilton	Connecticut State Of		Westport Rd	Mid Term
Wilton	Connecticut State Of		Westport Rd	Mid Term
Wilton	Wilton Town Of		700 Ridgefield Rd	Mid Term
Wilton	Wilton Town Of		Belden Hill Rd	Mid Term
Wilton	Wilton Town Of		Corner Of Town Rdgfd	Mid Term
Wilton	Wilton Town Of		Tamarack Pl	Mid Term
Wilton	Wilton Town Of		Whipstick Rd	Mid Term
Wilton	Wilton Town Of		Partrick La	Mid Term
Wilton	Connecticut State Of		Parish Rd	Mid Term
Wilton	Connecticut State Of		357 Olmstead Hill Rd	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Wilton Town Of		50 Ledgewood Dr	Mid Term
Wilton	Connecticut State Of		Danbury Rd	Mid Term
Wilton	Connecticut State Of		Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		102 Twin Oak La	Mid Term
Wilton	Connecticut State Of		429 Danbury Rd	Mid Term
Wilton	Connecticut State Of		627 Danbury Rd	Mid Term
Wilton	Wilton Town Of		160 Mather St	Mid Term
Wilton	Connecticut State Of		14 Gilly La	Mid Term
Wilton	Connecticut State Of		150 Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		111 Skunk La	Mid Term
Wilton	Connecticut State Of		14 Black Birch Dr	Mid Term
Wilton	Connecticut State Of		28 Chipmunk La	Mid Term
Wilton	Connecticut State Of		54 Mcfadden Dr	Mid Term
Wilton	Connecticut State Of		Old Belden Hl Rd	Mid Term
Wilton	Connecticut State Of		108 Twin Oak La	Mid Term
Wilton	Connecticut State Of		Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		422 Danbury Rd	Mid Term
Wilton	Connecticut State Of		50 Scribner Hill Rd	Mid Term
Wilton	Connecticut State Of		Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		52 Berch Ct	Mid Term
Wilton	Connecticut State Of		11 Winton Terr	Mid Term
Wilton	Connecticut State Of		Pimpewaug Rd	Mid Term
Wilton	Connecticut State Of		Mountain Rd	Mid Term
Wilton	Connecticut State Of		32 Bristol Pl	Mid Term
Wilton	Connecticut State Of		Scribner Hill Rd	Mid Term

Town	Owner	Description	Address	Focus
Wilton	Connecticut State Of		Scribner Hill Rd	Mid Term
Wilton	Connecticut State Of		Laurelwood Rd	Mid Term
Wilton	Connecticut State Of		30 Bristol Pl	Mid Term
Wilton	Connecticut State Of		46 Scribner Hill Rd	Mid Term
Wilton	Connecticut State Of		116 Twin Oak La	Mid Term
Wilton	Connecticut State Of		18 Black Birch Dr	Mid Term
Wilton	Connecticut State Of		28 Bristol Pl	Mid Term
Wilton	Connecticut State Of		46 Fenwood La	Mid Term
Wilton	Connecticut State Of		58 Scribner Hill Rd	Mid Term
Wilton	Connecticut State Of		94 Scribner Hill Rd	Mid Term
Wilton	Connecticut State Of		Twin Oak La Ext	Mid Term
Wilton	Connecticut State Of		Westport Rd	Mid Term
Wilton	Wilton Town Of		Collinswood Rd	Mid Term
Wilton	Wilton Town Of		Nod Hill Rd	Mid Term
Wilton	Wilton Town Of		Pipers Hill Rd	Mid Term
Wilton	Wilton Town Of		Powder Horn Hl	Mid Term
Wilton	Wilton Town Of		Spruce Meadow Ct	Mid Term
Wilton	Wilton Town Of		64 Wild Duck Rd	Mid Term
Wilton	Connecticut State Of		129 Mountain Rd	Mid Term
Wilton	Wilton Town Of		131 School Rd	Mid Term
Wilton	Connecticut State Of		Mcfadden Dr	Mid Term
Wilton	Connecticut State Of		Undercliff Dr	Mid Term
Wilton	Connecticut State Of		Dorado Ct	Mid Term
Wilton	Connecticut State Of		Cold Spring Rd	Mid Term
Wilton	Wilton Town Of		Pin Oak La	Mid Term
Wilton	Wilton Town Of		Linden Tree Rd	Mid Term
Wilton	Wilton Town Of		257 Hurlbutt St	Mid Term
Wilton	Connecticut State Of		10 Black Birch Dr	Mid Term
Wilton	Connecticut State Of		Mountain Rd	Long Term
Wilton	Wilton Town Of		Hunting Rdg La	Long Term
Wilton	Wilton Town Of		161 Thunder Lake Rd	Long Term
Wilton	Wilton Town Of		493 Ridgefield Rd	Long Term
Wilton	Wilton Town Of		Ryders La	Long Term
Wilton	Wilton Town Of		School Rd	Long Term
Wilton	Wilton Town Of		Spruce Meadow Ct	Long Term
Wilton	Connecticut State Of		Parish Rd	Long Term
Wilton	Wilton Town Of		Partrick La	Long Term
Wilton	Wilton Town Of		School Rd	Long Term
Wilton	Wilton Town Of		Hucklbery Hl Rd	Long Term
Wilton	Connecticut State Of		27 Bristol Pl	Long Term
Wilton	Wilton Town Of		School Rd	Long Term
Wilton	Wilton Town Of		Linden Tree Rd	Long Term
Wilton	Wilton Town Of		Charter Oak Dr	Long Term
Wilton	Wilton Town Of		Weston Town Line	Long Term
Wilton	Connecticut State Of		Scribner Hill Rd	Long Term
Wilton	Wilton Town Of		Spruce Meadow Ct	Long Term
Wilton	Wilton Town Of		Whipstick Rd	Long Term
Wilton	Connecticut State Of		Blue Ridge Rd	Long Term