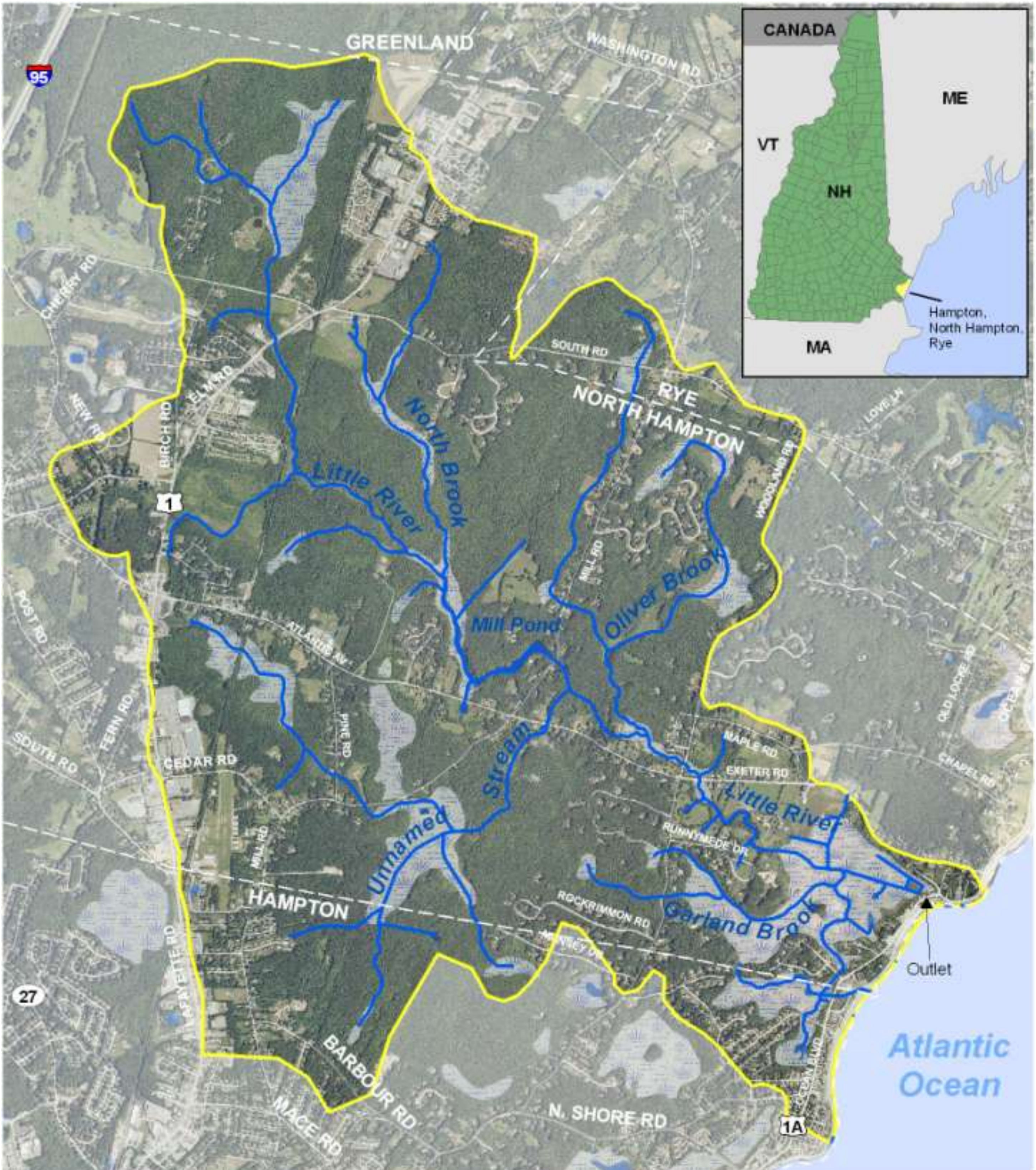
Little River
Watershed Based Plan

May 2011

Prepared by:
FB Environmental Associates, Inc.
97A Exchange St., Suite 305
Portland, ME 04101



Little River Watershed, North Hampton, NH

Stream   Wetland   Watershed Boundary (7.4 Sq. Mi.)

0 0.25 0.5 1 Miles

Data Source: UNH Grant
Coordinate System: NH State Plane
Created by: FB Environmental 4/14/11

N W E S

FB environmental

LITTLE RIVER
WATERSHED BASED PLAN

Prepared by FB Environmental Associates, Inc.
in cooperation with the Towns of North Hampton, Hampton, and Rye, and
New Hampshire Department of Environmental Services

May 2011

Contact:
Sonya Carlson
NH Department of Environmental Services
29 Hazen Drive
Concord, NH 03301

Cover Photo: View of Little River wetland channel (FB Environmental)

Acknowledgements

Thanks to:

Sonya Carlson, NH DES Beach Program

Jody Connor, NH DES

Megan Cook, NH DES Beach Program

Jessica Devoid, NH DES Beach Program

Teresa Ptak, NH DES

Sally Soule, NH DES

Town of North Hampton Board of Selectmen

Town of North Hampton Staff

Technical Staff

Forrest Bell, FB Environmental

Cayce Dalton, FB Environmental

Patrick Marass, FB Environmental

Kailee Mullen, FB Environmental

Project Funding and Support

New Hampshire Department of Environmental Services through the U.S. Environmental Protection Agency

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Project Overview

The Little River Watershed-Based Management Plan (WBMP) is a product of interest and ideas expressed by local individuals to protect and improve the water quality of Little River and reduce risks to human health at North Hampton State Beach. This group of land owners, business owners, community decision-makers, municipal officials, and state regulators understand the significant value that Little River provides for the communities of Hampton, North Hampton, and Rye, New Hampshire. The stakeholders also understand that long-term action is required in order to achieve improvement in water quality. Funding for this community-based plan was obtained from the United States Environmental Protection Agency through the New Hampshire Department of Environmental Services.

The Little River Watershed

This WBMP focuses on the watershed draining to State Beach both directly and through the Little River outlet. Little River consists of a single main stem draining from the forested area above Highlander Drive in North Hampton. North Brook joins the river to the south, before the Mill Pond impoundment at Mill Road. The outflow of the dam continues southeast, where two tributaries, Oliver Brook and an unnamed stream, enter the river from each side, before flowing under Woodland Road. The coastal area of North Hampton is made up of a network of channels that make up Garland Brook, which flows in to the Little River from the south prior to the outlet to the Atlantic Ocean. The entire watershed covers approximately 7.7 square miles primarily in the town of North Hampton.

Undeveloped land accounts for 59% of the watershed and is sectioned by roads and low density residential development. Development covers 12% of the watershed with a majority of light commercial and residential development along the waterfront and in the western watershed, along Route 1. Large natural areas, including the Perkins Parcel, the School Natural Area, and the Little River Marsh, are home to a diverse community of plants and animals that depend on the habitats and clean water for their survival.

The Problem

Little River is threatened by bacteria from developed area runoff, improperly functioning septic systems, agricultural runoff, and concentrated wildlife. In the ecosystem, bacteria exists both naturally and as a result of human activity . Natural background levels of bacteria are minute and are required for low levels of the food chain and decomposition. Augmented levels of bacteria in water can cause beach closures, foul odors, and algae blooms, thereby decreasing the use and value of the resource. All but three of the 12 sites, including the outlet, tested above the recommended New Hampshire state water quality criteria for human skin contact at a tidal beach. Increasing development pressures in the watershed could result in a greater amount of bacteria available which will increase bacteria levels in Little River without the proper control measures in place.

Why Develop a Management Plan?

The New Hampshire Coastal beaches are well known for their accessibility, aesthetic beauty, and outstanding recreational opportunities. State Beach plays a major role in the livelihoods of area residents and is a large draw for tourists. Based on current bacteria levels, Little River requires reductions by 81% in Enterococci to meet state water quality standards. Protecting the quality of the beaches through management measures in Little River is essential to ensure the economic and social values that the beach provides are upheld. This WBMP provides a roadmap for improving water quality in Little River, and provides a mechanism for acquiring grants and other funding to help pay for efforts to address the problem.

What the Plan Includes

The WBMP brought together a diverse group of stakeholders that provided input for an Action Plan. Timeframes and costs were associated with these actions and also listed in the Action Plan. FB Environmental Associates was hired to facilitate the planning process and help develop the Action Plan under guidance of the stakeholders. The following identifies key actions in the watershed to meet the project goals.

KEY ACTIONS FOR RESTORING LITTLE RIVER

- **Best Management Practices (BMPs)** Reduce the amount of polluted stormwater by retaining and filtering runoff through the ground. Suggested BMPs include buffer strips for agriculture sites and roadsides and reducing impervious cover to encourage natural vegetation.
- **Community Planning & Development** Local ordinances must be strengthened to protect water quality and enforced fairly. Ordinances required in the watershed are aimed at pet waste in developed areas as well as septic system pump out and inspection.
- **Education & Outreach** Coordinate with residents, both seasonal and permanent, to enhance the understanding of bacteria sources in the watershed to promote increased stewardship. Programs recommended for the watershed include: Pet waste removal programs, proper septic system care, importance of a vegetated buffer, and BMPs for agricultural areas.
- **Land Conservation** Land protected from development provides areas for infiltration and pollutant absorption before Little River reaches State Beach. The stakeholders should work with local governments and land owners to protect land in headwater areas and large blocks of forest especially where the river channel is located.

Funding the Plan and the Next Steps

Costs for this plan are determined by pollutant source. Overall, it is estimated to cost greater than $100,000 through 2015 to implement the Action Plan for Developed Area Runoff and Malfunctioning Septic Systems. Funding for these projects is available through many federal, state and local sources such as PREP, NRCS, and the EPA 319 program. In order for this plan to succeed, it will require a combined and focused effort from a strong and diverse steering committee and volunteers that will meet at least annually to discuss progress made and adjustments that are required to ensure the rehabilitation of Little River and safe recreation at State Beach.

Key Chapters in the Plan

Chapter 1 introduces the plan, describes the problem, outlines the goals and objectives of the project, and ongoing activity in the watershed. The first chapter also defines the federal requirements of a watershed-based plan and indicates where each element can be found in this plan.

Chapter 2 describes the watershed by providing detailed information on geography, demographics and population trends, climate, physical features, protected lands, and characteristics of Little River. The stream impairment is also described in chapter 2.

Chapter 3 provides an overview of state water quality standards, designated uses, applicable standards, and current water quality data for Little River and at both North Hampton State Beach. The chapter also explains why the Little River data is related to the water quality standard of a swimming tidal beach. Chapter 3 concludes by outlining the water quality goals for Little River.

Chapter 4 outlines the management plan strategy and approach and details the goals and techniques that may be employed to reach them. The beginning of the chapter reviews the two watershed surveys conducted to identify pollutant sources in the watershed. The identified sources of bacteria are quantified and the sources are prioritized.

Chapter 5 suggests recommendations for action through structural and non-structural best management practices (BMPs) to reduce bacteria inputs to Little River. Current and projected bacteria loads in the watershed are also described.

Chapter 6 contains the Action Plan, the core part of the watershed management plan. The Action Plan suggests ways to combat pollution sources in the watershed through BMPs, municipal ordinances, and stakeholder education. Costs and a timeline are provided with each item as can be determined without further investigation. Funding sources for each pollution source are also listed.

Chapter 7 describes who and what will be needed to carry out this plan and suggests methods for sustainable funding. This plan is adaptive based on the changing environment and stakeholder interests and should be revised over time.

Chapter 1. Introduction

1.1 Purpose of the Plan

A watershed-based management plan (WBMP) describes the environmental impairments that a polluted stream faces, usually due to conditions in the surrounding watershed, and indicates steps that can be taken to improve and restore the stream. New Hampshire Department of Environmental Services (NHDES), watershed interest groups, and stakeholders collaborated on the Little River WBMP. This document establishes water quality goals and objectives, and outlines the actions needed to reach them. Long-term management and financing options for water quality improvement are discussed. This plan is intended as a guide for the towns of North Hampton, Rye, Hampton, and stakeholder groups. Regular review and updates to the WBMP will be necessary to account for progress made in Little River, as well as new goals as they are identified.

Marsh area in the Little River watershed

1.2 Current Efforts within the Little River Watershed

The Little River watershed is located in 4 towns: North Hampton, Hampton, Rye, and Greenland. The main channel of the Little River does not exit North Hampton; therefore, North Hampton will be discussed primarily. However, water quality improvement is a watershed wide goal and the area is referred to as the "Little River watershed" throughout this plan.

Currently, the town of North Hampton and the New Hampshire Department of Environmental Services Beach Program

Table 1.1. New Hampshire Towns in the Little River Watershed

Town	Watershed Area Within Town (Sq. Mi.)	% of Watershed Area
North Hampton	6.22	84.3%
Hampton	0.91	12.3%
Rye	0.24	3.3%
Greenland	<0.001	0.0%

(NH DES Beach Program) monitor for water quality within Little River. They also are working to educate citizens, enrich their understanding of the watershed, and implement important management measures. These efforts are the foundation for planning and restoration in the Little River watershed and are further described below.

1.2.1 Stormwater and the MS4 Program

Rainwater which runs over streets, parking lots, roofs, and other developed areas of the Little River watershed picks up a variety of pollutants before entering streams or wetlands. This discharge of water flowing across development and into surface waters is referred to as "stormwater," or polluted runoff. Stormwater is considered a major form of non point source (NPS) pollution, because it comes from a large number of small sources (e.g., leaking oil on parking lots, pet waste, excessive fertilizer use on lawns, etc.) rather than from a large source like a factory or wastewater plant. Over time, these small sources combine to form relatively large amounts of pathogens (such as bacteria and viruses), oil and gasoline, toxic metals, and other contaminants into Little River.

Basins catch stormwater that carries pollutants to Little River.

Much of the stormwater is first collected in catch basins in streets, driveways, and parking lots, then carried to the river via storm sewers. The watershed towns, and all municipalities whose storm sewers discharge to streams, must obtain and comply with a Municipal Separate Storm Sewer (MS4) permit from the US EPA for these stormwater sources. Municipalities there are granted MS4 permits on the condition that they implement control measures, or best management practices (BMPs), that work in a variety of ways to reduce the pollutants carried within storm sewers. The types of control measures are:

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

1.2.2 The Town of North Hampton

North Hampton has taken and continues to take steps to improve water quality in Little River. The town is invested in the long term sustainable health of the river. Their continuing efforts form important building blocks toward a cleaner, safer Little River. Several of the past and present steps taken by North Hampton are documented below.

- Posting signs educating pet owners about pet waste and water quality, and reminding them of their legal responsibility to dispose of pet waste properly.
- Organizing community clean ups to increase public participation in watershed stewardship.
- Enforcing Land Development Regulations to reduce construction site runoff and inspect for post-construction stormwater management.
- Mapping catch basins, and maintaining a cleaning schedule to remove sediment and other pollutants.

In 2000, the Town of North Hampton was a project partner in a Tidal Restriction Removal Project. The goals of the project were to restore tidal flow to the large estuary west of Ocean Blvd (Route 1A), and reduce flooding due to improper drainage (NH DES 2005). Restricting tidal flow led to reduced salt marsh habitat, a reduction in overall marsh size, an influx of invasive species, and freshwater flooding of neighboring homes. Several undersized culverts were replaced in the watershed, most notably twin concrete box culverts were placed under Route 1A. Monitoring thus far has shown significant improvement in salinity concentrations and native plant life.

1.2.3 The Towns of Hampton and Rye

The headwaters of Oliver Brook and the unnamed tributary are located in Rye and Hampton, respectively. Like North Hampton, Hampton and Rye have taken steps to reduce watershed runoff. Both towns have pet waste policies, enforce state development regulations, and require conservation commissions to approve soil disturbance activities within the coastal area. They aim to educate citizens on water quality initiatives by organizing coastal clean ups and distributing clean water information to homeowners. Both towns have also worked with NH DES to monitor watersheds within their own boundaries.

1.2.4 NH DES Beach Program

In October of 2000, the Federal BEACH Act was passed. This law provides funding to coastal and Great Lake states for the design and implementation of water quality monitoring programs for public swimming beaches. With this funding, the New Hampshire DES created the NH DES Beach Program to monitor Enterococci bacteria as an indicator of potentially dangerous microorganisms (pathogens) found in swimming areas. The NH DES Beach Program educates citizens about the hazards, causes, and typical sources of pathogen pollution. The program also performs research into the sources of coastal pathogens and potential ways to mitigate them.

The NH DES Beach Program monitors three stations on State Beach.

NH DES Beach Program monitors for Enterococci bacteria at three different sites at North Hampton State Park Beach (referred to as State Beach). The outlet of Little River to the Atlantic Ocean is at the northern edge of the beach. The river was believed to be a major contributor of bacteria to State Beach. As a result, NH DES Beach Program began to sample for bacteria upstream from the beach outlet, at specific locations on Little River. In 2009, ten sampling stations were created on Little River. These inland watershed bacterial sampling stations provide the data NH DES Beach Program needed to conclude that Little River is a major conduit of bacteria to State Beach.

The outlet of Little River during high tide at State Beach.

Beginning in 2008, NH DES Beach Program partnered with FB Environmental Associates to publish the Coastal Beach Watershed Bacteria Source Investigation. One of the coastal watersheds examined during the study was Little River. For this analysis, additional bacteria sampling locations were established on Little River in 2009, further confirming that a large amount of bacteria reach the beach through the river. This highlighted the need to identify and mitigate the sources of pathogens to the river.

The work that NH DES Beach Program has been conducting in the Little River watershed is essential to protecting beach water quality in North Hampton and adjacent areas. The NH DES Beach Program bacteria sampling was fundamental in identifying areas of high pathogen loading to Little River, and ultimately to the beach. Discovering specific portions of the watershed where bacteria levels are highest focuses planning and restoration efforts on areas where opportunities for improvement are greatest.

1.3 Incorporating EPA's 9 Elements

EPA provides clear guidance for watershed-based plans such as this one. EPA lists nine components required to be included. They are:

1. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBMP (and to achieve any other watershed goals identified in the WBMP), as discussed in item (2) immediately below. See Section 4.2.

2. An estimate of the load reductions expected for the management measures described under (3) below, described in Section 7.1.

3. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under (2) above (as well as to achieve other watershed goals identified in this WBMP), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan. See Section 6.2 and 4.1, respectively.

4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan, described in Section 6.2.

5. An information/education component that will be used to enhance public understanding of the project, described in Section 6.2.

6. A schedule for implementing the NPS management measures identified in this plan, see Section 6.2.

7. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented, found in Section 7.4.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards water quality standards; and if not, the criteria for determining whether this WBMP needs to be revised. See Section 7.2.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (8) above, found in Section 7.4.

Chapter 2. Watershed Characterization

2.1 Location

Little River is primarily located in North Hampton, New Hampshire, in Rockingham County. Other towns in the 7.68 sq. mi. watershed are Rye, Greenland, and Hampton (Figure 2.1). Little River begins above North Road near the Greenland border. Both Little River and North Brook flow into Mill Pond which is dammed above Mill Road. Little River flows from the outlet of Mill Pond and continues southeast towards the Atlantic Ocean. Two tributaries enter the main channel between West and Woodland Roads. Oliver Brook enters west of Woodland Rd. Past Woodland Rd the channel flows into a large estuary. Garland Brook enters the Little River from the south just before the river outlet under Ocean Boulevard.

2.2 Population and Growth

The estimated population of North Hampton in 2010 was 4,301 people. Rockingham County has more than doubled in residents since 1970 in a general shift in population from inland to coastal towns. North Hampton has seen a much smaller increase in residents, growing 32% over this time (NH Office of Energy and Planning, 2011). Current population projections anticipate a growth of 22% by 2025 (NH Office of State Planning, 2003).

2.3 Climate

Coastal New Hampshire has a seasonal climate with cold winters and warm summers, typical of the northeastern U.S. coastal region. Temperatures reach an average high of 82.1°F in August and average lows of 12.9°F in February. Over the course of the year the region receives about 52 inches of precipitation (including the liquid equivalent of snow). Most of the rainfall occurs in April and the snow season typically begins in December. People are drawn to the beaches of New Hampshire to cool off during the summer and the coastal winds provide for recreational activities such as wind surfing and sailing.

2.4 Land Use and Land Cover

Impervious area in the watershed accounts for 13% of watershed area. The largest impervious areas, such as extensive parking lots and high density buildings, are along Route 1 and Route 111. The corridor along the ocean is also highly developed and largely impervious, especially near the intersection of Ocean Boulevard and Atlantic Avenue. Water quality impairments typically begin to appear when a watershed exceeds 5% impervious (Couch and Hamilton 2002), and are nearly universal when imperviousness is greater than 12%. (CT DEP 2007, Stanfield and Kilgour 2006, Wenger *et al*. 2008).

Analysis using the 2001 New Hampshire Land Cover layer provided by New Hampshire's Statewide Geographic Information System (GIS) Clearinghouse (GRANIT) shows that largest land use in the Little River is woods. Forested lands, made up of mixed forest types including oak, beech, pine, and hardwoods, accounts for 59% of land use area. Disturbed area is the second largest land use in the watershed. This category consists primarily (88%) of cleared/open

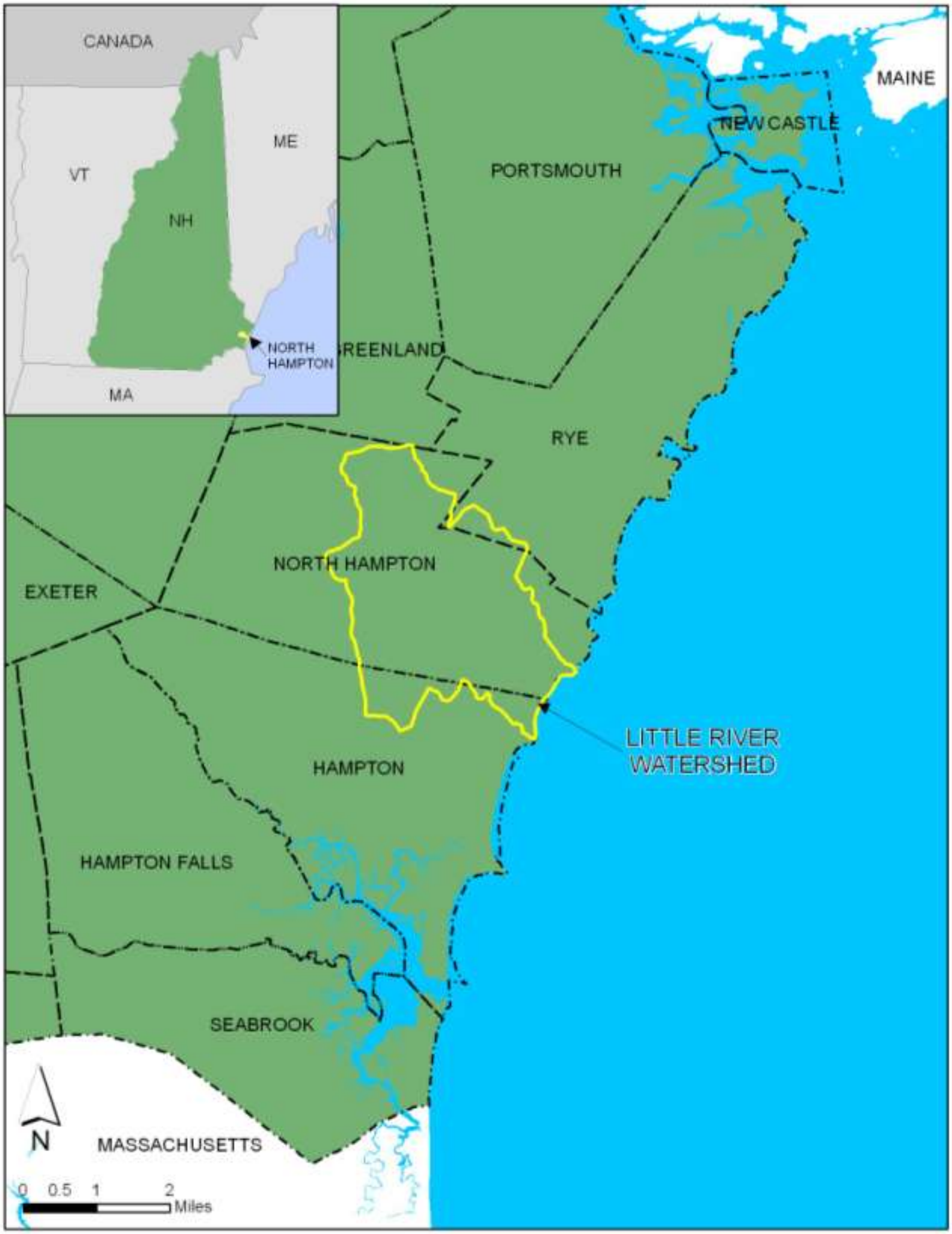


Figure 2.1. Location of Little River watershed in coastal New Hampshire

land. The remaining 28% of watershed area is comprised of other land covers types, including developed area, wetlands, and pasture (Figure 2.2).

The forest land is located in large habitat blocks inland from the coast and is separated only by roads and development (Figure 2.3). Forested wetland areas comprise most of the interior wetlands following the course of Little River. Development is concentrated near the coastline and Route 1, in the western area of the watershed. A majority of agriculture is fallow land and located around the intersection of Atlantic Ave and Maple Rd near the main tidal wetland.

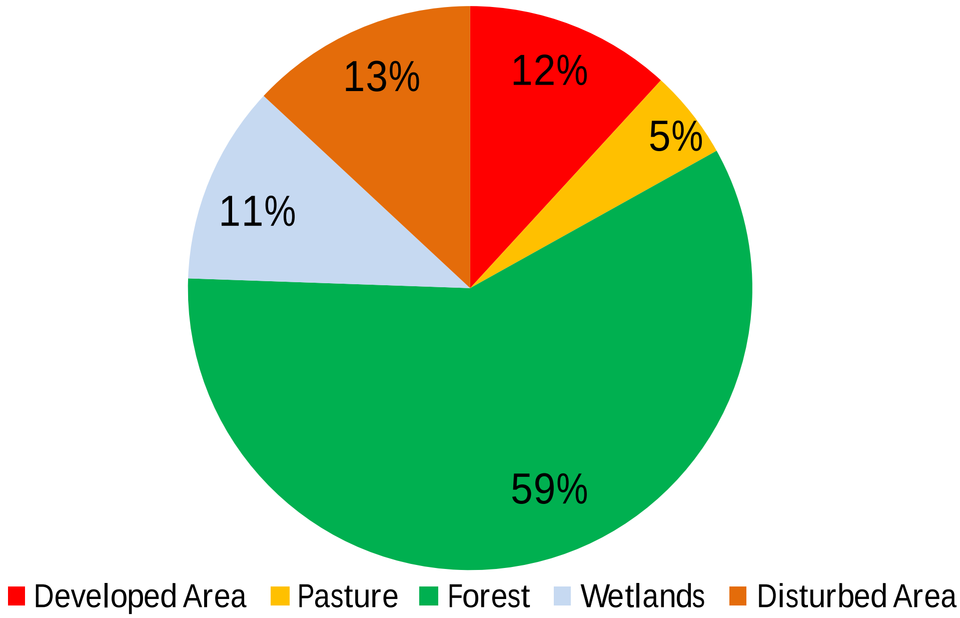


Figure 2.2 Pie Chart of Land Uses in Little River Watershed

2.5 Physical Features

2.5.1 Topography

Topography in coastal New Hampshire is rolling hills and flat estuaries and marshes. Most watershed boundaries are aligned with roads. The highest point in the watershed, at 118 ft above sea level, is to the northeast of North Brook, between South and Mill Roads (Figure 2.4).The watershed generally slopes southeast, gradually declining in elevation to the tidal marshes.

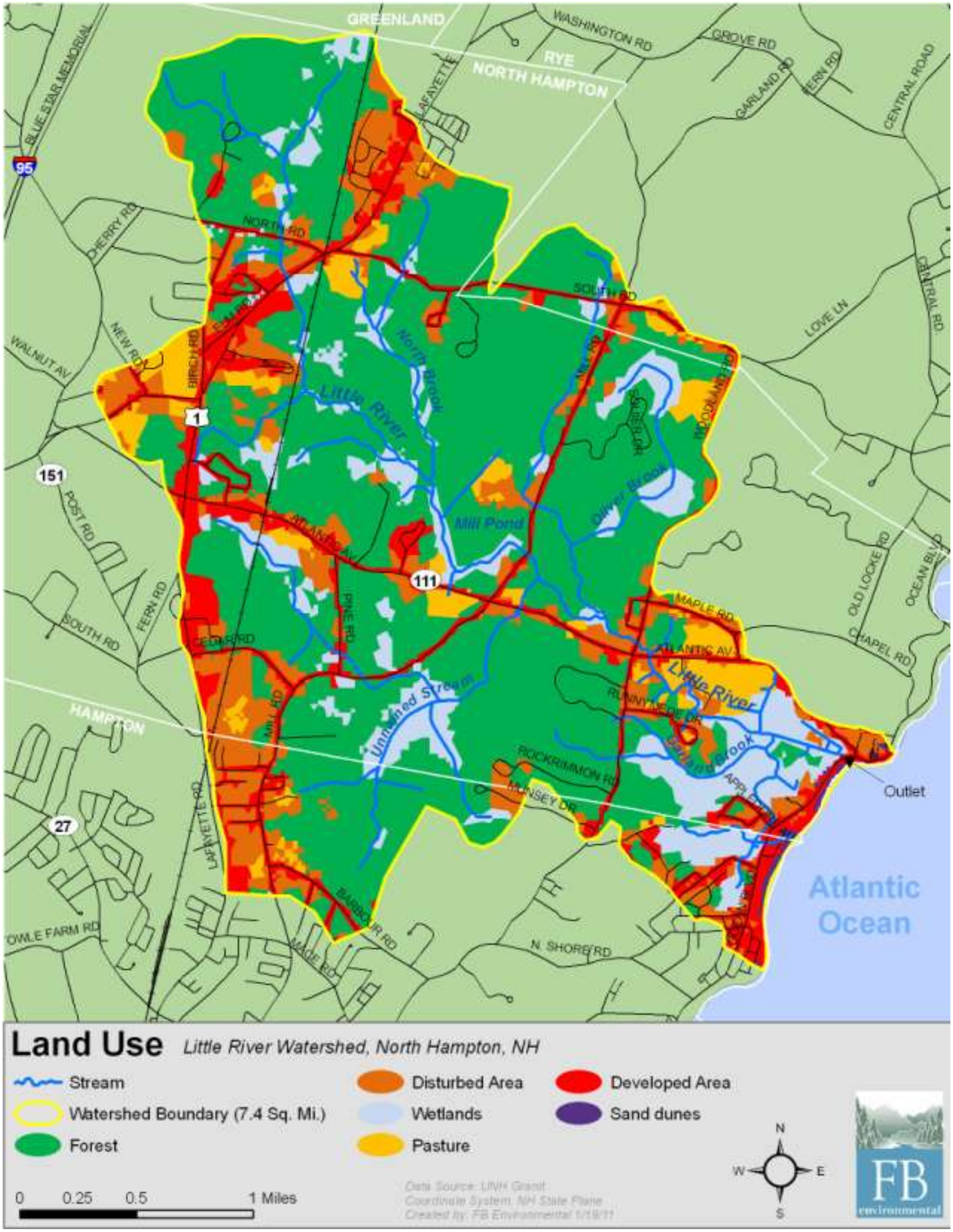


Figure 2.3. Map of Land Use in the Little River Watershed

2.5.2 Soils and Geology

Most soils in the watershed are mapped as fine sandy loam or muck. Wetland areas in the tidal marsh are primarily Ipswich mucky peat, a poorly drained salt grass habitat that is rich in organic matter deposits and salt. Areas along Garland Brook and the former Little River outlet are no longer tidal and are low salt Ipswich soils. Inland wetland soils along North Brook and Little River are primarily Chocorua mucky peat. Chocorua soils are also very poorly drained, high in nutrients, and not suitable farmland. The unnamed tributary, entering from the southwest, has a channel composed of Greenwood mucky peat and Scarboro muck soils. Scarboro muck is created by glacial deposits and decaying organic

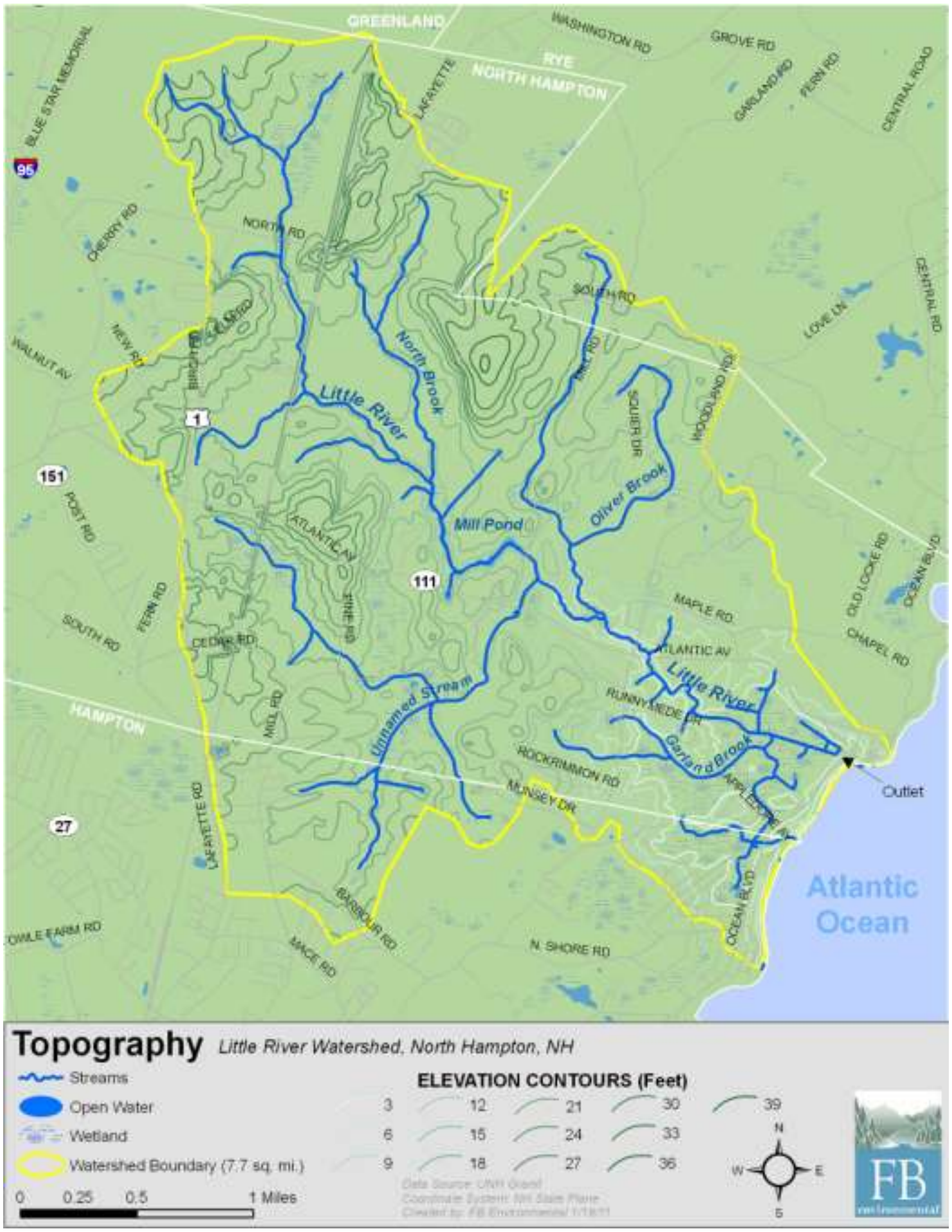


Figure 2.4. Map of Topography in the Little River Watershed

matter in shallow depressions where the water table is at or near the surface. Ossipee mucky peat is found beneath the Little River channel just before the salt marsh habitat. Ossipee mucky peat is created from plant and woody debris. This soil is also very poorly drained and characteristic of a wooded wetland (NRCS).

Non-wetland soils in the watershed transition from rocky, loamy soils in the north to fine sandy soils in the south. Chatfield-Hollis-Canton soils dominate the watershed. They are well drained soils with a sandy loam texture and glacial till deposits. Most forested areas in the watershed are found on these soils. Woodlands are also found on Squamscott and Hoosic fine sandy loam soils in the headwaters of Little River. Hoosic Complex soils also make up the developed beach area. Both Squamscott and Hoosic soils are found on gently slopped terrain and are composed of glacial outwash. Glacial outwash creates excessively dry, sandy soils with small gravel sized rocks. Areas with theses soils are typically used as farmland but can host a wide variety of hardy trees such as sugar maple, oak, and hickory. Land uses on these soils in Little River watershed are primarily developed (Figure 2.5).

2.5.3 General Stream Characteristics

Little River and its tributaries exhibit similar morphology. Headwater streams begin in forested areas and flow through low density residential neighborhoods. Few road crossings are heavily developed, such as Route 1 and 111. The area where North Brook and Little River meet is forested with scattered wetlands. There is little open water in the watershed and the only standing water, Mill Pond, is surrounded by forested wetlands and grassland. The unnamed stream and Oliver Brook are almost completely buffered by forest and wetlands, and far from buildings. Open marshes exist in the southern end of the watershed near the outlet. The channels of the open marshes are broad and slow moving. Plant materials consist of salt grasses and low lying shrubs. The salt marshes are bordered by high density development and disturbed areas.

A Little River tidal tributary adjacent to a mowed lawn.

2.5.4 Stream Life and Use Impairments

Little River is listed as impaired on the state 303(d) list for Enterococci , a fecal streptococci indicator bacterium. The river is also listed as impaired for polychlorinated biphenyols (PC Bs), mercury, and dioxins. Impaired uses include primary contact (e.g., swimming, surfing) and secondary contact recreation (e.g., boating), fish and shellfish consumption. Total Maximum Daily Load determinations was completed by NHDES for Enterococci and fecal coliform in 2010; determinations for PCBs, mercury, and dioxins are scheduled for 2017.

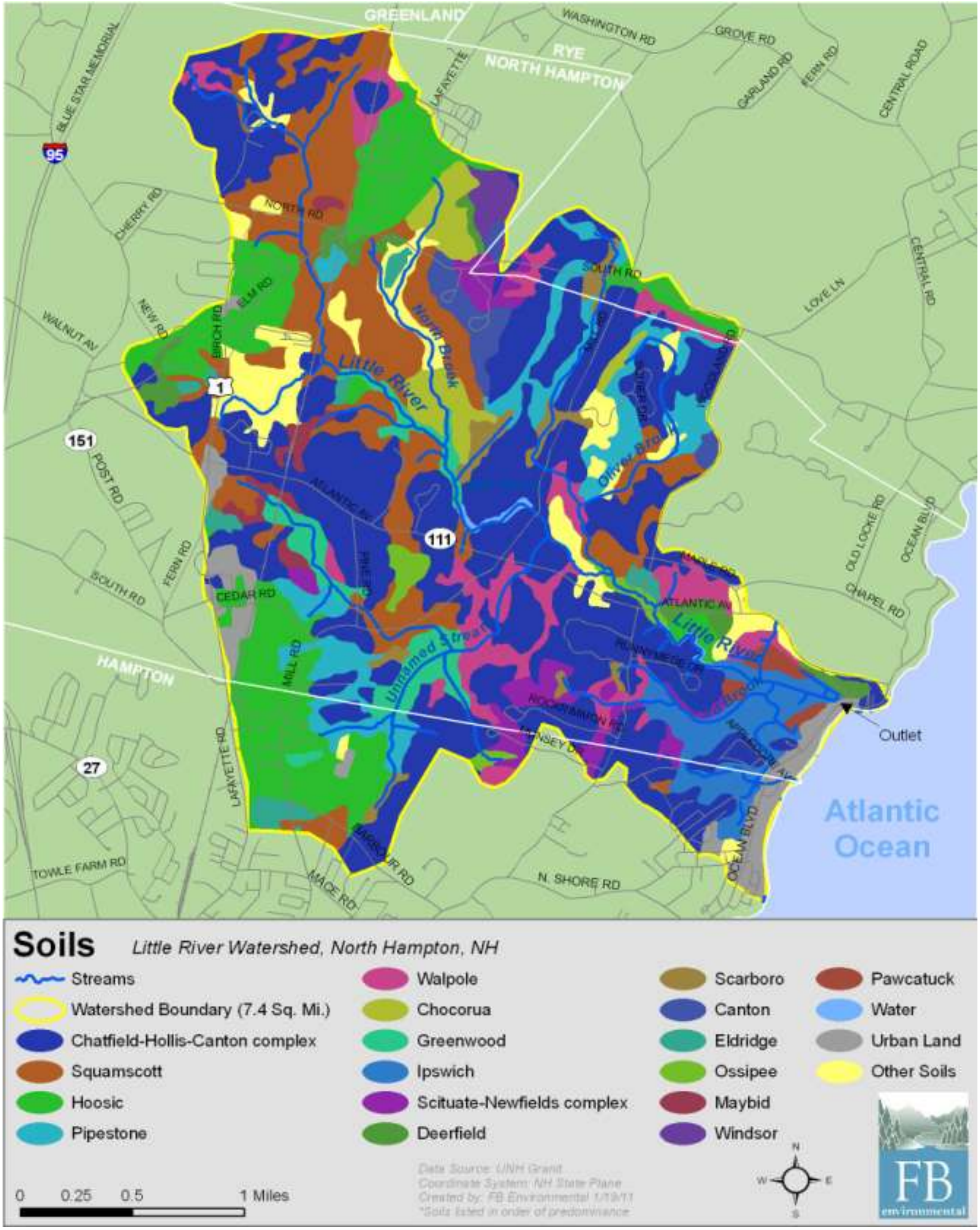


Figure 2.5. Map of Soils in the Little River Watershed

2.5.5 Protected Lands

There are currently 35 areas of land with development restrictions in the Little River watershed (Figure 2.6). These lands make up 12% of the watershed area. Preserved areas are a mix of private parcels, easements, and town owned land. The largest parcel is the Fitzgerald tract which is 104 acres in the Little River headwaters, above North Road, which includes the River channel.

The Wildlife Division of New Hampshire Department of Fish and Game, has outlined habitat of special significance in coastal areas of the state. These areas are designated as Conservation Focus Areas (CFAs). Each CFA is based around a core area which contains the natural resources necessary to maintain habitat and ecological integrity. Seventy-five areas have been identified as part of the conservation plan in coastal New Hampshire. There are three CFAs that are within or partially within Little River watershed:

- Upper Little River: above North Rd to outside of the watershed boundary (~327 acres)
- Middle Littler River: where North Brook and Little River meet above Atlantic Avenue (~595 acres)
- Lower Little River: the main tidal marsh area, below Garland Brook (~196 acres)

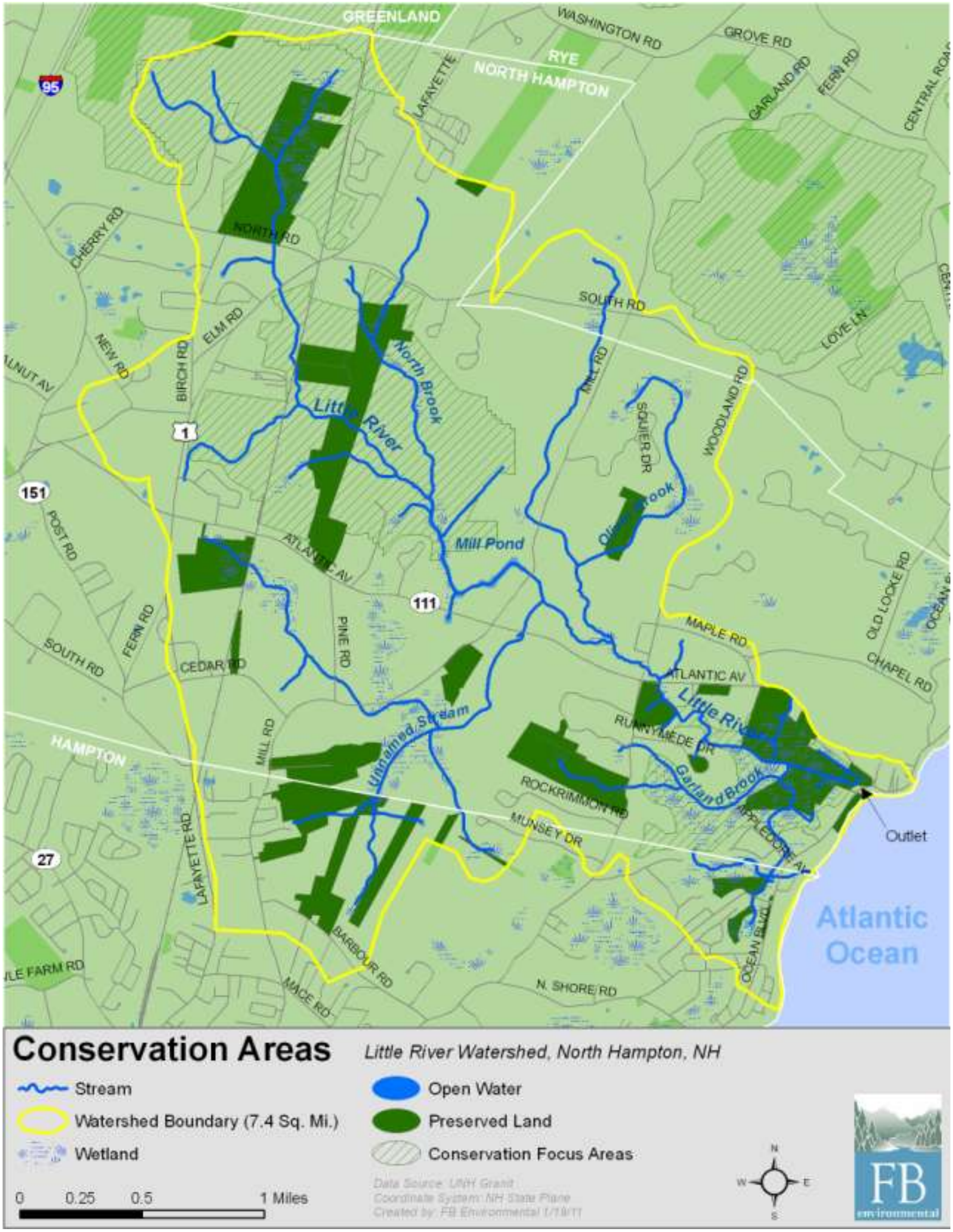


Figure 2.6. Map of Conservation Areas in Little River Watershed

Chapter 3. Water Quality Assessment

3.1 Water Quality Standards and Criteria

The types of pathogenic organisms potentially present in waters are highly varied and generally difficult to identify and assess individually. Therefore, scientists and public health officials usually monitor easy to enumerate nonpathogenic bacteria that typically occur at the same time as harmful pathogens. These associated bacteria are called indicator organisms. Indicator bacteria are not themselves typically a health risk but are used to measure the likely presence of pathogenic organisms. High densities of indicator bacteria signify the likelihood that pathogenic organisms are present (USEPA, 2001).

Water quality standards determine the baseline water quality that all surface waters of the State must meet in order to protect their intended uses. They are the "yardstick" for identifying where water quality violations exist and for determining the effectiveness of regulatory pollution control and prevention programs. The standards are composed of three parts: classification and designated uses, criteria, and anti-degradation regulations (NH DES, 2008a).

Little River is sampled for the indicator bacteria Enterococci , a subgroup of fecal streptococci. This organism lives in the gastrointestinal tract of warm blooded animals and has a lower die off rate than other fecal indicator organisms, such as *E. coli*. Nine sites in the Little River watershed were sampled for Enterococci .

3.1.1 Water Quality Classification and Designated Uses

Classification of surface waters is accomplished by state legislation under the authority of RSA 485-A:9 and RSA 485-A:10. By definition (RSA 485-A:2, XIV), "surface waters of the state means streams, lakes, ponds, and tidal waters within the jurisdiction of the state, including all streams, lakes, or ponds, bordering on the state, marshes, water courses and other bodies of water, natural or artificial." All State surface waters are either classified as Class A or Class B, with the majority of waters being Class B. NH DES maintains a list which includes a narrative description of all the legislative classified waters. Designated uses for each classification may be found in State statute RSA 485-A:8 and are summarized below and in Table 3.1.

- Class A: These are generally of the highest quality and are considered potentially usable for water supply after adequate treatment. Discharge of sewage or wastes is prohibited to waters of this classification.
- Class B: Of the second highest quality, these waters are considered acceptable for fishing, swimming and other recreational purposes, and, after adequate treatment, for use as water supplies.

Little River is classified as a Class B stream in New Hampshire and was listed on the 2008 303(d) list, the statewide listing of water features that do not meet water quality standards.

Pet waste is a contributor to high bacteria counts.

3.1.2 Applicable Water Quality Standards and Criteria

New Hampshire's water quality criteria for bacteria include numeric and narrative criteria which define the water quality requirements for Class A and B waters. Criteria are designed to protect the designated uses for each classification. Water quality criteria for bacteria are expressed in two ways: a geometric mean, and an instantaneous sample. A geometric mean is a way to average the results over time. It is commonly used assessing bacteria levels in water, because bacteria concentrations are often highly variable over the short term. Unlike an arithmetic mean, a geometric mean reduces the effect of an occasional high or low value on the average.

Bacteria levels at the mouth of Little River (station BCHSTBNHMLIT), which is tidal and held to the same standards as NH beaches, are consistently above the state Enterococci standards of 104 counts/100 mL instantaneous and 35 counts/100 mL geometric mean. Consistent violations at this site have led DES to list Little River as impaired due to bacteria concentrations which affect primary and secondary recreation uses.

Currently, New Hampshire does not have standards for Enterococci in freshwater streams. Much of the Little River is <u>not</u> tidal, and therefore high Enterococci levels measured in the freshwater portions of the river technically do not result in violations of any state water quality criteria. However, since a major water quality goal of this plan is to

Table 3.1. Designated Uses for New Hampshire Surface Waters

Designated Use	Definition	Applicability
Aquatic Life	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms	All surface waters
Fish Consumption	Waters that support fish free from contamination at levels that pose a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers	All tidal surface waters
Drinking Water Supply	Waters that with conventional treatment will be suitable for human intake and meet state/federal drinking water regulations.	All fresh surface waters
Primary Contact Recreation (i.e. swimming)	Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental indigestion of water.	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and riparian corridor to support wildlife as well as aquatic life.	All surface waters

provide safe recreation (swimming, boating, wading, etc.) at NH beaches, and the Little River drains to one of those beaches, the state standards that apply to tidal swimming beaches, 104 instantaneous and 35 geometric mean counts/100 mL, are used as comparison values.

3.2 Water Quality Data

3.2.1. State Beach

Little River water quality has been monitored since 2008 by NH DES Beach Program. Prior to 2008, NH DES Beach Program sampled only State Beach directly, which included the mouth of Little River upstream of Ocean Blvd (Figure 3.1). Bacteria levels at State Beach have continuously tested higher than state criteria allow for primary contact uses. Geometric means for the sites are comparatively high but they do decrease the farther away they are from the mouth of the Little River. Instantaneous sample maximums also follow the same declining pattern (Table 3.2). This pattern strongly suggests that bacteria are reaching State Beach from the Little River, causing exceedences of state water quality criteria. For full instantaneous sampling results, please refer to Appendix A.

Figure 3.1. Sampling Locations on State Beach, North Hampton

3.2.2 Little River

The Beach Program began monitoring upstream portions of the Little River because of concerns that bacteria were reaching State Beach, a popular summer recreation area, through the river. In 2009, this sampling was expanded to cover the entire watershed (Figure 3.2). Most sampling locations are easily accessed at road crossings and marsh edges.

Bacteria levels in Little River range from 8 to 6,000 colonies/100 mL (Table 3.3). Of the 9 sites sampled since 2009, all have at least one sample that exceeds 104 col/100mL, the state instantaneous standard for Enterococci for primary recreation (direct contact with water).

Hot spots identified through bacteria sampling are BCH 24 and BCH25. BCH18 needs continued monitoring to determine if recent efforts to remediate a malfunctioning septic system have been successful. BCH23 also needs continued monitoring and site assessment to identify sources. Since the site was first sampled in 2009 each subsequent sampling has yielded a result higher than the previous sample. Please refer to Appendix B for full sampling results.

Sampling was conducted on wet and dry weather days, resulting in variable bacteria concentrations. Higher counts were found on wet weather days due to storm runoff that picks up bacteria from a variety of sources and transports them to streams. All stations experienced wet weather bacteria exceedences.

Three of the stations experienced high bacteria counts during dry weather, including BCH25 identified above. High bacteria levels during dry weather may indicate malfunctioning septic systems, illicit connections of wastewater to storm drains, or other sources not associated with runoff.

Table 3.2. Summarized Enterococci results for monitoring stations on State Beach

Site ID	Site Location	Number of Samples	Data Date Range	Minimum Result	Maximum Result	Geometric Mean (cnts/100 mL)
BCHSTBNHMLF	State Beach - Left	255	2002-2010	<5	740	16
BCHSTBNHMCR	State Beach -Center	234	2002-2010	<5	520	12
BCHSTBNHMRT	State Beach - Right	249	2002-2010	0	490	12
BCHSTBNHLIT	State Beach - Little River Outlet	49	2008-2010	<5	880	**51**

Red text is used to indicate the sampling results that exceed the recommended geometric mean level for human skin contact: 35 cnts/100 mL

Table 3.3. Summarized Enterococci results of sampling stations in Little River

Site ID	Site Location	Number of Samples	Data Date Range	Minimum Result	Maximum Result	Geometric Mean (cnts/100 mL)
ACPS12-U30	Downstream side of Woodland Rd	21	7/31/2008 to 7/16/2010	9.0	420	**41**
BCHSTBNHMLRMR	Little River at Mill Rd	13	7/31/2008 to 7/16/2010	<10	310	**42**
BCH16	Little River -- North Rd	6	10/24/2009 to 07/16/2010	<10	640	**57**
BCH17	North Brook -- North Rd	6	10/24/2009 to 07/16/2010	<10	850	**55**
BCH18	Pipe at Shel Al Mobile Estates	6	10/24/2009 to 07/16/2010	<10	6000	**102**
BCH19	Upstream from pipe at Shel Al Mobile Estates	6	10/24/2009 to 07/16/2010	<10	200	31
BCH20	Oliver Brook -- House at 125A	8	10/24/2009 to 07/16/2010	8	230	31
BCH21	Little River --Rt 11 culvert	6	10/24/2009 to 07/16/2010	<10	210	33
BCH23	Little River -- Mill Rd culvert	6	10/24/2009 to 07/16/2010	9	1,300	**80**
BCH24	Garland Brook -- Woodland Rd	8	10/24/2009 to 07/16/2010	<10	1,500	**250**
BCH25	Little River -- Appledore Ave	6	10/24/2009 to 07/16/2010	100	260	**164**

Red text is used to indicate the sampling results that exceed the recommended geometric mean level for human skin contact: 35 cnts/100 mL

3.3 Establishing Water Quality Goals

Little River and associated wetlands cover a large amount of land in the town of North Hampton. They drain to State Beach which is a large attraction for tourism and residents. Measuring bacteria levels and addressing problem areas is essential to improving water quality in Little River, and protecting the beach. Reducing indicator bacteria counts to below state standards for a tidal swimming beach would protect human health and recreation in the watershed and at the beach.

The incoming tide floods the marsh in the Little River watershed.

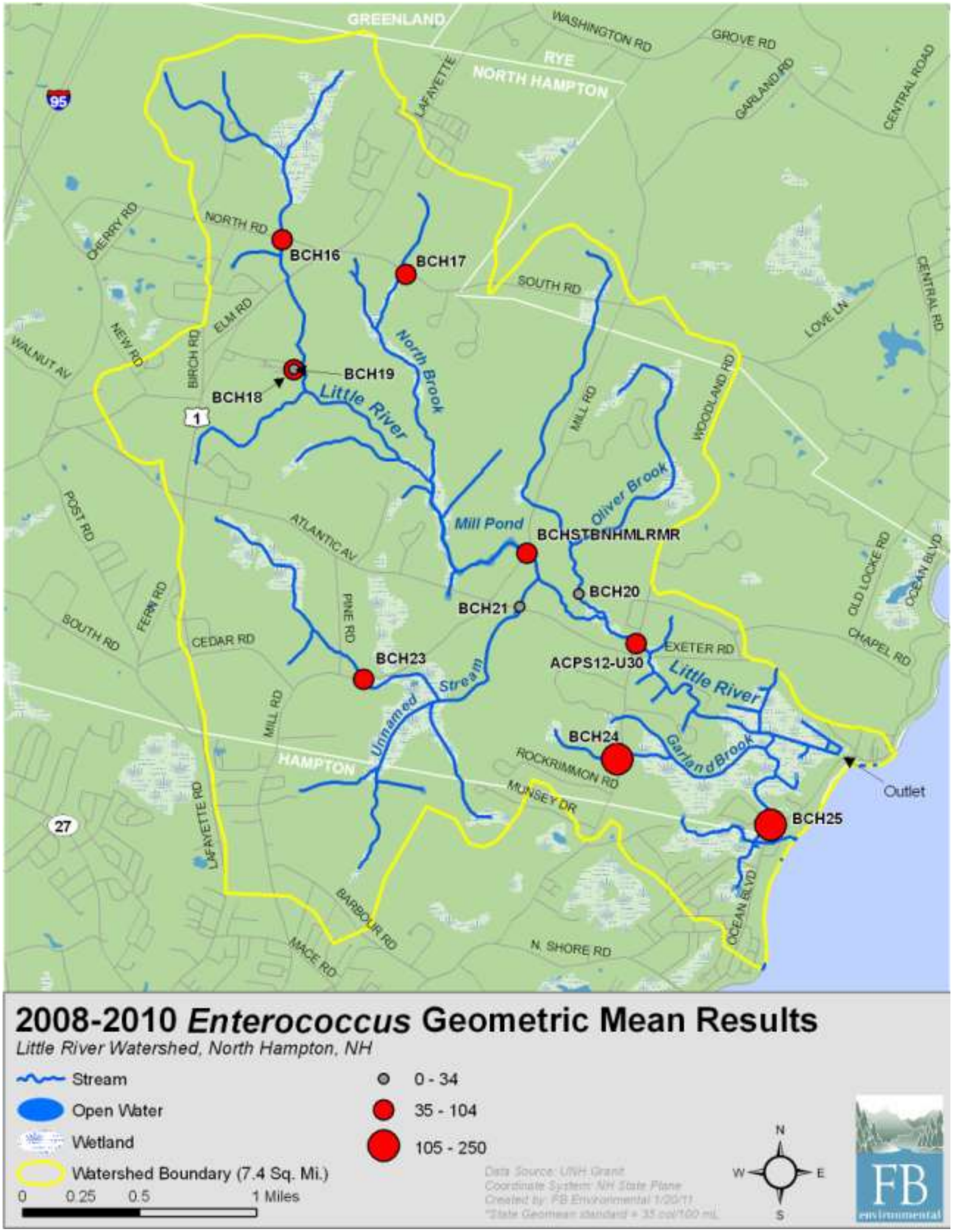


Figure 3.2. Map of Enterococci Sampling Locations and Geometric Means

4.Threats to Water Quality

4.1 Watershed Bacteria Source Investigation

Being able to identify areas of high bacteria concentrations, estimate loading, and prioritize pollutant sources within a watershed are all important aspects to successful watershed management. Two surveys, conducted by FB Environmental and NH DES staff, were completed to identify potential bacteria sources in the Little River Watershed. The surveys analyzed the entire watershed and were aimed at locating, describing, and documenting potential pollutant sources. The surveys were conducted on September 18, 2009, and November 24, 2009.

Bacteria sources, such as pet waste (bagged but abandoned), were noted at State Beach parking areas.

The September 18 survey focused on road/stream crossings and developed riparian areas. Maps of storm drains in North Hampton were unavailable at this time. Notable observations obtained during this survey include:

- The outlet of Little River was engineered to increase tidal influence and consists of 2 concrete box culverts under Ocean Boulevard near BCHSTBNHLIT (Figure 3.1)
- Little vegetated buffer was seen between homes and the estuary/river channel making waste disposal difficult. This was observed near sampling sites BCH25 and BCHSTBNHLIT.
- Improper pet waste disposal near State Beach despite clear signage.
- The second mouth (the breach) was blocked by sand, and water no longer reaches the ocean.

Figure 4.1. Map of hotspots explored in the Little River watershed during the November 16, 2009 watershed

The November 24, 2009, survey focused on identifying potential pollutant sources near locations where high bacteria counts had been observed in a late October, 2009, sampling event by NH DES staff. Order-of-magnitude exceedances of the Enterococci bacteria standard (104 Enterococci counts/100mL) were observed at 3 locations in the Little River watershed: site BCH24, site BCH25, and site BCH18. The results from that sampling event were used to target these specific areas during the survey. A summary of observations obtained upstream of each of these four sample sites is provided below.

Above Site BCH24

- A bacteria measurement of 1,500 cnts/100 mL was recorded in October 2009 during wet weather.
- The upstream site is entirely forested wetland with very low density residential.
- There were no clear signs of human-sources of bacteria-related contamination. Wildlife is a possible source.

Wildlife most likely impacts bacteria levels at BCH24

Above Site BCH25

- Enterococci levels of 260 counts/100mL were measured during wet weather sampling event in May 2010.
- New construction found directly adjacent to tidal channels with patchy vegetated buffers.
- Lawns appear to extend below the high water mark on to the marsh, as evidenced by tidal water rising through mowed areas.
- Given the close proximity of some buildings to the marsh in this area, these properties are considered a possible source of bacteria, as well as nutrients, to Little River.

Tidal waters adjacent to mowed marsh grass near BCH 25.

Above Site BCH18

Observations are from the September 8, 2009, survey

- A bacteria measurement of 6,000 counts/100mL Enterococci was collected during the early May 2010 wet weather sampling at Site BCH18.
- Biofilm was observed coating the pipe and discharge pool.
- The pipe is draining a residential mobile home park making wastewater and septic leachate a possible source of bacteria.

Pipe discharge in a wooded area near site BCH 18.

4.2 Bacteria Load Estimation

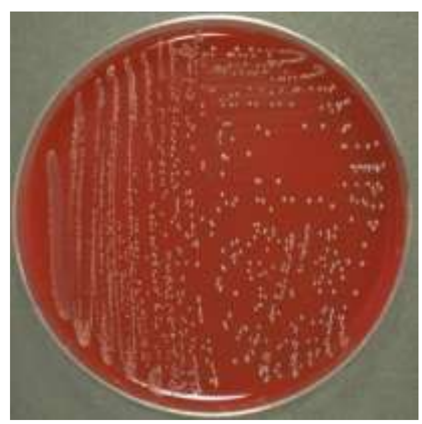
Creating bacteria load estimates helps to intelligently guide watershed protection and restoration efforts by providing insight into the most likely areas for water quality improvement. Much work towards a reasonable estimation of bacteria sources within NH coastal beach watersheds was completed last year as part of the *Coastal Beach Watershed Bacteria Source Investigation* report by FB Environmental (FBE), submitted to NH DES Beach Program in December 2009. Bacteria loads were estimated in 2008 and 2009 based on field reconnaissance, literature review, and use of computer modeling. Specifically, FBE used the Generalized Watershed Loading Function (GWLF) model, developed by Haith and Shoemaker in 1987, and refined regularly by Evans, Corradini, and Lehning at Penn State into a GIS-based model called AVGWLF (Evans *et al*., 2002).

Little River below Mill Rd.

Estimation of bacteria loading is difficult because there are many dispersed sources and bacteria counts can change dramatically and very quickly based on environmental conditions. There is significant uncertainty regarding several components of the bacteria load estimate, and it should be considered to an order-of-magnitude estimate. Specifically, key source characteristics, such as magnitude of sources and their proximity to streams, and key transport information, such as bacteria die-off rates, are extremely difficult to measure precisely, and the scientific literature is not extensive. The bacteria load estimates provided herein are screening level and are intended to support watershed planning and prioritization of remediation efforts.

4.2.1 Estimation Methods

A combination of literature, scientific models, and on-the-ground observations were used to estimate bacteria loads. The NH DES Beach Program samples for Enterococci at the Little River stations which is used to indicate the current fecal coliform load in the stream. The indicator bacteria used for the annual estimates is fecal coliform (FC). FC is a more general indicator of bacteria concentrations and includes all bacteria most commonly found in the fecal matter of organisms. FC includes *E. coli* and Enterococci and has the greatest amount of available research and data to support current and future load estimation in Little River. Bacteria load estimates are provided on an annual basis (i.e., counts/year) to allow uniform comparison across source types. The method of bacteria load estimation was deterministic, meaning that potential sources were identified, estimated based on field reconnaissance and literature values, and then summed. The following types of bacteria sources were considered:



Enterococci bacteria on an agar plate

- Developed area runoff (including abandoned pet waste): obtained by a spreadsheet model approach using event mean concentrations (ECM), annual precipitation, and developed area percent impervious cover.
- Malfunctioning septic systems: developed through a combination of field visits and literature review.
- Natural area runoff from wildlife: obtained by field visits, wildlife population estimates, and literature review.
- Agricultural area runoff from livestock: estimated through field visits, literature values, and the GWLF-E model. For a detailed description of methods utilized in this study see Appendix D.

A lack of vegetation can allow stormwater to flow, unfiltered, into Little River from developed areas.

For a detailed description of methods utilized in this study see Appendix C.

4.2.2 Estimated Annual Bacteria Load by Source

Developed Area Runoff

Developed area consists of buildings, roads, parking lots, landscaping, lawns, and all areas where land cover is altered or intensively managed. The Little River watershed has approximately 2.36 square miles of developed area representing approximately 31% of the watershed. Developed area runoff is surface water which flows across developed areas during precipitation events and enters streams or wetlands. Unmanaged pet waste is considered part of developed area runoff. Field surveys confirmed this assumption, finding pet waste left along streets and parking lots in developed areas. Developed area runoff was estimated using the widely applied event mean concentration (EMC) method utilized by the Center for Watershed Protection (CWP) (Schueler 1987). The following table (Table 4.1) summarizes the estimated annual developed area runoff bacteria loads in Little River watershed.

Seasonal cottages next to the Little River outlet have the potential to contribute a great amount of bacteria through sewage failures.

Table 4.1. Estimated Developed Area Runoff Bacteria (FC) Loads

	Developed Land Area (Sq. m.)	Developed Land Area (Sq. Mi.)	Annual Precip. (cm)	Runoff Fraction	EMC (org/100 mL)	Annual FC Load to Stream
Little River	6,105,000	2.36	118.4	0.22	7,000	1.1×10^{14}

** Runoff Fraction = 0.05+(0.9 x %IC) (Schueler 1987). For more information see appendix C.*

Failing Septic Systems

Septic systems can act as a major source of bacteria pollution when they do not function properly. The NH Subsurface Bureau defines septic system failure as Env-Wq 1002.30: "the condition produced when a subsurface sewage or waste disposal system does not properly contain or treat sewage or causes or threatens to cause the discharge of sewage on the ground surface or into adjacent surface or ground waters" (NH DES, 2008b). Malfunction can be caused by a variety of factors such as poor installment and maintenance, soil conditions, and overuse. Researchers conducted a literature review, and consulted with specialists in seacoast bacteria studies, and assigned a septic system failure rate within the Little River watershed of 24%.

This rate may appear high, but shallow subsurface transport of inadequately treated septic system waste to adjacent surface waters is considered a major portion of this loading. Shallow subsurface transport is greatly facilitated by seasonally high groundwater, and this condition is thought to be rarely detected by homeowners or neighbors because it does not affect interior plumbing, and it may only minimally affect lawn surfaces. For full detail on these calculations please see Appendix C. The following table (Table 4.2) summarizes the estimated annual failing septic system bacteria loads in Little River watershed.

Table 4.2. Estimated Population on Failing Septic Systems and Associated Bacteria Loading

	Little River
Total Population on Septic	2,538
Septic System Failure Rate	24%
Daily FC Load per Person	$2x10^{9}$
Population on Failing Septic Systems	190
Annual FC Load	$4.4x10^{13}$

Daily FC Load based on US EPA (2001)

Wildlife

Dr. Steve Jones, a microbiologist at UNH, conducted a review and compiled a wildlife bacteria sources report as part of the *Daily Bacterial Load Estimates for Wild Animals in the Seacoast Beaches of New Hampshire* (Jones 2009). His report identifies many different wildlife species present within the Little River watershed. The report also provides rough estimates of the magnitude of each wildlife source and identifies several dominant species including deer, geese, and raccoons. Therefore, these three species were selected and applied to represent large mammal, bird, and small mammal bacteria loads, respectively, in the watershed, given their high population densities. The above tables summarize

Table 4.3. Estimated Bacteria (FC) Loading for Selected Wildlife Species

Animal	Little River
Deer	$7.17x10^{11}$
Goose	$1.69x10^{10}$
Raccoon	$3.48x10^{13}$
Annual FC Load	$3.55x10^{13}$

the yearly bacteria loads for each of these three animals. The following table (Table 4.3) summarizes the total estimated annual wildlife bacteria loads in Little River watershed.

Agricultural runoff from Livestock

The total number of farm animals was estimated for the watershed, based on a combination of field observations and research into farming operations in the study area. It was estimated that Little River watershed contains 8 horses and 6 sheep. The AVGWLF model contains a well-developed farm animal bacteria loading estimation method that was applied. The method applied in AVGWLF requires inputs including bacterial loading rate per animal; number of each type of farm animal in the watershed; the amount of time spent by animals in barnyards, pasture, and streams; the amount of manure removed to agricultural land; manure soil incorporation rates; and runoff loss rates. These figures were obtained through literature review and field observations. These figures were obtained through literature review and field observations. Methods are described in detail in the *Coastal Beach Watershed Bacteria Source Investigation* (2009) report available from NH DES Beach Program.

Table 4.4. Estimated Bacteria (FC) Loading from Livestock

Farm Animal	Estimated Number of Animals	Annual FC Load per Animal/day	Annual FC Load in Little River
Horses	8	$4.2x10^{8}$	$6.4x10^{10}$
Sheep	6	$4.1x10^{10}$	$4.7x10^{12}$
Total			$4.7x10^{12}$

Annual FC Load per animal as determined from the American Society of Agricultural Engineers (2003)

4.3 Prioritization of Pollution Sources

The field surveys provided important information on the location of bacteria sources while the bacteria load estimates help to determine the greatest sources of bacteria pollution. This information was synthesized and potential sources were prioritized, allowing for a more targeted approach to watershed management. The basis for prioritization includes the size of the bacteria loads as previously estimated, but also the likelihood of successful mitigation. The highest estimated source may not be the easiest to manage and mitigate and therefore, will not be the highest priority. The following table provides a summary of the bacteria loads estimated by identified sources in the Little River watershed:

Table 4.5 Summarized Estimated Bacteria Loads from Identified Sources in Little River Watershed

	Land Area (Sq. Mi.)	Total Estimated (FC/yr)	Developed Area Runoff (FC/yr)	Failing Septic Systems (FC/yr)	Wildlife (FC/yr)	Farm Animals (FC/yr)
Little River	7.7	$1.9x10^{14}$	$1.1x10^{14}$	$4.4x10^{13}$	$3.6x10^{13}$	4.7×10^{12}

The resulting prioritized list of bacteria sources in Little River watershed are as follows, from highest priority to lowest: Potentially malfunctioning septic systems, specifically:

- In the vicinity of high bacteria counts, such as BCH18, and BCH24. Testing is ongoing, and will be analyzed when done to more fully identify potential source areas.
- All areas where wastewater infrastructure is greater than 25 years old. These areas are expected to occur throughout the watershed.
- The residential area near BCH25, including Appledore Ave and Boulters Cove Rd, North Hampton, due to the proximity to the marsh and shallow depth to bedrock.

High density development close to marshes, such as those in the Fifield Island development, have the potential to contribute bacteria to surface waters and beaches in cases of septic malfunctions.

Malfunctioning septic systems overall are estimated to contribute 4.4×10^{13} fecal coliform bacteria per year into surface waters of Little River watershed. This estimate assumes nearly one in four systems is failing, based on a detailed study of septic system records, structure ages, and available scientific literature. Records on file with both the state and the town were reviewed. As a source of bacteria, malfunctioning septic systems offer many direct opportunities for mitigation. To begin with, specific suspected sources (malfunctioning systems) can be definitively confirmed using soil tests, dye tests, smoke tests, or other methods. In addition, existing regulations prohibit inadequate wastewater treatment, and there are permitting and enforcement resources already at work in this field. Likewise, the technical expertise to fix these sources is readily available, in the form of thorough design guidelines and numerous design and installation professionals. Finally, and perhaps most importantly, almost all citizens and town officials already understand that wastewater must be properly treated to protect health and safety. These combined reasons make malfunctioning septic systems the highest priority bacteria source within Little River watershed.

Within the watershed, specific areas of suspected malfunctioning systems were identified using several methods. First and foremost among indicators is high bacteria counts in nearby surface waters. Other indications of wastewater failure include soggy lawns where septic disposal fields are likely sited, wastewater odors, and disproportionately lush vegetation growth. In some cases, though, wastewater failure might go undetected if these signs alone are relied upon, because bacteria can be carried long distances in groundwater flow. The watershed is highly susceptible to wastewater failures (see appendix C), and much of the infrastructure appears to be over 25 years old. At that age, the septic system failure rate is dramatically higher than for systems less than 10 years old. A watershed-wide approach, such as mandatory pump-outs every three to five years would be a good way to begin to mitigate this source.

Developed area runoff, specifically:

- Abandoned pet waste observed in the State Beach parking area.
- Lack of vegetated buffer surrounding the marsh on the Fifield Island development near BCH25.
- Lack of vegetated buffer between residences and the marsh along Huckleberry Ln.
- Lack of vegetated buffer between residences and the marsh along Runnymead Dr.
- Storm drains piped directly to surface waters from neighborhood north of BCH25.
- Roadway erosion upstream of BCH24.

Road erosion into the stream near BCH24.

Stormwater runoff from developed areas in the Little River watershed contributes an estimated 1.1×10^{14} fecal coliform bacteria per year, which is an order of magnitude above malfunctioning septic systems. Even though it is estimated as the largest contributor to overall bacteria loading, it is the second priority bacteria source. Stormwater runoff is somewhat less amenable to mitigation, because its sources are more diffuse. Even so, clear opportunities for reducing bacteria sources exist within Little River. Disconnecting storm drains from surface waters, promoting vegetative buffers along stream channels, and introducing or strengthening pet waste management programs are critical. Specific areas include those where abandoned pet waste has been observed adjacent to waterways, and where stormdrains convey developed area runoff directly into streams.

Horses can be a source of bacteria in the Little River watershed if not managed properly.

Farm animals represent the smallest source within Little River, however, sources are readily identified when present and mitigation is often straightforward. All reconnaissance to date indicates that farm animals remain separated from water features and their wastes properly managed, and thus are not a significant source. Best management practices have been published for manure handling and storage, and restricting direct access to streams. It is relatively easy to identify and correct cases where livestock are sources of bacteria pollution, and professional resources in the form of conservation services and cooperative extension are available. Therefore, agricultural sources are the third highest priority in this watershed.

Finally, wildlife is perhaps the most difficult bacteria source to mitigate. Specific animals are difficult to identify as sources. Management options, when they exist, are usually far from ideal. Wildlife, though not the smallest estimated source of bacteria, is considered the lowest priority source in the watershed.

4.4 Other Pollutant Sources

Some of the observed bacterial levels could be due to what are considered natural environmental background levels. A great deal more site-specific data would be necessary to attempt to separate these “background” bacteria levels from the total load in the WBP (USEPA 1999), and is impractical and unnecessary at the present time. The levels of Enterococci bacteria found by NH DES Beach Program in Little River were far above what is expected from natural background levels, evidenced by their frequently exceeding the levels for NH Class B streams. Numerous bacteria sources related to human activity were identified adjacent to streams, and remediation of those sources is clearly warranted to protect human health.

Chapter 5. Management Plan Rationale and Approach

5.1 Goals for Long Term Protection

Objectives of the Little River Watershed Based Plan are to improve the bacterial water quality of Little River, and therefore the adjacent public beaches, in order to protect human health. The NH DES lists impairment in the watershed on the 303(d) list as Forced Drainage Pumping and unknown causes. Identification of causes, further assessment, and community involvement are essential to long term protection of Little River. Specific objectives toward the attainment of these goals are indicated in the Action Plan (Section 6.2).


Wetland channel at BCH25

5.2 Structural Restoration Rationale

A structural Best Management Practice (BMP) is a physical installation intended to protect the environment from polluted runoff. Many are designed to mimic the natural hydrologic processes which are displaced by development, often trapping and filtering pollutants from stormwater runoff.

Developed area runoff can be lessened with stormwater retrofits such as:

- Removing unnecessary impervious pavement
- Planting rain gardens
- Installing rain barrels and drip edge filters for rooftop runoff
- Diverting runoff into natural areas for infiltration, rather than directly into surface waters; and
- Installing properly engineered and sized devices which detain and/or filter runoff from parking lots and buildings.


Pervious pavement allows water infiltration and reduction in winter road sand and salt necessary to keep roads clear.

Septic system replacement and repair is a form of structural BMP. Septic systems may malfunction for a variety of reasons, including improper installation or sizing, over use, failure to periodically pump out the tanks which can cause the leach field to clog, or old age. In many respects, they are an ideal candidate for pollution source reduction, because they are human-origin, under the direct control of their owners, and well-established regulations and procedures are in place to manage them at the state and municipal level. Replacement of septic systems is handled directly by the town, sometimes with assistance by the NH Subsurface Bureau.

Farm animal waste has the potential to contaminate the Little River through runoff. Management opportunities involving structural BMPs include waste containment and treatment. Stormwater BMPs, such as vegetated buffers and infiltration basins, can also be applied to catch and filter runoff before entering the River.

Methods for ensuring proper function of installed BMPs are to:

- Address the highest priority sites with an emphasis on sites with low-cost fixes;
- Work with landowners to get commitments for treating and maintaining sites;
- Work with experienced professionals on sites that require a high technical level of knowledge (engineering) to install, and ensure proper functioning of the system and BMP; and
- Measure the pollutant load reduction for each BMP installed in case of a failure.

These basic criteria will help guide the proper installation of BMPs in the watershed.

5.3 Non-structural Restoration Rationale

Non-structural watershed restoration practices focus on protecting and utilizing natural features to manage bacteria pollution at the source. Non-structural approaches to watershed restoration can be the most cost-effective elements of a watershed management plan. The non-structural approaches recommended in this plan not only improve water quality but can also enhance watershed aesthetics, streamline the permitting process, and reduce development costs. Examples of non-structural BMPs are:

- Protecting open space;
- Municipal regulations to require pet waste removal; and
- Educating landowners on septic system maintenance and stormwater runoff.

5.4 Addressing Current and Future Pollution Sources

Identified sources of pollution in the watershed include wildlife, farm animals, and septic systems. These sources were analyzed for bacteria loading using the model AVGWLF, as described above in section 4.2 and in Appendix C. Table 5.1 below provides a summary of estimated bacteria loads to Little River based on current populations.

Table 5.1. Summarized Estimated Bacteria Loads from Identified Sources in Little River Watershed

	Land Area (Sq. Mi.)	Total Estimated (FC/yr)	Developed Area Runoff (FC/yr)	Failing Septic Systems (FC/yr)	Wildlife (FC/yr)	Farm Animals (FC/yr)
Little River	7.7	$1.9x10^{14}$	$1.1x10^{14}$	$4.4x10^{13}$	$3.6x10^{13}$	4.7×10^{12}

Long term population trends show the watershed towns to be increasing in size over time. Even if the population did not grow, future pollutant loads from failing septic systems are expected to be larger than found today to reflect aging wastewater infrastructure. If long term trends continue and higher population density results, then loads may increase due to this fact. Septic system installation guidelines and inspections have become much more stringent in recent years, and redevelopment of older properties, if that redevelopment includes effective wastewater upgrades, could potentially mitigate some of the increased pressure on the Little River and beaches.

Developed area runoff bacteria loads are predicted to remain steady in the foreseeable future. Current activities in the watershed are expected to continue, and without effective BMPs, bacteria will wash into waterways as they do now. Regulations and education programs concerning pet waste management, plus stormwater reduction through landscaping and other onsite measures, can help address current and future polluted runoff in the watershed. Adapting regulations to treat stormwater on developed sites before leaving the property would be beneficial to the surrounding area and Little River.

It is important to note that while this plan concentrates on bacteria, treatment for bacteria could reduce other harmful pollutants as well, including:

- Nutrients (nitrogen, phosphorus, etc.)
- Heavy metals (cadmium, nickel, zinc, etc.)
- Petroleum products

Most of the above pollutants are carried in developed area runoff, identified above as a bacteria source. While these pollutants are currently not monitored, there are spreadsheet models available that would estimate pollutant reductions of these additional pollutants based on the type of BMP installed.

Developed area runoff can contribute nutrients, metals, and petroleum products, as well as bacteria to Little River and State Beach.

Chapter 6. Plan Implementation

6.1 Stakeholders to Administer the Plan

The Little River Watershed Based Plan is to be directed by a watershed stakeholder committee. It is important that watershed residents take part and direct the watershed based plan to gain valuable knowledge of water quality issues and how activities on the land affect the creek.

The watershed committee will meet regularly to direct and coordinate resources to implement practices that will reduce non-point source pollution and septic hazards. This task will need participation and support of a number of other entities including the Towns of North Hampton, Hampton, and Rye, NH DES, consultants/contractors, area landowners, volunteers, and commercial property owners. Smaller action committees of this stakeholder group should be formed to implement the Action Plan efficiently. Suggested action committees are as follows:

- Funding and Grants
- Water quality monitoring
- Stormwater
- Wastewater and Septic Systems
- Education and Outreach

All groups require interaction with others and cross-participation is encouraged for the successful implementation of this watershed based plan.

6.2 Watershed Action Strategy

The Action Plan recommends measures to reduce the highest priority bacteria pollution sources in the Little River watershed. These action items may be used to help the watershed towns apply for funding such as NH DES Watershed Assistance Program 319 grant program. The Action Plan is organized by prioritized pollutant source: malfunctioning septic systems, developed area runoff, followed by farm animals. Wildlife is not addressed in the action plan. Provided below is a summary of these action categories.

6.2.1 Malfunctioning Septic Systems

When properly installed, used, and maintained, septic systems effectively treat wastewater and protect surface and ground waters. New Hampshire has a thorough system of design standards, permitting, and installation inspections for new systems.

Malfunctioning septic systems, however, can be a significant source of bacterial pollution to surface waters. Age, overuse, and poor maintenance can cause malfunction. In addition, many older systems that are still in use were installed before the current era of thorough oversight, and may have been undersized or poorly installed. Together, these factors can result in the release of bacteria and other pollutants to nearby streams and ultimately the beaches.

*Funding sources:

Table 6.1. Summary of action items for malfunctioning septic systems

ACTION ITEM 1: Develop a comprehensive education and outreach plan to ensure community members understand proper maintenance or their septic system and the effects of malfunctioning systems to water quality						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319 Funding	Approximate Annual Cost**
a). Host education and outreach events	1). Host 3 Neighborhood "Septic Socials" per year	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319, PREP	Yes	$3,000
	2). Conduct 2 other septic system workshops (for town staff and govt.)	Town, NH DES, Consultants	2011-2012	DES 319, PREP	Yes	$2,000
b). Develop education and outreach materials	1). Create brochures and other literature to be made available to community members in town offices or via mailings	Town, Consultants	2011-2012	DES 319, PREP	Yes	$2,000
	2). Develop a webpage that provides information about septic system maintenance, water quality, town ordinances, and contact information for local septic maintenance businesses	Town, Consultants	2011-2012	DES 319	Yes	$3,000

DES 319 = New Hampshire Department of Environmental Services 319 grant program – pre-proposals due early September; project amounts $75-125K per year.
PREP = Piscataqua Region Estuaries Partnership – Programs to hire Technical Assistance Providers and provide outreach packets and educational materials to local communities.
CWSRF = Clean Water State Revolving Fund – Low or no interest loans available by states to fund local water quality projects.
SAG = State Aid Grant – Grant for up to 20% of eligible costs related to design, planning, and construction of some sewer facilities.
CDBG = Housing and Urban Development Community Development Block Grant – Grants can be used for construction and improvements to sewer facilities.
CEF = US EPA Center for Environmental Finance – Provides advice on obtaining funding for water quality projects.
**Cost estimates are based on a $60/hour rate and will need to be revised based on scope of services.

Table 6.1. Summary of action items for malfunctioning septic systems (continued)

ACTION ITEM 2: Conduct Illicit Discharge Detection and Elimination to identify malfunctioning systems						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319 Funding	Approximate Annual Cost**
a). Compile complete septic records in hot-spot areas	1). Continue work to identify septic system "hot-spot" areas through site surveys and prioritize based on age, proximity to surface water, and soil type	Town, Consultants	2011	DES 319, PREP	Yes	n/a
	2). Review town records to identify location and maintenance history of systems in hot-spot areas, i.e. around BCH 25	Town, Consultants	2011-2012	DES 319	Yes	$1,500
	3). Deliver "septic system surveys" to local residents to identify location and maintenance history of systems in hot-spot areas	Town, Consultants	2011-2012	DES 319	Yes	$2,000
	4). Conduct site visits to identify the location, age, and maintenance history of any septic systems not accounted for through other methods	Town, Consultants	2011-2012	DES 319	Yes	$6,000
b). Dye tests and/or septic inspections at areas with confirmed high bacterial results	1). Conduct dye tests or inspections on any systems already identified as malfunctioning	Town Health Officers	2015	NH DES, PREP, CWSRF	No	$5,000
	2). Expand the scope of these tests and inspections to include septic systems in areas with confirmed high bacteria counts	NH DES, Consultants	2015	NH DES, PREP, CWSRF	No	tbd

*Funding sources:
DES 319 = New Hampshire Department of Environmental Services 319 grant program – pre-proposals due early September; project amounts $75-125K per year.
PREP = Piscataqua Region Estuaries Partnership – Programs to hire Technical Assistance Providers and provide outreach packets and educational materials to local communities.
CWSRF = Clean Water State Revolving Fund – Low or no interest loans available by states to fund local water quality projects.
SAG = State Aid Grant – Grant for up to 20% of eligible costs related to design, planning, and construction of some sewer facilities.
CDBG = Housing and Urban Development Community Development Block Grant – Grants can be used for construction and improvements to sewer facilities.
CEF = US EPA Center for Environmental Finance – Provides advice on obtaining funding for water quality projects.
**Cost estimates are based on a $60/hour rate and will need to be revised based on scope of services.

Table 6.1. Summary of action items for malfunctioning septic systems (continued)

ACTION ITEM 3: Develop enforcement protocols for identified malfunctioning systems						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319 Funding	Approximate Annual Cost**
a). Develop a plan to identify, replace, and/or repair malfunctioning systems, using existing rules and resources	1). Coordinate with the NH DES Subsurface Bureau to develop these protocols	Town, NH DES	2011-2012	DES 319	Yes	n/a
	2). Encourage town residents to "register" their septic system with the town	Town, NH DES	2011-2012	DES 319	Yes	n/a
ACTION ITEM 4: Coordinate with the NH DES Subsurface Bureau to create universal record-keeping methods						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319	Approximate Annual
a). Develop a comprehensive, cross-checked database of septic system locations, ages, designs, etc.	1). Follow-up with any septic system records identified as incomplete by FBE through site visits and mailings	Town, NH DES, Consultants	2011-2012	DES 319	Yes	n/a
	2). Purchase specific "septic tracking software" to update and standardize record-keeping methods	Town, NH DES	2011-2012	DES 319	Yes	n/a

*Funding sources:
DES 319 = New Hampshire Department of Environmental Services 319 grant program – pre-proposals due early September; project amounts $75-125K per year.
PREP = Piscataqua Region Estuaries Partnership – Programs to hire Technical Assistance Providers and provide outreach packets and educational materials to local communities.
CWSRF = Clean Water State Revolving Fund – Low or no interest loans available by states to fund local water quality projects.
SAG = State Aid Grant – Grant for up to 20% of eligible costs related to design, planning, and construction of some sewer facilities.
CDBG = Housing and Urban Development Community Development Block Grant – Grants can be used for construction and improvements to sewer facilities.
CEF = US EPA Center for Environmental Finance – Provides advice on obtaining funding for water quality projects.
**Cost estimates are based on a $60/hour rate and will need to be revised based on scope of services.

Table 6.1. Summary of action items for malfunctioning septic systems (continued)

ACTION ITEM 5: Strengthen municipal ordinances to better protect surface waters from bacterial pollution						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319 Funding	Approximate Annual Cost**
a). Review municipal options to supplement state-level rules to ensure adequate water quality protection	1). Evaluate current state setback laws and identify which may need to be more stringent to protect waters in the Little River watershed	Town, Consultants	2011-2012	DES 319, PREP	Yes	$2,500
	2). Identify and report the procedures necessary to modify existing laws	Town, Consultants	2011-2012	DES 319, PREP	Yes	$3,000
	3). Review the waiver process to ensure adequate setbacks from wetlands and surface water	Town, Consultants	2011-2012	DES 319, PREP	Yes	$1,000
b). Institute an ordinance-level pump-out requirement	1). Develop a "maintenance schedule" for pump-outs	Town, Consultants	2011-2012	DES 319, PREP	Yes	$1,500
	2). Develop procedures to track maintenance throughout the watershed	Town, Consultants	2011-2012	DES 319, PREP	Yes	$2,500
c). Develop administrative protocols to ensure implementation of pump-out requirement	1). Send "pump-out reminders" to homeowners when it is time to service their septic system	Town	2011-2012	DES 319, PREP	Yes	$3,000
	2). Develop a universal "maintenance schedule" for septic systems	Town, Consultants	2011-2012	DES 319, PREP	Yes	$2,500

*Funding sources:
DES 319 = New Hampshire Department of Environmental Services 319 grant program – pre-proposals due early September; project amounts $75-125K per year.
PREP = Piscataqua Region Estuaries Partnership – Programs to hire Technical Assistance Providers and provide outreach packets and educational materials to local communities.
CWSRF = Clean Water State Revolving Fund – Low or no interest loans available by states to fund local water quality projects.
SAG = State Aid Grant – Grant for up to 20% of eligible costs related to design, planning, and construction of some sewer facilities.
CDBG = Housing and Urban Development Community Development Block Grant – Grants can be used for construction and improvements to sewer facilities.
CEF = US EPA Center for Environmental Finance – Provides advice on obtaining funding for water quality projects.
**Cost estimates are based on a $60/hour rate and will need to be revised based on scope of services.

Table 6.1. Summary of action items for malfunctioning septic systems (continued)

ACTION ITEM 6: Develop programs to finance septic system upgrades or replacements						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319 Funding	Approximate Annual Cost**
a). Explore possibility of zero or low interest loans for systems identified as malfunctioning	1). Evaluate similar existing programs in other states	Town, Consultants, NH DES	2011-2012	DES 319	Yes	$1,000
	2). Evaluate feasibility of developing a loan program in the Little River watershed	Town, Consultants, NH DES	2011-2012	DES 319, CEF	Yes	tbd
	3). Implement a loan program	Town, NH DES	2011-2012	DES 319, CWSRF	Yes	tbd
b). Explore other programs for septic system repair and replacement in water quality "hotspot" areas	1). Evaluate similar existing programs in other states	Town, Consultants	2011-2012	DES 319	Yes	$1,000
	2). Evaluate feasibility of developing a grant program in the Little River watershed	Town, Consultants	2011-2012	DES 319, CEF	Yes	tbd
	3). Evaluate feasibility of developing a fee-based program that requires homeowners to register their systems and pay an annual fee based on the calculated risk of contamination	Town, Consultants	2011-2012	DES 319, CEF	Yes	tbd
c). Explore possibility of using state, town, or federal funds to replace high-risk systems	1). Evaluate feasibility of developing a high-risk replacement program.	Town, NH DES, Consultants	2011-2012	DES 319, CEF	Yes	$1,000
	2). Develop protocols for replacement in emergency situations (i.e. placing a lien on the property).	Town, NH DES, Consultants	2011-2012	DES 319, CWSRF	Yes	n/a

*Funding sources:
DES 319 = New Hampshire Department of Environmental Services 319 grant program – pre-proposals due early September; project amounts $75-125K per year.
PREP = Piscataqua Region Estuaries Partnership – Programs to hire Technical Assistance Providers and provide outreach packets and educational materials to local communities.
CWSRF = Clean Water State Revolving Fund – Low or no interest loans available by states to fund local water quality projects.
SAG = State Aid Grant – Grant for up to 20% of eligible costs related to design, planning, and construction of some sewer facilities.
CDBG = Housing and Urban Development Community Development Block Grant – Grants can be used for construction and improvements to sewer facilities.
CEF = US EPA Center for Environmental Finance – Provides advice on obtaining funding for water quality projects.
**Cost estimates are based on a $60/hour rate and will need to be revised based on scope of services.

Table 6.1. Summary of action items for malfunctioning septic systems (continued)

ACTION ITEM 7: Evaluate alternatives to individual septic systems						
Tasks	Sub-Tasks	Who?	Schedule	Funding Sources*	Eligible for 319 Funding	Approximate Annual Cost**
a). Explore establishing community septic systems in at-risk areas	1). Evaluate similar existing programs in other states	Town, NH DES, Consultants	2011-2012	DES 319	Yes	n/a
	2). Identify areas that may be good candidates for community systems	Town, Consultants	2011-2012	DES 319, PREP	Yes	$2,000
	3). Replace individual systems in high-risk areas with community septic systems	Town, Consultants	2011-2012	DES 319, CWSRF	Yes	n/a
	4). Develop protocols for shared payment and maintenance responsibilities of community systems	Town, Consultants	2011-2012	DES 319	Yes	n/a
b). Explore installation of public sewers	1). Evaluate the feasibility of the construction of a public sewer system	Town, Consultants	2015	SAG, CDBG, CEF, PREP	No	high cost
Total Cost of Septic Action Items						$45,500
Suggested 2011 319 Grant Estimated Costs						$38,500

*Funding sources:
DES 319 = New Hampshire Department of Environmental Services 319 grant program – pre-proposals due early September; project amounts $75-125K per year.
PREP = Piscataqua Region Estuaries Partnership – Programs to hire Technical Assistance Providers and provide outreach packets and educational materials to local communities.
CWSRF = Clean Water State Revolving Fund – Low or no interest loans available by states to fund local water quality projects.
SAG = State Aid Grant – Grant for up to 20% of eligible costs related to design, planning, and construction of some sewer facilities.
CDBG = Housing and Urban Development Community Development Block Grant – Grants can be used for construction and improvements to sewer facilities.
CEF = US EPA Center for Environmental Finance – Provides advice on obtaining funding for water quality projects.
**Cost estimates are based on a $60/hour rate and will need to be revised based on scope of services.

Additional Technical and Financial Resources to Address Malfunctioning Septic Systems

Fortunately, there are ample technical resources for dealing with malfunctioning septic systems. These include:

- NH DES Subsurface Systems Bureau. This Bureau works to ensure that septic systems are properly designed, permitted, and installed. They also help address septic system failures. They may also help provide outreach and educational materials.
- NH DES Data Management Staff. These individuals maintain the OneStop online database through which septic system records are accessible. They may be able to help with data validation, and other issues to help ensure septic records can be integrated with municipal records.

- Municipal Building Officials. These staff may be able to help develop a catalog of buildings in town that have wastewater systems.
- Municipal Planning Board. These board members review ordinance proposals, and may play a role in drafting a septic system management ordinance.
- Rockingham Planning Commission, which is a voluntary local public organization funded by, sustained by, and tied directly to local governments. Their mission includes providing technical planning assistance, preparing water resource plans, helping towns develop master plans and capital improvement programs, informing towns about federal and state dollars that are available, and assisting them in applying for grants. This regional resource can assist the municipality in drafting a septic system management ordinance. *http://www.rpc-nh.org/*
- Licensed septic system designers and site evaluators. These professionals are hired by the landowner when a septic system needs to be designed and sited.
- NH DES Watershed Assistance Section, which works with local organizations, other programs within DES, and EPA New England, to improve water quality in New Hampshire at the watershed level, including Section 319 grants. *http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm*
- NH DES Wastewater Engineering Bureau. In the event alternatives to individual wastewater systems are considered, this Bureau addresses financing, engineering, and permitting of wastewater treatment facilities. *http://des.nh.gov/organization/divisions/water/wweb/*

The following organizations may provide useful case studies, documentation, or funding opportunities:

- Clean Water State Revolving Fund (CWSRF)
- State Aid Grant (SAG)
- U.S. Housing and Urban Development Community Development Block Grant (CDBG)
- EPA Center for Environmental Finance (CEF)
- Piscataqua Region Estuaries Partnership (PREP)
- Catskills Watershed Corporation (CWC)
- New York State Environmental Facilities Corporation (EFC)
- Henderson Watershed Protection Program (HWPP)

6.2.2 Developed Area Runoff

Runoff from developed areas is undoubtedly contributing bacteria to surface waters and wetlands. Sources of bacteria transported by runoff include pet waste, agricultural runoff, and many other diffuse sources. Stormwater runoff in the Little River watershed is estimated to contribute about the same quantity of bacteria to streams as malfunctioning septic systems. The overall strategy for addressing developed area runoff is to implement a combination of structural and non-structural best management practices (BMPs) that reduce pollutant loads to Little River (Table 6.2).

Additional Technical Assistance Available for Developed Area Runoff

There may be opportunities to reduce polluted runoff by collaborating with the following organizations.

- Seacoast Regional Stormwater Coalition, which focuses on assisting regulated New Hampshire Municipal Separate Storm Sewer System (MS4) municipalities comply with Phase II of the National Pollutant Discharge Elimination System Federal Stormwater regulations. The municipality is a member of this organization. *http://des.nh.gov/organization/divisions/water/stormwater/coalitions.htm*
- NH Natural Resources Outreach Coalition, a multi-organizational initiative offering coordinated assistance to communities wishing to protect their natural resources while accommodating growth. This organization selects up to three communities per year for assistance. *http://extension.unh.edu/CommDev/NROC/CANROC.cfm*
- UNH Stormwater Center. This research facility conducts research on the effectiveness of structural BMPs. *http://www.unh.edu/erg/cstev/*

There are many locally-based models for funding stormwater initiatives, such as a stormwater utility. A stormwater utility is an organization responsible for building and maintaining stormwater infrastructure. Participation can be voluntary or mandatory. It is typically funded by landowners using a fee structure based on amount of impervious cover owned. Examples include:

- Staunton, VA - formed by municipal ordinance.
- Sheboygan WI - formed by municipal ordinance.
- Long Creek Watershed Management District, Cumberland County, Maine - formed by interlocal agreement among several municipalities.
- Participation in a stormwater utility may be mandatory or voluntary, depending on the specific scope and responsibilities of the district.

Table 6.2. Summary of action items for developed area runoff

ACTION ITEM 1: Develop programs designed to reduce the amount of bacteria in developed area runoff						
Tasks	Sub-Tasks	Who?*	Schedule	Funding Sources	319 Funding Available	Approximate Annual Cost
a). Employ BMPs to encourage infiltration of runoff into soils	1). Install vegetated buffers between developed areas and wetlands	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	tbd
	2). Install an example vegetated buffer on municipal lands and post educational	Town, NH DES,	2011-2012	DES 319	Yes	$1,000
	3). Establish a town ordinance that requires vegetated buffers along "at-risk" sections of streams and wetlands	Town, NH DES	2015	tbd	No	$4,000
	4). Install rain gardens and filtering systems on residential properties and municipal lands	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	tbd
	5). Encourage the development of local watershed groups to assist with these efforts	Volunteers, Town, NH DES	2011-2012	DES 319	Yes	n/a
b). Employ BMPs to treat bacteria	1). Conduct a thorough review of existing BMPs and their ability to treat bacterial contamination	Town, Consultants	2011-2012	DES 319	Yes	$2,500
	2). Install rain gardens and filtering systems on residential properties and municipal lands	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	tbd
	3). Install constructed wetlands and bioretention ponds along roadways near "at-risk" streams and wetlands	Town, NH DES, NH DOT, Consultants	2011-2012	DES 319	Yes	tbd
	4). Encourage the development of local watershed groups to assist with these efforts	Volunteers, Town, NH DES	2011-2012	DES 319	Yes	n/a

*NHDOT = New Hampshire Department of Transportation

Table 6.2. Summary of action items for developed area runoff (continued)

ACTION ITEM 2: Develop programs to reduce impacts from storm water pipes to surface waters						
Tasks	Sub-Tasks	Who?*	Schedule	Funding Sources	319 Funding	Approximate Annual Cost
a). Continued research on storm drain-surface water connectivity	1). Obtain and review plans of existing storm drains	Town, NH DES,	2011-2012	DES 319	Yes	$1,500
	2). Conduct field visits to identify areas where storm drains are piped directly	Town, NH DES,	2011-2012	DES 319	Yes	$3,000
b). Employ structural Best Management Practices	1). Reduce the length of the outflow pipe so it does not drain directly into surface	Town, NH DES,	2011-2012	DES 319	Yes	tbd
	2). Install a vegetated buffer at the pipe outlet	Town, NH DES,	2011-2012	DES 319	Yes	tbd
	3). Install a UV light inside the pipe to treat for bacterial contamination	Town, NH DES,	2011-2012	DES 319	Yes	tbd
	4). Install filtering systems at the intake of the storm drain	Town, NH DES,	2011-2012	DES 319	Yes	tbd
	5). Develop a maintenance plan to ensure storm drains and filtering systems	Town, NH DES,	2011-2012	DES 319	Yes	$500
	6). Support rain barrel programs to reduce the amount of stormwater leaving residential properties	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	tbd
	7). Encourage the construction of rain gardens and vegetated buffers on residential properties to reduce the amount of stormwater leaving those	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	tbd
c). Employ non-structural Best Management Practices	1). Continue current "storm drain marking" programs	Town, NH DES,	2011-2012	DES 319	Yes	$1,000
	2). Develop education and outreach materials such as brochures and newsletters about BMP design, installation, and necessity	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	$2,000
	3). Develop a town webpage about BMP design, installation, and necessity	Volunteers, Town, NH DES, Consultants	2011-2012	DES 319	Yes	$1,500

*NHDOT = New Hampshire Department of Transportation

Table 6.2. Summary of action items for developed area runoff (continued)

ACTION ITEM 3: Evaluate current pet waste management programs						
Tasks	Sub-Tasks	Who?*	Schedule	Funding Sources	319 Funding Available	Approximate Annual Cost
a). Reduce pet waste along roads using ordinances	1). Review existing "pooper scooper" ordinances	Town, NH DES, Consultants	2011-2012	DES 319	Yes	$500
	2). Develop stricter enforcement of existing ordinances in "at-risk" areas	Town	2015		No	$1,000
b). Reduce pet waste along roads via education	1). Create brochures, posters, and newsletters outlining the importance of removing pet waste	Volunteers, Town	2011-2012	DES 319	Yes	$1,000
c). Create designated dog parks	1). Include techniques to reduce runoff of pet waste in the design of the park	Town, NH DES, Consultants	2011-2012	DES 319	Yes	$2,000
	2). Offer waste disposal bags and accessible trashcans within the park	Town	2011-2012	DES 319	Yes	$200
	3). Install a vegetated buffer between the park and nearby surface waters	Town, NH DES, Consultants	2011-2012	DES 319	Yes	tbd
	4). Include educational materials such as signs within the park	Town	2011-2012	DES 319	Yes	tbd
ACTION ITEM 4: Evaluate the placement and maintenance of public and portable toilets						
Tasks	Sub-Tasks	Who?*	Schedule	Funding Sources	319 Funding Available	Approximate Annual Cost
a). Remove portable toilets from streamside	1). Identify the location of any portable toilets near surface waters through site walks and surveys	Town, NH DES, Consultants	2011-2012	DES 319	Yes	$500
	2). Work with home or business owner to develop alternative placement	Town, NH DES, Consultants	2011-2012	DES 319	Yes	$500
b). Ensure properly functioning permanent facilities	1). Identify the location of permanent public toilets through the use of watershed maps, surveys, and GIS	Town, NH DES, Consultants	2011-2012	DES 319	Yes	$500
	2). Conduct dye or smoke tests at systems in high-risk areas	NH DES, Consultants	2015	PREP, CWSRF	No	$2,000
Total						$25,200
Suggested 2011 319 Grant Estimated Costs including $25,000 in BMP installation (sites tbd)						$50,200

*NHDOT = New Hampshire Department of Transportation

6.2.3 Agricultural Sources

Farm animals have the potential to contribute to the bacterial load of surface waters both directly, from grazing in and around streams and wetlands, and indirectly, from manure runoff. Though the total estimated contribution of bacteria from farm animals in the Little River watershed is not as large as malfunctioning septic systems or developed area runoff, it is a source of concern at some sites and there are opportunities to reduce loading (Table 6.3).

Additional Technical Assistance Available for Agricultural Pollution Reduction

There may be opportunities to reduce polluted runoff from livestock with the following organizations.

- Environmental Quality Incentives Program (EQIP), which is a voluntary program that provides assistance to farmers and ranchers who face threats to soil, water, air, and related natural resources on their land. *http://www.nh.nrcs.usda.gov/programs/Farm_Bill/EQIP/EQIP.html*
- USDA Farm Service Agency (FSA), among whose programs is the Conservation Reserve Program which is a voluntary program available to farmers to help them safeguard environmentally sensitive land. www.fsa.usda.gov
- NH Natural Resources Conservation Service, which offers the Agricultural Management Assistance (AMA) program, which is a cost-sharing program for farmers who voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation measures. *http://www.nh.nrcs.usda.gov/programs/Farm_Bill/AMA/AMA.html*
- NH DES Watershed Assistance Section, which works with local organizations, other programs within DES, and EPA New England, to improve water quality in New Hampshire at the watershed level, including Section 319 grants. *http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm*

Table 6.3. Summary of action items for agricultural runoff.

ACTION ITEM 1: Develop programs to repel wildlife						
Tasks	Sub-Tasks	Who?*	Schedule	Funding Sources	319 Funding Available	Approximate Annual Cost
a). Work with the state wildlife agency to repel birds and wildlife from surface waters	1). Modify habitat to make it unattractive to animals	Town, NHFG	2011-2012	n/a	Yes	n/a
	2). Use scarecrows, kites, or other devices to deter animals from sensitive areas	Town, NHFG	2011-2012	n/a	Yes	n/a
ACTION ITEM 2: Develop habitat-restriction programs						
Tasks	Sub-Tasks	Who?*	Schedule	Funding Sources	319 Funding Available	Approximate Annual Cost
a). Discourage wildlife from sensitive areas	1). Modify habitat through mowing or pruning of trees	Town, NHFG	2011-2012	n/a	Yes	n/a
b). Limit food sources from humans	1). Discourage the feeding of animals by humans through the use of signs	Town	2011-2012	n/a	Yes	n/a
	2). Continue programs to install closed-lid trashcans near beaches and parks	Town	2011-2012	n/a	Yes	n/a
Total						n/a
Suggested 2011 319 Grant Estimated Costs						n/a

*NHFG = New Hampshire Fish and Game

7. Methods for Measuring Success

7.1 Pollution Load Reduction Estimates Needed for Attainment

Little River (NH Assessment no. NHOCN000000000-06) is listed as impaired for bacteria under the Clean Water Act Section 303(d). The NH Statewide Bacteria Total Maximum Daily Load (NH DES 2010) indicates that the following load reductions are needed in order to attain water quality criteria:

- 92% reduction needed to meet Enterococci instantaneous sample criteria.
- 81% reduction needed to meet Enterococci geometric mean sample criteria.

Little River is also listed as impaired for fecal coliform. Currently, there is not sufficient data to determine reduction estimates.

In this watershed based plan, we adopt the most stringent of these load reductions. Applying this 90% reduction goal to the loading estimates presented in Section 4.1 results in the following reduction targets for each of the three priority sources.

Table 7.1: Fecal Coliform Loading Reduction Goals.

	Developed Area Runoff (FC/yr)	Failing Septic Systems (FC/yr)	Farm Animals (FC/yr)
Little River/State Beach Loading Estimates	$1.1x10^{14}$	$4.4x10^{13}$	$2.2 x 10^{10}$
Fecal Coliform Reduction Goal (90% Reduction)	$9.9x10^{13}$	$4.0x10^{13}$	$2.0 x 10^{10}$
Resulting FC Loading After Reductions	$1.1x10^{13}$	$4.4x10^{12}$	$2.2 x 10^{9}$

7.2 Measures Needed to Attain Bacteria Load Reduction

A 90% reduction in bacteria loads can be achieved by reducing loading from each of the three priority sources individually by 90%.

7.2.1 Septic System Load Reduction

In principle, all septic systems must be maintained in good working order by their owners to prevent potential health hazard due to failure of the system (see NH statute RSA 485-A:37). In practice, there are likely many systems in use today which do not meet that standard. Education, outreach, and enforcement applied consistently over a period of years will be required to attain a 90% reduction in malfunctioning septic systems in Little River watershed called for in this watershed plan. The measures outlined in Section 6.2.1 are aimed at the following goals:

1. Establishing a complete, readily-accessible record of all septic systems.

2. Requiring every septic system to be pumped out once every 3-5 years.

3. Inspecting systems at high risk for malfunction, specifically:

    a. Systems near streams with high bacteria levels, such as BCH 25.

    b. Systems which appear inundated during seasonally high groundwater, or that show other evidence of malfunction.

    c. Systems without any record of a permit or installation inspection on file anywhere.

    d. Systems older than 20-25 years.

4. Ensuring that all malfunctioning systems are promptly corrected.

If the above goals are achieved, the principle that every septic system must be maintained in good working order will gradually be put into practice, and the bacteria load reductions will be reduced by the 90% called for under this plan.

Table 7.2. Tips for homeowners to maintain their septic systems

Do	**Don't**
Install strainers around drains to catch hair, a major cause of septic failures.	Do not flush unnecessary paper products, food items, metal objects, or hygiene products.
Buy phosphate free detergents.	Don't use a garbage disposal—it adds harmful solids to the drainfield.
Use a dry well for back-flushing water softeners, instead of releasing it into your system.	Avoid disinfectants like bleach, which kill beneficial bacteria in your tank.
Use a lint filter on your washing machine; lint is a major source of solids that clog drainfields, especially from synthetic clothing.	Never use caustic toilet bowl and drain cleaners.
Never pour chemicals like paint, solvents, thinners, nail polish remover, kerosene, antifreeze, gas, or oil down drains. These can seep into ground water and poison drinking supplies.	

7.2.2 Developed Area Runoff Load Reduction

The steps outlined in Section 6.2.2 are aimed at reducing bacteria loading from developed area runoff by 90%. Specifically, those steps are intended to:

- Reduce the amount of runoff by reducing impervious cover.
- Reduce the bacteria in runoff by limiting abandoned pet waste and implementing non-structural BMPs such as street vacuum-sweeping.
- Reduce the impact of runoff by using structural BMPs.

Calculating load reductions from each individual measure is impractical at this stage of planning. In general, a 90% reduction in bacteria loading could be achieved by retaining via infiltration 90% of the runoff from developed areas in the watershed. This would involve removing direct discharges of stormwater from surface waters, and replacing them with outfalls that enter naturally pervious areas such as vegetative buffers, or constructed systems such as rain gardens, bioretention cells, and surface soil filters. Reducing impervious cover and allowing natural vegetation to grow disconnects runoff surfaces from Little River and its tributaries by providing a buffer and infiltration surfaces. New development should be encouraged to maximize natural areas and include low-impact development materials.

7.2.3 Agricultural Load Reduction

Direct runoff from active pasture into storm drains which connect to surface waters has been observed in the watershed. If this direct drainage to surface waters is replaced with infiltration BMPs, it is expected that the bacteria load to streams from agricultural sources would be virtually eliminated.

An example of an applicable infiltration BMP for agricultural load reduction is a conservation buffer. Conservation buffers are small strips of fallow land designed to intercept pollutants before exiting the agricultural area (NRCS, 2011). They can be used between agricultural fields and surface water, surrounding properties, and fields for different uses. The width of a buffer strip increases based on the slope of the land, the volume of stormwater, and the intensity of the land use (fertilizers, crop rotations, animal grazing, etc.).

In any case, bacteria loads from agriculture are estimated to be an order of magnitude below malfunctioning septic systems and developed area runoff, therefore attainment depends primarily on achieving load reductions in those two areas.

7.3 Criteria for Measuring Load Reductions

The primary measure of successful load reductions will be consistent attainment of geometric mean and instantaneous sample criteria for bacteria at the sites regularly sampled by the NH DES Beach Program at the coastal edge of the watershed. These sites are Little River Outlet and all three State Beach sample stations.

Additional stream bacteria sampling within the watershed will be useful as an intermediate measure of success in demonstrating whether bacteria hotspots have been successfully reduced. The map in Figure 7.1, shows where sampling has occurred in 2008-10. A series of samples (ideally more than 5 samples, and including both wet and dry weather) would be taken after targeted restoration activities in order to best assess effectiveness.

7.4 Measurable Milestones Toward Bacteria Load Reduction

Establishing interim milestones helps gauge ongoing progress in implementing the plan and allow for periodic updates to the plan. They provide a sense of progress that complements ongoing water quality monitoring. These measures should be assessed annually. The following indicators relate to the Action Plan in Section 6.2.

7.4.1 Septic System Milestones

1. Group of stakeholders has been formed and has met to plan actions.
2. NH DES Section 319 Grant, or other appropriate funding, has been applied for.

3. Educational materials have been mailed out to watershed residents outlining septic system maintenance.
4. An illicit discharge detection and elimination effort has been completed for hotspot areas.
5. A comprehensive list of septic systems in the watershed has been compiled and is being maintained.
6. Municipal planning board has been briefed on the issue of risk to water quality from malfunctioning septic systems, and the option for mandatory septic inspection and pump-out ordinances have been discussed.
7. Mandatory septic inspection and pump-out ordinances have been passed.
8. Administrative procedures are in place to track and enforce mandatory septic inspection and pump-out ordinances.

7.4.2 Developed Area Runoff Milestones

1. Stakeholder group has been formed and has met to plan actions.
2. NH DES Section 319 Grant, or other appropriate funding, has been applied for.
3. Pet waste ordinance and administrative / enforcement procedures have been reviewed.
4. Pet waste disposal educational materials have been mailed to watershed residents.
5. Ordinance limits on impervious cover have been reviewed.
6. Ordinance changes to pet waste and impervious cover limits have been enacted, if needed.
7. Stormwater hotspots needing structural BMPs have been identified.
8. Candidate structural BMPs have been identified for above hotspots.
9. Cost estimates and initial conceptual plan for installing structural BMPs above are complete.
10. Structural BMPs are installed.
11. Non-structural BMPs / good housekeeping methods have been reviewed and updated to reflect bacteria reduction goals.
12. MS4 program reports progress made in reducing stormwater impacts.

7.4.3 Agricultural Milestones

1. Stakeholder group has been formed and has met to plan actions.
2. NH DES Section 319 Grant, EQIP, FSA, AMA, or other appropriate funding, has been applied for.
3. Active pasture has been hydrologically disconnected from surface waters.
4. Manure management within watershed has been reviewed and modified if needed to ensure attainment of water quality criteria.
5. Buffer ordinances to prevent polluted runoff from leaving the site have been passed.
6. Buffers have been installed.

7. Ongoing inspection, through sampling and viewing, has shown runoff to decline in bacteria concentration and clarity and odor has improved.

7.4.4 Other Milestones

1. Overall stakeholder group has been formed and has met to coordinate the watershed based plan. The following stakeholders are represented:

    a. Municipal officers, including Planning Board, Town Administrators, Public Works, and MS4 Administrators

    b. NH DES Subsurface Systems Bureau

    c. NH DES Total Maximum Daily Load Program, handling impaired waters and the MS4 program

    d. NH DES Watershed Assistance Section

    e. NH DES Beach Program, handling bacteria monitoring

    f. EPA Region 1, NPDES / MS4 program

    g. Other local / state / federal stakeholders, as appropriate

2. Monitoring of Little River Outlet and State Beach continues in order to measure water quality attainment.

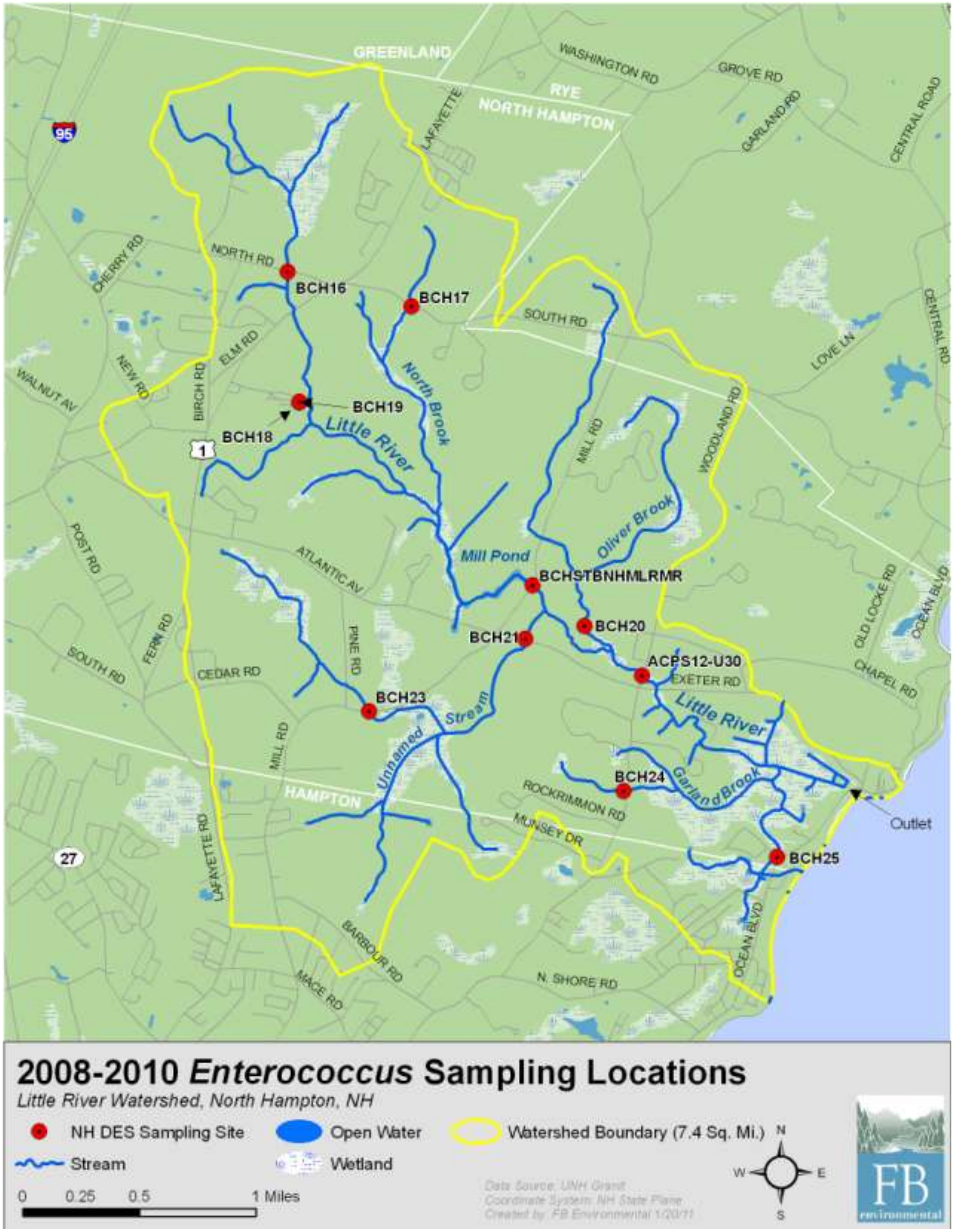


Figure 7.1. Map of Sampling Locations in Little River Watershed

Glossary of Terms

AMA –Agricultural Management Assistance (AMA) program, offered by the New Hampshire Natural Resources Conservation Service, is a cost-sharing program for farmers who voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation measures.

BMP - Best Management Practice (BMP) is a structural or procedural practice to reduce pollution carried in stormwater such as bacteria, nutrients, and metals. Examples of BMPs are buffer strips, retention ponds, fertilizer management, etc.

CFA -Conservation Focus Areas (CFAs) are tracts of land that host critical ecological, biological, and water resources that are vital to the local environment.

ECM - Event Mean Concentration (EMC) is a method for characterizing pollutant concentrations in a receiving water from a runoff event. EMC involves many samples taken at various points in time and place during a runoff event and compiling into a single sample.

EQIP - Environmental Quality Incentives Program (EQIP) provides assistance to agricultural land owners that are facing declining product production due to threats from natural resources such as soil, water, and air.

FC - Fecal coliform (FC) is a group of indicator bacteria that includes well-known varieties Enterococci and *E. coli*. FC is found in the gastrointestinal track of warm-blooded animals and can cause health effects in humans and animals alike when in contact with open wounds.

FSA - The Farm Service Agency (FSA), a part of the US Department of Agriculture, has multiple programs to assist the agricultural community, including the Conservation Reserve Program to help farmers protect environmental sensitive land.

GWLF - Generalized Watershed Loading Function (GWLF) is a modeling program, used in conjunction with ArcView GIS software, to estimate the extent and magnitude of non-point source pollution in a given watershed.

MS4 - Municipal Separate Storm Sewer Systems (MS4) transports stormwater runoff from impervious areas and discharges it, often untreated, into waterways. Towns must obtain a NPDES permit to discharge stormwater and must develop a stormwater management plan.

NHDES - New Hampshire Department of Environmental Services (NHDES)

NPS - Non-point Source (NPS) pollution, as opposed to point source pollution, is more difficult to determine a direct cause. Developed area runoff is a type of NPS pollution and occurs when stormwater washes over land area, collecting bacteria, nutrients, metals, and sediment and deposits it in surface water.

NRCS - The National Resources Conservation Service (NRCS), a federal organization, works with landowners on a local level to protect soil, water, air, plants, and animals through conservation planning and management.

PCB - Polychlorinated Biphenyl's (PCBs) are persistent organic pollutants that accumulate in the tissues of animals. PCBs were used in transformers, capacitors, and coolants and are no longer allowed to be produced in the Unites States.

PREP - Piscataqua Region Estuaries Partnership (PREP) is part of the US EPA National Estuary Program and is overseen by the University of New Hampshire. Its goal is to restore and protect the estuaries in the Piscataqua River watershed and provides funding for pollution mitigation projects.

TMDL - Total Maximum Daily Load (TMDL) is an assessment of the maximum amount of a pollutant per day a waterbody can receive and still meet water quality criteria. Section 303(d) of the Clean Water Act requires all surface waters to be evaluated for all impairments prior to remediation.

US EPA - United States Environmental Protection Agency (US EPA) is a branch of the federal government that regulates all environmental actions in the United States. The US EPA has many funding programs to encourage a clean and healthy environment.

WBMP - A Watershed Based Management Plan (WBMP) is an adaptive approach to impaired water resource management aimed to reduce or remove the impairment of the surface waterbody.

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Appendix A: Beach Sampling Data

State Beach

Table A1. Instantaneous Enterococci Results from State Beach (Left Station — **BCHSTBNHMLF) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2002	06/13/2002	**130**
SAMPLE - ROUTINE	2002	06/18/2002	<10
SAMPLE - ROUTINE	2002	06/25/2002	10
SAMPLE - ROUTINE	2002	07/03/2002	<10
SAMPLE - ROUTINE	2002	07/10/2002	<10
SAMPLE - ROUTINE	2002	07/15/2002	60
SAMPLE - ROUTINE	2002	07/22/2002	10
SAMPLE - ROUTINE	2002	07/24/2002	20
SAMPLE - ROUTINE	2002	07/30/2002	<10
SAMPLE - ROUTINE	2002	08/06/2002	10
SAMPLE - ROUTINE	2002	08/13/2002	<10
SAMPLE - ROUTINE	2002	08/19/2002	<10
SAMPLE - ROUTINE	2002	08/26/2002	<10
SAMPLE - ROUTINE	2002	08/28/2002	<5
SAMPLE - ROUTINE	2002	09/04/2002	30
SAMPLE - ROUTINE	2003	06/02/2003	40
SAMPLE - QC DUPLICATE	2003	06/02/2003	50
SAMPLE - ROUTINE	2003	06/09/2003	40
SAMPLE - ROUTINE	2003	06/16/2003	10
SAMPLE - ROUTINE	2003	06/24/2003	50
SAMPLE - ROUTINE	2003	06/30/2003	<10
SAMPLE - ROUTINE	2003	07/07/2003	10
SAMPLE - ROUTINE	2003	07/14/2003	20
SAMPLE - ROUTINE	2003	07/17/2003	40
SAMPLE - ROUTINE	2003	07/24/2003	20
SAMPLE - ROUTINE	2003	07/28/2003	<10
SAMPLE - ROUTINE	2003	08/04/2003	**120**
SAMPLE - ROUTINE	2003	08/07/2003	40
SAMPLE - ROUTINE	2003	08/11/2003	20
SAMPLE - ROUTINE	2003	08/18/2003	10
SAMPLE - ROUTINE	2003	08/25/2003	<10
SAMPLE - ROUTINE	2003	09/16/2003	<10
SAMPLE - ROUTINE	2004	04/15/2004	<10
SAMPLE - ROUTINE	2004	05/11/2004	<10
SAMPLE - ROUTINE	2004	05/27/2004	20
SAMPLE - ROUTINE	2004	06/01/2004	<10
SAMPLE - ROUTINE	2004	06/07/2004	**250**
SAMPLE - ROUTINE	2004	06/09/2004	10
SAMPLE - QC DUPLICATE	2004	06/15/2004	<10

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2004	06/15/2004	<10
SAMPLE - ROUTINE	2004	06/21/2004	<10
SAMPLE - ROUTINE	2004	06/29/2004	<10
SAMPLE - ROUTINE	2004	07/07/2004	20
SAMPLE - QC DUPLICATE	2004	07/07/2004	<10
SAMPLE - ROUTINE	2004	07/13/2004	5
SAMPLE - ROUTINE	2004	07/19/2004	10
SAMPLE - ROUTINE	2004	07/27/2004	<10
SAMPLE - QC DUPLICATE	2004	08/03/2004	10
SAMPLE - ROUTINE	2004	08/03/2004	10
SAMPLE - ROUTINE	2004	08/10/2004	<10
SAMPLE - ROUTINE	2004	08/17/2004	50
SAMPLE - ROUTINE	2004	08/23/2004	60
SAMPLE - ROUTINE	2004	08/30/2004	20
SAMPLE - ROUTINE	2005	06/01/2005	10
SAMPLE - ROUTINE	2005	06/13/2005	<10
SAMPLE - ROUTINE	2005	06/21/2005	<10
SAMPLE - ROUTINE	2005	06/28/2005	30
SAMPLE - ROUTINE	2005	07/05/2005	5
SAMPLE - ROUTINE	2005	07/13/2005	<10
SAMPLE - ROUTINE	2005	07/19/2005	30
SAMPLE - ROUTINE	2005	07/25/2005	<10
SAMPLE - ROUTINE	2005	08/03/2005	<10
SAMPLE - ROUTINE	2005	08/09/2005	<10
SAMPLE - ROUTINE	2005	08/15/2005	<10
SAMPLE - ROUTINE	2005	08/24/2005	<10
SAMPLE - ROUTINE	2005	08/30/2005	20
SAMPLE - ROUTINE	2006	05/31/2006	40
SAMPLE - ROUTINE	2006	06/06/2006	<10
SAMPLE - QC DUPLICATE	2006	06/08/2006	40
SAMPLE - ROUTINE	2006	06/08/2006	90
SAMPLE - ROUTINE	2006	06/12/2006	40
SAMPLE - QC DUPLICATE	2006	06/12/2006	50
SAMPLE - ROUTINE	2006	06/15/2006	30
SAMPLE - QC DUPLICATE	2006	06/15/2006	60
SAMPLE - QC DUPLICATE	2006	06/21/2006	<10
SAMPLE - ROUTINE	2006	06/21/2006	<10
SAMPLE - ROUTINE	2006	06/22/2006	40
SAMPLE - ROUTINE	2006	06/27/2006	20

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A1. Instantaneous Enterococci Results from State Beach (Left Station — BCHSTBNHMLF)

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2006	06/29/2006	70
SAMPLE - ROUTINE	2006	07/05/2006	<10
SAMPLE - ROUTINE	2006	07/10/2006	<10
SAMPLE - ROUTINE	2006	07/13/2006	**330**
SAMPLE - ROUTINE	2006	07/17/2006	40
SAMPLE - ROUTINE	2006	07/18/2006	10
SAMPLE - ROUTINE	2006	07/19/2006	10
SAMPLE - QC DUPLICATE	2006	07/19/2006	50
SAMPLE - ROUTINE	2006	07/24/2006	10
SAMPLE - QC DUPLICATE	2006	07/24/2006	<10
SAMPLE - ROUTINE	2006	07/25/2006	10
SAMPLE - ROUTINE	2006	08/02/2006	<10
SAMPLE - ROUTINE	2006	08/03/2006	<10
SAMPLE - QC DUPLICATE	2006	08/08/2006	10
SAMPLE - ROUTINE	2006	08/08/2006	<10
SAMPLE - QC DUPLICATE	2006	08/09/2006	10
SAMPLE - ROUTINE	2006	08/09/2006	<10
SAMPLE - QC DUPLICATE	2006	08/14/2006	30
SAMPLE - ROUTINE	2006	08/14/2006	<10
SAMPLE - QC DUPLICATE	2006	08/15/2006	<10
SAMPLE - ROUTINE	2006	08/15/2006	<10
SAMPLE - ROUTINE	2006	08/23/2006	<10
SAMPLE - ROUTINE	2006	08/24/2006	**740**
SAMPLE - ROUTINE	2006	08/25/2006	<10
SAMPLE - ROUTINE	2006	08/29/2006	20
SAMPLE - QC DUPLICATE	2006	08/30/2006	<10
SAMPLE - ROUTINE	2006	08/30/2006	<10
SAMPLE - QC DUPLICATE	2007	05/29/2007	<10
SAMPLE - ROUTINE	2007	05/29/2007	<10
SAMPLE - ROUTINE	2007	06/05/2007	<10
SAMPLE - ROUTINE	2007	06/07/2007	<10
SAMPLE - ROUTINE	2007	06/11/2007	20
SAMPLE - QC DUPLICATE	2007	06/11/2007	<10
SAMPLE - ROUTINE	2007	06/14/2007	10
SAMPLE - ROUTINE	2007	06/19/2007	50
SAMPLE - ROUTINE	2007	06/21/2007	<10
SAMPLE - ROUTINE	2007	06/26/2007	10
SAMPLE - ROUTINE	2007	06/28/2007	<10
SAMPLE - ROUTINE	2007	07/02/2007	<10
SAMPLE - QC DUPLICATE	2007	07/05/2007	**153**
SAMPLE - ROUTINE	2007	07/05/2007	**199**
SAMPLE - ROUTINE	2007	07/09/2007	**109**
SAMPLE - QC DUPLICATE	2007	07/09/2007	**121**
SAMPLE - QC DUPLICATE	2007	07/12/2007	<10
SAMPLE - ROUTINE	2007	07/12/2007	<10
SAMPLE - ROUTINE	2007	07/17/2007	<10
SAMPLE - ROUTINE	2007	07/18/2007	30
SAMPLE - ROUTINE	2007	07/23/2007	<10
SAMPLE - QC DUPLICATE	2007	07/24/2007	<10
SAMPLE - ROUTINE	2007	07/24/2007	<10
SAMPLE - ROUTINE	2007	08/01/2007	40
SAMPLE - ROUTINE	2007	08/02/2007	<10
SAMPLE - ROUTINE	2007	08/07/2007	**130**
SAMPLE - QC DUPLICATE	2007	08/07/2007	**140**
SAMPLE - ROUTINE	2007	08/08/2007	<10
SAMPLE - QC DUPLICATE	2007	08/13/2007	<10
SAMPLE - ROUTINE	2007	08/13/2007	<10
SAMPLE - QC DUPLICATE	2007	08/14/2007	20
SAMPLE - ROUTINE	2007	08/14/2007	<10
SAMPLE - ROUTINE	2007	08/21/2007	<5
SAMPLE - QC DUPLICATE	2007	08/23/2007	<10
SAMPLE - ROUTINE	2007	08/23/2007	<10
SAMPLE - ROUTINE	2007	08/28/2007	10
SAMPLE - ROUTINE	2007	08/29/2007	20
SAMPLE - ROUTINE	2007	09/13/2007	<10
SAMPLE - ROUTINE	2008	05/27/2008	<10
SAMPLE - ROUTINE	2008	05/28/2008	<10
SAMPLE - QC DUPLICATE	2008	06/02/2008	<10
SAMPLE - ROUTINE	2008	06/02/2008	<10
SAMPLE - ROUTINE	2008	06/05/2008	10
SAMPLE - ROUTINE	2008	06/11/2008	<10
SAMPLE - ROUTINE	2008	06/12/2008	<10
SAMPLE - ROUTINE	2008	06/17/2008	<10
SAMPLE - ROUTINE	2008	06/18/2008	<10
SAMPLE - ROUTINE	2008	06/23/2008	50
SAMPLE - ROUTINE	2008	06/27/2008	<10
SAMPLE - ROUTINE	2008	06/30/2008	60
SAMPLE - ROUTINE	2008	07/02/2008	20

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A1. Instantaneous Enterococci Results from State Beach (Left Station — **BCHSTBNHMLF) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2008	07/07/2008	20
SAMPLE - QC DUPLICATE	2008	07/07/2008	<10
SAMPLE - ROUTINE	2008	07/08/2008	<10
SAMPLE - ROUTINE	2008	07/16/2008	<10
SAMPLE - ROUTINE	2008	07/17/2008	<10
SAMPLE - ROUTINE	2008	07/22/2008	20
SAMPLE - ROUTINE	2008	07/24/2008	**550**
SAMPLE - ROUTINE	2008	07/26/2008	10
SAMPLE - ROUTINE	2008	07/28/2008	10
SAMPLE - ROUTINE	2008	07/29/2008	<10
SAMPLE - QC DUPLICATE	2008	08/04/2008	<10
SAMPLE - ROUTINE	2008	08/04/2008	<10
SAMPLE - QC DUPLICATE	2008	08/06/2008	30
SAMPLE - ROUTINE	2008	08/06/2008	30
SAMPLE - QC DUPLICATE	2008	08/13/2008	<10
SAMPLE - ROUTINE	2008	08/13/2008	<10
SAMPLE - ROUTINE	2008	08/14/2008	<10
SAMPLE - ROUTINE	2008	08/19/2008	<10
SAMPLE - ROUTINE	2008	08/21/2008	<10
SAMPLE - ROUTINE	2008	08/25/2008	<10
SAMPLE - QC DUPLICATE	2008	08/26/2008	<10
SAMPLE - ROUTINE	2008	08/26/2008	<10
SAMPLE - ROUTINE	2008	09/10/2008	<10
SAMPLE - ROUTINE	2008	09/17/2008	50
SAMPLE - ROUTINE	2008	09/24/2008	<10
SAMPLE - ROUTINE	2009	05/26/2009	10
SAMPLE - ROUTINE	2009	05/27/2009	40
SAMPLE - ROUTINE	2009	06/01/2009	<10
SAMPLE - QC DUPLICATE	2009	06/04/2009	<10
SAMPLE - ROUTINE	2009	06/04/2009	<10
SAMPLE - ROUTINE	2009	06/08/2009	10
SAMPLE - QC DUPLICATE	2009	06/08/2009	30
SAMPLE - ROUTINE	2009	06/11/2009	10
SAMPLE - ROUTINE	2009	06/16/2009	<10
SAMPLE - ROUTINE	2009	06/17/2009	20
SAMPLE - ROUTINE	2009	06/22/2009	<10
SAMPLE - ROUTINE	2009	06/24/2009	10
SAMPLE - ROUTINE	2009	06/30/2009	**230**
SAMPLE - ROUTINE	2009	07/02/2009	<10

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2009	07/07/2009	10
SAMPLE - ROUTINE	2009	07/09/2009	20
SAMPLE - ROUTINE	2009	07/15/2009	<10
SAMPLE - ROUTINE	2009	07/16/2009	10
SAMPLE - ROUTINE	2009	07/20/2009	<10
SAMPLE - ROUTINE	2009	07/22/2009	60
SAMPLE - ROUTINE	2009	07/27/2009	80
SAMPLE - ROUTINE	2009	07/28/2009	40
SAMPLE - ROUTINE	2009	08/03/2009	<10
SAMPLE - ROUTINE	2009	08/06/2009	<10
SAMPLE - ROUTINE	2009	08/10/2009	<10
SAMPLE - ROUTINE	2009	08/11/2009	90
SAMPLE - ROUTINE	2009	08/12/2009	30
SAMPLE - ROUTINE	2009	08/19/2009	20
SAMPLE - ROUTINE	2009	08/20/2009	10
SAMPLE - ROUTINE	2009	08/26/2009	<10
SAMPLE - ROUTINE	2009	08/27/2009	<10
SAMPLE - ROUTINE	2009	09/01/2009	<10
SAMPLE - ROUTINE	2009	09/02/2009	<10
SAMPLE - QC DUPLICATE	2009	09/09/2009	<10
SAMPLE - ROUTINE	2009	09/09/2009	<10
SAMPLE - ROUTINE	2009	09/15/2009	<10
SAMPLE - QC DUPLICATE	2009	09/21/2009	10
SAMPLE - ROUTINE	2009	09/21/2009	<10
SAMPLE - ROUTINE	2009	10/24/09	30
SAMPLE - ROUTINE	2009	10/27/09	9
SAMPLE - ROUTINE	2010	03/21/2010	<10
SAMPLE - ROUTINE	2010	04/06/2010	<10
SAMPLE - ROUTINE	2010	04/20/2010	<10
SAMPLE - ROUTINE	2010	05/06/2010	<9
SAMPLE - ROUTINE	2010	05/20/2010	230
SAMPLE - QC DUPLICATE	2010	06/01/2010	60
SAMPLE - ROUTINE	2010	06/01/2010	<10
SAMPLE - ROUTINE	2010	06/02/2010	20
SAMPLE - ROUTINE	2010	6/7/2010	<10
SAMPLE - ROUTINE	2010	06/10/2010	10
SAMPLE - ROUTINE	2010	06/14/2010	**270**
SAMPLE - ROUTINE	2010	06/16/2010	**290**
SAMPLE - ROUTINE	2010	06/18/2010	**150**

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A1. Instantaneous Enterococci Results from State Beach (Left Station — BCHSTBNHMLF).

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2010	06/21/2010	<10
SAMPLE - ROUTINE	2010	06/23/2010	20
SAMPLE - QC DUPLICATE	2010	06/23/2010	40
SAMPLE - ROUTINE	2010	06/28/2010	10
SAMPLE - QC DUPLICATE	2010	06/30/2010	<10
SAMPLE - ROUTINE	2010	06/30/2010	<10
SAMPLE - ROUTINE	2010	07/07/2010	5
SAMPLE - ROUTINE	2010	07/08/2010	<10
SAMPLE - ROUTINE	2010	07/13/2010	<10
SAMPLE - ROUTINE	2010	07/15/2010	40
SAMPLE - ROUTINE	2010	7/16/2010	**210**
SAMPLE - ROUTINE	2010	07/21/2010	10
SAMPLE - ROUTINE	2010	07/22/2010	<10
SAMPLE - ROUTINE	2010	07/26/2010	5
SAMPLE - ROUTINE	2010	07/28/2010	<10
SAMPLE - ROUTINE	2010	08/02/2010	10
SAMPLE - ROUTINE	2010	08/03/2010	20
SAMPLE - ROUTINE	2010	08/09/2010	10
SAMPLE - ROUTINE	2010	08/12/2010	20
SAMPLE - ROUTINE	2010	08/17/2010	10
SAMPLE - ROUTINE	2010	08/18/2010	<10

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — **BCHSTBNHMCR) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2002	06/13/2002	**240**
SAMPLE - ROUTINE	2002	06/18/2002	<10
SAMPLE - ROUTINE	2002	06/25/2002	<10
SAMPLE - ROUTINE	2002	07/03/2002	<10
SAMPLE - ROUTINE	2002	07/10/2002	<10
SAMPLE - ROUTINE	2002	07/15/2002	10
SAMPLE - ROUTINE	2002	07/22/2002	10
SAMPLE - ROUTINE	2002	07/24/2002	<10
SAMPLE - ROUTINE	2002	07/30/2002	20
SAMPLE - ROUTINE	2002	08/06/2002	10
SAMPLE - ROUTINE	2002	08/13/2002	10
SAMPLE - ROUTINE	2002	08/19/2002	<10
SAMPLE - ROUTINE	2002	08/26/2002	<10
SAMPLE - ROUTINE	2002	08/28/2002	<10
SAMPLE - ROUTINE	2002	09/04/2002	<10
SAMPLE - ROUTINE	2003	06/02/2003	<10
SAMPLE - ROUTINE	2003	06/09/2003	60
SAMPLE - ROUTINE	2003	06/16/2003	<10
SAMPLE - ROUTINE	2003	06/24/2003	10
SAMPLE - ROUTINE	2003	06/30/2003	<10
SAMPLE - ROUTINE	2003	07/07/2003	10
SAMPLE - ROUTINE	2003	07/14/2003	20
SAMPLE - ROUTINE	2003	07/17/2003	<10
SAMPLE - ROUTINE	2003	07/22/2003	<5
SAMPLE - ROUTINE	2003	07/24/2003	10
SAMPLE - ROUTINE	2003	07/28/2003	<10
SAMPLE - ROUTINE	2003	08/04/2003	100
SAMPLE - ROUTINE	2003	08/07/2003	10
SAMPLE - ROUTINE	2003	08/11/2003	10
SAMPLE - ROUTINE	2003	08/18/2003	<10
SAMPLE - ROUTINE	2003	08/25/2003	<10
SAMPLE - ROUTINE	2003	09/16/2003	10
SAMPLE - ROUTINE	2004	04/15/2004	<5
SAMPLE - ROUTINE	2004	05/11/2004	<10
SAMPLE - ROUTINE	2004	05/27/2004	**140**
SAMPLE - ROUTINE	2004	06/01/2004	<10
SAMPLE - ROUTINE	2004	06/07/2004	40
SAMPLE - ROUTINE	2004	06/09/2004	<10
SAMPLE - ROUTINE	2004	06/15/2004	<10
SAMPLE - ROUTINE	2004	06/21/2004	<10
SAMPLE - ROUTINE	2004	06/29/2004	30
SAMPLE - ROUTINE	2004	07/07/2004	<10
SAMPLE - ROUTINE	2004	07/13/2004	<10
SAMPLE - ROUTINE	2004	07/19/2004	30
SAMPLE - ROUTINE	2004	07/27/2004	<5
SAMPLE - ROUTINE	2004	08/03/2004	20
SAMPLE - ROUTINE	2004	08/10/2004	<10
SAMPLE - ROUTINE	2004	08/17/2004	<10
SAMPLE - ROUTINE	2004	08/23/2004	<10
SAMPLE - ROUTINE	2004	08/30/2004	<10
SAMPLE - ROUTINE	2005	06/01/2005	<10
SAMPLE - ROUTINE	2005	06/13/2005	<10
SAMPLE - ROUTINE	2005	06/21/2005	<10
SAMPLE - QC DUPLICATE	2005	06/28/2005	10
SAMPLE - ROUTINE	2005	06/28/2005	30
SAMPLE - QC DUPLICATE	2005	07/05/2005	<10
SAMPLE - ROUTINE	2005	07/05/2005	<10
SAMPLE - ROUTINE	2005	07/13/2005	<10
SAMPLE - ROUTINE	2005	07/19/2005	40
SAMPLE - ROUTINE	2005	07/25/2005	10
SAMPLE - ROUTINE	2005	08/03/2005	10
SAMPLE - ROUTINE	2005	08/09/2005	<10
SAMPLE - ROUTINE	2005	08/15/2005	<10
SAMPLE - ROUTINE	2005	08/24/2005	<10
SAMPLE - ROUTINE	2005	08/30/2005	<10
SAMPLE - ROUTINE	2006	05/31/2006	<10
SAMPLE - ROUTINE	2006	06/06/2006	<10
SAMPLE - ROUTINE	2006	06/08/2006	70
SAMPLE - ROUTINE	2006	06/12/2006	80
SAMPLE - ROUTINE	2006	06/15/2006	<10
SAMPLE - ROUTINE	2006	06/21/2006	<10
SAMPLE - ROUTINE	2006	06/22/2006	<10
SAMPLE - ROUTINE	2006	06/27/2006	60
SAMPLE - ROUTINE	2006	06/29/2006	<10
SAMPLE - ROUTINE	2006	07/05/2006	<10
SAMPLE - ROUTINE	2006	07/10/2006	20
SAMPLE - ROUTINE	2006	07/13/2006	**300**
SAMPLE - ROUTINE	2006	07/17/2006	30

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — **BCHSTBNHMCR) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2006	07/18/2006	20
SAMPLE - ROUTINE	2006	07/19/2006	20
SAMPLE - ROUTINE	2006	07/24/2006	10
SAMPLE - ROUTINE	2006	07/25/2006	<10
SAMPLE - ROUTINE	2006	08/02/2006	<10
SAMPLE - ROUTINE	2006	08/03/2006	20
SAMPLE - ROUTINE	2006	08/08/2006	10
SAMPLE - ROUTINE	2006	08/09/2006	<10
SAMPLE - ROUTINE	2006	08/14/2006	10
SAMPLE - ROUTINE	2006	08/15/2006	<10
SAMPLE - ROUTINE	2006	08/23/2006	<5
SAMPLE - ROUTINE	2006	08/24/2006	<10
SAMPLE - ROUTINE	2006	08/25/2006	<10
SAMPLE - ROUTINE	2006	08/29/2006	<10
SAMPLE - ROUTINE	2006	08/30/2006	<10
SAMPLE - ROUTINE	2007	05/29/2007	<10
SAMPLE - ROUTINE	2007	06/05/2007	<10
SAMPLE - QC DUPLICATE	2007	06/07/2007	20
SAMPLE - ROUTINE	2007	06/07/2007	<10
SAMPLE - ROUTINE	2007	06/11/2007	<10
SAMPLE - QC DUPLICATE	2007	06/14/2007	10
SAMPLE - ROUTINE	2007	06/14/2007	20
SAMPLE - ROUTINE	2007	06/19/2007	20
SAMPLE - ROUTINE	2007	06/21/2007	<10
SAMPLE - ROUTINE	2007	06/26/2007	10
SAMPLE - ROUTINE	2007	06/28/2007	<10
SAMPLE - ROUTINE	2007	07/02/2007	<10
SAMPLE - ROUTINE	2007	07/05/2007	<10
SAMPLE - ROUTINE	2007	07/09/2007	40
SAMPLE - ROUTINE	2007	07/12/2007	<10
SAMPLE - QC DUPLICATE	2007	07/17/2007	<10
SAMPLE - ROUTINE	2007	07/17/2007	<10
SAMPLE - QC DUPLICATE	2007	07/18/2007	<10
SAMPLE - ROUTINE	2007	07/18/2007	<10
SAMPLE - ROUTINE	2007	07/23/2007	<10
SAMPLE - ROUTINE	2007	07/24/2007	<10
SAMPLE - ROUTINE	2007	08/01/2007	<10
SAMPLE - QC DUPLICATE	2007	08/02/2007	<10
SAMPLE - ROUTINE	2007	08/02/2007	<10

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2007	08/07/2007	40
SAMPLE - ROUTINE	2007	08/08/2007	<10
SAMPLE - ROUTINE	2007	08/13/2007	<5
SAMPLE - ROUTINE	2007	08/14/2007	10
SAMPLE - QC DUPLICATE	2007	08/21/2007	<10
SAMPLE - ROUTINE	2007	08/21/2007	<10
SAMPLE - ROUTINE	2007	08/23/2007	<10
SAMPLE - ROUTINE	2007	08/28/2007	<10
SAMPLE - QC DUPLICATE	2007	08/29/2007	<10
SAMPLE - ROUTINE	2007	08/29/2007	<5
SAMPLE - ROUTINE	2007	09/13/2007	<10
SAMPLE - ROUTINE	2008	05/27/2008	<10
SAMPLE - QC DUPLICATE	2008	05/28/2008	<10
SAMPLE - ROUTINE	2008	05/28/2008	<10
SAMPLE - ROUTINE	2008	06/02/2008	<10
SAMPLE - ROUTINE	2008	06/05/2008	10
SAMPLE - ROUTINE	2008	06/11/2008	<10
SAMPLE - ROUTINE	2008	06/12/2008	<10
SAMPLE - ROUTINE	2008	06/17/2008	<10
SAMPLE - ROUTINE	2008	06/18/2008	<10
SAMPLE - ROUTINE	2008	06/23/2008	10
SAMPLE - ROUTINE	2008	06/27/2008	5
SAMPLE - ROUTINE	2008	06/30/2008	<10
SAMPLE - ROUTINE	2008	07/02/2008	30
SAMPLE - ROUTINE	2008	07/07/2008	10
SAMPLE - ROUTINE	2008	07/08/2008	<10
SAMPLE - ROUTINE	2008	07/16/2008	<10
SAMPLE - ROUTINE	2008	07/17/2008	5
SAMPLE - QC DUPLICATE	2008	07/22/2008	10
SAMPLE - ROUTINE	2008	07/22/2008	10
SAMPLE - ROUTINE	2008	07/24/2008	**520**
SAMPLE - ROUTINE	2008	07/26/2008	20
SAMPLE - ROUTINE	2008	07/28/2008	30
SAMPLE - ROUTINE	2008	07/29/2008	<10
SAMPLE - ROUTINE	2008	08/04/2008	<10
SAMPLE - ROUTINE	2008	08/06/2008	30
SAMPLE - ROUTINE	2008	08/13/2008	<10
SAMPLE - ROUTINE	2008	08/14/2008	<10
SAMPLE - ROUTINE	2008	08/19/2008	<10

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — **BCHSTBNHMCR) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2008	08/21/2008	10
SAMPLE - ROUTINE	2008	08/25/2008	10
SAMPLE - ROUTINE	2008	08/26/2008	10
SAMPLE - ROUTINE	2008	09/10/2008	<10
SAMPLE - ROUTINE	2008	09/17/2008	5
SAMPLE - ROUTINE	2008	09/24/2008	<10
SAMPLE - ROUTINE	2009	05/26/2009	30
SAMPLE - ROUTINE	2009	05/27/2009	<5
SAMPLE - ROUTINE	2009	06/01/2009	<10
SAMPLE - ROUTINE	2009	06/04/2009	<10
SAMPLE - ROUTINE	2009	06/08/2009	<10
SAMPLE - ROUTINE	2009	06/11/2009	10
SAMPLE - ROUTINE	2009	06/16/2009	20
SAMPLE - QC DUPLICATE	2009	06/16/2009	<10
SAMPLE - ROUTINE	2009	06/17/2009	<10
SAMPLE - ROUTINE	2009	06/22/2009	<10
SAMPLE - ROUTINE	2009	06/24/2009	30
SAMPLE - QC DUPLICATE	2009	06/24/2009	40
SAMPLE - ROUTINE	2009	06/30/2009	80
SAMPLE - QC DUPLICATE	2009	07/02/2009	<10
SAMPLE - ROUTINE	2009	07/02/2009	<10
SAMPLE - ROUTINE	2009	07/07/2009	<10
SAMPLE - QC DUPLICATE	2009	07/09/2009	30
SAMPLE - ROUTINE	2009	07/09/2009	30
SAMPLE - ROUTINE	2009	07/15/2009	<10
SAMPLE - ROUTINE	2009	07/16/2009	10
SAMPLE - ROUTINE	2009	07/20/2009	<10
SAMPLE - ROUTINE	2009	07/22/2009	10
SAMPLE - QC DUPLICATE	2009	07/27/2009	40
SAMPLE - ROUTINE	2009	07/27/2009	80
SAMPLE - ROUTINE	2009	07/28/2009	10
SAMPLE - ROUTINE	2009	08/03/2009	<10
SAMPLE - ROUTINE	2009	08/06/2009	<10
SAMPLE - ROUTINE	2009	08/10/2009	<10
SAMPLE - ROUTINE	2009	08/11/2009	30
SAMPLE - ROUTINE	2009	08/12/2009	50
SAMPLE - ROUTINE	2009	08/19/2009	<10
SAMPLE - QC DUPLICATE	2009	08/20/2009	30
SAMPLE - ROUTINE	2009	08/20/2009	<10

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - QC DUPLICATE	2009	08/26/2009	<10
SAMPLE - ROUTINE	2009	08/26/2009	<5
SAMPLE - ROUTINE	2009	08/27/2009	10
SAMPLE - ROUTINE	2009	09/01/2009	<10
SAMPLE - QC DUPLICATE	2009	09/02/2009	<10
SAMPLE - ROUTINE	2009	09/02/2009	<5
SAMPLE - ROUTINE	2009	09/09/2009	<10
SAMPLE - ROUTINE	2009	09/15/2009	<5
SAMPLE - ROUTINE	2009	09/21/2009	<5
SAMPLE - ROUTINE	2010	06/01/2010	<10
SAMPLE - ROUTINE	2010	06/02/2010	<10
SAMPLE - ROUTINE	2010	06/07/2010	<5
SAMPLE - ROUTINE	2010	06/10/2010	10
SAMPLE - QC DUPLICATE	2010	06/14/2010	70
SAMPLE - ROUTINE	2010	06/14/2010	100
SAMPLE - ROUTINE	2010	06/16/2010	60
SAMPLE - ROUTINE	2010	06/18/2010	<10
SAMPLE - ROUTINE	2010	06/21/2010	<10
SAMPLE - ROUTINE	2010	06/23/2010	<10
SAMPLE - QC DUPLICATE	2010	06/28/2010	<10
SAMPLE - ROUTINE	2010	06/28/2010	<10
SAMPLE - ROUTINE	2010	06/30/2010	<10
SAMPLE - ROUTINE	2010	07/07/2010	<10
SAMPLE - ROUTINE	2010	07/08/2010	<10
SAMPLE - ROUTINE	2010	07/13/2010	<10
SAMPLE - QC DUPLICATE	2010	07/15/2010	70
SAMPLE - ROUTINE	2010	07/15/2010	<10
SAMPLE - ROUTINE	2010	07/21/2010	<10
SAMPLE - ROUTINE	2010	07/22/2010	<10
SAMPLE - ROUTINE	2010	07/26/2010	<10
SAMPLE - QC DUPLICATE	2010	07/28/2010	<10
SAMPLE - ROUTINE	2010	07/28/2010	<10
SAMPLE - ROUTINE	2010	08/02/2010	<10
SAMPLE - ROUTINE	2010	08/03/2010	10
SAMPLE - ROUTINE	2010	08/09/2010	20
SAMPLE - ROUTINE	2010	08/12/2010	<10
SAMPLE - QC DUPLICATE	2010	08/17/2010	10
SAMPLE - ROUTINE	2010	08/17/2010	<10
SAMPLE - ROUTINE	2010	08/18/2010	<5

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — **BCHSTBNHMCR) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2002	06/13/2002	30
SAMPLE - ROUTINE	2002	06/18/2002	<10
SAMPLE - ROUTINE	2002	06/25/2002	10
SAMPLE - ROUTINE	2002	07/03/2002	10
SAMPLE - ROUTINE	2002	07/10/2002	<10
SAMPLE - ROUTINE	2002	07/15/2002	<10
SAMPLE - ROUTINE	2002	07/22/2002	<10
SAMPLE - ROUTINE	2002	07/24/2002	10
SAMPLE - ROUTINE	2002	07/30/2002	<10
SAMPLE - ROUTINE	2002	08/06/2002	<10
SAMPLE - ROUTINE	2002	08/13/2002	<10
SAMPLE - ROUTINE	2002	08/19/2002	<10
SAMPLE - ROUTINE	2002	08/26/2002	<10
SAMPLE - ROUTINE	2002	08/28/2002	<10
SAMPLE - ROUTINE	2002	09/04/2002	30
SAMPLE - ROUTINE	2003	06/02/2003	<10
SAMPLE - QC DUPLICATE	2003	06/09/2003	30
SAMPLE - ROUTINE	2003	06/09/2003	30
SAMPLE - ROUTINE	2003	06/16/2003	30
SAMPLE - QC DUPLICATE	2003	06/24/2003	0
SAMPLE - ROUTINE	2003	06/24/2003	<5
SAMPLE - ROUTINE	2003	06/30/2003	<10
SAMPLE - QC DUPLICATE	2003	07/07/2003	<10
SAMPLE - ROUTINE	2003	07/07/2003	<10
SAMPLE - ROUTINE	2003	07/14/2003	30
SAMPLE - ROUTINE	2003	07/17/2003	<10
SAMPLE - QC DUPLICATE	2003	07/22/2003	<10
SAMPLE - ROUTINE	2003	07/22/2003	<10
SAMPLE - ROUTINE	2003	07/24/2003	<10
SAMPLE - ROUTINE	2003	07/28/2003	<10
SAMPLE - QC DUPLICATE	2003	08/04/2003	50
SAMPLE - ROUTINE	2003	08/04/2003	50
SAMPLE - ROUTINE	2003	08/07/2003	40
SAMPLE - ROUTINE	2003	08/11/2003	20
SAMPLE - QC DUPLICATE	2003	08/18/2003	<10
SAMPLE - ROUTINE	2003	08/18/2003	<10
SAMPLE - ROUTINE	2003	08/25/2003	<10
SAMPLE - ROUTINE	2003	09/16/2003	<10
SAMPLE - ROUTINE	2004	04/15/2004	<10

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2004	05/11/2004	<10
SAMPLE - ROUTINE	2004	05/27/2004	40
SAMPLE - QC DUPLICATE	2004	06/01/2004	10
SAMPLE - ROUTINE	2004	06/01/2004	<10
SAMPLE - ROUTINE	2004	06/07/2004	10
SAMPLE - ROUTINE	2004	06/09/2004	20
SAMPLE - ROUTINE	2004	06/15/2004	<10
SAMPLE - ROUTINE	2004	06/21/2004	<5
SAMPLE - ROUTINE	2004	06/29/2004	10
SAMPLE - ROUTINE	2004	07/07/2004	5
SAMPLE - ROUTINE	2004	07/13/2004	<10
SAMPLE - ROUTINE	2004	07/19/2004	30
SAMPLE - ROUTINE	2004	07/27/2004	<10
SAMPLE - ROUTINE	2004	08/03/2004	40
SAMPLE - ROUTINE	2004	08/10/2004	<5
SAMPLE - ROUTINE	2004	08/17/2004	<10
SAMPLE - ROUTINE	2004	08/23/2004	<10
SAMPLE - ROUTINE	2004	08/30/2004	<5
SAMPLE - ROUTINE	2005	06/01/2005	<10
SAMPLE - ROUTINE	2005	06/13/2005	<10
SAMPLE - ROUTINE	2005	06/21/2005	<10
SAMPLE - ROUTINE	2005	06/28/2005	20
SAMPLE - ROUTINE	2005	07/05/2005	<10
SAMPLE - ROUTINE	2005	07/13/2005	<10
SAMPLE - ROUTINE	2005	07/19/2005	<10
SAMPLE - ROUTINE	2005	07/25/2005	<10
SAMPLE - ROUTINE	2005	08/03/2005	<10
SAMPLE - ROUTINE	2005	08/09/2005	<10
SAMPLE - ROUTINE	2005	08/15/2005	10
SAMPLE - ROUTINE	2005	08/24/2005	<10
SAMPLE - ROUTINE	2005	08/30/2005	10
SAMPLE - ROUTINE	2006	05/31/2006	<10
SAMPLE - ROUTINE	2006	06/06/2006	10
SAMPLE - QC DUPLICATE	2006	06/06/2006	<10
SAMPLE - ROUTINE	2006	06/08/2006	**210**
SAMPLE - ROUTINE	2006	06/12/2006	60
SAMPLE - ROUTINE	2006	06/15/2006	10
SAMPLE - ROUTINE	2006	06/21/2006	<10
SAMPLE - ROUTINE	2006	06/22/2006	<10

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — **BCHSTBNHMCR) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2006	06/27/2006	<10
SAMPLE - ROUTINE	2006	06/29/2006	10
SAMPLE - QC DUPLICATE	2006	06/29/2006	30
SAMPLE - ROUTINE	2006	07/05/2006	<10
SAMPLE - QC DUPLICATE	2006	07/10/2006	<10
SAMPLE - ROUTINE	2006	07/10/2006	<10
SAMPLE - ROUTINE	2006	07/13/2006	**280**
SAMPLE - ROUTINE	2006	07/17/2006	40
SAMPLE - ROUTINE	2006	07/18/2006	<10
SAMPLE - ROUTINE	2006	07/19/2006	<10
SAMPLE - ROUTINE	2006	07/24/2006	30
SAMPLE - QC DUPLICATE	2006	07/25/2006	<10
SAMPLE - ROUTINE	2006	07/25/2006	<5
SAMPLE - ROUTINE	2006	08/02/2006	10
SAMPLE - QC DUPLICATE	2006	08/02/2006	<10
SAMPLE - ROUTINE	2006	08/03/2006	<10
SAMPLE - ROUTINE	2006	08/08/2006	70
SAMPLE - ROUTINE	2006	08/09/2006	<10
SAMPLE - ROUTINE	2006	08/14/2006	<10
SAMPLE - ROUTINE	2006	08/15/2006	<10
SAMPLE - QC DUPLICATE	2006	08/23/2006	<10
SAMPLE - ROUTINE	2006	08/23/2006	<10
SAMPLE - ROUTINE	2006	08/24/2006	10
SAMPLE - ROUTINE	2006	08/25/2006	5
SAMPLE - ROUTINE	2006	08/29/2006	30
SAMPLE - ROUTINE	2006	08/30/2006	<10
SAMPLE - ROUTINE	2007	05/29/2007	<10
SAMPLE - ROUTINE	2007	06/05/2007	20
SAMPLE - ROUTINE	2007	06/07/2007	<10
SAMPLE - ROUTINE	2007	06/11/2007	20
SAMPLE - ROUTINE	2007	06/14/2007	20
SAMPLE - QC DUPLICATE	2007	06/19/2007	10
SAMPLE - ROUTINE	2007	06/19/2007	20
SAMPLE - QC DUPLICATE	2007	06/21/2007	<10
SAMPLE - ROUTINE	2007	06/21/2007	<10
SAMPLE - ROUTINE	2007	06/26/2007	10
SAMPLE - QC DUPLICATE	2007	06/26/2007	<10
SAMPLE - QC DUPLICATE	2007	06/28/2007	10
SAMPLE - ROUTINE	2007	06/28/2007	<10

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2007	07/02/2007	<10
SAMPLE - ROUTINE	2007	07/05/2007	10
SAMPLE - ROUTINE	2007	07/09/2007	<10
SAMPLE - ROUTINE	2007	07/12/2007	<10
SAMPLE - ROUTINE	2007	07/17/2007	<10
SAMPLE - ROUTINE	2007	07/18/2007	<10
SAMPLE - QC DUPLICATE	2007	07/23/2007	<10
SAMPLE - ROUTINE	2007	07/23/2007	<5
SAMPLE - ROUTINE	2007	07/24/2007	<10
SAMPLE - QC DUPLICATE	2007	08/01/2007	20
SAMPLE - ROUTINE	2007	08/01/2007	<5
SAMPLE - ROUTINE	2007	08/02/2007	<10
SAMPLE - ROUTINE	2007	08/07/2007	10
SAMPLE - QC DUPLICATE	2007	08/08/2007	10
SAMPLE - ROUTINE	2007	08/08/2007	<10
SAMPLE - ROUTINE	2007	08/13/2007	<10
SAMPLE - ROUTINE	2007	08/14/2007	20
SAMPLE - ROUTINE	2007	08/21/2007	<10
SAMPLE - ROUTINE	2007	08/23/2007	<10
SAMPLE - QC DUPLICATE	2007	08/28/2007	<10
SAMPLE - ROUTINE	2007	08/28/2007	<10
SAMPLE - ROUTINE	2007	08/29/2007	<10
SAMPLE - ROUTINE	2007	09/13/2007	<10
SAMPLE - ROUTINE	2008	05/27/2008	<10
SAMPLE - ROUTINE	2008	05/28/2008	<10
SAMPLE - ROUTINE	2008	06/02/2008	<10
SAMPLE - ROUTINE	2008	06/05/2008	10
SAMPLE - ROUTINE	2008	06/11/2008	<10
SAMPLE - QC DUPLICATE	2008	06/12/2008	<10
SAMPLE - ROUTINE	2008	06/12/2008	<10
SAMPLE - ROUTINE	2008	06/17/2008	<10
SAMPLE - QC DUPLICATE	2008	06/18/2008	<10
SAMPLE - ROUTINE	2008	06/18/2008	<5
SAMPLE - QC DUPLICATE	2008	06/23/2008	30
SAMPLE - ROUTINE	2008	06/23/2008	<10
SAMPLE - QC DUPLICATE	2008	06/27/2008	10
SAMPLE - ROUTINE	2008	06/27/2008	<10
SAMPLE - ROUTINE	2008	06/30/2008	<5
SAMPLE - QC DUPLICATE	2008	07/02/2008	10

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — **BCHSTBNHMCR) continued…**

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2008	07/02/2008	10
SAMPLE - ROUTINE	2008	07/07/2008	<5
SAMPLE - ROUTINE	2008	07/08/2008	<10
SAMPLE - QC DUPLICATE	2008	07/16/2008	<10
SAMPLE - ROUTINE	2008	07/16/2008	<10
SAMPLE - ROUTINE	2008	07/17/2008	<10
SAMPLE - ROUTINE	2008	07/22/2008	30
SAMPLE - QC DUPLICATE	2008	07/24/2008	**440**
SAMPLE - ROUTINE	2008	07/24/2008	**490**
SAMPLE - ROUTINE	2008	07/26/2008	30
SAMPLE - ROUTINE	2008	07/28/2008	<10
SAMPLE - QC DUPLICATE	2008	07/29/2008	10
SAMPLE - ROUTINE	2008	07/29/2008	<10
SAMPLE - ROUTINE	2008	08/04/2008	20
SAMPLE - ROUTINE	2008	08/06/2008	50
SAMPLE - ROUTINE	2008	08/13/2008	<10
SAMPLE - ROUTINE	2008	08/14/2008	<10
SAMPLE - ROUTINE	2008	08/19/2008	<10
SAMPLE - ROUTINE	2008	08/21/2008	<10
SAMPLE - ROUTINE	2008	08/25/2008	10
SAMPLE - ROUTINE	2008	08/26/2008	<10
SAMPLE - ROUTINE	2008	09/10/2008	<5
SAMPLE - ROUTINE	2008	09/17/2008	50
SAMPLE - ROUTINE	2008	09/24/2008	<5
SAMPLE - ROUTINE	2009	05/26/2009	10
SAMPLE - QC DUPLICATE	2009	05/26/2009	20
SAMPLE - ROUTINE	2009	05/27/2009	<10
SAMPLE - ROUTINE	2009	06/01/2009	<10
SAMPLE - ROUTINE	2009	06/04/2009	<10
SAMPLE - ROUTINE	2009	06/08/2009	<10
SAMPLE - ROUTINE	2009	06/11/2009	<10
SAMPLE - ROUTINE	2009	06/16/2009	<10
SAMPLE - ROUTINE	2009	06/17/2009	<5
SAMPLE - ROUTINE	2009	06/22/2009	<10
SAMPLE - ROUTINE	2009	06/24/2009	60
SAMPLE - ROUTINE	2009	06/30/2009	**130**
SAMPLE - ROUTINE	2009	07/02/2009	<10
SAMPLE - ROUTINE	2009	07/07/2009	<10
SAMPLE - ROUTINE	2009	07/09/2009	20

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2009	07/15/2009	<10
SAMPLE - QC DUPLICATE	2009	07/16/2009	<10
SAMPLE - ROUTINE	2009	07/16/2009	<10
SAMPLE - ROUTINE	2009	07/20/2009	<10
SAMPLE - QC DUPLICATE	2009	07/22/2009	10
SAMPLE - ROUTINE	2009	07/22/2009	40
SAMPLE - ROUTINE	2009	07/27/2009	70
SAMPLE - ROUTINE	2009	07/28/2009	20
SAMPLE - ROUTINE	2009	08/03/2009	<10
SAMPLE - QC DUPLICATE	2009	08/06/2009	10
SAMPLE - ROUTINE	2009	08/06/2009	<10
SAMPLE - ROUTINE	2009	08/10/2009	**130**
SAMPLE - QC DUPLICATE	2009	08/11/2009	10
SAMPLE - ROUTINE	2009	08/11/2009	<10
SAMPLE - ROUTINE	2009	08/12/2009	60
SAMPLE - ROUTINE	2009	08/19/2009	5
SAMPLE - ROUTINE	2009	08/20/2009	30
SAMPLE - ROUTINE	2009	08/26/2009	10
SAMPLE - ROUTINE	2009	08/27/2009	<10
SAMPLE - ROUTINE	2009	09/01/2009	<10
SAMPLE - ROUTINE	2009	09/02/2009	<10
SAMPLE - ROUTINE	2009	09/09/2009	<10
SAMPLE - QC DUPLICATE	2009	09/15/2009	<10
SAMPLE - ROUTINE	2009	09/15/2009	<10
SAMPLE - ROUTINE	2009	09/21/2009	<10
SAMPLE - ROUTINE	2010	06/01/2010	<10
SAMPLE - ROUTINE	2010	06/02/2010	10
SAMPLE - ROUTINE	2010	06/07/2010	<10
SAMPLE - ROUTINE	2010	06/10/2010	<10
SAMPLE - ROUTINE	2010	06/14/2010	80
SAMPLE - ROUTINE	2010	06/16/2010	**130**
SAMPLE - ROUTINE	2010	06/18/2010	<5
SAMPLE - ROUTINE	2010	06/21/2010	<10
SAMPLE - ROUTINE	2010	06/23/2010	<10
SAMPLE - ROUTINE	2010	06/28/2010	<10
SAMPLE - ROUTINE	2010	06/30/2010	<10
SAMPLE - ROUTINE	2010	07/07/2010	10
SAMPLE - QC DUPLICATE	2010	07/08/2010	<10
SAMPLE - ROUTINE	2010	07/08/2010	<10

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A2. Instantaneous Enterococci Results from State Beach (Center Station — BCHSTBNHMCR).

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2010	07/13/2010	10
SAMPLE - QC DUPLICATE	2010	07/13/2010	20
SAMPLE - ROUTINE	2010	07/15/2010	10
SAMPLE - ROUTINE	2010	07/21/2010	10
SAMPLE - ROUTINE	2010	07/22/2010	<10
SAMPLE - ROUTINE	2010	07/26/2010	<10
SAMPLE - ROUTINE	2010	07/28/2010	20
SAMPLE - QC DUPLICATE	2010	08/02/2010	10
SAMPLE - ROUTINE	2010	08/02/2010	20
SAMPLE - ROUTINE	2010	08/03/2010	<10
SAMPLE - ROUTINE	2010	08/09/2010	20
SAMPLE - QC DUPLICATE	2010	08/09/2010	<10
SAMPLE - ROUTINE	2010	08/12/2010	<10
SAMPLE - ROUTINE	2010	08/17/2010	<10
SAMPLE - ROUTINE	2010	08/18/2010	<10

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal beach.

Table A3. Instantaneous Enterococci Results from Little River Outfall (BCHSTBNHMLIT)

Sample Type	Sample Year	Sample Date	Sample Result (*Enterococcus* cts/100mL)
SAMPLE - ROUTINE	2008	05/27/2008	10
SAMPLE - ROUTINE	2008	05/28/2008	<10
SAMPLE - ROUTINE	2008	06/11/2008	**260**
SAMPLE - ROUTINE	2008	06/12/2008	10
SAMPLE - ROUTINE	2008	06/18/2008	<10
SAMPLE - ROUTINE	2008	06/23/2008	**180**
SAMPLE - ROUTINE	2008	06/27/2008	40
SAMPLE - ROUTINE	2008	07/07/2008	**160**
SAMPLE - ROUTINE	2008	07/08/2008	60
SAMPLE - ROUTINE	2008	07/22/2008	<10
SAMPLE - ROUTINE	2008	07/24/2008	**880**
SAMPLE - ROUTINE	2008	07/31/2008	20
SAMPLE - ROUTINE	2008	08/04/2008	**280**
SAMPLE - ROUTINE	2008	08/06/2008	**360**
SAMPLE - ROUTINE	2008	08/07/2008	**270**
SAMPLE - ROUTINE	2008	08/12/2008	**850**
SAMPLE - ROUTINE	2008	08/18/2008	<10
SAMPLE - ROUTINE	2008	08/27/2008	**220**
SAMPLE - ROUTINE	2008	09/11/2008	40
SAMPLE - QC DUPLICATE	2008	09/18/2008	<5
SAMPLE - ROUTINE	2008	09/18/2008	<10
SAMPLE - ROUTINE	2008	09/25/2008	10
SAMPLE - ROUTINE	2009	06/01/2009	10
SAMPLE - ROUTINE	2009	06/16/2009	20
SAMPLE - QC DUPLICATE	2009	06/17/2009	10
SAMPLE - ROUTINE	2009	06/17/2009	30
SAMPLE - ROUTINE	2009	06/30/2009	**250**
SAMPLE - ROUTINE	2009	07/09/2009	**240**
SAMPLE - ROUTINE	2009	07/15/2009	10
SAMPLE - ROUTINE	2009	07/16/2009	20
SAMPLE - ROUTINE	2009	07/27/2009	**140**
SAMPLE - ROUTINE	2009	07/28/2009	**240**
SAMPLE - ROUTINE	2009	08/11/2009	**660**
SAMPLE - ROUTINE	2009	08/12/2009	**250**
SAMPLE - ROUTINE	2009	08/27/2009	40
SAMPLE - ROUTINE	2009	09/01/2009	10
SAMPLE - ROUTINE	2009	09/09/2009	40
SAMPLE - ROUTINE	2009	09/15/2009	**110**
SAMPLE - ROUTINE	2009	10/24/2009	20
SAMPLE - ROUTINE	2009	10/27/2009	50
SAMPLE - ROUTINE	2010	05/06/2010	30
SAMPLE - ROUTINE	2010	05/20/2010	**170**
SAMPLE - QC DUPLICATE	2010	06/07/2010	50
SAMPLE - ROUTINE	2010	06/07/2010	40
SAMPLE - ROUTINE	2010	06/07/2010	45
SAMPLE - ROUTINE	2010	07/16/2010	**250**

Red text indicates an exceedance of New Hampshire water quality criteria at a swimming tidal

Appendix B:
Water Quality Data

Little River

Table B1. Instantaneous Enterococci Results from Little River Sampling Stations continued…

Station ID	Sample Type	Sample Year	Sample Date	Result (counts/100 mL)
ACPS12-U30	Sample - Routine	2008	07/31/08	50
	Sample - Routine	2008	08/07/08	**220**
	Sample - Routine	2008	08/12/08	**420**
	Sample - Routine	2008	08/18/08	60
	Sample - Routine	2008	08/18/08	41*
	Sample - Routine	2008	08/27/08	40
	Sample - QC Duplicate	2008	09/11/08	10
	Sample - Routine	2008	09/11/08	10
	Sample - Routine	2008	09/18/08	<10
	Sample - Routine	2008	09/25/08	30
	Sample - Routine	2009	10/24/09	20
	Sample - QC Duplicate	2009	10/27/09	30
	Sample - Routine	2009	10/27/09	20
	Sample - Routine	2009	10/27/09	25
	Sample - QC Duplicate	2010	05/06/10	9
	Sample - Routine	2010	05/06/10	<10
	Sample - QC Duplicate	2010	05/20/10	**230**
	Sample - Routine	2010	05/20/10	**160**
	Sample - Routine	2010	05/20/10	**195**
	Sample - Routine	2010	06/07/10	50
	Sample - Routine	2010	07/16/10	60
BCHSTBNHMLRMR	Sample - Routine	2008	07/31/08	40
	Sample - Routine	2008	08/07/08	**150**
	Sample - Routine	2008	08/12/08	70
	Sample - Routine	2008	08/18/08	10
	Sample - Routine	2008	08/18/08	20*
	Sample - Routine	2008	08/27/08	**200**
	Sample - Routine	2008	09/11/08	20
	Sample - Routine	2009	10/24/09	<10
	Sample - Routine	2009	10/27/09	60
	Sample - Routine	2010	05/06/10	<10
	Sample - Routine	2010	05/20/10	**310**
	Sample - Routine	2010	06/07/10	<10
	Sample - Routine	2010	07/16/10	**240**
BCH16	Sample - Routine	2009	10/24/09	20
	Sample - Routine	2009	10/27/09	<10
	Sample - Routine	2010	05/06/10	70
	Sample - Routine	2010	05/20/10	70
	Sample - Routine	2010	06/07/10	60
	Sample - Routine	2010	07/16/10	**640**

**Samples were assessed using Most Probable Number (MPN) methods*

Red text is used to indicate the sampling results that exceed the recommended level for human skin contact: 104 cts/100mL

Table B1. Instantaneous Enterococci Results from Little River Sampling Stations continued…

Station ID	Sample Type	Sample Year	Sample Date	Result (counts/100 mL)
BCH17	Sample - Routine	2009	10/24/09	<10
	Sample - Routine	2009	10/27/09	20
	Sample - Routine	2010	05/06/10	90
	Sample - Routine	2010	05/20/10	40
	Sample - Routine	2010	06/07/10	**850**
	Sample - Routine	2010	07/16/10	50
BCH18	Sample - Routine	2009	10/24/09	**210**
	Sample - Routine	2009	10/27/09	<10
	Sample - Routine	2010	05/06/10	<10
	Sample - Routine	2010	05/20/10	**6,000**
	Sample - Routine	2010	06/07/10	**180**
	Sample - Routine	2010	07/16/10	60
BCH19	Sample - Routine	2009	10/24/09	50
	Sample - Routine	2009	10/27/09	50
	Sample - Routine	2010	05/06/10	<10
	Sample - Routine	2010	05/20/10	20
	Sample - Routine	2010	06/07/10	<10
	Sample - Routine	2010	07/16/10	**200**
BCH20	Sample - Routine	2009	10/24/09	<10
	Sample - Routine	2009	10/27/09	8
	Sample - Routine	2010	05/06/10	20
	Sample - Routine	2010	05/20/10	90
	Sample - Routine	2010	06/07/10	**230**
	Sample - QC Duplicate	2010	07/16/10	**150**
	Sample - Routine	2010	07/16/10	70
	Sample - Routine	2010	07/16/10	**110**
BCH21	Sample - Routine	2009	10/24/09	<10
	Sample - Routine	2009	10/27/09	<10
	Sample - Routine	2010	05/06/10	<10
	Sample - Routine	2010	05/20/10	90
	Sample - Routine	2010	06/07/10	**210**
	Sample - Routine	2010	07/16/10	100

**Samples were assessed using Most Probable Number (MPN) methods*

Red text is used to indicate the sampling results that exceed the recommended level for human skin contact: 104 cts/100mL

Table B1. Instantaneous Enterococci Results from Little River Sampling Stations continued.

Station ID	Sample Type	Sample Year	Sample Date	Result (counts/100 mL)
BCH22	Sample - Routine	2009	10/24/09	**2,000**
	Sample - Routine	2009	10/27/09	**200**
BCH23	Sample - Routine	2009	10/24/09	9
	Sample - Routine	2009	10/27/09	20
	Sample - Routine	2010	05/06/10	30
	Sample - Routine	2010	05/20/10	**160**
	Sample - Routine	2010	06/07/10	**230**
	Sample - Routine	2010	07/16/10	**1,300**
BCH24	Sample - QC Duplicate	2009	10/24/09	**1,500**
	Sample - Routine	2009	10/24/09	**1,000**
	Sample - Routine	2009	10/24/09	**1,250**
	Sample - Routine	2009	10/27/09	<10
	Sample - Routine	2010	05/06/10	60
	Sample - Routine	2010	05/20/10	100
	Sample - Routine	2010	06/07/10	**300**
	Sample - Routine	2010	07/16/10	**500**
BCH25	Sample - Routine	2009	10/24/09	**150**
	Sample - Routine	2009	10/27/09	**160**
	Sample - Routine	2010	05/06/10	**150**
	Sample - Routine	2010	05/20/10	**260**
	Sample - Routine	2010	06/07/10	100
	Sample - Routine	2010	07/16/10	**210**

**Samples were assessed using Most Probable Number (MPN) methods*

Red text is used to indicate the sampling results that exceed the recommended level for human skin contact: 104 cts/100mL

Appendix C:

Landscape Analysis

MEMORANDUM

To: Sonya Carlson

From: Forrest Bell and Cayce Dalton, FB Environmental Associates

Subject: Deliverables 4D and 5D: Bacteria Load Estimates for Parsons Creek and Little River Watersheds

Date: Friday, May 21, 2010; Revised July 2010

Introduction

Creating bacteria load estimates helps to intelligently guide watershed protection and restoration efforts by providing insight into the most likely areas for water quality improvement. Much work towards a reasonable estimation of bacteria sources within NH coastal beach watersheds was completed last year as part of the *Coastal Beach Watershed*

Bacteria Source Investigation report by FB Environmental (FBE), submitted to NH DES Beach Program in December 2009. This spring, FBE re-examined these source estimates in detail, focusing significant addition attention on the one of the most difficult to estimate sources of bacteria: malfunctioning septic systems.

Septic systems are frequently discussed as a possible source of bacterial contamination. In many respects, they are an ideal candidate for pollution source reduction, because they are human-origin, under the direct control of their owners, and well-established regulations and procedures are in place to manage them at the state and municipal level. Generally, however, septic system management is handled on a case-by-case basis when failure is suspected, or when new construction is undertaken. This leaves the majority of systems off the radar screen, for better or worse.

To better understand the risk of bacterial contamination from failing septic systems, we examined data from a range of sources, including soils data from the National Resources Conservation Service, building information from town Assessing Departments, septic system permitting records from NH DES Subsurface Bureau, as well as others. The large amount of data on file, which continues to be collected each year, represents a wonderful opportunity for the state and municipalities to better understand and protect surface water quality from the risks of malfunctioning systems.

Septic system malfunctions which result in sewage backups into homes or breakouts to yards are easily identifiable and usually corrected promptly. Other types of malfunctions, however, may remain undetected for years. In particular, problems which interfere with the slow, steady movement of effluent through a suitable and unsaturated soil matrix may not result in any detectable problem to the homeowner or to neighbors, but may nevertheless release high levels of bacteria to nearby surface waters.

Many studies indicate that saturated soils interfere with adequate treatment of septic wastes. (Coyne 1996 and 1997; Hall 1990; US EPA 2002). Noss and Billa (1988) state that failure is inevitable, sooner or later, in all systems. High groundwater, suspended solids, inadequate pumping schedule, poor design or installation, and soil characteristics are all mentioned as factors which can reduce the longevity of a system.

Much of the NH seacoast is sensitive to water quality degradation from failing septic systems. Soils in the region are generally very limited in their natural suitability for septic waste disposal, as Natural Resource Conservation Service soils data indicate. In addition, patterns of development often show little to no shoreland setbacks for structures, lawns, and septic systems. While NH beaches generally exhibit high water quality, many of the tributaries to those beaches are showing signs of water quality impairment that could be caused by inadequately treated septic waste. These impairments include bacterial counts in excess of EPA water quality standards, and apparent nutrient loading, evidenced by algae-filled waters and thick invasive plant species (common reed, or *phragmites australis*) growth.

New septic systems in NH must meet modern regulatory requirements, be designed and installed by a licensed professional, and are inspected during installation. In addition, the state maintains a database of applications and permits publicly accessible through the web. The high standards that govern current septic installations, however, did not always exist, and undoubtedly there are some systems in operation today that were installed prior to the good design and oversight standards of today. Very old systems may even consist of a pit or cesspool, offering little to no disposal field treatment. Even for conventional systems, the probability of failure has been shown to increase with age (Dix and Hoxie 2001).

There are three components to this memo:

- Underlying Soil Suitability for Septic System, based on Natural Resource Conservation Service data;
- Improving understanding of septic system location and function; and
- Review and summary of bacteria load estimates.

This memo is submitted to fulfill deliverables 4D (Parsons Creek watershed) and 5D (Little River watershed), of the Beach Watershed Bacteria Investigation: Phase II.

Underlying Soil Suitability for Septic Systems

This section summarizes landscape analyses conducted by FBE for the watersheds of the Little River and Parsons Creek. The goal of the landscape analyses was to gain a greater understanding of the patterns and features in the landscape and the underlying processes that that may pose limitations for septic waste disposal, and to identify potential problem areas. The analyses were conducted using GIS to overlay various features in the watershed, resulting in the following maps:

1. *Soil Limitations for Septic Waste Disposal* – Soil features in each watershed that may pose limitations to the safe disposal of household effluent.
2. *Other Septic Risk Factors* – Additional landscape features that may pose limitations for septic waste disposal and potentially increase septic failure risk.
3. *Septic Failure Risk Assessment* – An overlay and ranking of all potential septic risk factors in the watersheds, to provide an overall assessment of relative risk.

Details and descriptions of each are provided below.

Soil Limitations for Septic Waste Disposal

Soil survey interpretation ratings are used for national and regional planning to identify the potential limitations for use of soils identified in soil surveys. Soil survey interpretations are models predicting the behavior of soil when managed, and result in a logical statement about that particular land use and the relationship of limiting features. In the National Soil Survey Handbook, soil interpretations rating guides for sanitary facilities are used to rate soil limitations for septic tank absorption fields. The following section describes the potential limitations for septic tank absorption fields (also known as disposal fields) in the Little River and Parsons Creek watersheds, as indicated by data obtained from the National Cooperative Soil Survey and the USDA-NRCS National Soil Information System (NASIS) database.

Septic tank absorption field interpretations are a tool for guiding site selection for safe disposal of household effluent. Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. For soil interpretation purposes, centerline depth of the tile is assumed to be 24 inches or deeper. Therefore, only soil between depths of 24 and 60 inches is considered in making the ratings. Soil properties and site features considered are those that affect the absorption of effluent, those that affect the construction and maintenance of the system, and those that may affect public health.

Soil properties and qualities that affect the absorption of effluent are permeability, depth to seasonal high water table, depth to bedrock, depth to a cemented pan, and susceptibility to flooding. Stones and boulders and a shallow depth to bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. In addition, soil erosion is a hazard where absorption fields are installed in steep soils.

Where soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines, the absorption field may not adequately filter the effluent, particularly when a system is new; consequently, ground water supplies may be contaminated.

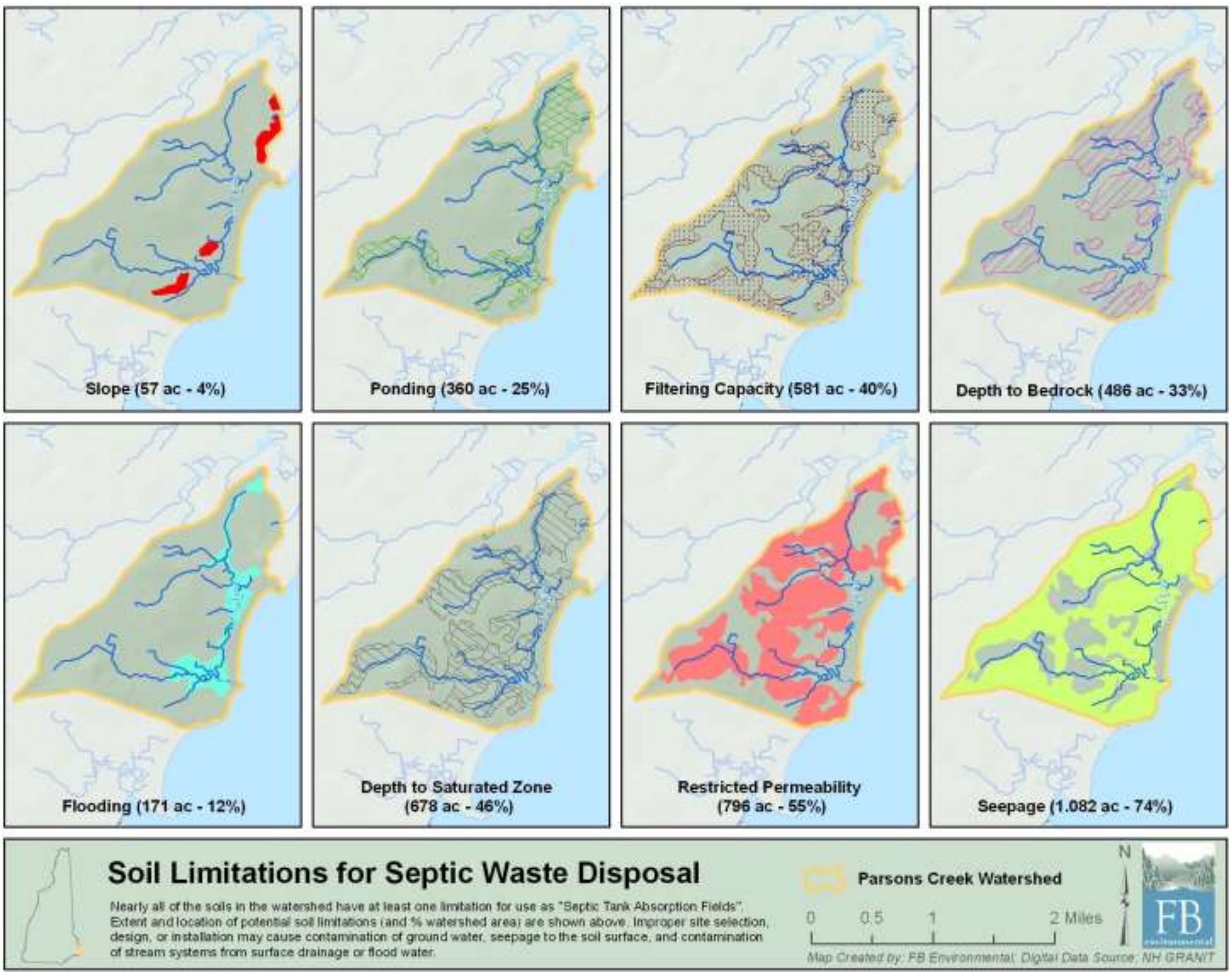

Figure 1: Parsons Creek watershed soil limitations for septic system, as indicated by the Natural Resource Conservation Service.

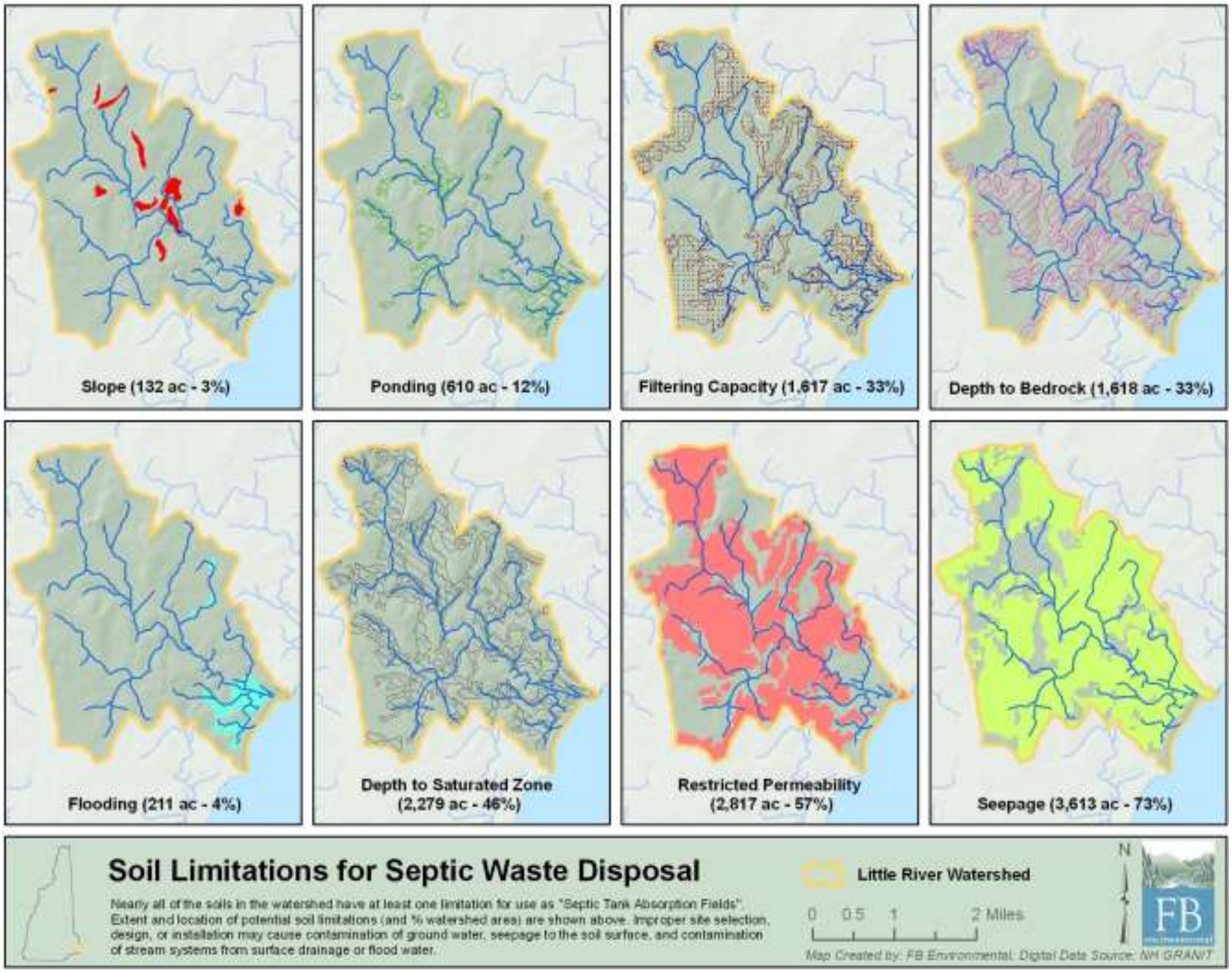

Figure 2: Little River watershed soil limitations for septic system, as indicated by the Natural Resource Conservation Service.

While general observations may be made from soil survey interpretations, onsite evaluation is required before the final site is selected. Improper site selection, design or installation may cause contamination of ground water, seepage to the soil surface, and contamination of stream systems from surface drainage or flood water.

In New Hampshire, percolation tests are used to evaluate the suitability of a soil for septic tank absorption fields. Percolation tests are necessary to determine the soil's ability to leach liquid at an adequate rate. An adequate location with proper drainage and with sufficient distance from the underlying water table is necessary to ensure that the leach field will operate both properly and in an environmentally sound manner. Test pits are holes that must be excavated into the soil within the area of a septic system's proposed leach bed. These pits are necessary to determine the level of the seasonal high water table and/or the depth of impermeable substratum.

According to soil survey interpretation ratings, nearly all of the soils in the Little River and Parsons Beach watersheds are rated as 'very limited' for septic tank absorption fields (the remaining soils are listed as 'not rated'). Soil limitations to septic waste disposal in the watersheds include:

1. Filtering capacity*:* The saturated hydraulic conductivity of soil, known as KSat, is an important physical property that influences the capacity of the soil to retain and transport water. The soil horizon with the maximum Ksat governs the leaching and seepage potential (or filtering capacity) of the soil. When this rate is high, transmission of fluids through the soil is unimpeded and leaching and seepage may become environmental, health, and performance concern. In the Little River and Parsons Creek watersheds, filtering capacity is a limiting feature in 33% and 40% of the soils, respectively.

2. Flooding: Flooding has the potential to transport agricultural waste off site and pollute surface waters. Flooding also limits building, recreational, and sanitary facility use and management of these soils. Soils in the Little River and Parsons Creek watersheds that pose flooding frequency limitations, cover 4% and 12% of the watersheds, respectively.

3. Ponding: Ponding is the condition where standing water is on the soil surface for a given period of time. Soils that pond have restrictions that limit the installation and function of most land use applications. Soil features considered are ponding duration and frequency. Ponding is a limitation in 12% of the Little River watershed and 25% of the Parsons Creek watershed.

4. Depth to bedrock: The depth to bedrock restricts the construction, installation, and functioning of septic tank adsorption fields and other site applications. Shallow soils have limited adsorptive capacity and biologically active zones through which waste materials can percolate. These soils may pose environmental and health risks when used as filter fields. Depth to bedrock is a soil limitation across 33% of both watersheds.

5. Slope: Absorption fields cannot be located too close to cuts or on steep slopes as there is a danger that the sewage can seep laterally out of the slope or cut before it has a chance to be fully treated. Septic systems can also cause slope failures if located in unstable slopes. Steep slopes are a limitation in 3% of the Little River watershed and 4% of the Parsons Creek watershed.

6. Depth to saturated zone: Soils with shallow depth to a water table may become waterlogged during periods of heavy precipitation and are slow to drain. These soils have the potential to contaminate ground water which may create health and environmental hazards. This limitation is present across 46% of the soils in both watersheds.

7. Seepage: The soil's bottom layer Ksat (saturated hydraulic conductivity) governs the leaching and seepage potential of the soil. When this rate is high, transmission of fluids through the soil and underlying materials is unimpeded and leaching and seepage may become an environmental, health, and performance concern. This is the most predominant soil limitation in both the Little River and Parsons Creek watersheds, present in 73% and 74% of the soils, respectively.

8. Restricted permeability: The soil horizon with the minimum Ksat governs the rate of water movement through the whole soil. When this rate is low, transmission of fluids into and through the soil is impeded and runoff, infiltration, and percolation of pollutants may result in environmental, health, and performance concerns. This limitation is present for 57% of the Little River soils and 55% of the Parsons Creek soils.

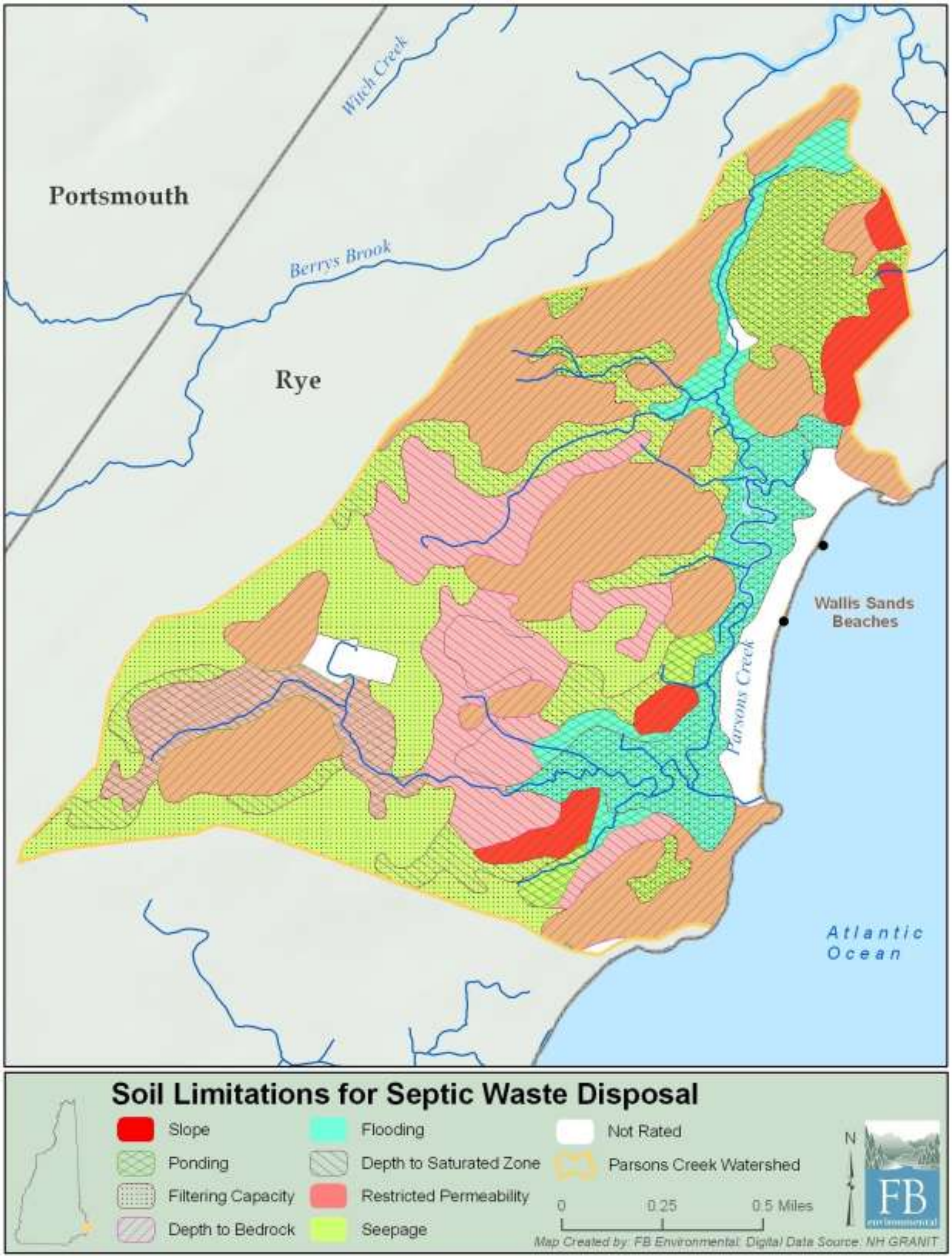

Figure 3: Parsons Creek septic disposal soil limitations, note the overlapping limitations in many areas.

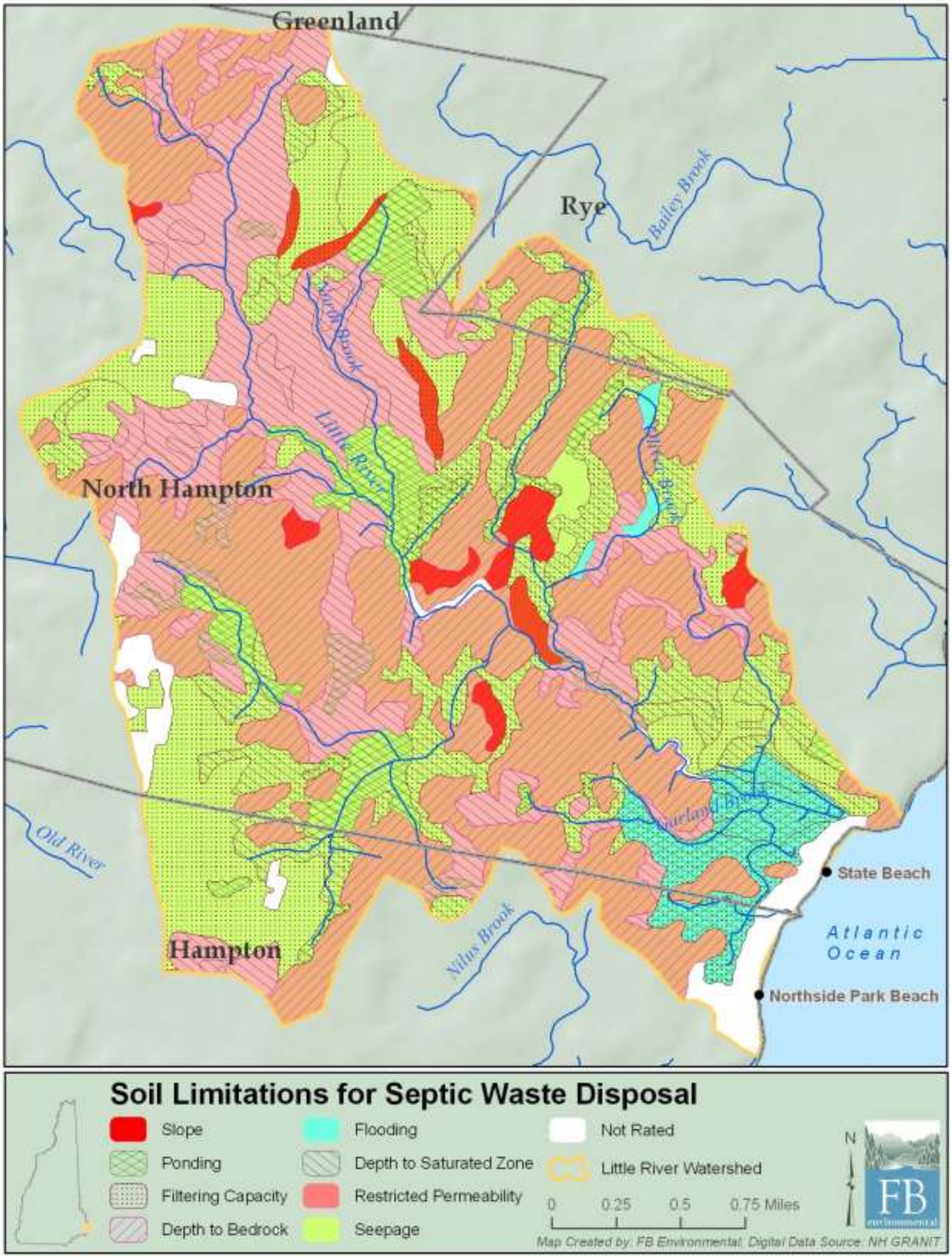

Figure 4: Little River watershed septic disposal soil limitations, note the overlapping limitations in many areas.

OTHER SEPTIC FAILURE RISK FACTORS

In addition to the soil limitations above, the following areas and landscape conditions were also considered as potential threats to the safe disposal of household effluent:

- Flood Areas: Also known as the 100-year floodplain. Bacterial contamination in the flood zone is likely during significant storm events.
- Wetlands: Most wetlands in the Little River and Parsons Creek watersheds are hydrologically connected to perennial streams. Contamination from septic failures in these areas would be more likely to reach nearby surface waters during storm events or astronomically high tides. In addition, bacteria travel much more easily and further through saturated soils.
- Non-Sewered Parcels: All developed parcels that were not on public sewer were assumed to pose a greater potential risk due to the possibility of inadequately functioning septic systems. Rye and North Hampton don't have public sewers and Hampton is partially sewered.
- Proximity to Streams: All streams in the watersheds were buffered by 100 feet, the average setback distance required in New Hampshire. Within these areas, there is increased potential for bacterial contamination from septic failure due to stormwater runoff and astronomically high tides.

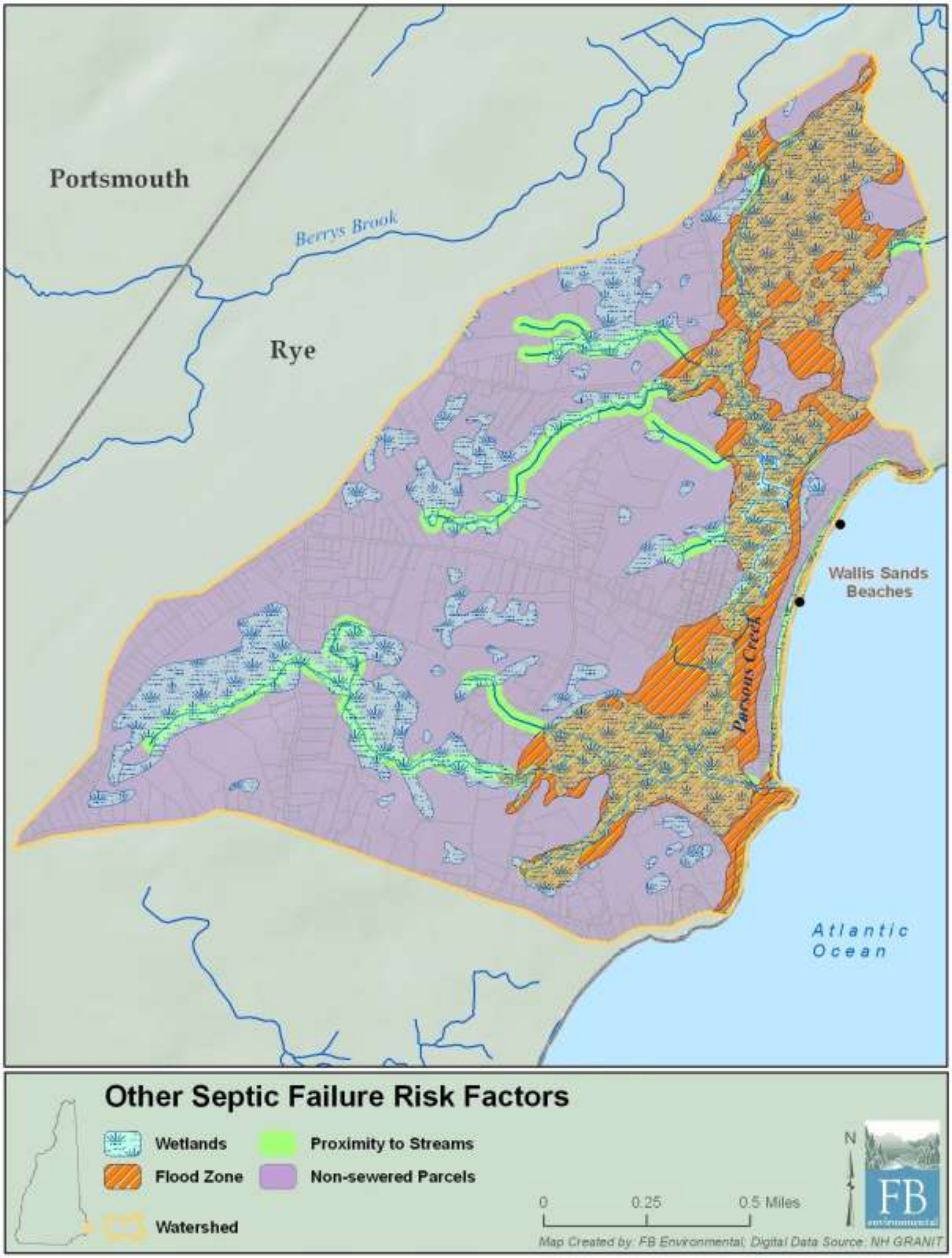

Figure 5: Parsons Creek watershed factors (beyond soils) contributing to risk of water quality contamination from malfunctioning septic systems.

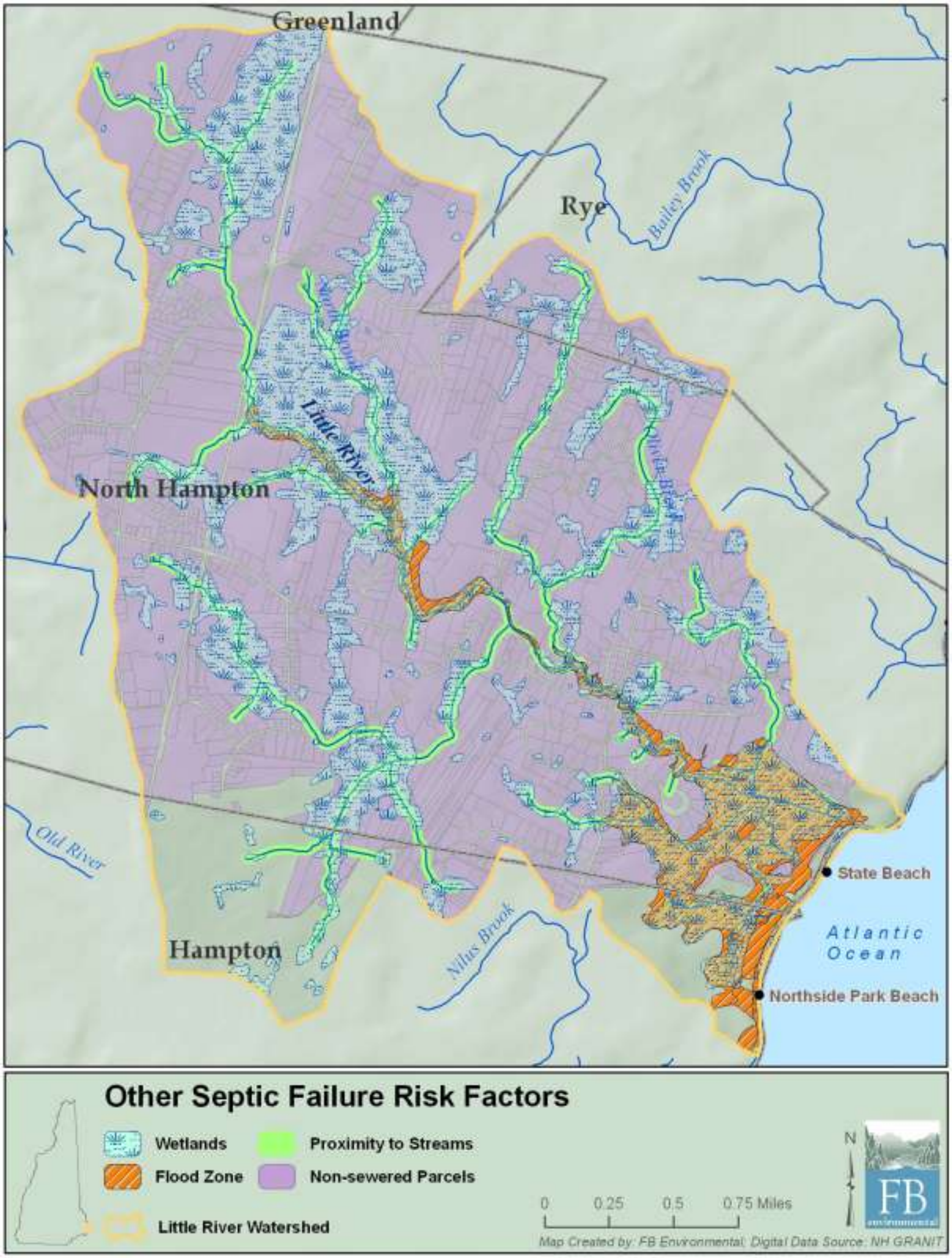

Figure 6: Little River watershed factors (beyond soils) contributing to risk of water quality contamination from malfunctioning septic systems.

Septic Failure Risk Assessment

A simple GIS model was used to determined relative risks from potential septic system failure by assigning scores to the criteria in each data layer. Each criterion was scored as follows:

- Flood Areas: Areas within the flood zone were assigned a risk score of 1 based on the assumption that bacterial contamination would be more likely during significant storm events.
- Soils: Each soil limitation discussed above was assigned a risk score of 1. Soil limitations overlapped in many areas, so the total limitation from soils could be greater than 1. These soil types were assumed to pose a greater potential risk due to the increased possibility of bacterial contamination from inadequately functioning septic systems.
- Wetlands: Wetlands were assigned a risk score of 1 based on the assumption that bacterial contamination in these areas would be more likely to reach nearby surface waters during storm events or astronomically high tides, and bacteria transport is heightened in saturated conditions.
- Non-Sewered Parcels: All such parcels were assigned a risk score of 1.
- Proximity to Streams: The areas falling inside the buffer were assigned a risk score of 1.

After assigning risk scores, all data layers were overlaid to create a composite risk map. Risk scores for overlapping criteria were summed to create a single risk factor for each area of intersection. Final risk factors ranged from 0 to 9, with 9 representing the greatest potential risk. Since the majority of soils in the watersheds are not well suited for septic systems, the primary determinant in identifying the greatest risk potential from bacterial contamination from septic failure risk was proximity to freshwater streams, estuaries, wetlands and flood hazard areas.

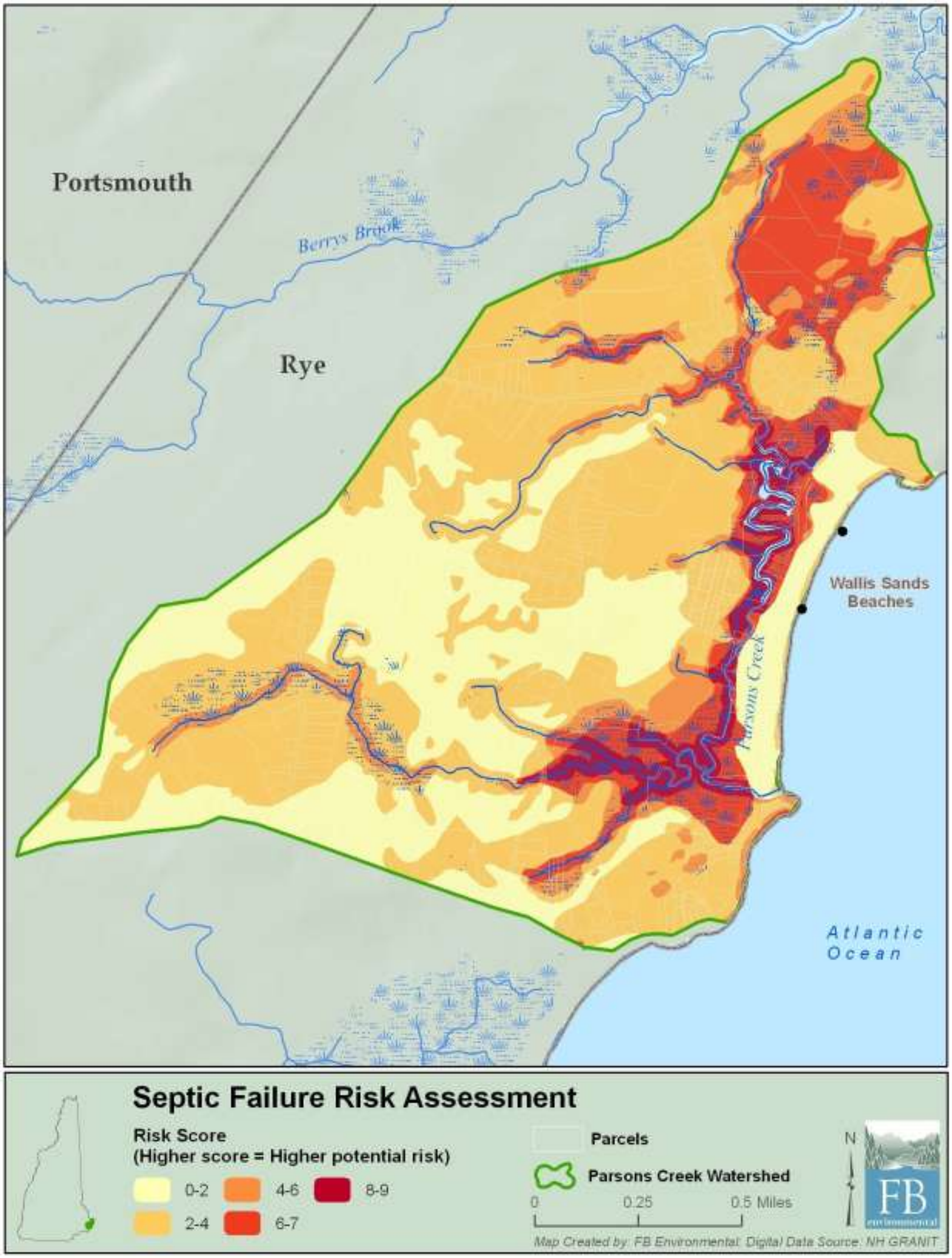

Figure 7: Parsons Creek watershed overall septic systems risk assessment.

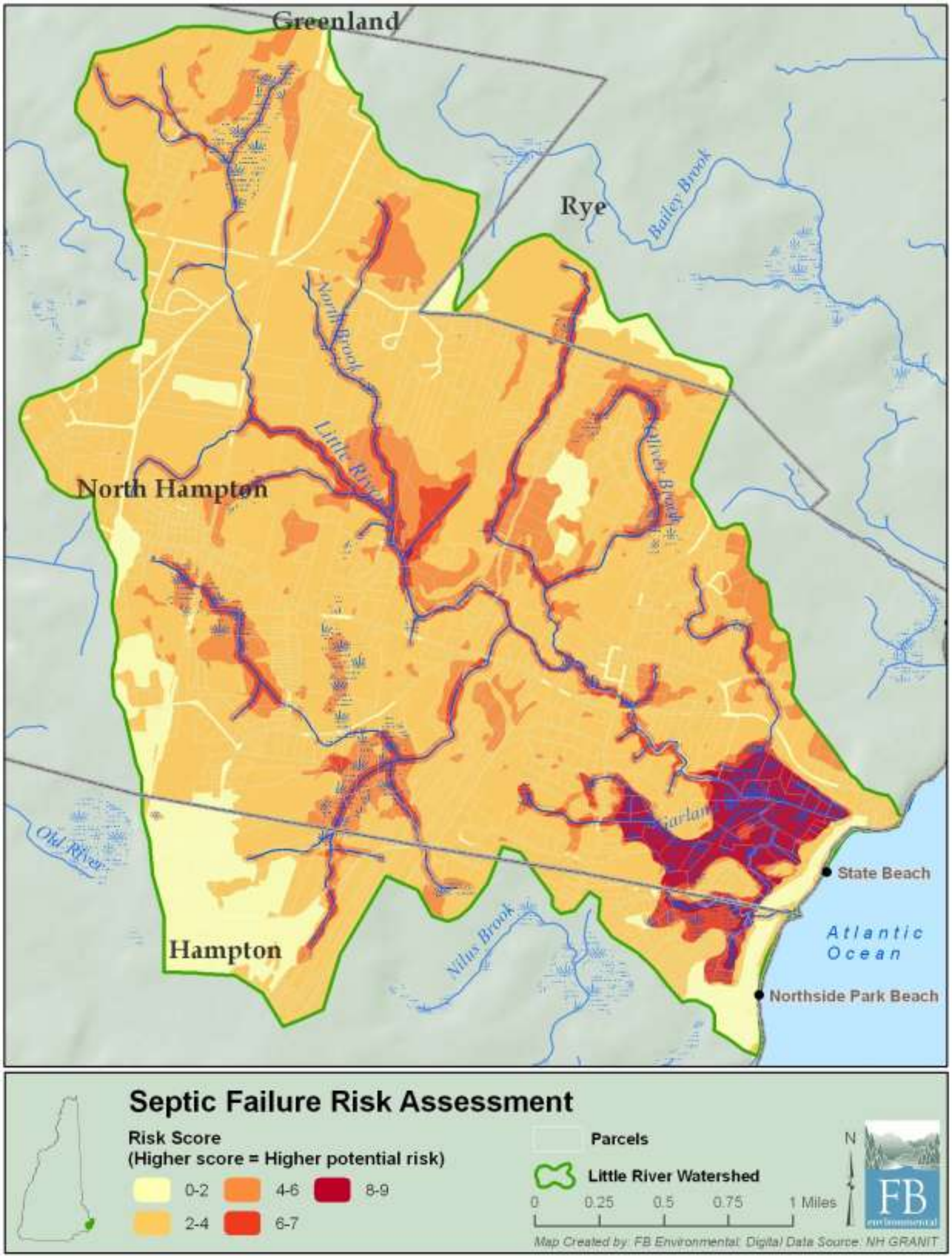

Figure 8: Little River watershed overall septic systems risk assessment.

Improving Understanding of Septic System Location and Function

Existing septic records were assessed for their potential as a tool for water quality protection. Specifically, four small focus areas were delineated, and septic records were sought. These areas were chosen because they were adjacent to surface waters that had shown signs of water quality stress, such as thick algae growth and high bacteria counts.

There were several sources of information used in our analysis:

- NH DES Water Division, Subsurface Systems Bureau database, via OneStop website;
- Building files and tax maps (at Rye and North Hampton Town Halls);
- GIS parcel maps (via NH DES);
- Assessors Online Database for Rye and North Hampton;
- Online maps (Google Maps, Bing Maps);
- GIS layers from GRANIT, such as streams, wetlands, roads, bacterial results, etc, to identify focus area boundaries; and
- Photographs, notes, and memos documenting recent field reconnaissance efforts.

Municipal Data

Municipalities collect and maintain certain information on septic systems. It is somewhat unclear, however, exactly what records are on file, since in years past, many permits were apparently issued without the town keeping a copy, according to recent conversations with Rye town staff. Currently, the state is the primary permit-issuer and inspector for septic systems, with towns reviewing variance requests. FBE visited both Rye and North Hampton to explore first-hand what records were on file and usable.

Rye, NH

FB Environmental staff visited the Town of Rye on May 4 and 5, 2010 to view files in the BCH11 and BCH26/BCH26A focus areas. Rye categorizes building files by street address, and the parcel only has a file if a building exists on the parcel. Older buildings may not have a file if the structure pre-dates current building permit requirements, and no building permit has been applied for since. Street address and year built information were found using the Vision database used by the Assessing Department. The Assessing Department's "year built" field was used to determine structure age, and when absent, to determine that a parcel was undeveloped.

As in North Hampton, evidence of septic permits and systems was documented when found. Files for 108 parcels were requested, 81 of which were found, including 6 properties without a year built in the Assessing database. Three types of records of a septic system installation were identified: a Town building permit, a state approval of construction, and a notice of operation which is required after a final inspection. Most files did not contain all three records and very few included the actual application (indicating design and exact location) for the septic permit from the state or town.

Town staff showed interest in this research and what it meant for the town of Rye. A staff member was concerned that finding septic problems may increase the workload to the town, yet was interested to know what was on file for septic systems and what the State might do with the information. She indicated that the town was supportive of the project and wants to protect the natural resources of Rye.

North Hampton, NH

North Hampton Municipal Offices were visited on May 4, 2010, and two focus areas were researched. Building files are organized by map and lot, and were pulled with help from town staff. Septic system records were found within many of the files.

Septic system permits were found in the building file for each property and organized by map and lot numbers. In the Town of North Hampton, each septic system must have a town Building Permit and a Notice of Operation after an inspection of the installed system was completed. Records were noted and tabulated.

Additionally, the use of municipal assessment records was explored as a way to determine neighborhood age. Both Rye and North Hampton publish assessing records online, as mentioned above. Using street address, it was possible to view—lot by lot—properties of interest to see if they contained principal structures and year built. This added to our understanding of the area, and was used to estimate septic system age in cases where no septic system record was found.

NH DES Subsurface Bureau Data via OneStop Website

NH DES Subsurface records were accessed via the DES OneStop website, specifically the query for "Application and Approval Status." The query was run once for each town (Rye, North Hampton, Hampton) to return all records in the NH DES Subsurface database for each town. The resulting table was exported to Excel, and reformatted to facilitate analysis.

To gauge data completeness, NH DES Subsurface database records were compared to a table of parcels for the town of Rye. The GIS parcel layer from which the table was exported was supplied to FBE by NH DES earlier in the study. Out of 1213 Subsurface records, 764 (63%) were matched to a parcel via map and lot. A small number (approx. 50) of additional records appeared to refer to multiple parcels ("19 & 20") or had extra characters inserted ("# 15", "M10-L61", etc) and therefore could not be automatically matched with certainty to a single parcel. They could possibly be manually matched if more time were available. The remaining records could not be matched at all, containing blanks, five-digit numbers, non-existent maps or lots, etc.

Selection of Focus Areas

Given the size of the data files involved, four focus areas were chosen to study in greater detail the quality and usefulness these septic system records to water quality efforts. We chose focus areas based on several factors. They all had shown elevated bacterial counts during wet weather. In addition, on-site reconnaissance had shown one or several potential bacteria sources in the area. In some cases, broader water quality issues, such as nutrient loading, appeared to be happening.

The focus areas were drawn to include parcels adjacent to the shoreline, plus those with obvious drainage to the area of concern. The GIS parcel layers were inspected for map and lot information. The Rye data layer contained map and lot in the attribute table, while North Hampton did not. In North Hampton, the Assessing database was queried to determine approximate map and lot, which was checked against the North Hampton tax maps on file at North Hampton Town Hall and corrected if necessary.

The focus areas correspond to the following four sampling stations:

- BCH11, along Marsh Rd in Rye.
- BCH26 and BCH26A, at the intersection of Wallis Rd and Ocean Rd in Rye, including the neighborhood just west of this intersection.
- BCH25, Appledore Ave in North Hampton.
- BCH18 and BCH19, along Lafayette Rd / US Route 1 in North Hampton.

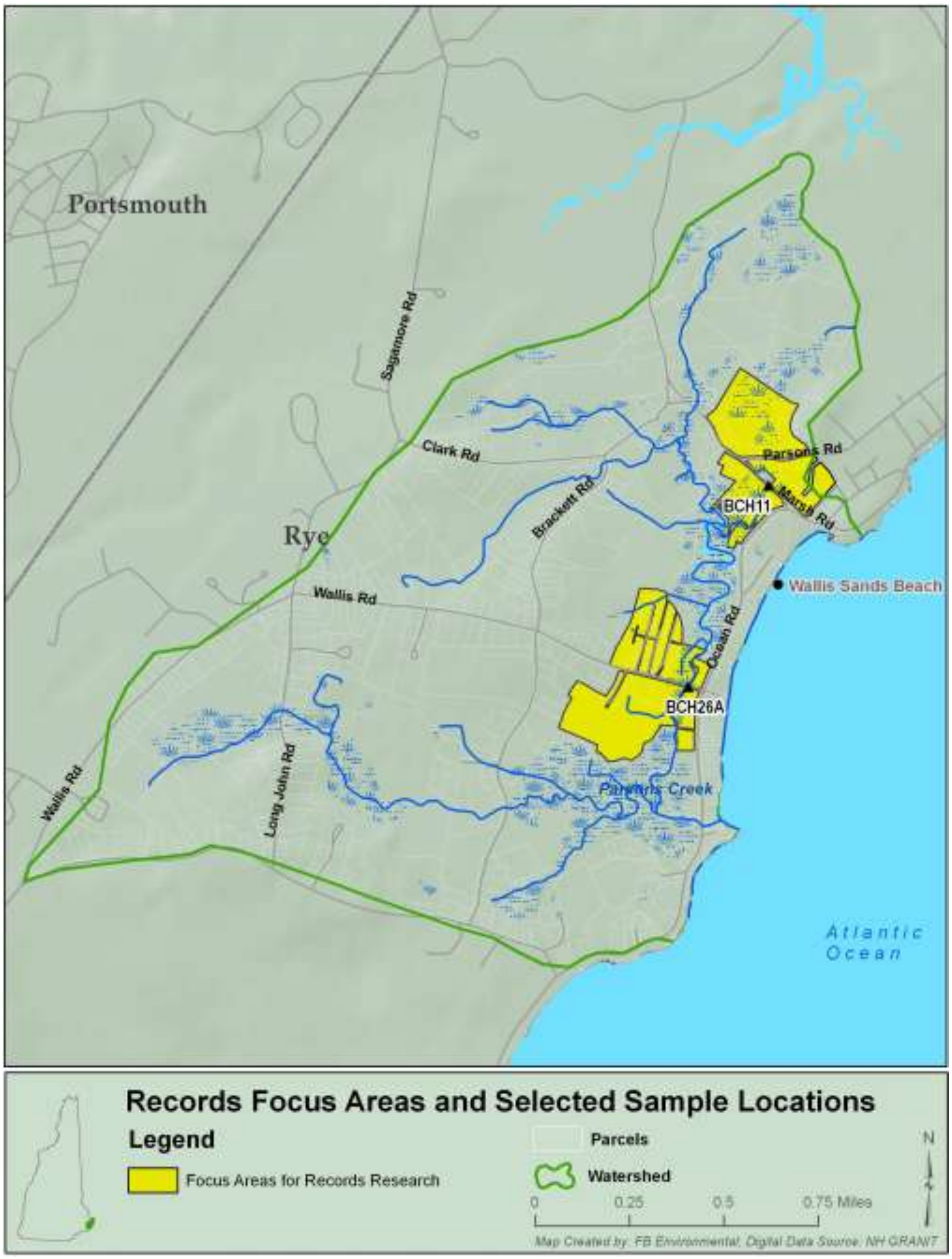

Figure 9: Focus areas for records research in Parsons Creek watershed.

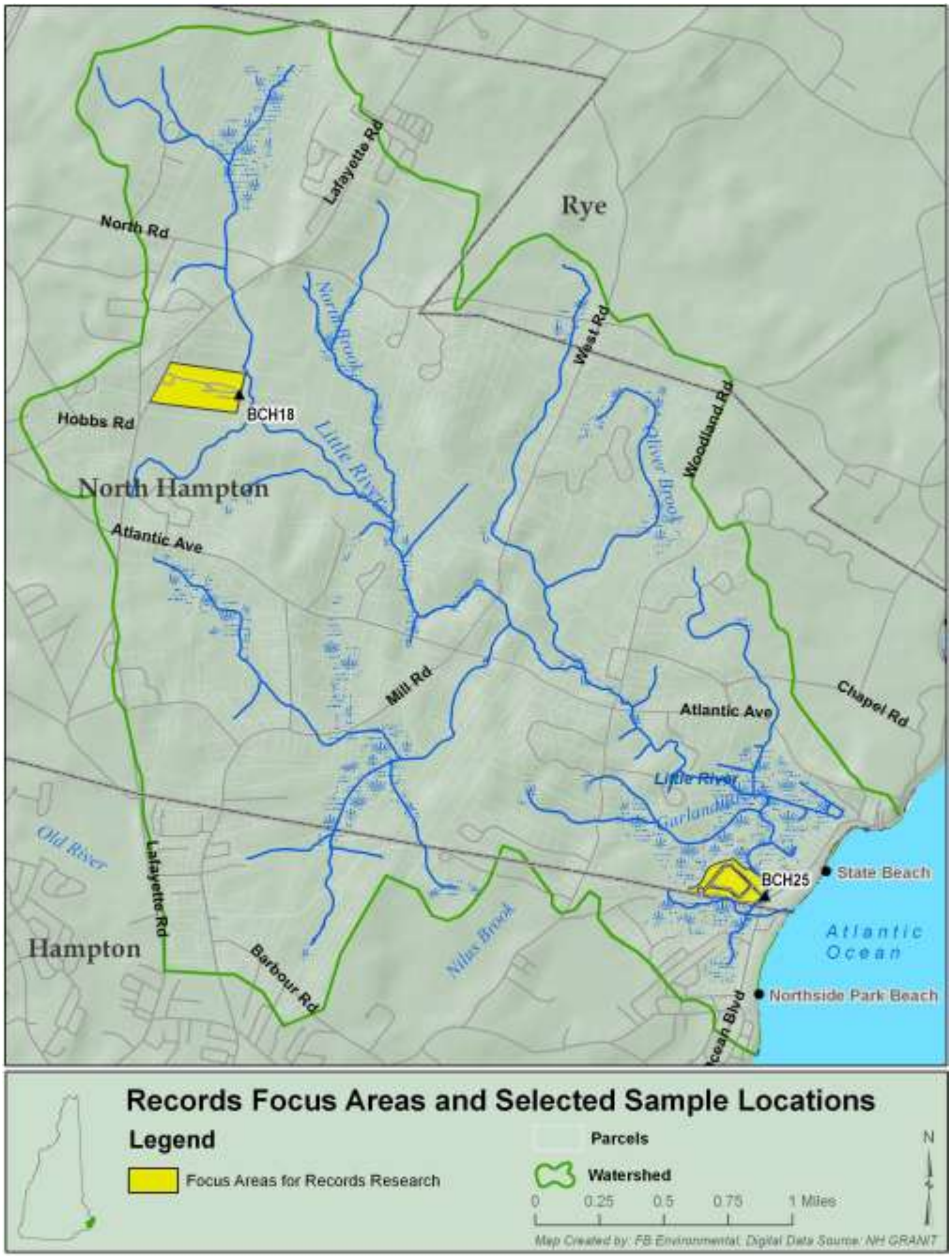

Figure 10: Focus areas for records research in Little River watershed.

SEPTIC SYSTEM RECORDS

BCH11, at Marsh Rd, Rye

Site visits to the area surrounding BCH11 along Marsh Rd show evidence of past ditching in the salt marsh itself. The roadside ditches are tidal, and filled with thick brown algae suggesting high nutrient loading. The marsh is surrounded by a residential development consisting of parcels on Parsons Rd, Port Way, Marsh Rd, Glendale Ave, and Manor Dr. Most homes in this area were built in the 1950's. The oldest is dated 1890, and the newest were 3 rebuilt in the early

2000's.

The large wetland was sometimes cited in the building files, and many property owners had obtained dredge and fill permits from the state. Most septic systems are still located between the home and the marsh. One site drawing located the septic 40 ft from the wetland edge and a sump pump drains directly to the wetland. This septic system was installed in 1992 and failed in 2003 requiring a new system. Another home installed a septic in 1972 that was authorized by the state but not the town. The town inspected the septic in 2001 and found 4 deficiencies requiring a new design before it could be granted a town permit. The system was removed and an approved septic was put in its place after the homeowner was granted a wetland setback variance from 100 ft to 37 ft.

There are 34 parcels in the focus area, and 23 appear to have a primary structure (as indicated by "year built" in the Assessing database). Of these 23 parcels, (48%) have a record pertaining to their septic system on file with the town. In the NH DES Subsurface database, there are 8 records (35% of total), some of which overlap with municipal records. Combining the two datasets, there are 12 parcels (52%) with either town or NH DES data on file.

BCH26 and BCH26A, at Wallis Rd, Rye

This focus area is defined as the drainage entering to the channels at BCH26 and BCH26A, where Wallis Rd in Rye crosses over Parsons Creek. There is a residential neighborhood along interior streets (Odiorne Dr, Park Ridge Ave, and Oceanview Ave) just west of the channel. There is moderate density commercial development along Ocean Boulevard, with Wallis Rd being generally undeveloped in the immediate vicinity due to tidal marsh. There is a single home on Rye Lane which connects Ocean View and Park Ridge Ave. There are 74 parcels in this area, 17 directly border the marsh and 13 do not have a record of year built, indicating that they do not have a primary (taxable) structure.

Many of the older homes have records of septic systems from 1970 on and have been turned into apartments. One property has 5 approvals of construction for a septic system, indicating that many revisions were made before the system was installed. The previous system had failed, as indicated by a dye test done by the town after seepage was found flowing to the wetland.

There are 74 parcels in the focus area, and 61 appear to have a primary structure (as indicated by "year built" in the Assessing database). The average year built of the developed parcels is 1955 and has a range from 1800 to 2008. Of the 61 developed parcels, 30 (49%) have some form of septic system record on file with the town. One parcel without a year built in the database has a town septic record. In the NH DES Subsurface database, there are 21 records (34% of total). Combining the two datasets, there are 35 parcels (57%) with either town or NH DES data on file.

BCH18 and BCH19, at Lafayette Rd / US Route 1, in North Hampton

This focus area includes a busy section of US Route 1 / Lafayette Rd, a small amount of high density commercial development along the road, a large mobile home park, and smaller campground, plus some undeveloped area. Surrounding parcels were viewed for records of septic system installations. Each mobile home in the park has its own town building file, however, only the master file for the land parcel was viewed. It is believed that each mobile home does not have its own septic system based on the very small land area surrounding each home as seen in field visits. Another parcel contained commercial uses and a campground. Structures in this area were built in the mid 1960's to 2008 with a majority being constructed in the mid 1980's.

FB Environmental staff talked with town staff, who indicated that a dye test had been done on a failed system and evidence of the dye was found much farther downstream of the outfall. Unfortunately, there was no written record found at Town Hall of this dye test, nor could the staff member recall who or what agency had conducted the dye test.

There are 4 parcels in the focus area, and 2 appear to have a primary structure (as indicated by "year built" in the Assessing database). Two parcels were shown to have septic records, 1 with a primary structure and 1 parcel without. NH DES Subsurface records were also available for the same 2 septic systems.

BCH25, at Appledore Ave, in North Hampton

This area is made up of Appledore Avenue and Boulters Cove Road. During field surveys it was noticed that this development is surrounded on all sides by tidal marsh, and most houses are non-conforming to current town zoning setback requirements. Most development occurred in the early 1970's, with 4 homes rebuilt from 2000 to the present. All of the parcels had a building file. Very few of the building files contained septic records. The lack of septic permits did not seem to correspond to age of structure as expected; 3 out of the 4 newer houses did not have a septic permit in the building file. Most permits in the files were for systems installed in the 1980's and did not have a more recent installation on record. Those properties that did have a more recent system were because the previous system had failed, as was the case in 2 of the parcels.

Proximity to the wetlands presents a risk factor to water quality in this development, both for developed area runoff and for septic systems. Almost all of the 22 parcels had a variance recorded for setbacks. In some cases the septic systems are as close as 20 feet to the wetland edge although currently, zoning for new construction is 100 feet. One system 20 ft from the edge of the wetland failed in 1999 and a replacement was put in the same location after the planning board found no other reasonable place on the property to accommodate the system.

There are 26 parcels in the focus area, and 23 appear to have a primary structure (as indicated by "year built" in the Assessing database). Of these 23 parcels, 8 (35%) have a record pertaining to their septic system on file with the town. NH DES Subsurface data has septic records for 3 of the 23 parcels, all 3 of which have town records as well.

Summary of Septic System Records

Research into septic system records on file in Rye and North Hampton showed that, at least in our four focus areas, only about half of the building files had records of septic system installations on file. The age of the structure did not appear strictly correlated to the presence or absence of septic system records on file, as several new structures (built since 2000), had no records. Many files that had a septic permit in the file indicated that their system had failed at some point in the past.

Bacterial Load Estimates

Bacterial load estimates were covered in detail in the report "Coastal Beach Watershed Bacteria Source Investigation," submitted by FBE in December of 2009 to NH DES Beaches Program. In that report, the following types of bacteria source loads were estimated:

- Developed area runoff (including pet waste);
- Failing septic systems;
- Agricultural area runoff from livestock; and
- Natural area runoff from wildlife.

These estimates are summarized below, and an excerpt of the report section (edited to show only the two watersheds of interest) is included here as an appendix. One of these categories—failing septic systems—is re-evaluated in this memo, while the others are maintained. There are several reasons for increasing the bacterial load estimate due to septic system failure rate.

The first is that NH coastal beach watersheds do not have soil conditions which would naturally mitigate a failing septic system. The NRCS soils data presented above make this case. The only areas within these watersheds without one or multiple soil restrictions for septic waste disposal are those relatively small areas that have not been rated. In these coastal watersheds, it is essential that septic systems adequately treat waste within the system itself. If that does not happen, it is likely that bacteria will travel into surface waters due to one or multiple limiting factors (inadequate filtering capacity, seepage, shallow depth to bedrock or restricted permeability, or encountering inundated soil conditions).

A second reason to increase the bacterial load estimate derives from reasonable assumptions about the age and condition of the septic waste infrastructure in coastal NH. Based on a careful study of septic system records, both at the municipal offices and using the online NH DES Subsurface Bureau database, it seems likely that a large proportion of septic systems in these watersheds are of an age and condition where treatment failures occur frequently. These generally fell into two categories. The first category was a septic system installed more than 25 years ago, and the second was a building over 25 years old with no records of septic systems. In the neighborhoods studied, the proportion of properties falling into this category was between 50% and 64%.

Finally, one additional motive for adjusting upward our estimate of loading from septic systems is that other studies have shown that professionals working with septic systems have underestimated the true failure rate in the past. Quoting Dix and Hoxie (2001), as they relate findings of Hoover (1989):

> *"A survey of health officials indicated a 5% estimate [of septic system failure], a survey of homeowners indicated problems with 11% of the systems, and an actual site inspection, using stratified random sample of permits during the wettest time of the year, showed 34% failure for conventional systems."*

Clayton (1973) indicated an average life expectancy of septic systems nationwide at 15-25 years. A more recent study by Dix and Hoxie (2001), based on an extensive review of records in Maine, estimated a maximum life for septic systems of 40 years. Based on the data found, and the septic system failure rates presented by Dix and Hoxie (2001), six categories of septic systems were created:

- low risk: septic record less than 10 years old (2000 - now); failure rate of 2% assumed, which is the mid-point of the failure rate for new systems (0%) and 10 year old systems (4%);
- moderate risk: septic record from 10-25 years old (1986 - 2000); failure rate of 13% assumed, which is the failure rate of a system at the midpoint of that range (17 years old);
- high risk: latest septic record on file is over 25 years old (1985 or older); septic failure rate set assumed to be 34%, consistent with Hoover (1989);
- uncertain - low risk: no septic record, and structure is less than 10 years old (2000 - now); failure rate of 2% assumed;
- uncertain - moderate risk: no septic record, and structure is 10-25 years old (1986 - 2000); septic failure rate of 13% assumed; and
- uncertain - high risk: no septic record on file, and structure is older than 25 years old (1985 or older); septic failure rate of 34% assumed.

Using these definitions, the results shown in Table 1 were found. Overall, no septic record could be located for about half (55%) of the structures. Some of these records are probably on file with NH DES Subsurface Bureau, but they just didn't have a valid map and lot within the database.

Perhaps more concerning, two-thirds (66%) of the structures overall were in a "high-risk" category, meaning that the most recent septic records was at least 25 years old, or if no records were found, the structure itself is that age.

Table 1: Results of Septic System Records Research.

	BCH25		BCH18-19*		BCH26-26A		BCH11		Overall	
low risk	3	14%			5	8%	1	4%	9	8%
moderate risk	3	14%	1	50%	10	16%	4	16%	18	16%
high risk	1	5%			18	28%	5	20%	24	21%
unknown - low risk	2	9%			2	3%	2	8%	6	5%
unknown - moderate risk	2	9%			3	5%	0	0%	5	4%
unknown - high risk	11	50%	1	50%	26	41%	13	52%	51	45%

Using the assumed failure rates for each risk level (2%, 13%, 34%, from low to high), a weighted average can be calculated to determine an overall estimated failure rate. This is done by multiplying the failure rate by the percentage represented by each risk category, then summing the results. The weighted risk average gives an overall septic system failure rate of 25% within these focus areas, resulting in the bacterial load estimate shown in Table 2.

Table 2: Revised Bacterial Load Estimate for Watersheds.

	Parsons Creek / Wallis Beach	Little River / State Beach
Total Population on Septic by Watershed	1,141	2,538
Septic System Failure Rate	25%	25%
Population on Failing Septic Systems	285	635
Annual FC Load	$2.1x10^{13}$	$4.6x10^{13}$

Inserting the adjusted septic system load estimate into the overall table of bacteria loads, produces the result shown in Table 3.

Table 3: Bacteria Loading Estimates for Watersheds.

	Land Area (sq mi)	Total Estimated (FC/yr)	Developed Area Runoff (FC/yr)	Failing Septic Systems (FC/yr)	Wildlife (FC/yr)	Farm Animals (FC/yr)
Parsons Creek / Wallis Beach	2.3	$5.8x10^{13}$	$2.8x10^{13}$	$2.1x10^{13}$	$7.9x10^{12}$	$1.6x10^{12}$
Little River / State Beach	7.7	$1.9x10^{14}$	$1.1x10^{14}$	$4.6x10^{13}$	$3.2x10^{13}$	$2.2x10^{10}$

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Appendix to May 21, 2010, Memo: Bacteria Loading Estimates Section from Coastal Beach Watershed Bacteria Source Investigation

A bacterial source load estimate was completed by FBE in the report "Coastal Beach Watershed Bacteria Source Investigation," submitted in December of 2009 to NH DES Beaches Program. The following information is largely taken from that report. The method of bacteria load estimation was deterministic, meaning that potential sources were identified, quantified using literature values and field reconnaissance data, then summed. The following types of bacteria source loads were estimated, and the analytical methods used are described in each section below:

1. Developed area runoff (including pet waste);
2. Failing septic systems;
3. Agricultural area runoff from livestock; and
4. Natural area runoff from wildlife.

Once bacteria load estimates are established for sources, simple estimates of bacteria load reduction associated with source mitigation are obtained. These load reduction estimates will prove useful in compiling and prioritizing bacteria sources for mitigation as part of Phase II of the beach bacteria project.

<u>Limitations</u>

Estimation of bacteria loading is difficult because there are many dispersed sources and ambient bacteria counts can change dramatically and very quickly based on environmental conditions. There is significant uncertainty in terms of several components of bacteria load estimation and the resulting estimates should be considered to be order-of-magnitude types of estimates. Specifically, key source characteristics, such as magnitude of sources and their proximity to streams, and key transport information, such as bacteria die-off rates, cannot be precisely specified. The bacteria load estimates provided herein are screening level and are intended to support watershed planning and prioritizing remediation efforts.

3.1 Developed Area Runoff

Developed area runoff is surface water flowing from residential and commercial areas during precipitation events and entering the stream. Roadways, parking lots, roofs, and lawns are included as developed area runoff. Bacteria load contributions from developed areas were estimated using the widely applied event mean concentration (EMC) method.

This method has been applied by the Center for Watershed Protection (CWP) (Schueler 1987) and is used within the AVGWLF watershed model (Evans et al. 2008). Input parameter values were obtained from studies conducted by the CWP and other investigators. The approach consists of estimating two components (1) runoff water volume and (2) average bacteria concentration in runoff water. As shown in Equation 1 below, the product of these components is the bacteria load, expressed in bacteria counts per year.

Bacteria concentrations estimated herein are for fecal coliform (FC) bacteria. FC was selected because it is the form of bacteria with the greatest amount of available research results and related available data to support load estimation. Bacteria load estimates are also provided herein on an annual basis (i.e., counts/year) to provide uniform units for comparison.

Runoff Volume

The hydrologic component is runoff volume and is estimated using developed land area, precipitation amount, and budgeting of water volume (e.g., infiltration, evaporation, and runoff). Runoff volume is calculated, as shown in Equation 1, using a method developed by Schueler (1987) at the CWP, whereby runoff fraction is a function of percent impervious cover (%IC). The Schueler method is very similar to the method applied by the AVGWLF model and was selected because it is straightforward to apply in spreadsheet form. Total precipitation was obtained from weather data at the Seabrook power plant, situated within the study area. Developed land area, annual precipitation, and runoff fractions for each watershed are shown in Table 2.

Equation 1: Developed Area Runoff

Runoff Bacteria Load (counts/year) = (Runoff Volume) x (Bacteria Concentration)

Where,

Annual Runoff Volume = (Annual Precipitation Volume) x (Runoff Fraction)

Runoff Fraction = 0.05 + (0.9 x %IC)

Event Mean Concentration

The average bacteria concentration in runoff is estimated using data provided by major investigations that have compiled over 1,000 stormwater pollutant load samples from similar land areas. Event mean concentration (EMC) is defined as the mean concentration of a pollutant over the duration of a storm event. This metric is widely applied in estimating pollutant concentrations associated with stormwater in developed areas. The Center for Watershed Protection and other investigators have compiled stormwater pollutant data and correlated pollutant concentration with land cover type and other factors. The EMC value for stormwater run-off from residential areas of 7,000 Fecal Coliform/100ml (Schueler, et al. 2007) was chosen for this application. This value was selected following a review of available data (see Appendix C of December 2009 report) because this land cover type most closely matches the development characteristics of the beach watersheds.

Summary

Table 4 provides a summary of estimated annual developed area runoff bacteria loads by watershed.

Table 4: Estimated Developed Area Runoff Bacteria (FC) Loads

	Developed Land Area (m^2)	Developed Land Area ($mi.^2$)	Annual Precip. (cm)	Runoff Fraction	EMC (org/ 100mL)	Annual FC Load to Stream
Parsons Creek / Wallis Beach	1,874,000	0.72	118.4	0.18	7000	2.8×10^{13}
Little River / State Beach	6,105,000	2.36	118.4	0.22	7000	1.1×10^{14}

3.2 FAILING SEPTIC SYSTEMS

Bacteria (FC) loading from failing septic systems was estimated using two components; (1) population on failing septic systems (FSS) and (2) the associated bacteria load per person on failing systems. These estimates were then applied to each watershed to support estimation of total bacteria loading due to failing septic systems.

Population on Failing Septic Systems

To estimate the population on failing septic systems, we needed to first estimate the number of septic systems and average number of people per septic system in each watershed. These estimates were obtained for each town and each watershed using a combination of census data and GIS-based parcel maps.

First, total watershed-level population estimates were obtained using US 2007 Census estimates by town, as shown in column 2 of Table 5 below. The total number of tax parcels was also obtained, using parcel map data and GIS-analysis (column 3). To obtain an estimate of the average number of people per tax parcel (by town), the town population was divided by the total number of tax parcels (column 4). The number of people per parcel ranged from 1.5 to 3.5 people/parcel in the study area towns.

Table 5: Estimates of Population by Town and per Tax Parcel.

	US Census Population Estimate (2007)	Total Tax Parcels	People per Tax Parcel
Rye	5,174	3,147	1.64
North Hampton	4,528	2,217	2.04
Hampton	15,390	6,856	2.24

Next, since town boundaries and watershed boundaries are different, the number of tax parcels per watershed needed to be obtained. Parcels per watershed were determined using GIS. Tax parcel center points (centroids) were utilized to avoid over-counting tax parcels that straddle watershed boundaries. Tax parcels within 150 feet of a sewer line (200 feet in Seabrook, per municipal ordinance) were assumed to be connected to public sewer systems and were excluded.

Using this method, the number of parcels without public sewer (and assumed to be on septic systems) was estimated and is provided in Table 6. The number of tax parcels assumed to be on septic was then multiplied by the people per tax parcel for each respective town to estimate the population on septic systems per watershed, as shown in Table 7.

Table 6: Estimated Parcels without Public Sewer by Watershed and Town

Watersheds → Towns ↓	Parsons Creek / Wallis Beach	Little River / State Beach
Rye	694	37
North Hampton	0	1094
Hampton	0	108
Totals by watershed	**694**	**1239**

Table 7: Estimated Population on Septic Systems per Watershed

Watersheds → Towns ↓	Parsons Creek / Wallis Beach	Little River / State Beach
Rye	1141	61
North Hampton	0	2234
Hampton	0	242
Total Population on Septic Systems	**1141**	**2,538**

It is difficult to estimate how many of the total number of septic systems are failing. After conducting a literature review and meeting with experts in seacoast bacteria studies, a range of septic system failure rates of 5 to 10% was selected initially. Further research into NH DES Subsurface Bureau records and permits on file with the towns revealed aging infrastructure leading to a revised failure rate of 25%. This rate may appear high, but groundwater transport of failing septic system waste to adjacent surface waters is common and is typically not detected. Several studies have shown that subsurface bacterial transport from septic leach fields is significantly increased when the leach field is saturated with groundwater (Viraraghavan 1978; McCoy and Hagedorn 1979).

Bacteria Loading per Person on Failing Septic Systems

The human organism sheds approximately 2×10^9 fecal coliform daily (US EPA 2001). Significant attenuation within failing septic systems and in the ambient environment is believed to occur in the failing septic system scenario, likely significantly reducing the total per person loading rate of 2×10^9 count/day. Some ambient attenuation of bacteria (e.g., via soil filtration) likely occurs within failing systems. This attenuation is believed to occur as waste goes through the failing system, settles within a tank or cesspool, and travels through failing leach-field soils. Therefore, the loading value directly from a human organism likely overestimates the actual loading to the environment by a human organism using a failing wastewater system. For our purposes, we assumed a one order of magnitude reduction in fecal coliform loading from people served by failing septic systems. This attenuation is approximately equal to the average attenuation through groundwater presented by Viraraghavan (1978) in two test trials in Ottawa, Canada. The resulting bacteria loading rate per person is 2×10^8 fecal coliform daily.

Table 8 summarizes the population on failing septic systems and the resultant bacteria loading by watershed. The population on failing septic systems is obtained by applying a revised 24% failure rate (see above), to the estimates presented in Table 7. The bacteria loading estimate is obtained by applying the per-person loading rate of 2×10^8 fecal coliform/person/day on failing septic systems.

Table 8: Revised Estimated Population on Failing Septic Systems and Associated Bacteria Loading

	Parsons Creek / Wallis Beach	Little River / State Beach
Total Population on Septic by Watershed	1,141	2,538
Septic System Failure Rate	25%	25%
Population on Failing Septic Systems	285	635
Annual FC Load	2.1×10^{13}	4.6×10^{13}

3.3 WILDLIFE

A review of microbial source tracking (MST) studies in the seacoast was conducted to support identification of dominant wildlife. Dr. Steve Jones, a microbiologist at UNH, conducted the review and compiled a wildlife bacteria sources report, as part of this investigation (Jones 2009). The report is Appendix D of December 2009 report and identifies deer, raccoons, coyotes, foxes, otters, rabbits, Canada geese, and herring gulls as present in the study area, based on microbial source tracking results. The report also provides rough estimates of the magnitude of each wildlife source and identifies several dominant species including deer, geese, and raccoons. These three species were selected and applied to represent large mammal, bird, and small mammal bacteria loads, respectively, in the seacoast area, given their high population densities. The method of estimating each of these wildlife bacteria sources is provided below.

Equation 2: Wildlife bacteria loading estimate.

Wildlife Bacteria Load (counts/year) = (Animal Population) x (Bacteria load/animal/year) x (Die-off Rate)

Where:

Animal Population = (Habitat Land Area) x (Species density)

Deer

Deer bacteria loads were estimated using Equation 2 and parameter values described below. Table 9 provides a summary of bacteria loading estimates for deer by watershed. NH Fish and Game (NH F&G) biometrician Kent Gustafson provided the project team with a deer density estimate in the seacoast area of 22.5 deer per square mile. Habitat land cover types for deer were specified as forest, crop land, pasture land, forested wetlands, and sand dunes. Using GIS, the total area of deer habitat per watershed was calculated and multiplied by deer density to provide an estimated deer population per watershed. Using the equation provided above, the estimated deer population was multiplied by the estimated fecal coliform load per deer of 5.1×10^{10} counts/year (Jones 2009; Appendix D of December 2009 report). Lastly, an overland die-off rate of 0.9 was applied to account for bacteria die-off as it is transported from the land area to the receiving waterbody. The die-off rate of 0.9 was recommended by Dr. Barry Evans, developer of the AVGWLF model.

Table 9: Estimated Bacteria (FC) Loading from Deer in Seacoast Watersheds

Watersheds	Area Deer Habitat (sq mi)	Estimated Deer Population in Watershed	Yearly FC Shed by Deer	Yearly FC Loading from Deer to Stream
Parsons Creek / Wallis Beach	1.55	35	1.79×10^{12}	1.79×10^{11}
Little River / State Beach	6.23	140	7.17×10^{12}	7.17×10^{11}

Canada Geese

Table 10 provides a summary of bacteria loading estimates for geese by watershed. New Hampshire Fish and Game estimated goose population in New Hampshire south of Franconia Notch of approximately 22,000 geese. In order to get a rough estimate of goose population in the watersheds, FB Environmental used a population estimate of 20,000 in the area south of the lakes region to determine an order of magnitude goose population density estimate. Using this population density estimate, we then estimated goose population for each watershed. Using Equation 2, the estimated goose population was multiplied by the estimated fecal coliform load per goose of $4.2x10^8$ counts/year (Jones 2009; Appendix D of December 2009 report). Lastly, an overland die-off rate of 0.9 was applied to account for bacteria die-off as it is transported from the land area to the receiving waterbody.

Table 10: Estimated Bacteria (FC) Loading from Geese in Seacoast Watersheds

Watersheds	Area Goose Habitat (sq mi)	Estimated Goose Population in Watershed	Yearly FC Loading from Goose	Yearly FC Loading from Goose to Stream
Parsons Creek / Wallis Beach	0.31	14	5.92×10^{10}	5.92×10^{9}
Little River / State Beach	0.90	39	1.69×10^{11}	1.69×10^{10}

Raccoons

Table 11 provides a summary of bacteria loading estimates for raccoons by watershed. Raccoon population estimates could not be located for NH, so a literature value (DeGraaf and Yamanski 2001) taken from another northeastern habitat was applied. This estimate of 1 raccoon per 4.4 acres (145 per square mile) was noted as a maximum in favorable New Jersey habitat. Patrick Tate, wildlife biologist for NH F&G, assisted the project team in identifying raccoon habitat. Using GIS, the total area of raccoon habitat per watershed was determined and multiplied by density to provide a raccoon population estimate for each watershed. Using Equation 2, the estimated raccoon population was multiplied by the estimated fecal coliform load per raccoon of $4.4x10^{11}$ counts/year (Jones 2009). Lastly, an overland die-off rate of 0.9 was applied to account for bacteria die-off as it is transported from the land area to the receiving waterbody.

Table 11: Estimated Bacteria (FC) Loading from Raccoon in Seacoast Watersheds

Watersheds	Area Raccoon Habitat (sq mi)	Estimated Raccoon Population in Watershed	Yearly FC Loading from Raccoon	Yearly FC Loading from Raccoon to Stream
Parsons Creek / Wallis Beach	1.42	210	9.01×10^{13}	9.01×10^{12}
Little River / State Beach	5.47	790	3.48×10^{14}	3.48×10^{13}

Other Wildlife Sources

Other wildlife, beyond deer, geese, and raccoons, are present in the study area. These species include gulls, foxes, rabbits, and otters. For example, otters have been observed to create localized bacteria "hotspots," (personal communication S. Jones). Otters use common latrines which are located in the water, and therefore their loading is considered to be highly localized and not subject to any overland die-off. They were not considered to be generally significant across the landscape and were not calculated separately.

Gulls are present in large numbers along the coast and have been anecdotally identified as sources of bacteria at locations such as the mouth of Parsons Creek. FC organisms / gull loading has been found to be on the order of magnitude of 10^{11} (Gould and Fletcher 1978). Gull contributions to bacteria loading are likely largest when their waste is directly deposited in surface waters. This type of source is not included in the watershed load estimation process described herein because the primary location of gulls seems to be outside of the watershed proper, in intertidal zones. Nonetheless, they may be important in the overall bacterial loading budget relative to seacoast beaches.

Several species are noted in the literature as having population densities in the seacoast, but have estimated populations much lower than deer, geese and raccoons (e.g., the red fox at 2.7 foxes per square mile). It appears reasonable to select three dominant species and sum the estimated loadings of these species. If additional analysis of wildlife bacteria sources is deemed worthwhile, then more detailed information about these species may be obtained and additional species may be added to the analysis.

Summary

Table 12 provides a summary of Bacteria loading estimates for wildlife, by species and by watershed.

Table 12: Estimated Bacteria (FC) Loading for Selected Wildlife Species by Watersheds

	Parsons Creek / Wallis Beach	Little River / State Beach
Deer	1.79×10^{11}	7.17×10^{11}
Goose	5.92×10^{9}	1.69×10^{10}
Raccoon	9.01×10^{12}	3.48×10^{13}
Total	**9.20×10^{12}**	**3.55×10^{13}**

3.4 Farm Animals

The AVGWLF model contains a well-developed farm animal bacteria loading estimation method that was used for this project. The method applied in AVGWLF requires inputs for the load estimation calculation including bacterial loading rate per animal; number of each type of farm animal per watershed; the amount of time spent by animals in barnyards, pasture, and streams; the amount of manure removed to agricultural land;

manure soil incorporation rates; and runoff loss rates. The fundamental equation used by AVGWLF is provided in Equation 3. Key input parameter values required to estimate farm animal bacteria loads are described and presented below.

Equation 3: Farm Animal Loading by Species

Farm Animal Bacteria Load (counts/year) = (Animal Pop.) x (Bacteria load/animal/year) x (Runoff Rate)

Total Population of Farm Animals

The total number of farm animals was estimated for each watershed, based on a combination of field observations and research into farming operations in the study area watersheds.

Table 13 provides estimated numbers of farm animals by species and by watershed.

Table 13: Estimated Number of Farm Animals by Species and Watershed

Number of Animals	Parsons Creek / Wallis Beach	Little River / State Beach
Beef Cows	0	0
Milk Cows	0	0
Broilers	0	0
Layers	0	0
Pigs	0	0
Sheep	0	6
Horses	10	8
Turkeys	0	0
Buffalo	10	0

Bacteria Loading Rates per Animal

Per animal daily bacteria loading rates were obtained from the American Society of Agricultural Engineers (2003). Manure production and characteristics: section D384.1, in ASAE Standards. ASAE, St. Joseph, MI. Table 14 is taken from the ASEA document and the fecal coliform values were applied to estimate farm animal loads.

In order to include animals not in the ASAE chart below, we made the following simplifying assumptions:

- Buffalo bacteria loading is the same as beef cattle loading.

- Goats and llamas bacteria loading is the same as sheep loading.

Table 11 and these assumptions were applied to estimate bacterial loading rates per animal.

Table 14: Characteristics of Livestock Manure per 1000kg of live animal mass per day (ASAE 2003)

			Animal Type†										
Parameter	Units*		Dairy	Beef	Veal	Swine	Sheep	Goat	Horse	Layer	Broiler	Turkey	Duck
Boron	g	mean	0.71	0.88	**	3.1	0.61	**	1.2	1.8	**	**	**
		std. deviation	0.35	0.064	**	0.95	0.30	**	0.48	1.7	**	**	**
Molybdenum	g	mean	0.074	0.042	**	0.028	0.25	**	0.083	0.30	**	**	**
		std. deviation	0.012	**	**	0.030	0.38	**	0.033	0.057	**	**	**
Zinc	g	mean	1.8	1.1	13	5.0	1.6	**	2.2	19	3.6	15	**
		std. deviation	0.65	0.43	**	2.5	1.0	**	2.1	33	**	12	**
Copper	g	mean	0.45	0.31	0.048	1.2	0.22	**	0.53	0.83	0.98	0.71	**
		std. deviation	0.14	0.12	**	0.84	0.066	**	0.39	0.84	**	0.10	**
Cadmium	g	mean	0.003 0	**	**	0.027	0.007 2	**	0.005 1	0.038	**	**	**
		std. deviation	**	**	**	0.028	**	**	**	0.032	**	**	**
Nickel	g	mean	0.28	**	**	**	**	**	0.62	0.25	**	**	**
		std. deviation	**	**	**	**	**	**	**	**	**	**	**
Lead	g	mean	**	**	**	0.084	0.084	**	**	0.74	**	**	**
		std. deviation	**	**	**	0.012	**	**	**	**	**	**	**
Total coliform bacteria	colonies#	mean	1 100	63	**	45	20	**	490	110	**	**	**
		std. deviation	2 800	59	**	33	26	**	490	100	**	**	**
Fecal coliform bacteria	colonies	mean	16	28	**	18	45	**	0.092	7.5	**	1.4	180
		std. deviation	28	27	**	12	27	**	0.029	2.0	**	**	180
Fecal streptococcus bacteria	colonies	mean	92	31	**	530	62	**	58	16	**	**	590
		std. deviation	140	45	**	290	73	**	59	7.2	**	**	**

Distribution of Farm Animal Wastes and Runoff Rates

AVGWLF estimates several source areas and pathways for farm animal waste. Several agricultural source areas are estimated, including pasture, barnyard, and manure spread on cropland. This method results in Equation 3 being applied several times; once for each source area type and for each animal type.

In terms of source areas, the following assumptions were made about farm animals in New Hampshire based on observations in the watershed:

- Farm animals do not have significant direct access to streams; and

- Grazing time was limited to non-winter months.

These estimates were used to partition the animal's time between the agricultural source areas. Also, AVGWLF requires several additional input parameter values and the default (i.e., recommended) values of these parameters were applied.

Summary

Table 15 indicates the final bacteria loading results for farm animals by watershed, obtained by applying the AVGWLF model based on the above assumptions. Calculations occurred internally within AVGWLF, and are not reproduced here.

Table 15: Estimated Bacteria (FC) Load from Farm Animals by Watershed

	Farm Animal FC Loading (FC/yr)
Parsons Creek / Wallis Beach	1.55×10^{12}
Little River / State Beach	2.24×10^{10}

3.5 SUMMARY OF BACTERIA LOAD ESTIMATES

Table 16 summarizes bacteria load estimates by source category and by watershed. These are planning level estimates and contain significant uncertainty.

Table 16: Compilation of Estimated Annual Bacteria Loads by Watershed and by Type

	Land Area (sq mi)	Total Estimated (FC/yr)	Developed Area Runoff (FC/yr)	Failing Septic Systems (FC/yr)	Wildlife (FC/yr)	Farm Animals (FC/yr)
Parsons Creek / Wallis Beach	2.3	5.8×10^{13}	2.8×10^{13}	2.0×10^{13}	7.9×10^{12}	1.6×10^{12}
Little River / State Beach	7.7	1.9×10^{14}	1.1×10^{14}	4.4×10^{13}	3.6×10^{13}	2.2×10^{10}

Figure 16 provides estimated percentages of each type of bacteria load for each watershed. Developed area runoff is estimated to be the largest bacteria source in all of the study area watersheds (as shown in red below) ranging from 64% to 91%. Developed area runoff contributions originate in roadways, in yards, with pets, in illicit storm drains, and from other sources. Failing septic systems (blue) and wildlife (green) are also estimated to be significant in most watersheds. Failing septic systems are estimated to range from 1% to 19%, with larger estimated loads in unsewered communities. Farm animals are estimated to be significant only in the Wallis & Pirates Cove watershed with a 4% estimated contribution.

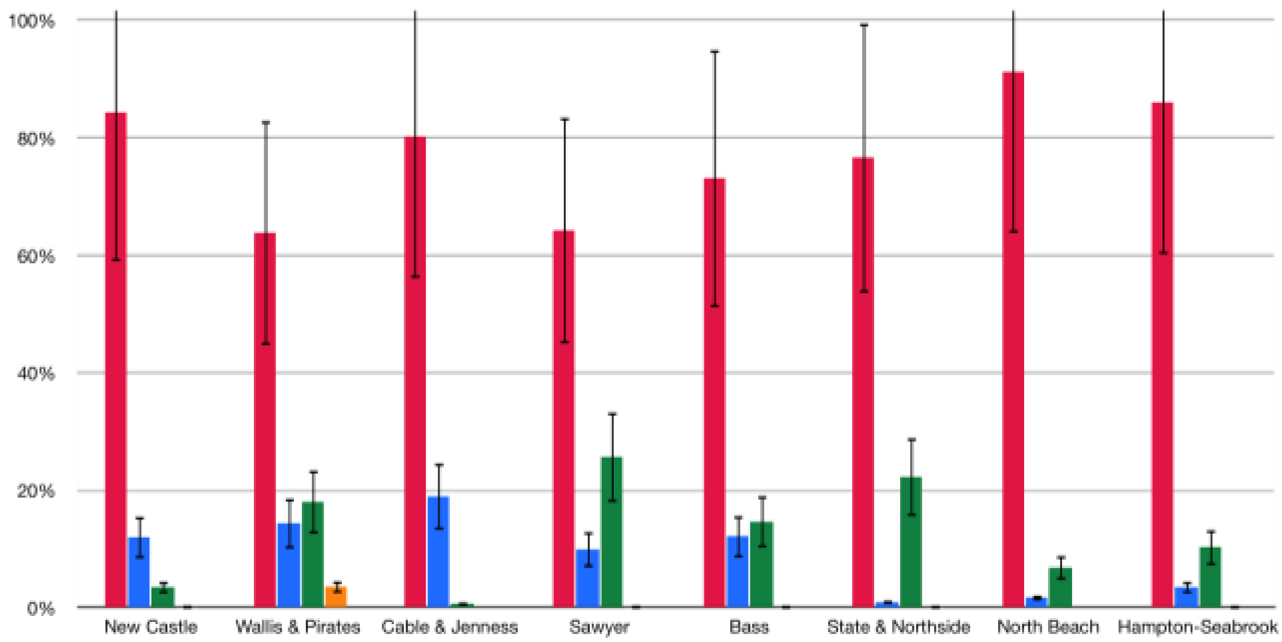

Figure 11: Estimated Bacteria Loads: Percentage of Each Type by Watershed.

There is significant uncertainty in the bacteria load estimates provided above. For failing septic systems, for example, the failure rate was estimated to range from 5% to 10%. Error bars are included in Figure 11 to represent uncertainty in the estimates. The bacteria load estimates provide useful screening level estimates, but do not represent exact characterizations of bacteria loads in the study area watershed.

Residential neighborhood in North Hampton: 64% (14 of 22) of developed properties showed a system 25 years or older, or records could not be located.

Mixed used area in Rye: 52% (32 of 61) of developed properties showed a system 25 years or older, or records could not be located.

Residential neighborhood in Rye: 61% (14 of 23) of developed properties showed a system 25 years or older, or records could not be located.

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