# Technical Memorandum #1: State of the Rooster River Watershed

# Rooster River Watershed Based Plan

**March 2013**

*Prepared For:*

**City of Bridgeport**

*In Cooperation With:*

**Connecticut Department of Energy & Environmental Protection**
**Southwest Conservation District**

FUSS & O'NEILL

Project No. 20090730.A20

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# 1 Introduction

The City of Bridgeport is working collaboratively with the Southwest Conservation District (SWCD), the Connecticut Department of Energy and Environmental Protection (CTDEEP), and several other watershed municipalities to develop a watershed based plan for the Rooster River[1]. The watershed based plan will be consistent with the CTDEEP and U.S. Environmental Protection Agency (EPA) "nine elements" watershed planning process. The plan will draw upon a similar watershed based plan that was completed in September 2011 for the adjacent Pequonnock River watershed, while incorporating watershed information and recommendations specific to the Rooster River. The plan will incorporate available water quality data and a 2005 Total Maximum Daily Load for the Rooster River, facilitate capacity building and engage the watershed municipalities, and prioritize water bodies and implementation projects to reduce pollutant loads in the watershed, with the goal of ultimately delisting the impaired segments of Rooster River and Ash Creek.

Funding for this project is being provided through the SWCD in the form of a CTDEEP Water Quality Management Planning Grant under section 604(b) of the Clean Water Act. Fuss & O'Neill, Inc. and Connecticut Fund for the Environment/Save the Sound (CFE/STS) were retained to lead the development of the watershed based plan, working with a Project Steering Committee consisting of representatives from the watershed municipalities, government organizations, educational institutions, non-profit organizations, and others who live and work within the watershed.

The watershed planning process includes the preparation of the following documents:

1. Technical Memorandum #1 – State of the Rooster River Watershed,
2. Technical Memorandum #2 – Low Impact Development and Green Infrastructure Assessment,
3. Watershed Based Plan.

Technical Memorandum #1 serves as a "State of the Watershed" report, summarizing existing water quality and land use conditions in the Rooster River watershed. Technical Memorandum #1 also identifies the major water quality and related water resources issues to be addressed by the watershed based plan. The second project deliverable, Technical Memorandum #2, will document a stormwater retrofit assessment of the watershed, identifying site-specific Low Impact Development and Green Infrastructure retrofit concepts to serve as future implementation projects and examples of projects that could be implemented at other locations in the watershed. Lastly, the watershed based plan will identify prioritized action items to protect and improve water quality and water resource conditions in the Rooster River and its watershed, guided by the Project Steering Committee. The watershed based plan will also incorporate the nine watershed management planning elements required by CTDEEP and EPA for future funding of plan recommendations through the 319 Nonpoint Source Grant program and similar state and federal grant programs.

[1] The primary focus of this watershed planning process is on the Rooster River, the non-tidal portion of the river upstream of the Ash Creek estuary.

## 1.1 Background

The Rooster River forms the border between Bridgeport and Fairfield and eventually flows to Black Rock Harbor and Long Island Sound via the Ash Creek Estuary. Ash Creek is part of the Rooster River watershed and consists of the tidal portion of the Rooster River. The Rooster River (including Ash Creek) has an approximately 15.3 square-mile, heavily urbanized watershed that encompasses portions of Bridgeport, Fairfield, and Trumbull and is home to approximately 80,000 people. The watershed consists of six primary subwatersheds – Rooster River (main stem), Horse Tavern Brook, Long Hill, Londons Brook, Ash Creek, and Turney Creek.

The Rooster River, like many other urbanized rivers and streams in Connecticut, has been impacted by historical development and land use activities in its watershed. The water quality in the Rooster River is degraded due to elevated bacteria levels resulting from combined sewer overflows, point discharges from industrial facilities, and nonpoint sources such as stormwater runoff from developed areas and impervious surfaces.

In 2005, CTDEEP developed a Total Maximum Daily Load (TMDL) for the Rooster River to begin to address the bacteria impairment. The TMDL identified reductions in indicator bacteria loads to the Rooster River (92% and 91% reductions in regulated point sources and nonpoint sources, respectively) that are necessary for the impaired segments to meet State water quality standards and once again support contact recreation. The TMDL can be achieved by implementing specific actions that will reduce indicator bacterial loads using a watershed framework. The watershed based plan for the Rooster River will therefore provide a roadmap for implementing the TMDL.

## 1.2 Prior Watershed Planning and Stewardship Efforts

Until recently, water and natural resource planning and stewardship efforts within the Rooster River watershed have been limited to traditional land use and open space planning by the individual watershed municipalities. Over the past few years, the watershed municipalities and other stakeholders have recognized the need for a watershed-based approach to address the water resource issues that face the Rooster River watershed and neighboring coastal urban watersheds. Notable recent, ongoing and planned water quality restoration and related stewardship efforts within the Rooster River watershed are highlighted below.

- **Pequonnock River Initiative and Watershed Based Plan** – In 2010, the Pequonnock River Initiative was formed as a partnership between the City of Bridgeport and the Towns of Monroe and Trumbull to develop a watershed plan for the Pequonnock River watershed. In September 2011, a watershed based plan was completed for the Pequonnock River watershed (http://www.gbrct.org/projects/environment-sustainability-2/pequonnock-river-watershed/). The plan identifies specific, measurable actions to address the water quality impairments in the Pequonnock River in order to restore the recreation and habitat uses that have been lost due to degraded water quality. The PRI, in conjunction with the Greater Bridgeport Regional Council and the watershed municipalities, is implementing various recommendations from the watershed based plan, which will serve as a model for the Rooster River plan.

- **Ash Creek Estuary Ecological Master Plan** – Ash Creek is one of Connecticut's few remaining ecologically-significant tidal estuaries located within a heavily urbanized area. The Ash Creek Estuary provides a diverse ecosystem of vegetation and wildlife and plays an important role in improving water quality and protecting shoreline areas from coastal flooding and erosion. Ash Creek also provides open space and recreational opportunities and an aesthetic identity to the surrounding neighborhoods. The Ash Creek Conservation Association, in association with a project steering committee, is developing a comprehensive ecological restoration plan for the Ash Creek Estuary (http://www.ashcreekassoc.org/categories/ecological-master-plan). The first phase of the master planning process has been completed. A second phase is planned, which will result in a detailed ecological restoration plan for Ash Creek. Recommendations from the Ash Creek master planning process will be integrated into the Rooster River watershed based plan.

- **Green Infrastructure Feasibility Scan** – Connecticut Fund for the Environment and Save the Sound recently completed a project to assess the feasibility of green infrastructure implementation in New Haven and Bridgeport. A feasibility scan was conducted for both cities to evaluate opportunities to incorporate green infrastructure into ongoing wet weather management efforts. Results of the feasibility scan indicate that green infrastructure can serve as an effective approach to managing Combined Sewer Overflows (CSOs) and other wet weather issues within Bridgeport and New Haven. The study is intended to serve as a foundation for future detailed planning and design efforts within these communities. It also demonstrates the applicability of green infrastructure approaches in similar urban communities including those within the Rooster River watershed (Save the Sound, http://reducerunoff.org/newhaven.htm).

## 1.3 Development of Technical Memorandum #1

The following tasks were completed in developing Technical Memorandum #1:

- Reviewed existing studies and reports for the watershed.
- Compiled, reviewed and summarized water quality monitoring data collected within the watershed.
- Identified and delineated subwatersheds within the overall Rooster River watershed.
- Consulted with the Project Steering Committee, the watershed municipalities, the regional planning agency, and other governmental entities regarding available land use information and mapping.
- Developed a description of existing watershed conditions and Geographic Information System (GIS) mapping of the watershed.
- Developed a surface runoff pollutant loading model for the Rooster River watershed to guide the development of the watershed based plan recommendations and to quantify the anticipated load reductions associated with the recommendations.

Technical Memorandum #1 documents watershed conditions for the following topics:

- Watershed description including watershed municipalities, demographics, and a brief history of the watershed (Section 2).
- Water quality conditions of the Rooster River and its tributaries based on available monitoring data (Section 3).
- Natural resources including geology, topography, wetlands, fish and wildlife resources, and vegetation (Section 4).
- Water infrastructure including dams, water supply, wastewater, stormwater, and flooding (Section 5).
- Land use and land cover, including an analysis of impervious cover in the watershed (Section 6).
- Pollutant loading (Section 7).

# 2 Watershed Description

## 2.1 Rooster River Watershed

The Rooster River watershed is a narrow, north-south oriented watershed that originates in Trumbull, north of Canoe Brook Lake, and discharges to Black Rock Harbor on Long Island Sound via Ash Creek (*Figure 2-1*). The 15.3 square-mile watershed is located in a highly urbanized area of Fairfield County in southeastern Connecticut. The watershed runs roughly parallel to State Route 25 (Colonel Henry Mucci Highway) and the combined State Routes 25 and 8 in Bridgeport. State Route 15 (the Merritt Parkway) runs east-west through the upper portion of the watershed and the Interstate 95 (I-95) corridor runs through the southern portion of the watershed, near the confluence with the Ash Creek Estuary (*Figure 2-2*).

The watershed is dominated by developed, mostly residential, land cover/land use, and the percentage of impervious cover nearly doubles moving south through the watershed, with effective impervious cover at approximately 33% near the watershed outlet.

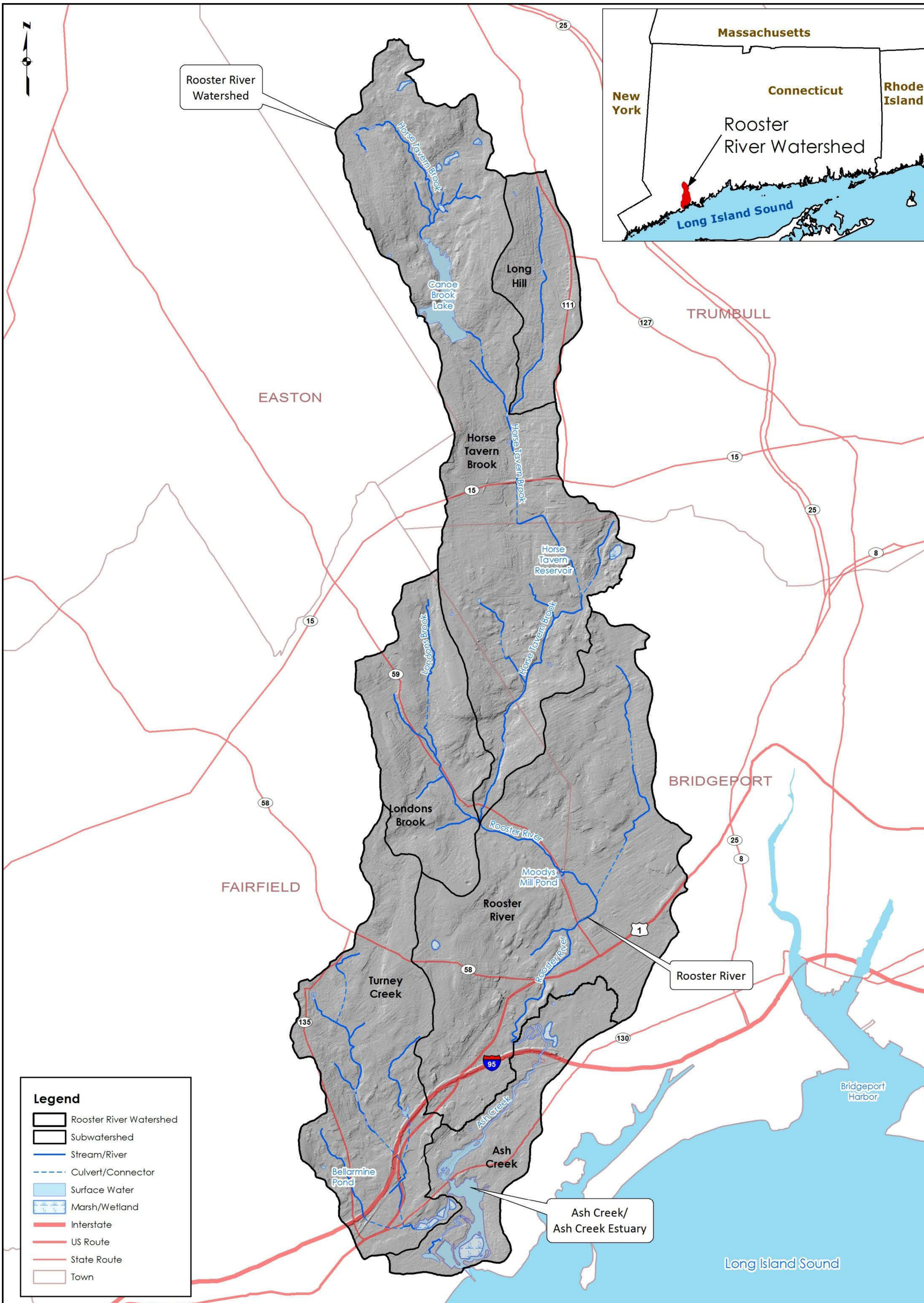
Like other watersheds in southeastern Connecticut, the Rooster River water quality has been impacted by a history of industrial activity and urbanization. A 5.4 linear mile segment of the Rooster River has been identified as impaired for contact recreation due to bacteria. The potential sources for the impairment are identified as both point and nonpoint sources, as discussed in detail in *Section 3.1*.

The United States Geological Survey (USGS) maintains a streamflow gaging station on the Rooster River in Fairfield. Gage Station 01208873 is located at latitude 40º10'47", longitude 73º13'10", just east of Briarwood Avenue, and has a drainage area of approximately 10.6 square miles. Although the gage has been in place since 1977, daily discharge data is readily available since October 1, 2007. As *Figure 2-3* shows, the river discharge is subject to fairly rapid fluctuations of over two orders of magnitude.

Over the 1978-2009 water years[2], annual average discharge ranged from 8.23 to 23.6 cubic feet per second (cfs). Discharge is typically highest in March and April, averaging 24 to 35 cfs over the period of record, with the lowest discharge in July through September (9.1-10 cfs). Peak streamflow values (*Figure 2-4*) have exceeded 2,000 cfs, with the maximum peak over the available period of record being 2,170 cfs on April 9, 1980. From 2000-2010, a peak steamflow of 2,040 cfs was recorded on March 2, 2007.

As *Figure 2-1* and *Table 2-1* show, there are six subwatersheds within the Rooster River watershed. For the purposes of this study, Ash Creek and its tributary, Turney Creek, are considered part of the Rooster River watershed. However, they are not tributary to the Rooster River, but are the connection between the Rooster River watershed and Long Island Sound.

[2] A water year is from October 1 to September 30. For example, water year 2013 is from October 1, 2012 to September 30, 2013.

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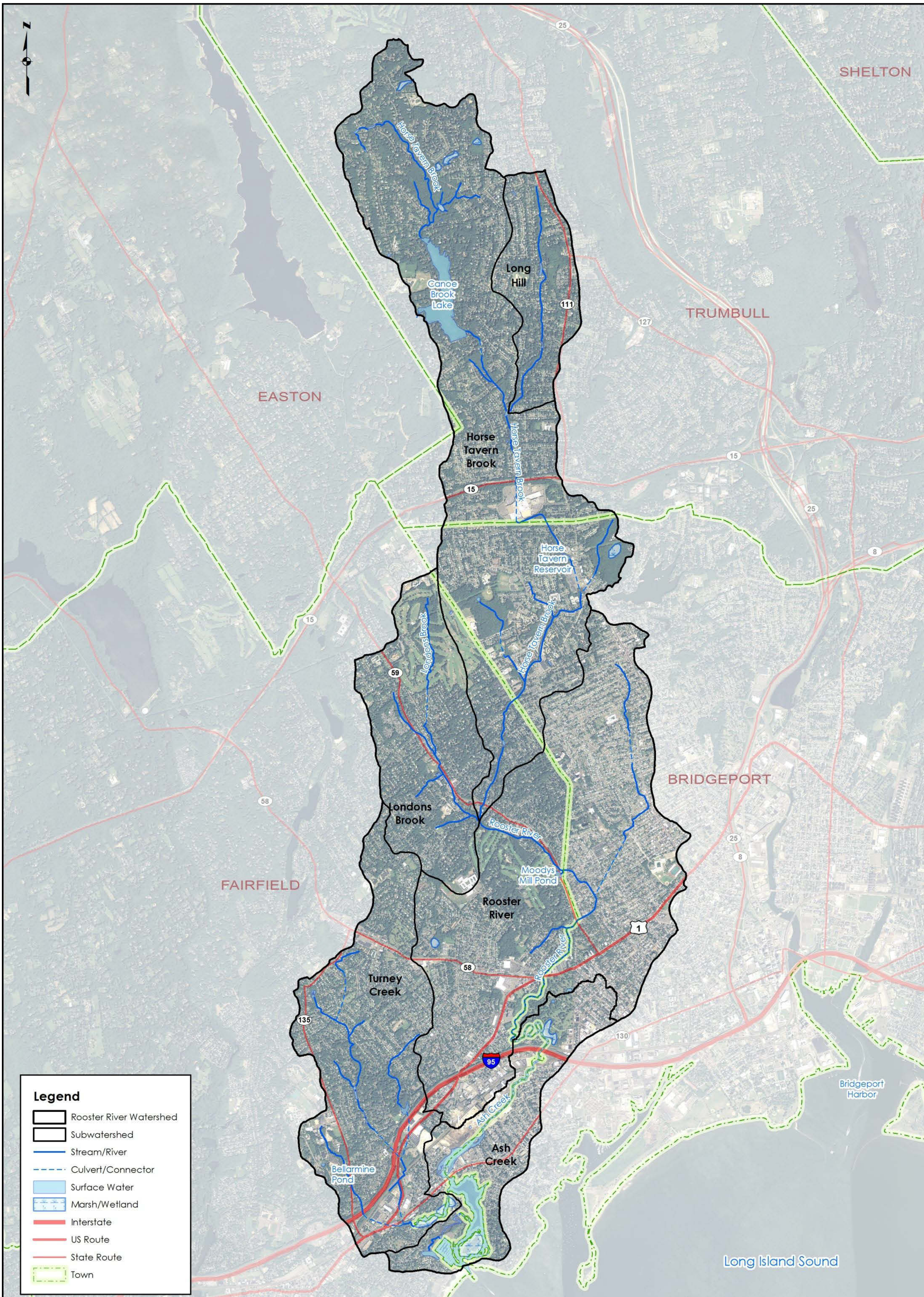
Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP), Watershed Boundaries 1:24,000 scale; Hydrography 1:24,000 scale by USGS and CTDEEP, Hillshade 2000 from http://www.ctecoapp2.uconn.edu/arcgis/services.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 2-1**
**ROOSTER RIVER WATERSHED**

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Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP), Watershed Boundaries 1:24,000 scale; Hydrography 1:24,000 scale by USGS and CTDEEP, 2010 statewide 4 band orthophotography of Connecticut: Ortho_2010_4Band_Color_NAIP from CTDEEP.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 2-2**
**WATERSHED AERIAL PHOTOGRAPH**

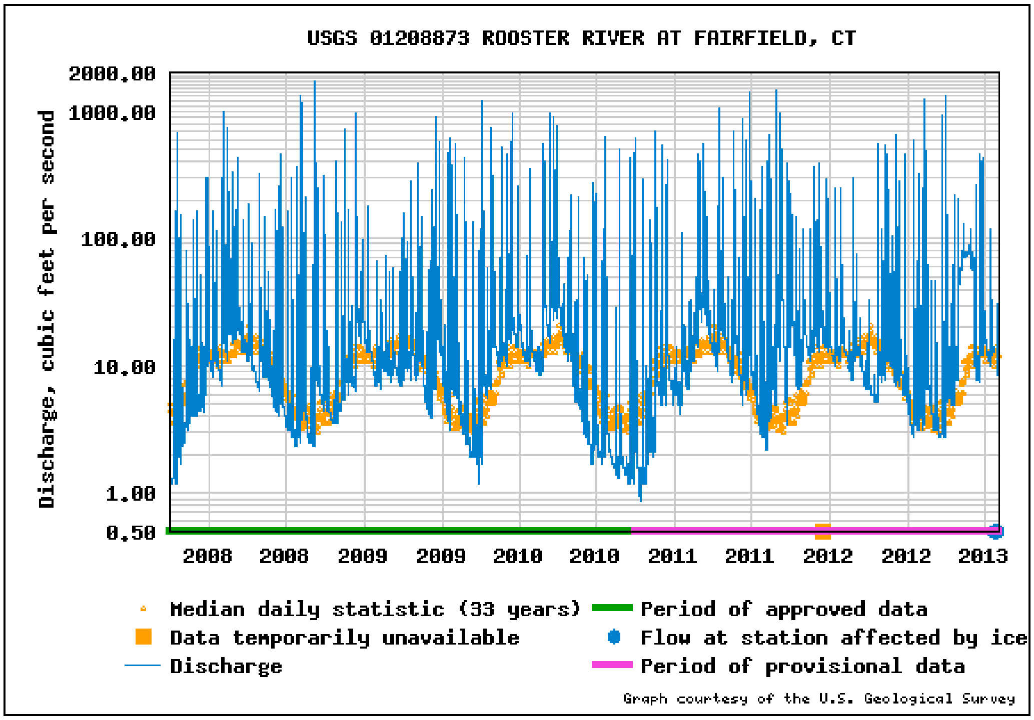



**Figure 2-3. Mean Daily Discharge of the Rooster River at Fairfield, CT (2007-2013)**

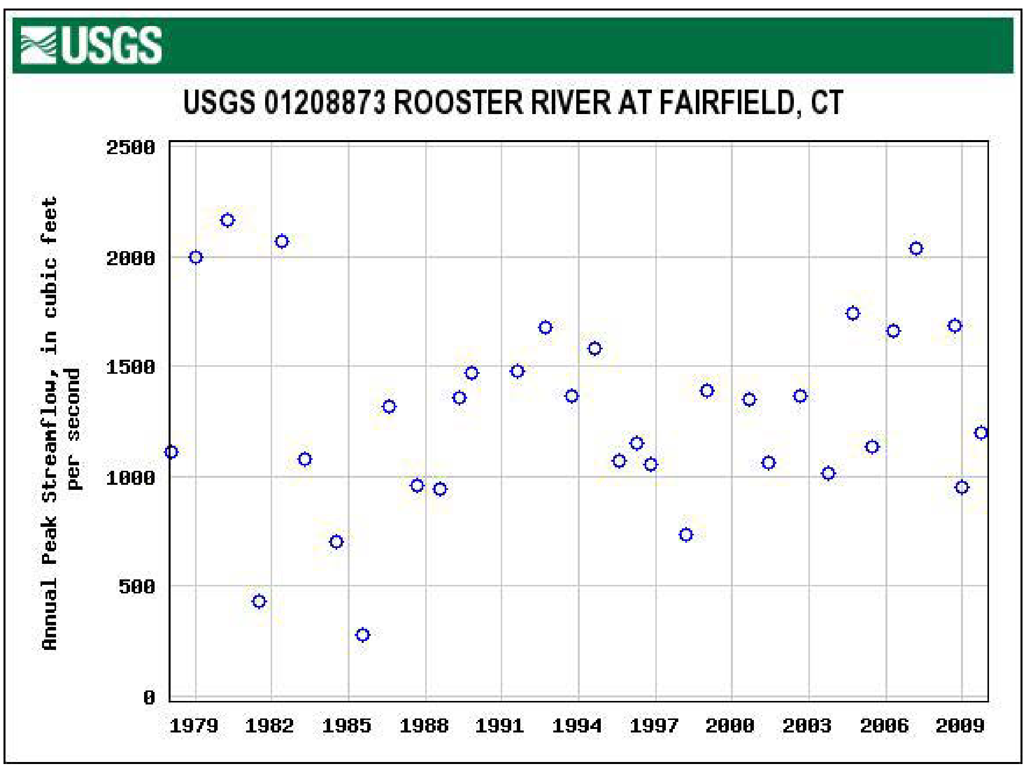



**Figure 2-4. Peak Streamflow Measurements of the Rooster River at Fairfield, CT**

### Table 2-1. Rooster River Subwatersheds

| Subwatershed | Acronym | Area (acres) | Area (square miles) | Length of Stream (miles) |
|---|---|---|---|---|
| Ash Creek | AC | 805 | 1.3 | 5.5 |
| Horse Tavern Brook | HT | 3,196 | 5.0 | 10.9 |
| Londons Brook | LB | 1,002 | 1.6 | 3.2 |
| Long Hill | LH | 518 | 0.8 | 1.9 |
| Rooster River | RR | 2,769 | 4.3 | 5.3 |
| Turney Creek | TC | 1,523 | 2.4 | 6.4 |
| **Watershed (Total)** | | **9,813** | **15.3** | **33.2** |

- Long Hill is the smallest subwatershed in the Rooster River watershed. It is located in Trumbull and runs parallel to State Route 111 for approximately 2 miles before discharging to Horse Tavern Brook at Blackhouse Road Pond. One low hazard dam is located in the subwatershed.

- Londons Brook is located on the western side of the watershed and runs parallel to State Route 58 in Fairfield before discharging to the Rooster River. This is the least developed of the subwatersheds and contains the City of Bridgeport D. Fairfield Wheeler Golf Course.

- Horse Tavern Brook is the largest of the subwatersheds in terms of both area and length of stream miles. It originates in Trumbull and flows south, discharging to the Rooster River, just south of State Route 59. Canoe Brook Lake and the high hazard dam at its outlet, and the Horse Tavern Reservoir are located in the subwatershed, along with Plymouth Avenue Pond and its dam, and another unnamed dam located on a southern tributary to Horse Tavern Brook. The brook is culverted in several locations, including beneath the Westfield Trumbull Mall. It is significantly developed, especially in the southern portion of the subwatershed.

- The main stem of the Rooster River begins at the confluence of Londons Brook and Horse Tavern Brook south of Route 59 in Fairfield. The Rooster River flows southeasterly through Brooklawn Country Club and enters the Brooklawn neighborhood in the City of Bridgeport via an underground culvert. The river flows underground and then in a channelized section, where it joins with a culverted section of Ox Brook. Rooster River flows southwesterly and eventually follows the municipal boundary between Fairfield and Bridgeport. The daylighted river flows beneath Route 1, alongside Mt. Grove Cemetery, and transitions to Upper Ash Creek near the end of Fairchild Avenue. The Ash Creek Estuary extends 3.5 miles downstream of the Rooster River, ultimately discharging to Black Rock Harbor and Long Island Sound.

- Turney Creek originates in Fairfield, near the intersection of Routes 135 and 58. It flows south-southwest and is culverted in several sections, flowing beneath Interstate 95 and Route 1 before discharging to Ash Creek. Five low to moderate hazard dams and tidal gates are located on the creek.

## 2.2 Watershed Municipalities and Demographics

While nearly half of the watershed area is located within the Town of Fairfield, approximately one-quarter of the municipal land area of both Bridgeport and Fairfield is located within the Rooster River watershed (*Table 2-2*). Despite its smaller land area, the population density within Bridgeport is just over 10,000 persons/square mile, approximately two and a half times the watershed population density in Fairfield (*Table 2-3*). This is reflective of the overall land use character of the two municipalities, with Bridgeport being a densely developed urban center and Fairfield being a less densely developed suburban community.

Population and demographic information for the watershed was analyzed using data from the Connecticut Economic Resource Center (CERC, 2012) and the Connecticut Department of Economic and Community Development (DECD, 2012). The watetershed population is estimated at approximately 80,000. The population within the watershed communities, with the exception of Bridgeport, has increased steadily since 1900 (*Figure 2-5*). While population in Bridgeport experienced a rapid increase in the decades surrounding World War I and during World War II, it decreased from 1970 to 2000. Population in Bridgeport is estimated to return to close to its 1950 high of nearly 159,000 by 2016. In contrast, population growth in Fairfield and Trumbull has leveled since 1970, but continues to show show minor growth. The CERC estimate for 2016 populations in the watershed municipalities of Bridgeport, Fairfield, and Trumbull is 254,169, an increase of 6% from 2010 population levels. This increase is slightly greater than the projected increases of 4% for the State of Connecticut and 4.6% for Fairfield County over the same time period.

**Table 2-2. Distribution of Municipalities in the Rooster River Watershed**

| Municipality | Total Acreage of Municipality | Acreage in Watershed | % of Municipality in Watershed | % of Watershed |
|---|---|---|---|---|
| Bridgeport | 10,361 | 2,807 | 27.1% | 28.8% |
| Easton | 18,310 | 6 | 0.0% | 0.1% |
| Fairfield | 19,432 | 4,441 | 22.9% | 45.6% |
| Trumbull | 15,099 | 2,490 | 16.5% | 25.6% |
| **Watershed (Total)** | **63,202** | **9,744** | | **100.0%** |

**Table 2-3. Population Densities in the Rooster River Watershed**

| Municipality | Watershed Population | Watershed Population Density (Population / Square Mile) | Town Population | Town Population Density (Population / Square Mile) |
|---|---|---|---|---|
| Bridgeport | 44,823 | 10,218 | 144,329 | 8,828 |
| Fairfield | 27,211 | 3,922 | 59,305 | 1,953 |
| Trumbull | 8,418 | 2,163 | 35,982 | 1,525 |
| **Watershed (Total)** | **80,452** | **5,284** | **239,616** | **3,408** |

Note: Easton has only 2 households within the watershed, and is therefore not included in the table.

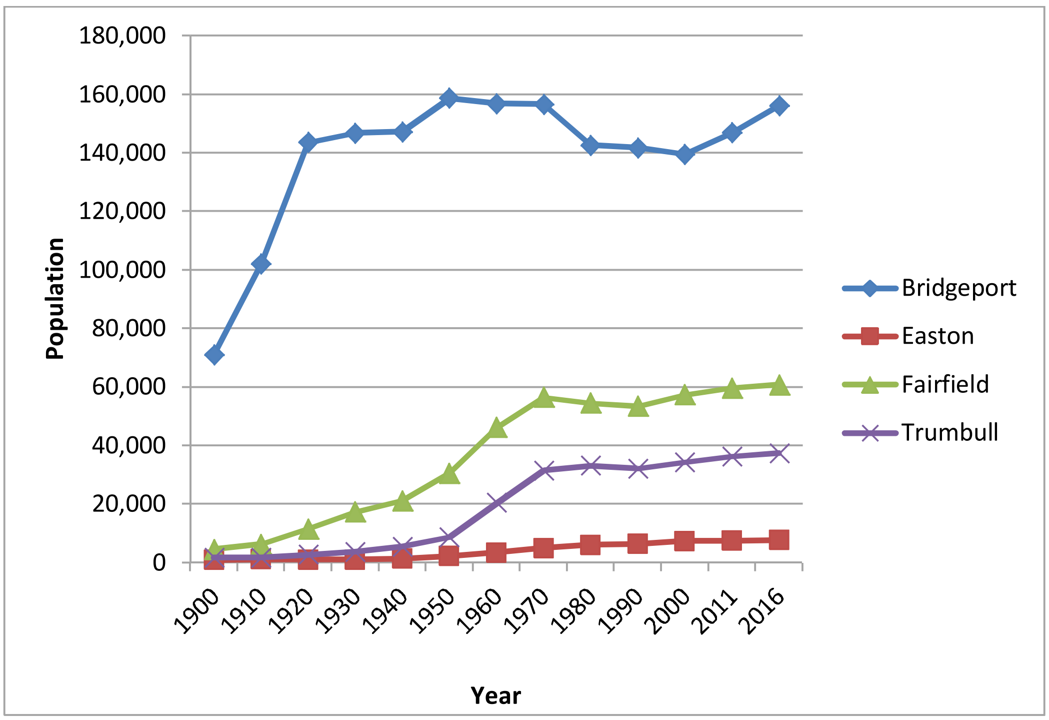



**Figure 2-5. Population Trends of the Rooster River Watershed Communities**

## 2.3 Historical Perspective

Originally the home of the Paugussett Indians and once called the Uncoway River, the watershed area was populated by members of the Uncowas, Sasquas, Maxumux, and Pequonnock tribes from 1500 to 1650. European settlement of the area began in 1630. Over the next 300 years, the region was predominately an agricultural area, with crops raised for both domestic consumption and export via harbors to the south. In the early 18th century, shipbuilding and other related maritime industries dominated the coastal portion of the watershed.

In the 1800s Bridgeport became a manufacturing center, with Fairfield supplying residential areas for housing the overflow of workers employed by Bridgeport industries. By the end of that century, the region was a major supplier of rifles, corsets, typewriters, pianos and organs, brass goods, sewing machines, and armaments. Railroad linkage to New York City was established in 1844, making the area an option for those willing to commute by train to the city.

World War I bought a massive demand for armaments, a boom in manufacturing, and unprecedented population growth (Nolen, 1916). The aircraft industry became established in the region in the 1920s and manufacturing continued to dominate the area into the 1970s. The 1970s brought a period of deindustrialization to the region, which has continued through present day.

# 3 Water Quality

Water quality is a primary indicator of the ecological health of a river and its ability to support specific uses such as water supplies, recreation, habitat, and industrial uses. Water quality is also inherently linked to the activities that take place in its watershed. The Rooster River and Horse Tavern Brook have been monitored over the past several decades. This section reviews previous water quality studies and monitoring efforts in the Rooster River watershed by the Town of Fairfield, the Connecticut Department of Energy and Environmental Protection (CTDEEP), and the U.S. Geological Survey (USGS). The monitoring data are reviewed in the context of the Connecticut Water Quality Standard (CWQS) and the Draft 2012 Integrated Water Quality Report to assess current water quality conditions in the watershed.

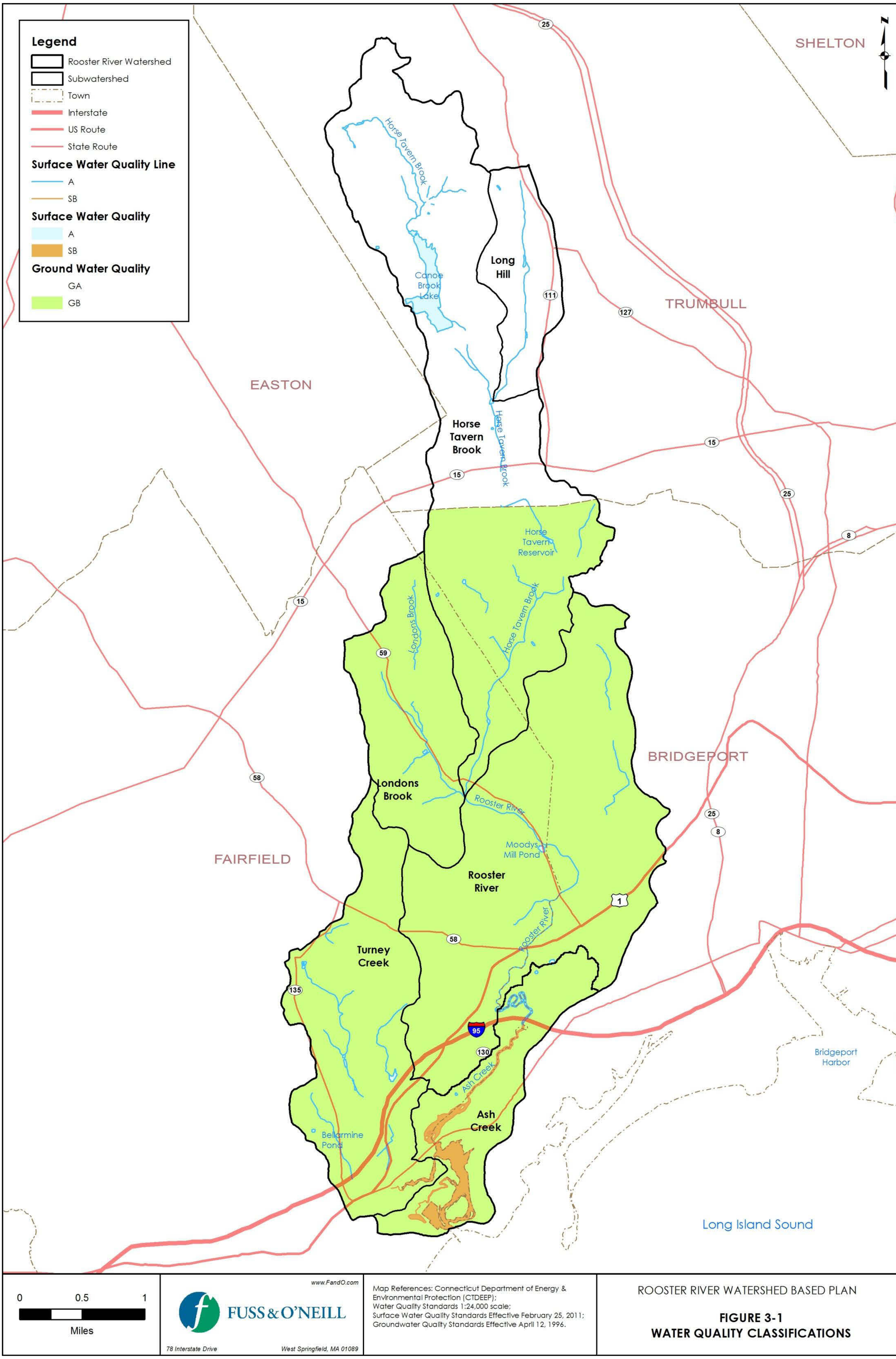
## 3.1 Classification, Standards, and Impairments

The Federal Clean Water Act (CWA) was established to protect the nation's surface waters. Through authorization of the CWA, the United States Congress declared as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water wherever attainable." The CWA requires states to:

1. Adopt Water Quality Standards,
2. Assess surface waters to evaluate compliance with Water Quality Standards,
3. Identify those waters not currently meeting Water Quality Standards, and
4. Develop Total Maximum Daily Loads (TMDL) and other management plans to bring water bodies into compliance with Water Quality Standards.

Connecticut Water Quality Standards are established in accordance with Section 22a-426 of the Connecticut General Statutes and Section 303 of the CWA. The Water Quality Standards are used to establish priorities for pollution abatement efforts. Based on the Water Quality Standards, Water Quality Classifications establish designated uses for surface, coastal and marine and ground waters and identify the criteria necessary to support these uses. The Water Quality Classification system classifies inland surface waters into three different categories, Class AA, Class A and Class B and coastal and marine surface waters into two categories, Class SA and SB (*Table 3-1*).

*Figure 3-1* depicts the Water Quality Classifications of surface water and groundwater in the Rooster River watershed. All of the streams within the Rooster River watershed are designated as Class A surface water bodies that have the following designated uses: potential drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply and other uses, including navigation. The Ash Creek Estuary is classified as Class SB, which is designated for habitat for marine fish, other aquatic life and wildlife; commercial shellfish harvesting; recreation; industrial water supply; and navigation.


Legend
Rooster River Watershed
Subwatershed
Town
Interstate
US Route
State Route
Surface Water Quality Line
A
SB
Surface Water Quality
A
SB
Ground Water Quality
GA
GB
SHELTON
TRUMBULL
EASTON
BRIDGEPORT
FAIRFIELD
Long Hill
Horse Tavern Brook
Londons Brook
Rooster River
Turney Creek
Ash Creek
Canoe Brook Lake
Horse Tavern Reservoir
Moodys Mill Pond
Bellarmine Pond
Bridgeport Harbor
Long Island Sound
0 0.5 1
Miles
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78 Interstate Drive West Springfield, MA 01089
Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP);
Water Quality Standards 1:24,000 scale;
Surface Water Quality Standards Effective February 25, 2011;
Groundwater Quality Standards Effective April 12, 1996.
ROOSTER RIVER WATERSHED BASED PLAN
FIGURE 3-1
WATER QUALITY CLASSIFICATIONS

**Table 3-1. Connecticut Surface Water Quality Classifications**

| Designated Use | Inland Surface Waters | | | Coastal and Marine Surface Waters | |
|---|---|---|---|---|---|
| | Class AA | Class A | Class B | Class SA | Class SB |
| Existing or proposed drinking water supply | ● | | | | |
| Potential drinking water supply | | ● | | | |
| Habitat for fish, other aquatic life, and wildlife habitat | ● | ● | ● | ● | |
| Shellfish harvesting for direct human consumption | | | | ● | |
| Commercial shellfish harvesting | | | | | ● |
| Recreation | ● | ● | ● | ● | ● |
| Industrial and/or agricultural supply | ● | ● | ● | ● | ● |
| Navigation | ● | ● | ● | ● | ● |

The CWA requires each state to monitor, assess and report on the quality of its waters relative to attainment of designated uses established by the State's Water Quality Standards. When waters are not suitable for their designated use, they are identified as "impaired." Each year, the State of Connecticut assesses watercourses and water bodies in the state and provides to EPA a list of impaired waters.

*Table 3-2* summarizes impaired designated uses for water bodies in the Rooster River watershed from the Draft 2012 Integrated Water Quality Report (IWQR), including the causes and potential sources of the impairments. *Figure 3-2* depicts the locations of the impaired water bodies. Two water bodies in the watershed are assessed in the IWQR: Rooster River -01 and Ash Creek Estuary. Rooster River-01 begins at the confluence with Ash Creek (upstream of the Interstate 95 crossing, near the end of Fairchild Avenue) and continues upstream to the confluence of Londons Brook and Horse Tavern Brook (near the Cornell Road crossing in Fairfield). The Ash Creek Estuary is named "LIS WB Inner - Ash Creek, Fairfield" in the IWQR and is a 0.157 square mile estuary area that encompasses the inner estuary at the mouth near South Benson Road, upstream to the saltwater limit where Rooster River-01 begins.

The Rooster River is impaired for recreation as determined by a combination of ambient monitoring data collected by CTDEEP, and physical, chemical and bacteria data collected by the USGS, which is presented in *Section 3.2*. The suitability of surface waters for recreation is determined using the *Enterococci* group bacteria in salt (estuarine) water, and *Escherichia coli (E. coli)* in fresh water as indicators of fecal pollution. The Ash Creek Estuary is also listed as impaired based primarily on physical, chemical and biological monitoring by the CTDEEP Long Island Sound Study and National Coastal Assessment (Strobel, 2000), with bacterial monitoring for shellfish sanitation by the Connecticut Department of Agriculture, Bureau of Aquaculture (CT DA/BA), and bathing beach monitoring by state and local authorities. The identified impairments include commercial shellfish harvesting; habitat for fish, other aquatic life; and wildlife recreational uses due to *Enterococcus*, gold, and silver (CTDEEP, 2012).

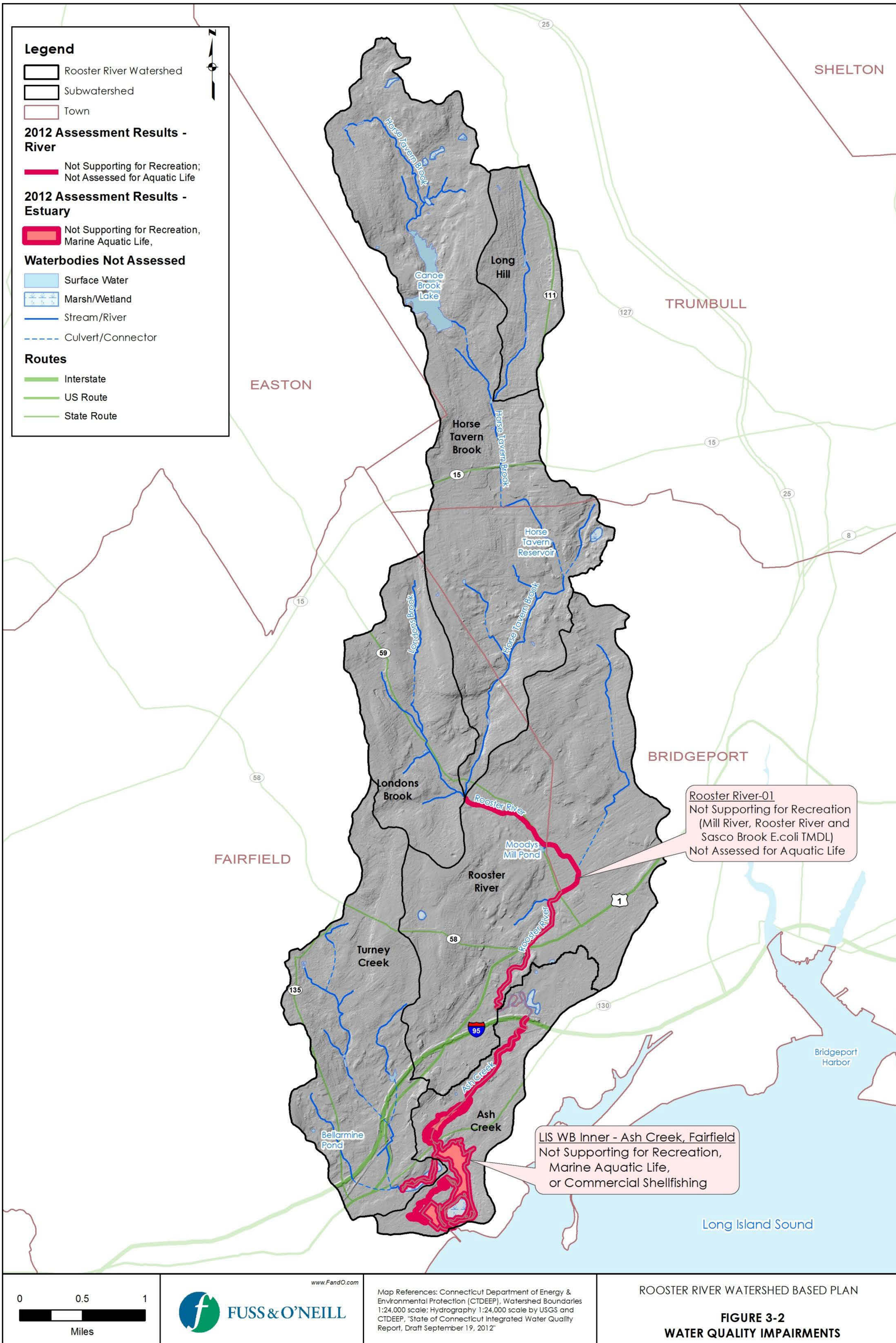



FIGURE 3-2
WATER QUALITY IMPAIRMENTS

**Table 3-2. Impaired River Segments in the Rooster Watershed**

| Waterbody Name | TMDL Category/ Priority Year | Impaired Designated Use | Cause | Potential Sources/ Comments |
|---|---|---|---|---|
| Rooster River-01 (CT7106-00_01) | Category 4a Mill River, Rooster River and Sasco Brook E.coli TMDL (2005) | Recreation | *Escherichia coli* | Nonpoint sources:<br>Collection System Failure, Source Unknown, Urban Runoff/Storm Sewers<br>Point sources:<br>Combined Sewer Overflow (CSO), Regulated Urban Runoff/Storm Sewers |
| LIS WB Inner - Ash Creek, Fairfield (CT-W1_003-SB) | Category 5/ None Specified | Commercial Shellfish Harvesting Where Authorized | *Enterococcus* | Unknown |
| | | Habitat for Marine Fish, Other Aquatic Life and Wildlife | Gold | Potential sources include industrial point source discharge |
| | | | Silver | Potential sources include industrial point source discharge |
| | | Recreation | *Enterococcus* | Unknown |

Total Maximum Daily Loads (TMDLs) provide the framework to restore impaired waters by establishing the maximum amount of a pollutant that a water body can assimilate without adverse impact to aquatic life, recreation, or other public uses.

A TMDL analysis was completed for indicator bacteria in the Mill River, Rooster River and Sasco Brook in 2005. The potential sources identified in the TMDL are listed in *Table 3-2*. In the TMDL, loadings are expressed as the average percent reduction from current loadings that must be achieved to meet water quality standards. The TMDL calls for overall reductions in indicator bacteria in the Rooster River of 91%, with 92% reductions in point source discharges and 91% reductions in nonpoint source discharges. The occurrence of combined sewer overflows during wet weather may be contributing to such a high percent reduction. The installation of engineered controls to improve water quality and reduce the discharge of stormwater to the river, as well as implementation of a plan to remove combined sewer overflows to the river may be necessary in order to achieve the required reduction in indicator bacteria levels (CTDEEP, 2005).

## 3.2 Water Quality Monitoring

Water quality monitoring data has been collected in the Rooster River watershed by the USGS and volunteers for the CTDEEP Ambient Monitoring and Assessment Program since 1993, as summarized in *Table 3-3*. The bacteria TMDL for the Rooster River was developed using *Escherichia coli* data from the "Rooster River at Route 1" monitoring station. More than 150 parameters are monitored at the USGS flow and water quality station, including numerous organic pesticides. Common heavy metals such as lead, copper, and zinc, have not been monitored at any of the stations within the Rooster River.

**Table 3-3. Summary of Available Water Quality Monitoring Data**

| Agency | Monitoring Program | Stations | Parameters | Monitoring Dates |
|---|---|---|---|---|
| CTDEEP | Volunteer Monitoring for the Ambient Monitoring and Assessment Program | Horse Tavern Brook<br>Rooster River at Westwood Rd<br>Rooster River at Route 1* | *Escherichia coli, Enterococci,* fecal coliform, ammonia, nitrate, nitrite, TKN, total phosphate, suspended solids, dissolved solids, turbidity | August 1999 to May 2002 |
| USGS | National Water-Quality Assessment Program | Station 01208873 - Rooster River at Fairfield, CT | Discharge, physical parameters, nutrients, inorganics, organics (pesticides) | March 1993 to December 2012 |

* *Escherichia coli* data from the "Rooster River at Route 1" monitoring station was used to develop the bacteria TMDL for the Rooster River.

Due to the large amount of data available, boxplots are used throughout the following sections to graphically summarize water quality monitoring data. Boxplots provide a succinct, graphical summary of water quality data to allow comparison of water quality conditions at different locations. A boxplot consists of a box, whiskers, and outliers. As shown in *Figure 3-3*, the top of the box is the 75th percentile value, the bottom of the box is the 25th percentile value, the line dividing the box is the median value (50th percentile), and the diamond is the average value. The vertical lines above and below the box are called whiskers and represent the minimum and maximum values of the observed data.

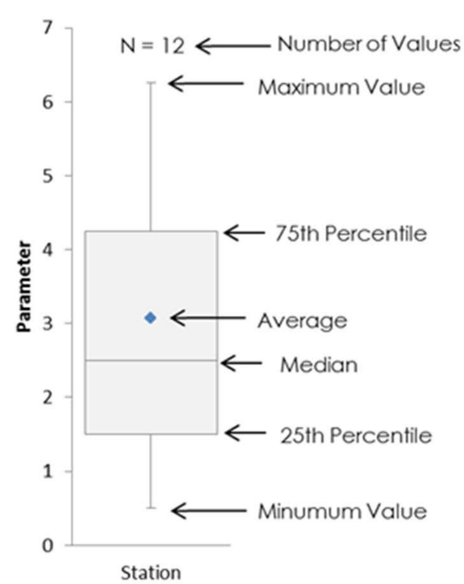
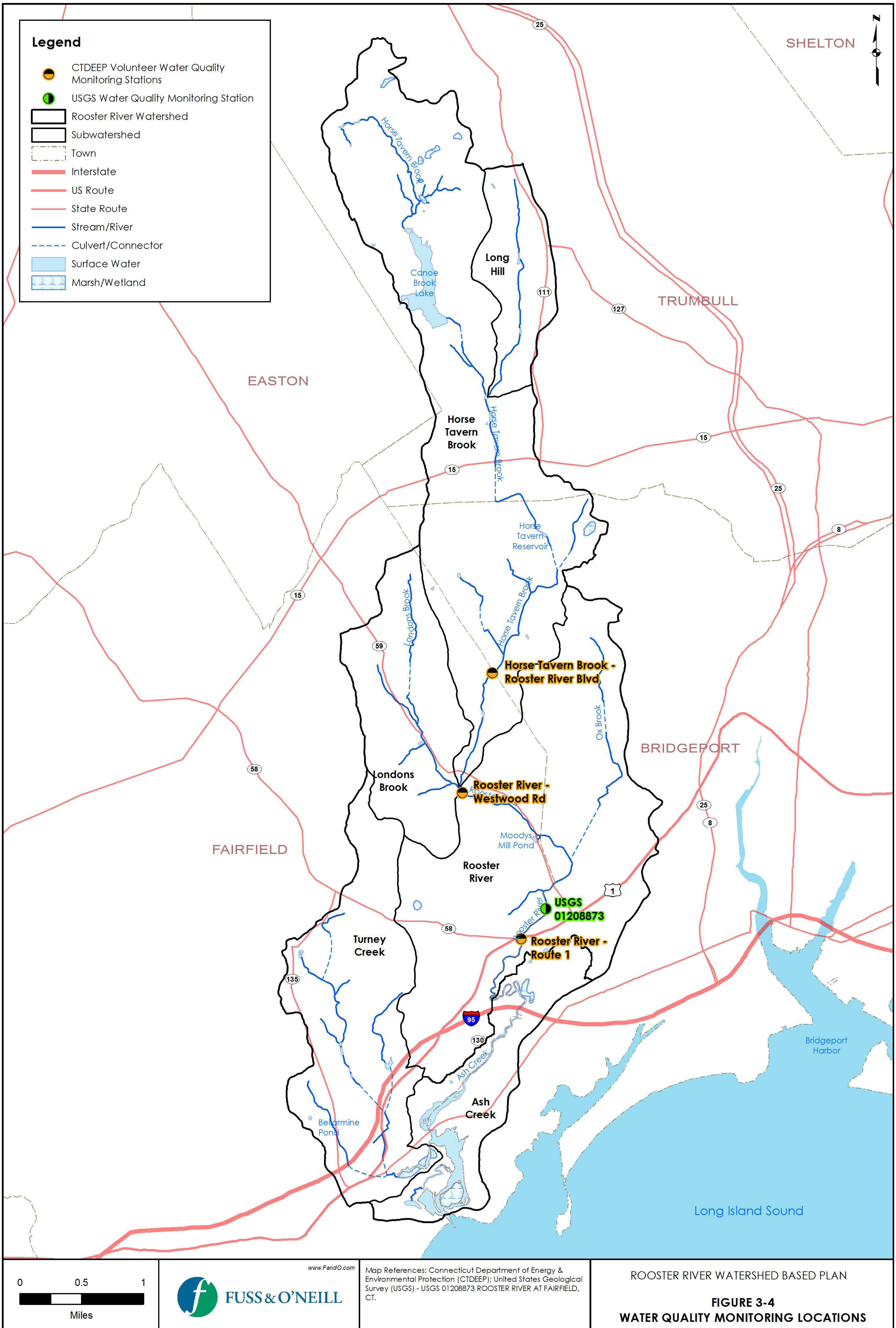



**Figure 3-3. Boxplot Elements**

## 3.2.1 CTDEEP Ambient Water Quality Monitoring Program

The determination of the supported uses in rivers across the state relies on the collection of physical, chemical and biological monitoring data of stream water quality. Two water quality monitoring locations exist on the Rooster River and one on Horse Tavern Brook (*Figure 3-4*). Water quality monitoring was conducted from 1999 to 2002 at these locations for nutrients, bacteria, turbidity, and solids. No water quality monitoring locations currently exist in Ash Creek.




Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP); United States Geological Survey (USGS) - USGS 01208873 ROOSTER RIVER AT FAIRFIELD, CT.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 3-4**
**WATER QUALITY MONITORING LOCATIONS**

Only limited, sporadic benthic macroinvertebrate monitoring and fish surveys have been conducted in the Rooster River watershed. Macroinvertebrate monitoring was performed in 1990 as part of a statewide stream survey. Fish population samples from Canoe Brook, Horse Tavern and Rooster River are available from several surveys conducted in 1990, 2001, and 2007. Information from these monitoring events is discussed in later sections of this report.

**Nutrients**

Nitrogen and phosphorus are the primary nutrients that enrich streams and rivers and cause nuisance levels of algae and aquatic weeds. Nutrients, especially phosphorus, are frequently the key stimulus to increased and excessive algal biomass in many freshwaters. Nitrogen is more of a concern in marine systems and estuaries, such as Long Island Sound to which the Rooster River and Ash Creek discharge.

Total nitrogen and phosphate were monitored between 1999 and 2002 in the Rooster River, during approximately 69 sampling events. Boxplots and time series plots of total nitrogen and total phosphate at the three monitoring locations are shown in *Figures 3-5 and 3-6*.

Total nitrogen levels measured at the three locations were consistently above the EPA reference criterion of 0.71 mg/L for background rivers and streams in southern New England (EPA, 2000). The average total nitrogen concentrations are slightly higher at the downstream monitoring locations. Similarly, the average total phosphate concentrations at all three locations are above the total phosphorus EPA reference criterion of 0.031 mg/L and are slightly higher downstream. Both parameters also exhibit a high degree of temporal variability, as shown in the time series plots. These observations reflect the contribution of nitrogen and phosphorus from wet weather sources in the watershed, such as precipitation and atmospheric deposition, urban stormwater runoff, and combined sewer overflows.

**Bacteria**

Connecticut's adopted water quality criteria for the indicator bacteria *E.coli* in the CWQS include a geometric mean and upper confidence limit (i.e., single sample maximum) for three recreational use categories. The standard for all recreational use categories is a geometric mean of less than 126 colony forming units per 100 millileters (CFU/100 mL) and a single sample maximum of 256 CFU/100 mL for designated swimming; 410 CFU/100 mL for non-designated swimming; and 576 CFU/100 mL for all other recreational uses. A TMDL analysis was completed in 2005 for indicator bacteria in the Mill River, Rooster River, and Sasco Brook, which are included on the List of Connecticut Waterbodies Not Meeting Water Quality Standards due to exceedances of the indicator bacteria criteria contained within the CWQS. The data collected at the "Rooster River - Route 1" station was used to support the development of the bacteria TMDL for the Rooster River.

As shown in *Figure 3-7*, E.coli levels are above both the geometric mean and simgle sample maximum standards at all three locations, with increasing concentrations at the downstream Rooster River locations. Nonpoint source pollution is a major source of bacteria loads to the river, and significant efforts to reduce nonpoint source pollution are required to achieve the TMDL target reductions for indicator bacteria.

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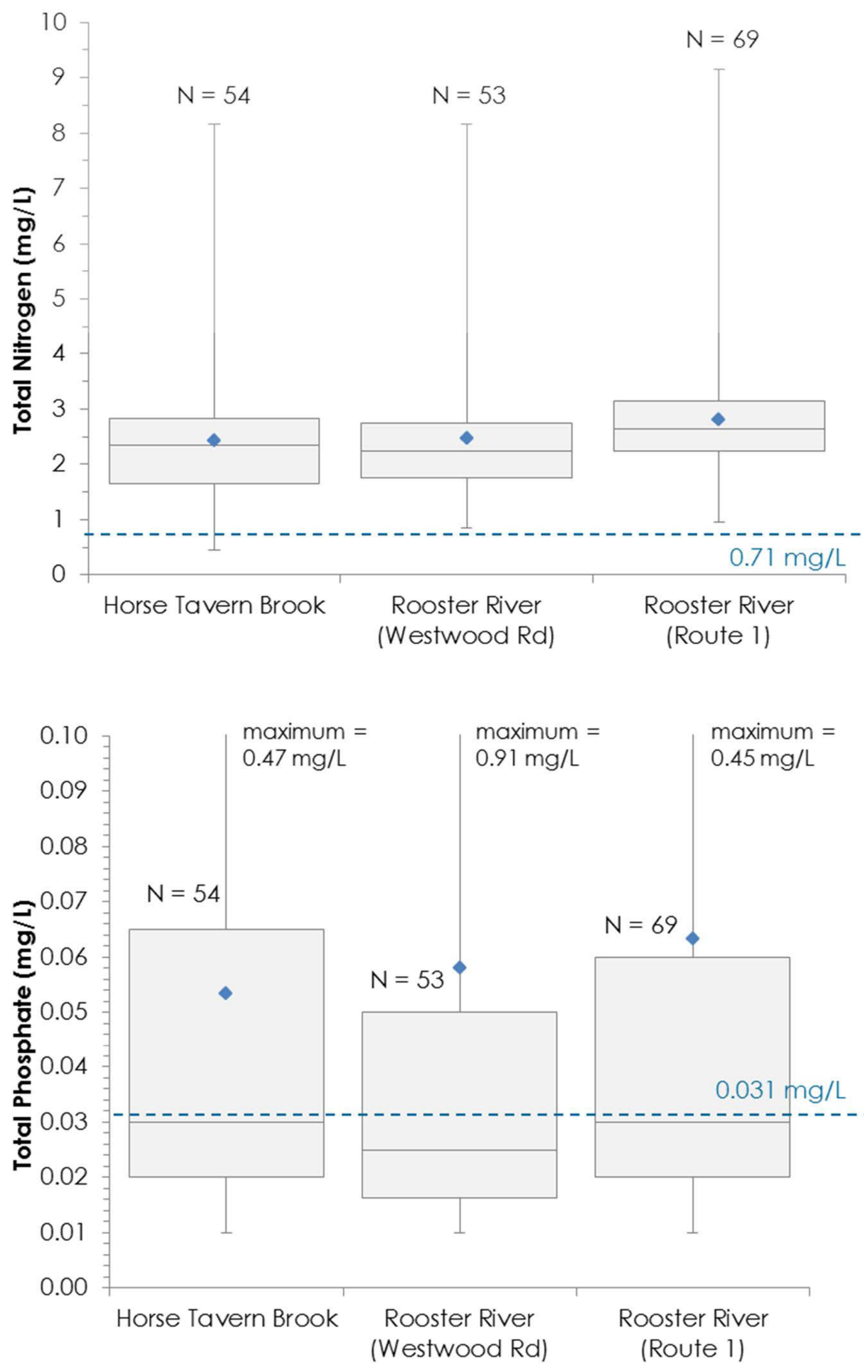



**Figure 3-5. Total Nitrogen and Phosphate Boxplots (CTDEEP)**

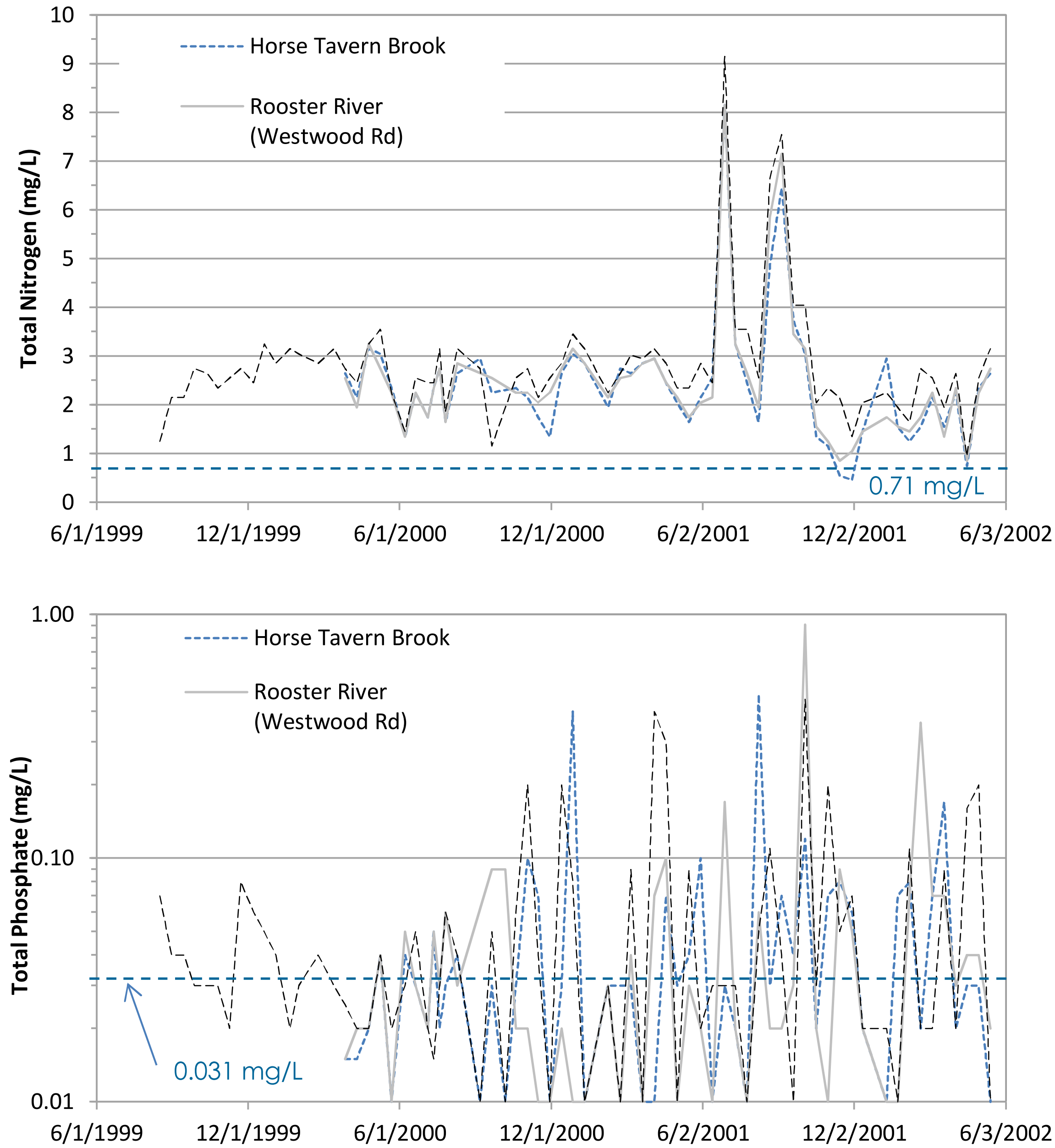



**Figure 3-6. Total Nitrogen and Phosphate Time Series Plots (CTDEEP)**

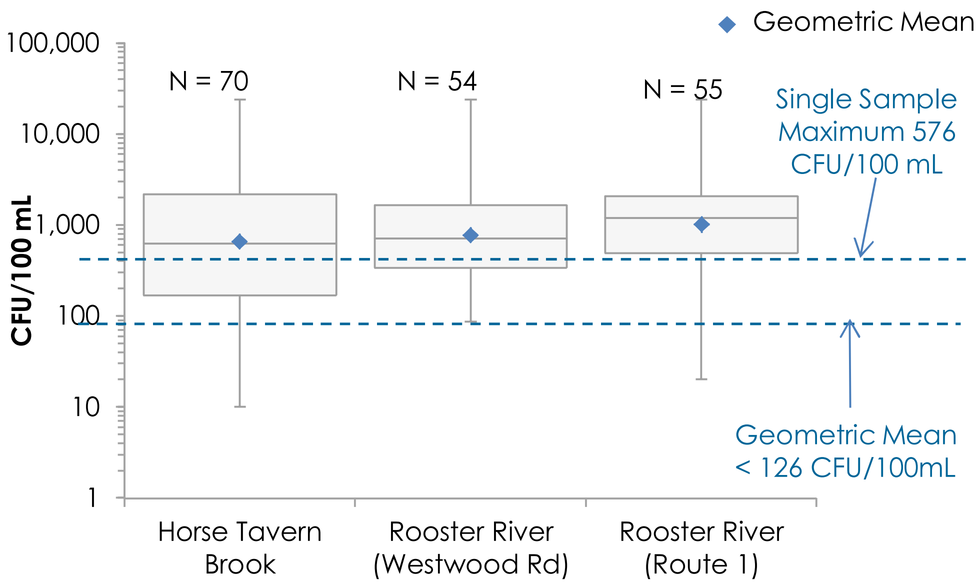



**Figure 3-7. *Escherichia coli* Boxplots (CTDEEP)**

**Solids and Turbidity**

Suspended solids and turbidity generally increase from upstream to downstream from Horse Tavern Brook to the Rooster River but are generally low except during wet weather events. Average total suspended solids concentrations at the three locations vary from 3.8 to 6.5 mg/L, while values between 10 and 70 mg/L are common during wet weather. Dissolved solids are highest at the station in Horse Tavern Brook (average of 206 mg/L) and decrease slightly at the Rooster River stations (average of 183 and 185 mg/L). The average turbidity at the three locations ranges from 1.6 to 2.3 NTU, which is below the standard of 5 NTU above ambient conditions for Class A streams. During wet weather, elevated turbidity levels have been observed between 10 and 60 NTU.

### 3.2.2 USGS Surface Water Monitoring Program

The USGS National Water-Quality Assessment (NAWQA) Program was developed to gather long-term information on streams, rivers, groundwater, and aquatic systems in support of national, regional, state, and local information needs and decisions related to water-quality management and policy. A USGS water quality monitoring station with long-term monitoring data is located on the Rooster River near Renwick Drive in Fairfield (*Figure 3-3*).

Water quality data, includign a variety of physical and chemical parameters, have been collected routinely from 1993 through 1995 and from 2007 through the present. The 68 sampling events conducted between 2007 and December of 2012 are presented in this section since they reflect the most current watershed conditions. Water quality parameters that are used by the CTDEEP to determine water quality classifications and impairments are discussed in this section, including turbidity, dissolved oxygen, water temperature, total nitrogen, and total phosphorus.

**Solids, Turbidity, and Dissolved Oxygen**

Turbidity levels measured at the USGS monitoring location are generally low, with an average of 2.1 Nephelometric Turbidity Ratio Units (NTRU), and relatively consistent with the levels measured at the CTDEEP monitoring locations. During wet weather, turbidity values of between 4 and 14 NTRU have been observed.

Dissolved oxygen is an important indicator of habitat quality and ecosystem condition. Dissolved oxygen is necessary in aquatic systems for the survival and growth of aquatic organisms. The CWQS establish a criterion for dissolved oxygen of 5 mg/L. Prolonged exposure to dissolved oxygen below this level may increase organisms' susceptibility to environmental stresses. Dissolved oxygen concentrations at the USGS monitoring location are generally well above the CWQS of 5 mg/L for Class A streams and vary inversely with water temperatures (*Figure 3-8*).

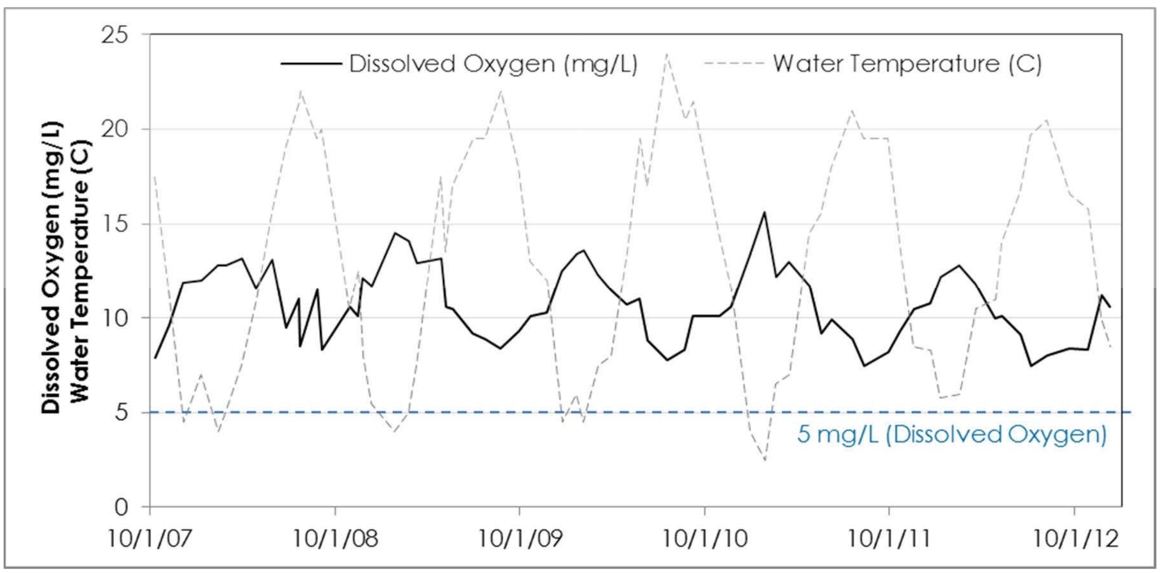



**Figure 3-8. Dissolved Oxygen and Water Temperature (USGS)**

**Nutrients**

Total nitrogen and phosphorus have been measured at the USGS monitoring location since 2007. Consistent with the water quality data collected by the CTDEEP volunteer monitoring program, the USGS data for total nitrogen is well above the EPA reference criterion (0.71 mg/L), with an average value of 2.1 mg/L (*Figure 3-9*). Total phosphorus levels measured at the USGS monitoring location are generally below or similar to the EPA reference criterion (0.031 mg/L), with an average concentration of 0.024 mg/L. Similar to the CTDEEP nutrient data, the variability in total nitrogen and phosphorus concentrations at this location reflects the strong influence of nonpoint sources on the Rooster River.

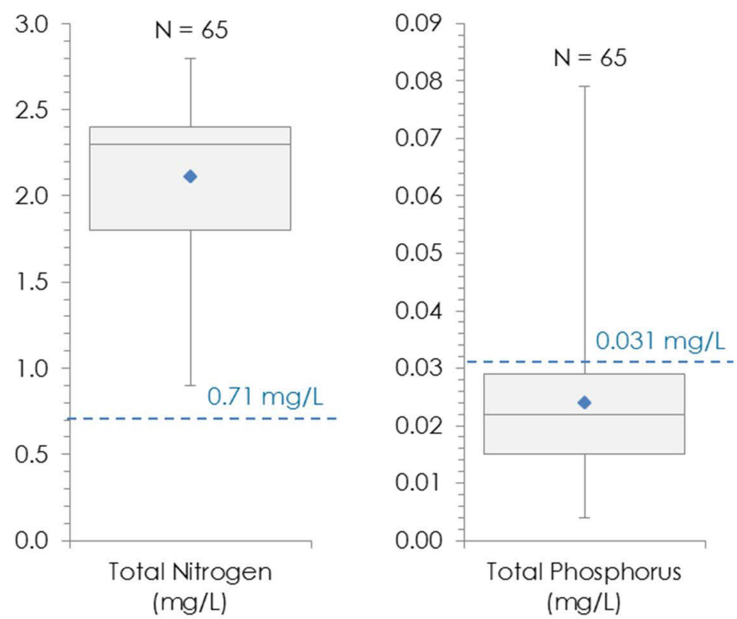



**Figure 3-9. Total Nitrogen and Total Phosphorus Boxplots (USGS)**

**Organic Compounds**

The USGS monitoring data includes a variety of organic compounds associated with pesticides, which were were monitored three times in 1994. Compunds that were detected during these monitoring events include Metribuzin, Diazinon, Dieldrin, Prometon, and Simazine.

The USGS has also studied the geographical distribution and adverse biological effects of selected trace elements and organic compounds in streambed sediment in the Connecticut, Housatonic, and Thames River Basins, including the Long Island Sound Coastal River Basin, which includes the Rooster River (Breault and Harris, 1997). The study identified the highest total Chlordane concentrations in streambed sediments at a monitoring site on the Rooster River near Fairfield. Chlordane was widely used as an insecticide for treatment of termite infestation in urban areas. This widespread application is the probable source of the high chlordane concentrations measured in streambed sediments at the Rooster River site, which has a highly urbanized drainage basin with one of the largest population densities in the study unit. No permitted dischargers are currently disposing of effluent into the Rooster River, yet it had the highest concentrations of total chlordane detected in the study. Concentrations of other selected trace elements and organic compounds also were high at the Rooster River site, with the exception of PCBs, which were not detected (Breault and Harris, 1997). These findings further illustrate the importance of nonpoint source pollution in the Rooster River watershed.

# 4 Natural Resources

Although the majority of the Rooster River watershed is heavily developed and densely populated, significant natural and ecological resources exist within this urban environment. This section examines the watershed's wetlands and wildlife as natural resources and indicators of environmental health. This section also includes a brief discussion of the geology and topography of the watershed as these and other watershed factors are closely related to watershed ecology.

## 4.1 Geology

The State of Connecticut is comprised of three distinct geologic units divided longitudinally across the state. These three units are known as the Western Uplands, the Central Valley, and the Eastern Uplands. The Rooster River watershed is within the Western Uplands. The Western and Eastern Uplands are comprised of metamorphic rocks – rocks subjected to intense heat and pressure of the Earth's interior while the Central Valley is a younger unit comprised of sedimentary rocks. The Iapetos Terrane region of the Western Uplands is composed of moderate-aged material (300 to 500 million years old), and is primarily schist, gneiss and granite (Bell, 1985).

The Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database for the State of Connecticut identifies urban land and urban land complexes as the predominant surficial materials in the Rooster River watershed. These soils are typically a mix of native and urban materials, which have resulted from soil disturbance by humans and various filling activities. In addition, smaller, non-contiguous areas of surficial material, include various types of sand and gravel, sand and fine soils and alluvial deposits, are found interspersed throughout the watershed.

## 4.2 Topography

The topography of the Rooster River watershed ranges from steep slopes to rolling hills and shallow sloping areas, which is characteristic of other small, coastal watersheds in Connecticut. A shaded relief map of the watershed is presented in *Figure 2-1,* which shows the variation in topography across the watershed.The topography in the middle and upper portions of the watershed is more varied, particularly along the river valleys, while the lower watershed in Fairfield and Bridgeport is relatively flat. The area surrounding the Ash Creek Estuary is topographically flat and provides flood and erosion protection to nearby upland areas, as well as important habitat, which is discussed further in *Section 4.5.4*.

## 4.3 Wetlands

Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Wetlands and buffer zones between watercourses and developed areas help to preserve stream water quality by filtering pollutants, encouraging infiltration of stormwater runoff, and protecting against stream bank erosion.

### 4.3.1 Inland Wetlands

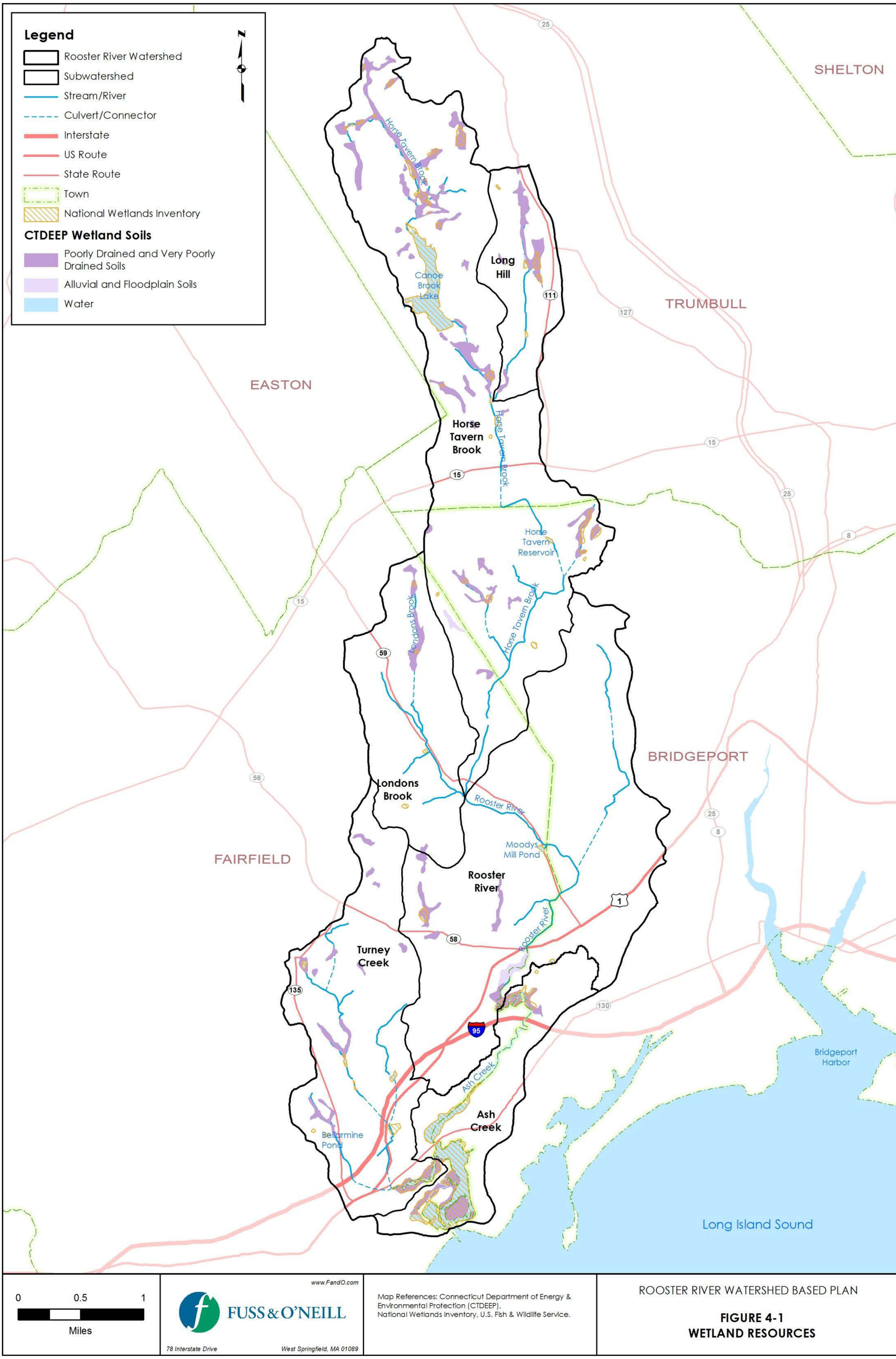
The State of Connecticut designates wetlands by soil classification since certain soils can cause groundwater to linger near the ground surface and since, conversely, groundwater lingering near the ground surface tends to transform soil characteristics. Wetland soils can also be defined by landscape position. The following classes of wetland soils are defined by the Connecticut Inland Wetlands and Watercourses Act (CTDEP, 2009).

- **Poorly drained soils** – These soils occur in places where the groundwater level is near or at the ground surface during at least part of most years. These soils generally occur in areas that are flat or gently sloping.
- **Very poorly drained soils** – These soils are typically characterized by groundwater levels at or above the ground surface during the majority of most years, especially during the spring and summer months. These areas are generally located on flat land and in depressions.
- **Alluvial and floodplain soils** – These soils form where sediments are deposited by flowing water, and thus typically occur along rivers and streams that are flooded periodically. The drainage characteristics of these soils vary significantly based on the characteristics of the flowing water, ranging from excessively drained where a stream tends to deposit sands and gravel to very poorly drained where a stream deposits silts or clays.

In contrast, the Federal Clean Water Act definition for wetlands is based on soil characteristics, vegetation, and hydrology. The federal wetland designation defines wetlands as (Cowardin et al., 1979):

> "Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominately hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water as some time during the growing season of each year."

*Figure 4-1* depicts the extent and distribution of wetland soils in the Rooster River watershed based on Natural Resources Conservation Service soil classifications, following the State of Connecticut definition. *Figure 4-1* also shows wetland classifications available from the U.S. Fish & Wildlife Service National Wetlands Inventory. State-designated wetlands and surface waters comprise approximately 6.3% of the overall watershed (approximately 622 acres), while 2.8 % of the watershed area (approximately 277 acres) is mapped as Federally-designated wetlands and surface waters (*Table 4-1*). Wetlands associated with the Ash Creek Estuary comprise roughly 25% and 50% of the State and Federally-designated wetlands and surface waters in the watershed, respectively.



Legend
Rooster River Watershed
Subwatershed
Stream/River
Culvert/Connector
Interstate
US Route
State Route
Town
National Wetlands Inventory
CTDEEP Wetland Soils
Poorly Drained and Very Poorly Drained Soils
Alluvial and Floodplain Soils
Water
N
SHELTON
TRUMBULL
EASTON
BRIDGEPORT
FAIRFIELD
Long Hill
Horse Tavern Brook
Londons Brook
Rooster River
Turney Creek
Ash Creek
Canoe Brook Lake
Horse Tavern Reservoir
Moodys Mill Pond
Bellarmine Pond
Bridgeport Harbor
Long Island Sound
Rooster River
Ash Creek
25
111
127
15
8
59
58
135
130
1
95
0
0.5
1
Miles
www.FandO.com
FUSS & O'NEILL
78 Interstate Drive
West Springfield, MA 01089
Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP), National Wetlands Inventory, U.S. Fish & Wildlife Service.
ROOSTER RIVER WATERSHED BASED PLAN
FIGURE 4-1
WETLAND RESOURCES

**Table 4-1. Wetlands in the Rooster River Watershed**

| Subwatershed | Area of Mapped State Wetlands & Surface Waters (acres) | % of Subwatershed | Area of Mapped Federal (NWI) Wetlands & Surface Waters (acres) | % of Subwatershed |
|---|---|---|---|---|
| Ash Creek | 154 | 19.2% | 137.9 | 17.1% |
| Horse Tavern Brook | 279 | 8.7% | 97.9 | 3.1% |
| Londons Brook | 25 | 2.5% | 2.4 | 0.24% |
| Long Hill | 42 | 8.2% | 6.1 | 1.2% |
| Rooster River | 53 | 1.9% | 7.0 | 0.25% |
| Turney Creek | 68 | 4.4% | 26.0 | 1.7% |
| **Watershed (Total)** | **622** | **6.3%** | **277** | **2.8%** |

In 1972, Connecticut enacted the Inland Wetlands and Watercourses Act, which regulates activities affecting wetlands and watercourses. This act is implemented through municipal inland wetlands and watercourses agencies statewide as well as the CTDEEP. Local commissions have adopted regulations governing activities affecting inland wetlands and watercourses, including land adjacent to inland wetlands and watercourses, which is referred to as upland review area. The upland review area defines the extent of regulated activities in non-wetland or non-watercourse upland areas.

### 4.3.2 Ash Creek Estuary

An estuary is a partially enclosed body of water where fresh water from rivers and streams mixes with salt water from the ocean. Estuaries are areas of transition between the land and the sea, and are among the most productive environments on earth, providing diverse habitats for wildlife and aquatic life, flood protection, and pollutant reduction, and supporting local economies through commercial and recreational activities.

The Ash Creek Estuary, situated between the Rooster River and Long Island Sound, is one of Connecticut's few remaining ecologically significant tidal estuaries located in an urban setting. Many urban tidal estuaries have been destroyed or are in such poor condition that they no longer function as a tidal estuary. Ash Creek serves as a wildlife sanctuary for nesting birds, shellfish and finfish, is a breeding ground for horseshoe crabs and an important habitat for oysters and hard shell clams. In addition, it provides food and habitat for migratory shorebirds.

The Ash Creek Estuary is tidally influenced for approximately 3.5 miles upstream from its mouth at St. Mary's sand spit, near Jennings Beach and Black Rock Harbor. Ash Creek flows along the municipal boundary between the City of Bridgeport and the Town of Fairfield. The tidal limit and northern extent of the estuary is located upstream of the Interstate 95 crossing, near the end of Fairchild Avenue. The Ash Creek Estuary supports a diverse ecosystem of vegetation and wildlife. Habitat types include upland meadow, extensive mudflats, maritime forest, freshwater wetlands, high and low marsh, and sand dunes and beaches at the mouth of the estuary. The present distribution and conditions of the various habitats that comprise the Ash Creek Estuary are described in detail in the "Ash Creek Estuary Master Plan," which was recently prepared by the Ash Creek Conservation Association, Inc. (2012).

The marsh is flooded twice a day by tidal action and is characterized by large areas of mudflats. The east bank of Ash Creek is heavily urbanized and consists of medium density residential and commercial land uses within the Blackrock Community of Bridgeport. The west bank of Ash Creek contains medium density residential development and the Metro Center train station complex, including a recently completed constructed wetland. Encroachment of industrial and commercial development, particularly the railroad line, has likely affected the conditions of the marsh, including tidal flow regimes and the vegetation and wildlife communities that reside there.

Upper Ash Creek, including the tidal mudflats, provides good habitat for invertebrates. Tidal marsh habitat conditions in this area are generally poor and contain significant stands of invasive plant species. Native tidal marsh plant species are limited to the land immediately adjacent to the creek, while other high marsh species are absent from the upper tidal marsh areas due to the presence of phragmites and other salt-tolerant shrubs. Freshwater inputs from the Rooster River and stormwater runoff, accompanied by significant human disturbance, likely creates the low-saline waters in which the phragmites and other salt-tolerant species can thrive. In contrast, lower Ash Creek receives greater concentrations of salt water and as a result, contains a higher concentration of native vegetation (Ash Creek Conservation Association, 2012).

The Ash Creek Conservation Association was formed as a unifying organization to protect and preserve the estuary and serves to develop and coordinate planning and restoration efforts of the adjacent communities. More recently, the Ash Creek Conservation Association has begun to take a more comprehensive planning approach to addressing the water resources and ecological challenges that face the estuary through the recently completed Ash Creek Estuary Master Plan and coordination with the Rooster River watershed planing efforts that are the subject of this report.

## 4.4 Fish and Wildlife Resources

The Rooster River watershed is heavily urbanized but provides habitat for a variety of fish and wildlife species, particularly along the river and stream corridors, in the forested areas of the watershed, in urban parklands, and in the ecologically-rich Ash Creek Estuary. Limited fish and wildlife inventories have been performed in the watershed, with the exception of the Ash Creek Estuary. The information described in this section is based on the Ash Creek Estuary Master Plan (2012) and the limited available information for other areas of the watershed.

### 4.4.1 Fisheries

*Table 4-2* lists fish species that have been identified in the Rooster River watershed based on fish population surveys conducted by the CTDEEP between 1990 and 2007.

### Table 4-2. Fish Species within the Rooster River Watershed

| Common Name | Scientific Name |
|---|---|
| **Native Fish** | |
| American eel | *Anguilla rostrata* |
| Blacknose dace | *Rhinichthys atrarulus* |
| Brook trout | *Salvelinus fontinalis* |
| Brown bullhead | *Ameiurus nebulosus* |
| Brown trout | *Salmo trutta* |
| Chain pickerel | *Esox niger* |
| Golden shiner | *Notemigonus crysoleucas* |
| Pumpkinseed | *Lepomis gibbosus* |
| Readbreast sunfish | *Lepomis auritus* |
| White sucker | *Catostomus commersonii* |
| Mummichog | *Fundulus heteroclitus* |
| Yellow perch | *Perca flavescens* |
| **Exotic Fish** | |
| Bluegill sunfish | *Lepomis macrochirus* |
| Largemouth bass | *Micropterus salmoides* |

The Ash Creek Estuary provides habitat for fish and shellfish. The Lower Creek provides the highest quality habitat for fish and shellfish. It provides the substrate for commercial and recreational shellfishing, especially oystering. Oysters are commercially cultivated, seasonally harvested, and then moved into deeper waters of Long Island Sound for purification before being sold. As discussed in *Section 3.1*, the estuary does not currently meet water quality goals for commercial shellfishing due to elevated levels of indicator bacteria originating from poitn and nonpoint sources. The marine and aquatic life impairment is related to heavy metal contamination of the estuary sediments due to historical industrial uses along the creek.

The estuary also provides opportunities for recreational fishing. Ash Creek does meet designated uses for fish consumption and is evaluated on a regular basis by the CTDEEP. There is currently no specific advisory for the consumption of fish caught within Ash Creek or the remainder of the Rooster River watershed (Ash Creek Conservation Association, 2012).

A number of issues affecting fisheries exist throughout the watershed. Lack of shade along the stream banks results in increased stream temperature, which can affect dissolved oxygen concentrations and negatively impact many fish species. Sediment and pollutants introduced into the streams from stormwater runoff can harm fish and smother eggs and invertebrate larvae. Abnormally low stream flow during dry periods due to development and loss of groundwater recharge are common to many areas of the watershed. In addition, the numerous modifications of the rivers and streams in the watershed for flood control purposes (e.g., channelization, stream bank hardening, burying the streams in underground culverts) impede or limit fish migration upstream. Tide gates within Ash Creek also reduce the ecological connectivity of the creek with its tributaries (Turney and Riverside Creeks).

### 4.4.2 Birds

The Ash Creek Estuary and other portions of the Rooster River watershed are located within the Atlantic Flyway. As a result, it is used by many migrating birds for food and cover. In addition, it provides nesting sites and habitat for resident bird species. The maritime forests within the Ash Creek Estuary serve as important refuge for birds during the migration season. The Ash Creek Estuary provides numerous opportunities for bird and other wildlife watching. Great Island Marsh, located in the lower estuary, is noteworthy for its Ospreys (Ash Creek Conservation Association, 2012).

### 4.4.3 Amphibians & Reptiles

*Table 4-3* lists amphibians and reptiles that have been observed within at least one of the Rooster River watershed municipalities, based on records from the Bulletin of the Peabody Museum of Natural History published in October 2006 and records published by Klemens in 1993.

**Table 4-3. Amphibians and Reptiles within the Rooster River Watershed**

| Common Name | Scientific Name |
|---|---|
| **Amphibians** | |
| Spotted salamander | *Ambystoma maculatum* |
| American toad | *Bufo americanus* |
| Northern dusky salamander | *Desmognathus fuscus* |
| Northern two-lined salamander | *Eurycea bislineata* |
| Gray treefrog | *Hyla versicolor* |
| Eastern newt | *Notophthalmus viridescens* |
| Red-backed salamander | *Plethodon cinereus* |
| Spring peeper | *Pseudacris crucifer* |
| American bullfrog | *Rana catesbeiana* |
| Green frog | *Rana clamitans* |
| Pickerel frog | *Rana palustris* |
| Wood frog | *Rana sylvatica* |
| **Reptiles** | |
| Eastern wormsnake | *Carphophis amoenus* |
| Common snapping turtle | *Chelydra serpentine* |
| Eastern Racer | *Coluber constrictor* |
| Eastern hog-nosed snake | *Heterodon platirhinos* |
| Milk snake | *Lampropeltis triangulum* |
| Northern water snake | *Nerodia sipedon* |
| Smooth green snake | *Opheodrys vernalis* |
| Brown snake | *Storeria dekayi* |
| Common garter snake | *Thamnophis sirtalis* |
| Red-eared slider | *Trachemys scripta* |

Source: Yale Peabody Museum of Natural History, Online Guide to Herpetology, 2006; and Klemens, 1993.

## 4.4.4 Threatened and Endangered Species and Critical Habitats

The CTDEEP Natural Diversity Data Base (NDDB) maintains information on the location and status of endangered, threatened, and special concern species in Connecticut. The Connecticut Endangered Species Act defines "Endangered" as any native species documented by biological research and inventory to be in danger of extirpation (local extinction) throughout all or a significant portion of its range within Connecticut and to have no more than five occurrences in the state. The Act defines "Threatened Species" as any native species documented by biological research and inventory to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range within Connecticut and to have no more than nine occurrences in the state. "Species of Special Concern" means any native plant or any native non-harvested wildlife species documented to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high economic demand that its unregulated taking would be detrimental to the conservation of its population, or has become locally extinct in Connecticut.

*Figure 4-2* depicts the generalized areas of endangered, threatened, and special concern species in the Rooster River watershed. These areas represent a buffered zone around known species or community locations. *Table 4-4* records state-listed species known to exist within Bridgeport, Fairfield and Trumbull. The locations of species and natural community occurrences depicted on the NDDB mapping are based on data collected over the years by the Environmental and Geographic Information Center's Geologic and Natural History Survey, other units of the CTDEEP, conservation groups, and the scientific community. Areas throughout the watershed are identified as Natural Diversity Areas.

**Table 4-4. Endangered, Threatened, and Special Concern Species**

| Common Name | Scientific Name | Status |
|---|---|---|
| **Reptiles** | | |
| Eastern hog-nosed snake | *Heterodon platirhinos* | Special Concern |
| Smooth green snake | *Opheodrys vernalis* | Special Concern |
| **Birds** | | |
| Grasshopper sparrow | *Ammodramus Savannarum* | Endangered |
| Long-eared owl | *Asio otus* | Endangered |
| Sedge Wren | *Cistothorus platensis* | Endangered |
| Yellow-breasted chat | *Icteria virens* | Endangered |
| Red-headed woodpecker | *Melanerpes erythrocephalus* | Endangered |
| Pied-billed grebe | *Podilymbus podiceps* | Endangered |
| Vesper sparrow | *Pooecetes gramineus* | Endangered |
| Seaside sparrow | *Ammodramus maritimus* | Threatened |
| Saltmarsh sharp-tailed sparrow | *Ammodramus caudacutus* | Special Concern |
| Broad-winged hawk | *Buteo platypterus* | Special Concern |
| Bobolink | *Dolichonyx oryzivorus* | Special Concern |
| Savannah sparrow | *Passerculus sandwichensis* | Special Concern |

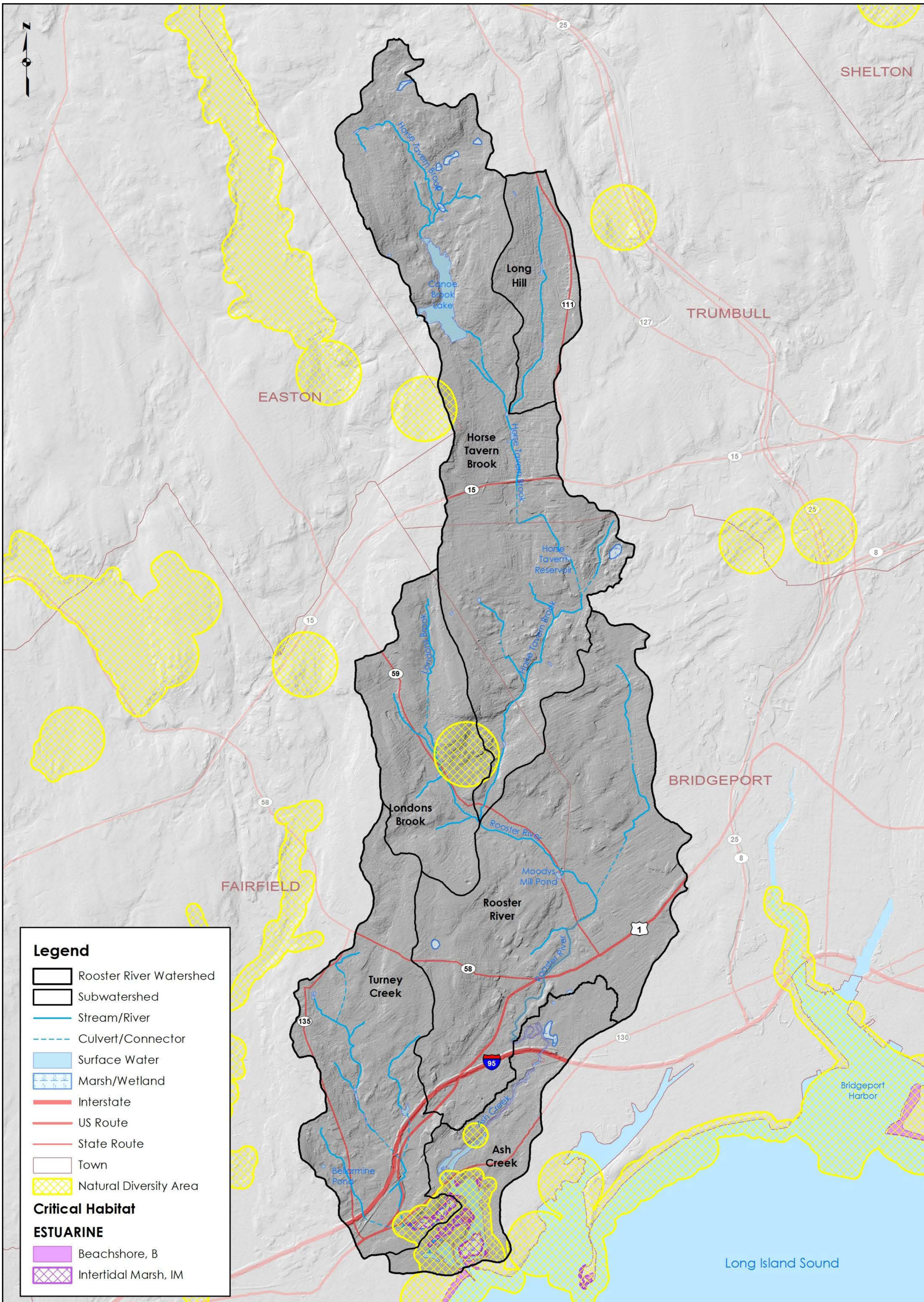
| | | |
|---|---|---|
| Ipswich sparrow | *Passerculus sandwichensis ssp. princeps* | Special Concern |
| Brown thrasher | *Toxostoma rufum* | Special Concern |
| Silver-haired bat | *Lasionycteris noctivagans* | Special Concern |
| Red bat | *Lasiurus borealis* | Special Concern |
| **Plants** | | |
| Purple giant hyssop | *Agastache scrophulariifolia* | Endangered |
| Beach needle grass | *Aristida tuberculosa* | Endangered |
| Water-plantain spearwort | *Ranunculus ambigens* | Endangered |
| Marsh pink | *Sabatia stellaris* | Endangered |
| Golden Alexanders | *Zizia aptera* | Endangered |
| False beach-heather | *Hudsonia tomentosa* | Threatened |
| Toothcup | *Rotala ramosior* | Threatened |
| Starry champion | *Silene stellata* | Threatened |
| Sand dropseed | *Sporobolus cryptandrus* | Threatened |
| Northern white cedar | *Thuja occidentalis* | Threatened |
| Hairy angelica | *Angelica venenosa* | Special Concern |
| Purple milkweed | *Asclepias purpurascens* | Special Concern |
| Yellow lady's-slipper | *Cypripedium parviflorum* | Special Concern |
| Dillenius' tick-trefoil | *Desmodium glabellum* | Special Concern |
| Creeping bush-clover | *Lespedeza repens* | Special Concern |
| Golden club | *Orontium aquaticum* | Special Concern |
| Threadfoot | *Podostemum ceratophyllum* | Special Concern |
| Arrowleaf | *Sagittaria subulata* | Special Concern |
| Smooth black-haw | *Viburnum prunifolium* | Special Concern |

Sources: Yale Peabody Museum of Natural History, Online Collections, 2011. A County Report of Connecticut's Endangered, Threatened and Special Concern: Fairfield County, CTDEEP, 2012.

## 4.5 Vegetation

Although heavily urbanized, the Rooster River watershed is home to a variety of vegetative communities including urban/suburban vegetation typical along Connecticut's developed shoreline and the more diverse vegetation that exists within the Ash Creek Estuary, which is summarized in *Section 4.3.2* of this report and more fully described in the Ash Creek Estuary Master Plan (Ash Creek Conservaton Association, 2012).

Riparian buffers are naturally vegetated areas adjacent to streams, ponds, and wetlands. Vegetative buffers help encourage infiltration of rainfall and runoff, and provide absorption for high stream flows, which helps reduce flooding and drought. The buffer area provides a living cushion between upland land use and water, protecting water quality, the hydrologic regime of the waterway and stream structure. The naturally vegetated buffer filters out pollutants, captures sediment, regulates stream water temperature and processes many contaminants through vegetative uptake. The vegetative community of riparian buffers provides habitat for plants and animals, many of which are dependent on riparian habitat features for survival.

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Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP), National Hydrography Dataset (NHD).

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 4-2**
**WILDLIFE HABITAT AND NATURAL DIVERSITY DATABASE AREAS**

Development along the stream corridors in the watershed has resulted in substantial loss of riparian vegetation. The high degree of stream buffer encroachment along the watercourses in the Rooster River watershed has a significant impact on overall stream and habitat conditions. A study funded by the Long Island Sound Study and conducted by the University of Connecticut Center for Land Use Education and Research (CLEAR) characterized Connecticut's watersheds and their riparian areas through the use of remotely-sensed land cover during the 1985 to 2006 time period. Results of this study indicate that the Rooster River watershed experienced a 0.5 to 2 percent loss of forested land within the 300-foot riparian corridor (i.e., within 300 feet on either side of the streams and rivers in the watershed) between 1985 and 2006 (CLEAR, 2011). Overall, the watershed has less than 20% forest cover within the 300-foot riparian corridor

As a result of human influences, invasive plant species, which are mostly non-native plant species that successfully out-compete native plants, are prevalent throughout the watershed, including portions of the Ash Creek Estuary. Local invasive species of most concern are listed in *Table 4-5*.

**Table 4-5. Invasive Plants Common to the Rooster River Watershed**

| Common Name | Scientific Name |
|---|---|
| Norway maple | *Acer platanoides* |
| Garlic mustard | *Alliaria petiolata* |
| Japanese barberry | *Berberis thunbergii* |
| Asiatic bittersweet | *Celastrus orbiculatus* |
| Autumn olive | *Eleagnus umbellifera* |
| Winged euonymous | *Euonymous alatus* |
| Japanese honeysuckle | *Lonicera japonica Thunbergii* |
| Purple loostrife | *Lythrum salicaria* |
| Japanese stilt-grass | *Microstegium vimineum* |
| Common reed | *Phragmites australis* |
| Japanese knotweed | *Polygonum cuspidatum* |
| Glossy and common buckthorn | *Rhamnus frangula and R. catharticus* |
| Multiflora rose | *Rosa multiflora* |

The common reed and purple loosestrife are common along the sides of highways, on lake shores and in tidal marsh areas. These species have the greatest tendency to become dense, homogenous stands which offer little wildlife support. The growth of common reed has been limited to a portion of Lower Ash Creek, at the end of Riverside Drive, near the tidal gates located in Fairfield and, near the stormwater outfalls along Gillman Drive in Bridgeport. These areas have experienced various forms of human disturbance. As a general observation, development along the stream corridors in the watershed has resulted in substantial loss of natural riparian vegetation.

# 5 Water Infrastructure

This section describes the water infrastructure within the Rooster River watershed – dams, water supply, wastewater collection and treatment, stormwater and flood management – as it relates to water quality and quantity issues.

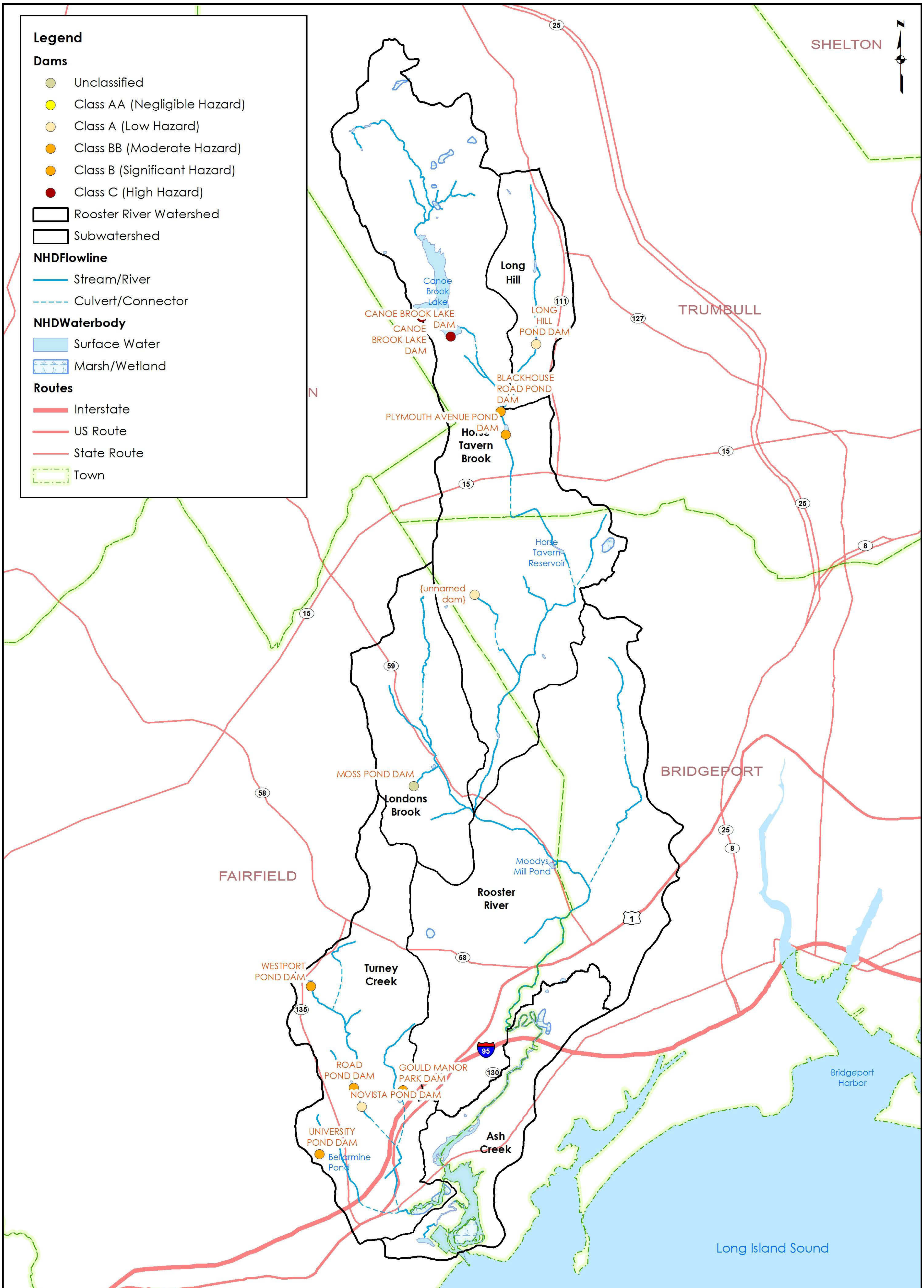
## 5.1 Dams

A number of primarily recreational and aesthetic impoundments are located throughout the watershed along tributaries of the Rooster River (*Figure 5-1*). Approximately 12 of these dams are registered with the CTDEEP, as indicated in *Table 5-1*.

**Table 5-1. Notable Dams within the Rooster River Watershed**

| Dam Name | Waterbody | Hazard Classification | Town |
|---|---|---|---|
| Canoe Brook Lake Dam (West) | Canoe Brook Lake | Class C (High Hazard) | Trumbull |
| Canoe Brook Lake Dam (South) | Canoe Brook Lake | Class C (High Hazard) | Trumbull |
| Long Hill Pond Dam | Long Hill Pond | Class A (Low Hazard) | Trumbull |
| Blackhouse Road Pond Dam (Wheelers Pond Dam) | Wheelers Pond | Class B (Significant Hazard) | Trumbull |
| Plymouth Avenue Pond Dam | Plymouth Avenue Pond | Class B (Significant Hazard) | Trumbull |
| Unnamed Dam in Ninety Acres Park | Unnamed Tributary to Horse Tavern Brook | Class A (Low Hazard) | Bridgeport |
| Moss Pond Dam | Moss Pond | Unclassified | Fairfield |
| Westport Pond Dam | Westport Pond | Class B (Significant Hazard) | Fairfield |
| Road Pond Dam | Road Pond | Class BB (Moderate Hazard) | Fairfield |
| Gould Manor Park Dam | Gould Manor Pond | Class BB (Moderate Hazard) | Fairfield |
| Novista Pond Dam | Novista Pond | Class A (Low Hazard) | Fairfield |
| University Pond Dam | University Pond | Class BB (Moderate Hazard) | Fairfield |

The dams and their associated impoundments in the watershed provide aesthetic amenities, recreational opportunities, and aquatic and wildlife habitat. However, dams and other manmade obstructions along the rivers and streams in the watershed (culverts, underground conduits, tide gates, etc.) can also serve as barriers or impediments to fish migration. The tide gates located along the major tributaries to Lower Ash Creek (Turney and Riverside Creeks) and the major road crossings in Upper Ash Creek (Interstate

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Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP), National Hydrography Dataset.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 5-1**
**DAMS**

95, Route 1) limit opportunties for anadromous[3] fish passage in the watershed. Although the CTDEEP or other organizations such as Trout Unlimited have not identified the Rooster River and Ash Creek as a high priority for anadromous fish restoration, opportunities still exist for improving fish passage for resident species and ecological connectivity throughout the watershed.

The tidal gates in Lower Ash Creek, which were originally installed for flood protection, also restrict tidal exchange, which has historically led to changes in salinity levels and the establishment of invasive plant species such as Phragmites. Replacement of the tide gates with newer self-regulating gates in the 1990s has improved water quality, although the presence of Phragmites in the vicinity of the gates suggests that flow might still be constricted to some degree (Ash Creek Conservation Association, 2012).

## 5.2 Water Supply

The majority of the population within the Rooster River watershed obtains water from public water supply systems, provided through the Aquarion Water Company. Water is supplied from three well fields and from eight reservoirs, all of which are located outside of the Rooster River watershed (*Table 5-2*).

Connecticut's Aquifer Protection Area Program protects major public water supply wells in sand and gravel aquifers. Aquifer Protection Areas (also referred to as "wellhead protection areas") are designated around active well fields in sand and gravel aquifers that serve more than 1,000 people. No designated Aquifer Protection Areas exist within the Rooster River watershed.

**Table 5-2. Public Water Supply Systems that Serve the Rooster River Watershed**

| Water Supply | Town |
|---|---|
| Housatonic Well Field | Shelton/Oxford/Seymour |
| Westport Well Field | Shelton |
| Coleytown Well Field | Norwalk/Wilton/Weston/Westport |
| Aspetuck Reservoir | Easton |
| Easton Lake | Easton/Trumbull |
| Far Mill Reservoir | Shelton |
| Hemlocks Reservoir | Easton/Fairfield |
| Means Brook Reservoir | Shelton |
| Saugatuck | Redding/Weston |
| Trap Falls Reservoir | Shelton |
| West Pequonnock | Monroe |

Watershed management is essential to the preservation and maintenance of water quality. In addition to town and watershed-level regulations, the CT DEEP has adopted streamflow standards and regulations on a state-wide level in order to protect Connecticut's rivers and streams by balancing human and

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

ecological needs for water. The regulation is primarily applicable to dam owners or operators that impound or divert the waters of a river or stream or that affect the flow of water in such a system, but also imposes restrictions for water users potentially impacting flow in a stream or river system as a result of groundwater withdrawal. The program's regulatory requirements are anticipated to be implemented over the next 10 years or more.

## 5.3 Wastewater

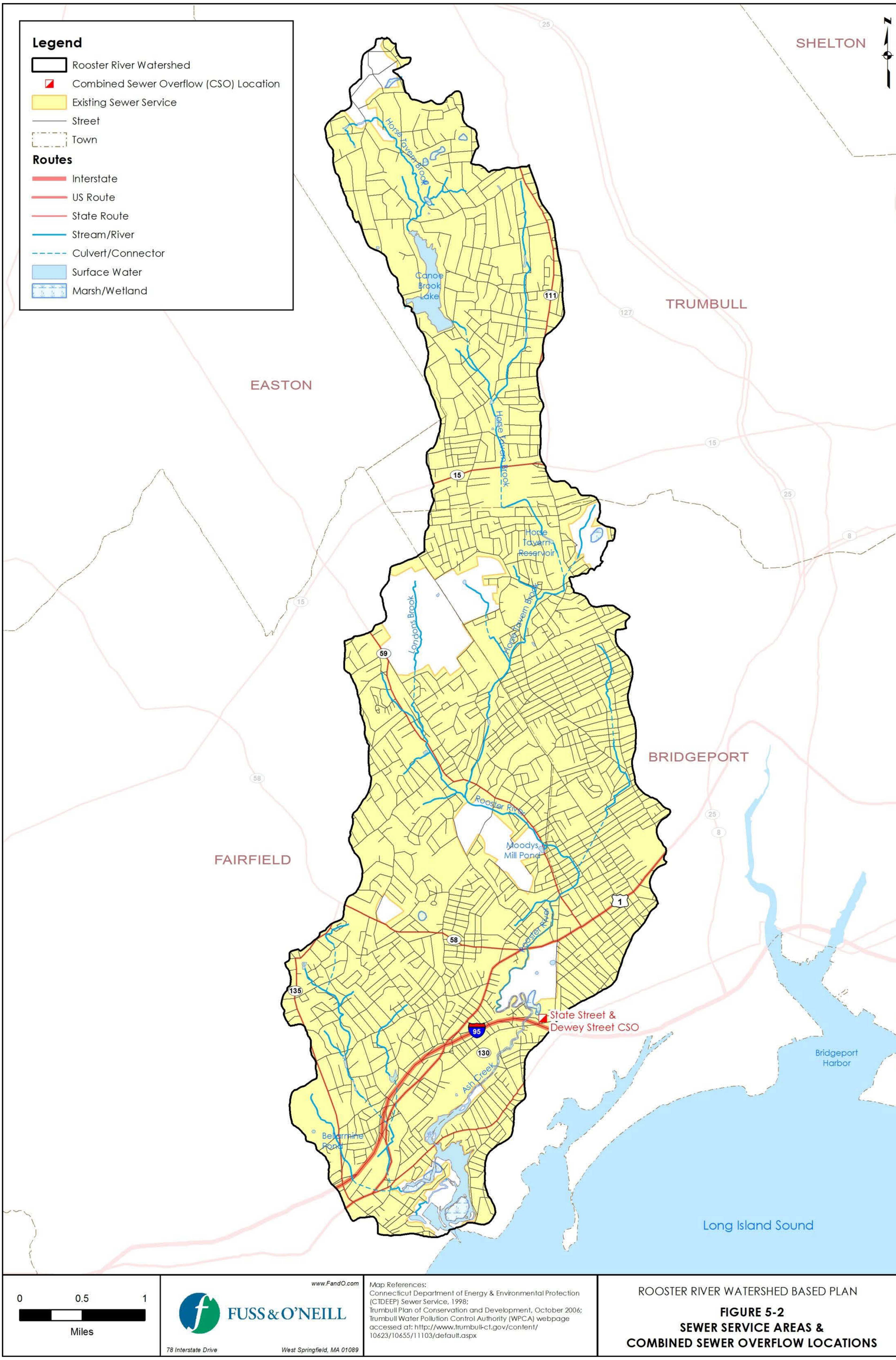
Nearly the entire Rooster River watershed is served by municipal sanitary sewers, with the exception of a small area in the northern portion of the watershed in Trumbull which has on-site septic systems (*Figure 5-2*). Sanitary sewers convey wastewater to Water Pollution Control Facilities in Bridgeport and Fairfield, which are located outside of the Rooster River watershed.

The City of Bridgeport has combined sanitary and storm sewer systems that discharge untreated sewage into Ash Creek during periods of heavy rain. These discharges are referred to as Combined Sewer Overflows (CSOs). Only one active CSO discharge location remains in the Rooster River watershed (*Figure 5-2*), located at State Street and Dewey Street in the upper portion of Ash Creek. A former CSO discharge located at the Mt. Grove Cemetery and Dewey Square was closed in December 2012.

Since the 1980s, the City of Bridgeport has implemented a number of major facility upgrades and CSO separation projects throughout the portions of the City with combined sewers. More recently, the City prepared a new Long-Term Control Plan in response to a CTDEEP Administrative Order. The LTCP identified a number of traditional grey infrastructure CSO abatement projects (e.g., illicit connection elimination, sewer separation, and CSO storage tanks and tunnels), as well as potentially cost-effective green infrastructure technologies including pervious pavement, rain barrels and cisterns, infiltration basins, rain gardens, tree planting, and green roofs. Implementation of green infrastructure approaches within the public realm (i.e., expansion of the urban tree canopy, incorporation of rain gardens and swales into street design, and the use of permeable pavement) is being considered to reduce the frequency and volume of overflows and mitigate some of the need for high-cost sewer separation. The City has also expressed a clear desire, through several of its major planning documents and initiatives, to implement green infrastructure for meeting overall sustainability and planning objectives.

## 5.4 Stormwater

As described in *Section 3* of this report, urban stormwater runoff, in the form of point discharges from stormwater collection systems and nonpoint sources such as diffuse runoff from parking lots and other impervious surfaces, is a significant cause of water quality impairments in the Rooster River watershed and Ash Creek.




Map References:
Connecticut Department of Energy & Environmental Protection (CTDEEP) Sewer Service, 1998;
Trumbull Plan of Conservation and Development, October 2006;
Trumbull Water Pollution Control Authority (WPCA) webpage accessed at: http://www.trumbull-ct.gov/content/10623/10655/11103/default.aspx

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 5-2**
**SEWER SERVICE AREAS & COMBINED SEWER OVERFLOW LOCATIONS**

Urbanization within the Rooster River watershed has altered the watershed's natural hydrologic characteristics. Large areas of marshes, wetlands and forests have been replaced by impervious surfaces, which prevent infiltration of stormwater into the ground and accumulate pollutants from the atmosphere, vehicles, industry, lawns, construction sites, humans and animals. These pollutants are quickly conveyed to storm drainage systems during storms, and are in turn directed to the receiving waterbodies without treatment. Impervious surfaces also increase the volume, peak flow rates, and timing of stormwater runoff to receiving waters, contributing to the channel erosion, sedimentation, and reduced stream baseflow during dry periods. *Section 6* of this report addresses the amount of impervious cover in the Rooster River watershed and the implications for water quality and overall stream health.

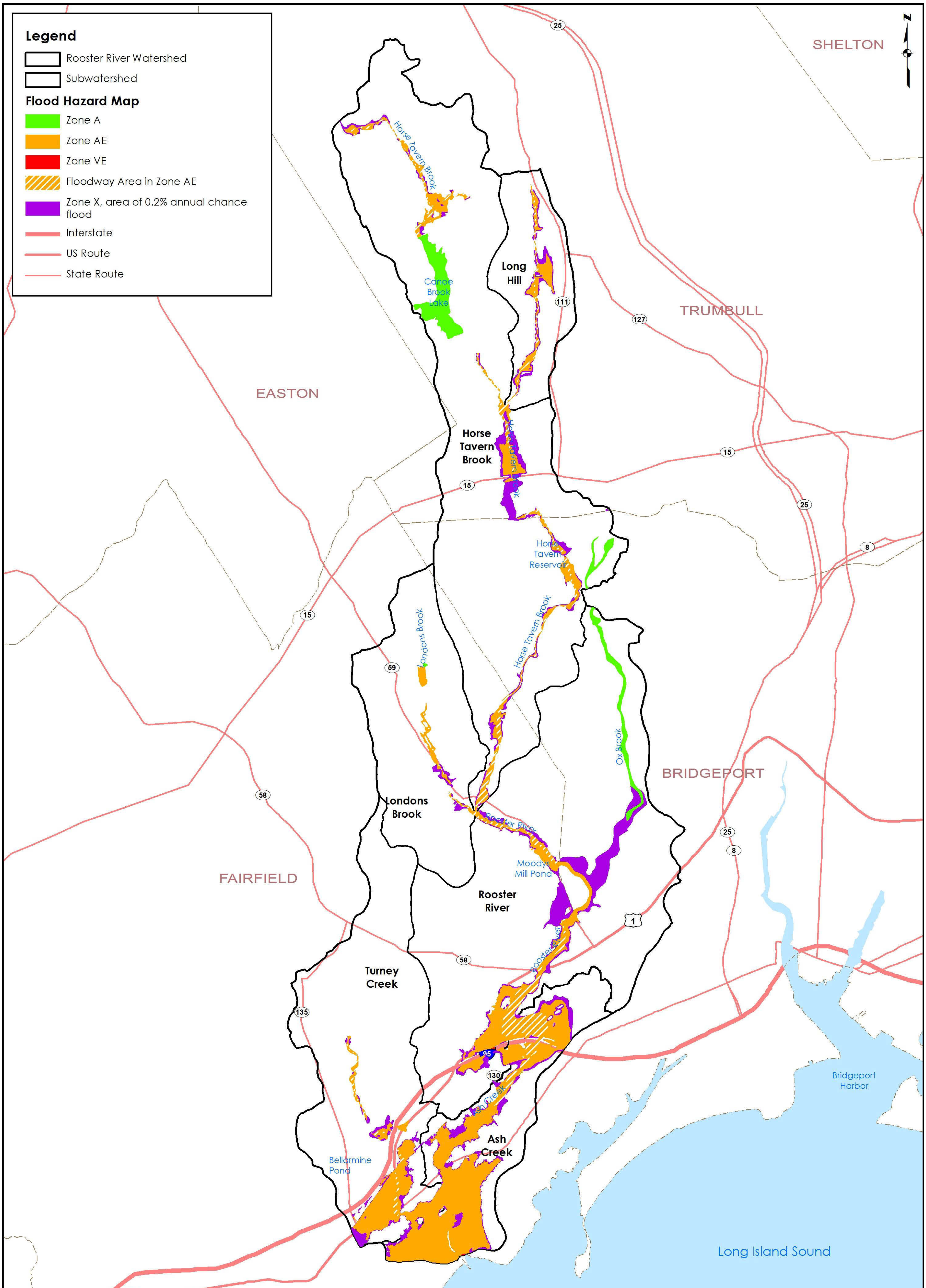
The CTDEEP regulates stormwater discharges from municipalities in designated urbanized areas under the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4). All of the municipalities in the Rooster River watershed are regulated under the MS4 General Permit. The MS4 General Permit requires these municipalities to register with CTDEEP, develop and implement a Stormwater Management Plan that addresses six minimum control measures, and annually collect stormwater samples for representative industrial, commercial, and residential land uses. The six minimum control measures include public education and outreach, public participation, illicit discharge detection/elimination, construction stormwater management, post-construction stormwater management, and pollution prevention/good housekeeping.

## 5.5 Flooding

The Rooster River watershed, like many coastal urban watersheds in Connecticut, has a long history of flooding as a result of historical development of the watershed. *Figure 5-3* depicts flood hazard areas within the Rooster River watershed, including the 100-year and 500-year flood zones (inland and coastal) and the regulatory floodway. Flood zones are defined by the Federal Emergency Management Agency (FEMA) as the area below the high water level that occurs during a flood of a specified size. FEMA also defines a "floodway" as the stream channel and adjacent areas that carry the majority of the flood flow at a significant velocity, whereas "floodplain" also includes the flood fringe or areas that are flooded without a strong current.

The United States Geological Survey (USGS) has estimated peak-flow magnitudes for various recurrence intervals based on historical peak streamflow measurements (Ahearn, 2003). *Table 5-3* summarizes peak flow frequency estimates for given recurrence intervals and the maximum known peak flow for the Rooster River in Fairfield.

Flooding problems along the Rooster River have been studied by various agencies and organizations since the 1950s. The State Legislature authorized funding for flood control along the Rooster River in 1967. Phase I and Phase II flood control improvements were constructed in the 1980s, focusing on the upper portions of the Rooster River and Ox Brook. Phase I and II flood control measures included reconstruction of the upper and lower Brooklawn Avenue bridges, channelization of the Rooster River from the upper Brooklawn Avenue bridge to upper Laurel Avenue and from lower Laurel Avenue to the lower Brooklawn Avenue bridge, relocation of the Rooster River to an underground conduit between upper Laurel Avenue and lower Laurel Avenue, and relocation of Ox Brook to an underground conduit

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Map References: Connecticut Department of Energy & Environmental Protection (CTDEEP), The Digital Flood Insurance Rate Map (DFIRM) Database, FEMA, 1:12,000 scale, 6/18/2010.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 5-3**
**FLOOD ZONES**

that begins at Lincoln Boulevard and joins the Rooster River conduit. Small amounts of flow were allowed to remain in the original channels of the Rooster River and Ox Brook for environmental reasons (FEMA, 2010).

**Table 5-3. Peak Flow Frequency Estimates and Maximum Peak Flow of the Rooster River**

| Parameter | Peak Flow (cubic feet per second) |
|---|---|
| **Peak-flow Frequency Estimates for Specified Recurrence Intervals** | |
| 1.5 years | 959 |
| 2 years | 1,140 |
| 10 years | 1,800 |
| 25 years | 2,070 |
| 50 years | 2,250 |
| 100 years | 2,410 |
| 500 years | 2,740 |
| **Maximum Known Peak Flow** | |
| April 9, 1980 | 2,170[1] |

[1] Estimated
Source: Based on stream flow data from USGS Gage Station 01208873, Rooster River at Fairfield, period of record 1978-2001 (Ahearn, 2003).

# 6 Watershed Land Use

The type and distribution of land use and land cover within a watershed has a direct impact on nonpoint sources of pollution and water quality. This section describes the current land use and land cover patterns in the watershed, and the implications for water quality and stream health.

## 6.1 Land Use/Land Cover

### 6.1.1 Land Use

*Figure 6-1* depicts generalized land use in the Rooster River watershed. The data in *Figure 6-1* reflect land use categories for the watershed communities based on GIS data from the City of Bridgeport (2008), the Town of Fairfield (2012), and the Greater Bridgeport Regional Planning Agency (GBRPA) (2000). The "water" land use category was derived from the National Hydrography Dataset (NHD). The recreation/open space parcels and roadways were derived from CTDEEP GIS data and other sources listed in *Section 6.3*. The data was verified using 2010 aerial photographs, and updates to the data set were made to reflect current conditions.

The land use categories were consolidated into 13 generalized land use categories (*Table 6-1*). Each of these land uses affects the quality of stormwater and nonpoint source runoff that flows into the Rooster River and its tributaries. Forested land, open space, and wetlands and waterbodies are generally beneficial to water quality. Residential, commercial, and industrial areas contribute greater amounts of runoff and associated pollutants, which tends to degrade water quality. *Table 6-1* identifies the various land cover types, and lists the subwatershed area and percent of the watershed associated with each of them.

The Rooster River watershed is highly developed with approximately 58% residential (including 1 family, 2 to 4 family, and 5 or more family housing), and another approximately 30% commercial, institutional, industrial, mixed use and roadways. Only approximately 12.4% of the watershed is forest, utilities or vacant land, water, or recreation/open space land use. The recreation/open space land use includes protected open space, parks, playing fields, cemeteries, and golf courses. The density of development increases from the northern portion of the watershed in Trumbull to the southern portion of the watershed in Fairfield and Bridgeport, with the majority of the commercial and industrial land uses centered around the major transportation corridors, including Fairfield Avenue/Post Road (Route 130), Kings Highway East (Route 1), and Black Rock Turnpike (Route 58).

**Table 6-1. Watershed Land Use**

| Land Use | Area (Acres) | | | | | | | Percent of Watershed |
|---|---|---|---|---|---|---|---|---|
| | Ash Creek | Horse Tavern Brook | Londons Brook | Long Hill | Rooster River | Turney Creek | Total | |
| 1 Family | 138 | 1,956 | 483 | 382 | 1,076 | 799 | 4,835 | 49% |
| 2-4 Family | 103 | 11 | 21 | 0 | 307 | 25 | 468 | 4.8% |
| 5+ Family | 30 | 115 | 44 | 18 | 155 | 22 | 384 | 3.9% |

**Table 6-1. Watershed Land Use**

| Land Use | Area (Acres) | | | | | | | Percent of Watershed |
|---|---|---|---|---|---|---|---|---|
| | Ash Creek | Horse Tavern Brook | Londons Brook | Long Hill | Rooster River | Turney Creek | Total | |
| Commercial | 40 | 121 | 8 | 1 | 151 | 109 | 430 | 4.4% |
| Institutional | 33 | 135 | 72 | 33 | 135 | 4 | 412 | 4.2% |
| Heavy Industrial | 19 | 0 | 0 | 0 | 9 | 174 | 203 | 2.1% |
| Light Industrial | 47 | 0 | 0 | 0 | 37 | 57 | 141 | 1.4% |
| Mixed Use | 5 | 1 | 6 | 0 | 19 | 305 | 336 | 3.4% |
| Recreation/Open Space | 78 | 167 | 232 | 11 | 244 | 19 | 751 | 7.6% |
| Roadway | 147 | 439 | 125 | 72 | 592 | 8 | 1384 | 14% |
| Utilities/Vacant | 42 | 45 | 6 | 1 | 39 | 0 | 132 | 1.3% |
| Forest | 0 | 133 | 5 | 0 | 3 | 1 | 141 | 1.4% |
| Water | 124 | 73 | 0 | 0 | 0 | 0 | 197 | 2.0% |
| **Total** | **805** | **3,196** | **1,002** | **518** | **2,769** | **1,522** | **9,813** | **100%** |

## 6.1.2 Land Cover

Land cover, as its name implies, refers to what is present on the land surface, which differs from land use, which is what is permitted, practiced or intended for a given area (UConn Center for Land Use Education and Research, 2012). *Figure 6-2* depicts land cover in the Rooster River watershed, which was derived from 2010 Landsat satellite imagery with a ground resolution of 30 meters. The land cover data in the watershed are classified into eleven categories (*Table 6-2*), which are used in the Connecticut Land Cover Map Series and described following the table (University of Connecticut Center for Land Use Education and Research, 2012).

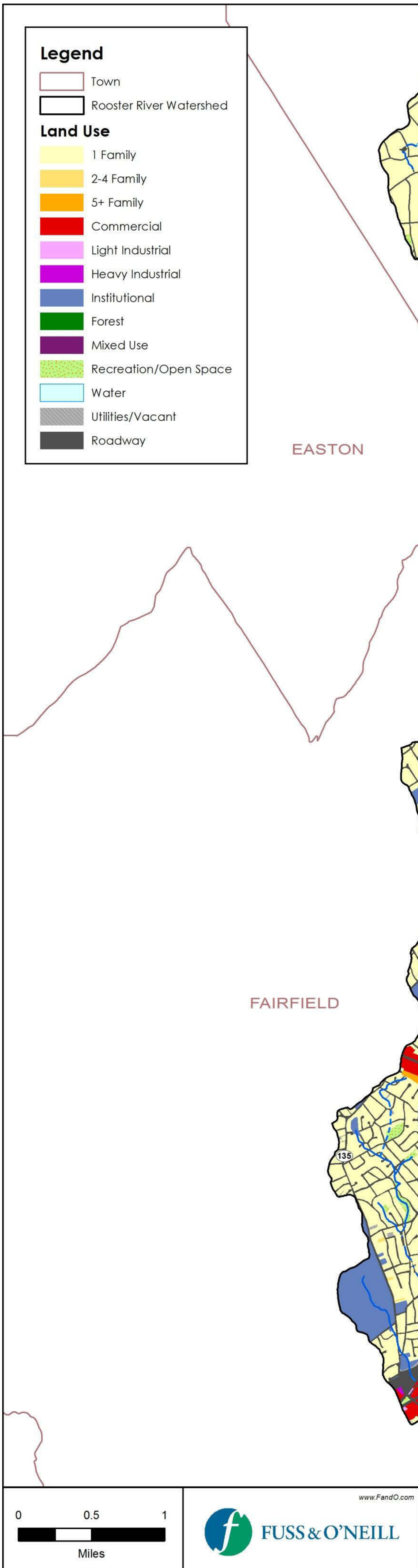
**Table 6-2. Watershed Land Cover**

| Land Cover Type | 1985 | | 2010 | | Absolute Change (Acres) | Relative Change in Percent of Watershed (%)[1] |
|---|---|---|---|---|---|---|
| | Acres | Percent of Watershed | Acres | Percent of Watershed | | |
| Developed | 6,363 | 64.8% | 6,536 | 66.6% | 173 | 1.76% |
| Turf & Grass | 1,882 | 19.2% | 1,889 | 19.3% | 7 | 0.07% |
| Other Grasses | 68 | 0.70% | 41 | 0.42% | -27 | -0.28% |
| Agriculture | 0 | 0% | 0 | 0% | 0 | 0.00% |
| Deciduous Forest | 1,156 | 11.8% | 1,011 | 10.3% | -145 | -1.48% |
| Coniferous Forest | 73 | 0.75% | 66 | 0.67% | -8 | -0.08% |
| Water | 165 | 1.7% | 154 | 1.6% | -11 | -0.11% |
| Non-forested Wetland | 2 | 0.02% | 2 | 0.02% | 0 | 0.00% |
| Forested Wetland | 38 | 0.39% | 26 | 0.27% | -12 | -0.12% |
| Tidal Wetland | 51 | 0.52% | 48 | 0.49% | -3 | -0.03% |
| Barren Land | 4 | 0.04% | 31 | 0.32% | 28 | 0.28% |
| Utility Rights-of-Way | 10 | 0.10% | 9 | 0.10% | -1 | -0.01% |

[1]Calculation = % land cover 2010 - % land cover 1985
Source: University of Connecticut Center for Land Use Education and Research (CLEAR), 2010.

The land cover types in *Table 6-2* have the following characteristics:

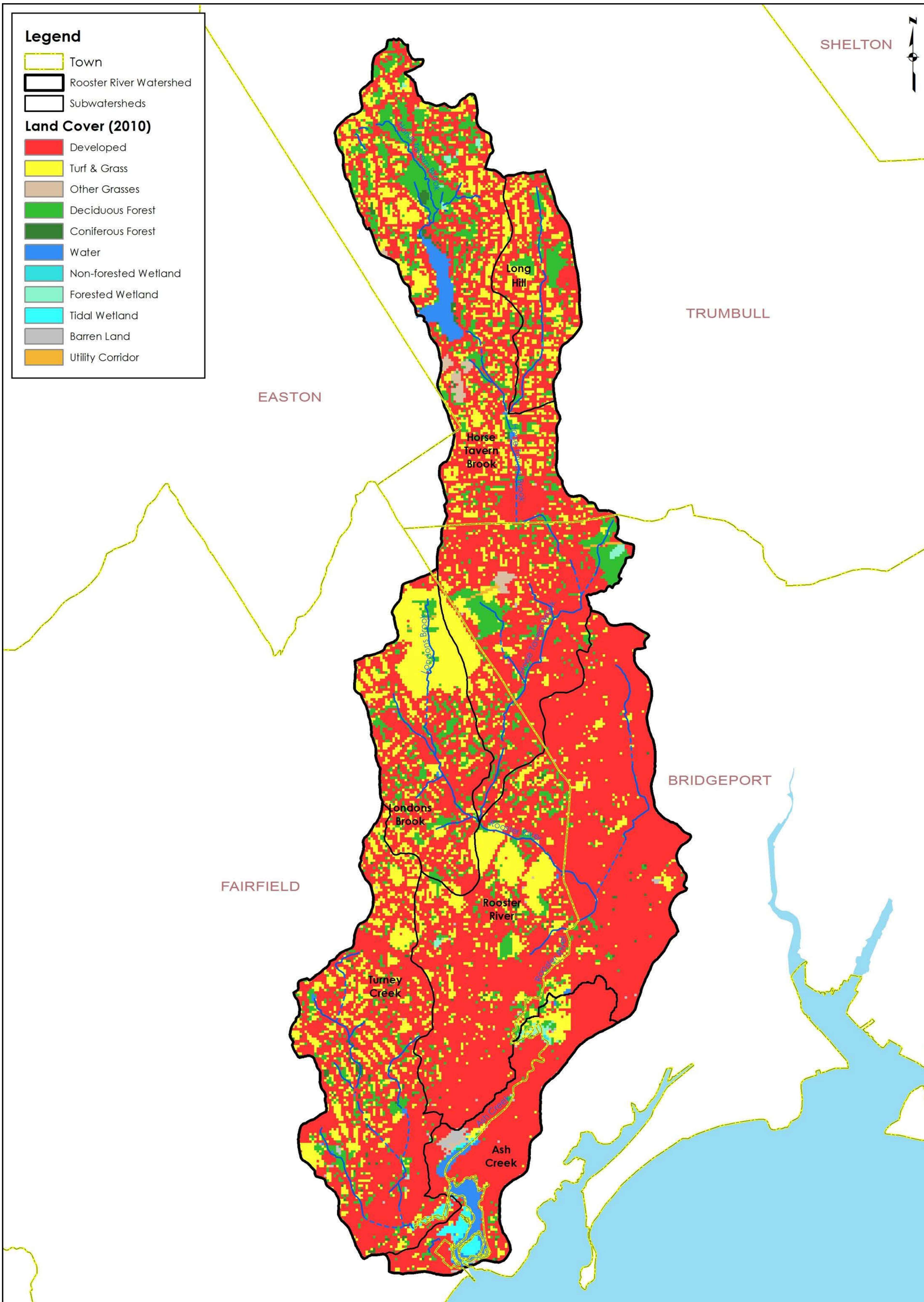
- Developed – High density built-up areas typically associated with commercial, industrial and residential activities and transportation routes. These areas contain a significant amount of impervious surfaces, roofs, roads, and other concrete and asphalt surfaces.
- Turf & Grass – A compound category of undifferentiated maintained grasses associated mostly with developed areas. This class contains cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas. Also includes some agricultural fields due to similar spectral reflectance properties.
- Other Grasses – Includes non-maintained grassy areas commonly found along transportation routes and other developed areas, and within and surrounding airport properties. Also likely to include forested clear-cut areas, and some abandoned agricultural areas that appear to be undergoing conversion to woody scrub and shrub cover.
- Agriculture - Includes areas that are under agricultural uses such as crop production and/or active pasture. Also likely to include some abandoned agricultural areas that have not undergone conversion to woody vegetation.
- Deciduous Forest – Includes Southern New England mixed hardwood forests. Also includes scrub areas characterized by patches of dense woody vegetation. May include isolated low density residential areas.
- Coniferous Forest – Includes Southern New England mixed softwood forests. May include isolated low density residential areas.
- Water – Open water bodies and watercourses with relatively deep water.
- Non-forested Wetland – Includes areas that predominantly are wet throughout most of the year and that have a detectable vegetative cover (therefore not open water). Also includes some small watercourses due to spectral characteristics of mixed pixels that include both water and vegetation.
- Forested Wetland – Includes areas depicted as wetland, but with forested cover. Also includes some small watercourses due to spectral characteristics of mixed pixels that include both water and vegetation.
- Tidal Wetland - Emergent wetlands, wet throughout most of the year, with distinctive marsh vegetation and located in areas influenced by tidal change.
- Barren Land – Mostly non-agricultural areas free from vegetation, such as sand, sand and gravel operations, bare exposed rock, mines, and quarries. Also includes some urban areas where the composition of construction materials spectrally resembles more natural materials. Also includes some bare soil agricultural fields.
- Utility ROWs – Includes utility rights-of-way. This category was manually digitized on-screen from rights-of-way visible in the Landsat satellite imagery. The class was digitized within the deciduous and coniferous categories only.




Map References:
Land use based on GIS data from City of Bridgeport (2008), Town of Fairfield (2012), and Greater Bridgeport Regional Planning Agency (GBRPA) (2000) for Trumbull; Water based on National Hygrography Dataset (NHD); Recreation/Open Space and Roadways adjusted using Connecticut Department of Energy & Environmental Protection (CTDEEP) data. Land use data verified using Ortho_2010_4Band_Color_NAIP.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 6-1**
**LAND USE**

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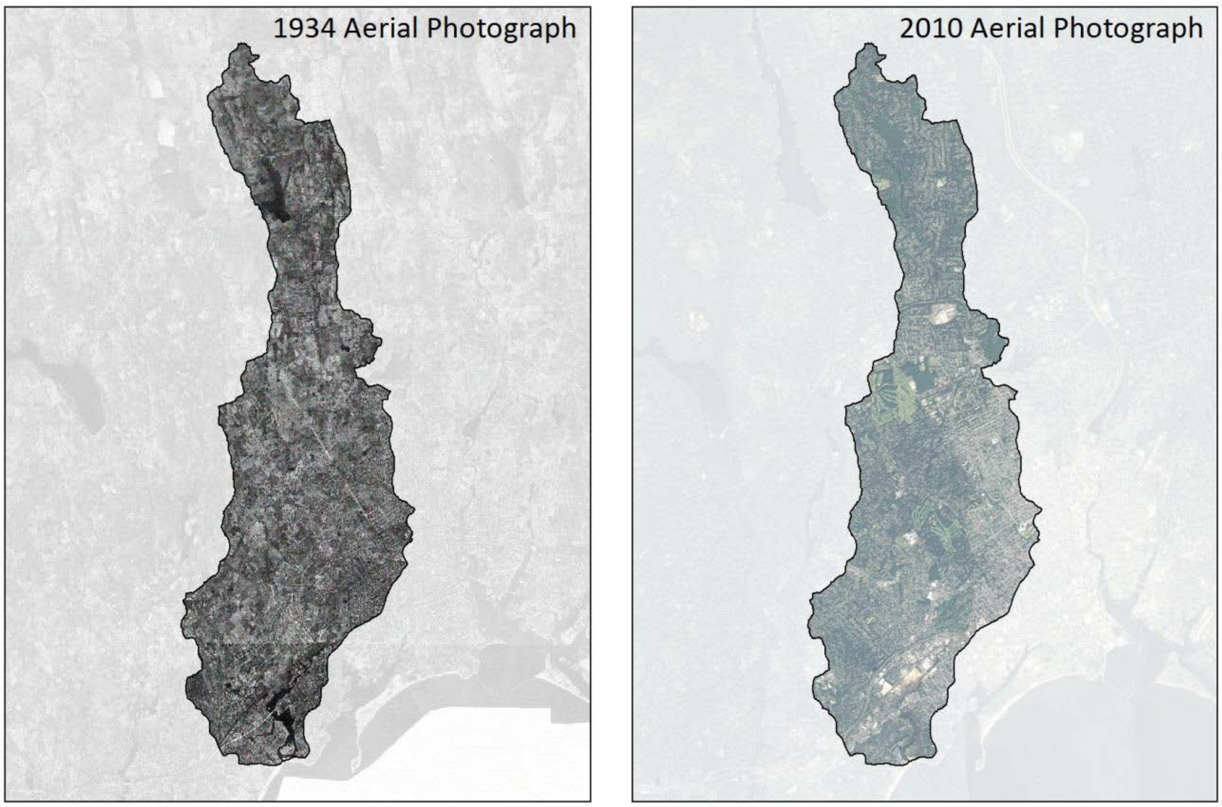
Map References:
Connecticut Department of Energy & Environmental Protection (CTDEEP), Watershed Boundaries 1:24,000 scale; Land Cover by Center for Land Use Education & Research (CLEAR), 2010.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 6-2**
**LAND COVER**

A comparison of watershed land cover between 1985 and 2010 (*Table 6-2*) shows a slight increase in watershed development during this period (173 acres, 1.7% increase in developed and 7 acres, <0.1% increase in turf/grass cover types) and a corresponding loss of forest (153 acres, 1.6% decrease). Figure 6-3 shows a comparison of aerial photographs from 1934 and 2010. The southern portion of the watershed was already heavily urbanized by 1934 and has not experienced significant change over the past 7 or 8 decades. The northern portion of the watershed was also moderately developed in 1934, although the density has increased and the agricultural land that existed in Fairfield and Trumbull in the 1930s has been converted to a 330-acre golf course and residential development.




Sources: 2010 Aerial Photography by National Agriculture Imagery Program (NAIP) from CTDEEP; 1934 Connecticut Aerial Photography by Connecticut State Library.

**Figure 6-3. Comparison of 1934 and 2010 Aerial Photographs**

Developed land cover, characterized by significant amounts of impervious surfaces such as roofs, roads, and other concrete and asphalt surfaces, accounts for approximately 67% of the watershed. When considered together with the turf/grass land cover category (primarily cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas), approximately 86% of the watershed land area consists of developed land cover types. The percentage of developed land cover (not including turf/grass) in each subwatershed (*Table 6-3*) ranges from approximately 51% in the Londons Brook subwatershed to approximately 82% in the Rooster River subwatershed.

**Table 6-3. Developed Land Cover by Subwatershed**

| Subwatershed Name | Developed Land Cover in Subwatershed (acres) | Percent Developed Land Cover in Subwatershed (%) |
|---|---|---|
| Ash Creek | 579 | 72% |
| Horse Tavern Brook | 1,858 | 58% |
| Londons Brook | 511 | 51% |
| Long Hill | 301 | 58% |
| Rooster River | 2,259 | 82% |
| Turney Creek | 1,028 | 68% |
| **Watershed (Total)** | **6,535** | **67%** |

Source: University of Connecticut's Center for Land Use Education and Research (CLEAR), 2010.

## 6.2 Impervious Cover

Impervious surfaces prevent precipitation from naturally soaking into the ground, resulting in a variety of hydrologic changes. Impervious cover is a measure of the amount of impervious surfaces covering the landscape. Impervious cover is a measurable, integrating concept used to assess the overall condition of a watershed. Numerous studies have documented the cumulative effects of urbanization on stream and watershed ecology (Center for Watershed Protection, 2003; Schueler et al., 1992; Schueler, 1994; Schueler, 1995; Booth and Reinelt, 1993, Arnold and Gibbons, 1996; Brant, 1999; Shaver and Maxted, 1996). Research has also demonstrated similar effects of urbanization and watershed impervious cover on downstream receiving waters such as lakes, reservoirs, estuaries, and coastal areas.

The correlation between watershed impervious cover and stream indicators is due to the relationship between impervious cover and stormwater runoff, since streams and receiving water bodies are directly influenced by stormwater quantity and quality. Although well-defined imperviousness thresholds are difficult to recommend, research has generally shown that when impervious cover in a watershed reaches between 10 and 25 percent, ecological stress becomes clearly apparent. Between 25 and 60 percent, stream stability is reduced, habitat is lost, water quality becomes degraded, and biological diversity decreases (NRDC, 1999). Watershed imperviousness in excess of 60 percent is generally indicative of watersheds with significant urban drainage. *Figure 6-4* illustrates this effect. These research findings have been integrated into a general watershed planning model known as the Impervious Cover Model (CWP, 2003).

*Figure 6-4* also demonstrates the wide variability in stream response found in less-urban watersheds at lower levels of impervious cover (generally less than 10 percent). Stream quality at lower ranges of impervious cover is generally influenced more by other watershed metrics, such as forest cover, road density, extent of riparian vegetative cover, and cropping practices. Less variability exists in the stream quality at higher levels of impervious cover because most streams in highly impervious, urban watersheds exhibit fair or poor stream health conditions, regardless of other conditions (CWP, 2008).

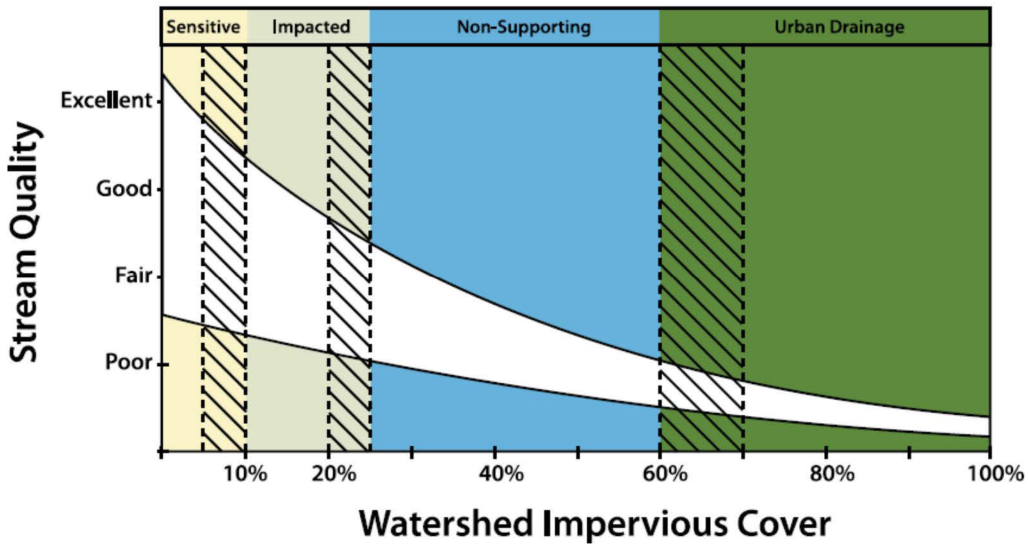



**Figure 6-4. Conceptual Model Illustrating Relationship Between Watershed Impervious Cover and Stream Quality**

A GIS-based impervious cover analysis was performed for the Rooster River watershed. The impervious cover acreage was calculated using the Impervious Surface Analysis Tool (ISAT) and land cover-dependent impervious surface coefficients for each category of land cover described in *Section 6.1.2*. The ISAT coefficients in *Table 6-4* were derived by the University of Connecticut's Center for Land Use Education and Research (CLEAR) based on planimetric data from nine Connecticut towns (Prisloe, et. al, 2003).

**Table 6-4. Impervious Surface Coefficients**

| Land Cover | ISAT Coefficient | | |
|---|---|---|---|
| | Low Density (< 500 people/mi$^2$) | Medium Density (500-1800 people/mi$^2$) | High Density (> 1800 people/mi$^2$) |
| Agricultural Field | 2.97 | 6.25 | 11.56 |
| Barren Land | 8.18 | 12.29 | 19.92 |
| Coniferous forest | 1.00 | 3.17 | 14.98 |
| Deciduous forest | 1.37 | 2.91 | 5.08 |
| Developed | 22.67 | 26.07 | 42.26 |
| Forested wetland | 0.46 | 1.03 | 1.20 |
| Non-forested wetland | 0.48 | 2.29 | 5.98 |
| Other Grasses | 2.97 | 6.25 | 11.56 |
| Tidal wetland | 3.11 | 1.63 | 1.02 |
| Turf & Grass | 8.58 | 12.09 | 12.87 |
| Utility Corridor | 1.20 | 0.80 | 5.52 |
| Water | 0.46 | 0.77 | 4.25 |

Source: University of Connecticut's Center for Land Use Education and Research (CLEAR).
Prisloe, Michael, Emily Hoffhine Wilson, & Chester Arnold (2003), "Final Report Refinement of Population-Calibrated Land-Cover-Specific Impervious Surface Coefficients for Connecticut." Accessed at http://nemo.uconn.edu/tools/impervious_surfaces/pdfs/Prisloe_etal_2003.pdf

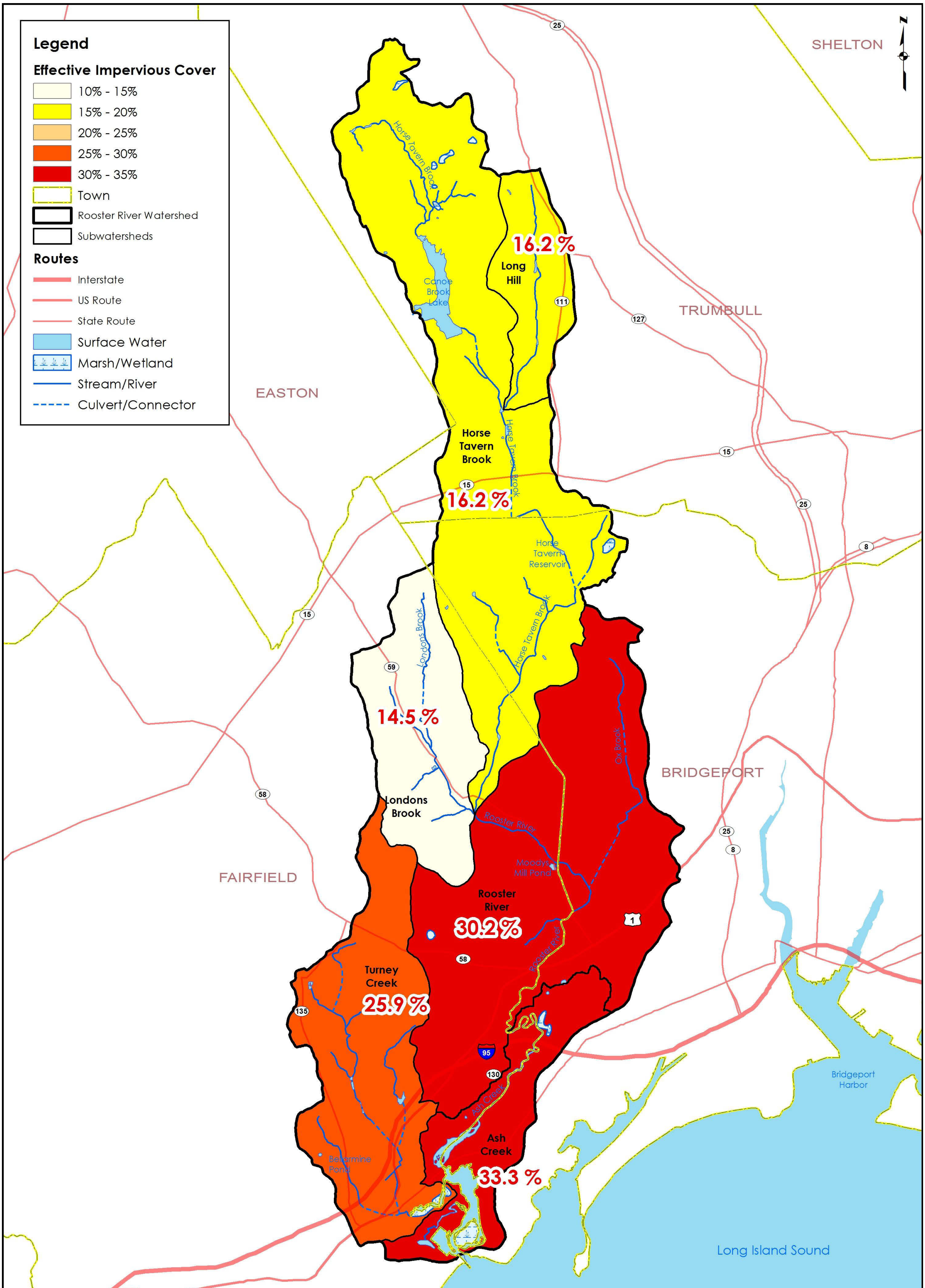
Impervious cover percentages were calculated for each subwatershed. "Mapped or total impervious cover" includes all mapped impervious surfaces and is based on land cover data, while "effective impervious cover" is impervious cover that is hydraulically connected to the drainage system. Effective impervious cover is estimated for each subwatershed based on an empirical relationship between drainage system connectivity, land use, and development intensity (Sutherland, 1995). Effective impervious cover is a more representative measure of potential water resource impacts than mapped impervious cover.

Mapped impervious cover for the overall Rooster River watershed is estimated at 32%, while the effective impervious cover for the overall watershed is estimated at approximately 23% (*Table 6-5*), which exceeds the 10% threshold in the ICM where ecological stress and stream impacts become apparent. The Horse Tavern Brook, Londons Brook, and Long Hill subwatershed have between 10 and 20% effective impervious cover (*Figure 6-5*) and are considered in the "Impacted" ICM category. The Ash Creek, Rooster Rover, and Turney Creek subwatersheds have greater than 20% effective impervious cover (the "Non-supporting" ICM category), which is consistent with the higher-density development in the southern portion of the watershed.

**Table 6-5. Existing Subwatershed Impervious Cover**

| Subwatershed | Drainage System Connectivity Level | Mapped Impervious Cover | Effective Impervious Cover# | ICM Category* |
|---|---|---|---|---|
| Ash Creek | Completely Connected | 33% | 33% | Non-Supporting |
| Horse Tavern Brook | Average | 30% | 16% | Impacted |
| Londons Brook | Average | 28% | 15% | Impacted |
| Long Hill | Average | 30% | 16% | Impacted |
| Rooster River | Highly Connected | 37% | 30% | Non-Supporting |
| Turney Creek | Highly Connected | 32% | 26% | Non-Supporting |
| **Watershed (Total)** | | **32%** | **23%** | **Non-Supporting** |

* ICM = Center for Watershed Protection Impervious Cover Model Category shown in *Figure 6-4*.
# Effective impervious cover is estimated for each subwatershed based on an empirical relationship between drainage system connectivity, land use, and development intensity (Sutherland, 1995).
Sources: National Land Cover Database (NLCD 2001) and University of Connecticut's Center for Land Use Education and Research (CLEAR) 2010 Land Cover Data, Sutherland, 1995.

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Map References:
Connecticut Department of Energy & Environmental Protection (CTDEEP), Watershed Boundaries 1:24,000 scale;
Land Cover by Center for Land Use Education & Research (CLEAR), 2010.

ROOSTER RIVER WATERSHED BASED PLAN

**FIGURE 6-5**
**EFFECTIVE IMPERVIOUS COVER**
**BY SUBWATERSHED**

The results of this analysis provide an initial diagnosis of potential stream and receiving water quality within the watershed study area. The analysis method and ICM are based on several assumptions and caveats, which limits its application to screening-level evaluations. Some of the assumptions of the ICM include:

- Requires accurate estimates of percent impervious cover.
- Predicts potential rather than actual stream quality.
- Does not predict the precise score of an individual stream quality indicator but rather predicts the average behavior of a group of indicators over a range of impervious cover.
- The impact thresholds are approximate transitions rather than sharp breakpoints.
- Does not currently predict the impact of watershed best management practices (treatment or non-structural controls).
- Does not consider the geographic distribution of the impervious cover relative to the streams and receiving waters. (Some of the geographic distribution is captured by using effective impervious cover in place of mapped impervious cover.)
- Impervious cover is a more robust and reliable indicator of overall stream quality beyond the 10 percent threshold. The influence of impervious cover on stream quality is relatively weak compared to other potential watershed factors such as percent forest cover, riparian community, historical land use, soils, agriculture, etc. for impervious cover less than 10 percent.
- Use should be restricted to 1st to 3rd order alluvial streams with no major point sources of pollutant discharge and no major impoundments or dams.
- Stream slope, as measured across the subwatershed, should be in the same range for all subwatersheds.
- Management practices in the contributing watershed must be good (e.g., no deforestation, acid mine drainage, major point sources, intensive row crops, etc.).

## 6.3 Open Space

Open space can provide opportunities for active or passive outdoor recreation, enhance the aesthetic appeal and character of an area, or support natural resources, including plant and animal habitat. Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious coverage, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as community preservation and passive recreation. Open space includes preserved natural areas as well as lightly developed parks and playgrounds.

Active and passive open space areas in the Rooster River watershed were derived from GIS data and municipal open space plans, including the CTDEEP GIS data for Municipal and Private Open Space (1997) and Protected Open Space Mapping (2011), the City of Bridgeport parks GIS layer (2008), the Town of Fairfield open space parcels GIS data (2012), the City of Bridgeport Plan of Conservation and Development "*BGreen 2020: A Sustainability Plan for Bridgeport, Connecticut,*" (2010), the Town of Fairfield *Conservation Department Open Space Program*, and the Town of Trumbull *Plan of Conservation and Development* (2006). *Figure 6-6* shows open space land in the Rooster River watershed.

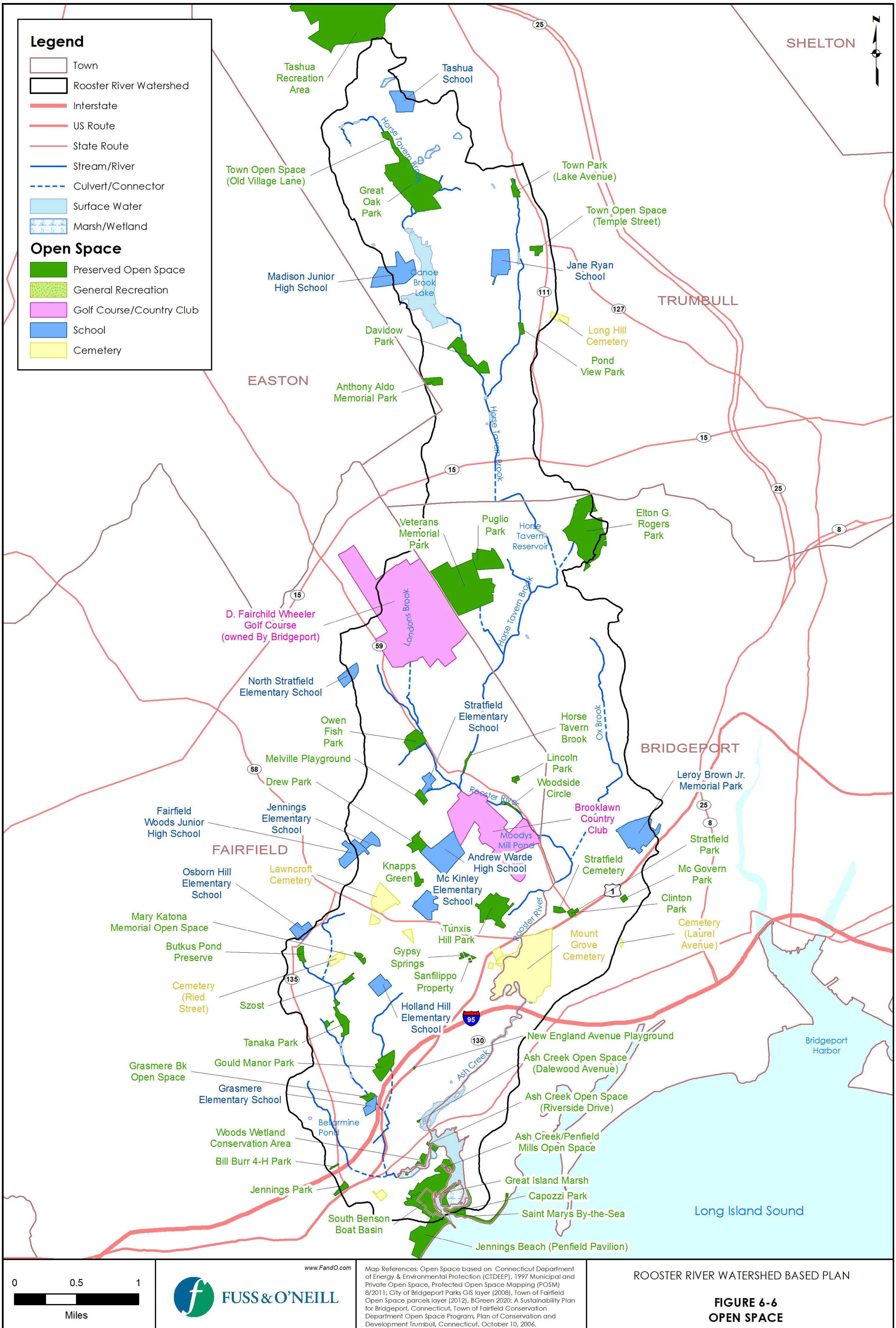


**FIGURE 6-6**
**OPEN SPACE**

Approximately 12.5% of the watershed consists of open space, composed of municipally-owned parks, cemeteries, golf courses, and schools. There are no Federal or State parks within the watershed. Schools were included in the open space inventory since they are typically publically-owned land and include public recreation fields. Preserved open space that is protected against future development or is unlikely to be developed in the future accounts for approximately 4.6% of the watershed. Some of the notable or sizable open space areas within the watershed listed by type and acreage include:

- Preserved Open Spaces
    - Veterans Memorial Park, 86.9 acres
    - Great Oak Park, 71.9 acres
    - Elton G. Rogers Park, 69.3 acres
    - Jennings Beach (Penfield Pavilion), 33.0 acres
    - Ash Creek/Penfield Mills Open Space, 29.3 acres
    - Tunxis Hill Park, 28.9 acres
    - Puglio Park, 20.6 acres
    - South Benson Boat Basin, 20.5 acres
- Golf Courses/Country Clubs
    - D. Fairchild Wheeler Golf Course (owned by City of Bridgeport), 330 acres
    - Brooklawn Country Club, 145 acres
- Schools
    - Andrew Warde High School, 39.7 acres
    - Leroy Brown Jr. Memorial Park, 37.0 acres
    - Madison Junior High School, 35.8 acres
- Cemeteries
    - Mount Grove Cemetery, 113 acres
    - Lawncroft Cemetery, 19.6 acres

There are several common methods that undeveloped land can be preserved and protected as open space. These include outright purchase, conservation easements, restrictive covenants, purchase or transfer of development rights, tax lien procedures, and land donations. Regardless of the mechanism, critical to the success of protecting open space land is the ability to readily leverage financing when windows of opportunity arise to acquire or preserve significant parcels. The watershed communities have identified open space protection goals and priorities within the watershed primarily through their Plans of Conservation and Development.

# 7 Pollutant Loading

A pollutant loading analysis was performed for the Rooster River watershed to guide the development of the watershed based plan recommendations and to quantify the anticipated load reductions associated with the recommendations. The pollutant loading model will be used to identify and rank pollutant sources, as well as assist in identifying, prioritizing, and evaluating subwatershed pollutant control strategies. This section summarizes the methods and results of the existing conditions pollutant loading analysis, which are presented in greater detail in *Appendix A*.

## 7.1 Model Description

A pollutant loading model was developed for the Rooster River watershed using the land use/land cover data described in *Section 6*. This screening-level analysis is intended to help identify and rank pollutant sources, as well as assist in identifying, prioritizing, and evaluating subwatershed pollutant control strategies. The model is not intended to predict future water quality. The Watershed Treatment Model (WTM), Version October 17, 2011, developed by the Center for Watershed Protection, was used for this analysis. This model calculates watershed pollutant loads primarily based on nonpoint source (NPS) runoff from various land uses. The model was also used to estimate pollutant loads from other sources, including:

- Combined Sewer Overflows
- Illicit Discharges
- Septic Systems
- Managed Turf
- Road Sanding

Although upland pollutant loadings to the Ash Creek subwatershed are included in the analysis, WTM does not account for pollutants carried into the estuary from Long Island Sound resulting from tidal exchange within the Ash Creek Estuary. Pollutant transport due to tidal exchange with the estuary is goverened by complex processes and is beyond the scope of this screening-level loading analysis.

The pollutants modeled in this analysis are total phosphorus (TP), total nitrogen (TN), total suspended solids (TSS), and total fecal coliform (FC) bacteria. These pollutants are the major nonpoint source pollutants of concern.

## 7.2 Model Inputs

### 7.2.1 Nonpoint Source Runoff

Land use/land cover data described in *Section 6* were adapted for use in WTM. The model uses the Simple Method to calculate nutrient, sediment, and bacteria loads from various land uses. The user specifies several model parameters for each land use in the watershed that are used to estimate runoff quantity and pollutant levels. These parameters include Event Mean Concentrations (EMCs), which are literature values for the mean concentration of a pollutant in stormwater runoff for each land use, and an average impervious cover percentage for each land use. A literature review was conducted to determine EMC values and impervious percentage values for use in the evaluation. The default impervious cover coefficients in the model were adjusted to better reflect local conditions in the Rooster River watershed. Impervious cover coefficients for each land use category were selected from WTM default impervious cover coefficients and literature values. EMC and impervious cover coefficient values are included in *Appendix A*.

### 7.2.2 Other Pollutant Sources

In addition to nonpoint source runoff pollutant loads, WTM also provides the capability to model other pollutant sources including point sources and subsurface contributions. The following sections describe the model inputs and parameter values for other pollutant sources within the Rooster River watershed.

**Combined Sewer Overflows**
WTM uses a modification of the Simple Method to calculate annual loads from Combined Sewer Overflows (CSOs). The primary assumption is that CSO discharges occur when the combined volume of stormwater and wastewater exceeds the total system capacity. Only one ctive CSO discharge location remains in the Rooster River watershed (*Figure 5-2*), which is located in Bridgeport near the Mt. Grove Cemetery. The CSO drainage area is estimated at approximately 350 acres based on combined sewer line GIS data from the City of Bridgeport. The system is assumed to experience approximately 50 CSO discharge events annually to the Rooster River. Statistical analysis of 11 years of daily precipitation data at a nearby weather station indicates that the median storm in the area is approximately 0.15 inches and the critical depth of rain that causes a CSO discharge event is assumed to be 0.1 inches. The volume of a typical CSO is based on the median storm event. In the model, any rainfall beyond the system capacity contributes to the CSO volume. Thus, this volume is calculated as the runoff caused by the difference between the median storm event depth and the rainfall depth that causes CSOs (assumed to be 0.1 inch). The runoff volume from this storm event is determined using the Simple Method. The resulting CSO pollutant load is the product of the CSO volume, the number of CSO events, and typical CSO pollutant concentrations.

**Illicit Discharges**
The WTM default assumptions for illicit discharges were used (i.e., a fraction of the total sewage flow contributes to illicit connections). The model makes separate assumptions for residential and business illicit connections. For residential connections, the WTM default assumption is that one in every 1,000 sewered individuals is connected to the sewer system via an illicit connection. This value is then multiplied by the number of individuals connected to the system, and then by typical per capita flow and pollutant concentrations for raw sewage. The number of sewered dwelling units was estimated as the number of households in the sewered 2010 U.S. Census blocks within the watershed. For businesses, it is assumed that 10% of businesses have illicit connections, and approximately 10% of those have direct sewage discharges. The number of businesses was estimated as the number of parcels with commercial and industrial land uses.

**Septic Systems**
The number of unsewered dwelling units in each subwatershed was estimated using GIS data including the mapped sewer service areas, number of households in the unsewered 2010 U.S. Census blocks, and aerial photographs. The WTM default values were used for septic system failure rate (30%) and effluent concentrations from both working and failing septic systems.

**Managed Turf**
In urban watersheds, subsurface flow constitutes a relatively small fraction of total annual flow, and most constituents have a relatively low concentration in groundwater. One possible exception is nitrogen, which can leach from urban lawns and other managed turf grass. The annual nitrogen load from managed turf areas is calculated as the product of its concentration and the annual infiltration volume. The area of managed turf in each subwatershed is based on typical lawn areas of residential land uses.

**Road Sanding**
Sediment loads from road sanding are calculated based on the quantity of sand applied to roads in a typical year. A sanding application rate for typical roads was based on the average rate of 5 tons per lane-mile per year (Transportation Research Board, 1991). Two-lane roads are assumed throughout the watershed. The local roads GIS layer was used to calculate the total length of roads in each subwatershed and the total amount of sand applied to the roads in an average year. Default delivery ratios were used for various road types since not all road sand that is applied will reach the receiving water body.

## 7.3 Existing Pollutant Loads

*Table 7-1* presents the existing modeled pollutant loads for the Rooster River watershed. Existing annual pollutant loads are dominated by nonpoint sources, with the exception of indicator bacteria, which has a significant nonpoint contribution from CSOs and illicit discharges (*Figure 7-1*).

Nonpoint source runoff accounts for approximately 95% of the TN load, 79% of the TP load, 38% of the TSS load, and 42% of the FC load for the entire watershed. Channel erosion accounts for approximately 18% and 19% of the total TP and TSS loads, respectively. Road sanding accounts for approximately 43% of the TSS load, while illicit discharges and CSOs contribute approximately 58% of the FC load for the watershed. *Table 7-2* presents a breakdown of estimated annual loadings of TN, TP, TSS, and FC by subwatershed. *Figure 7-2* depicts the variability in pollutant loads by subwatershed.

**Table 7-1. Modeled Existing Pollutant Loads by Source Type**

| | Source Type | TN (1,000 lb/yr) | TP (1,000 lb/yr) | TSS (1,000 lb/yr) | FC (trillion/ yr) | Runoff Volume (1,000 acre-feet/year) |
|---|---|---|---|---|---|---|
| Primary Sources - Land Use | Nonpoint | 116 | 17 | 2,564 | 861 | 11 |
| Secondary Sources | | 6 | 5 | 4,246 | 1,194 | - |
| CSOs | Point | 0.6 | - | 2.1 | 306 | - |
| Channel Erosion | Nonpoint | 4 | 4 | 1,327 | - | - |
| Road Sanding | Nonpoint | - | - | 2,904 | - | - |
| Illicit Discharges | Point | 1.6 | 0.5 | 12 | 888 | - |
| Septic Systems | Nonpoint | 0.2 | 0.0 | 1.3 | 0.3 | - |
| **Total** | | **122** | **22** | **6,810** | **2,055** | **11** |

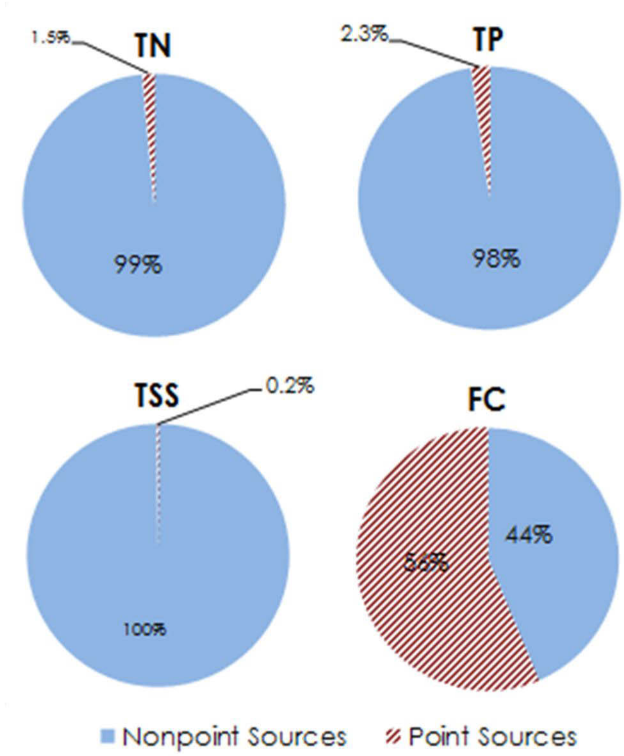


**Figure 7-1. Contribution of Point and Nonpoint Sources to Watershed Pollutant Loads**

## Table 7-2. Modeled Existing Pollutant Loads by Subwatershed

| Subwatershed | Point and Nonpoint Source Loads | | | | Nonpoint Source Loading Rates | | | |
|---|---|---|---|---|---|---|---|---|
| | TN ($10^3$ lb/yr) | TP ($10^3$ lb/yr) | TSS ($10^3$ lb/yr) | FC ($10^9$/yr) | TN (lb/ac-yr) | TP (lb/ac-yr) | TSS (lb/ac-yr) | FC ($10^9$/ac-yr) |
| Ash Creek (805 acres) | 11 | 2 | 601 | 478 | 11.9 | 2.3 | 741 | 67 |
| Horse Tavern Brook (3,196 acres) | 49 | 8 | 2,115 | 487 | 15.2 | 2.6 | 661 | 96 |
| Londons Brook (1,002 acres) | 13 | 2 | 1,595 | 133 | 13.3 | 2.4 | 1,591 | 84 |
| Long Hill (518 acres) | 9 | 1 | 368 | 81 | 16.5 | 2.7 | 710 | 110 |
| Rooster River (2,769 acres) | 42 | 8 | 2,405 | 684 | 15.0 | 2.8 | 866 | 94 |
| Turney Creek (1,523 acres) | 26 | 4 | 1,142 | 256 | 16.8 | 2.6 | 749 | 108 |
| **Watershed Total (18,639 ac)** | **149** | **26** | **8,225** | **2,119** | **15.0** | **2.6** | **837** | **94** |

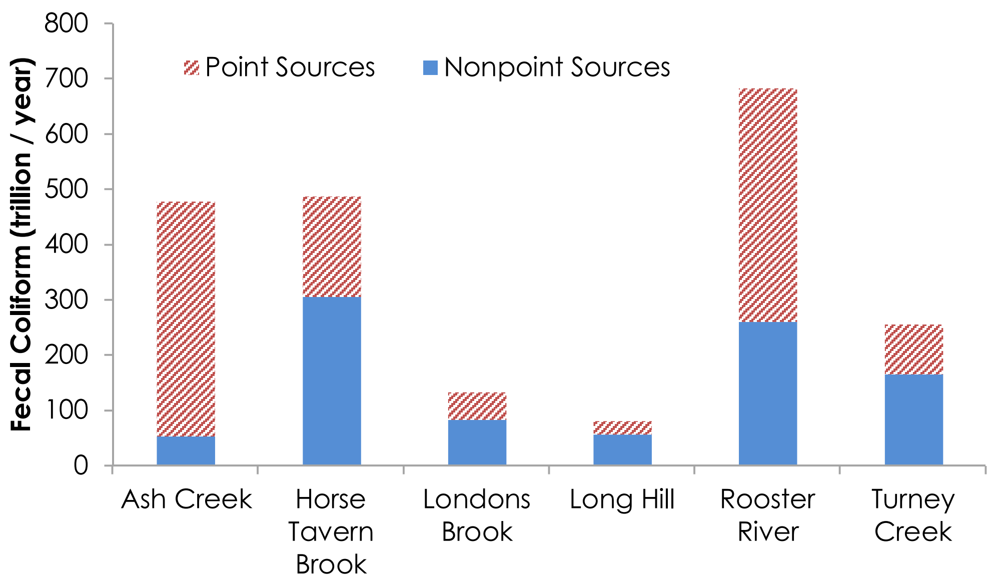


Figure 7-2. Contribution of Point and Nonpoint Sources to Subwatershed Pollutant Loads

Because the study subwatersheds vary in size, nonpoint source pollutant loads were also evaluated in terms of loading rates (i.e., pollutant loads per acre of land area, as shown in *Table 7-2*). Point source discharges are not considered in these loading rates, which includes CSOs and illicit discharges. A higher loading rate indicates relatively greater pollutant sources per unit area, which suggests that implementation of nonpoint source best management practices (BMPs) in these areas may be more effective in reducing pollutant loads. The highest loading rates for TN, TP, TSS, FC and the highest total runoff volumes are associated with the Long Hill, Turney Creek, and Rooster River subwatersheds.

- **Long Hill Subwatershed** – The Long Hill subwatershed is the smallest subwatershed, although has the highest annual loading rate per acre for FC and the second highest annual loading rate for TP and TN. Since this subwatershed is smaller in total land area than others, it does not have the highest absolute pollutant loadings. The high loading rates are due to the proportionally large amount of single family (74%) and roadway (14%) land uses in this subwatershed. The estimated nonpoint source TN loading rate is 16.5 lb/ac-year, the TP loading rate is estimated at 2.7 lb/ac-year, the TSS loading rate is estimated at 710 lb/ac-year, and the estimated fecal coliform loading due to point and nonpoint source runoff is approximately 110 billion/ac-year. The estimated pollutant loading rates in this subwatershed are generally 1.1 to 1.6 times larger than the subwatershed with the lowest pollutant loading rates.

- **Turney Creek Subwatershed** – The Turney Creek subwatershed is the third largest subwatershed in the Rooster River watershed, and it has the highest estimated annual nonpoint source loading rate for TN and the second highest loading rates for FC and total runoff volume. The subwatershed has high percentages of heavy industrial land use (11% of the subwatershed area) and mixed use (20% of the subwatershed area), which contribute to the high pollutant loading rates. In addition, the high intensity of land uses corresponds to a larger impervious cover percentage in the subwatershed, therefore increasing the runoff volume from land areas contributing to nonpoint source pollutant loads in the Rooster River and its tributaries. The estimated nonpoint source TN loading rate is 16.8 lb/ac-year, the TP loading rate is estimated at 2.6 lb/ac-year, the TSS loading rate is 749 lb/ac-year, and the estimated FC loading due to point and nonpoint source runoff is approximately 108 billion/ac-year.

- **Rooster River Subwatershed** – The Rooster River subwatershed is the second largest in the watershed in terms of land area. It also has the largest estimated TP and TSS loading rate and the second largest runoff volume per acre in the watershed from nonpoint sources due to the high percentages of 1 family, 2 to 4 family, 5 or more family housing and roadway land uses. The estimated nonpoint source TN loading rate is 15.0 lb/ac-year, the TP loading rate is estimated at 2.8 lb/ac-year, the TSS loading rate is 866 lb/ac-year, and the estimated FC loading is approximately 94 billion/ac-year due to nonpoint sources only.

*Table 7-3* summarizes the contribution of modeled nonpoint source pollutant loads by land use for the entire watershed. The majority of the TN, TP, TSS, and FC loads in the watershed are from single family residential and roadway land uses. Other modeled pollutant sources contribute significantly to the watershed pollutant loads. Illicit discharges are a predominant nonpoint source of FC loads in the watershed (43% of the total FC loads) and road sanding is a predominant point source of TSS loads in the watershed (42% of the total TSS loads).

**Table 7-3. Modeled Existing Pollutant Loads by Land Use**

| Land Use | N ($10^3$ lb/yr) | P ($10^3$ lb/yr) | TSS ($10^3$ lb/yr) | Fecal Coliform ($10^9$/yr) | N (%) | P (%) | TSS (%) | Fecal Coliform (%) |
|---|---|---|---|---|---|---|---|---|
| 1 Family | 80 | 11 | 1,334 | 622 | 69.0% | 64.9% | 52.0% | 72.2% |
| 2-4 Family | 4 | 1 | 189 | 75 | 3.5% | 5.8% | 7.4% | 8.7% |
| 5+ Family | 4 | 1 | 183 | 73 | 3.4% | 5.3% | 7.2% | 8.4% |
| Commercial | 8 | 1 | 215 | 18 | 7.1% | 6.0% | 8.4% | 2.1% |
| Forest | 0 | 0 | 14 | 1 | 0.4% | 0.8% | 0.5% | 0.1% |
| Heavy Industrial | 4 | 0 | 166 | 12 | 3.8% | 2.5% | 6.5% | 1.4% |
| Institutional | 5 | 1 | 130 | 11 | 4.3% | 4.5% | 5.1% | 1.3% |
| Light Industrial | 3 | 0 | 95 | 7 | 2.2% | 1.6% | 3.7% | 0.8% |
| Mixed Use | 4 | 1 | 154 | 40 | 3.8% | 4.5% | 6.0% | 4.6% |
| Recreation/Open Space | 3 | 1 | 83 | 4 | 2.3% | 4.2% | 3.3% | 0.4% |
| Roadway | 26 | 4 | 1,399 | 63 | 22.6% | 26.4% | 54.6% | 7.4% |
| Utilities/Vacant | 1 | 0 | 16 | 1 | 0.5% | 0.7% | 0.6% | 0.1% |
| Water | 0 | 0 | 0 | 0 | 0.1% | 0.0% | 0.0% | 0.0% |
| **Watershed (Total)** | **116** | **17** | **2,564** | **861** | **0.0%** | **0.0%** | **0.0%** | **0.0%** |

## 7.4 Rooster River Bacteria TMDL Pollutant Loads

A TMDL analysis was completed for indicator bacteria in the Mill River, Rooster River and Sasco Brook in 2005. These waterbodies are included on the List of Connecticut Waterbodies Not Meeting Water Quality Standards due to exceedances of the indicator bacteria criteria contained within the Connecticut Water Quality Standards (CWQS). In general, a TMDL represents the maximum loading that a waterbody can receive without exceeding the water quality criteria, which have been adopted in the CWQS for that parameter. In the Rooster River Watershed TMDL, target load reductions are expressed as the average percent reduction from current loadings that must be achieved to meet water quality standards.

The CWQS establish criteria for bacterial indicators of sanitary water quality that are based on protecting recreational uses such as swimming (both designated and non-designated swimming areas), kayaking, wading, water skiing, fishing, boating, aesthetic enjoyment and others. The applicable water quality criteria for indicator bacteria to the Rooster River are Geometric Mean less than 126/100 ml and Single Sample Maximum 576/100 ml. The TMDL calls for overall reductions in indicator bacteria in the Rooster River of 91%, with 92% reductions in point source discharges and 91% reductions in nonpoint source discharges (CTDEEP, 2005).

Estimated pollutant load reductions for the watershed plan recommendations will be presented in the Watershed Based Plan. The predicted pollutant load reductions will be evaluated relative to the required reductions specified in the TMDL.

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# Appendix A

## Pollutant Loading Analysis

## Table A-1. Impervious Cover Coefficients

| | Impervious Cover Coefficients | | | | |
|---|---|---|---|---|---|
| Land Use | Cappiella and Brown (2001) | Sleavin et al. (2000) | Prisloe et al. (2003) | WTM (2010) | Selected |
| 1 Family | 0.10 - 0.32 | 0.08 - 0.14 | 0.26 | 0.21 | 0.21 |
| 2-4 Family | 0.40- 0.44 | 0.21 - 0.28 | 0.29 | 0.33 | 0.33 |
| 5+ Family | 0.40- 0.44 | 0.39 | 0.38 | 0.44 | 0.44 |
| Commercial | 0.72 | 0.54 | 0.26 - 0.56 | 0.72 | 0.7 |
| Forest | - | 0.01 - 0.068 | 0.007 - 0.197 | - | 0.01 |
| Heavy Industrial | - | 0.53 | 0.56 | 0.53 | 0.55 |
| Institutional | 0.344 | - | - | - | 0.34 |
| Light Industrial | 0.53 | 0.53 | 0.32 | 0.53 | 0.4 |
| Mixed Use | - | - | - | - | 0.5 |
| Recreation/Open Space | 0.086 - 0.125 | 0.050 - 0.094 | 0.036 - 0.056 | - | 0.05 |
| Roadway | - | 0.433 | - | 0.8 | 0.8 |
| Utilities/Vacant | - | 0.09 | 0.01 - 0.08 | - | 0.08 |
| Water | - | - | - | - | 0 |

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## Table A-2. Runoff Event Mean Concentrations (EMCs)

| Source | NH Stormwater Manual | | | PLOAD/ CH2M Hill |
|---|---|---|---|---|
| Pollutant | TN | TP | TSS | FC |
| Units | mg/L | mg/L | mg/L | #/100mL |
| 1 Family | 5.15 | 0.52 | 85 | 8,700 |
| 2-4 Family | 2.2 | 0.4 | 100 | 8,700 |
| 5+ Family | 2.2 | 0.4 | 100 | 8,700 |
| Commercial | 2.97 | 0.33 | 77 | 1,400 |
| Forest | 1.78 | 0.11 | 51 | 500 |
| Heavy Industrial | 3.97 | 0.32 | 149 | 2,300 |
| Institutional | 2.97 | 0.33 | 77 | 1,400 |
| Light Industrial | 3.97 | 0.32 | 149 | 2,300 |
| Mixed Use* | 2.585 | 0.365 | 88.5 | 5,050 |
| Recreation/Open Space | 1.74 | 0.11 | 51 | 500 |
| Roadway | 2.65 | 0.43 | 141 | 1,400 |
| Utilities/Vacant | 1.74 | 0.11 | 51 | 500 |
| Water | 1.38 | 0.08 | 6 | 500 |

Sources:

McCarthy, Jillian, 2008. *New Hampshire Stormwater Manual Volume 1: Stormwater and Antidegradation,* December 2008. http://des.nh.gov/organization/divisions/water/stormwater/documents/wd-08-20a_apxd.pdf.

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Notes:
TP - Total Phosphorus
TN - Total Nitrogen
TSS - total suspended solids
FC - fecal coliform bacteria

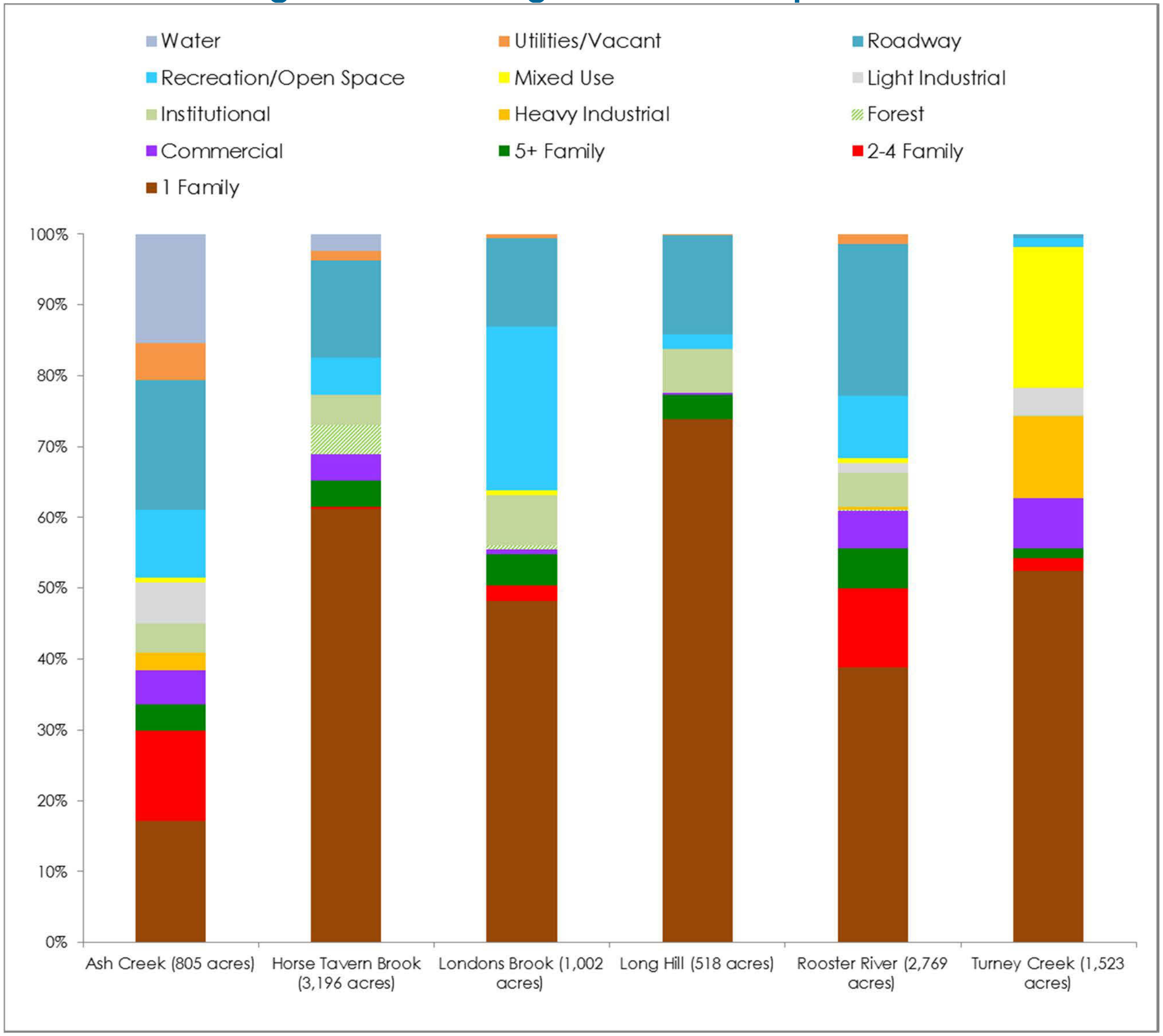
## Table A-3. Existing Land Use Composition by Subwatershed

| | Area (acres) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subwatershed** | **1 Family** | **2-4 Family** | **5+ Family** | **Commercial** | **Forest** | **Heavy Industrial** | **Institutional** | **Light Industrial** | **Mixed Use** | **Recreation/Open Space** | **Roadway** | **Utilities/Vacant** | **Water** |
| **Ash Creek (805 acres)** | 138 | 103 | 30 | 40 | 0 | 19 | 33 | 47 | 5 | 78 | 147 | 42 | 124 |
| **Horse Tavern Brook (3,196 acres)** | 1956 | 11 | 115 | 121 | 133 | 0 | 135 | 0 | 1 | 167 | 439 | 45 | 73 |
| **Londons Brook (1,002 acres)** | 483 | 21 | 44 | 8 | 5 | 0 | 72 | 0 | 6 | 232 | 125 | 6 | 0 |
| **Long Hill (518 acres)** | 382 | 0 | 18 | 1 | 0 | 0 | 33 | 0 | 0 | 11 | 72 | 1 | 0 |
| **Rooster River (2,769 acres)** | 1076 | 307 | 155 | 151 | 3 | 9 | 135 | 37 | 19 | 244 | 592 | 39 | 0 |
| **Turney Creek (1,523 acres)** | 799 | 25 | 22 | 109 | 1 | 174 | 4 | 57 | 305 | 19 | 8 | 0 | 0 |
| **Total (Watershed)** | **4835** | **468** | **384** | **430** | **141** | **203** | **412** | **141** | **336** | **751** | **1384** | **132** | **197** |

## Table A-4. Existing Land Use Composition Percentages

| Subwatershed | 1 Family | 2-4 Family | 5+ Family | Commercial | Forest | Heavy Industrial | Institutional | Light Industrial | Mixed Use | Recreation/Open Space | Roadway | Utilities/Vacant | Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ash Creek (805 acres)** | 17% | 13% | 4% | 5% | 0% | 2% | 4% | 6% | 1% | 10% | 18% | 5% | 15% |
| **Horse Tavern Brook (3,196 acres)** | 61% | 0% | 4% | 4% | 4% | 0% | 4% | 0% | 0% | 5% | 14% | 1% | 2% |
| **Londons Brook (1,002 acres)** | 48% | 2% | 4% | 1% | 0% | 0% | 7% | 0% | 1% | 23% | 12% | 1% | 0% |
| **Long Hill (518 acres)** | 74% | 0% | 3% | 0% | 0% | 0% | 6% | 0% | 0% | 2% | 14% | 0% | 0% |
| **Rooster River (2,769 acres)** | 39% | 11% | 6% | 5% | 0% | 0% | 5% | 1% | 1% | 9% | 21% | 1% | 0% |
| **Turney Creek (1,523 acres)** | 53% | 2% | 1% | 7% | 0% | 11% | 0% | 4% | 20% | 1% | 1% | 0% | 0% |
| **Total (Watershed)** | 49% | 5% | 4% | 4% | 1% | 2% | 4% | 1% | 3% | 8% | 14% | 1% | 2% |

## Figure A-1. Existing Land Use Composition



## Table A-5 Model Input Data – Septic Systems, Illicit Connections, and Road Sanding

| Subwatershed | Estimated Number of Dwelling Units | Estimated Number of Unsewered Dwelling Units | Estimated Unsewered Dwelling Units (% of Total) | Septic Systems <100 ft from a waterway (% of Total) | Estimated Number of Businesses | Length of Roads (miles) | Road Sand Application (lbs/yr) |
|---|---|---|---|---|---|---|---|
| Ash Creek (805 acres) | 3,905 | 0 | 0.00% | 0% | 248 | 19.4 | 194,255 |
| Horse Tavern Brook (3,196 acres) | 6,837 | 80 | 1.17% | 0% | 45 | 70.0 | 699,675 |
| Londons Brook (1,002 acres) | 1,849 | 0 | 0.00% | 0% | 8 | 20.1 | 201,027 |
| Long Hill (518 acres) | 924 | 0 | 0.00% | 0% | 2 | 13.4 | 133,507 |
| Rooster River (2,769 acres) | 14,874 | 36 | 0.24% | 0% | 524 | 89.7 | 896,810 |
| Turney Creek (1,523 acres) | 3,245 | 0 | 0.00% | 0% | 93 | 39.7 | 397,226 |
| Watershed Total (9,813 acres) | 31,634 | 0 | 0.00% | 0% | 920 | 252 | 2,522,500 |

Sources and Notes:

1. Number of Households from 2010 census data, by subwatershed block groups - FTP directory is at http://www2.census.gov/census_2010/; 2010 Census Summary File 1 and 2010 Census Summary File 2.

2. Road sand application rate based on the Massachusetts average of 5 tons/lane-mile (annual); assumed 2 lane roads and a 50/50 sand mix. From *Highway Deicing Comparing Salt and Calcium Magnesium Acetate.* Transportation Research Board National Research Council Washington, D.C. 1991 Special Report 235.

3. Sewered Areas from CTDEEP GIS Data: http://www.ct.gov/dep/cwp/view.asp?a=2698&q=322898 updated based on information from City of Bridgeport, Town of Fairfield, and Town of Trumbull.

4. Estimated number of businesses - 1 business per parcel within commercial and industrial land use areas

## Table A-6. Modeled Existing Pollutant Loads by Source Type

| | TN (1,000 lb/yr) | TP (1,000 lb/yr) | TSS (1,000 lb/yr) | FC (trillion/yr) | Runoff Volume (1,000 acre-feet/year) |
|---|---|---|---|---|---|
| Primary Sources - Land Use | 143 | 22 | 3,980 | 925 | 15 |
| Secondary Sources | 6 | 5 | 3,265 | 1,194 | 0 |
| CSOs | 0.6 | 0 | 2.1 | 306 | 0 |
| Channel Erosion | 4 | 4 | 1,327 | 0 | 0 |
| Road Sanding | 0 | 0 | 1,923 | 0 | 0 |
| Illicit Discharges | 1.6 | 0.5 | 12 | 888 | 0 |
| Septic Systems | 0.2 | 0.0 | 1.3 | 0.3 | 0.0 |
| **Total** | **149** | **26** | **7,245** | **2,119** | **15** |
| *Nonpoint Sources* | *147* | *26* | *7,231* | 926 | *15* |
| *Point Sources* | 2 | *1* | *14* | *1,193* | *0* |

## Table A-7. Modeled Existing Nonpoint Source Pollutant Loads by Source Type

| Land Use | TN (1,000 lb/yr) | TP (1,000 lb/yr) | TSS (1,000 lb/yr) | FC (trillion/ yr) | Runoff Volume (1,000 ac-ft/yr) | TN (%) | TP (%) | TSS (%) | FC (%) | Runoff Volume (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Family | 80 | 11 | 1,334 | 622 | 6 | 56.1% | 51.0% | 33.5% | 67.2% | 39.6% |
| 2-4 Family | 4 | 1 | 189 | 75 | 1 | 2.9% | 4.6% | 4.8% | 8.1% | 4.8% |
| 5+ Family | 4 | 1 | 183 | 73 | 1 | 2.8% | 4.1% | 4.6% | 7.9% | 4.6% |
| Commercial | 8 | 1 | 215 | 18 | 1 | 5.8% | 4.7% | 5.4% | 1.9% | 7.1% |
| Forest | 0 | 0 | 14 | 1 | 0 | 0.3% | 0.6% | 0.3% | 0.1% | 0.7% |
| Heavy Industrial | 4 | 0 | 166 | 12 | 0 | 3.1% | 2.0% | 4.2% | 1.3% | 2.8% |
| Institutional | 5 | 1 | 130 | 11 | 1 | 3.5% | 3.5% | 3.3% | 1.2% | 4.3% |
| Light Industrial | 3 | 0 | 95 | 7 | 0 | 1.8% | 1.2% | 2.4% | 0.7% | 1.6% |
| Mixed Use | 4 | 1 | 154 | 40 | 1 | 3.1% | 3.5% | 3.9% | 4.3% | 4.4% |
| Recreation/ Open Space | 3 | 1 | 83 | 4 | 1 | 1.9% | 3.3% | 2.1% | 0.4% | 4.1% |
| Roadway | 26 | 4 | 1,399 | 63 | 4 | 18.4% | 20.8% | 35.2% | 6.8% | 25.1% |
| Utilities/Vacant | 1 | 0 | 16 | 1 | 0 | 0.4% | 0.6% | 0.4% | 0.1% | 0.8% |
| Water | 0 | 0 | 0 | 0 | 0 | 0.1% | 0.0% | 0.0% | 0.0% | 0.2% |
| **Total** | **143** | **22** | **3,980** | **925** | **15** | **--** | **--** | **--** | **--** | **--** |

## Table A-8. Modeled Existing Pollutant Loads by Subwatershed

| Subwatershed | Pollutant Loads | | | | Pollutant Loading Rates | | | |
|---|---|---|---|---|---|---|---|---|
| | TN ($10^3$ lb/yr) | TP ($10^3$ lb/yr) | TSS ($10^3$ lb/yr) | FC ($10^9$/yr) | TN lb/ac-yr | TP lb/ac-yr | TSS lb/ac-yr | FC $10^9$/ac-yr |
| Ash Creek (805 acres) | 11 | 2 | 601 | 478 | 13.1 | 2.5 | 746 | 594 |
| Horse Tavern Brook (3,196 acres) | 49 | 8 | 2,115 | 487 | 15.3 | 2.6 | 662 | 152 |
| Londons Brook (1,002 acres) | 13 | 2 | 614 | 133 | 13.4 | 2.4 | 613 | 132 |
| Long Hill (518 acres) | 9 | 1 | 368 | 81 | 16.6 | 2.8 | 711 | 157 |
| Rooster River (2,769 acres) | 42 | 8 | 2,405 | 684 | 15.2 | 2.9 | 869 | 247 |
| Turney Creek (1,523 acres) | 26 | 4 | 1,142 | 256 | 16.9 | 2.7 | 750 | 168 |
| **Watershed Total (9,813 acres)** | **149** | **26** | **7,245** | **2,119** | **15.2** | **2.7** | **738** | **215.9** |

## Table A-9. Modeled Existing nonpoint Source Pollutant Loads by Subwatershed

| Subwatershed | Nonpoint Source Loads | | | | Nonpoint Source Loading Rates | | | |
|---|---|---|---|---|---|---|---|---|
| | TN ($10^3$ lb/yr) | TP ($10^3$ lb/yr) | TSS ($10^3$ lb/yr) | FC ($10^9$/yr) | TN lb/ac-yr | TP lb/ac-yr | TSS lb/ac-yr | FC $10^9$/ac-yr |
| Ash Creek (805 acres) | 10 | 2 | 596 | 54 | 11.9 | 2.3 | 741 | 67 |
| Horse Tavern Brook (3,196 acres) | 49 | 8 | 2,113 | 306 | 15.2 | 2.6 | 661 | 96 |
| Londons Brook (1,002 acres) | 13 | 2 | 614 | 84 | 13.3 | 2.4 | 613 | 84 |
| Long Hill (518 acres) | 9 | 1 | 368 | 57 | 16.5 | 2.7 | 710 | 110 |
| Rooster River (2,769 acres) | 41 | 8 | 2,399 | 260 | 15.0 | 2.8 | 866 | 94 |
| Turney Creek (1,523 acres) | 26 | 4 | 1,140 | 165 | 16.8 | 2.6 | 749 | 108 |
| **Watershed Total (9,813 acres)** | **147** | **26** | **7,231** | **926** | **15.0** | **2.6** | **737** | **94** |