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Lower Natchaug River Abbreviated Watershed-Based Plan

Photo by ECCD

Prepared by the Eastern Connecticut Conservation District, Inc.

Eastern Connecticut Conservation District

www.ConserveCT.org/eastern

This project is funded in part by CT DEEP through a US EPA Water Quality Management Planning grant under §604b of the Clean Water Act.

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Cover Photograph: A canoe rests on the bank of Natchaug River in Windham, CT. (Photo 2013 by ECCD staff).

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Executive Summary
Lower Natchaug River Abbreviated Watershed Based Plan

Eastern Connecticut Conservation District

May 2014

Introduction:

This document provides a summary of the *Lower Natchaug River Abbreviated Watershed-Based Plan* (the Plan). The purpose of the Plan is to identify sources of nonpoint source pollution (NPS), including fecal bacteria, that have degraded water quality in the lower Natchaug River, and to provide management recommendations to improve water quality.

The lower Natchaug River is located in the towns of Mansfield and Windham, Connecticut. The river segment identified as the lower Natchaug River begins at the outlet of the Willimantic Reservoir and ends at the confluence with the Willimantic River. The lower Natchaug River is listed as impaired by the Connecticut Department of Energy and Environmental Protection (CT DEEP) for recreational use due to periodic high levels of the fecal bacteria *Escherichia coli (E. coli)*.

In 2013, the Eastern Connecticut Conservation District (ECCD), in partnership with CT DEEP, the Connecticut Department of Public Health (CT DPH), Eastern Highlands Health District (EHHD), the towns of Mansfield and Windham, and local volunteers, conducted a water quality investigation to determine current levels of *E. coli* bacteria in the Natchaug River and its primary tributaries, and identify potential sources of fecal bacteria and other nonpoint source pollutants. ECCD used the water quality data that was collected to prepare the *Lower Natchaug River Abbreviated Watershed-Based Plan.*

Funding to conduct this study was provided in part by CT DEEP through a US Environmental Protection Agency (US EPA) Water Quality Management Planning grant under Section 604b of the Clean Water Act.

Watershed Description:

The lower Natchaug River watershed encompasses the southernmost 2.7 square miles of the greater Natchaug River watershed. The Sawmill Brook watershed, which includes Sawmill Brook, an important tributary to the lower Natchaug River, Conantville Brook and several small unnamed streams, is 7.3 square miles in size. The Sawmill Brook watershed is located to the west of the Natchaug River.

The lower Natchaug River and the tributary streams in the Sawmill Brook watershed have surface water quality classifications of A. Water quality classifications serve to establish designated uses for surface and ground waters and identify criteria necessary to support those uses. Groundwater within the lower Natchaug River watershed is classified as GA, with small areas classified as GB. Groundwater in the Sawmill Brook watershed was classified GA.

Land cover in the lower Natchaug River watershed is dominated by suburban and urban development (44%). Developed land is concentrated along the Route 195 and Route 6 corridors and extends southward to downtown Willimantic. Forests comprise 26% of the watershed; turf grasses and other grasses 20% of the watershed; 4% of the watershed was barren land; 5% is comprised of wetlands and waterbodies; and only 1% was under agricultural use. By comparison, the Sawmill Brook watershed is primarily forested (55%). Developed land along the Route 6 and Route 195 corridors comprises 19% of the watershed; agriculture 14%; turf and other grasses 8%; wetlands and waterbodies 3%; and less than 1% is barren land.

Land management policies in the lower Natchaug River watershed exist on multiple jurisdictional levels, from state and regional to local levels.

Regional planning documents include:

- *2013-2018 Conservation & Development Policies: The Plan for Connecticut*, prepared by the State of Connecticut Office of Policy and Management (OPM)
- *Regional Plan of Conservation and Development 2007* and *Land Use 2011,* prepared by the Southeastern Connecticut Council of Governments
- *2009 Regional Plan of Conservation and Development,* prepared by the Capitol Region Council of Governments
- Connecticut Department of Transportation *Stormwater Management Plan (SWMP)*
- *The Natchaug Basin Conservation Action Plan (CAP)* and *Municipal Conservation Compact,* adopted by the eight municipalities in the Natchaug Basin, including Mansfield and Windham.

Municipal planning documents include:

- Plans of Conservation and Development
- Open Space Plans
- Planning and Zoning, Subdivision, and Inland Wetland regulations
- local ordinances

Other local planning documents include:

- The Connecticut Airport Authority's *Windham Airport Master Plan* (being updated at the time of this document preparation).

Watershed Conditions:

The State of Connecticut has established water quality standards in order to evaluate the condition of waterbodies throughout the state to determine if they are meeting their intended uses. The lower Natchaug River was not meeting the standard for swimming due to periodic high levels of bacteria measured at the swimming area at Lauter Park. ECCD evaluated available water quality data, including data collected by ECCD and volunteers throughout the lower Natchaug and Sawmill Brook watersheds in 2013, data collected at Lauter Park by Project Search from 1998-2001, and data collected by North Central District Health Department at the Lauter Park swimming area from 2008-2013. ECCD and volunteers also conducted stream corridor assessments of the Natchaug River and the streams in the Sawmill Brook watershed to identify and document conditions such as stormwater outfalls, impacted riparian buffers, eroded stream banks, and visual water conditions that might contribute to degraded water quality. ECCD used the data that was collected to prepare the *Lower Natchaug River Abbreviated Watershed-Based Plan.*

Abbreviated Watershed-Based Plan:

A. Identification of Pollutant Sources

Based on data that was collected by the Eastern Connecticut Conservation District and volunteers in the lower Natchaug River watershed in Mansfield and Windham, Connecticut in 2013, the following potential sources of nonpoint source pollution that may have contributed to the degradation of water quality in the lower Natchaug River were identified (Table 6).

Possible Source	Location	Number of Occurrences
Urban Runoff/ Stormwater Outfalls	Watershed-wide	44% IC in lower Natchaug River watershed/ 48 outfalls
Sewers/Septic Systems	Watershed-wide	17 septic system failures/repairs in Mansfield and 1 septic system failure/repair in Windham between 2010 and 2013
Pets	Watershed -wide	1651 dogs licensed in Mansfield/ 998 dogs licensed in WIndham
Nuisance Wildlife/Waterfowl	Sawmill Brook watershed	~59% of watershed undeveloped; 1000+ migratory Canada geese (seasonal)
Agriculture/Livestock	Sawmill Brook watershed	2 commercial farms, multiple private farms
Degraded Buffer	Watershed-wide	21
Stream Bank Erosion	Multiple locations	15
Trash/Debris	Multiple locations	14
Gravel Mining	Boston Post Road	1
Atmospheric Deposition	Watershed-wide	Unknown

B. Load Reduction Assessment

An important aspect of this watershed plan is to estimate load reductions of pollutants known to be impairing water quality in the lower Natchaug River. This section proves pollutant load reduction recommendations for pollutants known to be impairing water quality in the lower Natchaug River. *E. coli* load reductions are proposed in the table below (Table 8) , based on the results of bacteria sampling conducted by ECCD and volunteers in 2013.

Bacteria Reduction Targets for the lower Natchaug River and tributaries.

Sampling Site	**Site Description**	**geomean**	**% of limit**	**% Reduction Needed**
NR01	Natchaug River US of Windham Water Treatment Plant	94	75	0
NR02	Natchaug River @ Willowbrook Rd	77	61	0
NR03	Natchaug River @ Lauter Park	78	62	0
NR04	Natchaug River DS of Windham Water Works	26	21	0
SMB01	Sawmill Brook DS of South Frontage Rd	439	348	**71**
SMB02	Sawmill Brook DS of North Frontage Rd	319	253	**61**
CB01	Conantville Brook @ North Frontage Rd	420	333	**70**
CB02	Conantville Brook US of Sunny Acres Park	637	506	**80**
UN3208-03	unnamed tributary DS of Meadowbrook Rd	498	395	**75**
UN3200-11	unnamed tributary US of Stonegate Drive	68	54	0

While E. coli is the primary pollutant of concern as the cause of the existing water quality impairment to the lower Natchaug River, it is important to evaluate other pollutants that may degrade water quality as well. To estimate loads and load reductions, EPA recommends the use of models which have been developed for these purposes. ECCD selected the Simple Method (Schueler, 1987) to estimate pollutant loads. The Simple Method estimates pollutant loads based on known pollutant loading coefficients associated with specific land use types. Common pollutants associated with nonpoint source pollution, including total suspended solids (TSS), the nutrients phosphate (TP) and nitrogen (TN), zinc (ZN) as a measure of other metals, total petroleum hydrocarbons (TPH), and dissolved inorganic nitrogen (DIN), as an indicator of industrial, municipal and agricultural waste were selected. NPS load reduction recommendations are presented in the table below (Table 10).

Pollutant Load Reductions Required to Meet Water Quality Standards in the lower Natchaug and Sawmill Brook Watersheds.

Lower Natchaug Watershed	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Current Pollutant Loads (lbs/yr)	1,305,731	3,105	16,388	555	5,532	2,344
Pre-developed Watershed Loads	342,420	423	5430	0	0	732
% Load Reduction Required	**74%**	**86%**	**67%**	**100%**	**100%**	**69%**

Sawmill Brook Watershed	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Current Pollutant Loads (lbs/yr)	1,215,790	2,652	19,281	442	3,910	3,306
Pre-developed Watershed Loads	936,239	1,077	14,558	0	0	2,005
% Load Reduction Required	23%	59%	24%	100%	100%	39%

Combined Watersheds	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Current Pollutant Loads (lbs/yr)	2,521,521	5,757	35,669	997	9,442	5,650
Pre-developed Watershed Loads	1,278,659	1,500	19,988	0	0	2,736
% Load Reduction Required	**49%**	**74%**	**44%**	**100%**	**100%**	**52%**

C. Watershed Best Management Practices:

Best management practices (BMPs) are control measures that are used to improve the quality of stormwater runoff. Stormwater BMPs can be classified as "structural" (i.e., brick and mortar devices installed or constructed on a site), or "non-structural" (procedures such as modified landscaping practices, preservation of open space, or behavioral changes). This portion of the Plan identifies critical areas in the watershed where BMPs will have greatest impact and includes an extensive table (Table 12) that provides locations, descriptions and approximate cost of recommended BMPs, based on data collected during the watershed investigation.

D. Financial and Technical Assistance Needed:

Watershed municipalities have local funding options, including bonding, capital improvement budgets, and department budget line items that can be utilized to fund water quality improvement implementations and municipal outreach efforts. Funds may also be available in the form of donations and in-kind services provided by local businesses, community and environmental organizations, and local volunteers. Financial assistance in the form of grants and cost sharing is available from multiple sources, including federal, state, and local sources, as identified in the table below (Table 13).

Potential Funding Source	Award Amount	Contact Information
CT DEEP CWA §319 Grant Program	Varies by project	
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325588&depNav_GID=1654		
CT DEEP Clean Water Fund		Susan Hawkins (860) 424-3325
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654		
CT DEEP Long Island Sound License Plate Program	$25,000.	Kate Brown (860) 424-3034
http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323782&depNav_GID=1635		
CT DEEP Open Space and Watershed Land Acquisition Grant Program	40-60% of fair market value	Dave Stygar (860) 424-3016
http://www.ct.gov/deep/cwp/view.asp?A=2687&Q=322338		
Ct Dept of Agriculture Environmental Assistance Prgm	Varies by practice	(860) 713-2511
http://www.ct.gov/doag/cwp/view.asp?a=3260&q=398986		
Ct Dept of Agriculture Agriculture Viability Grant	Varies by project	860-713-2500
http://www.ct.gov/doag/cwp/view.asp?a=3260&q=398982		
Ct Dept of Agriculture Farmland Restoration Program	Varies by project	J. Dippel/Lance Shannon(860) 713-2511
http://www.ct.gov/doag/cwp/view.asp?a=3260&Q=498322&PM=1		
CT DECD Small Cities Program	Varies by town	Jim Watson (860) 270-8182
http://www.ct.gov/doh/cwp/view.asp?a=4513&q=530474		
CT OPM Regional Performance Incentive Program		Sandy Huber (860) 418-6293
http://www.ct.gov/opm/cwp/view.asp?q=487924		
CT OPM Small Town Economic Assistance Program	Varies by project	Barbara Rua (860) 418-6303
http://www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793		
Community Foundation of Eastern Connecticut	Varies by program	Jennifer O'Brien (860) 442-3572
http://www.cfect.org/		
US EPA Healthy Communities Grant Program		Jennifer Padula (617) 918-1698
http://www.epa.gov/region1/eco/uep/hcgp.html		
NOAA Coastal Management Programs		
http://coastalmanagement.noaa.gov/funding/welcome.html		
US EPA Five Star Restoration Grant Program	$20,000 average	Myra Price (202) 566-1225
http://www.epa.gov/owow/wetlands/restore/5star		
NFWF Long Island Sound Futures Fund	Varies by project	Lynn Dwyer lynn.dwyer@nfwf.org
http://www.nfwf.org/		
NRCS Wetlands Reserve Program (WRP)		Javier Cruz (860) 887-3604 x307
http://www.ct.nrcs.usda.gov/programs/whip/whip.html		
NRCS Environmental Quality Incentives Program (EQIP)	$300,000 over a six year period	Javier Cruz (860) 887-3604 x307
http://www.ct.nrcs.usda.gov/programs/eqip/eqip.html		
Rivers Alliance of CT Watershed Assistance Small Grants Program	$5000, req. 40% non-federal funding match	Rivers Alliance of CT (860) 361-9349
http://www.riversalliance.org/watershedassistancegrantrfp.cfm		

E. Education/Outreach Component:

The objective of a successful education/outreach campaign is to raise awareness of the water quality issues associated with the lower Natchaug River, in order to create an educated populace that understands the issues of NPS and its effects on water quality, and actions that can be taken to address the problem. The table below (Table 15) provides potential outreach topics, as well as potential partners to assist with outreach. By successfully educating and engaging the public, this plan should lead to behavioral change that should result in reduction of NPS to the lower Natchaug River.

Outreach Topic	**Potential Outreach Partner**
Agricultural BMPs	UConn Cooperative Extension System, NRCS
Agricultural Nutrient Management	ECCD, NRCS, UConn Cooperative Extension System
Benefits of vegetated riparian buffers	CT SeaGrant
Composting	UConn Cooperative Extension System
Homeowner BMPS	ECCD, UConn Cooperative Extension System
Illicit Discharge Detection and Elimination Programs	CT DEEP Stormwater Management, DPWs
Invasive plant species identification and control	CT Invasive Plant Work Group (CIPWG), Invasive Plant Atlas of New England (IPANE)
Land use commissioners roles and responsibilities	CT NEMO, municipal land use commissions
Low impact development (LID)/ Green Infrastructure (GI)	CT NEMO,CLEAR
Municipal “Good Housekeeping” Public Works practices	CT DOT, DPWs
Non-migratory Geese Management	CT DEEP Wildlife Division, USDA
The Value of Open Space	CT DEEP, CT NEMO
Organic lawn/garden care	UConn Cooperative Extension System, NOFA
Pet waste management	Towns of Mansfield and Windham, Local Health Districts
Recycling	WWPCA, municipalities
Septic System BMPs for Homeowners	Local Health Districts, CT Dept. of Health
Trash/litter management	Local Conservation Commissions, DPWs
Understanding Non-point Source (NPS) Pollution	CT NEMO, Towns of Mansfield and Windham Conservation Commissions, CT DEEP
“What not to flush down drains”	WWPCA, Local Health Districts, UConn/ ECSU Environmental Science Depts.

F. Implementation Schedule:

An implementation schedule is a blueprint that is adopted by stakeholders to move forward the goals and objectives of the watershed plan. The 5-year implementation schedule proposed in the Plan (Table 16) provides structure and guidance that ensures the management recommendations of this plan are achieved in an expeditious manner. An example of an implementation schedule with measurable milestones for a specific management objective is presented below.

Management Objectives & Milestones to Achieve Plan Recommendations

Management Objective 1: Create a implementation team comprised of watershed stakeholders	
Actions/Milestones:	• Identify and contact prospective team members • Conduct inaugural informational meeting • Establish regular meeting schedule • Review, identify and prioritize initial action items • Establish focus groups as needed • Establish an evaluation procedure to measure progress
BMPs:	Urban Bacteria/NPS Sources
Responsible Parties:	Municipalities, ECCD, CT DEEP, ECSU, ACOE, local businesses, residents, others as appropriate
Anticipated Products:	Implementation team, meeting schedule, work plan
Evaluation:	Successful establishment of implementation team
Timeline:	2014-2015

G. Measurable Milestones:

Measurable milestones are specific actions that are to useful to ensure that progress is being made in achieving plan goals. In Table 16 of the Plan, management objectives and milestones are proposed that can be used to measure the progress that watershed stakeholders are making toward meeting the goals of this watershed plan (see example above).

H. Monitoring and Assessment Component:

Monitoring is an essential component to determining the effectiveness of Plan implementations, and whether adjustments need to be made within an adaptive management framework. On-going monitoring will provide necessary water quality data to allow watershed managers to assess the effectiveness of BMPs. Water quality monitoring should be coordinated with the implementation of management measures to determine if the desired results (a reduction in the amounts of indicator bacteria) are being achieved.

I. Implementation Effectiveness:

As implementations are undertaken and completed, water quality data should continue to be collected, evaluated and compared to the TMDL to determine if the implementations are achieving the desired results and that improvements to water quality are sustained. Implementation should be considered successful when the water quality targets are reached or exceeded. If implementations are not as effective as planned, watershed stakeholders should investigate the effectiveness of selected BMP practices, and may revise the watershed plan as necessary.

Next Steps

This section outlines steps to be taken once the plan is adopted to launch implementation of plan recommendations. Key among these is the distribution of the plan to all stakeholders, the formation of a watershed management team to guide implementation efforts, the creation of a watershed identity or brand, and the promotion of the Plan to raise public awareness and increase public engagement in the watershed process.

Closing

The degradation of water quality in the lower Natchaug River is a process that has occurred incrementally over many years. Likewise, the process of addressing water quality issues in the lower Natchaug River will be a long term effort. The successful implementation of this watershed plan by a watershed management team that represents the interests of all stakeholders in the lower Natchaug River watershed should result in the improvement of water quality in the lower Natchaug River, allowing all the designated uses for this waterbody including fishing and swimming.

The Eastern Connecticut Conservation District intends to remain an active participant and central point of contact as the implementation of this Watershed-Based Plan is undertaken.

Any comments or questions regarding this plan should be directed to the Eastern Connecticut Conservation District:

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Introduction

The Eastern Connecticut Conservation District (ECCD) conducted a track down survey of the lower Natchaug River in Mansfield and Windham, Connecticut, in order to identify potential sources of *Escherichia coli* (*E. coli)* bacteria that have degraded water quality. The lower Natchaug River has been listed for several cycles, most recently in 2012, in the State of Connecticut Integrated Water Quality Report as impaired for recreation due to elevated levels of *E. coli*, from sources that may include permitted and non-permitted stormwater, illicit discharges, CSOs/SSOs, insufficient septic systems, nuisance wildlife and/or pets.

As part of the track down survey, ECCD recruited and trained local volunteers to collect water samples from the lower Natchaug River and its tributaries to be analyzed for bacteria content, and to conduct Streamwalk surveys, utilizing a protocol developed by the USDA Natural Resource Conservation Service (NRCS). ECCD reviewed CT DEEP's 2012 Statewide Total Maximum Daily Load Analysis for Bacteria Impaired Waters, and water quality data collected by Windham Water Works, North Central District Health Department, and Project Search. Project Search is a now-defunct water quality monitoring and aquatic studies program for Connecticut secondary schools jointly administered by the Science Center of Connecticut and CT DEP (now CT DEEP). ECCD staff also interviewed local officials, area business owners and residents to identify other potential causes of the observed degradation to the lower Natchaug River.

Based on the information gathered, this abbreviated nine-element watershed based plan was prepared. This plan recommends management practices for watershed managers that address the documented areas of concern, with the goal of reducing NPS pollution contributions to the lower Natchaug River, including *E. coli*, allowing it to be removed from the Connecticut 303d Impaired Waters list.

Watershed Description

Physical and Natural Features:

The Natchaug River watershed (3200) is located in northeast Connecticut, in the towns of Eastford, Chaplin, Mansfield and Windham (Figure 1). This sub-regional watershed encompasses a land area of 29.3 square miles and is part of the Thames Main Stem regional watershed (CT3000). The lower Natchaug River watershed, which is the focus of this document, is located in Mansfield and Windham (Willimantic), Connecticut. The 2.7 square mile lower Natchaug River watershed is comprised of the southern-most watershed area contributing to the lower Natchaug River (segment CT3200-00_01), a 3.38 mile stretch of river that extends from the outlet of the Willimantic Reservoir to the confluence with the Willimantic River.

Figure 1: Location of investigation area in Mansfield and Windham, CT.

The Sawmill Brook watershed (3208), located in Windham and Mansfield, Connecticut, contributes to the lower Natchaug River below the Willimantic Reservoir. The 7.3 square mile watershed has a stream network comprised of five first and second order tributaries, including two named streams, Conantville Brook and Sawmill Brook. The Sawmill Brook watershed flows into the lower Natchaug River at the north end of Lauter Park in Willimantic, upstream of the designated swimming area.

Water Quality:

The lower Natchaug River and the tributary streams in the Sawmill Brook watershed have surface water quality classifications of A (Figure 2). Water quality classifications

Figure 2: Lower Natchaug River and Sawmill Brook watersheds surface water classification (CT DEEP).

serve to establish designated uses for surface and ground waters and identify criteria necessary to support those uses. Designated uses in Class A surface waters include habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture. Permitted discharges to a Class A water may include discharges from public or private drinking water treatment systems, dredging activity and dredge material dewatering operations, including the discharge of dredged or fill material and clean water discharges (State of CT Department of Environmental Protection Water Quality Standards, 2011).

Groundwater within the lower Natchaug River watershed is classified as GA, with areas classified as GB (Figure 3). Groundwater in the Sawmill Brook watershed was classified GA. Designated uses for Class GA groundwater include existing private and potential public or private supplies of water suitable for drinking without treatment; and base flow for hydraulically-connected surface water bodies. Groundwaters designated GB are assumed to be degraded due to a variety of pollutant sources. Designated uses for Class GB groundwater include industrial process water and cooling waters; baseflow for hydraulically-connected surface water bodies; presumed not suitable for human consumption without treatment.

The Windham Water Works draws surface water from the Willimantic Reservoir, an impoundment of the Natchaug River, to provide drinking water for residents and businesses in Mansfield and Windham. The Water Works distribution service area has about 82 miles of water main, and over four thousand water services (households), which serves over 15,000 people in the service area. Willimantic Reservoir is classified AA. Designated uses for Class AA surface waters include existing or proposed drinking water supplies; habitat for fish and other aquatic life and wildlife; recreation; and water supply for industry and agriculture.

<u>Geology:</u>

The lower Natchaug and Sawmill Brook watersheds are located over the Willimantic Dome, an exposed layer of Avalonian Basement Terrane, a volcanic island arc which attached to the proto-Euramerican plate during the Devonian period (420 mya), and which dates from the Proterozoic Z age, 600-700 million years ago. Bedrock geology of the Avalonian Terrane is composed of the Hope Valley belt, a light pink to gray, medium to coarse-grained granitic gneiss; the Quinebaug formation, a light to dark, medium-grained gneiss or schist; and several members of the pre-Silurian Tatnic Hill formation, comprised of light to dark gray, fine to medium-grained gneisses or schists, or calc-silicate gneisses.

Soils in the lower Natchaug River watershed are comprised of melt-out tills in the upper elevations, and glaciofluvial and alluvial floodplain soils in the lower elevations, with extensive placement of udorthent (urban land complex) soils along transportation corridors (Routes 6 and 195), in commercial areas, and in the vicinity of downtown Willimantic (Figure 4). Dominant soils include udorthents - urban land complex (27%), Hinckley gravelly sandy loams (18.5%), and Canton and Charlton soils (15%) (Figure 5).

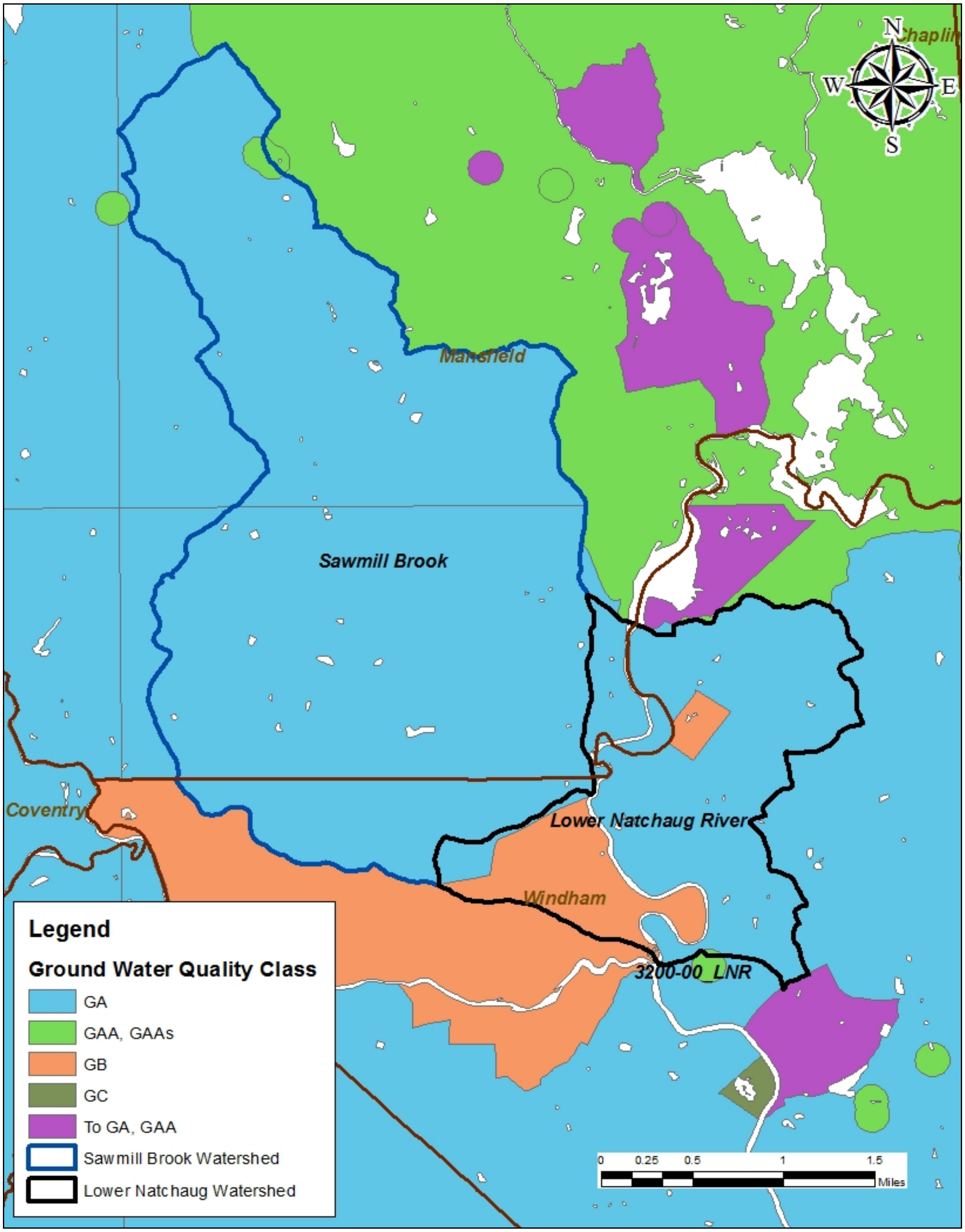


Figure 3: Lower Natchaug River and Sawmill Brook watersheds ground water classification (CT DEEP).

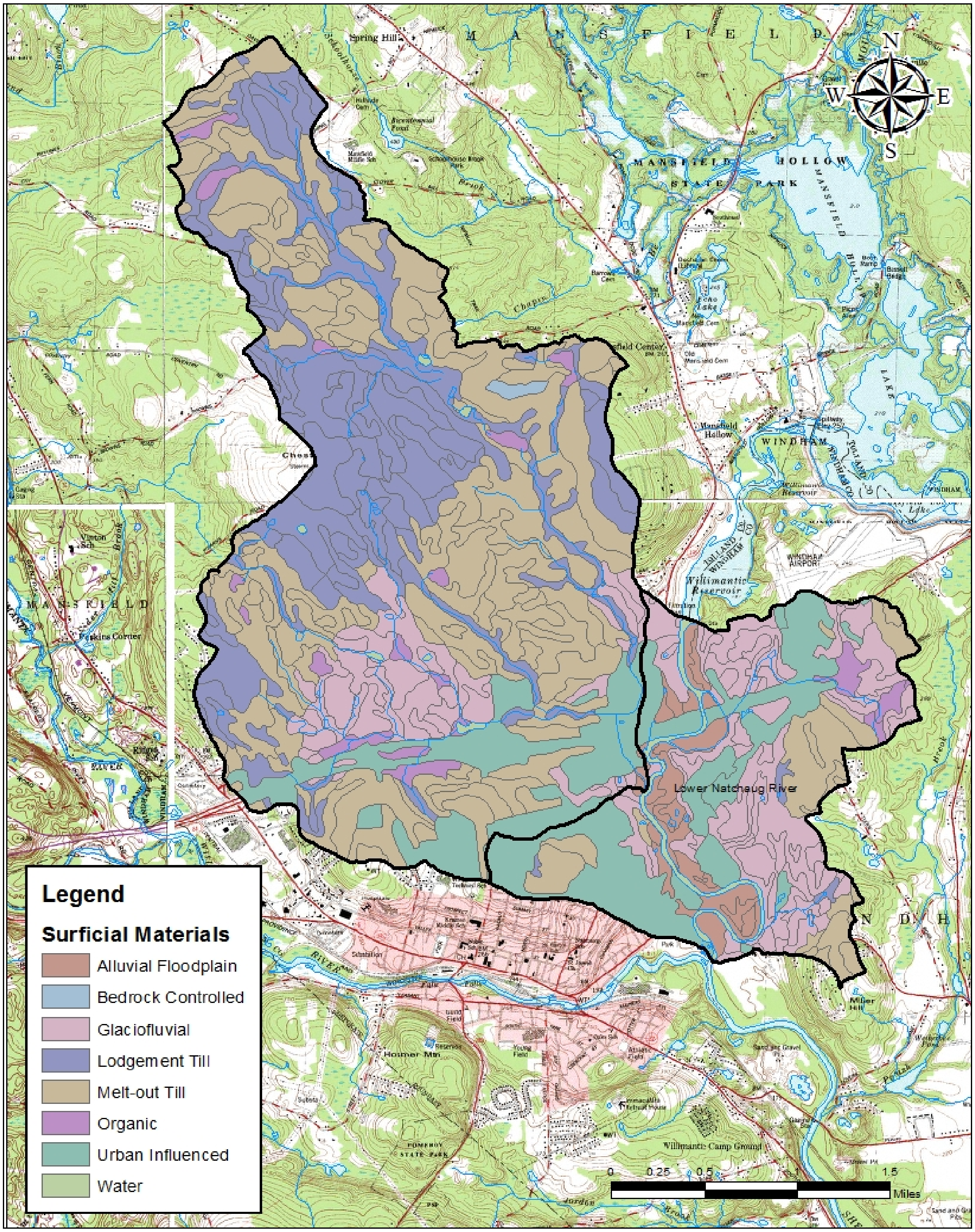


Figure 4: Surficial materials in the lower Natchaug River and Sawmill Brook watersheds (SSURGO 2011).

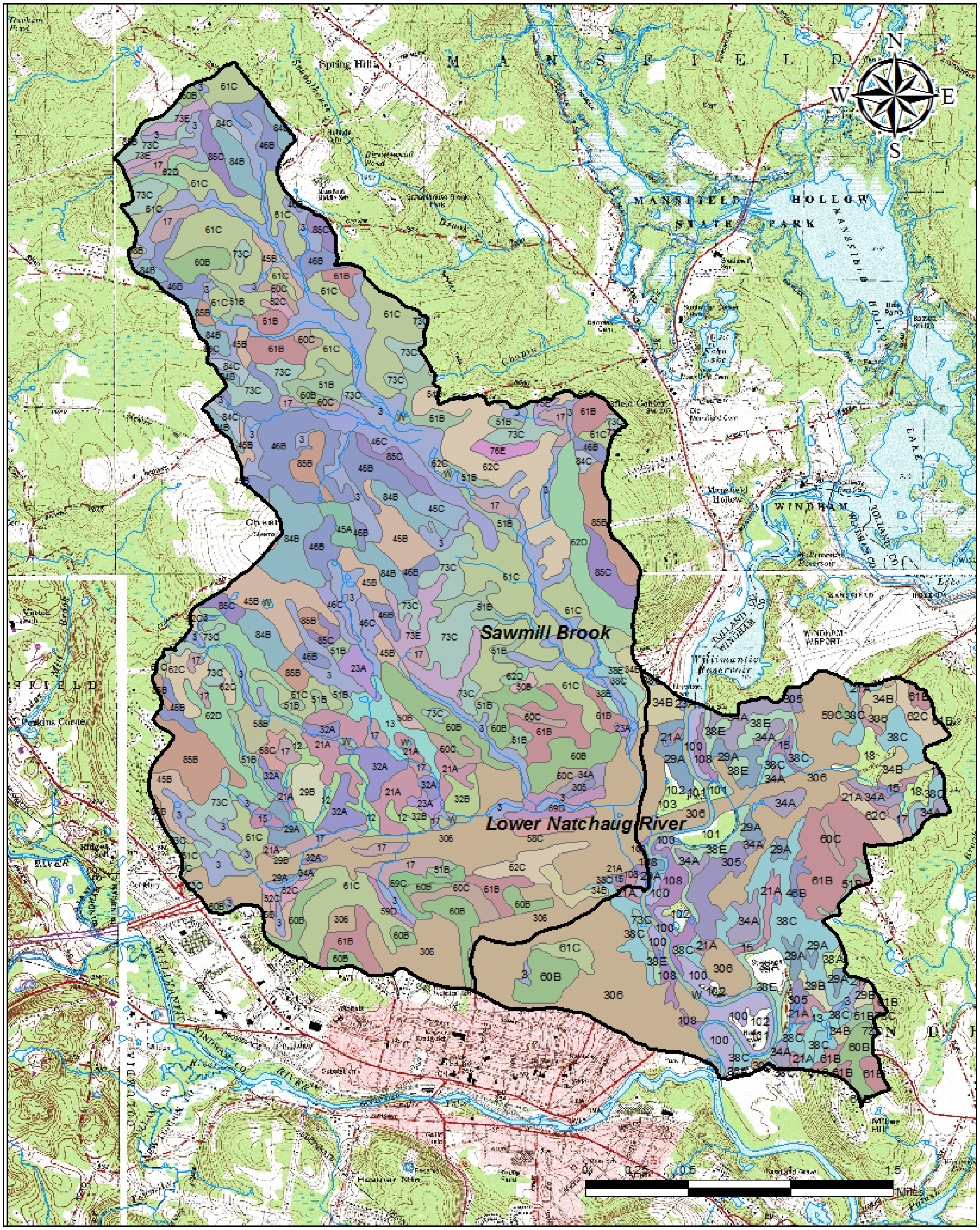


Figure 5: Soils in the lower Natchaug River and Sawmill Brook watersheds (CT DEEP).

Table 1: Soils in the lower Natchaug Rive and Sawmill Brook watersheds.

Soil Symbol	Soil Description	Soil Symbol	Soil Description
3	Ridgebury, Leicester, and Whitman soils, extremely stony	58B	Gloucester gravelly sandy loam, 3 to 8 percent slopes, very stony
12	Raypol silt loam	58C	Gloucester gravelly sandy loam, 8 to 15 percent slopes, very stony
13	Walpole sandy loam	59C	Gloucester gravelly sandy loam, 3 to 15 percent slopes, extremely stony
15	Scarboro muck	59D	Gloucester gravelly sandy loam, 15 to 35 percent slopes, extremely stony
17	Timakwa and Natchaug soils	60B	Canton and Charlton soils, 3 to 8 percent slopes
18	Catden and Freetown soils	60C	Canton and Charlton soils, 8 to 15 percent slopes
21A	Ninigret and Tisbury soils, 0 to 5 percent slopes	61B	Canton and Charlton soils, 3 to 8 percent slopes, very stony
23A	Sudbury sandy loam, 0 to 5 percent slopes	61C	Canton and Charlton soils, 8 to 15 percent slopes, very stony
29A	Agawam fine sandy loam, 0 to 3 percent slopes	62C	Canton and Charlton soils, 3 to 15 percent slopes, extremely stony
29B	Agawam fine sandy loam, 3 to 8 percent slopes	62D	Canton and Charlton soils, 15 to 35 percent slopes, extremely stony
32A	Haven and Enfield soils, 0 to 3 percent slopes	73C	Charlton-Chatfield complex, 3 to 15 percent slopes, very rocky
32B	Haven and Enfield soils, 3 to 8 percent slopes	73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky
34A	Merrimac sandy loam, 0 to 3 percent slopes	75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes
34B	Merrimac sandy loam, 3 to 8 percent slopes	76E	Rock outcrop-Hollis complex, 3 to 45 percent slopes
36A	Windsor loamy sand, 0 to 3 percent slopes	84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes
38A	Hinckley gravelly sandy loam, 0 to 3 percent slopes	84C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	85B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony
38E	Hinckley gravelly sandy loam, 15 to 45 percent slopes	85C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes, very stony
45A	Woodbridge fine sandy loam, 0 to 3 percent slopes	100	Suncook loamy fine sand
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	101	Occum fine sandy loam
45C	Woodbridge fine sandy loam, 8 to 15 percent slopes	102	Pootatuck fine sandy loam
46B	Woodbridge fine sandy loam, 2 to 8 percent slopes, very stony	103	Rippowam fine sandy loam
46C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	108	Saco silt loam
50B	Sutton fine sandy loam, 3 to 8 percent slopes	305	Udorthents-Pits complex, gravelly
51B	Sutton fine sandy loam, 2 to 8 percent slopes, very stony	306	Udorthents-Urban land complex
52C	Sutton fine sandy loam, 2 to 15 percent slopes, extremely stony	W	Water

Soils in the Sawmill Brook watershed are comprised of lodgement and melt-out tills in the upper elevations and glaciofluvial and organic soils in the lower elevations, with extensive placement of udorthent soils along the Route 6 transportation corridor. Predominant soil types include Canton and Charlton soils (31%), Woodbridge fine sandy loams (12%), and Ridgebury, Leicester and Whitman soils (11.5%).

Vegetative Cover:

Vegetation in the lower Natchaug River watershed is comprised primarily of deciduous forest, with isolated stands of white pine in upland areas, and hemlocks along stream corridors and in forested wetlands. Common invasive plant species, including bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), common reed (*Phragmites australis*), and Japanese Knotweed (*Fallopia japonica*), were noted in disturbed areas and along stream corridors. Common reed was especially prevalent in areas along Conantville and Sawmill Brooks. Dense stands of common reed were noted in Eaton's Pond, in Mansfield, located to the south of the ESCU Athletic Complex.

Endangered Species:

The Connecticut Department of Energy and Environmental Protection's Natural Diversity Database (NDDB) identifies multiple Natural Diversity Database sites along the entire reach of the lower Natchaug River, from the Willimantic Reservoir outlet to the confluence with the Willimantic River (Figure 6). Additional NDDB sites were identified along Sawmill Brook and Conantville Brook near the confluence with the Natchaug River, as well as several sites throughout the Sawmill Brook watershed. According to CT DEEP, these sites may include both terrestrial and aquatic plant and animal species. The Natural Diversity Database also identified several areas of acidic Atlantic White Cedar Swamp Critical Habitat in the Sawmill Brook watershed. For more specific information on listed species, inquiries should be directed to CT DEEP's Natural Diversity Database program.

Fisheries:

The Natchaug River is a recreational trophy trout stream and is stocked annually by CT DEEP. The goal of the trout management plan is "to improve fishing quality by diversifying the angling opportunities provided by hatchery trout and by increasing the value of fisheries sustained by wild trout" (Connecticut's Trout Management Plan). The lower Natchaug River was evaluated by CT DEEP Inland Fisheries Division in 1993, 1994, 1995 and 2003 (Table 2). Both the main channel and an old channel just north of Route 6 were surveyed. Sawmill Brook upstream of Puddin Lane was surveyed in 1994, upstream of the confluence with the Natchaug River in 1995, and upstream of Conantville Road in 2003. DEEP Fisheries staff documented the presence of wild brook trout and American eels upstream of Puddin Lane and noted that good cover and undercuts upstream of Conantville Road contributed to favorable habitat.

No information regarding the presence of native stream mussels was reviewed; however the invasive Asian clam (*Corbicula fluminea*) was noted in the Natchaug River in the vicinity of Route 66.

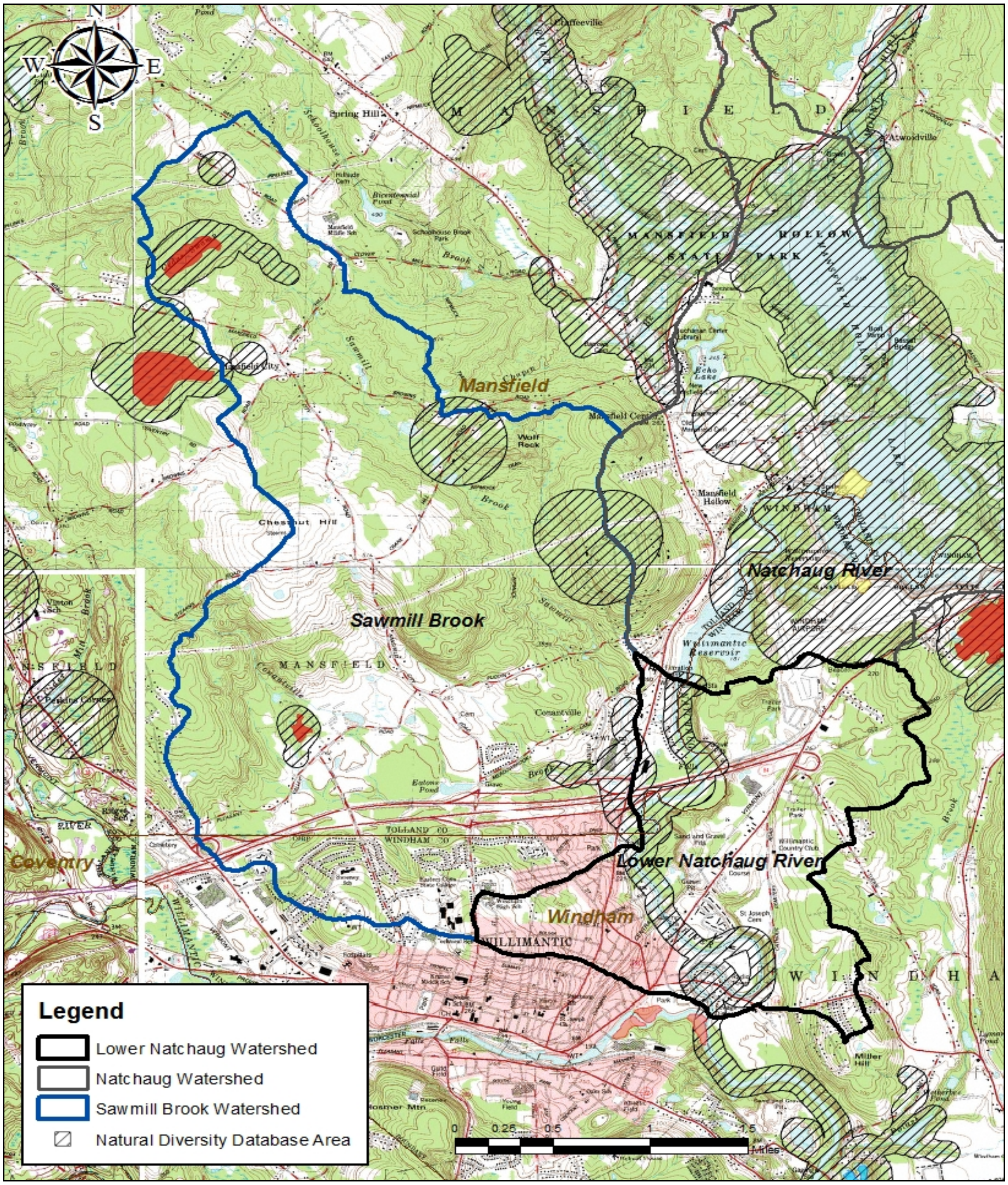


Figure 6: CT DEEP Natural Diversity Database areas in the lower Natchaug watershed (CT DEEP 2012). Red areas represent Critical Habitats.

Table 2. Results of CT DEEP Fisheries Surveys of the Natchaug River and tributaries.

Waterbody	Natchaug River				Natchaug River (Old Channel)			Sawmill Brook			Unnamed Trib to Conantville Brook (3208-03)
Year	1993	1994	1995	2003	1993	1994	1995	1994	1995	2003	2009
American Eel	55	19		5	10	22		15		1	
Black Crappie	1	2									
Blacknose Dace	10							114		173	24
Bluegill	44	154		7	2	75		9			1
Brook Trout								79	5	159	9
Brown Bullhead		1								2	1
Brown Trout	1		2	5					7		
Chain Pickerel	3	12	2	1	1	9	21			2	
Common Carp	5	45		4							
Common Shiner	13	8			31	14				50	
Fallfish	197	27		4	116	118		8		19	
Golden Shiner	9	31									3
Green Sunfish											1
Largemouth Bass	8	16	1	2	7	3					
Longnose Dace	21			5	5	7					
Northern Pike	1	2	2			1					
Pumpkinseed	1	80		1		14					1
Rainbow Trout				2							
Redbreast Sunfish	11	4		18	3	77					
Rock Bass	5	21	11	1	1	19					
Smallmouth Bass	59	14	26	7	9	15					
Spottail Shiner	23	3			14				1		
Tessellated Darter	63	9		1	23	53		6		7	
Unknow Sunfish	5										
White Sucker	68	36		6	39	47		35		20	
Yellow Bullhead	1	14									
Yellow Perch		84				3					

Land Use

Land Use and Land Cover:

Land cover in the lower Natchaug River watershed is dominated by suburban and urban development (44%). Developed land is concentrated along the Route 195 and Route 6 corridors and extends southward to downtown Willimantic. Development varies from commercial and light industrial to densely settled residential areas, and includes mixed urban residential/commercial areas in Willimantic; and commercial and industrial development on Boston Post Road (State Route 6), such as the Windham Airport and the western edge of the North Windham shopping center area. Residential development varies from suburban single family dwellings in the northern and eastern extents of the watershed, to densely developed, multiple occupancy dwellings in the southern extent of the watershed. Forests comprise 26% of the watershed; turf grasses and other grasses, which include managed turf and landscaped areas, such as the Willimantic Country Club, landscaping around housing complexes and commercial/retail complexes, and residential neighbors, accounted for 20% of the watershed;, 4% of the watershed was barren land; 5% of the watershed is comprised of wetlands and waterbodies; and only 1% was under agricultural use (Center for Landuse Education and Research 2006 - Figures 7 and 8).

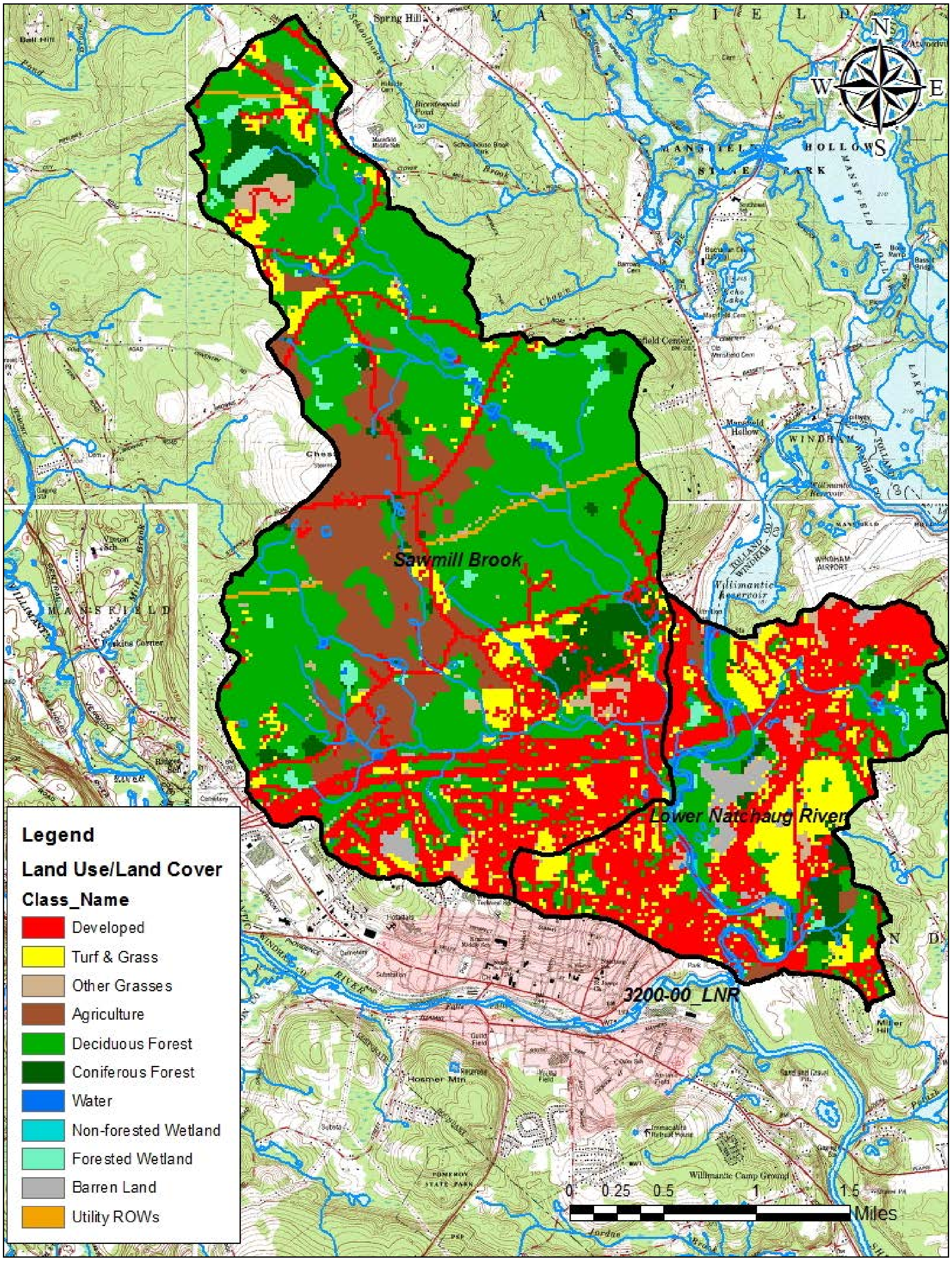
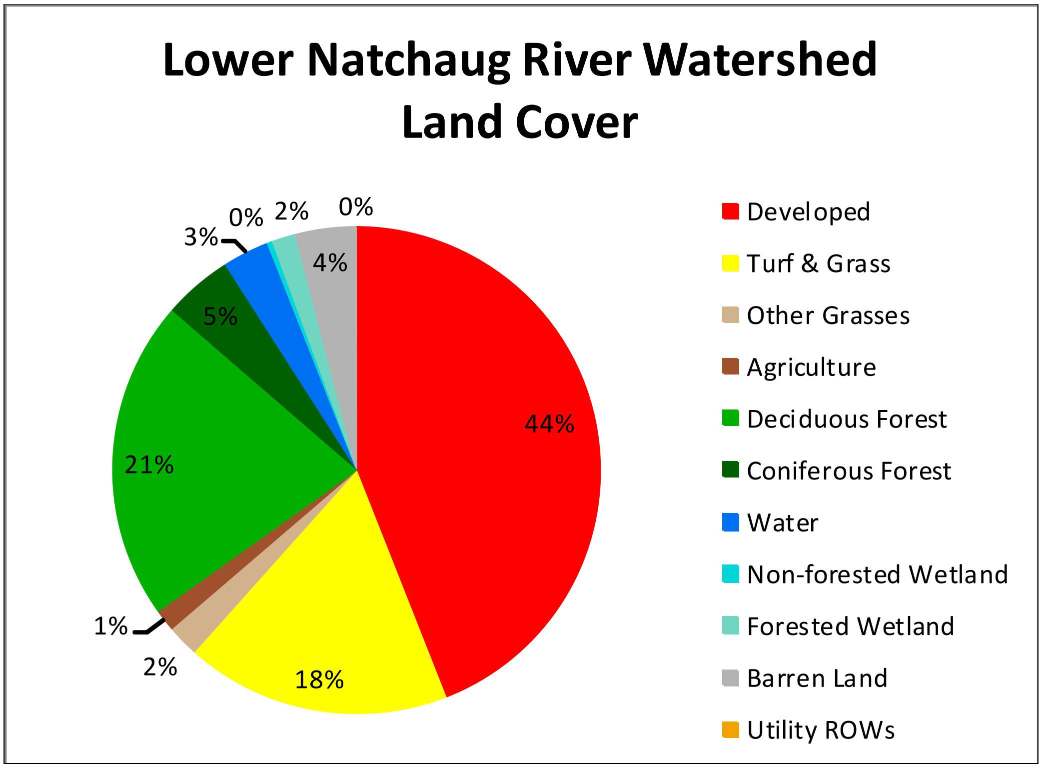


Figure 7: Land use and land cover in the lower Natchaug River and Sawmill Brook watersheds (CLEAR 2006).



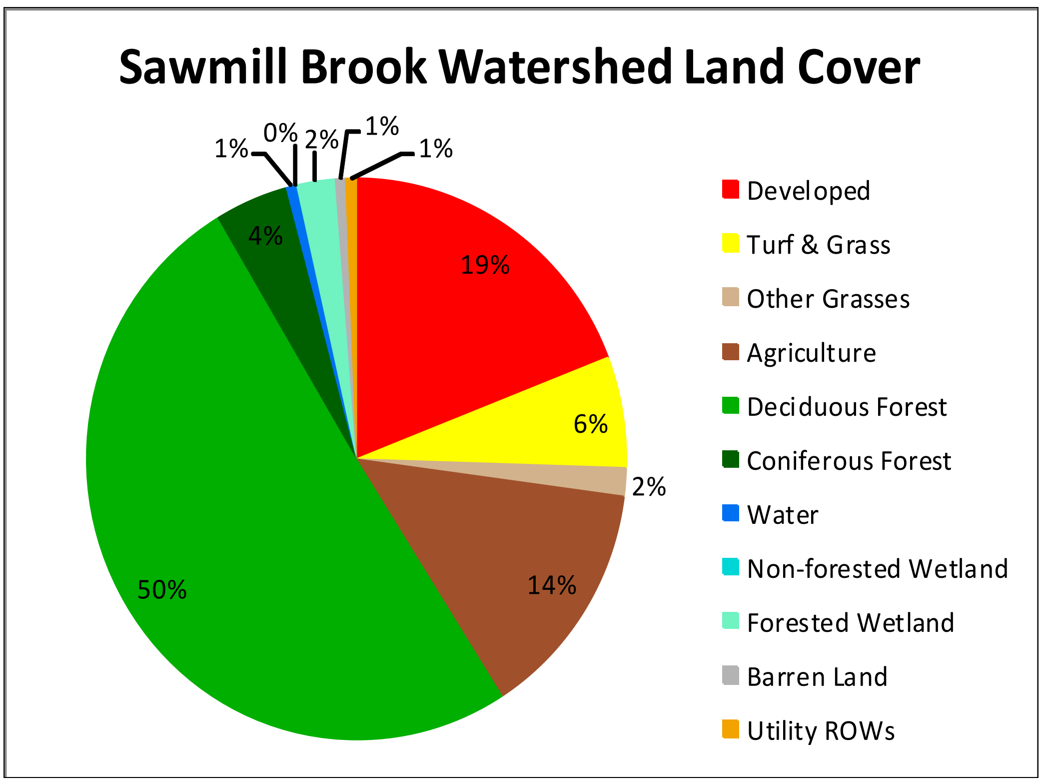


Figure 8: Percent land cover type for the lower Natchaug River and Sawmill Brook watersheds (derived from 2006 Center for Landuse Education and Research land cover data).

By comparison, the Sawmill Brook watershed is primarily forested (55%). Developed land comprises 19% of the watershed, including urban residential along and extending south of the Route 6 corridor, suburban and rural residential north of the Route 6 corridor, and commercial/retail development along Route 195; agriculture 14%, especially in the western portion of the watershed; turf and other grasses, which include managed turf and landscaped areas, such as the Eastern Connecticut State University Athletic Complex, landscaping around housing complexes and commercial/retail complexes, and residential neighbors 8%; wetlands and waterbodies 3%; and less than 1% is barren land. Significant agricultural activity was noted in the Sawmill Brook watershed (643 acres, or 14%). Numerous small private farms were noted, as was extensive hay and cropland (corn). Two commercial farms were noted, including one large dairy farm.

Open Space:

Open space in the lower Natchaug River and Sawmill Brook watersheds is comprised of a combination of private, municipal and state-owned properties and conservation easements (Figure 9). Joshua's Tract Conservation and Historic Trust owns three properties, including the Dorothy Goodwin Reserve (16 acres), and Wolf Rock Nature Preserve (108 acres), in Mansfield, CT. The Town of Mansfield owns and manages several open space parcels and town parks, including the Jacobs Hill Preserve, the 121-acre Sawmill Brook Preserve and Sunny Acres Park. The Sawmill Brook Preserve connects to Joshua's Trust's Wolf Rock Preserve. A small portion of Schoolhouse Brook Park is located in the Sawmill Brook watershed as well. The Town of Windham owns Lauter Park and Windham Recreation Park, both located along the Natchaug River, as well as Alex Caisse Park, located on Route 195 near the Mansfield town line. A portion of Natchaug State Forest is located within the lower Natchaug watershed in Windham, as well as large tracts of privately owned open space including the Willimantic Country Club and St. Joseph's Cemetery.

Recreation/Trails:

Recreation opportunities in the lower Natchaug and Sawmill Brook watersheds include both passive and active recreational activities (Figure 9). Hiking trails are available on numerous private, town and state-owned properties, including the Airline State Park Trail, which in Windham forms a portion of the East Coast Greenway, and is locally known as Veteran's Memorial Greenway, the Nipmuck Trail which is part of Connecticut's Blue-Blazed Hiking Trail System, Joshua's Tract Conservation and Historic Trust's Wolf Rock Nature Preserve, Sawmill Brook Preserve, and the Jacob's Hill Preserve, which provides access to the Nipmuck Trail. Sunny Acres Park in Mansfield, and Lauter Park and Windham Recreation Park in Windham provide playgrounds and athletic fields for visitors. Lauter Park has a public swimming area and boat launch for aquatic recreational activities.

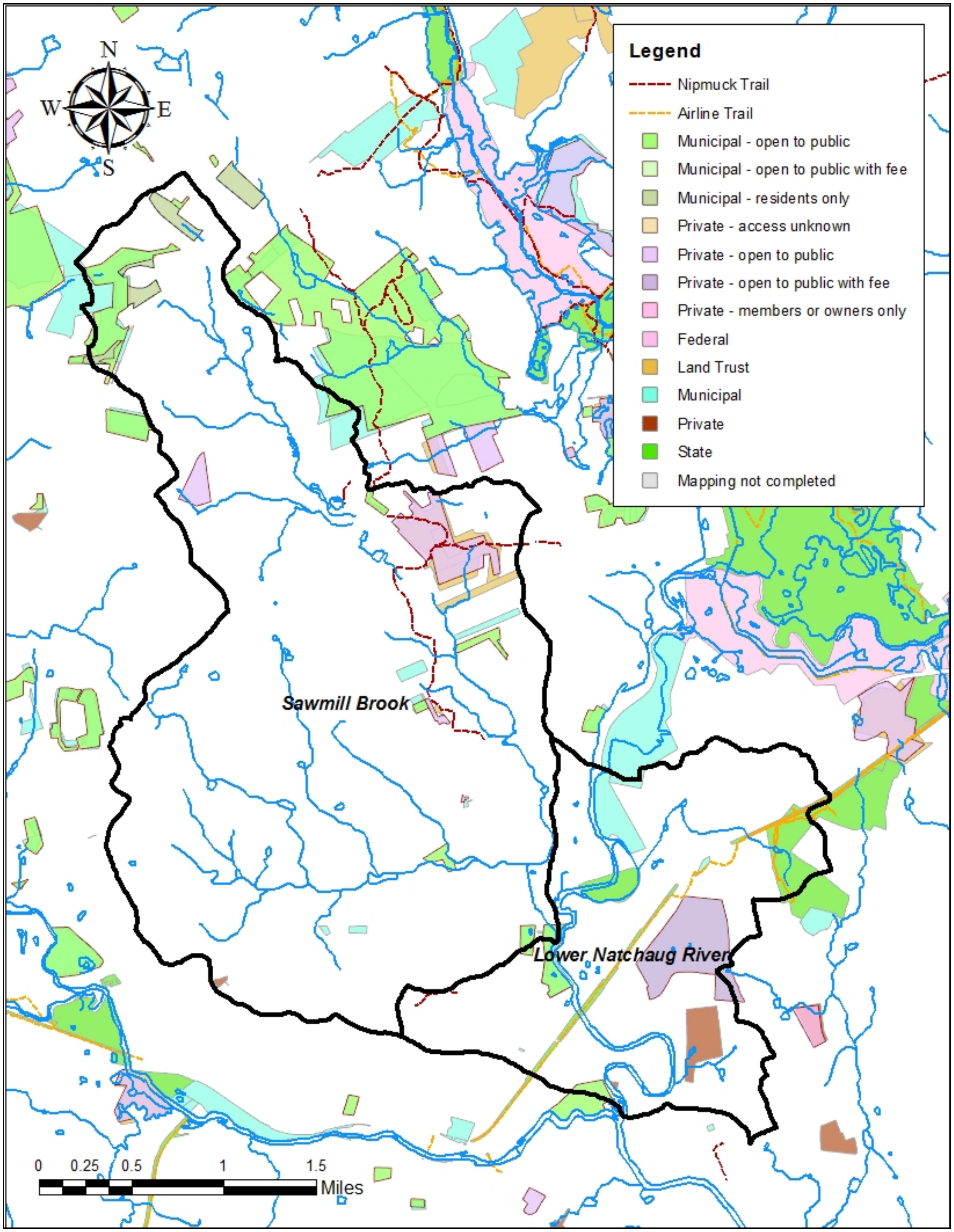


Figure 9: Protected Open Space and Hiking Trails in the Lower Natchaug River watershed (CT DEEP 2011).

Demographic Characteristics

Demographics/Economics:

The town of Mansfield encompasses a land area of 44 square miles. The population in 2011 was 26,130, with a population density of 588 people per square mile (it should be noted that as of 2010, almost 12,000 or 44% of Mansfield's population were students living in campus housing). Local industries include hospitality/food services, healthcare, retail, manufacturing and construction. Major employers include the State of Connecticut (including the University of Connecticut), the Town of Mansfield and Natchaug Hospital. Per capita income in Mansfield is slightly greater than the state average (Connecticut Economic Resource Center, 2013).

The town of Windham encompasses a land area of 27 square miles and is a regional center for some commercial and retail businesses, and governmental and non-governmental organization social services. The population in 2011 was 25,129, with a population density of 940 people per square mile. Local industries include healthcare/social assistance, retail, manufacturing and construction. Major employers include the Eastern Connecticut State University, Windham Hospital and retail outlets. Per capita income in Windham is below the state average (Connecticut Economic Resource Center, 2013). The Willimantic section of Windham is 4.39 square miles. The population of Willimantic is 17,737, with a density of 4043 people per square mile (www.city-data.com).

Land Management Policies

Land use and land management planning and policy development occurs on multiple administrative levels, from state to the local level and determine how land will be used and developed. Land management policies, especially in the form of municipal land use regulations, can play a significant role in the protection of water quality and other natural resources. The State of Connecticut conducts state-wide land use planning through the Office of Policy and Management (OPM). The State Plan of Conservation and Development serves as the official state policy in matters pertaining to land and water resources conservation and development, and directs and informs decision making by the executive branch of government. Regional planning occurs through regional planning organizations, and identifies regional goals for land use, development and natural resource protection. Local planning occurs via municipal plans of conservation and development and other planning documents, including local ordinances and municipal land use regulations, stormwater management plans, and watershed management plans. Planning on the local level typically has the most direct impact on how conservation and development occur at the community level. Local land

use planning is most effective when consistent with regional and state conservation and development policies and plans.
This section reviews and summarizes existing planning documents that affect and influence water quality protection.

1. Regional Land Planning Policies

   a. State of Connecticut: The *2013-2018 Conservation & Development Policies: The Plan for Connecticut*, prepared by the Office of Policy and Management in accordance with Connecticut General Statutes Section 16a-29, identifies six growth management principles to direct growth and development throughout the State of Connecticut. Growth management principles pertinent to the lower Natchaug River and Sawmill Brook watersheds include:
      - Growth Management Principle #1 - Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure
      - Growth Management Principle #4 - Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural Lands
      - Growth Management Principle #5 - Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety

   b. Windham Region Council of Governments: The Windham Region Council of Governments identifies regional goals for conservation and development in the 2010 Windham Region Land Use Plan. It should be noted that the Windham Region Council of Governments will be formally disbanded by 6/30/14, and member towns, will be absorbed into surrounding councils of government. Mansfield will be joining the Capitol Region Council of Governments. Windham will be joining the Southeastern Connecticut Council of Governments.

      Regional goals pertinent to the lower Natchaug River and Sawmill Brook watersheds include:
      - Goal 1. Development, especially intensive development, should be concentrated in areas where there is public water and sewer, public transportation service and facilities, sidewalks, schools, and other community infrastructure.
      - Goal 5. Economic growth should be focused in areas with existing public infrastructure.
      - Goal 8. Wildlife habitats should be preserved because they are critical to the health of our natural environment and are the foundation of ecological communities.
      - Goal 9. Municipal land use controls should foster and create strong, cohesive community centers and discourage expansion into valuable farmland and woodland.

The Plan identifies the following regional land use actions:

- implement flexible land use regulations
- use best management practices and low impact development
- encourage alternative/community septic systems in priority development nodes
- consider a transfer of development rights program

The Plan identifies distinct regional centers, and recognizes that regional centers are "…are the principle hubs of economic and social activity in the region. They provide services and opportunities to surrounding towns that could only be provided on a regional scale (pg. 10)." The Plan recognizes Willimantic, including portions of the Route 6 corridor in North Windham and the Eastbrook Mall in Mansfield, as a distinct regional center.

The Plan further identifies rural community centers, "small nodes with relatively higher development densities than the surrounding lands and are the focus of rural community activity (pg.13)," and reservation areas, "areas that should be protected from harmful forms of development or resource use (pg.17)" and provides guidance for preservation.

c. <u>Natchaug Basin Conservation Action Plan/Municipal Conservation Compact:</u> The Natchaug Basin Conservation Action Plan (CAP) and Municipal Conservation Compact are non-regulatory planning documents adopted by the eight municipalities in the 114,000 acre Natchaug Basin, including Mansfield and Windham. The CAP and Compact were developed through a series of workshops attended by land use professionals, municipal staff and local volunteers, utilizing a process called Conservation Action Planning, which was developed by The Nature Conservancy. The Conservation Action Planning process identifies conservation targets and assesses their condition or ecological viability; Identifies and ranks the primary threats affecting the overall condition of the watershed systems; defines strategies to specifically address the threats and restoration needs of the conservation targets; and creates a document which assigns measurable actions and dates specific to each strategy, to determine if the strategies are working and if not, why (The Nature Conservancy, 2009).

   The Municipal Conservation Compact, which was adopted by the eight watershed municipalities in 2011, is a non-binding document that acknowledges the commitment of the participants "to work cooperatively to balance conservation and growth by:

   1. Protecting and restoring the natural resources of the watershed;

2. Reviewing land use regulations and municipal practices and adapting them to be compatible with the goals of this conservation compact;
3. Supporting efforts to link and maintain ecologically viable habitats and rural landscapes; and
4. Ensuring the long-term environmental health, vitality and security of the watershed to enhance the social and economic strength of our communities."

d. Connecticut Department of Transportation: The Connecticut Department of Transportation (CT DOT) has adopted a Stormwater Management Plan (SWMP) for the purpose of "establishing, implementing and enforcing a stormwater management program to reduce the discharge of pollutants from the department's highways, roadways, railways and facilities to the maximum extent practicable, to protect water quality, and to satisfy the appropriate requirements of the Clean Water Act. The SWMP will cover all of the department's highways, roadways and railways located within Urbanized Areas (UA) as indicated by the 2000 Census. Additionally, all interstate highways within the state will be covered under this SWMP regardless of location. Individual facilities such as airports, maintenance garages, ports, salt sheds and other miscellaneous facilities are or will be covered under general permits (industrial) with the Connecticut Department of Environmental Protection (CTDEP)."

In additions to programs and practices already in place relating to stormwater management and pollution prevention, the CTDOT SWMP "outlines a program of best management practices (BMPs) and measurable goals for the following six minimum control measures.

· Public education and outreach
· Public involvement / participation
· Illicit discharge detection and elimination
· Construction site stormwater runoff control
· Post-construction stormwater management
· Pollution prevention/good housekeeping."

e. Connecticut Airport Authority: The Windham Airport Master Plan was in the process of being updated at the time of this report preparation. The update will include an inventory of on-site environmental conditions which will be used for the analysis of environmental and land use impacts. Stakeholders can refer to the 2013 Master Plan Update document, and should contact airport managers for the Master Plan Document when it is finalized.

2. Municipal Land Use Policies:

a. Town of Mansfield:

The Town of Mansfield addresses land management policies in a variety of documents, including its Plan of Conservation and Development (2006), Land of Unique Value Study (2003), Open Space Action Plan, and municipal ordinances and land use regulations. As of the writing of this watershed plan, the Town of Mansfield was in the process of a comprehensive update to its Plan of Conservation and Development and zoning regulations. Following is a summary of land management policies in effect at the time of the preparation of this document that address water quality concerns. Readers are advised that they should contact the Town of Mansfield to obtain the most current land management regulations and policies.

<u>Mansfield Plan of Conservation and Development:</u>
The Town of Mansfield Plan of Conservation and Development (2006) addresses issues of water quality and natural resource protection, and makes recommendations to guide and inform future development in Mansfield while providing protection to natural and manmade resources identified as valuable. The Plan of Conservation and Development identifies the Natchaug River and the Conantville Brook stream corridors as significant water resources. The Plan of Conservation and Development further refers to the importance of protected open space and provides criteria to be considered by municipal decision makers when considering the acquisition of open space.

<u>Municipal Land Management Regulations:</u>
The Town of Mansfield has adopted land use regulations to protect water quality and natural resources, including zoning, subdivision, and inland wetland regulations. Following is a summary of land use regulations that address water quality concerns.

1. *Zoning Regulations:*
   - <u>Windham Water Works/ Connecticut Department of Public Health Notification</u> –Article 3.L. requires an applicant to provide written notice to a water company and the Commissioner of Public Health, if a proposed subdivision is “within an aquifer protection area delineated pursuant to Section 22a-354c of the General Statutes or which is within the watershed of the Willimantic Water Works or other water company as defined in Section 25-32a of the General Statutes (pg.13).”
   - <u>Erosion and Sediment Control Plans</u> – Article 5, Section A.4.f. requires preparation and submittal of an Erosion & Sediment Plan as part of the site plan application packet.
   - <u>Discharges of Liquids or Solids</u> – Article 6, Section B.23.i . require that “No land use shall discharge into the ground, into a wetland or surface water body or into a storm drainage or waste disposal system, any liquid or solid matter which endangers the public's health and safety, or is likely to cause

detrimental effects on surface and ground water quality or personal property values."

- o <u>Flood Hazard Areas</u> – Article 6, Section B.l. requires that "Land which is subject to flooding shall only be built upon or utilized according to the requirements of Article X, Section E (pg. 44)."
- o <u>Aquifer Areas</u> - Article 6, Section B.m. requires that "To prevent or minimize detrimental effects on the groundwater quality within aquifer areas, which are existing or potential sources of significant quantities of potable water, land use activities on or within 500 feet of identified aquifer areas must be carefully reviewed and appropriately regulated (pg. 44)."
- o <u>Landscape Buffers</u> – Article 6, Section B.q. requires that "Where a site abuts a more restrictive zone or existing residential uses, a landscaped buffer area shall be required along the subject property lines and/or zone boundary lines. A landscape buffer area shall also be required when a commercial, industrial, multi-family or other nonresidential land use abuts an historic structure, cemetery or environmentally sensitive feature such as a river, brook, pond or wetland area (pg. 46)."

2. *Subdivision Regulations:*
   - o <u>Cluster development</u> - Section 7.4 authorizes the Commission to require new subdivisions to be clustered with reduced lot sizes and larger areas of preserved open space.
   - o <u>Erosion & Sedimentation Control Plan</u>- Section 6.9 requires preparation and submittal of an Erosion & Sediment Plan.
   - o <u>Open Space</u> -Section 13.0 allows for a set aside of the land to be subdivided as open space.
   - o <u>Drainage</u> - Section 10.3 requires natural streams to be left in their natural state.

3. *Inland Wetlands Regulations:*
   The Inland Wetlands and Watercourses Commission of the Town of Mansfield, established in accordance with an ordinance adopted January 14, 1974, is charged with enforcing the provisions of the Inland Wetlands and Watercourses Act, Sections 22a-36 through 22a-45, inclusive, of the Connecticut General Statutes, as amended. The Inland Wetlands Commission is authorized to regulate any activity within 150 feet "measured horizontally from the boundary of any wetland or watercourse and in addition, areas at a greater distance than 150 feet from the edge of a wetland or watercourse where in the determination of the agency proposed activities are likely to impact or affect wetlands or watercourses."

b. <u>Town of Windham:</u>

The Town of Windham addresses land management policies in a variety of documents, including its Plan of Conservation and Development (2007), Open Space Plan (2001), and municipal ordinances and land use regulations. Following is a summary of land management policies that address water quality concerns.

The Town of Windham Plan of Conservation and Development (2007): The Plan of Conservation and Development addresses issues of water quality and natural resource protection, and makes recommendations to protect natural resources, to review and/or revise current zoning and subdivision regulations that are incompatible with natural resource protection, and to balance development with conservation.

Municipal Land Management Regulations:
The Town of Windham has adopted land use regulations to protect water quality and natural resources, including zoning, subdivision and inland wetland regulations. Following is a summary of land use regulations that address water quality concerns.

1. *Zoning Regulations:*
   - Flood Plain Restrictions - Section 3.13 prohibits the encroachment upon any flood plain, or other area subject to potential flooding, by filling or by buildings or other structures.
   - Aquifer Protection Zone - Section 54 establishes aquifer protection zones and defines permitted and prohibited uses.
   - Water Quality and Quantity – Section 61.8 requires "the design of stormwater drainage systems to minimize soil erosion and maximize absorption of pollutants by the soil. Runoff from impervious areas shall be attenuated to reduce peak flow volume and sediment loads to pre-development levels. Practices as outlined in the 2004 Stormwater Quality Manual of the Connecticut DEP (as updated), shall be followed (pg. 142)."
   - Soil Erosion and Sediment Control - Section 61.8 requires "the design of soil erosion and sediment control plans are such as to reduce the danger from storm water run-off, minimize non-point sediment pollution from land being developed and conserve and protect the land, water, air and other environmental resources of the Town and is consistent with the Connecticut Erosion & Sedimentation control Guidelines as updated (pg. 142)."

2. *Subdivision Regulations:*
   - Soil Sediment & Erosion Control Plan – Sections 4.1.13 and 9 require the preparation of a sediment and erosion plan utilizing techniques outlined in t the *2002 Connecticut Guidelines for Soil Erosion and Sediment Control*.

- Open Space Land Ownership and Management Plan – Section 5.12 establishes standards for the preservation of open space.
- Flexible Design subdivisions – Section 6 provides for " increased flexibility, balanced by increased control, in the development of land so as to facilitate the preservation of Open Space, natural resources, recreational uses, and rural character (pg. 29)."
- Standards for Stormwater Drainage - Section 8 establishes standards for stormwater drainage, including utilization of techniques outlined in the *2004 Connecticut Stormwater Quality Manual*, and use of Best Management Practices (BMP) and Low Impact Development (LID) techniques for stormwater management whenever possible.
- Standards for Protection of Natural Resources - Section 5.10 authorizes the Zoning Commission to modify a proposed subdivision plan prior to approval if it deems such modifications(s) necessary to protect specifically identified natural resources.

3. *Inland Wetlands Regulations:*

The Inland Wetlands and Watercourses Commission of the Town of Windham, created by Town Meeting on June 17, 1974, is charged with enforcing the provisions of the Inland Wetlands and Watercourses Act, Sections 22a-36 through 22a-45, inclusive, of the Connecticut General Statutes, as amended. The Inland Wetlands Commission is authorized to regulate any activity in:

"a) any area extending 200 horizontal feet from high water marks of the Willimantic, Natchaug, North Atlantic White Cedar Bog and/or Shetucket Rivers; and/or,

b) any area extending one-hundred (100) horizontal feet from other stream(*s)* edge(s) and/or wetland edge*(s)*.

1. any area within 100 horizontal feet of the boundary of any wetlands and watercourses as identified by a soil scientist;
2. any area within 200 horizontal feet of the Willimantic, Natchaug, North Atlantic White Cedar Bog, Natchaug, and Shetucket Rivers;
3. any area within 150 horizontal feet of the boundary of such wetlands or watercourses from any proposed subsurface waste disposal or drainage system;
4. any area within 200 horizontal feet of the boundary of a vernal body of water or as otherwise amended by State Law."

Watershed Conditions

Water Quality Standards:

The 1972 Federal Clean Water Act requires all states to designate uses for all waterbodies within their jurisdictional boundaries, and to test waters to determine if they are meeting their designated uses. The lower Natchaug River's designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. The lower Natchaug River has not been meeting its designated use for recreation due to periodic high levels of *Escherichia coli* from unknown sources.

The State of Connecticut Department of Energy and Environmental Protection Water Quality Standards (effective February 25, 2011) set water quality criteria for *E. coli* as defined in Table 3. For the purposes of this investigation, water quality data collected at the public swimming area at Lauter Park in Willimantic utilized the *Freshwater, Recreation, designated swimming* criteria of 235 colony-forming units (cfu) per 100 milliliters of water for a single sample maximum. All other sampling sites used the criteria for *Freshwater – All other recreational uses* of 576 cfu/100ml. All sites utilized the maximum sample set geometric mean of less than 126 cfu/100 ml.

Table 3: State of CT Water Quality Criteria for Indicator Bacteria for Fresh Water

DESIGNATED USE	CLASS	INDICATOR	CRITERIA
Freshwater			
Drinking Water Supply (1) Existing / Proposed	AA	Total coliform	• Monthly Moving Average less than 100/100ml • Single Sample Maximum 500/100ml
Potential	A	----	--------
Recreation (2)(3) Designated Swimming (4)	AA, A, B	*Escherichia coli*	• Geometric Mean less than 126/100ml • Single Sample Maximum 235/100ml
Non-designated Swimming (5)	AA, A, B	*Escherichia coli*	• Geometric Mean less than 126/100ml • Single Sample Maximum 410/100ml
All Other Recreational Uses	**AA, A, B**	***Escherichia coli***	• **Geometric Mean less than 126/100ml** • **Single Sample Maximum 576/100ml**

Table Notes:

(1) Criteria applies only at the drinking water supply intake structure.
(2) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23.
(3) See Standard # 25.
(4) Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protection and the Department of Public Health, May 1989, revised April 2003 and updated December 2008.
(5) Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

Available Monitoring/Resource Data:

Bacteria Data:
In 2013, ECCD collected fecal bacteria data from ten sites on the lower Natchaug River and its tributaries over an eight week period (Table 4). Several samples were also collected from two stormwater outfalls at Lauter Park, during both wet and dry conditions. In addition, water quality data from other sources was reviewed as part of this investigation, including data collected by the North Central District Health Department (NCDHD) from the public swim beach at Lauter Park from 2008 to 2013 (Appendix A), data collected by Project SEARCH program at Lauter Park from 1998 to 2001 (Appendix A), and industrial stormwater permit data reviewed by CT DEEP as part of the development of a bacteria TMDL for the Natchaug River (Appendix D). The sampling locations are displayed on Figure 10.

Bacteria levels at five of the ten sites sampled by ECCD in 2013 failed to meet Connecticut water quality standards (Figure 10). Additionally, the two stormwater outfall sites at Lauter Park that were sampled several times over the investigative period also failed to meet water quality standards. The four sampling sites on the Natchaug River and the sampling site on a small unnamed tributary draining watershed 3200-11, located on Stonegate Drive to the south of Windham Airport, met state standards for recreational contact. The five sampling sites associated with streams in the Sawmill Brook watershed failed to meet established water quality standards (Figure 11).

During bacteria sampling, volunteers recorded the weather for the past three days on the field form. The bacteria results were plotted against rainfall for the months of July and August (Figure 12). It was noted that bacteria levels spiked during and immediately after periods of rainfall, and that during dry periods, bacteria levels were generally low, indicating that stormwater flow most likely contributes to the majority of pollutant loading to the Natchaug River and tributaries.

Water samples collected by North Central District Health Department for bacteria analysis at the Lauter Park swimming area from 2008 to 2013 met the geometric mean of less than 126 cfu/100 ml for designated swimming areas (Table 5). Two samples (240 cfu/100 ml collected on 6/30/09 and 1700 cfu/100ml collected on 7/19/12) exceeded the single sample limit of 235 cfu/100 ml. It was noted that the 7/19/12 sample was collected during a light rainfall. It was not noted if the 2009 sample was collected under wet or dry conditions.

Project Search collected four water samples from the Natchaug River at Lauter Park approximately 300 feet upstream of the swimming area from 1998 to 2001. The individual samples and the geometric mean of applicable sample sets met the State of Connecticut water quality criteria for indicator bacteria for freshwater for recreation

(Table 5), with the exception of a sample collected on 10/5/1999, which at 310 cfu/100 ml, exceeded the single sample limit of 235 colonies/100 ml.

Table 4. ECCD Lower Natchaug River Bacteria Data Summary

Sampling Site	Site Description	06/11/13	06/18/13	06/25/13	07/02/13	07/09/13	07/16/13	07/23/13	07/30/13	geomean	Reduction Needed
NR01	Natchaug River US of WWTP	**730**	60	31	50	110	41	330	61	94	0
NR02	Natchaug River @ Willowbrook Rd	**680**	10	63	40	31	63	460	63	77	0
NR03[1]	Natchaug River @ Lauter Park	**1400**	80	10	20	52	41	**250**	120	78	0
NR04	Natchaug River DS of WWW	**490**	30	10	10	<10	31	<10	20	26	0
SMB01	Sawmill Brook DS of So. Frontage Rd	**6900**	100	85	200	160	130	**1700**	270	**439**	**71**
SMB02	Sawmill Brook DS of No. Frontage Rd	**5300**	90	190	200	160	120	**3300**	130	**319**	**61**
CB01	Conantville Brook @ No. Frontage Rd	**6900**	90	**1200**	220	220	150	**4400**	41	**420**	**70**
CB02	Conantville Brook US of Sunny Acres Park	**8700**	350	450	150	470	350	**7700**	290	**637**	**80**
UN3208-03	unnamed tributary DS of Meadowbrook Rd	**2600**	350	210	210	320	310	**4400**	470	**498**	**75**
UN3200-11	unnamed tributary US of Stonegate Drive	**750**	20	10	40	31	30	190	63	68	0
NR03-sw pond	Lauter Park - outfall of sm pond US of beach	230							110	**159**	**21**
NR03-outfal	Lauter Park - outfall near skateboard park				60		20	**5500**		**188**	**33**
Wet/Dry		Wet	Wet	Wet	Dry	Dry	Dry	Wet	Dry		

[1] NR03 utilized the *Freshwater, Recreation, designated swimming* criteria of 235 colony-forming units (cfu) per 100 milliliters of water for a single sample maximum. All other sampling sites used the criteria for *Freshwater – All other recreational uses* of 576 cfu/100ml.

Bold denotes sample exceeded established indicator bacteria criteria for that site.

Streamwalk Data:
ECCD staff members and trained volunteers conducted Streamwalks in September and October of 2013, utilizing a stream corridor assessment protocol developed by the USDA Natural Resource Conservation Service. Stream corridor data, including the type and extent of riparian vegetation, land use adjacent to the stream, the presence, absence and/or extent of conditions (called areas of concern) such as impacted riparian buffers, stream bank erosion, stormwater outfalls, modified stream channels, algae, visual water conditions, fish passage barriers, and trash, were documented on field forms developed by NRCS. Photographs and GPS (global positioning system) locations, or waypoints, were taken of the noted conditions. The GPS data was downloaded into a geographic information system (GIS) data layer for analysis. The streamwalk field data was tabulated and evaluated by ECCD, in order to identify and prioritize areas where watershed management implementation practices would be most beneficial.

Streamwalks were conducted on approximately 11 stream miles along the lower Natchaug River and its perennial tributaries (Figure 13). Only those tributary streams that exhibited high bacteria levels during the bacteria data collection phase of this project were evaluated. The streamwalk data, including field notations, GPS data and digital photographs, was processed and compiled into a database. The documented areas of concern are quantified by stream in Table 5. The locations of the Areas of Concern are displayed by type in Figure 14. Descriptions of each Area of Concern are provided in Appendix B. Areas of Concern are depicted on reach-level maps in Appendix C. The stream corridor assessment was funded through the Small Watershed Assistance Grant program of the Rivers Alliance of Connecticut, from US EPA Clean Water Act §319 NPS program funding, administered by CT DEEP.

Table 5: Locations and number of Areas of Concern identified during the lower Natchaug River Streamwalks.

Area of Concern	Natchaug River	Sawmill Brook	Conantville Brook	Unnamed Tributary 3208-03	Total
Stormwater Outfall	12	22	9	5	48
Degraded Buffer	10	4	6	1	21
Erosion	5	2	6	2	15
Modified Channel	5	1	3	1	10
Trash/Debris	8	3	2	1	14
Visual Water Conditions	4	0	12	0	16
Fish Barrier	1	4	3	4	12

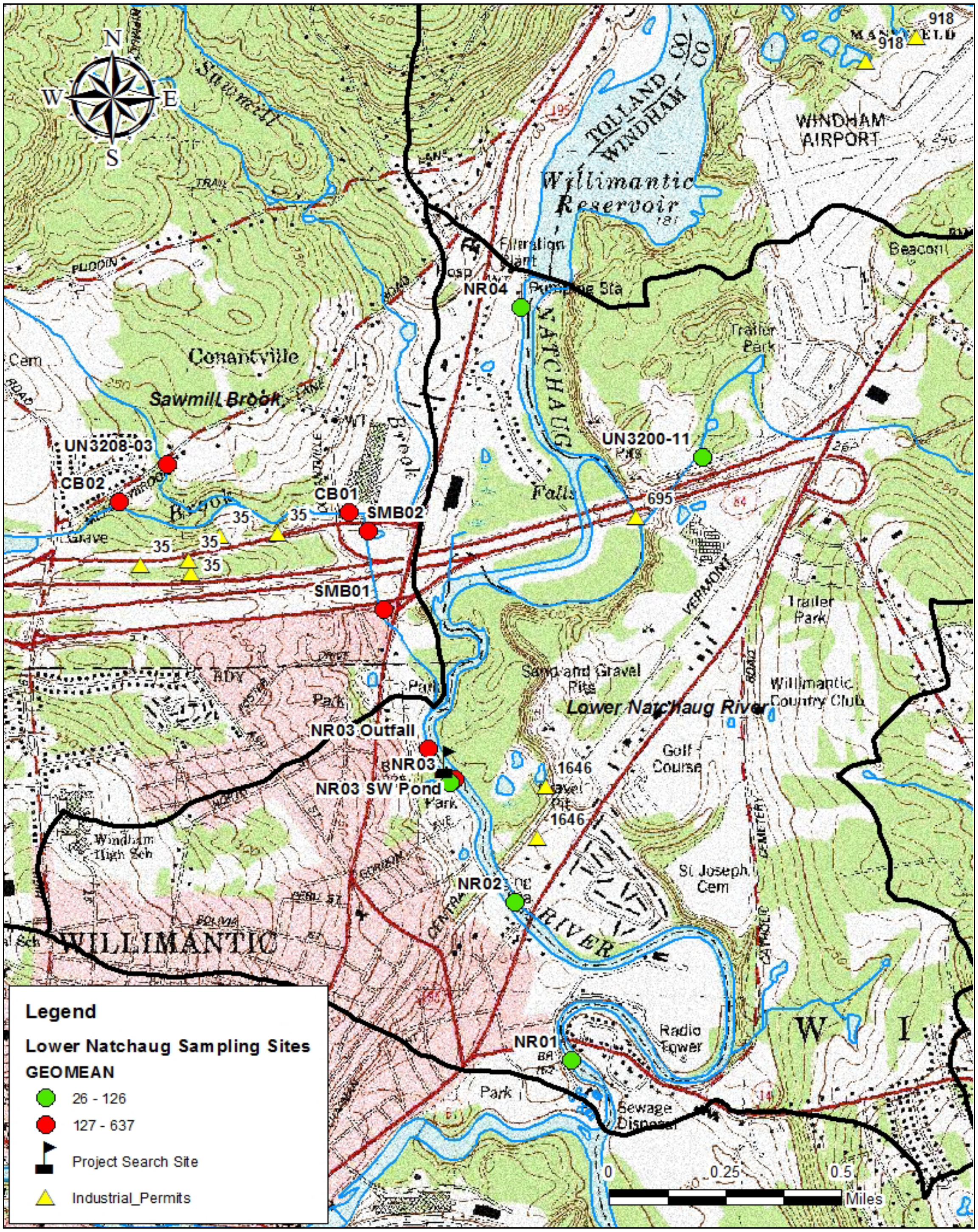


Figure 10: The lower Natchaug River Bacteria Sampling Locations. Sites indicated by a green dot met Connecticut water quality standards, while sites indicated by a red dot failed to meet established water quality standards.

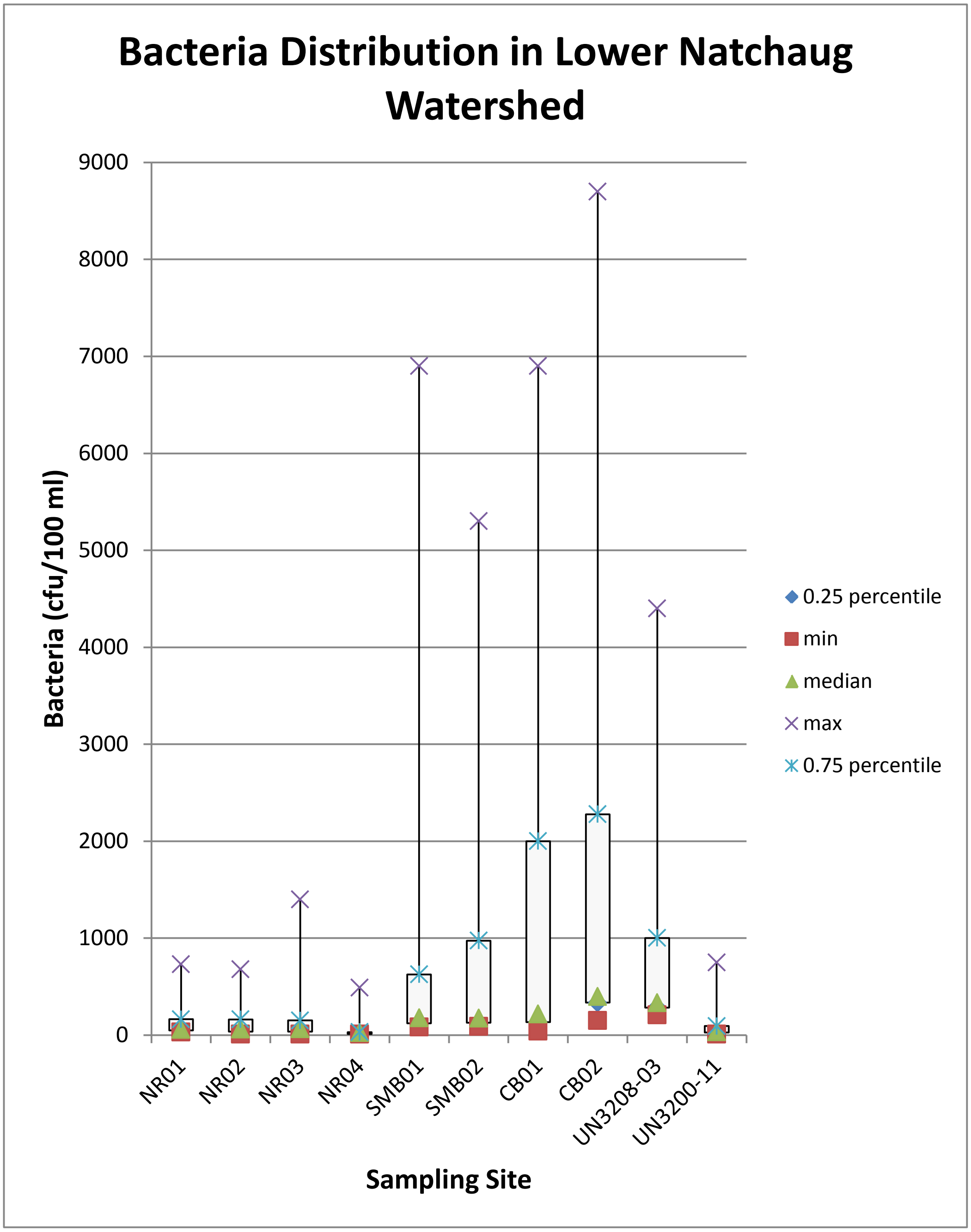


Figure 11: Distribution of bacteria sample results by sampling site.

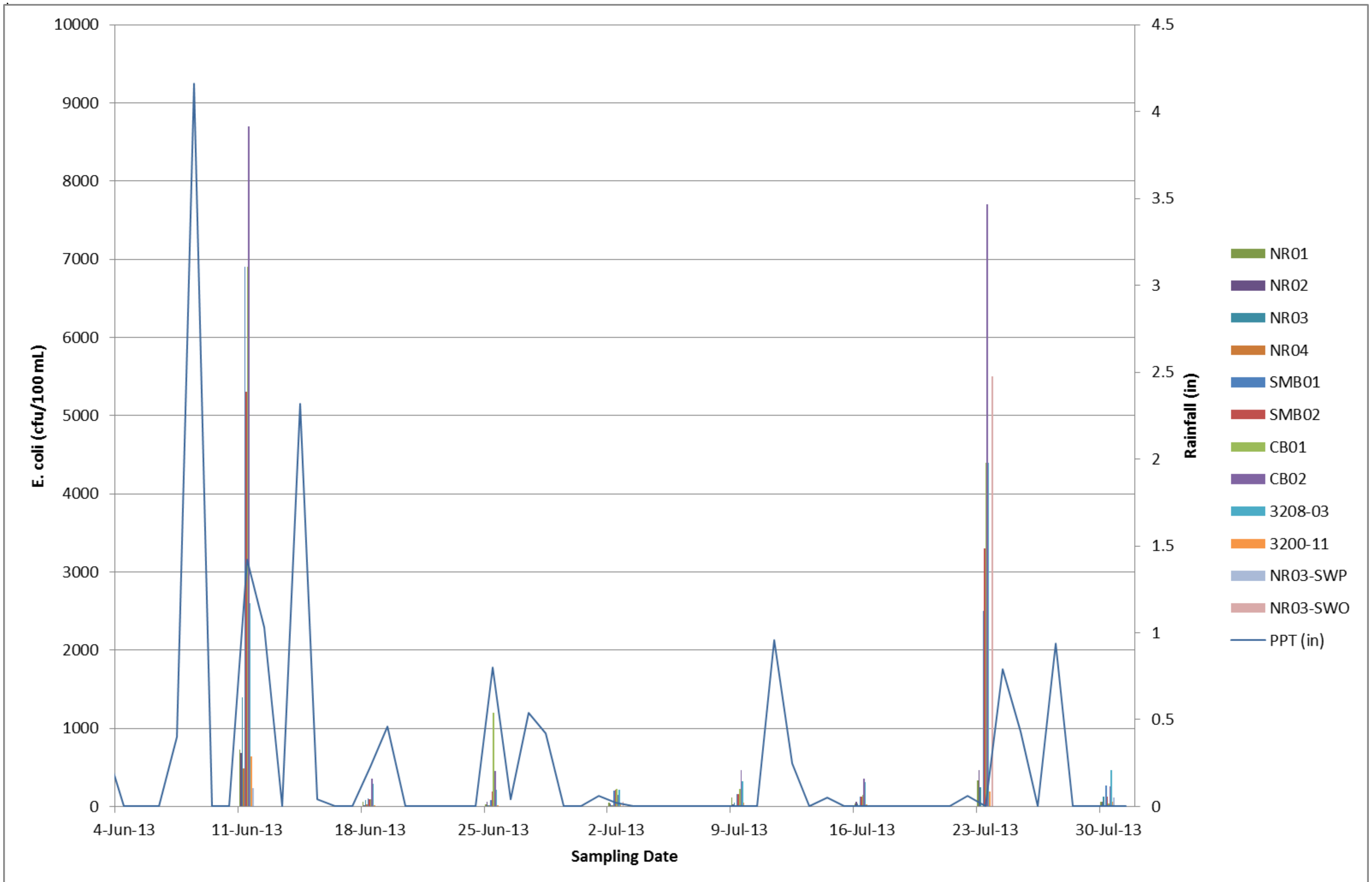


Figure 12: Stream sample bacteria levels plotted against rainfall.

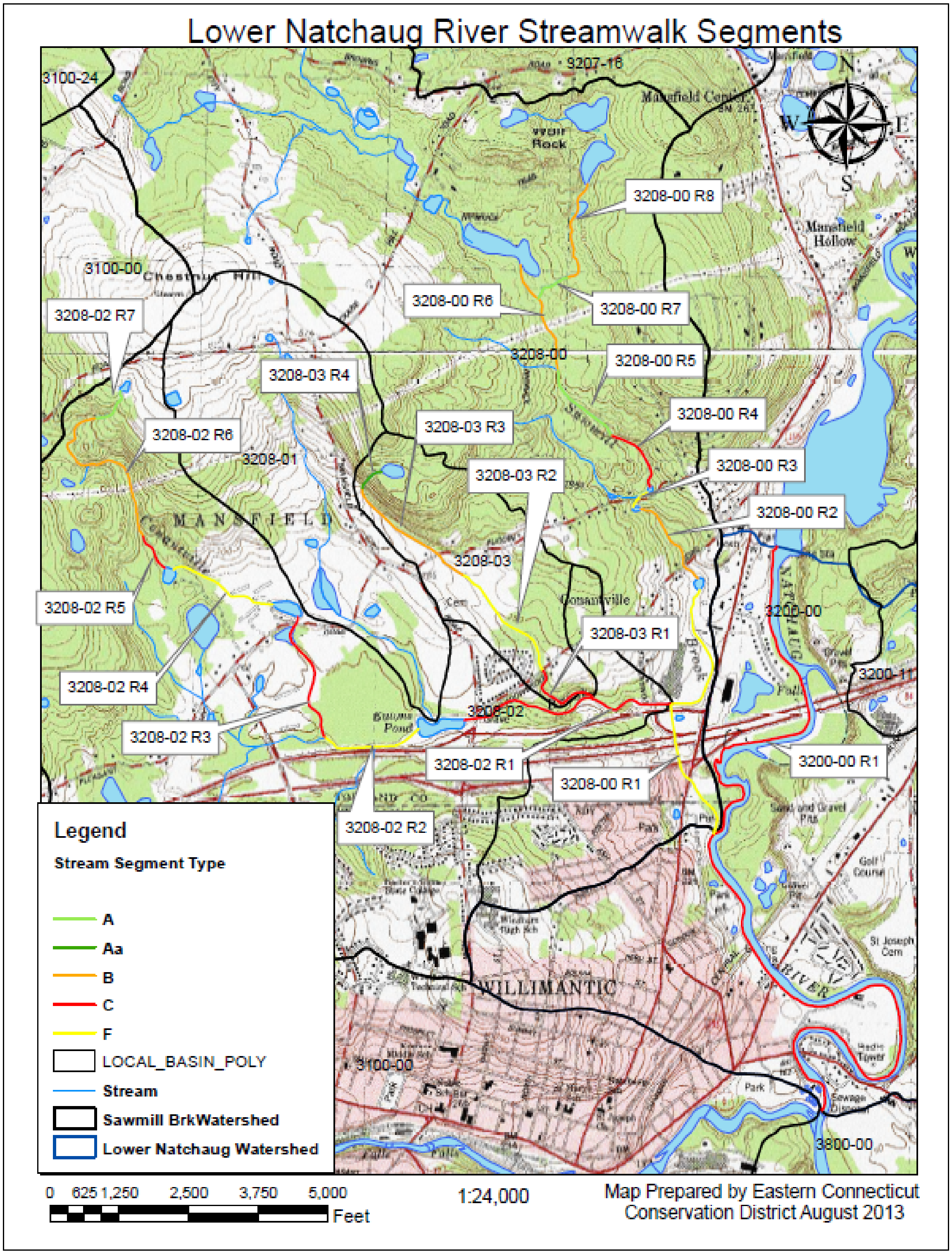


Figure 13: Streamwalk segments and stream types of lower Natchaug River and tributaries, Mansfield and Windham, CT.

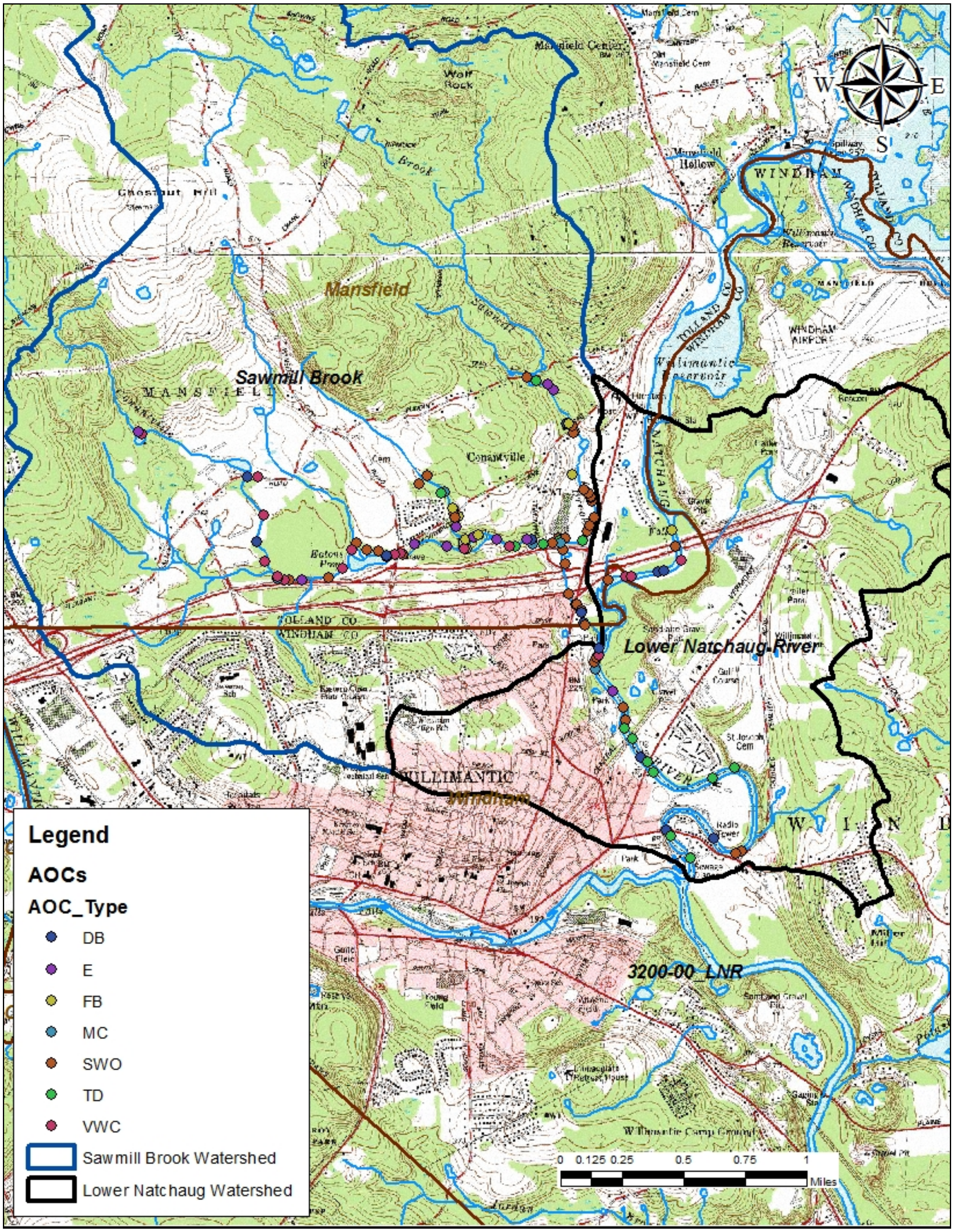


Figure 14: Locations of Areas of Concern identified during Streamwalks.

Abbreviated Watershed-Based Plan for the Lower Natchaug River

A. Identification of Pollutant Causes and Sources

The Eastern Connecticut Conservation District (ECCD) and volunteers conducted a track down survey in the lower Natchaug River watershed in Mansfield and Windham, Connecticut in 2013 to identify potential sources of nonpoint source pollution that have contributed to the degradation of water quality in the lower Natchaug River (Table 6). The lower Natchaug River has been listed in numerous recent State of Connecticut 303d reports as impaired for recreation due to periodic elevated levels of *Escherichia coli*. As part of the trackdown, ECCD and volunteers collected water samples for fecal bacteria analysis from multiple sites on the lower Natchaug River and its tributaries. ECCD reviewed water quality data collected by the North Central District Health Department (NCDHD) at the public swim beach at Lauter Park from 2008 to 2013, and data collected by the Project SEARCH program at Lauter Park from 1998 to 2001. The Project SEARCH data was used to develop a bacteria Total Maximum Daily Load (TMDL) for the Natchaug River (CT DEEP, 2012). Based on that data, CT DEEP proposed a bacteria reduction of 24% at Lauter Park to meet the statewide bacteria TMDL.

Table 6: Possible Sources of Fecal Bacteria and Other NPS Contaminants to the lower Natchaug River.

Possible Source	Location	Number of Occurrences
Urban Runoff/ Stormwater Outfalls	Watershed-wide	44% IC in lower Natchaug River watershed/ 48 outfalls
Sewers/Septic Systems	Watershed-wide	Sewer system inspection and repair; 17 septic system failures/repairs in Mansfield and 1 septic system failure/repair in Windham between 2010 and 2013
Pets	Watershed -wide	1651 dogs licensed in Mansfield/ 998 dogs licensed in WIndham
Nuisance Wildlife/Waterfowl	Sawmill Brook watershed	~59% of watershed undeveloped; 1000+ migratory Canada geese (seasonal)
Agriculture/Livestock	Sawmill Brook watershed	2 commercial farms, multiple private farms
Degraded Buffer	Watershed-wide	21
Stream Bank Erosion	Multiple locations	15
Trash/Debris	Multiple locations	14
Gravel Mining	Boston Post Road	1
Atmospheric Deposition	Watershed-wide	Unknown

While the primary purpose of the lower Natchaug River track down survey was to identify possible sources of indicator bacteria that have impaired the lower Natchaug River for recreational contact, ECCD and volunteers also conducted stream corridor assessments of the lower Natchaug River and perennial tributaries to document conditions that might contribute to nonpoint source (NPS) pollution to the lower Natchaug River, including stormwater outfalls, degraded riparian buffers, stream bank erosion, trash and visual water conditions. Possible sources of indicator bacteria and other NPS contaminants to the lower Natchaug River are listed in Table 7.

1. Potential Sources of Fecal Coliform Bacteria and Nonpoint Source Pollution (NPS) in the lower Natchaug River Watershed:

Urban Runoff/Stormwater Systems:

Numerous studies, including those conducted by Schueler (1994) have established that the amount of impervious cover in a watershed directly impacts stream quality (Figure 15). In 2007, Roy Schiff and Gaboury Benoit published data from a study of the West River in New Haven, CT. Their study showed that water quality declined when total impervious area exceeded 5%. A 2008 study conducted by CT DEEP indicated that water quality declined when impervious cover exceeded 6% (Bellucci, Beauchene and Becker, 2008). Approximately 44% of the lower Natchaug River watershed is developed, exceeding the recommended impervious cover of 10% or less for good stream quality. Developed areas are located along main transportation corridors, including Routes 6 and 195, which have significant commercial and high density residential development, and extend into downtown Willimantic. Approximately 19% of Sawmill Brook watershed is developed, also exceeding recommendations for impervious cover.

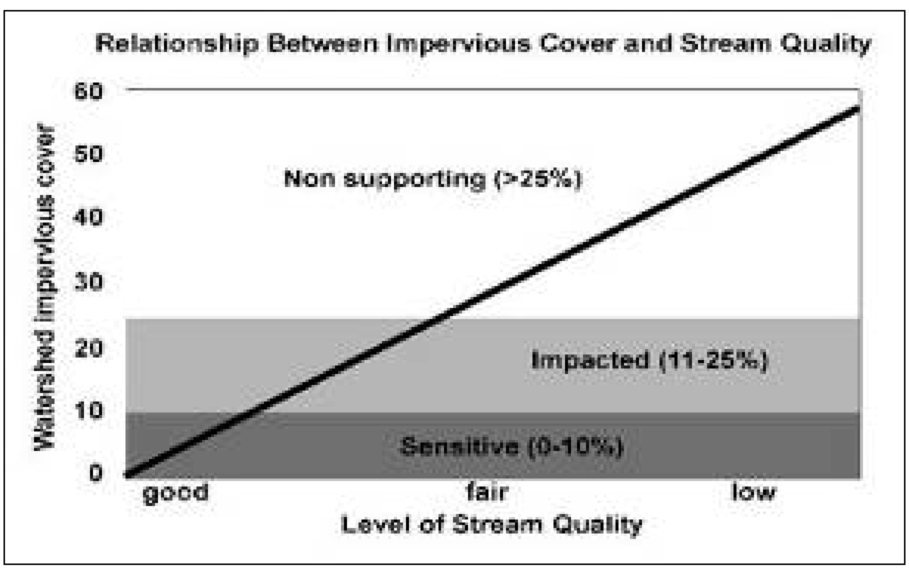


Figure 15: Relationship between impervious cover and stream Quality (Schueler, 1994).

Forty-eight stormwater outfalls were identified during the Streamwalk survey, including pipe outfalls, leak offs and catch basins placed directly over, and discharging to, stream channels. These outfalls discharge untreated stormwater directly into the receiving streams. In areas of urban development, these outfalls can contribute multiple pollutants to the Natchaug River, including bacteria, nutrients from pets and lawn care products, trash and debris, and oils, greases and other chemicals from vehicles. Traditional storm drain systems may be a significant source of fecal bacterial loading, either via the transmission of contaminated surface stormwater runoff to the receiving waterbody, or by loading of bacteria originating in the storm drain. Recent studies have indicated that *E. Coli* and other fecal coliform bacteria, once introduced into the environment, can survive and proliferate in the biofilm (scum) layer that forms in storm drain pipes (Skinner *et al*, 2010).

<u>Sewers/Septic Systems:</u> Fecal bacteria loading can occur as a result of undetected leaks in the municipal sewer systems or as a result of malfunctioning or under-functioning septic systems. Much of the Willimantic section of Windham is sewered, as are densely developed areas in Mansfield north of the Route 6 corridor (Figure 16). Sewer lines are owned and maintained by the Windham Water Pollution Control Authority (WWPCA). Sewer lines in Mansfield date from the 1970s, and from the 1950s in Windham. Sewer lines are cleaned every year, and are inspected using cameras every two years. Additional information regarding sewer line maintenance and repairs can be obtained from the WWPCA.

Properties that are not sewered have individual subsurface sewage treatment systems (septic systems), which are regulated by local public health districts. Property owners are encouraged to maintain their systems through best management practices, including regular tank pumping and system inspections. There is no regulatory mechanism in place to require or enforce septic system maintenance and inspections.

Eighteen septic system repairs in the project area were documented by the Eastern Highlands Health District (Mansfield) and North Central District Health Department (Windham) between 2010 and 2013. Septic system failures can release untreated effluent containing both nutrients and fecal bacteria into groundwater, which can then be conveyed to nearby waterbodies. Septic system functionality can be affected by limitations including soil suitability, depth to groundwater, and depth to bedrock. Figure 17 depicts the septic suitability of soils in the lower Natchaug River and Sawmill Brook watersheds. In general, soils appear to be well suited for septic systems.

<u>Pets/Nuisance Wildlife/Waterfowl:</u> In urban settings, pet feces, particularly dog feces, can be a significant source of bacteria. A study conducted by the University of Nevada Cooperative Extension (Walker and Garfield, 2008) determined that one gram of fresh dog feces contained an average of 50 million colony forming units (CFU) of E. coli

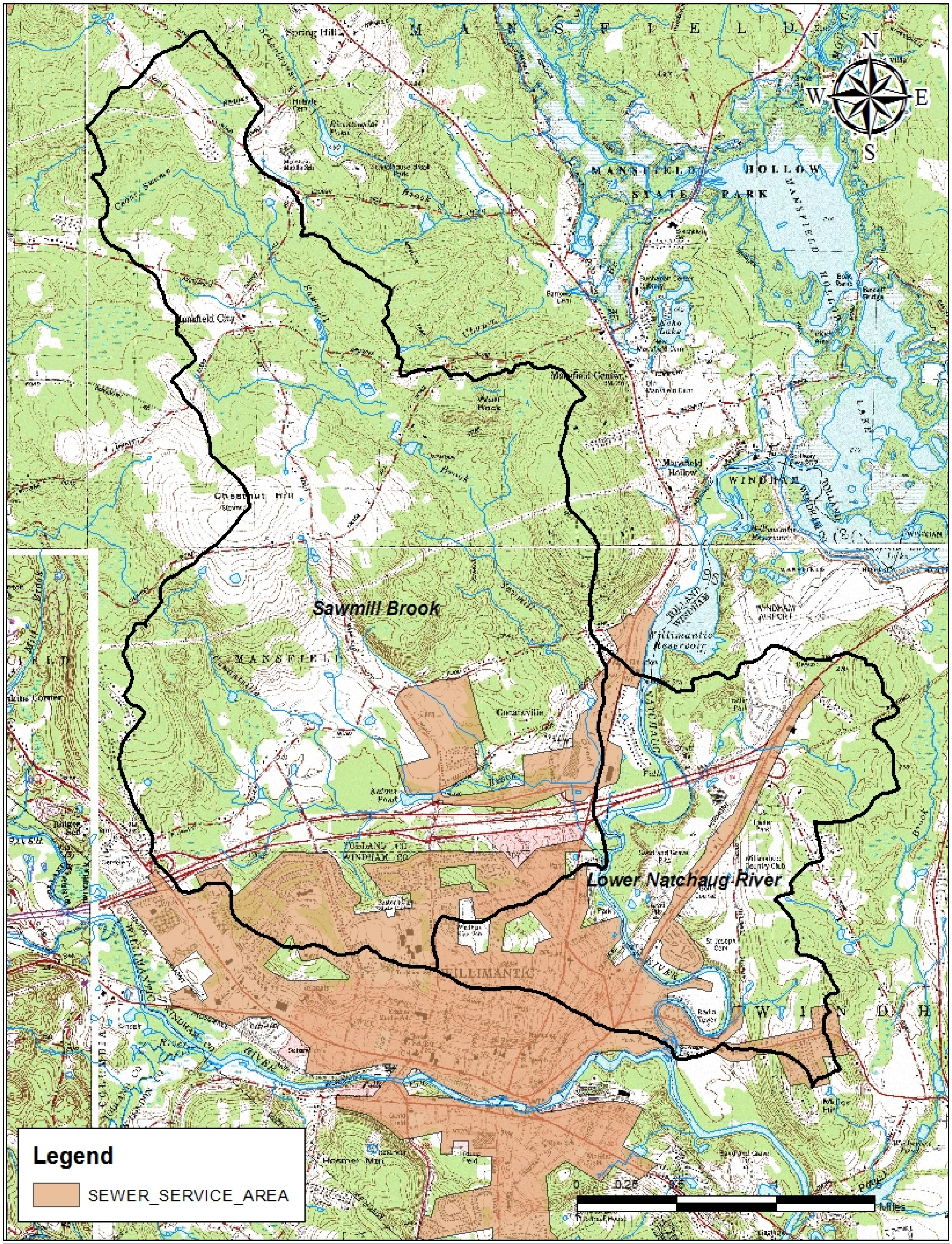


Figure 16: Sewer service area in Mansfield and Windham (CT DEEP 2013).

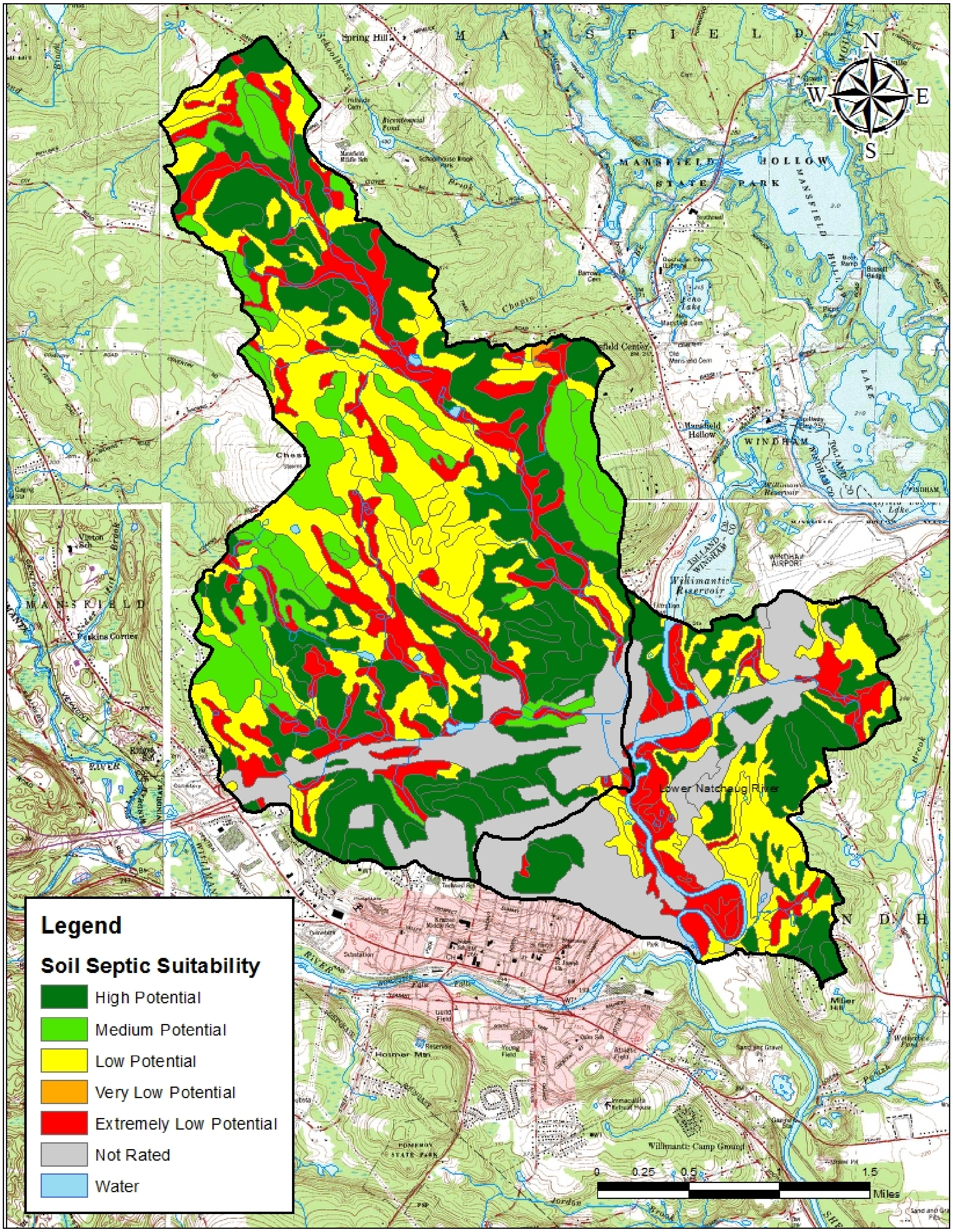


Figure 17: Septic Suitability of soils in the lower Natchaug River and Sawmill Brook watersheds (USDA-NRCS Web Soil Survey).

bacteria. In 2013, 1651 dogs were licensed in Mansfield (37.5 dogs per square mile), and 998 dogs were licensed in Windham (37 dogs per square mile). However, during the watershed investigation, few dogs were noted. No areas in the lower Natchaug River watershed, such as dog parks, where dog populations might be concentrated, were identified.

In undeveloped watersheds, wildlife can contribute significantly to bacteria loading. Approximately 59% of the Sawmill Brook watershed is undeveloped. CT DEEP conservatively estimates the population of whitetail deer in northeast Connecticut to be an average of 28 animals per square mile (Howard Kilpatrick, personal communication, March 11, 2014), contributing, along with other wildlife, to "background" or natural levels of bacteria found in the watershed.

No estimates of Canada geese flock size were made during the bacteria trackdown. Resident Canada geese were not reported to be a problem at Lauter Park, however resident Canada geese were reported to travel between Windham Airport, the Willimantic Country Club and Willimantic Reservoir, and possibly elsewhere in the watershed, including the agricultural areas in the Sawmill Brook watershed. A flock of approximately 15-20 birds was noted foraging in mowed corn fields in the vicinity of Pleasant Valley Road in Mansfield during the water quality investigation. Water managers from Windham Water Works reported that extremely large flocks of migratory Canada geese use the Willimantic Reservoir and Mansfield Hollow Lake during spring and fall migrations. Large flocks of resident geese can contribute significantly to bacteria loading, and migratory geese can produce seasonal plugs of fecal bacteria, temporarily inflating bacteria levels in watercourses. According to a study conducted by Alderisio and DeLuca (1999), the "average [wet] weights ranged from 5.85 to 9.98 grams, depending on the season. Fecal coliform bacteria contents (probably mostly Escherichia coli) averaged from 4,500 to 24,200,000 colony-forming units per gram of feces, depending on the season and year of observation." However, since bacteria sampling for this project was conducted outside of the bird migration period, no elevated bacteria levels were noted in the Natchaug River that could be associated with migratory waterfowl.

Agriculture/Livestock: There was no agricultural activity observed in the lower Natchaug River watershed, however there was a significant amount of agriculture in the Sawmill Brook watershed. Observed agricultural activity included two commercial farms and several small private farms. Also observed were numerous corn and hay fields. Manure from livestock can contribute to both bacteria and nutrient loading to local waterbodies, as can application of manure and fertilizer to crop fields. Lack of adequate stormwater management practices and access by livestock to streams and ponds in pastures can also contribute to both nutrient and bacteria loading.

Degraded Riparian Buffers: Twenty-one instances of degraded riparian buffers were noted during the Streamwalk surveys. Degraded riparian buffers included areas with minimal buffer width, minimal riparian vegetation, the presence of invasive plant species, and livestock access to streams. Degradation reduces the capacity of the buffer vegetation to slow stormwater run-off and absorb any nutrients or contaminants contained in the run-off. The presence of invasive plants within riparian buffers diminishes buffer quality. The presence of livestock within the riparian buffer increases degradation through grazing which can reduce plant biomass, stream bank erosion, and introduction of animal waste into the waterbody.

Stream Bank Erosion: Fifteen instances of stream bank erosion were noted along the lower Natchaug River and its perennial tributaries. Stream bank erosion delivers sediment to the stream, and ultimately to the receiving waterbody, along with any nutrients or contaminants that may be adsorbed to the eroded sediments. Re-deposited sediments can degrade the stream substrate, damaging in-stream habitat for aquatic species. Stream bank erosion is often associated with degraded buffer conditions, especially in instances of vegetation removal. Stream bank erosion can be especially prevalent in urbanized areas such as Willimantic, where large areas of impervious surfaces increase stormwater volume.

Trash/Debris: Fourteen instances of trash and debris deposited in streams or riparian corridors were observed during Streamwalks. In some instances, the debris appeared to be windblown or waterborne, and could have been the result of recent flood events. In other instances, materials, including bicycles and shopping carts, appeared to have been deliberately placed. Trash and debris have the capacity to introduce a number of pollutants into the lower Natchaug River, including bacteria, particularly if it contains human or animal fecal waste.

Gravel Mining: There is one gravel operation to the east of the Natchaug River on Boston Post Road in Windham. Mining activities, while not necessarily significant sources of bacteria, can contribute to water quality degradation by opening up large tracts of land to erosion and introducing the possibility of chemical spillage from mining equipment.

Atmospheric Deposition: Atmospheric deposition is not a known source of *E. coli*, though it could be a source of other contaminants, including atmospheric nitrogen and other airborne particulates.

2. Potential Sources of Habitat Degradation:

Fish Barriers: Twelve fish barriers were noted during the Streamwalk of the lower Natchaug River and tributaries, including natural and man-made dams. While fish barriers do not contribute to nonpoint source pollution, they do inhibit the passage of fish and other aquatic species up and downstream, can result in the degradation of habitat, and the fragmentation and isolation of the populations of fish and other aquatic species.

Modified Channel: Ten modified channels were noted during the Streamwalk, including channelization associated with dams, and channelization as part of residential landscaping schemes. Stream channelization can contribute to NPS pollution by increasing storm flow velocities, which can result in bank erosion, channel scouring and downstream deposition, degrading water quality and in-stream habitat.

Visual Water Conditions: Sixteen instances of visual water conditions were noted. While visual water conditions are not contributors to water quality degradation, they can be visual indicators that conditions exist that are causing water quality degradation. Orange flocculent associated with iron bacteria was observed in several locations along the lower Natchaug River near Route 6 and in Conantville Brook. "Oily" deposits associated with iron bacteria were also noted on the water surface in many areas. Much of Conantville Brook exhibited a milky, cloudy appearance. Several areas with either excessive plant growth within the stream channel or the presence of unmanaged invasive species, particularly common reed (*Phragmites australis*), were noted.

3. Potential Point Sources:

Potential point sources can include National Pollutant Discharge Elimination System (NPDES) permits, Phase I and ll Municipal Stormwater permits, Construction Stormwater General permits, and confined animal feeding operation (CAFO) permits. Commercial enterprises, particularly shopping malls, may be subject to the Commercial Stormwater General permit, which applies to discharges from any stormwater system that collects and conveys stormwater and is directly related to retail, commercial, and/or office services whose facilities occupy *five acres or more* of contiguous impervious surface. A review of existing CT DEEP and US EPA data indicated that four NPDES Industrial Stormwater Permits have been issued in the lower Natchaug River watershed (Table 7). The Towns of Mansfield and Windham do not currently participate in the Municipal Separate Storm Sewer System (MS4) program, since neither is in a designated urban area (UA) as defined by the US Census Bureau. The Willimantic area is defined as an Urban Cluster (UC), a designation that was created in 2000 by the US Census Bureau to supplement UA blocks of land (an Urban Cluster is defined as a densely settled area that has a census population of 2500 to 49,999). Urban Clusters are not currently regulated by the CT DEEP MS4 permit program. There are no CAFOs located in the lower Natchaug River watershed.

4. Hazardous Waste/Brownfields:

There are multiple sites in the lower Natchaug River and Sawmill Brook watersheds listed on the CT DEEP *List of Contaminated or Potentially Contaminated Sites* (as defined by §22a-134f of the Connecticut General Statutes). There are six sites associated with leaking underground storage tanks in Mansfield. Remediation on five sites is complete, and is underway on the sixth. There are seventy listed sites in Windham. Sixty-three of the sites are associated with leaking underground storage tanks. Remediation on all but seven has been completed. Three sites are associated with hazardous waste disposal. Two are designated as Superfund sites, including the Windham Municipal Dump. The remaining listed sites are associated with property transfers.

The Connecticut Brownfields Redevelopment Authority (CBRA) maintains a town- by-town brownfields inventory that can be found on the CT DEEP brownfields portal (http://www.ct.gov/deep/cwp/view.asp?A=2715&Q=324930), along with additional information regarding brownfields redevelopment. A brownfield is defined by Connecticut General Statutes §32-9kk(a)(1) as "any abandoned or underutilized site where redevelopment, reuse or expansion has not occurred due to the presence or potential presence of pollution in the buildings, soil or groundwater that requires investigation or remediation before or in conjunction with the restoration, redevelopment, reuse and expansion of the property." There are no identified brownfields listed in the lower Natchaug River or Sawmill Brook watersheds.

Table 7: CT DEEP Industrial Stormwater Permits in the lower Natchaug River and Sawmill Brook watersheds.

Site Town	Site Name and Street Address	Client	Permit Number	Permit Type	Authorization Date
North Windham	Builders Concrete East, LLC., 79 Boston Post Road	Builders Concrete East, LLC.	GSI001646	Stormwater Associated with Industrial Activities	2/20/2013
North Windham	United Abrasives Inc., 185 Boston Post Road	United Abrasives Inc.	GSI000695	Stormwater Associated with Industrial Activities	10/1/2011
North Windham	Windham Airport, 15 Airport Road	CT Airport Authority	GSI000918	Stormwater Associated with Industrial Activities	8/24/2013
North Windham	Windham Airport, 15 Airport Road	CT Department of Transportation	GSI000918	Stormwater Associated with Industrial Activities	10/1/2011
Mansfield	Mansfield Maintenance Facility	CT Department of Transportation	GSI000035	Stormwater Associated with Industrial Activities	10/1/2011

B. Load Reduction Assessment

1. Estimation of Pollutant Load Reductions

One of the primary goals of this watershed plan is to estimate load reductions of pollutants known to be impairing water quality in the lower Natchaug River. *E. coli* load reductions are proposed in Table 8, based on the results of bacteria sampling conducted by ECCD and volunteers in 2013. ECCD utilized this data in lieu of data collected by Project Search from 1998-2001. Although the Project Search data was used to develop a bacteria TMDL for the lower Natchaug River, ECCD utilized the 2013 data because it is more recent, provides multiple samples per site over an extended sampling period and geographic area, and is more representative of varying water conditions within the watershed as a whole. The State of Connecticut bacteria TMDL for the lower Natchaug River recommends a single sample bacteria reduction of 24%. Based on data collected by ECCD in 2013, the geometric means of the four sampling sites on the Natchaug River, including one site at the Lauter Park swimming area, indicated that the Natchaug River meets Connecticut water quality standards for designated swimming areas (Table 8). However, the data also indicates that Sawmill Brook, a tributary to the Natchaug River, Conantville Brook, and an unnamed tributary to Conantville Brook (UN3208-03) do not meet Connecticut water quality standards for recreational use.

Table 8: Bacteria Reduction Targets for the lower Natchaug River and tributaries.

Sampling Site	Site Description	geomean	% of limit	% Reduction Needed
NR01	Natchaug River US of Windham Water Treatment Plant	94	75	0
NR02	Natchaug River @ Willowbrook Rd	77	61	0
NR03	Natchaug River @ Lauter Park	78	62	0
NR04	Natchaug River DS of Windham Water Works	26	21	0
SMB01	Sawmill Brook DS of South Frontage Rd	439	348	**71**
SMB02	Sawmill Brook DS of North Frontage Rd	319	253	**61**
CB01	Conantville Brook @ North Frontage Rd	420	333	**70**
CB02	Conantville Brook US of Sunny Acres Park	637	506	**80**
UN3208-03	unnamed tributary DS of Meadowbrook Rd	498	395	**75**
UN3200-11	unnamed tributary US of Stonegate Drive	68	54	0

2. Load Reduction Estimates for Nonpoint Source Pollutants

While E. coli is the primary pollutant of concern as the cause of the existing water quality impairment to the lower Natchaug River, it is important to evaluate other pollutants that may degrade water quality as well. To estimate loads and load reductions, EPA recommends the use of models which have been developed for these purposes. In the absence of available pollutant data, ECCD selected the Simple Method (Schueler, 1987) to estimate pollutant loads and load reductions in the lower Natchaug River watershed:

$L = 0.226(P)(P_j)(R_v)(C)(A)$, where:

L = pollutant loading in pounds per year
P = annual precipitation in inches
P_j = the fraction of annual rainfall that does not produce measurable runoff
R_v = runoff coefficient
C = pollutant concentration in mg/l
A = site area in acres
0.226 = conversion factor

The Simple Method calculates pollutant loading in pounds per year, based on watershed drainage area, impervious cover, annual precipitation and storm water runoff pollutant concentrations associated with specific land cover types. In order to calculate pollutant load reductions, a pre-developed watershed load was calculated, using a forested condition as a typical pre-development land cover for Connecticut. No net gain of wetlands was assumed, and an impervious cover of 1% was used to represent ledge and naturally barren land.

Pollutant load contributions for various land use/land covers were gleaned from several sources including the National Stormwater Quality Database (Maestre & Pitt, 2005), the National Urban Runoff Program (EPA, 1993) and the University of New Hampshire Stormwater Center (Table 9). Pollutant load concentrations for seven common pollutants associated with Non-Point Source pollution, including total suspended solids (TSS), total phosphorous (TP), total nitrogen (TN), zinc (Zn) as an indicator for other metals, total petroleum hydrocarbons (TPH), and dissolved inorganic nitrogen (DIN), as an indicator of industrial, municipal and agricultural waste, were calculated.

In order to better isolate pollutant loading, Sawmill Brook and the lower Natchaug River watersheds were divided into sub-watersheds. The sub-watersheds are depicted in Figure 18. Pollutant load reductions for the two watersheds investigated for this project are depicted in Table 10. Pollutant loads for each sub-watershed are depicted in Table 11.

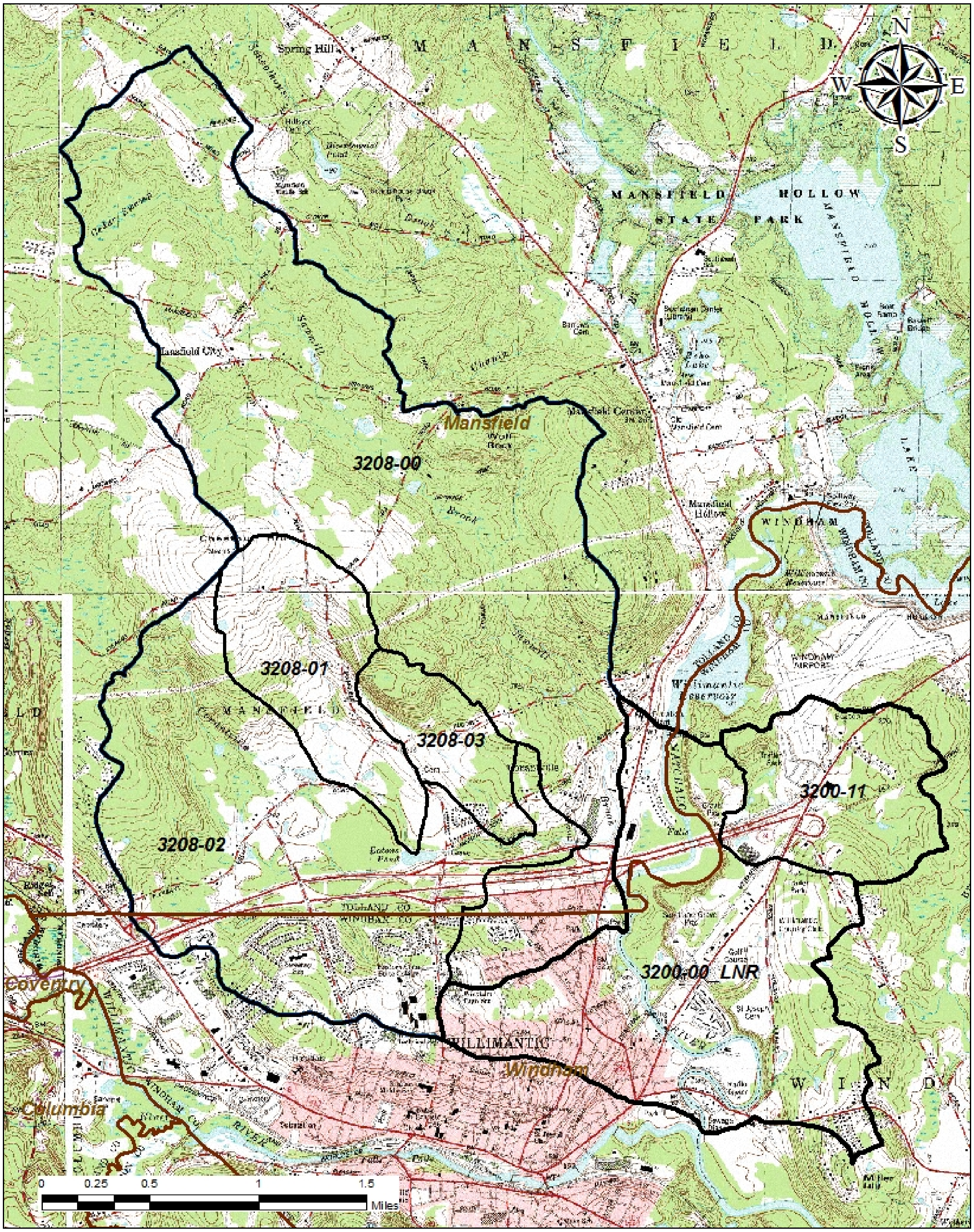


Figure 18: Local watersheds delineated for pollutant loading calculations.

Table 9: Pollutant Load Contribution "C" for each Type of Land Use/Land Cover (pollutant concentration contained in runoff mg/l)

Land use/Land cover	TSS	TP	TN	Zn	TPH	DIN
Low Density Residential	60	0.38	2.1	0.16	0.5	0.51
Medium Density Residential	60	0.3	2.1	0.18	1.25	0.344
High Density Residential	60	0.3	2.1	0.22	1.5	0.344
Commercial Development	58	0.25	2.6	0.15	3	0.324
Industrial Development	50	0.23	2.1	0.17	3	0.324
Institutional Development	58	0.27	2.1	0.67	3	0.521
Transportation	99	0.25	2.3	0.15	3	0.375
Turf and Grass	357	1	2.92	0	0	0.215
Pasture	145	0.38	2.2	0	0	0.65
Forest	90	0.1	1.5	0	0	0.215
Wetlands	0	0.38	1.5	0	0	0
Bare Ground	1000	0.38	1.5	0	0	0
Sources: 1) National Stormwater Quality Database (NSQD), v. 1.1-9/4/05 by Maestre &Pitt						
2) National Urban Runoff Program (NURP), 1983						
3) University of New Hampshire Stormwater Center, 2005-2012						

Table 10: Pollutant Load Reductions Required to Meet Water Quality Standards in the lower Natchaug and Sawmill Brook Watersheds.

Lower Natchaug Watershed	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Current Pollutant Loads (lbs/yr)	1,305,731	3,105	16,388	555	5,532	2,344
Pre-developed Watershed Loads	342,420	423	5430	0	0	732
% Load Reduction Required	**74%**	**86%**	**67%**	**100%**	**100%**	**69%**

Sawmill Brook Watershed	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Current Pollutant Loads (lbs/yr)	1,215,790	2,652	19,281	442	3,910	3,306
Pre-developed Watershed Loads	936,239	1,077	14,558	0	0	2,005
% Load Reduction Required	**23%**	**59%**	**24%**	**100%**	**100%**	**39%**

Combined Watersheds	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Current Pollutant Loads (lbs/yr)	2,521,521	5,757	35,669	997	9,442	5,650
Pre-developed Watershed Loads	1,278,659	1,500	19,988	0	0	2,736
% Load Reduction Required	**49%**	**74%**	**44%**	**100%**	**100%**	**52%**

Table 11: Pollutant loading and percent pollutant loading for each land type in each watershed.

Pollutant Loading for each Land Use / Land Cover Type (pounds/year)

3200-00	TSS	TP	TN	Zn	TPH	DIN
Low Density Residential	62,691	397	2,194	167	522	533
Medium Density Residential	25,100	125	878	75	523	144
High Density Residential	0	0	0	0	0	0
Commercial Development	9,941	43	446	26	514	56
Industrial Development	1,453	7	61	5	87	9
Institutional Development	1,685	8	61	19	87	15
Transportation	52,247	132	1,214	79	1,583	198
Turf and Grass	394,791	1,106	3,229	0	0	238
Pasture	28,363	74	430	0	0	127
Forest	124,714	139	2,079	0	0	298
Wetlands	0	113	447	0	0	0
Bare Ground	250,802	95	376	0	0	0
Σ =	951,787	2,239	11,416	372	3,317	1,618
3200-11	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Low Density Residential	16,496	104	577	44	137	140
Medium Density Residential	14,406	72	504	43	300	83
High Density Residential	1,941	10	68	7	49	11
Commercial Development	504	2	23	1	26	3
Industrial Development	1,120	6	39	3	23	6
Institutional Development	0	0	0	0	0	0
Transportation	55,422	140	1,288	84	1,679	210
Turf and Grass	135,905	381	1,112	0	0	82
Pasture	11,906	31	181	0	0	53
Forest	57,773	64	963	0	0	138
Wetlands	0	33	131	0	0	0
Bare Ground	58,471	22	88	0	0	0
Σ =	353,944	865	4,972	183	2,215	726
3208-00	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Low Density Residential	15,860	100	555	42	132	135
Medium Density Residential	2,746	14	96	8	57	16
High Density Residential	513	3	18	2	13	3
Commercial Development	5,135	22	230	13	266	29
Industrial Development	0	0	0	0	0	0
Institutional Development	2,053	10	74	24	106	18
Transportation	26,434	67	614	40	801	100
Turf and Grass	102,613	287	839	0	0	62
Pasture	57,989	152	880	0	0	260
Forest	285,981	318	4,766	0	0	683
Wetlands	0	71	282	0	0	0
Bare Ground	11,976	5	18	0	0	0
Σ =	511,301	1,048	8,373	129	1,375	1,306
3208-01	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Low Density Residential	1,148	7	40	3	10	10
Medium Density Residential	57	0	2	0	1	0
High Density Residential	0	0	0	0	0	0
Commercial Development	0	0	0	0	0	0
Industrial Development	0	0	0	0	0	0
Institutional Development	0	0	0	0	0	0
Transportation	4,131	10	96	6	125	16
Turf and Grass	9,410	26	77	0	0	6
Pasture	54,688	143	830	0	0	245
Forest	12,482	14	208	0	0	30
Wetlands	0	2	8	0	0	0
Bare Ground	0	0	0	0	0	0
Σ =	81,915	204	1,261	9	136	306
3208-02	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Low Density Residential	29,356	186	1,027	78	245	250
Medium Density Residential	16,403	82	574	49	342	94
High Density Residential	1,318	7	46	5	33	8
Commercial Development	7,403	32	332	19	383	41
Industrial Development	0	0	0	0	0	0
Institutional Development	8,513	40	308	98	440	76
Transportation	26,970	68	627	41	817	102
Turf and Grass	102,769	288	841	0	0	62
Pasture	106,318	279	1,613	0	0	477
Forest	182,347	203	3,039	0	0	436
Wetlands	0	32	127	0	0	0
Bare Ground	67,389	26	101	0	0	0
Σ =	548,786	1,241	8,636	291	2,260	1,545
3208-03	**TSS**	**TP**	**TN**	**Zn**	**TPH**	**DIN**
Low Density Residential	1,772	11	62	5	15	15
Medium Density Residential	750	4	26	2	16	4
High Density Residential	0	0	0	0	0	0
Commercial Development	0	0	0	0	0	0
Industrial Development	0	0	0	0	0	0
Institutional Development	0	0	0	0	0	0
Transportation	3,598	9	84	5	109	14
Turf and Grass	29,197	82	239	0	0	18
Pasture	6,341	17	96	0	0	28
Forest	29,289	33	488	0	0	70
Wetlands	0	3	12	0	0	0
Bare Ground	2,840	1	4	0	0	0
Σ =	73,788	159	1,011	12	139	149

Percent Pollutant Loading for each Land Use / Land Cover Type

3200-00	TSS %	TP %	TN %	Zn %	TPH %	DIN %
Low Density Residential	7	18	19	45	16	33
Medium Density Residential	3	6	8	20	16	9
High Density Residential	0	0	0	0	0	0
Commercial Development	1	2	4	7	16	3
Industrial Development	0	0	1	1	3	1
Institutional Development	0	0	1	5	3	1
Transportation	5	6	11	21	48	12
Turf and Grass	41	49	28	0	0	15
Pasture	3	3	4	0	0	8
Forest	13	6	18	0	0	18
Wetlands	0	5	4	0	0	0
Bare Ground	26	4	3	0	0	0
Σ =	100	100	100	100	100	100
3200-11	**TSS %**	**TP %**	**TN %**	**Zn %**	**TPH %**	**DIN %**
Low Density Residential	5	12	12	24	6	19
Medium Density Residential	4	8	10	24	14	11
High Density Residential	1	1	1	4	2	2
Commercial Development	0	0	0	1	1	0
Industrial Development	0	1	1	2	1	1
Institutional Development	0	0	0	0	0	0
Transportation	16	16	26	46	76	29
Turf and Grass	38	44	22	0	0	11
Pasture	3	4	4	0	0	7
Forest	16	7	19	0	0	19
Wetlands	0	4	3	0	0	0
Bare Ground	17	3	2	0	0	0
Σ =	100	100	100	100	100	100
3208-00	**TSS %**	**TP %**	**TN %**	**Zn %**	**TPH %**	**DIN %**
Low Density Residential	3	10	7	33	10	10
Medium Density Residential	1	1	1	6	4	1
High Density Residential	0	0	0	1	1	0
Commercial Development	1	2	3	10	19	2
Industrial Development	0	0	0	0	0	0
Institutional Development	0	1	1	18	8	1
Transportation	5	6	7	31	58	8
Turf and Grass	20	27	10	0	0	5
Pasture	11	14	11	0	0	20
Forest	56	30	57	0	0	52
Wetlands	0	7	3	0	0	0
Bare Ground	2	0	0	0	0	0
Σ =	100	100	100	100	100	100
3208-01	**TSS %**	**TP %**	**TN %**	**Zn %**	**TPH %**	**DIN %**
Low Density Residential	1	4	3	32	7	3
Medium Density Residential	0	0	0	2	1	0
High Density Residential	0	0	0	0	0	0
Commercial Development	0	0	0	0	0	0
Industrial Development	0	0	0	0	0	0
Institutional Development	0	0	0	0	0	0
Transportation	5	5	8	66	92	5
Turf and Grass	11	13	6	0	0	2
Pasture	67	70	66	0	0	80
Forest	15	7	16	0	0	10
Wetlands	0	1	1	0	0	0
Bare Ground	0	0	0	0	0	0
Σ =	100	100	100	100	100	100
3208-02	**TSS %**	**TP %**	**TN %**	**Zn %**	**TPH %**	**DIN %**
Low Density Residential	5	15	12	27	11	16
Medium Density Residential	3	7	7	17	15	6
High Density Residential	0	1	1	2	1	0
Commercial Development	1	3	4	7	17	3
Industrial Development	0	0	0	0	0	0
Institutional Development	2	3	4	34	19	5
Transportation	5	5	7	14	36	7
Turf and Grass	19	23	10	0	0	4
Pasture	19	22	19	0	0	31
Forest	33	16	35	0	0	28
Wetlands	0	3	1	0	0	0
Bare Ground	12	2	1	0	0	0
Σ =	100	100	100	100	100	100
3208-03	**TSS %**	**TP %**	**TN %**	**Zn %**	**TPH %**	**DIN %**
Low Density Residential	2	7	6	38	11	10
Medium Density Residential	1	2	3	18	11	3
High Density Residential	0	0	0	0	0	0
Commercial Development	0	0	0	0	0	0
Industrial Development	0	0	0	0	0	0
Institutional Development	0	0	0	0	0	0
Transportation	5	6	8	44	78	9
Turf and Grass	40	51	24	0	0	12
Pasture	9	10	10	0	0	19
Forest	40	20	48	0	0	47
Wetlands	0	2	1	0	0	0
Bare Ground	4	1	0	0	0	0
Σ =	100	100	100	100	100	100

C. Watershed Best Management Practices

Best management practices (BMPs) are control measures that are used to "manage the quantity and improve the quality of stormwater runoff" (US EPA, 2012), typically caused by changes in land use. Generally BMPs focus on water quality problems caused by increased impervious surfaces from land development. BMPs are designed to reduce stormwater volume, peak flows, and/or nonpoint source pollution through evapotranspiration, infiltration, detention, and filtration or biological and chemical actions (Debo and Reese, 2003).

Stormwater BMPs can be classified as "structural" (i.e., brick and mortar devices installed or constructed on a site), or "non-structural" (procedures such as modified landscaping practices, preservation of open space, or behavioral changes). There are a variety of BMPs available; selection typically depends on site characteristics and pollutant removal objectives. EPA has published a list of stormwater BMPs for use by local governments, builders and property owners (EPA, 2012).

Structural BMPs, including pervious pavement, surface and subsurface infiltration basins, vegetated roofs, and constructed wetlands, mitigate stormwater runoff by reducing peak runoff volume, infiltrating stormwater, and otherwise managing stormwater as close to the source as possible. Non-structural BMPs focus on preserving open space, protecting natural systems, incorporating existing landscape features such as wetlands and stream corridors into a site plan to manage stormwater at its source. Some focus on clustering and concentrating development, minimizing disturbed areas, and reducing the size of impervious areas (www.StormwaterPA.org, 2012).

1. Identification of Critical Areas

Best Management Practices (BMPs) may have the greatest impact on water quality if they are implemented in critical areas, e.g. areas in which the greatest potential for pollutant loading occurs, or areas which have extenuating conditions (such as seasonal flooding, poor soils or extensive impervious land cover) which increase the likelihood of pollutant loading. Critical areas identified in the lower Natchaug River watershed include:

- State Route 195 from Windham Water Works to the intersection with Main Street (State Route 14): Commercial (retail, food and automotive sales) and high density residential development (including apartments/condominiums and multi-family homes) along State Route 195 contribute to high levels of impervious cover, in the form of buildings, parking lots and driveways. This area also has older traditional storm water conveyance systems which deliver untreated storm water runoff to the receiving waterbodies. Stormwater runoff from this area may contain sediments, automotive chemicals such as oil, gasoline and antifreeze, trash, and fecal bacteria from pet waste.

Additionally, commercial establishments may contribute contaminated runoff from dumpsters and stored or stockpiled materials, and sand and de-icing agents from parking lot and sidewalk maintenance.

- Boston Post Road (State Route 66): Commercial (primarily retail and food sales) and industrial development (including manufacturing and earth materials processing) along Boston Post Road contribute to high levels of impervious cover, due to the presence of commercial and industrial buildings, parking lots and driveways. This area has several sites with industrial stormwater permits, and numerous sites listed on the State of Connecticut *Contaminated or Potentially Contaminated Sites*. Stormwater runoff may contain sediments, automotive chemicals such as oil, gasoline and antifreeze, industrial chemicals, and trash. Commercial and industrial establishments may contribute contaminated runoff from dumpsters, stored or stockpiled materials, and sand and de-icing agents from parking lot and sidewalk maintenance.

- Mansfield City Road/Pleasant Valley Road: Agricultural activities, including livestock pastures and containment areas, manure storage, silage storage, and the transporting and spreading of manure on fields, may contribute stormwater-borne pollutants including nutrients and fecal coliform bacteria to nearby waterbodies.

2. Location of Potential Best Management Practices

The locations of Potential Best Management Practices are described in Table 12. The table identifies the target pollutants/sources, BMP locations, recommended management measures and approximate cost. Locations of potential BMPs are depicted on reach level maps in Appendix C. Descriptions of the Best Management Practices are included in section 3 following Table 12.

Table 12: Recommended Best Management Practices for Specific Areas of Concern, with Cost Estimates

Pollutant Source	Pollutant	Reach/ Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Urban Runoff	Storm Water Volume/NPS	-	-	Watershed-wide	-	Promote NPS BMPs among watershed residents	Municipal staff time/salaries
		-	-	Watershed-wide	-	Employ municipal "good housekeeping" practices	Municipal staff time/salaries
		-	-	Watershed-wide	-	Promote use of/offer incentives for low impact development techniques (LID) in site development	Municipal staff time/salaries
		-	-	Watershed-wide	-	Require stormwater management plans for site development	Municipal staff time/salaries
		-	-	Watershed-wide	-	Require erosion & sediment control plans for site development	Municipal staff time/salaries
		-	-	Watershed-wide	-	Complete, publish, and distribute Natchaug CAP Dashboard Manual	$15,000 labor and materials
		-	-	Colonial Square Townhouses Foster Drive	Yes	Installation of bio-retention as appropriate, including tree filter units or rain gardens	Tree Filter Units- $8,500/unit Commercial Rain Gardens -$40/sf

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Urban Runoff	Storm Water Volume/NPS	Sawmill Brook 3208-00-R1a	-	Big Y Plaza 141 Storrs Road	Yes	Installation of bio-retention as appropriate, including tree filter units or rain gardens	Tree Filter Units- $8,500/unit Commercial Rain Gardens -$40/sf
		Sawmill Brook 3208-00-R1a	-	Best Western Regent Inn 123 Storrs Road	Yes	Installation of bio-retention as appropriate, including tree filter units or rain gardens	Tree Filter Units- $8,500/unit Commercial Rain Gardens -$40/sf
		Sawmill Brook 3208-00-R1a	-	East Brook Mall 95 Storrs Road	Yes	Install bio-retention basins along edge of parking lot to capture and treat runoff	Bio-retention Basins -$40 per sf
		Sawmill Brook 3208-00-R1a	-	East Brook Mall 95 Storrs Road	Yes	Install tree filter units to treat runoff	Tree Filter Units- $8,500/unit
		Sawmill Brook 3208-00-R1a	-	East Brook Mall 95 Storrs Road	Yes	Convert interior parking islands to bio-retention basins	Bio-retention Basins -$40 per sf
		Sawmill Brook 3208-00-R1a	-	East Brook Mall 95 Storrs Road	Yes	Install subsurface stormwater storage/ infiltration	$3-$10 per ft^3 water stored
		Sawmill Brook 3208-00-R1	-	1st Niagara Bank 6 Storrs Road	Yes	Install rain gardens to capture roof runoff	Commercial Rain Gardens -$40/sf
		Unnamed Stream 3208-03-R2	-	Constitution Square Condominiums Mansfield City Road	No	Encourage homeowner BMPs to reduce NPS	Municipal staff time/salaries

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Urban Runoff	Storm Water Volume/NPS	Unnamed Stream 3208-03-R2		Constitution Square Condominiums Mansfield City Road	No	Rain Gardens to capture roof and driveway runoff	Rain Gardens -$4 - $40 per sf
		Unnamed Stream 3208-03-R2		Constitution Square Condominiums Mansfield City Road	No	Tree filter units as practicable throughout complex	Tree Filter Units- $8,500/unit
		Natchaug River 3200-00-R1 #287	SWO 2	North end of Lauter Park - stormwater outfall from Ashland Street/Park Avenue	Yes	Install gravel wetland in Lauter Park to treat stormwater runoff	$39,000-$82,000/ac
		Natchaug River 3200-00-R1		South end of Lauter Park – stormwater outfall from vicinity of 465 Jackson Street	Yes	Install gravel wetland in Lauter Park to treat stormwater runoff	$39,000-$82,000/ac
		Natchaug River 3200-00-R1 #302	SWO 5	Gordon Avenue	No	Move outfall away from stream, install energy dissipater	$2200 (materials, municipal staff time/salaries)
		Natchaug River 3200-00-R1 #304	SWO 7	Pleasant View Avenue	No	Move outfall away from stream, install energy dissipater	$2200 (materials, municipal staff time/salaries)
		Sawmill Brook 3208-00-R1a #342, #344, #346, #347, #348, #349,	SWO 23 SWO 25 SWO 27 SWO 28 SWO 29 SWO 30	East Brook Mall 95 Storrs Road	Yes	Eliminate leak-offs and allow stormwater to flow/ infiltrate into grass	$1000 (labor and materials)

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Urban Runoff	Storm Water Volume/NPS	Sawmill Brook 3208-00-R1 #335	SWO 19	1st Niagara Bank 6 Storrs Road	Yes	Install tree filter units in parking lot	Tree Filter Units- $8,500/unit
		Unnamed stream 3208-03 R2 #372, #374	SWO 47 SWO 48	Constitution Square Condominiums Mansfield City Road	No	Install tree filter units throughout development	Tree Filter Units- $8,500/unit
Storm Water Outfalls	NPS	Unnamed stream 3208-03 R2 #366	SWO 46	Circle Drive	No	Install tree filter units throughout development	Tree Filter Units- $8,500/unit
Sewers/ Septic Systems	Bacteria/ Nutrients	-	-	Watershed-wide	-	Continuation of regular inspections/maintenance by WWPCA	Operating Costs
		-	-	Watershed-wide	-	Conduct education program for homeowners on septic system BMPs	$1250 (2500 brochures @ $0.50/pc)
		-	-	Watershed-wide	-	Initiate septic system inspection program	Local Health District staff time/salaries
		Unnamed stream 3208-03	-	US of Meadowbrook Lane	Yes	Conduct additional bacteria sampling to bracket potential bacteria source locations	$35 per test

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Sewers/ Septic Systems	Bacteria/ Nutrients	Sawmill Brook, Conantville Br, Unnamed stream 3208-03	-	Sawmill Brook watershed	Yes	Conduct bacteria DNA source tracking to determine host species	$700 per sample ($175 per test for 4 host species)
Pets/ Wildlife	Bacteria/ Nutrients	-	-	Watershed-wide	-	Encourage pet waste management BMPS	$1250 (2500 brochures @ $0.50/pc)
				Willimantic Reservoir, Windham Airport, Willimantic Country Club	No	Coordinated resident Canada Geese management	Project partner staff time
	NPS			Watershed-wide	-	Trash/waste bin BMPs campaign (to exclude pets/urban wildlife)	$1250 (2500 brochures @ $0.50/pc)
Livestock	Nutrients/ Bacteria	Conantville Br 3208-02 (R3 –7), Unnamed stream 3208-03 (R2-R4)	-	Hobby farms in vicinity of Pleasant Valley Road & Mansfield City Road	Yes	Manure BMPS - Cover manure piles, compost manure, or remove manure from site	Lg. tarp: $80 - $100 3-bay Composter: $1200 - $1500 Dumpster: $50 - $300/mo
		Conantville Br 3208-02-R4	-	Private farm, Pleasant Valley Road	Yes	Install exclusionary fencing	$15/ linear ft fencing

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Livestock	Nutrients/ Bacteria	Conantville Br 3208-02-R3 #387	-	Commercial farm Mansfield Road	Yes	Establish system of rotational grazing to reduce manure concentrations, increase uptake by plants	$15/ linear ft fencing
		Conantville Br 3208-02-R3	-	Commercial farm Mansfield Road	Yes	Utilize manure BMPS in livestock feeding and bedding areas	To be determined by practices selected
		Conantville Br 3208-02-R6/7	-	Commercial farm Stearns Road	Yes	Install roof gutters and other clean water diversions to reduce barnyard runoff	$4.50 - $7.25/ linear foot of roof gutter
		Conantville Br 3208-02-R6/7	-	Commercial farm Stearns Road	Yes	Upgrade silage storage and divert leachate into manure lagoon	$50,000 - $300,000
		Conantville Br 3208-02-R6/7	-	Commercial farm Stearns Road	Yes	Upgrade manure lagoon to prevent overflows into Conantville Brook	$9,000-$60,000
Degraded Riparian Buffers	Nutrients/ Sediment/ Bacteria	-	-	Watershed-wide	-	Conduct public outreach and education on function and value of riparian buffers	$500 (1000 brochures @ $0.50/pc)
		Natchaug River 3200-00-R1 #285, #335-336	DB-1	Lauter Park – parking area to car top boat launch	Yes	Revegetate 500 linear feet of 15 ft wide buffer	$100-$900 (0.2 acres @ $500 - $4500 per acre)

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Degraded Riparian Buffers	Nutrients/ Sediment/ Bacteria	Natchaug River 3200-00-R1	DB-1	Lauter Park –car top boat launch	Yes	Install interpretive signage regarding benefits of riparian buffers	$2000 sign development and installation
		Natchaug River 3200-00-R1 #306, #308	DB-5 DB-6	US/DS Natchaug Road	No	Revegetate 1000 linear ft of 15 ft wide buffer	$200 - $1500 (0.34 acres @ $500 - $4500 per acre)
		Natchaug River 3200-00-R1 #315, #318	DB-8 DB-10	Bricktop Road to WWTP	No	Revegetate 3500 linear ft of 15 ft wide buffer (multiple land owners)	$600 - $5400 (1.2 acres @ $500 - $4500 per acre)
		Sawmill Brook 3200-00-R1 #333-334	DB-11	First Niagara Bank 6 Storrs Road	Yes	Revegetate 350 linear ft of 15 ft wide buffer	$0 (Allow existing native vegetation to grow in)
		Natchaug River 3200-00-R1	-	Alex Caisse Park	Yes	Restore 550 linear ft of 15 ft wide riparian buffer surrounding pond	$100 - $900 (0.2 acres @ $500 - $4500 per acre)
		Sawmill Brook 3208-00-R1 #144	DB 12	Lauter Park – from north property line behind ball field	Yes	Manage invasive plant species and increase width of 1000 linear ft long buffer	$200 - $1500 (0.34 acres @ $500 - $4500 per acre)
		Sawmill Brook 3208-00-R1a #341 to #350	-	East Brook Mall	Yes	Revegetate 1500 linear ft of 15 ft wide buffer	$250 - $2250 (0.5 acres @ $500 - $4500 per acre)

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Degraded Riparian Buffers	Nutrients/ Sediment/ Bacteria	Sawmill Brook 3208-00-R2 #327	DB-14	Conantville Road	No	Revegetate 135 linear ft of 15 ft wide buffer	$150 - $700 (0.05 acres @ $500 - $4500 per acre)
		Conantville Br 3208-02-R1 #338	DB-15	South of Ledgebrook Road	No	Revegetate 100 linear ft of 15 ft wide buffer, remove invasive plants	$100 - $500 (0.03 acres @ $500 - $4500 per acre)
		Conantville Br 3208-02-R1 #360, #370	DB-16	Eatons Pond, west of Mansfield City Road	No	Treat approximately 3.8 acres of phragmites	$75 - $300 (3.8 ac @ $20 - $75/ac – chemical trmt)
		Conantville Br 3208-02-R3 #387, #389	DB 18 – DB 19	Commercial farm Mansfield Road	Yes	Exclude livestock from Conantville Brook, install stream crossing	Fencing- $15/ft Stream Crossing - $1000 - $2100
		Unnamed stream 3208-03 #368	DB-21	Meadowbrook Road	No	Revegetate 100 linear ft of 15 ft wide buffer	$0 (Allow existing native vegetation to grow in)
Stream Bank Erosion	Sediment	Natchaug River 3200-00-R1 #285, #287	E-1 E-2	Lauter Park	Yes	Stabilize and restore 425 ft of stream bank	$370 (0.08 mi @ $46,000/mi)
		Sawmill Brook 3208-00-R2 #325, #326	E-6 E-7	DS of Puddin Lane	No	Identify upstream opportunities to infiltrate stormwater to reduce stream “flashinesss”	TBD

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Stream Bank Erosion	Sediment	Conantville Br 3208-02-R1 #344	E-9	US of North Frontage Road	No	Remove breached dam, allow re-establishment of stream channel	Dam removal: ~$1,500 - $50,000 (to be determined by qualified expert)
		Conantville Br 3208-02-R1 #351, #352	E-10 E-11	South of Meadowbrook Lane	No	Identify upstream opportunities to infiltrate stormwater to reduce stream “flashinesss”	TBD
		Unnamed stream 3208-03-R1 #358, #362	E-14 E-15	South of Meadowbrook Lane	No	Identify upstream opportunities to infiltrate stormwater to reduce stream “flashinesss”	TBD
Trash/ Debris	NPS	-	-	Watershed-wide	-	Promote public awareness regarding trash.	Municipal staff time/salaries
		Natchaug River 3200-00-R1 #304, #305, #307, #308, #310, #311, #317, #318	TD-1 to TD-8	Natchaug River from Lauter Park to WWTP	Yes	Organize/conduct stream clean-up, enact/enforce littering ordinance, provide trash receptacles	Volunteer time
		Unnamed stream 3208-03-R1 #342	TD-14	US Meadowbrook Lane	No	Remove grass clipping from wetlands assoc. with stream	Municipal staff time/salaries
Gravel Mining	Sediment/ Chemicals	Natchaug River		Boston Post Road	Yes	Employ municipal permitting/oversight, E&S/stormwater mgmt. plans, operator BMPs	Municipal staff time/salaries, property owner staff time/salaries

Pollutant Source	Pollutant	Reach/GPS Waypoint	Site ID Number	Location	Critical Area?	BMP Recommendation	Cost Estimate
Fish/ Aquatic Species Passage Barriers	Habitat Degradation	Sawmill Brook 3208-00-R2	FB-3	DS Conantville Road	No	Replace perched culvert	Municipal staff salaries, materials
		Sawmill Brook 3208-00-R2	FB-4	US Conantville Road	No	Remove debris dams (brush, branches)	$0 – manually remove debris from stream channel
		Conantville Br 3208-02-R1	FB-6	US North Frontage Road	No	Remove breached dam	Dam removal: $1,500 - $50,000
		Conantville Br 3208-02-R1	FB-7	US North Frontage Road	No	Remove debris dams (brush, branches)	$0 – manually remove debris from stream
		Unnamed 3208-02-R1	FB-9, FB-10, FB-11	DS Meadowbrook Road	No	Remove debris dams (brush, branches)	$0 – manually remove debris from stream
		Unnamed 3208-03 R2	FB-12	US Meadowbrook RD	No	Remove small dam (12”) across stream channel	Dam removal: $1,500 - $50,000

3. Description of Potential Best Management Practices

Urban Runoff BMPs – Urban sources of pollution are inherently diverse, and cover the spectrum of nonpoint source pollutants originating from multiple sources including public and private lands. Successful efforts to reduce NPS are equally diverse and involve participation from the governmental and private sectors, including federal, state and local governmental agencies, non-governmental organizations, industrial and commercial partners and private landowners.

Municipalities are responsible for maintaining much of the impervious surface in urban settings, including roads, sidewalks, municipal buildings and parking lots. Employment of municipal "Good Housekeeping" or Best Management Practices, such as frequent street sweeping and storm drain cleaning, as well as proper storage of materials, may reduce the amount of NPS discharging to local waterways. Municipalities may replace older catch basins with newer units that capture and/or separate grease and oils, trash, sediment and so forth. Municipal highway departments should be informed about and trained to utilize the most current advances and technologies in stormwater management and should incorporate these advances into their regular stormwater management practices.

As an outcome of the Natchaug Basin Conservation Action Plan (NCAP), participants began the creation of a Road Maintenance and Construction Tasks "Dashboard Manual," geared towards CT DOT and municipal departments of public works. The draft manual, which addressed maintenance topics including road surfaces, drainage, excavation, and winter road maintenance, was not completed. However, if completed, the Dashboard Manual would be an excellent reference for local and state highway departments.

Municipal land-use boards and staff are able to influence the management of NPS through encouragement of the adoption of land use regulations that promote thoughtful site design, enforcement of erosion and sediment control regulations, and utilization of the effective reduction of impervious surfaces. This includes incorporating low impact development (LID) and green infrastructure (GI) techniques in site plans located in highly developed areas (those exceeding 25% impervious cover), and retrofitting existing stormwater infrastructure to treat and reduce the volume of storm runoff. Incoming development plans should include both erosion and sediment control plans and stormwater management plans. Land use boards can also improve the quality of runoff by increasing the width of upland review areas for inland wetland permitting functions and mandating wider vegetative buffers when issuing building and subdivision permits in areas adjacent to water courses. Land use regulations should, at a minimum, include recommendations for incorporating the 2002 Connecticut Erosion & Sediment Guidelines and the 2004 Stormwater Quality Manual and Appendices.

Outreach programs that inform the public, including homeowners as well as owners of private sector commercial, industrial and retail properties, about the causes and consequences of water quality impairments, and educational programs identifying behavioral change required to reduce impairments should be undertaken. Educational programs may address simple behavior changes that will protect and improve water quality such as properly managing animal waste, reducing the use of lawn chemicals, washing cars on lawns (rather than paved surfaces where runoff may enter the storm drain system) or using commercial carwash facilities. Commercial and industrial property owners should encourage in-house and/or contractual property maintainers to employ best management practices while conducting maintenance, including lawn/landscaping maintenance, winter application of sand and de-icing agents, and spring property clean-up. Additionally, watershed towns should sponsor hazardous waste collection days, if they do not currently do so, and property owners should be encouraged to participate.

<u>Storm Water Outfall Retrofits</u> – Bio-retention of stormwater is a proven and effective stormwater management practice. Bio-retention systems such as rain gardens and stormwater tree filters have minimal space requirements, making them practical for urban retrofits. Additional stormwater practices that can be considered include stormwater planters, vegetated roofs, infiltration trenches, and pervious pavement.

Target areas for bio-retention, including tree filters and rain gardens include:

- Shopping centers and businesses on Rt. 195,
- Constitution Square Condominiums in Mansfield
- Circle Drive neighborhood in Mansfield
- Commercial/industrial development on Boston Post Road

Subsurface stormwater storage, although expensive, can be an effective method of attenuating stormwater flows from large parking lots, reducing both volume and thermal pollution. Where soils allow, retained water may be infiltrated into the native soil rather than discharged to the nearest waterbody. Stored stormwater can also be re-used for on-site non-potable water needs, including landscape irrigation.

Target areas for subsurface stormwater storage include:

- Shopping centers on Rt. 195, especially East Brook Mall

Subsurface gravel wetlands approximate the look and function of natural wetlands, effectively removing sediments and other pollutants commonly found in runoff. Subsurface gravel wetlands do not infiltrate stormwater. Rather, they convey stormwater horizontally through treatment cells to a discharge point. Because gravel wetlands can require a significant amount of area, they are not as suitable for retrofits as some other treatments, but where space allows, can be very effective stormwater management practices.

Target areas for gravel wetlands include:

- Outfall in Lauter Park from the Ashland Street/Park Avenue area
- Outfall in Lauter Park from vicinity of 465 Jackson Street

Septic Systems Inspections and BMPs – Regular inspections and maintenance by water pollution control authorities is critical to ensuring the proper functioning of municipal sewer systems and to identify and repair leaky sewer lines. Regular inspections may also identify cross-connections with stormwater systems, particularly in older sewer systems, and illicit hook-ups. In areas with individual sub-surface sewer systems (septic systems), homeowners should be encouraged to engage in septic system best management practices, including regular pumping of their holding tanks in accordance with the manufacturer or installer's recommendations (usually every two years), and periodic inspections to ensure the leach field is functioning properly. Local health districts should promote or institute a system of regular septic system inspections. Two health districts have jurisdiction in the lower Natchaug River watershed; the Eastern Highlands Health District in Mansfield, and the North Central District Health Department in Windham. Watershed municipalities should investigate whether they qualify for the Connecticut Department of Economic and Community Development (DECD) Small Cities Program, which can provide assistance to property owners to support septic systems repairs and/or replacements on a case by case basis.

Watershed municipalities should institute illicit discharge detection and elimination programs (IDDE), if they do not already do so. Illicit discharges, including grey water discharges, and footing, roof and yard drains can be significant sources of nonpoint source pollutants, including fecal bacteria. Illicit discharges have been shown in many locations to overwhelm the aggregate of nonpoint source BMP installations. Establishment of an IDDE program is typically a requirement of a Municipal Separate Storm Sewer Systems (MS4) permit. Neither watershed town participates in the Connecticut MS4 program, but could establish an IDDE program via town ordinance.

Additional bacteria sampling on streams with high bacteria loads may help to bracket bacteria sources. Bacteria DNA source tracking of water samples testing positive for E. coli bacteria would identify the host, and aid in selecting the most effective management measures.

Target areas for additional bacteria sampling and DNA testing include:

- Unnamed stream 3208-03 upstream of Meadowbrook Lane
- Conantville Brook upstream of Unnamed stream 3208-03
- Sawmill Brook upstream of East Brook Mall

Pet Waste Management - Residents should be encouraged to employ pet waste best management practices, including picking up and disposing of pet waste. Towns ordinances related to the management of pet waste should be enforced on a case by case basis to reduce the impact of pet waste on water quality. Because there were no discernible gathering areas for dogs, such as dog parks, pet waste management would be most effective on a watershed-wide scale. Brochures and other outreach material related to water quality problems associated with pet waste should be made available at locations frequented by pet owners, including local veterinarians, kennels, retail pet supply centers and town hall license centers.

Agriculture/Livestock- Livestock owners and commercial agricultural operations should be encouraged to employ manure BMPs to reduce nutrient and bacteria loading from manure, including covering manure piles, composting manure, or removing manure from the site. Larger operations should maintain manure storage facilities that are adequate to store manure until it can be spread on fields identified in a nutrient management plan. Soil testing is recommended to determine nutrient levels in fields. Excess manure that cannot be stored or spread on the farm fields should be utilized off-site.

Target areas for manure storage improvements include:

- Commercial farm on Mansfield Road
- Commercial farm on Stearns Road

Exclusionary fencing and crossings should be installed where livestock have access to streams to prevent bacterial contamination from manure and to prevent stream bank erosion.

Target areas for exclusionary fencing include:

- Commercial farm on Mansfield Road
- Commercial farm on Stearns Road
- Private farm on Pleasant Valley Road

Rotational grazing reduces nutrient concentrations, allows manure to break down and be taken up by plants as the pasture recovers, and reduces the potential for overgrazing and subsequent erosion.

Target areas for rotational grazing include:

- Commercial farm on Mansfield Road

The installation of roof gutters on barns is an effective way to divert clean stormwater and reduce the potential for nutrient and bacteria-laden stormwater runoff.

Target areas for roof gutter installation include:

- Commercial farm on Mansfield Road
- Commercial farm on Stearns Road

Silage pits should be designed to prevent discharge of leachate into nearby waterbodies. Silage leachate, a liquid that is formed when water comes in contact with silage, can be extremely harmful if discharged to nearby waterbodies. Silage leachate is extremely acidic and has a very high biological oxygen demand (BOD).

Target areas for silage pit improvements include:

- Commercial farm on Stearns Road

Riparian Buffer Restoration – Public education on the benefits and services of riparian buffers may encourage some landowners to restore or manage riparian buffers on their land. Expanded monitoring and enforcement of permitted riparian land uses by municipal land use commissions could lead to enhanced maintenance of vegetative buffers in these areas. The adoption of riparian buffer setbacks by municipal land use/planning commissions may preserve vegetated riparian zones and negate future need for riparian buffer restoration. Targeted riparian buffer restoration may include management of invasive species as well as re-establishment of de-vegetated riparian areas. Additionally, installation of informational/educational signage related to the benefits of riparian buffers should be considered in public areas, including Alex Caisse Park and Lauter Park.

Target areas for riparian buffer restoration include:

- The perimeter of the small pond at Alex Caisse Park on Rt. 195
- The Natchaug River at Lauter Park, from the north property line to the cartop boat launch area
- The Natchaug River along Bricktop Road, from the intersection with Club Road to the WWTP
- Sawmill Brook behind First Niagara bank on Rt. 195
- Sawmill Brook at East Brook Mall

Stream Bank Erosion Mitigation – Much stream bank erosion documented during the Streamwalks appeared to be on private land, presenting a challenge to mitigation. Public education on the benefits of riparian buffers may reduce instances of stream bank erosion. Several areas, particularly at Lauter Park, were associated with degraded riparian buffers, indicating that restoration of the degraded vegetative buffers would likely stabilize the stream banks. The adoption of riparian buffer setbacks by municipal land use/planning commissions would reduce the incidence of stream bank erosion associated with inadequate riparian vegetation. Several instances of erosion on Sawmill Brook appeared to be associated with stormwater volume, particularly downstream of road crossings. Actions to divert road-derived stormwater runoff from direct discharge into the stream channel may lessen peak volumes, and reduce the incidences of erosion.

<u>Trash/Debris Reduction</u> – A public education/social marketing campaign on the link between littering and water quality should be instituted watershed-wide. Local organizations and business may want to sponsor clean-up days, either watershed-wide or focused on the watershed streams. Trash clean-ups introduce and connect local residents to waterways and create a sense of ownership that may foster additional and on-going stewardship. The municipalities should enact ordinances regarding littering, if none exist, and enforce any existing ordinances.

Target areas for trash reduction include:

- Natchaug River at Lauter Park
- Natchaug River at the Airline Trail crossing
- Natchaug River at Recreation Park
- Conantville Brook near East Brook Mall
- Sawmill Brook downstream of East Brook Mall

<u>Gravel Mining/Silviculture</u> - Gravel mining operation adjacent to the Natchaug River on Boston Post Road appear to maintain adequate separation distances from the river to provide adequate water quality protection. Operators should be encouraged to continue to use best management practices in order to minimize the effects of their activities on water quality, including erosion and sedimentation control, stormwater management, and management and handling of on-site chemicals. Municipal land use regulations should require adequate separating distances to protect waterbodies from the effects of sedimentation and tree canopy removal. Municipal staff should enforce any applicable permit requirements or other oversight.

<u>Modified Channel Retrofits</u> – Where practicable, areas where the watershed streams have been channelized should be restored to their natural state, reconnecting the streams to their flood plains and providing attenuation of storm flows.

<u>Fish Passage Barriers</u> - Fish passage barriers degrade aquatic wildlife habitat by fragmenting fish populations, as well as populations of other aquatic organisms, such as freshwater mussels, which depend of certain species of fish during specific periods of their development. There were numerous debris dams composed of branches, leaves and sediments noted during the Streamwalk phase of this investigation.

Target areas for debris dam removal include:

- Debris dams on Sawmill Brook upstream of Conantville Road
- Debris dams on Conantville Brook upstream of North Frontage Road

- Debris dams on unnamed stream 3208-03 downstream of Meadowbrook Lane

Several concrete dams that were noted on tributaries to the Natchaug River should be evaluated to determine if removal or installation of alternative fish passageways are feasible, or in the case of fish passageways, beneficial.

Target areas for dam evaluation/removal include:

- Dam on Sawmill Brook downstream of Puddin Lane
- Breached concrete dam on Conantville Brook upstream of North Frontage Rd.
- Small concrete dam on unnamed stream 3208-03 upstream of Meadowbrook Lane

D. Financial and Technical Assistance Needed

Reasonable financial estimates for each management practice have been provided in Table 13 above, however costs associated with the development and implementation of each proposed measure will need to be estimated individually as management strategies are undertaken, and as cost estimates may change over time. Technical assistance will be critical to the successful implementation of the management recommendations. Organizations such USDA/NRCS, CT DEEP, Conservation Districts, University of CT Cooperative Extension Service, US Fish & Wildlife Service, and others, depending on the nature of the implementation, may provide technical assistance to project managers and watershed stakeholders.

Watershed municipalities have local funding options, including bonding, capital improvement budgets, and department budget line items that can be utilized to fund water quality improvement implementations and municipal outreach efforts. Planning and Zoning departments can establish open space set-aside funds for the purchase of open space. Highway/public works departments include budget line items for infrastructure repair, maintenance and improvements. Conservation Commission and Park & Recreation Commission budgets can include line items for environmental education and outreach programs/campaigns and materials. The establishment and growth of this local capacity is important, in that when municipalities apply for outside grants, loans and/or foundation support, they can leverage local funds as match. Additionally, numerous grant applications are strengthened by the availability of in-kind services provided by municipal staff.

Financial assistance in the form of grants and cost-sharing is available from multiple sources, including federal, state, and local sources. These include, but are not limited, to US Environmental Protection Agency (Clean Water Act §319 Non-Point Source program); Connecticut Department of Economic Development (Small Cities, STEAP); CT Department of Energy and Environmental Protection (Open Space grants, CWA grants);

Table 13: Potential Funding Sources

Funding Source	Award Amount	Contact Information
CT DEEP CWA §319 Grant Program	Varies by project	
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325588&depNav_GID=1654		
CT DEEP Clean Water Fund		Susan Hawkins (860) 424-3325
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654		
CT DEEP Long Island Sound License Plate Program	$25,000.	Kate Brown (860) 424-3034
http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323782&depNav_GID=1635		
CT DEEP Open Space and Watershed Land Acquisition Grant Program	40-60% of fair market value	Dave Stygar (860) 424-3016
http://www.ct.gov/deep/cwp/view.asp?A=2687&Q=322338		
Ct Dept of Agriculture Environmental Assistance Prgm	Varies by practice	(860) 713-2511
http://www.ct.gov/doag/cwp/view.asp?a=3260&q=398986		
Ct Dept of Agriculture Agriculture Viability Grant	Varies by project	860-713-2500
http://www.ct.gov/doag/cwp/view.asp?a=3260&q=398982		
Ct Dept of Agriculture Farmland Restoration Program	Varies by project	J. Dippel/Lance Shannon(860) 713-2511
http://www.ct.gov/doag/cwp/view.asp?a=3260&Q=498322&PM=1		
CT DECD Small Cities Program	Varies by town	Jim Watson (860) 270-8182
http://www.ct.gov/doh/cwp/view.asp?a=4513&q=530474		
CT OPM Regional Performance Incentive Program		Sandy Huber (860) 418-6293
http://www.ct.gov/opm/cwp/view.asp?q=487924		
CT OPM Small Town Economic Assistance Program	Varies by project	Barbara Rua (860) 418-6303
http://www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793		
Community Foundation of Eastern Connecticut	Varies by program	Jennifer O'Brien (860) 442-3572
http://www.cfect.org/		
US EPA Healthy Communities Grant Program		Jennifer Padula (617) 918-1698
http://www.epa.gov/region1/eco/uep/hcgp.html		
NOAA Coastal Management Programs		
http://coastalmanagement.noaa.gov/funding/welcome.html		
US EPA Five Star Restoration Grant Program	$20,000 average	Myra Price (202) 566-1225
http://www.epa.gov/owow/wetlands/restore/5star		
NFWF Long Island Sound Futures Fund	Varies by project	Lynn Dwyer lynn.dwyer@nfwf.org
http://www.nfwf.org/		
NRCS Wetlands Reserve Program (WRP)		Javier Cruz (860) 887-3604 x307
http://www.ct.nrcs.usda.gov/programs/whip/whip.html		
NRCS Environmental Quality Incentives Program (EQIP)	$300,000 over a six year period	Javier Cruz (860) 887-3604 x307
http://www.ct.nrcs.usda.gov/programs/eqip/eqip.html		
Rivers Alliance of CT Watershed Assistance Small Grants Program	$5000, req. 40% non-federal funding match	Rivers Alliance of CT (860) 361-9349
http://www.riversalliance.org/watershedassistancegrantrfp.cfm		

Long Island Sound program grants, and National Fish and Wildlife Fund grants. The US Department of Agriculture- Natural Resource Conservation Service (NRCS) offers cost share programs for qualified agricultural producers, including comprehensive nutrient management planning (CNMP) and environmental quality incentive programs (EQIP). The Connecticut Department of Agriculture offers several grant programs to assist agricultural producers, including farm restoration and agriculture viability grant programs. Local and regional sources may include banks, chambers of commerce, civic/social organizations (such as Lions or Rotary), private, commercial and institutional foundations, and environmental/professional organizations grants. Funds may also be available in the form of donations and in-kind services provided by local businesses, community and environmental organizations, and local volunteers. A non-exhaustive sampling of funding opportunities is listed in Table 13.

Table14: Watershed Stakeholders, Roles and Responsibilities

Stakeholder	**Roles/Responsibilities**
Army Corps of Engineers	Mgmt. of Mansfield Hollow flood control facility
CT Airport Authority	Management of Windham Airport
CT Department of Agriculture	Technical assistance/permitting
CT DEEP	Water quality, technical assistance
CT Department of Transportation	Maintenance of State highways/stormwater systems and maintenance facilities
Eastern CT Conservation District	Water quality investigation, BMP implementations, technical assistance
Eastern Highlands Health District	Review and approval of septic systems
Eastern CT State University	Facilities maintenance, BMPs, tech. assistance
Local Businesses/Associations	Conformance with local regulations, BMPs
Local Councils of Government	Regional land use planning
The Nature Conservancy	Outreach/education, technical assistance
North Central District Health Department	Review and approval of septic systems
Town of Mansfield – including staff and land use commissions	Enforcement of land use regulations, site plan review/permitting, public utilities maintenance
Town of Windham - including staff, land use commissions, WWW and WWPCA	Enforcement of land use regulations, site plan review/permitting, public utilities maintenance
USDA/NRCS	Technical assistance/funding for agricultural BMPs
University of Connecticut	Technical assistance/implementation of LID/GI
University of Connecticut Cooperative Extension Service	Technical assistance/education/outreach for land use and agricultural practices
Watershed Residents	Conformance with local regulations, BMPs

The successful implementation of a watershed plan depends on the establishment of an effective implementation team. This team is comprised of watershed stakeholders – individuals, groups or organizations that may be affected by or have an interest in the project's outcome. By forming, monitoring and maintaining constructive relationships, the implementation team plays a vital role in ensuring that the watershed plan's goals and objectives will be achieved in an expeditious manner. The implementation team reviews and prioritizes management recommendations, creates partnerships necessary to implement plan goals and recommendations, identifies and obtains funding sources, conducts or assists with the implementation of recommended management practices, and reviews and evaluates the results. It is impossible to understate the importance of the implementation team to the successful implementation of a watershed plan. Without a strong, organized implementation team, watershed plan goals and objectives will not be achieved. Watershed stakeholders who may be instrumental in implementing the Lower Natchaug River Watershed-Based Plan recommendations and assisting with obtaining funding are identified in Table 14.

E. Education/Outreach

The objective of the education/outreach component of this plan is to raise awareness of the water quality issues associated with the lower Natchaug River, in order to create an educated populace that understands the issues of nonpoint source pollution and its effects on water quality, and actions that can be taken to address the problem. By successfully educating and engaging the public, including commercial/industrial property owners as well as private landowners, municipal staff and land use commissioners, this plan should lead to behavioral change that should result in reduction of NPS to the lower Natchaug River.

Outreach efforts may be watershed-scale, and seek to address issues that are watershed-wide. Such efforts may include homeowner best management practices such as encouraging recycling, washing cars on lawns or using a carwash, properly disposing of pet waste, encouraging composting, reducing the use of lawn chemicals, and discouraging the dumping or depositing of chemicals or other waste in storm drains. These efforts may target a broad spectrum of watershed residents through activities such as presentations at meetings or conferences (land-use commissions, civic organizations, schools), news articles or feature stories in local or regional newspapers or other media outlets, displays at festivals or field days, such as the Willimantic River Festival, or work days, such as community clean-up days.

Outreach efforts may also be more small-scale or focused, and may be tied to specific implementation projects or target a water quality issue in a specific locale. Examples of these types of outreach efforts may include a rain garden workshop conducted in tandem with the installation of a rain garden at a targeted location; a workshop directed to a specific target audience, such as a manure management workshop for horse owners; or the installation of educational signage at a location with a specific resource concern such as cleaning up animal (dog) waste in a public park, not feeding geese or other waterfowl, or carrying out trash.

Table 15: Outreach & Education Topics and Partners

Outreach Topic	**Potential Outreach Partner**
Agricultural BMPs	UConn Cooperative Extension System, NRCS
Agricultural Nutrient Management	ECCD, NRCS, UConn Cooperative Extension System
Benefits of vegetated riparian buffers	CT SeaGrant
Composting	UConn Cooperative Extension System
Homeowner BMPS	ECCD, UConn Cooperative Extension System
Illicit Discharge Detection and Elimination Programs	CT DEEP Stormwater Management, DPWs
Invasive plant species identification and control	CT Invasive Plant Work Group (CIPWG), Invasive Plant Atlas of New England (IPANE)
Land use commissioners roles and responsibilities	CT NEMO, municipal land use commissions
Low impact development (LID)/ Green Infrastructure (GI)	CT NEMO,CLEAR
Municipal “Good Housekeeping” Public Works practices	CT DOT, DPWs
Non-migratory Geese Management	CT DEEP Wildlife Division, USDA
The Value of Open Space	CT DEEP, CT NEMO
Organic lawn/garden care	UConn Cooperative Extension System, NOFA
Pet waste management	Towns of Mansfield and Windham, Local Health Districts
Recycling	WWPCA, municipalities
Septic System BMPs for Homeowners	Local Health Districts, CT Dept. of Health
Trash/litter management	Local Conservation Commissions, DPWs
Understanding Non-point Source (NPS) Pollution	CT NEMO, Towns of Mansfield and Windham Conservation Commissions, CT DEEP
“What not to flush down drains”	WWPCA, Local Health Districts, UConn/ ECSU Environmental Science Depts.

Numerous excellent sources exist in Connecticut to educate municipal staff and the general public about land use and water quality issues. The University of Connecticut

Cooperative Extension System can conduct programs on a wide variety of conservation topics, including organic lawn care, integrated pest management, invasive plant management, forestry management, livestock best management practices, land use and community planning, soil and water resource management and restoration, geospatial information, fisheries and wildlife, and atmospheric resources. The Cooperative Extension helps people gain the knowledge needed to help protect, preserve, conserve and restore the state's environment and natural resources.

The University of Connecticut Center for Land Use Education and Research (CLEAR), a UConn Extension partner, is an excellent resource for land use decision makers, community organizations and citizens. CLEAR has a number of programs under its umbrella, including CT NEMO (Non-point Education for Municipal Officials), the Land Use Training Academy, geospatial training (GIS and GPS), and the LERIS lab, a remote sensing and GIS research program locate at the University of Connecticut in Storrs. The CT NEMO program offers numerous training workshops to land use officials. The CT NEMO program website (http://nemo.uconn.edu/index.htm) provides a link to the CT LID (low impact development) Inventory, which lists LID practices installed in Connecticut on an interactive map. The site provides additional information about LID practices and the companies that design and/or install them. Potential education topics and potential partners are listed in Table 15.

F. Implementation Schedule

An implementation schedule is a blueprint that is adopted by stakeholders to move forward the goals and objectives of the watershed plan. The implementation schedule provides structure and guidance that ensures the management recommendations of this plan are achieved in an expeditious manner.

Management objectives, milestones, interim measures, and responsible entities are identified in Table 16 below. The implementation of the recommended management strategies is scheduled over a 5 year period. A reduction of nonpoint source pollutants, including indicator fecal bacteria, should be noted after implementation of year 1 and 2 recommendations, which target municipal best management practices and home and business owner education. Stormwater pollutant reductions should continue over years 3, 4 and 5 as stormwater retrofits are installed. Successful implementation should yield measurable reductions in the levels of indicator bacteria, with the goal of reducing the level of indicator bacteria for recreational contact to below the standard set by the State of Connecticut Water Quality Standards. As management recommendations are completed, both the implementations and the schedule should be evaluated by watershed stakeholders or the implementation team to ensure that the expected results are being achieved. If measurable results are not being achieved, the implementation team should review and revise the implementation schedule.

G. Measurable Milestones

Measurable milestones are useful to ensure that progress is being made in achieving plan goals. Described in Table 16 below are management objectives and milestones that may be used to measure the progress that the watershed stakeholders are making toward meeting the goals of this watershed plan.

Table 16: Management Objectives & Milestones to Achieve Plan Recommendations

Management Objective 1: Create a implementation team comprised of watershed stakeholders	
Actions/Milestones:	• Identify and contact prospective team members • Conduct inaugural informational meeting • Establish regular meeting schedule • Review, identify and prioritize initial action items • Establish focus groups as needed • Establish an evaluation procedure to measure progress
BMPs:	Urban Bacteria/NPS Sources
Responsible Parties:	Municipalities, ECCD, CT DEEP, ECSU, ACOE, local businesses, residents, others as appropriate
Anticipated Products:	Implementation team, meeting schedule, work plan
Evaluation:	Successful establishment of implementation team
Timeline:	2014-2015

Management Objective 2: Build public awareness of NPS, including sources of nonpoint source pollution and management practices through outreach and education	
Actions/Milestones:	• Identify target audiences • Gather existing educational materials • Create new educational materials as needed • Identify most appropriate venues to disseminate information (e.g. Newspaper, Town website) • Distribute materials to residential and urban watershed residents • Conduct workshops focusing on non-point source issues
BMPs:	Urban Bacteria/NPS Sources
Responsible Parties:	Municipalities, ECCD, CT DEEP,CT NEMO, TRBP, TLGV
Anticipated Products:	Educational materials/workshops
Evaluation:	# educational materials distributed, # workshops conducted
Timeline:	2014-2015

Management Objective 3: Promote Good Housekeeping Practices among municipalities and commercial/industrial/residential property owners	
Actions/Milestones:	• Review municipal Good Housekeeping Practices (GHP) • Provide staff training, as necessary • Adopt revised GHPs in priority areas identified in WBP, as needed • Gather existing educational materials • Create new educational materials as needed • Distribute information regarding GHPs to property owners in priority areas as identified by the WBP
BMPs:	Urban Bacteria/NPS Sources
Responsible Parties:	Municipalities/DPW, stakeholders
Anticipated Products:	Revised municipal and property owner maintenance practices
Evaluation:	Adoption of improved GHPs, # educational brochures distributed, reduction in measured bacteria levels
Timeline:	2014-2015

Management Objective 4: Review and strengthen land use regulations pertaining to water quality, erosion and sediment control, stormwater management	
Actions/Milestones:	• Form municipal regulation review team • Review/evaluate existing municipal land use regulations, municipal ordinances, etc. • Review environmental/watershed- based municipal land use evaluations done by others (Farmington River, Salmon River) • Review work previously done as part of Natchaug CAP • Review sample/model regulations pertaining to water quality, E&S controls, stormwater mgmt. • Work with land use staff/ boards to revise regulations • Adopt new regulations
BMPs:	Stormwater management, E&S control, green infrastructure/low impact development
Responsible Parties:	Municipalities, ECCD, NEMO, CT DEEP, local COGs
Anticipated Products:	Proposed regulation amendments, revised regulations
Evaluation:	Adoption/revision of regulation amendments that effectively address water quality issues
Timeline:	2014-2016

Management Objective 5: Implement structural measures to reduce bacteria and other NPS loading in agricultural areas	
Actions/Milestones:	• Review and prioritize implementation sites • Select sites, contact landowners (if private property) to determine level of interest and cooperation • Identify and obtain funding • Develop construction design for BMP implementation • Obtain necessary permits • Construct structural measures • Design and conduct pre- and post-construction monitoring program to assess practice effectiveness
BMPs:	Agricultural stormwater management practices
Responsible Parties:	Land owners, CT Dept. Agriculture, NRCS, UConn Extension, ECCD
Anticipated Products:	Prioritized list of implementation sites, BMP design plans, water monitoring data
Evaluation:	# structural measures installed, measured reduction in NPS/bacteria
Timeline:	2015-2019

Management Objective 6: Implement structural measures to reduce bacteria and other NPS loading in commercial and residential areas	
Actions/Milestones:	• Review and prioritize implementation sites • Select sites, contact landowners (if private property) to determine level of interest and cooperation • Identify and obtain funding • Develop construction design for BMP implementation • Obtain necessary permits • Construct structural measures • Design and conduct pre- and post-construction monitoring program to assess practice effectiveness
BMPs:	Urban stormwater management practices
Responsible Parties:	Municipalities, private land owners, ECCD, CT DEEP, US EPA
Anticipated Products:	Prioritized list of implementation sites, BMP design plans, water monitoring data
Evaluation:	# structural measures installed, measured reduction in NPS/bacteria
Timeline:	2015-2019

Management Objective 7: Sewer/Septic System Maintenance	
Actions/Milestones:	• Encourage/support regular maintenance of municipal sewer system • Develop and approve municipal Illicit Discharge Detection & Elimination (IDDE) ordinances • Work with Health District sanitarians to evaluate the residential septic systems in areas not served by municipal sewer system • Identify potential funding sources for septic repairs • Work with property owners to repair failing systems • Provide educational materials to property owners about septic system BMPs
BMPs:	Sewer System Maintenance/Septic System BMPs
Responsible Parties:	Municipalities, Sewer Authority, Local Health Districts, property owners
Anticipated Products:	Few to no sewer system leaks, repaired/upgraded septic systems
Evaluation:	Regular sewer system inspections/maintenance, # failing systems repaired, # educational brochures distributed
Timeline:	2015-2019

Management Objective 8: Bracket bacteria sources, identify bacteria source hosts	
Actions/Milestones:	• Implement additional bacteria sampling in Conantville Brook and unnamed stream 3208-03 • Identify locations for monitoring, based on 2013 bacteria sampling • Design water quality monitoring program • Obtain funding for training and equipment • Recruit and train volunteers • Conduct site monitoring, including DNA source tracking • Report water quality results
BMPs:	Additional data necessary to narrow down sources of bacteria
Responsible Parties:	ECCD, CT DEEP, Municipality, TLGV
Anticipated Products:	Water quality data, summary report, identification of bacteria host(s)
Evaluation:	# sites monitored, data submitted to appropriate agencies
Timeline:	Begin 2014, ongoing thereafter, as needed

Management Objective 9: Restore functionality of riparian corridors	
Actions/Milestones:	• Evaluate and identify priority areas for buffer establishment or invasive species removal • Select sites, contact landowners (if private property) to determine level of interest and cooperation • Identify and obtain funding • Develop site design • Conduct buffer planting or invasive species removal • Conduct pre- and post-planting water quality monitoring
BMPs:	Riparian buffer restoration
Responsible Parties:	Private land owners, municipalities, NRCS, ECCD
Anticipated Products:	List of priority areas, construction design, photo-documentation, water quality data
Evaluation:	# acres or stream feet restored to industry established recommended standards, reduction in NPS/bacteria
Timeline:	2015-2019

Management Objective 10: In-stream Habitat Evaluation/Improvement	
Actions/Milestones:	• Conduct macro-invertebrate surveys in Conantville Brook • Evaluate and identify priority areas for fish barrier removal or fish ladder installation • Select sites, contact landowners (if private property) to determine level of interest and cooperation • Identify and obtain funding • Develop site design • Conduct fish barrier removal or fish ladder installation
BMPs:	Fish passage improvement, aquatic habitat assessment
Responsible Parties:	CT DEEP, private land owners, ECCD, TLGV
Anticipated Products:	List of priority areas, construction design, removal of barriers/installation of fish ladders, macro-invertebrate data
Evaluation:	Number of fish passing, absence/presence of indicator macro-invertebrates
Timeline:	2015-2019

H. Monitoring and Assessment Component

Monitoring is an essential component to determining the effectiveness of Plan implementations, and whether adjustments need to be made within an adaptive management framework. On-going monitoring will provide necessary water quality data to allow watershed managers to assess the effectiveness of BMPs. Water quality monitoring should be coordinated with the implementation of management measures to determine if the desired results (a reduction in the amounts of indicator bacteria) are being achieved.

The following items should be included as part of the monitoring and assessment of Watershed Plan implementations.

1) Establishment and implementation of monitoring activities should be coordinated with watershed project partners.
2) Continuation of CT DEEP Ambient Water Quality Probabilistic Bacteria Monitoring program at the lower Natchaug River at Lauter Park, as part of the five-year rotational basin assessments.
3) Macro-invertebrate sampling of Conantville Brook prior to and subsequent to upstream implementations to determine if noted visual water conditions are indicative of impact to aquatic habitat.
4) If existing data is not available, BMP implementations should include pre- and post-implementation water quality monitoring, as practicable, to determine effectiveness of BMP in reducing pollutant loading.
5) Comparison of post-BMP water quality monitoring data to bacteria TMDL targets to determine if bacteria load reductions have been achieved. If no load reductions have been achieved, the TMDL may be reassessed, as needed.
6) Comparison of post-BMP implementation data collection to NPS pollutant load targets to determine if NPS pollutant load reductions have been achieved.

I. Implementation Effectiveness

The Connecticut Department of Energy and Environmental Protection's *A Statewide Total Maximum Daily Load Analysis for Bacteria Impaired Waters*, *Appendix 13: Sub-Regional Basin CT3200 - Natchaug River Summary* (Appendix D of this document), recommends a 24% reduction of bacteria to meet the single sample limit of 235 colonies/100 ml, based on data collected between 1998 and 2001. Recommended pollutant load reductions for other pollutants, and for bacteria in tributaries to the Natchaug River are listed in Section B of this document.

As implementations are undertaken and completed, water quality data should continue to be collected, evaluated and compared to the TMDL to determine if the implementations are achieving the desired results and that improvements to water quality are sustained. Implementation should be considered successful when the above targets are reached or exceeded. If implementations are not as effective as planned, watershed stakeholders may investigate the effectiveness of selected BMP practices, and may revise the watershed plan.

Next Steps

Following the acceptance of the lower Natchaug River Abbreviated Watershed-Based Plan by CT DEEP, this Plan should be distributed to all watershed stakeholders for implementation, including but not limited to the watershed municipalities, Councils of Government, local health districts, local utilities (including Windham Water Works and the Windham Water Pollution Control Authority), NGOs, CT Department of Transportation, CT Airport Authority, and business and land owners. It will be incumbent upon all watershed stakeholders to review, understand and adopt the plan recommendations in order for water quality improvements to be achieved. Upon approval of the Plan, the following steps are recommended:

1) The plan should be made available to the general public via postings on the CT DEEP, ECCD and Towns of Mansfield and Windham municipal websites. Efforts should be made to publicize the watershed plan in order to raise public awareness of water quality issues associated with the lower Natchaug River, and steps being taken to improve water quality.

2) In order to ensure the success of the lower Natchaug River Abbreviated Watershed-based Plan, it is recommended that the stakeholders form a watershed management team to coordinate the implementation of the Plan recommendations.

3) The watershed management team should develop a work plan based on the watershed plan recommendations, and should devise a process to implement the plan strategies. The team may benefit from partnering with the University of Connecticut and Eastern Connecticut State University, both of which have done substantial work reducing NPS on their campuses. The team may also benefit from partnering with the Eagleville Brook (Mansfield) Impervious Cover TMDL team to learn what has worked in the Eagleville Brook (much of which includes the UConn campus).

4) The watershed management team should develop and maintain an assessment process, such as a watershed progress report card, to document completion of Plan recommendations and evaluate the effectiveness of the completed implementations, in order to demonstrate progress towards achieving water quality improvement goals.

5) The watershed management team should review and revise the Plan as implementations are completed and as new technology and information becomes available. The management team should solicit input from local, state and federal agencies and stakeholders as appropriate.

6) The watershed management team should strive to develop a “lower Natchaug” identity or brand that will be adopted by the diverse community. While the diversity of the Mansfield/ Windham area is one of its greatest strengths, it can also create disconnections among residents with dissimilar interests. The development of a “lower Natchaug” identity can be used to connect the more urban residents and business owners, shopping mall and apartment managers, and store and services customers with quiet back street neighborhoods, rural residents and agricultural operators; and public works and DOT crews, storm water and sewer system operators, town hall management, parks and recreation directors with park visitors, fishermen, canoeists, dog walkers, and open space stewards via the one element they all have in common - the Natchaug River.

7) The watershed management team should conduct activities that engage the community, such as annual roadside and river clean-ups, storm drain stenciling, riparian buffer plant-a-thons, taking a “pledge” for the watershed, water conservation, and participation at community events.

8) The watershed management team should consider initiating or supporting additional water quality investigation in the Sawmill Brook watershed to further narrow down sources of indicator bacteria identified in this watershed plan, particularly in Conantville Brook and unnamed stream 3208-03.

9) The watershed management team should consider conducting DNA source tracking to determine the bacterial host species. Identification of the host species will allow watershed managers to target BMPs to the most likely sources, maximizing BMP effectiveness.

Closing

The degradation of water quality in the lower Natchaug River is a process that has occurred incrementally over many years. Likewise, the process of addressing water quality issues in the lower Natchaug River will be a long term effort. The adoption of a watershed management plan is an important first step in taking a more holistic, watershed-wide, land use-based approach to resource management. A watershed-based approach promotes the evaluation of the impacts of multiple, individual, and often wide-spread activities on water quality, and considers those individual impacts in aggregate. And, because watersheds do not recognize political divisions, the adoption of a watershed approach to land management often requires inter-municipal communication and cooperation. In order for goals of this watershed management plan to be achieved, it will be important for the watershed municipalities to work together to support the watershed management team In order to maximize effectiveness.

The successful implementation of this watershed plan by a watershed management team that represents the interests of all stakeholders in the lower Natchaug River watershed should result in the improvement of water quality in the lower Natchaug River, allowing all the designated uses for this waterbody including fishing and swimming.

The Eastern Connecticut Conservation District intends to remain an active participant and central point of contact as the implementation of this Watershed-Based Plan is undertaken.

Any comments or questions regarding this plan should be directed to the Eastern Connecticut Conservation District:

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Appendix A

Summary of Bacteria Data Collected by North Central District Health Department and Project SEARCH at Lauter Park, Willimantic, CT.

North Central District Health Department Lauter Park Swim Area Bacteria Data

Sampling Site	Site Description	06/06/13	06/27/13	07/16/13	08/01/13	08/13/13	Geomean	% Reduction Needed
L1	Left Side	42	31	31	99	42		
C2	Center	20	31	42	64	42		
R3	Right Side	10	31	<10	20	20	32	0
Weather		dry	recent light rain					

Sampling Site	Site Description	06/12/12	07/05/12	07/19/12	07/24/12	08/07/12	08/23/12	Geomean	% Reduction Needed
L1	Left Side	42	31	64	87	190	87		
C2	Center	20	42	120	120	180	64		
R3	Right Side	42	53	**1700**	75	160	64	85	0
Weather		dry	light rain	light rain	light rain	light rain	n/a		

Sampling Site	Site Description	05/31/11	06/21/11	07/05/11	07/19/11	Geomean	% Reduction Needed
Swim Beach		42	110	20	64		
		42	64	42	53		
		20	64	10	53	41	0
Weather		n/a	n/a	n/a	n/a		

Sampling Site	Site Description	06/01/10	06/16/10	06/28/10	07/12/10	07/26/10	08/09/10	08/30/10	Geomean	% Reduction Needed
Swim Beach		10	190	210	64	64	130	190		
		10	210	120	110	110	98	190		
		20	120	140	64	64	110	220	88	0
Weather		n/a	n/a	n/a	n/a	n/a	n/a	n/a		

Sampling Site	Site Description	06/08/09	06/30/09	07/06/09	07/13/09	07/27/09	08/14/09	08/24/09	Geomean	% Reduction Needed
Swim Beach		87	**240**	140	10	180	10	75		
		53	210	87	31	150	31	31		
		10	150	87	10	180	10	42	53	0
Weather		n/a	n/a	n/a	n/a	n/a	n/a	n/a		

Sampling Site	Site Description	06/10/08	07/10/08	07/22/08	08/19/08	Geomean	% Reduction Needed
Swim Beach		10	42	98	62		
		42	110	74	120		
		64	110	110	63	64	0
Weather		n/a	n/a	n/a	n/a		

Project Search Lauter Park Bacteria Data

Sampling Site	Site Description	9/25/98	10/5/99	5/11/01	10/3/01
Natchaug River	Lauter Park off Gordon Ave.	97	**310**	10	52
Weather		n/a	n/a	n/a	n/a
Geomean		n/a	n/a		23
% Reduction Needed		0	24	0	0

Bold denotes sample exceeded established indicator bacteria criteria for that site.

Appendix B

Streamwalk Area of Concern Summary

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
DB-1	Degraded buffer	285	41.72553007	-72.19978793	9/6/13	Natchaug River 3200-00 R1	Lauter Park, Willimantic	put-in at Lauter Park - degraded buffer
DB-2	Degraded buffer	294	41.7312482	-72.19486934	9/6/13	Natchaug River 3200-00 R1	south of Rt. 6	ATV river crossings
DB-3	Degraded buffer	295	41.73134996	-72.19436727	9/6/13	Natchaug River 3200-00 R1	south of Rt. 6	ATV river crossings
DB-4	Degraded buffer	298	41.73370712	-72.19370761	9/6/13	Natchaug River 3200-00 R1	north of Rt. 6	degraded buffer DS fall near Riverview Rd
DB-5	Degraded buffer	306	41.72031686	-72.19629301	9/6/13	Natchaug River 3200-00 R1	north of Natchaug St	degraded buffer at sampling site NR-02
DB-6	Degraded buffer	308	41.71941027	-72.19529196	9/6/13	Natchaug River 3200-00 R1	east of Rt 66	RB degraded buffer
DB-7	Degraded buffer	310	41.71908505	-72.19065785	9/6/13	Natchaug River 3200-00 R1	opposite fires school	degraded buffer at fire school
DB-8	Degraded buffer	315	41.71553163	-72.19059533	9/6/13	Natchaug River 3200-00 R1	north of Rt 14	degraded buffer
DB-9	Degraded buffer	316	41.71603421	-72.19430943	9/6/13	Natchaug River 3200-00 R1	Rt 14 river crossing	degraded buffer
DB-10	Degraded buffer	318	41.71438741	-72.19244513	9/6/13	Natchaug River 3200-00 R1	opposite WWTP	degraded buffer
DB-11 - begin	Degraded buffer	333	41.72889406	-72.20085871	9/3/13	Sawmill Brook 3208-00 R1	east of Rt. 195	begin degraded buffer
DB-11 - end	Degraded buffer	334	41.72826927	-72.2006842	9/3/13	Sawmill Brook 3208-00 R1	behind bank on Rt. 195	end degraded buffer

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
DB-12 - begin	Degraded buffer	335	41.72816265	-72.20057792	9/3/13	Sawmill Brook 3208-00 R1	behind bank on Rt 195	begin degraded buffer
DB-12 - end	Degraded buffer	336	41.72675491	-72.19949867	9/3/13	Sawmill Brook 3208-00 R1	north end Lauter Park	Sawmill Br approx 150 ft US of confluence with Natchaug River
DB-13 - begin	Degraded buffer	322	41.73988508	-72.20152516	9/10/13	Sawmill Brook 3208-00 R2	north side of Conantville Rd	degraded buffer at Conantville Road
DB-13 - end	Degraded buffer	323	41.74006445	-72.20194526	9/10/13	Sawmill Brook 3208-00 R2	north side of Conantville Rd	end of degraded buffer
DB-14	Degraded buffer	327	41.74255765	-72.20437174	9/10/13	Sawmill Brook 3208-00 R2	south of Puddin Lane	degraded buffer
DB-15	Degraded buffer	338	41.73319448	-72.20478103	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	degraded buffer/inv plants
DB-16 - begin	Degraded buffer	360	41.73230046	-72.21621076	9/17/13	Conantville Br 3208-02 R1	south of ECSU Athletic Complex	east end of Eatons Pond, begin degraded buffer
DB-16 - end	Degraded buffer	370	41.73155908	-72.21969738	9/17/13	Conantville Br 3208-02 R2	north of Rt 6	end degraded buffer at west end Eatons Pond
DB-17	Degraded buffer	381	41.73101652	-72.22473951	9/17/13	Conantville Br 3208-02 R2	north of Rt 6	confluence with W-E trib, end degraded buffer
DB-18 - begin	Degraded buffer	387	41.73318769	-72.22637348	9/17/13	Conantville Br 3208-02 R3	South of Pleasant Valley Rd	degraded buffer at livestock enclosures
DB-18 - end	Degraded buffer	389	41.73478025	-72.22586336	9/17/13	Conantville Br 3208-02 R3	farm south of Pleasant Valley Rd	degraded buffer at farm pond
DB-19	Degraded buffer	377	41.73700606	-72.22708125	9/24/13	Conantville Br 3208-02 R3	stream crossing Pleasant Valley Rd	degraded buffer to +/- 1700 ft US

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
DB-20	Degraded buffer	379	41.73960395	-72.23535217	10/18/13	Conantville Br 3208-02 R4	north of Pleasant Valley Rd	lawn surrounding small pond
DB-21	Degraded buffer	368	41.73512257	-72.21094089	9/24/13	unnamed 3208-03 R2	north of Meadowbrook La	begin degraded buffer at small conc. dam - 12",
E-1	Stream bank erosion	285	41.72553007	-72.19978793	9/6/13	Natchaug River 3200-00 R1	Lauter Park, Willimantic	stream bank erosion at put-in
E-2	Stream bank erosion	287	41.72622501	-72.19975767	9/6/13	Natchaug River 3200-00 R1	north end of Lauter Park	eroded stream bank
E-3	Stream bank erosion	301	41.7242157	-72.19846887	9/6/13	Natchaug River 3200-00 R1	Lauter Park	beach erosion at Lauter park swim area
E-4	Stream bank erosion	302	41.72327475	-72.19762003	9/6/13	Natchaug River 3200-00 R1	opposite end of Gordon Ave	erosion assoc. with outfall
E-5	Stream bank erosion	307	41.72007261	-72.19576344	9/6/13	Natchaug River 3200-00 R1	west of Rt. 66	runoff from road
E-6	Stream bank erosion	325	41.74203973	-72.20300314	9/10/13	Sawmill Brook 3208-00 R2	south of Puddin Lane	erosion
E-7	Stream bank erosion	326	41.74238917	-72.20344881	9/10/13	Sawmill Brook 3208-00 R2	south of Puddin Lane	erosion
E-8	Stream bank erosion	340	41.73324267	-72.20511136	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	stream bank erosion
E-9	Stream bank erosion	344	41.73321208	-72.20753046	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	stream bank erosion assoc. w/broken conc. dam
E-10	Stream bank erosion	351	41.7328442	-72.21148345	9/10/13	Conantville Br 3208-02 R1	south of Meadowbrook La	eroded stream bank
E-11	Stream bank erosion	352	41.73296163	-72.21397748	9/10/13	Conantville Br 3208-02 R1	south of Meadowbrook La	bank erosion

Area of Concern Number	Area of Concern Type	GPS	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
E-12	Stream bank erosion	377	41.73088862	-72.22281955	9/17/13	Conantville Br 3208-02 R2	north of Rt. 6	stream bank erosion - very sandy
E-13	Stream bank erosion	380	41.73972515	-72.23565878	10/18/13	Conantville Br 3208-02 R5	north of Pleasant Valley Rd	Eroded stream bank w/assoc. sediment plume
E-14	Stream bank erosion	358	41.73402814	-72.21066252	9/24/13	unnamed 3208-03 R1	south of Meadowbrook La	LB erosion
E-15	Stream bank erosion	362	41.7333591	-72.20934053	9/24/13	Unnamed 3208-03 R1	south of Meadowbrook La	LB erosion
FB-1	Fish barrier	298	41.73370712	-72.19370761	9/6/13	Natchaug River 3200-00 R1	north of Rt 6	riffle/fall near Riverview Rd, fish barrier during low flow conditions
FB-2	Fish barrier	351	41.7370608	-72.20151837	9/3/13	Sawmill Brook 3208-00 R1b	north of East Brook Mall	beaver dam
FB-3	Fish barrier	354	41.73956045	-72.20138133	9/3/13	Sawmill Brook 3208-00 R2	south side of Conantville Rd	DS end perched culvert under Conantville Rd
FB-4	Fish barrier	324	41.74004559	-72.20183068	9/10/13	Sawmill Brook 3208-00 R2	north side of Conantville Rd	fish barrier log dam across stream channel
FB-5	Fish barrier	327	41.74255765	-72.20437174	9/10/13	Sawmill Brook 3208-00 R2	south of Puddin Lane	12 ft conc dam
FB-6	Fish barrier	344	41.73321208	-72.20753046	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	broken conc dam
FB-7	Fish barrier	348	41.73268075	-72.20988393	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	series of woody debris dams
FB-8	Fish barrier	379	41.73960395	-72.23535217	10/18/13	Conantville Br 3208-02 R4	north of Pleasant Valley Rd	3ft dam at south end of sm pond

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
FB-9	Fish barrier	357	41.73464656	-72.21047242	9/24/13	Unnamed 3208-03 R1	south of Meadowbrook La	debris dam/branches. Leaves
FB-10	Fish barrier	359	41.7332591	-72.20994084	9/24/13	unnamed 3208-03 R1	south of Meadowbrook La	debris dam/branches. Leaves
FB-11	Fish barrier	363	41.73350008	-72.20899151	9/24/13	unnamed 3208-03 R1	south of Meadowbrook La	debris dam/branches. Leaves
FB-12	Fish barrier	368	41.73512257	-72.21094089	9/24/13	unnamed 3208-03 R2	north of Meadowbrook La	small conc dam - 12"
MC-1	Modified channel	285	41.72553007	-72.19978793	9/6/13	Natchaug River 3200-00 R1	Lauter Park, Willimantic	put-in at Lauter Park - modified channel
MC-2	Modified channel	287	41.72622501	-72.19975767	9/6/13	Natchaug River 3200-00 R1	north end Lauter Park	modified channel
MC-3	Modified channel	290	41.73082005	-72.19879316	9/6/13	Natchaug River 3200-00 R1	south of Rt. 6	culvert under RT 6, low flow, large sed. delta
MC-4	Modified channel	299	41.73277429	-72.19344676	9/6/13	Natchaug River 3200-00 R1	Rt. 6 river crossing	Bet. RT 6 bridge spans, armored stream banks
MC-5	Modified channel	307	41.72007261	-72.19576344	9/6/13	Natchaug River 3200-00 R1	west of Rt. 66	RT 66 overpass, USGS gauge, bank armored
MC-6	Modified channel	328	41.72941156	-72.20137605	9/3/13	Sawmill Brook 3208-00 R1	west of Rt. 195	end of bank armoring at US end of dbl box culvert under Rt. 195
MC-7 - end	Modified channel	337	41.73293078	-72.20466234	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	end mod channel
MC-7-begin	Modified channel	333	41.73299708	-72.20248254	9/10/13	Conantville Br 3208-02 R1	south of East Brook Mall	begin Conantville Br at Sawmill Br
MC-8	Modified channel	358	41.73238236	-72.21553903	9/17/13	Conantville Br 3208-02 R1	west of Mansfield City Rd	stream armored and straightened

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
MC-9 - end	Modified channel	381	41.73101652	-72.22473951	9/17/13	Conantville Br 3208-02 R2	north of Rt 6	confluence with W-E trib, end modified channel
MC-9 - begin	Modified channel	370	41.73155908	-72.21969738	9/17/13	Conantville Br 3208-02 R2	north of Rt 6	west end Eatons Pond, beg modified channel
MC-10	Modified channel	369	41.73603703	-72.211637	9/24/13	unnamed 3208-03 R2	north of Meadowbrook La	mod channel - rip rap, at outfall of 2' CP
SWO-1	Stormwater outfall	286	41.72594204	-72.19987258	9/6/13	Natchaug River 3200-00 R1	north end Lauter Park	12" conc pipe w/flow
SWO-2	Stormwater outfall	287	41.72622501	-72.19975767	9/6/13	Natchaug River 3200-00 R1	north end Lauter Park	36" conc pipe w/flow
SWO-3	Stormwater outfall	290	41.73082005	-72.19879316	9/6/13	Natchaug River 3200-00 R1	south of Rt 6	culvert under RT 6, with perched storm drain
SWO-4	Stormwater outfall	299	41.73277429	-72.19344676	9/6/13	Natchaug River 3200-00 R1	Rt 6 river crossing	stormdrain from Rt 6
SWO-5	Stormwater outfall	302	41.72327475	-72.19762003	9/6/13	Natchaug River 3200-00 R1	opposite end of Gordon Ave	stormdrain outfall from Gordon Ave
SWO-6	Stormwater outfall	303	41.72254586	-72.19751693	9/6/13	Natchaug River 3200-00 R1	south of Gordon Ave	2 - 4" PVC pipes at stream level, small pond approx.. 215 ft to west
SWO-7	Stormwater outfall	304	41.72205065	-72.19753261	9/6/13	Natchaug River 3200-00 R1	opposite end of Pleasant View Ave	paved leakoff and dirt channel assoc. w/Pleasant View Ave
SWO-8	Stormwater outfall	307	41.72007261	-72.19576344	9/6/13	Natchaug River 3200-00 R1	west of Rt 66	RT 66 overpass, USGS gauge, runoff from road
SWO-9	Stormwater outfall	308	41.71941027	-72.19529196	9/6/13	Natchaug River 3200-00 R1	east of Rt 66	SWO

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
SWO-10	Stormwater outfall	310	41.71908505	-72.19065785	9/6/13	Natchaug River 3200-00 R1	opposite fires school	SWO assoc. with Windham Hgts
SWO-11	Stormwater outfall	312	41.71475211	-72.18845677	9/6/13	Natchaug River 3200-00 R1	north of Club Rd and Rt 14	2 conc pipes from Club Rd, lower pipe has flow
SWO-12	Stormwater outfall	314	41.71462848	-72.18887142	9/6/13	Natchaug River 3200-00 R1	north of Club Rd and Rt 14	SWO perched, broken
SWO-13	Stormwater outfall	320	41.73260506	-72.20234441	9/3/13	Sawmill Brook 3208-00 R1	south of North Frontage Rd	SWO DS end culvert N Frontage Rd.
SWO-14	Stormwater outfall	323	41.73177509	-72.20218289	9/3/13	Sawmill Brook 3208-00 R1	north of Rt 6 off ramp	SWO in top of culvert
SWO-15	Stormwater outfall	325	41.73177509	-72.20218289	9/3/13	Sawmill Brook 3208-00 R1	north of Rt 6 off ramp	CB and SWO in top of culvert
SWO-16	Stormwater outfall	327	41.72997675	-72.2018622	9/3/13	Sawmill Brook 3208-00 R1	north of South Frontage Rd	SWO at DS end culvert
SWO-17	Stormwater outfall	329	41.72937049	-72.20129021	9/3/13	Sawmill Brook 3208-00 R1	west of Rt 195	SWO from side of culvert
SWO-18	Stormwater outfall	331	41.72905717	-72.20093155	9/3/13	Sawmill Brook 3208-00 R1	east of Rt 195	SWO at DS end culvert under RT 195
SWO-19	Stormwater outfall	335	41.72816265	-72.20057792	9/3/13	Sawmill Brook 3208-00 R1	behind bank on Rt 195	SWO from above CB
SWO-20	Stormwater outfall	337	41.73314578	-72.2026138	9/3/13	Sawmill Brook 3208-00 R1	south end of East Brook Mall	3ft conc pipe in conc headwall, flowing
SWO-21	Stormwater outfall	338	41.7332731	-72.20269318	9/3/13	Sawmill Brook 3208-00 R1	south end of East Brook Mall	leak off
SWO-22	Stormwater outfall	340	41.73327914	-72.20216881	9/3/13	Sawmill Brook 3208-00 R1a	south end of East Brook Mall	SWO from roof drains Kohls bldg

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
SWO-23	Stormwater outfall	342	41.73367216	-72.20037541	9/3/13	Sawmill Brook 3208-00 R1a	east side East Brook Mall pkg lot	asphalt leak off from EBM pkg lot
SWO-24	Stormwater outfall	343	41.73366009	-72.20036343	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	SWO from EBM pkg lot
SWO-25	Stormwater outfall	344	41.733989	-72.20019587	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	asphalt leak off from EBM pkg lot
SWO-26	Stormwater outfall	345	41.73447238	-72.19984576	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	SWO from EBM pkg lot
SWO-27	Stormwater outfall	346	41.73546715	-72.19996898	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	asphalt leak off from EBM pkg lot
SWO-28	Stormwater outfall	347	41.73562733	-72.20010258	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	asphalt leak off from EBM pkg lot
SWO-29	Stormwater outfall	348	41.73573235	-72.2001377	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	asphalt leak off from EBM pkg lot
SWO-30	Stormwater outfall	349	41.73592597	-72.20031867	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	asphalt leak off from EBM pkg lot
SWO-31	Stormwater outfall	350	41.73613954	-72.2006894	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	SWO from EBM pkg lot
SWO-32	Stormwater outfall	353	41.73947571	-72.2014773	9/3/13	Sawmill Brook 3208-00 R2	south side of Conantville Rd	leak off from Conantville Rd
SWO-33	Stormwater outfall	322	41.73988508	-72.20152516	9/10/13	Sawmill Brook 3208-00 R2	north side of Conantville Rd	leak off from Conantville Rd

Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
SWO-34	Stormwater outfall	330	41.74279888	-72.20503508	9/10/13	Sawmill Brook 3208-00 R2	south of Puddin Lane	SWO in conc. headwall pond so side Puddin La
SWO-35	Stormwater outfall	334	41.73299365	-72.20310632	9/10/13	Conantville Br 3208-02 R1	south of East Brook Mall	24" CP
SWO-36	Stormwater outfall	335	41.73295065	-72.2038591	9/10/13	Conantville Br 3208-02 R1	west of Conantville Rd	12" pipe
SWO-37	Stormwater outfall	353	41.73241354	-72.21490771	9/10/13	Conantville Br 3208-02 R1	east of Mansfield City Rd	Tributary flowing from 1 ft. high perched culvert with assoc. SWO
SWO-38	Stormwater outfall	354	41.73245846	-72.21508775	9/10/13	Conantville Br 3208-02 R1	east of Mansfield City Rd	Storm drain from Mansfield City Road
SWO-39	Stormwater outfall	361	41.73256927	-72.21685616	9/17/13	Conantville Br 3208-02 R2	south of ECSU Athletic Complex	storm outfall from athletic fields to pond/marsh
SWO-40	Stormwater outfall	362	41.73268821	-72.2177651	9/17/13	Conantville Br 3208-02 R2	south of ECSU Athletic Complex	storm outfall from athletic fields to pond/marsh
SWO-41	Stormwater outfall	364	41.73306858	-72.21859247	9/17/13	Conantville Br 3208-02 R2	west of ECSU Athletic Complex	SWO with grassy swale from new athletic field construction to tributary
SWO-42	Stormwater outfall	371	41.73102977	-72.22074654	9/17/13	Conantville Br 3208-02 R2	north of Rt. 6	storm water outfall from Rt. 6
SWO-43	Stormwater outfall	378	41.7309384	-72.22383569	9/17/13	Conantville Br 3208-02 R2	north of Rt. 6	storm water outfall from Rt. 6
SWO-44	Stormwater outfall	356	41.7347536	-72.21076143	9/24/13	unnamed 3208-03 R1	south of Meadowbrook La.	2 asphalt leak-offs
SWO-45	Stormwater outfall	365	41.73476323	-72.21084005	9/24/13	unnamed 3208-03 R2	north of Meadowbrook La.	dirt leak off

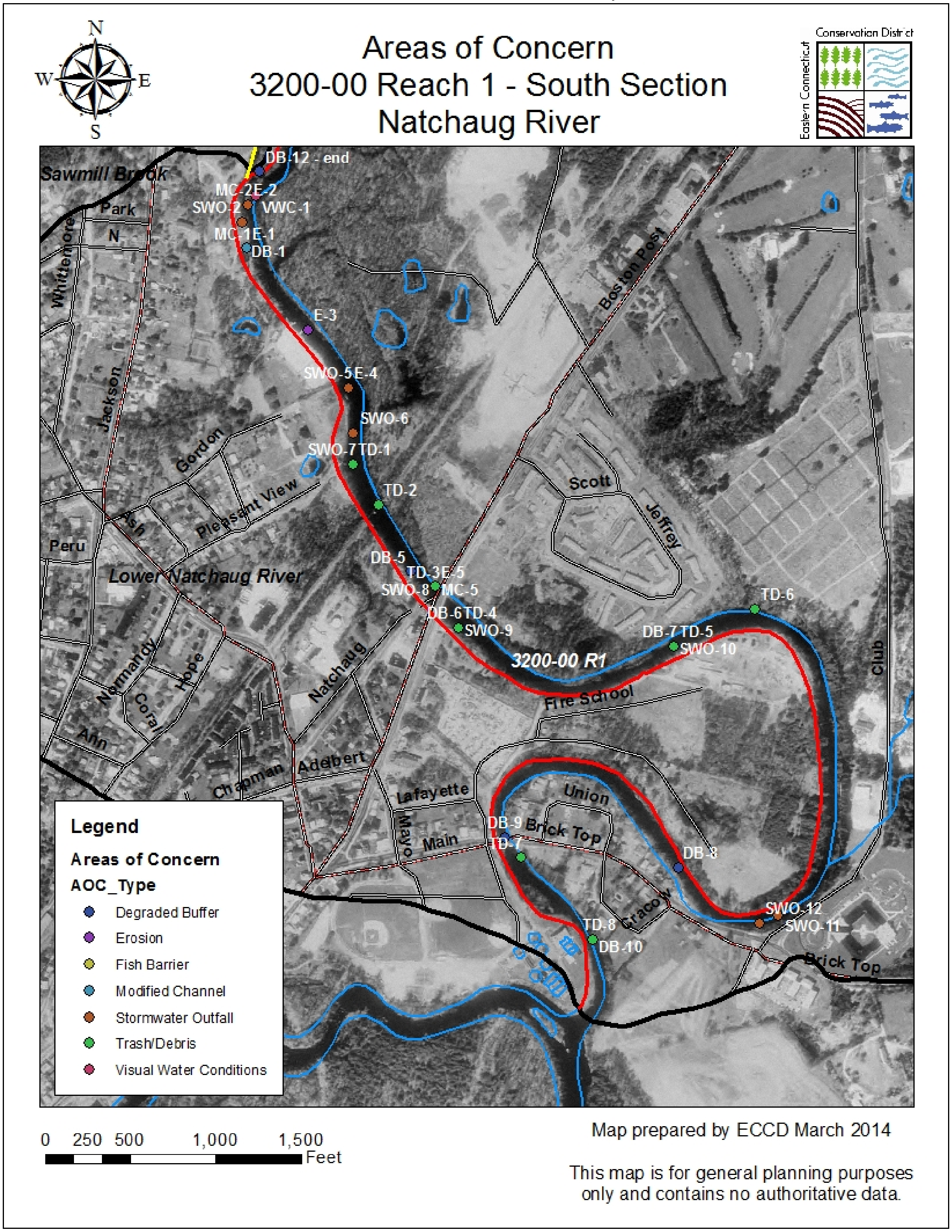
Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
SWO-46	Stormwater outfall	366	41.73455302	-72.21081516	9/24/13	unnamed 3208-03 R2	north of Meadowbrook La	outfall from unknown source - 2ft CPP - dry
SWO-47	Stormwater outfall	372	41.7365718	-72.21358823	9/24/13	unnamed 3208-03 R2	Independence Drive	storm outfall from Independence Dr
SWO-48	Stormwater outfall	374	41.73703054	-72.21294324	9/24/13	unnamed 3208-03 R2	Independence Drive	storm outfall from Independence Dr
TD-1	Trash/debris	304	41.72205065	-72.19753261	9/6/13	Natchaug River 3200-00 R1	opposite end of Pleasant View Ave	Floatables/blowables
TD-2	Trash/debris	305	41.7213967	-72.19698275	9/6/13	Natchaug River 3200-00 R1	Airline Trail crossing	Airline Trail crossing, shopping carts and trash
TD-3	Trash/debris	307	41.72007261	-72.19576344	9/6/13	Natchaug River 3200-00 R1	west of Rt 66	RT 66 overpass @ USGS gauge, floatables
TD-4	Trash/debris	308	41.71941027	-72.19529196	9/6/13	Natchaug River 3200-00 R1	east of Rt 66	trash
TD-5	Trash/debris	310	41.71908505	-72.19065785	9/6/13	Natchaug River 3200-00 R1	opposite fires school	trash on bank
TD-6	Trash/debris	311	41.71968025	-72.18890939	9/6/13	Natchaug River 3200-00 R1	btwn Windham Hgts and cemetery	trash
TD-7	Trash/debris	317	41.71570631	-72.19397021	9/6/13	Natchaug River 3200-00 R1	Rt. 14 river crossing	trash on bank near rec. field
TD-8	Trash/debris	318	41.71438741	-72.19244513	9/6/13	Natchaug River 3200-00 R1	opposite WWTP	yard waste on bank
TD-9	Trash/debris	339	41.73313279	-72.20254105	9/3/13	Sawmill Brook 3208-00 R1a	south end of East Brook Mall	landscape waste pile at EBM
TD-10	Trash/debris	341	41.73316137	-72.20073885	9/3/13	Sawmill Brook 3208-00 R1a	east side of East Brook Mall parking lot	shopping carts/debris in stream

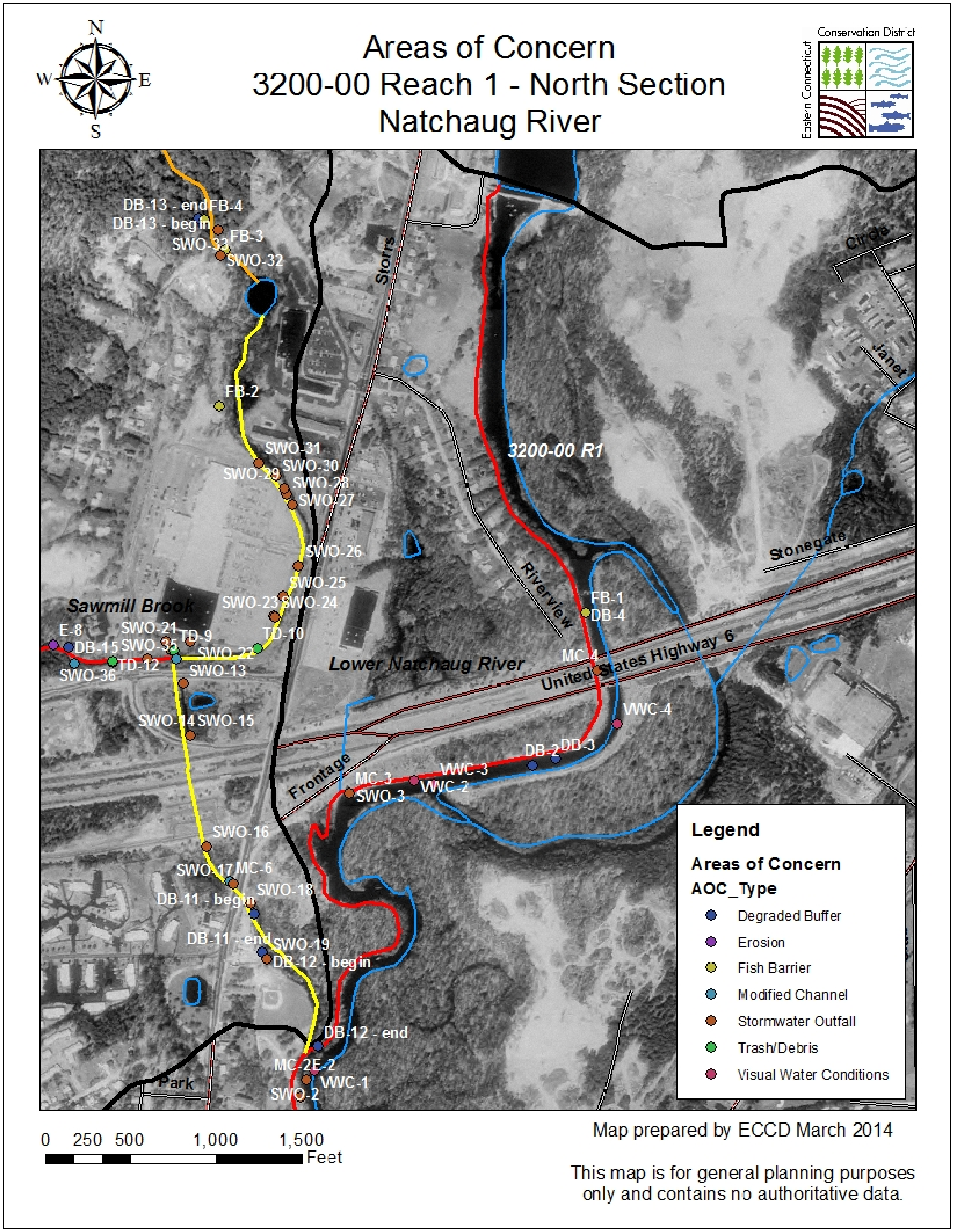
Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
TD-11	Trash/debris	327	41.74255765	-72.20437174	9/10/13	Sawmill Brook 3208-00 R2	south of Puddin Lane	12 ft conc. dam/misc. floatables
TD-12	Trash/debris	336	41.73296297	-72.20385818	9/10/13	Conantville Br 3208-02 R1	west of Conantville Rd	trash/modified channel - riprap
TD-13	Trash/debris	342	41.7328359	-72.20605449	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	brush pile on stream bank
TD-14	Trash/debris	370	41.73598716	-72.21185057	9/24/13	unnamed 3208-03 R2	north of Meadowbrook La	lawn clippings deposited in wetland adj. to strm
VWC-1	Visual water condition	288	41.72637127	-72.199571	9/6/13	Natchaug River 3200-00 R1	north end Lauter Park	confluence with Sawmill Brook/filamentous algae
VWC-2	Visual water condition	291	41.73102122	-72.19741291	9/6/13	Natchaug River 3200-00 R1	south of Rt. 6	Fe bacteria
VWC-3	Visual water condition	292	41.73096632	-72.19698217	9/6/13	Natchaug River 3200-00 R1	south of Rt. 6	curly pondweed
VWC-4	Visual water condition	297	41.73190827	-72.19304259	9/6/13	Natchaug River 3200-00 R1	south of Rt. 6	benthic algae
VWC-5	Visual water condition	343	41.73280874	-72.20648574	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	intermittent stream with Fe bacteria plume
VWC-6 - begin	Visual water condition	349	41.73267589	-72.21010127	9/10/13	Conantville Br 3208-02 R1	north of North Frontage Rd	milky water
VWC-6 - end	Visual water condition	354	41.73245846	-72.21508775	9/10/13	Conantville Br 3208-02 R1	east of Mansfield City Rd	sediment delta in stream channel with excessive plant growth
VWC-7	Visual water condition	358	41.73238236	-72.21553903	9/17/13	Conantville Br 3208-02 R1	west of Mansfield City Rd	milky water
VWC-8	Visual water condition	359	41.732263	-72.21622853	9/17/13	Conantville Br 3208-02 R1	south of ECSU Athletic Complex	milky water

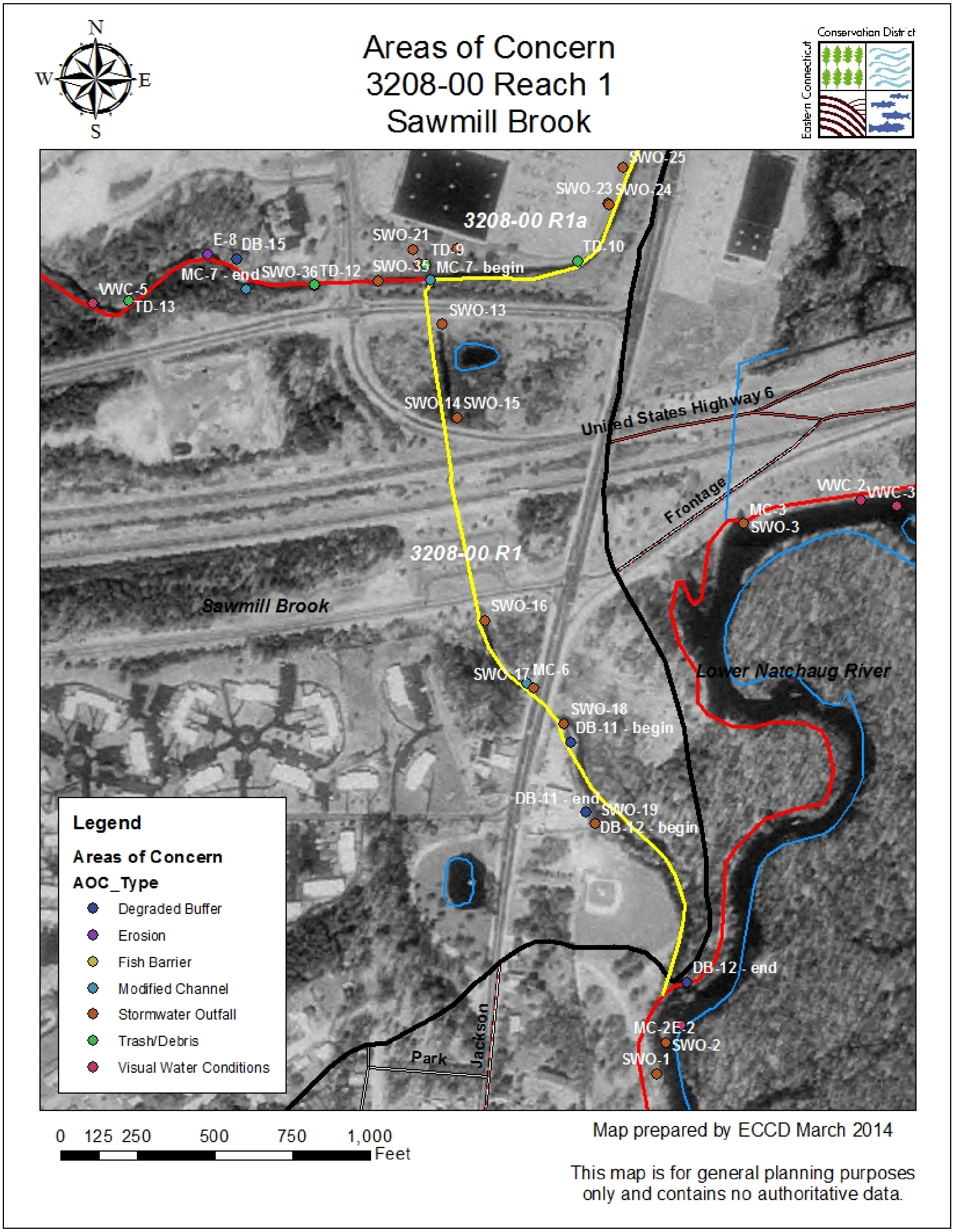
Area of Concern Number	Area of Concern Type	GPS ID #	Latitude	Longitude	Date Acquired	Stream/Basin Code/Reach	Location	Description
VWC-9	Visual water condition	368	41.73265343	-72.21891744	9/17/13	Conantville Br 3208-02 R2	west of ECSU Athletic Complex	Fe bacteria
VWC-10	Visual water condition	370	41.73155908	-72.21969738	9/17/13	Conantville Br 3208-02 R2	north of Rt. 6	west end Eatons Pond, resume stream channel, milky water
VWC-11	Visual water condition	380	41.73092097	-72.22423308	9/17/13	Conantville Br 3208-02 R2	north of Rt. 6	filamentous algae along left bank 50 ft
VWC-12	Visual water condition	382	41.73115256	-72.22473742	9/17/13	Conantville Br 3208-02 R2	north of Rt. 6	oily sheen on water surface assoc. with Fe bacteria
VWC-13	Visual water condition	386	41.73199813	-72.2257305	9/17/13	Conantville Br 3208-02 R3	north of Rt. 6	blue-green algae
VWC-14	Visual water condition	389	41.73478025	-72.22586336	9/17/13	Conantville Br 3208-02 R3	farm south of Pleasant Valley Rd	farm pond with duckweed
VWC-15	Visual water condition	390	41.73700556	-72.22623719	9/17/13	Conantville Br 3208-02 R3	farm south of Pleasant Valley Rd	water very silty/murky at Pleasant Valley Road crossing
VWC-16	Visual water condition	379	41.73960395	-72.23535217	10/18/13	Conantville Br 3208-02 R4	north of Pleasant Valley Rd	pond covered by watermeal/duckweed

Appendix C

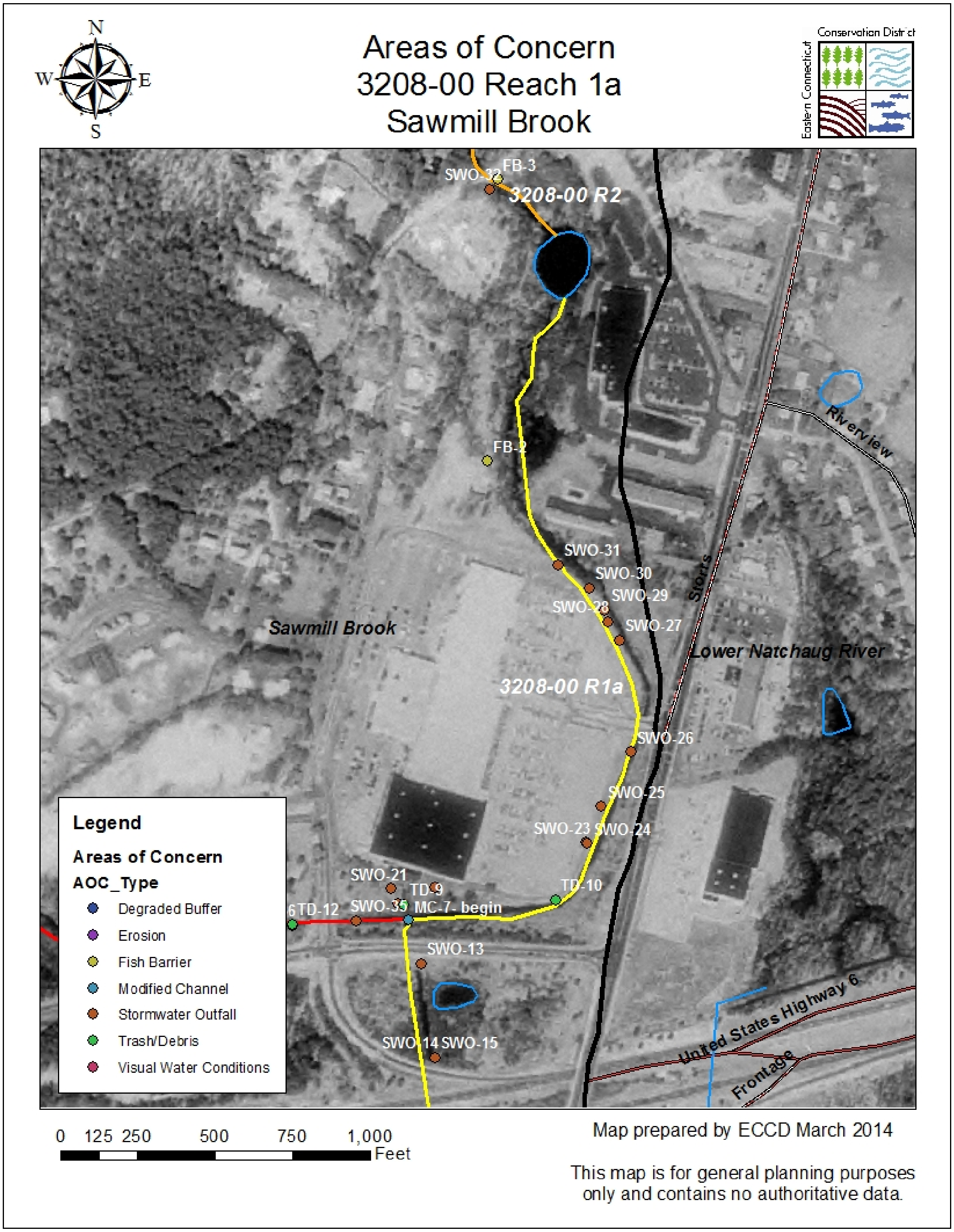
Streamwalk Reach Level Maps



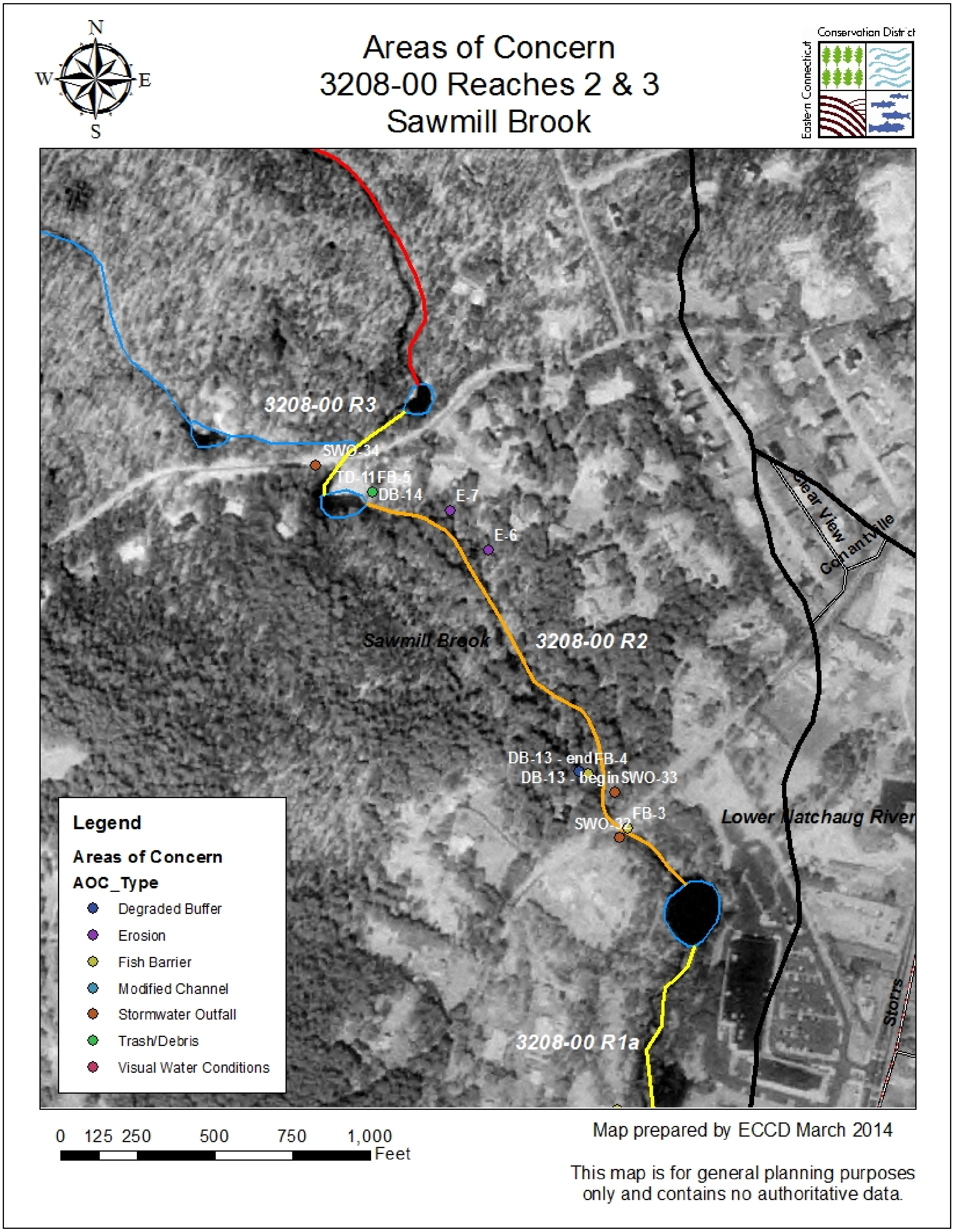

Areas of Concern
3200-00 Reach 1 - North Section
Natchaug River
N
S
E
W
Eastern Connecticut Conservation District
DB-13 - end
FB-4
DB-13 - begin
FB-3
SWO-33
SWO-32
Storrs
FB-2
SWO-31
SWO-30
SWO-29
SWO-28
SWO-27
SWO-26
SWO-25
SWO-23
SWO-24
Sawmill Brook
E-8
DB-15
SWO-21
SWO-35
TD-9
TD-10
SWO-22
SWO-36
TD-12
SWO-13
SWO-14
SWO-15
3200-00 R1
Riverview
FB-1
DB-4
Lower Natchaug River
MC-4
United States Highway 6
Stonegate
Circle
Janet
VWC-4
DB-2
DB-3
Frontage
MC-3
SWO-3
VWC-3
VWC-2
SWO-16
SWO-17
MC-6
SWO-18
DB-11 - begin
DB-11 - end
SWO-19
DB-12 - begin
DB-12 - end
MC-2
E-2
VWC-1
SWO-2
Park
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0
250
500
1,000
1,500
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.

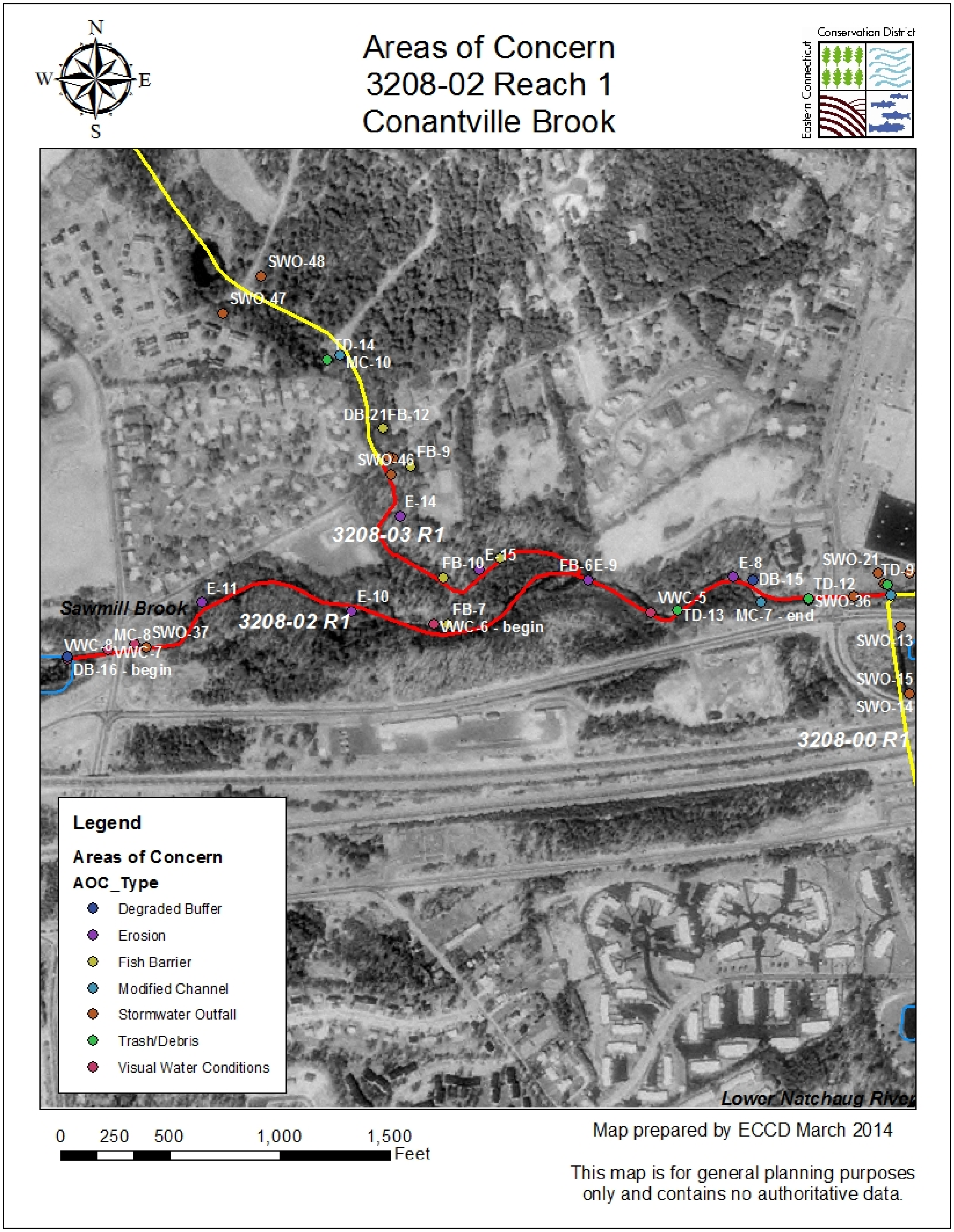


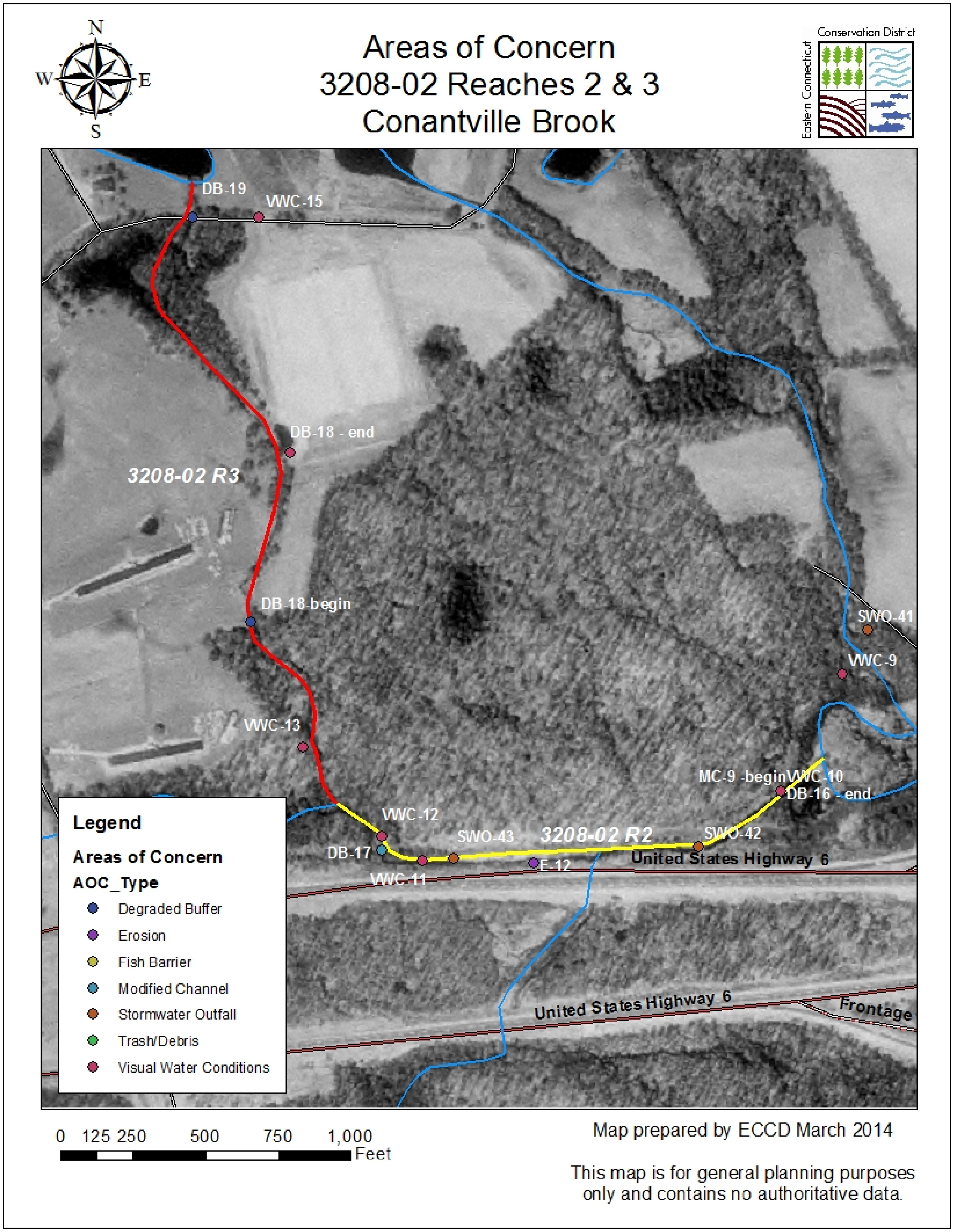
N
W
E
S
Areas of Concern
3208-00 Reach 1
Sawmill Brook
Conservation District
Eastern Connecticut
SWO-25
SWO-23
SWO-24
3208-00 R1a
SWO-21
TD-9
TD-10
E-8
DB-15
MC-7 - end
SWO-36
TD-12
SWO-35
MC-7- begin
VWC-5
TD-13
SWO-13
SWO-14
SWO-15
United States Highway 6
Frontage
VWC-2
VWC-3
MC-3
SWO-3
3208-00 R1
Sawmill Brook
SWO-16
Lower Natchaug River
MC-6
SWO-18
DB-11 - begin
DB-11 - end
SWO-19
DB-12 - begin
DB-12 - end
MC-2
E-2
SWO-2
SWO-1
Park
Jackson
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0
125
250
500
750
1,000
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.

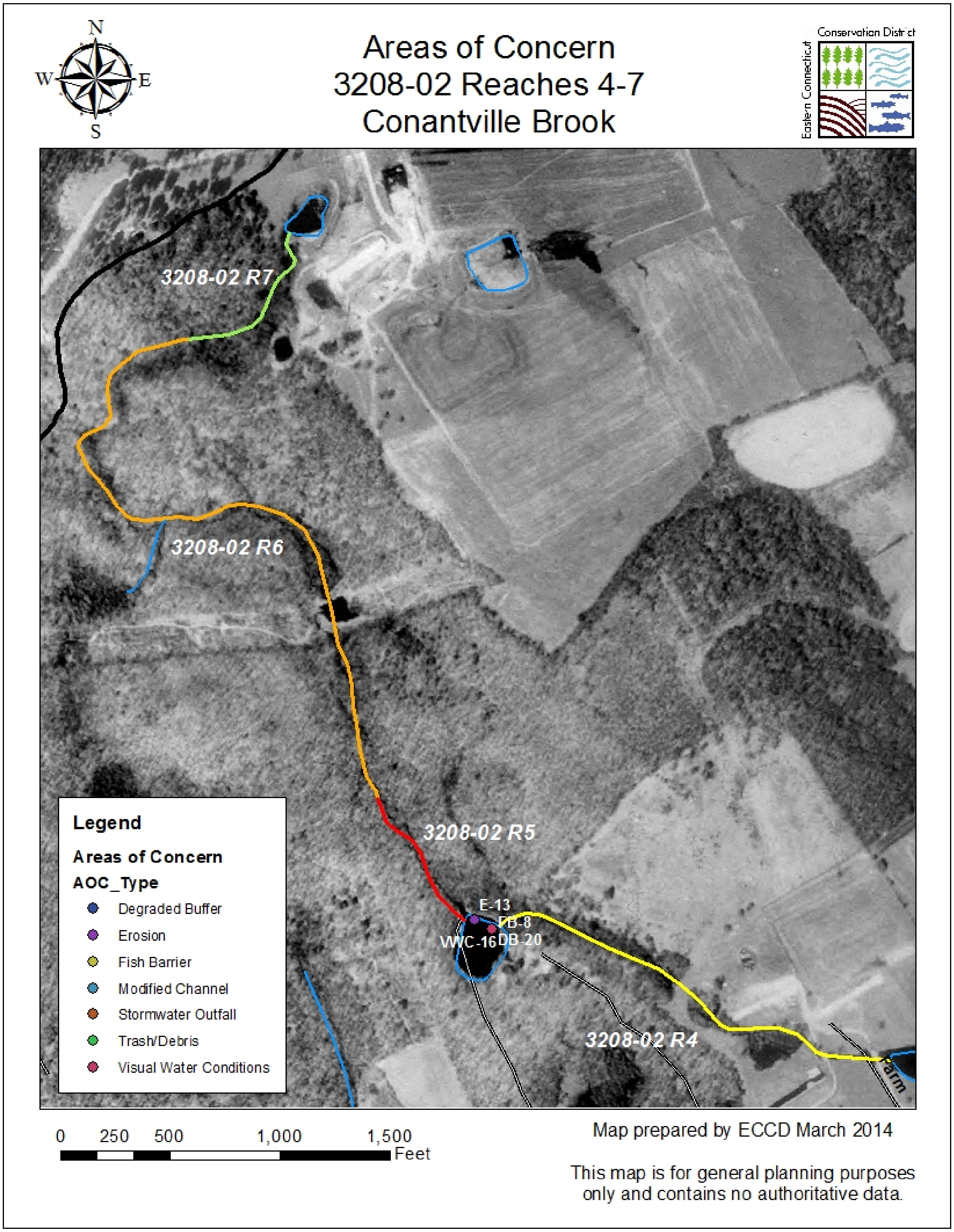


Areas of Concern
3208-00 Reach 1a
Sawmill Brook
N
S
W
E
Conservation District
Eastern Connecticut
FB-3
SWO-32
3208-00 R2
FB-2
SWO-31
SWO-30
SWO-29
SWO-28
SWO-27
Sawmill Brook
3208-00 R1a
Lower Natchaug River
Riverview
Storrs
SWO-26
SWO-25
SWO-23
SWO-24
SWO-21
TD-9
TD-10
6TD-12
SWO-35
MC-7- begin
SWO-13
SWO-14
SWO-15
United States Highway 6
Frontage
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0 125 250 500 750 1,000
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.

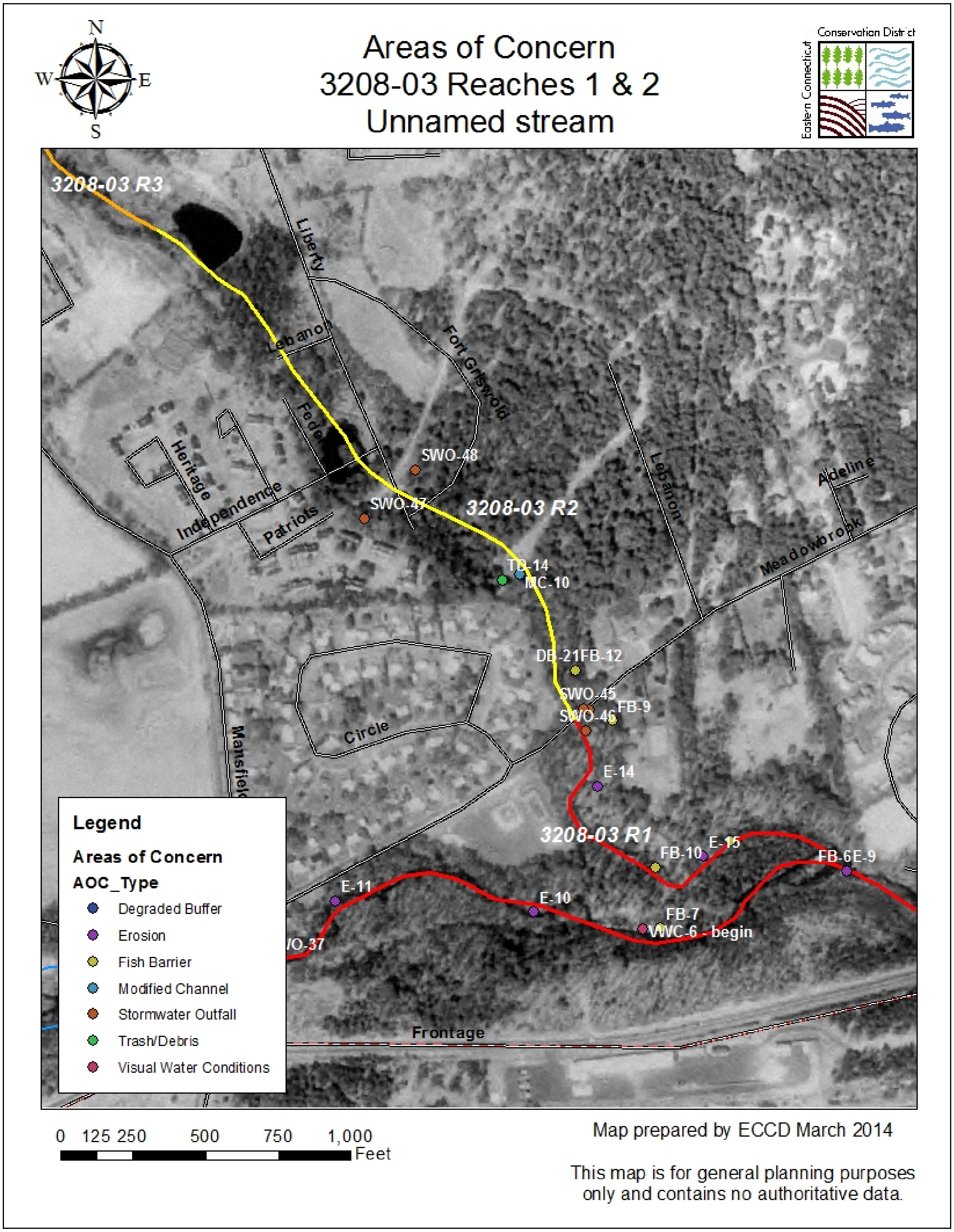

N
W
E
S
Areas of Concern
3208-00 Reaches 2 & 3
Sawmill Brook
Conservation District
Eastern Connecticut
3208-00 R3
SWO-34
TD-11 FB-5
DB-14
E-7
E-6
Clear View
Conantville
Sawmill Brook
3208-00 R2
DB-13 - end FB-4
DB-13 - begin SWO-33
FB-3
SWO-32
Lower Natchaug River
Storrs
3208-00 R1a
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0 125 250 500 750 1,000
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.


Areas of Concern
3208-02 Reach 1
Conantville Brook
N
S
E
W
Eastern Connecticut Conservation District
SWO-48
SWO-47
TD-14
MC-10
DB-21
FB-12
SWO-46
FB-9
E-14
3208-03 R1
FB-10
E-15
FB-6
E-9
E-8
DB-15
SWO-21
TD-9
TD-12
SWO-36
VWC-5
TD-13
MC-7 - end
Sawmill Brook
E-11
E-10
3208-02 R1
FB-7
VWC-6 - begin
VWC-8
MC-8
SWO-37
VWC-7
DB-16 - begin
SWO-13
SWO-15
SWO-14
3208-00 R1
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
Lower Natchaug River
0
250
500
1,000
1,500
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.


N
W
E
S
Areas of Concern
3208-02 Reaches 2 & 3
Conantville Brook
Conservation District
Eastern Connecticut
DB-19
VWC-15
DB-18 - end
3208-02 R3
DB-18-begin
SWO-41
VWC-9
VWC-13
MC-9 -begin
VWC-10
DB-16 - end
VWC-12
SWO-43
3208-02 R2
SWO-42
DB-17
E-12
United States Highway 6
VWC-11
United States Highway 6
Frontage
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0 125 250 500 750 1,000
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.



N
S
W
E
Areas of Concern
3208-02 Reaches 4-7
Conantville Brook
Conservation District
Eastern Connecticut
3208-02 R7
3208-02 R6
3208-02 R5
3208-02 R4
E-13
FB-8
WC-16
DB-20
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0 250 500 1,000 1,500
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.



N
S
W
E
Areas of Concern
3208-03 Reaches 1 & 2
Unnamed stream
Eastern Connecticut
Conservation District
3208-03 R3
Liberty
Lebanon
Fort Griswold
Heritage
Independence
Patriots
SWO-48
SWO-47
3208-03 R2
TD-14
MC-10
Lebanon
Adeline
Meadowbrook
DB-21FB-12
SWO-45
SWO-46
FB-9
Circle
Mansfield
E-14
3208-03 R1
FB-10
E-15
FB-6E-9
E-11
E-10
FB-7
VWC-6 - begin
Frontage
Legend
Areas of Concern
AOC_Type
Degraded Buffer
Erosion
Fish Barrier
Modified Channel
Stormwater Outfall
Trash/Debris
Visual Water Conditions
0 125 250 500 750 1,000
Feet
Map prepared by ECCD March 2014
This map is for general planning purposes only and contains no authoritative data.

Appendix D

Statewide Bacteria TMDL Appendix 13 – Natchaug River

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Natchaug River

Watershed Summary

Impaired Segment Facts

Impaired Segment Name: Natchaug River (CT3200-00_01)

Municipalities: Windham and Mansfield

Impaired Segment Length (miles): 3.38

Water Quality Classification: Class A

Designated Use Impairment: Recreation

Sub-regional Basin Name and Code: Natchaug River, 3200

Regional Basin: Natchaug

Major Basin: Connecticut

Watershed Area (acres): 18,733

MS4 Applicable? No

Figure 1: Watershed location in Connecticut

WATERSHED DESCRIPTION AND MAPS

The Natchaug River watershed makes up 114,000 acres of land in northeastern Connecticut, and supports the largest public surface drinking water supply watershed in Connecticut. The smaller Natchaug subwatershed, and the focus of this TMDL, covers an area of approximately 18,733 acres in northeastern Connecticut, and makes up the southern portion of the larger Natchaug River watershed (Figure 1). The upper watershed is located primarily in Eastford, with a small portion of land in Ashford to the west. The central watershed is located in Chaplin with a small portion in Hampton to the east. The southern portion of the watershed is located in Mansfield and Windham.

The Natchaug River watershed includes one segment impaired for recreation due to elevated bacteria levels. This segment was assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and included in the CT 2010 303(d) list of impaired waterbodies. An excerpt of the Integrated Water Quality Report is included in Table 1 (CTDEEP, 2010).

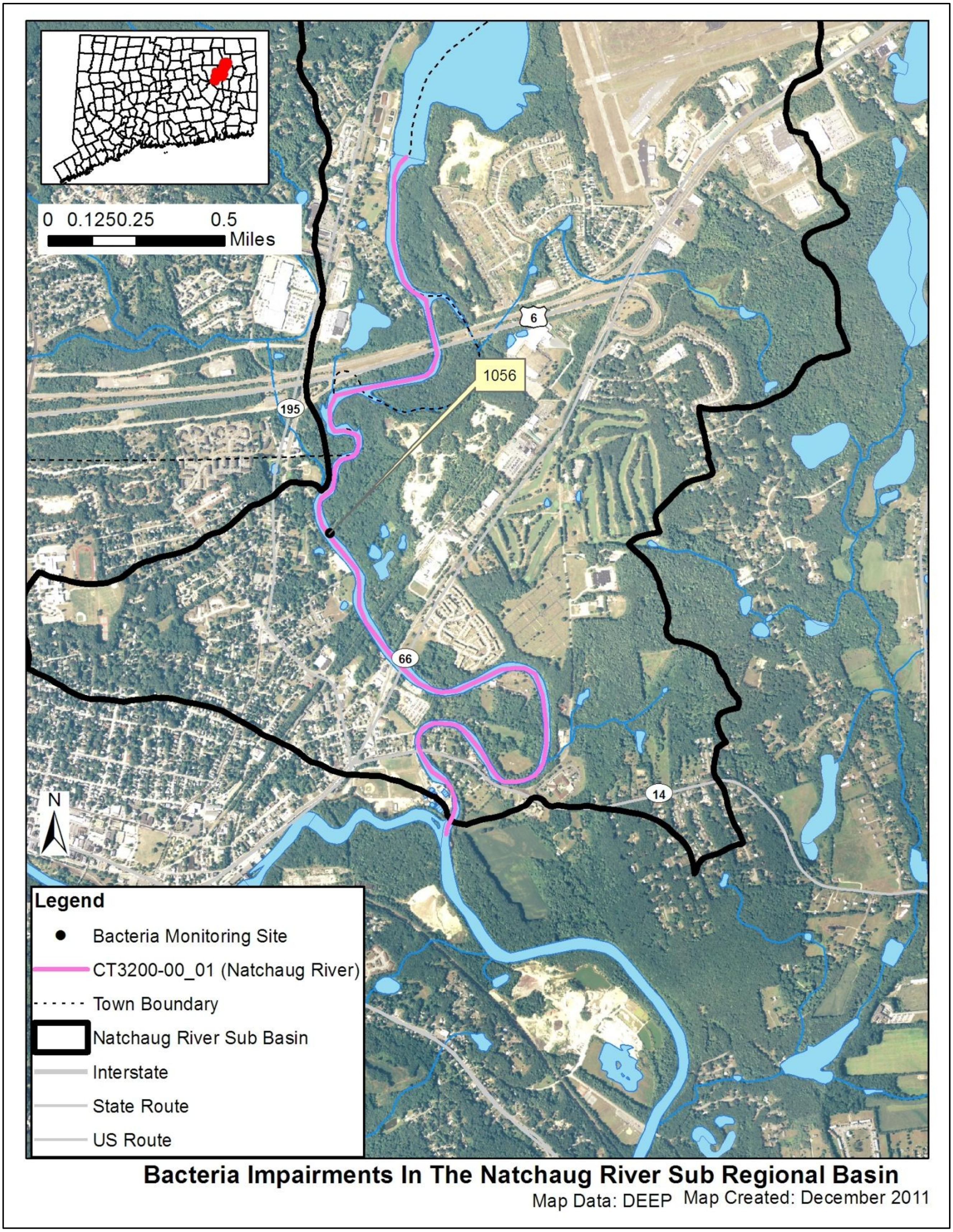
The Natchaug River begins within the northwest corner of the Natchaug State Forest just south of the intersection of Routes 44 and 198 in Eastford. From there, the river flows south along the edge of the State Forest, and then flows southwest into Chaplin, and west into the Mansfield Hollow State Park in Mansfield. The river flows through Mansfield Hollow Lake, a 500-acre lake created by the damming of the Natchaug River. The river continues south into the Willimantic Reservoir, a public drinking water supply which includes the Windham Reservoir Dam, a pump house and the Town of Windham Water Treatment Facility. The impaired segment (CT3200-00_01) begins at the dam outlet and flows south under Route 6, past Phillip Lauter Park, under Route 66, and into the Willimantic River within the City of Willimantic. The Natchaug River and Willimantic River join to form the Shetucket River. The most heavily developed area of the watershed is located in the southern portion of the watershed adjacent to the impaired segment.

The impaired segment of the Natchaug River has a water quality classification of A. Designated uses include potential drinking water supply, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. This segment of the river is impaired due to elevated bacteria concentrations, affecting the designated use of recreation. Phillip Lauter Park in Willimantic has a designated beach and therefore, the specific recreation impairment is for designated swimming and other water contact related activities.

Table 1: Impaired segment from the Connecticut 2010 Integrated Water Quality Report

Waterbody ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation	Fish Consumption
CT3200-00_01	Natchaug River-01	From mouth at confluence with Willimantic River, above Shetucket River (DS of Brick Top Road (Route 14) crossing), Windham, US to Willimantic Reservoir outlet dam (Natchaug River Dam), southwest of Windham Airport, Windham/Mansfield town border.	3.38	U	NOT	FULL*
CT3200-00_02	Natchaug River-02	From Mansfield Hollow Reservoir inlet at Basset Bridge Road crossing (name changes to Station Road between North Windham Road and Route 6), Windham, US to headwaters (confluence of Bigalow Brook and Still River), Eastford.	11.03	FULL	FULL	FULL*
Shaded cells indicate impaired segment addressed in this TMDL **FULL = Designated Use Fully Supported** **NOT = Designated Use Not Supported** **U = Unassessed**						

Figure 2: GIS map featuring general information of the Natchaug River watershed at the sub-regional level (the location and name of the sampling station is indicated on the impaired segment)



Land Use

Existing land use can affect the water quality of waterbodies within a watershed (USEPA, 2011c). Natural processes, such as soil infiltration of stormwater and plant uptake of water and nutrients, can occur in undeveloped portions of the watershed. As impervious surfaces (such as rooftops, roads, and sidewalks) increase within the watershed landscape from commercial, residential, and industrial development, the amount of stormwater runoff to waterbodies also increases. These waterbodies are negatively affected as increased pollutants from nutrients and bacteria from failing and insufficient septic systems, oil and grease from automobiles, and sediment from construction activities become entrained in this runoff. Agricultural land use activities, such as fertilizer application and manure from livestock, can also increase pollutants in nearby waterbodies (USEPA, 2011c).

As shown in Figures 3 and 4, the Natchaug River watershed consists of 67% forest, 17% urban, 9% water (which includes wetlands), and 7% agricultural land uses. A concentrated area of urban development is located in the southern portion of the watershed adjacent to the impaired segment (Figure 4). This area includes the Windham Airport, large residential subdivisions and condominium complexes, the North Windham Shopping Center, the Willimantic Country Club, a portion of the Eastern Connecticut State University campus, mining operations, and a mix of commercial and residential development. The remainder of the urban development in the watershed is limited to the roadways and village centers. The upper Natchaug River watershed is dominated by forestland including a large area within the Natchaug State Forest in Eastford which forms the headwaters of the Natchaug River. Additional protected land in the watershed includes the Nathaniel Lyon Memorial State Park, north of the Natchaug State Forest, portions of the James L. Goodwin State Forest and CT State Wildlife Management Area in Chaplin, and a portion of the Beaver Brook State Park Scenic Reserve in Windham. There are several lakes and ponds throughout the watershed, upstream of the impaired segment, including the Willimantic Reservoir and Mansfield Hollow Lake in the southern portion of the watershed, Black Spruce Pond within the State Forest in Chaplin, and Hall's Pond in Eastford. The Natchaug River wateshed has been called the "Last Green Valley" between Washington and Boston (GVI, 2000).

Figure 3: Land use within the Natchaug River watershed

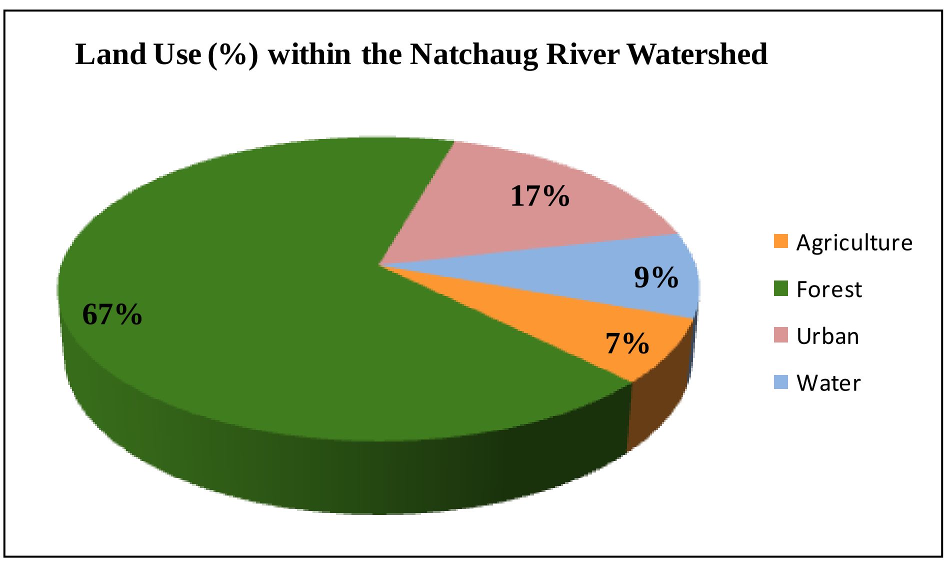
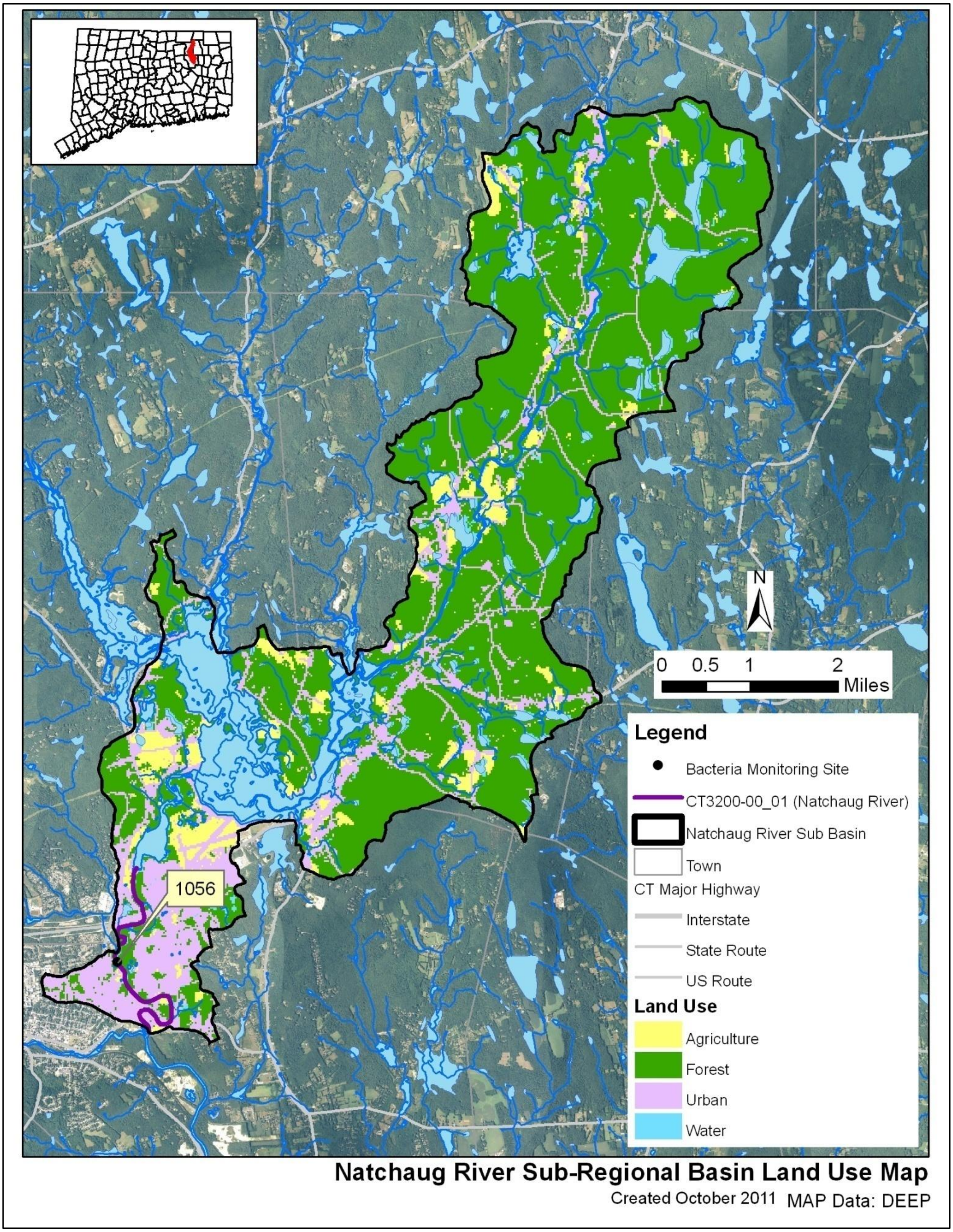


Figure 4: GIS map featuring land use for the Natchaug River watershed at the sub-regional level



WHY IS A TMDL NEEDED?

E. coli is the indicator bacteria used for comparison with the CT State criteria in the CT Water Quality Standards (WQS) (CT DEEP, 2011). All data results are from CT DEEP, USGS, Bureau of Aquaculture, or volunteer monitoring efforts at stations located on the impaired segments.

Table 2: Sampling station location description for the impaired Segment in the Natchaug River watershed

Waterbody ID	Waterbody Name	Station	Station Description	Municipality	Latitude	Longitude
CT3200-00_01	Natchaug River	1056	Lauter Park off Gordon Ave.	Windham	41.725000	-72.199167

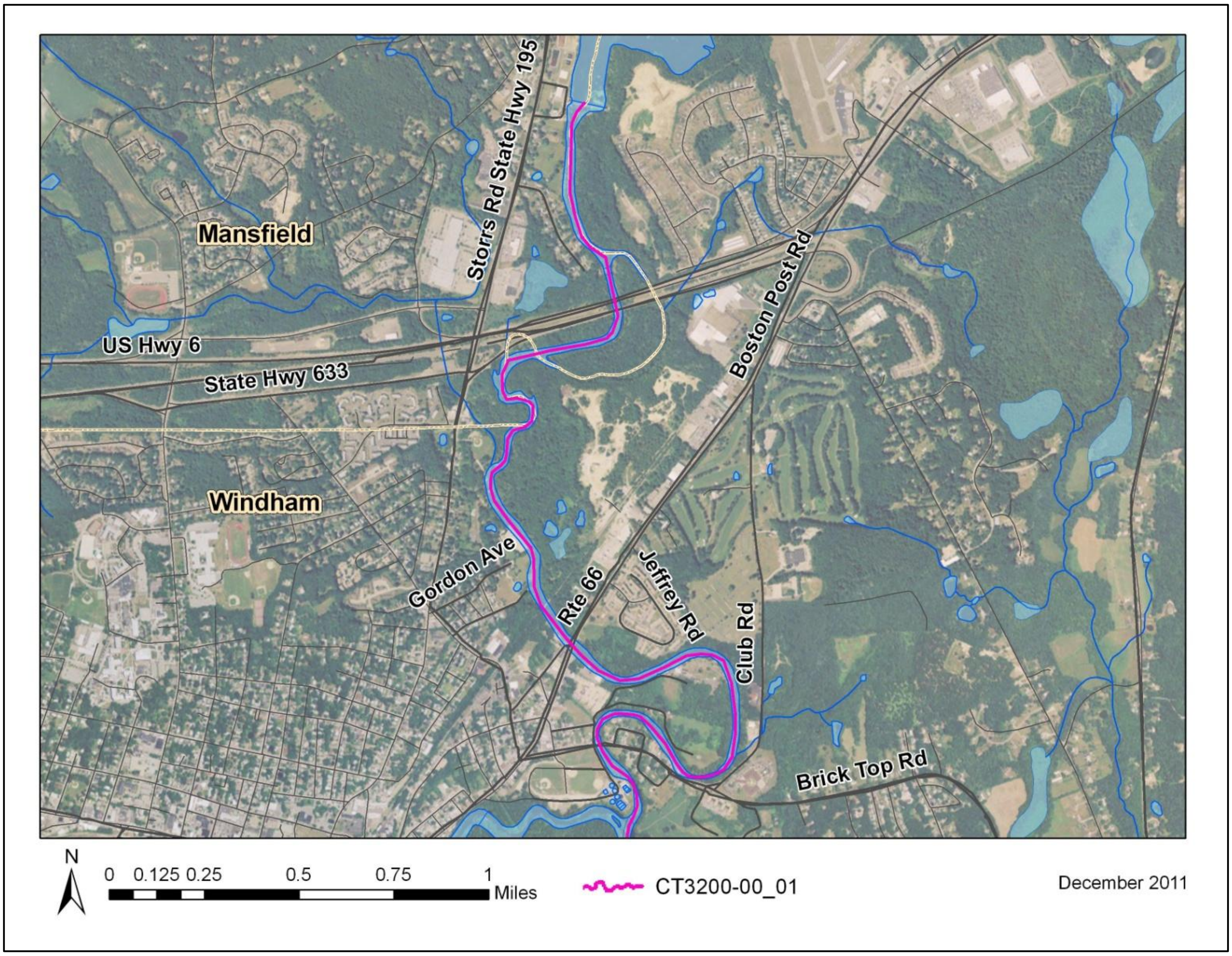
Natchaug River (CT3200-00_01) is a Class A freshwater river (Figure 5). Its applicable designated uses are potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Water quality analyses were conducted using data from one sampling location from 1998, 1999 and 2001 (Station 1056) (Table 2).

The water quality criteria for *E. coli*, along with bacteria sampling results for Station 1056 from 1998, 1999 and 2001, are presented in Table 8. Single sample values at this station exceeded the WQS for *E. coli* once in 1999 during a wet-weather sampling event. The annual geometric mean was calculated for Station 1056 in 2001, but did not exceed the WQS for *E. coli*.

To aid in identifying possible bacteria sources, the geometric mean was also calculated for wet-weather and dry-weather sampling days at Station 1056 (Table 8). There was not enough data to calculate a geometric mean for wet-weather samples because only one wet-weather sample was collected over the sampling period. The geometric mean during dry-weather did not exceed the WQS for *E. coli.*

Due to the elevated bacteria measurement presented in Table 8, this segment of Natchaug River did not meet CT's bacteria WQS, was identified as impaired, and was placed on the CT List of Waterbodies Not Meeting Water Quality Standards, also known as the CT 303(d) Impaired Waters List. The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with State WQS.

Figure 5: Aerial map of the Natchaug River



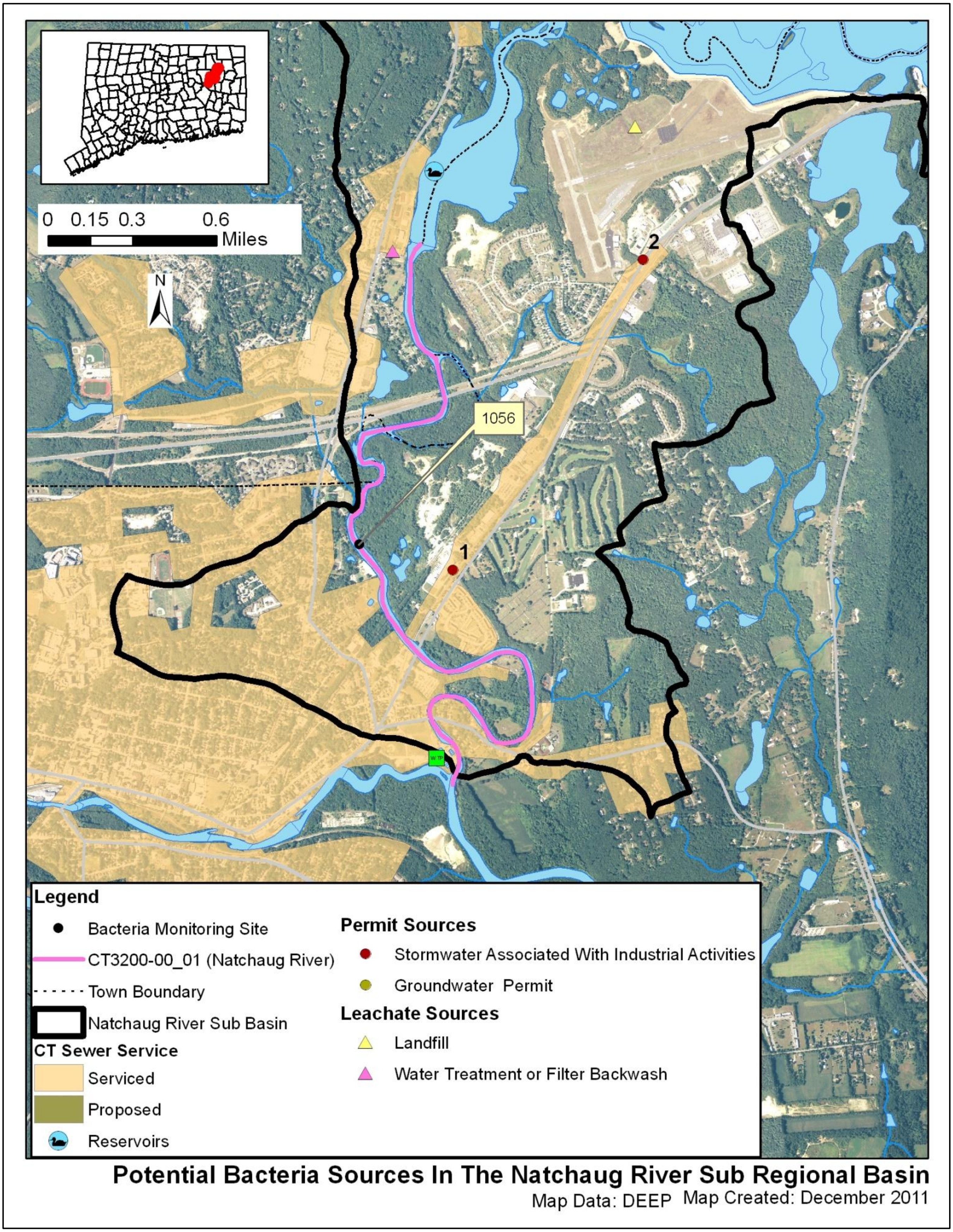
POTENTIAL BACTERIA SOURCES

Potential sources of indicator bacteria in a watershed include point and non-point sources, such as stormwater runoff, agriculture, sanitary sewer overflows (collection system failures), illicit discharges, and inappropriate discharges to the waterbody. Potential sources that have been tentatively identified in the Natchaug River watershed based on land use (Figures 3 and 4) and a collection of local information for the impaired waterbody is presented in Table 3 and shown in Figure 6. The list of potential sources is general in nature and should not be considered comprehensive. There may be other sources not listed here that contribute to the observed water quality impairment in the study segment. Further monitoring and investigation will confirm listed sources and discover additional sources. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement these TMDLs.

Table 3: Potential bacteria sources in the Natchaug River watershed

Impaired Segment	Permit Source	Illicit Discharge	CSO/SSO Issue	Failing Septic System	Agricultural Activity	Stormwater Runoff	Nuisance Wildlife/ Pets	Other
Natchaug River CT3200-00_01	x	x	x	x		x	x	

Figure 6: Potential sources in the Natchaug River watershed at the sub-regional level



The potential sources map for the impaired basin was developed after thorough analysis of available data sets. If information is not displayed in the map, then no sources were discovered during the analysis. The following is the list of potential sources that were evaluated: problems with migratory waterfowl, golf course locations, reservoirs, proposed and existing sewer service, cattle farms, poultry farms, permitted sources of bacteria loading (surface water discharge, MS4 permit, industrial stormwater, commercial stormwater, groundwater permits, and construction related stormwater), and leachate and discharge sources (agricultural waste, CSOs, failing septic systems, landfills, large septic tank leach fields, septage lagoons, sewage treatment plants, and water treatment or filter backwash).

Point Sources

Permitted sources within the watershed that could potentially contribute to the bacteria loading are identified in Table 4. This table includes permit types that may or may not be present in the impaired watershed. A list of permits in the watershed is included in Table 5 and Table 6. Additional investigation and monitoring could reveal the presence of additional discharges in the watershed. Available effluent data from each of these permitted categories found within the watershed are compared to the CT State WQS for the appropriate receiving waterbody use and type.

Table 4: General categories list of other permitted discharges

Permit Code	Permit Description Type	Number in watershed
CT	Surface Water Discharges	0
GPL	Discharge of Swimming Pool Wastewater	0
GSC	Stormwater Discharge Associated with Commercial Activity	0
GSI	Stormwater Associated with Industrial Activity	3
GSM	Part B Municipal Stormwater MS4	0
GSN	Stormwater Registration – Construction	0
LF	Groundwater Permit (School)	1
UI	Underground Injection	0

Permitted Sources

As shown in Table 5, there are several permitted discharges in the Natchaug River watershed. Bacteria data from 2001-2002 from some of these industrial permitted facilities are included in Table 6. Though this data cannot be compared to a water quality standard as Connecticut only has a water quality standard for fecal coliform bacteria for shellfishing uses, multiple samples were high, with several samples from multiple outfalls at United Abrasives (GSI695) exceeding 600 colonies/100 mL and samples from one site at the State of Connecticut Department of Transportation (GSI918) as high as 38,000 colonies/100 mL. Likewise, runoff from Republic Oil, Inc. exceeded 600 colonies/100 mL.

Since the MS4 permits are not targeted to a specific location, but the geographic area of the regulated municipality, there is no one accurate location on the map to display the location of these permits. One dot will be displayed at the geographic center of the municipality as a reference point (Figure 6). Sometimes this location falls outside of the targeted watershed and therefore the MS4 permit will not be displayed in the Potential Sources Map. Using the municipal border as a guideline will show which areas of an affected watershed are covered by an MS4 permit.

Table 5: Permitted facilities within the Natchaug River watershed

Town	Client	Permit ID	Permit Type	Site Name/Address	Map #
North Windham	Builders Concrete East LLC	GSI001646	Stormwater Associated With Industrial Activities	Builders Concrete East, LLC	1
North Windham	State Of Connecticut Department Of Transportation	GSI000918	Stormwater Associated With Industrial Activities	Windham Airport	2
North Windham	Town Of Windham	UI0000141	Groundwater Permit	North Windham Elementary School	N/A
Chaplin	Town Of Chaplin	GSI000953	Stormwater Associated With Industrial Activities	Chaplin Transfer Station	N/A

Table 6: Industrial permits on the Natchaug River and available fecal coliform data (colonies/100mL)

Town	Location	Permit Number	Receiving Water	Sample Location	Sample Date	Result
Windham	United Abrasives	GSI000695	Natchaug River	'10"CI,6"PVC drainpipe 6ft rear of property	09/25/01	1,800
Windham	United Abrasives	GSI000695	Natchaug River	'10"CI,6"PVC drainpipe 6ft rear of property	10/16/02	1,020
Windham	United Abrasives	GSI000695	Natchaug River	Ex 36" Accmp. at entrance of un-named brook	09/25/01	10
Windham	United Abrasives	GSI000695	Natchaug River	Ex 36" Accmp. at entrance of un-named brook	10/16/02	>600
Windham	ST of CT DOT	GSI000918	Natchaug River	Windham Airport DSN A	10/16/02	38,000
Windham	ST of CT DOT	GSI000918	Natchaug River	Windham Airport DSN B	10/16/02	20
Windham	Republic Oil Inc	GSI000983	Natchaug River	Runoff from SW portion	08/29/02	>600

Municipal Stormwater Permitted Sources

Per the EPA Phase II Stormwater rule all municipal storm sewer systems (MS4s) operators located within US Census Bureau Urbanized Areas (UAs) must be covered under MS4 permits regulated by the appropriate State agency. There is an EPA waiver process that municipalities can apply for to not participate in the MS4 program. In Connecticut, EPA has granted such waivers to 19 municipalities. All participating municipalities within UAs in Connecticut are currently regulated under MS4 permits by CT DEEP staff in the MS4 program.

The US Census Bureau defines a UA as a densely settled area that has a census population of at least 50,000. A UA generally consists of a geographic core of block groups or blocks that exceeds the 50,000 people threshold and has a population density of at least 1,000 people per square mile. The UA will also include adjacent block groups and blocks with at least 500 people per square mile. A UA consists of all or part of one or more incorporated places and/or census designated places, and may include additional territory outside of any place. (67 FR 11663)

For the 2000 Census a new geographic entity was created to supplement the UA blocks of land. This created a block known as an Urban Cluster (UC) and is slightly different than the UA. The definition of a UC is a densely settled area that has a census population of 2,500 to 49,999. A UC generally consists of a geographic core of block groups or blocks that have a population density of at least 1,000 people per square mile, and adjacent block groups and blocks with at least 500 people per square mile. A UC consists of all or part of one or more incorporated places and/or census designated places; such a place(s) together with adjacent territory; or territory outside of any place. The major difference is the total population cap of 49,999 people for a UC compared to >50,000 people for a UA. (67 FR 11663)

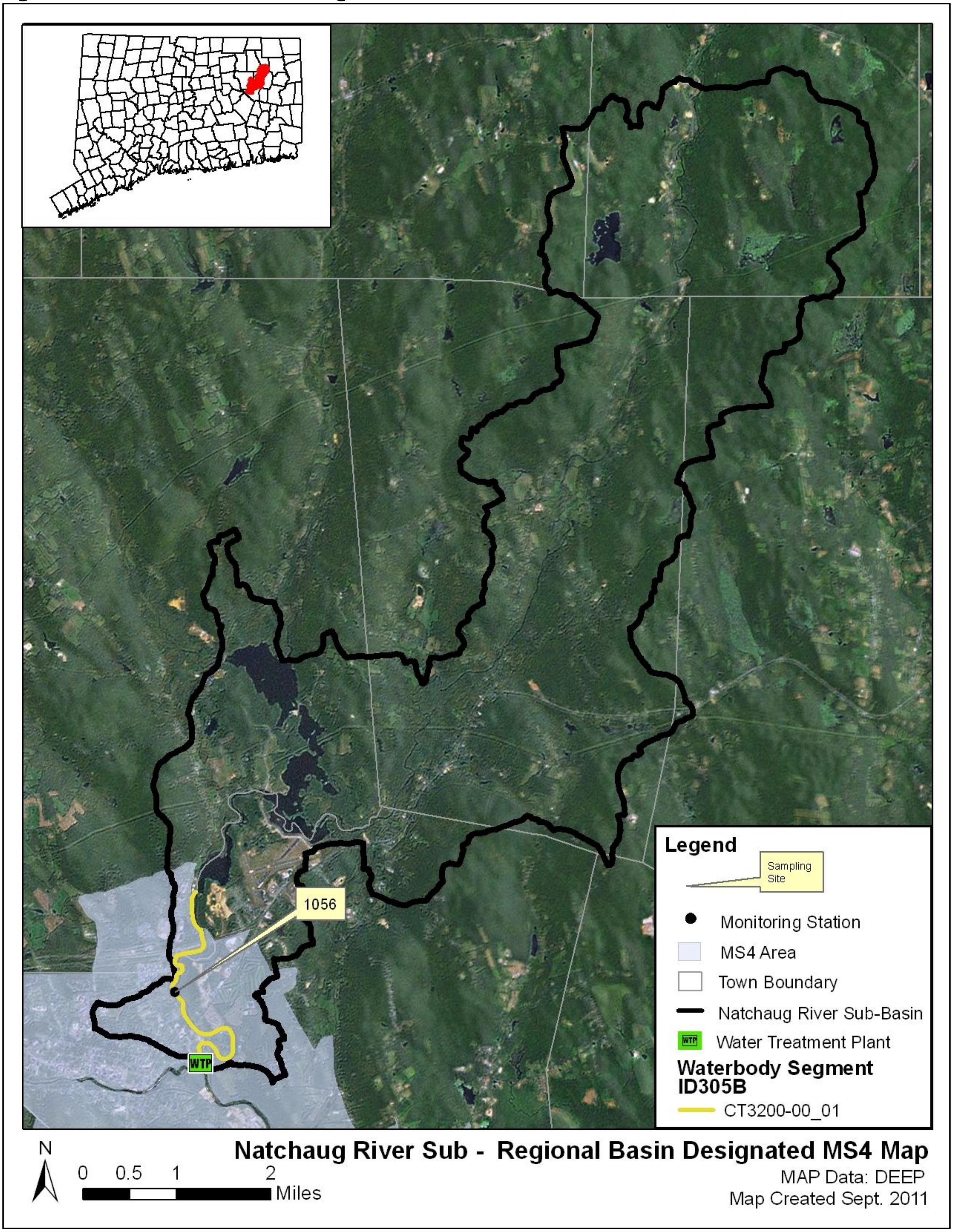
While it is possible that CT DEEP will be expanding the reach of the MS4 program to include UC municipalities in the near future they are not currently under the permit. However, the GIS layers used to create the MS4 maps in this Statewide TMDL did include both UA and UC blocks. This factor creates some municipalities that appear to be within an MS4 program that are not currently regulated through an MS4 permit. This oversight can explain a municipality that is at least partially shaded grey in the maps and there are no active MS4 reporting materials or information included in the appropriate appendix. While these areas are not technically in the MS4 permit program, they are still considered urban by the cluster definition above and are likely to contribute similar stormwater discharges to affected waterbodies covered in this TMDL.

As previously noted, EPA can grant a waiver to a municipality to preclude their inclusion in the MS4 permit program. One reason a waiver could be granted is a municipality with a total population less than 1000 people, even if the municipality was located in a UA. There are 19 municipalities in Connecticut that have received waivers, this list is: Andover, Bozrah, Canterbury, Coventry, East Hampton, Franklin, Haddam, Killingworth, Litchfield, Lyme, New Hartford, Plainfield, Preston, Salem, Sherman, Sprague, Stafford, Washington, and Woodstock. There will be no MS4 reporting documents from these towns even if they are displayed in an MS4 area in the maps of this document.

The list of US Census UCs is defined by geographic regions and is named for those regions, not necessarily by following municipal borders. In Connecticut the list of UCs includes blocks in the following Census Bureau regions: Colchester, Danielson, Lake Pocotopaug, Plainfield, Stafford, Storrs, Torrington, Willimantic, Winsted, and the border area with Westerly, RI (67 FR 11663). Any MS4 maps showing these municipalities may show grey areas that are not currently regulated by the CT DEEP MS4 permit program.

The area identified in Figure 7 is the Willimantic Urban Cluster, and is therefore not an MS4 community. Additional information regarding stormwater management and the MS4 permit can be obtained on CTDEEP's website (http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325702&depNav_GID=1654).

Figure 7: MS4 areas of the Natchaug River watershed



Publicly Owned Treatment Works

As shown in Figure 6, there is one publicly owned treatment works (POTWs), or wastewater treatment plant (WTP) in the Natchaug River watershed. The Windham Water Treatment Control Facility (WTCF) is located on the watershed boundary where the Natchaug River flows into the Willimantic River. While a portion of the treatment facility is located in the watershed, the plant discharges to the Willimantic River. Bacteria data from this permitted facility is not currently available, nor would it have any impact on the impaired Natchaug River segment (Table 6).

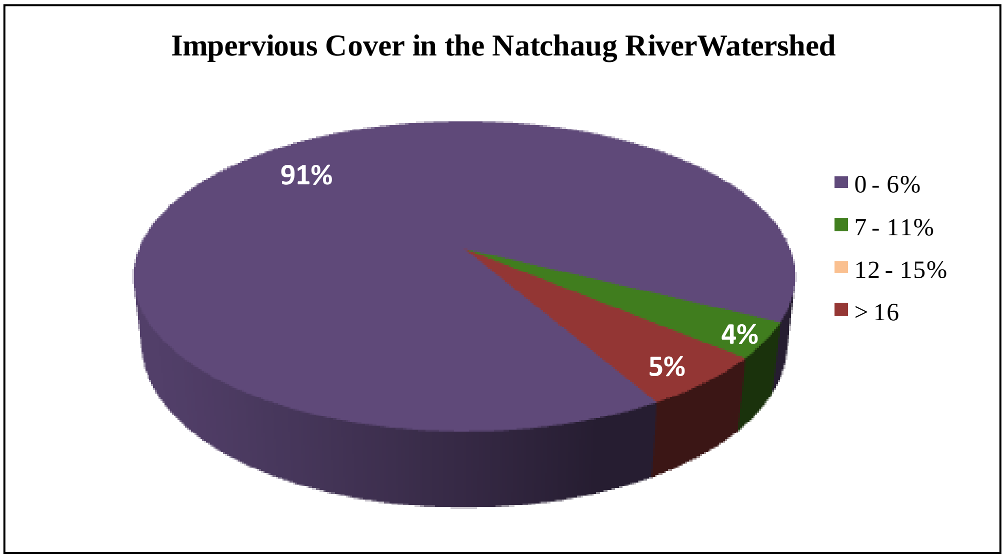
Non-point Sources

Non-point source pollution (NPS) comes from many diffuse sources and is more difficult to identify and control. NPS pollution is often associated with land-use practices. Examples of NPS that can contribute bacteria to surface waters include insufficient septic systems, pet and wildlife waste, agriculture, and contact recreation (swimming or wading). Potential sources of NPS within the Natchaug River watershed are described below.

Stormwater Runoff from Developed Areas

Approximately one-quarter of the Natchaug River watershed is developed (including industrial, commercial and residential development and agriculture). The majority of this development is located south of the Willimantic Reservoir within the land adjacent to the impaired segment. This area includes the Windham Airport, large residential subdivisions and condominium complexes, the North Windham Shopping Center, the Willimantic Country Club, a portion of the Eastern Connecticut State University campus, mining operations, and a mix of commercial and residential development. The remainder of the urban development in the watershed is limited to the roadways and village centers. Approximately 17% of the land use in the watershed is considered urban, with the majority of that urban development adjacent to the impaired segment in the lower watershed (Figures 4 and 8). Urban areas are often characterized by impervious cover, or surface areas such as roofs and roads that force water to run off land surfaces rather than infiltrate into the soil. Studies have shown a link between increasing impervious cover and degrading water quality conditions in a watershed (CWP, 2003). In one study, researchers correlated the amount of fecal coliform to the percent of impervious cover in a watershed (Mallin *et al*., 2000).

Figure 8: Range of impervious cover (%) in the Natchaug River watershed

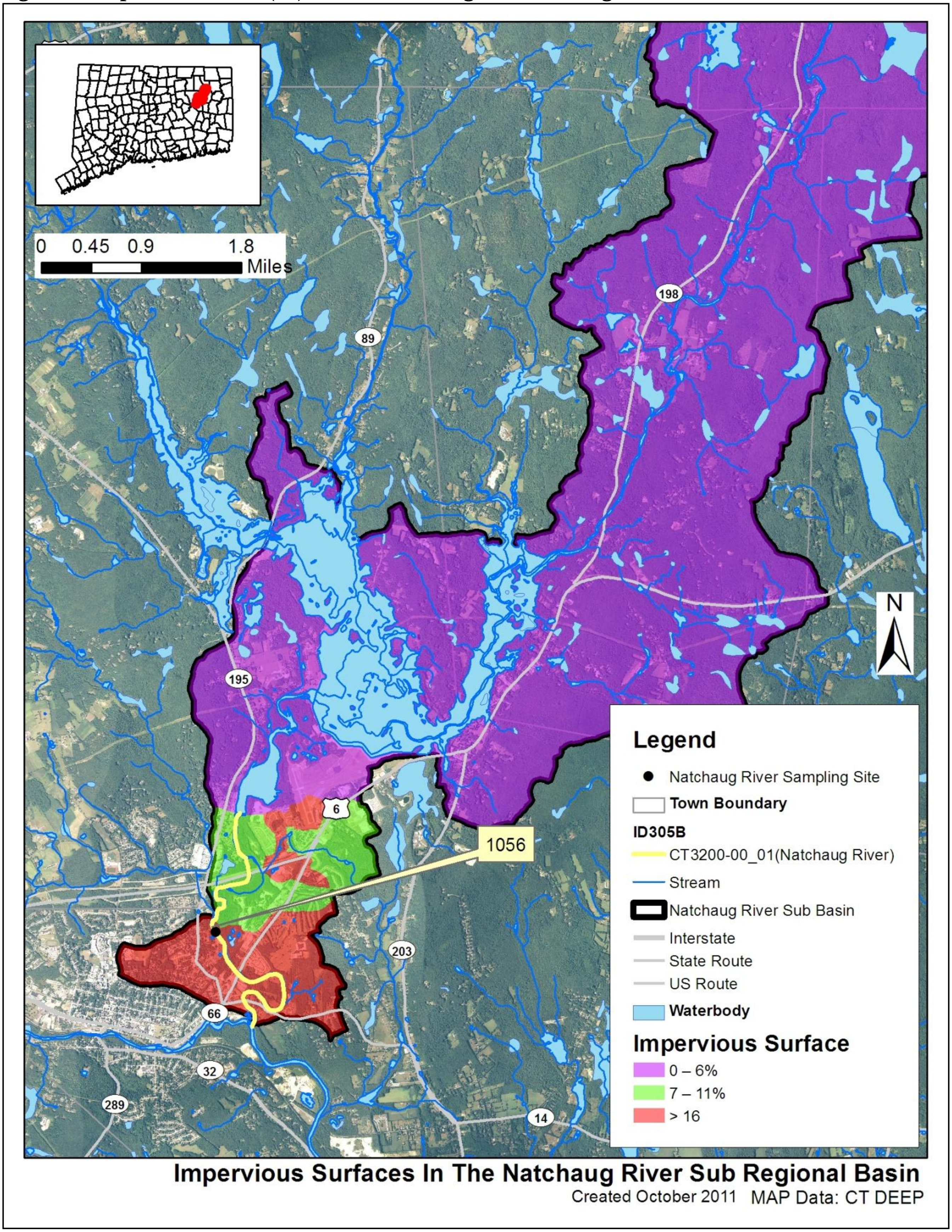


There are at least two active permitted stormwater outfalls in the watershed (Figure 6), with potential for many more inactive permits (Tables 6 and 7) as well as unknown stormwater outfalls to the Natchaug River. Potential bacteria sources from these outfalls could impact the water quality of the Natchaug River. A watershed study to map stormwater outfalls that contribute to the impairment in the river should be considered to improve water quality.

As shown in Figure 9, the portion of the Natchaug River watershed containing the impaired segment contains a high percentage of impervious cover, ranging from 7-11% in the section immediately below the dam, to greater than 16% impervious cover in the southern portion of the watershed below the sampling station, and around the Windham Airport. The remainder of the watershed above the impaired segment contains areas of impervious cover between 0-6% typical of more rural residential, agricultural, and forested watersheds. High geometric means during wet-weather may indicate that stormwater runoff is contributing to the bacterial impairment in a river segment. As shown in Table 8, the bacteria concentration in the Natchaug River exceeded the WQS at Station 1056 on the impaired segment during a wet-weather sampling event.

The Town of Windham/Willimantic is experiencing continued growth, with a surge of development in the less developed areas of North Windham, new homes filling in previously undeveloped lots in both Windham Center and South Windham, and a major downtown revitalization taking place (Windham, 2012). This new development will increase the percentage of impervious cover in the watershed and if not managed well, could increase the volume of polluted stormwater entering the Natchaug River.

Figure 9: Impervious cover (%) for the Natchaug River sub-regional watershed



Wildlife and Domestic Animal Waste

Wildlife and domestic animals within the Natchaug River watershed represent another potential source of bacteria. Wildlife, including waterfowl, may be a significant bacteria source to surface waters, including the Natchaug River, especially in the riparian areas adjacent to the river that wildlife use as wildlife corridors. These corridors provide trail systems for wildlife to get from one food source to the next, and are often linked to large blocks of undeveloped land, including the conservation land located throughout the watershed. In addition, construction of roads and drainage systems may convey these wastes via stormwater runoff to the nearest surface water. These physical land alterations can exacerbate the impact of natural sources on water quality because the wastes are no longer retained on the landscape (USEPA, 2001).

Waterfowl, especially grazers like geese, prefer easy access to water. Reservoirs and other large open bodies of water such as the Willimantic Reservoir and Mansfield Hollow Lake upstream of the impaired segment are attractive to waterfowl such as ducks and geese. Maintaining a natural, uncut vegetated buffer around these waterbodies will help make shoreline less desirable to these birds and limit this bacteria source. Waterfowl are also known to congregate in open areas including recreational fields, public beaches such as Philip Lauter Park, and golf courses such as the Willimantic Country Club. In addition to creating a nuisance, large numbers of geese can also create unsanitary conditions on the grassed areas and cause water quality problems due to bacterial contamination associated with their droppings. Large populations of geese can also lead to habitat destruction as a result of overgrazing on wetland and riparian plants.

Residential development in the watershed can result in stormwater runoff containing waste from domestic animals, such as dogs, which may also be contributing to high bacteria concentrations in the impaired segment of Natchaug River.

Insufficient Septic Systems and Illicit Discharges

As shown in Figure 6, residents in the Town of Windham (including Willimantic) are on a sanitary sewer system that is operated by the Town of Windham Water Pollution Control Facility (WPCF). Remaining areas of the watershed rely on onsite wastewater treatment systems such as septic systems. Insufficient or failing septic systems can be significant sources of bacteria by allowing raw waste to reach surface waters. In Connecticut, local health directors or health districts are responsible for keeping track of any reported insufficient or failing septic systems in a specific municipality. The Town of Windham is a member of the North Central Health District (http://www.ncdhd.org).

Agricultural Activities

Agricultural operations are an important economic activity and landscape feature in many areas of the State. Runoff from agricultural fields may contain pollutants such as bacteria and nutrients (USEPA, 2011a). This runoff can include pollutants from farm practices such as storing manure, allowing livestock to wade in nearby waterbodies, applying fertilizer, and reducing the width of vegetated buffers along the shoreline. Agricultural land use makes up 7% of the Natchaug River watershed, though some areas designated agricultural (especially around the airport-Figure 4), may actually be grass or lawn. The agricultural land is spread across the watershed in small isolated land areas adjacent to forestland, although none could be located near the impaired segment.

Additional Sources

There may be other sources not listed here that contribute to the observed water quality impairment in Natchaug River including small hobby farms containing horses, goats, pigs or other animals that may be a potential source of bacteria to the river. Further monitoring and investigation will confirm the listed sources and discover additional ones. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement this TMDL.

Land Use/Landscape

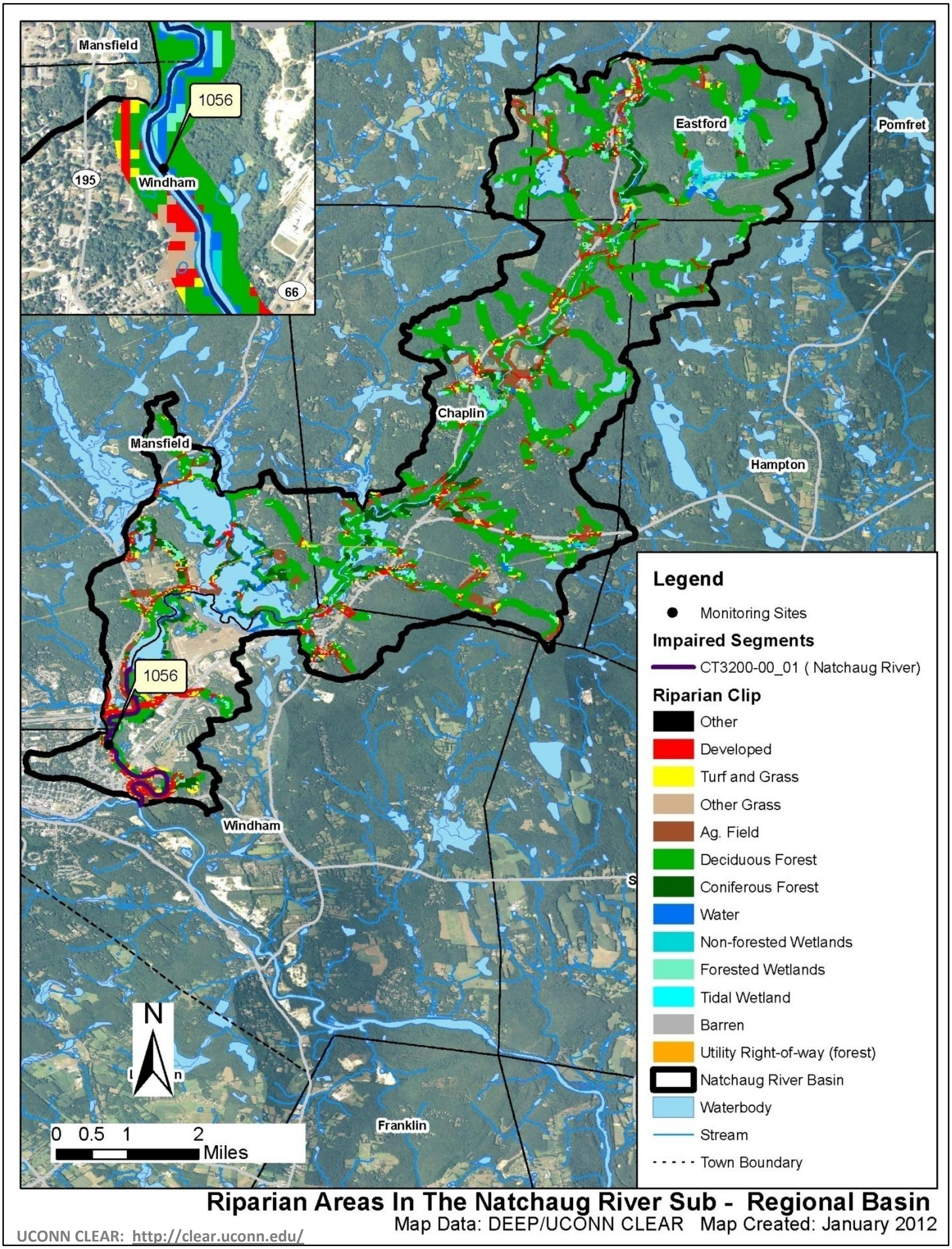
Riparian Buffer Zones

The riparian buffer zone is the area of land located immediately adjacent to streams, lakes, or other surface waters. The boundary of the riparian zone and the adjoining uplands is gradual and not always well-defined. However, riparian zones differ from uplands because of high levels of soil moisture, frequent flooding, and the unique assemblage of plant and animal communities found there. Through the interaction of their soils, hydrology, and vegetation, natural riparian areas influence water quality as contaminants are taken up into plant tissues, adsorbed onto soil particles, or modified by soil organisms. Any change to the natural riparian buffer zone can reduce the effectiveness of the natural buffer and has the potential to contribute to water quality impairment (USEPA, 2011b).

The CLEAR program at UCONN has created streamside buffer layers for the entire State of Connecticut (http://clear.uconn.edu/), which have been used in this TMDL. Analyzing this information can reveal potential sources and implementation opportunities at a localized level. The land use directly adjacent to a waterbody can have direct impacts on water quality from surface runoff sources.

A large portion of the riparian zone for the impaired segment of the Natchaug River is characterized by developed land, with patches of deciduous forests and agricultural land (Figure 10). Riparian areas upstream of the impaired segment are largely comprised of deciduous forest with patches of agricultural land and developed land near roads. As previously noted, if not properly treated, runoff from developed areas and agricultural fields may contain pollutants such as bacteria and nutrients.

Figure 10: Riparian buffer zone information for the Natchaug River watershed



CURRENT MANAGEMENT ACTIVITIES

The Natchaug River watershed is located in a region that is considered one of the last remaining open spaces in Connecticut due to extensive urban and suburban development pressures. In 2006, the area was designated a Connecticut Greenway. Since then, municipal leaders have been working together to identify potential threats to the watershed and to address those threats. In 2009, the Natchaug River Basin Municipal Regulation Report (Wasstrom-Welz, 2009) was developed, which provided specific municipal zoning recommendations that would protect natural resources in each of the towns in the watershed. In 2010, the Green Valley Institute put out maps that identified unprotected forested parcels with greatest impact on water quality (GVI, 2010) to aid in long-term conservation planning. Working with the Green Valley Institute and The Nature Conservancy, eight municipalities within the Natchaug River watershed took a pledge to protect the water quality within the Natchaug River watershed (Chronicle, 2011). The Natchaug River Basin Conservation Compact is one of many planning tools to protect the natural resources within the watershed.

RECOMMENDED NEXT STEPS

As discussed above, there is a concerted effort on the part of local municipalities to work together to protect the Natchaug River. However, many of the objectives to protect water quality are directed toward land conservation/preservation activities. While no specific language within these planning documents focus on bacteria impairments in the river, recommendations such as installing Best Management Practices for erosion control in the watershed may potentially help reduce bacteria inputs.

1) Identify areas along the the Natchaug River to implement Best Management Practices (BMPs) to control stormwater runoff.

As noted previously, approximately 17% of the Natchaug River watershed is considered urban, with portions falling within the Willimantic Urban Cluster, according to the US Census. The heaviest development is located at the southern tip of the watershed below the Willimantic Reservoir adjacent to the impaired river segment. Stormwater runoff from these developed areas, including the airport, golf course, commercial and industrial development, and high intensity residential development are likely sources of bacteria and nutrients in the Natchaug River.

Since a large portion of the watershed is located upstream of the impaired segment, it is possible that the bacteria impairment in the river could originate from land uses upstream of the impaired segment. Therefore, it is critical that the Town of Windham communicate with the upstream municipalities to begin discussions about how to address the bacteria problem, especially the Town of Mansfield which contains Willimantic Reservoir and Mansfield Hollow Lake just upstream of the impaired segment.

To identify specific areas that are contributing bacteria to the impaired segments additional wet-weather sampling is needed at stormwater outfalls that discharge directly to the impaired segment of the Natchaug River (including the outflow at the dam). The Natchaug River Compact recommends a stormwater infrastructure inventory be conducted for each town. To treat stormwater runoff, the towns of Windham and Mansfield should identify areas along the river to install BMPs designed to encourage stormwater to infiltrate into the ground before entering the waterbodies. These BMPs would disconnect impervious areas and reduce pollutant loads to the river.

2) Continue monitoring of permitted sources.

Monitoring will provide information essential to better locate, understand, and reduce pollution sources. If any current monitoring is not done with appropriate bacterial indicator based on the receiving water, then a recommended change during the next permit reissuance is to include the appropriate indicator species. If facility monitoring indicates elevated bacteria, then implementation of permit required, and voluntary measures to identify and reduce sources of bacterial contamination at the facility are an additional recommendation. Regular monitoring should be established for all permitted sources to ensure compliance with permit requirements and to determine if current requirements are adequate or if additional measures are necessary for water quality protection.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within four months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established by the TMDL. For discharges to impaired waterbodies, the municipality must assess and modify the six minimum measures of its plan, if necessary, to meet TMDL standards. Particular focus should be placed on the following plan components: public education, illicit discharge detection and elimination, stormwater structures cleaning, and the repair, upgrade, or retrofit of storm sewer structures. The goal of these modifications is to establish a program that improves water quality consistent with TMDL requirements. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of DEEP for review and approval.

Table 7 details the appropriate bacteria criteria for use as waste load allocations established by this TMDL for use as water quality targets by permittees as permits are renewed and updated, within the Natchaug River watershed.

For any municipality subject to an MS4 permit and affected by a TMDL, the permit requires a modification of the SMP to include BMPs that address the included impairment. In the case of bacteria related impairments municipal BMPs could include: implementation or improvement to existing nuisance wildlife programs, septic system monitoring programs, any additional measures that can be added to the required illicit discharge detection and elimination (IDDE) programs, and increased street sweeping above basic permit requirements. Any non-MS4 municipalities can implement these same types of initiatives in effort to reduce bacteria source loading to impaired waterways.

Any facilities that discharge non-MS4 regulated stormwater should update their Pollution Prevention Plan to reflect BMPs that can reduce bacteria loading to the receiving waterway. These BMPs could include nuisance wildlife control programs and any installations that increase surface infiltration to reduce overall stormwater volumes. Facilities that are regulated under the Commercial Activities Stormwater Permit should report any updates to their SMP in their summary documentation submitted to DEEP.

Table 7. Bacteria (e.coli) TMDLs, WLAs, and LAs for Recreational Use

		Instantaneous *E. coli* (#/100mL)						Geometric Mean *E. coli* (#/100mL)	
Class	**Bacteria Source**	**WLA[6]**			**LA[6]**			**WLA[6]**	**LA[6]**
A	Non-Stormwater NPDES	0	0	0				0	
	CSOs	0	0	0				0	
	SSOs	0	0	0				0	
	Illicit sewer connection	0	0	0				0	

	Leaking sewer lines	0	0	0				0	
	Stormwater (MS4s)	235[7]	410[7]	576[7]				126[7]	
	Stormwater (non-MS4)				235[7]	410[7]	576[7]		126[7]
	Wildlife direct discharge				235[7]	410[7]	576[7]		126[7]
	Human or domestic animal direct discharge[5]				235	410	576		126

(1) **Designated Swimming.** Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protections and the Department of Public Health. May 1989. Revised April 2003 and updated December 2008.

(2) **Non-Designated Swimming.** Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

(3) **All Other Recreational Uses.**

(4) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23. (Class B surface waters located north of Interstate Highway I-95 and downstream of a sewage treatment plant providing seasonal disinfection May 1 through October 1, as authorized by the Commissioner.)

(5) Human direct discharge = swimmers

(6) Unless otherwise required by statute or regulation, compliance with this TMDL will be based on ambient concentrations and not end-of-pipe bacteria concentrations

(7) Replace numeric value with “natural levels” if only source is naturally occurring wildlife. Natural is defined as the biological, chemical and physical conditions and communities that occur within the environment which are unaffected or minimally affected by human influences (CT DEEP 2011a). Sections 2.2.2 and 6.2.7 of this Core Document deal with BMPs and delineating type of wildlife inputs.

3) Evaluate municipal education and outreach programs regarding animal waste.

As a large area of the lower Natchaug River watershed is developed, any education and outreach programs in this portion of the watershed should highlight the importance of managing waste from dogs and other pets and not feeding waterfowl and wildlife. Waterfowl, especially grazers like geese, prefer easy access to water. Maintaining an uncut vegetated buffer near public bathing areas and other water sources will make the habitat less desirable to geese and encourage migration. In addition, any educational program should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in the Natchaug River and can harm human health and the environment.

Animal wastes should be disposed of away from any waterbody or storm drain system. BMPs effective at reducing the impact of animal waste on water quality include installing signage, providing pet waste receptacles in high-use areas, enacting ordinances requiring the clean-up of pet waste, and targeting educational and outreach programs in problem areas.

4) Implement a program to evaluate the sanitary sewer system.

A portion of the Natchaug River watershed relies on a municipal sewer system (Figure 6), including those residents near the river. It is important for the Town of Windham to develop a program to evaluate its sanitary sewer system and reduce leaks and overflows. This program should include periodic inspections of the sewer line.

5) Develop a system to monitor septic systems.

Less developed areas of the Natchaug River watershed rely on septic systems for human waste disposal. If not already in place, towns within the watershed should establish a program to ensure that existing septic systems in the watershed are properly operated and maintained, and create an inventory of existing septic systems through mandatory inspections. Inspections help encourage proper maintenance and identify failed and sub-standard systems. Policies that govern the eventual replacement of sub-standard systems within a reasonable timeframe can be adopted. Somers can also develop a program to assist citizens with the replacement and repair of older and failing systems.

6) Ensure there are sufficient buffers on agricultural lands along the Natchaug River.

If not already in place, agricultural producers should work with the CT Department of Agriculture and the U.S. Department of Agriculture Natural Resources Conservation Service to develop conservation plans for their farming activities within the watershed. These plans should focus on ensuring that there are sufficient stream buffers, that fencing exists to restrict livestock and horse access to streams and wetlands, and that animal waste handling, disposal, and other appropriate Best Management Practices (BMPs) are in place. Particular attention should be paid to those agricultural operations located within the riparian buffer zone along the impaired segment and directly upstream from the impaired segment (Figure 10).

BACTERIA DATA AND PERCENT REDUCTIONS TO MEET THE TMDL

Table 8: Natchaug River Bacteria Data

Waterbody ID: CT3200-00_01

Characteristics: Freshwater, Class A, Potential Drinking Water Supply, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, Navigation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 235 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **NA**

Single Sample: **24%**

Data: 1998-2001 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from Station 1056 on Natchaug River with annual geometric means calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
1056	Lauter Park off Gordon Avenue	9/25/1998	97	dry	NA
1056	Lauter Park off Gordon Avenue	10/5/1999	**310* (24%)**	wet	NA
1056	Lauter Park off Gordon Avenue	5/11/2001	10	dry	**23* (0%)**
1056	Lauter Park off Gordon Avenue	10/3/2001	52	dry	
Shaded cells indicate an exceedance of water quality criteria					
***Indicates single sample and geometric mean values used to calculate the percent reduction**					

Wet and dry weather geometric mean values for Station 1056 on Natchaug River

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1056	Lauter Park off Gordon Avenue	1998, 1999, 2001	1	3	63	NA	37
Shaded cells indicate an exceedance of water quality criteria							
Weather condition determined from rain gauge at Norwich Public Utility Plant in Norwich, CT							

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