Contract #17-04

2021

Anguilla Brook/Inner Wequetequock Cove Watershed-Based Plan

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Conservation District

Eastern Connecticut

www.ConserveCT.org/eastern

Prepared by the Eastern Connecticut Conservation District, Inc.

Cover Photos: Inner Wequetequock Cove (lower left) and Anguilla Brook at the head of Wequetequock Cove (upper right). Photos by ECCD.

CONTENTS

FIGURES

TABLES

APPENDICES

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ACRONYMS & ABBREVIATIONS

AMSL – Above mean sea level
CACIWC – Connecticut Association of Conservation and Inland Wetland Commissions
CAS – Connecticut Audubon Society
CCMP – Comprehensive Conservation and Management Plan
CEDC – Connecticut Economic Development Commission
CFPA – Connecticut Forest and Parks Association
CFU – Colony-forming units
CLEAR – Center for Land Use Education and Research
CNMP – Comprehensive Nutrient Management Plan
CLCC – Connecticut Land Conservation Council
CT DOAg – Connecticut Department of Agriculture
CT DOT – Connecticut Department of Transportation
CT RC&D – Connecticut Resource Conservation and Development Area
CUSH – Clean Up Sound and Harbors
CWA – Clean Water Act
DABA – Department of Agriculture Bureau of Aquaculture
DCIA – Directly connected impervious area
DPH – Connecticut Department of Public Health
DPW _ Department of Public Works
ECCD – Eastern Connecticut Conservation District
ECSC – Easter Connecticut Stormwater Collaborative
EPA – US Environmental Protection Agency
ERT – Environmental Review Team
FISRWG - Federal Interagency Stream Restoration Working Group
FSA – Farm Service Agency
GHP – Good Housekeeping Practices
GIS – Geographic Information System
GMP – Growth Management principle
HUC – Hydrologic unit code
IC – Impervious cover
IDDE – Illicit Discharge Detection and Elimination
IPM – Integrated Pest Management
LISFF – Long Island Sound Futures Fund
LIS – Long Island Sound
LISS – Long Island Sound Study
LLHD – Ledge Light Health District
LUST – Leaking underground storage tank
MEP – Maximum extent practicable
MPN – Most probable number
MS4 – Small Municipal Separate Storm Sewer System
NEMO – Non-point Education for Land Use Officials
NFWF – National Fish & Wildlife Foundation
NOFA – Northeast Organic Farming Association

NPS – Nonpoint source pollution
NRCS – Natural Resources Conservation Service
NOAA – National Oceanic and Atmospheric Administration
NOFA – Northeast Organic Farming Association
O&M – Operations and Maintenance
OPM – Connecticut Office of Policy and Management
POCD – Plan of Conservation and Development
SCCOG – Southeastern Connecticut Council of Governments
SSURGO - Soil Survey Geographic Database
STEAP – Small Town Economic Assistance Program
SWMP – Stormwater Management Plan
SWPPP – Stormwater Pollution Prevention Plan
UA – Urbanized area
UCONN – University of Connecticut
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
USGS – United States Geological Survey
UST – Underground storage tank
WPCA – Water Pollution Control Authority

EXECUTIVE SUMMARY

This Executive Summary provides an overview of the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan. It can be used as a stand-alone guide to the fuller watershed plan, and may be used as a reference document by watershed managers. The purpose of the Plan is to identify sources of fecal coliform bacteria and other common contaminants that have degraded water quality in the Inner Wequetequock Cove, and to provide management recommendations to improve water quality so that the Inner Wequetequock Cove can meet established water quality standards for all its designated uses.

ES-1 Introduction

Wequetequock Cove, in Stonington, Connecticut, is an embayment of Little Narragansett Bay located at the outfall of the Pawcatuck River at the boundary between the states of Connecticut and Rhode Island. Inner Wequetequock Cove is the 0.09- square mile portion of Wequetequock Cove located north of a railroad crossing near the southern end of the cove. Inner Wequetequock Cove has been listed by the Connecticut Department of Energy and Environmental Protection (DEEP) as impaired for its designated uses, which include habitat for fish, other aquatic life and wildlife, recreation and the direct consumption of shellfish. Suspected causes include enterococcus, algae and estuarine bioassessments related to illicit discharges, failing septic systems, marinas, stormwater runoff and nuisance wildlife/pets.

The Anguilla Brook watershed in Stonington, CT.

The six-mile-long Anguilla Brook is the primary tributary to Wequetequock Cove. Anguilla Brook has its headwaters in North Stonington in the area north of the Providence-New London Turnpike (State Route 184) and discharges into the north end of Wequetequock Cove south of Chesebrough (aka Wequetequock) Pond. The Anguilla Brook watershed (CT2101), which comprises all the land area that drains to the Inner Wequetequock Cove, is 12.3 square miles (7,891 acres). Unlike Wequetequock Cove, Anguilla Brook and its tributaries have not been assessed.

ES-2 Document Overview

Anguilla Brook and Wequetequock Cove are important resources to residents and visitors to coastal southeastern Connecticut. The waterways and their environs provide a variety of recreation opportunities, including fishing, boating, bird watching and hiking. Undeveloped coastal forest blocks and floodplains adjacent to the stream are important wildlife habitats and flood mitigation areas. Anguilla Brook supports an anadromous fish population including alewife and the catadromous

American eel (*Anguilla rostrata*) for which the stream is named. Portions of the stream support cold water fish species including native brook trout. Wequetequock Cove is an aesthetic, recreational and commercial resource. Marinas and commercial businesses located along the shore of the Cove support recreational boating and fishing. Coastal marshes provide wildlife habitat and storm surge and flood protection. Like other coastal Connecticut watersheds, the Anguilla Brook watershed faces challenges associated with stormwater management, eutrophication, climate change and the potential for future development.

The Anguilla Brook Watershed-Based Plan (the Plan) was developed to address water quality impairments and restore Inner Wequetequock Cove (the Cove) for all its intended uses. A watershed management plan is "a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, actions, participants, and resources related to developing and implementing the plan" (US Environmental Protection Agency, 2008). The goal of this watershed-based plan is to provide information and data in order to allow watershed managers to address the sources of pollution that are impacting the water quality of Wequetequock Cove.

This Plan utilizes the nine minimum elements identified by the US Environmental Protection Agency (USEPA) to be used in the preparation of a watershed-based plan for impaired waters (US EPA, 2013). These elements include:

1. identification of the impairment and pollutant sources,
2. description of management measures to achieve load reductions,
3. estimate of load reductions expected from proposed management measures,
4. technical and financial assistance needed to implement management measures,
5. education and outreach required to achieve management goals,
6. implementation schedule,
7. interim measurable milestones,
8. water quality improvement evaluation criteria, and
9. water quality monitoring component.

Watershed planning is both a collaborative and participatory process. In order to guide the water quality investigation and aid the development of this watershed-based plan, ECCD convened a diverse stakeholder group to assist with the watershed planning process. Stakeholders met quarterly to review the progress of the investigation and provide guidance and insight.

The Anguilla Brook watershed planning process was conducted in several phases. The first phase involved a review of existing watershed conditions and water quality data. In the summer of 2019, ECCD collected water quality data from Anguilla Brook and other perennial tributaries to Wequetequock Cove, which were analyzed by CT DPH for fecal bacteria content. The second phase, a desktop assessment of the watershed and interviews with watershed stakeholders, land owners, and policy makers were conducted to identify possible contaminant sources based on the results of the bacteria collection. Stream corridor assessments of the streams that did not meet water quality standards due to high fecal bacteria levels were conducted in the fall of 2019. The assessments documented conditions along the stream corridors that could contribute to fecal bacteria and other types of water quality and stream habitat degradation. The third phase, a desktop pollutant load analysis, was conducted using the Center for Watershed Protection's Watershed Treatment Model (Center for Watershed Protection, 2013). This analysis predicted annual loads (in pounds per acre) for various common NPS pollutants based on land use and land cover within the Anguilla Brook watershed. The final, and most important, phase in the plan development process involved the incorporation of the water quality data and information collected during the first three phases into the watershed-based plan. These data and information were used to identify potential sources of pollutant loading to Wequetequock Cove. It also informed the selection and locations of recommended management measures to be implemented in order to reduce pollutant loading and restore water quality and aquatic habitat in Wequetequock Cove.

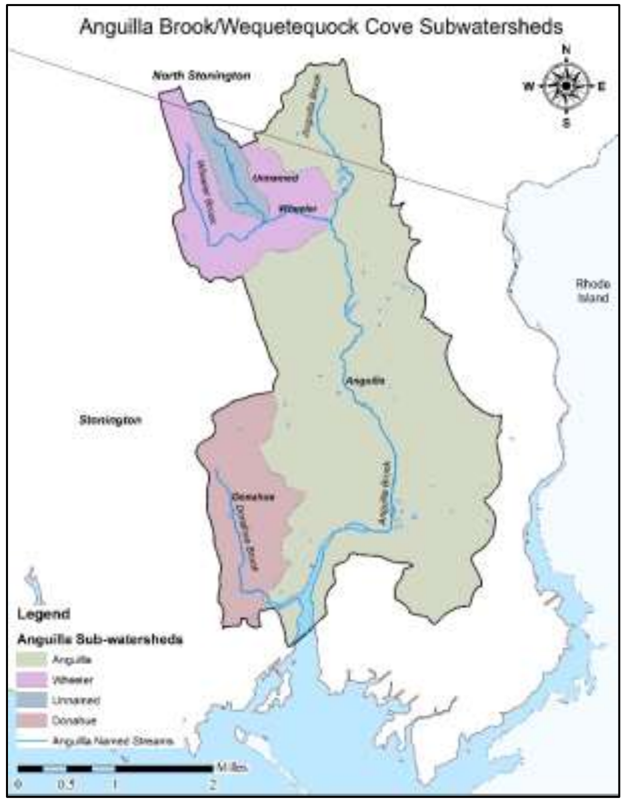
Anguilla Brook Bacteria Trackdown and Watershed-Based Plan Stakeholder Team

Avalonia Land Conservancy	Town of North Stonington Planning Department
Clean Up Sounds and Harbors (CUSH)	Town of Stonington Department of Public Works
CT Department of Agriculture Bureau of Aquaculture	Town of Stonington – Pawcatuck River Harbor Management
CT Department of Energy & Environmental Protection	Town of Stonington – Stonington Harbor Management
Connecticut Sea Grant	Town of Stonington Planning Department
Eastern Connecticut Conservation District	The Nature Conservancy
Pine Point School	Trout Unlimited (Thames Valley CT Chapter)
Save the Sound	University of Connecticut Marine Science Dept.
Stonington Conservation Commission	USDA Natural Resources Conservation Service
Stonington Land Trust	Watershed Residents and Businesses
Stonington Shellfish Commission	Wild Ones
Stonington Stormwater Task Force	

ES-3 Watershed Characteristics

The Anguilla Brook watershed (CT-2101) is located in the towns of Stonington and North Stonington in southeastern Connecticut and encompasses a land area of 12.3 square miles (7,891 acres). The headwaters of Anguilla Brook, the primary tributary to Wequetequock Cove, are located in North Stonington, in a wooded wetland north of Providence-New London Turnpike (State Route 184). Anguilla Brook flows into Wequetequock Cove south of Chesebrough Pond near Stonington Road (US Route 1). The watershed is part of the Southeast Eastern Complex (CT-21), a regional coastal watershed in southeastern Connecticut that drains to Little Narragansett Bay and Long Island Sound. There are four (4) local watersheds located within the Anguilla Brook subregional watershed, including the Anguilla Brook local watershed, the Wheeler Brook watershed and the watershed of an unnamed tributary to Wheeler Brook. The fourth local watershed, the Donahue Brook watershed, discharges directly to Wequetequock Cove.

The topography of the Anguilla Brook watershed is defined by north-south-oriented rolling hills. Jeremy Hill in the northwest part of the watershed is, at 330 ft above mean sea level (AMSL), the highest elevation in the watershed. Elevation relief along Anguilla Brook is approximately 150 feet along the 5.9 miles of stream, from approximately 160 feet AMSL at its headwaters in North Stonington to about 10 feet AMSL at the head of Wequetequock Cove. Bedrock in the Anguilla Brook watershed is comprised of granite and fractured crystalline metamorphic rock, including gneisses and granitic gneisses of the Avalonian Terrane (400 -350 million years ago). Soils in the Anguilla Brook watershed are comprised of



glacial lodgment and melt-out tills in upper elevations, with glaciofluvial and alluvial floodplain soils and muck soils in the lower elevations. Predominant soil types include Charlton-Chatfield Complex soils (15%), Canton and Charlton soils (13%), and Woodbridge fine sandy loam (10%) in upland areas, and Ridgebury, Leicester, and Whitman soils (9%), and Paxton and Montauk fine sandy loams (9%) in valleys.

There are approximately 12 miles of perennial streams in the Anguilla Brook watershed, including Anguilla Brook, which is 5.9 miles from its headwaters in North Stonington to its outlet at Wequetequock Cove. Other perennial streams in the watershed include Donahue Brook (1.8 miles), a tributary to Wequetequock Cove, Wheeler Brook (2.6 miles), a tributary to Anguilla Brook, and an unnamed tributary to Wheeler Brook (1.5 miles). Although there are a few small impoundments along the perennial streams in the Anguilla Brook watershed, the only pond of note is Chesebrough Pond (also known as Wequetequock Pond), a 7.1-acre impoundment of Anguilla Brook, located upstream of Wequetequock Cove.

Inner Wequetequock Cove, the receiving waterbody of Anguilla Brook, is a 202.3-acre estuary of Little Narragansett Bay. The inner cove is defined by a railbed that crosses the lower end of the cove and separates it from the outer cove and bay. Ingress and egress to the Cove is controlled by the relatively low height of the culvert under the railbed, which limits the size of craft that can enter and exit the Cove, and more importantly, also likely reduces tidal flushing, impacting water quality in the Cove.

The Anguilla Brook watershed is predominantly rural. Land cover (CLEAR, 2016) in the watershed is dominated by undeveloped deciduous and coniferous forests and forested wetlands (55%). Developed land (defined as residential, commercial and/or industrial development, and paved surfaces) and turf grass areas associated with developed land, comprise approximately 26% of the watershed. About 15% of the watershed is used for pasture, hay and cropland. Approximately 4% of the watershed is comprised of unforested wetlands, tidal wetlands and other waterbodies.

ES-4 Land Management Policies

Land management policies in Connecticut occur on multiple administrative levels, from federal to state to regional to local levels. State planning is administered through the Office of Policy and Management, while regional planning is conducted by regional planning organizations such as councils of government. Local planning occurs via the preparation of municipal planning documents and is administered through land use boards or commissions. In order for land use planning to be at its most effective, it is important for policies and goals to be aligned on local, regional, state and federal levels.

Federal, interstate, state, and regional planning documents include:

- *Nitrogen Reduction Strategy for Long Island Sound* (USEPA, 2015),
- *Long Island Sound Comprehensive Conservation and Management Plan* (LISS, 2020),
- *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* (NYDEC and CT DEP, 2000),
- *Connecticut Second Generation Nitrogen Strategy for Long Island Sound 2017-2022* (DEEP, 2019),
- *2018-2023 Conservation & Development Policies: The Plan for Connecticut (OPM, 2018),*
- *Connecticut Statewide Total Maximum Daily Load for Bacteria-Impaired Waters (DEEP, 2012),*
- *Bacteria TMDL for Estuary 12: Stonington* (DEEP, 2013),
- *Integrated Water Resource Management in Connecticut* (DEEP, 2016), and
- *Regional Plan of Conservation and Development 2017* (SCCOG, 2017).

North Stonington municipal planning documents include:

- *2013 North Stonington Plan of Conservation and Development,*
- *Inland Wetlands and Watercourses Regulations of the Town of North Stonington (Revised March 14, 2012 Effective March 22, 2012),*
- *Plan of Conservation and Recreation Lands of the Town of North Stonington, CT (October 3, 2013),*
- *Subdivision Regulations of the Town of North Stonington (March 8, 2016),*
- *Town of North Stonington "Level A" Aquifer Protection Area Regulations (effective September 15, 2010), and*
- *Zoning Regulations of the Town of North Stonington (amended July 25, 2019).*

Stonington municipal planning documents include:

- *Aquifer Protection Area Regulations, Stonington, CT (effective December 5, 2008),*
- *Regulations Providing for Standards of Subdivision Development for the Town of Stonington, CT (adopted August 8, 2016),*
- *Stonington Harbor Management Plan (2012),*
- *Town of Stonington 2015 Plan of Conservation and Development,*
- *Town of Stonington Inland Wetlands and Watercourses Regulations (revised October 5, 2006),*
- *Town of Stonington Coastal Resilience Plan (2017),*
- *Town of Stonington Design Review Guidelines (2009),*
- *Town of Stonington Open Space Plan (2007),*
- *Town of Stonington Zoning Regulations – Twenty Sixth Edition (amended through February 1, 2018), and*
- *2017 Stormwater Management Plan - Town and Borough of Stonington.*

ES-5 Water Quality Conditions

The regulation of the waters of the United States is authorized by the Federal Clean Water Act (1972). Section 303 of the Clean Water Act (CWA) requires all states to designate uses for all waterbodies within their jurisdictional boundaries, assign water classifications based on those designated uses, and assess waters to determine if they are meeting their designated uses. Water quality classifications serve to reinforce the designated uses for surface, ground and estuarine waters, identify criteria necessary to support those uses, and allow the development of numeric pollutant reduction targets if the water quality of a waterbody does not meet its designated use(s). In Connecticut, the Department of Energy and Environmental Protection is charged with implementing the Clean Water Act, assigning designated uses and water classifications, and conducting water quality assessments for all waterbodies in the state (Section 22a-426 of the Connecticut General Statutes).

All surface waters in the Anguilla Brook watershed are designated Class A waters. Designated uses for Class A waters are habitat for fish and other aquatic life and wildlife; recreation; navigation; and industrial and agricultural water supply. Wequetequock Cove is designated a Class SA water. Designated uses for Class SA waters are habitat for marine fish, other aquatic life and wildlife; shellfish harvesting for direct human consumption; recreation; industrial water supply; and navigation.

CT DEEP has established water quality standards for indicator bacteria in fresh and salt water for each water class. The water quality standards for indicator bacteria are presented in the tables below.

State of Connecticut water quality criteria for indicator bacteria in freshwater (CT WQS Table 2A).

Designated Use	Class	Indicator	Criteria
Drinking Water Supply (1)	AA	Total coliform	Monthly Moving Average less than 100/100ml Single Sample Maximum 500/100ml
Recreation (2)(3) - Designated Swimming (4)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 235/100ml
Recreation - Non-designated Swimming (5)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 410/100ml
Recreation (2)(3) - All other uses	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 576/100ml

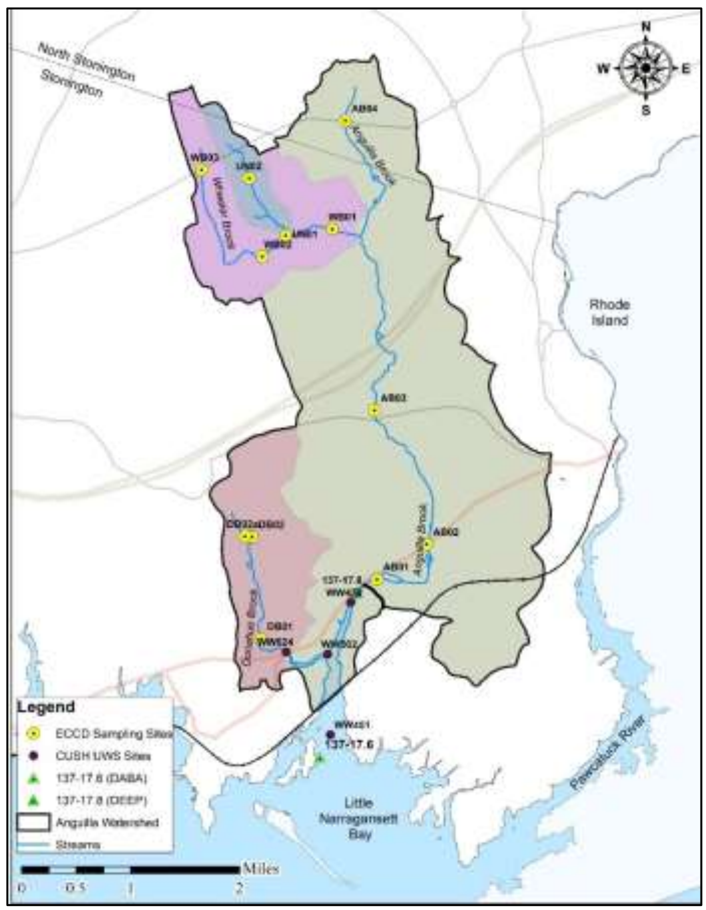
Table Notes for CT WQS Tables 2A and 2B:

(1) Criteria applies only at the drinking water supply intake structure.
(2) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23.
(3) See section 22a-426-9(a)(2) of the Regulations of Connecticut State Agencies.
(4) Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protection and the Department of Public Health, May 1989, revised April 2003 and updated December 2008.
(5) Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.
(6) Criteria are based on utilizing the mTec method as specified in the U.S. Food and Drug Administration National Shellfish Sanitation Program-Model Ordinance (NSSP-MO) document Guide for the Control of Molluscan Shellfish 2007.

State of Connecticut water quality criteria for indicator bacteria in saltwater (CT WQS Table 2B).

Designated Use	Class	Indicator	Criteria
Shell fishing [6] – Direct consumption	SA	Fecal coliform	Geometric mean less than 14/100 ml 90% of samples less than 31/100 ml
Shell fishing [6] – Indirect consumption	SB	Fecal coliform	Geometric mean less than 88/100 ml 90% of samples less than 260/100 ml
Recreation - Designated Swimming [4]	SA, SB	*Enterococci*	Geometric Mean less than 35/100ml Single Sample Maximum 104/100ml
Recreation - All other uses	SA, SB	*Enterococci*	Geometric Mean less than 35/100ml Single Sample Maximum 500/100ml

Anguilla Brook, Donahue Brook and Wheeler Brook have not been assessed by DEEP. Inner Wequetequock Cove, which has been assessed, does not meet its designated uses, which include habitat for fish, other aquatic life and wildlife, recreation and the direct consumption of shellfish. Suspected causes include enterococcus, algae and estuarine bioassessments related to illicit discharges, failing septic systems, marinas, stormwater runoff and nuisance wildlife/pets.



In 2019, in consultation with DEEP TMDL Program staff, ECCD developed a fecal bacteria (*E. coli*) monitoring plan, prepared a Quality Assurance Project Plan (QAPP), and collected water samples for fecal bacteria analysis. Water samples were processed by the CT Department of Public Health Microbiology Lab. While *E. coli* levels in Anguilla Brook were within allowable levels, *E. coli* levels in Wheeler Brook and Donahue Brook exceeded allowable limits established in the Connecticut Water Quality Standards.

Fecal bacteria sampling results are presented in the table below.

*Fecal bacteria (E. coli) sampling results. **Bolded** figures exceeded established water quality standards.*

Anguilla Brook Watershed *E. coli* Sampling Results (MPN/100 ml[1])											
Sampling Site/ Date	6/24/19	7/1/19	7/8/19	7/15/19	7/22/19	7/29/19	8/5/19	8/12/19	8/19/19	8/26/19	Geomean
AB01	98	160	31	41 (10)	31	130	10	41 (<10)	280	31	42
AB02	180	110	120 (180)	75	95	170	63	52	540	74	119
AB03	150	150	96	160	200	97	20	52	420	86 (75)	106
AB04	120	400	**2,200**	280	420	41	52 (41)	<10	52	41	108
WB01	*DNS*	260	85	63	**20,000**	210	270	<10	510	10	**163**
WB02	120	200 (170)	220	260	230	200 (86)	51	**1,300**	450	310	**213**
WB03	250	460	110	**590**	**3,700**	250	86	290	**1,100**	96	**336**
UN01	31 (41)	63	260	180	96 (85)	31	52	52	340	20	71
UN02	74	52	63	120	130	62	20	*DNS*	360	360	95
DB01	*DNS*	97	**4,400**	310	260	120	86	170	**1,700**	280	**313**
DB02	97	180	110	*DNS*	*DNS*						124
DB02a[2]						98	260	**1,400**	350 (380)	52	**250**
Wet/ Dry	dry	wet	dry	dry	dry	dry	dry	dry	wet	dry	

Notes:
[1]MPN/100 ml - *E. coli* is measured as the most probable number (MPN) of colonies per 100 ml water sample
[2] Two branches of Donahue Brook emerged from a wooded wetland/stream complex north of Barnes Road. The west branch dried up; sampling switched to the east branch which had adequate flow.
DNS - did not sample
Number in parentheses is a duplicate sample collected for quality control purposes
Single sample limit for *E. coli* for Recreation – all other uses is 576 colony-forming units (CFU)/100 ml - CFU = MPN
Geometric mean limit for *E. coli* for Recreation – all other uses is less than 126 CFU/100 ml

ES-6 Pollutant Loads and Load Reductions

The estimation of pollutant loads is a critical element in the overall process of watershed-based planning, and is necessary in order to determine the pollutant load reduction that is needed to restore the water quality of an impaired waterbody. Nitrogen and fecal bacteria are the primary pollutants of concern in Wequetequock Cove. As previously stated, inner Wequetequock Cove is impaired for aquatic habitat, recreation and the direct consumption of shellfish. These impairments are related to nutrient enrichment (eutrophication) that has rendered water quality unsuitable for aquatic wildlife and sea grass, and the presence of fecal bacteria (and other potentially harmful pathogens) in the water that make recreational activities and the direct consumption of shellfish unsafe.

Where water quality measurements are made, it is possible to determine pollutant loading directly. ECCD reviewed fecal bacteria data collected from streams in the Anguilla Brook/Inner Wequetequock Cove Watershed in 2019. ECCD also reviewed bacteria data and bacteria load reductions in the Stonington Estuary TMDL prepared by DEEP in 2013, and data collected by CUSH in Wequetequock Cove in 2019.

Bacteria load reductions required for streams in the Anguilla Brook/Inner Wequetequock Cove Watershed to meet water quality standards are presented in the table below.

E. coli loads and load reductions for stream sampling sites in the Anguilla Brook/Inner Wequetequock Cove Watershed.

2019 Anguilla Brook/Inner Wequetequock Cove Watershed *E. coli* Loads and Load Reductions[1]			
Site	Description	Geometric Mean (MPN/100mL)	% Reduction to Meet WQS
AB01	Anguilla Brook at 11 Trolley Crossing	42	-
AB02	Anguilla Brook at Rt 1 (Handle Bar Plaza)	119	-
AB03	Anguilla Brook at Anguilla Brook Road	106	-
AB04	Anguilla Brook at Rt 184	108	-
WB01	Wheeler Brook at 215 Miner Pentway	163	23
WB02	Wheeler Brook at Taugwonk Road	213	41
WB03	Wheeler Brook at Rt 184	336	62
DB01	Donahue Brook at 711 Stonington Road	313	60
DB02	Donahue Brook at Barnes Road - west branch	124	-
DB02Alt	Donahue Brook at Barnes Road - east branch	250	50
UN01	unnamed brook at 456 Taugwonk Road	71	-
UN02	unnamed brook at Stony Brook Road	95	-

[1] ECCD applied the Connecticut Water Quality Standards single sample criteria for “Freshwater – All other recreational uses” of 576 cfu/100ml and the maximum sample set geometric mean of less than 126 cfu/100 ml to evaluate the water quality data and determine the load reductions necessary to comply with established water quality standards.

Fecal coliform loads and load reductions for data collected by DABA and used by DEEP to develop the fecal bacteria TMDL for Wequetequock Cove are presented in the table below.

CT DEEP 2012 TMDL cycle single sample fecal coliform data for Station 137-17.8, Wequetequock Cove at US RT 1, from 2003-2008 (from Stonington Estuary TMDL, CT DEEP, 2013).

Date	Results	Wet/Dry	Geomean	90% Reduction
4/1/2003	29	Wet	96.5	40
9/2/2003	321	Wet		
3/8/2004	11	Dry	38.8	40
4/28/2004	137	Wet		
1/4/2005	22	Wet	22	n/a
4/11/2006	9	Dry	9	n/a
1/2/2007	171	Wet	51	90
5/13/2008	170	Dry	86	90
4/7/2009	171	Wet	97.9	90
10/21/2009	56	Dry		

Fecal bacteria loads and load reductions for data collected by CUSH in Wequetequock Cove are presented in the table below.

Fecal bacteria loads and load reductions for CUSH Unified Water Study sampling sites in Wequetequock Cove.

2019 CUSH Wequetequock Cove Fecal Bacteria Loads and Load Reductions					
		Enterococci[1]		Fecal Coliform[2]	
Site	Description	Geometric Mean (MPN/100mL)	% Reduction to Meet WQS	Geometric Mean (MPN/100mL)	% Reduction to Meet WQS
WW470	Head of Wequetequock Cove	60	42	113	88
WW502	Inlet near Cove Marina	43	19	94	85
WW624	Oxecosset Brook at US RT 1	619	94	759	98
WW451	Mouth of Wequetequock Cove (located in outer cove)	32	-	15	7

[1] All other recreational uses, geometric mean less than 35/100 ml and single sample maximum 500/100 ml.
[2] Direct consumption of shellfish in Class SA waters, geometric mean less than 14/100 ml and 90% of samples less than 31/100 ml.

ECCD reviewed total nitrogen data collected by CUSH in Inner Wequetequock Cove to determine total nitrogen loads and load reductions. Connecticut Water Quality Standards provide a narrative rather than numeric standard for total nitrogen. ECCD utilized guidance from *Establishing Nitrogen Target Concentrations for Three Long Island Sound Watershed Groupings: Embayments, Large Riverine Systems, and Western Long Island Sound Open Water, Subtasks F/G. Summary of Empirical Modeling and Nitrogen Target Concentrations* (TetraTech, 2020) to identify a nitrogen target of 0.46 mg/l as an ecological endpoint that is protective of eelgrass, a keystone estuarine plant species.

CUSH total nitrogen data and nitrogen load reductions are presented in the table below.

Summary of total nitrogen data collected by CUSH in Wequetequock Cove in 2019.

Sampling Site	Description	Total Nitrogen Geomean (mg/L)	Suggested Load Reduction (%)
WW 470	Wequetequock Cove - head	0.71	35
WW 502	Inlet	0.51	10
WW 624	Oxecosset Brook	0.82	44
WW 451	Wequetequock Cove - mouth	0.37	-

When no water quality data is available, the use of models can be used to estimate pollutant loading. ECCD used the Watershed Treatment Model (2013 "Off the Shelf" edition), developed by the Center for Watershed Protection, to estimate other watershed pollutant loads based on existing land use conditions and reviewed nitrogen loading data for Wequetequock Cove from *A Comparative analysis and model development for determining the susceptibility to eutrophication of Long Island Sound embayments* (Vaudrey et al., 2016), modeled by researchers at the University of Connecticut. Common NPS pollutants that were modeled using the Watershed Treatment Model include total phosphorus (TP), total nitrogen (TN), total suspended sediments (TSS) and fecal coliform (FC). Modeled pollutant loads by watershed land use types and sub-watershed, and watershed pollutant load reductions are presented in the tables below.

NPS Pollutant Loads by land use/land cover type in the Anguilla Brook/Inner Wequetequock Cove Watershed modeled using the Center for Watershed Protection Watershed Treatment Model. Pollutant loads represent the aggregate mass export of pollutant from each land/land cover use in pounds per year. Pollutant yields represent the areal mass export of pollutant for each land use/land cover in pounds per acre per year. Loads are based on primary sources only.

Land Use/Land Cover	**Existing Pollutant Loads (lbs/year)**				**Existing Pollutant Yields (lbs/ac/year)**			
	TN	**TP**	**TSS**	**Fecal Coliform (billion/yr)**	**TN**	**TP**	**TSS**	**Fecal Coliform (billions/ac)**
Residential (1,744 acres)	9,730	1,436	227,039	422,341	5.6	0.8	130	242
Commercial (107 acres)	1,588	166	32,517	68,928	14.8	1.6	304	644
Roadways (323 acres)	5,701	620	332,163	225,946	17.7	1.9	1028	700
Forest (4,373 acres)	10,937	875	437,460	52,495	2.5	0.2	100	12
Rural/ Agriculture (1,170 acres)	5,381	819	116,970	45,618	4.6	0.7	100	39
Water (177 acres)	2,259	88	27,358	0	12.8	0.5	155	0
Active Construction/ Barren (0.2 acres)	1	0.2	656	0	5.0	1.0	3,280	0
Land Cover Total (7,892 acres)	**35,597**	**4,005**	**1,174,162**	**815,330**	-	-	-	-

NPS Pollutant loads and pollutant yields by sub-watershed, modeled using the Center for Watershed Protection Watershed Treatment Model. Pollutant loads represent the aggregate mass export of pollutant from each sub-watershed in pounds per year. Pollutant yields represent the areal mass export of pollutant in pounds per acre per year. Loads include primary and secondary sources.

Anguilla Brook/ Wequetequock Cove Sub-watershed	Existing Pollutant Loads (lbs/year)				Existing Pollutant Yields (lbs/ac/year)			
	TN	TP	TSS	Fecal Coliform (billions/yr)	TN	TP	TSS	Fecal Coliform (billions/ac)
Anguilla Brook (5,657acres)	26,730	4,037	997,075	557,687	4.7	0.7	176	99
Wheeler Brook (995 acres)	4,697	647	191,265	76,326	4.7	0.7	192	77
Unnamed Brook (247 acres)	1,187	186	60,739	24,437	4.8	0.8	246	99
Donahue Brook (993 acres)	4,606	564	183,258	64,261	4.6	0.6	185	65
Watershed Total (7,892 acres)	**37,221**	**5,434**	**1,432,337**	**722,710**	4.7	0.7	181	92

Watershed NPS pollutant load reductions.

NPS Pollutant	Watershed Load/Reduction	Anguilla Brook (2101-00)	Wheeler Brook (2101-01)	Unnamed Brook (2101-02)	Donahue Brook (2101-03)
Total Nitrogen (TN)	Existing TN (lb/year)	26,730	4,697	1,187	4,606
	Pre-developed TN (lb/year)	15,691	2,490	627	2,751
	% Reduction TN (lb/year)	**41**	**47**	**47**	**40**
Total Phosphorus (TP)	Existing TP (lb/year)	4,037	647	186	564
	Pre-developed TP (lb/year)	1,182	200	50	207
	% Reduction TP (lb/year)	**71**	**69**	**73**	**63**
Total Suspended Sediment (TSS)	Existing TSS (lb/year)	997,075	191,265	60,739	183,258
	Pre-dev TSS (lb/year)	747,124	129,365	32,195	131,083
	% Reduction TSS (lb/year)	**25**	**32**	**47**	**28**
Fecal Coliform (FC)	Existing FC (billion/ year)	557,687	76,326	24,437	64,261
	Pre-dev FC (billion/ year)	66,115	11,938	2,955	11,604
	% Reduction FC (billion/year)	**88**	**84**	**88**	**82**

In order to provide a baseline against which current pollutant loading could be compared, pre-developed watershed loads were calculated for each of the sub-watersheds, using a forested condition as a typical pre-development land cover for Connecticut. No net gain of wetlands was assumed. Based on the evaluation of pollutant loads and load reductions, three areas in the Anguilla Brook/Inner Wequetequock Cove Watershed emerged as critical areas for pollutant load reductions. These include the Donahue Brook and Wheeler Brook watersheds, which do not meet Connecticut water quality standards for the indicator bacteria *E. coli*, and the Wequetequock Cove shoreline area.

ES-7 Pollutant Source Assessment

Pollution in a watershed can come from a variety of sources and may derive from point or non-point sources. Point sources may include identifiable points such as factory or sewage treatment plant pipes which discharge pollution (called effluent) into a receiving waterbody. Non-point source pollution (or NPS) is comprised of a diffuse array of pollutants distributed on the ground across the landscape. These pollutants are mobilized by rainwater or snowmelt and transported into receiving waterbodies by direct overland flow or via storm drainage systems. Known or potential pollution sources in the Anguilla Brook/Inner Wequetequock Cove Watershed are identified in the following section.

Non-Point Sources:

- stormwater runoff/impervious cover
- septic systems/sanitary sewers
- recreation fields
- agriculture
- pets, wildlife and waterfowl
- atmospheric deposition
- degraded shoreline and riparian buffer areas
- silviculture
- land clearing/development
- earth removal/gravel mining
- winter paved surface de-icing practices

Point Sources:

- NPDES Phase I and II Stormwater Permits
- hazardous waste sites
- marinas/boating

ES-8 Watershed Goals and Objectives

The overarching goal of the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan is to restore the water quality of Wequetequock Cove so that it is compatible with all its intended uses including supporting a healthy and thriving estuarine habitat with clean water that is safe for all recreational activities and the safe consumption of shellfish. Watershed objectives to meet this goal are:

Objective 1: Form a sustainable, long-term coalition of stakeholders to adopt and implement this watershed management plan.

Objective 2: Raise public awareness of water quality conditions and actions to reduce water quality impacts.

Objective 3: Reduce nutrient loading (especially nitrogen loading) from sources such as agriculture; agricultural, commercial and residential fertilizer use; and septic systems.

Objective 4: Reduce bacteria loading from sources such as pets, livestock, agricultural activities, and septic systems.

Objective 5: Reduce NPS pollutant loading from sources such as stormwater runoff from roadways, commercial, industrial and residential areas; agriculture; recreational fields; marinas, boat maintenance and boating activities.

ES-9 Watershed Management Strategies

Watershed management recommendations are strategies designed to implement the stated watershed management objectives in order to achieve the goals of the watershed management plan. Best management practices (BMPs) may be comprised of "non-structural" practices - procedures such as behavioral changes, revisions to municipal regulations and practices, preservation of open space, and modified landscaping practices; or "structural" practices, such as brick and mortar devices installed or constructed on a site to improve water quality. This section outlines management strategies that, once implemented, are intended to restore surface water quality conditions in the Anguilla Brook/Inner Wequetequock Cove Watershed so that all waterbodies will comply with Connecticut water quality standards for their designated uses.

Recommended Best Management Practices and interim milestones include:

1. Create a Watershed Coalition

- Establish the watershed management team.
- Review watershed management goals and objectives.
- Identify sources of financial assistance.
- Identify sources of technical assistance.
- Identify and establish a mechanism for outreach.
- Implement the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan.
- Develop a framework to evaluate implementation effectiveness.
- Assess implementation effectiveness.

2. Conduct a Public Awareness Campaign

- Promote the watershed-based plan among the general public.
- Review watershed-based plan recommendations with land use commissions.
- Conduct targeted outreach to address specific water quality threats.
- Incorporate the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan into K-12 school curriculum.

- Update the public about water quality improvement projects as they are conducted.
- Promote watershed stewardship among general public.

3. Review, Update and Enhance Land Use Management Practices

   - Adopt land-use planning recommendations proposed in the Towns of Stonington and North Stonington Plans of Conservation and Development.
   - Adopt and/or update farm-friendly land-use regulations.
   - Review and strengthen existing land-use regulations pertaining to erosion and sediment control and stormwater management.
   - Identify and evaluate any existing or perceived institutional barriers to GI and LID.
   - Incorporate language to encourage or require the use of green infrastructure (GI) and low-impact development (LID) practices into site plan design and development.
   - Adopt regulatory language necessary to implement the MS4 General Permit.

4. Reduce Nutrient and Bacteria Loading to Surface Waterbodies and Wequetequock Cove

   - Encourage pet waste management.
   - Conduct manure management outreach and education, especially among non-commercial farms.
   - Encourage the reduction of fertilizer use.
   - Reduce nitrogen and bacteria loads from septic systems.
   - Support Nitrogen Reduction Strategies Developed by The Nature Conservancy.
   - Install permeable reactive barriers in near-shore areas.

5. Reduce NPS Pollutant Loading to Surface Waterbodies and Wequetequock Cove

   - Reduce stormwater runoff from impervious surfaces.
   - Promote Good Housekeeping Practices.
   - Restore impacted riparian areas.
   - Promote the Clean Marina and Clean Boater Programs.
   - Support area pump-out boat programs.

Targeted Best Management Practices include watershed-scale, neighborhood-scale and site-specific watershed best management practices to reduce watershed fecal bacteria and nitrogen loads based on site conditions identified by ECCD and watershed stakeholders during the water quality investigation. Best Management Practice recommendations are summarized in the tables below.

Watershed-scale Recommended BMPs.

Watershed-wide Best Management Practices:
1. Pet waste education leading to proper dog waste disposal
2. Septic system care education leading to proper maintenance practices
3. 50% reduction in use of lawn fertilizer
4. 100% reduction in use of lawn fertilizer

Neighborhood-scale Recommended BMPs

Location	Recommended BMPs
Wequetequock Cove Shoreline	Pet waste education, septic system maintenance education, 50% fertilizer reduction or 100% fertilizer reduction, install ±7,125 LF permeable reactive barrier
Marlin Drive neighborhood	Pet waste education, septic system maintenance education, 50% fertilizer reduction or 100% fertilizer reduction, install ±16 rain gardens, 2 tree filters, bio-retention basin
Birdland Neighborhood	Pet waste education, 50% fertilizer reduction or 100% fertilizer reduction, install ±77 rain gardens, 12 tree filters, ±2,700 LF riparian buffer
Castle Hill Road Neighborhood	Pet waste education, 50% fertilizer reduction or 100% fertilizer reduction, install ±20 rain gardens, 12 tree filters
Cedarcrest Neighborhood	Pet waste education, septic system maintenance education, 50% fertilizer reduction or 100% fertilizer reduction, install ±31 rain gardens
Jeremy Hill Road Neighborhood	Pet waste education, septic system maintenance education, 50% fertilizer reduction or 100% fertilizer reduction, install ±30 rain gardens

Site-Specific Recommended BMPs

Location	Recommended BMPs
Saltwater Farm Vineyard	Install ±2,000 LF permeable reactive barrier, ±4,910 LF riparian buffer
The Meadows Event Center	50% fertilizer reduction or 100% fertilizer reduction, install 2 bio-retention basins, ±430 LF permeable reactive barrier, ±400 LF riparian buffer
Stonington High School/Spellman Sports Complex	50% fertilizer reduction or 100% fertilizer reduction, install ±2,900 SF pervious pavement, 10 tree filters
Pawcatuck Little League Complex	50% fertilizer reduction or 100% fertilizer reduction, install ±675 LF permeable reactive barrier
Elmridge Golf Course	50% fertilizer reduction or 100% fertilizer reduction, conversion of ±14 acres of greens to solar facility
Stonington Country Club	50% fertilizer reduction or 100% fertilizer reduction
Stonington Vineyard	±1,300 LF riparian buffer, ±1,300 LF permeable reactive barrier

ES-10 Financial and Technical Assistance

Most, if not all, of the management practices provided will require some financial investment. Watershed municipalities have local funding options, including bonding, capital improvement budgets, and department budget line items that can be utilized to fund water quality improvement implementations and municipal outreach efforts. Funds and support may be available in the form of donations and in-kind services provided by local businesses, community and environmental organizations, and local volunteers. Financial assistance in the form of grants and cost-sharing is available from multiple sources, including federal, state, and local sources.

The planning, design and execution of complex water quality improvement projects may require expertise to which small towns, watershed groups and civic organizations do not have access. As a result, assistance from organizations or agencies that have the technical capacity will be critical to the successful implementation of the management recommendations. Organizations that may provide financial and technical assistance to project managers and watershed stakeholders are listed in the tables below.

Potential funding sources for watershed-based plan implementations.

Funding Source	Award Amount	Contact Information
Community Foundation of Eastern Connecticut Website: www.cfect.org	Varies by program	Jennifer O'Brien (860) 442-3572
CT DEEP CWA §319 NPS Grant Program Website: portal.ct.gov/DEEP/Water/NPS/	Varies by project	Eric Thomas (860) 424 -3548
CT DEEP CWA §604(b) Watershed Planning grant program Website: portal.ct.gov/DEEP/Water/NPS/	Varies by availability	
CT DEEP Clean Water Fund (for municipalities) Website: www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654	Varies by project	Susan Hawkins (860) 424-3325
CT DEEP Open Space and Watershed Land Acquisition Grant Program Website: www.ct.gov/deep/cwp/view.asp?A=2687&Q=322338	40-60% of fair market value	Allyson Clarke - (860) 424-3774
CT Dept of Agriculture Agriculture Viability Grant Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398982	Varies by project	(860) 713-2500
CT Dept of Agriculture Environmental Assistance Program Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398986	Varies by practice	(860) 713-2511
CT Dept of Agriculture Farmland Restoration Program Website: www.ct.gov/doag/cwp/view.asp?a=3260&Q=498322&PM=1	Varies by project	Cam Weimer/Lance Shannon (860) 713-2511
CT DOH Small Cities Program Website: www.ct.gov/doh/cwp/view.asp?a=4513&q=530474	Varies by town	Jim Watson (860) 270-8182
CT OPM Regional Performance Incentive Program Website: www.ct.gov/opm/cwp/view.asp?q=487924		Sandy Huber (860) 418-6293
CT OPM Small Town Economic Assistance Program Website: www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793	Varies by project	Barbara Rua (860) 418-6303
Environmental Professionals of CT Website: www.epoc.org/grants	$2,500	Seth Molofsky - (860) 537-0337
Long Island Community Foundation Website: www.lisfc.org/		Jeannie DeMaio - jdemaio@licf.org
Long Island Sound Funders Collaborative Website: www.lisfc.org/	Up to $400,000 is available for grants annually.	Trip Killin - tripp@lisfc.org

Table 8 1. Potential funding sources for watershed-based plan implementations (cont.).

Funding Source	Award Amount	Contact Information
NFWF Long Island Sound Futures Fund Website: www.nfwf.org/	Varies by project	Lynn Dwyer - lynn.dwyer@nfwf.org
NFWF New England Forests and Rivers Fund Website: www.nfwf.org/programs/new-england-forests-and-rivers-fund/	$50,000 to $200,000	John Wright - John.wright@nfwf.org
NRCS Agricultural Conservation Easement program Website: www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/easements/acep/	Varies by project	Garrett Timmons - (860) 319-8803
NRCS Environmental Quality Incentives Program Website: www.ct.nrcs.usda.gov/programs/eqip/eqip.html	$450,000 over 6 yrs	Garrett Timmons – (860) 319-8803
NRCS Conservation Stewardship Program (CSP) Website: www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/financial/csp/	$200,000 over 5 yrs	Garrett Timmons – (860) 319-8803
NRCS Agricultural Management Assistance Program Website: www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/programs/financial/?cid=nrcs142p2_011027	$50,000/yr	Garrett Timmons – (860) 319-8803
NRCS Watershed Grant Program Website: www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/planning/wpfp/	varies	Garrett Timmons – (860) 319-8803
NOAA Coastal Management Programs Website: coastalmanagement.noaa.gov/funding/welcome.html		
NOAA Coastal Resilience Fund Website: www.nfwf.org/programs/national-coastal-resilience-fund	Varies by program priority area Average $250,000-$350,000	Amanda Bassow - Amanda.Bassow@nfwf.org
Rivers Alliance of CT Watershed Assistance Small Grants Program Website: www.riversalliance.org/watershedassistancegrantrfp.cfm	$5000, req. 40% non-federal funding match	Rivers Alliance of CT- (860) 361-9349
Society of Women Environmental Professional-CT Website: www.swep-ct.org/	$2,000	Kathie Cyr - Kathleen.cyr@gza.com
US EPA Five Star Restoration Grant Program Website: www.epa.gov/urbanwaterspartners/five-star-and-urban-waters-restoration-grant-program	$20,000 average	Myra Price (202) 566-1225
US EPA Healthy Communities Grant Program Website: www.epa.gov/region1/eco/uep/hcgp.html		Jennifer Padula (617) 918-1698

Potential sources of technical assistance.

Agency/Organization	**Type of Assistance Available**
CT Department of Agriculture www.ct.gov/doag	Available programs, permitting, agricultural waste management
Connecticut Department of Agriculture Bureau of Aquaculture	Support and technical assistance regarding coastal water quality, shellfish management and restoration; water quality data
CT DEEP www.ct.gov/deep	Water quality, forestry, stormwater management, land protection, wildlife, endangered species
CT Department of Transportation www.ct.gov/dot	Design and maintenance of State highways/ stormwater systems and maintenance facilities, design standards
CT Resource Conservation & Development Area www.ctrcd.org	Farm energy program, soil health education, AGvocate program, partnerships/grant management, greenways, planning and development projects, Environmental Review Team (ERT)
Eastern CT Conservation District www.ConserveCT.org/eastern	Water quality, BMP implementations, technical and resource assistance, grant writing
Ledge Light Health District www.llhd.org	Review and approval of septic systems, repairs
Local Businesses/Associations chamberect.com/	Potential funding and partnership opportunities
Southeastern CT Council of Governments www.seccog.org	Regional land use planning support and assistance, GIS assistance
The Nature Conservancy www.nature.org	Outreach/education, planning/ management tools, technical expertise
Town of Stonington www.stonington-ct.gov	Enforcement of land use regulations, site plan review/permits, public utilities maintenance, land records, stormwater management plan, planning documents
Town of North Stonington www.northstoningtonct.gov	Enforcement of land use regulations, site plan review/permits, public utilities maintenance, land records, stormwater management plan, planning documents
USDA Natural Resources Conservation Service (NRCS) www.nrcs.usda.gov/wps/portal/nrcs/site/ct/home/	Programmatic/cost-share funding for agricultural BMPs, nutrient management, woodland and wildlife habitat management and improvement
USDA Farm Service Agency (FSA) www.fsa.usda.gov/	Technical/financial assistance for agricultural producers
University of Connecticut – Center for Land Use Education and Research (CLEAR) clear.uconn.edu	Outreach and education, GIS support, tools and data, implementation of LID/GI, MS4 permit support
University of Connecticut – Nonpoint Education for Municipal Officials (NEMO) nemo.uconn.edu	NPS education and support for municipal land use organizations
University of Connecticut Extension www.extension.uconn.edu	Technical assistance/education/outreach for land use, forest management and agricultural practices
University of Connecticut Sea Grant Program www.seagrant.uconn.edu	Education and outreach on coastal topics, riparian buffers, coastal habitat restoration, shellfish management /restoration

ES-11 Water Quality Monitoring

The collection of water quality data is necessary to evaluate the effectiveness of implementations over time. At a minimum, the two pollutants of greatest concern to water quality in Wequetequock Cove, nitrogen and fecal bacteria, should be monitored. The development of a monitoring program that collects other physical water quality parameters such as dissolved oxygen, suspended sediments, pH, conductivity, other nutrients like phosphorus, and biological data, such as the types and abundance of aquatic plants and animals will provide equally important data that can be used to evaluate the health of the estuary and the effectiveness of implementations.

As Plan recommendations are being implemented, existing water quality data, such as that collected by the Town of Stonington as part of its MS4 permit obligations can be evaluated, or additional water quality data should be collected to evaluate whether the implementations are having the desired effect. Where possible, water quality data should be collected before and after the implementation or upstream and downstream of the implementation site to determine if target pollutant load reductions have occurred. Successful implementations will demonstrate reductions in the targeted pollutants (e.g., reductions in fecal coliform and enterococci concentrations, pounds of nitrogen, or reductions in nitrogen concentrations) indicating gains are being made toward attaining water quality standards. The demonstration of measurable progress is not only indicative that implementations are having the intended effect, but is also critical to ensuring the continued support of watershed projects by the community and funding agencies.

ES-12 Plan Evaluation Process

The successful implementation of a watershed-based plan includes the periodic review of management measures that have been completed. This evaluation process will help watershed managers determine if watershed goals are being achieved. The plan evaluation process also allows watershed managers to assess and improve not only implementation measures, but the implementation process as a whole. The implementation of a watershed management plan is necessarily an iterative process. As management measures are undertaken and completed, they should be evaluated to determine if the desired outcome is being achieved. If the desired outcome is not being achieved (e.g., no reduction in nitrogen concentration has been observed), the measure should be re-evaluated, adjusted, re-implemented, re-evaluated and so on until the desired outcome (water quality goals) is reached.

In order to evaluate watershed-based plan implementation outcomes, the watershed team should develop a method to track progress. This tracking methodology should document evaluation criteria such as whether management measures are being implemented, if implementation milestones are being met, if water quality improvements are being documented, and if intended outcomes are being achieved.

If the watershed team determines that intended outcomes are not being achieved, the implementation process will need to be adjusted. The team will need to evaluate why outcomes are not being achieved. This could be due to an overly ambitious work plan, the lack of funding, the need for additional or different management measures to target a particular pollutant, or new conditions in the watershed, such as a large development in a sensitive area that has altered pollutant loads and load reduction targets, in which case the Plan itself may need to be revised to reflect altered watershed conditions.

Finally, the watershed team should conduct the Plan evaluation on a regular (e.g., annual or biennial) basis. This regular evaluation will allow managers to closely track implementations and effect any course corrections necessary.

ES-13 Watershed-Based Plan Implementation

This Plan provides a roadmap for watershed managers to conduct actions that are intended to improve the water quality and aquatic habitat of Wequetequock Cove. However, without a plan to initiate its implementation, these watershed goals will not be achieved. Further, watershed managers will need to have an understanding of how they will prioritize, schedule, and evaluate actions, measure success, evaluate the overall effectiveness of the Plan implementation, and provide corrective actions if the goals of the Plan are not being realized. The following section, drawn from *A Quick Guide to Developing Watershed Plans to Restore and Protect Our Waters (*USEPA, 2013), provides guidance to stakeholders to begin the implementation of this Plan. Suggested steps include:

1. Convene the Watershed Team
2. Prepare a Work Plan
3. Implement the management strategies
4. Conduct monitoring and analyze data
5. Conduct information/education activities
6. Measure progress and make adjustments

ES-14 Conclusion

Restoring the water quality and aquatic habitat of Inner Wequetequock Cove will be a long-term effort. It will take the actions of many individuals, community leaders and decision makers to address current watershed conditions and take measures to reduce the levels of NPS pollutants, especially fecal bacteria and nitrogen, so that the Inner Wequetequock Cove will support all its designated uses.

Following the acceptance of the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan by CT DEEP, this Plan should be distributed to all watershed stakeholders for implementation, including, but not limited to, the Towns of North Stonington and Stonington, the Southeastern Connecticut Council of Governments, Ledge Light Health District, local utilities (including the Stonington Water Pollution Control Authority), CT Department of Transportation, agricultural producers, and business and land owners.

The Plan should be made available to the general public via postings on the CT DEEP, ECCD and municipal websites. Efforts should be made to publicize the watershed plan using multiple approaches and media platforms to reach different audiences, in order to raise public awareness of water quality and water quality threats in the Anguilla Brook/Inner Wequetequock Cove watershed, and steps being taken to protect and/or improve water quality.

The Eastern Connecticut Conservation District intends to remain an active participant and central point of contact as implementations recommended by this Watershed-Based Plan are undertaken.

Any comments or questions regarding this Plan should be directed to:

Eastern Connecticut Conservation District, Inc.
238 West Town Street
Norwich, CT 06360
(860) 319-8806

1 INTRODUCTION

1.1 DOCUMENT OVERVIEW

The Anguilla Brook Watershed-Based Plan (the Plan) was developed to address water quality impairments and restore Inner Wequetequock Cove (the Cove) for all its intended uses. A watershed management plan is "a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, actions, participants, and resources related to developing and implementing the plan" (US Environmental Protection Agency, 2008). The purpose of a watershed-based plan is to provide guidance to local managers and a spectrum of stakeholders for the management of resources within a geographically defined area – the watershed. The Anguilla Brook Watershed-Based Plan is a guidebook or blueprint for stakeholders in the watershed to manage the resources in order to improve water quality in Wequetequock Cove.

Watershed management plans are holistic; they evaluate the multiple existing and potential uses of a watershed, from residential, commercial or industrial development to drinking water protection, agriculture, forest planning, wildlife and open space management. The watershed planning process is both iterative and adaptive, requiring periodic review of stated goals and objectives, assessment of whether goals and objectives are being met, and providing a mechanism for mid-course adjustments if it is determined that that goals and objectives are not being achieved (Fig. 1-1). This type of adaptive approach allows the plan to evolve as plan recommendations are implemented and evaluated, as land uses and priorities change over time, and as new information or technologies that may further the goals of the plan become available.

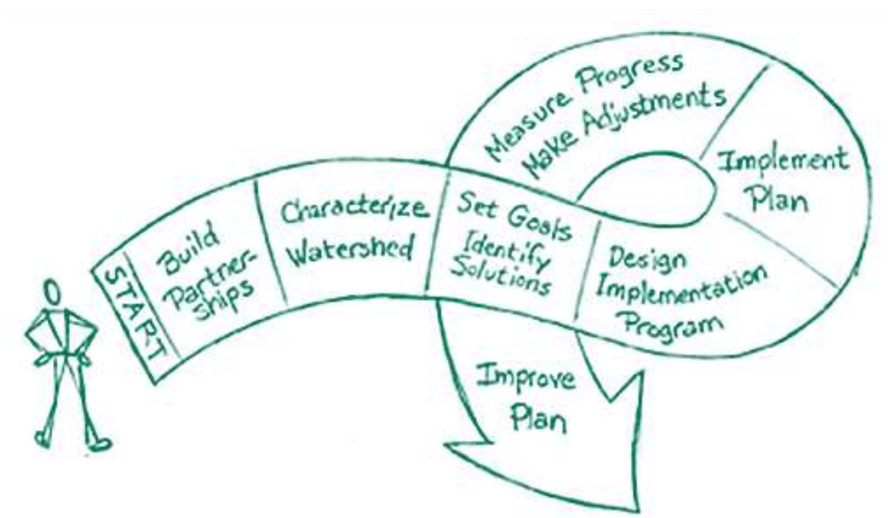


Figure 1-1. This graphic from the USEPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters depicts the watershed planning process (USEPA 2008).

This Plan utilizes the nine minimum elements identified by the US Environmental Protection Agency (USEPA) to be used in the preparation of a watershed-based plan for impaired waters (US EPA, 2013). These elements include:

1. Identification of the impairment and pollutant sources
2. Description of management measures to achieve load reductions
3. Estimate of load reductions expected from proposed management measures
4. Technical and financial assistance needed to implement management measures
5. Education and outreach required to achieve management goals
6. Implementation schedule
7. Interim measurable milestones
8. Water quality improvement evaluation criteria
9. Water quality monitoring component.

The goal of this watershed-based plan is to provide information and data in order to allow watershed managers to address the sources of pollution that are impacting the water quality of Wequetequock Cove. The following sections of this document will provide a description of the watershed, including current watershed conditions. Potential pollution sources are identified and assessed, and the impacts to water quality are estimated. Specific watershed goals and objectives intended to reduce the pollution load have been developed, and management strategies, including implementation timelines, potential funding sources and available technical assistance necessary to meet those goals, are outlined.

1.2 Background

Wequetequock Cove, in Stonington, Connecticut, is an embayment of Little Narragansett Bay located at the outfall of the Pawcatuck River at the boundary between the states of Connecticut and Rhode Island (Fig. 1-2). Inner Wequetequock Cove (CT-E1_003) is the 0.09- square mile portion of Wequetequock Cove located north of a railroad crossing near the southern end of the cove. Inner Wequetequock Cove has been listed by the Connecticut Department of Energy and Environmental Protection (DEEP) as impaired for its designated uses, which include habitat for fish, other aquatic life and wildlife, recreation and the direct consumption of shellfish. Suspected causes include enterococcus, algae and estuarine bioassessments related to illicit discharges, failing septic systems, marinas, stormwater runoff and nuisance wildlife/pets.

Figure 1-2. The Anguilla Brook watershed in Stonington, CT.

The six-mile-long Anguilla Brook (CT2101-00) is the primary tributary to Wequetequock Cove. Anguilla Brook has its headwaters in North Stonington in the area north of the Providence-New London Turnpike (State Route 184) and discharges into the north end of Wequetequock Cove south of Chesebrough (aka

Wequetequock) Pond. The Anguilla Brook watershed (CT2101), which comprises all the land area that drains to the Inner Wequetequock Cove, is 12.3 square miles (7,891 acres). Unlike Wequetequock Cove, Anguilla Brook and its tributaries have not been assessed.

Due to the water quality impairment, the direct consumption of shellfish, both within Inner Wequetequock Cove (north of the railroad crossing) and in Wequetequock Cove and Stonington Point Harbor south of the railroad, is prohibited. Commercial shell fishing is designated restricted-relay; all shellfish must be moved to clean water for depuration prior to consumption.

In order to address the water quality impairment, the Connecticut Department of Energy and Environmental Protection (CT DEEP) developed a statewide Total Maximum Daily Load (TMDL) for bacteria-impaired waters in 2012 (CT DEEP, 2012) and a bacteria TMDL for estuaries in Stonington in 2013 (CT DEEP, 2013). The TMDL provides guidance regarding sources of bacterial pollution in the watershed and recommends bacteria load reductions to enable Inner Wequetequock Cove to meet its water quality goals.

1.3 Challenges Facing the Anguilla Brook Watershed and Wequetequock Cove

Anguilla Brook and Wequetequock Cove are important resources to residents and visitors to coastal southeastern Connecticut. The waterways and their environs provide a variety of recreation opportunities, including fishing, boating, bird watching and hiking. Undeveloped coastal forest blocks and floodplains adjacent to the stream are important wildlife habitats and flood mitigation areas. Anguilla Brook supports an anadromous fish population including alewife, herring and the catadromous American eel (*Anguilla rostrata*) for which the stream is named. Portions of the stream support cold water fish species including native brook trout. Wequetequock Cove is an aesthetic, recreational and commercial resource. Marinas and commercial businesses located along the shore of the Cove support recreational boating and fishing. Coastal marshes provide wildlife habitat and storm surge and flood protection.

Like other coastal Connecticut watersheds, the Anguilla Brook watershed faces challenges associated with stormwater management, eutrophication, climate change and the potential for future development.

Stormwater Management

Although about three-quarters of the Anguilla Brook watershed is considered undeveloped, water quality issues associated with stormwater run-off from developed areas is a primary concern. Stormwater run-off mobilizes a wide array of pollutants from the land surface and transports them over the ground or through storm drain systems, into Wequetequock Cove and out into Little Narragansett Bay. These pollutants are termed nonpoint source (NPS) pollutants. NPS pollutants do not originate from a single readily discernable location such as a pipe or other discrete discharge point but are the aggregate of contaminants that are found in both the built and natural landscape, and include sediment, lawn, garden and agricultural fertilizers, herbicides and pesticides, vehicular chemicals, heavy metals, pathogens, industrial chemicals, pharmaceuticals, and litter/floatable debris. NPS can have significant impact on the estuarine aquatic habitat, degrading water quality and impacting eelgrass beds that are critical habitat for many marine species.

Eutrophication

Eutrophication is the over-enrichment of nutrients in a body of water that causes the excessive growth of aquatic plant life and algae. This excessive plant growth can have significant impact on the aquatic habitat, including the depletion of oxygen which can result in the death of fish and other aquatic animals. Poor water quality in Wequetequock Cove due to eutrophication has significantly impacted aquatic habitat. Based on data collected by Clean Up Sounds and Harbors (CUSH) in 2019 as part of Save the Sound's Unified Water Study and reported in the 2020 Long Island Sound Report Card, Wequetequock Cove has dangerously low dissolved oxygen levels during the summer and high phytoplankton levels, creating conditions that are not supportive of seagrasses, including eelgrass, and native seaweeds or aquatic animals. This nutrient enrichment is driven by excess levels of nitrogen that are entering the Cove via groundwater. Sources of nitrogen in the Inner Wequetequock Cove Watershed may include fertilizer, animal manure and septic system discharges.

Climate Change

In the 2017 Stonington Coastal Resilience Plan, town managers recognize that "many of Stonington's community resources, assets, and residential properties are at significant risk from coastal flooding." A USEPA review of climate change indicators, criteria that track environmental conditions over time, indicate that weather patterns have changed in Connecticut (USEPA, 2016). Connecticut has become subject to hotter, drier summers, leading to droughts and increased risk of wild fire. Annual precipitation in Connecticut has increased, but is more likely to fall in fewer, more intense rain storms, resulting in rainfalls that tend to run off rather than soak into the ground, increasing the likelihood of flash floods. Storms have increased in frequency, and the intensity and duration of coastal flooding related to sea level rise and storm surge has likewise increased. Warmer winter temperatures result in winter precipitation that is more likely to fall as rain than snow, which runs off due to frozen ground surfaces. The lack of snowpack also decreases groundwater recharge from spring snowmelt, contributing to drought, low or no flow in stream beds, exposed lake and pond shorelines, impacted wetlands, and decreased recharge of groundwater-fed wells.

Future Development

Finally, the potential for suburban development threatens the rural character of Stonington. Although most of the area encompassed within the Anguilla Brook watershed has been designated by the Town for low density residential development (POCD, 2015), future changes to zoning regulations, and infrastructure improvements such as expanded water and sewer services, could increase the potential for greater residential, commercial and industrial development, and related impacts to water quality.

1.4 Plan Development Process

The Anguilla Brook watershed planning process was conducted in several phases. The first phase involved a review of existing watershed conditions and water quality data. Material reviewed included the Estuary 12: Stonington Watershed Summary appendix to the Statewide Bacteria Total Maximum Daily Load Analysis for Bacteria Impaired Waters (CT DEEP, 2013), and water quality data collected by Clean Up Sound and Harbors (CUSH). Stream fecal bacteria data collected by the University of Connecticut as part of a USDA-NRCS Regional Conservation Partnership Program (RCPP) *Path to Reduce*

Pathogens in CT Agricultural Runoff project was reviewed as well. Based on existing conditions, available water quality data and other information, ECCD, in consultation with CT DEEP, prepared a water quality monitoring plan, and in the summer of 2019, collected water quality data from Anguilla Brook and other perennial tributaries to Wequetequock Cove. The water samples were analyzed by the CT Department of Public Health for fecal bacteria content.

The second phase, a desktop assessment of the watershed and interviews with watershed stakeholders, land owners, and policy makers were conducted to identify possible contaminant sources based on the results of the bacteria collection. Stream corridor assessments of the streams that did not meet water quality standards due to high fecal bacteria levels were conducted in the fall of 2019. The assessments documented conditions along the stream corridors that could contribute to fecal bacteria and other types of water quality and stream habitat degradation.

The third, a desktop pollutant load analysis, was conducted using the Center for Watershed Protection's Watershed Treatment Model (Center for Watershed Protection, 2013). This analysis predicts annual loads (in pounds per acre) for various common NPS pollutants based on land use and land cover within the Anguilla Brook watershed.

The final, and most important, phase in the plan development process involved the incorporation of the water quality data and information collected during the first three phases into the watershed-based plan. These data and information were used to identify potential sources of pollutant loading to Wequetequock Cove. It also informed the selection and locations of recommended management measures to be implemented in order to reduce pollutant loading and restore water quality and aquatic habitat in Wequetequock Cove.

1.5 Stakeholder and Public Participation

Watershed planning is both a collaborative and participatory process. An effective watershed planning process is supported by the active engagement of a local watershed stakeholder team. A well-balanced stakeholder team should consist of a variety of members of the community, and may include municipal officials and commissioners, business owners, landowners, environmental and civic organizations, as well as any other organizations, agencies or individuals with a stake in the preservation and improvement of water quality in the watershed.

In order to guide the water quality investigation and aid the development of this watershed-based plan, a diverse stakeholder group was convened (Table 1-1). Stakeholders met quarterly to review the progress of the investigation and provide guidance and insight. Stakeholders, along with members of the general public, participated in bacteria sample collection and stream corridor assessments.

Prior to the first stakeholder meeting, which was held in January 2019, stakeholders were asked to complete a short survey about what they valued about Anguilla Brook and Wequetequock Cove and what they perceived as challenges to both waterbodies. Discussion about the survey at the January 2019 stakeholder meeting facilitated the establishment of reasonable goals for water quality restoration and aided ECCD with framing and developing the Anguilla Brook water quality investigation and watershed-based plan. The survey responses are summarized in Table 1-2.

Upon the completion of this plan, this stakeholder group may form the nucleus of a watershed management team, which will adopt and implement the management recommendations contained herein.

Table 1-1. Anguilla Brook Bacteria Trackdown and Watershed-Based Plan Stakeholder Team

Avalonia Land Conservancy	Town of North Stonington Planning Department
Clean Up Sounds and Harbors (CUSH)	Town of Stonington Department of Public Works
CT Department of Agriculture Bureau of Aquaculture	Town of Stonington – Pawcatuck River Harbor Management
CT Department of Energy & Environmental Protection	Town of Stonington – Stonington Harbor Management
Connecticut Sea Grant	Town of Stonington Planning Department
Eastern Connecticut Conservation District	The Nature Conservancy
Pine Point School	Trout Unlimited (Thames Valley CT Chapter)
Save the Sound	University of Connecticut Marine Science Dept.
Stonington Conservation Commission	USDA Natural Resources Conservation Service
Stonington Land Trust	Watershed Residents and Businesses
Stonington Shellfish Commission	Wild Ones
Stonington Stormwater Task Force	

Table 1-2. Summary of stakeholder watershed values survey

What Do You Value About…?

	Anguilla Brook:	Wequetequock Cove:
	• aesthetics • recreation	• aesthetics • recreation
Challenges:	• septic systems • water withdrawals • agriculture	• Nutrient enrichment • Flow/flushing • Little Narragansett Bay
Goals:	• Protect water quality • Evaluate/reduce nitrogen loads	• Reduce nutrient and bacteria loading • Improve aquatic habitat

2 Watershed Characteristics

2.1 Physical and Natural Features

2.1.1 Watershed Boundaries

The Anguilla Brook watershed (CT-2101) is located in the towns of Stonington and North Stonington in southeastern Connecticut and encompasses a land area of 12.3 square miles (7,891 acres). The headwaters of Anguilla Brook, the primary tributary to Wequetequock Cove, are located in North Stonington, in a wooded wetland north of Providence-New London Turnpike (State Route 184). Anguilla Brook flows into Wequetequock Cove south of Chesebrough Pond, the site of a 17th century gristmill (Wheeler, 1900), near Stonington Road (US Route 1).

The watershed is part of the Southeast Eastern Complex (CT-21), a regional coastal watershed in southeastern Connecticut that drains to Little Narragansett Bay and Long Island Sound. Long Island Sound is part of the United States National Estuary Program and is designated an estuary of national significance (www.epa.gov/nep).

The watershed is also part of the larger Stony Brook-Frontal Fishers Island Sound (HUC 011000030303). HUC, or hydrologic unit codes, are designators within a hierarchical cataloguing system developed by the US Geological Survey to identify hydrologic units (watersheds) throughout the US. The HUC system is based on major river systems, with nested regional, sub-regional and smaller units contained within. It should be noted for future reference that DEEP is transitioning to the use of the HUC system for watershed boundary delineations.

The Anguilla Brook watershed is oriented north-south and is roughly twice as long (±5.8 miles) as it is wide (±2.5 miles). The watershed is bounded by glacially-smoothed ridgelines which divide it from the Southeast Shoreline watershed to the west and the Pawcatuck River watershed to the east.

There are four (4) local watersheds located within the Anguilla Brook subregional watershed (Fig. 2-1), including the Anguilla Brook local watershed, the Wheeler Brook watershed and the watershed of an unnamed tributary to Wheeler Brook. The fourth local watershed, the Donahue Brook watershed, discharges directly to Wequetequock Cove.

2.1.2 Topography/Elevation

The topography of the Anguilla Brook watershed is defined by north-south-oriented rolling hills formed during the Acadian orogeny (mountain-building episode), when the oceanic plate containing the Avalonia island arc collided with the continental Laurentia plate 400 – 350 million years ago (Long Island Sound Resource Center, nd,). The Wisconsinan glaciation, which ended approximately 15,500 years ago, ground and smoothed the hilltops, creating the rolling topography characteristic of southern New England (Fig. 2-2). Glaciers deposited till (unsorted sediment eroded, transported and ultimately deposited by glacial ice) in upland areas and sand and gravel outwash deposits in low lying areas and river valleys, leaving terminal moraines and outwash plains along the coastline. These landforms and deposits have been further modified by Holocene (post-glacial) fluvial processes. Jeremy Hill in the northwest part of the watershed is, at 330 ft above mean sea level (AMSL), the highest elevation in the watershed. Elevation relief along Anguilla Brook is approximately 150 feet along the 5.9 miles of stream, from approximately 160 feet AMSL at its headwaters in North Stonington to about 10 feet AMSL at the head of Wequetequock Cove.

2.1.3 Geology and Soils

Bedrock in the Anguilla Brook watershed is comprised of granite and fractured crystalline metamorphic rock, including gneisses and granitic gneisses of the Avalonian Terrane. The Avalonian Terrane is a volcanic island arc which attached to the Laurentian plate during the Devonian period, approximately 400 -350 million years ago (mya). This collision event resulted in the formation of the Acadian Mountains (Long Island Sound Resource Center, 2011). Bedrock geology of the Avalonian Terrane in the Anguilla Brook watershed is dominated by the Potter Hill Granite Gneiss Formation, a light-pink to gray, tan-weathering, fine- to medium-grained, well-foliated granitic gneiss; the Rope Ferry Gneiss, an interlayered light to dark, fine- to medium-grained gneiss; and the Mamacoke Formation, an interlayered light to dark-gray, medium-grained gneiss. These formations date from the Proterozoic Z period, 570 - 800 mya. Lesser bedrock formations include the Narragansett Pier Granite Formation, a pink to red, medium- to coarse-grained, massive granite and the Westerly Granite Formation, a light-gray, pink-weathering, fine-grained, massive granite, which date from the Permian period, 240 - 290 mya, and the Hope Valley Alaskite Gneiss Formation, light-pink to gray, medium- to coarse-grained granitic gneiss from the Proterozoic Z period (CT DEP, 1985).

Soils in the Anguilla Brook watershed are comprised of glacial lodgment and melt-out tills in upper elevations, with glaciofluvial and alluvial floodplain soils and muck soils in the lower elevations. These soils were deposited during and after the last glacial period in Connecticut, which ended approximately 15,500 years ago. Predominant soil types include Charlton-Chatfield Complex soils (15%), Canton and Charlton soils (13%), and Woodbridge fine sandy loam (10%) in upland areas, and Ridgebury, Leicester, and Whitman soils (9%), and Paxton and Montauk fine sandy loams (9%) in valleys (Table 2-1 and Fig.2-3). Charlton-Chatfield Complex soils are “gently sloping to very steep, well drained and somewhat excessively drained, loamy soils located on glacial till uplands” (USDA-NRCS, 2003). Canton and Charlton soils are “gently sloping, very deep, well-drained coarse, loamy melt-out till derived from granite and/or schist and/or gneiss located on hills on uplands” (USDA-NRCS, 2003). Woodbridge fine sandy loams are “very deep, moderately well drained, gently sloping soil on tops of hills, on side slopes, and on toe slopes within uplands” (USDA-NRCS, 2003). Ridgebury, Leicester and Whitman soils are “poorly drained and very poorly drained soils in depressions and drainage-ways on uplands and in valleys” (USDA-NRCS, 2003). Paxton and Montauk fine sandy loams are gently to steeply sloping, deep, well-drained lodgment tills derived from granite and/or schist and/or gneiss, located on upland hills, till plains and drumlins (USDA-NRCS, 2003).

The Connecticut Inland Wetlands and Watercourses Act (sections 22a-36 through 22a-45 of the General Statutes of Connecticut) defines wetland soils as soils that are poorly drained, very poorly drained, alluvial and floodplain (Table 2-2). Wetland soils comprise approximately 23% of soils in the Anguilla Brook watershed (Table 2-3 and Fig. 2-4).

The US Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) and Farm Service Agency (FSA) have identified prime, statewide and locally important farmland soils in Connecticut (Fig. 2-5). These are soils that have physical and chemical characteristics that render them suitable for the production of crops (Table 2-4). There are approximately 4,827 acres of farmland soils in the Anguilla Brook watershed, which comprise 61% of the soils in the watershed. Of those, 506 acres

(6%) are Statewide Important Farmland Soils, 1,701 acres (22%) are Prime Farmland Soils, and 2,620 acres (33%) are locally important farmland soils (Table 2-5).

Over the last few years, the Connecticut and Rhode Island offices of the USDA Natural Resources Conservation Service have partnered to map subaqueous soils along the coastlines of Connecticut and Rhode Island. The NRCS (2017) defines subaqueous soils as "soils [that] occur in shallow freshwater and marine environments, such as ponds, lakes, and the subtidal areas of estuaries and tidal embayments."

Subaqueous soils in inner Wequetequock Cove are comprised of Wequetequock mucky silt loam, 0- to 2-meter water depth. This soil type has high suitability for eelgrass and hard clam habitat restoration and moderate suitability for oyster restoration (NRCS Web Soil Survey, 2020).

Table 2-1. Soils in the Anguilla Brook watershed (SSURGO, 2009).

Symbol	***Soil Description***	***Acres***	***% Watershed***
2	Ridgebury fine sandy loam	7.6	0.1
3	Ridgebury, Leicester, and Whitman soils, extremely stony	719.0	9.1
12	Raypol silt loam	185.2	2.3
13	Walpole sandy loam	49.4	0.6
15	Scarboro muck	140.4	1.8
17	Timakwa and Natchaug soils	328.2	4.2
18	Catden and Freetown soils	241.2	3.1
21A	Ninigret and Tisbury soils, 0 to 5 percent slopes	313.9	4.0
23A	Sudbury sandy loam, 0 to 5 percent slopes	5.6	0.1
29A	Agawam fine sandy loam, 0 to 3 percent slopes	27.2	0.3
29B	Agawam fine sandy loam, 3 to 8 percent slopes	102.5	1.3
32A	Haven and Enfield soils, 0 to 3 percent slopes	171.7	2.2
32B	Haven and Enfield soils, 3 to 8 percent slopes	222.5	2.8
34B	Merrimac sandy loam, 3 to 8 percent slopes	1.4	0.0
38A	Hinckley gravelly sandy loam, 0 to 3 percent slopes	14.5	0.2
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	121.8	1.5
38E	Hinckley gravelly sandy loam, 15 to 45 percent slopes	76.6	1.0
43A	Rainbow silt loam, 0 to 3 percent slopes	18.8	0.2
43B	Rainbow silt loam, 3 to 8 percent slopes	8.6	0.1
44B	Rainbow silt loam, 2 to 8 percent slopes, very stony	89.7	1.1
45A	Woodbridge fine sandy loam, 0 to 3 percent slopes	104.1	1.3
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	241.9	3.1
45C	Woodbridge fine sandy loam, 8 to 15 percent slopes	24.9	0.3
46B	Woodbridge fine sandy loam, 2 to 8 percent slopes, very stony	230.4	2.9
46C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	40.9	0.5
47C	Woodbridge fine sandy loam, 2 to 15 percent slopes, extremely stony	171.0	2.2
50B	Sutton fine sandy loam, 3 to 8 percent slopes	41.5	0.5
51B	Sutton fine sandy loam, 2 to 8 percent slopes, very stony	120.0	1.5
52C	Sutton fine sandy loam, 2 to 15 percent slopes, extremely stony	40.4	0.5
60B	Canton and Charlton soils, 3 to 8 percent slopes	156.1	2.0

Table 2-1. Soils in the Anguilla Brook watershed (SSURGO, 2009; cont.).

Symbol	Soil Description	Acres	% Watershed
60C	Canton and Charlton soils, 8 to 15 percent slopes	14.3	0.2
60D	Canton and Charlton soils, 15 to 25 percent slopes	8.9	0.1
61B	Canton and Charlton soils, 3 to 8 percent slopes, very stony	525.9	6.7
61C	Canton and Charlton soils, 8 to 15 percent slopes, very stony	100.6	1.3
62C	Canton and Charlton soils, 3 to 15 percent slopes, extremely stony	208.3	2.6
62D	Canton and Charlton soils, 15 to 35 percent slopes, extremely stony	78.7	1.0
68C	Narragansett silt loam, 3 to 15 percent slopes, extremely stony	8.2	0.1
73C	Charlton-Chatfield complex, 3 to 15 percent slopes, very rocky	938.4	11.9
73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky	251.4	3.2
74C	Narragansett-Hollis complex, 3 to 15 percent slopes, very rocky	280.5	3.6
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	134.5	1.7
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	97.5	1.2
76E	Rock outcrop-Hollis complex, 3 to 45 percent slopes	3.0	0.0
82B	Broad Brook silt loam, 3 to 8 percent slopes	7.6	0.1
84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes	277.4	3.5
84C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes	30.3	0.4
85B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony	287.6	3.6
85C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes, very stony	114.5	1.5
86D	Paxton and Montauk fine sandy loams, 15 to 35 percent slopes, extremely stony	3.5	0.0
96	Ipswich mucky peat	55.9	0.7
99	Westbrook mucky peat, low salt	6.6	0.1
107	Limerick and Lim soils	57.8	0.7
302	Dumps	38.5	0.5
306	Udorthents-Urban land complex	264.9	3.4
307	Urban land	5.2	0.1
W	Water	74.5	0.9
	Total	**7,891.3**	**100.0**

Table 2-2. Connecticut Wetland Soils Definitions (CT DEEP, 2015).

Wetland soils are defined in the Connecticut Inland Wetlands and Watercourses Act (sections 22a-36 through 22a-45) by soil drainage class and landscape position:
Poorly drained soils occur where the water table is at or just below the ground surface, usually from late fall to early spring. The land where poorly drained soils occur is nearly level or gently sloping. **Very poorly drained** soils generally occur on level land or in depressions. In these areas, the water table lies at or above the surface during most of the growing season. **Alluvial and Floodplain** soils occur along watercourses occupying nearly all level areas subject to periodic flooding. These soils are formed when material is deposited by flowing water. Such material can be composed of clay, silt, sand or gravel. Alluvial and floodplain soils range from excessively drained to very poorly drained.

Table 2-3. Wetland Soils in the Anguilla Brook watershed (SSURGO, 2009).

Symbol	Soil Type	Soil Class	Acres	% Watershed
2	Ridgebury fine sandy loam	Poorly Drained and Very Poorly Drained Soils	7.6	0.1
3	Ridgebury, Leicester, and Whitman soils, extremely stony	Poorly Drained and Very Poorly Drained Soils	719.0	9.1
11	Raypol silt loam	Poorly Drained and Very Poorly Drained Soils	185.2	2.3
13	Walpole sandy loam	Poorly Drained and Very Poorly Drained Soils	49.4	0.6
15	Scarboro muck	Poorly Drained and Very Poorly Drained Soils	140.4	1.8
17	Timakwa and Natchaug soils	Poorly Drained and Very Poorly Drained Soils	328.2	4.2
18	Catden and Freetown soils	Poorly Drained and Very Poorly Drained Soils	241.2	3.1
96	Ipswich mucky peat	Poorly Drained and Very Poorly Drained Soils	0.01	0
97	Pawcatuck mucky peat	Poorly Drained and Very Poorly Drained Soils	55.9	0.7
99	Westbrook mucky peat, low salt	Poorly Drained and Very Poorly Drained Soils	6.6	0.1
107	Limerick and Lim soils	Alluvial and Floodplain Soils	57.8	0.7
		Total	**1,791.4**	**22.7%**

Table 2-4. USDA Farmland Soil Classes Descriptions (CT ECO, 2015).

Prime Farmland Soils:
Soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops, and are also available for these uses (the land could be cropland, pastureland, range-land, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season and moisture supply needed to economically produce sustained high yields or crops when treated and managed, including water management, according to acceptable farming practices.
Statewide Important Farmland Soils:
Soils that fail to meet one or more of the requirements of prime farmland, but are important for the production of food, feed, fiber, or forage crops. They include those soils that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods.
Locally Important Farmland Soils:
Soils that are not prime or statewide importance but are used for the production of high value food, fiber or horticultural crops. This land may be important to the local economy due to its productivity or value.

Table 2-5. Farmland Soils in the Anguilla Brook Watershed (USDS-NRCS, 2014 and 2018).

Symbol	Soil Name	Farmland Soil Class	Area_Ac	% WS
2	Ridgebury fine sandy loam, 0 to 3 percent slopes	Statewide Important Farmland Soils	8	0.2
12	Raypol silt loam	Statewide Important Farmland Soils	185	3.8
13	Walpole sandy loam, 0 to 3 percent slopes	Statewide Important Farmland Soils	49	1.0
21A	Ninigret and Tisbury soils, 0 to 5 percent slopes	Prime Farmland Soils	314	6.5
23A	Sudbury sandy loam, 0 to 5 percent slopes	Prime Farmland Soils	6	0.1
29A	Agawam fine sandy loam, 0 to 3 percent slopes	Prime Farmland Soils	27	0.6
29B	Agawam fine sandy loam, 3 to 8 percent slopes	Prime Farmland Soils	103	2.1
32A	Haven and Enfield soils, 0 to 3 percent slopes	Prime Farmland Soils	172	3.6
32B	Haven and Enfield soils, 3 to 8 percent slopes	Prime Farmland Soils	223	4.6
34B	Merrimac fine sandy loam, 3 to 8 percent slopes	Prime Farmland Soils	1	0.0
38A	Hinckley loamy sand, 0 to 3 percent slopes	Statewide Important Farmland Soils	14	0.3
38C	Hinckley loamy sand, 3 to 15 percent slopes	Statewide Important Farmland Soils	122	2.5
43A	Rainbow silt loam, 0 to 3 percent slopes	Prime Farmland Soils	19	0.4
43B	Rainbow silt loam, 3 to 8 percent slopes	Prime Farmland Soils	9	0.2
44B	Rainbow silt loam, 2 to 8 percent slopes, very stony	Local Important Farmland Soils	90	1.9
45A	Woodbridge fine sandy loam, 0 to 3 percent slopes	Prime Farmland Soils	104	2.2
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	Prime Farmland Soils	242	5.0
45C	Woodbridge fine sandy loam, 8 to 15 percent slopes	Statewide Important Farmland Soils	25	0.5
46B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	Local Important Farmland Soils	230	4.8
46C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	Local Important Farmland Soils	41	0.8
50B	Sutton fine sandy loam, 3 to 8 percent slopes	Prime Farmland Soils	41	0.9
51B	Sutton fine sandy loam, 0 to 8 percent slopes, very stony	Local Important Farmland Soils	120	2.5
60B	Canton and Charlton fine sandy loams, 3 to 8 percent slopes	Prime Farmland Soils	156	3.2
60C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes	Statewide Important Farmland Soils	14	0.3
61B	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony	Local Important Farmland Soils	526	10.9
61C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes, very stony	Local Important Farmland Soils	101	2.1
73C	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	Local Important Farmland Soils	938	19.4
74C	Narragansett-Hollis complex, 3 to 15 percent slopes, very rocky	Local Important Farmland Soils	280	5.8
82B	Broad Brook silt loam, 3 to 8 percent slopes	Prime Farmland Soils	8	0.2
84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes	Prime Farmland Soils	277	5.7
84C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes	Statewide Important Farmland Soils	30	0.6
85B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony	Local Important Farmland Soils	288	6.0
85C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes, very stony	Local Important Farmland Soils	6	0.1
107	Limerick and Lim soils	Statewide Important Farmland Soils	58	1.2
		Total	**4,827**	**100.0**

2.1.4 Climate/Precipitation

Southeastern Connecticut has a fully humid, mild temperate climate (Cfa in the Köppen climate classification), characterized by cold winters and hot summers (Chen and Chen, 2013). Temperature ranges from 20º F to 90º F are typical, and short duration temperature extremes ranging from 0º F to 100º F are not uncommon. Southeastern Connecticut receives approximately 44 inches of precipitation each year. Precipitation is distributed relatively evenly throughout the year and falls as either rain or snow.

Changes in weather patterns due to global climate change have been noted in Connecticut. Temperatures in Connecticut have increased about 3°F since the beginning of the 20th century. Sea level has risen at the rate of 10–11 inches per century along the Connecticut coast, resulting in tidal flooding and nuisance flooding from even moderate rainfalls (Runkle et al, 2017). These changes include warmer winter temperatures which have led to an increase in rainfall versus snowfall, resulting in more surface runoff due to frozen ground conditions, and less spring snowmelt; decreased precipitation during the hotter summer months, resulting in lower groundwater levels and decreased stream and river baseflow; and an increase in rainstorm intensity, resulting in greater potential for storm runoff and flash flooding. Increased rainfall, coupled with rising sea levels, has also resulted in an increase in coastal flooding and storm surges (USEPA, 2016).

2.1.5 Vegetation

The majority of the Anguilla Brook watershed is located in the Long Island Sound Coastal Lowland Level IV ecoregion (USDA Forest Service, 1976). This ecoregion is characterized by “low-elevation rolling coastal plain, tidal marshes, estuaries, sandy dunes and beaches, and rocky headlands... The coastal hardwood forests contain black, red, and white oaks, hickories, and black cherry. Dense thickets of vines and shrubs such as catbrier, greenbrier, and poison ivy are common. Some Southeastern flora and fauna species of the Piedmont and coastal plain reach their northern limit in this ecoregion, including holly, post oak, sweetgum, and persimmon. On coastal headlands, pitch pine and post oak occur, while some scarlet oak and sassafras stand on stabilized dunes” (Griffith et al, 2009).

A small portion of the northern-most extent of the watershed is located in the Southern New England Coastal Plains and Hills (USDA Forest Service, 1976), which is comprised of “irregular plains with low hills and some open high hills with relief of about 100 to 400 feet. Surface materials are mostly glacial till, with some stratified deposits in valleys. A variety of dry to mesic successional oak and oak-pine forests cover the region today, along with some elm, ash, and red maple that are typical of southern New England’s forested wetlands” (Griffith et al, 2009).

The *Long Island Sound Habitat Restoration Initiative,* Section 8: Coastal Forests (Barrett, 2018), identifies coastal forests as an important habitat type. According to Barrett, “coastal forests provide numerous ecosystem services including carbon sequestration, wildlife habitat (for both native species and migrant species), watershed protection, nutrient cycling, coastal protection and erosion control, air and water pollution reduction, microclimate control, and riparian buffer protection.”

2.1.6 Exotic/Invasive Species

Non-native plant and animal species can be detrimental to native plants and wildlife. Invasive species are non-native species that exhibit qualities that allow them to out-compete native species, resulting in the reduction of available habitat and food resources, displacement of native species, and alteration of the food web. Costs associated with the environmental and economic impacts and management of invasive species can be in the billions of dollars annually (US Fish & Wildlife Service, 2012).

Common non-native or invasive plant species, including oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), Chinese privet (*Ligustrum sinense*), winged euonymus - also known as Burning bush (*Euonymus alatus*), autumn olive (*Elaeagnus umbellata*), Japanese knotweed (*Fallopia japonica*) and common reed (*Phragmites australis*) were noted in disturbed areas, along roadsides and along stream corridors in the Anguilla Brook watershed and along the shore of Wequetequock Cove.

No other non-native or invasive plant or animal species were noted during the water quality investigation; however, that does not preclude their presence or absence.

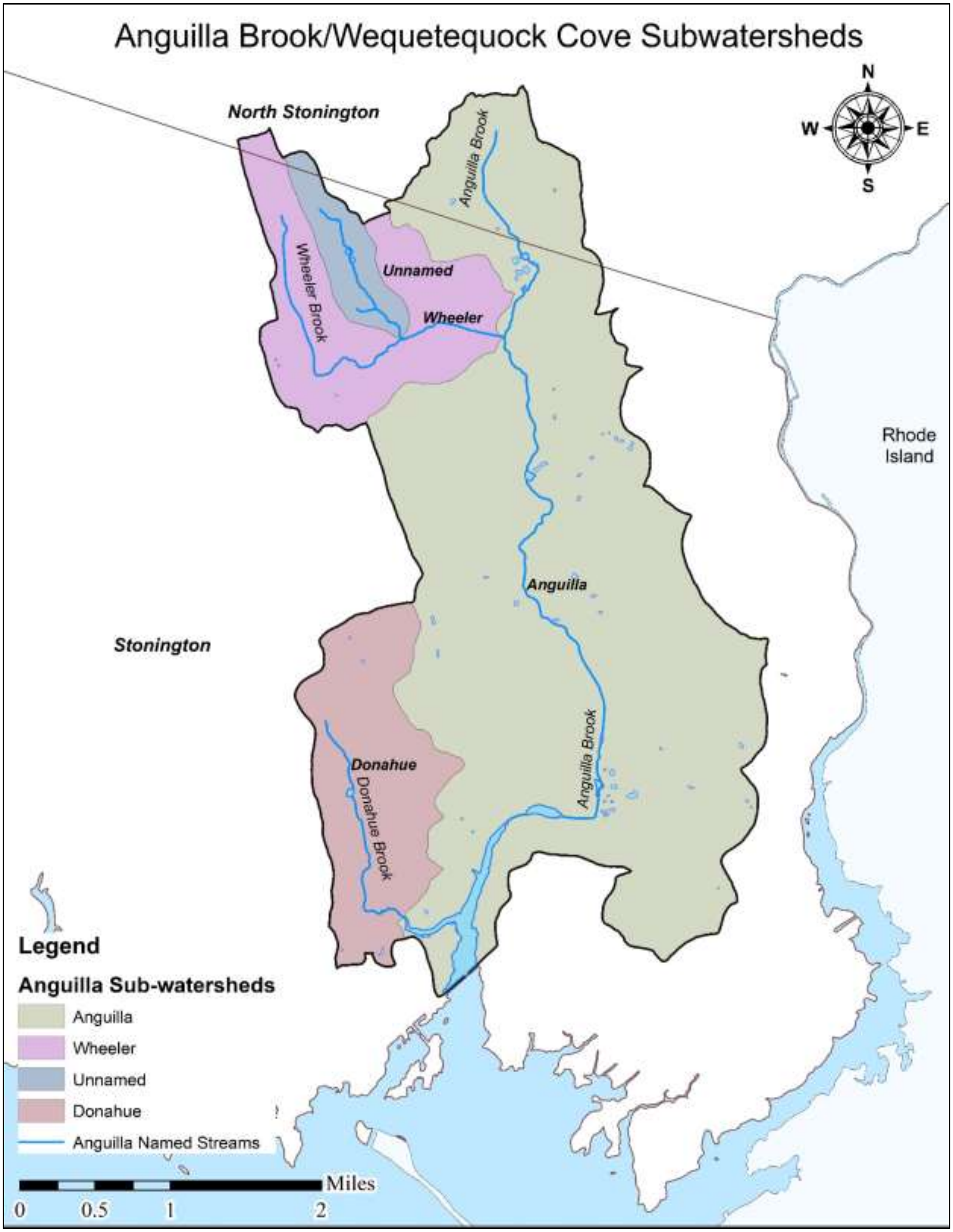


Figure 2-1. The Anguilla Brook/Inner Wequetequock Cove watershed and sub-watersheds.

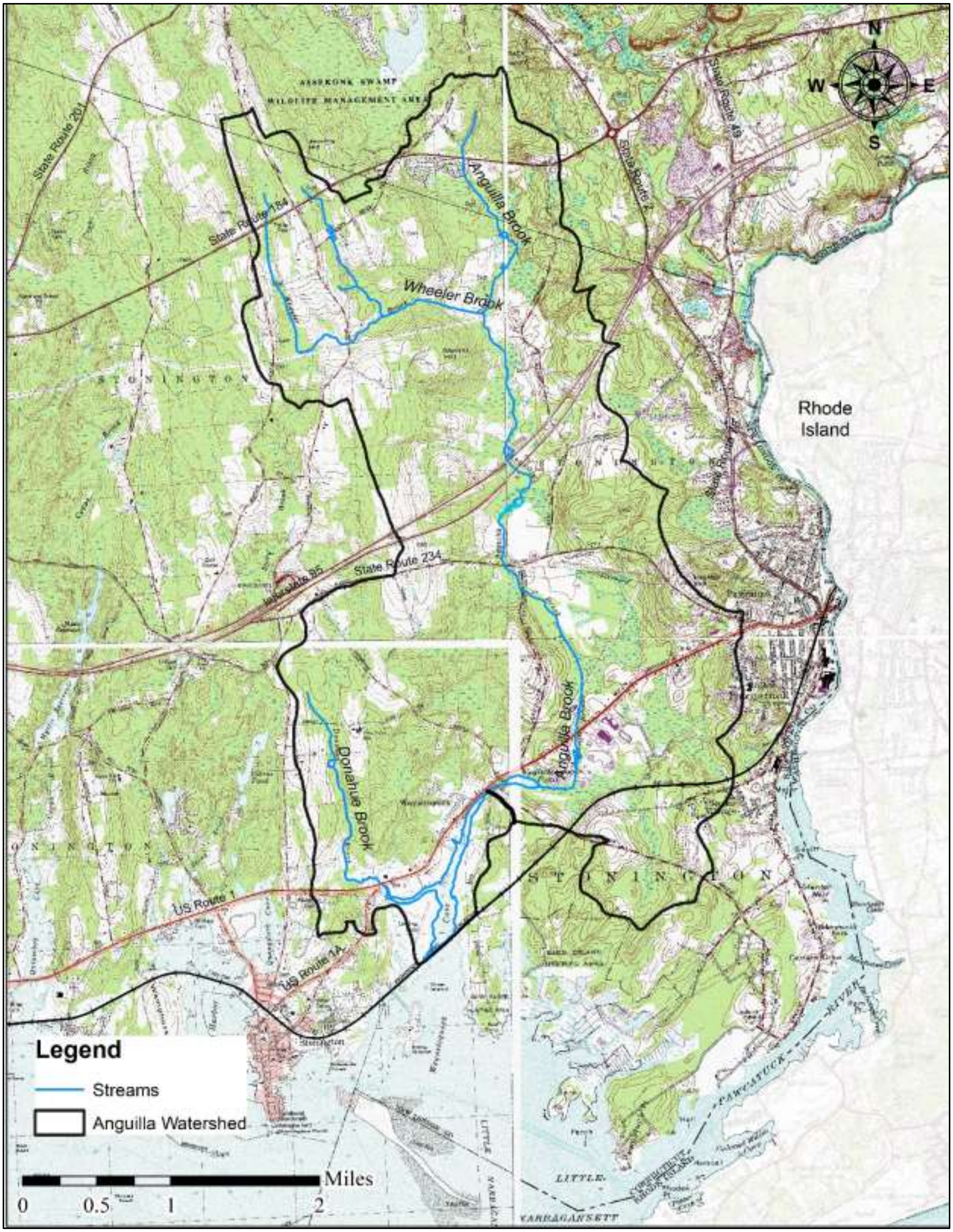


Figure 2-2. The topography of the Anguilla Brook/Inner Wequetequock Cove watershed.

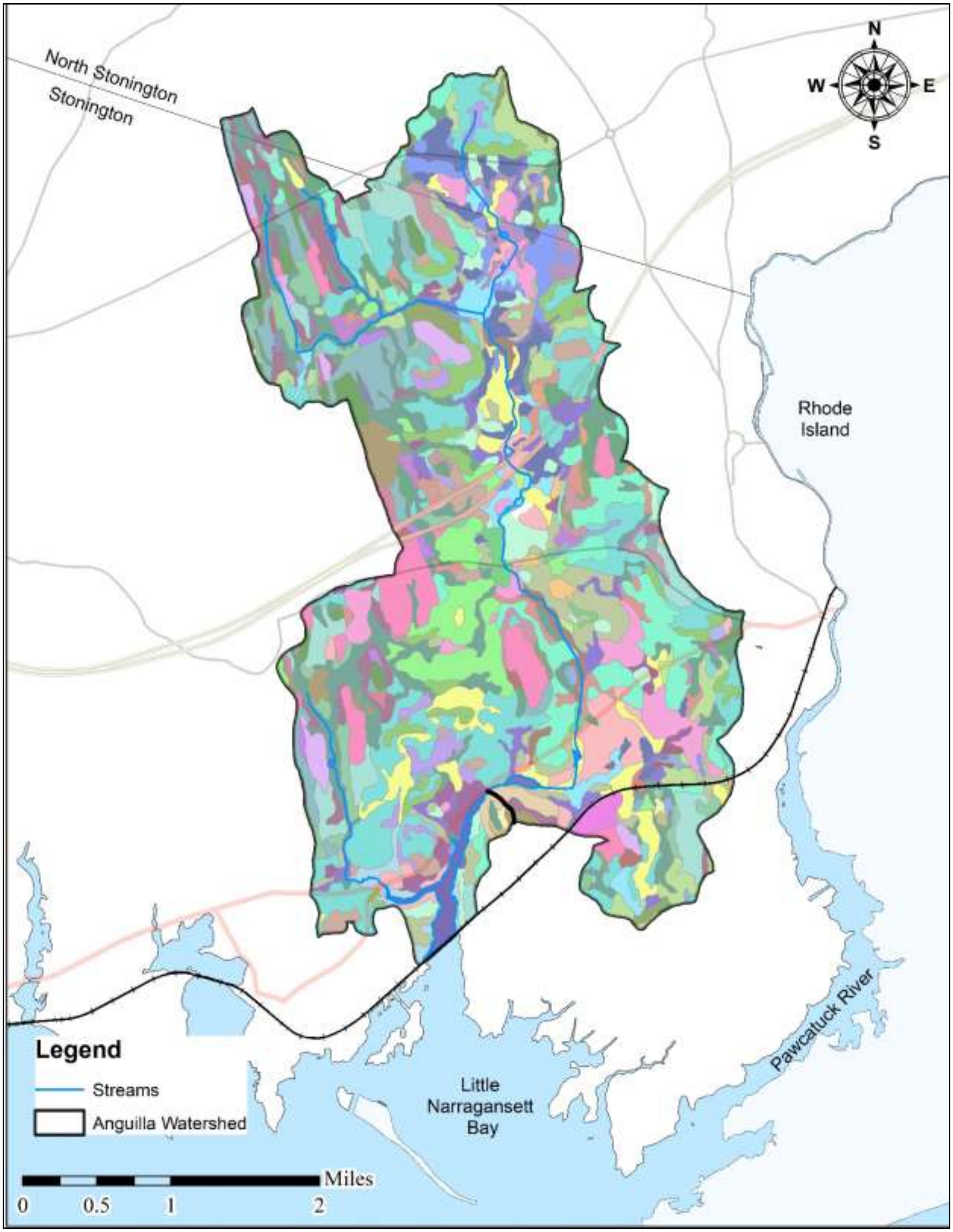


Figure 2-3. Soils in the Anguilla Brook/Inner Wequetequock Cove watershed.

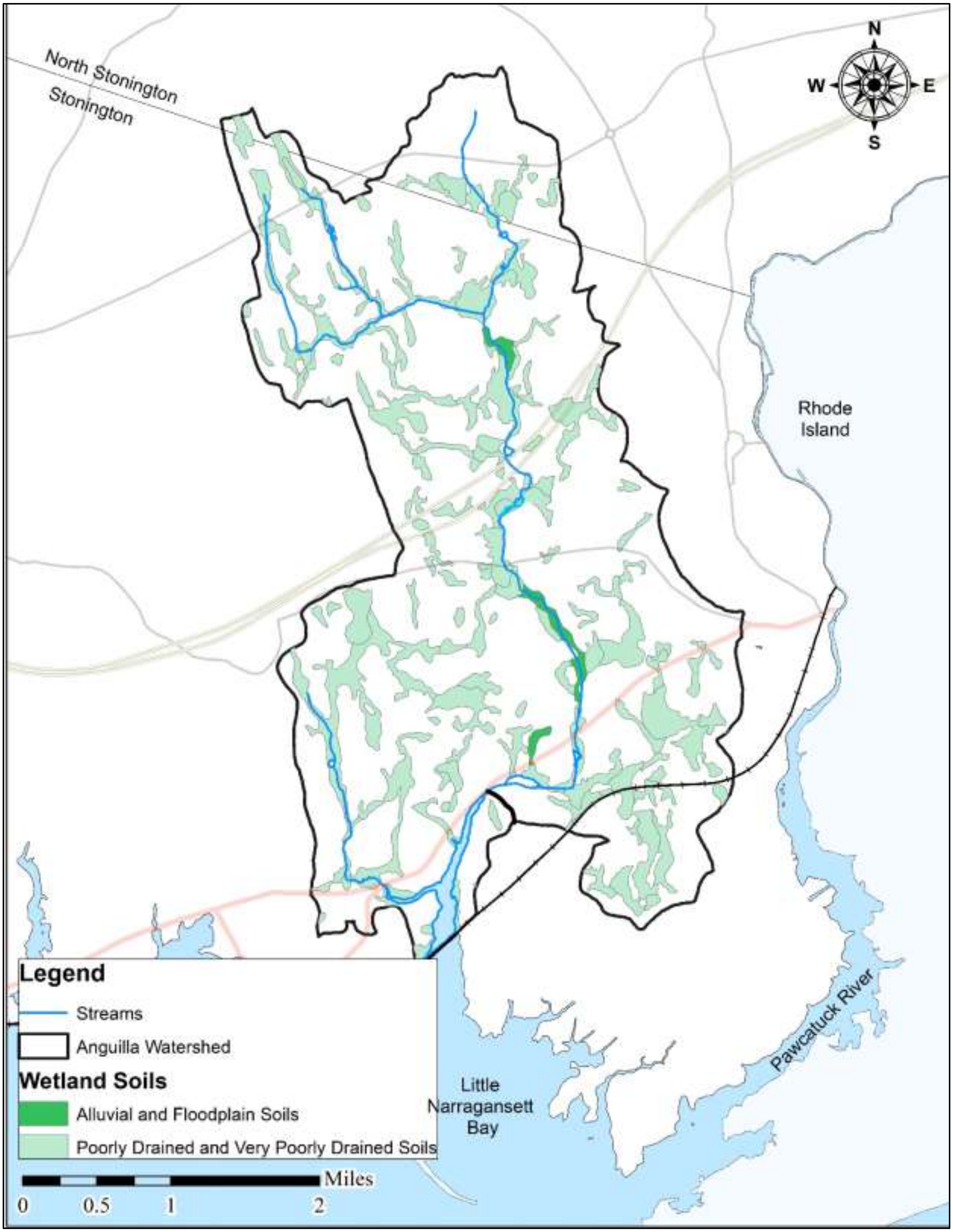


Figure 2-4. Wetland soils in the Anguilla Brook/Inner Wequetequock Cove watershed.

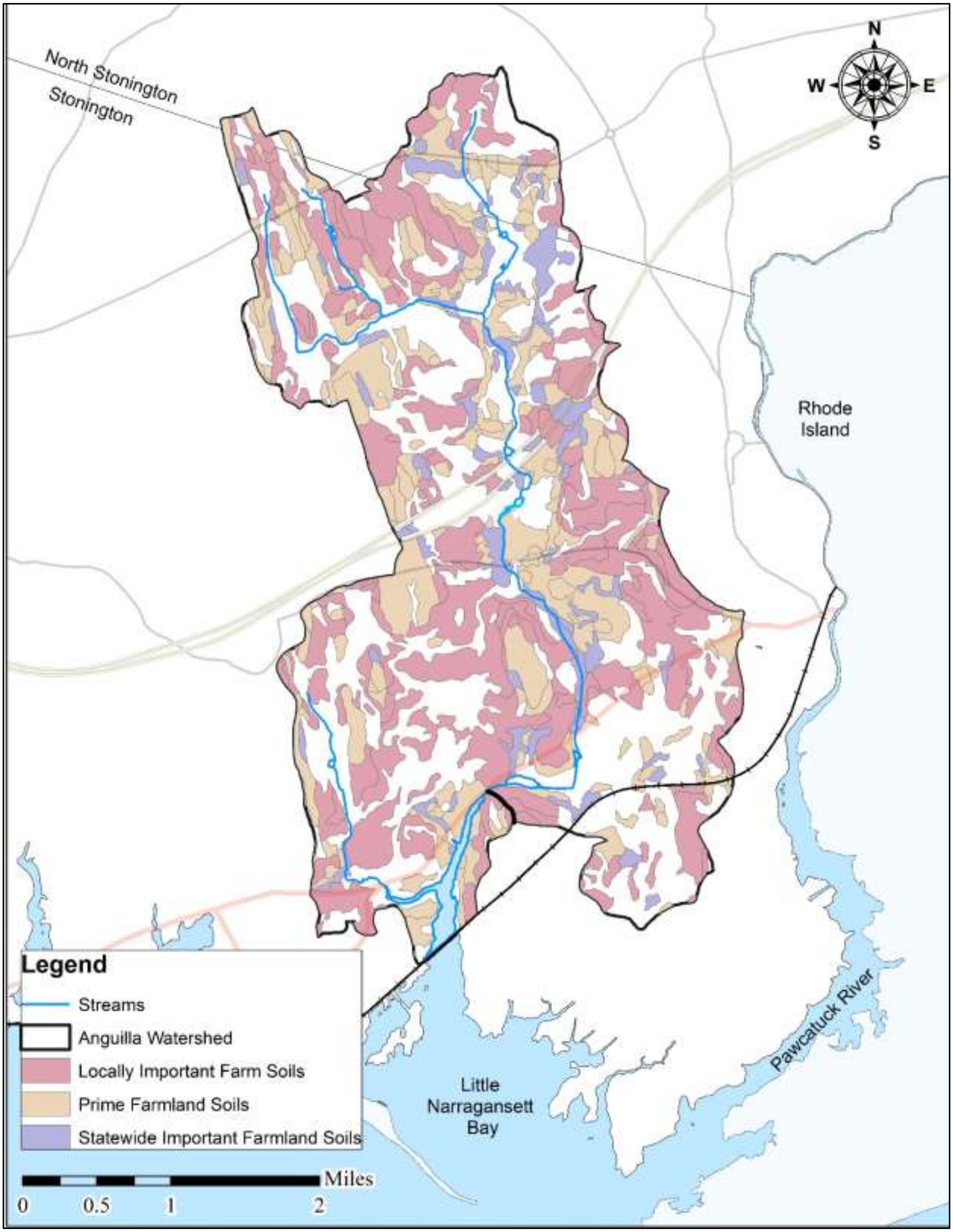


Figure 2-5. Farmland soils in the Anguilla Brook/Inner Wequetequock Cove watershed.

2.2 Water Resources

2.2.1 Hydrology

There are approximately 12 miles of perennial streams in the Anguilla Brook watershed (Fig. 2-6), including Anguilla Brook, which is 5.9 miles from its headwaters in North Stonington to its outlet at Wequetequock Cove. Other perennial streams in the watershed include Donahue Brook (1.8 miles), a tributary to Wequetequock Cove, Wheeler Brook (2.6 miles), a tributary to Anguilla Brook, and an unnamed tributary to Wheeler Brook (1.5 miles).

Although there are a few small impoundments along the perennial streams in the Anguilla Brook watershed, the only pond of note is Chesebrough Pond (also known as Wequetequock Pond), a 7.1-acre impoundment of Anguilla Brook, located upstream of Wequetequock Cove. The Chesebrough Pond dam is formed around large glacially-deposited boulders and is the site of what may be one of the earliest grist mills in CT (Wheeler, 1900).

2.2.2 Dams

Dams are impoundments of free-flowing waters. In colonial New England, many small streams were dammed to provide hydro-power for small gristmills and sawmills to grind grain for flour and provide lumber for construction. In the mid-1800s, at the advent of the industrial era, larger dams were erected to provide hydro-power for thread and cloth mills. Dams were also erected to create ponds for watering livestock and for fire suppression.

According to the Regulations of Connecticut State Agencies Sec. 22a-409-2, dam safety inspection and classification (revised 3-11-16), dams in Connecticut are assigned to one of five classes according to the potential downstream impacts related to dam failure. Factors to evaluate dams and assign a hazard potential include dam height, capacity (maximum volume) of the impoundment, the potential area impacted by a dam failure, and the potential damage to property, infrastructure and human life. The dam classes and hazards associated with each are described in Table 2-6. In 2016, the State of Connecticut adopted regulations (Public Act 13-197) that require dam owners to periodically inspect their dams and prepare and submit an Emergency Action Plan every two years if they own a high or significant hazard dam.

Connecticut DEEP identifies two dams in the Anguilla Brook watershed, both on Anguilla Brook (DEEP, 1996). The first is located at Miner Pond (located north of Miner Pentway) and the second is at Chesebrough Pond (Fig. 2-6). Neither dam is included in CT DEEP's Listing of High, Significant, and Moderate Hazard Dam Owners and Dams in Connecticut (updated on January 21, 2016); however, the DEEP Connecticut Dams GIS data layer assigns a dam classification of A (low hazard) for the Chesebrough Pond dam. The Miner Pond dam is not assigned a dam classification.

A third dam located on Anguilla Brook north of State Route 1, upstream of the "Birdland" neighborhood, was removed in 2012.

Table 2-6 Dam Hazard Classifications (CT DEEP, 2016).

Dam Class	Hazard Potential	Damage potential if dam were to fail
AA	Negligible hazard	(i) no measurable damage to roadways; (ii) no measurable damage to land and structures; and (iii) negligible economic loss.
A	Low hazard	(i) damage to agricultural land; (ii) damage to unpaved local roadways; or (iii) minimal economic loss.
BB	Moderate hazard	(i) damage to normally unoccupied storage structures; (ii) damage to paved local roadways: or (iii) moderate economic loss.
B	Significant hazard	(i) possible loss of life; (ii) minor damage to habitable structures, residences, including, but not limited to, industrial or commercial buildings, hospitals, convalescent homes, or schools; (iii) damage to local utility facilities including water supply, sewage treatment plants, fuel storage facilities, power plants, cable or telephone infrastructure, causing localized interruption of these services; (iv) damage to collector roadways and railroads; or (v) significant economic loss.
C	High hazard	(i) probable loss of life; (ii) major damage to habitable structures, residences, including, but not limited to, industrial or commercial buildings, hospitals, convalescent homes, or schools; (iii) damage to major utility facilities, including public water supply, sewage treatment plants, fuel storage facilities, power plants, or electrical substations causing widespread interruption of these services; (iv) damage to arterial roadways; or (v) Great economic loss.

2.2.3 Wetlands and Flood Plains

2.2.3.1 *Inland Wetlands*

Wetlands are low-lying areas in the landscape where water is at or near the ground surface. Wetlands are characterized by the presence of hydric soils, which are soils that have been saturated for extended periods of time and which have developed physio-chemical characteristics in the upper soil layers related to anaerobic conditions (NRCS, 2015). Wetlands support specific plant and animal communities, including hydrophytes, plants that are adapted to the prolonged presence of water.

Wetlands provide important ecosystem services including water quality benefits and flood management. Wetlands renovate surface waters impacted by stormwater runoff by filtering sediment, nutrients and other water-borne pollutants. As water is transported through the wetland system, physio-chemical and biological processes entrain, transform and neutralize pollutants. Wetlands have great capacity to capture and store rainwater, holding it and slowly infiltrating it into the ground, mitigating flooding, and replenishing groundwater supplies. The replenishment of groundwater is especially important in rural areas where many residents rely on wells for their drinking water.

The Center for Land-use Education and Research at the University of Connecticut identifies about 944 acres of inland wetland in the Anguilla Brook/Inner Wequetequock Cove watershed, including 117 acres of non-forested and 827 acres of forested wetlands (CLEAR, 2016).

2.2.3.2 *Tidal Wetlands*

Tidal wetlands are coastal wetlands that are subject to regular flooding by the tides. According to CT DEEP (2018), tidal wetlands "… are an indispensable part of the Long Island Sound ecosystem, serving such functions as waterfowl and wildlife habitat, pollution control, floodwater storage, and nurseries for fish and shellfish." In the Anguilla Brook/Inner Wequetequock Cove watershed, tidal wetlands are found along the shoreline of Wequetequock Cove and Oxocosset Brook. These tidal wetlands are typically salt marshes "… characterized by such plants as salt marsh cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*Spartina patens*) and spikegrass (*Distichlis spicata*)" (DEEP, 2018).

CLEAR identifies about 64 acres of tidal wetlands in the Donahue Brook watershed and along the shorelines of Inner Wequetequock Cove (see Section 2.5 - Land Use and Land Cover). These tidal wetlands include Paffard Marsh Preserve and Wequetequock Cove Preserve, both owned by the Avalonia Land Conservancy.

2.2.3.3 *Flood Plains*

Flood plains are low-lying areas adjacent to watercourses, ponds and coastal shorelines that are subject to flooding. Flood plains are important to the management of flood waters and especially to the mitigation of potential down-stream flood damage. Like wetlands, flood plains capture and hold flood waters, infiltrating them into the ground or releasing them slowly as flood waters recede. In coastal areas, flood plains, including coastal marshes, not only capture flood waters but also may mitigate the effects of wave action and storm surge. When coastal flood plains are developed, they lose their capacity to attenuate flood flows, and ameliorate wave action and storm surge, which increases the potential for flood damage to structures and critical infrastructure such as roads, bridges, and municipal sewer and drinking water systems.

The Federal Emergency Management Agency (FEMA) has designated Wequetequock Cove, the lower portion of Donahue Brook, and Anguilla Brook from Wequetequock Cove to the confluence with Wheeler Brook as Flood Zone AE. Flood Zone AE is the base floodplain where base flood elevations are provided. Flood Zone A is designated as having a 1% annual chance of flooding. The 1% annual chance flood is also referred to as a 100-year flood (FEMA, 2015). The remainder of Anguilla Brook to just north of the Stonington/North Stonington town line is designated Zone A, as are several short sections of Wheeler Brook (Fig. 2-7). Additionally, Anguilla Brook from Wequetequock Cove to the Wheeler Brook confluence is designated a floodway. According to FEMA, a Regulatory Floodway is "the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations" (FEMA, 2019).

Watershed managers are advised to review FEMA flood hazard data as it is periodically updated and becomes available to determine flood risk within the Anguilla Brook watershed. Managers should also review the 2017 Town of Stonington Coastal Resilience Plan, 2017 Southeastern Connecticut Council of Governments Multi-Jurisdiction Hazard Mitigation Plan Update (SCCOG, 2017) and 2017 Hazard Mitigation Plan Update Annex for the Town of Stonington (SCCOG 2017), as they relate to potential flood risks.

Additional coastal management tools available for watershed and flood plain managers include:

- The *Connecticut Sea Level Rise and Storm Surge Viewer* and the *Connecticut Coastal Towns Storm Surge Return Interval Viewer* available from the Connecticut Institute for Resilience & Climate Adaptation (CIRCA) at circa.uconn.edu
- CIRCA *Resilient Connecticut Planning Framework*, a planning tool designed to assist Connecticut towns with addressing the impacts of flooding, sea-level rise and climate change. Available at resilientconnecticut.uconn.edu/planning-tools/
- *Sea Level Affecting Marshes Model (SLAMM) to Connecticut's Shoreline,* which help identify the potential responses of coastal marshes and infrastructure to sea level rise
    - available for view at the CT ECO *Sea Level Rise Effects on Roads & Marshes* Viewer at cteco.uconn.edu/viewer/index.html?viewer=slamm
    - available as downloadable GIS data files from the CT DEEP data portal at portal.ct.gov/DEEP/GIS-and-Maps/Data/GIS-DATA
- The CT ECO map viewer at cteco.uconn.edu/ contains other coastal resource management data and coastal imagery.

FEMA Flood Zones:

"Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30. Moderate flood hazard areas, labeled Zone B or Zone X (shaded) are also shown on the FIRM, and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. The areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled Zone C or Zone X (unshaded)."

www.fema.gov/flood-zones

2.2.4 Surface and Groundwater Water Resources

The State of Connecticut is required through Section 303 of the 1972 Federal Water Pollution Control Act (better known as the Clean Water Act) to assess surface and groundwater within the state and assign water classifications based on designated uses. Water quality classifications serve to establish designated uses for surface and groundwaters and identify criteria necessary to support those uses. Designated uses may include public water supplies, support of fish and other aquatic wildlife, agricultural and industrial purposes, recreation and navigation.

The Connecticut Water Quality Standards (CT DEEP, 2013) establish standards for surface and groundwater in Connecticut. The general goal of the Water Quality Standards is to "…restore or maintain the chemical, physical and biological integrity of surface waters. Where attainable, the level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water shall be achieved" and to maintain or restore areas with groundwater classifications of GAA, GAAs and GA to their natural quality, such that the ground water is "…suitable for drinking and other domestic uses without treatment" (CT DEEP, 2013).

2.2.4.1 *Surface Waters*

All streams and surface waters in the Anguilla Brook watershed have surface water quality classifications of A (Fig. 2-8). Designated uses in Class A surface waters include habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture. Allowable discharges to Class A waters may include discharges from public or private drinking water treatment systems, dredging activity and dredge material dewatering operations, including the discharge of dredged or fill material and clean water discharges (CT DEEP, 2013).

2.2.4.2 *Groundwater*

Groundwater throughout most of the Anguilla Brook watershed is classified as GA (Fig. 2-8). Designated uses for Class GA groundwater include existing private and potential public or private supplies of water suitable for drinking without treatment, and base flow for hydraulically-connected surface water bodies. Allowable discharges for Class GA waters include "…discharge from a septage treatment system or of other wastes that are predominantly human, plant, or animal in origin so long as any such wastes are of natural origin, easily biodegradable and, if properly managed, pose no threat of pollution to the ground water. The ground water plume generated by a discharge from a septage treatment system shall terminate in a stream with classification of B or SB unless the permittee treats the discharge in a manner which the Commissioner determines is adequate to maintain class A water in the receiving stream" (CT DEEP, 2013).

In Stonington, approximately 71% of households rely on private wells for drinking water. The Northstone Gardens community on State Route 184 has its own small public water supply service, which is designated GAA-Well-Impaired due to the presence of *E. coli* (Connecticut Department of Public Health, 2019). The Cedar Ridge neighborhood located to the south of State Route 184 in North Stonington has a community public water supply which is designated GAA-Well. Designated uses for Class GAA groundwater includes existing or potential public supply of water suitable for drinking without treatment and baseflow for hydraulically-connected surface water bodies. Allowable discharges to Class GAA groundwater include "…treated domestic sewage as defined in section 22a-430-1 of the Regulations of Connecticut State Agencies, waste generated by certain agricultural practices, certain water treatment waste waters from public water supply treatment systems, or certain minor cooling waters or clean waters (CT DEEP, 2013)."

The southeastern portion of the Anguilla Brook watershed, including Pawcatuck, the Elmridge Road area, Clarks Village area, Green Haven Road and the US Route 1 corridor, is served by the Westerly (Rhode Island) Water Department (Fig. 2-8).

2.2.4.3 *Streamflow*

In 2011, Connecticut adopted stream flow standards and regulations (Sections 26-141b-1 to 26-141b-8 of the Regulations of Connecticut State Agencies). The purpose of these regulations is to protect Connecticut's rivers and stream systems by establishing standards for stream flows that are protective of stream aquatic life. The standards apply to all river and stream systems in the state through a classification process and require minimum releases from dams.

The stream flow standards balance human and ecological needs for water by establishing different flow standards for each of four classes of waters, as described in Table 2-7. The flow standards for each class are based on maintaining the natural variation in flow expected in Connecticut given seasonal climate and rainfall patterns and human use (CT DEEP, 2011).

Table 2-7. Connecticut Stream Flow Definitions (CT Stream Flow Standards and Regulations, rev. 2015).

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

Rivers and streams in the Southeast Coastal watershed, including the Anguilla Brook watershed, were classified in 2014. The majority of streams in the Anguilla Brook watershed are designated free-flowing (Fig. 2-9). One segment of Anguilla Brook located to the east of Swan Street is designated minimally altered, as is a tributary to Donahue Brook. An unnamed tributary that converges with Anguilla Brook north of South Broad Street is designated moderately altered.

2.2.5 Navigation Channels, Ports and Harbors

Inner Wequetequock Cove, the receiving waterbody of Anguilla Brook, is a 202.3-acre estuary of Little Narragansett Bay. The inner cove is defined by a railbed that crosses the lower end of the cove and separates it from the outer cove and bay. Ingress and egress to the Cove is controlled by the relatively low height of the culvert under the railbed, which limits the size of craft that can enter and exit the Cove, and also likely reduces tidal flushing, impacting water quality in the Cove.

There three commercial marinas located on the west side of the cove; Stonington Marina, Cove Ledge Inn and Marina, and Lockwood's Coveside Marina, as well as several other commercial businesses located along US Route 1. Saltwater Farm Vineyard is located on the west side of the cove, on the site of the former Foster Field community airport. Avalonia Land Conservancy owns the 16.8-acre Wequetequock Cove Preserve on the east side of Wequetequock Cove, which

The culvert under the Amtrak rail line at the entrance to inner Wequetequock Cove.

is managed as grassland habitat by CT DEEP. The Cove is within boating distance of numerous notable locales, including Barn Island Wildlife Management Area (CT DEEP), Napatree Point Conservation Area (Watch Hill Conservancy), Watch Hill, and Sandy Point (Avalonia Land Conservancy).

Marine activities in Wequetequock Cove are regulated by the Stonington Harbor Management Commission and are defined in the Stonington Harbor Management Plan (2012).

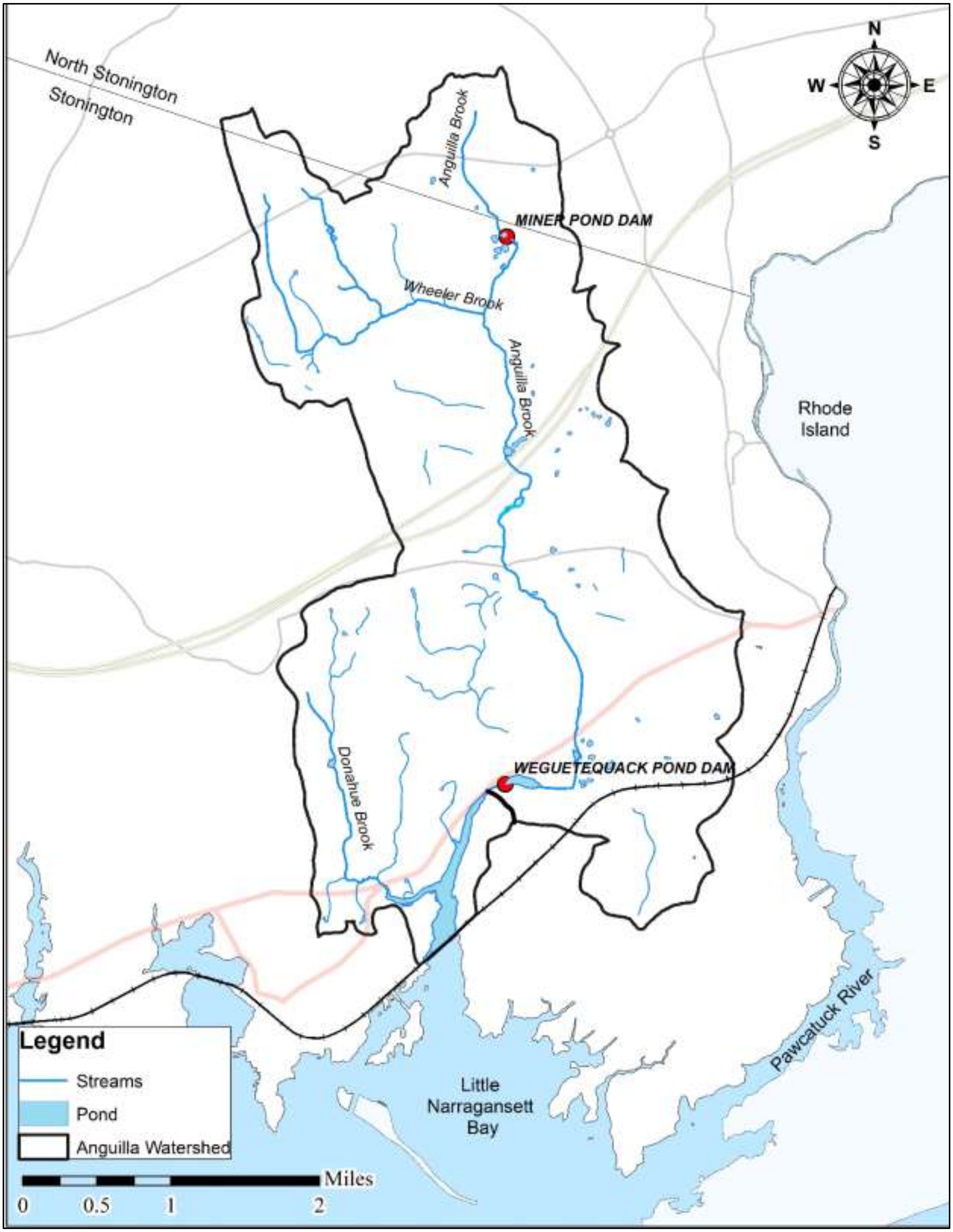


Figure 2-6. Water resources in the Anguilla Brook/Inner Wequetequock Cove watershed.

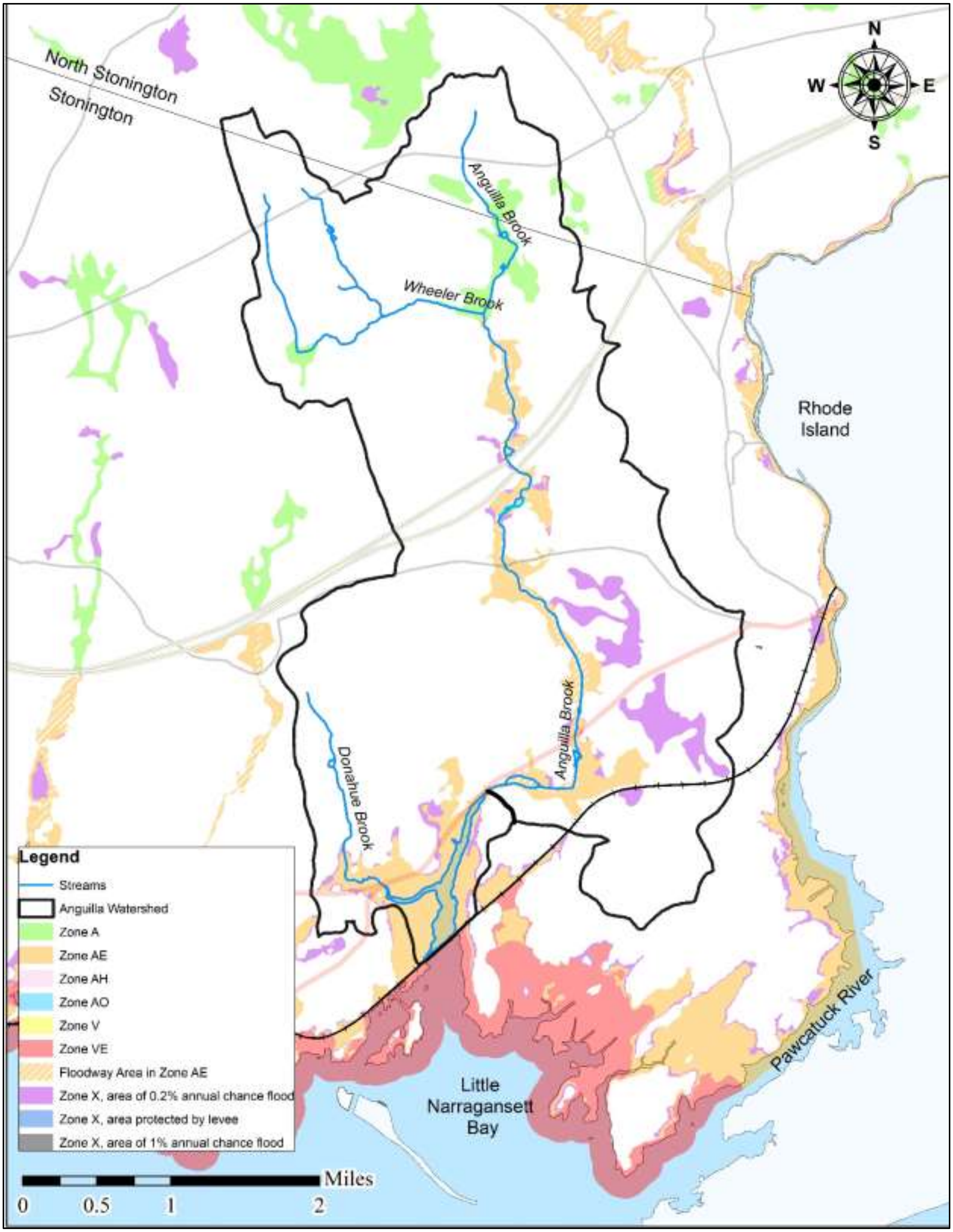


Figure 2-7. Federal Emergency Management Agency (FEMA) designated flood zones and floodways.

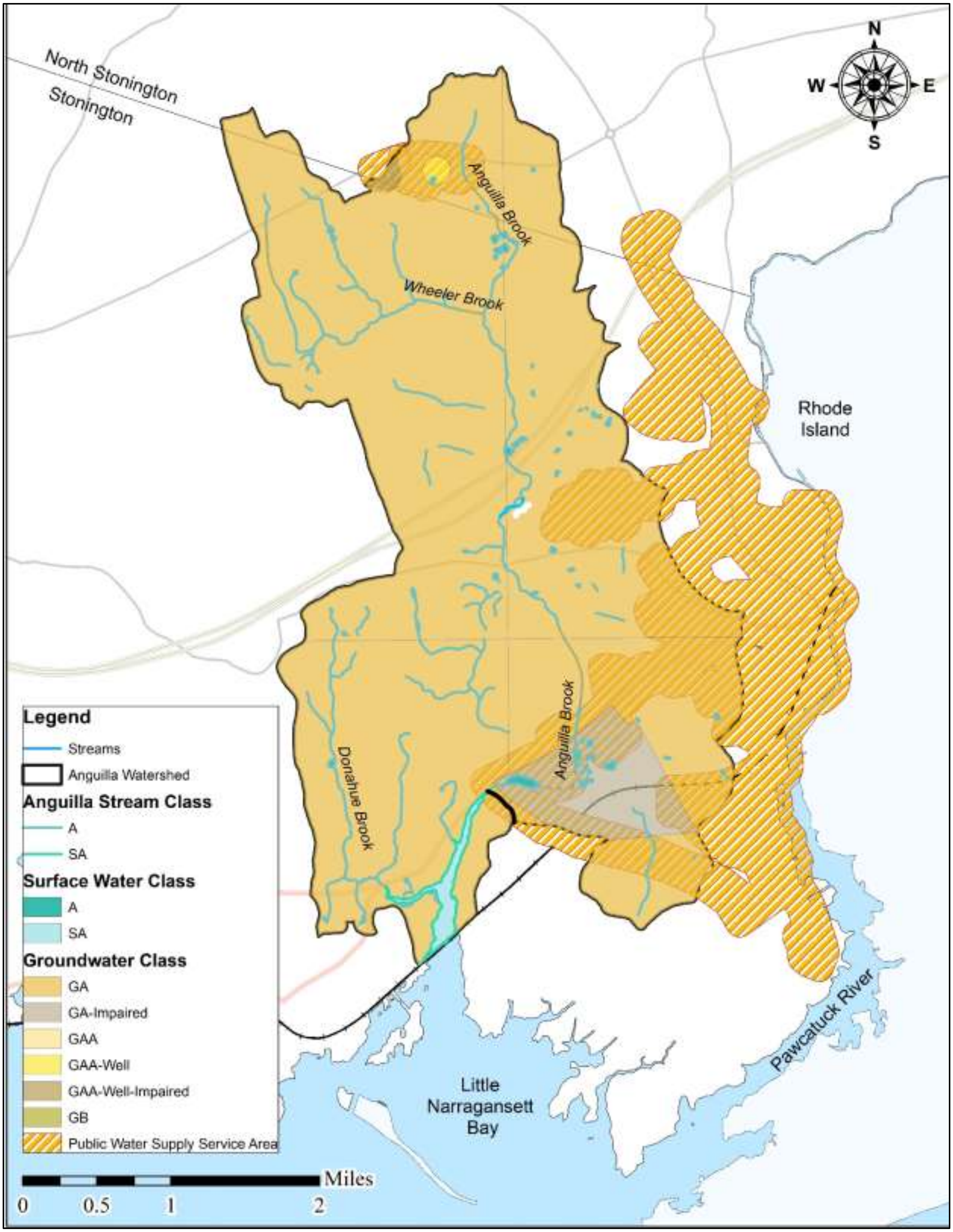


Figure 2-8. Surface and groundwater classifications in the Anguilla Brook/Inner Wequetequock Cove watershed. The Public Water Supply Service Area is designated by the hatched area.

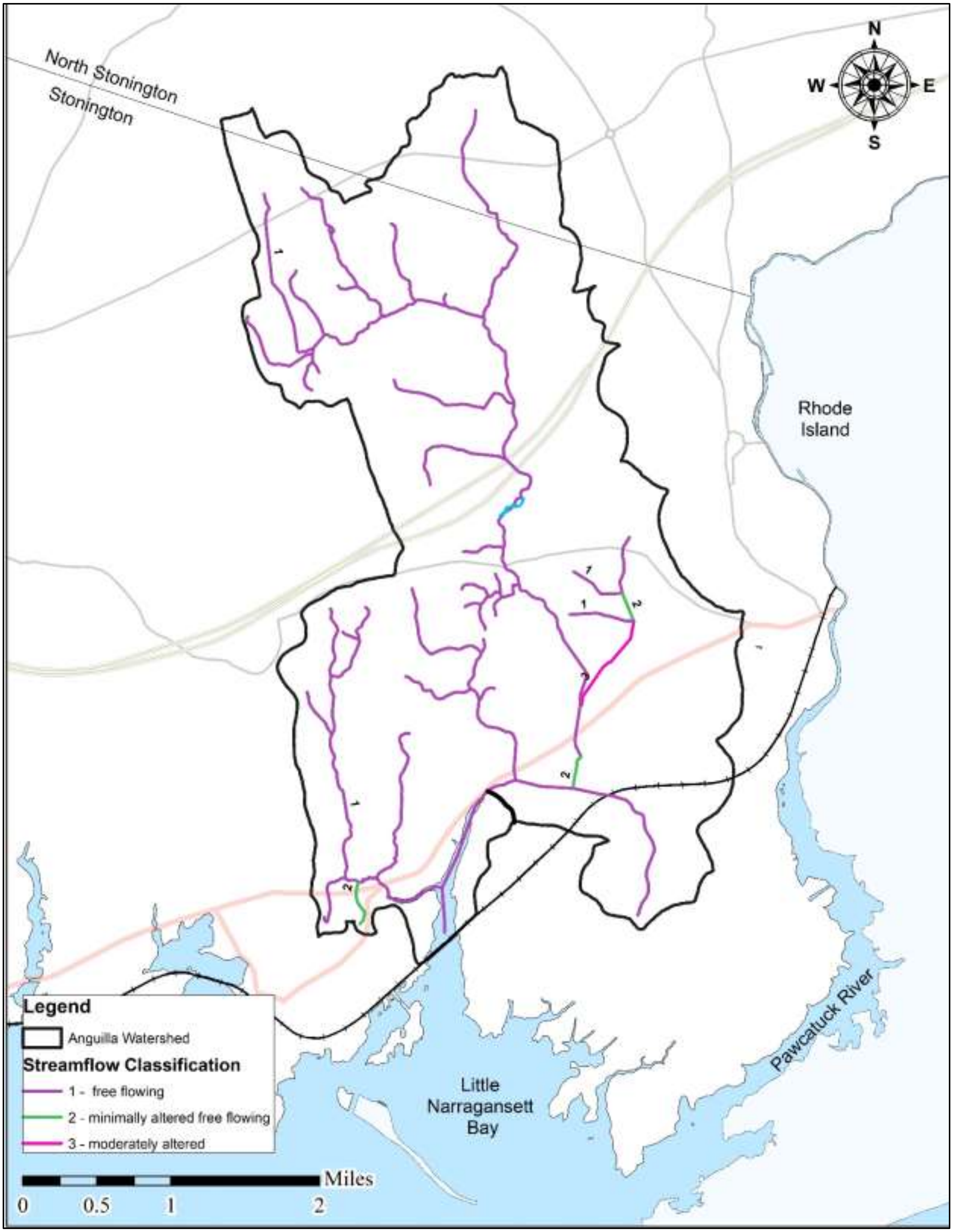


Figure 2-9. The classifications of streamflow for streams in the Anguilla Brook/Inner Wequetequock Cove watershed.

2.3 Wildlife and Fisheries

2.3.1 Wildlife

The Anguilla Brook watershed is located in the Long Island Sound Coastal Lowland ecological region of the Eastern Broadleaf forest province (Griffith et al, 2009). This ecoregion includes "… low-elevation rolling coastal plain, tidal marshes, estuaries, sandy dunes and beaches, and rocky headlands" and hardwood forests with "… black, red, and white oaks, hickories, and black cherry" (Griffith et al, 2009). This diverse ecosystem supports a correspondingly highly diverse variety of animal species, including some that are at the northern or southern limits of their natural ranges (CT DEEP, 2015). According to CT DEEP's 2015 Connecticut Wildlife Action Plan, the state's "physiographic gradient and associated regional climatic differences provided a complex ecological framework that supports 84 species of mammals, 335 species of birds, 50 species of reptiles and amphibians, 169 species of fish and an estimated 20,000 species of invertebrates."

Due to the generally rural character of the Anguilla Brook watershed, relatively large undeveloped forest tracts, variety of upland and coastal habitats, and connectivity to extensive undeveloped areas outside of the watershed, such as the Assekonk Swamp Wildlife Management Area, the watershed provides habitat for a wide variety of mammal species common to southern New England. These may include black bear, white-tailed deer, coyote, grey and red fox, bobcat, raccoon, opossum, skunk, fisher, beaver, muskrat, weasel, mink, eastern cottontail, woodchuck, several squirrel species, bats, and a variety of mouse, mole and vole species. The diverse habitats also support a wide variety of bird species, including forest and grassland specialists, marsh species and shore birds, and reptiles and amphibians.

2.3.2 Fisheries

Streams in the Anguilla Brook watershed support a variety of warm- and cold-water fish species. Fisheries surveys conducted by CT DEEP in 1993, 2010 and 2017 identified a variety of fish species (CT ECO DEEP Fish Community Data - Inland Waters, 2020; Meghan Lally, CT DEEP, personal communication, 2020). Details are provided in Table 2-8. In past years, Anguilla Brook has been stocked with trout. However, 2016 was the last year the brook was stocked; 350 brown trout were released that year (Michael Beauchene, CT DEEP, personal communication, 2020). Wild brook trout were documented by DEEP in the past and may persist in cold water stream segments (Fig. 2-10). Wild brook trout were documented in Donahue and Anguilla Brooks by project volunteers in 2019 and 2020.

Anguilla Brook is known to support a population of diadromous fish (fish that spend portions of their life cycles partially in fresh water and partially in salt water), including alewife (*Alosa pseudoharengus*) and the eponymous American eel (*Anguilla rostrata*). In 2013, CT DEEP, the Nature Conservancy, and the Avalonia Land Conservancy partnered to remove a dam on Anguilla Brook north of US Route 1 (Steve Gephard, CT DEEP, personal communication, 2020; Sally Harold, The Nature Conservancy, personal communication, 2019). The removal of this dam opened the full extent of Anguilla Brook for migratory fish passage. At the same time, an artisanal fishway was installed at the Chesebrough Pond dam to allow passage over that structure. Although no formal fish counts have been conducted at this fishway, it is DEEP's belief that alewife and American eel are successfully passing through the fishway and accessing upstream waters for spawning.

Table 2-8 Summary of CT DEEP Fisheries Surveys

Fish Species/#	Anguilla Brook 1993	Anguilla Brook 2010	Donahue Brook 1993	Wheeler Brook 1993	Wheeler Brook 2017
American eel	100	11	11	7	28
Bluegill sunfish	12	3			
Brook trout (stocked)	2				
Brook trout (wild)	30		6	38	19
Brown bullhead		1			
Brown trout (stocked)	15				
Chain pickerel					12
Common shiner	8				
Creek chubsucker	2	7			
Fallfish	28				
Golden shiner		42			1
Largemouth bass	3	1			
Pumpkinseed	4	1		4	18
Rainbow trout (stocked)	2				
Redfin pickerel	31	3	11	2	26
Tessellated darter	23			4	21
Three-spine stickleback			1		
White sucker	5			18	30

Due to poor water quality, Wequetequock Cove does not support a thriving marine aquatic habitat. Poor flushing related to the restrictive culvert under the Amtrak railbed, coupled with nutrient enrichment from the watershed, significantly impacts water quality. Water clarity is often poor due to the excessive growth of phytoplankton, which impacts and inhibits the growth of eelgrass (*Zostera marina*), a keystone estuarine nursery habitat species. Consequently, eelgrass is not found in Wequetequock Cove, and so the Cove does not support the rich and diverse nursery habitat typical of estuarine environments. Nutrient enrichment contributes to hypoxia through much of the summer (Fran Pijar, CUSH, personal communication, 2019) which detrimentally impacts aquatic wildlife, including shellfish.

Subaqueous soil surveys conducted by the Connecticut office of the USDA-NRCS indicate that the substrate of the inner Cove is moderately suitable for hard clams and highly suitable for oysters (CT ECO Aquaculture Mapping Atlas, nd). However, due to poor water quality, shellfish do not thrive in the inner Cove. Water quality in the inner and outer Coves is such that both are designated “restricted relay,” which means any shellfish must be moved to clean waters outside of the Cove to flush (depurate) before they can be consumed; the taking of shellfish for direct consumption (recreational shell fishing) is prohibited in both locations.

2.3.3 Protected Species

In 1989, Connecticut passed the Endangered Species Act (Sec. 26-303 to 26-316 of the Connecticut General Statutes). The Endangered Species Act recognizes that certain plant and animal species and their habitats have become extinct or are threatened with extinction due to human activity (Table 2-9). The Act charges the State to “…conserve, protect, restore and enhance any endangered or threatened species and essential habitat.”

Table 2-9. State of Connecticut Listed Species Risk Level Definitions.

Endangered Species:
Any native species documented by biological research and inventory to be in danger of extirpation throughout all or a significant portion of its range within the state and to have no more than five occurrences in the state, and any species determined to be an "endangered species" pursuant to the federal Endangered Species Act.
Threatened Species:
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 the state and to have no more than nine occurrences in the state, and any species determined to be a "threatened species" pursuant to the federal Endangered Species Act, except for such species determined to be endangered by the Commissioner in accordance with section 4 of this act.
Species of Special Concern:
Any native plant species or any native non-harvested wildlife species documented by scientific research and inventory to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high demand by man that its unregulated taking would be detrimental to the conservation of its population or has been extirpated from the state. -State of Connecticut Endangered Species Act, 1989

Each listed species is assigned a risk level and is listed in the Connecticut Natural Diversity Data Base (NDDB). The NDDB compiles data on listed species and designated areas of conservation concern and maintains maps that represent their approximate locations. Designated areas of conservation concern contain critical habitat and natural communities, which are "…groupings of plants that occur together in recurring patterns based on soils, water, nutrients, and climate" (Snyder, 2001). Such sites may include both terrestrial and aquatic plant and animal species. The Connecticut Department of Energy and Environmental Protection's Natural Diversity Database does not identify any designated areas of conservation concern in the Anguilla Brook watershed. However, it does note that the Anguilla Brook watershed is just south of an Acidic Atlantic White Cedar Basin Swamp Critical Habitat and that the watershed terminates in Salt Marsh Critical Habitat (Fig. 2-10).

CT DEEP has identified multiple state and federally listed endangered, threatened and special concern animal, insect and vascular plant species in the Anguilla Brook watershed. In order to protect the identity and locations of those species, that information will not be included in this report. Instead, watershed managers are encouraged to review the most currently updated Natural Diversity database and contact NDDB staff to determine if new sites have been added, and are encouraged to submit documentation to report sightings of state-listed species or critical habitats. Watershed managers should take the presence of these species into account when planning watershed management or implementation activities. Local regulatory and advisory authorities should be aware of the presence of these species as well when reviewing land use permit applications to ensure that necessary actions are

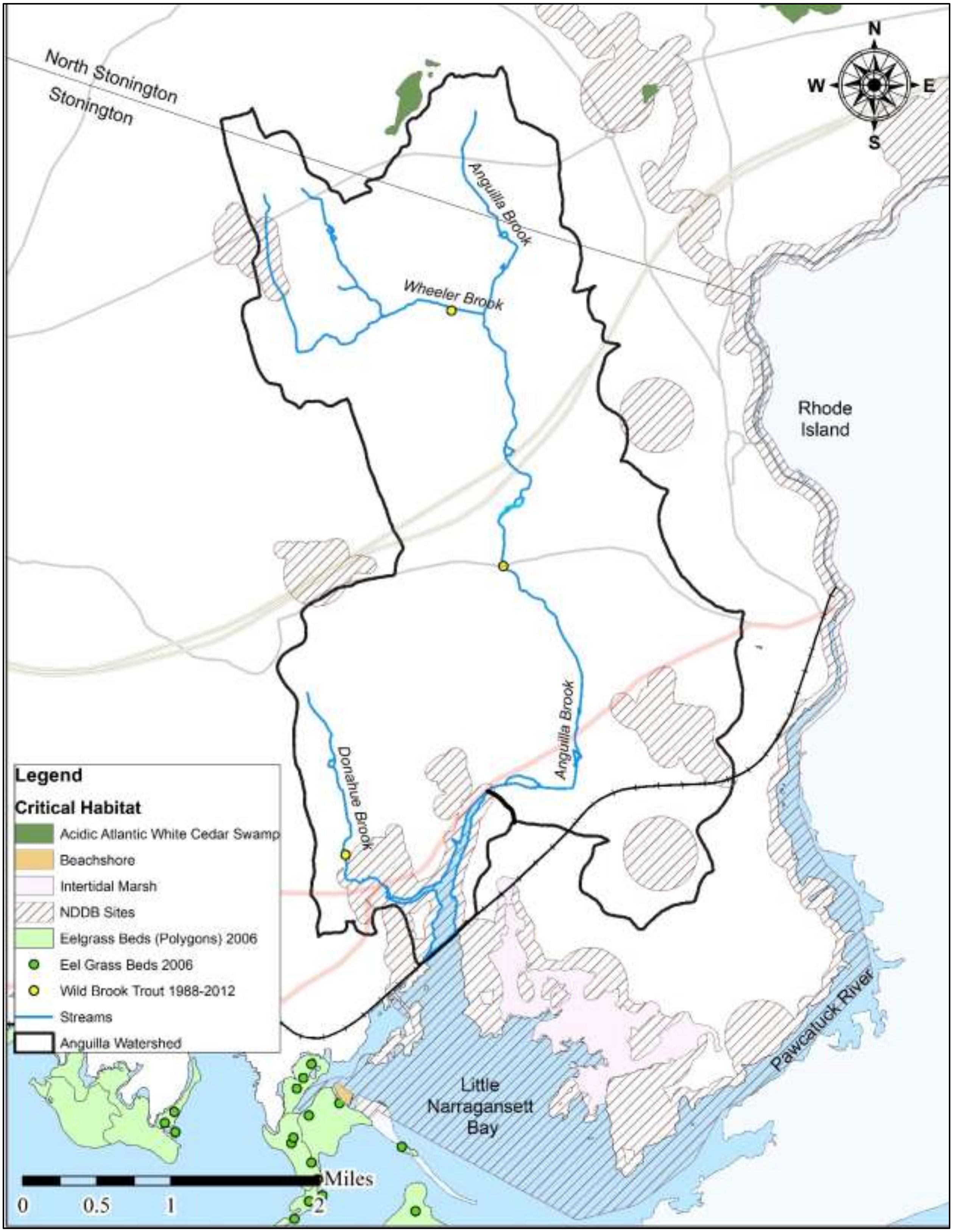


Figure 2-10. Natural Diversity Database (NDDB) sites, critical habitats and wild brook trout sites in the Anguilla Brook/Inner Wequetequock Cove watershed.

taken to protect these species, natural communities and habitats. For more specific information on listed species and natural communities, inquiries should be directed to CT DEEP's Natural Diversity Database program. The Natural Diversity Database website can be accessed at:

www.ct.gov/deep/cwp/view.asp?a=2702&q=323464&deepNav_GID=1628.

A species that is not listed, but is of special interest is the New England Cottontail (*Sylvilagus transitionalis*). According to the 2015 Connecticut Wildlife Action Plan, the New England Cottontail was recognized by all five New England states and New York as a species of greatest conservation need. This led to the development of the Conservation Strategy for the New England Cottontail (*Sylvilagus transitionalis*) by Fuller and Tur (2012). In 2016, the U.S. Fish and Wildlife Service created the Great Thicket National Wildlife Refuge in ten separate parts of Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island and New York. The goal of the refuge is to acquire land with suitable habitat for New England Cottontail and several other species of greatest conservation need in those ten identified areas through conservation easements or fee-title acquisition (newenglandcottontail.org/content/great-thicket-national-wildlife-refuge).

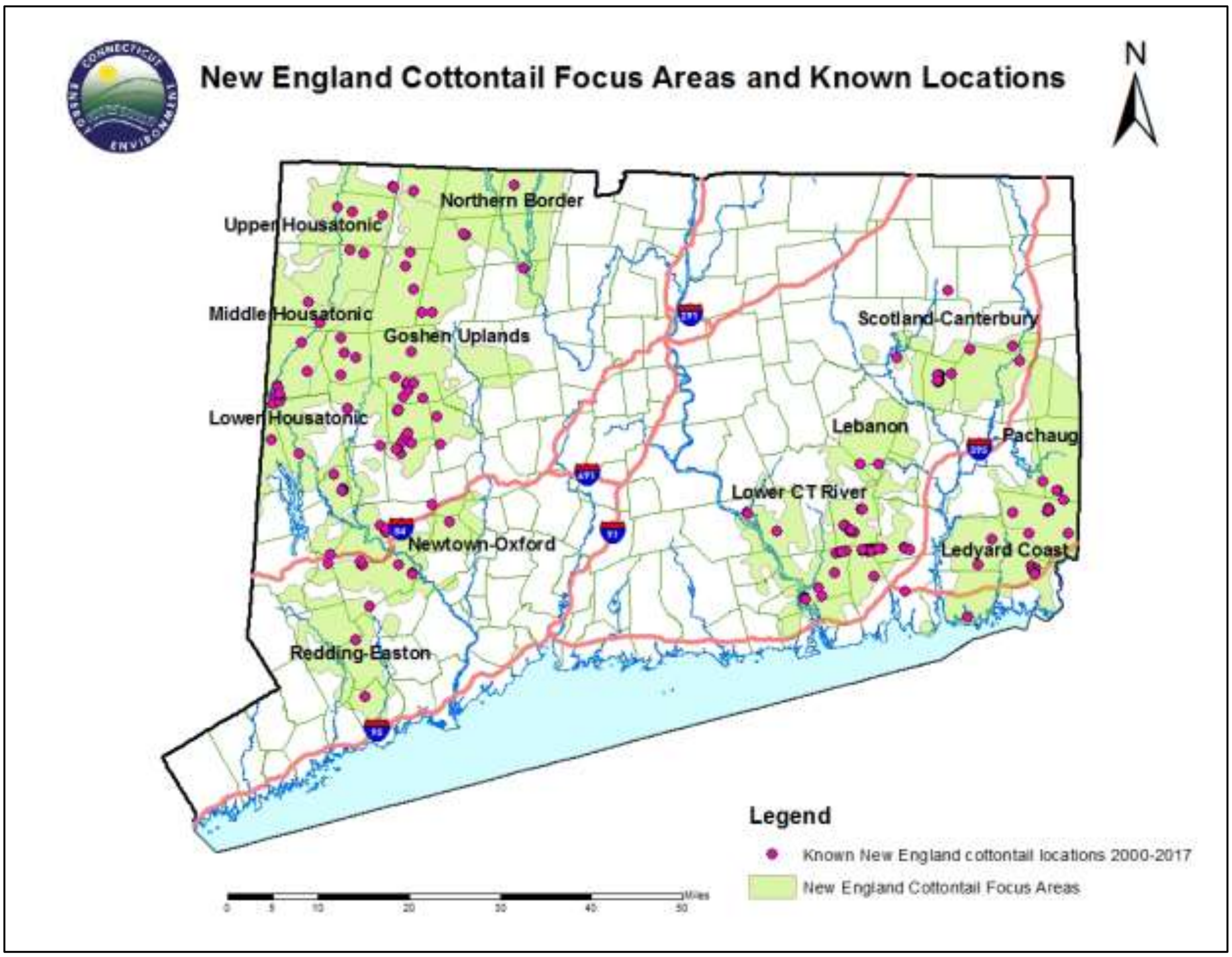


Figure 2-11. New England Cottontail Focus Area and Known Locations (CT DEEP, 2019). The cluster of known New England cottontail locations just north of Interstate 95 is located within the Anguilla Brook watershed.

2.4 SENSITIVE AREAS

Sensitive areas are those locations that contain plants, animals, and physical or geographic features that could be threatened by poor land management or unrestricted development. These may include areas with listed species and natural communities, wetlands, floodways and floodplains, riparian corridors, and areas with steep slopes, erodible soils, or other physical or cultural constraints.

Sensitive areas within the Anguilla Brook watershed include:

- **Salt Marsh habitat along Wequetequock Cove and Donahue Brook**. Salt marsh habitat in the Anguilla Brook watershed has been identified as an area of conservation concern because it is associated with numerous State-listed animal and plant species. According to the CT Natural Diversity Database, the salt marsh at the terminus of the watershed is utilized by tidal-marsh specialists, and is an important nesting and foraging area for many bird species (Shannon Kearney, CT DEEP, personal communication, 5/8/2020).
- **Floodway along Anguilla Brook.** This federally-designated floodway is "…reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height" (FEMA, 2019). Development in the floodway is regulated by the Town of Stonington to ensure that there are no increases in upstream flood elevations.
- **Large tracts of undeveloped land and riparian corridors along Anguilla Brook, Donahue Brook and tributary streams.** These large tracts of undeveloped, primarily forested lands and riparian corridors contribute to high water quality of watershed streams and protect the overall quality of water in Wequetequock Cove.
- **Great Thicket Wildlife Refuge.** The area within the Anguilla Brook watershed that has been designated as part of the Great Thicket Wildlife Refuge and in particular areas north of I-95 where the presence of New England Cottontail has been documented should be evaluated for habitat enhancement and permanent protection.
- **NDDB sites.** There are numerous sites in the Anguilla Brook watershed with State-listed plant and animal species and areas of conservation concern, as identified by the CT Natural Diversity Database. These sites should be managed in a manner that is protective of listed species and habitats. Any development proposals should include an evaluation by a qualified biologist to determine if listed species are present.
- **Farmland soils.** Farmland soils, as designated by the USDA NRCS, should be afforded all possible protection. According to the American Farmland Trust (www.Farmland.org), "farmland soils provide multiple benefits. Farmlands produce the food we eat, and local farms produce locally-sourced products that support local businesses, including farm stands and farmers markets, restaurants, grocery and specialty stores, and tourism destinations. Farmlands provide habitat for a multitude of animal species, including many that require the specific habitat provided by open land to thrive. Farmlands can also provide clean air and water benefits. Once farmland soils are converted to other uses, those benefits are lost forever."
- **Highly erodible soils.** Highly erodible soils in the Anguilla Brook watershed are found primarily along Anguilla Brook and Wequetequock Cove (Fig. 2-12). These soils are susceptible to erosion when disturbed by activity such as land clearing, excavation/construction, forestry activities and tillage, which may result in the mobilization and deposition of eroded sediments into wetlands and waterways. Much of the soil designated as highly erodible is located in agricultural areas and co-occurs with farmland soils.

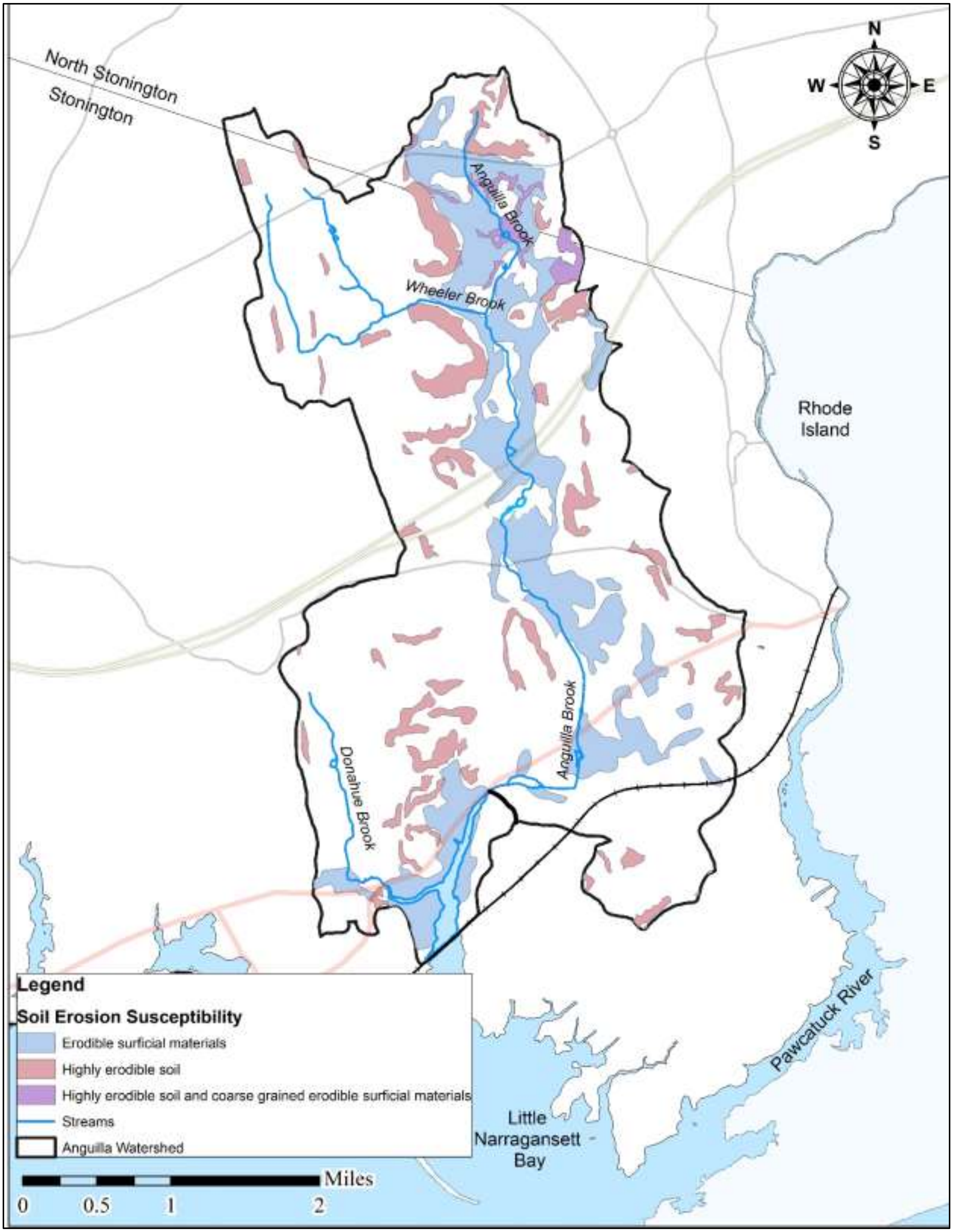


Figure 2-12. Highly erodible soils in the Anguilla Brook/Inner Wequetequock Cove watershed.

2.5 LAND USE AND LAND COVER

The character of a community is defined by the nature of its land cover and how the land is used. Whether a landscape is developed and how that development is distributed across the landscape can affect not only the aesthetic qualities of place, but also the quality of the land, air and water, all of which ultimately contribute to quality of life. The following section characterizes land cover types in the Anguilla Brook watershed and how the land is used.

The Anguilla Brook watershed is predominantly rural (Figs. 2-13 and 2-14). Land cover in the watershed is dominated by undeveloped deciduous and coniferous forests and forested wetlands (55%). Developed land (defined as residential, commercial and/or industrial development, and paved surfaces) and turf grass areas associated with developed land, comprise approximately 26% of the watershed (Table 2-10). About 15% of the watershed is used for pasture, hay and cropland. Approximately 4% of the watershed is comprised of unforested wetlands, tidal wetlands and other waterbodies.

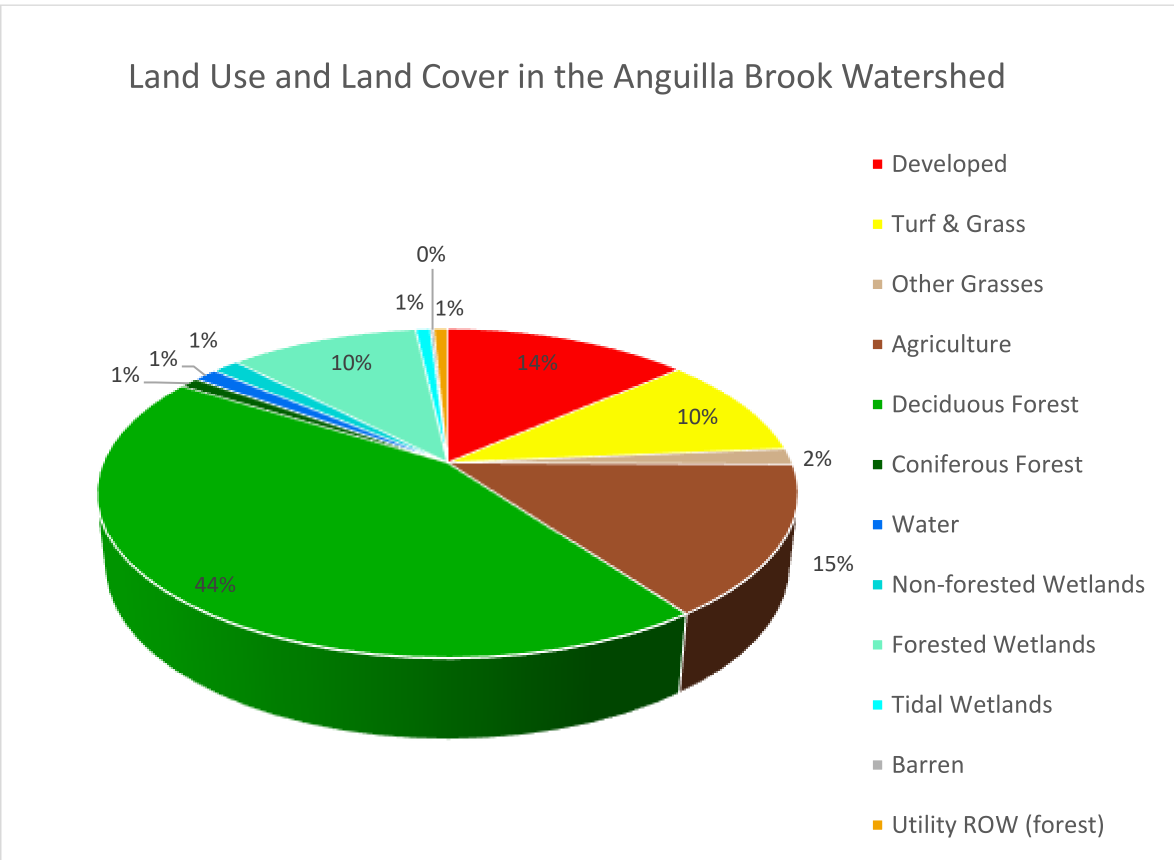


Figure 2-13. Land Use and Land Cover in the Anguilla Brook Watershed (CLEAR, 2016).

Table 2-10. Land Use and Land Cover in the Anguilla Brook Watershed (CLEAR, 2016).

Land Cover Class	Area (acres)	% Watershed
Developed	1,068	13.5
Turf & Grass	794	10.1
Other Grasses	126	1.6
Agricultural	1,168	14.8
Deciduous Forest	3,464	43.9
Coniferous Forest	83	1.1
Water	105	1.3
Non-forested Wetland	117	1.5
Forested Wetland	827	10.5
Tidal Wetlands	64	0.8
Barren Land	15	0.2
Utility Corridor	60	0.8
Total	7,891	100%

2.5.1 Developed Areas

Developed areas are defined as areas with impervious surfaces (buildings, roof tops, roads, parking lots and sidewalks) which prevent rainwater from infiltrating into the ground. Rainwater that lands on impervious surfaces typically flows along the ground from these areas, is directed into storm drain systems and is then discharged to areas where it can soak into the ground or flow into nearby waterbodies. Developed land, including residential, commercial and/or industrial properties, paved surfaces, and associated lawns areas, comprises approximately 25% of the Anguilla Brook watershed. The majority of the watershed is lightly developed, and is characterized by undeveloped backland with rural residential development along road frontages. Development increases in density along the US Route 1 corridor, which features mixed-used development, and in the Pawcatuck area of Stonington.

2.5.2 Transportation

There are approximately 57.6 miles of roadway in the Anguilla Brook watershed. There are 45.6 miles of local surface roads owned and maintained by the towns of North Stonington and Stonington (3.4 and 42.2 miles, respectively). There are 8.2 miles of state and federal highway, including US Route 1, and State Routes 138 and 234, and 3.8 miles of limited-access highway (Interstate Route 95), which are maintained by the Connecticut Department of Transportation. There are approximately 2.4 miles of rail line, owned and maintained by Amtrak.

2.5.3 Open Space

Protecting and preserving open space is an important component of watershed planning. Large tracts of undeveloped land provide habitat and migration corridors for wildlife. Open spaces provide ecosystem services including oxygen production, carbon sequestration and rain water purification and infiltration. Human benefits provided by open space include recreational opportunities for residents, aesthetic values, and economic values supported by tourism. Undeveloped areas are often included in the open space category, although undeveloped should not be equated with protected. Approximately 75% of the Anguilla Brook watershed is undeveloped; however, this includes land that could be developed, including recreational, agricultural, and forest land. There are approximately 2,242 acres of protected open space in the Anguilla Brook watershed (Fig. 2-15). This land is owned or managed variously by the Town of Stonington, as either municipal properties or private land held under conservation easements, land trusts (Avalonia Land Conservancy, Stonington Land Trust), The Nature Conservancy, Connecticut Farmland Trust, the State of Connecticut (Barn Island Wildlife Management Area) and private landowners. Figure 2-15 does not include open spaces such as cemeteries, which, although unprotected, are extremely unlikely to be developed, or private recreational facilities that could be developed in the future.

2.5.4 Recreation

There are many publicly accessible outdoor or nature-based recreational opportunities in the Anguilla Brook watershed. Stonington Country Club and Elmridge Golf Course are located in the watershed, as is the Pawcatuck Little League facility. The Coast Guard Foundation owns property abutting Stonington Country Club for recreational opportunities for cadets. The Town of Stonington owns the Spellman Recreation Complex, located behind Stonington High School on US Route 1. Many of the land trust properties located throughout the watershed have walking trails and bird watching opportunities that are open to the public. The State of Connecticut's Barn Island Wildlife Management Area, located on the southeastern boundary of the watershed, has walking trails and a boat launch that serves as a jumping-off point for other nearby attractions. Boating and kayaking are popular activities in Wequetequock Cove and Little Narragansett Bay. Boating services are available from Stonington Marina, Cove Ledge Inn, and Marina and Lockwood's Coveside Marina in Wequetequock Cove, including kayak rentals at Stonington Marina.

2.5.5 Forested Areas

CLEAR land cover data (CLEAR, 2016) indicates that approximately 56% of the Anguilla Brook watershed is forested. Forest cover is composed primarily of deciduous broadleaf trees (3,464 acres), scattered stands of conifers (83 acres), forested wetlands (827 acres), and utility rights-of-way (59.5 acres).

A 2009 study conducted by CLEAR evaluated forest fragmentation, the fracturing of large forest blocks into smaller and smaller pieces as a result of development, throughout Connecticut (Wilson and Arnold, 2009). The CLEAR study evaluated various categories of forest cover, including core forest, perforated forest, edge forest and patch forest to determine levels of fragmentation (Table 2-11). The fragmentation of forest land can be detrimental to many species of wildlife, especially those that require large tracts of undisturbed forestland to thrive. Fragmentation can also affect ecosystem services associated with forests, including clean air, water and carbon sequestration; the viability of forest products; habitat quality for wildlife, especially species that require core forest to thrive; and recreation opportunities.

Table 2-11. Forest Fragmentation Categories

Core Forest:
Intact forest blocks 100 meters or more from the forest/non-forest boundary.
Perforated Forest:
Small clearings within a forested landscape.
Edge Forest:
The forested area located within the 100-meter boundary between core forest and non-forested land.
Patch Forest:
Small forested areas surrounded by non-forested areas that are isolated from core forests. - CLEAR, 2009

A review of CLEAR forest fragmentation data from 1985 and 2015 indicates that forest fragmentation in the Anguilla Brook watershed has increased, that large blocks of core forest (>500 acres), which are critical for certain forest species, have decreased by 14%, and that medium blocks of core forest (250-500 acres) have decreased significantly (Table 2-12). For more information about forest fragmentation, visit the CLEAR webpage at clear.uconn.edu/projects/landscape/CT/forestfrag.htm.

Table 2-12. Change in Forest Fragmentation in the Anguilla Brook watershed in Connecticut from 1985 to 2015.

Forest Class	1985 Forest Class Area (Ac)	2015 Forest Class Area (Ac)	Change in Forest Class (Ac)	% Change
Patch Forest	197	285	88.4	31%
Edge Forest	2,058	2,042	-16.5	-0.8%
Perforated Forest	229	298	69.1	23.2%
Core Forest (<250 acres)	1,198	1,288	90.4	7.0%
Core Forest (250-500 acres)	1,231	360	-871	-241.7%
Core Forest (>500 acres)	116	101	-14.5	-14.3%
Total Core Forest	2,545	1,750	-795	-31%

2.5.6 Wetlands

Approximately 13% (1,113 acres) of land cover in the Anguilla Brook watershed is classified by CLEAR as wetlands. Of that, 105 acres are identified as open water; 827 acres are identified as forested wetlands; 117 acres are identified as non-forested wetland and 64 acres are identified as tidal wetlands. Land use change between 1985 and 2010, as depicted in Table 2-13 indicates an 17% loss of wetlands in the watershed.

2.5.7 Agricultural Lands

Approximately 15% (1,168 acres) of the Anguilla Brook watershed is under agricultural use. Agriculture is distributed evenly throughout the watershed. Agricultural products include wine, herbs, vegetable plants, cut flowers, hay, sweet corn and silage corn.

2.5.8 Changes in Land Use

A review of CLEAR land use/land cover data from 1985 to 2015 indicates that the amount of developed land in the watershed (including turf and grass areas, other grasses, and barren land) has increased by 69% (+817 acres), land under cultivation has decreased by 10% (-136 acres) and the amount of forest has decreased by 22% (-589 acres; Table 2-13).

Table 2-13. Change in land cover between 1985 and 2015 in the Anguilla Brook watershed (CLEAR, 2016).

Land Cover Class	1985 Land Cover (acres)	2015 Land Cover (acres)	Land Cover Change (acres)	% Change
Developed	776	1,068	293	38%
Turf & Grass	368	794	426	116%
Other Grasses	39	126	87	222%
Agricultural Field	1,303	1,168	-136	-10%
Deciduous Forest	4,045	3,464	-581	-14%
Coniferous Forest	91	83	-8	-8%
Water	123	105	-17	-14%
Non-forested Wetland	118	117	-1	-1%
Forested Wetland	893	827	-66	-7%
Tidal Wetlands	70	64	-6	-9%
Barren Land	2	15	12	482%
Utility Corridor	62	59	-3	-4%

Development within riparian corridors, the areas immediately adjacent to streams and other surface waters, can have a more direct impact on water quality than development further away. Intact riparian corridors provide a number of ecosystem services (Sweeney et al, 2004). These include protecting water quality and aquatic habitat by slowing and filtering surface stormwater runoff, removing pollutants, shading streams to maintain cooler water temperatures, providing exogenous sources of food for aquatic organisms, and reducing stream bank erosion. An examination of 1985 and 2015 CLEAR land use and land cover data within the 100-foot riparian corridor in the Anguilla Brook watershed indicates that the amount of developed land in the watershed (including turf and grass areas, other grasses, and barren land) has increased by 64% (+25.5 acres), land under cultivation has decreased by 6% (-2 acres) and the amount of forest and wetlands has decreased by almost 7% (-24 acres).

2.5.9 Future Land Use Considerations

The 2015 Town of Stonington Plan of Conservation and Development categorizes future land use in much of the Anguilla Brook watershed as Low Density Residential (Fig. 2-16). This land use category is characterized by:

- Areas that lack the public infrastructure for intensive development
- Lower densities of less than 1 unit per acre recommended
- Agricultural uses supported as both land conservation and an economic resource
- Sensitive redevelopment or enhancement of any existing commercial areas recommended
- "Open Space Development" recommended for new residential construction
- Conservation of sensitive areas recommended (Town of Stonington, 2015)

The Town of North Stonington 2013 Plan of Conservation and Development identifies areas within the Anguilla Brook watershed as medium-density residential (R60) and high-density residential (R40) (Figure 2-17).

Unless the expansion of municipal water and sewer infrastructure occurs, it is unlikely that the Anguilla Brook watershed in Stonington will experience significant additional development in the future. However, due to higher density zoning in North Stonington, the potential for development is greater. Although only 7% (577 acres) of the Anguilla Brook watershed is located in North Stonington, this portion of the watershed contains the headwaters for Anguilla Brook, Wheeler Brook, and the unnamed tributary to Wheeler Brook. Any future development should take into consideration the proximity to these sensitive headwater areas in order to reduce potential impacts on water quality.

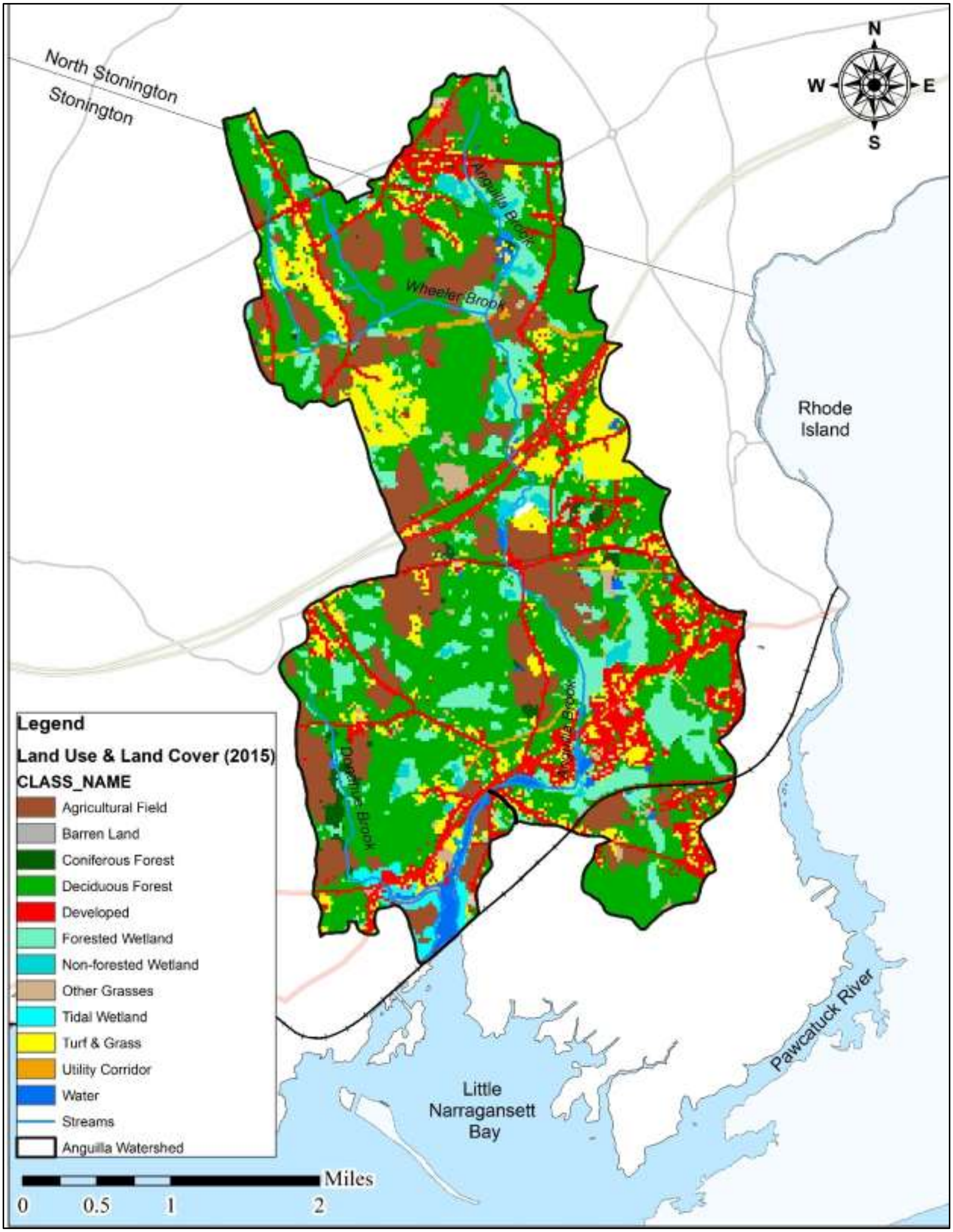


Figure 2-14. Land use and land cover in the Anguilla Brook/Inner Wequetequock Cove watershed (CLEAR, 2016).

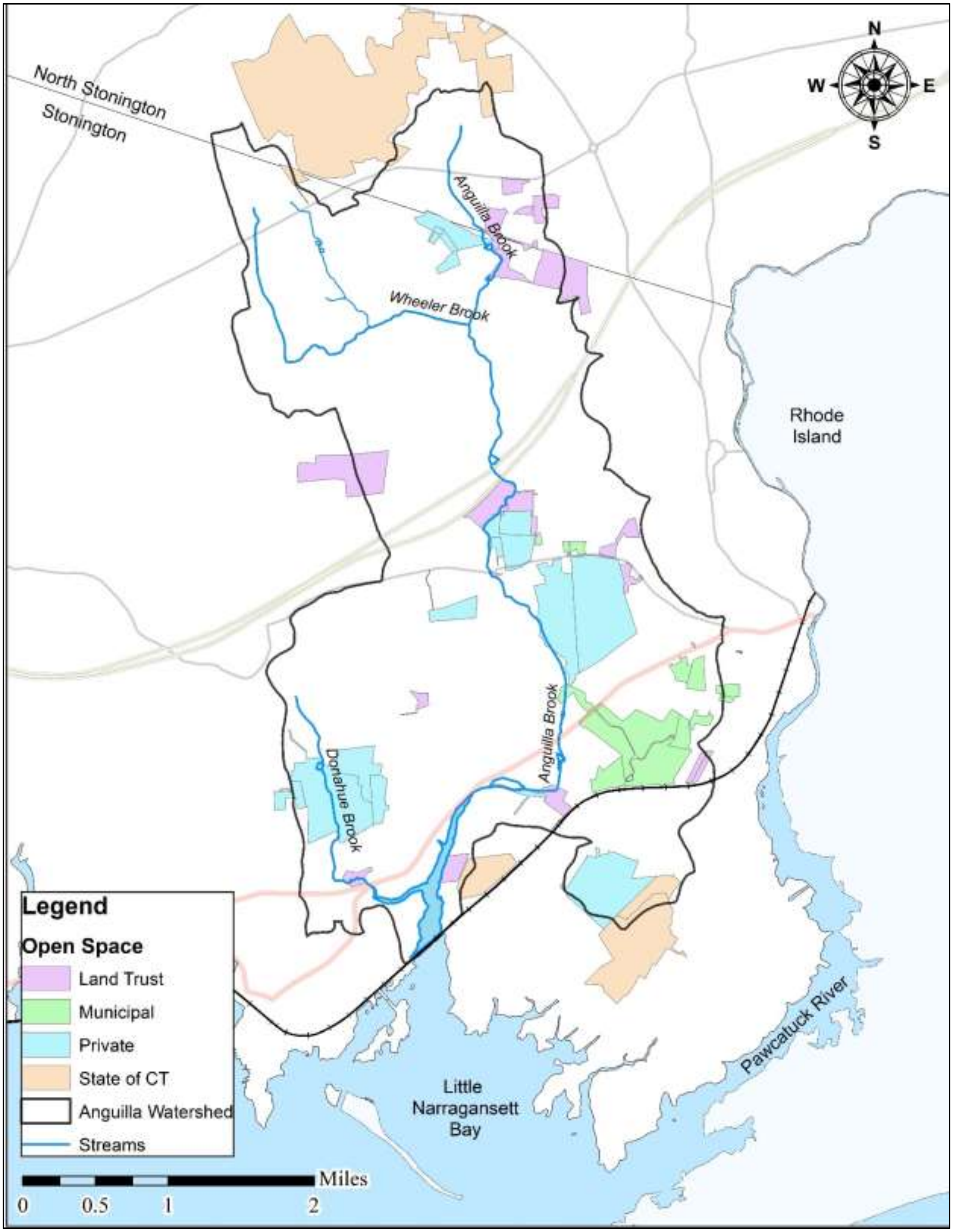


Figure 2-15. Protected open space in the Anguilla Brook/Inner Wequetequock Cove watershed.

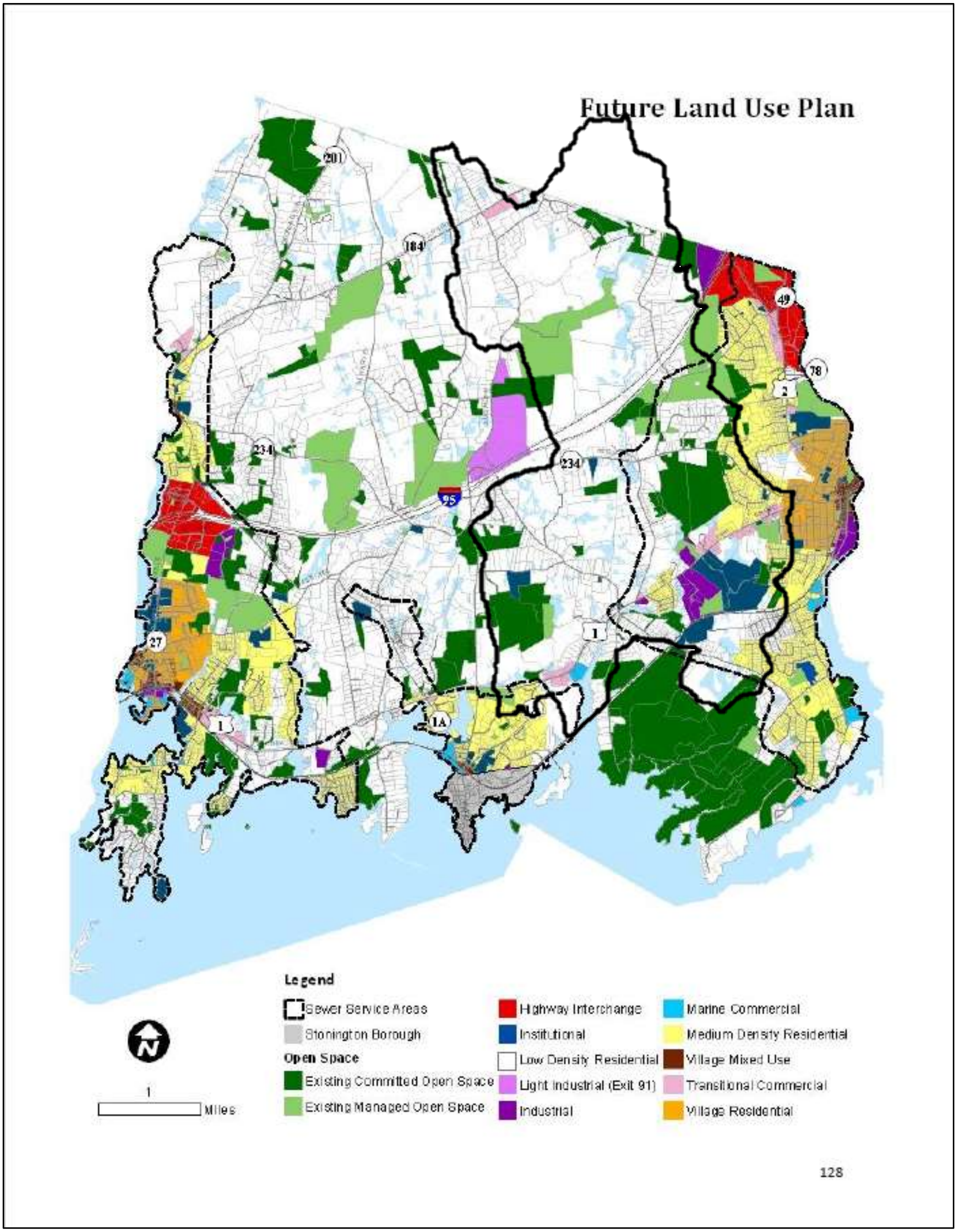


Figure 2-16. Future Land Use Plan from the Stonington 2015 Plan of Conservation and Development. The Anguilla Brook watershed, outlined in black, was superimposed on the map by ECCD.

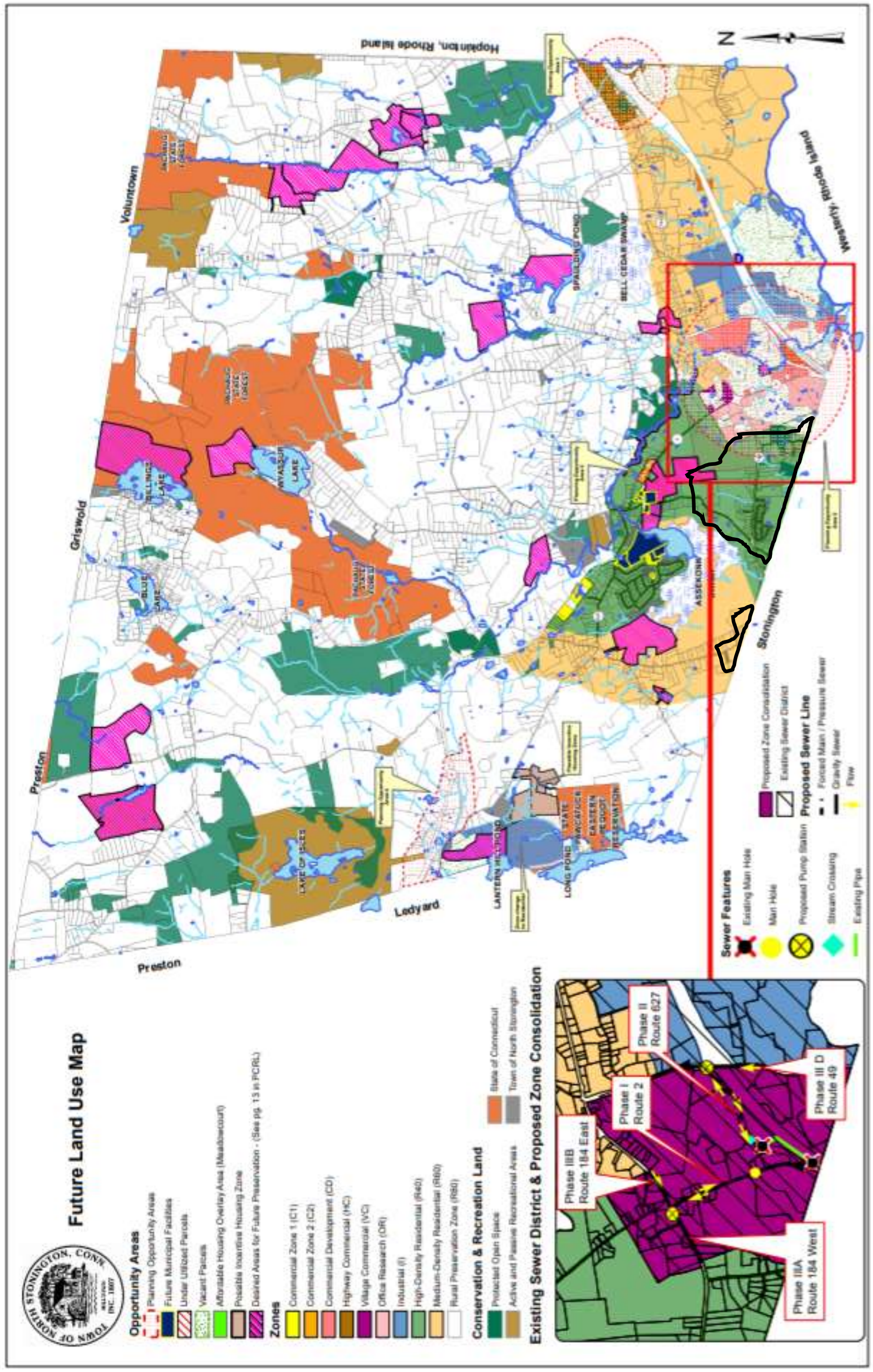


Figure 2-17. Future Land Use Map from the North Stonington Plan of Conservation and Development 2013. The Anguilla Brook watershed, outlined in black, was superimposed on the map by ECCD.

2.6 DEMOGRAPHIC CHARACTERISTICS

2.6.1 Cultural Resources

Southeastern Connecticut has a rich cultural heritage that spans the pre-colonial and colonial eras. North Stonington and Stonington are characterized by their rural heritage, with many former and current farms, 18th and 19th century houses, miles of stone walls, and ancient cemeteries contributing to structure and the scenic beauty of the community.

Stonington was settled by William Chesebrough, who settled on the shore of Wequetequock Cove in 1649 (Wheeler, 1900). Stonington was known for farming in the coastal and Caribbean trades. In time, the town became known for its shipbuilding, sealing and whaling (innatstonington.com/the-inn/history). North Stonington, originally part of Stonington, separated from Stonington and incorporated in 1807 (connecticuthistory.org/towns-page/north-stonington). According to Connecticut History.org, “In the 19th century, the town prospered with numerous farms, mills, and tanneries and was a well-known mercantile center that produced silk and satin, wools, and thread lace among other items. After the Civil War, the town turned primarily agricultural with dairy farming its principal industry. Now a residential community, it still boasts numerous structures from the late 1700s and early 1800s.”

There are many notable historic structures and landmarks in the Anguilla Brook watershed. These include the Wequetequock Burial Ground on Palmer Neck Road, the 17th century dam that forms Chesebrough Pond, and the Pequot Trail, as well as the aforementioned 18th and 19th century homes and farmsteads found throughout the watershed. The remnants of the historical Groton & Stonington trolley line can be seen just west of the Greenhaven Road/US RT 1 intersection. The former trolley line continues along Trolley Crossing through the Avalonia Land Conservancy’s Anguilla Brook Preserve Birdland Tract.

Southeast Connecticut was a rich and fertile region for Native Americans. Native Americans utilized a wide variety of upland and coastal resources found in the area. The CT Office of State Archaeology identifies a number of archaeological sites in Stonington, including a cluster in the Anguilla Brook watershed, shown on the CT Blue Plan viewer (cteco.uconn.edu/viewer/index.html?viewer=blueplan) below (Fig. 2-18).

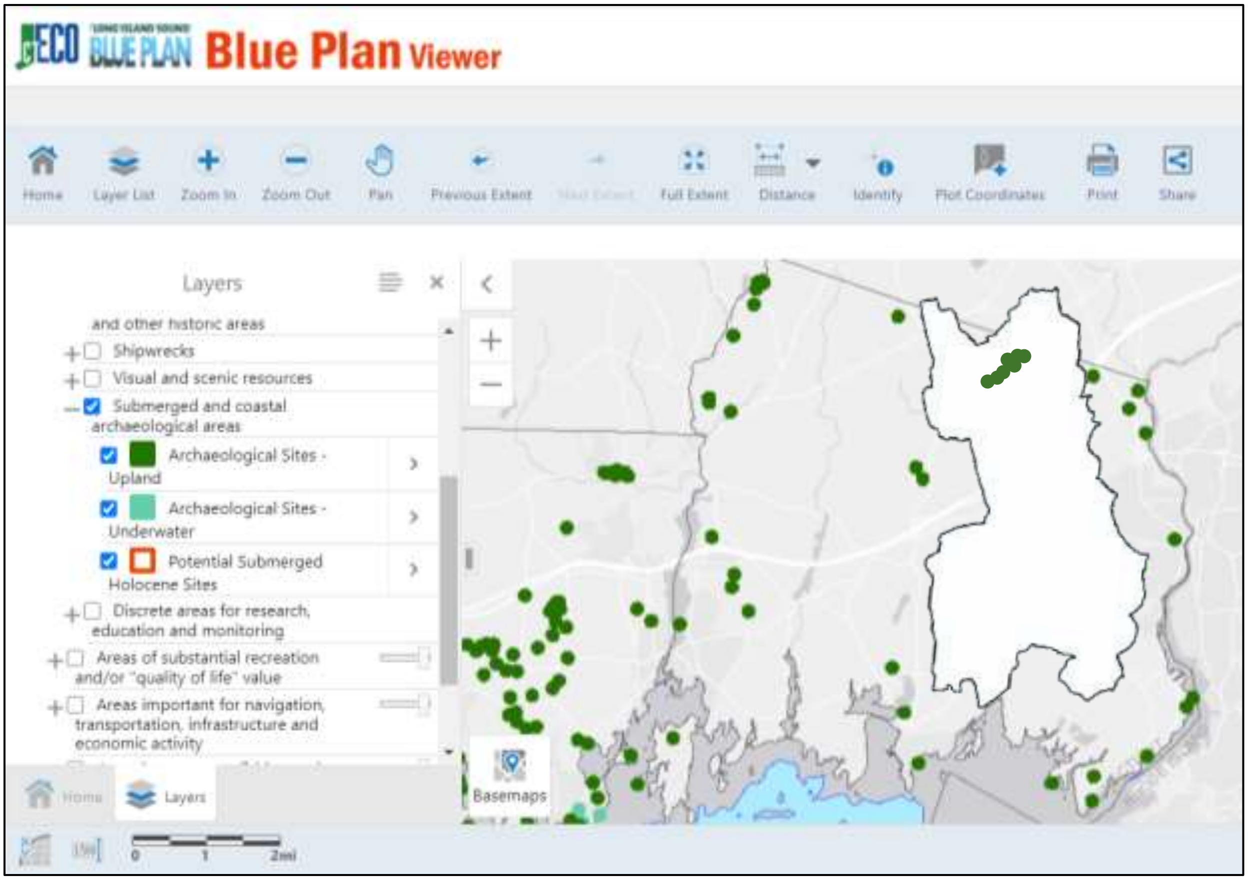


Figure 2-18. CTECO Long Island Sound CT Blue Plan Viewer, depicting upland archaeological sites in Stonington (green dots; CT Office of State Archaeology). The Anguilla Brook watershed was superimposed over the viewer for locational purposes.

2.6.2 Population and Economics

Stonington and North Stonington, Connecticut were incorporated in 1649 and 1807, respectively. Both towns are located in New London County and are part of the Southeastern Connecticut Planning Area and the Economic Development District of Southeastern Connecticut. Local government is conducted by town meeting, and is administered by an elected board of selectmen.

Stonington encompasses a land area of 39 square miles. The population forecast in 2017 for 2020 was 17,825, yielding a population density of 478 people per square mile. According to recent census data, ninety-one percent (91%) of the population identifies as white (non-Hispanic), 3.6% as Hispanic/Latino, 2% as Asian, 1% as black, <1% as Native American, and 2% as multi-race/other ethnicity. Twenty-five percent of residents are high school graduates, 8% have an Associate's degree, and 48% have a Bachelor's degree or higher. Labor statistics indicate that the unemployment rate in 2017 was 3.3%, which was lower than county and state averages. Median household incomes are 14% higher than the county average and 7% higher than state averages. Stonington is an aging community. The median age is 49 years old. Residents aged 45-64 and 65 and over comprise 57% of the population (32% and 25%, respectively).

Local industries include construction, manufacturing, retail trade, accommodation/food services, health care and social assistance, and arts, entertainment and recreation. Major employers include Davis

Standard LLC, CAW LLC, Big Y Foods Inc., Aquarion Water Co., and McQuades Marketplace, Inc. (Connecticut Economic Resource Center, 2019).

North Stonington encompasses a land area of 54 square miles. The population forecast in 2017 for 2020 was 5,205, yielding a population density of 97 people per square mile. According to recent census data, eighty-four percent (84%) of the population identifies as white (non-Hispanic), 3% as black, 2% as Hispanic/Latino, 2% as Asian, 0.5% as Native American, and 8.5% as multi-race/other ethnicity. Thirty-six percent of residents are high school graduates, 7% have an Associate's degree, and 30% have a Bachelor's degree or higher. Labor statistics indicate that the unemployment rate in 2017 was 3.5%, which was lower than county and state averages. Median household incomes are 22% higher than the county average and 15% higher than the state average. The median age is 46 years old. Residents aged 45-64 comprise 37% of the population.

Local industries include manufacturing, retail trade, accommodation/food services, and health care and social assistance. Major employers include A/Z Corporation, Connecticut Hospital Management Corp., A Thyme to Cook Inc., and the Town of North Stonington, including the North Stonington Board of Education (Connecticut Economic Resource Center, 2019).

2.7 Land Management Policies

Land management policies determine how land is used, developed and protected. Documents such as land use plans, policies and regulations provide a framework for municipalities, land use commissions and land use managers to guide development while protecting important natural and cultural resources. Land use planning determines the "character of place" by identifying what aspects of a landscape are important or significant, providing guidance to protect, preserve and enhance those qualities, and generally establishing how a community wishes to grow.

Land management in Connecticut occurs on multiple administrative levels, from state to regional to local levels. Land management policies, especially in the form of municipal land use regulations, can play a significant role in the protection of water quality and other natural resources. When land use planning policies and goals are designed to be consistent on local, regional and state levels, land use planning is at its most effective. As a consequence, local land use planners should review regional and state-level guidance documents and work with regional and state agencies to ensure that planning goals align.

This section reviews and summarizes existing planning documents that affect and influence land use and development, and subsequently, water quality protection in the Anguilla Brook watershed

2.7.1 Federal

The US Environmental Protection Agency (EPA) has implemented a *Nitrogen Reduction Strategy for Long Island Sound* (USEPA, 2015). Among the goals of this strategy is to identify total nitrogen (TN) limits to support various endpoints, such as seagrass protection, chlorophyll-a production and aquatic life protection, so that nutrient levels can be targeted and reduced. This strategy is intended to complement other existing policies including a nitrogen total maximum daily load (TMDL) adopted by EPA and the States of New York and Connecticut (2001), and state nitrogen reduction strategies. Additional information about the EPA nitrogen reduction strategy can be found at longislandsoundstudy.net/our-vision-and-plan/clean-waters-and-healthy-watersheds/nitrogen-strategy/.

2.7.2 Interstate (New York/Connecticut)

Long Island Sound, which is designated an estuary of national importance, is part of the National Estuary Program (NEP), authorized by section 320 of the Clean Water Act and overseen by EPA. NEP is "a non-regulatory program that improves the waters, habitats and living resources of 28 estuaries across the country" (EPA, nd, Overview of the National Estuary Program). The Long Island Sound National Estuary Program is locally managed by the Long Island Sound Study (LISS), a group of local, state and federal stakeholders which is charged with developing and implementing the Long Island Sound Comprehensive Conservation and Management Plan (CCMP). Most recently updated in 2020, the CCMP is a long-term plan that identifies conservation goals around four themes: Clean Waters and Healthy Watersheds, Thriving Habitats and Abundant Wildlife, and Sustainable and Resilient Communities. The CCMP identifies ecosystem targets and actions to achieve those goals. Pertinent to the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan are actions to reduce hypoxia, nitrogen loads, restore eelgrass beds and improve commercial and recreational shellfish harvesting.

2.7.3 State

The State of Connecticut conducts state-wide land use planning through the Office of Policy and Management (OPM). The State Plan of Conservation and Development serves as the official state policy in matters pertaining to land and water resources conservation and development, and directs and informs decision making by the executive branch of state government. The *2018-2023 Conservation & Development Policies: The Plan for Connecticut (revised Draft)*, prepared by the Office of Policy and Management in accordance with Connecticut General Statutes Section 16a-29, identifies six growth management principles (GMPs) to direct growth and development throughout the State of Connecticut. Growth principles that address environmental issues include *Growth Management Principle #4: Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural* and *Growth Management Principle #5: Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety.*

Connecticut DEEP has developed a number of planning documents and strategies to protect water quality in embayments and Long Island Sound. As stated in Section 2.7.1, in 2000, the State of Connecticut, in partnership with USEPA and the State of New York, developed and adopted *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* (NYDEC and CT DEP, 2000). The goal of this document was "to reduce nitrogen to the levels necessary to improve dissolved oxygen concentrations and meet water quality standards" (CT DEEP, 2020, Long Island Sound Hypoxia and Nitrogen Reduction Efforts.)

The *Connecticut Second Generation Nitrogen Strategy for Long Island Sound 2017-2022* (DEEP, 2019) was developed to address hypoxia (low levels of dissolved oxygen) in Long Island Sound. The second-generation nitrogen strategy addresses nitrogen reduction efforts in three focus areas, including wastewater sewage treatment plants, stormwater and nonpoint sources, and embayments. The *Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* and *Second Generation Nitrogen Strategy for Long Island Sound* can be accessed at portal.ct.gov/DEEP/Water/LIS-Monitoring/LIS-Hypoxia-and-Nitrogen-Reduction-Efforts.

In 2012, CT DEEP developed the *Connecticut Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters*. The purpose of the TMDL was to evaluate fecal bacteria loading in fresh and estuarine waters and develop bacteria loads limits in order to meet water quality standards. To supplement the core TMDL document, DEEP developed TMDL appendices for each bacteria-impaired waterbody, including an appendix for Estuary 12: Stonington (DEEP, 2013), of which Wequetequock Cove is a part. The *Connecticut Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters* and impaired waters appendices can be accessed at portal.ct.gov/DEEP/Water/TMDL/Total-Maximum-Daily-Load.

In 2014, CT DEEP completed the *CT Pawcatuck River Watershed Bacteria TMDL*. This document complements the *TMDL Analysis for the Pawcatuck River and Little Narragansett Bay Waters: Bacteria Impairments* developed by the Rhode Island Department of Environmental Management (RIDEM) in 2010. The *CT Pawcatuck River Watershed Bacteria TMDL* is available at portal.ct.gov/-/media/DEEP/water/tmdl/CTFinalTMDL/PawcatuckWatershedTMDLFINAL. The *TMDL Analysis for the Pawcatuck River and Little Narragansett Bay Waters: Bacteria Impairments* is available at www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/lnbwdrft.pdf.

The *Integrated Water Resource Management in Connecticut* plan (DEEP, 2016) is a new approach to water resource management that utilizes existing programs and policies to develop plans to protect and restore Connecticut's waters. This approach is based on six key elements: prioritization, assessment, protection, alternatives, engagement and integration. Through the application of this approach, DEEP has developed a list of eight embayments, including the Pawcatuck River and Stony Brook Frontal embayments, for action plan development (Fig. 2-19). The Stony Brook Frontal/Fishers Island Sound watershed, of which the Anguilla Brook watershed is a part, has been selected for restoration and the Ashaway River/Lower Pawcatuck River watershed has been selected for protection. The *Integrated Water Resource Management in Connecticut* plan can be accessed at portal.ct.gov/DEEP/Water/Water-Quality/Integrated-Water-Resource-Management.

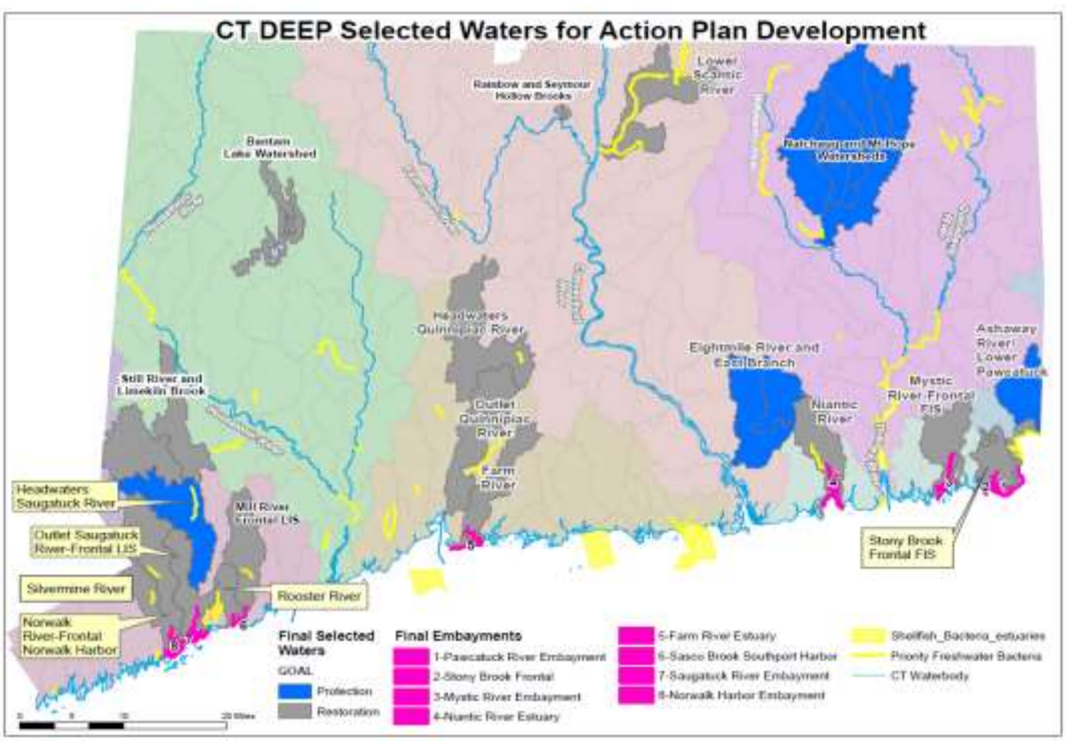


Figure 2-19. Connecticut waters selected for action plan development. (Reprinted from the 2016 DEEP Integrated Water Resource Management in Connecticut plan.)

2.7.4 Regional

Regional planning occurs through Connecticut's nine regional planning areas, each overseen by a regional planning agency (Fig. 2-20), as well as other regional organizations, such as the Southeastern Connecticut Enterprise Region (seCTer). Stonington and North Stonington are members of the Southeastern Connecticut Council of Governments (SCCOG), located in Norwich. Connecticut's planning regions, through the Councils of Government "… provide a geographic framework within which municipalities can jointly address common interests, and coordinate such interests with state plans and programs" (CT OPM, 2015).

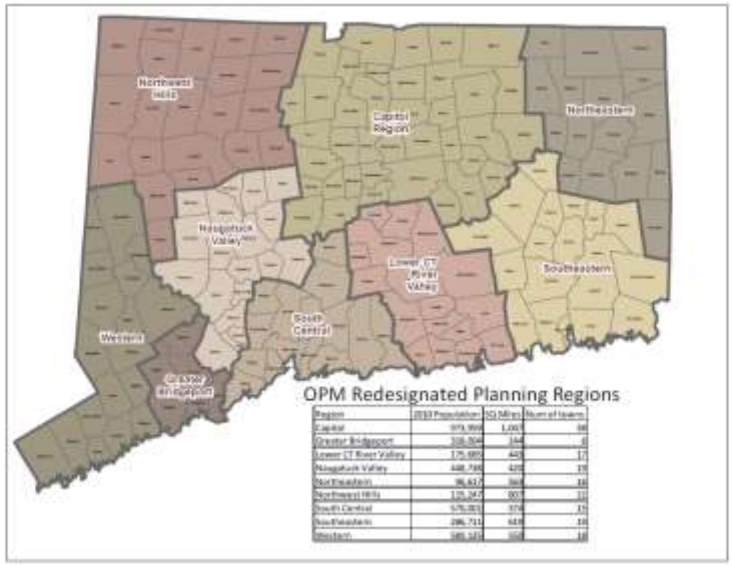


Figure 2-20. Connecticut's planning regions.

Key planning documents for southeast Connecticut include:

- Coordinated Water System Plan (Milone and MacBroom, 2016, 2017, 2018),
- Multi-Jurisdictional Natural Hazard Mitigation Plan Update (Milone and MacBroom, 2017), which includes Hazard Mitigation Plan Update Annexes for both North Stonington and Stonington,
- Municipal Infrastructure Resilience Project Critical Facilities Assessment: Final Report (SCCOG, 2019),
- Regional Plan of Conservation and Development 2017 (SCCOG, 2017),
- Regional Wastewater Management Plan (Milone and MacBroom, 2019), and
- Southeastern Connecticut Metropolitan Transportation Plan FY 2019-2045 (SCCOG, 2019).

2.7.5 Local/Municipal

Planning on the local level typically has the most direct impact on how development and resource protection are managed at the community level. Municipalities address land management policies through a variety of documents, including Plans of Conservation and Development, which towns are required by Section 8-23 of the Connecticut General Statutes to update every ten years. Other planning documents include local ordinances and municipal land use regulations, such as planning, zoning, subdivision and inland wetlands and watercourses regulations, stormwater management plans, and watershed management plans. These regulations are administered by land use commissions, boards and/or committees comprised of volunteer commissioners and guided by municipal land-use staff. The regulations may be updated or amended from time to time as necessary to ensure they provide the framework necessary for the protection of water and other natural and cultural resources.

Numerous organizations in Connecticut offer support, technical tools, assistance and training to municipal land-use commissioners and staff. These include the Center for Land Use Education and Research (CLEAR), the Connecticut Nonpoint Education for Municipal Officials (NEMO) program and the

Connecticut Institute for Resilience & Climate Adaptation (CIRCA) at the University of Connecticut, the Connecticut Conservation Districts, the DEEP Inland Wetlands Management Section, the Connecticut Association of Zoning Enforcement Officials and the Connecticut Chapter of the American Planning Association.

Following is a summary of land management regulations and policies in effect in North Stonington and Stonington at the time of the preparation of this document that address water quality concerns. Readers are advised that they should contact North Stonington and Stonington municipal land use and planning staff to obtain the most current land management regulations and policies.

North Stonington:

- 2013 North Stonington Plan of Conservation and Development,
- Inland Wetlands and Watercourses Regulations of the Town of North Stonington (Revised March 14, 2012 Effective March 22, 2012),
- Plan of Conservation and Recreation Lands of the Town of North Stonington, CT (October 3, 2013),
- Subdivision Regulations of the Town of North Stonington (March 8, 2016),
- Town of North Stonington "Level A" Aquifer Protection Area Regulations (effective September 15, 2010), and
- Zoning Regulations of the Town of North Stonington (amended July 25, 2019).

Stonington:

- Aquifer Protection Area Regulations, Stonington, CT (effective December 5, 2008),
- Regulations Providing for Standards of Subdivision Development for the Town of Stonington, CT (adopted August 8, 2016),
- Stonington Harbor Management Plan (2012),
- Town of Stonington 2015 Plan of Conservation and Development,
- Town of Stonington Inland Wetlands and Watercourses Regulations (revised October 5, 2006),
- Town of Stonington Coastal Resilience Plan (2017),
- Town of Stonington Design Review Guidelines (2009),
- Town of Stonington Open Space Plan (2007),
- Town of Stonington Zoning Regulations – Twenty Sixth Edition (amended through February 1, 2018), and
- 2017 Stormwater Management Plan - Town and Borough of Stonington.

3 Water Quality Conditions

3.1 Water Quality Standards

The regulation of the waters of the United States is authorized by the Federal Clean Water Act (1972). Section 303 of the Clean Water Act (CWA) requires all states to designate uses for all waterbodies within their jurisdictional boundaries, assign water classifications based on those designated uses, and assess waters to determine if they are meeting their designated uses. Water quality classifications serve to reinforce the designated uses for surface, ground and estuarine waters, identify criteria necessary to support those uses, and allow the development of numeric pollutant reduction targets if the water quality of a waterbody does not meet its designated use(s).

In Connecticut, the Department of Energy and Environmental Protection is charged with implementing the Clean Water Act, assigning designated uses and water classifications, and conducting water quality assessments for all waterbodies in the state (Section 22a-426 of the Connecticut General Statutes).

The *State of Connecticut Water Quality Standards* (effective October 10, 2013) establish water quality criteria. The standards can be found at the DEEP website at portal.ct.gov/DEEP/Water/Water-Quality/Water-Quality-Standards-and-Classification.

As previously stated, water quality classifications are based on designated uses. Current water quality classifications are available from the DEEP website at portal.ct.gov/DEEP/Water/Water-Quality/Water-Quality-Classification-Maps.

Water quality assessments, the evaluation of whether the quality of Connecticut waters is sufficient to meet their intended uses, are compiled in a biennial report to Congress, the *Integrated Water Quality Report (IWQR)*. The IWQR summarizes water quality assessment data (pursuant to section 305(b) of the CWA) and waterbodies that have been identified for restoration and protection strategies (pursuant to section 303(d) of the CWA). At the time of the preparation of this Plan, the most recent report was the *2020 Integrated Water Quality Report*, which is available from the DEEP website at portal.ct.gov/DEEP/Water/Water-Quality/Water-Quality-305b-Report-to-Congress.

3.1.1 Designated Uses and Water Quality Criteria

All surface waters in the Anguilla Brook watershed, including Anguilla Brook, Donahue Brook and Wheeler Brook, are designated Class A waters. Designated uses for Class A waters are:

- habitat for fish and other aquatic life and wildlife;
- recreation;
- navigation; and
- industrial and agricultural water supply.

Wequetequock Cove is designated a Class SA water. Designated uses for Class SA waters are:

- habitat for marine fish, other aquatic life and wildlife;
- shellfish harvesting for direct human consumption;
- recreation;
- industrial water supply; and

- navigation.

Water quality criteria for Class A and SA surface waters, from the *State of Connecticut Water Quality Standards* (2013), are presented in Tables 3-1, 3-2 and 3-3.

Table 3-1. Surface water criteria by classification.

Parameter	Class A	Class SA
Aesthetics	Uniformly excellent.	Uniformly excellent.
Dissolved Oxygen	Not less than 5 mg/l at any time.	Acute: Not less than 3.0 mg/l. Chronic: Not less than 4.8 mg/l with cumulative periods of dissolved oxygen in the 3.0 – 4.8 mg/l range as detailed in Note 1 to this table.
Sludge deposits-solid refuse-floating solids-oils and grease-scum	None other than of natural origin.	None other than of natural origin.
Color	None other than of natural origin.	None other than of natural origin.
Suspended and settleable solids	None in concentrations or combinations which would impair designated uses; none aesthetically objectionable; none which would significantly alter the physical or chemical composition of the bottom; none which would adversely impact aquatic organisms living in or on the bottom substrate.	None other than of natural origin.
Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, dredging activity or the discharge of dredged or fill materials provided all reasonable controls or Best Management Practices are used in such activities and all designated uses are protected and maintained.	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, dredging activity or the discharge of dredged or fill materials provided all reasonable controls or Best Management Practices are used in such activities and all designated uses are protected and maintained.
Turbidity	Shall not exceed 5 NTU over ambient levels and none exceeding levels necessary to protect and maintain all designated uses. All reasonable controls or Best Management Practices are to be used to control turbidity.	None other than of natural origin except as may result from normal agricultural, road maintenance, or construction activity, dredging activity or discharge of dredged or fill materials provided all reasonable controls and Best Management Practices are used to control turbidity and none exceeding levels necessary to protect and maintain all designated uses.
Indicator bacteria	See Table 2A of this section.	See Table 2B of this section.
Taste and odor	None other than of natural origin.	As naturally occurs.
pH	As naturally occurs.	6.8 – 8.5
Allowable temperature increase	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and, in no case exceed 85^{o} F, or in any case raise the temperature of surface water more than 4^{o} F.	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and, in no case exceed 83^{o} F, or in any case raise the temperature of the receiving water more than 4^{o} F. During the period including July, August and September, the temperature of the receiving water shall not be raised more than 1.5^{o} F unless it can be shown that spawning and growth of indigenous organisms will not be significantly affected.

Table 3-1. Surface water criteria by classification (cont.).

Parameter	Class A	Class SA
Chemical constituents	None in concentrations or combinations which would be harmful to designated uses. Refer to Table 3 of CT Water Quality Standards and sections 22a-426-4(a)(5); 22a-426-4(a)(9); 22a-426-4(a)(9)(B); 22a-426-4(a)(11); 22a-426-4(l); 22a-426-4(m); 22a-426-9(a)(3); 22a-426-9(a)(4) and 22a-426-9(a)(5) of the Regulations of Connecticut State Agencies.	
Nutrients	The loading of nutrients, principally phosphorus and nitrogen, to any surface water body shall not exceed that which supports maintenance or attainment of designated uses.	The loading of nutrients, principally phosphorus and nitrogen, to any surface water body shall not exceed that which supports maintenance or attainment of designated uses.
Sodium	None other than of natural origin.	
Biological condition	Sustainable, diverse biological communities of indigenous taxa shall be present. Moderate changes, from natural conditions, in the structure of the biological communities, and minimal changes in ecosystem function may be evident; however, water quality shall be sufficient to sustain a biological condition within the range of Connecticut Biological Condition Gradient Tiers 1-4 as assessed along a 6-tier stressor gradient of Biological Condition Gradient (See section 22a-426-5 of the Regulations of Connecticut State Agencies).	Sustainable, diverse biological communities of indigenous taxa shall be present. Moderate changes, from natural conditions, in the structure of the biological communities, and minimal changes in ecosystem function may be evident; however, water quality shall be sufficient to sustain a healthy, diverse biological community.

Table 3-2. State of Connecticut water quality criteria for indicator bacteria in freshwater (CT WQS Table 2A).

Designated Use	Class	Indicator	Criteria
Drinking Water Supply (1)	AA	Total coliform	Monthly Moving Average less than 100/100ml Single Sample Maximum 500/100ml
Recreation (2)(3) - Designated Swimming (4)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 235/100ml
Recreation - Non-designated Swimming (5)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 410/100ml
Recreation (2)(3) - All other uses	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 576/100ml

Table Notes for CT WQS Tables 2A and 2B:

(1) Criteria applies only at the drinking water supply intake structure.
(2) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23.
(3) See section 22a-426-9(a)(2) of the Regulations of Connecticut State Agencies.
(4) Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protection and the Department of Public Health, May 1989, revised April 2003 and updated December 2008.
(5) Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.
(6) Criteria are based on utilizing the mTec method as specified in the U.S. Food and Drug Administration National Shellfish Sanitation Program-Model Ordinance (NSSP-MO) document Guide for the Control of Molluscan Shellfish 2007.

Table 3-3. State of Connecticut water quality criteria for indicator bacteria in saltwater (CT WQS Table 2B).

Designated Use	Class	Indicator	Criteria
Shell fishing [6] – Direct consumption	SA	Fecal coliform	Geometric mean less than 14/100 ml 90% of samples less than 31/100 ml
Shell fishing [6] – Indirect consumption	SB	Fecal coliform	Geometric mean less than 88/100 ml 90% of samples less than 260/100 ml
Recreation - Designated Swimming [4]	SA, SB	*Enterococci*	Geometric Mean less than 35/100ml Single Sample Maximum 104/100ml
Recreation - All other uses	SA, SB	*Enterococci*	Geometric Mean less than 35/100ml Single Sample Maximum 500/100ml

3.1.2 Antidegradation Policies

The Clean Water Act requires that states and tribes establish a three-tiered anti-degradation policy to protect water quality. An anti-degradation policy is a “framework and methodology for deciding if, when, and how water quality that exceeds the CWA 101(a) goal can be degraded by regulated activities and when that water quality must be maintained” by identifying steps and questions that need to be addressed when specific activities affect water quality. Tier 1 of the anti-degradation procedures is applicable to all surface waters. It maintains and protects current uses and water quality conditions to support existing uses. Current uses are identified by showing that fishing, swimming, and other water uses have occurred and are suitable since November 28, 1975. Tier 2 maintains and protects water bodies with existing conditions that are better able to support CWA 101(a)(2) "fishable/swimmable" uses. Tier 3 maintains and protects water quality in outstanding national resource waters, which are the highest quality waters in the US (USEPA, 2015).

The Clean Water Act further specifies that states must identify implementation methods that:

- protect existing uses,
- authorize the lowering of water quality in high quality waters, where necessary for social or economic importance, and
- provide mechanisms to provide additional protection for water of exceptional ecological or recreational significance.

Connecticut’s Anti-Degradation Standards and Anti-Degradation Implementation Policies (Section 22a-426-8 of the Connecticut General Statutes) are fully defined in the 2013 Connecticut Water Quality Standards.

3.2 WATER QUALITY/RESOURCE DATA

3.2.1 Impaired Uses and/or Water Quality Threats

Wequetequock Cove has not been meeting its designated uses for recreation, habitat for marine fish, other aquatic life and wildlife, or the direct consumption of shellfish. Causes of the impairments include algae and estuarine bioassessments (DEEP, 2020). Suspected bacteria sources include illicit discharges, failing septic systems, marinas, stormwater runoff and nuisance wildlife and pets (DEEP, 2013). Suspected sources of other pollutants, including nutrients, may include stormwater runoff, agriculture activities throughout the watershed, and residential and commercial fertilizer use.

Within the Anguilla Brook watershed, as reported in the 2020 Connecticut Integrated Water Quality Report, which incorporated water quality data collected as part of the Anguilla Brook bacteria track down, Anguilla Brook (CT2101-00_01) and the unnamed tributary to Wheeler Brook (CT2101-02_01) were assessed as fully supporting their designated recreational uses, while Wheeler Brook (CT2101-01_01) and Donahue Brook (CT2101-03_01) were assessed as not supporting their designated recreational uses. Wheeler Brook, the unnamed tributary to Wheeler Brook, and Donahue Brook have not been assessed for habitat for fish, other aquatic life and wildlife, and insufficient information exists to assess Anguilla Brook for habitat for fish, other aquatic life and wildlife.

Inner Wequetequock Cove discharges to the outer portion of Wequetequock Cove and Little Narragansett Bay. Outer Wequetequock Cove, which is the portion of the cove that is south of the Amtrak railroad, is comprised of the Wequetequock Cove estuary (CT-E2_001) and the Stonington Point estuary (CT-E2_002). Both of these estuaries are embayments of Little Narragansett Bay (CT-E3_001). Like Inner Wequetequock Cove, both estuaries and Little Narragansett Bay are designated class SA waters, and are impaired for their designated uses (recreation, habitat for marine fish, other aquatic life and wildlife, and the direct consumption of shellfish).

Water quality in Little Narragansett Bay is significantly influenced by the Pawcatuck River, which discharges to it at the Connecticut-Rhode Island border in Pawcatuck, CT and Westerly, RI. The Pawcatuck River carries heavy nutrient loads from multiple sources including several sewage treatment plants upstream in Connecticut and Rhode Island and bacteria loads from urban areas including Pawcatuck and Westerly. Most of the discharge from the Pawcatuck River flows into Fishers Island Sound; however, approximately 30% of the discharge flows to Little Narragansett Bay (Vaudrey, 2016), where, due to poor flushing, it has a relatively long residence time. Additionally, that discharge is tidally transported into Wequetequock Cove, where it impacts water quality and aquatic habitat. According to Vaudrey (2016), the 30% of discharge from the Pawcatuck River that flows into Little Narragansett Bay contributes as much as 93% of the total nitrogen load. In 2019, CT DEEP and Rhode Island Department of Environmental Management (RIDEM) began collaborating on a Pawcatuck nutrient project to address nutrient pollution in Little Narragansett Bay. Additional information about that project can be found at portal.ct.gov/DEEP/Water/TMDL/Pawcatuck-Watershed-Nutrient-Project.

3.2.2 Water Quality Data

ECCD collected fecal bacteria data from Anguilla Brook (CT2101-00_01), Wheeler Brook (CT2101-01_01), an unnamed tributary to Wheeler Brook (CT2101-02_01), and Donahue Brook (CT2101-03_01) in 2019 as part of the development of this Plan (Table 3-4 and Fig. 3-1). ECCD developed a bacteria monitoring plan in consultation with DEEP TMDL Program staff and revised a previously approved bacteria sampling quality assurance project plan (QAPP). Water samples were collected once a week for ten weeks from June to August 2019, utilizing the QAPP protocols in accordance with the approved monitoring plan. Water samples were processed by the Connecticut Department of Public Health (DPH) Laboratory in Rocky Hill, CT for *Escherichia coli* (Table 3-5). Water samples collected at the lowermost site on Anguilla Brook (AB-01), were also analyzed for fecal coliform and enterococcus (Table 3-6). Bacteria analysis results were reported to Ledge Light Health District and submitted to CT DEEP in October 2019 for consideration in DEEP's 2022 Integrated Water Quality Assessment. The fecal bacteria summary report is included in Appendix A.

Table 3-4. Locations and descriptions of the bacteria sampling sites in the Anguilla Brook watershed

Site ID	Stream Name	Location/Description
AB-01	Anguilla Brook	off Trolley Crossing – at outlet of Chesebrough Pond above the salt-water limit; downstream-most site on Anguilla Brook
AB-02	Anguilla Brook	at RT 1 Handlebar Plaza – same location as the UConn PATH sampling site; downstream of agricultural and commercial uses
AB-03	Anguilla Brook	At the end of Anguilla Brook Road – downstream of residential, agriculture and recreational uses
AB-04	Anguilla Brook	at RT 184 – upstream-most site; downstream of agricultural uses
WB-01	Wheeler Brook	upstream of the confluence with Anguilla Brook at end of Miner Pentway; downstream of agricultural uses
WB-02	Wheeler Brook	at Taugwonk Road – upstream of the confluence with Stony Brook; downstream of agricultural uses
WB-03	Wheeler Brook	at RT 184 – upstream-most site; downstream of residential use
UN-01	Unnamed stream	upstream of confluence with Wheeler Brook; downstream of agricultural uses
UN-02	Unnamed stream	at Stony Brook Rd – upstream-most site on the unnamed stream
DB-01	Donahue Brook	upstream of the confluence with Oxocossett Brook above the salt-water limit; downstream of agricultural uses; tributary to Wequetequock Cove
DB-02	Donahue Brook	at Barnes Road – upstream-most site on Donahue Brook

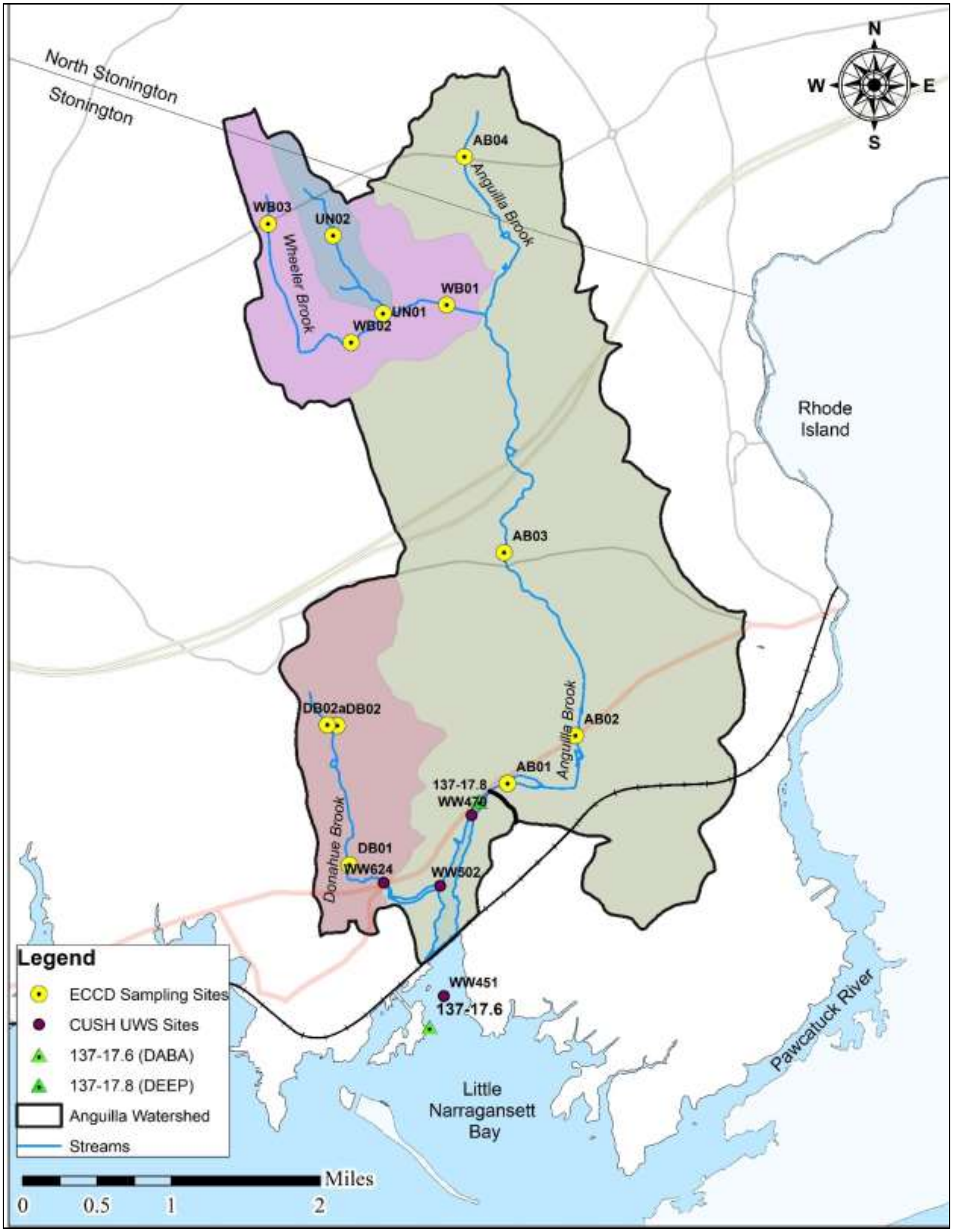


Figure 3-1. Fecal bacteria sampling sites in the Anguilla Brook watershed in North Stonington and Stonington, Connecticut.

Table 3-5. Fecal bacteria (E. coli) sampling results. ***Bolded*** *figures exceeded established water quality standards.*

Anguilla Brook Watershed *E. coli* Sampling Results (MPN/100 ml[1])											
Sampling Site/ Date	6/24/19	7/1/19	7/8/19	7/15/19	7/22/19	7/29/19	8/5/19	8/12/19	8/19/19	8/26/19	Geomean
AB01	98	160	31	41 (10)	31	130	10	41 (<10)	280	31	42
AB02	180	110	120 (180)	75	95	170	63	52	540	74	119
AB03	150	150	96	160	200	97	20	52	420	86 (75)	106
AB04	120	400	**2,200**	280	420	41	52 (41)	<10	52	41	108
WB01	*DNS*	260	85	63	**20,000**	210	270	<10	510	10	**163**
WB02	120	200 (170)	220	260	230	200 (86)	51	**1,300**	450	310	**213**
WB03	250	460	110	**590**	**3,700**	250	86	290	**1,100**	96	**336**
UN01	31 (41)	63	260	180	96 (85)	31	52	52	340	20	71
UN02	74	52	63	120	130	62	20	*DNS*	360	360	95
DB01	*DNS*	97	**4,400**	310	260	120	86	170	**1,700**	280	**313**
DB02	97	180	110	*DNS*	*DNS*						124
DB02a[2]						98	260	**1,400**	350 (380)	52	**250**
Wet/ Dry	dry	wet	dry	dry	dry	dry	dry	dry	wet	dry	

Notes:
[1]MPN/100 ml - *E. coli* is measured as the most probable number (MPN) of colonies per 100 ml water sample
[2] Two branches of Donahue Brook emerged from a wooded wetland/stream complex north of Barnes Road. The west branch dried up; sampling switched to the east branch which had adequate flow.
DNS - did not sample
Number in parentheses is a duplicate sample collected for quality control purposes
Single sample limit for *E. coli* for Recreation – all other uses is 576 colony-forming units (CFU)/100 ml - CFU = MPN
Geometric mean limit for *E. coli* for Recreation – all other uses is less than 126 CFU/100 ml

Table 3-6. Fecal bacteria (Enterococci and fecal coliform) results at Site AB-01, Anguilla Brook at the Chesebrough Pond outlet off Trolley Crossing

Date	Enterococci[1] (MPN/100 ml[3])	Fecal Coliform[2] (MPN/100 ml)
6/24/2019	97	110
7/1/2019	41	200
7/8/2019	20	10
7/15/2019	<10 (10)[4]	41 (20)
7/22/2019	41	31
7/29/2019	52	52
8/5/2019	74	31
8/12/2019	10 (10)	<10 (41)
8/19/2019	300	428
8/26/2019	<10	31
Water Quality Standards Criteria	Single sample maximum for recreation – all other uses: 500/100 ml	90% of sample less than 31/100 ml = 50%
	Geomean: less than 35/100 ml = 29	Geomean: less than 14/100 ml = **44**

Notes:

[1] Enterococci is the indicator bacteria for recreation.

[2] Fecal coliform is the indicator bacteria for the consumption (direct and indirect) of shellfish.

[3] MPN/100 ml – Fecal coliform and enterococcus are measured as the most probable number (MPN) of colonies per 100 ml water sample.

[4] The number in parentheses is a duplicate sample collected for quality control purposes.

A fairly robust body of water quality data exists for the Anguilla Brook watershed and Wequetequock Cove. In addition to stream bacteria data collected by ECCD in 2019, water quality data has been collected by Clean Up Sounds and Harbors (CUSH), the Connecticut Department of Agriculture Bureau of Aquaculture (DABA), and the University of Connecticut.

Clean Up Sounds and Harbors (CUSH) is a Stonington-based volunteer organization. Founded in 2007, CUSH began collecting water quality data including nutrient (nitrogen) and bacteria data at the mouth of Wequetequock Cove in 2008 under the guidance of the University of Rhode Island Watershed Watch (www.uri.edu/ce/wq/ww). Wequetequock Cove Inlet and Head were added in 2011 and Oxecosset Brook was added in 2016. In 2017, CUSH became a participant in the Long Island Sound Unified Water Study lead by Save The Sound. Wequetequock Cove is one of three bays monitored by CUSH as part of the study. Wequetequock Cove sampling sites in are depicted in Fig. 3-1. Fecal bacteria data and total nitrogen data collected in 2019 are provided in Table 3-7.

The **Connecticut Department of Agriculture Bureau of Aquaculture** (DABA) collects fecal coliform bacteria data at the head of Wequetequock Cove and in outer Wequetequock Cove along the east side of Elihu Island (stations 137-17.8 and 137-17.6; Fig. 3-1). DABA also conducts periodic shellfish sanitary surveys to determine that shellfish growing areas are meeting criteria for their current classification. From the DABA website, "The sanitary survey identifies all actual and potential pollution sources, and their impact upon a growing area, reviews bacteriological quality of waters in the growing area, analyses [*sic*] meteorological, hydrodynamic, and geographic characteristics of the growing area, evaluates changes in land use and their potential to impact the growing area, evaluates the performance of sewage treatment plants, and looks for any failing septic systems. The NSSP MO [National Shellfish Sanitation Program Model Ordinance] requires sanitary surveys to be re-evaluated and updated yearly, reviewed and updated every three years, and repeated every 12 years" (portal.ct.gov/DOAG/Aquaculture1/Aquaculture/Shellfish-Sanitation-Program).

The **Connecticut Department of Energy and Environmental Protection** (DEEP) used water quality data collected by DABA at station 137-17.8 (at the head of Wequetequock Cove) from 2003 – 2011 in support of the development of a fecal bacteria total maximum daily load (TMDL) for Wequetequock Cove (see Section 4.1.2.2). Based on this data, DEEP determined that an 86% reduction in fecal coliform bacteria levels was required to meet the geometric mean and a 90% reduction in fecal coliform bacteria levels was required for 90% of the samples to be less than 31 colonies/100 ml. At the time of the preparation of this watershed-based plan, DEEP TMDL staff were in the process of developing a new TMDL for inner Wequetequock Cove and other Stonington estuaries. Watershed managers are encouraged to review the 2021 Stonington estuaries bacteria TMDL when it becomes available. The 2013 bacteria TMDL Appendix for Estuary 12: Stonington is available from CT DEEP at:

portal.ct.gov/-/media/DEEP/water/tmdl/CTFinalTMDL/estuary12stonington.

Researchers from the **University of Connecticut** have collected water quality data in the Anguilla Brook and Wequetequock Cove. As part of a USDA-NRCS Regional Conservation Partnership Program (RCPP) grant "PATH to Reduce Pathogens in CT Agricultural Runoff," researchers from the UConn Department of Natural Resources and the Environment collected water samples in 2017 at the US Route 1 crossing of Anguilla Brook for fecal bacterial analysis. In 2013 and 2014, researchers from the Marine Sciences Department at UConn Avery Point collected water quality data from Wequetequock Cove as part of the Long Island Sound embayment study (Vaudrey, 2016).

Table 3-7. CUSH water quality data from Wequetequock Cove sampling sites for 2019

CUSH 2019 Water Quality Data for Wequetequock Cove				
Monitoring Location	Sample Date	Parameter		
		Enterococci (MPN/100 mL)	Fecal coliform (MPN/100mL)	Nitrogen, Total (unfiltered) ug/l
WW470 - Wequetequock Cove – Head (dock close to head of cove)	5/29/2019	20	31	535
	6/19/2019	345	1,314	985
	7/24/2019	2,005	1,091	840
	8/28/2019	53	64	820
	9/25/2019	63	74	650
	10/16/2019	1	10	-
	10/19/2019	-	-	550
	Geomean	*60*	*113*	*712*
WW502 -Wequetequock Cove Inlet (south of Coveside Marina)	5/29/2019	30	20	355
	6/19/2019	30	121	495
	7/24/2019	2,006	2,006	845
	8/28/2019	42	87	480
	9/25/2019	85	164	500
	10/16/2019	1	10	-
	10/19/2019	-	-	-
	Geomean	*43*	*94*	*513*
WW624 - Oxecosset Brook (north side of Route 1 bridge)	5/29/2019	1,658	2,755	710
	6/19/2019	1,259	1,918	985
	7/24/2019	2282	3,130	1,140
	8/28/2019	207	238	670
	9/25/2019	784	933	825
	10/16/2019	73	52	680
	Geomean	*619*	*759*	*818*
WW451 - Wequetequock Cove – Mouth (between Goat & Barn Islands)	5/29/2019	41	10	350
	6/19/2019	10	41	365
	7/24/2019	2,005	1,091	740
	8/28/2019	20	1	340
	9/25/2019	63	31	305
	10/16/2019	1	1	-
	10/19/2019	-	-	250
	Geomean	*32*	*15*	*367*

3.2.3 Stream Corridor Assessments

In the fall of 2019, ECCD and volunteers conducted riparian corridor assessments in the Anguilla Brook watershed. Using the Streamwalk protocol developed by the Connecticut office of the USDA NRCS

(2005), ECCD conducted evaluations of the two streams, Wheeler Brook and Donahue Brook, that did not meet Connecticut water quality standards for fecal bacteria and Inner Wequetequock Cove. The purpose of the assessments was to identify any conditions along or adjacent to the stream corridors and the Cove shoreline that could contribute to the documented water quality conditions. The streamwalk data, which included field notations, GPS locations and digital photographs, were compiled into a database for evaluation as part of the development of this Plan. The documented conditions, identified as "Areas of Concern," are quantified by waterbody in Table 3-8 below. The Visual Stream Corridor Assessment report is included in Appendix B.

Table 3-8. Summary of the visual stream corridor assessment data from streams in the Anguilla Brook watershed that exceeded water quality standards for recreation (E. coli) and the visual shoreline assessment of Wequetequock Cove.

Area of Concern	Wequetequock Cove	Donahue Brook	Wheeler Brook	Total
Degraded Buffer	6	3	6	**15**
Fish Barrier	0	4	3	**7**
Stormwater Outfall	0	0	3	**3**
Visual Water Conditions	0	1	2	**3**
Erosion	0	0	2	**2**
Trash/Debris	1	1	0	**2**
Modified Channel	0	1	0	**1**

3.2.4 Other Data

Nitrogen Loading to Long Island Sound Embayments: From 2011 – 2015, researchers from the Department of Marine Sciences at the University of Connecticut conducted a study on nitrogen loading to Long Island Sound, *Comparative analysis and model development for determining the susceptibility to eutrophication of Long Island Sound embayments* (Vaudrey et al., 2016). This study, funded by the Long Island Sound Study, CT Sea Grant and NY Sea Grant, evaluated nitrogen loading to 110 embayments on Long Island Sound in Connecticut and New York. The study found that while embayments contributed only about 20% of the nitrogen load to Long Island Sound (the four primary rivers contributed ~80%), nitrogen loading to embayments could be substantial and have significant impacts on the water quality in individual embayments. As part of the project, a Long Island Sound nitrogen loading model was developed. The model predicts nitrogen loading to embayments based on well-researched nitrogen loading coefficients associated with various land covers and land uses. In the Wequetequock Cove/Anguilla Brook watershed, the model estimates a total nitrogen load of 14,510 kilograms (kg) nitrogen (N) per year. Approximately 57% of nitrogen is estimated to come from fertilizer, 23% from septic systems or cesspools, 12% from the atmospheric deposition of nitrogen to the watershed (land),

and 8% from the atmospheric deposition of nitrogen to the estuary. The model further estimates that about 8% of the load is derived from sources within 200 feet of the estuary, 65% of the load is derived from sources more than 200 foot from the estuary that drain directly to the estuary, and 27% of the load is derived from sources more than 200 foot from the estuary that drain indirectly to the estuary.

As part of the embayment study, a biomass survey of the green algae *Cladophora sp.* was conducted in the Pawcatuck River, Little Narragansett Bay and Wequetequock Cove in 2014 (Fig. 3-2). The eutrophication of those waterbodies has resulted in the excessive growth of *Cladophora*. According to Vaudrey, "Wequetequock Cove exhibits long periods of both hypoxia and supersaturation. This is attributable to a massive bloom of a fine green alga, *Cladophora sp*." In 2014, the *Cladophora* mat in Wequetequock Cove was 2 to 10 mm thick.

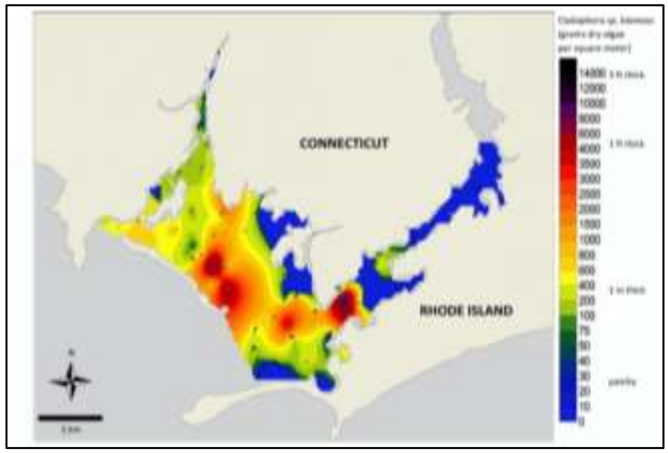


Figure 3-2. Biomass survey of the green algae Cladophora sp. (reprinted from Vaudrey, 2016).

Additional information about the embayment study and nitrogen loading to Long Island Sound can be found at vaudrey.lab.uconn.edu/embayment-n-load/.

Pawcatuck River and Little Narragansett Bay Watershed Management Project: CT DEEP and the Rhode Island Department of Environmental Management (RIDEM) partnered in 2018 to develop a watershed model and management plan for the Wood-Pawcatuck watershed to reduce nutrient loads in the Pawcatuck River and Little Narragansett Bay. Water quality data collected from 2019 – 2020 will be used to develop a watershed model. The project is scheduled for completion in September 2022. Additional information about this project, including water quality data, can be found at portal.ct.gov/DEEP/Water/TMDL/Pawcatuck-Watershed-Nutrient-Project.

4 Pollutant Loads and Load Reductions

4.1 Estimation of Pollutant Loads and Load reduction Targets

The estimation of pollutant loads is a critical element in the overall process of watershed-based planning, and is necessary in order to determine the pollutant load reduction that is needed to restore the quality of an impaired waterbody. In order to identify where pollutant load reductions may be addressed to improve water quality, it is necessary to quantify the pollutant load contributions from the watershed. Where water quality measurements are made, it is possible to determine pollutant loading directly. When no water quality data is available, the use of models can be used to estimate pollutant loading. It should be noted that due to the complexity of watershed processes, models are inherently imprecise, and should be used to guide watershed management decision-making and not as a predictor of future water quality.

Nitrogen and fecal bacteria are the primary pollutants of concern in Wequetequock Cove. As previously stated, inner Wequetequock Cove is impaired for aquatic habitat, recreation and the direct consumption of shellfish. These impairments are related to nutrient enrichment (eutrophication) that has rendered water quality unsuitable for aquatic wildlife and sea grass, and the presence of fecal bacteria (and other potentially harmful pathogens) in the water that make recreational activities and the direct consumption of shellfish unsafe.

4.1.1 Fecal Bacteria Load Estimates

ECCD collected fecal bacteria data from streams in the Anguilla Brook/Inner Wequetequock Cove Watershed in 2019. ECCD also reviewed bacteria data and bacteria load reductions in the Stonington Estuary TMDL prepared by DEEP in 2013, and data collected by CUSH in Wequetequock Cove in 2019. ECCD used the Watershed Treatment Model (2013 "Off the Shelf" edition), developed by the Center for Watershed Protection, to estimate other watershed pollutant loads based on existing land use conditions. The Watershed Treatment Model (WTM) is derived from the Simple Method (Schueler, 1987). The Simple Method uses parameters including watershed area, annual rainfall, runoff coefficients, and selected pollutant concentrations (in mg/l) to estimate annual pollutant loads. The WTM incorporates additional elements into the Simple Method model, such as existing structural and behavioral management practices that may reduce existing pollutant loading, the effects of the adoption or implementation of future management practices on pollutant loading, and the effects of future development in the subject watershed on existing loading levels.

ECCD collected *E. coli* bacteria data from perennial streams throughout the watershed in 2019 (Fig. 3-1 and Table 3-5). Additionally, water samples collected from the lowermost site on Anguilla Brook (AB-01), located at the outlet of Chesebrough Pond, were analyzed for enterococci and fecal coliform (Table 3-6). It should be noted that there is no standard for enterococci or fecal coliform in freshwater. These data were collected to determine if Anguilla Brook was a significant source of either bacteria in the brackish Wequetequock Cove. Based on the data collected, Donahue Brook and Wheeler Brook did not meet water quality standards for *E. coli* bacteria, and it appears Anguilla Brook may be a source of fecal coliform bacteria to Wequetequock Cove. Water quality data collected by DABA from 2003-2011 at Wequetequock Cove at US RT 1 (Station 137-17.8 on Fig. 3-1), and used by DEEP to develop the Inner

Wequetequock Cove Bacteria TMDL, are provided in Section 4.1.2.2. Data collected by CUSH in 2019 for the Unified Water Study are provided in Section 3, Table 3-7 and are summarized in Section 4.1.2.2.

4.1.2 Fecal Bacteria Load Reductions

4.1.2.1 *Stream Bacteria Load Reductions*

Bacteria load reductions required for streams in the Anguilla Brook/Inner Wequetequock Cove Watershed to meet water quality standards are presented in Table 4-1.

Table 4-1. E. coli loads and load reductions for stream sampling sites in the Anguilla Brook/Inner Wequetequock Cove Watershed.

2019 Anguilla Brook/Inner Wequetequock Cove Watershed *E. coli* Loads and Load Reductions[1]			
Site	Description	Geometric Mean (MPN/100mL)	% Reduction to Meet WQS
AB01	Anguilla Brook at 11 Trolley Crossing	42	-
AB02	Anguilla Brook at Rt 1 (Handle Bar Plaza)	119	-
AB03	Anguilla Brook at Anguilla Brook Road	106	-
AB04	Anguilla Brook at Rt 184	108	-
WB01	Wheeler Brook at 215 Miner Pentway	163	23
WB02	Wheeler Brook at Taugwonk Road	213	41
WB03	Wheeler Brook at Rt 184	336	62
DB01	Donahue Brook at 711 Stonington Road	313	60
DB02	Donahue Brook at Barnes Road - west branch	124	-
DB02Alt	Donahue Brook at Barnes Road - east branch	250	50
UN01	unnamed brook at 456 Taugwonk Road	71	-
UN02	unnamed brook at Stony Brook Road	95	-

[1] ECCD applied the Connecticut Water Quality Standards single sample criteria for "Freshwater – All other recreational uses" of 576 cfu/100ml and the maximum sample set geometric mean of less than 126 cfu/100 ml to evaluate the water quality data and determine the load reductions necessary to comply with established water quality standards.

4.1.2.2 *Wequetequock Cove Bacteria Load Reductions*

Fecal bacteria loads and load reductions for water samples collected in Wequetequock Cove by the CT Department of Agriculture Bureau of Aquaculture and CUSH are presented in Tables 4-2 and 4-3, respectively. CT DEEP applied water quality criteria for fecal coliform (the indicator bacteria for the direct consumption of shellfish) in class SA waters to the DA/BA data to develop of the 2013 Inner Wequetequock Cove Bacteria TMDL:

Geometric mean:	14 colonies/100 ml
90% of samples less than:	31 colonies/100 ml

Based on these criteria, an 86% reduction in fecal coliform bacteria levels was required to meet the geometric mean and a 90% reduction in fecal coliform bacteria levels was required for 90% of the samples to be less than 31 colonies/100 ml.

Table 4-2. CT DEEP 2012 TMDL cycle single sample fecal coliform data for Station 137-17.8, Wequetequock Cove at US RT 1, from 2003-2008 (from Stonington Estuary TMDL, CT DEEP, 2013).

Date	Results	Wet/Dry	Geomean	90% Reduction
4/1/2003	29	Wet	96.5	40
9/2/2003	321	Wet		
3/8/2004	11	Dry	38.8	40
4/28/2004	137	Wet		
1/4/2005	22	Wet	22	n/a
4/11/2006	9	Dry	9	n/a
1/2/2007	171	Wet	51	90
5/13/2008	170	Dry	86	90
4/7/2009	171	Wet	97.9	90
10/21/2009	56	Dry		

In 2019, CUSH collected water samples at three sites in the inner Wequetequock Cove (WW470, WW502 and WW624) as well as one site at the mouth of outer Wequetequock Cove (WW451). The sites within inner Wequetequock Cove did not meet water quality standards for recreation (enterococci) or the direct consumption of shellfish (fecal coliform). Load reductions necessary to meet water quality standards are presented in Table 4-3.

Table 4-3. Fecal bacteria loads and load reductions for CUSH Unified Water Study sampling sites in Wequetequock Cove.

2019 CUSH Wequetequock Cove Fecal Bacteria Loads and Load Reductions					
Site	Description	Enterococci[1]		Fecal Coliform[2]	
		Geometric Mean (MPN/100mL)	% Reduction to Meet WQS	Geometric Mean (MPN/100mL)	% Reduction to Meet WQS
WW470	Head of Wequetequock Cove	60	42	113	88
WW502	Inlet near Cove Marina	43	19	94	85
WW624	Oxecosset Brook at US RT 1	619	94	759	98
WW451	Mouth of Wequetequock Cove (located in outer cove)	32	-	15	7

[1] All other recreational uses, geometric mean less than 35/100 ml and single sample maximum 500/100 ml.
[2] Direct consumption of shellfish in Class SA waters, geometric mean less than 14/100 ml and 90% of samples less than 31/100 ml.

4.1.3 Watershed Pollutant Load Estimates

4.1.3.1 *Wequetequock Cove Nitrogen Loads*

Although nitrogen is a significant pollutant of concern in Wequetequock Cove, nitrogen data was not collected by ECCD as part of the water quality investigation. Instead, ECCD reviewed water quality data collected by CUSH in Wequetequock Cove in 2019 as part of the Unified Water Study, including total nitrogen (see Table 3-7 in Section 3).

4.1.3.2 *Watershed Pollutant Loads*

Loads for watershed pollutants other than *E. coli*, such as sediment, nutrients (phosphorus and nitrogen) and fecal coliform, were modeled by ECCD using the Watershed Treatment Model (WTM; "Off the Shelf" edition, Center for Watershed Protection, 2013). The WTM is a spreadsheet-based model that estimates primary and secondary watershed pollutant loads based on existing land use conditions and areas, annual rainfall amounts, hydrologic soil groups and loading coefficients for common non-point source pollutants such as those identified in Section 5.1. Primary loads are those that can be determined solely by land use and/or land cover. Secondary loads include pollutant sources that cannot be determined by land use/land cover and require additional model data input, such as wastewater treatment plants, on-site septic systems, illicit connections and CSO/SSOs.

The following land uses were included in the model:

- LDR - Low density residential (less than one dwelling unit per acre)
- MDR - Medium density residential (1-4 dwelling units per acre)
- HDR - High density residential (greater than four dwelling units per acre)
- Commercial Development
- Industrial Development
- Roadways
- Forest
- Pasture/Hay
- Cropland
- Open Water.

In addition to pollutant loading from the land uses listed above, pollutant loading from other potential sources in the watershed were evaluated, including:

- On-site subsurface sewage disposal systems
- Stream channel erosion
- Livestock.

Finally, existing structural and non-structural management practices were incorporated into the model, including:

- Riparian (stream corridor) buffers
- Erosion and sediment controls
- Lawn management practices
- Pet waste management practices.

Common NPS pollutants that were modeled using the Watershed Treatment Model include total phosphorus (TP), total nitrogen (TN), total suspended sediments (TSS) and fecal coliform (FC). The Anguilla Brook/Wequetequock Cove sub-watersheds that were included in the model are depicted in Figure 4-1. Modeled pollutant loads and annual pollutant yields by sub-watershed are presented in Table 4-4. Modeled pollutant loads for the watershed land use types are presented in Table 4-5. Modeled pollutant loads (pounds per year) and yields (pounds per acre per year) by sub-watershed are presented in Figures 4-2 to 4-5. Pollutant loads and yields for each modeled pollutant by land use/land cover type are presented in Figures 4-6 to 4-9.

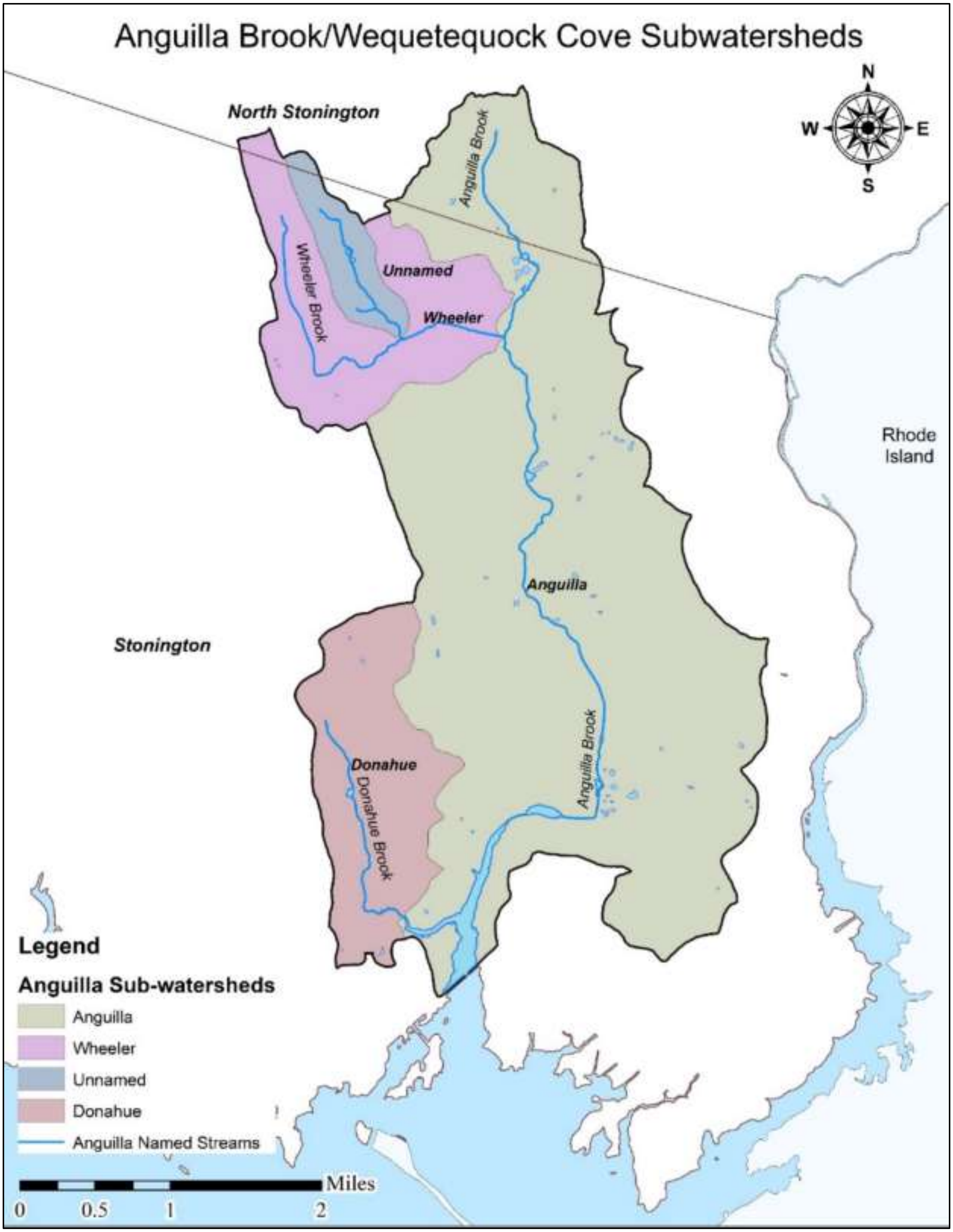


Figure 4-1. Sub-watersheds in the Anguilla Brook/Inner Wequetequock Cove Watershed.

Table 4-4. NPS Pollutant loads and pollutant yields by sub-watershed, modeled using the Center for Watershed Protection Watershed Treatment Model. Pollutant loads represent the aggregate mass export of pollutant from each sub-watershed in pounds per year. Pollutant yields represent the areal mass export of pollutant in pounds per acre per year. Loads include primary and secondary sources.

Anguilla Brook/ Wequetequock Cove Sub-watershed	Existing Pollutant Loads (lbs/year)				Existing Pollutant Yields (lbs/ac/year)			
	TN	TP	TSS	Fecal Coliform (billions/yr)	TN	TP	TSS	Fecal Coliform (billions/ac)
Anguilla Brook (5,657acres)	26,730	4,037	997,075	557,687	4.7	0.7	176	99
Wheeler Brook(995 acres)	4,697	647	191,265	76,326	4.7	0.7	192	77
Unnamed Brook (247 acres)	1,187	186	60,739	24,437	4.8	0.8	246	99
Donahue Brook (993 acres)	4,606	564	183,258	64,261	4.6	0.6	185	65
Watershed Total (7,892 acres)	**37,221**	**5,434**	**1,432,337**	**722,710**	4.7	0.7	181	92

Table 4-5. NPS Pollutant Loads by land use/land cover type in the Anguilla Brook/Inner Wequetequock Cove Watershed modeled using the Center for Watershed Protection Watershed Treatment Model. Pollutant loads represent the aggregate mass export of pollutant from each land/land cover use in pounds per year. Pollutant yields represent the areal mass export of pollutant for each land use/land cover in pounds per acre per year. Loads are based on primary sources only.

Land Use/Land Cover	Existing Pollutant Loads (lbs/year)				Existing Pollutant Yields (lbs/ac/year)			
	TN	TP	TSS	Fecal Coliform (billion/yr)	TN	TP	TSS	Fecal Coliform (billions/ac)
Residential (1,744 acres)	9,730	1,436	227,039	422,341	5.6	0.8	130	242
Commercial (107 acres)	1,588	166	32,517	68,928	14.8	1.6	304	644
Roadways (323 acres)	5,701	620	332,163	225,946	17.7	1.9	1028	700
Forest (4,373 acres)	10,937	875	437,460	52,495	2.5	0.2	100	12
Rural/ Agriculture (1,170 acres)	5,381	819	116,970	45,618	4.6	0.7	100	39
Water (177 acres)	2,259	88	27,358	0	12.8	0.5	155	0
Active Construction/ Barren (0.2 acres)	1	0.2	656	0	5.0	1.0	3,280	0
Land Cover Total (7,892 acres)	**35,597**	**4,005**	**1,174,162**	**815,330**	-	-	-	-

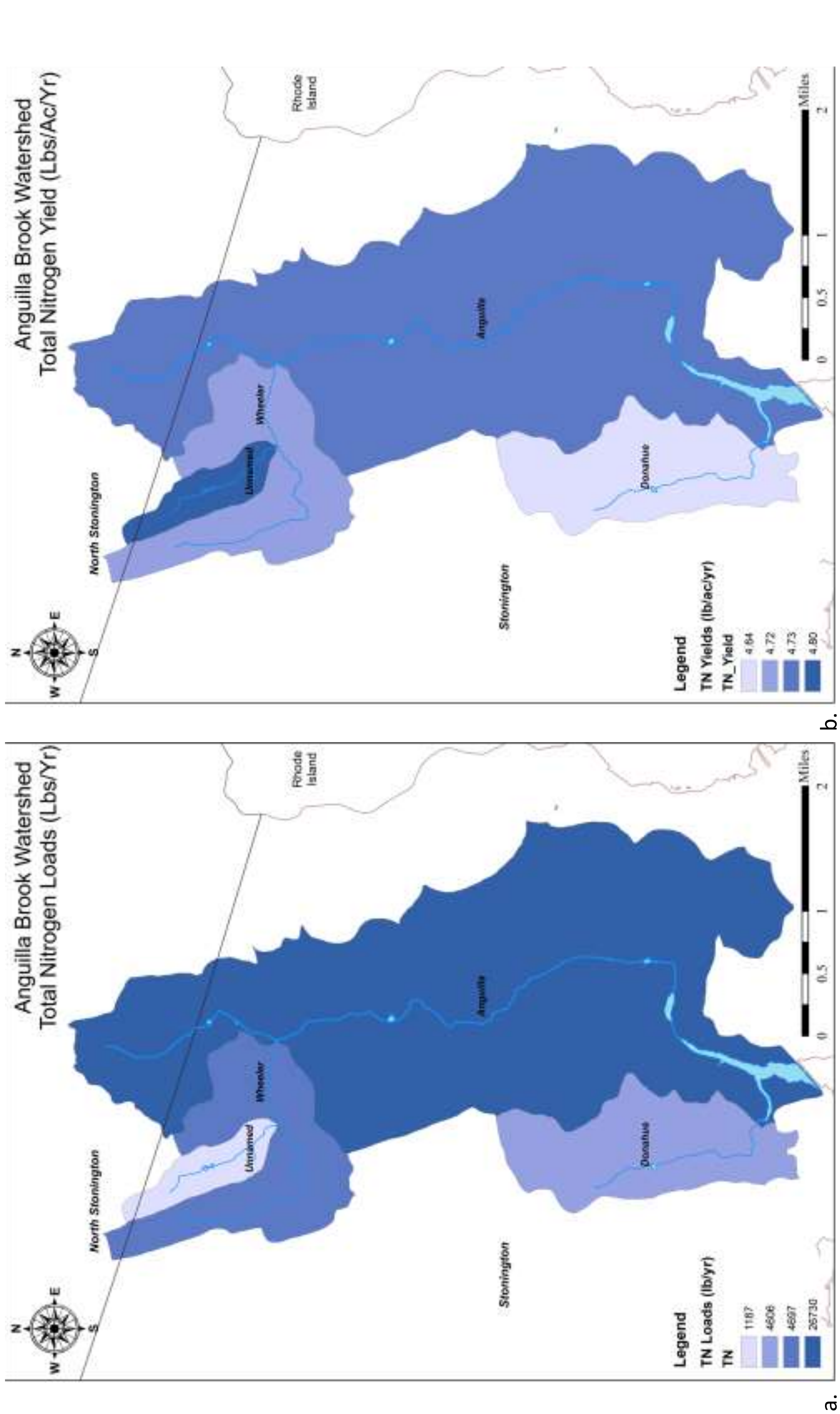


Figure 4-2. Total nitrogen loads in pounds/year (a) and yields in pounds/acre/year (b) by sub-watershed in the Anguilla Brook/Inner Wequetequock Cove Watershed.

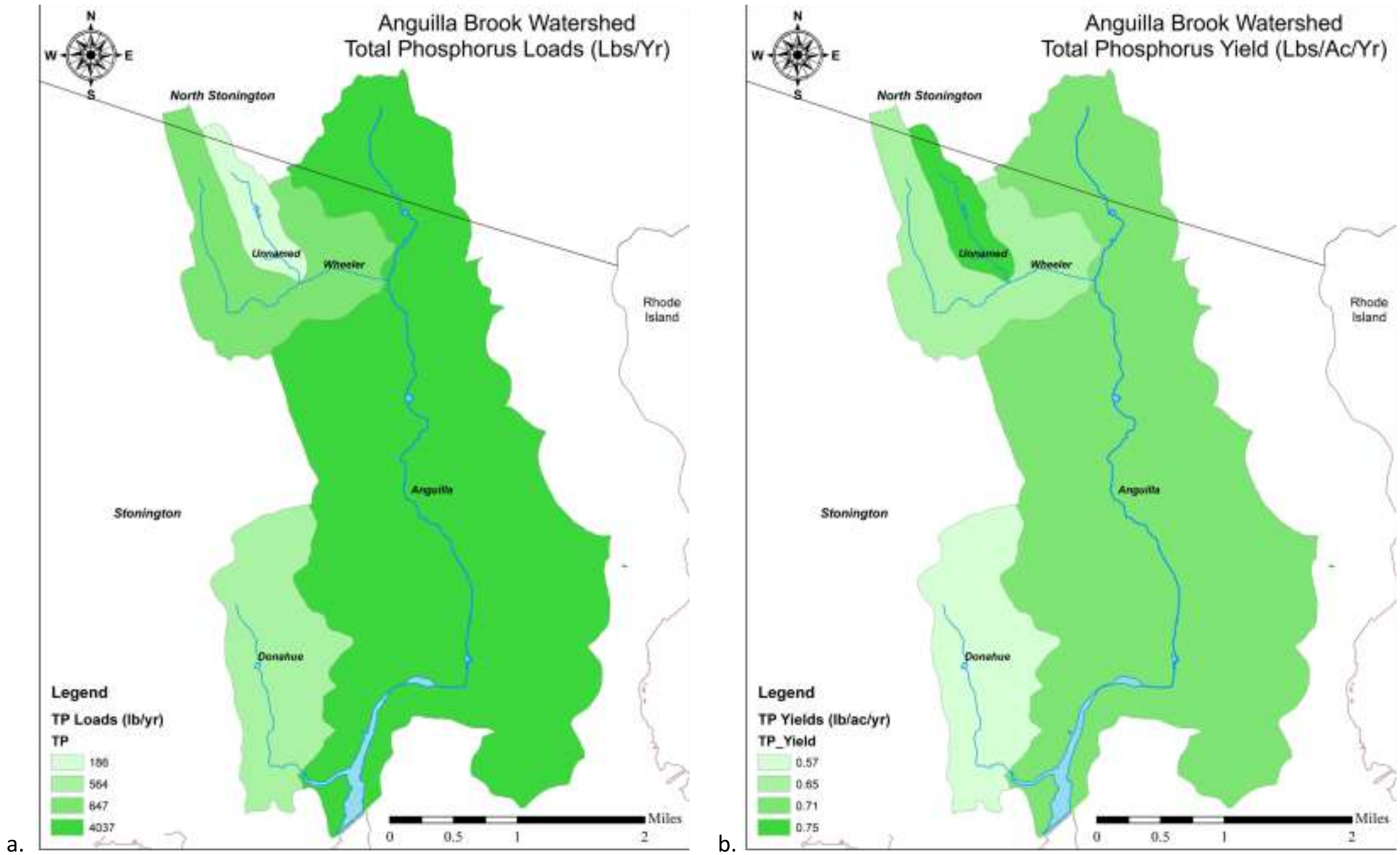
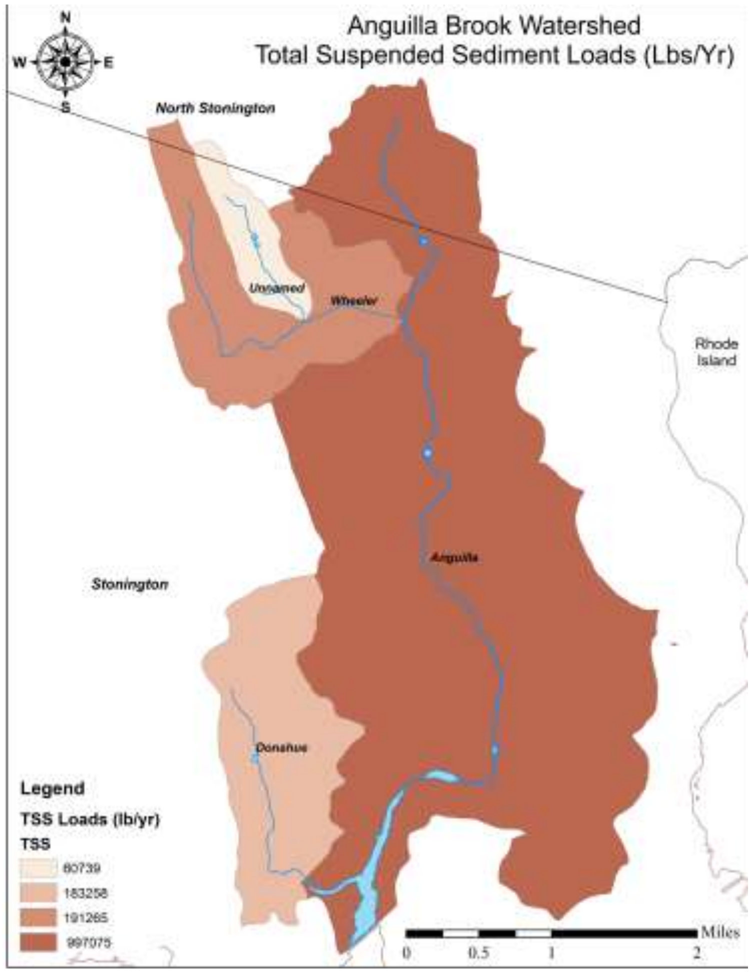
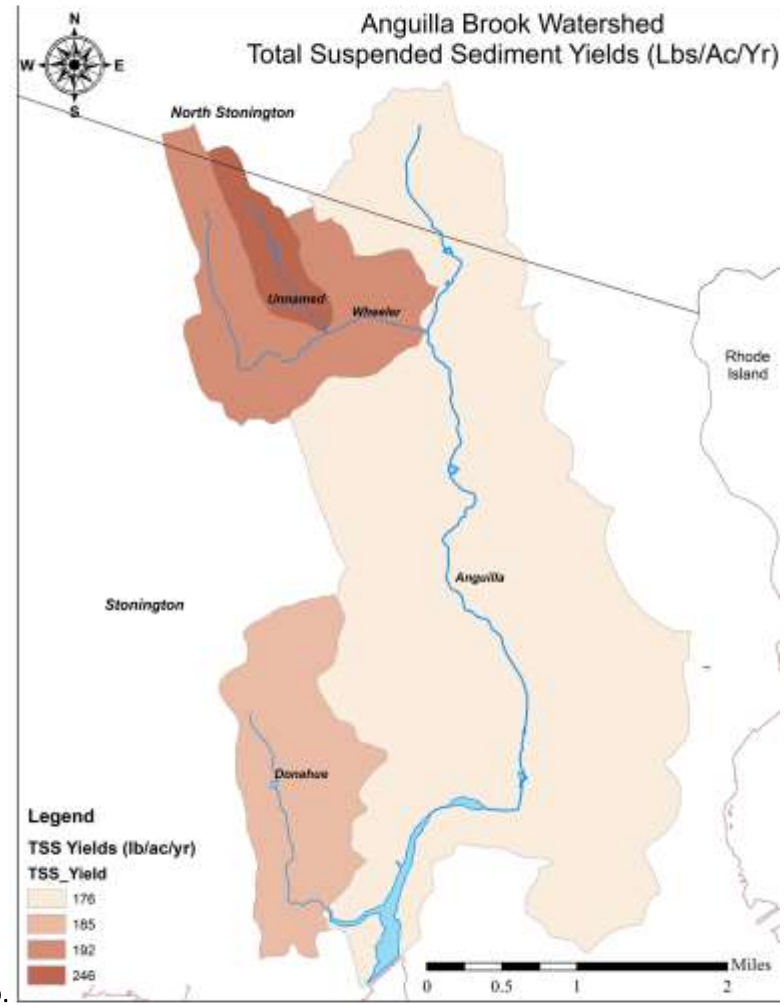


Figure 4-3. Total phosphorus loads by sub-watershed in pounds/year (a) and yields in pounds/acre/year (b) in the Anguilla Brook/Inner Wequetequock Cove Watershed.

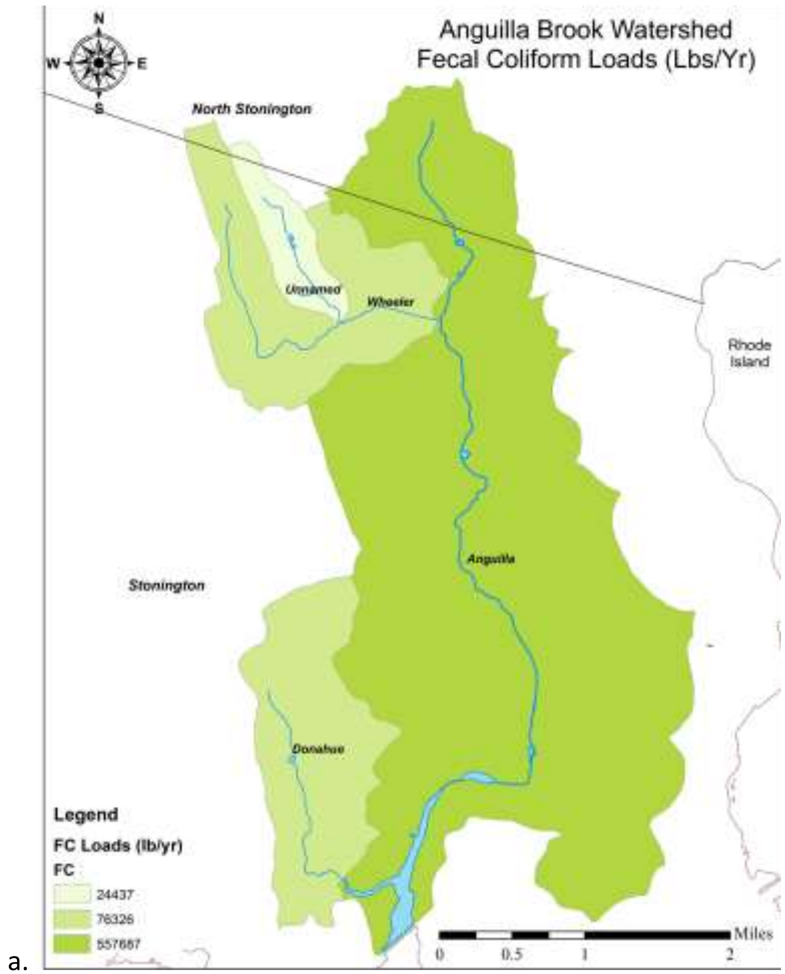


a.



b.

Figure 4-4. Total suspended sediment loads by sub-watershed in pounds/year (a) and yields in pounds/acre/year (b) in the Anguilla Brook/Inner Wequetequock Cove Watershed.



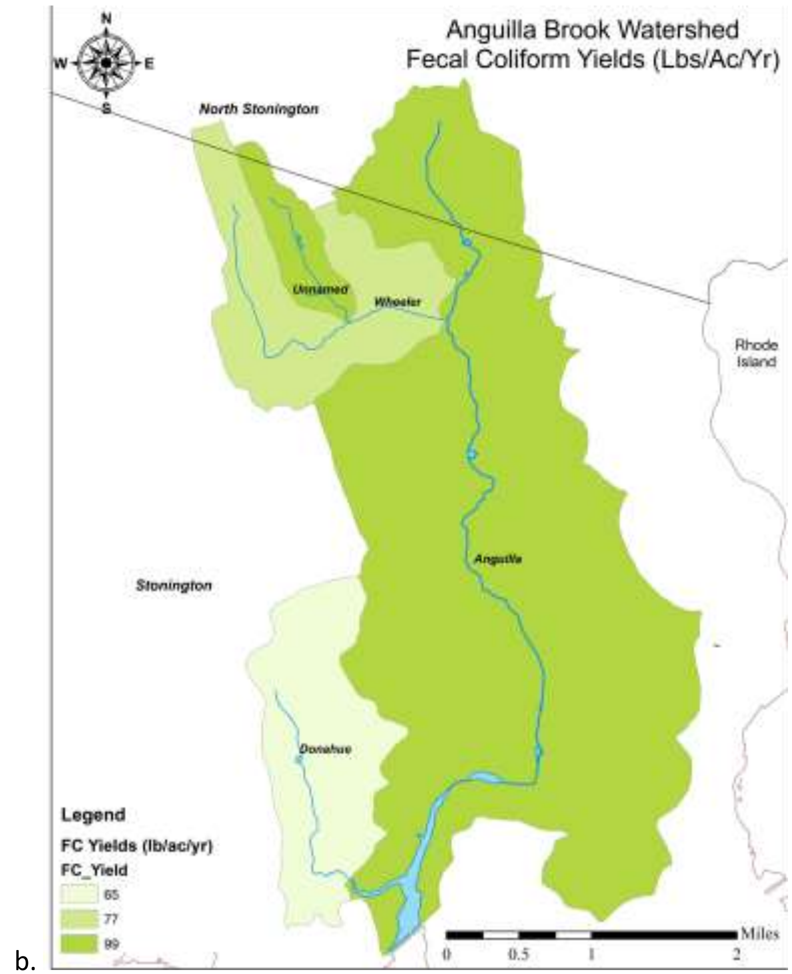


Figure 4-5. Total fecal coliform loads in pounds/year (a) and yields in pounds/acre/year (b) by sub-watershed in the Anguilla Brook/Inner Wequetequock Cove Watershed.

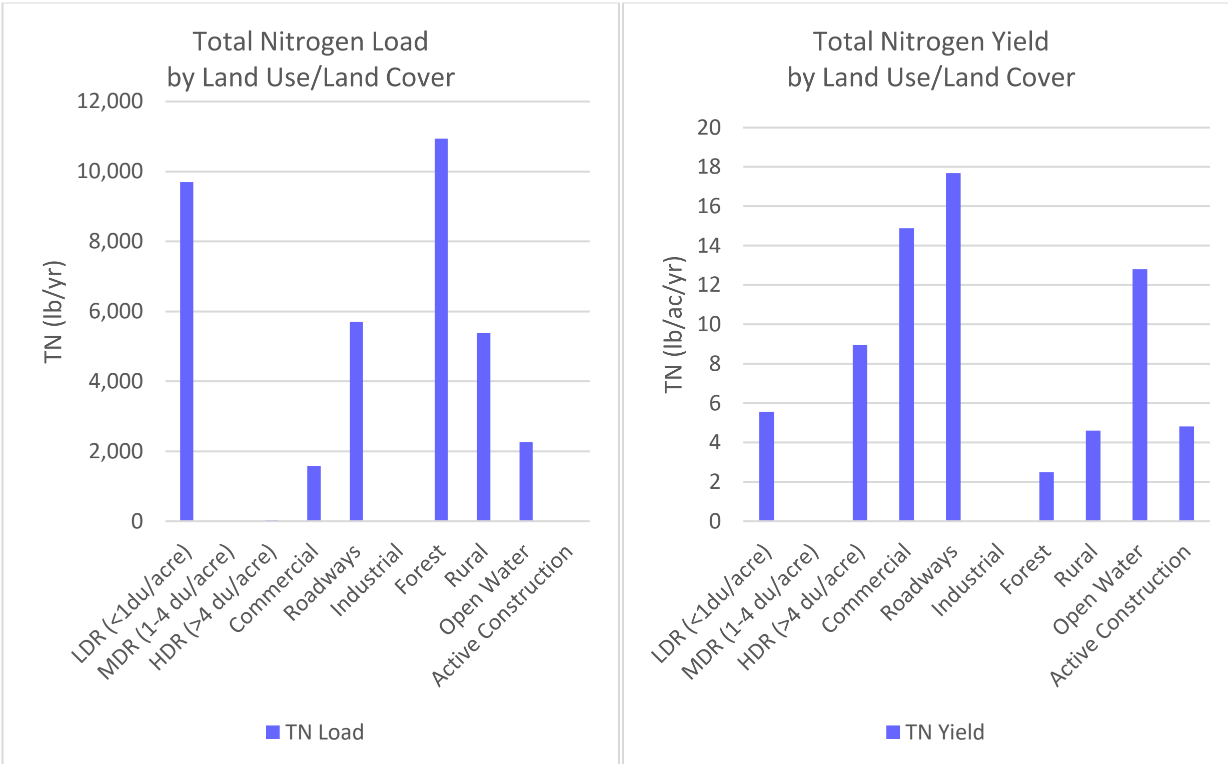


Figure 4-6. Total nitrogen loads (pounds/year) and yields (pounds/acre/year) by land use/land cover type.

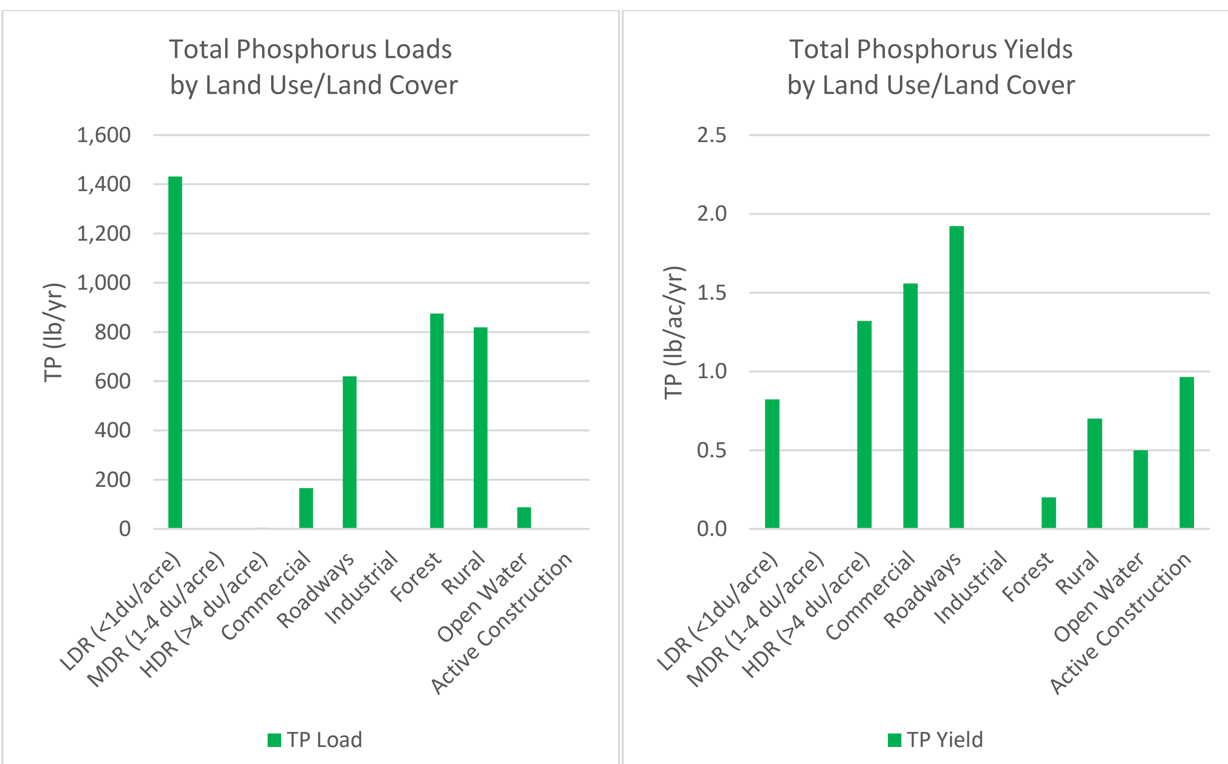
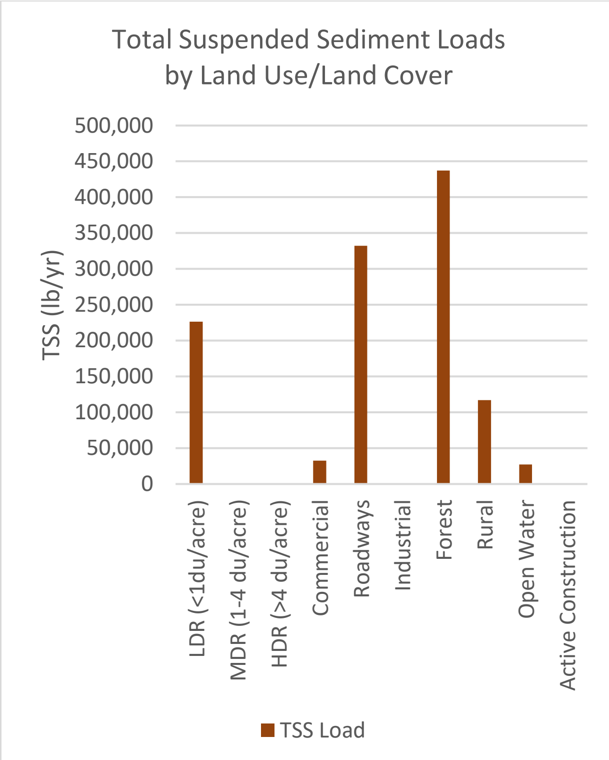


Figure 4-7. Total phosphorus loads (pounds/year) and yields (pounds/acre/year) by land use/land cover type.



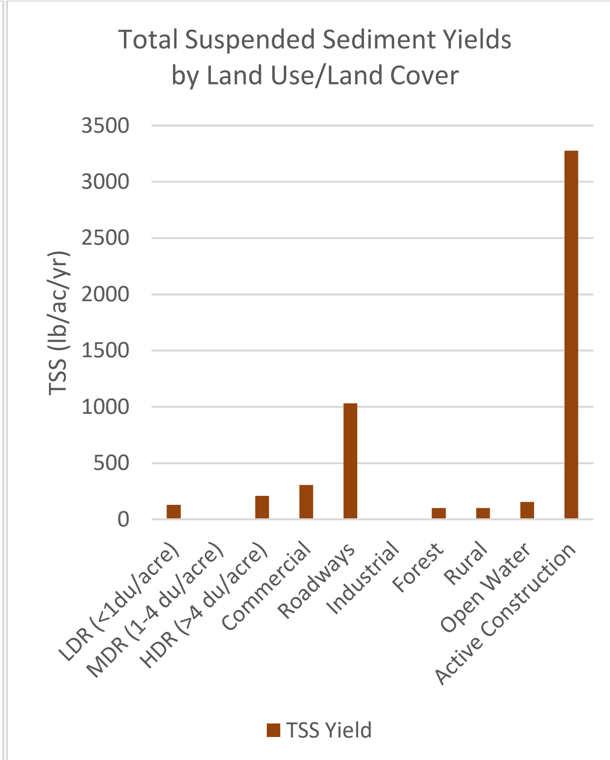
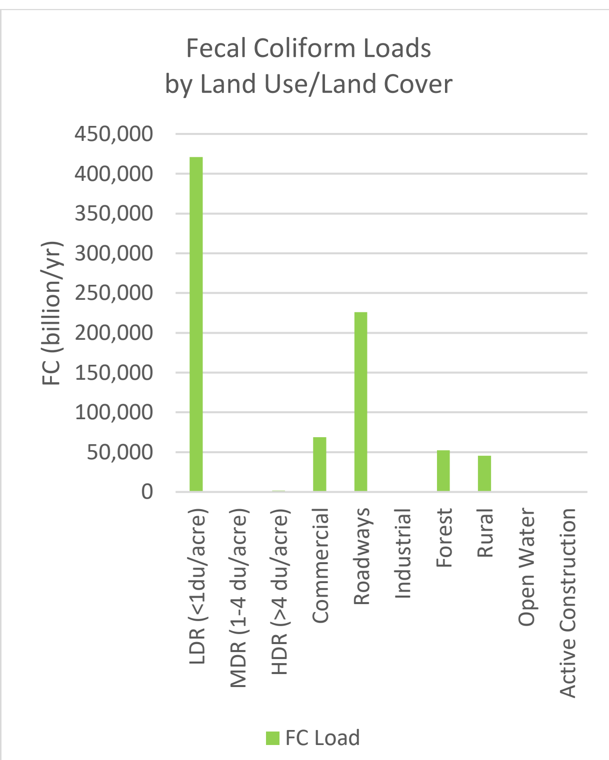


Figure 4-8. Total suspended sediment loads (pounds/year) and yields (pounds/acre/year) by land use/land cover type.



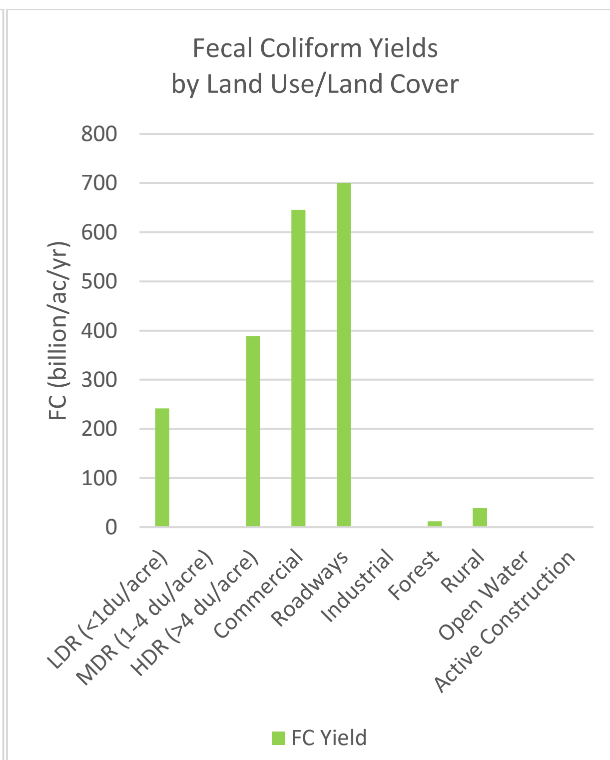


Figure 4-9. Fecal coliform loads (billions/year) and yields (billions/acre/year) by land use/land cover type.

4.1.4 Watershed NPS Pollutant Load Reductions

4.1.4.1 *Wequetequock Cove Nitrogen Load Reductions*

CT DEEP has not established a numeric water quality standard for total nitrogen for Long Island Sound and it is unlikely that it will do so in the future. As an alternative, The *Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* (NYDEC and DEEP, 2000) establishes a TMDL target of a 10% reduction from the 1990 nitrogen levels for NPS and stormwater nitrogen loads to achieve water quality standards for dissolved oxygen. The *CT Second Generation Nitrogen Strategy* is founded on the 2000 DO TMDL and provides additional strategies "…aimed at reducing nitrogen in order to achieve dissolved oxygen concentrations in offshore Long Island Sound."

A recent publication, *Establishing Nitrogen Target Concentrations for Three Long Island Sound Watershed Groupings: Embayments, Large Riverine Systems, and Western Long Island Sound Open Water, Subtasks F/G. Summary of Empirical Modeling and Nitrogen Target Concentrations* (2020) prepared for US EPA and the Long Island Sound Office by Tetra Tech, Inc., provides total nitrogen targets for embayments throughout Long Island Sound based on ecological endpoints. The report identifies a TN target concentration of 0.46 mg/l using estuarine eelgrass habitat abundance and distribution as an assessment endpoint for the Pawcatuck River estuary. The report provides TN Primary Causal Variable Target Concentrations for the Little Narragansett Bay Watershed, CT and RI (Table G-27), but notes that "…values exceeding 0.49 mg/L are not considered protective of eelgrass."

ECCD has applied the 0.46 mg/L eelgrass threshold to water quality data collected by CUSH (Table 4-6) to identify load reductions necessary to support eelgrass habitat abundance and distribution in Inner Wequetequock Cove.

Table 4-6. Summary of total nitrogen data collected by CUSH in Wequetequock Cove in 2019.

Sampling Site	Description	Total Nitrogen Geomean (mg/L)	Suggested Load Reduction (%)
WW 470	Wequetequock Cove - head	0.71	35
WW 502	Inlet	0.51	10
WW 624	Oxecosset Brook	0.82	44
WW 451	Wequetequock Cove - mouth	0.37	-

4.1.4.2 *Watershed Pollutant Load Reductions*

Watershed pollutant load reductions derived using pollutant loads calculated by the WTM are presented in Table 4-7. In order to provide a baseline against which current pollutant loading could be compared, pre-developed watershed loads were calculated for each of the sub-watersheds, using a forested condition as a typical pre-development land cover for Connecticut. No net gain of wetlands was assumed. Current condition land cover and land uses were derived from the CLEAR 2015 Connecticut land cover dataset (CLEAR, 2016) and the Multi-Resolution Land Characteristics Consortium (MRLC) 2016 National Land Cover Dataset (NLCD; USGS, 2019).

Watershed pollutant load reduction values are based on values modeled by the WTM and are intended to provide guidance to watershed managers regarding the potential reduction of common NPS pollutants in the Anguilla Brook/Inner Wequetequock Cove Watershed, including total nitrogen (TN), total phosphorus (TP) and total suspended sediment (TSS). Unlike *E. coli*, which has a specific numerical water quality standard, Connecticut utilizes narrative rather than numeric standards for nutrients or suspended sediments. Therefore, these load reduction recommendations are provided to allow watershed managers to evaluate loading of the various NPS pollutants, and determine where beneficial loading reductions may be made. Watershed managers should keep in mind that these recommended pollutant load reductions utilize watershed load values calculated by the Watershed Treatment Model based on existing land use practices in the Anguilla Brook/Inner Wequetequock Cove Watershed and do not represent physical water quality measurements.

Table 4-7. Watershed NPS pollutant load reductions.

Watershed NPS Pollutant	Watershed Load/Reduction	Anguilla Brook (2101-00)	Wheeler Brook (2101-01)	Unnamed Brook (2101-02)	Donahue Brook (2101-03)
Total Nitrogen (TN)	Existing TN (lb/year)	26,730	4,697	1,187	4,606
	Pre-developed TN (lb/year)	15,691	2,490	627	2,751
	% Reduction TN (lb/year)	**41**	**47**	**47**	**40**
Total Phosphorus (TP)	Existing TP (lb/year)	4,037	647	186	564
	Pre-developed TP (lb/year)	1,182	200	50	207
	% Reduction TP (lb/year)	**71**	**69**	**73**	**63**
Total Suspended Sediment (TSS)	Existing TSS (lb/year)	997,075	191,265	60,739	183,258
	Pre-dev TSS (lb/year)	747,124	129,365	32,195	131,083
	% Reduction TSS (lb/year)	**25**	**32**	**47**	**28**
Fecal Coliform (FC)	Existing FC (billion/ year)	557,687	76,326	24,437	64,261
	Pre-dev FC (billion/ year)	66,115	11,938	2,955	11,604
	% Reduction FC (billion/year)	**88**	**84**	**88**	**82**

4.2 IDENTIFICATION OF CRITICAL AREAS

Three areas in the Anguilla Brook/Inner Wequetequock Cove Watershed have emerged as critical areas, based on an evaluation of pollutant loads and load reductions presented in Section 4.1. These include the Donahue Brook and Wheeler Brook watersheds, which do not meet Connecticut water quality standards for the indicator bacteria *E. coli*, and the Wequetequock Cove shoreline area.

Approximately 15% of Donahue Brook is developed and about 20% is agricultural (Fig. 4-10). Like the Wheeler Brook watershed, much of the Donahue Brook stream corridor is located adjacent to or in crop and pasture land. Agricultural activities in the Donahue Brook watershed include the raising of livestock and hay production. The headwaters of Donahue Brook are located in a residential neighborhood in the north end of the watershed between Heritage Drive and Farmholme Road. The brook is located approximately 80 to 200 feet from the residences on the two roads. A 60% reduction in *E. coli* levels (at the downstream-most sampling site located north of US RT 1) is required to meet Connecticut water quality standards for recreational use. Based on total nitrogen data collected by CUSH at Oxecosset Brook at US RT 1 (Donahue Brook discharges to Oxecosset Brook approximately 250 feet upstream of that sampling site), a 51% reduction in total nitrogen is required to reduce nitrogen levels to suggested levels that are supportive of eelgrass preservation.

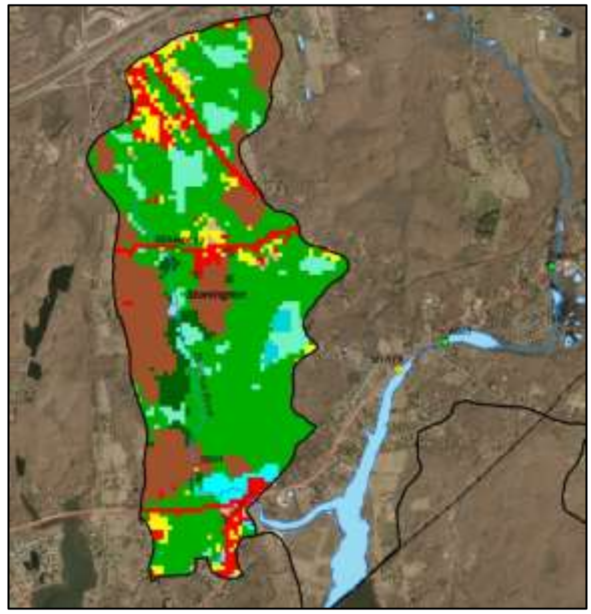
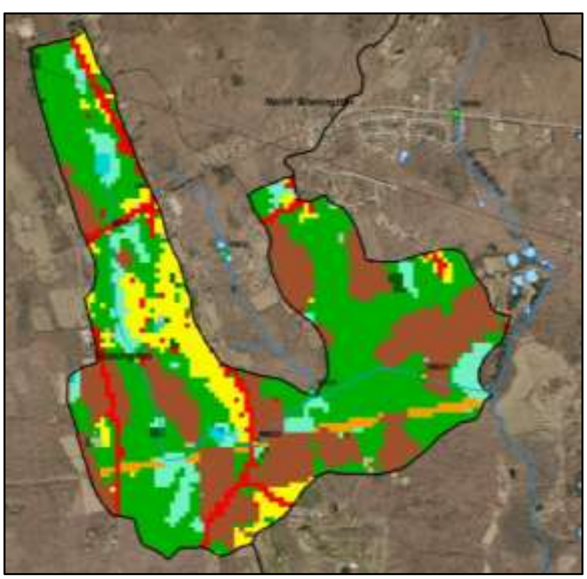


Figure 4-10. Land use/land cover in the Donahue Brook watershed (CLEAR, 2016). Forest is depicted by dark green and green, agriculture is depicted by brown, turf grass (lawns, golf courses, etc.) are yellow and developed land (roads, buildings, parking lots) is red.



Approximately 16% of the Wheeler Brook watershed is developed and about 28% is agricultural (Fig. 4-11). Much of the stream corridor is located in or adjacent to pasture and crop land. Agricultural activities in the Wheeler Brook watershed include the raising of livestock, viticulture, hay and *row* crop (corn) production. A 23% reduction in *E. coli* levels (at the downstream-most sampling site located at the end of Miner Pentway) is required to meet Connecticut water quality standards for recreational use. *Figure*

Figure 4-11. Land use/land cover in the Wheeler Brook watershed (CLEAR, 2016). Forest is depicted by dark green and green, agriculture is depicted by brown, turf grass (lawns, golf courses, etc.) are yellow and developed land (roads, buildings, parking lots) is red.

The Wequetequock Cove shoreline is dominated by mixed commercial, residential and agricultural use on the western shoreline and residential and agricultural use on the eastern shoreline (Fig. 4-12). An 86% reduction in fecal coliform bacteria is required to meet the Wequetequock Cove Bacteria TMDL for the direct consumption of shellfish. Based on total nitrogen data collected by CUSH in 2019 at the head of the Cove, a 44% reduction in total nitrogen levels is necessary to reduce total nitrogen to levels that are supportive of eelgrass preservation. Vaudrey's LIS Embayments Nitrogen Loading study (2015) indicates that approximately 8% of the nitrogen load to Wequetequock Cove originates in the 200-foot buffer area along the shoreline. The embayment study further identifies fertilizer (57%) and septic systems/cesspools (23%) as primary sources of nitrogen. The remaining 20% is attributed to the atmospheric deposition of nitrogen directly to the embayment (8%) and watershed land (12%). The proximity of businesses, residences and farmland to the shores of the Cove limits the potential for the breakdown of nitrogen from fertilizer, manure and septic systems before it flows into the Cove via groundwater and surface runoff.

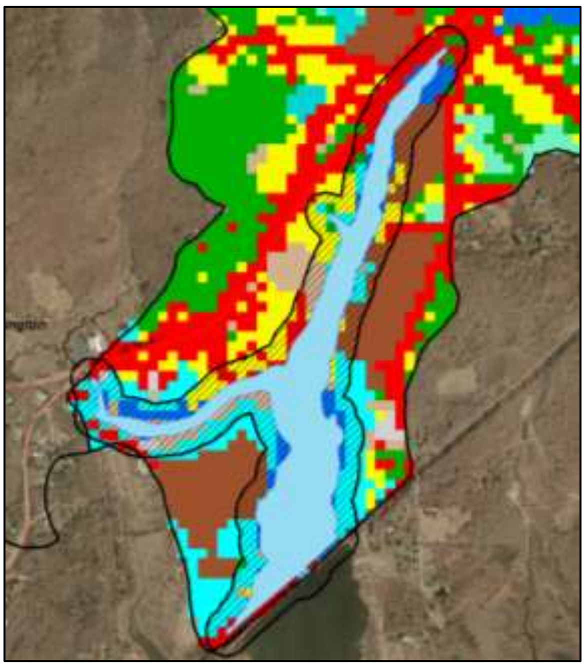


Figure 4-12. Land use/land cover in the vicinity of Wequetequock Cove (CLEAR. 2016). Forest is depicted by dark green and green, agriculture is depicted by brown, turf grass (lawns, golf courses, etc.) are yellow, developed land (roads, buildings, parking lots) is red, grasses other than turf grass are tan, and tidal wetlands are light blue. The LIS Embayments Nitrogen Loading study 200-foot shoreline buffer area is depicted by the black hatching.

5 POLLUTANT SOURCE ASSESSMENT

Pollution in a watershed can come from a variety of sources and may derive from point or non-point sources. Point sources may include identifiable points such as factory or sewage treatment plant pipes which discharge pollution (called effluent) into a receiving waterbody. Non-point source pollution (or NPS) is comprised of a diffuse array of pollutants distributed on the ground across the landscape. These pollutants are mobilized by rainwater or snowmelt and transported into receiving waterbodies by direct overland flow or via storm drainage systems. The following sections evaluate known or potential pollution sources in the Anguilla Brook/Inner Wequetequock Cove Watershed.

5.1 NON-POINT SOURCES

Non-point source pollution (NPS) is pollution that is not derived from a single discernible source or point, such as a pipe or outfall. NPS results from a diffuse and diverse array of pollutants derived from our everyday activities that are found on the ground surface. These pollutants are mobilized and transported via rain or snowmelt into streams, rivers, lakes, ponds, estuaries and ultimately the ocean, and include:

- Excess or poorly managed fertilizers, herbicides and insecticides from agricultural lands and residential areas
- Oil, grease and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks
- Salt from roadway de-icing materials, irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, faulty septic systems and leaky sewer pipes
- Atmospheric deposition and hydro-modification (US EPA, 2014).

Potential sources of NPS that were identified during the 2019-2020 water quality investigation are discussed in the following sections.

5.1.1 Stormwater Runoff/ Impervious Cover

Stormwater runoff is rain water that is unable to soak into the ground due to the presence of impervious surfaces. Stormwater runoff can contribute a significant amount of NPS to watershed streams and ponds. Commercial, institutional and industrial properties can contribute NPS including sediment, fertilizer, pesticides and herbicides from lawn and landscape maintenance, oils and greases, vehicular chemicals and heavy metals from parking lots, wind- and water-borne trash, leachate from leaky dumpsters, and other chemicals that may be used or stored on-site. Stormwater runoff from commercial and private residential properties may include pollutants such

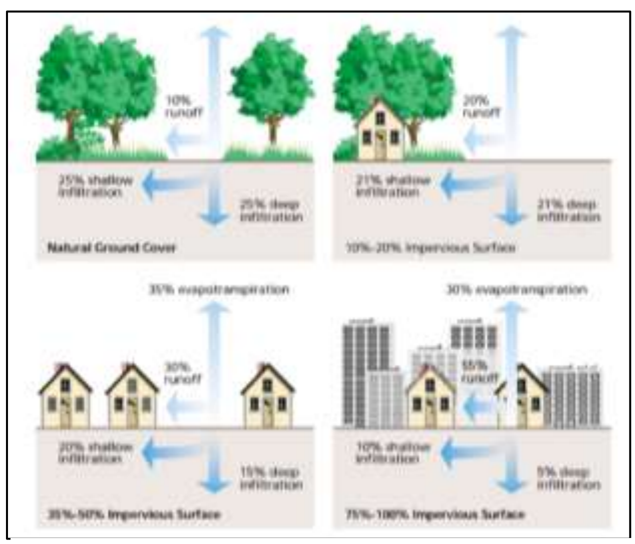


Figure 5-1. Effects of impervious cover on surface stormwater runoff (from Stream Corridor Restoration: Principles, Processes and Practices, FISRWG, 1998).

as fertilizer, pesticides and herbicides from lawn and garden maintenance, pet waste and/or animal manure, sediment, dumpster or trash bin leachate, and chemicals and detergents from vehicle maintenance.

Impervious surfaces, also called impervious cover or IC, are any hard surfaces in the landscape that cannot absorb or infiltrate rainfall. Impervious surfaces include rooftops and paved areas like roads, sidewalks, driveways and parking lots. Because IC prevents rainwater from soaking into the ground, it contributes to the volume of stormwater runoff that is shed from developed areas into nearby waterbodies (Fig. 5-1).

The amount of impervious cover in a watershed has been directly linked to impacts to stream quality and stream biodiversity. Numerous studies, including those conducted by Schueler (1994; Fig. 5-2) and Schiff and Benoit (2007), have demonstrated that the amount of impervious cover in a watershed directly impacts stream quality.

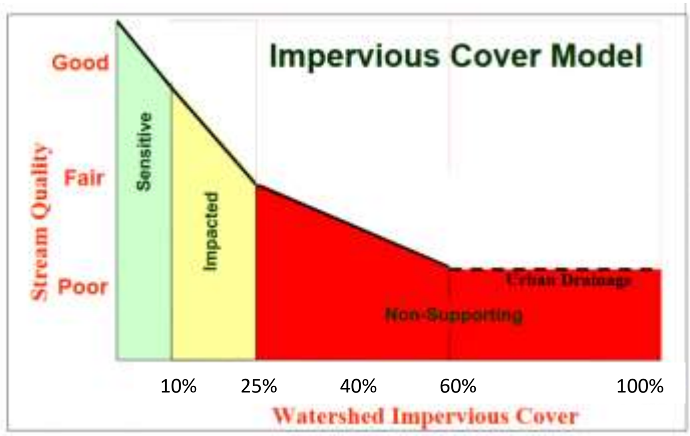


Figure 5-2. The impervious cover model describes the relationship between stream quality and watershed impervious cover (Schueler, 1994).

A 2008 study conducted by CT DEEP indicated that water quality declined when impervious cover in a watershed exceeded 6% (Bellucci, Beauchene and Becker, 2008). The Connecticut Watershed Response Plan for Impervious Cover (DEEP, 2015), which was developed to provide guidance for "managing stormwater and impervious cover to support water quality improvements," suggests a target impervious cover limit of 12%. Twelve percent impervious cover represents "the level of impervious cover in the contributing watershed, below which a stream is likely to support a macroinvertebrate community that meets aquatic life use goals in Connecticut Water Quality Standards" (DEEP, 2015).

Approximately 24% of the Anguilla Brook/Inner Wequetequock Cove Watershed is developed, and of that, approximately 5.4% is comprised of impervious cover (CT ECO MS4 Map Viewer, 2018). Development occurs mainly along arterial corridors, including state routes 184 and 234 and US RT 1, and in the village of Pawcatuck, at the eastern limits of the watershed.

Institutions and businesses in the Anguilla Brook watershed that have large areas of impervious surfaces such as extensive roof areas and parking lots include Stonington High School, the Extrusion Drive industrial center, the Stonington Police Department, the commercial plaza at 163-165 South Broad Street, the Pawcatuck Shopping Center and various other commercial businesses along US RT 1.

Residential subdivisions and neighborhoods in the Anguilla Brook/Wequetequock Cove watershed may have higher imperviousness than the less dense rural residential development patterns that dominate the watershed. These neighborhoods include the Castle Hill Road/Rose Ridge neighborhood in Pawcatuck, the "Birdland" neighborhood off US Rt 1, Brookside Village Condominiums, Stonington Arms Apartments, and Spruce Meadows Apartments on US RT 1 in Pawcatuck, Northstone Gardens on RT 184 in North Stonington, and the Cedar Drive neighborhood off RT 184 in North Stonington.

5.1.2 Septic Systems and Sanitary Sewers

5.1.2.1 *Septic Systems*

Approximately 96% of the Anguilla Brook watershed is served by individual on-site subsurface sewage (septic) systems. Individual septic systems with design flow less than 2,000 gallons per day are regulated by the Ledge Light Health District (LLHD) located in New London, CT. The Health District is responsible for the review of septic system siting and design, including soil evaluations to ensure septic effluent will infiltrate the soil at a specified range of rates and provide adequate bacteria renovation. The CT Department of Public health regulates conventional septic systems with design flows of greater than 2,000 gallons per day but less than 7,500 gallons per day. CT DEEP regulates conventional septic systems with design flows greater than 7,500 gallons per day, community septic systems, and alternative treatment systems.

Septic systems can be sources of both fecal bacteria and nitrogen. Fecal bacteria loading can occur as a result of malfunctioning or under-functioning septic systems. Failure to provide proper maintenance of a septic system, including regular inspections, holding tank maintenance, and proper care and maintenance of the leach field can cause septic system failure. Septic system failures can result in sewage breakouts, in which untreated effluent containing both nutrients and fecal bacteria is discharged to the ground surface, where it can contaminate not only nearby waterbodies, but nearby drinking water wells. Septic system failures can also result in the leaching of untreated effluent into groundwater, which can then be conveyed to nearby wells and waterbodies. At the time of this writing, Northstone Gardens in North Stonington was in the process of registering the community septic system for compliance with CT DEEP after *E. coli* was detected in its drinking water wells and was working to develop a septic system repair plan (M. Hart, CT DEEP, personal communication, 1/12/21). The drinking water wells were upgraded in 2019 under orders from the CT Department of Public Health (C. Seery, Ledge Light Health District, personal communication, 8/11/20). Additionally, it was reported in the Town of Stonington 2018 MS4 Annual Report that a failing septic system on Stonington Road (US Route 1) near Wequetequock Cove was replaced.

Septic system functionality can be affected by improper installation and limitations including soil suitability, depth to groundwater, and depth to bedrock. Figure 5-3 depicts the septic suitability of soils in the Anguilla Brook watershed. In general, the watershed appears to be dominated by soils that have low septic potential, necessitating the need for engineered septic systems to ensure effluent is treated properly. Property owners are encouraged to maintain their systems through best management practices, including regular tank pumping, system inspections and proper disposal of chemicals and other materials that might otherwise impact or impair the proper function of the septic system. The Stonington Estuary Bacteria TMDL (DEEP, 2013) recommends the development of a program or system to monitor septic systems "…to ensure that existing septic systems are properly operated and maintained." At the present time, there is no regulatory mechanism in place to require or enforce septic system maintenance and inspections.

Septic systems can also be a vector for the delivery of nitrogen to groundwater and nearby waterways. Although septic waste is high in nitrogen (Valiela et al, 1997, estimate 10.58 pounds per person per year), septic systems are not designed to remove nitrogen. The average septic system removes only about 6% of nitrogen as a by-product of other septic system functions. The remaining 94% is discharged from the leach field where it infiltrates into the water table or is carried via shallow subsurface flow into

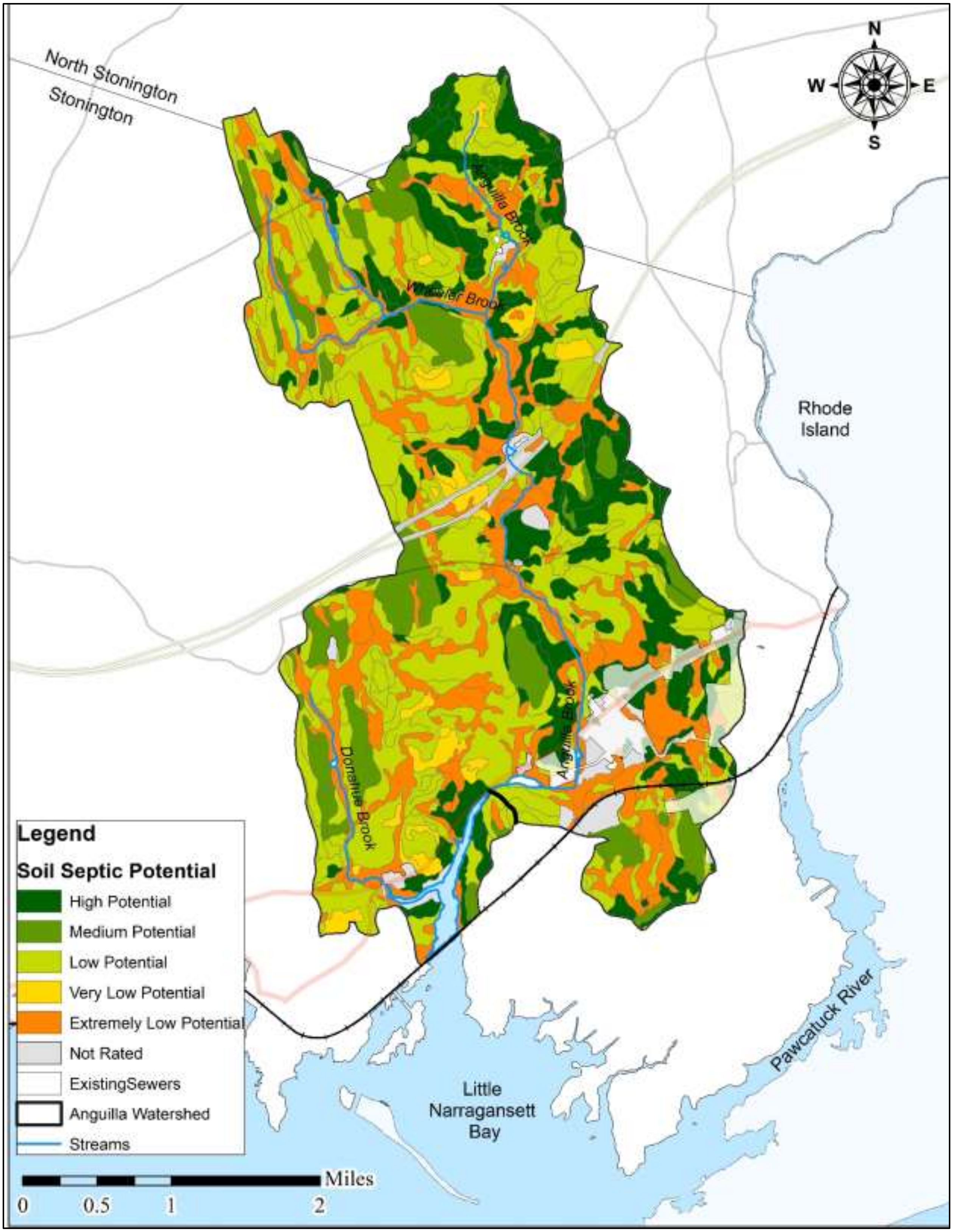


Figure 5-3. Soil septic system potential in the Anguilla Brook/Inner Wequetequock Cove watershed.

nearby waterbodies. In most cases, natural biochemical processes convert the nitrogen to inert forms. However, in locations where there are inadequate separating distances between a leach field and the point of discharge, or where highly permeable soils convey the leachate rapidly, nitrogen may not be adequately treated before it is discharged to a local waterbody. Although the technology exists to treat nitrogen in septic waste, it has not been widely adopted in Connecticut.

5.1.2.2 *Sewer Systems*

The municipal sewer system in Stonington, which in the Anguilla Brook/Inner Wequetequock Cove Watershed, is located along the US Route 1 corridor from the head of Wequetequock Cove easterly to the village of Pawcatuck, is owned by the Stonington Water Pollution Control Authority (WPCA) and operated and maintained by Suez Water Environmental Services, Inc. Waste is treated at the Pawcatuck Wastewater Treatment Facility (WWTF) and is discharged to the Pawcatuck River (NPDES Permit ID CT0101290, effective date 06/01/2019, expiration date 05/31/2024).

The municipal sewer system in the Pawcatuck area dates from at least the early 70's and portions may be older. The WPCA has contracted with Suez to inspect and maintain the system. At the time of the preparation of this Plan, Suez was conducting a sonar inspection of the sewer system to identify problem areas. Undetected leaks in municipal sewer systems can be a source of both fecal bacteria and nutrient loading to ground water and allow the infiltration of groundwater into the treatment system. The results of the Suez inspection will be reported to the WWTF, which will use the information to prioritize maintenance and repairs.

5.1.3 Recreation Fields

Recreational fields are often associated with the application of fertilizer, herbicides, and pesticides in order to maintain playability and enhance their appearance. Legislation adopted in Connecticut in 2010 (C.G.S. Sec. 10-231) banned the application of EPA-registered pesticides on the grounds of public and private daycares and grades K-8 schools. However, pesticides are allowed on high school athletic fields and are not prohibited on non-municipal athletic fields.

Athletic fields in the Anguilla Brook/Inner Wequetequock Cove Watershed include the Pawcatuck Little League Complex on North Anguilla Brook Road, the Pine Point School on Barnes Road, the Coast Guard Foundation on Taugwonk Road, and the Spellman Recreation Complex, located behind Stonington High School on Spellman Drive. The Spellman Recreation Complex is owned by the Town of Stonington and is jointly maintained by the Department of Public Works and the School Department. The Spellman Recreation Complex is bounded on the east and south by large wetlands that flow into Anguilla Brook.

There are two golf courses in the Anguilla Brook watershed, Stonington Country Club and Elmridge Golf Course. The 155-acre Stonington Country Club is located at the western limit of the Anguilla Brook watershed, just south of the Wheeler Brook watershed. The 255-acre Elmridge Golf Course is located on the eastern side of the Anguilla Brook watershed. Anguilla Brook flows past several greens on the western side of the course. Each of these golf courses operates under an individual DEEP consumptive water diversion permit. Elmridge Golf Course (Permit No. DIVC-201809964, effective 12/13/2018, expires 12/3/2043) is currently permitted to withdraw up to 0.2 million gallons per day (mgd) from Anguilla Brook and an unnamed storage pond. At the time of the preparation of this Plan, Stonington Country Club was in the process of renewing its water diversion permit. The previous permit (Permit No. DIV-200301942) for the withdrawals of up to 0.53 mgd expired on 3/10/2021. The new permit (Permit

No. DIVC-202078299) will authorize the country club to withdraw "…a total combined maximum of 0.232 million gallons per day (mgd) from Wells 1 through 7, 10 and 12 for the purpose of supplementing the irrigation pond, providing potable water to the club house and water to wash maintenance equipment," and "…a maximum of 0.250 mgd from Pond 15 to irrigate an 18-hole golf course" (CT DEEP Draft Water Diversion Permit DIVC-202078299 for Stonington Country Club, 2021).

It should be noted that a petition for a 3-megawatt AC photovoltaic electric generating facility on two parcels at the Elmridge Golf Course totaling about 14 acres was approved in February 2021 by the Connecticut Siting Council. This facility will remove approximately 8% of the fairway area from use. Both golf courses are encouraged to adopt BMPs established by the Connecticut Golf Industry *Best Management Practices Guide* (2020), particularly for the use of fertilizer, and *Best Management Practices for Golf Course Water Use* (CT DEEP, 2006).

5.1.4 Agriculture

Agricultural activities, from the cultivation of livestock to crop production, are distributed relatively evenly throughout the Anguilla Brook/Inner Wequetequock Cove Watershed. According to CLEAR land use/land cover data, approximately 1,168 acres (15%) of the watershed are being used for agriculture. Agricultural activities can contribute to both point and nonpoint source pollution. Common agriculture-related pollutants include sediment, nutrients from fertilizer and manure (particularly phosphorus and nitrogen), herbicides and pesticides, vehicular chemicals from farm equipment, and pathogens from animal waste. Pollutant loading varies depending on the type of farming activity, and can be minimized through the selection of appropriate farm management practices and application methods.

5.1.4.1 *Livestock/Poultry*

Small private (non-commercial) farms with small numbers of livestock are located throughout the Anguilla Brook/ Inner Wequetequock Cove Watershed. Livestock on these farms includes chickens, beef and dairy cattle for personal consumption and horses for recreational use. There is one commercial equine facility located in the Donahue Brook watershed near Wequetequock Cove.

Livestock and poultry can contribute to non-point source pollution in several ways. Nutrient and pathogen loading can occur from poor or improper manure management practices. Sediment loading can occur via pasture overgrazing and runoff from bare soils in confined paddock areas and barn lots. Nutrient, pathogen and sediment loading can also occur in areas where livestock are kept near, or allowed access to, waterways. During the stream corridor assessments, livestock in the Wheeler Brook and Donahue Brook watersheds were observed in near proximity to both waterbodies.

5.1.4.2 *Cropland*

There is a variety of crop cultivation in the Anguilla Brook/Inner Wequetequock Cove Watershed. Approximately 15% of the watershed (1,168 acres) is used for agriculture (CLEAR, 2016). Most of that land is used for pasture, hay or corn production although the National Land Cover Database (NLCD) identifies about 76 acres (~1% of the watershed) dedicated to row crops (NLCD, 2015). Two vineyards, Stonington Vineyard and Salt Marsh Farm Vineyard, cultivate grapevines for the production of wine. Adams Garden of Eden Garden Center cultivates a combination of row and greenhouse crops for sale at their farm store.

Croplands have varying requirements for fertilizer, pesticides and herbicides, depending on the crop being cultivated. Hay lands may require little input other than the periodic application of manure. Row crops such as corn are more intensive, requiring herbicides to kill cover crops and several applications of fertilizer at specific intervals during the growing season. The timing of fertilizer applications as well as the careful calibration of the amount of fertilizer needed is important to preventing any excess nitrogen in fertilizer from washing off or entering the groundwater table and being discharged into watershed streams or Wequetequock Cove.

Specialty crops like vegetables and grapes can have specific requirements that are more intensive. Grapevines, for instance, require relatively little fertilizer once established, but have higher pesticide and fungicide requirements than other crops. Fungicides (Zubrod et al, 2019) and pesticides (Anderson et al, 2014) can be toxic to a wide range of organisms in aquatic systems. Stonington Vineyard has, in the past, enrolled in the NRCS Conservation Stewardship Program and adopted Integrated Pest Management (IPM) practices to control pests.

5.1.5 Pets, Wildlife and Waterfowl

In developed areas, pet feces, particularly dog feces, can be a significant source of bacteria if not properly managed. The improper disposal of pet waste can contribute to the total amount of bacteria in stormwater runoff. A study conducted by the University of Nevada Cooperative Extension (Walker and Garfield, 2008) determined that one gram of fresh dog feces contained an average of 50 million colony forming units (CFU) of *E. coli* bacteria. According to the website clearchoicescleanwater.org, the average dog excretes 340 grams (¾ pound) of waste per day. Based on Walker and Garfield's study, that equates to 17 billion *E. coli* bacteria per dog per day. Based on data provided by the Stonington Town Clerk and Animal Control offices, there may be as many as 800 dogs in the Anguilla Brook/Inner Wequetequock Cove Watershed, which equates to 13.6 trillion *E. coli* bacteria per day.

The Stonington Estuary Bacteria Total Maximum Daily Load Summary (DEEP, 2013) cites waste from nuisance wildlife and pets as a potential nonpoint source of bacteria in the watershed. Although approximately 55% of the watershed is forested or otherwise undeveloped, stakeholders did not report that nuisance wildlife was a concern. Unless specific overpopulation problems have been identified, the wildlife contribution is considered representative of "background" or natural levels of bacteria found in a watershed.

Coastal marshes in and in close proximity to the Anguilla Brook/Inner Wequetequock Cove Watershed are not only known to support migratory shore birds, but in many cases are actively managed for migratory birds. Non-migratory waterfowl such as Canada geese (*Branta canadensis*) are often cited as significant contributors to fecal bacteria levels; however, non-migratory waterfowl were not noted to be prevalent or problematic in the Anguilla Brook watershed by local authorities or stakeholders.

5.1.6 Atmospheric Deposition

Atmospheric deposition can be a significant source of airborne pollutants. These pollutants are typically dissolved in rain or snow and are deposited in the form of precipitation. Obviously, it is difficult to control atmospheric deposition at the local level. Airborne pollutants must be managed at the regional, national or even international level. However, when determining pollutant load reductions, it is important to take these pollutants into account. In the Inner Wequetequock Cove Watershed, the atmospheric deposition of nitrogen is relatively significant. According to Vaudrey (2016), direct atmospheric deposition of nitrogen to the watershed makes up 12% of the annual load, and direct atmospheric deposition to the estuary contributes 8% of the total annual load.

5.1.7 Shoreline and Riparian Buffer Areas

Encroachment into the vegetated areas growing along streams and other waterbodies can create conditions that diminish water quality and wildlife habitat. Streamside vegetation performs multiple functions that protect water quality (Osborne and Kovacic, 1993). Riparian plants and trees provide shade to waterbodies, cooling the water and creating thermal refugia for fish and other aquatic species, especially during the warmer months of the years. Riparian plants slow the flow of surface water, allowing it to soak into the ground, and plant roots hold the soil of streambanks and shorelines together, especially during high flows and floods, preventing erosion. A lack of riparian vegetation can allow pollutant-laden stormwater runoff to flow into waterbodies, and that same lack of vegetation can result in streambank and shoreline erosion and even streambank failure.

During the stream corridor assessments conducted on Donahue and Wheeler Brooks, ECCD documented several areas where the riparian vegetation between the streams and adjacent areas, including fields and developed areas, was diminished. These included several reaches on Wheeler Brook and Donahue Brook that flowed alongside agricultural fields. Many of these areas also contained an abundance of invasive plant species, such as multiflora rose, Japanese barberry and Chinese privet. It is not uncommon for invasive plants to colonize areas where the removal of native plant species or other disturbances have occurred.

Stream corridor assessments were not conducted on Anguilla Brook; however, during other activities associated with the development of this Plan, it was noted that in developed areas such as the Birdland neighborhood, US RT 1 and Anguilla Brook Road, it was not uncommon to see lawn areas extend to the edge of the brook. Likewise, lawns on many properties on Wequetequock Cove extended to the water's edge with little or no intervening riparian vegetation such as tall grasses, shrubs or trees.

5.1.8 Other Sources of NPS

5.1.8.1 *Silviculture*

Silviculture, or timber harvesting, can be a significant source of NPS. Certain activities associated with timber harvesting, including clear-cutting, establishment of skid trails, and wetland and stream crossings can be a significant source of pollution, including sediment and nutrients, if not properly managed. Private landowners may choose to manage their forest lands. Those that do so often retain professional forest practitioners to develop forest management plans. Forest management plans inventory forest resources and present a long-term plan for timber harvesting. Property owners who intend to harvest timber from wetland areas are required to retain a certified forester.

Timber harvesting is considered a form of agriculture (Connecticut General Statutes Section 1-1(q)) and is exempt from land use regulation pursuant to Section 22a-40(a) of the Connecticut General Statutes. However, certain activities not directly related to the timber harvest may not exempt from regulations. In order to minimize the potential for soil erosion as a result of timber harvesting activities, forestry practitioners should follow industry-established guidelines such as those outlined in the BMPs for Water Quality While Harvesting Forest Products guidebook (CT DEP, 2007) and recommendations by the University of Connecticut Extension and CT DEEP foresters. At the time of the development of this plan, there were not any commercial timber harvesting activities in the watershed.

5.1.8.2 *Land Clearing/Development*

Land clearing and development can be a significant source of pollution. The clearing of large tracts of land preparatory to development can result in the disturbance of many acres of soil, creating the potential for soil erosion, usually due to run-off from rain storms.

Land development and land clearing activities occur under the oversight of the municipal land use commissions, including Planning and Zoning and Inland Wetlands and Watercourses Commissions. Commissions are responsible for reviewing land development permit applications, ensuring the proposed activities comply with land-use regulations, including the Construction Stormwater General Permit for parcels from 1 to 5 acres in size, and issuing permit conditions as necessary. Land use staff are responsible for ensuring permitted activities are being conducted in compliance with the municipal regulations and the terms of the permits. At the time of the development of this watershed-based plan, there was no large-scale construction activity in the watershed.

5.1.8.3 *Earth Removal/Gravel Mining*

Earth removal, including sand and gravel removal and processing of bedrock material can be a significant source of pollutants. Pollutants associated with quarries include sediment, dust, suspended and dissolved solids in stormwater runoff, gasoline, diesel, oil and other hydrocarbons associated with mining equipment. Earth removal also changes the contours of the land, affecting how stormwater and shallow subsurface flow travels through the landscape. Stormwater runoff from mineral mining and processing facilities are regulated under the NPDES General Permit for the Discharge of Stormwater Associated with Industrial Activity and are subject to all provisions and requirements contained therein. At the time of the preparation of this Plan, there were not any earth removal or gravel mining operations in the Anguilla Brook/ Inner Wequetequock Cove Watershed.

5.1.8.4 *Winter Paved Surface De-icing*

Winter paved surface de-icing is critical to providing safe road, parking and walking surfaces. Unfortunately, the most common products used for de-icing, rock salt and sand, can have negative impacts on infrastructure and the environment. Chloride is a prime constituent of rock salt. Chloride can negatively impact terrestrial and aquatic flora and fauna, ground and surface water quality, and road infrastructure and vehicles. The use of sand and salt-sand mixes can result in the transport and deposition of substantial amounts of sand into catch basins and nearby waterbodies by snowmelt and stormwater, where they build up and clog streambeds, negatively impacting the stream habitat for many aquatic species.

The Stonington and North Stonington highway departments manage all municipal roads within their respective municipal boundaries. Stonington utilizes rock salt for winter road management. The Town of North Stonington uses an 80/20 sand/salt mix. The Connecticut Department of Transportation maintains 12 miles of state and interstate highway in the Anguilla Brook/Inner Wequetequock Cove Watershed. In 2006, CT DOT discontinued the use of road sand, switching to a winter de-icing program utilizing salt and liquid chemicals.

Private companies provide plowing and other snow removal services for private properties, including commercial businesses, condominiums, and apartment complexes. The industry standard is to apply rock salt, salt brine, salt-sand mixes or ice melt agents. Due to liability concerns, the application of rock salt on sidewalks and stairways is often quite heavy.

A relatively new program, the Certified Green SnowPro program, was developed by the New Hampshire Department of Environmental Services (NHDES) in response to the realization that private companies were applying excessive amounts of salt in order to reduce their potential exposure to liability in slip and fall lawsuits. The New Hampshire legislature enacted legislation in 2013 that provided liability protection, provided that the companies took specialized training and received a “Certified Salt Applicator” certificate. The certification program resulted in the reduction of over-application of salt. According to the University of Connecticut Extension, efforts to implement a Connecticut Green SnowPro program are underway (Dietz, 2019). Trainings for public works staff have been conducted and efforts are underway to develop liability protection. Several Stonington DPW staff, including the DPW director, have attended the CTI Green Snow Pro: Sustainable Winter Operations class.

5.1.9 Solar Facilities

In recent years, the installation of photovoltaic electric generating facilities has increased in Connecticut as a result of state policies that support the development of alternate energy sources and decreased dependence of fossil fuels. Although they are often referred to as solar farms, solar facilities are, in fact, industrial installations. Solar power-generating facilities often encompass many acres and the plastic solar panels create acres of impervious surfaces. Due to the nature of the installation process, it is difficult to phase the construction of solar installations in the same way that residential subdivisions are often phased. Consequently, large areas of land are often “opened up” during construction, necessitating vigilant stormwater management to avoid environmental impacts. Additionally, the long-term management of runoff from the solar arrays after construction is completed is necessary to avoid future soil erosion and impacts to permanent stormwater management structures.

Pollutants typically associated with solar facilities include sediment and fertilizer, especially during the construction and site stabilization phases. Increased stormwater discharge may occur, particularly if the site was converted from woodlands or agricultural land, increasing peak flows in nearby receiving waterbodies. Thermal pollution, the discharge of stormwater which has been warmed to levels above ambient temperature of receiving waters, may also occur.

Solar facilities are exempt from local permitting. Projects are reviewed and approved by the Connecticut Siting Council (CSC) and are subject to review by CT DEEP, which regulates construction through the General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities ("Construction General Permit"). At the time of the preparation of this Plan, two solar facilities were proposed in the Anguilla Brook/ Inner Wequetequock Cove Watershed. The first, which was approved by the Connecticut Siting Council in October of 2019, is a 5-megawatt AC photovoltaic electric generating facility located on ±16.5 acres east of Taugwonk Road and north of Interstate 95. Approximately 9.9 acres of this project is located in the Anguilla Brook watershed on agricultural land. The second project is the previously mentioned 3.0-megawatt facility at the Elmridge Golf Course. This petition, which was approved by the CSC in February 2021, consists of two parcels totaling about 14.2 acres located on the golf course property west and east of North Anguilla Road. If approved, this project will remove approximately 8% of the fairway area from recreational use.

5.2 Point Sources

Point source pollution is pollution that is discharged from a single, identifiable point, such as a sewage outfall or combined sewer overflow pipe, factory, or confined animal feedlot. Point sources are regulated by state or federal authorities via the National Pollutant Discharge Elimination System (NPDES) permit program (www.epa.gov/npdes/about-npdes). The NPDES permit program is authorized by Section 402 of the Clean Water Act through the 1987 Water Quality Act. The NPDES program regulates direct discharges into navigable waters of the US, including point and non-point sources. NPDES permits may be issued directly by the US EPA or by states authorized by EPA, including Connecticut. Permits establish pollutant monitoring and reporting requirements, and may include pollutant discharge limits based on specific water quality criteria or standards (US EPA, 2017).

5.2.1 NPDES Phase I and II Stormwater Permits

Stormwater permits issued under Phase l of the NPDES program include the following stormwater discharges:

- discharges permitted prior to February 4, 1987
- discharges associated with industrial activity
- discharges from large Municipal Separate Storm Sewer Systems (MS4s) (systems serving a population of 250,000 or more)
- discharges from medium MS4s (systems serving a population of 100,000 or more, but less than 250,000)
- discharges judged by the permitting authority to be significant sources of pollutants or which contribute to a violation of a water quality standard (US EPA, 2014).

Stormwater permits issued under Phase ll of the stormwater program include discharges not covered by Phase I, including small MS4s; construction sites of one to five acres; and industrial facilities owned or operated by small MS4s which were previously exempted under the Intermodal Surface Transportation Efficiency Act (US EPA, 2014).

Stormwater permits issued by the State of Connecticut under the NPDES program include:

- General Permit for the Discharge of Stormwater Associated with Industrial Activity (“Industrial General Permit”), which regulates industrial facilities with point source stormwater discharges that are engaged in specific activities according to their Standard Industrial Classification (SIC) code.
- General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities ("Construction General Permit"), which requires developers and builders to implement a Stormwater Pollution Control Plan to prevent the movement of sediments off construction sites into nearby water bodies and to address the impacts of stormwater discharges from a project after construction is complete.
- General Permit for the Discharge of Stormwater Associated with Commercial Activity ("Commercial General Permit"), found only in Connecticut, which requires operators of large paved commercial sites such as malls, movie theaters, and supermarkets to undertake actions such as parking lot sweeping and catch basin cleaning to keep stormwater clean before it reaches water bodies.

- General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems ("MS4 General Permit"), which requires each municipality to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies (CT DEEP, 2014).

5.2.1.1 *General Permit for the Discharge of Stormwater Associated with Industrial Activity*

This stormwater permit authorizes the discharge of stormwater associated with industrial activity to a surface water or storm sewer system. Permittees are required to register with CT DEEP and prepare and submit a Stormwater Pollution Prevention Plan.

The Town of Stonington landfill and transfer station (permit ID GSI000947) on Green Haven Road is regulated under the industrial stormwater general permit. A review of individual permits at the US EPA Region 1 NPDES permit webpage (www3.epa.gov/region1/npdes/permits_listing_ct.html) did not identify other industrial stormwater general permits in the Anguilla Brook/Inner Wequetequock Cove Watershed.

5.2.1.2 *General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities*

The construction stormwater general permit authorizes "…construction activities and associated stormwater and dewatering wastewater discharges on a site, as defined in this general permit, with a total disturbance of one or more acres of land area on a site, *regardless of project phasing*" (CT DEEP, 2020).

Construction stormwater general permits regulate construction activities that fall into one of two categories: locally approvable and locally exempt. Locally approvable projects are those "…for which the registration is not for a municipal, state or federal project and is required to obtain municipal approval for the project" (CT DEEP, 2020). Permittees are also required to comply with recommendations of the Connecticut Guidelines for Soil Erosion & Sediment Control (CT DEP, 2002) and Connecticut Stormwater Quality Manual (CT DEP, 2004). A locally exempt project is one for which "…a registration is required under this general permit and which is not a locally approvable project" (CT DEEP, 2020). Permittees must register the activity with the State and must have the construction plans, including construction phasing, a Stormwater Pollution Control Plan, and an erosion and sediment control plan, reviewed and certified by a qualified professional as defined in the general permit.

A review of CT DEEP's Registrations for the Construction Stormwater General Permit (re-issued on 12/31/2020; filings.deep.ct.gov/DEEPPortal/PublicSearch/SWC) did not indicate any registrations in the Anguilla Brook/Inner Wequetequock Cove Watershed.

5.2.1.3 *General Permit for the Discharge of Stormwater Associated with Commercial Activity*

The commercial stormwater general permit regulates the discharge of stormwater associated with commercial activity that is discharged to surface waters or a municipal separate storm sewer system. The permit further applies to "…any activity or facility under Standard Industrial Classifications (SIC) (as defined in *Standard Industrial Classification Manual, Executive Office of the President, Office of Management and Budget 1987*) 50-59 and 70-79, with five (5) acres or more of contiguous impervious surface. Impervious surface means roof area, paved walk, paved parking area, paved driveway, paved roadway and any other paved surface" (CT DEEP, 2017).

Commercial facilities subject to the commercial stormwater general permit are required to register with CT DEEP and prepare and submit a stormwater management plan (SWMP). The SWMP must identify stormwater management measures, including:

- pollution prevention team
- sweeping
- outside storage
- washing
- spill control
- maintenance and inspection
- employee training
- comprehensive annual stormwater evaluation and inspection
- record keeping
- future construction

Most commercial establishments in the Anguilla Brook/Inner Wequetequock Cove Watershed appear to be no more than a few acres. The Pawcatuck Shopping Center on US Route 1 may exceed five acres of impervious surfaces and may be subject to the commercial stormwater general permit.

5.2.1.4 *Small Municipal Separate Storm Sewer Systems (MS4)*

The purpose of the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit) is to protect surface waters from stormwater runoff from storm drain systems originating in urbanized areas (CT DEEP, 2016). Urbanized areas (UAs) are densely populated areas that surround urban centers, and are defined by the Federal Census Bureau.

Traditionally, storm drain systems have not been designed to treat the many pollutants that are mobilized and transported by rainwater as it is conveyed into the receiving waterbodies. As a result, stormwater can contain a variety of pollutants including bacteria, sediment, nutrients from pets, livestock and lawn care products, trash and debris, and oils, greases and other chemicals from vehicles that can be detrimental to water quality and exceed established water quality standards. Storm drain systems may also be a significant source of fecal bacterial loading, either via the transmission of contaminated surface stormwater runoff to the receiving waterbody, or by loading of bacteria originating in the storm drain. Studies have indicated that *E. Coli* and other fecal coliform bacteria, once introduced into the environment, can survive and proliferate in the biofilm (scum) layer that forms in storm drain pipes (Skinner et al, 2010).

The current Connecticut MS4 General Permit was issued by CT DEEP on January 20, 2016. It became effective on July 1, 2017 and expires on June 30, 2022. The permit has specific requirements, including the development of a Stormwater Management Plan (SWMP) and the monitoring of specified stormwater outfalls. The SWMP contains information and recommendations to reduce or eliminate the discharge of pollutants through the stormwater system to the maximum extent practicable (MEP). The SWMP also identifies six Minimum Control Measures that the permittee must implement, including:

- Public education and outreach
- Public participation
- Illicit discharge detection and elimination (IDDE)
- Construction site stormwater runoff control
- Post-construction stormwater management
- Pollution prevention and good housekeeping.

Stonington is located within the Norwich-New London Urbanized Area and is therefore subject to MS-4 permitting (Fig. 5-4). North Stonington is outside the UA and is currently not subject to the MS4 permit. In compliance with the permit, Stonington has prepared and submitted a Stormwater Management Plan for the Town and Borough of Stonington (dated March, 2017) to CT DEEP and is on schedule with the implementation of the permit requirements. The Stormwater Management Plan and draft annual reports can be found at the Town of Stonington website at www.stonington-ct.gov/engineering/pages/phase-2-stormwater-permitting.

The Connecticut Department of Transportation is subject to the General Permit for the Discharge of Stormwater from the Department of Transportation Separate Storm Sewers Systems (DOT MS4). Like the municipal MS4 general permit, the DOT MS4 general permit is intended to protect waters of the state from pollution contained in DOT storm drain systems within Urbanized Areas. State Route 284, US RT 1 and Interstate 95 are located within the UA in Stonington. Requirements of the DOT MS4 permit generally mirror those of the small municipal MS4 permits; preparation of a stormwater management plan, six minimum control measures, outfall monitoring and preparation of annual reports which are submitted to DEEP.

5.2.2 CAFO Permits

Concentrated Animal Feeding Operations (CAFOs) are agricultural operations where:

> Animals are kept and raised in confined areas for a total of 45 days or more in any 12-month period, and crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility. CAFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land. CAFOs are point sources, as defined by the CWA Section 502(14) and are regulated through the NPDES program (US EPA, 2014).

Currently, in Connecticut, permits are not being issued for CAFOs, although DEEP does review Comprehensive Nutrient Management Plans (CNMPs) that are voluntarily submitted by producers enrolled in USDA-NRCS programs. There are no AFOs or CAFOs located in the Anguilla Brook/Inner Wequetequock Cove Watershed.

5.3 Hazardous Waste

EPA defines hazardous waste as “waste that is dangerous or potentially harmful to our health or the environment. Hazardous wastes can be liquids, solids, gases, or sludges. They can be discarded commercial products, like cleaning fluids or pesticides, or the by-products of manufacturing processes” (US EPA, 2014). Authority for the State of Connecticut to regulate hazardous waste is prescribed through Connecticut General Statutes Section 22a-449. A summary of hazardous waste sites in the Anguilla Brook/Inner Wequetequock Cove Watershed is provided in the following sections. Sites are depicted on Fig. 5-4.

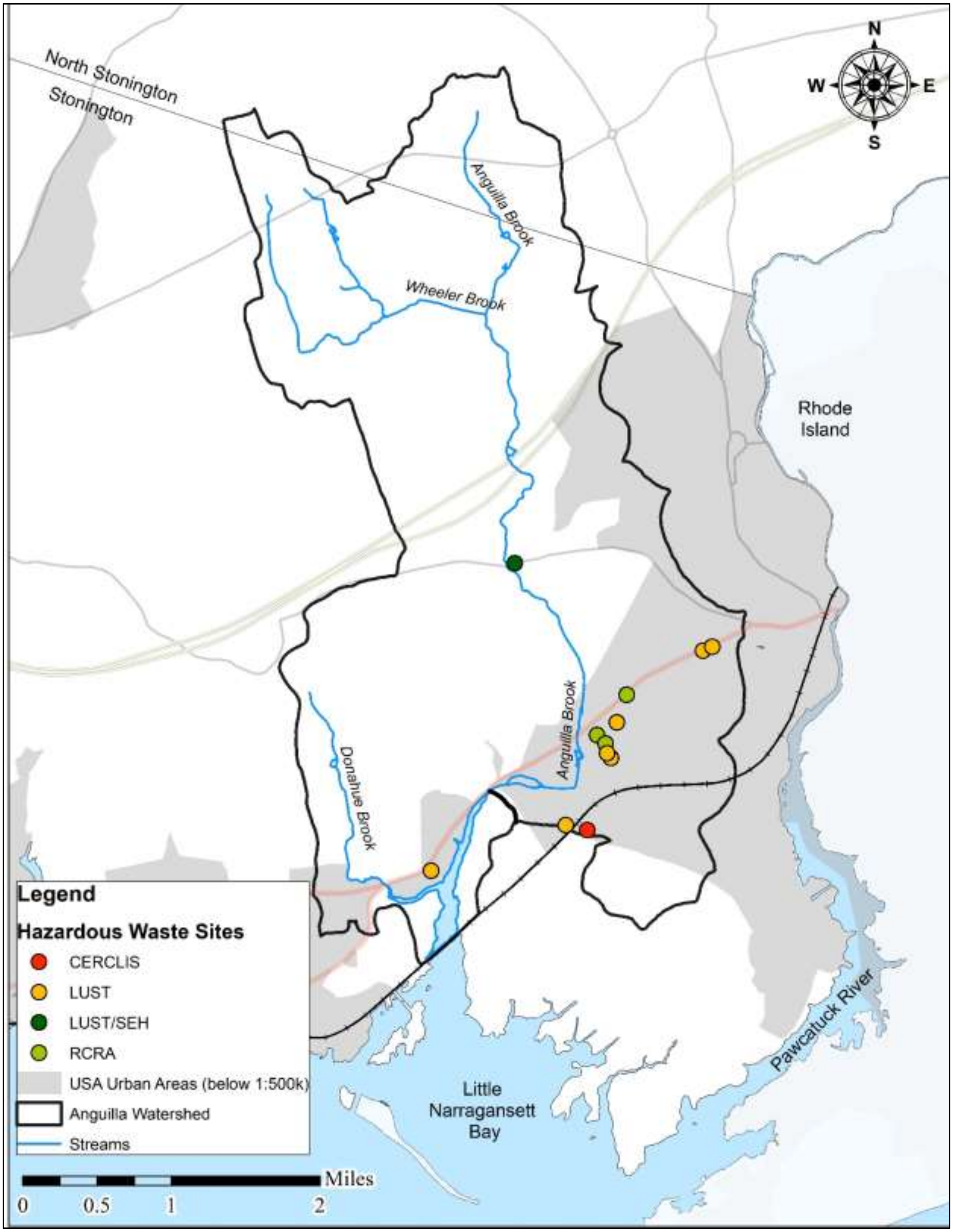


Figure 5-4. Hazardous waste sites in the Anguilla Brook/Inner Wequetequock Cove watershed.

5.3.1 CERCLA Sites

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the Superfund, was enacted by Congress on December 11, 1980. A CERCLA or Superfund site is an uncontrolled or abandoned place where hazardous waste or other contamination is located (US EPA, 2014). The Stonington municipal landfill is listed on the CERCLA inventory and is also listed on the CT Inventory of Hazardous Waste Disposal Sites (Sect 5.3.2 RCRA Sites) and is depicted on Fig. 5-4.

5.3.2 RCRA Sites

The Resource Conservation and Recovery Act (RCRA) was enacted by Congress in 1976. RCRA's primary goals are "to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. RCRA regulates the management of "solid waste (e.g., garbage), hazardous waste, and underground storage tanks holding petroleum products or certain chemicals" (US EPA, 2014). Facilities regulated under the Resource Conservation and Recovery Act (RCRA) may have releases into the environment, thereby requiring cleanup. RCRA sites in the Anguilla Brook/Inner Wequetequock Cove Watershed include Davis-Standard LLC, the Stonington landfill, and a commercial site on South Broad Street (Fig. 5-4).

5.3.3 Leaking Underground Storage Tanks

The US EPA defines an underground storage tank (UST) as "a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground" and that stores petroleum or certain hazardous substances (US EPA, 2014). This typically refers to underground tanks at gas and service stations and residential heating oil tanks. The State of Connecticut regulates leaking USTs (LUST) through the Department of Energy and Environmental Protection Storage Tank Enforcement Unit. There are nine registered LUST sites in the Anguilla Brook/Inner Wequetequock Cove Watershed, including one which is listed as a controlled significant environmental hazard (SEH) site. As of late 2020, remediation had been completed on three of the listed sites, started on three sites, and was pending on three sites. LUST sites are depicted on Fig. 5-4.

5.3.4 Brownfields

A brownfield is defined by Connecticut General Statutes Section 32-9kk(a)(1) as "any abandoned or underutilized site where redevelopment, reuse or expansion has not occurred due to the presence or potential presence of pollution in the buildings, soil or groundwater that requires investigation or remediation before or in conjunction with the restoration, redevelopment, reuse and expansion of the property." The Connecticut Brownfields Redevelopment Authority (CBRA) maintains a town-by-town brownfields inventory that can be found on the CT DEEP brownfields portal (portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Brownfields/Brownfields-in-Connecticut), along with additional information regarding brownfields redevelopment. No brownfields were listed in the DEEP Brownfield Inventory in the Anguilla Brook/Inner Wequetequock Cove Watershed.

5.4 Other Potential Pollutant Sources

5.4.1 Marinas/Boating

There are three marinas on Wequetequock Cove; Stonington Marina, Cove Ledge Inn and Marina, and Lockwood's Coveside Marina. Stonington Marina offers slip rentals, boat and motor repair, and kayak and paddleboard rentals. Cove Ledge Inn and Marina offers lodging and slip rentals. Lockwood's Coveside Marina offers slip rentals, full-service boat maintenance, boat repair and boat storage.

Marinas and boating activities can contribute to both point and nonpoint source pollution. Marina-based activities associated with the maintenance and repair of boats such as cleaning, refueling, sanitary waste pump-outs, and scraping, sanding and painting have the potential to contaminate marine waters (US EPA, www.epa.gov/nps/nonpoint-source-marinas-and-boating). According to NOAA, "Chemicals used to maintain and repair boats, such as solvents, oils, paints, and cleansers, may spill into the water, or make their way into waterbodies via runoff. Spilling fuel (gasoline or oil) at marinas or discharging uncombusted fuels from engines also contribute to nonpoint source pollution. In addition, poorly maintained sanitary waste systems aboard boats or poorly maintained pump-out stations at marinas can significantly increase bacteria and nutrient levels in the water" (oceanservice.noaa.gov/education/tutorial_pollution/09activities.html#:~:text=Marinas%20and%20boating%20activities%20can,way%20into%20waterbodies%20via%20runoff). Marinas are regulated under the Industrial Stormwater General Permit.

The Clean Marinas Program, developed by CT DEEP and presently administered through the Connecticut Marine Trades Association (CMTA), is a voluntary program that encourages marinas and boatyards to adopt best management practices in order to achieve environmental compliance. Facilities that fulfill the requirements of the program are designated certified Clean Marinas and may display their certification to the boating community.

Pollution associated with boating activities include on-the-water oil and fuel spills, septic (head) discharge, trash, and fishing waste. The Connecticut Clean Boater program encourages the adoption of best management practices by boaters to manage spills and leaks, reduce or eliminate occurrences of overboard trash and waste, and make use of pump-out stations (portal.ct.gov/DEEP/Boating/Clean-Marina/Connecticut-Clean-Boater-Program). All Connecticut coastal waters are federally designated "No Discharge Areas" (NDAs). Within NDAs, the discharge of sewage, treated or untreated is prohibited. Little Narragansett Bay, of which Wequetequock Cove is a part, is served by the Westerly (Rhode Island) pump-out boat.

6 WATERSHED MANAGEMENT GOAL AND OBJECTIVES

6.1 WATERSHED MANAGEMENT GOAL

As expressed at the outset of this document, the overarching goal of the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan is to restore the water quality of Wequetequock Cove so that it is compatible with all its intended uses including supporting a healthy and thriving estuarine habitat with clean water that is safe for all recreational activities and the safe consumption of shellfish.

Section 6.2 identifies watershed management objectives intended to assist watershed managers with minimizing or eliminating the impacts of pollution by addressing the sources of pollution identified in Section 5. Pollutant sources, indicators and load reduction targets pertaining to the watershed management objectives are presented in Table 6-1.

6.2 WATERSHED MANAGEMENT OBJECTIVES

Management objectives to aid watershed managers realize the goal of this watershed-based plan are presented below. Structural and non-structural strategies to help managers implement each objective are presented in Section 7.

Objective 1: Form a sustainable, long-term coalition of stakeholders to adopt and implement this watershed management plan.

Objective 2: Raise public awareness of water quality conditions and actions to reduce water quality impacts.

Objective 3: Reduce nutrient loading (especially nitrogen loading) from sources such as agriculture; agricultural, commercial and residential fertilizer use; and septic systems.

Objective 4: Reduce bacteria loading from sources such as pets, livestock, agricultural activities, and septic systems.

Objective 5: Reduce NPS pollutant loading from sources such as stormwater runoff from roadways, commercial, industrial and residential areas; agriculture; recreational fields; marinas, boat maintenance and boating activities.

Table 6-1. Watershed Management Objectives, Pollutant Sources, Indicators and Targets

Management Objectives	Pollutant Source(s)	Indicator	Target
Form a sustainable, long-term coalition of stakeholders to adopt and implement this watershed management plan.	NA	NA	NA
Raise public awareness of water quality conditions and adoptable actions to reduce water quality impacts.	NA	NA	NA
Reduce nutrient loading (especially nitrogen loading) to freshwater surface waterbodies and Wequetequock Cove.	Agriculture (manure); agricultural, commercial and residential fertilizer use; and septic systems.	Total Nitrogen	Recommended threshold level of 0.4 mg/L for the preservation of eelgrass and 0.34 mg/L for eelgrass restoration (Simpson and Dahl, 2018).
Reduce bacteria loading to freshwater surface waterbodies and Wequetequock Cove.	Pets, livestock, agricultural activities, and septic systems.	Fecal bacteria	Fecal coliform: Geometric Mean less than 14/100ml; 90% of Samples less than 31/100ml (CT WQS, 2013) Enterococci: Geometric Mean less than 35/100ml; Single Sample Maximum 500/100ml (CT WQS, 2013)
Reduce NPS pollutant loading to freshwater surface waterbodies and Wequetequock Cove.	Stormwater runoff from roadways, and commercial, industrial and residential areas; agriculture; recreational fields; marinas, boat maintenance and boating activities.	• Sediment • Pesticides • Herbicides • Fungicides • Chlorine • Vehicular chemicals • Heavy metals • Other chemical constituents	None in concentrations or combinations which would be harmful to designated uses. Refer to Tables 1 and 3 of CT Water Quality Standards and sections 22a-426-4(a)(5); 22a-426-4(a)(9); 22a-426-4(a)(9)(B); 22a-426-4(a)(11); 22a-426-4(l); 22a-426-4(m); 22a-426-9(a)(3); 22a-426-9(a)(4) and 22a-426-9(a)(5) of the Regulations of Connecticut State Agencies (CT WQS, 2013).

7 WATERSHED MANAGEMENT STRATEGIES

Watershed management strategies, or “Best Management Practices” (BMPs), are control measures that are used to “manage the quantity and improve the quality of stormwater runoff” (US EPA, 2012) typically caused by changes in land use. Generally, BMPs focus on water quality problems caused by increased impervious surfaces from land development. BMPs are designed to reduce stormwater volume, peak flows, and/or nonpoint source pollution through evapotranspiration, infiltration, detention, and filtration or biological and chemical actions (Debo and Reese, 2003). Watershed management strategies are measurable actions with definable interim steps (milestones) that watershed managers can adopt or implement in order to attain watershed management goals and objectives.

Management strategies may be comprised of "non-structural" actions or practices - procedures such as individual or community behavioral changes, revisions to municipal regulations and practices, preservation of open space, and the use of modified landscaping practices; or "structural" practices, such as brick-and-mortar devices installed or constructed on a site to manage and improve water quality. There are a variety of best management practices (BMPs) available; selection typically depends on site characteristics and pollutant removal objectives. The US EPA has published a list of stormwater BMPs for use by local governments, builders and property owners (US EPA, 2012) to assist water quality managers with understanding and selecting site-appropriate stormwater BMPs. CT DEEP promotes Low Impact Development (LID) practices through newer appendices to the CT Erosion & Sediment Control Guidelines (DEEP, 2002), the 2004 CT Stormwater Quality Manual (DEEP, 2004) and an updated CT Stormwater Quality Manual, the revision of which is currently underway.

The following sections identify existing management strategies and additional strategies that will be needed to achieve the goals of this Plan. Section 7.1 identifies management strategies that exist or have been implemented in the watershed. Section 7.2 provides additional general recommendations that can be adopted to target the pollutant sources identified in Section 5. Section 7.3 identifies more targeted management practices on watershed-, neighborhood-, and site-specific-scales, based on the general recommendations presented in Section 7.2.

7.1 EXISTING MANAGEMENT STRATEGIES

As part of compliance with its Small Municipal Separate Storm Sewer System (MS4) permit, the Town of Stonington has adopted non-structural and structural stormwater management strategies. These strategies align with the six minimum control measures (MCM) required by the MS4 permit:

- MCM 1. Public education and outreach
- MCM 2. Public participation
- MCM 3. Illicit discharge detection and elimination (IDDE)
- MCM 4. Construction site stormwater runoff control
- MCM 5. Post-construction stormwater management
- MCM 6. Pollution prevention and good housekeeping.

7.1.1 Existing Non-Structural Strategies

7.1.1.1 *Public Education, Outreach and Participation*

The Town of Stonington has adopted a variety of outreach strategies to inform and educate residents, businesses, students, town staff and contractors about stormwater and associated pollutants that align with MCMs 1 & 2. These include the development of a municipal stormwater website, informational brochures, articles in municipal publications such as the annual Flood Awareness Newsletter and the Stonington Events quarterly town newsletter, and curriculum and activities in the public school system. Public participation activities conducted in collaboration with CUSH, the Avalonia Conservancy, Stonington public schools and other local organizations include the installation of storm drain markers, neighborhood cleanups, and hazardous waste collection events (Stonington Stormwater Management Plan, 2017).

In 2018, the Town and Borough re-established the Stonington Stormwater Task Force to assist with the implementation of the MS4 permit. The task force includes members from the Board of Selectman, CUSH, and the Shellfish, Mystic Harbor Management, and Stonington Harbor Management Commissions. The group focuses on water quality issues, public education, and regulations and standards.

Public education and outreach activities conducted under the MS4 permit and reported in the 2017 - 2020 Annual MS4 Reports to CT DEEP are listed in Table 7-1.

Table 7-1. Town of Stonington Public Education and Outreach Activities

MS4 Annual Report	Public Education and Outreach Activity
2017	○ Updated the town stormwater webpage. ○ Published two stormwater articles to the general public in the quarterly town magazine "Stonington Events" regarding fertilizers, pesticides, detergents and pet waste. ○ Implemented pet waste education program and installed additional signage, baggies, and disposal receptacles, as needed, in areas where pet walking is common.
2018	○ Re-established stormwater task force to assist in implementation of MS4 permit reqts. ○ Published an article to the general public in the quarterly town magazine "Stonington Events" regarding nitrogen and bacteria. ○ Partnered with ECCD to conduct a rain garden workshop at the United Congregational Church of Pawcatuck in April 2018. ○ Partnered with ECCD to conduct a rain barrel workshop at United Congregational Church of Pawcatuck in August 2018
2019	○ The Town purchased stencils and intends to begin marking catch basins in 2020. ○ The Town and borough intend to work with their consultant to create and disseminate educational stormwater materials to the schools in 2020.
2020	○ Maintained the Town and Borough's Stormwater webpage. ○ Distributed 26 copies of *Mermaid Island*, by Sarah Ridyard, a children's book on the importance of water quality protection, to 3 middle schools, 7 pre-schools and 1 library. ○ Participated in Eastern Connecticut Stormwater Collaborative events. ○ Distributed Flood Awareness Newsletter to all residents in flood hazard zones. ○ Marked approximately 50 catch basins through catch basin marking program.

7.1.1.2 *Land-Use Regulation and Legal Authorities Review*

Municipalities determine how a town will be developed, and consequently how it will look and function, in large part through the codification of land-use regulations. Land-use regulations are authorized through the passage of municipal ordinances and enacted through review and revision by the land-use commissions, often in response to legislative changes at the state level. It is incumbent upon municipal decision-makers, including the board of selectmen and land-use boards and commissions, to ensure that regulations and policies both reflect and support the municipality's plans for future growth as defined by the municipal Plan of Conservation and Development, are up-to-date with current state land-use legislation, and are representative of the most current land use planning practices.

The MS4 permit has specific requirements for the review and update of land-use regulations and legal authorities pertaining to actions associated with the management of stormwater. These include establishing the legal authority to implement and enforce an Illicit Discharge Detection and Elimination (IDDE) program, construction site stormwater management, stormwater retention standards, and municipal regulatory barriers to the implementation of low-impact development (LID) practices.

Land-use regulation and legal authorities review and updates conducted under the MS4 permit and reported in the 2017 - 2020 Annual MS4 Reports to CT DEEP are listed in Table 7-2.

Table 7-2. Town of Stonington Land-use Regulation and Legal Authorities Review and Updates

MS4 Annual Report	Land-use Regulation and Legal Authorities Review and Update Actions
2017	○ Established and/or updated legal authority and guidelines regarding LID and runoff reduction in site development planning. ○ Enforced LID/runoff reduction requirements for development and redevelopment projects.
2018	○ Established legal authority to prohibit illicit discharges.
2019	○ Began review and update, as necessary, of existing land use regulations and implementation policies for compliance with the MS4 General Permit construction site stormwater runoff control requirements. ○ Established and/or updated legal authority and guidelines regarding LID and runoff reduction in site development planning.
2020	○ Began a review of the Town and Borough's land use regulations and implementation policies for compliance with the MS4 permit.

7.1.1.3 *Municipal Good Housekeeping*

Good housekeeping practices are best management practices that control pollutant discharges and keep pollutants out of waterways. Municipalities are responsible for maintaining much of the impervious surfaces within their jurisdictional boundaries, including roads, sidewalks, parking lots, and municipal buildings. Municipal facilities can create NPS pollutants from normal activities such as structure, vehicle and equipment maintenance, and grounds management. Vehicle fueling, material loading, unloading and storage can also be sources of NPS.

The MS4 permit requires municipalities to adopt good housekeeping practices (GHPs) to minimize the impacts of NPS from municipal activities and to train staff to implement these practices. Good housekeeping practices related to the MS4 permit include:

- the development and implementation of a formal employee training program,
- implementation of GHPs,
- the disconnection of directly connected impervious areas (DCIA),
- stormwater infrastructure inspection and repair,
- development and implementation of a street sweeping program,
- development and implementation of a catch basin cleaning program, and
- development and implementation of snow management practices.

Municipal Good Housekeeping activities adopted and conducted under the MS4 permit and reported in the 2017 - 2020 Annual MS4 Reports to CT DEEP are listed in Table 7-3.

Table 7-3. Town of Stonington Existing Municipal Good Housekeeping

MS4 Annual Report	Good Housekeeping Practices

2017	○ Spill prevention & response training and stormwater management training for all municipal staff and facilities staff.
	○ Identification of retention and detention ponds in priority areas.
	○ Implementation of long-term maintenance plan for stormwater basins & treatment structures.
	○ Addressed erosion and sediment problems noted during inspections conducted under BMP 5-3 through the retrofit program developed under BMP 6-7 defined within the Stormwater Management Plan (SMP).
	○ Implemented turf/fertilizer management BMPs for parks and open space.
	○ Implemented waterfowl management BMPs in targeted areas as needed.
	○ Evaluated municipal buildings and facilities for spill prevention and pollution prevention practices and implemented additional BMPs as necessary.
	○ Evaluated and modified, as necessary, municipal vehicle and equipment parking, fueling, and maintenance practices.
	○ Developed and implemented street sweeping program.
	○ Developed and implemented catch basin cleaning program.
	○ Developed and implemented snow management program:
	  ○ All plow drivers attended training for salt application and snow removal BMPs.
	  ○ GPS installed on all plow trucks and software installed on some trucks to track salt application and the rate of application per truck.

2018	○ Developed record keeping system for IDDE tracking ○ Reduced the application of fertilizers (since start of permit) on Town land by 25%. ○ 2 town employees obtained herbicide/pesticide applicator certification. ○ 11 town employees attended snow removal training at UConn.
2019	○ 2 town employees attended snow removal training. ○ 2 town employees attended pesticide/herbicide training, leading to a 20% reduction in pesticide use.
2020	○ Began dry weather outfall inspections and sampling and wet weather sampling of outfalls that discharge to impaired waters. ○ 1 employee attended pesticide/herbicide training. The Town was able to reduce herbicides used on town properties by 10% in 2020.

7.1.2 Existing Structural Strategies

7.1.2.1 *Stormwater BMPs*

In 2018, ECCD partnered with the Town and community partners to install several rain gardens throughout Stonington. As part of that effort, a rain garden was installed at the United Congregational Church of Pawcatuck in the Anguilla Brook/Inner Wequetequock Cove Watershed to catch and infiltrate runoff from the parking lot. This rain garden, which drains a 2,500-square foot area of parking lot, removes an estimated 0.4 lb/yr of total nitrogen, 0.1 lb/yr of total phosphorus, 33 lb/yr total suspended solids, and 93 billion MPN/yr of fecal indicator bacteria.

7.1.2.2 *Septic Systems Repairs:*

As discussed in Section 5, underperforming and failing septic systems can be significant sources of fecal bacteria and nitrogen to both surface waters and groundwater. The Town of Stonington has documented septic systems repairs/replacements that have been reviewed and approved by Ledge Light Health District as part of the MS4 reporting requirements. Septic system repairs documented in the 2017 - 2020 MS4 Annual Reports are listed in Table 7-4.

Table 7-4. Septic System Repairs in the Anguilla Brook/Inner Wequetequock Cove Watershed

MS4 Annual Report	Location/Reason for Repair
2017	○ 15 Sherwood Dr* - single family house (SFH) - failing septic system: septic repair (tank, pump chamber and leach field) ○ 45 Greenhaven Rd* (SFH) - septic failure: septic repair (tank and leach field) ○ 4 High Ridge Ct (SFH) - septic failure: septic repair (leach field only)
2018	○ 916 Stonington Rd* – multi-family (MF) - failing septic system: new tank and leaching system installed ○ 120 Pequot Trail (SFH) - full repair/tear down/rebuild ○ 620 Taugwonk Rd (SFH) - new tank and leach field
2019	○ 22 Greenhaven Rd* (SFH) - full repair ○ 75 Farmholme Rd (SFH) - tank replacement only ○ 308 Greenhaven Rd (SFH) - full system replacement: failure for Real Estate Trans. ○ 44 Renee Dr (SFH) - full repair: failure for Real Estate Trans. ○ 587 Taugwonk Rd - full repair: failure for Real Estate Trans. ○ 171 South Anguilla Rd - full replacement system to abandon grey water system ○ 14 Stanton Lane* - tank replacement only
2020	○ 978 Stonington Rd* (SFH) - new tank and leaching system installed ○ 335 Elm St (SFH) – tank replacement only ○ 908 Stonington Rd* (SFH) – full repair ○ 10 Marlin Dr* (SFH) – full repair ○ 985 Stonington Rd* (SFH) – repair of new sewer line to existing tank/system

* Septic system repair/replacement located in a critical area as identified in Section 4.2.

7.1.2.3 *Municipal Stormwater Infrastructure Repairs:*

In 2019, the Stonington Department of Public Works completed the following Town-wide stormwater infrastructure repairs/improvements (2019 MS4 Annual report):

- Replaced five (5) culverts,
- Repaired sixty-nine (69) catch basins, and
- Inspected one-thousand-three-hundred-and-ten (1,310) catch basins.

In 2020, all catch basins and drainage structures in the Anguilla Brook/Inner Wequetequock Cove Watershed were inspected and cleaned, and one catch basin was repaired (C. Greenlaw, Stonington Town Engineer, personal communication, Feb. 8, 2021).

7.2 Recommended Management Strategies

This section outlines general management strategies that may be adopted or implemented to restore surface water quality conditions in the Anguilla Brook/Inner Wequetequock Cove Watershed, so that all waterbodies will meet Connecticut water quality standards for healthy aquatic habitat, recreational activities, and the direct consumption of shellfish. A variety of management strategies are provided to target the pollutant sources identified in Section 5. These recommendations align with the watershed objectives identified in Section 6.2. The recommended strategies include short- (1 to 2 years), medium- (2 to 5 years), and long-term (5 to 10 years or longer) controls and actions that vary in relative effort and cost, and that can be adopted and implemented by a wide variety of stakeholders. Information regarding BMP load reductions, implementation costs, technical and financial assistance, associated education and outreach, implementation schedules, and interim measurable milestones are provided where it is relevant to the recommendation.

7.2.1 Create a Watershed Coalition

Objective 1: Form a sustainable, long-term coalition of stakeholders to adopt and implement this watershed management plan.

It is strongly recommended that, as a key first step, stakeholders form a watershed management team to formally adopt and implement the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan. A strong, cohesive, and committed watershed management team will play a vital role in ensuring that the watershed-based plan's goals and objectives will be achieved in an organized and expeditious manner. It is impossible to understate the importance of the management team to the successful implementation of this watershed-based plan. Without a strong, organized management team, the stated watershed-based plan goals and objectives will not be achieved.

The watershed management team will be responsible for:

- raising awareness and promoting the Plan throughout the watershed;
- coordinating the implementation of the Plan recommendations;
- developing a work plan that identifies water quality goals and objectives for the Anguilla Brook/Inner Wequetequock Cove Watershed;
- reviewing, prioritizing and implementing Plan recommendations;
- identifying funding sources and in-kind services, prospective partners and technical assistance; and,
- evaluating the results to determine if revisions to the implementation approach are required.

The watershed management team should take an adaptive 3-step approach to implementing the recommendations contained in this Plan, evaluating implementation measures as they are conducted, and making necessary adjustments based on the results to improve outcomes. The team should devise a method to track the progress of Plan implementation, and should seek important feedback from land owners, municipal staff/leaders and other stakeholders. The watershed management team will also be responsible for reporting initial steps and results to stakeholders and the broader community, and for celebrating successes throughout the community.

Potential watershed team members are listed in Table 7-5. Watershed management team capacity building actions or milestones are described below and summarized in Table 7-6. These tables can be used as a preliminary plan or guideline for the establishment of a watershed team.

Recommended Management Actions:

1. Establish the watershed management team.

A well-balanced watershed management team should consist of a variety of members of the community, and may include municipal officials and commissioners, business owners, landowners, environmental and civic organizations, as well as any other organizations, agencies or individuals with an interest in the preservation and improvement of water quality and water uses in the watershed. It is recommended that at a minimum, the Anguilla Brook/Inner Wequetequock Cove Watershed management team include a land-use planner or similarly trained professional, members of the Stonington and North Stonington land use commissions, watershed residents and local watershed businesses. It should be noted that the involvement of various watershed stakeholders may change throughout the planning and implementation phases, depending on their interests, expertise and availability.

The stakeholders who participated in the development of this Plan may form the kernel of the watershed management team. Their inclusion would guarantee continuity from plan development to implementation. Additionally, the members of Plan development stakeholder team represented a broad spectrum of local, regional and state organizations with a diverse array of interests in the watershed and expertise in environmental advocacy, management and protection. Once the members of the watershed team have been established, an initial meeting should be conducted, partner roles and responsibilities should be discussed and a regular meeting schedule established.

Table 7-5. Potential watershed management team members and their roles/responsibilities.

Stakeholder Team Member	Potential Role/Responsibility
Agricultural producers and non-commercial farmers	Adoption of agricultural BMPs to manage nutrient/manure applications; peer to peer outreach; open space preservation and advocacy.
Area residents	Awareness of water quality conditions and challenges; adoption of practices that are supportive of good water quality and aquatic habitat.
Avalonia Land Conservancy	Land conservation; advocacy; outreach and education.
CT Department of Agriculture Bureau of Aquaculture	Water quality sampling/support; shellfish restoration; technical support and assistance.
CT Department of Energy and Environmental Protection	Development of updated fecal bacteria TMDL; data collection via Ambient WQM program; SWGP and MS4 programs support; technical support in water, natural resources and land management.
CT Sea Grant Program	Education and outreach; technical information; shellfish/habitat restoration.
CUSH	Collection, analysis and dissemination of water quality data; outreach and education.
Eastern CT Conservation District	Technical assistance; plan implementation; project support.
Ledge Light Health District	Review and approval of septic systems; identification and repair of failing on-site wastewater systems.
Manatuck Land Preserve/Denison Pequotsepos Nature Center, Inc.	Land conservation; advocacy; outreach and education.
Mystic Aquarium	Outreach and education; conservation; Long Island Sound advocacy.
Native Fish Coalition (CT Chapter)	Education and outreach; natural resource/fisheries advocacy.
Pawcatuck River Harbor Management Commission	Education and outreach; harbor management; water quality management.
Pine Point School	Outreach; incorporation of water quality and natural resource topics into curriculum; project support.
Save the Sound	Unified Water Study; education and outreach; Long Island Sound advocacy; technical and project support.
Southeastern CT Council of Governments	Regional land use planning; grant writing; sharing of regional plan and implementation resources; technical support.
Stonington and North Stonington Municipal Land-use Departments, Commissions and Departments of Public Works	Watershed-based plan promotion; review, update and enforcement of land use regulations and/or ordinances; coordination with Plan of Conservation & Development; site plan review/permitting; public utilities maintenance; development of incentive programs to encourage adoption of BMPs; staff Good Housekeeping training.
Stonington Harbor Management Commission	Education and outreach; harbor management; water quality management.
Stonington Land Trust	Land conservation; advocacy; outreach and education.
Stonington Shellfish Commission	Education and outreach; shellfish management; water quality sampling.
Stonington Stormwater Task Force	Management of stormwater; compliance with 2016 MS4 permit.
The Nature Conservancy	Nitrogen reduction strategy support; Long Island Sound advocacy; technical support.
Trout Unlimited	Education and outreach; natural resource/fisheries advocacy.
University of Connecticut Dept. of Marine Sciences	Water quality data; technical support and assistance.
UCC of Westerly	Education and outreach; project support.

2. Review watershed management goals and objectives.

The Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan is a blueprint for watershed managers to achieve the stated watershed goals and objectives. Once the watershed management team has been established, the team should review the watershed-based plan carefully and identify the goals and objectives, along with a set of measurable outcomes. The goals and objectives will set the framework for how the management team will proceed with the implementation of the Plan recommendations.

There are a number of resources, agencies and organizations available to assist the watershed team with implementing the watershed-based plan, including:

- US EPA Watershed Planning - www.epa.gov/nps/watershed-planning
- CT DEEP Watershed Planning - www.ct.gov/deep/watershed
- Center for Watershed Protection - www.cwp.org/
- Eastern Connecticut Conservation District – www.ConserveCT.org/eastern

3. Identify sources of financial assistance.

Most, if not all, of the management recommendation in the following sections will require some financial investment. Some costs, especially those associated with programmatic changes or improvements, may be able to be absorbed into existing municipal budgets or programs. However, as the watershed team and other stakeholders undertake the implementation of Plan recommendations, particularly structural water quality improvement projects, outside sources of funding and community partnerships will likely be required. A list of sources of financial assistance is provided in Section 8-1.

4. Identify sources of technical assistance.
As watershed-based plan implementations are identified and prioritized, the watershed team may need to identify sources of technical assistance to aid with the development and implementation of the proposed stormwater management practices. There are a number of agencies and organizations available to assist with the implementation of the Anguilla Brook/Inner Wequetequock Cove Watershed-based plan.

Organizations such as the US Department of Agriculture Farm Services Agency (FSA) and Natural Resources Conservation Service (NRCS), CT DEEP, the CT Department of Agriculture, the Southeastern Connecticut Council of Governments (SCCOG), the Eastern Connecticut Conservation District, the University of Connecticut Cooperative Extension Service, Connecticut Sea Grant, the US Fish & Wildlife Service, local land conservation trusts and others may provide technical assistance to project managers and watershed stakeholders that can ensure project success.

A list of organizations and agencies that can provide technical assistance is provided in Section 8-2. Most of these organizations and agencies have broad experience working with other watershed-based plans across Connecticut and the region.

5. Identify and establish a mechanism for outreach.

Over the course of the watershed-based plan implementation, the watershed team will want to convey information to the general public regarding its activities and success stories. In order to be prepared to effectively communicate its message to watershed residents, the watershed team should establish a mechanism for public outreach, including partnerships with like-minded community organizations who can assist with the broad distribution of outreach information and materials. Outreach mechanisms can include the development of social media platforms such as a free-standing website or a webpage on the Towns of North Stonington and Stonington websites, Facebook, Instagram and /or Twitter, updates in the towns' newsletters, periodic articles in local newspapers, and the development of a series of handouts or brochures to highlight specific resource concerns. The watershed team should identify within its ranks a point person or committee to organize and implement outreach activities.

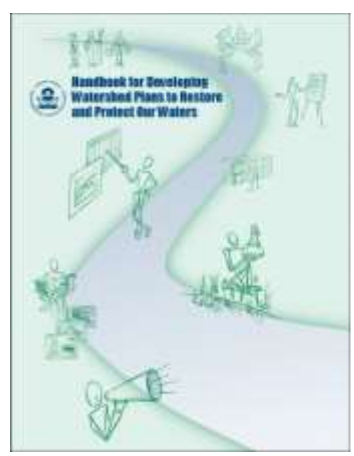
6. Implement the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan.

The primary goal of the watershed management team will be to coordinate and oversee the implementation of the recommendations of this Plan. In order to determine how to implement the Plan, the watershed team should review the goals, objectives and implementation strategies. The objectives and implementation strategies should be prioritized, and a priority list developed and distributed among team members and watershed stakeholders. This prioritization process will help the watershed team focus its efforts and provide for a positive outcome. The watershed management team should identify potential partners with whom to collaborate on larger or more complex plan recommendations. Project partners may contribute expertise that will contribute to the success of implementation projects, including project design, planning, installation and long-term maintenance.

7. Develop a framework to evaluate implementation effectiveness.

Before or concurrent with conducting watershed-based plan recommendations, the watershed team should develop a framework to assess whether the implementation is having the desired outcome and to help to report out the results to the broader community. This should include the identification of criteria by which the success of the implementation will be measured. The purpose of the evaluation framework is to demonstrate, through data collection or other methodology, that by implementing the management measures, the intended goals are being achieved. The evaluation framework will also provide watershed managers the opportunity to assess and refine the implementation process, which will improve and strengthen the watershed management program.

8. Assess implementation effectiveness.



Utilizing the assessment methodology created above, watershed managers should assess the effectiveness of each implementation measure as it is conducted. The watershed team should create a database or other document to track implementations, including pertinent information such as implementation type, location, start and completion dates, project manager, project goals, and notes specific to the implementation. The implementation should be evaluated utilizing the appropriate methodology specified by the evaluation framework to determine if the project goals have been met, and alternative actions should be identified if goals are not met. Information about how to develop an evaluation framework and evaluate implementation effectiveness is provided in the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA, 2008). Additional sources of technical assistance are provided in Section 8.2.

Table 7-6. Create a Watershed Coalition

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
1. Establish the watershed management team: • Identify team members • Obtain team member buy-in • Organize/conduct initial meeting • Identify team member roles • Establish regular meeting schedule	Towns of North Stonington and Stonington, ECCD, DEEP, land use commissions, watershed stake-holders	Short-term: 2021 -2022	Identification of team members; establishment of mgmt. team; establishment of regular meetings	$5,000 (10 partners/ 10 hr ea. @$ 50/hr)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, SCCOG, DEEP, UConn Extension
2. Review watershed management goals: • Review watershed plan • Identify goals and objectives • Prioritize goals • Identify watershed management resources	Watershed management team	Short-term: 2021 - 2022	Identification & prioritization of clear goals and objectives; watershed management resources	$5,000 (10 partners/ 10 hr ea. @$ 50/hr)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, SCCOG, DEEP
3. Identify sources of funding: • Review goals to determine type/level of funding needed • Review funding for applicability to goals • Prepare a list of potential funding sources	Watershed management team	Short-term: 2022 - 2023	List of potential funding sources (see Table 8-1)	$5,000 (10 partners/ 10 hr ea. @$ 50/hr)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, SCCOG, DEEP
4. Identify sources of technical assistance: • Review goals to determine type of technical assistance needed • Identify organizations/agencies offering needed technical assistance • Contact and/or partner with appropriate organization/agency to obtain needed technical assistance	Watershed management team	Short-term: 2022 - 2023	List of agencies/ organizations to provide technical assistance (see Table 8-2)	$5,000 (10 partners/ 10 hr ea. @$ 50/hr)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, SCCOG, DEEP

Table 7- 6. Create a Watershed Coalition (Cont.)

BMP Implementation Milestones/ Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
5. Identify and establish a mechanism for outreach: • Identify key outreach elements to disseminate to the public • Establish an outreach mechanism (website, report card, brochure, etc.) • Identify a point person to lead outreach efforts • Organize/implement an outreach campaign	Watershed management team	Short-term: 2022-2023	Identification of outreach needs; identification/ establishment of mechanism for outreach; type/amount of outreach conducted	$7,500 (printing & mailing costs; webpage development; etc.)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, SCCOG, consulting services
6. Implement the watershed management plan: • Identify and prioritize implementation projects • Identify /assign managing entity • Identify and obtain funding • Identify and obtain technical assistance • Development implementation design/plans • Obtain required materials • Promote municipal and other local champions project for high visibility or technical transfer elements.	Watershed management team, other watershed stakeholders	Long-term: 2021-2030, on-going thereafter	Number of successfully completed implementation projects	$1000 - $50,000 or more. Cost will vary by BMP project.	Watershed towns, community foundation and private philanthropic grants, corporate grants, CWA 319 & 604b grants, NRCS programs	Municipal staff, ECCD, DEEP, NRCS, SCCOG, consulting services
7. Develop an assessment framework: • Identify plan elements to be evaluated • Develop an evaluation methodology Identify/ establish assessment metrics • Identify a timeline for evaluation/assessment	Watershed management team	Mid-term: 2022-2025	Establishment of viable assessment procedure	$5,000 (10 partners/ 10 hr ea. @ $50/hr)	Watershed towns, community foundation grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, SCCOG, consulting services
8. Assess implementation effectiveness: • Create an implementation completion tracking database • Review completed implementations • Evaluate implementation effectiveness utilizing previously established methodology • Determine if intended goals and objectives have been achieved • Identify alternative actions if goals/objectives have not been achieved	Watershed management team	Mid to long-term: 2023-2030, on-going thereafter	Periodic review/ evaluation of implementation; evaluation of implementation effectiveness; refinement of goals and objectives	$5,000 (10 partners/ 10 hr ea. @ $50/hr)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 319 and 604b watershed grants	Municipal staff, ECCD, DEEP, SCCOG, consulting services

7.2.2 Conduct a Public Awareness Campaign

Objective 2: Raise public awareness of water quality conditions and actions to reduce water quality impacts.

Raising public awareness is an important component to the successful adoption of a watershed-based plan. Educating the community about the water quality status of waterbodies in their neighborhoods, and actions they can take to protect and improve that water quality engenders a sense of stewardship and fosters support for watershed management efforts. Members of the general public have a great capacity to influence water quality through their everyday actions when they are informed and educated about the water quality benefits of those actions.

Community outreach efforts may be watershed-scale, and seek to address issues that are watershed-wide. Such efforts may include the creative integration of watershed and water quality lessons into local school science curriculums, possibly including an examination of local water quality conditions; or the promotion of homeowner best management practices such as encouraging recycling, washing cars on lawns or using a carwash, properly disposing of pet waste, encouraging composting, reducing the use of lawn chemicals, and discouraging the dumping or depositing of chemicals or other waste in storm drains. These efforts may target a broad spectrum of watershed residents through activities such as presentations at meetings or conferences (land-use commissions, civic organizations, schools), news articles or feature stories in local or regional newspapers or other media outlets, displays at local festivals or field days, and work days such as community clean-up days.

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

The following sections identify action steps the watershed management team, watershed towns, project partners other local organizations can undertake to raise public awareness and conduct outreach and education to the general public regarding the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan.

Recommended actions or milestones to raise public awareness are described below. Suggested outreach topics are provided in Table 7-7 and management recommendations, including milestones and interim measures are summarized in Table 7-8. These tables can be used as a preliminary plan or guideline for the development of a public awareness campaign.

Recommended Management Actions:

1. Promote the watershed-based plan among the general public.

Upon adoption of the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan, the general public should be made aware of the Plan via news articles or feature stories in local or regional newspapers, other media outlets, and/or displays at farmers markets, local festivals, or community events. The Plan should be made available for public viewing via posting on the websites such as DEEP's Watershed Management webpage (portal.ct.gov/DEEP/Water/Watershed-Management/Watershed-Based-Plans), the Towns' websites (www.stonington-ct.gov; www.northstoningtonct.gov) or ECCD's webpage (www.ConserveCT.org/eastern) and at easily accessible locations such as the Stonington and North Stonington Town Halls and public libraries. Additionally, the Plan should be promoted by the many environmental/natural resource organizations located in southeastern Connecticut.

2. Review watershed-based plan recommendations with land use commissions.

Watershed managers should review the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan with municipal decision-makers, including land use staff and commissions to discuss how plan recommendations may be integrated into land use decision-making. Land use commission are encouraged to take into consideration plan recommendations when reviewing permit applications in the Anguilla Brook/Inner Wequetequock Cove Watershed.

3. Conduct targeted outreach to address specific water quality threats.

Watershed managers should conduct outreach to promote the Plan recommendations. In Stonington, outreach actions may be paired with MS4 outreach requirements to reach a broader audience or may be targeted to specific outreach issues and audiences. Table 7-7 presents potential outreach topics that address the pollution sources that were identified in Section 5 and suggests potential partners to assist with outreach.

4. Incorporate the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan into K-12 school curriculum.

The Connecticut Next Generation Science Standards introduces water quality concepts to students at all grade levels (portal.ct.gov/SDE/Science/Science-Standards-and-Resources). Incorporation of the Anguilla Brook/Inner Wequetequock Cove Watershed-based Plan into the watershed towns' science curriculum will provide an example of a real-world water quality issue and allow students to learn about and connect to water quality issues that exist in their own community.

5. Update the public about water quality improvement projects as they are conducted.

The watershed team should develop a strategy to inform the community when water quality improvement projects are being conducted. By creating public awareness of on-going water quality improvement projects in the community, the watershed management team reinforces Wequetequock Cove and its tributaries as valuable resources, and builds community support for watershed management efforts. This creates a sense of ownership among residents that can lead to the development of a longer-term stewardship ethos and strengthened appreciation for natural resources in the Anguilla Brook/Inner Wequetequock Cove Watershed.

6. Promote watershed stewardship among general public.

The watershed team should sponsor or support activities that engage the general public and engender environmental stewardship. These activities can include participation in citizen science programs sponsored by Mystic Aquarium, CUSH, CT Audubon Society, and CT DEEP, partnering with Trout Unlimited or CT DEEP to promote water-based recreational activities such as fishing and boating, or participating in or conducting community-based coastal clean-ups, such as the annual Save the Sound coastal clean-ups, invasive plant removal, riparian buffer restorations, and Pollinator Pathways plantings.

Table 7-7. Recommended outreach and education topics and target audiences.

Outreach Topic	Target Audience	Potential Outreach Partner(s)
Agricultural BMPs, including soil health, tillage practices, and cover cropping	Agricultural producers/home vegetable gardeners	NRCS, UConn Cooperative Extension System, ECCD, CT RC&D
Clean Boater Program	Recreational boaters	CT DEEP Boating Div., harbor commissions, shellfish commissions, marinas
Commercial Property Good House Keeping	Commercial property owners/managers	CT DEEP, CT DOT, CLEAR
Fertilizer Reduction Strategies	Residents, recreational facilities, commercial applicators	ECCD, Long Island Sound Study, CT Sea Grant, UConn Extension System, NOFA
Homeowner lawn, garden and stormwater BMPS	Residents/property owners	ECCD, UConn Extension System, CT Sea Grant
Implementation of MS4 program	Municipality/DPW/residents	DPW, CT NEMO, Eastern CT Stormwater Collaborative, CT DEEP Stormwater Management Division, Stonington Stormwater Task Force, SCCOG
Land use commissioner roles and responsibilities	Land use staff and commissions	CT NEMO, CLEAR, CACIWC, municipal advisory and regulatory land use staff
Livestock Manure Management	Hobby farm owners	ECCD, UConn Extension System, NRCS
Low impact development (LID)/ Green Infrastructure (GI)	Land use staff and commissions/DPW	CT NEMO, CLEAR, DEEP, ECCD
Municipal "Good Housekeeping" Public Works practices	Municipality/DPW	CT DOT, DPW, CT NEMO, Eastern CT Stormwater Collaborative
Organic lawn/garden care	Residents/property owners	UConn Cooperative Extension System, NOFA, Wild Ones
Pet waste management	Residents/property owners	Town of Stonington, Ledge Light Health District, veterinarians, local pet stores
Rain Gardens and Native Plants	Residents/property owners Land use staff and commissions	CT NEMO, UConn Extension, ECCD, Wild Ones, area plant nurseries, garden clubs and beautification committees
Riparian Buffers	Residential and agricultural land owners	CT NEMO, NRCS, CT Sea Grant, ECCD, Wild Ones, area plant nurseries, garden clubs and beautification committees
Septic System BMPs for Homeowners	Residents/property owners	Ledge Light Health District, CT DPH, local septic services companies
Understanding Non-Point Source (NPS) Pollution	Residents/property owners Land use staff and commissions	CT NEMO, municipal Conservation Commissions, Eastern CT Stormwater Collaborative, DEEP, ECCD,

Table 7-8. Conduct a Public Awareness Campaign

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
1. Promote the water quality watershed plan among general public: • Publicize watershed investigation via widely distributed news media • Post watershed plan on accessible platforms such as municipal website, ECCD website, CT DEEP website	Watershed management team, watershed towns, ECCD, DEEP, other stake-holders	Long-term: 2021-2030, on-going	Publication of WBP through local media outlets; access to Plan via Town, ECCD, DEEP websites	$1000 (staff salary)	Watershed towns, community foundation and private philanthropic grants, corporate grants	Municipal staff, ECCD, SCCOG, DEEP
2. Review watershed plan recommendations with land use commissions: • Review water quality investigation and watershed plan with land use commissions • Provide Plan for commission use • Encourage incorporation of Plan recommendations in permit application reviews	ECCD, municipal staff	Short-term: 2021	Provide paper and/or digital copies of Plan to land use commissions; meet with commissions to review Plan	$2000 (WBP printing costs; ECCD staff time)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CWA § 319 grants	Municipal staff, ECCD, SCCOG, DEEP, CLEAR, CT NEMO
3. Conduct targeted outreach to address specific WQ threats: • Identify outreach partners • Identify outreach topics • Prepare outreach materials • Identify best method for dissemination • Conduct public outreach utilizing selected outreach vector	Watershed management team	Long-term: 2021-2030, on-going	Outreach partners selected; outreach topics identified; outreach material compiled or created; outreach campaigns conducted	$1000 - $5000 (printing costs; varies by outreach topic)	Watershed towns, community foundation and private philanthropic grants, corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, SCCOG, DEEP, CLEAR, CT NEMO, CLCC, UConn Extension, NRCS, others

Table 7-8. Conduct a Public Awareness Campaign (Cont.)

BMP Implementation Milestones/ Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
4. Incorporate Plan into K-12 school curriculum: • Meet with teachers to review Plan • Identify relevant curriculum topics at all grade levels • Provide available watershed information to assist teachers with curriculum topics • Identify and install relevant BMPs at school facilities, where possible	Watershed management team, school boards, teachers	Short-term: 2021-2022, on-going thereafter	# teachers consulted; # curriculum topics identified; # WBP topics/BMPs incorporated into lesson plans	$5,000 (teacher and staff salary)	Watershed towns, school department, community foundation and private philanthropic grants, corporate grants,	Municipal staff, ECCD, DEEP, CT Dept of Education
5. Update public about water quality improvement projects as they are conducted: • Prepare project summaries for news media outlets • Post project update on outreach platforms such as websites, Facebook, etc. • Prepare and distribute relevant outreach material	Watershed management team, ECCD, DEEP, other project participants	Long-term: 2021-2030, on-going thereafter	WBP updates disseminated to general public; # website/Facebook posts; outreach material distributed	$1000/ project	Watershed towns, community foundation and private philanthropic grants, corporate grants, CWA § 319 grants	Municipal staff, ECCD, SCCOG, DEEP, NRCS
6. Promote watershed stewardship among general public: • Support existing activities such as annual clean-ups • Promote participation in CUSH/STS Water Quality Monitoring Program • Promote participation in Citizen Science programs • Publicize stewardship activities through local media outlets and platforms such as websites, Instagram and Facebook	Watershed management team, watershed towns, partners and stakeholders	Long-term: 2021-2030, on-going thereafter	# stewardship activities conducted; # participants; activities promoted through local media outlets and platforms	$1000/ activity	Watershed towns, community foundation and private philanthropic grants, corporate grants	Municipal staff, ECCD, SCCOG, DEEP, CFPA, Trails Committee

7.2.3 Review, Update and Enhance Land Use Management Practices

Objective 2: Raise public awareness of water quality conditions and actions to reduce water quality impacts

- o preservation of open space – well done in watershed – continue to support
- o encourage infilling of developed areas rather than sprawl
- o incorporation of LID to manage stormwater as a practice rather than alternative

Municipalities determine how a town will be developed, and consequently how it will look and function, in large part through the codification of land-use regulations. Land-use regulations are enacted through the passage of municipal ordinances, and through review and revision by the land-use commissions, often in response to legislative changes at the state level. It is incumbent upon municipal decision-makers, including the board of selectmen and land-use boards and commissions, to ensure that regulations and policies both reflect and support the municipality's plans for future growth as defined by the municipal Plan of Conservation and Development; are up-to-date with current state land-use legislation; and are representative of current land use planning practices. Several of the strategies below are required by the current Connecticut MS4 permit and have been implemented in Stonington.

Recommended actions or milestones related to the review, update and enhancement of land use management practices in the Anguilla Brook/Inner Wequetequock watershed are described below and are summarized in Table 7-9. These tables can be used as a preliminary plan or guideline to review, update and enhance existing land use management practices.

Recommended Management Actions:

1. Adopt land-use planning recommendations proposed in the Towns of Stonington and North Stonington Plans of Conservation and Development.

The Stonington and North Stonington Plans of Conservation and Development (POCD) make recommendations pertaining to land-use management and regulation that are protective of water quality. These recommendations should be considered for inclusion in land use regulations, if not already incorporated.

Recommendations in the 2015 Stonington POCD include:

- Using green infrastructure techniques to manage stormwater, avoiding structural solutions wherever possible.
- Discouraging new public infrastructure or development in flood prone areas.
- Encouraging Low Impact Development (LID) standards for site designs that maximize pervious surfaces, promote infiltration of stormwater and reduce runoff.
- Requiring vegetative buffers, swales and other appropriate drainage diversion and minimization methods to wetland and watercourses to filter pollutants from stormwater runoff.
- Ensuring best practices regarding clearing and grading of sites so as to minimize the impact on natural drainage patterns.

- Updating Open Space Development regulations to eliminate requirement that open space cannot have a greater percentage of wetlands than the entire property.
- Establishing a Municipal Land Acquisition and Development Authority under CT General Statutes Section 7-131p.

Recommendations in the 2013 North Stonington POCD include:

- Adopting conservation subdivision regulations
- Actively support goals, objectives and actions identified by the Conservation Commission in the [2013] Plan of Conservation and Recreation Lands (PCRL).

2. Adopt and/or update farm-friendly land-use regulations.

There is a long history of farming in the Anguilla Brook/Inner Wequetequock Cove Watershed and farming maintains a strong presence in the watershed to this day. Land use regulators should evaluate the consistency of planning and zoning regulations and municipal ordinances with existing and future farming activities, including farm-friendly policies and regulations and the identification of potential barriers to farms and farming practices. The support and protection of farms through the adoption of farm-friendly land-use regulations increase the viability of farming, especially for small and start-up farmers, and thus preserves farmland as open space.

The 2015 Stonington Plan of Conservation and Development recommends the following actions to support agriculture:

- Establish a town Agricultural and Aquacultural Commission.
- Adopt the statutory definitions of "agriculture," 'farming," "farm," "livestock" and "poultry."
- Adopt a "Right to Farm" ordinance.

Planning for Agriculture: A Guide for Connecticut Municipalities (newly updated in 2020) and *Guidance and Recommendations for Connecticut Municipal Zoning Regulations and Ordinances for Livestock* (2012) are two excellent resources for municipal leaders, land use regulators and agriculture commissions. Both documents can be found at the Farmland Information Center website at www.farmlandinfo.org.

3. Review and strengthen existing land-use regulations pertaining to erosion and sediment control and stormwater management.

Land use regulators should review and strengthen existing land-use regulations pertaining to erosion and sediment control and stormwater management to comply with the *2002 CT Erosion & Sediment Guidelines* and the *2004 Stormwater Quality Manual and Appendices* and the upcoming (2021) Erosion & Sediment Guidelines and Stormwater Quality Manual, which were undergoing revision at the time of the preparation of this Plan.

4. Identify and evaluate any existing or perceived institutional barriers to GI and LID.

As part of the municipal regulation, land use regulators should identify and evaluate existing or perceived institutional barriers to GI and LID, and investigate opportunities where incentives can be developed to encourage the inclusion of GI and LID into site planning and development. Land-use commissions may benefit from reviewing municipal land-use evaluation projects in the Farmington and

Salmon River watersheds, which assessed institutional barriers and evaluated how they may be removed. Additional information on municipal outreach for GI and LID is available at CT DEEP's website at www.ct.gov/deep/cwp/view.asp?a=2719&q=464958&deepNav_GID=1654.

Watershed managers should also review *The State of LID in Connecticut: Policies, Drivers, and Barriers* at the UConn Center for Land Use Education and Research website (clear.uconn.edu).

5. Incorporate language to encourage or require the use of green infrastructure (GI) and low impact development (LID) practices into site plan design and development.

Land use regulators should incorporate language to encourage or require the use of green infrastructure (GI) and low impact development (LID) practices into site plan design and development. These practices seek to mimic the pre-development hydrology of a site and encourage site design that utilizes the natural features of the landscape in a way that minimizes runoff and promotes resource protection. The use of LID/GI is protective of water quality in headwater areas and can be used to reduce the effects of impervious cover in highly developed areas in the watershed, including the MS4 urban areas in Stonington. The inclusion of LID language in land use regulations will support the reduction of runoff from directly connected impervious areas (DCIA), a requirement of the 2016 MS4 permit.

6. Adopt regulatory language necessary to implement the MS4 General Permit.

Stonington land use regulators will need to adopt a regulatory framework as necessary to comply with the 2016 MS4 Stormwater General Permit. Although the general permit is typically administered through public works departments, elements will come under the regulatory authority of land-use commissions, including construction site stormwater runoff control and post-construction stormwater management. The legal authority to administer the MS4 permit will reside in the regulations and land-use policies of the land-use commissions.

Table 7-9. Review, Update and Enhance Land Use Management Practices

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
1. Adopt land-use planning recommendations proposed in Plans of Conservation and Development and other planning documents: • Form a POCD review team • Review Plans of Conservation and Development and other planning documents • Develop proposed regulatory language • Review and revise existing regulations or adopt new regulations, as needed	Watershed management team, land-use commissions, staff	Mid-term: 2021-2025	List of proposed recommendations; development of proposed regulatory language; adoption of recommendations from POCD and other planning documents	$3,000 (staff salary)	Municipal general budget	Municipal staff, SCCOG, DEEP, CT NEMO. CLEAR
2. Adopt/update farm-friendly land-use regulations: • Form an agriculture regulation review team • Review existing land-use regulations and policies related to farming • Review recommended guidance documents • Prepare and revise existing regulations, or adopt new regulations, as needed	Watershed management team, land-use staff and commissions, agriculture commission, farmers	Mid-term: 2021-2025	Identification of relevant regulations; preparation of proposed farm-friendly revisions; adoption of proposed regulation revisions	$3,000 (staff salary)	Municipal general budget	Municipal staff, UConn Extension, CT Farmland Trust, DoAg, DEEP, CT RC&D
3. Review and strengthen existing land-use regulations pertaining to erosion and sediment control and stormwater management: • Form a regulation review team or convene Stormwater Task Force • Review existing land-use regulations/ ordinances • Review sample/model regulations pertaining to E&S controls, stormwater management • Work with DPW, land-use staff and boards to develop revised regulations • Adopt new regulations	Watershed management team, land-use commissions, staff	Short term: 2021-2023	Formation of review team; review of regulations; proposed regulations revisions; adoption of revised regulatory language	$3,000 (staff salary)	Municipal general budget	Municipal staff, CT NEMO, DEEP, SCCOG, CLEAR, ECSC

Table 7 9. Review, Update and Enhance Land Use Management Practices (Cont.)

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
4. Identify and evaluate any existing or perceived institutional barriers to GI and LID: • Form a review team • Review existing studies on barriers to GI/LID • Review existing land-use regulations for barriers to GI/LID • Interview land-use managers/decision makers about knowledge/attitudes regarding GI/LID • Evaluate results of interviews • Develop outreach to remove barriers • Disseminate outreach material	DPW, watershed management team, land-use commissions, staff	Short-term: 2021-2022	Review of existing regulations/ ordinances; review of model regulations; development of proposed revisions; adoption of revised regulations	$3,000 (staff salary)	Municipal general budget	Municipal staff, CT NEMO, DEEP, SCCOG, CLEAR
5. Incorporate language to encourage or require the use of green infrastructure (GI) and low impact development (LID) practices into site plan design and development: • Convene GI/LID review team • Review existing land-use regulations/ ordinances • Review sample/model regulations pertaining to GI/LID • Work with land-use staff and boards to develop revised regulations • Adopt new regulations	DPW, watershed management team, land-use commissions, staff	Short-term: 2021-2022	Formation of review team; regulation review; completion of interviews; analysis of results; development and dissemination of outreach material	$3,000 (staff salary)	Municipal general budget	Municipal staff, CT NEMO, DEEP, SCCOG, CLEAR
6. Adopt regulatory language necessary to implement MS4 General Permit: • Review permit requirements for required regulatory language • Develop stormwater management plan • Develop land-use regulatory language to authorize required activities • Adopt proposed regulatory language	DPW, Land-use commissions, staff, Board of Selectmen	Short-term: 2021-2022	Comprehension of MS4 permit reqts; development / adoption of SWMP; development of regulatory language/ordinances; adoption of regulations	$3,000 (staff salary)	Municipal general budget	Municipal staff, DEEP, CT NEMO, SCCOG, CLEAR, ECSC

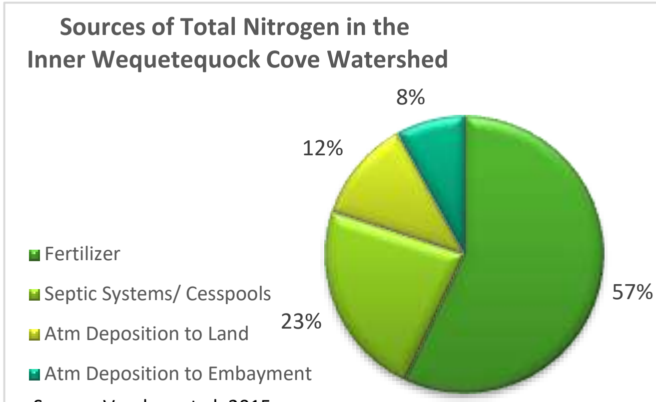
7.2.4 Reduce Nutrient and Bacteria Loading to Surface Waterbodies and Wequetequock Cove

Objective 3: Reduce nutrient loading (especially nitrogen loading) from sources such as pet waste and manure; agricultural, commercial, recreational, and residential fertilizer use; and septic systems.

Objective 4: Reduce bacteria loading from sources such as pets, livestock, agricultural activities, and septic systems.

Total nitrogen levels in Inner Wequetequock Cove exceed suggested threshold levels for the preservation of eelgrass identified by Tetra Tech, Inc. for comparable nearby estuaries (2020). Eelgrass (*Zostera marina L.*), a keystone estuarine plant that provides habitat for many aquatic species and is indicative of estuarine health, is absent from Inner Wequetequock Cove due to poor water quality conditions. An empirical relationship between eelgrass health and survival and watershed nitrogen load has been established by Latimer (Latimer and Charpentier, 2010; Latimer and Rego, 2010).

Vaudrey et al (2015) identified sources of nitrogen in the Little Narragansett Bay watershed, which includes the Anguilla Brook/Inner Wequetequock Cove Watershed. These nitrogen sources include fertilizer (the most significant watershed source of nitrogen) from agricultural crops/hay fields, golf courses, parks and recreational fields, and lawns, septic systems and sewers, and atmospheric deposition to the land and embayment. Other sources may include nitrogen as a component of livestock manure and pet waste.



Source: Vaudrey et al, 2015

The critical importance of the reduction of nitrogen loading to the restoration of the estuarine habitat of Wequetequock Cove cannot be understated.

The discharge of fecal bacteria and pathogens into surface waters results in those waters being unsafe for swimming and other recreational activities. In coastal waters, high fecal bacteria levels render shellfish unsafe for direct consumption. Bacteria sources include pet waste, livestock manure, and malfunctioning septic systems. Bacteria can leach from pet waste, uncovered manure piles, livestock heavy use areas, pastures, manure applied on fields, and failing septic systems when it rains. The proper management of septic systems, pet waste and manure will reduce the conveyance of bacteria by stormwater into surface waters and reduce bacteria loading to Wequetequock Cove.

Recommended actions or milestones to reduce nitrogen and bacteria loading are described below. Management recommendations, including milestones and interim measures are summarized in Table 7-11.

Recommended Management Actions:

1. Encourage pet waste management.

Although dog waste is typically not as high in nitrogen as livestock manure, in aggregate it contributes to the total nitrogen load to coastal waters. As stated in Section 5.1.5, dog waste can be a significant source of fecal bacteria; a single dog can produce as many as 17 billion *E. coli* bacteria per day. The Town of Stonington adopted an animal waste removal ordinance in 2000 which requires pet owners or handlers to pick up after their pets, and which levies a modest fine for failure to do so. This ordinance does not apply to animal feces excreted on the owner's own property.

It was reported in the Stonington 2017 MS4 Annual Report that the Town "implemented [a] pet waste education program and installed additional signage, baggies, and disposal receptacles, as needed, in areas where pet walking is common." The Town should continue to provide outreach and education regarding dog waste, encourage pet owners to pick up and properly dispose of dog waste on their own properties in addition to public properties, and enforce the pet waste ordinance where warranted.

Potential pollutant load reductions associated with a watershed-wide pet waste outreach campaign are provided in Section 7.3.1.

2. Conduct manure management outreach and education, especially among private farms.

Unmanaged livestock manure can be a significant source of nitrogen and bacteria. During rainstorms, both pollutants can leach from uncovered manure piles, livestock manure on heavy use areas, pastures, and manure spread on crop and hay fields. Nitrogen is highly soluble in water, and once dissolved it may easily infiltrate to the groundwater table or be carried by stormwater flow into surface waters.

The nitrogen (N) content in the raw manure of various types of livestock is depicted in Table 7-10. Common livestock observed in the Anguilla Brook/Inner Wequetequock Cove Watershed included beef cattle and horses. Based on data provided in the table below, one horse can contribute ~99 pounds of nitrogen per year to the total watershed nitrogen load, while one beef cow can contribute ~124 pounds of nitrogen per year to the total watershed nitrogen load. Poultry manure is particularly high in nitrogen content; a single laying hen can contribute as much as ~265 pounds of nitrogen per year to the total watershed nitrogen load.

While commercial agriculture producers may have many resources available to assist them with manure/nutrient management, including programs offered through the CT Department of Agriculture and the USDA Natural Resources Conservation Service (NRCS), private farms may not be aware of these programs and services or may not be eligible to access them. As a result, they might not employ management practices that reduce the impacts of bacteria and nitrogen loading from livestock manure. These practices may include actions such as:

- composting manure,
- storing manure in covered enclosures or covering piles with tarps,
- placing manure in roll-off dumpsters for periodic removal from the site,
- cleaning manure from heavy use areas,
- diverting stormwater away from manure storage areas and other heavy use areas,
- manure application strategies,
- restricting livestock from surface waters, and
- installing and/or maintaining vegetated buffer strips between pastures, crop fields, and surface waters.

Table 7-10. Annual Raw Manure Production per 1,000 lb Animal Weight (Table 1 is reprinted from Ohio State University Extension Agronomy Facts, AGF-208-95).

Animal Type	Manure Tons/yr	Prod Gal/yr	Percent Solids	Nutrient Content					
				N	P2O5	K2O	N	P2O5	K2O
				(lb/ton)			(lb/1,000 gal)		
Dairy	15.0	3614	12.7	10.0	4.1	7.9	41.5	17.0	32.8
Beef	11.0	2738	11.6	11.3	8.4	9.5	45.4	33.7	38.2
Veal	11.5	2738	8.4	8.7	2.1	9.0	36.5	8.8	37.8
Swine:									
Growing pig	11.9	3008	9.2	13.8	10.8	10.8	54.6	42.7	42.7
Mature hog	5.9	1425	9.2	13.9	10.8	10.8	57.5	44.7	44.7
Sow & litter	15.9	3894	9.2	14.2	10.7	11.1	58.0	43.7	45.3
Sheep	7.3	1679	25.0	22.5	7.6	19.5	97.8	33.0	83.5
Goat	7.0	1789	31.7	22.0	5.4	15.1	86.1	21.1	59.1
Poultry:									
Layers	9.7	2464	25.0	27.3	23.5	13.2	107.5	92.5	52.0
Broilers	13.1	3285	25.0	33.4	16.7	12.5	133.2	66.6	49.8
Turkey	8.4	2044	25.0	23.7	20.8	16.9	97.4	85.5	69.5
Horse	8.2	2048	21.0	12.1	4.6	9.0	48.4	18.4	36.0

Watershed managers should partner with NRCS, the University of Connecticut Extension System, the CT 4-H program, the Conservation District, and local environmental organizations to raise awareness of the impacts of bacteria and nitrogen in animal manure to water quality, prepare and distribute informational material, conduct educational workshops for livestock owners, and assist farm owners with adopting manure best management practices.

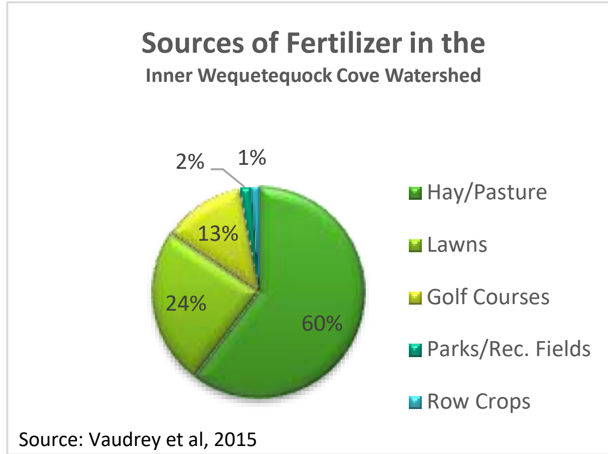
Resources for small farm management include:

- *Good Horse Keeping - Best Practices Manual for Protecting the Environment*. Horse Environmental Awareness Program (HEAP), 2011. ctrcd.org/wp-content/uploads/2017/10/GOODHORSEKEEPINGBMP_WEB.pdf
- *Manure Management for Small and Hobby Farms*. Athena Lee Bradley, Northeast Recycling Council, Inc., ©June 2008. www.sccd.org/wp-content/uploads/2015/07/manure-management-for-small-and-hobby-farms.pdf
- USDA NRCS - Connecticut: www.nrcs.usda.gov/wps/portal/nrcs/site/ct/home
- CT Department of Agriculture: portal.ct.gov/DOAG

3. Encourage the reduction of fertilizer use.

As identified in the 2015 Long Island Sound Embayment Study (Vaudrey et al), 57% of nitrogen loading to Wequetequock Cove was derived from fertilizer.

Of that, ~60% came from pasture and hay land, ~24% from lawns, ~13% from golf courses, ~2% from parks and recreational fields, and ~1% from row crops (2011 National Landcover Database). Encouraging landowners and maintainers to evaluate fertilizer application rates and reduce fertilizer applications will have a significant impact on nitrogen loading to Wequetequock Cove, resulting in improved water quality and aquatic habitat.



Watershed managers should:

- encourage eligible farmers to enroll in USDA NRCS cost-share programs and develop Comprehensive Nutrient Management Plans (CNMPs) to create nutrient budgets for their farming operations,
- encourage farmers to adopt healthy soils/regenerative farm practices to reduce dependence on fertilizer and enhance soil resiliency and fertility,
- conduct a community-based social marketing (CBSM) campaign to encourage the reduction of residential fertilizer use, especially along waterways and Wequetequock Cove,
- engage commercial fertilizer applicators in order to reduce fertilizer applications, and
- encourage and/or train recreational field maintainers to determine the correct amount of fertilizer to apply; reduce fertilizer use; apply fertilizer at the most beneficial times of the growing season; and adopt alternate practices to fertilizer application.

Recommended Resources:

- USDA NRCS - Connecticut: www.nrcs.usda.gov/wps/portal/nrcs/site/ct/home
- CT Resource Conservation & Development Area Soil Health Initiative: ctrcd.org/agriculture/soil-health-initiative
- New England Regional Nitrogen and Phosphorus Fertilizer and Associated Management Practice Recommendations for Lawns Based on Water Quality Considerations – Revised 2017: www.uvm.edu/sites/default/files/Extension-Master-Gardener/NE_Recommendations_for_P_and_N_Lawns.pdf
- CLEAR Nitrogen Reduction Resources: nemo.uconn.edu/tools/nitrogen/index.htm
- Community-Based Social Marketing (CBSM): cbsm.com
- Long Island Sound Study Examples of CBSM projects: longislandsoundstudy.net/our-vision-and-plan/sustainable-and-resilient-communities/behavior-change-projects/

Potential pollutant load reductions associated with a watershed-wide community-based social marketing campaign to reduce or eliminate the use of lawn fertilizer are provided in Section 7.3.1.

4. Reduce nitrogen and bacteria loads from septic systems.

On-site subsurface sewage treatment systems, or septic systems, are designed to treat wastewater from residential and commercial uses where centralized sewage systems are not available. Septic systems are designed to treat fecal bacteria and pathogens in order to reduce health risks to ground and surface waters. It has only been in recent years that attention has been focused on nitrogen contributions from septic systems and the development of technologies to reduce septic system nitrogen loads. As stated in previous sections of this Plan, septic systems can be significant sources of nitrogen (Valiela et al, 1997). The discharge of nitrogen from septic systems can be especially problematic in coastal areas with highly permeable sandy soils that convey groundwater quickly to surface waters and embayments.

Nitrogen-reducing septic systems remove nitrogen from septic effluent by creating anoxic conditions that convert nitrate (NO_3-) to nitrogen gas (N_2). Although the technology has been well-studied, it has not been widely adopted in Connecticut. Rationale is provided in the 2018 Connecticut Public Health Code On-site Sewage Disposal Regulations and Technical Standards for Subsurface Sewage Disposal Systems, "PNR [passive nitrogen removal] technology is relatively new and its use should be limited until such time that standardized design criterion is established. PNR technology use shall be limited to areas where nitrogen pollution from on-site sewage systems is a concern, such as high density residential development areas under community pollution abatement orders. PNR technology should only be permitted if the DOH has determined that its usage is appropriate, and the DOH has sufficient resources to ensure the systems are properly designed and installed."

Until such time as the installation of N-reducing septic systems is widely adopted in Connecticut, septic system owners should be encouraged to regularly maintain their septic systems and use septic system best management practices to ensure systems are operating at their peak effectiveness. Watershed managers should partner with Ledge Light Health District to provide necessary information, including informational brochures, workshops and so forth to assist septic system owners with maintaining their systems.

In order to encourage the adoption of nitrogen-reducing septic systems in Connecticut, watershed managers should educate southeastern Connecticut residents and civic leaders regarding the benefits of nitrogen-reducing septic systems, especially in coastal areas. Further, watershed managers, residents and civic leaders should encourage state regulatory agencies to develop standardized design criteria for PNR in order to expedite the use of this technology in Connecticut in order to reduce nitrogen loading to groundwater and coastal waters from septic systems.

Additional information about passive nitrogen removal technology can be found at the following sites:

- Florida Department of Health: www.floridahealth.gov/environmental-health/onsite-sewage/research/_documents/rrac/hazensawyervolireportrmall.pdf
- Massachusetts Alternative Septic System Test Center: www.barnstablecountyhealth.org/programs-and-services/massachusetts-alternative-septic-system-test-center/
- New York Center for Clean Water Technology: www.stonybrook.edu/cleanwater/
- Westbrook, CT Pilot Septic Study: www.zip06.com/news/20180306/westbrook-to-test-passive-nitrogen-removal-through-pilot-septic-study

Potential pollutant load reductions associated with a watershed-wide septic system maintenance outreach campaign are provided in Section 7.3.1.

5. Support Nitrogen Reduction Strategies Developed by The Nature Conservancy

In 2019, The Nature Conservancy and CUSH, in partnership with Mystic Aquarium, led a Southeast Connecticut Clean Coastal Harbors and Bays Nitrogen Reduction Community Planning project in southeastern Connecticut. The purpose of the project was to develop a community-based planning approach for cleaner coastal waters. Over the course of three community workshops, stakeholders evaluated sources of nitrogen to embayments in southeastern Connecticut and developed nitrogen reduction scenarios. These scenarios, focused on nitrogen loading to Little Narragansett Bay, evaluated the effects of the reduction of nitrogen from fertilizer use and septic systems.

In parallel with the Nitrogen Reduction Community Planning workshops, a spin-off Southeastern Connecticut Public Communication & Advocacy Work Group met several times in 2019 and early 2020 to develop a public communication strategy.

Watershed stakeholders are urged to review the final Southeast Connecticut Clean Coastal Harbors and Bays Nitrogen Reduction Community Planning report at tnc.box.com/s/39tyl8bmisfmyc5mh1c8rcbhe34f3sgv.

6. Install permeable reactive barriers in near-shore areas.

Permeable reactive barriers (PRB) are subsurface treatment practices that remove nitrogen from groundwater and shallow subsurface flow. Like PNR septic systems, PRBs create anoxic conditions that allow for the denitrification of nitrate (NO_3-) to nitrogen gas (N_2). A PRB consists of a cell or trench (the barrier component) filled with woodchips or other carbon source that is placed perpendicular to the direction of flow, so that the groundwater flows through it (Fig. 7-1). Denitrifying bacteria in the carbon source convert nitrate to nitrogen gas.

The TNC nitrogen reduction strategy recommends the installation of permeable reactive barriers within 200 meters of shorelines in the Stonington area to reduce nitrogen in groundwater. The installation of PRBs along the shoreline of Wequetequock Cove will intercept and treat nitrate-laden groundwater from septic systems and other surface sources.

Additional information about permeable reactive barriers can be found at the following:

- USEPA: www.epa.gov/remedytech/citizens-guide-permeable-reactive-barriers
- Cape Cod Commission: www.capecodcommission.org
- Cape Cod Green Infrastructure Guide: capecodgreenguide.wordpress.com/permeable-reactive-barrier/
- Town of Falmouth, MA: www.falmouthma.gov/276/Permeable-Reactive-Barrier-PRB
- New York Center for Clean Water Technology: www.stonybrook.edu/commcms/cleanwater/research/PRB%20white%20paper_FINAL.pdf

See Section 7.3 for suggested PRB installation sites and load reductions.

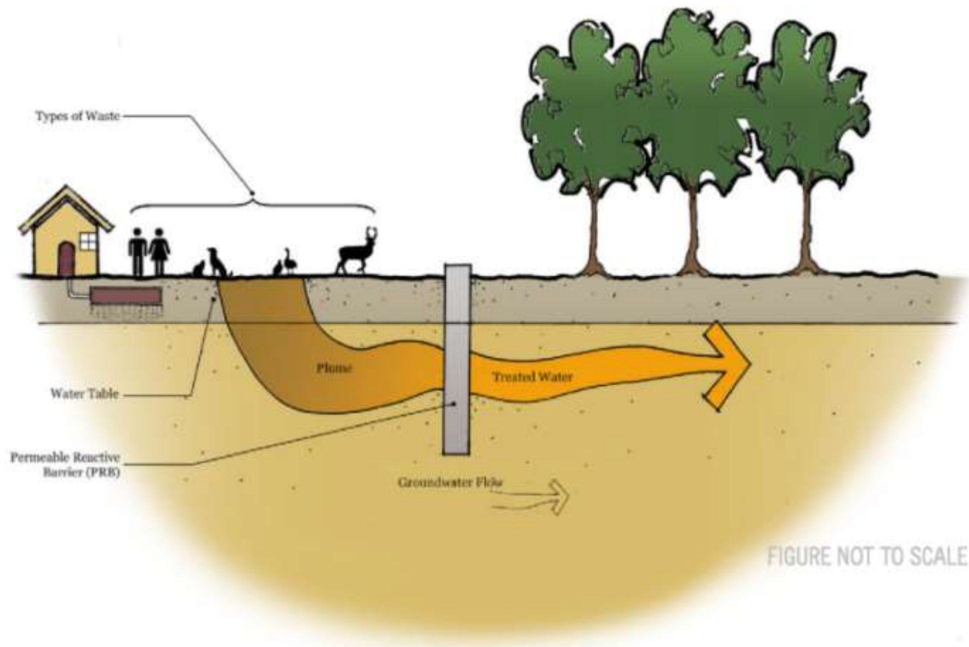


Diagram of a trench-style PRB. Source: Cape Cod Commission.

Figure 7-1. A permeable reactive barrier (reprinted from the Cape Cod Green Infrastructure Guide).

Table 7-11. Reduce Nutrient and Bacteria Loading to Surface Waterbodies and Wequetequock Cove

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
1. Encourage pet waste management. • Continue existing (MS4) pet waste education program • Maintain public signage and baggy/disposal receptacles • Develop outreach campaign/ materials to encourage pet owners to pick up after pets on private properties • Identify outlets to distribute outreach material (town newsletter, town clerk office, dog license reminders)	DPW, dog warden, town clerk, watershed team, pet owners, local veterinarians	Long-term: 2021-2030, on-going thereafter	Outreach material developed, posted on town MS4 website, # of site views, # brochures distributed	Town staff salary included in general budget Color brochures $3,000 (2500 @ $1.20; less if printed in-house)	Municipal DPW/ MS4 budget, small grant programs, local civic organizations	LLHD, ECCD, ECSC, CLEAR
2. Conduct manure management outreach and education, especially among private farms. • Raise awareness of impacts of nitrogen and bacteria from livestock manure to water quality • Prepare and distribute educational material • Conduct manure management workshops • Encourage adoption of manure BMPs	DPW, watershed team, private farm owners, conservation and/or agriculture commissions	Short - to mid-term: 2021-2026, on-going thereafter	Outreach material compiled/ developed, # educational workshops conducted, # farm/livestock owners educated, # BMPs adopted	Town staff salary included in general budget, $2,500 – manure management workshop	Municipal DPW/ MS4 budget, , NFWF Long Island Sound Future Funds grant, small grant programs, local civic organizations	Univ. CT Extension Program, NRCS
3. Encourage the reduction of fertilizer use. • Raise community awareness of the impacts of nitrogen from fertilizer to water quality • Encourage eligible farmers to enroll in NRCS programs • Promote the use of Healthy Soil practices • Encourage the reduction in fertilizer use through a CBSM campaign • Conduct outreach/education to recreational field maintainers	DPW, watershed team, watershed property owners, conservation and/or agriculture commissions	Short - to mid-term: 2021-2026, on-going thereafter	Outreach material compiled/ developed, # farm/livestock owners educated, # farms enrolled in NRCS cost-share programs, # maintainers educated, amt of fertilizer reduction (lbs), # acres utilizing Healthy Soils practices, % nitrogen reduction, % fecal bacteria	Town staff salary included in general budget, $3,000 – Healthy Soils workshop, $15,000 – CBSM Fertilizer Reduction Campaign, $2,500 – Recreation field maintenance workshop	Municipal DPW/ MS4 budget, NFWF Long Island Sound Future Funds grant, CT DEEP CWA § 319 grant program, small grant programs, local civic organizations	Univ. CT Extension Program, NRCS, ECCD, LISS,

Table 7-11. Reduce Nutrient and Bacteria Loading to Surface Waterbodies and Wequetequock Cove (Cont.)

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
4. Reduce nitrogen and bacteria loads from septic systems. • Raise public awareness of impacts of nitrogen and bacteria from septic systems • Compile or develop outreach material • Promote septic system BMPs • Support adoption of PNR septic systems by CT DPH	Watershed team, towns, LLHD	Mid-term: 2023-2026	Outreach material developed, posted on town MS4 website, # of site views, # brochures distributed	Town staff salary included in general budget Color brochures $3,000 (2500 @ $1.20; less if printed in-house)	Municipal DPW/ MS4 budget, small grant programs, local civic organizations	LLHD, DPH, Cape Cod Commission, Center for Clean Water Technology, Massachusetts Alternative Septic System Test Center
5. Support Nitrogen Reduction Strategies Developed by The Nature Conservancy. • Disseminate results of TNC Nitrogen Reduction Community Planning project • Implement plan recommendations • Convene public communication work group • Review and implement public communication strategy	Watershed team, TNC Nitrogen Reduction Project Work Group, Stonington Stormwater Task Force	Long-term: 2021-2030	Project outcomes disseminated among stakeholders/residents, public communication work group activated, outreach messages developed and delivered to community	Town staff salary included in general budget, volunteers (no cost)	Municipal DPW/ MS4 budget, small grant programs, local civic organizations, NFWF LISFF grant program, Long Island Sound Stewardship Fund	TNC, DEEP, Univ. CT, Cape Cod Commission, Center for Clean Water Technology
6. Install permeable reactive barriers in near-shore areas. • Identify suitable sites for PRB installation along Wequetequock Cove • Identify funding sources/obtain funding • Obtain property owner permissions and necessary permits • Retain contractor, install PRBs	Watershed team, residents, ECCD, TNC	Mid- to Long-term: 2023-2030, on-going thereafter	Linear feet (LF) of PRB installed, lbs N removed/yr	$650/LF (Cape Cod Commission) Annual O&M $200/yr (Cape Cod Commission)	CWA § 319 grant program, NFWF LISFF grant program, Long Island Sound Stewardship Fund	DEEP, Cape Cod Commission, Center for Clean Water Technology

7.2.5 Reduce NPS Pollutant Loading to Surface Waterbodies and Wequetequock Cove

Objective 5: Reduce NPS pollutant loading from sources such as stormwater runoff from roadways, commercial, industrial and residential areas; agriculture; recreational fields; marinas, boat maintenance and boating activities.

Nonpoint source pollution, or NPS, is comprised of a broad range of pollutants that result from our everyday activities. These pollutants accumulate on the landscape until they are mobilized by stormwater or snowmelt and carried into stormdrain systems or waterways where they can, in aggregate, have significant impacts on water quality. This section provides management recommendations for NPS associated with stormwater runoff other than fecal bacteria and nitrogen which were addressed in Sections 7.2.4. These include herbicides and insecticides from agricultural lands, recreational fields and residential areas; oil, grease, heavy metals and toxic chemicals from urban runoff and commercial and industrial activities; water- and wind-borne trash; sediment from agriculture, stream erosion and construction activities; salt from roadway de-icing materials; and the atmospheric deposition of fine particulate matter. Like fecal bacteria and nitrogen, these pollutants contribute to the degradation of the aquatic habitat of Inner Wequetequock Cove. Because everyone who lives, works or engages in recreational activities in the watershed contributes to NPS, it is incumbent on everyone to do their part to reduce pollution.

Recommended actions or milestones to reduce NPS loading to Anguilla Brook and Inner Wequetequock Cove are described below. Management recommendations, including milestones and interim measures are summarized in Table 7-12. These tables can be used as a preliminary plan or guideline reduce NPS pollutant loading to surface waterbodies and Wequetequock Cove.

Recommended Management Actions:

1. Reduce stormwater runoff from impervious surfaces.

The presence of impervious surfaces (roofs, parking lots, driveways, sidewalks and roads) in developed areas, such as the commercial area along US Route 1 and residential developments throughout the watershed, limits the ability of stormwater to soak into the ground. Green infrastructure (GI) and low impact development (LID) practices mimic pre-development hydrology by capturing and infiltrating stormwater into the ground near where it falls. LID practices like rain gardens, vegetated swales, planter boxes, bio-retention basins, and tree filters, and rain harvesting practices like rain barrels and cisterns, are relatively easy to retrofit into the built environment, and have high pollutant load removal capacity.

Per the 2016 MS4 permit, the Town of Stonington is required to conduct a series of actions that will result in the disconnection of 2% of impervious surfaces from the stormdrain system in high priority areas by the end of the permit (2022). Actions taken by watershed managers to raise public awareness in order to encourage residential and commercial property owners to install LID practices on their properties will assist the Town with meeting that goal.

Watershed managers should:

- conduct public outreach and education to raise awareness of NPS,
- support Stonington MS4 permit compliance,

- conduct LID workshops for the general public to encourage the installation of rain gardens, riparian buffers, bioswales, rain barrels, in conjunction with initiatives like the Pollinator Pathways project, to disconnect stormwater from the municipal stormdrain system and reduce runoff from residential areas,
- encourage land use commissions to require the use of LID practices to mimic pre-development hydrology during the permit review process, and
- identify opportunities to reduce runoff from commercial, industrial and institutional areas.

Watershed managers are urged to review the Eagleville Brook Impervious Cover TMDL website (clear.uconn.edu/projects/tmdl/) for information and resources related to impervious cover reduction.

2. Promote Good Housekeeping Practices.

Good housekeeping practices are best management practices that are intended to control pollutant discharges and keep pollutants out of waterways. Watershed managers should promote good housekeeping practices to all stakeholders in the watershed to prevent the discharge of pollutants to Anguilla Brook and Wequetequock Cove.

- **Promote Municipal Good Housekeeping Practices.**

  Municipalities are responsible for maintaining much of the impervious surfaces within their jurisdictional boundaries, including roads, sidewalks, municipal buildings and parking lots. Municipal facilities can create NPS pollutants from normal activities such as structure, vehicle and equipment maintenance and grounds management. Vehicle fueling, material loading, unloading and storage can also be sources of NPS. Town-owned properties in the Anguilla Brook/Inner Wequetequock Cove Watershed include the transfer station, Stonington High School, the Spellman Sports Complex, and the Stonington Police Department. All of these properties contain significant impervious cover.

  The 2016 MS4 permit requires that eligible municipalities adopt good housekeeping practices (GHPs) to minimize the impacts of NPS from maintenance activities and train staff to utilize these practices (US EPA, 2014). Good Housekeeping Practices include the utilization of best management practices while servicing vehicles and equipment, properly managing stockpiled materials, and preparing and utilizing emergency spill protocols. Other requirements include (at least) annual street sweeping, and catch basin cleaning, and stormwater outfall inspections and maintenance.

  Municipalities can also protect waterways from the dumping of dangerous chemicals by sponsoring hazardous materials collections days and partnering with the local health district (LLHD), pharmacies and local or state police to establish drop-off programs for unused medicines. These programs promote the safe and proper handling and disposal of unwanted chemicals, hazardous materials and pharmaceuticals that might otherwise be disposed of improperly.

- **Promote CT DOT Good Housekeeping Practices.**

  CT DOT is responsible for maintaining 12 miles of roadway in the Anguilla Brook/Inner Wequetequock Cove Watershed including 3.2 miles of Interstate 95. Pollutants such as sediment from road-side erosion and land disturbances, vehicular chemicals from drips and spills, trash, dust and particles from transported loads, and de-icing agents can be conveyed into highway storm drain systems by stormwater runoff. Like municipalities in designated urban areas, CT DOT is subject to MS4 permit requirements.

Good housekeeping practices by CT DOT should include:

- Development and adoption of operation and maintenance programs to prevent or reduce pollutant runoff from DOT operations,
- employee training to prevent and reduce stormwater pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance,
- development and implementation of an (at least) annual street sweeping program,
- development and implementation of a program to evaluate and (at a minimum) annually clean catch basins and other stormwater structures that accumulate sediment, and
- the development and implementation of a program to evaluate and prioritize the repair and/or upgrade of stormwater conveyances, structures and outfalls (CT DOT, 2015).

- **Promote Commercial/Industrial/Institutional Good Housekeeping Practices.**

Non-point source pollution from commercial, industrial and institutional development is associated with the use and maintenance of lawns and landscaped areas, parking lots, driveways and sidewalks and waste management (dumpster) areas. Commercial and industrial properties also may have stored or stockpiled materials; staff should be properly trained to manage these materials to prevent spills and runoff, and be trained to respond to spill emergencies, should they occur. Common pollutants include sediment, especially from winter sanding and de-icing, pollutants associated with motor vehicles, and fertilizers and pesticides applied to lawns and landscaping. These pollutants are often conveyed via on-site stormwater infrastructure located in the parking lots and driveways to nearby waterways.

Good housekeeping management activities adopted by commercial, industrial and institutional property managers to reduce NPS pollution from driveways, parking lots, material storage and dumpsters areas include:

- litter management/control,
- minimizing bare soils by mulching and/or re-seeding,
- spring and fall parking lot, sidewalk and driveway sweeping/vacuuming,
- spring and fall catch basin cleaning,
- safe materials handling, containment and spills protocols, and
- dumpster/dumpster area management, including the periodic cleaning, managing leaks and runoff, and replacement of corroded/leaking dumpsters in coordination with waste management contractors.

Best management practices that can reduce the volume of stormwater runoff from impervious surfaces, including rooftops, driveways, parking lots and compacted lawn/turf areas, include:

- installation of rain gardens and vegetated swales to catch and infiltrate runoff,
- use of rain planter boxes, drywells, or rain barrels to capture, infiltrate or store roof runoff for non-potable uses, and
- reduction of impervious surfaces through the installation of pervious paving materials, green roofs, or the elimination of unneeded paved surfaces.

Property managers can improve water quality by reducing the amounts of chemicals, including herbicides, pesticides and fertilizers, they apply to lawns and landscaping by:

- properly composting and utilizing compost as an alternative to chemical fertilizers,
- placement of lawn and landscape waste away from nearby waterbodies,
- testing soils to determine soil nutrient levels and needs,
- utilizing proper fertilizer application rates and timing, or eliminating the use of fertilizer, and
- utilizing integrated pest management (IPM) as an alternative to the application of herbicides and pesticides.

- **Promote Residential Good Housekeeping practices.**

  Landowners can exert considerable influence on NPS loading through their choices of land management practices and behaviors; aside from forest land cover, residential land use is the most prevalent land-use in the Anguilla Brook/Inner Wequetequock Cove Watershed. The adoption of practices that reduce the amount of stormwater runoff from residential properties can reduce NPS significantly. The adoption of sustainable lawn and land care practices will reduce nutrient loads, the use of toxic chemicals, and promote water conservation. These practices include:

  - avoidance of lawn compaction from driving or parking vehicles, which can increase stormwater runoff,
  - installation of rain gardens and vegetated swales to catch and infiltrate runoff,
  - use of rain planter boxes, drywells, or rain barrels to capture, infiltrate or store roof runoff for non-potable uses, and
  - reduction and/or disconnection of impervious surfaces from draining to waterbodies through the installation of pervious paving materials, disconnecting roof downspouts from piped drainage systems to allow discharge onto permeable ground areas away from building foundations, or elimination of unneeded paved surfaces.

  Property owners can improve water quality by reducing the amounts of chemicals, including herbicides, pesticides and fertilizers, they put on lawns and gardens by:

  - composting and careful utilization of compost as an alternative to chemical fertilizers,
  - testing soils to determine soil nutrient levels and needs,
  - reducing or eliminating the use of lawn fertilizer,
  - utilizing alternative landscaping methods such as reducing lawn area, that reduces maintenance needs, and
  - utilizing integrated pest management (IPM) as an alternative to the application of herbicides and pesticides.

Property owners can also reduce the amount of NPS generated by general household activities by adopting water-friendly practices such as:

- use of non-phosphate dish and laundry detergents,
- use of septic system-friendly cleaning chemicals,
- awareness of what is safe to put down the drain,
- washing of cars on the lawn or using a commercial car wash, and
- regular maintenance and inspections of septic systems.

3. Restore impacted riparian areas.

Riparian vegetation and vegetated buffer strips help to mitigate the effects of stormwater runoff. Riparian vegetation growing along streambanks and shorelines and vegetated buffer strips growing between agricultural areas and waterways slow storm water runoff, allowing sediment to settle out and runoff to soak into the ground before it reaches the waterways. Riparian vegetation strengthens stream banks and shorelines, reducing erosion. Impacted riparian buffers may consist of areas with minimal plant growth, such as an area where plants have been cleared from a streambank or shoreline, areas with minimal vegetative buffer width, such as a farm field that extends to within a few feet of a waterway, or a riparian area that is dominated by invasive plant species.

During the water quality investigation phase of this project, approximately 700 feet and 1,610 feet of impacted riparian buffers were noted along Donahue Brook and Wheeler Brook, respectively. Both were associated with minimal vegetated buffer width between the streams and nearby agricultural uses. The extensive proliferation of invasive plants along both stream corridors was also noted. During a stream corridor evaluation of Inner Wequetequock Cove, it was noted that much of the Wequetequock Cove shoreline (~8,400 feet) and approximately 1,000 feet of the Oxecosset Brook inlet had minimal or no riparian vegetation. Additionally, several stands of the invasive common reed *Phragmites australis*, were documented along the shoreline of Oxecosset Brook. Finally, an aerial imagery review indicated that approximately 7,275 feet of stream bank along Anguilla Brook had minimal or no vegetated riparian buffer between the brook and nearby agricultural, residential and commercial land uses.

Watershed managers should:

- raise public awareness regarding the benefits of riparian buffers and the water quality impacts associated with the lack of riparian vegetation,
- encourage agriculture land owners to increase the width of vegetated buffer strips between fields and waterways,
- encourage residential land owners to plant riparian vegetation or allow existing shoreline vegetation grow along waterways and shorelines; this could be promoted in conjunction with other programs, such as the Pollinator Pathways program,
- restore impacted riparian buffers identified during the stream corridor assessment, and
- provide information so that property owners can learn to recognize invasive plants and methods to remove them.

Suggested locations for riparian buffer restorations, as well as potential pollutant load reductions, are presented in Section 7.3.

4. Promote the Clean Marina and Clean Boater Programs.

The Clean Marina and Clean Boater programs were developed to educate marina operators and boaters and encourage them to adopt practices and behaviors that protect Long Island Sound. Common activities at marinas including boat maintenance, mechanical maintenance and repairs, and boat refueling can contribute a myriad of industrial NPS pollutants to Wequetequock Cove. The Clean Marina program provides guidance that encourages marinas to adopt BMPs to minimize the impacts of marina activities on water quality.

Watershed managers are encouraged to:

- Partner with the CT Marine Trades Association to promote the Clean Marina program among marinas. The Clean Marina program (ctmarinetrades.org/clean-marina), presently administered through the Connecticut Marine Trades Association (CMTA), is a voluntary program that encourages marinas and boatyards to adopt a suite of best management practices in order to achieve certification. These include safe chemical storage, handling and disposal; painting and fiberglass repair; boat hauling and storage; fueling; facility management; and emergency planning. Facilities that fulfill the requirements of the program are designated certified Clean Marinas and may display their certification to the boating community.
- Partner with DEEP to promote the Clean Boater program among recreational boaters. A companion program to the Clean Marina program, the Clean Boater program "…encourages the state's boaters to learn about and implement clean boating techniques" (CT DEEP, 2019; portal.ct.gov/DEEP/Boating/Clean-Marina/Connecticut-Clean-Boater-Program). The Clean Boater program participants learn common clean boating practices to help keep pollutants out of LIS and take a pledge to follow *Tips for Clean Boating on Long Island Sound*.

5. Support area pump-out boat programs.

The Clean Water Act prohibits the discharge of untreated sewage from all vessels in Long Island Sound. Connecticut has designated No Discharge Areas (NDAs) in all of Connecticut's coastal waters from the Rhode Island state boundary to the New York State. In these waters the discharge of any sewage from any vessel is prohibited. Pump-out services are available at several marinas in the Stonington and Mystic Harbors areas. In Little Narragansett Bay and Wequetequock Cove, pump-out service is provided by the Westerly (Rhode Island) Pump Out Boat service. This service funded in part by grants from CT DEEP and the Town of Westerly, and is the only bi-state program within the northeast region: westerlyri.gov/281/Pump-Out-Boat-Program.

Table 7-12. Reduce NPS Pollutant Loading to Surface Waterbodies and Wequetequock Cove.

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
1. Reduce stormwater runoff from impervious surfaces. • Conduct public outreach and education to raise awareness of NPS • Support Stonington MS4 permit compliance • Conduct LID workshops for general public • Support/encourage land use commissions to require the use of LID during the permit review process • Identify opportunities to reduce runoff from impervious areas	Watershed team, watershed towns, property owners	Long-term: 2021-2030, on-going thereafter	Outreach material developed, posted on town MS4 website/ # of site views, # brochures distributed, public LID workshops/ # workshops, # participants, # LID practices installed	Outreach material - $1.20/dbl-sided brochure, $1,500/LID workshops, LID cost varies depending on practice installed	Municipal budgets/MS4 budget, municipal staff salary, foundation grants, CWA § 319 grant program, NFWF LISFF grant program	CT DEEP, CLEAR, ECCD, ECSC, USEPA
2. Promote Good Housekeeping Practices. • Raise awareness among business owners and residents regarding GHPs • Compile, prepare and disseminate GHP information to business owners and residents	Watershed Team, watershed towns, DPWs, CT DOT, business owners, watershed residents	Mid-term: 2023 - 2028	Outreach material developed, posted on town MS4 website/ # of site views, # brochures distributed,	Outreach material - $1.20/dbl-sided brochure	Municipal budgets/MS4 budget, municipal staff salary, foundation grants, small grant programs, civic organizations	CT DEEP, CT DOT, CLEAR, ECCD, ECSC, USEPA
3. Restore impacted riparian areas • Identify sites for riparian buffer restoration • Identify funding sources/obtain funding • Obtain property owner permissions and necessary permits • Conduct riparian buffer restorations	Property owners	Mid- to Long-Term: 2023-2030, on-going thereafter	Linear feet of riparian buffer restored/ lbs TN removed, % fecal coliform reductions (MPN/100 ml)	$330/acre – riparian forest buffer[1] $233/acre – vegetative filter strip[1]	CWA § 319 NPS grant program, NFWF LISFF, NRCS Cost-share programs	CT DEEP, USEPA, NRCS, ECCD, Univ CT Extension, CT Sea Grant, CT NEMO, CT DoAg, Wild Ones

Table 7-12. Reduce NPS Pollutant Loading to Surface Waterbodies and Wequetequock Cove (Cont.)

Best Management Practice Implementation Milestones/Interim Measures	Responsible Entities	Milestone Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Potential Funding Source	Technical Assistance
4. Promote the Clean Marina and Clean Boater Programs. • Raise awareness of Clean Marina program among marina owners/operators • Encourage marina owners to obtain Clean Marina certification • Raise awareness of Clean Boater program among boaters • Partner with CT DEEP and marinas to sponsor Clean Boater awareness events • Encourage boaters to take the Clean Boater pledge	Watershed team, marina owners, boaters	Long-term: 2026-2030	# certified marinas, # Clean Boater outreach events, # boaters taking Clean Boater pledge	Cost to obtain Clean Marina certification undetermined	Marina operating costs	CT DEEP, CT Marine Trades Association
5. Support area pump-out boat programs. • promote continued DEEP support for pump-out program • promote Westerly pump-out program among area marinas and boaters • prepare and distribute pump-out program information and call channel information	Watershed Team, watershed towns, DPWs, CT DOT, business owners, watershed residents	Long-term: 2021- 2030, on-going thereafter	Outreach material developed, posted on town MS4 website/ # of site views, # brochures distributed,	$200,000 – 75% DEEP grant, 25% Town of Westerly	Westerly RI municipal budget, CT DEEP, shellfish commission, harbor management commission, small grant programs, civic organizations, private donations	CT DEEP, Town of Westerly, RI
[1]. www.nrem.iastate.edu/bmpcosttools/						

7.3 Targeted Best Management Practices

The following section provides watershed-scale, neighborhood-scale and site-specific watershed best management practices to reduce watershed fecal bacteria and nitrogen loads that are based on the recommendations provided in Section 7.2 and site conditions identified by ECCD and watershed stakeholders during the water quality investigation. These conditions, which could contribute to water quality degradation, were identified via a variety of sources, including analysis of the 2019 ECCD and CUSH water quality data, stakeholder feedback, a Google Earth review of the watershed and conditions documented during the 2019 water quality investigation and windshield survey. In some cases, the recommendations include management measures that could be implemented on the watershed or neighborhood scale, in others, BMPs are proposed for a single site. The sites were selected based on their proximities to nearby waterways, the potential for pollutant loading and the likelihood of positive water quality outcomes. Additional site investigation by stakeholders seeking to implement these recommended BMPs will be necessary to ensure the site conditions (soil types, presence of infrastructure, property ownership, etc.) are conducive for the implementation of the recommended practices.

This section highlights a variety of sites in the Anguilla Brook/Inner Wequetequock Cove Watershed where water quality improvement practices could be implemented. These sites and the recommended management measures were selected to provide examples of actions that could also be conducted at other sites throughout the watershed. As such, this list should not be considered to preclude the identification of other sites in the watershed where water quality improvement practices could be implemented. Recommended BMPs range from simple practices that could be adopted by homeowners, such as rain gardens, vegetated swales and rain barrels, to more complex practices requiring engineered site design, professional installation, and maintenance. Watershed managers are advised that additional site investigation should be conducted to identify site conditions that might preclude installation of the recommended BMPs and should coordinate with local and state regulatory agencies to determine if permits are required.

The location, description, cost estimate and estimated pollutant load reduction are provided for each recommended BMP. Pollutant load reductions were calculated using the Future Practices tool in the WTM.

7.3.1 Watershed-Wide Recommendations

In Section 7.2.4, recommendations were made to encourage behavioral changes among watershed residents through watershed-wide outreach and education programs. Behaviors targeted through these outreach programs include the adoption of proper pet waste management practices, septic system care and maintenance, and reductions in the application of lawn fertilizer. Pollutant load reductions and costs associated with the adoption of these behavior changes on a watershed-wide scale are presented in Table 7-13.

Table 7-13. Watershed-wide BMP recommendations.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Watershed-wide	Varies	NA	TN = 177 lb/yr TP = 23 lb/yr TSS = NA FC = 1,542 billion/yr
Septic system care education leading to proper maintenance practices[1]	Watershed-wide	Varies	$250 -Septic tank inspection/pumping; System repair/ replacement cost must be individually determined.	TN = 877 lb/yr TP = 146 lb/yr TSS = NA FC = 16,762 billion/yr
50% reduction in use of lawn fertilizer[1,2]	Watershed-wide	Varies	NA (will result in homeowner cost savings)	TN = 1,096 lb/yr TP = 237 lb/yr
100% reduction in use of lawn fertilizer[1,2]	Watershed-wide	Varies	NA (will result in homeowner cost savings)	TN = 1,823 lb/yr TP = 346 lb/yr

Notes:

[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).

[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).

7.3.2 Neighborhood-scale Recommendations

The sections below identify neighborhood-scale BMPs that were recommended in Sections 7.2.4 and 7.2.5. These BMPs include neighborhood-scale outreach and education programs and the installation of structural stormwater management practices. Pollutant load reductions and costs associated with the recommended BMPs are presented in each sub-section.

7.3.2.1 *Wequetequock Shoreline*

The Wequetequock shoreline (Fig. 7-2) features a diverse mix of uses. The western shoreline, along which Stonington Road (US RT 1) runs, is a mix of commercial and residential properties. The eastern shoreline is dominated by residential properties and the Avalonia Land Conservancy's 16-acre Wequetequock Cove Preserve.

Pollutants associated with the residential properties and businesses along the shores of the cove include nitrogen from septic systems, sediment, vehicular chemicals, fertilizer and other lawn/garden chemicals, and industrial chemicals and waste associated with marinas. A review of the area on the NRCS Web Soil Survey website indicates that 53% of the soils in the vicinity of the Wequetequock Cove shoreline have hydrological soil group (HSG) ratings of B, indicating the soils would be suitable for infiltration practices.

Proposed best management practices include:

- pet waste management outreach and education,
- septic system care and maintenance outreach and education,

- lawn fertilizer reduction or discontinued use, and
- ±7,125 linear feet of permeable reactive barrier along the shoreline of Wequetequock Cove.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-14.

Figure 7-2. Recommended BMPs along the Wequetequock Cove shoreline. The proposed locations of permeable reactive barriers are depicted by the white lines (Google Earth, imagery date 4/22/2018).

Table 7-14. Recommended BMPs along the Wequetequock Cove shoreline.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Neighborhood-wide	Yes	NA	TN = 7 lb/yr TP = 1 lb/yr TSS = NA FC = 60 billion/yr
Septic system care education leading to proper maintenance practices[1,2]	Neighborhood-wide	Yes	$250 -Septic tank inspection/pumping; System repair/ replacement cost must be individually determined.	TN = 34 lb/yr TP = 6 lb/yr TSS = 230 lb/yr FC = 52 billion/yr
50% reduction in use of lawn fertilizer[1]	Along the shoreline of Wequetequock Cove	Yes	NA (will result in property owner cost savings)	TN = 80 lb/yr TP = 17 lb/yr
100% reduction in use of lawn fertilizer[1]	Along the shoreline of Wequetequock Cove	Yes	NA (will result property owner cost savings)	TN = 127 lb/yr TP = 24 lb/yr
±7,125 linear feet of permeable reactive barrier[1]	Along the shoreline of Wequetequock Cove	Yes	$ 1,092/kgN removed[3]	TN = 366 lb/yr TP = 79 lb/yr

Notes:

[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).

[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).

[3] Cape Cod Commission Technologies Matrix (2021).

7.3.2.2 *Marlin Drive, Stonington*

Marlin Drive (Figs. 7-3 and 7-4) is located off US Route 1 (Stonington Road) just northwest of Wequetequock Cove. The 9-acre neighborhood contains 21 residential properties. Impervious surfaces (roads, driveways and roofs) comprise approximately 1.8 acres or 20% of the land cover, with the remaining acreage primarily lawns. Stormwater is collected by a pair of catch basins midway along the length of the road and is discharged to a wetland located to the west of the development, and via a catch basin at the end of the cul de sac that discharges to a small stream that drains that same wetland and flows into Wequetequock Cove. Roof runoff from most of the residences is discharged via downspouts onto driveways where it then flows onto the road and into the storm drain network.

Pollutants associated with this residential neighborhood include sediment, vehicular chemicals, dog waste, fertilizer and other lawn and garden chemicals. A review of the area on the NRCS Web Soil Survey website indicates that 76% of the soils in the Marlin Drive neighborhood have hydrological soil group (HSG) ratings of B, indicating the soils would be suitable for infiltration practices.

Proposed best management practices include:

- pet waste management outreach and education,

- septic system care and maintenance outreach and education,
- lawn fertilizer reduction or discontinued use,
- the installation of rain gardens at 75% of all residences to infiltrate roof runoff,
- the installation of tree filters (Fig. 7-5) upgradient of the paired catch basins, and
- the installation of a bio-retention basin (Fig. 7-6) at the end of the cul de sac.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-15.

Figure 7-3. The Marlin Drive neighborhood in Stonington, CT (Google Earth, imagery date 4/22/2018).

Figure 7-4. Locations of proposed stormwater management practices (Google Earth, imagery date 4/22/2018).

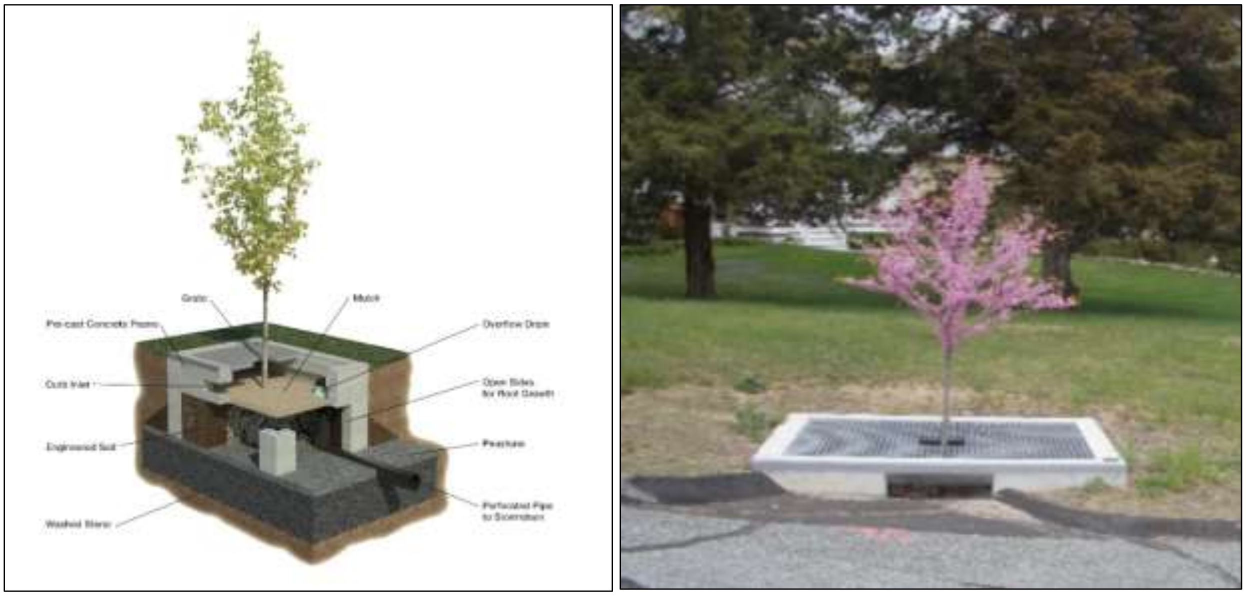


Figure 7-5. Schematic and example of a stormwater tree filter (graphic and photo credit ECCD).

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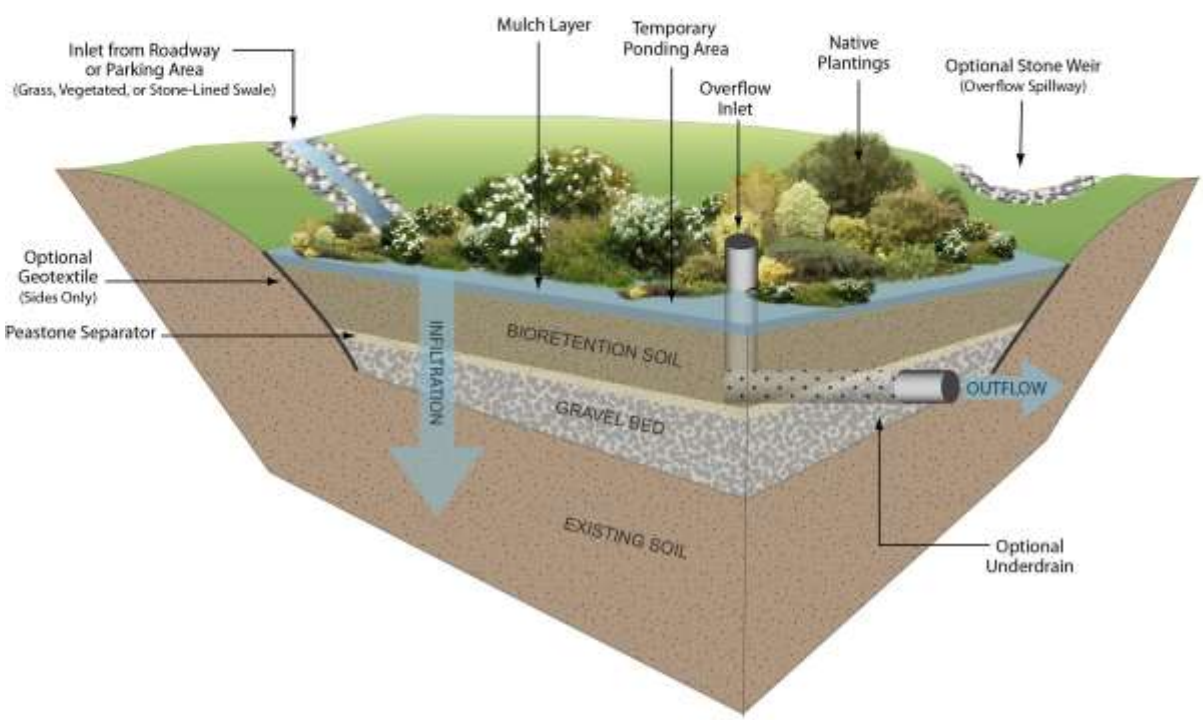


Figure 7-6. Schematic of a bio-retention basin (from Massachusetts Clean Water Toolkit, MA DEP).

Table 7-15. Recommended BMPs for the Marlin Drive neighborhood.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Neighborhood-wide	Yes	NA	TN = 10 lb/yr TP = 1 lb/yr TSS = NA FC = 59 billion/yr
Septic system care education leading to proper maintenance practices[1]	Neighborhood-wide	Yes	$250 -Septic tank inspection/pumping; System repair/ replacement cost must be individually determined.	TN = 5 lb/yr TP = 1 lb/yr TSS = 36 lb/yr FC = 8 billion/yr
50% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	Yes	NA (will result in homeowner cost savings)	TN = 6 lb/yr TP = 1 lb/yr
100% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	Yes	NA (will result in homeowner cost savings)	TN = 9 lb/yr TP = 2 lb/yr
16 rain gardens[1] (±55 sf each)	Neighborhood-wide	Yes	$8/sf[3]	TN = 2 lb/yr TP = 0.3 lb/yr TSS = 65 lb/yr FC = 88 billion/yr
2 tree filter units[1] (0.32-ac est. drainage area)	At catch basins mid-way along Marlin Drive	Yes	$14,000/unit[3]	TN = 3 lb/yr TP = 0.4 lb/yr TSS = 90 lb/yr FC = 127 billion/yr
Bio-retention basin[1] (±1,650 cu ft)	End of cul de sac	Yes	$3 - $7/cu ft treated[4]	TN = 3 lb/yr TP = 0.4 lb/yr TSS = 91 lb/yr FC = 124 billion/yr

Notes:

[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).
[3] ECCD BMP project costs.
[4] Connecticut Stormwater Quality Manual (DEEP, 2004), adjusted for inflation.

7.3.2.3 *Birdland Neighborhood, Pawcatuck*

The Birdland neighborhood (Fig. 7-7), located off US Route 1 (South Broad Street) in the Anguilla Brook watershed, is comprised of Wren, Robin, Swan, Oriole and Canary Streets. The ±34-acre neighborhood contains approximately 77 residential properties, and is connected to the municipal sewer system. Anguilla Brook forms the eastern and southern boundaries (along Swan and Canary Streets), while wetlands associated with Anguilla Brook and Chesebrough Pond form the western boundary of the neighborhood (along Wren Street). The rear lawns of most of the houses along Swan and Canary Streets extend to the edge of Anguilla Brook. Impervious surfaces (roads, driveways and roofs) in the neighborhood comprise approximately 4.5 acres or 13% of the land cover, with the remaining acreage primarily lawns. Roof runoff from most of the residences is discharged via downspouts onto driveways where it then flows onto the road and into the storm drain network.   Stormwater collected from the stormdrain systems on Swan and Wren Streets is discharged to Anguilla Brook.

Pollutants associated with this residential neighborhood include sediment, vehicular chemicals, dog waste, fertilizer and other lawn and garden chemicals. A review of the area on the NRCS Web Soil Survey website indicates that 57% of the soils in the neighborhood have hydrological soil group (HSG) ratings of B and 38% are rated C, indicating the soils would be suitable for infiltration practices.

Figure 7-7. The Birdland neighborhood in Pawcatuck, CT (Google Earth, imagery date 4/22/2018). The proposed riparian buffer restoration area is depicted by the yellow outline.

Proposed best management practices include:

- pet waste management outreach and education,

- lawn fertilizer reduction or discontinued use,
- the installation of rain gardens (Fig. 7-8) at up to 77 residences to infiltrate roof runoff,
- the installation of up to 12 tree filters upgradient of existing catch basins located throughout the neighborhood, and
- the installation of 2,700 linear feet of riparian buffer (Fig. 7-7) along Anguilla Brook (this site would be a good candidate for inclusion in the Stonington Pollinator Pathways project).

Pollutant load reductions and costs associated with each BMP are presented in Table 7-16.

Figure 7-8. Schematic of a residential rain garden catching rain water from a house roof (Image www.500eco.com).

Table 7-16. Recommended BMPs for the Birdland neighborhood.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Neighborhood-wide	No	NA	TN = 12 lb/yr TP = 2 lb/yr TSS = NA FC = 108 billion/yr
50% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	No	NA (will result in homeowner cost savings)	TN = 21 lb/yr TP = 4 lb/yr
100% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	No	NA (will result in homeowner cost savings)	TN = 31 lb/yr TP = 6 lb/yr
Up to 77 rain gardens[1] (±110 sf each)	Neighborhood-wide	No	$8/sf[3]	TN = 8 lb/yr TP = 1 lb/yr TSS = 228 lb/yr FC = 329 billion/yr
Up to 12 tree filter units[1] (est. 0.25-ac drainage area ea.)	Upgradient of catch basins located throughout the neighborhood	No	$14,000/unit[3]	TN = 22 lb/yr TP = 3 lb/yr TSS = 571 lb/yr FC = 823 billion/yr
2,700 linear feet of riparian buffer[1] (20 ft wide)	Along rear property lines of houses on Swan, Canary and Wren Streets	No	$233/acre[4]	TN = 22 lb/yr TP = 5 lb/yr TSS = 577 lb/yr FC = 823 billion/yr

Notes:

[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).
[3] ECCD BMP project costs.
[4] Tyndall and Bowman, 2016.

7.3.2.4 *Castle Hill Road Neighborhood, Pawcatuck*

The Castle Hill Road neighborhood (Fig. 7-9) is located off Pequot Trail (SR 234) in Pawcatuck, in the Anguilla Brook watershed. The ±49-acre neighborhood contains about 69 residential properties. Impervious surfaces (roads, driveways and roofs) comprise approximately 7.9 acres or 11% of the land cover, with the remaining acreage primarily lawns. Stormwater from the neighborhood is discharged to a wooded wetland associated with Anguilla Brook. Roof runoff from many of the residences is discharged via downspouts onto driveways where it then flows onto the road and into the storm drain network.

Pollutants associated with this residential neighborhood include sediment, vehicular chemicals, dog waste, fertilizer and other lawn and garden chemicals. A review of the area on the NRCS Web Soil Survey website indicates that all the soils in the Castle Hill Road neighborhood have hydrological soil group (HSG) ratings of B, indicting the soils would be suitable for infiltration practices.

Proposed best management practices include:

- pet waste management outreach and education,
- septic system care and maintenance outreach and education,
- lawn fertilizer reduction or discontinued use,
- the installation of at least 20 rain gardens to infiltrate roof runoff, and
- the installation of up to 20 tree filters upgradient of catch basins located throughout the neighborhood.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-17.

Figure 7-9. The Castle Hill Road neighborhood in Pawcatuck, CT (Google Earth, imagery date 4/22/2018).

Table 7-17. Recommended BMPs for the Castle Hill Road neighborhood.

Best Management Practice	Location	Sensitive Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Neighborhood-wide	No	NA	TN = 11 lb/yr TP = 1 lb/yr TSS = NA FC = 97 billion/yr
50% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	No	NA (will result in homeowner cost savings)	TN = 33 lb/yr TP = 7lb/yr
100% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	No	NA (will result in homeowner cost savings)	TN = 45 lb/yr TP = 9 lb/yr
Up to 20 rain gardens[1] (±100 sf each)	Neighborhood-wide	No	$8/sf[3]	TN = 4 lb/yr TP = 0.5 lb/yr TSS = 105 lb/yr FC = 151 billion/yr
Up to 12 tree filter units[1] (est. 0.25-ac drainage area ea.)	Upgradient of catch basins located throughout the neighborhood	No	$14,000/unit[3]	TN = 23 lb/yr TP = 3 lb/yr TSS = 690 lb/yr FC = 913 billion/yr

Notes:
[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).
[3] ECCD BMP project costs.

7.3.2.5 *Cedarcrest Neighborhood, North Stonington*

The estimated 42-acre Cedarcrest neighborhood (Fig. 7-10) in North Stonington is located off State Route 184 (Providence-New London Tpk) near the headwaters of the Anguilla Brook watershed. It is comprised of approximately 124 single-family residences on ¼ to ⅓-acre lots with on-site septic systems. About 700 linear feet of Anguilla Brook is culverted under the neighborhood, emerging into wetlands located to the south of Pond Street. Impervious surfaces (roads, driveways and roofs) comprise approximately 4.1 acres or 17% of the land cover in the neighborhood, with the remaining 38 acres comprised primarily of lawn.

Pollutants associated with this residential neighborhood include sediment, vehicular chemicals, dog waste, fertilizer and other lawn and garden chemicals. A review of the area on the NRCS Web Soil Survey website indicates that 98% of the soils in the Cedarcrest neighborhood have hydrological soil group (HSG) ratings of A or B, indicating the soils would be suitable for infiltration practices.

Proposed best management practices include:

- pet waste management outreach and education,
- septic system care and maintenance outreach and education,
- lawn fertilizer reduction or discontinued use, and
- the installation of rain gardens at 25% of the residences to infiltrate roof runoff.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-18.

Figure 7-10. The Cedarcrest neighborhood in North Stonington, CT (Imagery, CRCOG, 2017)).

Table 7-18. Recommended BMPs for the Cedarcrest neighborhood.

Best Management Practice	Location	Sensitive Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Neighborhood-wide	Yes	NA	TN = 20 lb/yr TP = 3 lb/yr TSS = NA FC = 174 billion/yr
Septic system care education leading to proper maintenance practices[1]	Neighborhood-wide	Yes	$250 -Septic tank inspection/pumping; System repair/ replacement cost must be individually determined.	TN = 32 lb/yr TP = 5 lb/yr TSS = 211 lb/yr FC = 48 billion/yr
50% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	Yes	NA (will result in homeowner cost savings)	TN = 21 lb/yr TP = 4 lb/yr
100% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	Yes	NA (will result in homeowner cost savings)	TN = 42 lb/yr TP = 8 lb/yr
31 rain gardens (at least 25% of properties; ±50 sf each)[1]	Neighborhood-wide	Yes	$8/sf [3]	TN = 83 lb/yr TP = 11 lb/yr TSS = 2,695 lb/yr FC = 3,453 billion/yr

Notes:

[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).
[3] ECCD BMP project costs.

7.3.2.6 *Jeremy Hill Road Neighborhood, Stonington & North Stonington*

The Jeremy Hill Road neighborhood (Fig. 7-11) is located north of Providence-New London Tpk (SR 184) in Stonington and North Stonington, CT. The road follows the watershed divide between the Wheeler Brook and unnamed brook watersheds; consequently, the neighborhood sits in a sensitive location between the headwaters of both streams. The ±64-acre neighborhood is comprised of about 30 residential properties. Impervious surfaces (roads, driveways and roofs) comprise approximately 10 acres or 16% of the land cover. The remaining acreage is divided between lawn and forest.

Pollutants associated with this residential neighborhood include sediment, vehicular chemicals, dog waste, livestock manure, fertilizer and other lawn and garden chemicals. A review of the area on the NRCS Web Soil Survey website indicates that 76% of the soils in the Jeremy Hill Road neighborhood have hydrological soil group (HSG) ratings of D, indicating the soils would generally not be suitable for suitable for large-scale infiltration practices without engineered modifications.

Proposed best management practices include:

- pet waste management outreach and education,
- septic system care and maintenance outreach and education,
- lawn fertilizer reduction or discontinued use, and
- the installation of up to 30 rain gardens to infiltrate roof runoff.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-19.

Figure 7-11. The Jeremy Hill Road neighborhood in Stonington and North Stonington, CT (Google Earth, imagery date 4/22/2018). The Wheeler Brook and unnamed brook watersheds are delineated by the purple line.

Table 7-19. Recommended BMPs for the Jeremy Hill Road neighborhood.

Best Management Practice	Location	Sensitive Area	Estimated BMP Cost	Estimated Load Reduction
Pet waste education leading to proper dog waste disposal[1]	Neighborhood-wide	Yes	NA	TN = 5 lb/yr TP = 1 lb/yr TSS = NA FC = 42 billion/yr
Septic system care education leading to proper maintenance practices[1]	Neighborhood-wide	Yes	$250 -Septic tank inspection/pumping; System repair/ replacement cost must be individually determined.	TN = 11 lb/yr TP = 2 lb/yr TSS = 74 lb/yr FC = 59 billion/yr
50% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	Yes	NA (will result in homeowner cost savings)	TN = 25 lb/yr TP = 4 lb/yr
100% reduction in use of lawn fertilizer[1,2]	Neighborhood-wide	Yes	NA (will result in homeowner cost savings)	TN = 47 lb/yr TP = 9 lb/yr
Up to 30 rain gardens (±115 sf each)[1]	Neighborhood-wide	Yes	$8/sf [3]	TN = 11 lb/yr TP = 1 lb/yr TSS = 585 lb/yr FC = 398 billion/yr

Notes:

[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).

[2] Load reductions were determined based on information provided by a limited sample of respondents to a telephone survey conducted by The Nature Conservancy in the Groton/Mystic/Stonington area in March 2017 (n=400). Of the 400 respondents, 28% reported that they applied fertilizer at least once in the previous year (n=377), and 77% of respondents were willing to use less fertilizer to protect water quality (n=400).

[3] ECCD BMP project costs.

7.3.3 Site-Specific Recommendations

The sections below identify a variety of potential sites for best management practices that were recommended in Sections 7.2.4 and 7.2.5. These BMPs include site-scale non-structural (behavioral) actions as well as the installation of structural stormwater management practices to reduce nitrogen, fecal bacteria and other NPS pollutant loads to Inner Wequetequock Cove. Pollutant load reductions and costs associated with the recommended BMPs are presented in each sub-section.

As with the neighborhood-scale recommendations, these recommendations will require thorough site review to determine that the site conditions are suitable for the recommended BMPs. Required actions will include obtaining property owner consent, evaluating hydrologic soil conditions, and identifying existing utilities and other infrastructure. These recommendations do not preclude the potential that upon further investigation, the BMPS may not prove suitable for the sites or that other BMPs may be equally suitable or even preferable.

7.3.3.1 *Saltwater Farm Vineyard*

Saltwater Farm Vineyard (Fig. 7-12) is located on the west shoreline of Inner Wequetequock Cove on the site of the former Foster Field airport. Approximately one-third of the 108-acre parcel has been converted into the vineyard, including the former hanger. Pollutants associated with this commercial/

agricultural site include sediment, vehicular chemicals, fertilizer, herbicides, pesticides, fungicides, and nitrogen from the septic system. A review of the area on the NRCS Web Soil Survey website indicates that 43% of the soils on the site have hydrological soil group (HSG) ratings of C, indicating the soils are generally suitable for infiltration practices, but that engineered modifications may be necessary.

Proposed best management practices include:

- ±4,910 feet of 20-ft wide riparian buffer along the driveway and the perimeter of the vineyard fields. This site would be a good candidate for inclusion in the Stonington Pollinator Pathways project, and
- ±2,000 linear feet of permeable reactive barrier between the vineyard fields and Wequetequock Cove.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-20.

Figure 7-12. Saltwater Farm Vineyard, along the shore of Inner Wequetequock Cove in Stonington, CT (Google Earth, imagery date 4/22/2018). The yellow line represents the proposed riparian buffer restoration area. The thick white line represents the proposed PRB.

Table 7-20. Recommended BMPs for the Saltwater Farm Vineyard.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
±4,910 linear feet of riparian buffer[1] (20 ft wide)	Along the driveway and the perimeter of the vineyard fields	Yes	\$233/acre[2]	TN = 90 lb/yr TP = 14 lb/yr TSS = 1,439 lb/yr FC = 3,051 billion/yr
±2,000 linear feet of permeable reactive barrier[1]	Between the vineyard fields and Wequetequock Cove	Yes	\$ 1,092/kgN removed[3]	TN = 88 lb/yr TP = 20 lb/yr
Notes: [1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014). [2] Tyndall and Bowman (2016). [3] Cape Cod Commission Technologies Matrix (2021).				

7.3.3.2 *The Meadows Event Center*

The Meadows Event Center (Fig. 7-13) is located on Stonington Road (US RT 1) in Stonington, CT. The site abuts the Paffard Marsh Preserve (Avalonia Land Conservancy) and Oxecosset Brook, which flows into Wequetequock Cove. The ±3.3-acre parcel is comprised of approximately 85% impervious cover (roofs, driveways and sidewalks).

Figure 7-13. The Meadows Event Center in Stonington, CT (Google Earth, imagery date 4/22/2018). The proposed riparian buffer is depicted by the yellow line along the rear of the parcel. The thick white line depicts the proposed permeable reactive barrier. The proposed bio-retention basins are depicted by the blue rectangles. The white arrows depict the locations of asphalt leak-offs from the parking lot. The left-most leak-off presently discharges directly to the brook.

Pollutants associated with this parcel include sediment, vehicular chemicals, nitrogen from the septic system, fertilizer, and other lawn and garden chemicals. A review of the area on the NRCS Web Soil Survey website indicates that 85% of the soils on the site have hydrological soil group (HSG) ratings of B, indicating the soils would be suitable for infiltration practices.

Proposed best management practices include:

- lawn fertilizer reduction or discontinued use,
- the installation of 2 bio-retention basins on either side of the entrance between the parking lot and US RT 1 to infiltrate runoff from the parking lots; existing catch basins will be raised to function as overflow devices,
- the installation of ±430 feet of permeable reactive barrier along the rear of the parcel, and
- the installation of ±400 feet of riparian buffer along the rear of the property. This site would be a good candidate for inclusion in the Stonington Pollinator Pathways project.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-21.

Table 7-21. Recommended BMPs for the Meadows Event Center.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
50% reduction in use of lawn fertilizer[1]	Lawn area at rear of event center	Yes	NA (will result in property owner cost savings)	TN = 5 lb/yr TP = 1 lb/yr
100% reduction in use of lawn fertilizer[1]	Lawn area at rear of event center	Yes	NA (will result property owner cost savings)	TN = 9 lb/yr TP = 2 lb/yr
2 bioretention basins[1] (Left unit: ±1,875 sf; Right unit: 1,675 sf)	On either side of the entrance between the parking lot and US RT 1	Yes	$15/sf [2]	TN = 20 lb/yr TP = 2lb/yr TSS = 939 lb/yr FC = 813 billion/yr
±430 linear feet of permeable reactive barrier	Along the rear of the event center property	Yes	$ 1,092/kgN removed[3]	TN = 15 lb/yr TP = 2 lb/yr
±400 linear feet of riparian buffer[1] (20 ft wide)	Along the rear of the event center property	Yes	$233/acre[4]	TN = 2 lb/yr TP = 0.1 lb/yr TSS = 28 lb/yr FC = 59 billion/yr

Notes:
[1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[2] ECCD BMP project costs.
[3] Cape Cod Commission Technologies Matrix (2021).
[4] Tyndall and Bowman (2016).

7.3.3.3 *Stonington High School and Spellman Sports Complex*

Stonington High School and the Spellman Sports Complex are located on South Broad Street (US RT 1) in Pawcatuck (Fig. 7-14). The school campus and athletic fields are located on approximately 46 acres of the 149-acre property. Impervious surfaces (rooftops, roads, driveways, impervious athletic field surfaces and sidewalks) comprise approximately 17 acres or 37% of the developed area.

Pollutants associated with this municipal property include sediment, vehicular chemicals, fertilizer and other turf management chemicals. A review of the area on the NRCS Web Soil Survey website indicates that 90% of the soils on the site have hydrological soil group (HSG) ratings of B, indicating the soils would be highly suitable for infiltration practices.

Proposed best management practices include:

- Reduced or discontinued fertilizer use,
- the installation of pervious pavement in the dirt parking lot opposite the school building, and
- the installation of up to 10 stormwater tree filters in the parking areas and along Spellman Drive to infiltrate stormwater runoff (Fig. 7-15).

Pollutant load reductions and costs associated with each BMP are presented in Table 7-22.

Figure 7-14. Stonington High School and the Spellman Sports Complex (Google Earth, imagery date 4/22/2018).

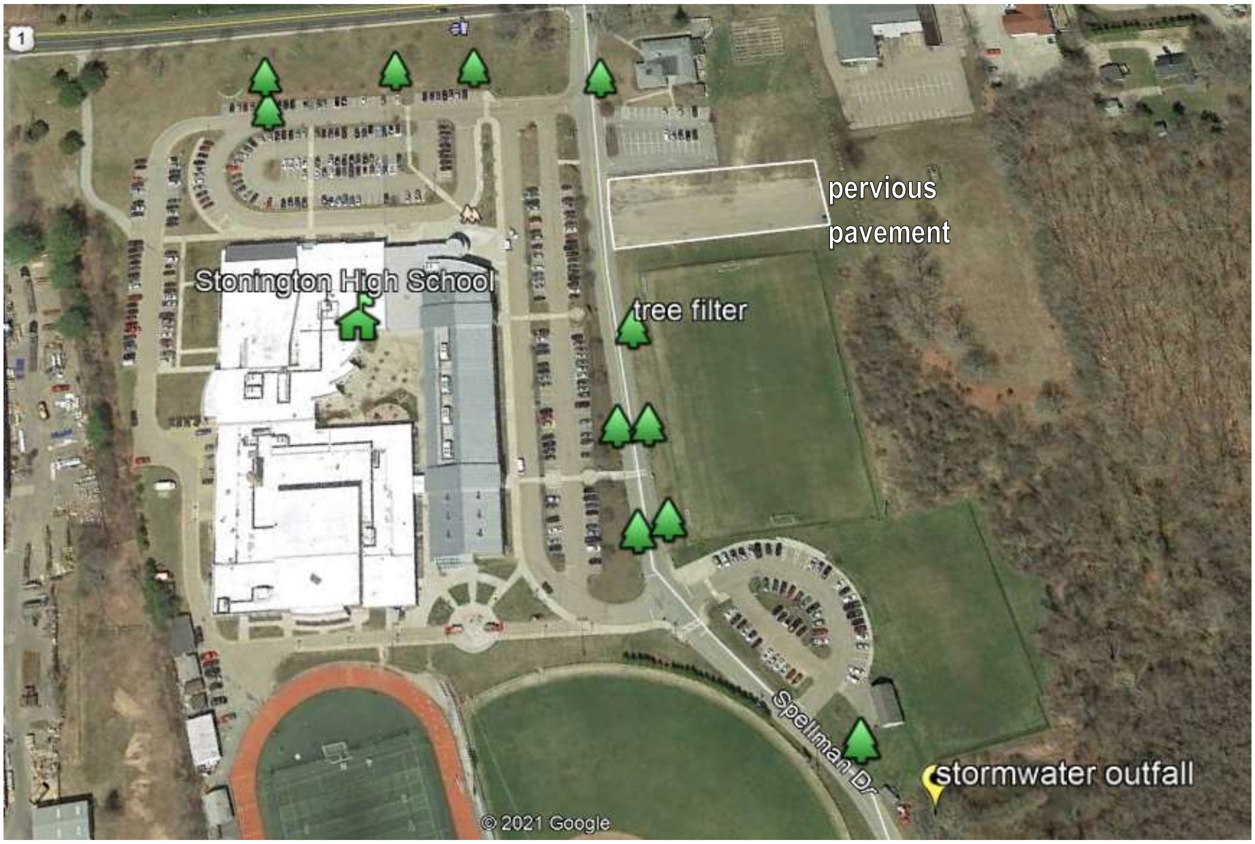


Figure 7-15. Locations of proposed BMPs at Stonington High School. Potential tree filter locations are depicted by the tree icon (Google Earth, imagery date 4/22/2018).

Table 7-22. Recommended BMPs for Stonington High School and the Spellman Sports Complex.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
50% reduction in use of turf fertilizer[1]	Athletic fields	No	NA (will result in cost savings)	TN = 414 lb/yr TP = 0 lb/yr[5]
100% reduction in use of turf fertilizer[1]	Athletic fields	No	NA (will result in cost savings)	TN = 828 lb/yr TP = 0 lb/yr[5]
Pervious pavement[2] (est. 2,900 sf)	Dirt parking lot opposite the school building	No	\$3.44-\$5.37/sf[3]	TN = 0.4 lb/yr TP = <0.1lb/yr TSS = 16 lb/yr FC = 16 billion/yr
Up to 10 tree filter units[2] (est. 0.25-ac drainage area ea.)	Upgradient of catch basins in parking areas and along Spellman Drive	No	\$14,000/unit[4]	TN = 15 lb/yr TP = 2 lb/yr TSS = 430 lb/yr FC = 51 billion/yr

Notes:
[1] Pollutant load reductions calculated based on Cornell University fertilizer application rates for athletic fields.
[2] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[3] Univiversity of Maryland Extension Permeable Pavement Fact Sheet (2016).
[4] ECCD BMP project costs.
[5] Based on assumption that municipality currently uses phosphorus-free fertilizer.

7.3.3.4 *Pawcatuck Little League Complex*

The Pawcatuck Little League complex is located on North Anguilla Road (Fig. 7-16) in the Anguilla Brook watershed. The complex is located adjacent to Anguilla Brook, which, at its closest, is approximately 115 feet from the brook. The 22-acre parcel contains five ball fields totaling about 5.9 acres.

Pollutants associated with the complex include sediment, vehicular chemicals, herbicides and pesticides, although the primary pollutant of concern is nitrogen from fertilizer. A review of the area on the NRCS Web Soil Survey website indicates that 78% of the soils on the site have hydrological soil group (HSG) ratings of B, indicating the soils are highly permeable.

Proposed best management practices include:

- a 50% reduction or discontinued use of fertilizer, and
- install ±675 linear feet of permeable reactive barrier between the two northwest-most fields and Anguilla Brook (Fig. 7-17).

Pollutant load reductions and costs associated with each BMP are presented in Table 7-23.

Figure 7-16. Pawcatuck Little League complex (Google Earth, imagery date 4/22/2018).

Figure 7-17. Proposed BMPs at the Pawcatuck Little League Complex (Imagery CRCOG, 2017)). The locations of the PRBs are depicted by the white lines.

Table 7-23. Recommended BMPs for the Pawcatuck Little League Complex.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
50% reduction in use of turf fertilizer[1]	Ballfields	No	NA (will result in cost savings)	TN = 124 lb/yr TP = 62 lb/yr
100% reduction in use of turf fertilizer[1]	ballfields	No	NA (will result in cost savings)	TN = 248 lb/yr TP = 124 lb/yr
Permeable reactive barriers (PRB)[2]; ±675 linear ft	Along the west side of the two fields adjacent to Anguilla Brook	No	$ 1,092/kgN removed[3]	TN = 24 lb/yr TP = 4 lb/yr

Notes:

[1] Pollutant load reductions calculated based on Cornell University fertilizer application rates for athletic fields.
[2] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014).
[3] Cape Cod Commission Technologies Matrix (2021).

7.3.3.5 *Elmridge Golf Course*

The Elmridge Golf Course is located on North Anguilla and Elmridge Roads in the Anguilla Brook watershed (Fig. 7-18). An estimated 100 acres of the golf course is located in the Anguilla Brook watershed. As was noted in Section 5.1.3, an application for the construction of a 3-megawatt AC photovoltaic electric generating facility was approved by the Connecticut Siting Council in February 2021. This project will result in the removal of approximately 14 acres from fairway use.

Pollutants associated with the golf course include sediment, vehicular chemicals, fertilizer, pesticides and herbicides. Proposed best management practices include:

- a 50% reduction or discontinued use of fertilizer.

Pollutant load reductions and costs associated with each BMP and the removal of 14 acres from golf course use as a result of the solar installation are presented in Table 7-24.

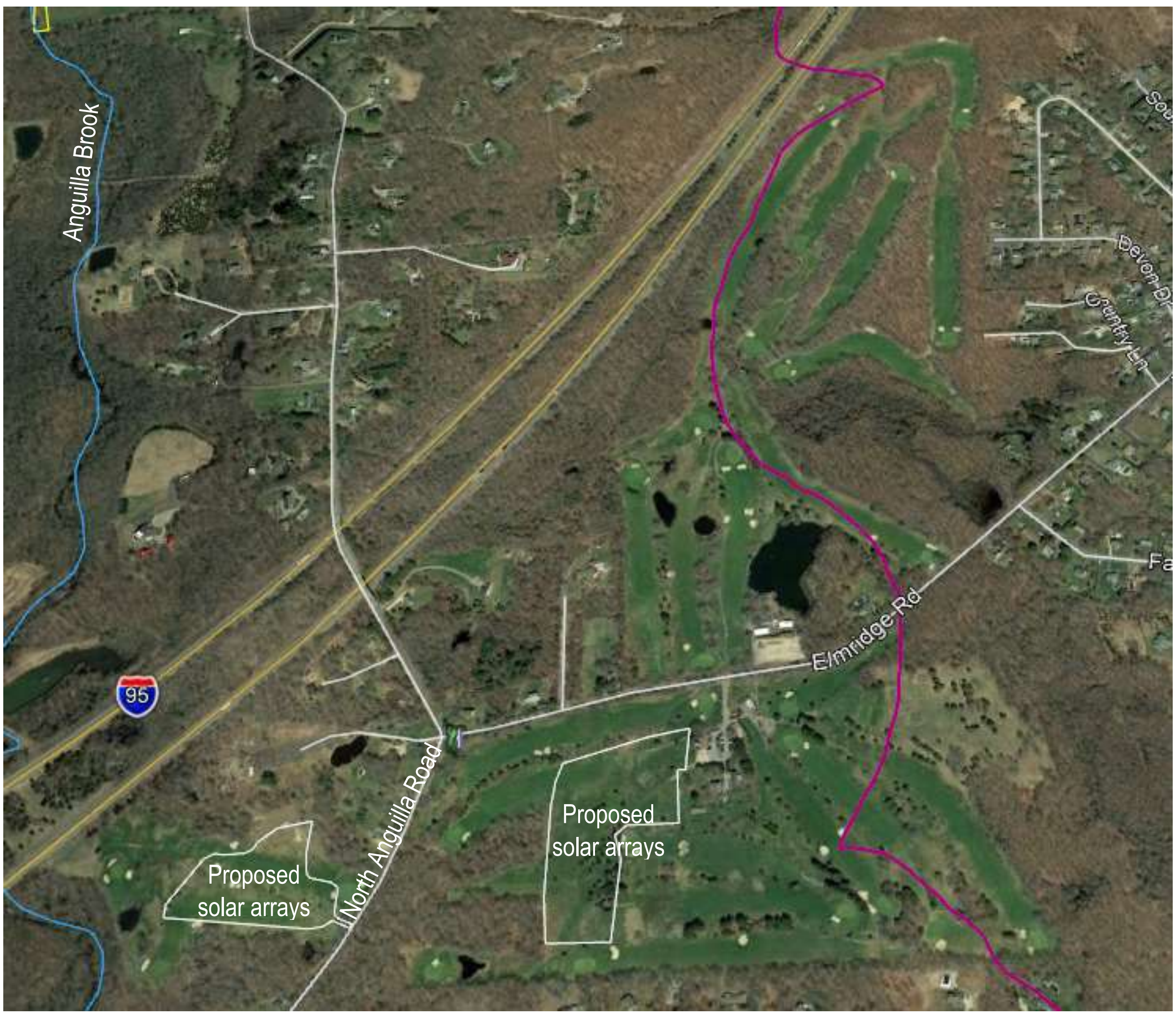


Figure 7-18. Elmridge Golf Course (Google Earth, imagery date 4/22/18). The eastern limit of the Anguilla Brook watershed is delineated in purple. The white outlines depict the proposed locations of solar generating arrays.

Table 7-24. Recommended BMPs for the Elmridge Golf Course.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
50% reduction in use of turf fertilizer[1]	Golf course	No	NA (will result in cost savings)	TN = 4,687 lb/yr TP = 2,064 lb/yr
100% reduction in use of turf fertilizer[1]	Golf course	No	NA (will result in cost savings)	TN = 9,374 lb/yr TP = 4,128 lb/yr
Conversion of ±14 acres to solar generating facility use[1]	Golf course	No	NA	TN = 1,525 lb/yr TP = 671 lb/yr
Notes: [1] Pollutant load reductions based on GCSSS (2009) fertilizer application rates for golf courses.				

7.3.3.6 *Stonington Country Club*

Stonington Country Club (Fig. 7-19) is located on Taugwonk Road in the Anguilla Brook watershed. Pollutants associated with this 154-acre golf course include sediment, vehicular chemicals, fertilizer, pesticides and herbicides. Proposed best management practices include:

- a 50% reduction or discontinued use of fertilizer.

Figure 7-19. Stonington Country Club. The watershed limits are is delineated in purple (Google Earth, imagery date 4/22/18).

Table 7-25. Recommended BMPs for Stonington Country Club.

Best Management Practice	Location	Critical Area	Estimated BMP Cost	Estimated Load Reduction
50% reduction in use of turf fertilizer[1]	Golf course	No	NA (will result in cost savings)	TN = 5,941 lb/yr TP = 2,616 lb/yr
100% reduction in use of turf fertilizer[1]	Golf course	No	NA (will result in cost savings)	TN = 11,881 lb/yr TP = 5,232 lb/yr
Notes: [1] Pollutant load reductions based on GCSSS (2009) fertilizer application rates for golf courses.				

7.3.3.7 *Stonington Vineyard*

Stonington Vineyard is located on Taugwonk Road in the Wheeler Brook watershed (Fig. 7-20). Wheeler Brook flows along the western side of the winery and vineyard fields. The separating distance from the building and fields to the brook varies from about 40 feet to as little as 10 feet. During the stream corridor assessment of Wheeler Brook, it was noted that a swale between the two vineyard fields directs runoff into the stream (Fig. 7-20). A compost pile on the edge of the stream located to the south of the drainage swale was also documented.

Pollutants associated with this site include sediment, vehicular chemicals, nitrogen from the septic system and fertilizer, pesticides, herbicides, and fungicides. A review of the site on the NRCS Web Soil Survey website indicates that 60% of the soils on the site have hydrological soil group (HSG) ratings of C, indicating the soils are suitable for infiltration practices.

Proposed best management practices include:

- the installation of 1,300 linear feet of 20-foot- wide riparian buffer to intercept runoff from the winery and vineyard fields to Wheeler Brook, ***or***
- the installation of 1,300 linear feet of permeable reactive barrier between the winery and vineyard fields and Wheeler Brook.

Pollutant load reductions and costs associated with each BMP are presented in Table 7-26.

Figure 7-20. Stonington Vineyard. The white line depicts the location of the proposed vegetated riparian buffer and/or permeable reactive barrier (Google Earth, imagery date 4/22/18).

Table 7-26. Recommended BMPs for Stonington Vineyard.

Best Management Practice	Location	Sensitive Area	Estimated BMP Cost	Estimated Load Reduction
±1,300 linear feet of riparian buffer[1] (20 ft wide)	Along the east bank of Wheeler Brook	Yes	\$233/acre[2]	TN = 44 lb/yr TP = 7 lb/yr TSS = 725 lb/yr FC = 1,400 billion/yr
±1,300 linear feet of permeable reactive barrier[1]	Along the east bank of Wheeler Brook	Yes	\$ 1,092/kgN removed[3]	TN = 41 lb/yr TP = 10 lb/yr
Notes: [1] Pollutant load reductions modeled using the Watershed Treatment Model (CWP, 2014). [2] Tyndall and Bowman (2016). [3] Cape Cod Commission Technologies Matrix (2021).				

8 Financial and Technical Assistance

8.1 Financial Assistance

Most, if not all, of the management practices recommended in the preceding sections will require some financial investment. Critical to the success of the implementation of these management measures is the ability to obtain funding. Reasonable financial estimates for each management practice, and particularly those in Section 7.3, have been provided. However, costs associated with the development and implementation of each proposed measure will need to be estimated individually as management strategies are undertaken. Factors that may affect the cost of developing and implementing management measures as part of a watershed-based plan include the type of management practice proposed, installation costs, operation and maintenance costs, and methods of cost calculations. Watershed managers should also be advised that, while every effort was made to identify accurate cost estimates, those estimates may change over time.

There are a number of options for watershed managers to identify and secure funding to conduct watershed-based plan implementation projects. Watershed municipalities have local funding options, including bonding, capital improvement budgets, and department budget line items that can be utilized to fund water quality improvement implementations and municipal outreach efforts. Town planning and land use departments can establish open space set-aside funds for the acquisition of open space, if they do not already have them. Highway/public works departments include annual budget line items for infrastructure repair, maintenance and improvements, and should also include funding for outreach related to MS4 Permit requirements. Municipal land use commission budgets can include line items for environmental education and outreach programs/ campaigns and materials. The establishment and growth of this local capacity is important. When municipalities or other stakeholders apply for outside grants, loans and/or foundation support, they can leverage these local funds. Additionally, numerous grant applications are strengthened by the availability of in-kind services provided by municipal staff, local volunteers and technical assistance providers, among others, as well as donated materials and use of equipment. In recent legislative sessions, bills have been raised to authorize municipalities to create stormwater authorities to manage stormwater and generate funding for stormwater improvement projects. Pilot stormwater utilities have been established in several Connecticut towns, including the City of New London, through legislation authorizing these pilot projects. The New London stormwater utility has proven very successful and would be a good model to emulate should stormwater utility legislation be passed in the future.

Financial assistance in the form of grants and cost-sharing is available from multiple sources, including federal, state, and local sources. These include, but are not limited to, US Environmental Protection Agency (Clean Water Act §319 Non-Point Source program), Connecticut Department of Housing (Small Cities grant program), the Connecticut Office of Policy and Management (STEAP grants), CT Department of Energy and Environmental Protection (Open Space grants, CWA grants), Long Island Sound program grants, and National Fish and Wildlife Fund grants. The US Department of Agriculture Natural Resources Conservation Service (NRCS) offers cost-share programs for qualified agricultural producers, such as the Environmental Quality Incentive Program (EQIP), which includes the development of comprehensive nutrient management plans (CNMP). The Connecticut Department of Agriculture offers several grant programs to assist agricultural producers, including farm restoration and agriculture viability grant programs. Local and regional sources may include banks, chambers of commerce, civic/social organizations (such as Lions or Rotary), private, commercial and institutional foundations like the Community Foundation of Eastern Connecticut, and environmental/professional organizations.

Funds and support may also be available in the form of donations and in-kind services provided by local businesses, community and environmental organizations, and local volunteers. These funding sources are subject to the availability of funding and changes in funding cycles and should be reviewed by the applicant for applicability and availability. Stakeholders and watershed managers should be aware of the importance of thoroughly reviewing potential financial assistance programs; some of the provided examples require specific timelines that may take considerable preparation time (and in some cases the assistance of technical expertise) to meet.

A sampling of potential funding opportunities is provided in Table 8-1. Watershed stakeholders are encouraged to explore other funding sources via the internet.

Table 8-1. Potential funding sources for watershed-based plan implementations.

Funding Source	Award Amount	Contact Information
Community Foundation of Eastern Connecticut Website: www.cfect.org	Varies by program	Jennifer O'Brien (860) 442-3572
CT DEEP CWA §319 NPS Grant Program Website: portal.ct.gov/DEEP/Water/NPS/	Varies by project	Eric Thomas (860) 424 -3548
CT DEEP CWA §604(b) Watershed Planning grant program Website: portal.ct.gov/DEEP/Water/NPS/	Varies by availability	
CT DEEP Clean Water Fund (for municipalities) Website: www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654	Varies by project	Susan Hawkins (860) 424-3325
CT DEEP Open Space and Watershed Land Acquisition Grant Program Website: www.ct.gov/deep/cwp/view.asp?A=2687&Q=322338	40-60% of fair market value	Allyson Clarke - (860) 424-3774
CT Dept of Agriculture Agriculture Viability Grant Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398982	Varies by project	(860) 713-2500
CT Dept of Agriculture Environmental Assistance Program Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398986	Varies by practice	(860) 713-2511
CT Dept of Agriculture Farmland Restoration Program Website: www.ct.gov/doag/cwp/view.asp?a=3260&Q=498322&PM=1	Varies by project	Cam Weimer/Lance Shannon (860) 713-2511
CT DOH Small Cities Program Website: www.ct.gov/doh/cwp/view.asp?a=4513&q=530474	Varies by town	Jim Watson (860) 270-8182
CT OPM Regional Performance Incentive Program Website: www.ct.gov/opm/cwp/view.asp?q=487924		Sandy Huber (860) 418-6293
CT OPM Small Town Economic Assistance Program Website: www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793	Varies by project	Barbara Rua (860) 418-6303
Environmental Professionals of CT Website: www.epoc.org/grants	$2,500	Seth Molofsky - (860) 537-0337

Table 8 1. Potential funding sources for watershed-based plan implementations (cont.).

Funding Source	Award Amount	Contact Information
Long Island Community Foundation Website: www.lisfc.org/		Jeannie DeMaio - jdemaio@licf.org
Long Island Sound Funders Collaborative Website: www.lisfc.org/	Up to $400,000 is available for grants annually.	Trip Killin - tripp@lisfc.org
NFWF Long Island Sound Futures Fund Website: www.nfwf.org/	Varies by project	Lynn Dwyer - lynn.dwyer@nfwf.org
NFWF New England Forests and Rivers Fund Website: www.nfwf.org/programs/new-england-forests-and-rivers-fund/	$50,000 to $200,000	John Wright - John.wright@nfwf.org
NRCS Agricultural Conservation Easement program Website: www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/easements/acep/	Varies by project	Garrett Timmons - (860) 319-8803
NRCS Environmental Quality Incentives Program Website: www.ct.nrcs.usda.gov/programs/eqip/eqip.html	$450,000 over 6 yrs	Garrett Timmons – (860) 319-8803
NRCS Conservation Stewardship Program (CSP) Website: www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/financial/csp/	$200,000 over 5 yrs	Garrett Timmons – (860) 319-8803
NRCS Agricultural Management Assistance Program Website: www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/programs/financial/?cid=nrcs142p2_011027	$50,000/yr	Garrett Timmons – (860) 319-8803
NRCS Watershed Grant Program Website: www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/planning/wpfp/	varies	Garrett Timmons – (860) 319-8803
NOAA Coastal Management Programs Website: coastalmanagement.noaa.gov/funding/welcome.html		
NOAA Coastal Resilience Fund Website: www.nfwf.org/programs/national-coastal-resilience-fund	Varies by program priority area Average $250,000-$350,000	Amanda Bassow - Amanda.Bassow@nfwf.org
Rivers Alliance of CT Watershed Assistance Small Grants Program Website: www.riversalliance.org/watershedassistancegrantrfp.cfm	$5000, req. 40% non-federal funding match	Rivers Alliance of CT- (860) 361-9349
Society of Women Environmental Professional-CT Website: www.swep-ct.org/	$2,000	Kathie Cyr - Kathleen.cyr@gza.com
US EPA Five Star Restoration Grant Program Website: www.epa.gov/urbanwaterspartners/five-star-and-urban-waters-restoration-grant-program	$20,000 average	Myra Price (202) 566-1225
US EPA Healthy Communities Grant Program Website: www.epa.gov/region1/eco/uep/hcgp.html		Jennifer Padula (617) 918-1698

8.2 TECHNICAL ASSISTANCE

The planning, design and execution of complex water quality improvement projects may require expertise to which small towns, watershed groups and civic organizations do not have access. As a result, assistance from organizations or agencies that have the technical capacity will be critical to the successful implementation of the management recommendations. Organizations such as the US Department of Agriculture Farm Services Agency (FSA) and Natural Resources Conservation Service (NRCS), CT DEEP, the CT Department of Agriculture, the Southeastern Connecticut Council of Governments (SCCOG), the Eastern Connecticut Conservation District, the University of Connecticut Cooperative Extension Service and CT Sea Grant program, US Fish & Wildlife Service and others may provide technical assistance to project managers and watershed stakeholders that will ensure project success.

Agencies and organizations that may provide technical assistance as well as the type of assistance available are listed in Table 8-2.

Table 8-2. Potential sources of technical assistance.

Agency/Organization	Type of Assistance Available
CT Department of Agriculture www.ct.gov/doag	Available programs, permitting, agricultural waste management
Connecticut Department of Agriculture Bureau of Aquaculture	Support and technical assistance regarding coastal water quality, shellfish management and restoration; water quality data
CT DEEP www.ct.gov/deep	Water quality, forestry, stormwater management, land protection, wildlife, endangered species
CT Department of Transportation www.ct.gov/dot	Design and maintenance of State highways/ stormwater systems and maintenance facilities, design standards
CT Resource Conservation & Development Area www.ctrcd.org	Farm energy program, soil health education, AGvocate program, partnerships/grant management, greenways, planning and development projects, Environmental Review Team (ERT)
Eastern CT Conservation District www.ConserveCT.org/eastern	Water quality, BMP implementations, technical and resource assistance, grant writing
Ledge Light Health District www.llhd.org	Review and approval of septic systems, repairs
Local Businesses/Associations chamberect.com/	Potential funding and partnership opportunities
Southeastern CT Council of Governments www.seccog.org	Regional land use planning support and assistance, GIS assistance
The Nature Conservancy www.nature.org	Outreach/education, planning/ management tools, technical expertise
Town of Stonington www.stonington-ct.gov	Enforcement of land use regulations, site plan review/permits, public utilities maintenance, land records, stormwater management plan, planning documents
Town of North Stonington www.northstoningtonct.gov	Enforcement of land use regulations, site plan review/permits, public utilities maintenance, land records, stormwater management plan, planning documents
USDA Natural Resources Conservation Service (NRCS) www.nrcs.usda.gov/wps/portal/nrcs/site/ct/home/	Programmatic/cost-share funding for agricultural BMPs, nutrient management, woodland and wildlife habitat management and improvement

Table 8 2. Potential sources of technical assistance (cont.).

Agency/Organization	Type of Assistance Available
USDA Farm Service Agency (FSA) www.fsa.usda.gov/	Technical/financial assistance for agricultural producers
University of Connecticut – Center for Land Use Education and Research (CLEAR) clear.uconn.edu	Outreach and education, GIS support, tools and data, implementation of LID/GI, MS4 permit support
University of Connecticut – Nonpoint Education for Municipal Officials (NEMO) nemo.uconn.edu	NPS education and support for municipal land use organizations
University of Connecticut Extension www.extension.uconn.edu	Technical assistance/education/outreach for land use, forest management and agricultural practices
University of Connecticut Sea Grant Program www.seagrant.uconn.edu	Education and outreach on coastal topics, riparian buffers, coastal habitat restoration, shellfish management /restoration

9 WATER QUALITY MONITORING PROGRAM

The development of a water quality monitoring program is necessary to evaluate the effectiveness of implementations over time. At a minimum, the two pollutants of greatest concern to water quality in Wequetequock Cove, nitrogen and fecal bacteria, should be monitored. However, a monitoring program that collects other physical water quality parameters such as dissolved oxygen, suspended sediments, pH, conductivity, other nutrients like phosphorus, and biological data, such as the types and abundance of aquatic plants and animals provides equally important data that can be used to evaluate the health of the estuary and the effectiveness of implementations. For example, it was previously noted in this document that biomass surveys of green algae in the Pawcatuck River, Little Narragansett Bay and Wequetequock Cove provided valuable biological information regarding nitrogen loading.

As Plan recommendations are being implemented, existing water quality data, such as that collected by the Town of Stonington as part of its MS4 permit obligations can be evaluated, or additional water quality data should be collected to evaluate whether the implementations are having the desired effect. Where possible, water quality data should be collected before and after the implementation or upstream and downstream of the implementation site to determine if target pollutant load reductions have occurred. Successful implementations will demonstrate reductions in the targeted pollutants (e.g., reductions in fecal coliform and enterococci concentrations, pounds of nitrogen, or reductions in nitrogen concentrations) indicating gains are being made toward attaining the water quality standards identified in Section 3.1. The demonstration of measurable progress is not only indicative that implementations are having the intended effect, but is also critical to ensuring the continued support of watershed projects by the community and funding agencies.

Clean Up Sounds and Harbors (CUSH; www.cushinc.org) is an established, experienced and credible water quality monitoring organization that is an invaluable asset to southeastern Connecticut. CUSH collects valuable water quality data that is used by local, regional and state water quality managers to make informed management decisions about waterbodies and embayments in southeastern Connecticut. CUSH participates in water quality monitoring programs sponsored by the University of Rhode Island (Water Watch) and Save the Sound (Unified Water Study). Ongoing water quality sampling by CUSH through these programs will provide valuable data to determine if water quality improvement efforts in the Anguilla Brook watershed are having the desired effect. Any water quality improvement projects undertaken as part of the implementation of this plan should include a water quality monitoring component, and include funding to support water quality testing by CUSH or another entity.

10 PLAN EVALUATION PROCESS

The successful implementation of a watershed-based plan includes the periodic review of management measures that have been completed. This evaluation process will help watershed managers determine if watershed goals are being achieved. The plan evaluation process also allows watershed managers to assess and improve not only implementation measures, but the implementation process as a whole. The implementation of a watershed management plan is necessarily an iterative process. As management measures are undertaken and completed, they should be evaluated to determine if the desired outcome is being achieved. If the desired outcome is not being achieved (e.g., no reduction in nitrogen concentration has been observed), the measure should be re-evaluated, adjusted, re-implemented, re-evaluated and so on until the desired outcome (water quality goals) is reached.

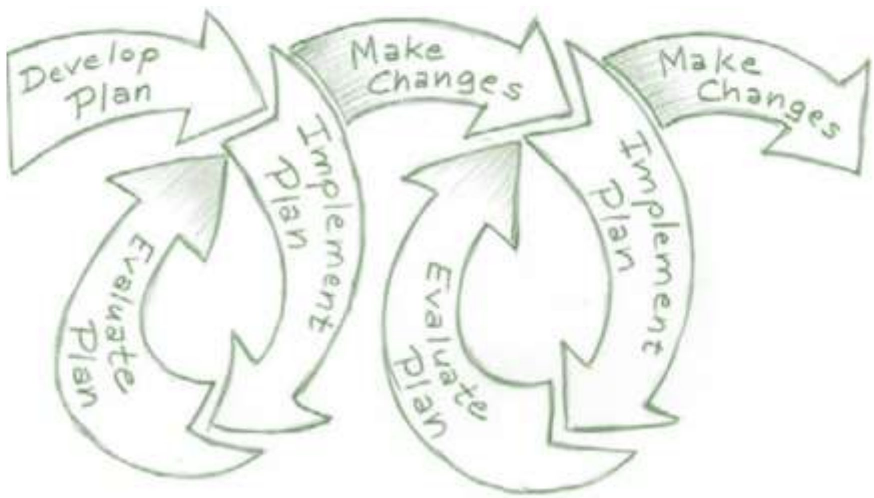


Figure 10-1. This graphic from the USEPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters depicts the iterative nature of the watershed planning process (USEPA 2008).

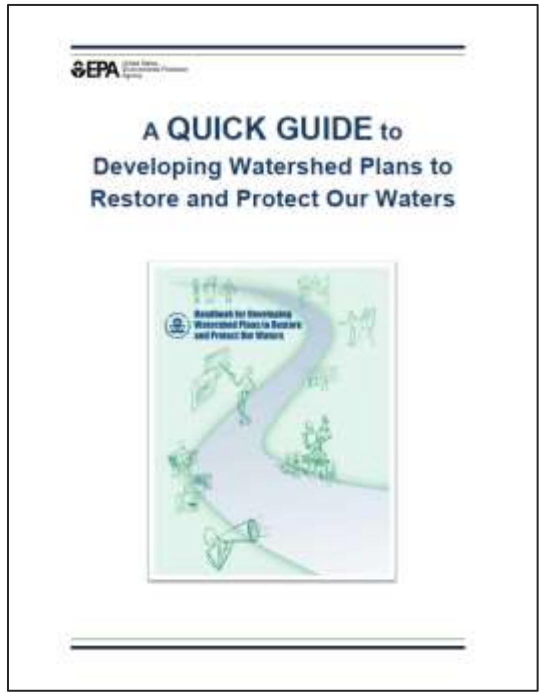
In order to evaluate watershed-based plan implementation outcomes, the watershed team should develop a method to track progress. This tracking methodology should document evaluation criteria such as whether management measures are being implemented, if implementation milestones are being met, if water quality improvements are being documented, and if intended outcomes are being achieved.

If the watershed team determines that intended outcomes are not being achieved, the implementation process will need to be adjusted. The team will need to evaluate why outcomes are not being achieved. This could be due to an overly ambitious work plan, the lack of funding, the need for additional or different management measures to target a particular pollutant, or new conditions in the watershed, such as a large development in a sensitive area that has altered pollutant loads and load reduction targets, in which case the Plan itself may need to be revised to reflect altered watershed conditions.

Finally, the watershed team should conduct the Plan evaluation on a regular (e.g., annual or biennial) basis. This regular evaluation will allow managers to closely track implementations and effect any course corrections necessary.

11 WATERSHED-BASED PLAN IMPLEMENTATION

A watershed-based plan is only as good as its successful implementation. While this Plan provides a roadmap for watershed managers to conduct actions that are intended to improve the water quality and aquatic habitat of Wequetequock Cove, without a plan to initiate its implementation, these watershed goals will not be achieved. Further, watershed managers need to have an understanding of how they will prioritize, schedule, and evaluate actions, measure success, evaluate the overall effectiveness of the Plan implementation, and provide corrective actions if the goals of the Plan are not being realized. The following section provides guidance to stakeholders to begin the implementation of this Plan.



Guidance for this section was drawn from *A Quick Guide to Developing Watershed Plans to Restore and Protect Our Waters (*USEPA, 2013), a resource we strongly suggest the watershed team review and revisit as the Plan is implemented.

11.1 CONVENE THE WATERSHED TEAM

The first, and most important, step in implementing this Plan is to convene the watershed management team. The watershed team will tackle critical decisions that will determine how the Plan will be implemented, how actions will be prioritized, when and in what order actions will be implemented, how the effectiveness of the actions will be evaluated, whether the overall implementation of the Plan is having the desired effect, and, if not, what steps to take to correct the course of action. In addition to determining how the watershed-based plan will be implemented, the watershed team will be responsible for assigning roles such as project manager or implementation teams, to facilitate the implementation of projects. It will also be the responsibility of the team to share information, including water quality problems and success stories, with the general public.

The watershed team may be an informal action committee comprised of key members from the watershed community, or may be a more formalized organization, such as the many 501(c)(3) watershed associations that have formed throughout the US. Key to the formation of a watershed team is that it agrees to meet regularly to conduct its work. Additional guidance regarding the creation of a watershed coalition, including potential members, was provided in Section 7.2.1.

It is recommended that the watershed team formally endorse the Watershed Plan and encourage the towns of North Stonington and Stonington to do so as well in order to demonstrate their willingness to support the objectives of the Watershed Plan.

11.2 Prepare a Work Plan

The Anguilla Brook/Inner Wequetequock Cove Watershed-Based Plan is a long-term document that is intended to guide the actions of the watershed team over a 10- year timeframe (and beyond). In order to implement the management measures recommended in the Plan, the watershed team should develop a watershed work plan. A work plan is a short-term strategic "to-do" list, usually spanning a 1 to 3-year timeframe, that identifies actions the team intends to conduct within that timeframe. Elements of the work plan are drawn from the Watershed-based Plan, with work plan activities based on the Plan recommendations and the timeframes provided in the Plan.

11.3 Implement the Management Strategies

With the work plan in place, the watershed team should begin to implement the management strategies provided in Section 7 of this Plan. The management strategies include a variety of short -, medium- and long-term non-structural and structural controls that vary in complexity from easily implemented practices like rain gardens to more complex structural practices that will need to be installed by experienced practitioners. As the management strategies are implemented, the team should be sure to track progress to ensure targets in the work plan are being met and evaluate the effectiveness of the implementations to ensure that the over-arching goals of the Plan are being attained.

11.4 Conduct Monitoring and Analyze Data

Water quality monitoring and data analysis provide valuable information to the watershed team. Routine data analysis "…tracks progress, assesses the quality of data relative to measurement quality objectives (i.e., whether the data are of adequate quality to answer the monitoring questions), and provides early feedback on trends, changes, and problems in the watershed," while intensive analysis can be used by the watershed team to "…determine status, changes, trends, or other issues that measure the response to watershed plan implementation" (USEPA, 2013).

As management measures are being implemented, their effectiveness should be monitored and the results analyzed relative to the management practice objectives. The type of monitoring conducted and the data collected will be specific to the practice or activity being implemented and should be tied to water quality standards or other criteria established in earlier sections of this Plan. For example, a lawn fertilizer reduction campaign might document the number of participating property owners, the number of acres taken out of fertilization, or the reduction in the pounds of nitrogen applied. The installation of a riparian buffer alongside an agricultural field might document the linear feet of buffer installed, and/or the *E. coli* concentrations upstream and downstream of the installation. The effectiveness of the installation of a series of stormwater tree filters in a neighborhood might be measured by conducting pre- and post-installation water quality testing at the stormwater outfall to which the tree filters discharge.

Whatever the methodology used, monitoring is a means to document and demonstrate that positive gains are being achieved through the implementation of the Plan management measures, and inform partners and the public that the goals of the Watershed-based Plan are being attained.

11.5 Conduct Information/Education Activities

It will be the responsibility of the watershed team to raise awareness among watershed residents about water quality issues in the Anguilla Brook/Inner Wequetequock Cove watershed and to share results and success stories. As outlined in Section 7.2.2, the watershed team should undertake a series of outreach actions to raise public awareness, educate the public about water quality problems in the watershed, and conduct educational programs so that members of the public can learn what actions they can take to help protect and improve water quality.

The watershed team should develop a means to communicate with the broader watershed community and to highlight key activities and success stories, or assign that role to a team member. This could include the establishment of social media sites such as Facebook and Instagram accounts to publicize implementation actions, workshops and other community events.

11.6 Measure Progress and Make Adjustments

As discussed in Section 10, the successful implementation of a watershed-based plan requires the periodic review and evaluation of the implementation activities, a comparison to interim milestones and water quality criteria, and a review of feedback from project partners, watershed residents and others.

As suggested in Section 10, the watershed team should conduct the Plan evaluation on a regular (e.g., annual or biennial) basis, which will allow managers to closely track implementations and effect any course corrections necessary.

11.7 Keys to Successful Implementation

Although there is no single component that defines success, several factors, if implemented, will enhance your chances of a successful watershed implementation plan:

- Measurable goals and objectives
- Dedicated staff to carry out administrative duties
- Consistent, long-term funding
- Involvement of stakeholders in planning efforts
- Dedicated individuals who are supported by local government agencies
- Local ownership of the watershed plan
- A method for monitoring and evaluating implementation strategies
- Open communication between organization members.

From *A Quick Guide to Developing Watershed Plans* (US EPA, 2013).

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APPENDIX A

Water Quality Sampling Report

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EASTERN CONNECTICUT CONSERVATION DISTRICT, INC.

www.ConserveCT.org/eastern

Contract 17-04
Anguilla Brook Bacteria Trackdown
and Watershed-Based Plan

Eastern Connecticut Conservation District
January 28, 2020

Task 1d – Conduct Water Quality Sampling

This project is funded in part by CT DEEP through a US EPA Clean Water Act §319 Nonpoint Source Program grant.

Introduction

The Eastern Connecticut Conservation District (ECCD) has received funding from the Connecticut Department of Energy and Environmental Protection (CT DEEP) through the Clean Water Act Section 319 Nonpoint Source program to conduct water quality sampling of perennial steams in North Stonington and Stonington, Connecticut that discharge to Wequetequock Cove and develop a watershed-based plan for the Anguilla Brook watershed (Fig. 1).

Figure 1. The Anguilla Brook watershed, located in North Stonington and Stonington, CT. Subwatersheds are outlined in gray.

Wequetequock Cove is an embayment of Little Narragansett Bay, located at the outfall of the Pawcatuck River at the boundary between the States of Connecticut and Rhode Island. The Inner Wequetequock Cove estuary (CT_E1_003), located in Stonington, is listed in the State of Connecticut's biennial Integrated Water Quality Report to Congress as not meeting its designated uses for habitat for marine fish, other aquatic life and wildlife, recreation, and direct consumption of shellfish due to estuarine bioassessments, excess algal growth, and high levels of enterococcus and fecal coliform bacteria, respectively (CT DEEP, 2017). Potential pollutant sources include stormwater, agricultural activities, and other unidentified upstream sources.

ECCD conducted bacteria sampling from June to August of 2019. Sampled streams include Anguilla Brook (CT2101-00_01), Wheeler Brook (CT2101-01_01), an unnamed tributary to Wheeler Brook (CT32101-02_01), and Donahue Brook (CT2101-03_01). The purpose of the bacteria sampling was to quantify fecal bacteria levels in the streams in order to determine if watershed sources are contributing to fecal bacteria documented in Inner Wequetequock Cove. The bacteria data, along with other project data, will be used to develop a watershed-based plan for the Anguilla Brook watershed.

Procedure

Monitoring Plan and Quality Assurance Project Plan

ECCD developed a monitoring plan (Attachment A) for the Anguilla Brook bacteria trackdown in consultation with DEEP TMDL Program staff and a review and incorporation of recommendations made in the Stonington Estuary Bacteria Total Maximum Daily Load (TMDL) Summary (Appendix 12) (CT DEEP, 2013). The monitoring plan outlined the procedure that ECCD would use to conduct bacteria sampling and identified bacteria sampling sites. The monitoring plan was approved by CT DEEP on March 28, 2019. In order to ensure that water quality data would be collected using the generally accepted sample collection protocols, ECCD revised a previously approved Bacteria Sampling Quality Assurance Project Plan (QAPP) (Attachment B). ECCD received approval for the Bacteria Sampling QAPP (EPA Tracking # RFA 19088) from CT DEEP on 4/29/19 and EPA on 6/10/19.

Volunteer Recruitment and Training

In cooperation with The Last Green Valley Volunteer (TLGV) Water Quality Monitoring program, ECCD held a bacteria sampling workshop for water quality volunteers on May 20, 2019 at ECCD's Norwich office. Volunteers were solicited from among the Anguilla Brook Trackdown Project stakeholder group and the TLGV Water Quality Monitoring program. During the workshop, volunteers were trained in the sample collection method outlined in the Anguilla Brook Bacteria Sampling QAPP to ensure that all samples would be directly comparable.

Bacteria Sample Collection

Prior to the commencement of bacteria sample collection, ECCD identified eleven sites along the Anguilla Brook and its tributaries to be sampled (Table 1 and Fig. 2). The sampling sites were selected to quantify bacteria levels in watershed streams based in part on a review of local land use (Fig. 3). ECCD also considered recommendations made in the (Appendix 12) of *A Statewide Total Maximum Daily Load Analysis for Stonington Estuary Summary Bacteria Impaired Waters* (CT DEEP, 2012). The sampling sites were numbered sequentially, beginning with the designation of the downstream-most site on each stream as '01' and proceeding numerically upstream. Named tributaries were identified by their initials (e.g. Wheeler Brook was called 'WB'). The single unnamed tributary was designated as 'UN'. For example, the downstream-most site on Anguilla Brook was designated AB-01; the upstream-most site was designated AB-04, and the two additional sampling sites in between were designated AB-02 and AB-03.

Table **1.** Anguilla Brook Bacteria Trackdown project bacteria sampling sites.

Site ID	Stream Name	Location/Description
AB-01	Anguilla Brook	Off Trolley Crossing – at outlet of Wequetequock Pond. Downstream-most site; above salt-water limit
AB-02	Anguilla Brook	At RT 1 Handlebar Plaza – same as UConn PATH sampling site – downstream of agricultural and commercial uses
AB-03	Anguilla Brook	End of Anguilla Brook Road – downstream of residential, agriculture and recreational uses
AB-04	Anguilla Brook	AT RT 184 – upstream-most site; downstream of agricultural uses
DB-01	Donahue Brook	US of confluence with Oxocossett Brook above salt-water limit; downstream of agricultural uses; tributary to Wequetequock Cove
DB-02	Donahue Brook	At Barnes Road – upstream-most site
WB-01	Wheeler Brook	Upstream of the confluence with Anguilla Brook at end of Miner Pentway; downstream of agricultural uses
WB-02	Wheeler Brook	At Taugwonk Road –upstream of the confluence with Stony Brook; downstream of agricultural uses
WB-03	Wheeler Brook	At RT 184 – upstream-most site; downstream of residential use
UN-01	Unnamed stream	Upstream of confluence with Wheeler Brook; downstream of agricultural uses
UN-02	Unnamed stream	At Stony Brook Rd – upstream-most site

Water samples were collected once a week for ten weeks, beginning June 24th and ending August 26th, utilizing the QAPP protocols in accordance with the approved monitoring plan. Water samples were collected by hand or via an extension pole, using sterilized 125 ml Nalgene collection bottles provided by the CT Department of Public Health. In order to ensure quality control, on each sampling day one duplicate and one blank sample was collected for every ten samples. The locations of the duplicate and blank sample sites were determined using a random number generator. Duplicate samples were collected side-by-side to ensure they were accurately representative of the same water condition. Butterfield's buffer solution was used for the blank sample. Water samples were placed on ice in a cooler during the sampling process. Water samples were delivered to Ledge Light Health District (LLHD) in New London, CT., where they were picked up by a Connecticut Department of Public Health (DPH) courier and delivered to the DPH Laboratory in Rocky Hill, CT., for processing. Water samples from all the sampling sites were analyzed for *Escherichia coli* (E. coli). Additionally, water samples collected at the lowermost site on Anguilla Brook (AB-01), were analyzed for fecal coliform and Enterococcus. Bacteria analysis results were reported to Ledge Light Health District and relayed to ECCD by LLHD staff. Bacteria results were tabulated and evaluated by ECCD. Data was submitted to CT DEEP in October 2019 for consideration in DEEP's 2020 Integrated Water Quality Assessment.

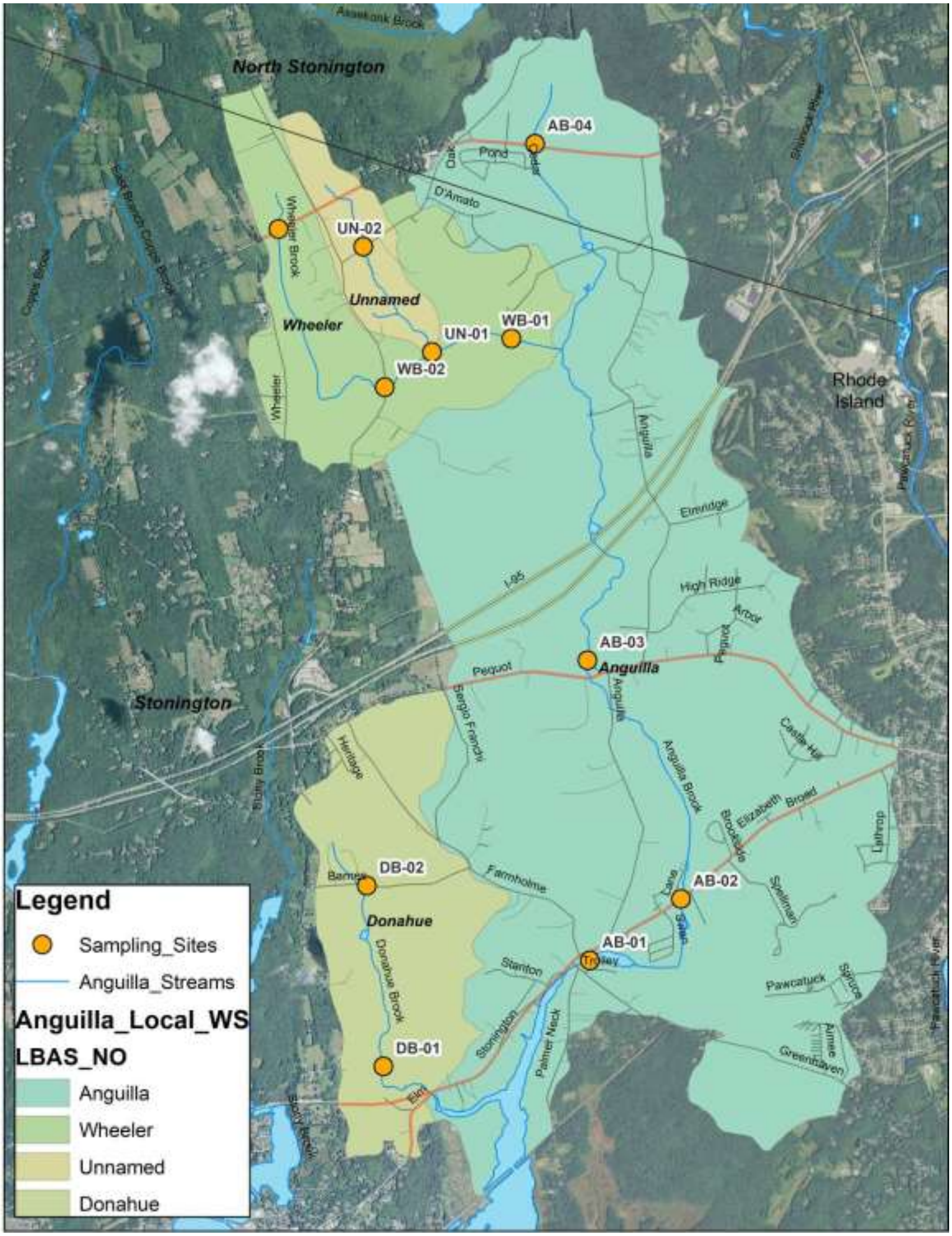


Figure 2. Fecal bacteria sampling sites in the Anguilla Brook watershed.

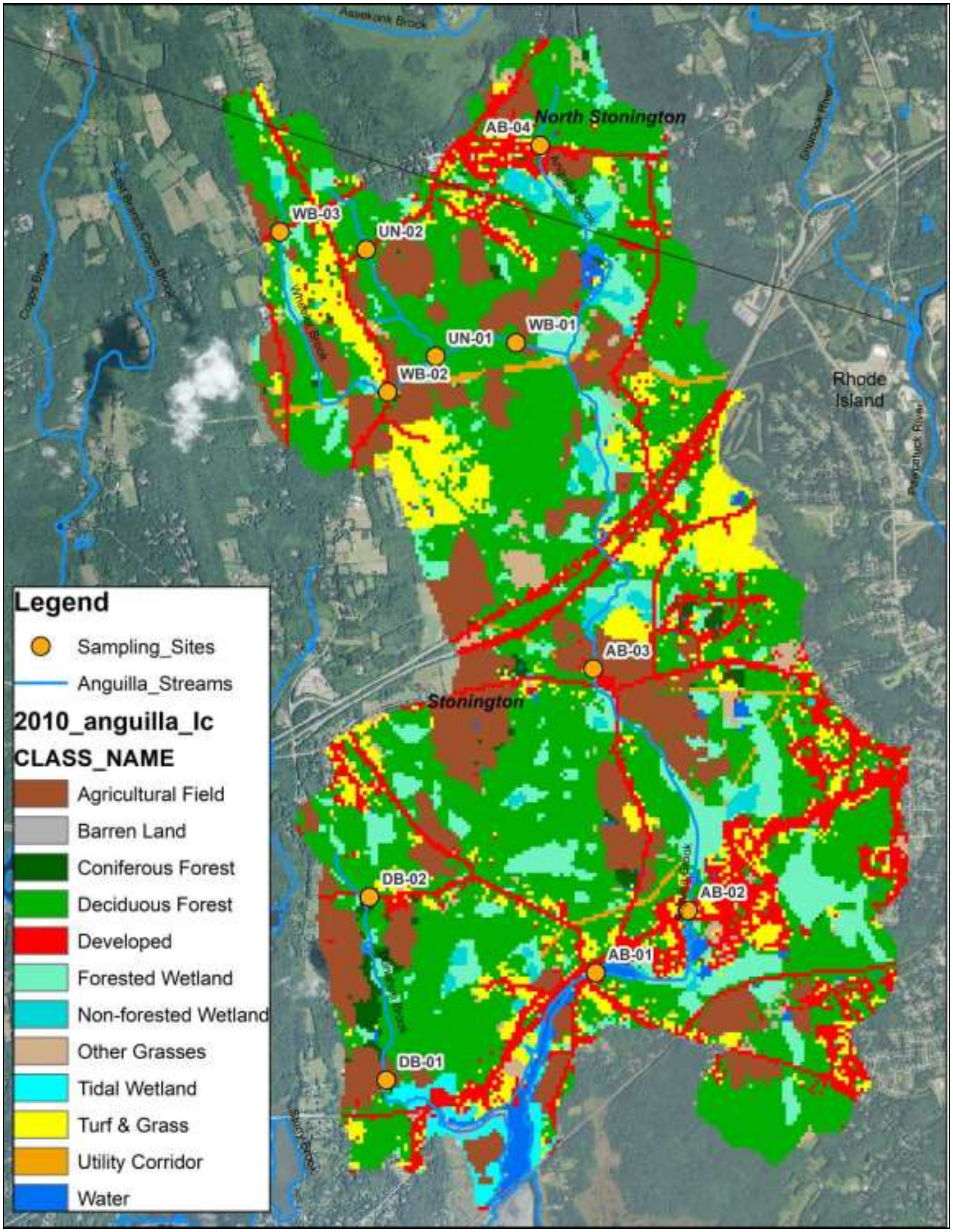


Figure 3. Land cover type and land use in the vicinity of the bacteria sampling sites (2010 land cover data from the Center for Landuse Education and Research, 2012).

Results

E. coli bacteria sampling results for Anguilla Brook and its tributary streams are summarized in Table 2. A geometric mean was calculated for each sample set. Bacteria levels listed in **bold** font in Table 2 exceed the established water quality limits. Bacteria samples with (D = *n*) indicate a duplicate sample was collected at that site on that sampling day. Table 2 also notes whether the sample was collected during wet (a rainfall in excess of 0.1 inches within 24 hours) or dry conditions. Bacteria results are graphically depicted in Figure 4. A simple statistical distribution of the *E. coli* bacteria sampling results was prepared, using a box and whicker plot of the data set (Fig. 5).

For comparison to established water quality standards, the 2012 Connecticut Water Quality Standards for freshwater is presented in Fig. 6. *Escherichia coli* is the preferred indicator bacteria for freshwater sampling. Indicator bacteria are easily quantified surrogates for other, more harmful bacteria and pathogens that may be present in water. The designated use for this project was *Recreation – all other uses*. Water quality criteria for that use are a single sample maximum of 576 colony-forming units (cfu) per 100 milliliters of water and a maximum sample set geometric mean of less than 126 cfu/100 ml.

In saltwater, fecal coliform is the indicator bacteria for the consumption (direct and indirect) of shellfish, and enterococcus is the indicator bacteria for recreation. Fecal coliform and enterococcus bacteria results from site AB-01 are presented in Table 3. There are no water quality criteria for fecal coliform or enterococcus in freshwater; these data were collected to determine if freshwater sources contributed to bacteria levels in the estuary. However, for reference, the Connecticut Water Quality Standards for saltwater are presented in Fig. 7.

Summaries of bacteria sampling results for each individual sampling site are provided below, following Figure 7.

Table 2. Anguilla Brook watershed *E. Coli* bacteria sampling results.

E. coli (MPN/100 ml[1])											
Site	6/24/19	7/1/19	7/8/19	7/15/19	7/22/19	7/29/19	8/5/19	8/12/19	8/19/19	8/26/19	Geomean
AB01	98	160	31	41 (10)	31	130	10	41 (<10)	280	31	42
AB02	180	110	120 (180)	75	95	170	63	52	540	74	119
AB03	150	150	96	160	200	97	20	52	420	86 (75)	106
AB04	120	400	**2,200**	280	420	41	52 (41)	<10	52	41	108
WB01	*DNS*	260	85	63	**20,000**	210	270	<10	510	10	**163**
WB02	120	200 (170)	220	260	230	200 (86)	51	**1,300**	450	310	**213**
WB03	250	460	110	**590**	**3,700**	250	86	290	**1,100**	96	**336**
UN01	31 (41)	63	260	180	96 (85)	31	52	52	340	20	71
UN02	74	52	63	120	130	62	20	*DNS*	360	360	95
DB01	*DNS*	97	**4,400**	310	260	120	86	170	**1,700**	280	**313**
DB02	97	180	110	*DNS*	*DNS*						124
DB02a[2]						98	260	**1,400**	350 (380)	52	**250**
Wet/ Dry	dry	wet	dry	dry	dry	dry	dry	dry	wet	dry	

Notes: [1]MPN/100 ml - E. coli is measured as the most probable number (MPN) of colonies per 100 ml water sample

[2] Two branches of Donahue Brook emerged from a wooded wetland/stream complex north of Barnes Road. The west branch dried up; sampling switched to the east branch which had adequate flow.

DNS - did not sample

Number in parentheses is a duplicate sample collected for quality control purposes

Single sample limit for E. coli is 576 colony-forming units (CFU)/100 ml - CFU = MPN

Geometric mean limit is <126 CFU/100 ml

Table 3. Site AB01 Enterococcus and fecal coliform bacteria data.

Date	Enterococcus (MPN/100 ml)	Fecal Coliform (MPN/100 ml)
6/24/2019	97	110
7/1/2019	41	200
7/8/2019	20	10
7/15/2019	<10 (10)	41 (20)
7/22/2019	41	31
7/29/2019	52	52
8/5/2019	74	31
8/12/2019	10 (10)	<10 (41)
8/19/2019	**300**	428
8/26/2019	<10	31
Water Quality Standards Criteria	Single sample limit: 104/100ml	90% of sample less than 31/100ml = 50%
	Geomean: less than 35/100ml = 29	Geomean: less than 14/100ml = 44

Notes: MPN/100 ml – Fecal coliform and enterococcus are measured as the most probable number (MPN) of colonies per 100 ml water sample.

The number in parentheses is a duplicate sample collected for quality control purposes.

Enterococcus is the indicator bacteria for the consumption (direct and indirect) of shellfish.

Fecal coliform is the indicator bacteria for recreation.

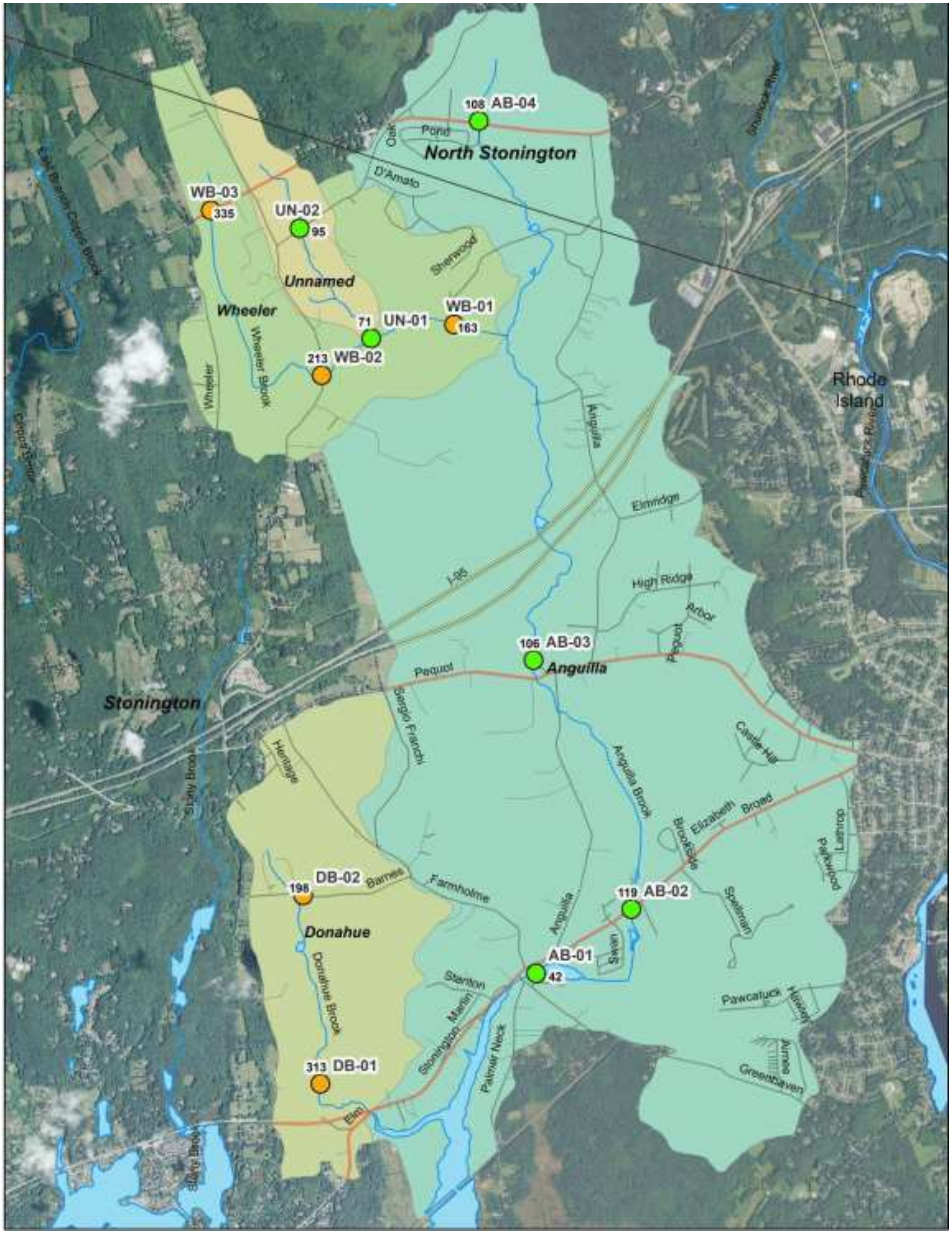


Figure 4. Anguilla Brook watershed *E. coli* bacteria sampling results. A green dot indicates the site met established water quality criteria for the geometric mean; an orange dot indicates that the site failed to meet the geometric mean criteria.

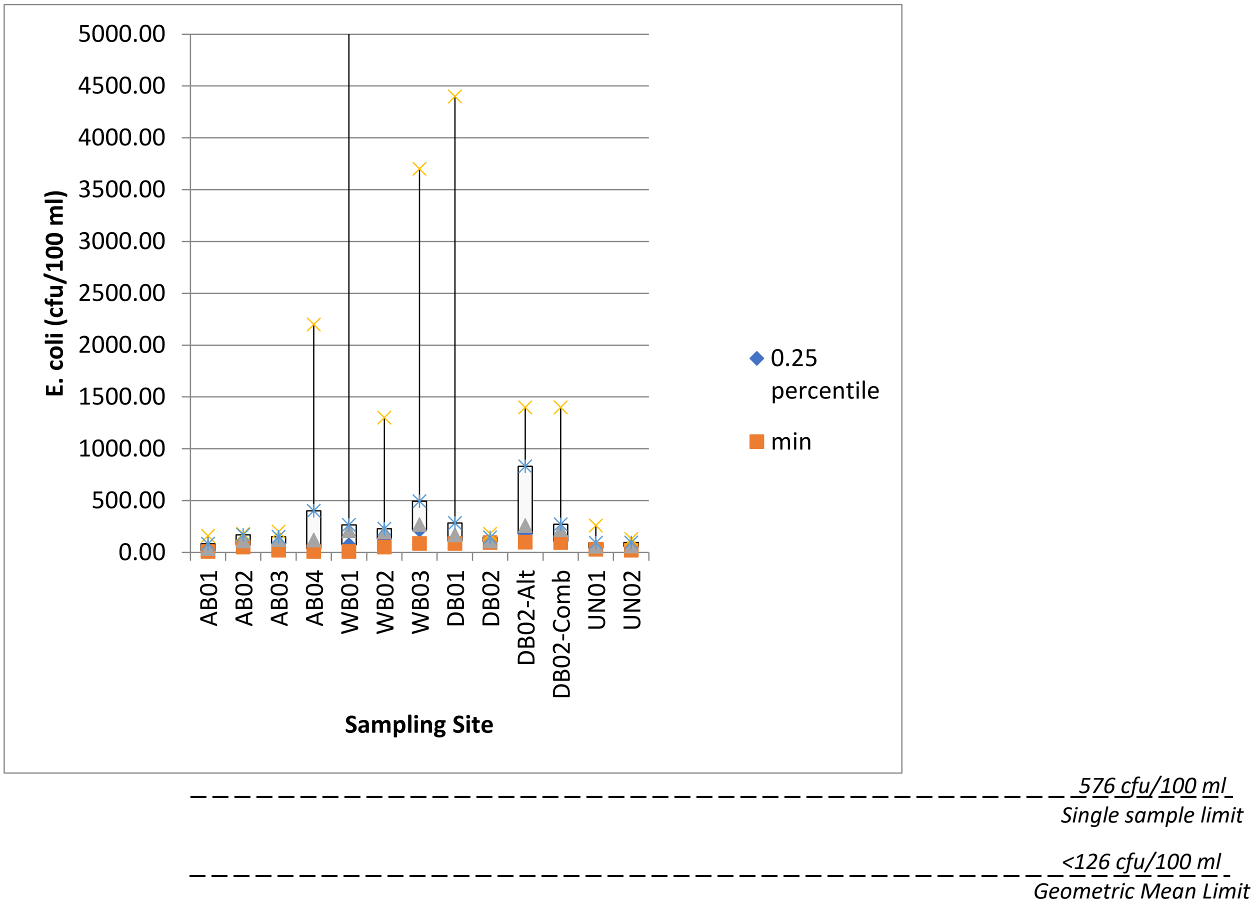


Figure 5. Statistical distribution of bacteria results by sampling site.

Designated Use	Indicator	Criteria by classification				
		AA	**A**	**B**	**SA**	**SB**
Drinking water supply[1]	Total Coliform	Monthly moving average less than 100/100 ml Single sample maximum 500/100 ml				
Recreation[2][3] **– Designated swimming**[4]	Escherichia coli	Geometric mean less than 126/100 ml Single sample maximum 235/100 ml				
Recreation[2][3] **– Non Designated Swimming**[5]	Escherichia coli	Geometric mean less than 126/100 ml Single sample maximum 410/100 ml				
Recreation[2][3] **– All other uses**	Escherichia coli	Geometric mean less than 126/100 ml Single sample maximum 576/100 ml				

Figure 6. Indicator Bacteria for Freshwater (CT Water Quality Standards, CT DEEP, 2012).

Designated Use	Indicator	Criteria by classification				
		AA	A	B	SA	SB
Shell fishing[6] **– Direct Consumption**	Fecal coliform				Geometric mean less than 14/100 ml 90% of samples less than 31/100 ml	
Shell fishing[6] **– Indirect consumption**	Fecal coliform					Geometric mean less than 88/100 ml 90% of samples less than 260/100 ml
Recreation - Designated swimming[4]	Enterococci				Geometric mean less than 35/100ml Single sample maximum 104/100 ml	
Recreation – All other uses	Enterococci				Geometric mean less than 35/100 ml Single sample maximum 500/100 ml	

Figure 7. Indicator Bacteria for Saltwater (CT Water Quality Standards, CT DEEP, 2012).

Bacteria Sampling Results by Sampling Site

<u>AB01 – Anguilla Brook at the outlet of Wequetequock Pond:</u>

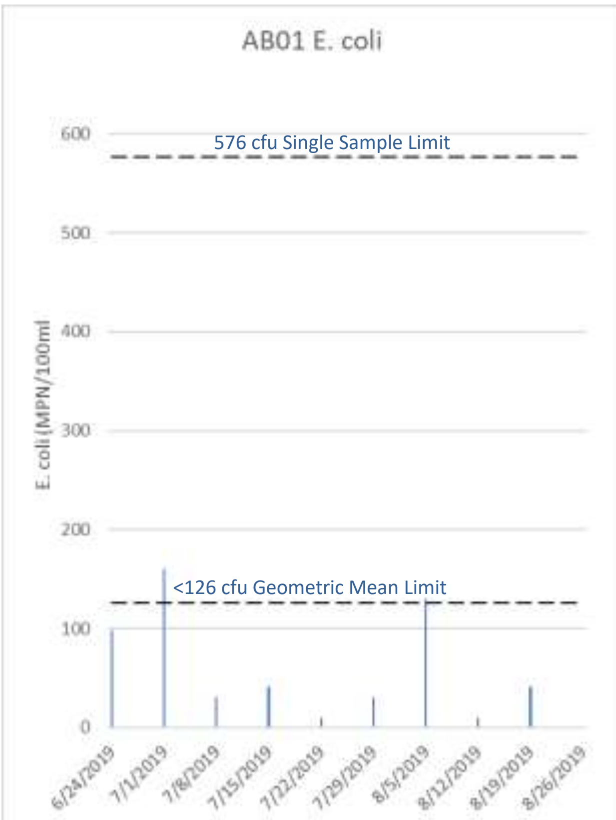


Figure 8. Graph of bacteria sampling results at AB01; upstream view of Anguilla Brook at the sampling location; and an aerial (Google Earth) image of the sampling site location and vicinity.

AB01 is located at the outlet of Wequetequock Pond (aka Cheeseborough Pond), upstream of the saltwater limit of Anguilla Brook. This is the downstream-most sampling site on Anguilla Brook and is located approximately 760 feet upstream of the top of Wequetequock Cove. This site was selected to document bacteria levels in Anguilla Brook prior to its discharge into Wequetequock Cove. Nearby land cover includes residential and commercial uses.

Twelve water samples were collected and analyzed for *E. coli* at this site, including two duplicates. All of the *E. coli* samples met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 42, which is within the allowable geometric mean of less than 126 cfu/100 ml. No bacteria reduction is required at this site.

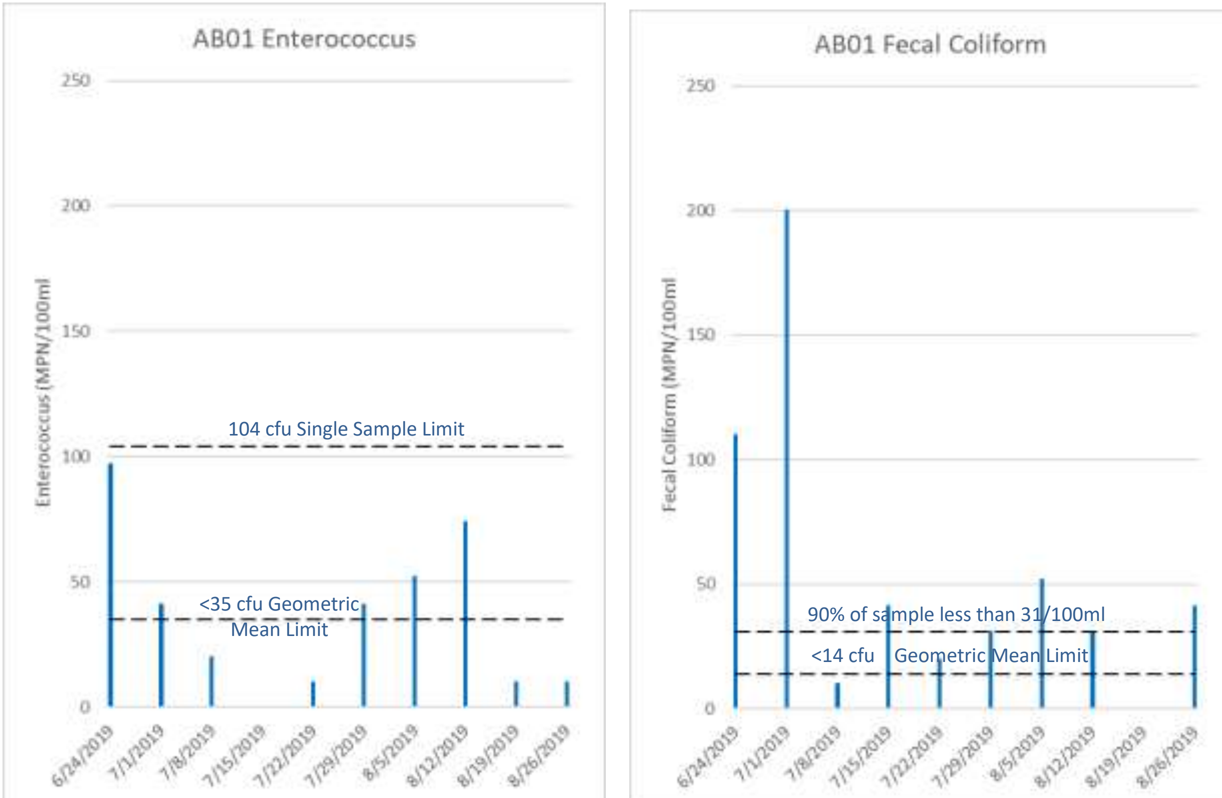


Figure 9. Graphs of enterococcus and fecal coliform bacteria sampling results at AB01.

In order to determine if terrestrial sources from the Anguilla Brook watershed were contributing to bacteria levels that have been documented in Wequetequock Cove by CUSH and others, water samples collected at AB01 were analyzed for enterococcus and fecal coliform in addition to *E. coli.* Although there is no protocol for the analysis of either bacteria in freshwater samples, the presence of either or both could indicate that terrestrial sources are contributing to the bacteria loading of Wequetequock Cove.

Eleven of the twelve samples analyzed for enterococcus, the indicator bacteria for recreation in saltwater, met the single sample water quality limit of 104 cfu/100ml. The geometric mean of the sample set was 29 cfu/100ml, which is within the allowable geometric mean of 35 cfu/100 ml.

There is no single sample limit for fecal coliform, the indicator bacteria for the consumption of shellfish. Instead, 90% of the sample must be less than 31 cfu/100ml. Six of the twelve samples (50%) analyzed for fecal coliform exceeded the standard of 31 cfu/100ml. The sample set exceeded the geometric mean limit of less than 14 cfu/100ml at 44 cfu/100ml.

AB02 – Anguilla Brook at State Route 1:

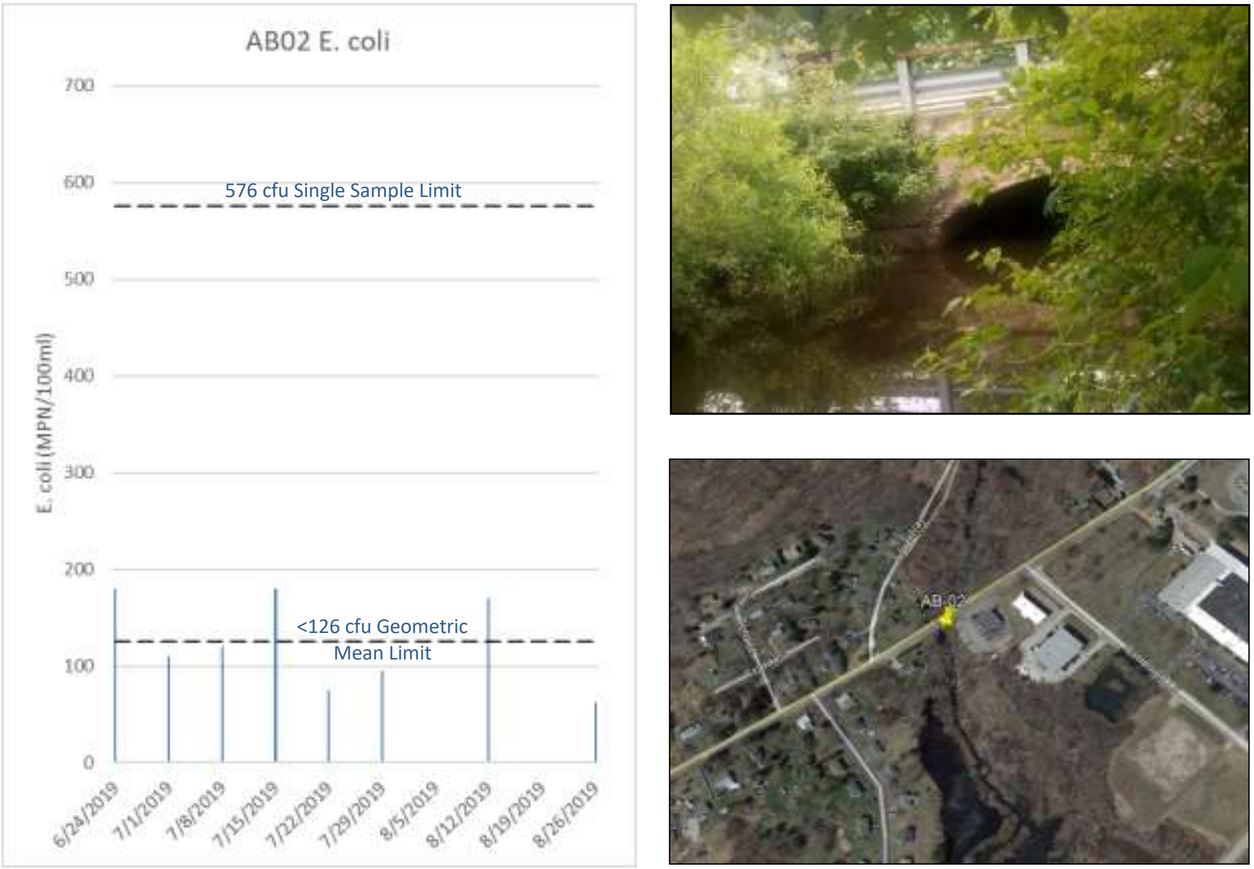


Figure 10. Graph of bacteria sampling results at AB02; upstream view of Anguilla Brook (towards RT 1) at the sampling location; and an aerial image of the sampling site location and vicinity.

AB02 is located at the downstream side of the crossing of Anguilla Brook and South Broad Street (State Route 1), at the Handlebar Plaza. This site is downstream of a forested wetland and agricultural and commercial uses. Bacteria samples were collected at this site by the University of Connecticut in 2017 for an NRCS Regional Conservation Partnership Program project (PATH to Reduce Pathogens in CT Agricultural Runoff).

Eleven water samples were collected at this site, including one duplicate sample. All of the samples (100%) met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 119, which is within the allowable geometric mean of less than 126 cfu/100 ml. No bacteria reduction is required at this site.

AB03 – Anguilla Brook at Anguilla Brook Road:

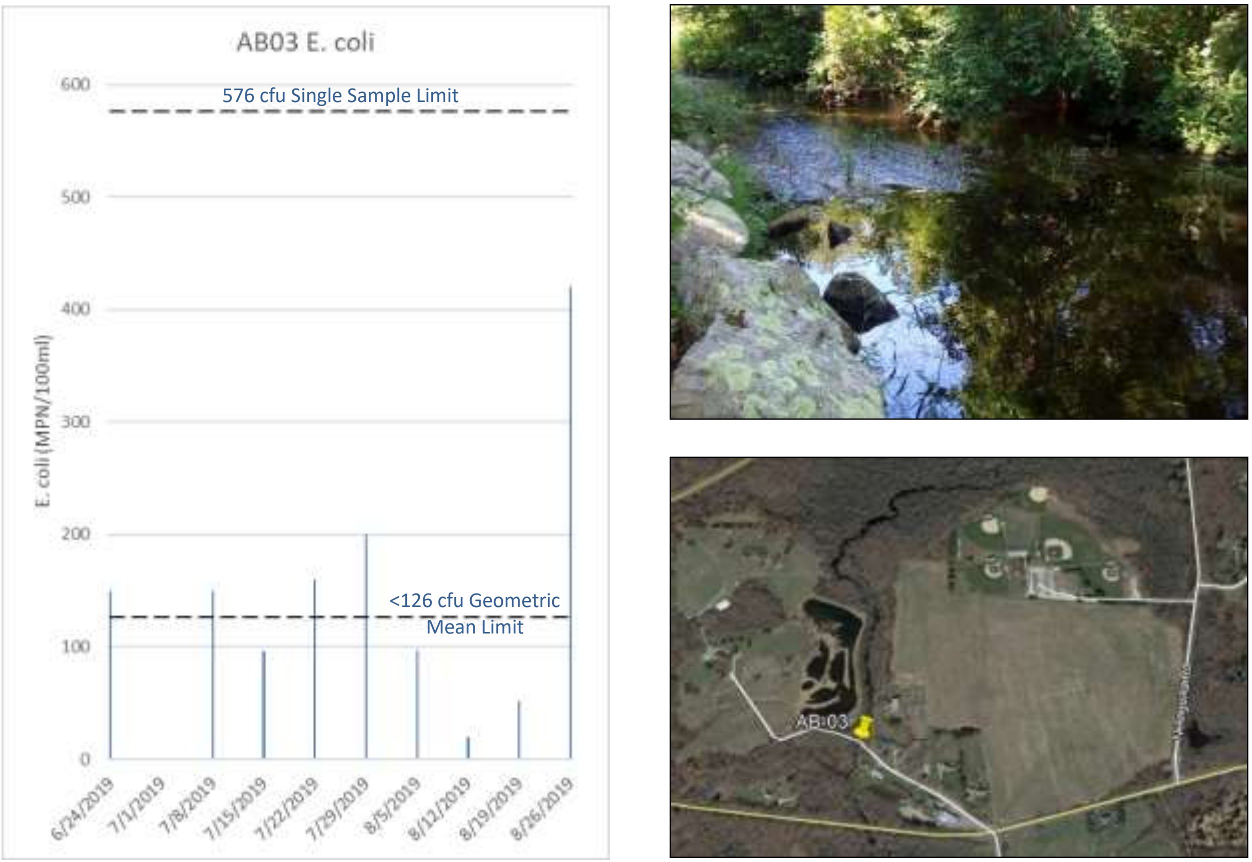


Figure 11. Graph of bacteria sampling results at AB03; downstream view of Anguilla Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

AB03 is located on Anguilla Brook at the end of Anguilla Brook Road. This site is downstream of a forested wetland and residential, agricultural and recreational uses.

Eleven water samples were collected at this site, including one duplicate sample. All of the samples (100%) met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 106, which is within the allowable geometric mean of less than 126 cfu/100 ml. No bacteria reduction is required at this site.

AB04 – Anguilla Brook at State Route184:

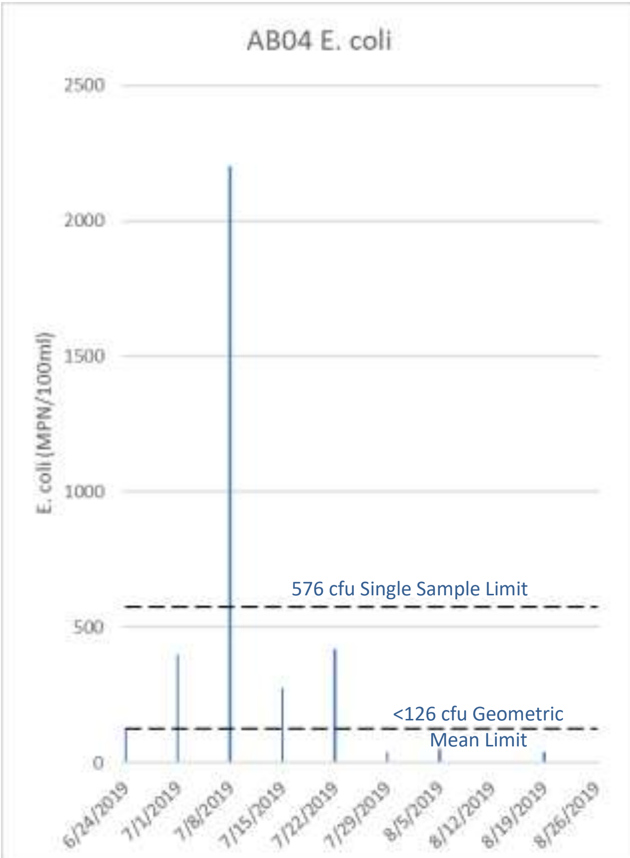


Figure 12. Graph of bacteria sampling results at AB04; upstream view of Anguilla Brook at Route 184 and an aerial image of the sampling site location and vicinity.

AB04 is located at the downstream side of the crossing of Providence-New London Turnpike (State Route 184). This is the upstream-most sampling site on Anguilla Brook and is located just south of a forested wetland which forms the Anguilla Brook headwaters. Land cover upstream of this site is comprised primarily of forest land, with a small amount of agricultural land.

Eleven water samples were collected at this site, including one duplicate sample. Ten of the eleven samples (91%) met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 108, which is within the allowable geometric mean of less than 126 cfu/100 ml. No bacteria reduction is required at this site.

WB01 – Wheeler Brook off Miner Pentway:

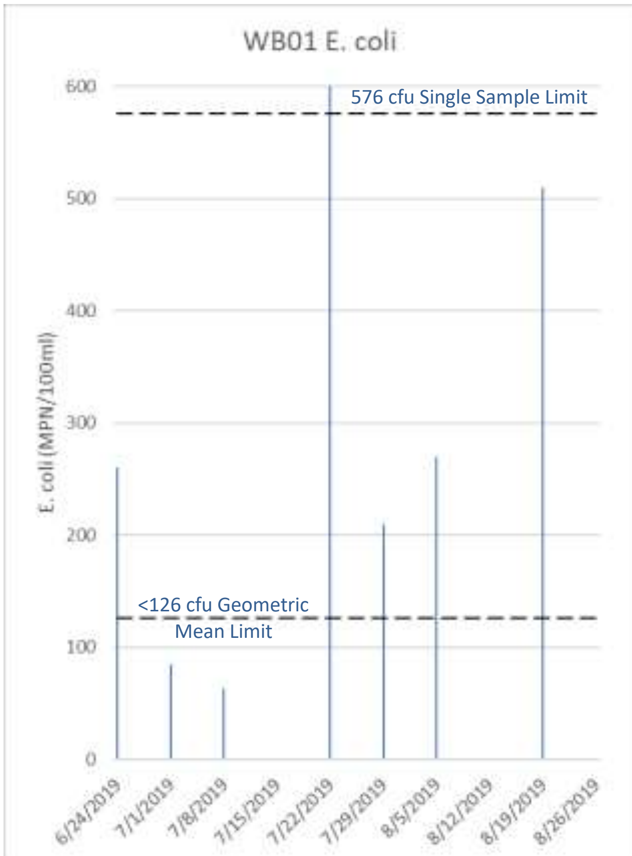


Figure 13. Graph of bacteria sampling results at WB01; upstream view of Wheeler Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

WB01 is located approximately 1,400 feet upstream of the confluence with Anguilla Brook off Miner Pentway. Upstream land cover/uses include forest land and agriculture.

Nine water samples were collected at this site. Eight of the samples (89%) met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 163, which exceeds the allowable geometric mean of less than 126 cfu/100 ml. A 23% bacteria reduction is required at this site.

WB2 – Wheeler Brook at Taugwonk Road:

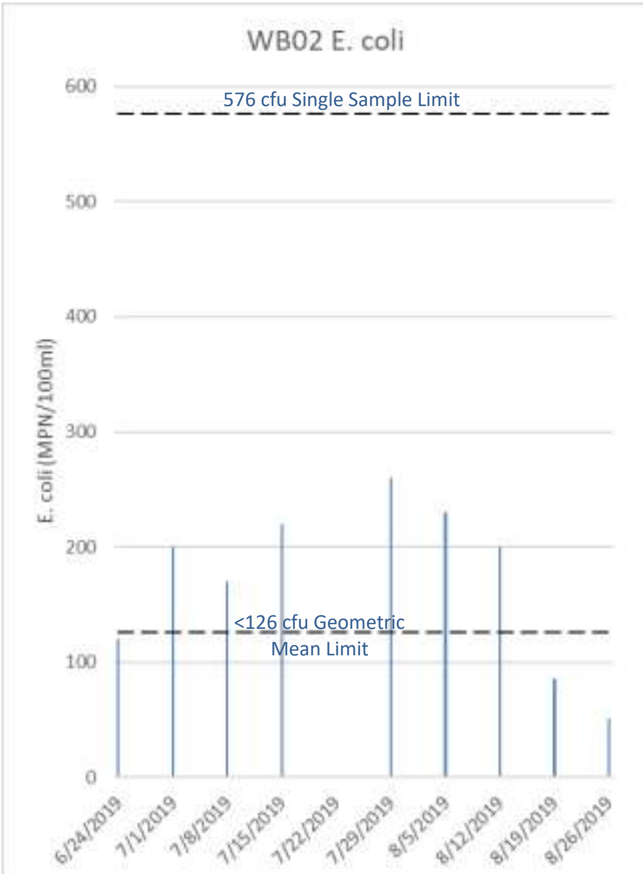


Figure 14. Graph of bacteria sampling results at WB02; downstream view of Wheeler Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

WB02 is located at the downstream side of the crossing of Wheeler Brook at Taugwonk Road. This site is approximately halfway along the length of Wheeler Brook and is downstream of forest and agricultural uses.

Twelve water samples were collected at this site, including two duplicates. Eleven of the samples (92%) met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 213, which exceeds the allowable geometric mean of less than 126 cfu/100 ml. A 41% bacteria reduction is required at this site.

WB03 – Wheeler Brook at State Route 184:

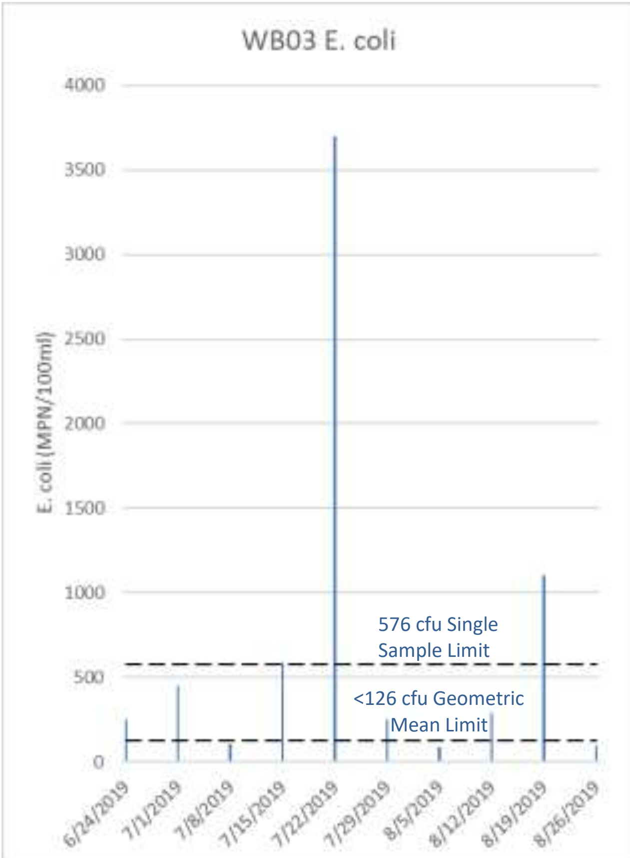
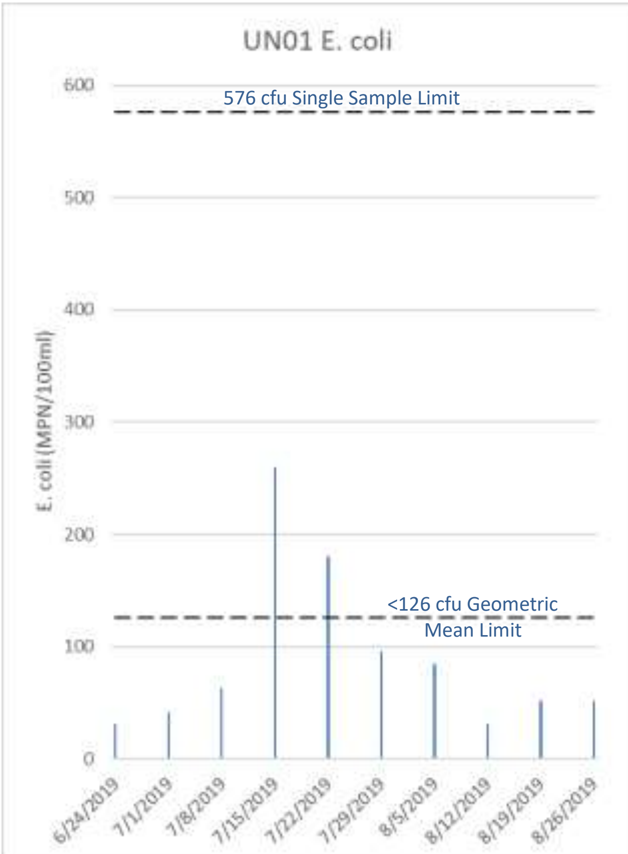


Figure 15. Graph of bacteria sampling results at WB03; downstream view of Wheeler Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

WB03 is located downstream of the Providence-New London Turnpike (State Route 184) crossing of Wheeler Brook. This is the upstream-most site on Wheeler Brook approximately 1,000 feet downstream of the Wheeler Brook headwaters. The surrounding area is rural residential, agricultural and forested.

Ten water samples were collected at this site. Seven of the samples (70%) met the Connecticut water quality standard of 576 cfu/100ml for single samples. The geometric mean for this site is 335, which exceeds the allowable geometric mean of less than 126 cfu/100 ml. A 62% bacteria reduction is required at this site.

UN01– Unnamed brook off Taugwonk Road:



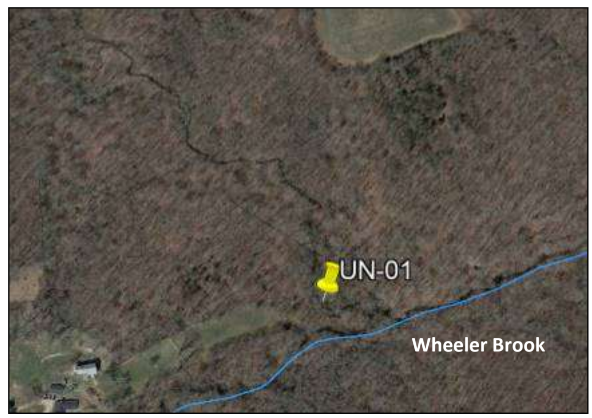


Figure 16. Graph of bacteria sampling results at UN01; upstream view of the unnamed tributary to Wheeler Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

UN01 is the downstream-most sampling site on an unnamed brook that originates in a wetland north of State Route 184. The stream is a tributary to Wheeler Brook. UN01 is located approximately 200 feet upstream of the confluence with Wheeler Brook. Land cover upstream of UN01 is primarily forested with rural residential and agricultural uses.

Twelve water samples were collected at this site, including two duplicate samples. All the samples (100%) met the single sample Connecticut water quality standard of 576 cfu/100ml. The geometric mean for this site is 71, which is within the allowable geometric mean of less than 126 cfu/100 ml. No bacteria reduction is required at this site.

UN02 – Unnamed brook at Stony Brook Road:

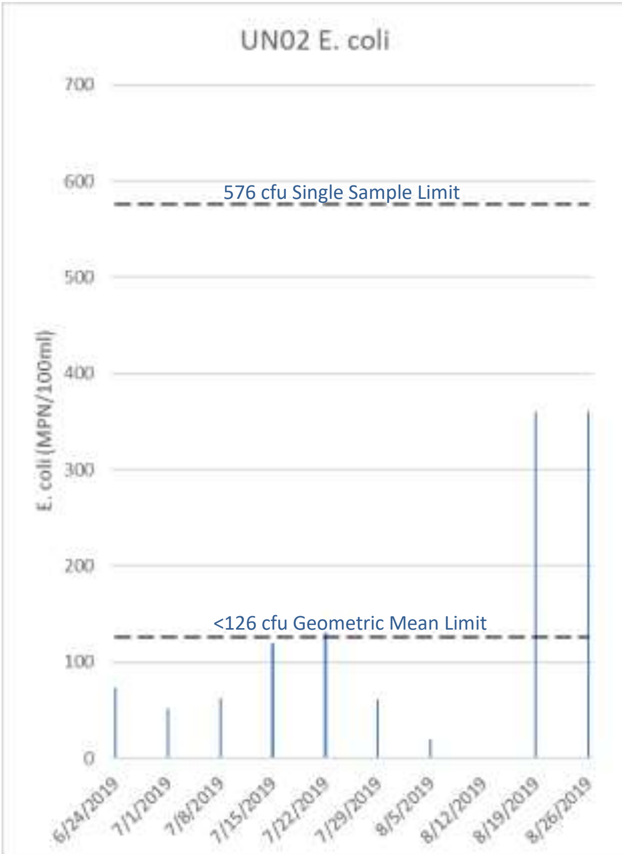


Figure 17. Graph of bacteria sampling results at UN02; downstream view of the unnamed tributary to Wheeler Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

UN02 is located at the downstream crossing of the unnamed tributary to Wheeler Brook at Stony Brook Road. Land-use upstream of UN02 is primarily forest with scattered rural residential land use.

Nine water samples were collected at this site. All the samples (100%) met the Connecticut water quality standard of 576 cfu/100ml for single samples. The geometric mean for this site is 95, which is within the allowable geometric mean of less than 126 cfu/100 ml. No bacteria reduction is required at this site.

DB01 – Donahue Brook at 711 Stonington Road:

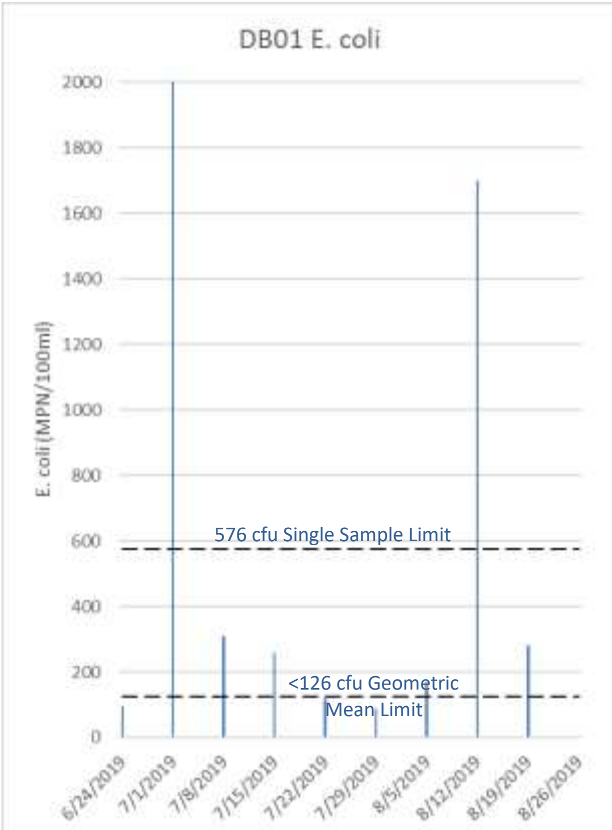


Figure 18. Graph of bacteria sampling results at DB01; downstream view of Donahue Brook at the sampling location; and an aerial image of the sampling site location and vicinity.

DB01 is located upstream of the saltwater limit along Donahue Brook, approximately 1,425 feet upstream of the confluence with Oxocosset Brook. Oxocosset Brook is a tributary to Wequetequock Cove. Land cover upstream of DB01 includes forest and agricultural uses.

Nine water samples were collected at this site. Seven samples (78%) met the Connecticut water quality standard of 576 cfu/100 ml for single samples. The geometric mean for this site is 313, which exceeds the allowable geometric mean of less than 126 cfu/100 ml. A 60% bacteria reduction is required at this site.

DB02/DB02a– Donahue Brook at Barnes Road:

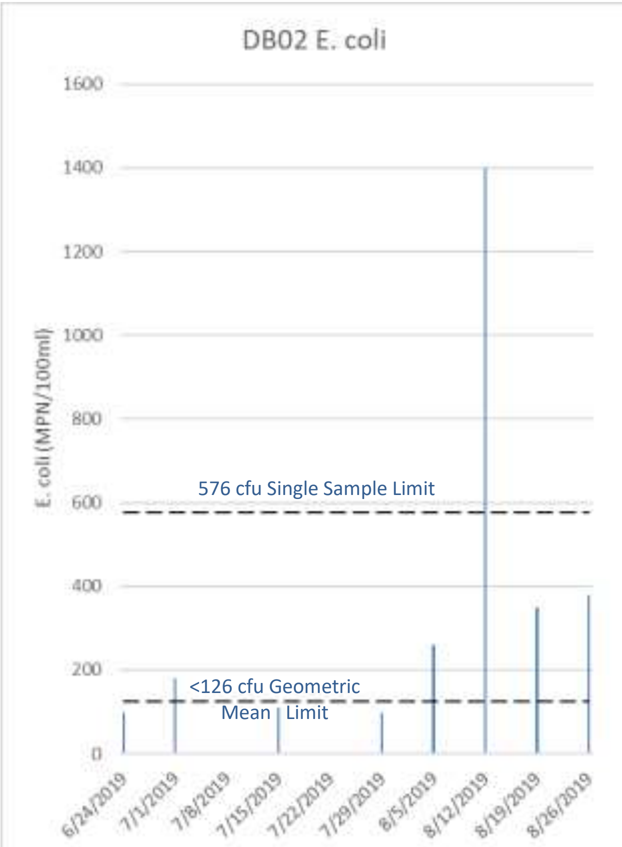


Figure 19. Graph of bacteria sampling results at DB02; view of Donahue Brook downstream of the sampling site; and an aerial image of the sampling site locations and vicinity.

DB02 and DB02a are located along Donahue Brook on the downstream side of the Barnes Road crossing. DB02 drains the east side of a forested wetland located north of Barnes Road. DB02a is located approximately 300 feet west of DB02, and drains the west side of the same forested wetland. The two branches of Donahue Brook rejoin approximately 300 feet downstream of the road crossing. Sampling commenced at DB02a on 7/29/19 when diminished flow at DB02 made sampling at the site not possible.

Since both sites discharged from the same forested wetland, the bacteria results were combined. Nine water samples were collected at this site, including one duplicate sample. Eight of the samples (89%) met Connecticut water quality standard of 576 cfu/100 ml for single samples. The geometric mean for this site is 198, which is exceeds the allowable geometric mean of less than 126 cfu/100 ml. A 36% bacteria reduction is required at this site.

Discussion

E. coli bacteria levels in Anguilla Brook and an unnamed tributary to Wheeler Brook met Connecticut water quality standards for their designated recreational use, while Wheeler Brook and Donahue Brook failed to meet Connecticut water quality standards for their designated recreational use. All sampling sites on Wheeler and Donahue Brooks failed to meet the geometric mean for recreation (less than 126 cfu/100 ml) and all sampling sites except for WB02 had one or more single sample exceedances. A brief analysis of enterococcus and fecal coliform bacteria levels at AB01 indicates that while enterococcus levels were within allowable levels established by the Connecticut Water Quality Standards, fecal coliform levels exceeded allowable levels. While fresh water flowing into Wequetequock Cove from the Anguilla watershed may not be contributing significant levels of enterococcus to the Cove, it is possible that unidentified terrestrial sources in the watershed may be contributing to the fecal coliform load.

A review of the *E. coli* bacteria results under dry and wet (rainfall of 0.1 inch or more within 24 hours of the sampling period) conditions (Fig. 20) indicates that bacteria levels generally increased after rainfalls, although the increases varied by site and in most cases did not exceed the single sample limit of 576 cfu/100ml. Over the ten-week sampling period, two samples were collected during wet periods. Westerly State Airport, which is located approximately 4.5 miles from the Anguilla watershed, documented 0.12 inches of rain on 7/01/19 and 1.71 inches of rain on 8/18/19. Elevated bacteria levels are noted on 7/1/19 and 8/19/19 on Figure 20. In general, an increase in bacteria levels after rainstorms indicates that stormwater runoff rather than baseflow (groundwater) is a more significant vector for the mobilization of non-point source pollution including fecal bacteria into waterways.

There are several high dry weather data points on Figure 20, including results associated with AB04 and DB01 (on 7/8/19), WB03 (on 7/22/19), and WB02 and DB02 (on 8/12/19). An additional data point of 20,000 cfu/100ml at WB01 on 7/22/19 is not depicted on Figure 20. It is difficult to determine if those results are representative of water quality conditions or are the result of sampler error related to low water levels due to the general lack of rain over the sampling period. Because these high dry weather data points were not repeated at any of the sites, it is not likely that they are indicative of high levels of bacteria in baseflow.

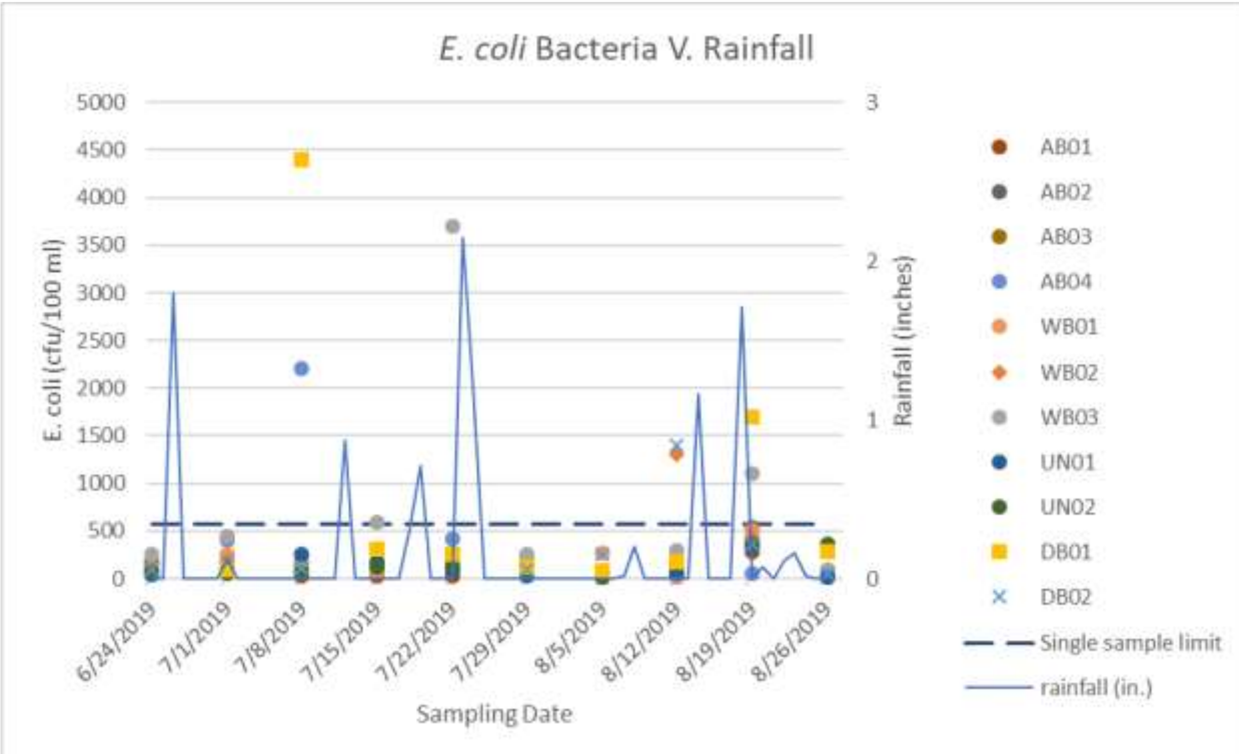


Figure 20. Plot of E. coli levels (cfu/100 ml) at each sampling site versus recent rainfall (inches).

In order to compare wet weather to dry weather stream bacteria levels, wet and dry weather *E. coli* averages were calculated (Table 4). To account for potential sampler error, an adjusted dry weather average, which excludes the outliers identified in Figure 20, was calculated. In general, wet weather *E. coli* averages were greater than dry weather levels, again indicating that stormwater is the most likely source of fecal bacteria in the streams.

Table 4. Comparison of wet weather to dry weather *E. coli* averages (cfu/100ml) for each sampling site.

	AB01	AB02	AB03	AB04	WB01	WB02	WB03	UN01	UN02	DB01	DB02
Wet weather average	220	325	285	226	385	318	775	202	206	899	273
Dry weather average	48	107	107	395	2,581	329	672	90	104	703	252
Adjusted dry weather average*				137	108	191	239			204	123

* Outliers were removed from the calculation of the dry weather average to eliminate potential sampler error.

Non-point source pollution (NPS) is the type of pollution most associated with stormwater runoff. NPS is composed of a wide variety of pollutants distributed across the ground surface that are immobile until they are mobilized by rain or snowmelt and transported into nearby waterways. NPS includes sediment, lawn and garden chemicals, vehicular chemicals, trash, yard waste, animal waste/manure, and underperforming or failing septic systems.

A review of land cover and landuse in the Wheeler Brook and Donahue Brook watersheds (Figure 21) indicates several potential sources of fecal bacteria. These include agricultural and residential land uses (brown and yellow areas, respectively). Agricultural activities that could contribute to bacteria loads includes the stockpiling of manure, the spreading of manure on agricultural fields and manure produced by grazing livestock. Bacteria in residential areas could derive from pet waste, manure from backyard livestock such as chickens, and effluent from underperforming or failing septic systems.

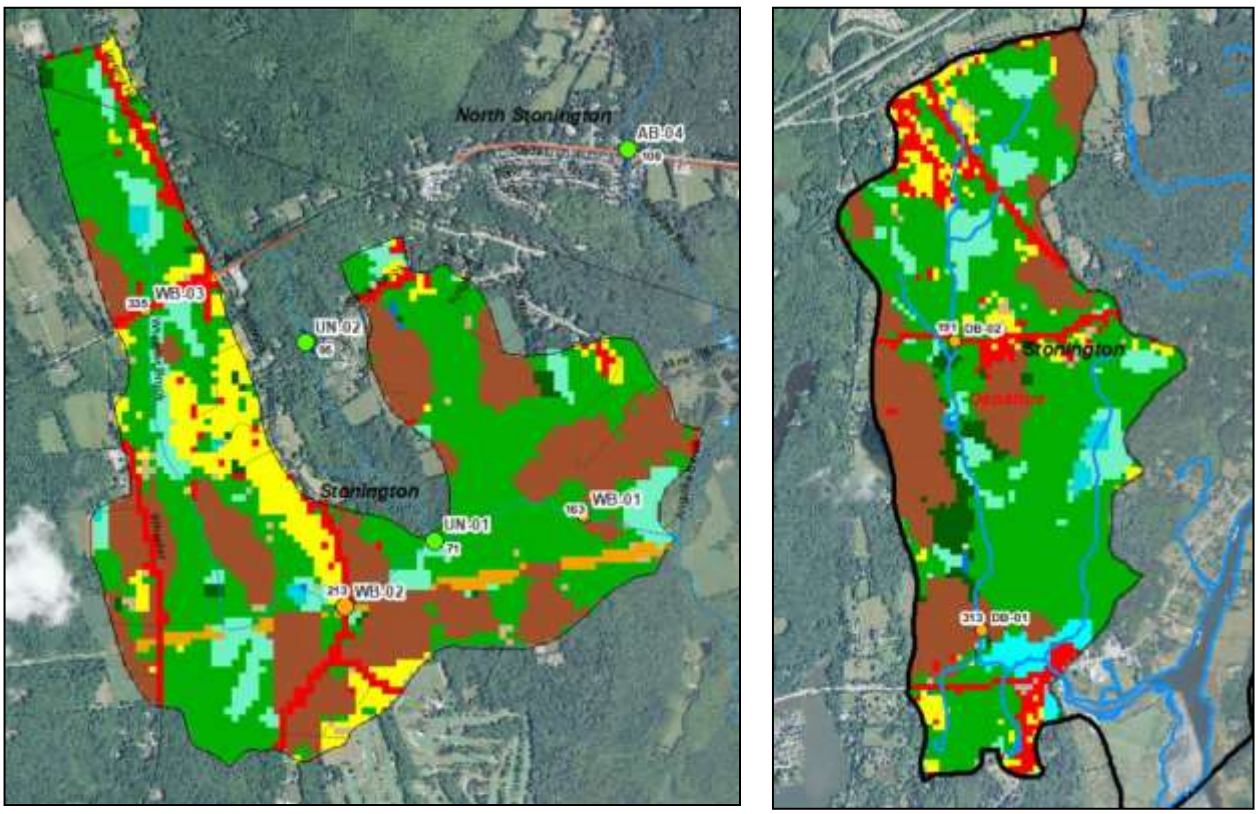


Figure 21. Bacteria sampling sites relative to land use in the Wheeler Brook watershed (left) and Donahue Brook watershed (right). Geometric means for each site are depicted next to the site identification code. Green indicates forest, aqua indicates forested wetlands, blue indicates open water, yellow indicates turf grass such as lawns or athletic fields, brown indicates agricultural fields, red indicates impervious surfaces such as roads, parking lots or large buildings, and orange indicates utility rights-of-way (CLEAR, 2012).

Conclusion

From June to August of 2019, ECCD and TLGV water quality monitoring volunteers collected water samples from eleven sites along Anguilla Brook and its tributaries in Stonington and North Stonington, Connecticut. The water samples were analyzed by the CT Department of Public Health's Microbiology Laboratory for fecal bacteria (*E. coli*, enterococcus and fecal coliform) content. A review of the bacteria data indicates that Wheeler Brook (CT3300-10) and Donahue Brook (CT3300-05) do not currently meet State of Connecticut water quality standards for recreational use and that the watershed may be a source of fecal coliform to Wequetequock Cove. A comparison of *E. coli* data to rainfall records collected by the Westerly State Airport indicates that that stormwater runoff rather than baseflow may be a more significant vector for the mobilization of fecal bacteria in the Anguilla Brook watershed. ECCD will incorporate the results of the Anguilla Brook bacteria sampling into the development of a watershed management plan for the Anguilla Brook watershed.

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APPENDIX B

Stream Corridor Assessment Report

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EASTERN CONNECTICUT CONSERVATION DISTRICT, INC.

www.ConserveCT.org/eastern

Contract 17-04
Anguilla Brook Bacteria Trackdown
and Watershed-Based Plan

Eastern Connecticut Conservation District
January 28, 2020

Visual Stream Corridor Assessments (Task 1e)

This project is funded in part by CT DEEP through a US EPA Clean Water Act §319 Nonpoint Source Program grant.

Introduction

The Eastern Connecticut Conservation District (ECCD) has received funding from the Connecticut Department of Energy and Environmental Protection (CT DEEP) through the Clean Water Act Section 319 Nonpoint Source program to conduct water quality sampling of perennial steams in North Stonington and Stonington, Connecticut that discharge to Wequetequock Cove and develop a watershed-based plan for the Anguilla Brook watershed (Fig. 1).

Figure 1. The Anguilla Brook watershed, located in North Stonington and Stonington, CT. Sub-watersheds are outlined in gray.

Wequetequock Cove is an embayment of Little Narragansett Bay, located at the outfall of the Pawcatuck River at the boundary between the States of Connecticut and Rhode Island. The Inner Wequetequock Cove estuary (CT_E1_003), located in Stonington, is listed in the State of Connecticut's biennial Integrated Water Quality Report to Congress as not meeting its designated uses for habitat for marine fish, other aquatic life and wildlife, recreation, and direct consumption of shellfish due to estuarine bioassessments, excess algal growth, and high levels of enterococcus and fecal coliform bacteria, respectively (CT DEEP, 2017). Potential pollutant sources include stormwater, agricultural activities, and other unidentified upstream sources.

In October and November of 2019, ECCD conducted visual stream corridor assessments of Wequetequock Cove, Wheeler Brook and Donahue Brook. The purpose of the assessments was to evaluate and/or identify physical stream and stream corridor conditions and nearby land cover and land use activities that could potentially contribute to the degradation of water quality in Inner Wequetequock Cove. The stream corridor assessment data, along with other project data, will be used to develop a watershed-based plan for the Anguilla Brook watershed.

Procedure

Stream Corridor Assessment Method and Quality Assurance Project Plan

ECCD utilized the *Streamwalk* stream corridor assessment protocol developed by the Connecticut office of the USDA-Natural Resources Conservation Service (USDA-NRCS, 2005). This protocol outlines a methodology to assess the stream corridor and document in-stream and adjacent riparian corridor conditions that could indicate or contribute to water quality and habitat degradation. The NRCS Streamwalk Guide is included in Attachment A.

In order to ensure that stream corridor assessment data would be collected using the protocols developed by NRCS, ECCD revised a previously approved Streamwalk Quality Assurance Project Plan (QAPP). ECCD received approval for the Streamwalk QAPP (CT RFA #12095) from DEEP on or about 7/15/19, and from EPA on 7/30/19. The QAPP (including streamwalk forms) is included in Attachment B.

Volunteer Recruitment and Training

Volunteers were solicited from among the Anguilla Brook Trackdown Project stakeholder group and the general public via the ECCD Facebook. ECCD held a Streamwalk workshop for volunteers on August 10, 2019 at the Stonington Police Department Community Room. At the workshop, volunteers were trained in the sample collection method outlined in the NRCS Streamwalk Guide and Anguilla Brook Streamwalk QAPP to ensure that each volunteer would conduct the assessment using the proper protocols. Following the indoor component of the workshop, volunteers assessed a short segment of Anguilla Brook and practiced filling out the field assessment forms.

Figure 2. Volunteers at the August 10, 2019 Streamwalk workshop.

Stream Corridor Assessments

Stream corridor assessments were conducted on Inner Wequetequock Cove, Wheeler Brook and Donahue Brook in October and November 2019. Inner Wequetequock Cove, including the portion of Oxocossett Brook south of the Route 1 crossing, was assessed by kayak to identify conditions along and immediately adjacent to the shoreline that could directly contribute to degradation of the Cove. Wheeler Brook and Donahue Brook, which both failed to meet established Connecticut water quality standards for their designated recreational uses (Fig. 2), were assessed to identify potential sources of fecal bacteria as well as other stream conditions that could contribute to water quality degradation. Anguilla Brook and Wheeler Brook were not assessed because both met established Connecticut water quality standards for the designated recreational use. Additionally, a review of the stream corridor along Anguilla Brook indicated it was heavily dominated by forested wetlands and would likely be inaccessible.

The QAPP specified that streamwalks be conducted during August and September when stream water levels are likely to be lowest. However, due to an outbreak of Eastern Equine Encephalitis in the region during the summer and fall of 2019, it was decided that for safety reasons, streamwalks would not be conducted until a state-issued public health warning had been lifted.

Prior to conducting the assessments, streams were divided into discrete segments (or reaches) based on geomorphological characteristics using the Rosgen Stream Classification Method (Rosgen, 1994). Reaches were numbered in ascending order beginning with the downstream-most reach designated R1. Using ArcGIS software, streamwalk maps depicting each stream to be assessed were prepared (Attachment C). Streamwalks were conducted beginning at the downstream-most reach of each stream and proceeding upstream. A reach-level assessment was prepared for each stream reach. This assessment form documented the average character of the reach, including stream type, width, depth, substrate type, canopy cover, and adjacent land cover and land use. Area of Concern worksheets were filled out if conditions that could contribute to water quality or habitat degradation were observed. Each Area of Concern was also photo-documented and georeferenced using a Garmin handheld GPS (global positioning system) unit. Areas of Concern include:

- Erosion (E)
- Fish Barriers (FB)
- Stormwater Outfalls (SWO)
- Modified Channels (MC)
- Impacted Riparian Buffers (DB)
- Trash/Debris (T/D)
- Visual Water Conditions (VWC)

Upon completion of the streamwalks, the GPS data was downloaded into a geographic information system (GIS) for review and analysis. The streamwalk data will be used to identify potential sources of bacteria loading to watershed streams and to develop management recommendations to reduce bacteria and other pollutants.

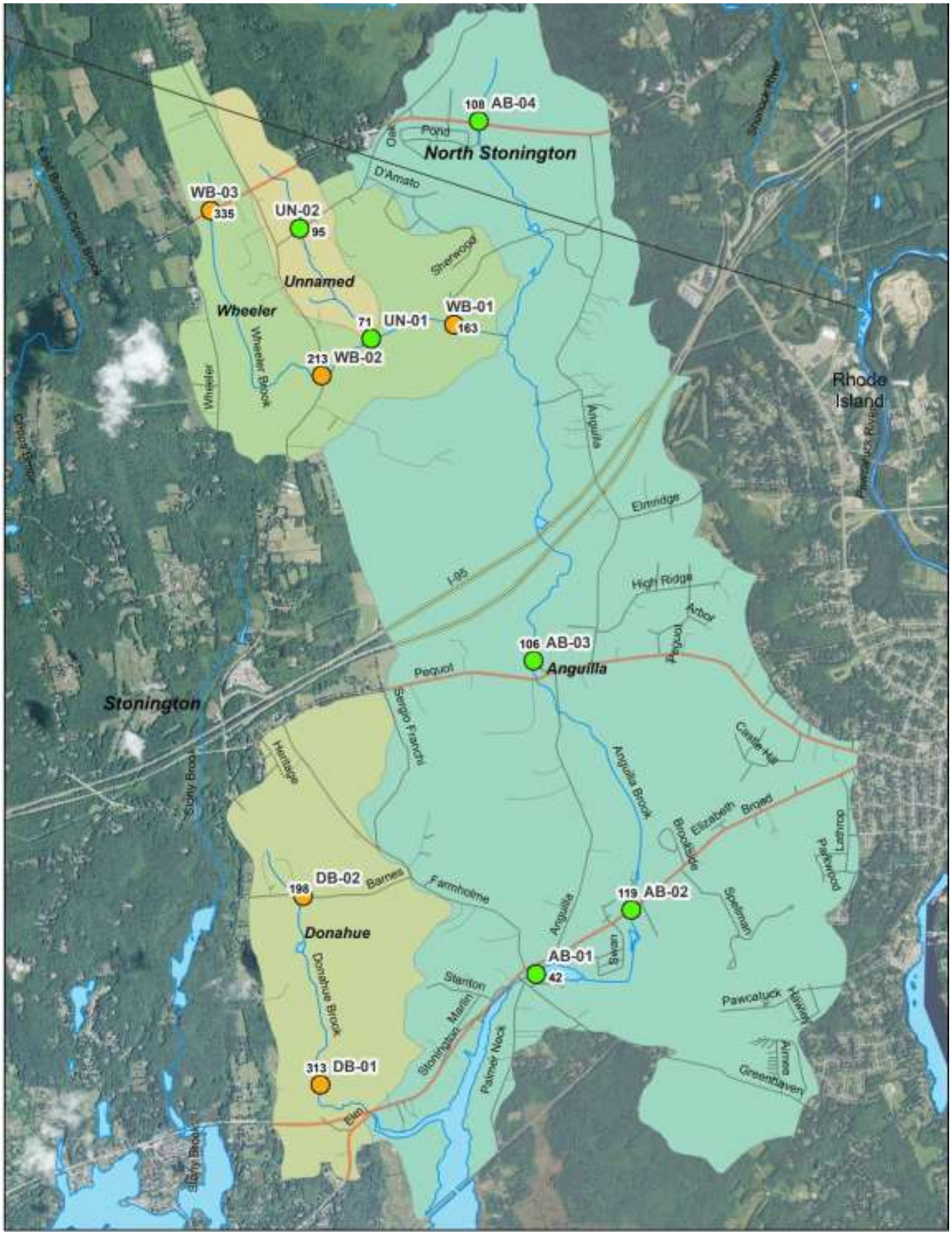

Figure 3. Anguilla Brook watershed *E. coli* bacteria sampling results. A green dot indicates the site met established water quality criteria for the geometric mean; an orange dot indicates that the site failed to meet the geometric mean criteria. Donahue Brook and Wheeler Brook failed to meet water quality standards for their designated recreational uses.

Results

ECCD and volunteers conducted streamwalks on approximately 5.75 stream miles in the Anguilla Brook watershed. The streamwalk data, which included field notations, GPS data and digital photographs, will be compiled into a database for incorporation into the Anguilla Brook watershed-based plan. The data will also be submitted to DEEP for review. In Table 1 below, the documented Areas of Concern are quantified by stream. The Areas of Concern are displayed at Anguilla Brook watershed-scale in Figure 5, and by local watershed in Figures 6-8.

Table 1. Summary of Visual Stream Corridor Assessment Data.

Area of Concern	Wequetequock Cove	Donahue Brook	Wheeler Brook	Total
Degraded Buffer	6	3	6	**15**
Fish Barrier	0	4	3	**7**
Stormwater Outfall	0	0	3	**3**
Visual Water Conditions	0	1	2	**3**
Erosion	0	0	2	**2**
Trash/Debris	1	1	0	**2**
Modified Channel	0	1	0	**1**

Figure 4. Invasive plants, including *Rosa multiflora, Celastrus orbiculatus* and *Berberis thunbergii* growing along Donahue Brook.

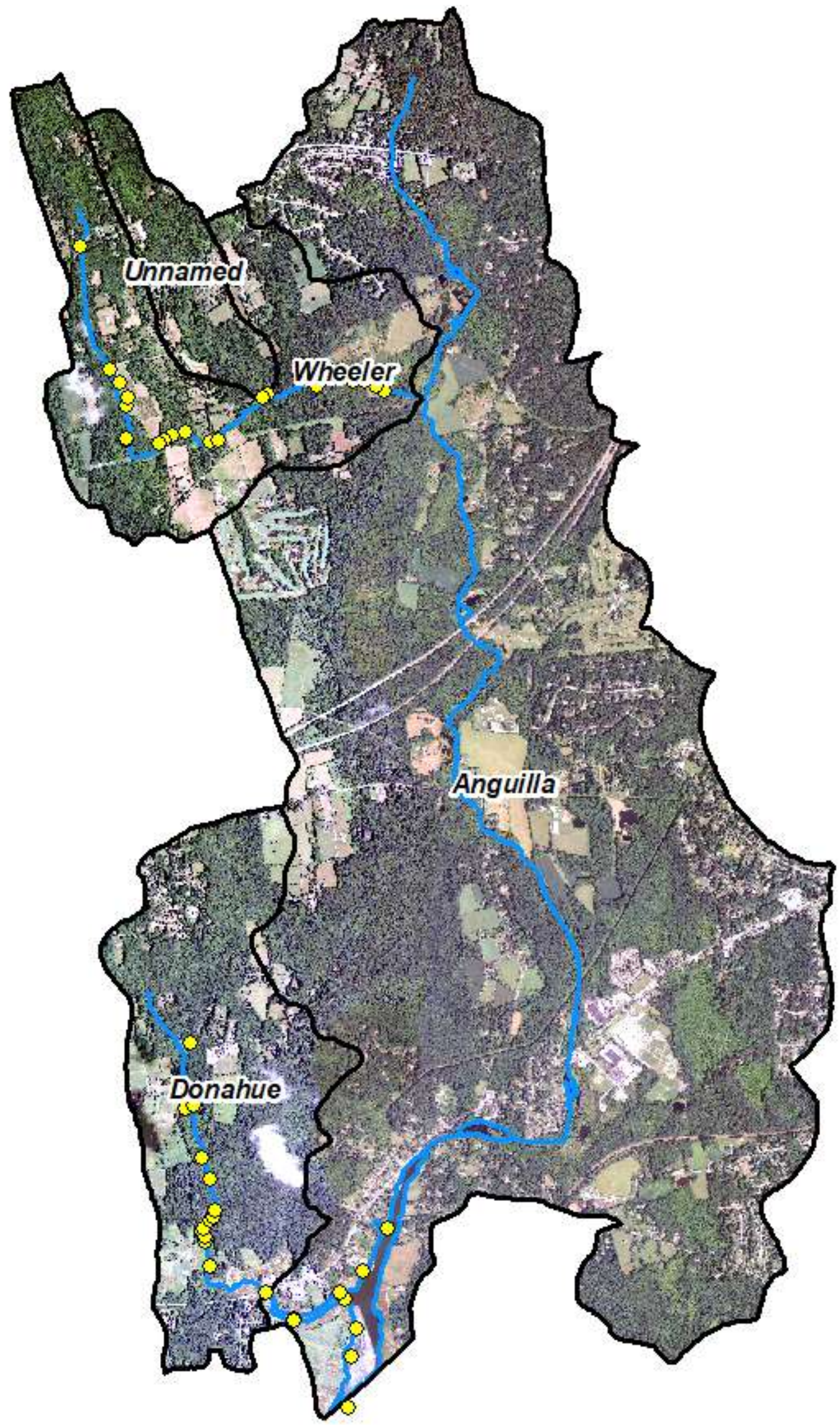

Figure 4. Locations and distribution of Areas of Concern (yellow markers) in the Wheeler Brook and Donahue Brook watershed and along the shoreline of Wequetequock Cove that were identified and documented during the Anguilla Brook watershed visual stream corridor assessments.

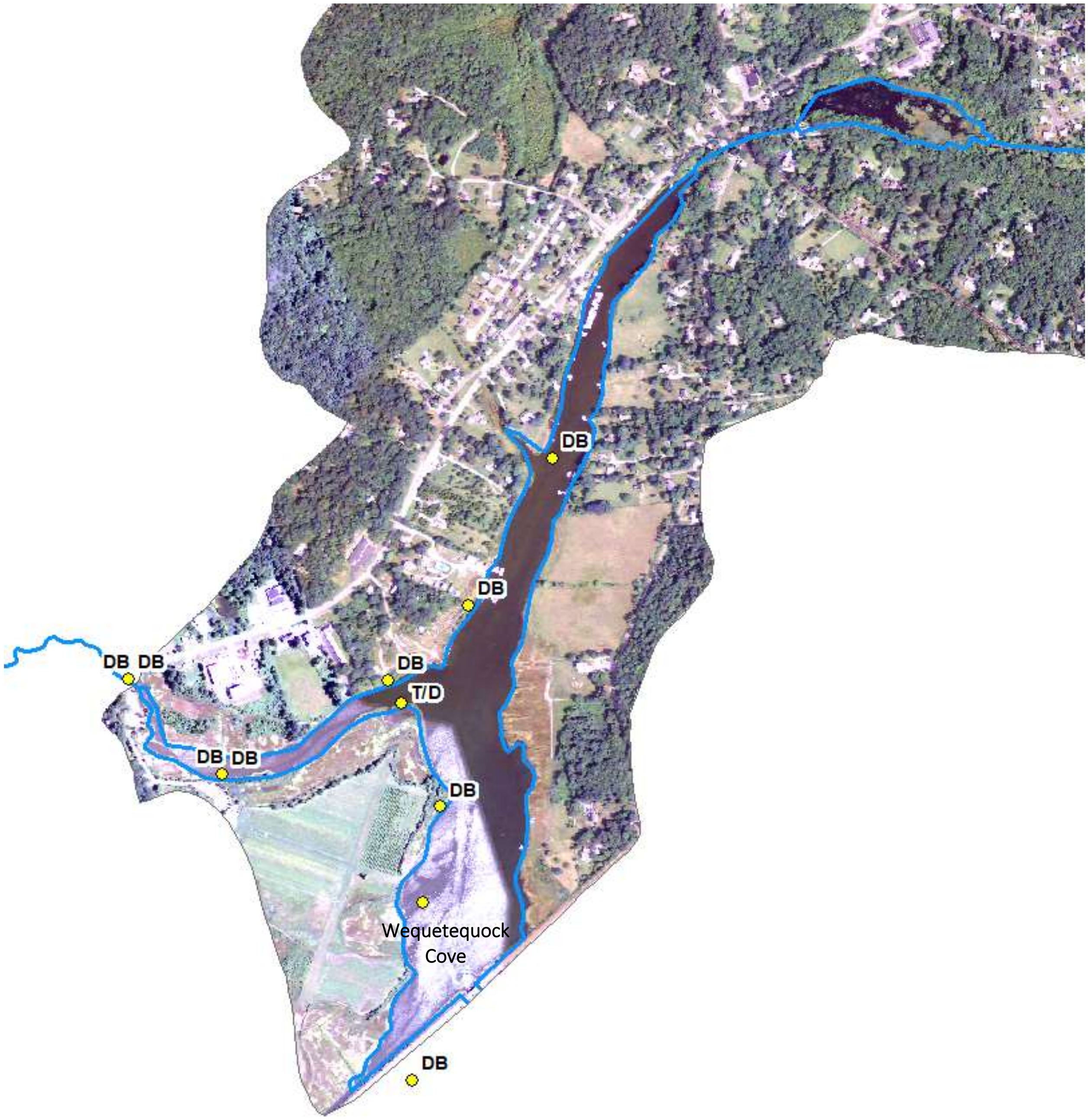

Figure 5. Areas of Concern (yellow markers) identified and documented along the shoreline of Wequetequock Cove. DB indicates a degraded riparian buffer. T/D indicates the presence of trash or other debris.

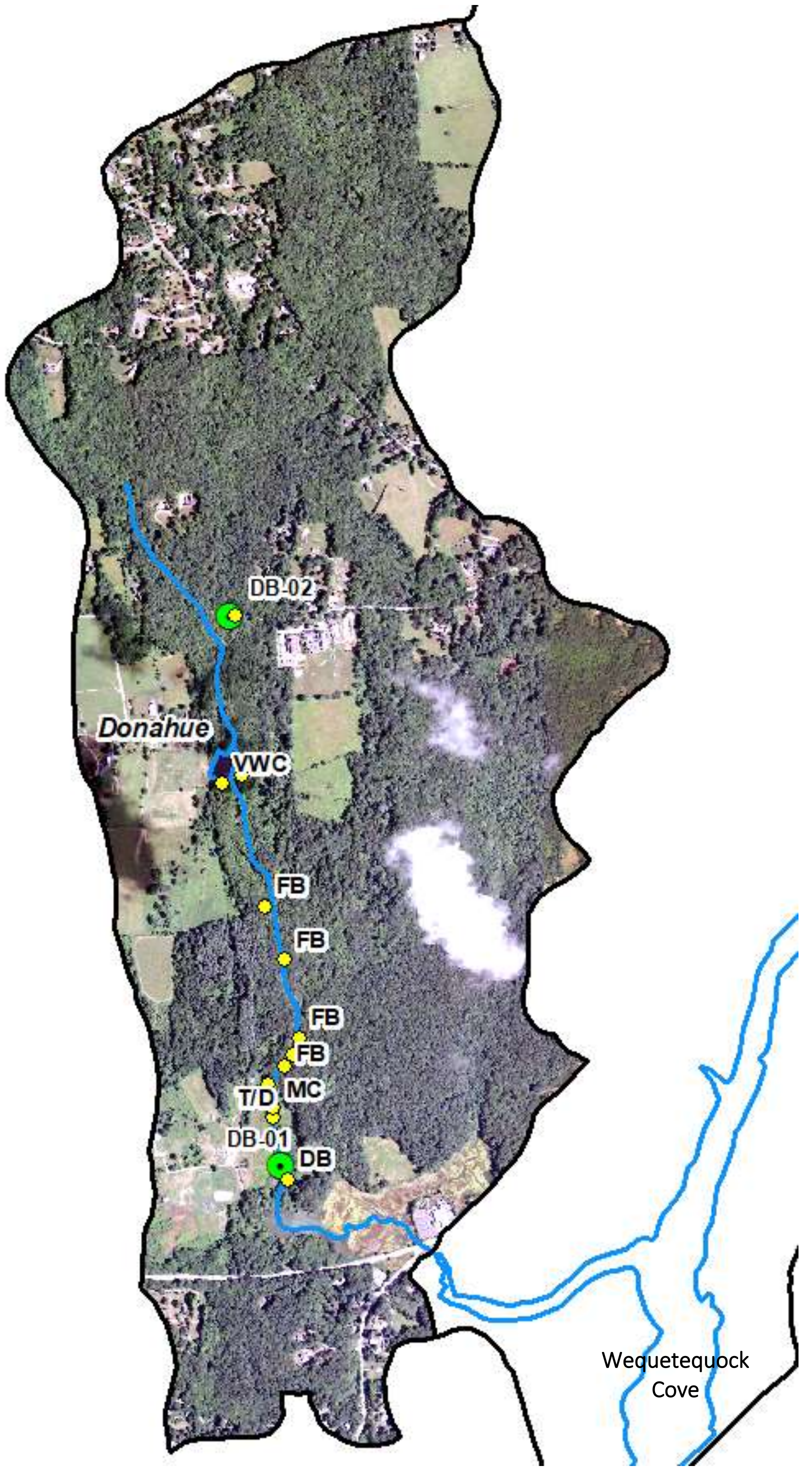

Figure 6. Stream corridor Areas of Concern (yellow markers) identified and documented in the Donahue Brook watershed. Bacteria monitoring locations are depicted by the green circles (DB01 and DB02). The Area of Concern code DB indicates a degraded riparian buffer. FB indicates a possible fish passage barrier. MC indicates the presence of channel modification. T/D indicates the presence of trash or other debris. VWC indicates a visual water condition.

Figure 7. Stream corridor Areas of Concern (yellow markers) identified and documented in the Wheeler Brook watershed. Bacteria monitoring locations are depicted by the green circles (WB01, WB02 and WB03). DB indicates a degraded riparian buffer. E indicates streambank erosion. FB indicates a possible fish passage barrier. MC indicates the presence of channel modification. T/D indicates the presence of trash or other debris. SWO indicates the presence of a stormwater outfall. VWC indicates a visual water condition. Unlabeled yellow markers represent stream features not identified as Areas of Concern, such as the beginning or end of a reach, points along the stream or anthropogenic features.

Discussion

Conditions that were noted during the stream corridor assessments were typical of land uses in the Anguilla Brook watershed. Although certain areas of the watershed, particularly along primary transportation corridors such as State Routes 1, 184 and 234, were more heavily developed and characterized by mixed residential, commercial and industrial uses, the watershed was primarily lightly developed and a rural character was predominant. Small farms and agricultural activity were distributed throughout the watershed. Agricultural activity, including cropland, hayland and pasture, often abutted watershed streams and in some areas extended into the riparian corridor (a riparian corridor is the area immediately adjacent to a waterway, and in a natural condition, is typically well-vegetated). In several areas, livestock were provided access to the waterways or connected ponds in order to have a readily available water supply. Along Wequetequock Cove, it was typical for the lawns of residential properties to extend to the shoreline, and for the shoreline to be armored to prevent shoreline erosion. The properties of several businesses on the shore of the Cove were also cleared to the shoreline to allow access to the water as necessary for the conduct of their business. Areas of Concern are displayed in relation to nearby land cover/land use in Figures 20, 21 and 22 at the end of this section.

Degraded Buffers

The most commonly observed Area of Concern documented during the Anguilla Brook watershed stream corridor assessments was degraded riparian buffers. The water quality and habitat benefits of intact riparian corridors have been well documented. Riparian buffers protect streambanks from erosion, provide shade to keep stream water temperatures cool, slow flood waters, slow the flow of surface stormwater, promote the infiltration and absorption of pollutants in stormwater, and provide a source of terrigenous vegetative matter to streams. The NRCS streamwalk protocol identifies several forms of degraded riparian buffers, including a lack of buffer width or vegetation and the presence of invasive plant species. The majority of the degraded buffers documented during the Anguilla Brook streamwalks fell into one of two categories, the presence of invasive plants or close proximity to another land use (primarily agriculture) which impinged on the riparian buffer area.

Along the shoreline of Wequetequock Cove, land use was predominantly residential, although there was some commercial use and, on the west shoreline, agricultural land use. The lack of riparian vegetation was the primary form of buffer degradation noted along the shore of the Cove. The natural vegetation along the shore of the cove would have been saltmarsh, and saltmarsh was the dominant land cover along the southeastern shore of the Cove, at the Avalonia Land Conservancy's Wequetequock Cove Preserve. Areas of the shoreline included expanses of lawn right to the shoreline, with retaining walls in some areas (Fig. 8). In other areas, the invasive reed *Phragmites australis* had become established along the shoreline (Fig. 9).

Figure 8. Lack of riparian buffer offers little opportunity for stormwater to be slowed down and infiltrated into the ground. Additionally, the removal of riparian vegetation oftens results in the need to install hard structures like this stonewall to prevent shoreline erosion.

Figure 9. Invasive common reed (*Phragmites australis*) growing along the shore of Wequetequock Cove.

Along Donahue and Wheeler Brooks, rural residential and agricultural land-use dominated. Degraded buffers were predominated by the presence of invasive species (Fig. 10), including Japanese barberry (*Berberis thunbergii*), multiflora rose (*Rosa multiflora*), oriental bittersweet (*Celastrus orbiculatus*), winged euonymus (*Euonymus alatus*) – also known as burning bush, autumn olive (*Elaeagnus umbellata*), Japanese knotweed (*Fallopia japonica*) and Chinese privet (*Ligustrum sinense*). In several areas along Donahue and Wheeler Brooks, the proliferation of invasive plants (especially thorned invasive plants) was so dense, passage was impossible. The establishment of invasive plants is often associated with the transition of farmland to forest. Several characteristics of invasive plants, including the ability to thrive in a variety of habitats, extended growing seasons, and high seed dispersal rates, give invasive plants an advantage over native plants in disturbed and transitional landscapes like abandoned pastures.

Figure 10. Japanese barberry (*Berberis thunbergii)* and multiflora rose (*Rosa multiflora*) growing along Wheeler Brook.

In several areas along Donahue and Wheeler Brooks, the riparian buffer was impacted by nearby land use. In a number of locations, farm fields encroached upon the riparian buffer, or extended to the edge of the stream (Fig. 11), reducing the riparian buffer width. Both streams were also crossed by several farm roads. In two cases, the roads forded the streams and in one a culvert had been installed.

Figure 11. Agricultural land adjacent to Wheeler Brook has decreased the width of the riparian buffer.

Fish Passage Barriers

The second most commonly occurring Area of Concern identified was fish passage barriers. These included culverts, downed trees with debris dams, stonewalls built across the stream, and in one case a natural waterfall (Figs. 12 & 13). Although not likely to contribute to water quality degradation, fish passage barriers can contribute to the degradation of in-stream habitat by prohibiting fish from travelling freely up- and downstream. This lack of free passage can diminish fish genetic diversity and also prevent fish from accessing needed habitats over the course of the year such as breeding habitats and deep water refugia.

Figure 12. This tree, which has fallen across Wheeler Brook, has created a natural dam which could impair the passage of fish, limiting their access to various stream habitats such as deep pools and breeding habitats, fragmenting fish populations and reducing genetic diversity.

Figure 13. This stonewall built across Donahue Brook may impair fish passage particularly during periods of low flow.

Stormwater Outfalls

Three stormwater outfalls were identified during the Anguilla Brook watershed streamwalks. Stormwater outfalls, which include storm drain pipes, leak-offs, and ditches or swales, can discharge a myriad of stormwater-borne pollutants into receiving waterbodies. Pollutants can include sediment, road salt, trash and other debris, pesticides, herbicides, fecal bacteria, petrochemicals and so forth.

Stormwater outfalls from the municipal storm drain system were identified at the Wheeler Brook crossing of Taugwonk Road (Fig. 14). Storm drain outfalls were located on both the upstream and downstream side of the road. Both outfalls had dry weather discharge, indicating they may be conveying groundwater. A riprap-lined swale that discharged stormwater from an agricultural field to Wheeler Brook was also documented.

Figure 14. Stormwater outfalls from the municipal storm drain system discharged to Wheeler Brook from both the upstream and downstream sides of Taugwonk Road.

Visual Water Conditions

Visual water conditions are conditions that may not contribute to water quality or habitat degradation in of themselves, but indicate that contributing factors or conditions may exist in the stream corridor system. Visual water conditions that may be documented during the stream corridor assessment include water discoloration, cloudiness or milkiness, foam or soap bubbles, odor, oily sheens, excessive sedimentation, and excessive algae or plant growth.

Iron bacteria was noted below the outfall of a by-pass farm pond on Donahue Brook. The outfall was not part of the mainstem of Donahue Brook but discharge to it (Fig. 15). Iron bacteria form in the presence of dissolved iron in the water and may be indicative of naturally-occurring iron in acidic soils.

Excessive aquatic vegetation was noted in Wheeler Brook upstream of Taugwonk Road (Fig 16). This vegetation may be associated with nearby agricultural activity.

Figure 15. Orange-colored iron bacteria was found at the outfall of a small pond along Donahue Brook. Iron bacteria, which form a fluffy orange flocc, can be found where there are naturally high levels of iron in the soil or bedrock.

Figure 16. Excessive aquatic plant growth, possibly common water moss (*Fontinalis antipyretica)*, in Wheeler Brook.

Erosion

Streambank erosion was noted in two locations in the lower reaches of Wheeler Brook. In both instances the stream was adjacent to pasture and may have been accessible to livestock and wildlife.

Streambank erosion is typically caused by a lack of vegetation on the streambank. Plant roots grow deeply into the soil and provide structural support during periods of high stream flow. Streambank erosion degrades stream habitat through the deposition of eroded sediment on the stream bottom. This can reduce habitat quality for many stream organisms. In addition, some pollutants, including the plant nutrient phosphorus, can adhere to sediment and be transported downstream.

Figure 17. The lack of riparian vegetation at a meander bend on Wheeler Brook has resulted in streambank erosion. Additionally, frost appears to have resulted in slumping of the soil on streambank.

Trash and Debris

Only two instances of trash and debris were noted in watershed streams. A tire was found in Donahue Brook just upstream of the Paffard Woods Preserve marsh and an abandoned rowing scull was found in Wequetequock Cove. Trash typically found in streams includes wind-blown and floatable items like plastic bags, drink cups, soda and beer cans, straws and inexplicably, tires.

Figure 18. An old tire found in the lower reaches of Donahue Brook.

Modified Channel

Modified channels are segments of streams that have been altered from their natural state. They can be sections of streams that have been straightened or moved from their original course. They can have natural or armored streambanks and bottoms. They can be completely culverted to allow for nearby land development. One instance of stream channeling was noted along Donahue Brook (Fig. 19). A 70-foot long segment of stream adjacent to pasture had been channelized with dry-stone walls armoring both streambanks.

Figure 19. Section of modified channel on Donahue Brook.

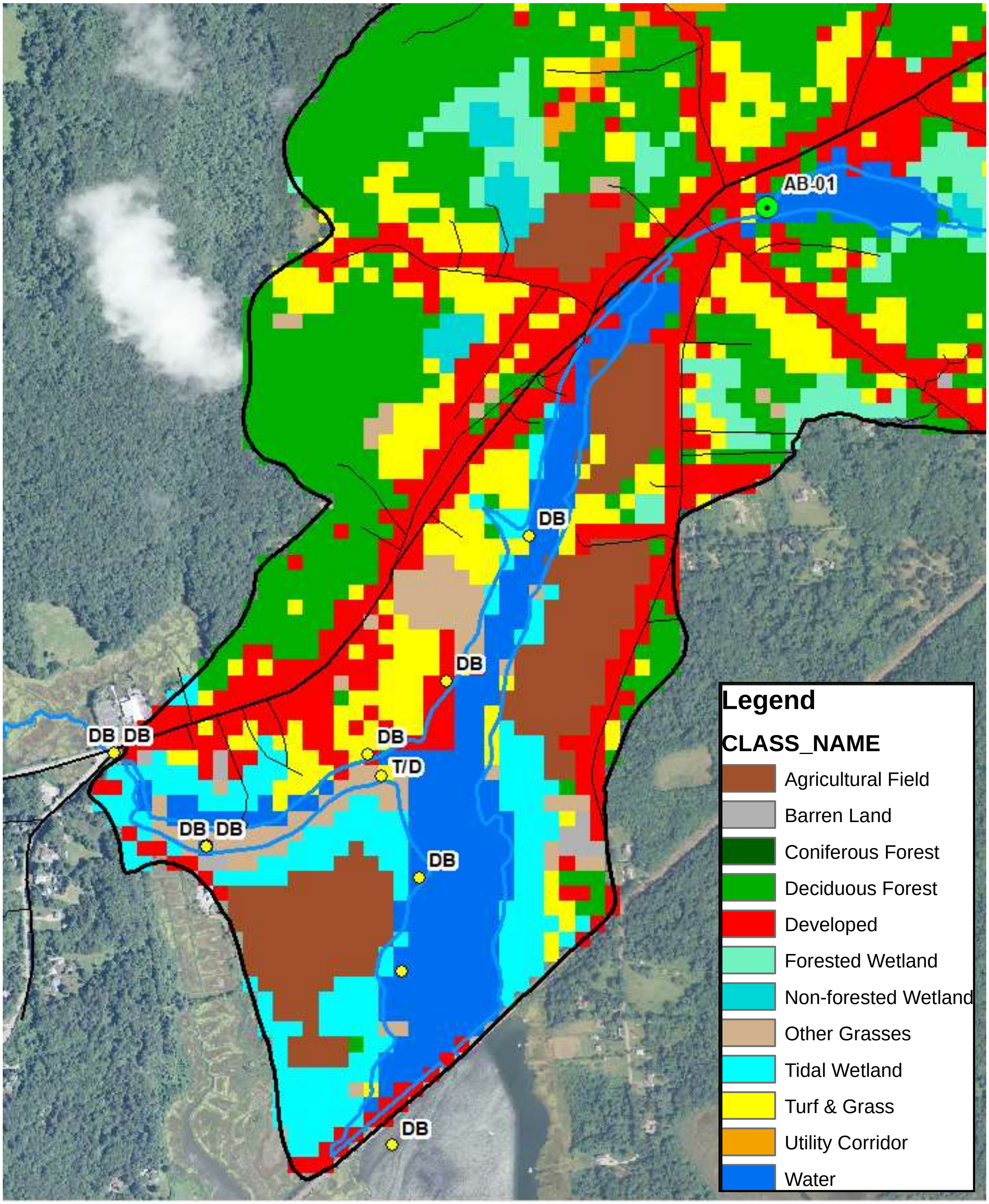

Figure 20. Areas of Concern identified along the shores of Wequetequock Cove are displayed relative to nearby land use/land cover (CLEAR, 2012). DB indicates a degraded riparian buffer. T/D indicates the presence of trash or other debris. AB-01 (green circle) designates the downstream-most bacteria sampling site on Anguilla Brook, at the outlet of Wequetequock Pond.

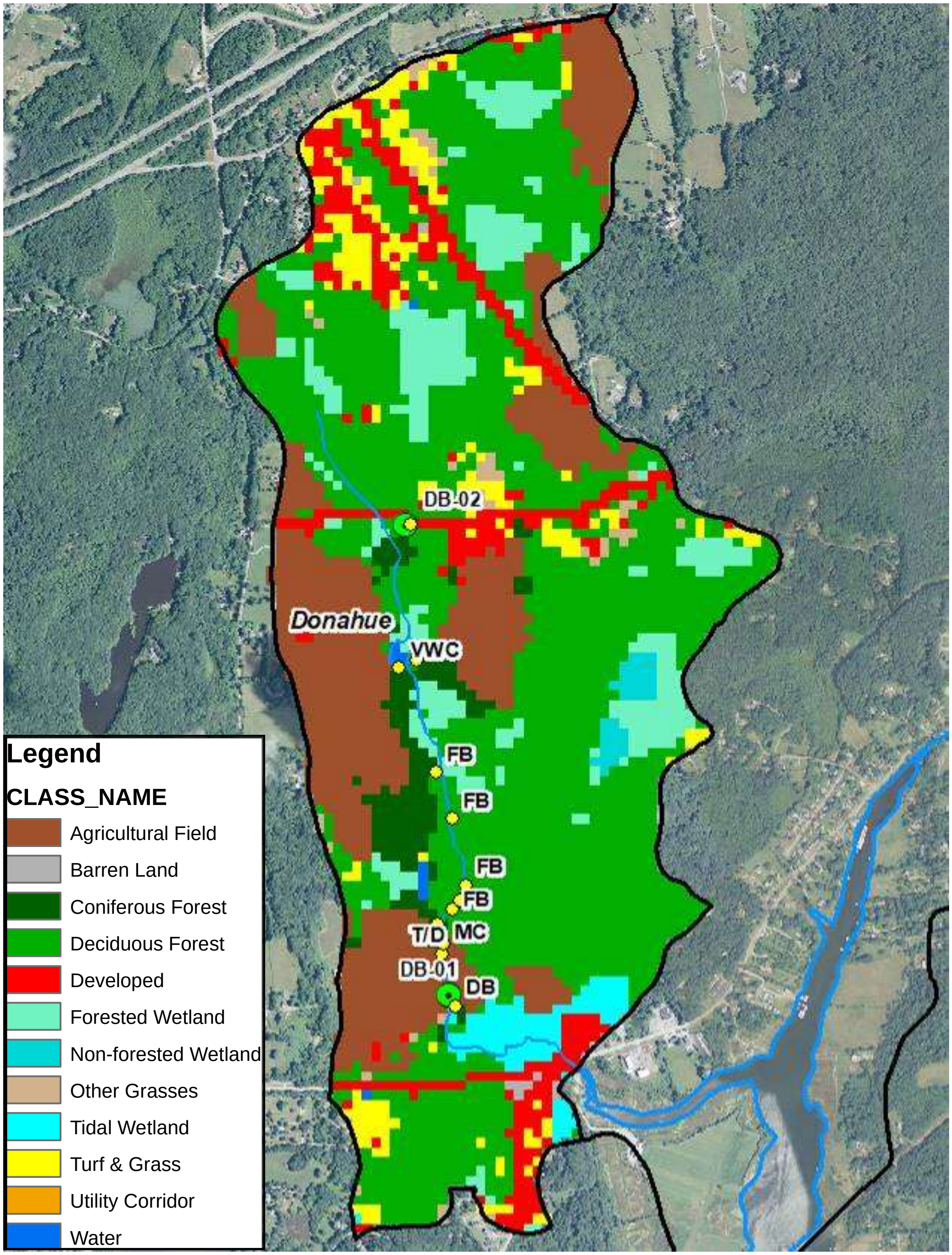

Figure 21. Areas of Concern identified along Donahue Brook are displayed relative to nearby land use/land cover (CLEAR, 2012). The Area of Concern code DB indicates a degraded riparian buffer. FB indicates a possible fish passage barrier. MC indicates the presence of channel modification.

T/D indicates the presence of trash or other debris. VWC indicates a visual water condition. DB-01 and DB-02 (green circles) designate the bacteria sampling sites on Donahue Brook.

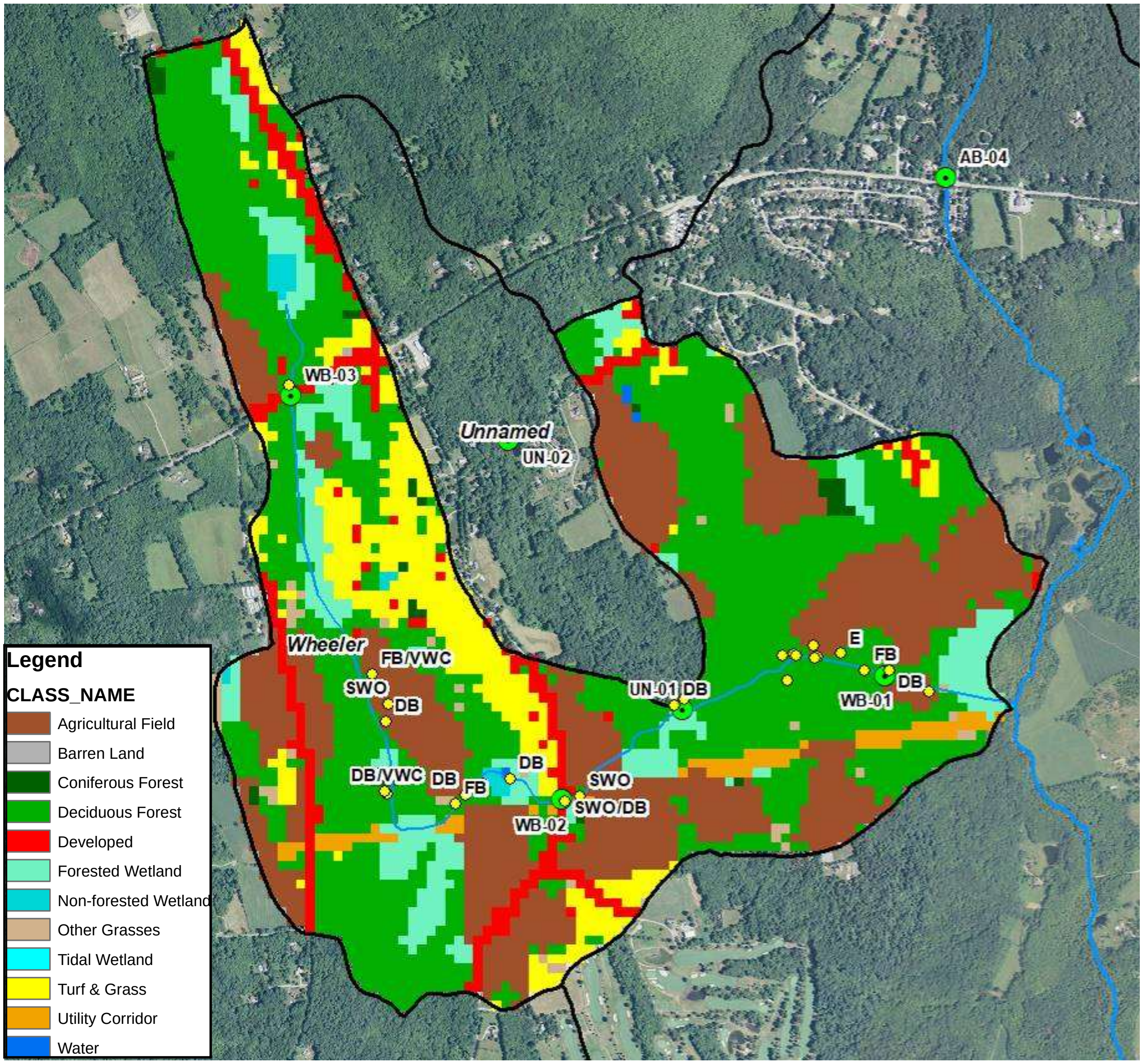

Figure 21. Areas of Concern identified along Wheeler Brook are displayed relative to nearby land use/land cover (CLEAR, 2012). DB indicates a degraded riparian buffer. E indicates streambank erosion. FB indicates a possible fish passage barrier. MC indicates the presence of channel modification. T/D indicates the presence of trash or other debris. SWO indicates the presence of a stormwater outfall. VWC indicates a visual water condition. Unlabeled yellow markers represent stream features not identified as Areas of Concern, such as the beginning or end of a reach, points along the stream or anthropogenic features. WB-01, WB-02 and WB-03 (green circles) designate the bacteria sampling sites on Wheeler Brook.

Conclusion

In October and November of 2019, ECCD and volunteers conducted stream corridor assessments of Donahue Brook, Wheeler Brook and Wequetequock Cove in Stonington, Connecticut. Thirty-three instances of conditions that could indicate or contribute to water quality or habitat degradation of waterbodies in the Anguilla Brook watershed were documented. ECCD will use the results of the stream corridor assessment to further evaluate the Anguilla Brook watershed for activities that could contribute to water quality conditions of Wequetequock Cove and to develop a watershed management plan for the Anguilla Brook watershed.

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APPENDIX C

Recommended BMP Pollutant Load Reduction Summary

Recommended BMP Pollutant Load Reduction Summary							
BMP	Location	Critical Area	Estimated Cost	Load Reduction			
				TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	FC (bn/yr)
Pet waste education leading to proper dog waste disposal	• Watershed-wide • Neighborhood-scale	Varies	NA	65	9	-	1,542
Septic system care education leading to proper maintenance practices	• Watershed-wide • Neighborhood-scale	Varies	$250 -Septic tank inspection/pumping; System repair/replacement cost must be individually determined.	82	14	551	16,762
50% reduction in use of lawn fertilizer	• Watershed-wide • Neighborhood-scale	Varies	NA (will result in homeowner cost savings)	12,262	4,979	-	-
100% reduction in use of lawn fertilizer	• Watershed-wide • Neighborhood-scale	Varies	NA (will result in homeowner cost savings)	24,154	9,830	-	-
± 11,530 linear feet of permeable reactive barrier	• Along the shoreline of Wequetequock Cove • Along the rear of the Meadows Event Center • Pawcatuck Little League - Along the west side of the two ball fields adjacent to Anguilla Brook • Along the east bank of Wheeler Brook at Stonington Vineyard	Yes	$ 1,092/kgN removed (Cape Cod Commission)	534	115	-	-
± 9,310 linear feet of riparian buffer (20 ft wide)	• Along rear property lines of houses on Swan, Canary and Wren Streets • Saltwater Farm Vineyard - Along the driveway and the perimeter of the vineyard fields • Along the rear of the Meadows Event Center property • Stonington Vineyard - Along the east bank of Wheeler Brook	Yes	$233/acre	158	26	2,769	2,633
up to 174 rain gardens	Marlin Drive, Castle Hill, Cedar Crest, Jeremy Hill, Birdland neighborhoods	Yes	$8/sf	144	14	3,678	4,419
36 tree filter units (8.8-ac est. drainage area)	Marlin Drive, Birdland, Castle Hill Rd, Stonington High School	Yes	$14,000/unit	63	8	1,781	1,914
3 Bio-retention basins (±5,200 cu ft)	Marlin Drive, Meadows Event Center		$3 - $7/cu ft treated	23	2	1,030	937
Pervious pavement (est. 2,900 sf)	Stonington High School/Spellman Sports Complex - Dirt parking lot opposite the school building	No	$3.44-$5.37/sf3	0.4	0.1	16	16
Conversion of ±14 acres to solar facility use	Elmridge Golf course	No	NA	1,525	671		
	Total proposed pollutant reductions with a 50% reduction in lawn/turf fertilizer use			*14,856*	*5,839*	*9,825*	*28,223*
	Total proposed pollutant reductions with a 100% reduction in lawn/turf fertilizer use			*26,748*	*10,690*	*9,825*	*28,223*