LOWER MEDOMAK RIVER

WATERSHED-BASED MANAGEMENT PLAN

WALDOBORO, MAINE

JANUARY 2020

2019 - 2029

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LOWER MEDOMAK RIVER

Watershed-Based Management Plan

A Nine-Element Plan to Guide Restoration of the Lower Medomak River from 2019 - 2029

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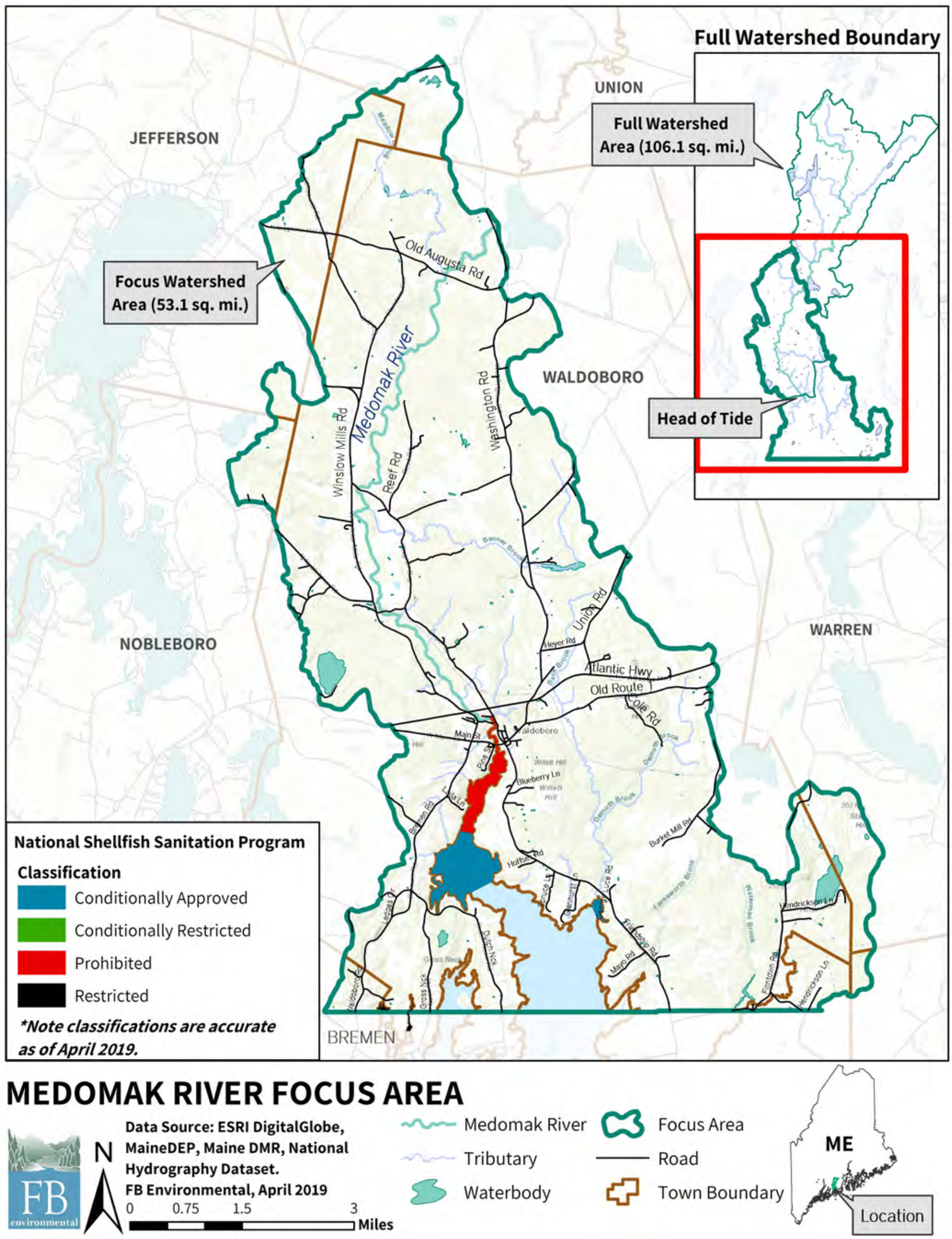

Full Watershed Boundary
Full Watershed Area (106.1 sq. mi.)
Head of Tide
Focus Watershed Area (53.1 sq. mi.)
UNION
JEFFERSON
WALDOBORO
NOBLEBORO
WARREN
BREMEN
Medomak River
Old Augusta Rd
Winslow Mills Rd
Washington Rd
Reef Rd
Union Rd
Heyer Rd
Atlantic Hwy
Old Route 1
Cole Rd
Main St
Pine St
Blueberry Ln
Bremen Rd
Burkett Mill Rd
Hoffses Rd
Spruce Ln
Luce Rd
Mayo Rd
Friendship Rd
Dutch Neck
Gross Neck
Ledges Dr
Waldoboro Rd
Hendrickson Ln
National Shellfish Sanitation Program
Classification
Conditionally Approved
Conditionally Restricted
Prohibited
Restricted
*Note classifications are accurate as of April 2019.
MEDOMAK RIVER FOCUS AREA
Data Source: ESRI DigitalGlobe, MaineDEP, Maine DMR, National Hydrography Dataset.
FB Environmental, April 2019
N
0 0.75 1.5 3 Miles
Medomak River
Tributary
Waterbody
Focus Area
Road
Town Boundary
ME
Location

ACKNOWLEDGMENTS

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Much of the work in this document builds on the Medomak River Water Quality Project Report written by Phil Garwood and published in March 2019. The success of this Plan is not without the tremendous effort of the entire Medomak Task Force listed in this document. Please access this full report here: http://www.waldoboromaine.org/docs/medomak.pdf.

ACRONYMS

BMP	Best Management Practice
DACF	Department of Agriculture, Conservation, and Forestry
FIB	Fecal Indicator Bacteria
FVCOM	Finite Volume Coastal Ocean Model
LID	Low Impact Development
ME DEP	Maine Department of Environmental Protection
ME DMR	Maine Department of Marine Resources
MMHP	Medomak Mobile Home Park
MVLT	Medomak Valley Land Trust
MST	Microbial Source Tracking
NSSP	National Shellfish Sanitation Program
NPS	Nonpoint Source
WUD	Watershed Utility District
WBMP	Watershed-Based Management Plan

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1. INTRODUCTION

1.1 BACKGROUND & PURPOSE

1.1.1 Background

The Medomak River is a 32.3-mile-long river with its headwaters originating in the Town of Liberty and flowing generally south through the towns of Appleton, Washington, and Union. The river then maintains its course through Waldoboro where it reaches head of tide just below Route 1. The Medomak River estuary is bordered by the towns of Bremen and Friendship before entering Muscongus Bay. The entire watershed area is 106.1 square miles with 80 square miles in the freshwater watershed and 26 square miles below head of tide. The largest portion of the full watershed (45.3% or 48.1 square miles) is located in the Town of Waldoboro. The Maine Department of Environmental Protection (Maine DEP) classifies the main stem of the river as Class A until Wagner's Bridge Road where it drops to Class B until Old Route 1[1]. All freshwater tributaries in the watershed are Class A. The Medomak River is listed on the Maine NPS Priority list as impaired with the listing reason as 'DMR/NPS Threat'. The tidal section is categorized as Class SB and is impaired for marine life use due to low dissolved oxygen and elevated fecal indicator bacteria (FIB) (see Section Problem & Need below for detailed information).

For the purposes of this Watershed-Based Management Plan (WBMP), **the Town is focusing on the portion of the watershed located below Medomak Pond.** This includes the small tributary area to the northwest of Medomak Pond. This is due to fecal indicator bacterial contamination noted in this portion of the watershed that has caused a significant loss of access to shellfishing in the river over the last decade.

The Town of Waldoboro is frequently the **leading softshell clam producer** in the State of Maine, despite experiencing regular closures due to nonpoint source (NPS) pollution (primarily fecal bacteria). Despite a statewide low production year in 2018, the combined towns of Waldoboro and Bremen caught 604,072 lbs. of softshell clams with a total value of $1,031,202. Waldoboro alone caught 468,857 lbs. (valued at $815,325) from its approximately 175 registered harvesters[2]. In total, this has ranged from 3.4-13.0% of the total economic value of softshell clams in the state over the past few years. Prior to 2018, Waldoboro was the leading producer in 2015, 2016, and 2017. Because of bacteria exceedances, the Maine Department of Marine Resources (Maine DMR) limits shellfish harvesting on significant portions of the river. In the upper Medomak River estuary, a 0.2 square mile area (133.8 acres) is listed as prohibited (pollution area WS26A1), and two areas totaling 0.6 square miles (352.4 acres) are listed as conditionally approved for either rainfall (WS26C1) or seasonality (WS26D)[3]. Efforts to abate nonpoint source pollution have proved successful, evidenced by a series of classification changes in recent years (e.g. October 2016 removal of Back River Cove from the prohibited list) (Maine Department of Marine Resources, 2016). Depending on seasonal precipitation, closures on the Medomak River can account for more than half of the harvest year.

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[1] The Maine DEP water classification system began in the 1950s and provides the State with water quality goals in the management of its surface waters. These classifications *"…establish designated uses, related characteristics of those uses, and criteria necessary to protect the uses, and establish specific conditions for certain activities such as the discharge of wastewater."* See the Maine DEP webpage link here for more details: https://www.maine.gov/dep/water/monitoring/classification/

2 Data obtained from Maine DMR is preliminary for 2018.

3 Prohibited areas are completely closed for shellfish harvesting. Restricted areas require a Maine DMR permit. Conditionally Approved areas are closed for nine days following precipitation events greater than one inch in 24 hours. At this point, the closure areas are automatically re-opened. However, if days seven through nine receive cumulative rainfall totals of greater than or equal to 0.75 inches, the areas remain closed for three additional days. Seasonally Approved areas are closed from May 1st to September 30th.

In addition to the economic benefit, the diverse terrestrial and aquatic wildlife on the river provides a **recreational and scenic** destination for outdoor enthusiasts, local community members, and tourists. The Dutch Neck Boat Ramp and the Town landing on Pine Street provide points of public access to the river. The public can also enjoy the river from multiple preserves maintained by the Medomak Valley Land Trust (MVLT; now Midcoast Conservancy) in both the estuarine and freshwater corridors of the river (e.g. Geele Preserve, Riverbrook Preserve).

1.1.2 Problem & Need

To date, a 1,218-acre section of the river is listed as impaired due to elevated fecal indicator bacteria (Maine DEP waterbody ID 726, DMR pollution area 26). Additionally, a 156-acre section of the river is listed as impaired for Marine Life Use caused by low dissolved oxygen. The assumed cause of this impairment (spray irrigation) has been eliminated, but no recent data exists to remove the impaired classification (Maine Department of Environmental Protection, 2014).

With significant input from the Waldoboro Shellfish Committee, the Town of Waldoboro petitioned the State to commit staff and resources to address the aforementioned fecal bacteria pollution on the Medomak River. Their efforts created a strong inter-agency collaboration (hereafter referred to as the 'Medomak Task Force') beginning in 2013 and included representatives from the Maine DMR, the Maine DEP, the Department of Agriculture, Conservation, and Forestry (DACF), the Shellfish Committee, the Town of Waldoboro, the Waldoboro Utility District (WUD), and the Medomak Valley Land Trust (now part of the Midcoast Conservancy). This successful collaboration has worked tirelessly to eliminate sources of fecal bacteria from entering the river. This includes investigation and remediation of sources from agriculture, residential septic systems, (Maine Department of Environmental Protection, 2016)industrial pollutants, waterfowl and wildlife, and pets.

The Medomak Task Force was formed in early 2013 with a kickoff meeting that was attended by State department commissioners and additional government representatives. Key accomplishments to date have included:

- Surveyed 210 properties in 2013 and 2014. Of these properties, 12 problem properties were identified and referred to the appropriate agency (either the Town's Utility District, DACF, or DEP).
- In one example, high fecal coliform results at Winslows Mills led to the discovery that a cracked condenser at a local business was allowing river water to leak into the condenser water, where the bacteria from the river grew exponentially and were discharged back to the river at very high levels (*E. coli* in the 7,500 col/100 mL range and total coliforms over 240,000 col/100 mL). The company was proactive and thorough in repairing and ultimately replacing the condenser.
- Based on a review of five years of DMR data, the Medomak Task Force conducted a canine detection study in 2014 to focus on human sources of bacteria at 18 different sampling sites. Based on these findings, in 2015 the Task Force chose to focus on small streams that flow directly into the prohibited, restricted and conditional areas of the river, and sampled all 37 streams that fit this description.
- These findings then allowed the Medomak Task Force to focus on 21 priority streams in 2016 with the use of Microbial Source Tracking (MST), an advanced sampling technique that identifies the source species (or species group) contributing to fecal pollution. Results have further narrowed the areas of concern; next steps involve further property surveying and closer, more intensive monitoring of high priority streams.

Despite these efforts, **the Medomak River estuary still suffers** from elevated bacteria counts that cause significant portions of the river to close following precipitation events, although scores from 2017 and 2018 have shown significant improvements. This collaborative team effort to eliminate nonpoint source contamination remains committed to improving water quality in the river to remove the conditional closures. In 2017, the Medomak Task Force **identified the need to synthesize this data and use it to create an organized WBMP** to outline the goals and structural framework necessary to continue successful elimination of NPS pollution to the Medomak River.

1.2 UNDERSTANDING FECAL INDICATOR BACTERIA (FIB)

Indicator organisms (such as *Escherichia coli* or *E. coli*, Enterococci, and Fecal Coliform) are used to track a wide variety of potentially harmful pathogens such as viruses and bacteria found in mammalian fecal waste that would otherwise be too expensive to monitor comprehensively (Figure 1-1). Despite their widespread use, research suggests that these indicators have significant limitations and caution should be used in interpreting results of these indicators as a metric for risk management. Similar to other nonpoint source pollutants, addressing pathogen-impaired waters is challenging because fecal waste can come from a number of sources on the landscape (e.g., septic, pet waste, livestock, and wildlife/waterfowl). In addition to these more traditional nonpoint source pollutant challenges, pathogen impairments pose additional challenges because of the limitations of selected fecal indicator bacteria currently used to identify and track fecal contamination. Each of these limitations are explained below:

(1) Non-Fecal Sources of Fecal Indicator Bacteria

Most state water quality standards use fecal indicator bacteria (primarily *E. coli* in freshwater and enterococci and fecal coliform in brackish and marine water) as an estimate of the likelihood that harmful pathogens from fecal source types in the watershed are present and that surface waters are unsafe for drinking water or recreational purposes. Previous studies of beaches impacted by point sources of sewage discharge found a significant correlation between fecal indicator bacteria and the probability of gastrointestinal (GI) illness in swimmers (Wade, Pai, Eisenberg, & Colford, 2003; Wade, et al., 2010). However, subsequent studies of surface waters impacted by nonpoint sources of pollution did not find similar results (Colford, et al., 2007; Young, 2016). These subsequent studies found that fecal indicator bacteria come not just from fecal sources but also non-fecal sources such as soils, sediment, algal wrack, decaying vegetation, and beach sands (Badgley, Thomas, & Harwood, 2010) (Byappanahalli, Fowler, Shively, & Whitman, 2003; Hardina & Fujioka, 1991; Imamura, Thompson, Boehm, & Jay, 2011; Ishii, Ksoll, Hicks, & Sadowsky, 2006; Park, Pachespsky, Hong, Shelton, & Coppock, 2017; Whitman, et al., 2014; Wu, O'Carroll, Vogel, & Robinson, 2017; Yamahara, Layton, Santoro, & Boehm, 2007). Given this, it is important to recognize that the tools we currently use to track pathogens (fecal indicator bacteria) are imperfect indicators and may not always represent the presence of harmful pathogens.

(2) Fate and Transport of Fecal Indicator Bacteria

Fecal indicator bacteria are highly variable and can proliferate or degrade in the environment depending on conditions such as temperature, sunlight, flow, salinity, among other factors; (Byappanahalli, Nevers, Staley, & Harwood, 2012; Nelson, et al., 2018; Boehm, et al., 2009; Pisciotta, Rath, Stanek, Flanery, & Harwood, 2002; Boehm A. B., 2007). Bacterial and viral pathogens have been shown to react differently in the environment, so that external factors may influence the concentration of fecal indicator bacteria but not the viral pathogens of interest for protecting public health.

(3) Variability of Culturable Fecal Indicator Bacteria

Measuring fecal indicator bacteria in the laboratory can be challenging (and potentially confounding) as well due to variability in the ability of cultured specimens in each sample to grow. Because of this, laboratory and field duplicates can vary up to 200% or more, particularly at lower concentrations.

The scientific community recognizes these limitations and is developing alternative methods to identify harmful fecal pathogens in waterbodies that represent a human health risk. However, these innovative methods have their own limitations including high costs not yet suitable for wide-spread regulation of fecal contamination and protection of human health and safety.

One of these alternative methodologies, microbial source tracking or MST, has been used in the Lower Medomak River watershed. MST is a scientific approach to target and identify bacterial genes specific to humans and other animals when identifying the source(s) of fecal pollution. From water samples, scientists can use FIB parameters (such as *E. coli*, *Enterococci*, and Fecal Coliform discussed above) coupled with DNA extraction and PCR (polymerase chain reaction) assays to determine the source animal of the fecal contamination. PCR tests provide a presence/absence result for a variety of host species (e.g., general mammalian, human, gull, avian, dog, ruminant), while quantitative PCR (qPCR) can provide more detail on the quantity of the targeted gene in the sample. Remediation and best management practice (BMP) efforts can then be targeted to reduce the source of pollution such as upgrading septic systems, installing pet waste signs, and limiting livestock access to waterways, while increasing vegetated buffers.

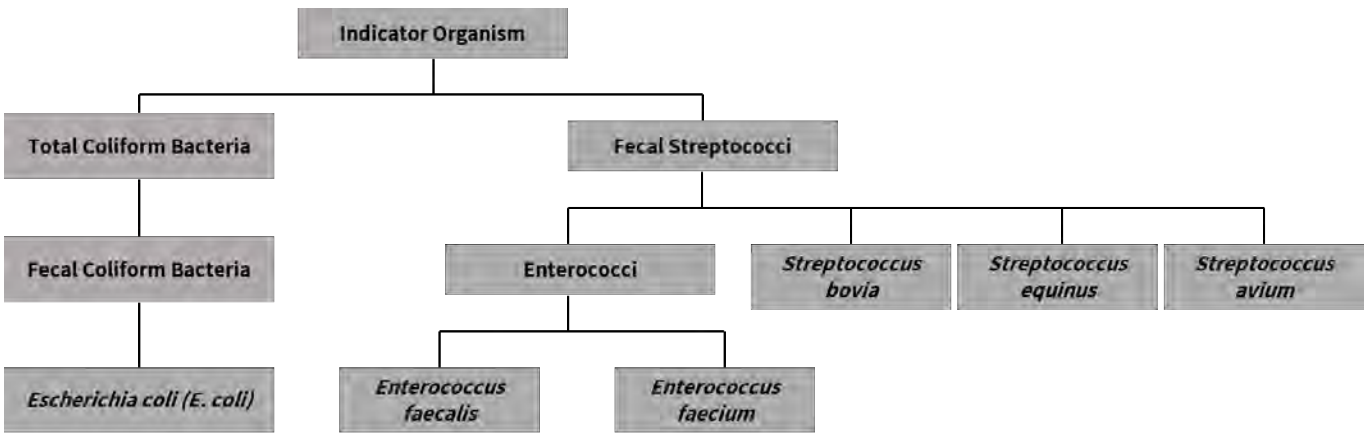


Figure 1-1. The relationship between different fecal indicator bacteria. Figure adapted from the US EPA (United States Environmental Protection Agency, 2001).

1.2.1 Purpose

The purpose of this watershed plan is to capitalize on the rich data collection history and the successful collaborative stakeholder working group, to produce a detailed, user-friendly plan for restoring the Medomak River and its estuary. This plan outlines effective actions to eliminate nonpoint source pollution to the Medomak River estuary to restore water quality, aquatic habitat, and the shellfish harvesting community. Project tasks included:

- Building strong local support for the project by forming a technical advisory committee, hosting public meetings, and meeting with key landowners;
- Developing a comprehensive water quality database that stores all historical Medomak River data collected across state and local entities, in a user-friendly format for ease of updates;
- Conducting a comprehensive water quality analysis using all sources of available water quality data;
- Build on existing data through targeted sampling.

1.2.2 Goal

The Plan goal was to provide stakeholders with a roadmap to eliminate fecal bacteria contamination, with the ultimate goal of removing the conditional closures in the estuary. Watershed education and outreach needs were addressed by informing the public about the project and posting project updates on the Town's website and through press releases.

1.3 INCORPORATING EPA'S NINE ELEMENTS

In order to access future Clean Water Act Section 319 funding, EPA requires that watershed-based plans include nine key planning elements. These elements ensure that WBMPs satisfactorily address the key components needed to successfully restore and/or preserve our waters. This plan is divided into seven major sections and these sections address the following nine planning elements (*referred to as elements a through i*) as follows:

- Section 1 (Introduction) describes the purpose of the plan, provides background information about the Medomak River, a description of the planning process, and a brief description of recent efforts in the watershed *(element a).*
- Section 2 (Watershed Characterization) describes the watershed, including local climate, demographics and growth trends in the Town of Waldoboro, land cover, topography, land conservation, soils and geology, and stormwater/sewer infrastructure *(element a)*.
- Section 3 (The Medomak Task Force) summarizes previous efforts and stakeholder involvement in management efforts *(element c, f).*
- Section 4 (Water Quality) describes causes of impairment and applicable water quality standards, summarizes water quality data collected from the Medomak River *(element a, c).*
- Section 5 (Bacteria Source Identification) describes the results of the bacteria loading model, model limitations, and addresses possible sources of pollution in the watershed *(element a, b).*
- Section 6 (Management Strategies) describes watershed restoration goals and objectives. Both structural and non-structural restoration opportunities and recommendations are discussed. Action strategies are presented in tables describing what needs to be done, how it will be done, who will help get it done, when it will be done, and how much it will cost. Restoration strategies are divided into several primary categories (shown above *(elements, b, e, f)*.
- Section 7 (Restoration Plan) describes plan implementation, including who is in charge of administering the plan, and summarizes actions, costs, and technical assistance needed to ensure progress. Section 6 provides the needed reduction in fecal contamination to the estuary to remove Maine DMR pollution areas from prohibited and conditional closures *(element d).*
- Section 8 (Measuring Success) describes specific recommendations for monitoring and evaluating the effectiveness of restoration efforts. This includes criteria for measuring progress and measurable milestones along the way *(elements g, h, i).*

EPA identifies 9 important elements for a successful WBMP

a) Identification of causes of impairment and pollutant sources

b) Estimated load reductions from management efforts

c) Nonpoint source management efforts

d) Necessary technical and financial assistance needed

e) Information and education component

f) Project timeline

g) Measurable milestones and indicators of progress

h) Criteria to measure success

i) Water quality monitoring plan

(Elements are paraphrased from EPA for brevity)

1.4 DEVELOPING A COMMUNITY-BASED WATERSHED MANAGEMENT PLAN

A WBMP helps identify problems, list priorities, and outline actions that are needed to restore the water quality of a stream (United States Department of Environmental Protection, 2008). A good plan acts as a road map pointing out where to start, how long it will take to get there, how much it will cost, and how you know you've arrived. Since each watershed is unique, the WBMP is also unique in order to address the major issues and concerns of the watershed's community.

Successful development of this watershed restoration plan depended heavily on the commitment and involvement of community members. These partnerships helped strengthen the plan by increasing both public awareness of the problems and public commitment to the solutions. Many of the recommendations in the plan will require landowner cooperation with the Town of Waldoboro to implement retrofits on private land that reduce stormwater and/or groundwater contamination pathways. As such, it will be important to continue with a strong education and outreach program that targets residents of the Lower Medomak River watershed in an effective and trusting way; once landowners understand the importance of restoring the river, they may be more likely to participate in the restoration process. The WBMP is a 'living breathing, document', meaning that it should be revisited and updated as restoration continues in the Lower Medomak River watershed.

The following groups or individuals have been identified as potential public stakeholders to help implement recommendations described in this plan:

- Town of Waldoboro and Shellfish Committee
- Medomak Valley Land Trust (now Midcoast Conservancy)
- Maine Department of Environmental Protection
- Maine Department of Marine Resources
- The University of Maine at Orono
- Department of Agriculture, Conservation, and Forestry

Local partners have demonstrated a strong commitment to improving water quality conditions in the Medomak River. The Medomak Task Force[4] held meetings on 12/05/2017, 04/19/2018, and 03/26/2019 to help guide the watershed planning process. The Task Force provided indispensable support in both preparation and planning as well as execution for hotspot sampling in 2018. At the final project meeting (03/26/2019), Phil Garwood (former Maine DEP project manager for the Medomak River Project) joined the group to contribute his institutional knowledge on the river as the Medomak Task Force discussed next steps for sampling and surveying across the watershed.

Abden Simmons on the Medomak. Photo credit: Julie Keizer.

4 The Medomak Task Force served the role as the project Technical Advisory Committee

2. WATERSHED CHARACTERIZATION

2.1 CLIMATE

Waldoboro, Maine is located in the temperate broadleaf and mixed forest biome with warm and cool seasons. The average annual high temperature is 55 °F (12.8 °C) and the average annual low is 36 °F (2.2 °C). January is the coldest month with an average high of 30 °F (-1.1 °C) and average low of 12 °F (-11.1 °C), while July is on average the warmest month with an average high of 79 °F (26.1 °C) and average low of 58 °F (14.4) (Figure 2-1). Average monthly precipitation is approximately 3.91 inches (9.93 cm) with August, the driest month, averaging 2.75 inches (6.95 cm) and December, the wettest month, averaging 4.63 in (6.99 cm). Shellfish closures are triggered by large rain events making closures most frequent during the wettest seasons (spring and fall). Average snow annually is 75.8 inches (192.5 cm), occurring 8 months of the year, and occurring 6 months of the year as greater than 1 inch (2.54 cm). January has the greatest average snow of 21.5 inches (54.61 cm; all weather data sourced from Intellicast[5]).

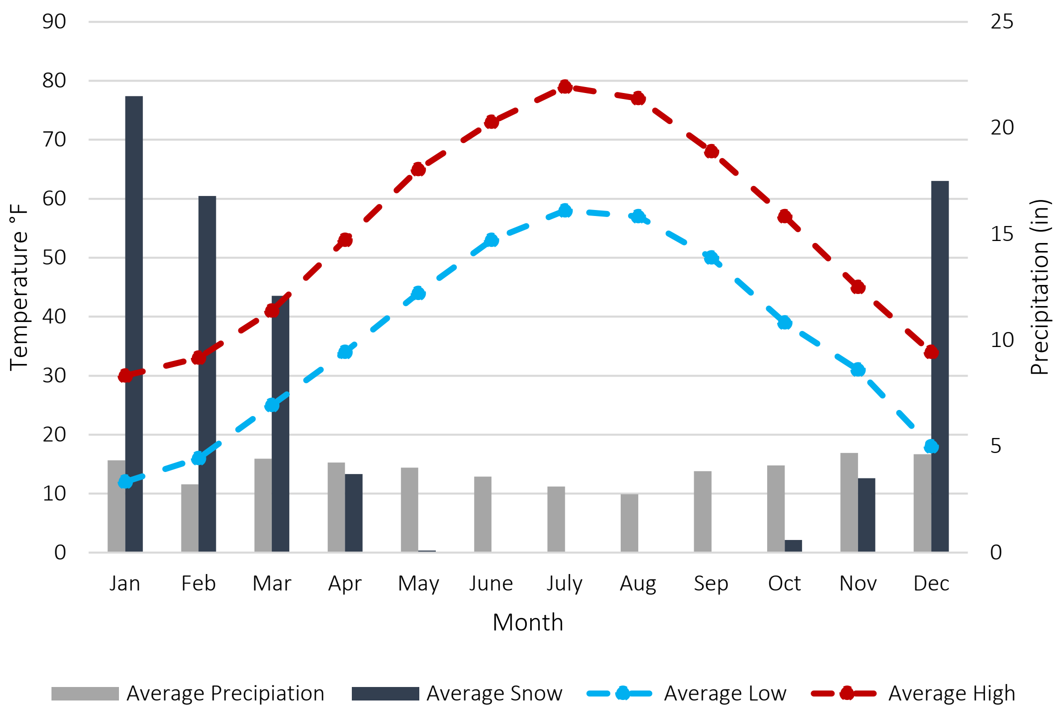


Figure 2-1. Average monthly climate normals for Waldoboro, ME. Data from Intellicast Weather Data (www.intellicast.com).

2.2 HISTORY OF SHELLFISHING IN WALDOBORO

Softshell clamming is one of Maine's most valuable commercial fisheries and has historically been a major marine species providing income to Maine's coastal residents. Clammers typically work on seasonal cycles, and historically have moved along the coast digging when weather, tide, and local harvesting restrictions allowed. In the early 1900s, softshell clams were typically harvested commercially for canneries (Maine/New Hampshire Sea Grant College Program, 1998), and small amounts of fresh softshell clams were shipped out of Maine. There were approximately 1,500 licensed harvesters in the Maine fishery in the early 1900s. Clams were plentiful and before 1945, harvesters

[5] Intellicast was acquired by Weather Underground after compilation of these data.

could harvest more than 1,000 bushels annually, while today clammers typically harvest 300-500 bushels annually (Maine/New Hampshire Sea Grant College Program, 1998).

State licenses were first issued in 1947 to 2,474 harvesters to comply with federal public health requirements and to gather better statistics on the clam fishery. While the first clam flat closure due to pollution had occurred in the 1930s in southern Maine, there was no program overseeing shellfish harvesting until 1947 (Maine/New Hampshire Sea Grant College Program, 1998). Highest recorded clam landings at the time occurred in the late 1940s and 1950s, and then decreased by almost 75% in the late 1950s and 1960s (Maine Department of Marine Resources, 2019). In the 1960s, clams began to go to market for steamed and fried clams, and prices began to increase rapidly in the mid-1970s. Between 1968 and 1973, state commercial clam licenses increased to around 6,000 licenses, and landings rose again to some of the highest recorded levels, peaking in 1977 at almost 40 million pounds (Figure 2-2). Today, license numbers are approximately 1,700 or less (Maine/New Hampshire Sea Grant College Program, 1998). Clamming has historically and continues to be a town-based tradition in Maine.

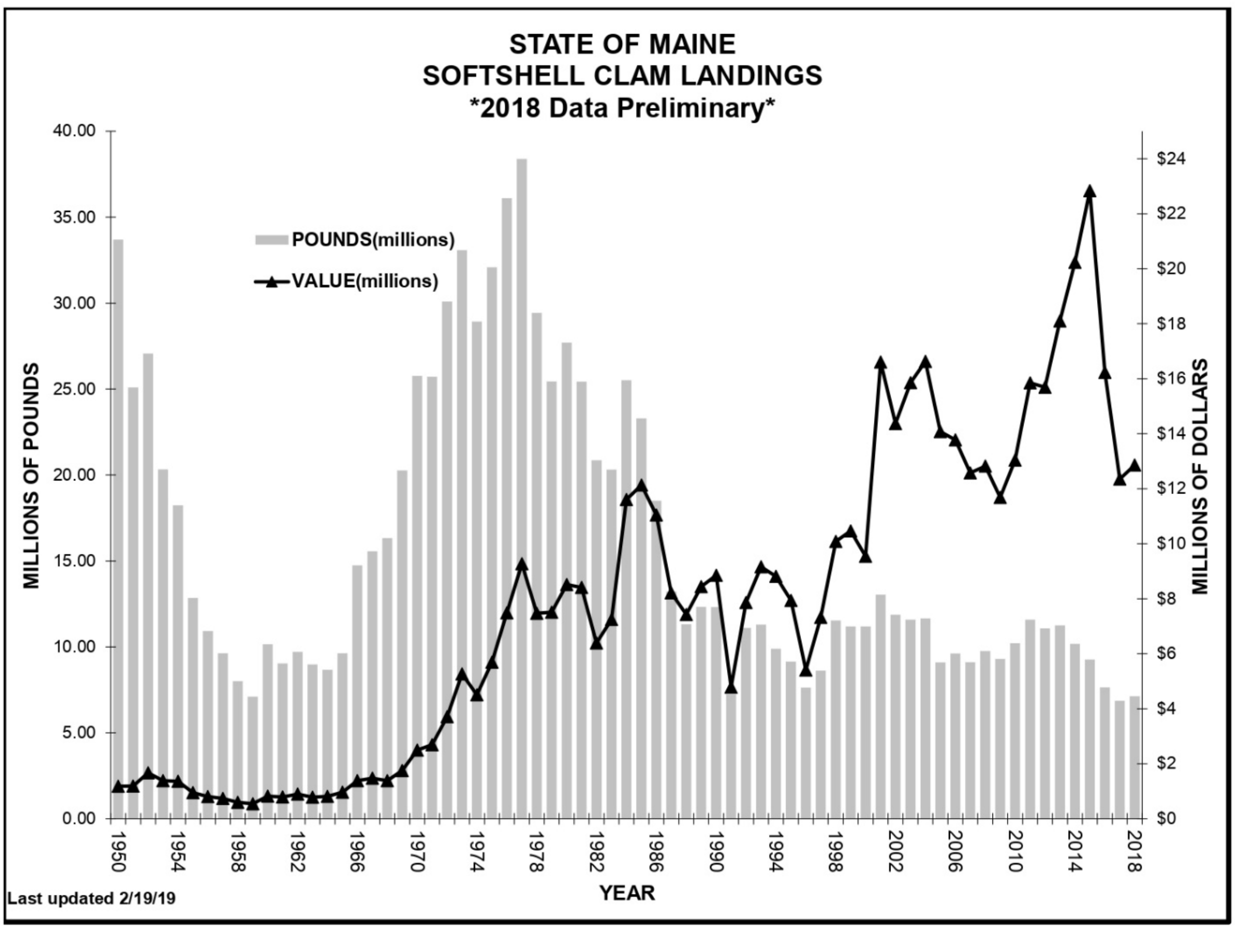


Figure 2-2. Maine Softshell Clam Landings 1950 – 2017. Data from Maine DMR (https://www.maine.gov/dmr/commercial-fishing/landings/historical-data.html).

The Medomak River Estuary, and specifically the portion in Waldoboro, is Maine's most productive shellfish harvesting area. The river has the potential to yield up to two million dollars in income for approximately 175 shellfish harvesters, and more for the local economy when shellfish dealers, seafood markets, and restaurants are taken into account.

Waldoboro was consistently a top soft-shell clam Maine port from 2007 – 2018 (DMR 2018, Figure 2-3). The port of Waldoboro yielded a harvest value above one million dollars seven years of the last decade, and above two million for two of those years (Figure 2-4).

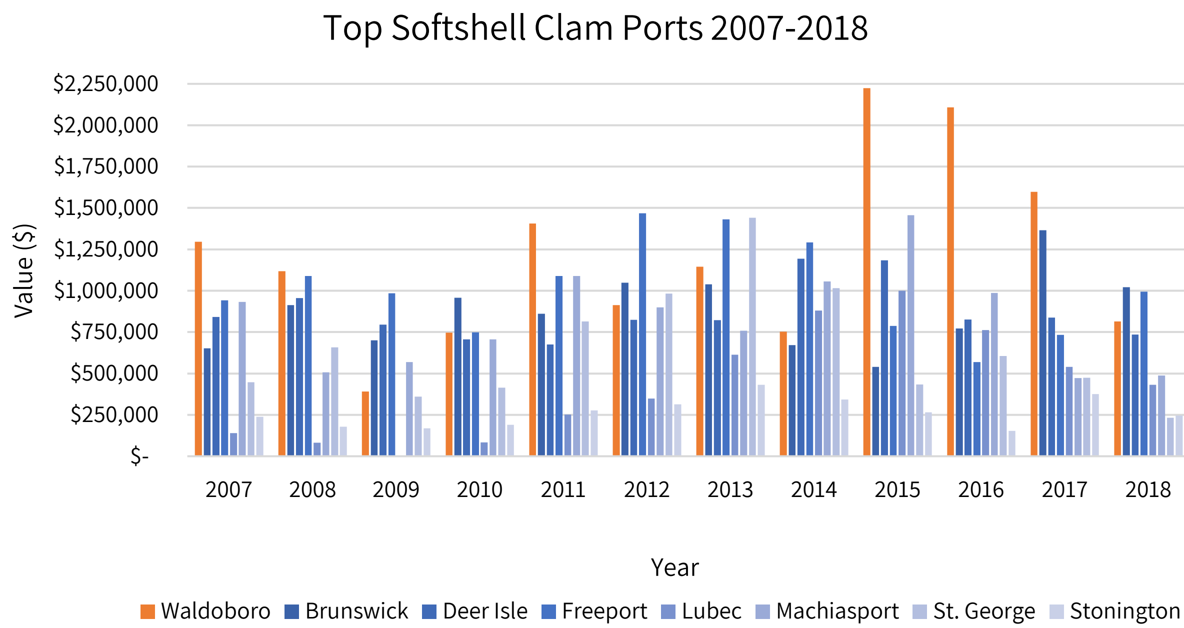


Figure 2-3. Harvest values for the past twelve years of the ten top softshell clam ports, by pounds (live) through 2018. Data from Maine DMR (https://www.maine.gov/dmr/commercial-fishing/landings/historical-data.html).

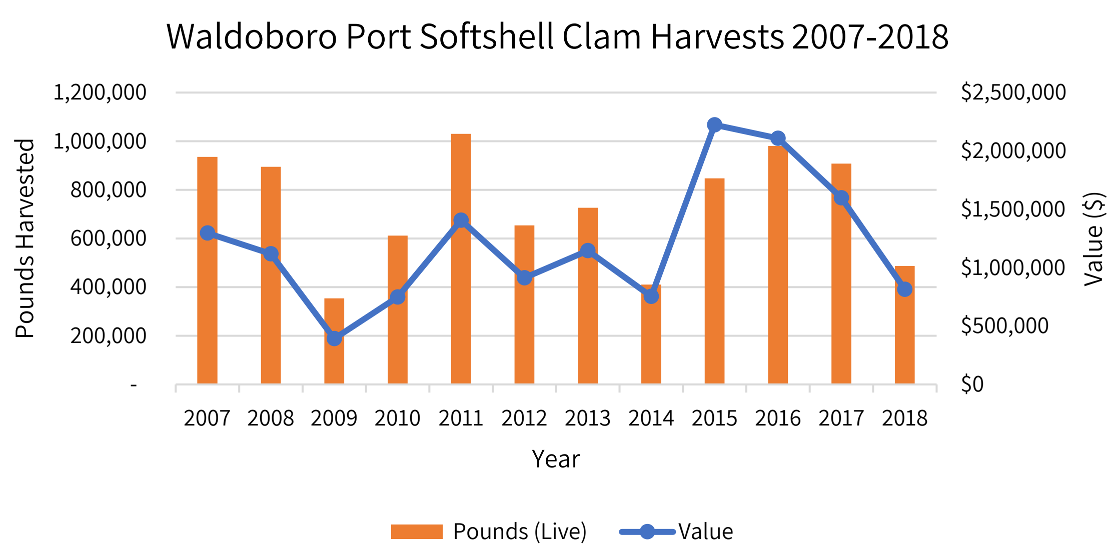


Figure 2-4. Waldoboro Port's pounds harvested and value from 2007-2018. Data from Maine DMR (https://www.maine.gov/dmr/commercial-fishing/landings/historical-data.html).

In the 1990s, sections of the Medomak River were not meeting water quality standards for bacteria. The Waldoboro Utility District was discharging effluent directly into the Medomak River estuary, harmfully affecting shellfish harvests. A new lagoon and land application treatment facility was constructed 2.8 miles away from the river, completed by 2001. In 2002, the Maine DMR imposed conditional closures on the river for the National Shellfish Sanitation Program (NSSP) default rain closure period of two weeks. The river would sometimes be closed for more than half of the harvest year. In 2003, the Maine DMR asked the Maine DEP for aid with tracking bacteria pollution sources. Surveys by the Maine DEP with assistance of the University of Maine Cooperative Extension Program in 2003-2004 and again in 2008-2009 identified 20 wastewater problems, all of which were corrected by 2009. Sections of the Medomak River continued to not meet water quality standards for fecal indicator bacteria, and in 2010 the Maine DMR and the Town of Waldoboro began to enlist help from governmental agencies that could address animal husbandry or manure handling problems.

Data collected in 2011-2012 supported ≥1"/24 hour as an appropriate trigger for bed closure but reduced the closure time from 14 days to nine days. Additional rain from days seven to nine of 0.75" extends the closure by three days. In 2013, the Maine DMR, Maine DEP, and the DACF all began working to assist with improving water quality and shellfish harvesting conditions. The number of softshell clam bed closures in the Medomak River, as triggered by rain events measured at two stations in Waldoboro (KMEWALDO4 and KMEWALDO6) adversely affect the number of pounds harvested (Figure 2-5). High numbers of closures significantly reduce the number of harvest days for clammers.

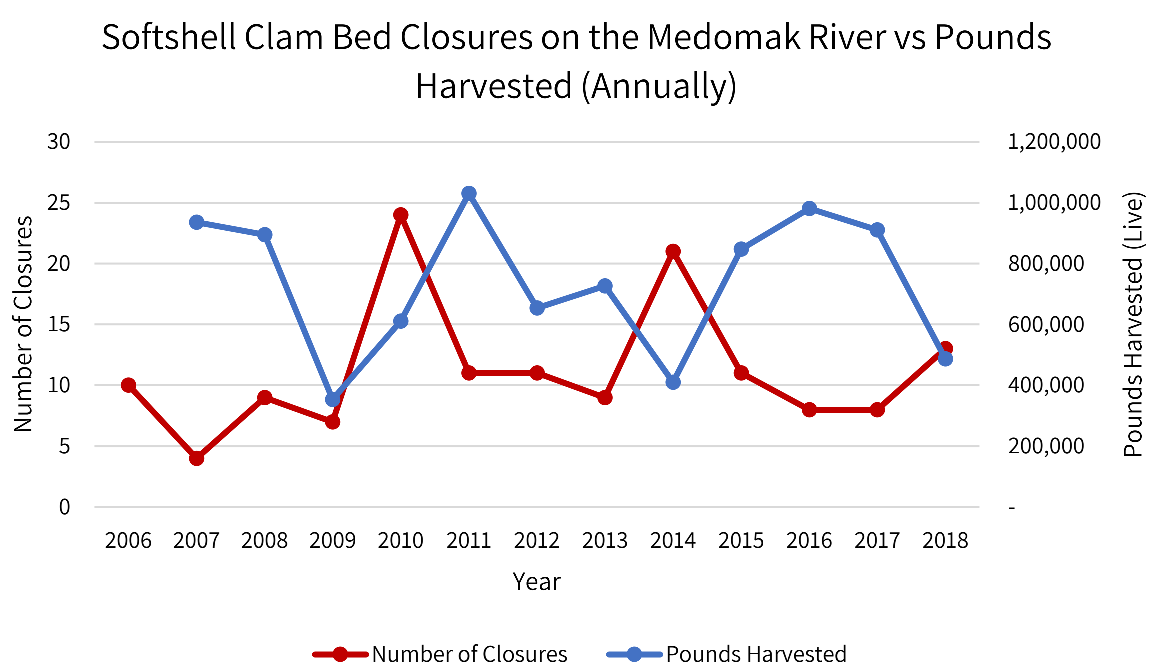


Figure 2-5. The number of annual closures due to rain in the Medomak River, compared to pounds harvested (live) in Waldoboro. Data from Maine DMR (https://www.maine.gov/dmr/commercial-fishing/landings/historical-data.html).

2.3 PHYSICAL FEATURES OF THE WATERSHED

2.3.1 Topography and Watershed

The entire Medomak River watershed, extending from the Towns of Searsmont, Appleton, and Liberty to the Atlantic Ocean, encompasses approximately 106 square miles of land area. For the purposes of this plan, the Medomak Task Force chose to focus on the Lower Medomak River watershed. This area, totaling 53 square miles, begins below Medomak Pond (at Route 220/Washington Rd) and extends to the estuary. Historical monitoring of the river suggests that the water quality concerns are concentrated in the lower watershed. Therefore, focusing on the lower watershed for this management plan allows the Medomak Task Force to use resources where maximum restoration can occur. Additionally, the lower portion of the direct drainage entering the Medomak River estuary was not included in this Plan as to focus on the portion of the watershed with previous bacteria impairments causing a significant loss in access to shellfishing in the river within the Town of Waldoboro. For the remainder of this plan, our reference to the "Lower Medomak River watershed" refers to this lower watershed, represented in light blue shading on the map found below.

The lowest point of elevation in the Lower Medomak River watershed is the meeting of land between the Medomak River estuary and the coast. The highest point of elevation is at 360 feet above sea level, at the western edge of the watershed between Waldoboro and Warren. The total watershed area is 33,961.04 acres *(Topography Map: Appendix A, Map 1).*

2.3.2 Soils and Geology

The Lower Medomak River watershed is composed of numerous soil series, with the two most prevalent soil series being Swanville silt loam, 0 to 3 percent slopes, at 18.9% (6,438.5 acres), and Peru fine sandy loam, 0 to 8 percent, very stony, at 12.3% (4,174.3 acres) *(Soil Classification: Appendix A, Map 2)* (United States Department of Agriculture, 2017). The majority of the soil series in the Lower Medomak River watershed are classified as "not prime farmland" (81 %), with only 19% classified as "prime farmland" or "farmland of statewide importance" (WSS, accessed 2019). It Is important to note that most of the land parcels suitable for farming are located along the shoreline of the Medomak River and Medomak River estuary *(Farmland Soil Classification: Appendix A, Map 3)*. This is evidence in the land use along the shoreline which consists of significant agricultural tracts (see following section).

2.3.3 Land Cover

Approximately 67.0% of the land in the Lower Medomak River watershed is classified as forest (deciduous, evergreen, and mixed) and 9.3% of the land is composed of crop land or cultivated land *(Land Cover Map: Appendix A, Map 4)*. Many of these parcels of land used for agriculture are located along the Medomak River and surrounding tributaries, allowing for potential agricultural runoff into the watershed, especially during heavy rain events. Developed land (developed open space, developed low, medium, and high intensity) comprises 2.9% of the watershed. Developed areas, such as asphalt and pavement, create impervious surfaces which cause stormwater to carry pollutants into waterbodies that would otherwise soak into the ground. Stormwater, such as from a heavy rain, can carry sediment, nutrients, pathogens, pesticides, hydrocarbons, chloride, and metals into waterways (Center for Watershed Protection, 2003). These pollutants can be harmful to aquatic life such as shellfish.

2.3.4 Habitat Conservation

The Lower Medomak River watershed contains tidal marshes classified as Salt-hay Saltmarshes, located in the outer reaches of the estuary. This natural community is typically extensive along both sides of a tidal river or stream and the full extent of the vegetation zone is only flooded by above average high tides. Salt-hay Saltmarshes provide a valuable wetland buffer that helps reduce degradation resulting from adjacent land uses and sediment runoff during above average high tide and storm events, helping to protect estuary organisms such as shellfish. Salt-hay Saltmarshes are found along coastal Maine and classified as state rank S-3; rare in Maine. There is approximately 207.2 acres of Salt-hay Saltmarshes in the Lower Medomak River watershed. The Lower Medomak River watershed contains two endangered species, the tidewater mucket, (*Leptodea ochracea*), a species of freshwater mussels which is listed as threatened in Maine, and the scarlet bluet (*Enallagma pictum*), a species of damsel fly, listed as a species of special concern in Maine. Tidal marshes, especially the Salt-hay Saltmarsh, provide nesting and foraging habitat for tidal waterfowl and rare species *(Habitat Conservation Map: Appendix A, Map 5)*.

Eelgrass beds, another important habitat in coastal estuary habitats, serve as an indicator species of estuary health, as the base of food production, and as a shelter for juvenile fish and invertebrates. Eelgrass meadows are also central sites for primary settlements of bivalve mollusk larvae and invertebrates, such as shellfish. These habitats help stabilize sediment and shorelines. A 1993-1997 survey by Maine DMR in the Lower Medomak River watershed mapped 377.78 acres of eelgrass beds, which increased to 461.93 acres in 2010 when the survey was repeated (Maine Department of Marine Resources, 2019; Northeast Ocean Data, 2014).

The principal land conservation agency in the Lower Medomak River watershed is Midcoast Conservancy, formerly the Medomak Valley Land Trust. Midcoast Conservancy owns or manages 32 parcels of conserved land in the Lower Medomak River watershed, totaling 2,699 acres; 1,485 acres of easements and 1,214 acres of preserves (Table 2-1). In addition to conserved land owned or managed by Midcoast Conservancy, there are four parcels owned by other agencies. These parcels are Farnsworth Point (Maine Coast Heritage Trust; 30 acres), an easement north of the Farnsworth Brook easement (NRCS, 140 acres), and the East 40 preserve (Maine Farmland Trust, 40 acres). Figure 2-6 on the following page contains a map of all conserved land, with Midcoast Conservancy easements in green, preserves in orange, and other conserved land in purple.

Table 2-1. Conserved land parcels (easements and preserves) within the Lower Medomak River watershed owned or managed by the Midcoast Conservancy (formerly held by the Medomak Valley Land Trust).

NAME	ACRES	YEAR ACQUIRED
EASEMENTS		
Storer Homestead	18	1996
Libis	6	2003
Sunny Side Farm	80	2004
Tall Tree Farm	15	2004
Farnsworth Brook	91	2006
Broad Bay Farm	240	2006
Geele	65	2006
Quarry Hill Farm	320	2007
Blueberry Ledges	165	2007
Longview	16	2008
Dirigowoods	200	2009
Geele Fields	22.5	2011
Geele Fields Connector	3	2011
Tenney	30	2012
Riverbend	25	2015
Morse	90	2017
Kalina	98	2018
TOTAL ACRES:	**1,485**	

NAME	ACRES	YEAR ACQUIRED
PRESERVES		
Reef Point	55	1996
Goose River Peace Corps	54	2001
Burkett Mill	258	2003
Burkett Mill Extension	133	2004
Mill Pond	44	2004
River Park	1.7	2011
Peter's Pond	30	2012
Riverbrook	371	2014
Peter's Pond	16	2014
MVLT Founders	107	2015
Waterman Brook	27	2016
Geele	15	2016
Ben's Island	16	2017
Burnham	80	2017
Cooper	6	2018
TOTAL ACRES:	**1,214**	

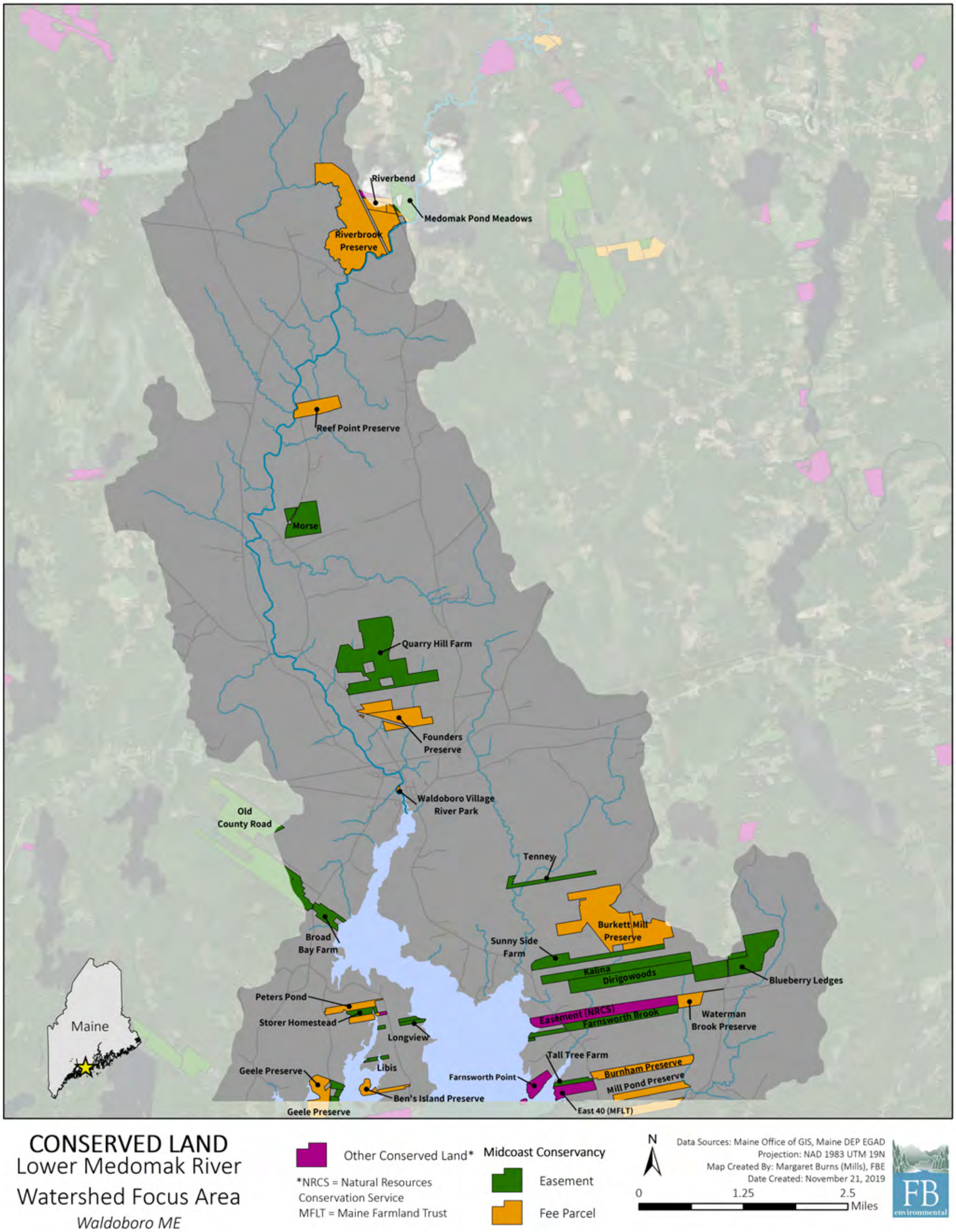


Figure 2-6. Map of conserved land within the Lower Medomak River watershed.

2.3.5 Hydrology and Water Resources

The hydrology of the Lower Medomak River watershed consists of significant tidal wetlands as well as several streams and tributaries connecting to the main stem of the river and estuary. An aquifer is located at the top of the estuarine watershed, and several public wells are located around Waldoboro Village and Winslows Mills (Figure 2-7, *Hydrology Map: Appendix A, Map 6)*.

Many of Maine's coastal communities, including Waldoboro, have significant town infrastructure built just slightly above sea level (Natural Resources Council of Maine, 2019). With the Gulf of Maine warming faster than many of the world's oceans, sea level rise predictions have varied widely from six inches of sea level rise by 2050 to two feet by 2050. Rising sea levels of any amount intensify storm surges, especially during a high astrological tide, or king tide (Natural Resources Council of Maine, 2019). This results in damaged infrastructure, as well as increased pollution loads into estuarine watersheds as essential riparian buffers such as the Salt-hay Saltmarsh acreage are inundated and ultimately reduced. Most relevant to the Lower Medomak River is the possible inundation of septic systems in the areas vulnerable to sea level rise.

The Medomak River estuary. Photo credit: Melissa Smith.

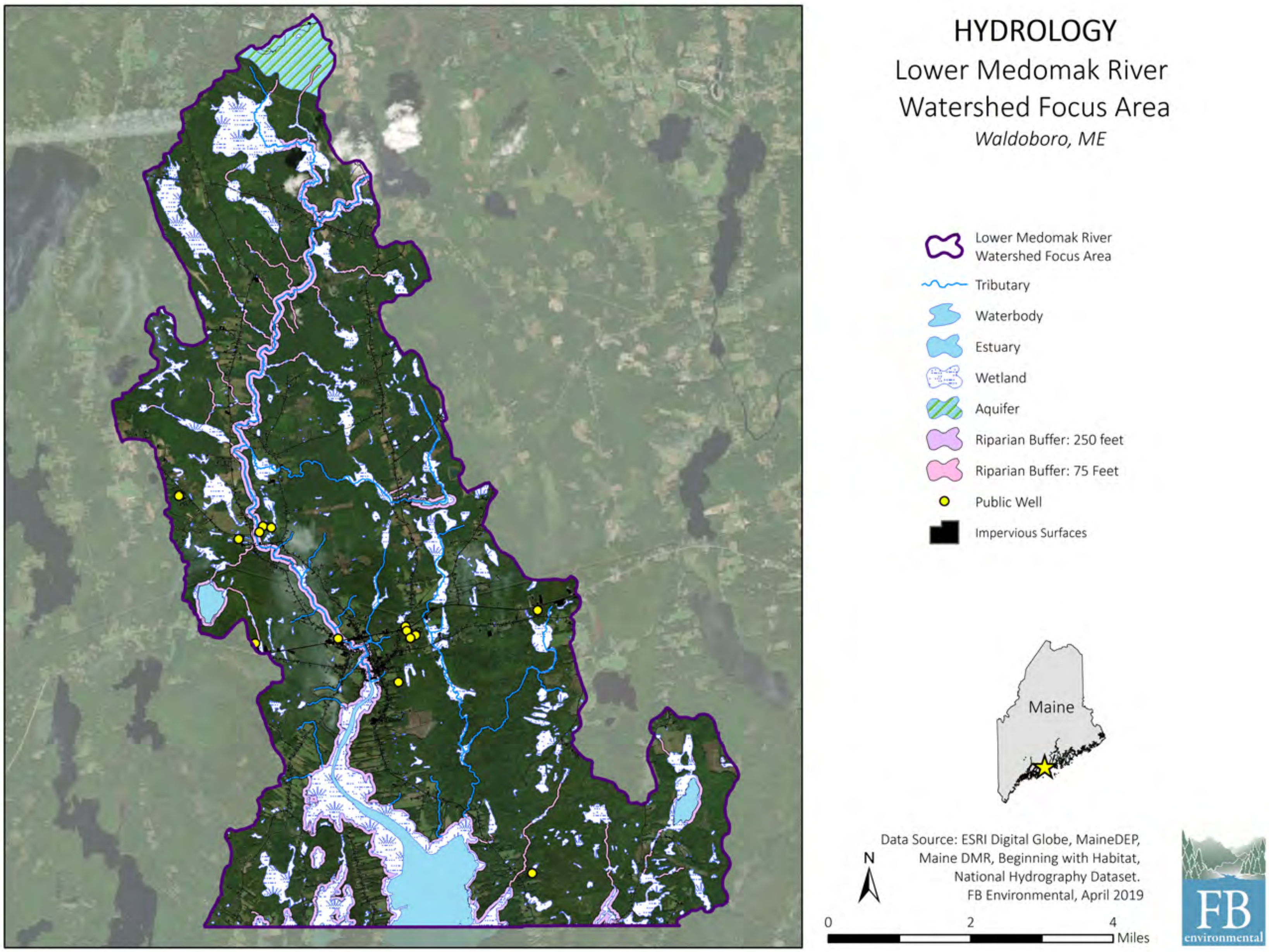


Figure 2-7. Map of water resources within the Lower Medomak River watershed.

2.3.6 Stormwater and Sewer Infrastructure

In the mid-1990s, the Waldoboro Utility District wastewater treatment facility was discharging effluent directly into the Medomak River estuary, potentially contributing harmful bacteria. A new lagoon and land application treatment facility was constructed in 2001 to manage and prevent runoff. Unfortunately, digitally-mapped stormwater and sewer infrastructure data were not available for this plan. This Plan recommends that mapping is completed as soon as possible during plan implementation.

2.4 POPULATION DEMOGRAPHICS

According to the U.S. Census Bureau, the population of Waldoboro, ME in 2010 was 5,075 people, representing a 2.25 % population increase since the 2000 census (US Census Bureau, 2010)(Table 2-2). The population of Lincoln County, Maine in 2010 was 34,457 people, increasing 2.44% since 2000. Waldoboro has reflected similar growth as Lincoln County over the past 80 years (Table 2-3). Income from coastal activities, including recreation, tourism, and fisheries, has most likely contributed to the consistent population growth in Lincoln County.

Table 2-2. Decadal census population for Waldoboro, ME and Lincoln County, ME.

POPULATION									
	1930	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**
Waldoboro	2,311	2,497	2,536	2,882	3,146	3,985	4,601	4,961	5,075
Lincoln County	15,498	16,294	18,004	18,497	20,537	25,691	30,357	33,616	34,457

Table 2-3. Growth rates for Waldoboro, ME and Lincoln County, ME.

GROWTH RATES				
	10-Yr Annual Growth Rate (2000-2010)	**20-Yr Annual Growth Rate (1990-2010)**	**50-Yr Annual Growth Rate (1960-2010)**	**80-Yr Annual Growth Rate (1930-2010)**
WALDOBORO	2.25%	9.34%	43.21%	54.46%
LINCOLN COUNTY	2.44%	11.90%	46.32%	55.02%

At the time of the most recent decadal census (2010), the majority of the population in the Town of Waldoboro and Lincoln County fell within the 20-64 age range category (Table 2-4). In Lincoln County, seasonal houses are 28.7% of total housing units, while in Waldoboro, seasonal houses compose 9.8% of total housing units. Of occupied housing units, the majority in both Waldoboro and Lincoln County are owner occupied.

Table 2-4. Population demographics for Waldoboro, ME and Lincoln County, ME from the 2010 census.

POPULATION DEMOGRAPHICS									
	Total	**Aged 0-19**	**Aged 20-64**	**Aged 65+**	**Total Housing Units**	**Total Occupied Houses**	**Owner Occupied Houses**	**Renter Occupied Houses**	**Seasonal Houses**
WALDOBORO	5,075	1,195	2,991	889	2,651	2,171 (81.9%)	1,661 (76.5%)	510 (23.5%)	9.8%
LINCOLN COUNTY	34,457	7,107	19,957	7,393	23,493	15,149 (64.5%)	12,267 (81.0%)	2,882 (19.0%)	28.7%

3. THE MEDOMAK RIVER TASK FORCE

The Medomak River poses the challenge of crossing jurisdictional boundaries between the Maine DMR and the Maine DEP. Historically, fecal contamination in the estuary was solely regulated by Maine DMR in the context of shellfish closures. In 2010, the Maine DMR Director of Public Health, contacted the Waldoboro Shellfish Committee to offer further assistance to address fecal contamination causing shellfish closures in the Medomak River. However, Maine DMR enforcement is limited to the first 500 feet from the shore and has no enforcement authority regarding pollution sources from the landscape. With this understanding, the Waldoboro Shellfish Committee conducted a campaign to enlist further support. With the initial support from the Town Manager, Town Selectmen, WUD, MVLT, State Senator Chris Johnson, and State Representative Ellen Winchenbach, the Shellfish Committee wrote a letter to the Maine DMR, Maine DEP, and Maine DACF commissioners requesting a collaborative effort to address fecal contamination to the estuary. The three Commissioners committed to providing staff and other resources towards this effort, and in January 2013, a kick-off meeting was held to initiate the Medomak Task Force. The Medomak Task Force is still operating today through the Technical Advisory Committee facilitating the completion of this Plan.

A brief timeline of efforts on the Medomak River is provided in Figure 3-1, on the following page.

The Button Factory. Photo credit: Julie Keizer.

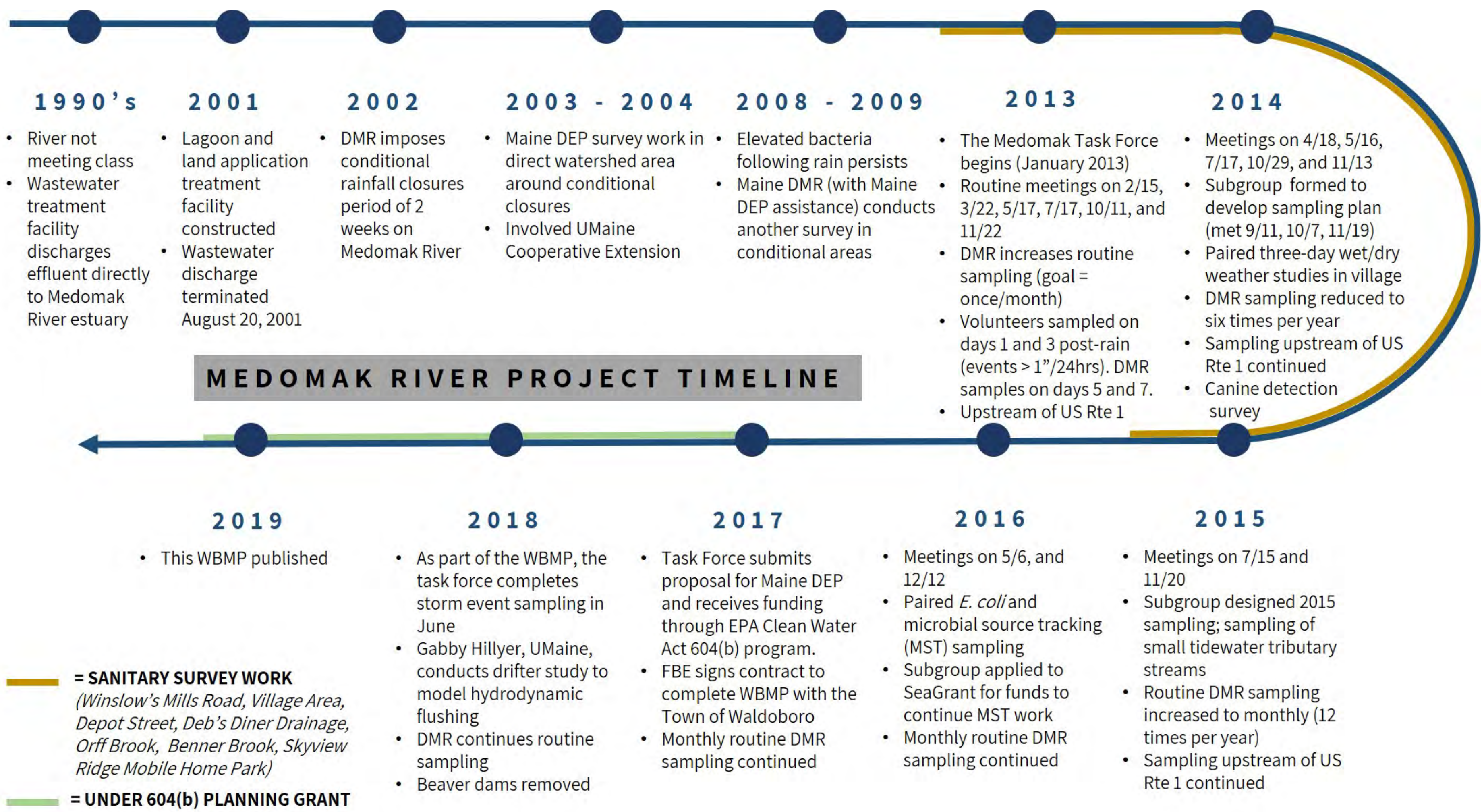


Figure 3-1. Project timeline for key work completed on the Medomak River since the 1990s. The Medomak Task Force formed in 2013.

4. WATER QUALITY

4.1 APPLICABLE CRITERIA

Table 4-1, below, outlines all applicable state criteria for the Lower Medomak River watershed. The main stem of the lower Medomak River and its tributaries are categorized as Class A waters to Wagner's Bridge where the main stem drops to Class B until Main Street/Old Route 1 (head of tide); beyond head of tide, the estuary is classified as Class SB waters. Maine DMR classification areas listed in Table 4-1 and Figure 4-1 are valid through 4/01/2019.

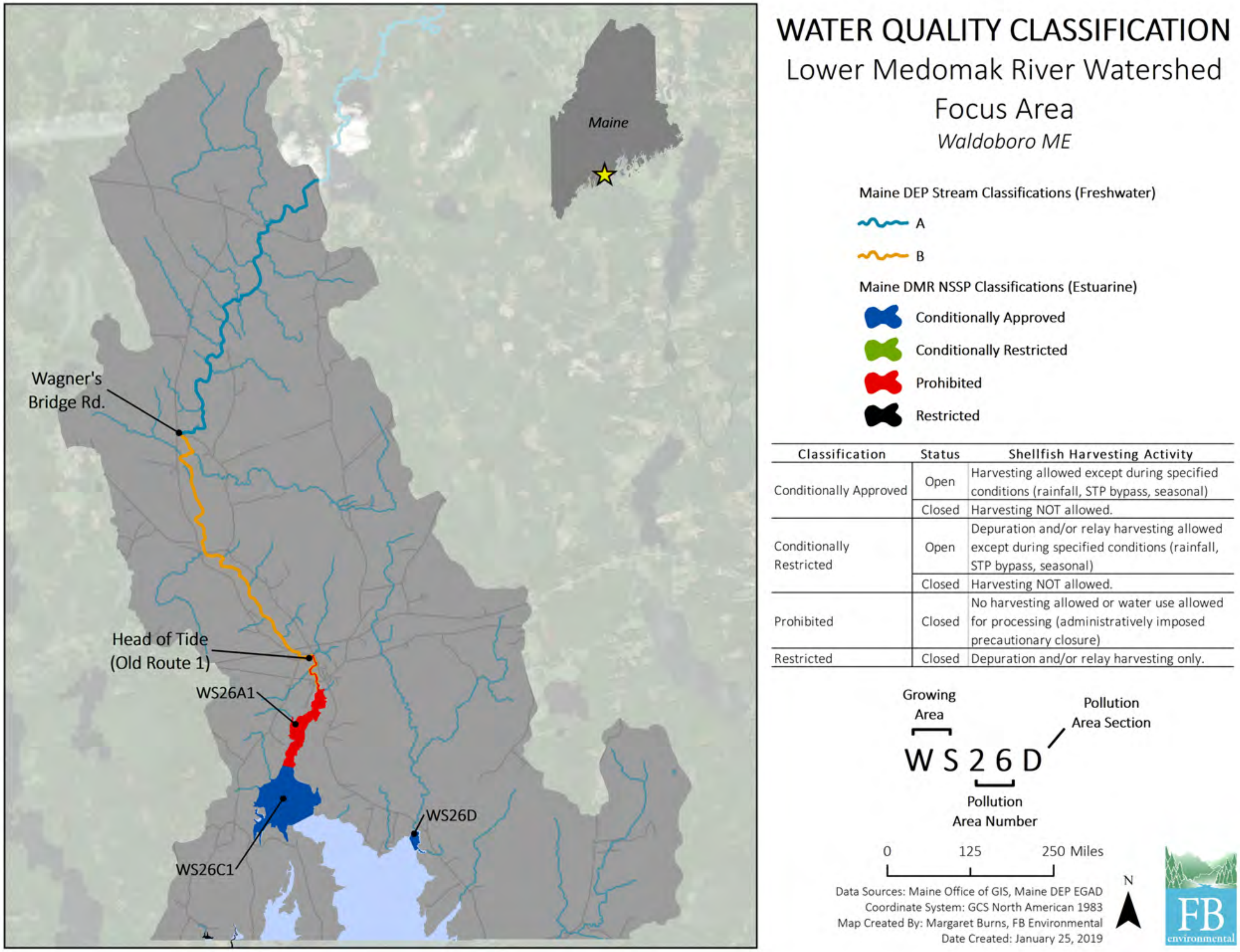
Table 4-1. Applicable state thresholds for all parameters applicable to the Medomak River project[6].

PARAMETER	TYPE	CLASSIFICATION	AGENCY	THRESHOLD	APPLICABLE TO
*E. coli***	Freshwater	Class A	Maine DEP	**236 CFU/100mL** (in more than 10% of samples in any 90-day interval); **64 CFU/100mL** (geometric mean over 90-day interval)	Medomak River to Wagner's Bridge and all freshwater tributaries
		Class B		**236 CFU/100mL** (in more than 10% of samples in any 90-day interval); **64 CFU/100mL** (geometric mean over 90-day interval)	Medomak River from Wagner's Bridge to Old Route 1 (head of tide)
Enterococci**	Estuarine	Class SB	Maine DEP	**54 CFU/100mL** (in more than 10% of samples in any 90-day interval); **8 CFU/100mL** (geometric mean in any 90-day interval)	Medomak River below Old Route 1 (head of tide) to Muscongus Bay
Fecal Coliform	Shellfish Growing Areas	Conditionally Approved (Harvesting allowed except during specified conditions)	Maine DMR	**14 CFU/100mL** (geomean); **31 CFU/100mL** (90^{th} percentile)	Growing Area WS, Pollution Area 26D (seasonal closure); 26C1 (rainfall closure)
Fecal Coliform	Shellfish Growing Areas	Prohibited (No harvesting allowed)	Maine DMR	**88 CFU/100mL**(geomean); **163 CFU/100mL** (90^{th} percentile)	Growing Area WS, Pollution Area 26A1
Dissolved Oxygen	Freshwater	Class A/B	Maine DEP	**7 mg/L** and **75% saturation***	All fresh waters
	Estuarine	Class SB	Maine DEP	**85% saturation**	All estuarine waters
Temperature	Freshwater	None	Maine DEP	Recommended **<24°C** for cold water fish survival	All fresh waters
Specific Conductance	Freshwater	None	Maine DEP	Recommended **<854 µS/cm**	All fresh waters

**Except for Oct 1 – May 14 during spawning and egg incubation. 7-day mean dissolved oxygen not less than 9.5 ppm and 1-day minimum not less than 8.0 ppm in identified fish spawning areas.*

***E. coli and Enterococci criteria only applicable seasonally (between April 15th and October 31st).*

[6] See LD1298 for recent changes to Maine Water Quality bacteria standards. Available here: http://legislature.maine.gov/bills/getPDF.asp?paper=HP0895&item=3&snum=128.



Classification	Status	Shellfish Harvesting Activity
Conditionally Approved	Open	Harvesting allowed except during specified conditions (rainfall, STP bypass, seasonal)
	Closed	Harvesting NOT allowed.
Conditionally Restricted	Open	Depuration and/or relay harvesting allowed except during specified conditions (rainfall, STP bypass, seasonal)
	Closed	Harvesting NOT allowed.
Prohibited	Closed	No harvesting allowed or water use allowed for processing (administratively imposed precautionary closure)
Restricted	Closed	Depuration and/or relay harvesting only.

Figure 4-1. Map of Maine DEP and Maine DMR water quality classifications on the Medomak River (freshwater and tidal) and its tributaries.

4.2 FECAL COLIFORM SAMPLING FOR NSSP REQUIREMENTS

Maine DMR is responsible for conducting routine sampling in the Medomak River estuary in accordance with regulations required by the NSSP (National Shellfish Sanitation Program). This is a cooperative program between the federal government and individual states, as well as the Food and Drug Administration and the Interstate Shellfish Sanitation Conference. The goal of this program is to ensure that harvested molluscan shellfish[7], which feed through filter feeding, are safe for human consumption.

To comply with this program, Maine DMR samples in estuaries with shellfish beds, such as the Medomak River, on a routine and rain event basis. Each year the Maine DMR conducts routine random sampling. Through a random generator, sample sites and dates are selected throughout the year in each estuary with a minimum of six random sampling events each year. Through their involvement with the Medomak Task Force, Maine DMR has worked to increase the random run sampling in the Medomak River estuary. In addition to random sampling, Maine DMR samples at identified sites following qualifying rain events.

Using the fecal coliform data collected from each site, the Maine DMR calculates a geometric mean and a P90 score; calculation of the 90th percentile from the previous 30 fecal coliform scores. This statistical calculation is run for each site and takes into account the previous 30 fecal coliform values. Given this, P90 scores are dynamic, and change each year with additional data collected at each site. Sections of the river and associated shellfish beds are classified based on the P90 scores at sites in that area along with the geometric mean and shoreline surveys. These classifications are revisited annually be the Maine DMR.

Table 4-2. Maine DMR water quality classifications and descriptions of the shellfish harvesting activity under each classification. (ME DMR).

CLASSIFICATION	STATUS	SHELLFISH HARVESTING ACTIVITY
Approved	Open	Harvesting allowed
Conditionally Approved	Open	Harvesting allowed except during specified conditions (rainfall, STP bypass or seasonal)
	Closed	Harvesting NOT allowed
Restricted	Open	Depuration and/or Relay harvesting only
Conditionally Restricted	Open	Depuration and/or Relay harvesting allowed except during specified conditions (rainfall, Standard Temperature and Pressure (STP) bypass or seasonal)
	Closed	Harvesting NOT allowed
Prohibited	Closed	No harvesting allowed or water use allowed for processing (administratively imposed precautionary closure)

The Medomak River has seen significant changes to the classification of the river in the past three years (Figure 4-2). Between the 2016 and 2017 season, a large section of conditionally approved river was approved for harvesting. Further, in 2018 the restricted area adjacent to area WS26C1 was opened for harvesting. Recent results from WS26C1 have indicated that this area could also be reclassified to be approved in the future if further testing continues to show low fecal coliform scores. At the writing of this plan, area WS26A1 is prohibited for harvesting while areas WS26D and WS26C1 are classified as conditionally approved. WS26D is seasonally closed from May 1 to September 30 each year. In contrast, WS26C1 is closed on the condition that Waldoboro receives greater or equal to 1" of precipitation in a 24-hr period. Areas are marked on the ground with red painted posts by Maine DMR. It is important to note that area classifications are dynamic and those listed in this document represent a static period in time. Real-time classification information can be found at the following webpage and/or by contacting the Maine DMR: https://www.maine.gov/dmr/aquaculture/leases/aquaculturemap.html.

7 Molluscan shellfish are those with a hinged shell such as clams, mussels, oysters and quahogs (ME DMR)

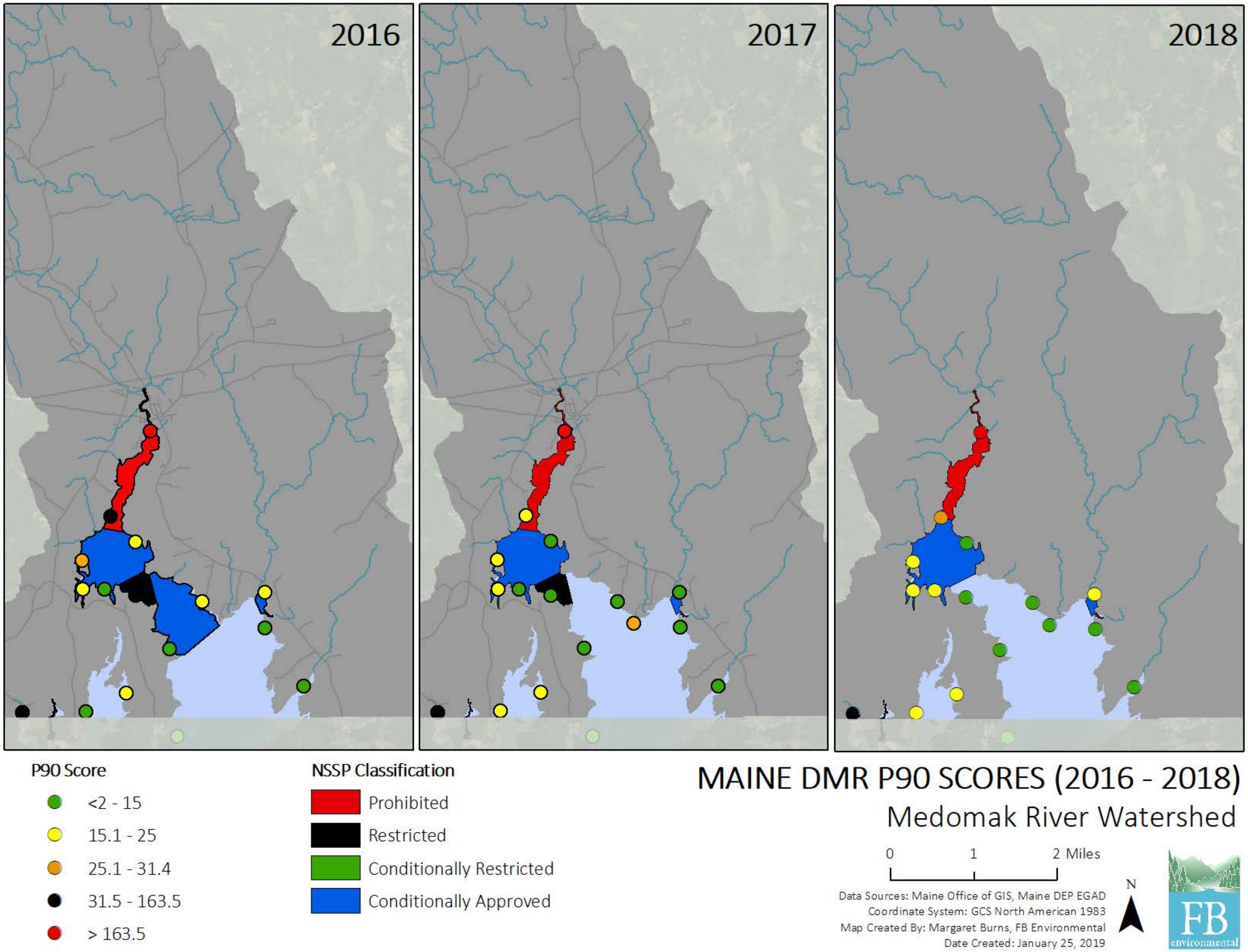


Figure 4-2. Map series of the upper Medomak River in 2016 (left), 2017 (middle), and 2018 (right). Each map displays the P90 scores from that year's sampling and the NSSP/Maine DMR classification for that year.

4.3 INVESTIGATIVE SAMPLING

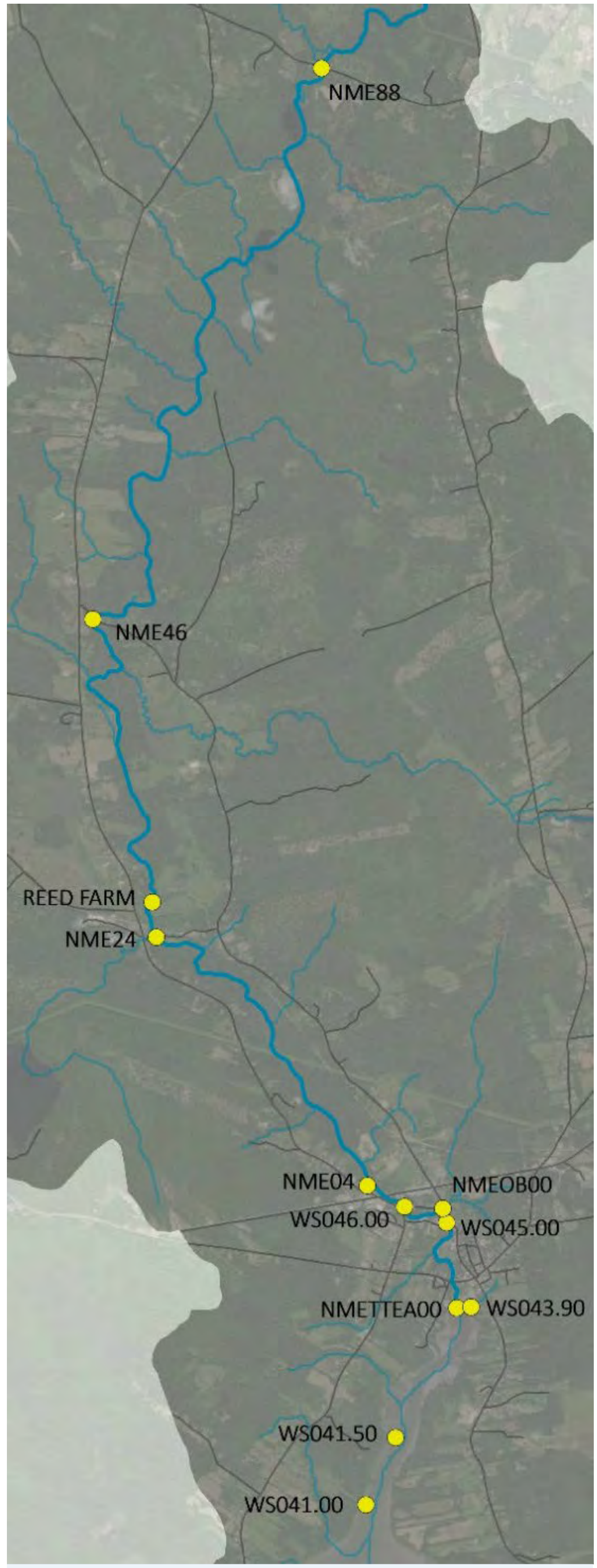
The following sub-sections are organized by year and highlight key data relevant to the goals of this watershed plan. Because fecal contamination responds to repairs and mitigation efforts, summaries across years are not representative of current and future contamination concerns. However, Maine DMR uses the most recent 30 datapoints in their calculation of the P90 score for each site.

The majority of the data in this section (excluding Maine DMR fecal coliform data) was obtained from the Medomak River Water Quality Project Report, written and finalized by Phil Garwood in early 2019.

4.3.1 2011 – 2012

In 2011, the Waldoboro Shellfish Committee, MVLT, and the University of Maine Cooperative Extension office worked with Maine DMR to take fecal coliform samples to expand upon the routine DMR sampling (completed six times per year based on a stratified random sampling design). The results of that effort are summarized in Figure 4-3, with sampling results from sites sampled by Maine DMR and the additional sites sampled by the volunteers. This figure shows the geometric mean for the twelve sites sampled in 2011 and 2012 with the number of samples listed above the respective bar on the bar graph. These data highlighted highest fecal contamination at NME24 (cross street) and just upstream at Reed Farm. The source of fecal contamination at both of these sites was subsequently identified.

These data also confirmed that fecal coliform was elevated in response to wet weather conditions. (e.g. 5/16/2011, 5/17/2011 on Figure 4-4). Given this information, volunteers decided to conduct higher frequency wet weather sampling in 2013, sampling on days one and three following 1" or greater rain events. The goal of this effort was to gain a better understanding of bacteria levels following rain in addition to the Maine DMR sampling on days five and seven following wet weather events.



2011-2012 sampling stations on the Medomak River.

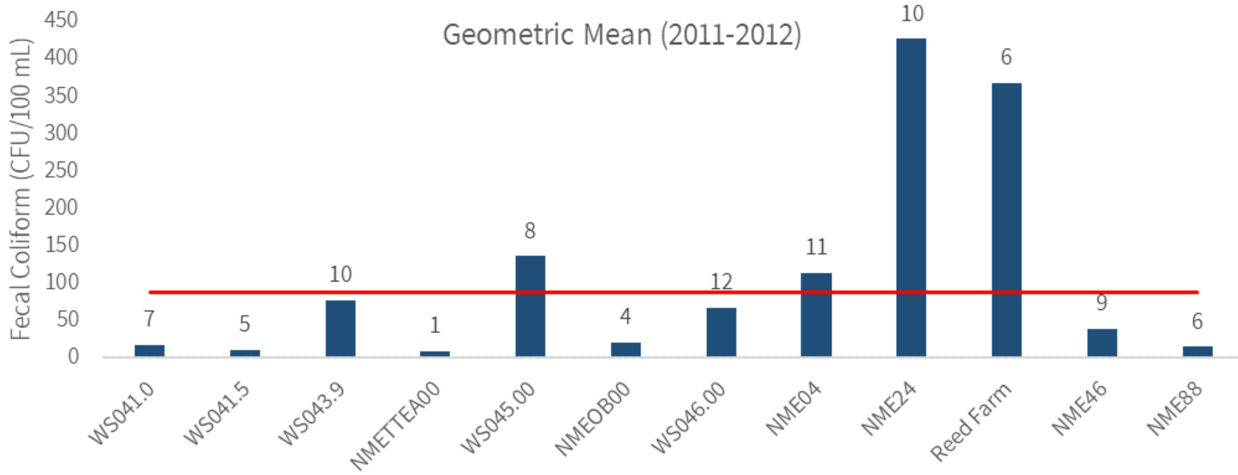


Figure 4-3. Geometric means for Fecal Coliform samples collected at twelve stations in 2011 and 2012. Numbers on the top of bars is the count of samples used in that geometric mean (note that NMETTEA00 is only one sample value).

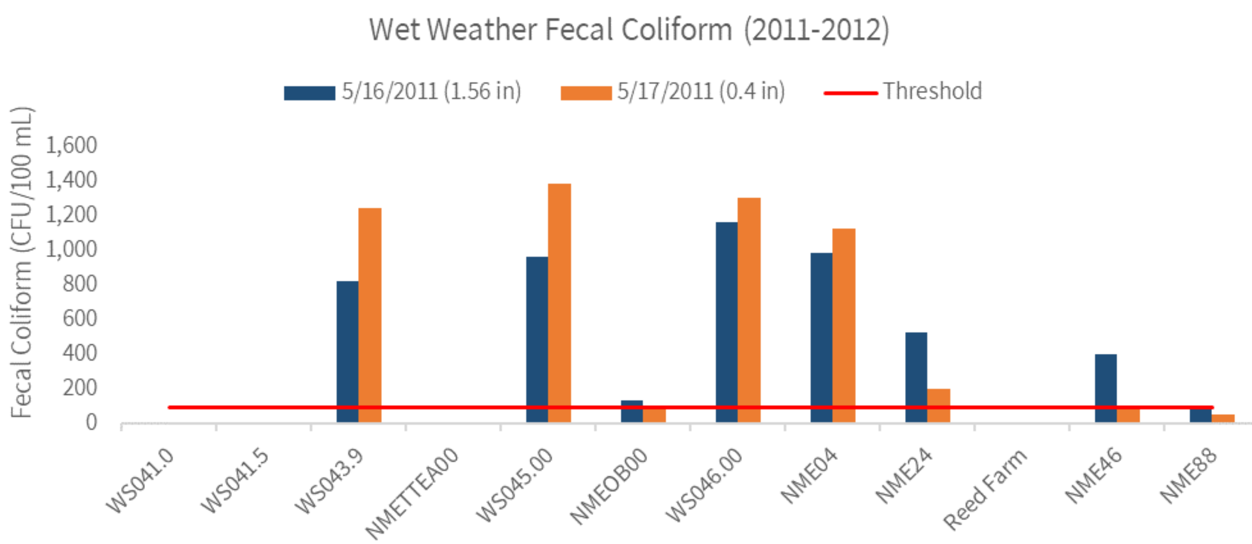


Figure 4-4. Fecal coliform results across a wet weather event in May 2011 at the same twelve sites. 1.56 inches of rain fell on 05/16/2011 and samples were collected that day and the following day (5/17/2011 with an additional 0.4 inches of rainfall).

4.3.2 2013 – 2014

Following the formation of the official Medomak Task Force in January of 2013, sampling on the Medomak River was more intensive across 2013 and 2014.

In 2013, Maine DMR agreed to increase routine sampling with a goal of once per month and volunteers sample additional sites on these same sampling dates. In addition, volunteers collected samples post-rain events (events greater than 1” in 24 hours) on days 1 and 3. The task force also began sampling upstream of US Route 1.

In 2014, the Medomak Task Force designed a subgroup focused on developing a sampling to evaluate the village area. This subgroup designed paired three-day studies (one dry weather, one wet weather) in the village area (Table 4-3). This sampling effort resulted in relatively low *E. coli* levels at all sites during dry weather conditions (September 2014). However, wet weather sampling revelated significantly elevated *E. coli* one day following a 1.5” rain storm. By day 2, these numbers had mostly recovered to their pre-storm conditions. The three tidewater tributary sites included in this wet weather sampling had the most elevated *E. coli* one day following the storm. This led to the focus on these tidewater tributaries starting in 2015 and 2016.

Table 4-3. ***E. coli*** **results from a dry weather series (9/22/2014 – 9/24/2014) and a wet weather series (10/17/2014 – 10/19/2014).**

DRY WEATHER SERIES			
SITE	**9/22/2014**	**9/23/2014**	**9/24/2014**
NME24	64	46	40
NME04	64	40	210
NME02	57	61	79
NME01	32	66	48
NME-01	84	40	35
NME-03	54	37	32
NMEMO00	73	36	84
WS043.9	22	17	13
WET WEATHER SERIES*			
SITE	**10/17/2014**	**10/18/2014**	**10/19/2014**
NME04	**866**	54	22
NMEUK00	**2,420**	58	39
NME02	**921**	61	36
NMEUB00	**517**	64	35
NMEOB00	**1,986**	56	43
NME-01	**687**	71	43
NMETTWA00	**921**	51	38
WS043.9	45	60	41
**Rain event on October 16 of 1.5" in 24hrs*			
Red = E. coli results greater than 236 MPN/ 100mL			

In further attempt to evaluate the village area, the Medomak Task Force hired FB Environmental and Environmental Canine Solutions which uses dogs to identify fecal contamination specifically from human sources. This method utilizes two canines (Sable and Logan) capable of detecting human-sourced wastewater. The results are presented in Table 4-4, showing an alert at eight sites for both dogs and an additional three sites for Logan. (Logan has been tested as more sensitive to low levels of human-sourced wastewater.)

Table 4-4. Canine detection results from 2014. Listed are the sites sampled and the two canines used (Sable and Logan). A "Yes" indicates that the dog indicated human-sourced fecal contamination. A sub-sample was analyzed for Fecal Coliform and results are presented in the last column.

SITE	SABLE	LOGAN	FECAL COLIFORM (CFU/100 mL)
NME24	No	No	19
Site A	No	No	--
Site B	No	No	--
NME20	**Yes**	**Yes**	4
NMEUI02	**Yes**	**Yes**	16
NME08	**Yes**	**Yes**	11
NMEUG04	No	No	54
NME04	**Yes**	**Yes**	36
NMEUC00	No	No	361
NME02	**Yes**	**Yes**	1

SITE	SABLE	LOGAN	FECAL COLIFORM (CFU/100 mL)
NMEUB00	No	No	689
NME01	**Yes**	**Yes**	35
NMEUA00	No	No	32
NMEOB00	No	**Yes**	4
NME-01	No	No	22
NME-01	**Yes**	**Yes**	--
NME-03	**Yes**	**Yes**	58
NME-03	No	**Yes**	--
WSO43.9	No	No	102
WSO43.9	No	No	--
NMETTEA01	No	**Yes**	27

4.3.3 2015 – 2016

In response to continued elevated fecal indicator bacteria in the estuary and the results from the 2014 intensive study, the Medomak Task Force decided to investigate the tidewater tributaries. Sampling was conducted following three rain events that triggered closures on the Medomak River; (1) 6/21/215: 1.53” in 24hrs, (2) 8/11/2015: 1.28” in 24hrs, and (3) 10/29/2015: 1.77” in 24hrs. Sites were sampled at Day 2 (one day following the storm) and Day 4 (three days following the storm; see Figure 4-5). Antecedent conditions before the August rain event were dry and despite the size of this storm, less overland flow was observed. Major conclusions taken from this study are summarized in the following bulleted list and are available in more detail in the 2018 Medomak Report.

- A handful of streams were identified as severe concerns; including NMETTEF00, NMETTEL00, NMETTEM00, NMETTEN00, and on the west side, NMETTWB00, and NMETTWC00.
- High counts taken in the stream during the August storm could have been a result of stagnant water and/or pulses of contaminated water entering the stream.
- Tidewater tributaries could be a significant driver of fecal coliform levels in the estuary system.

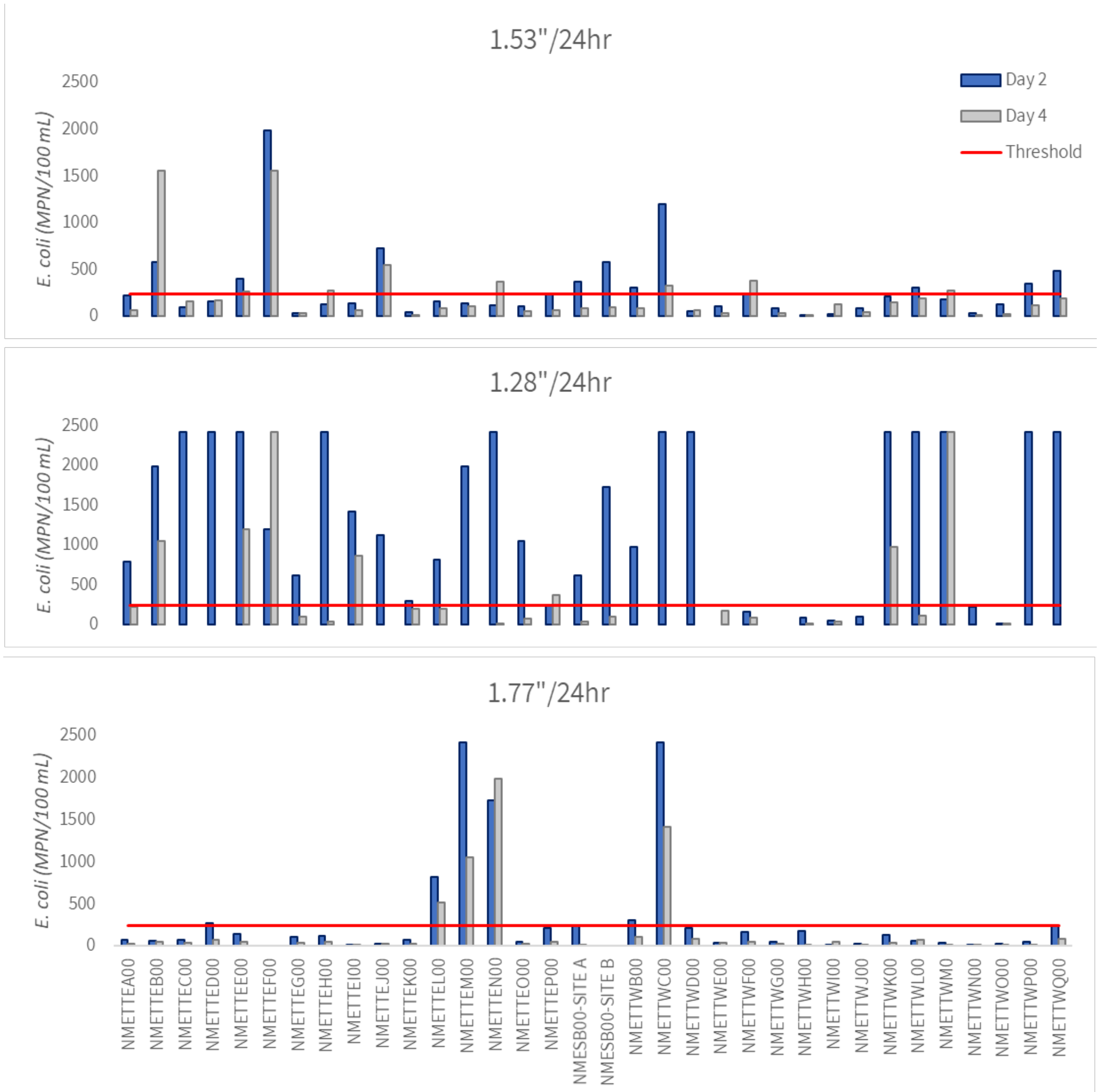


Figure 4-5. Three wet weather sampling events in 2015; 1.53" in 24 hours on 6/21/2015, 1.28 inches per 24 hours on 8/11/2015, and (3) 1.77 inches in 24 hours on 10/29/2015. All events were sampled on Day 2 and Day 4 following the storm, represented by blue and grey, respectively.

In response to the 2015 tidewater tributary results, the task force conducted paired *E. coli* and microbial source tracking sampling in 2016. The task force first sampled during baseflow (dry) conditions and subsequently sampled all sites one day following a closure across three storm events. Samples from each site were split and one sub-sample was immediately analyzed for *E. coli*. If the *E. coli* result was elevated, the split sample was sent to the University of New Hampshire for microbial source tracking analysis. Samples were analyzed for presence/absence of a human marker, dog marker, gull marker, and general mammalian marker. MST analysis highlighted the following:

- All 38 sites that were elevated for *E. coli* had a positive marker for general mammalian sources.
- 24 of these sites had a positive marker for human.
- Three sites had a positive marker for dog. All of these hits were during the largest rain event (1.88" in 24hrs on 10/29/2016).
- Three sites had a positive marker for gull. Again, all of these hits were during the largest rain event on 10/29/2016. The sites with a positive marker for gull were all unique from the sites with a positive marker for dog.
- All sites that had a positive dog or gull marker were also positive for human.

4.3.4 2017 – 2018

In 2017, the Medomak Task Force submitted a proposal to Maine DEP for 604(b) funds to complete this watershed plan. Due to high turnover of key task force members, no investigative sampling is conducted in 2017. Maine DMR continued to sample twelve times over the year in 2017.

2018 Fecal Coliform (estuarine sites)

As required by the NSSP, the Maine DMR must conduct sampling in the Medomak River shellfish growing area (WS) six times per year at dates determined using a stratified random sampling design. In 2018, the randomly selected dates were 4/18/2018, 5/21/2018, 6/18/2018, 7/10/2018, 8/14/2018, and 10/1/2018. From the random run samples taken in 2018 across 53 sites, three sites stood out as consistently elevated. These sites are the Town Landing (WS043.90), the Medomak River Rest Area (WS045.50), and the stream flowing just south of Hannaford Supermarket (WS046.00/NMEUC00) (Figure 4-6).

Glen Melvin. Photo credit: Phil Garwood

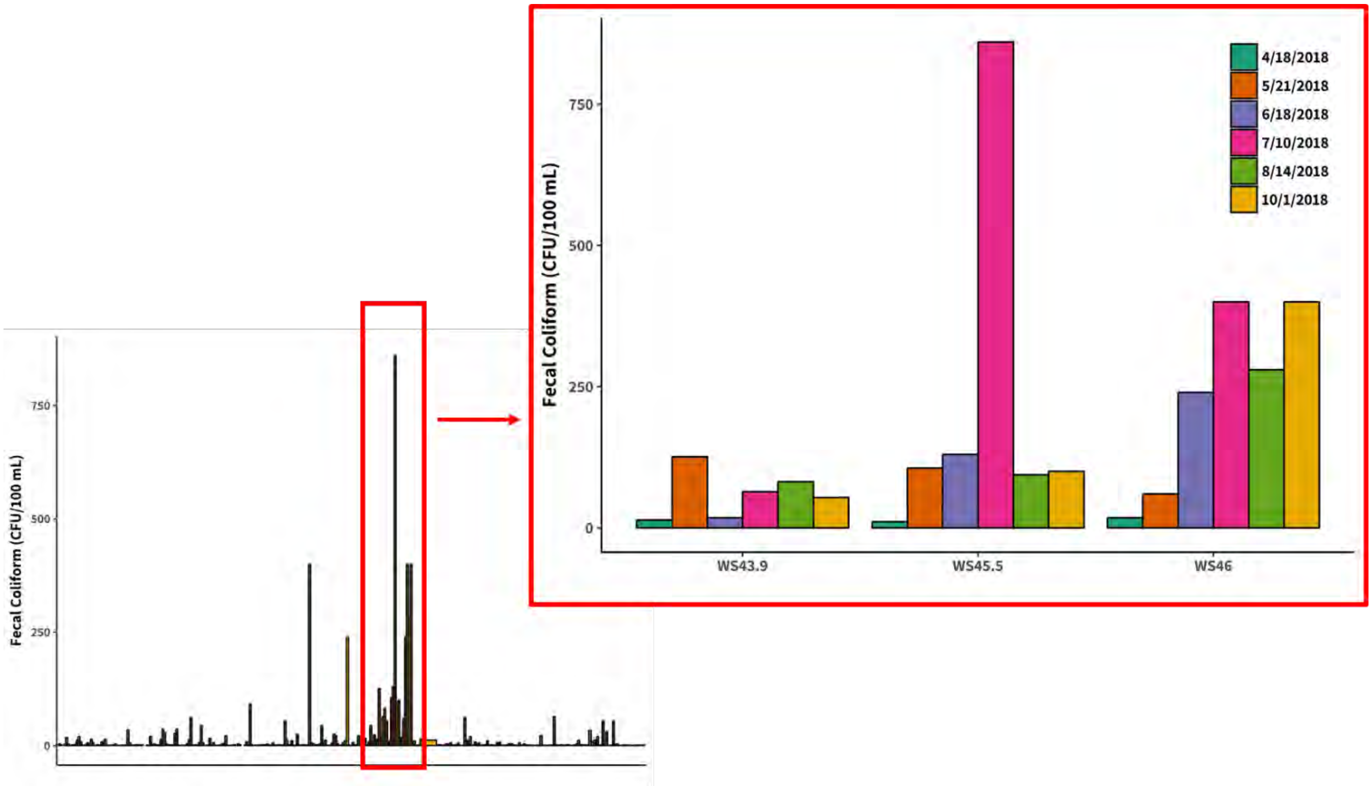


Figure 4-6. Fecal coliform results from 2018 random runs completed by Maine DMR. Highlighted are three sites with persistent elevated fecal coliform (WS43.9, WS45.5, and WS46).

2018 *E. coli* (freshwater sites)

The following section includes results from the 20 sites sampled across a storm event on 6/28/18 (Figure 4-7). Samples were collected from the Medomak River prior to the storm event (morning of 6/28/18), during the peak of the storm (afternoon of 6/28/18), and after the storm (6/29/18). Samples were analyzed for *E coli* enumeration, the primary FIB for freshwater environments. The narrative below includes the results from this sampling effort in the context of previous sampling efforts at each site.

East Side

NMETTEA00 (formerly NMEUL00, NMEUL01-05): This site is located at the outlet of the stream that originates near the Button Factory on the east side of the river and drains a significant portion of the village area. Dry weather sampling in 2016 indicated elevated *E. coli* in this stream and subsequent MST at this site had a positive marker for human. A house was identified as the source and the wastewater utility district worked with the homeowner to redirect the internal plumbing, install a small pump station, and connect the discharge to the main sewer. Additionally, the lateral line from the Button Factory was abandoned. All work was completed in December 2016. Despite this, testing in 2018 showed elevated *E. coli* before the storm (691 MPN/100mL) and reached the maximum detection limit (2,420 MPN/100mL) during the peak of the event. Post-storm sampling returned the lowest *E. coli* result in the study group (260 MPN/100mL). The high result during pre-storm conditions suggests that there could be continued fecal contamination from groundwater inputs.

NMETTEF00 (formerly NMEUQ00, Vil0.5): This site is located at the outlet of a small stream below the Marble Oaks development. *E. coli* testing in 2015 and 2016 was high and MST in 2016 was positive for both human and dog markers. The area has a private pump station, dense development, and agricultural land. 2018 results were only slightly elevated in pre-storm conditions at 313 MPN/100mL. An *E. coli* result at the maximum detection limit (2,420

MPN/100mL) during the peak-storm suggests that significant fecal contamination is mobilizing in surface runoff. By post-storm sampling, conditions were markedly improved with a result of 172 MPN/100mL.

NMETTEM00 (formerly NMEUY00): This site is located near Koskela Road off Friendship Road. This stream is ephemeral and has often been dry during historical dry weather sampling. Wet weather sampling has indicated fecal contamination and qPCR testing was high for gull. Property surveying in this watershed in 2015 showed no issues with properties in this area. This site was again dry in 2018 during pre-storm, dry weather conditions but reached the maximum detection limit (2,420 MPN/100mL) during the peak of the storm and was still elevated the following day (344 MPN/100mL). This Plan recommend a survey of the stream buffers in this watershed to identify areas where waterfowl could easily migrate from the stream to the open agricultural land. An increase in stream buffer could lessen the movement of waterfowl through this corridor.

NMETTEN00 (formerly WS0New4, DMR3): Historical results for this stream showed elevated *E. coli* on two dates, a positive marker for general mammalian using MST, and PCR showing contamination from gull. 2018 testing showed high *E. coli* at the pre-, peak-, and post-storm testing (870 MPN/100mL, 2,420 MPN/100mL, and 575 MPN/100mL, respectively). The salinity and specific conductance were elevated at this site during pre-storm sampling. Staff should follow up with specific conductance at this site to determine if the source is from the landscape or tidal inundation.

NMESB01 (formerly Slaigo Brook, S10WS049): This site, at the outlet of Slaigo Brook into Sampson Cove, originated as a Maine DMR site. Testing on this stream has shown intermittently elevated *E. coli* and human DNA markers. Maine DEP staff surveyed adjacent properties to Slaigo Brook in 2017 and found no malfunctioning waste systems or other possible fecal contamination sources. 2018 results remained elevated, with persistent high *E. coli* in the post-storm sample (756 MPN/100mL) compared to other sites that returned or improved on dry weather pre-storm base conditions. This site remains a high priority for follow-up due to persistent elevated FIB in dry and wet conditions. This higher-volume stream discharges directly to the estuary in the seasonal closure area and preventative actions should be taken to avoid further shellfish closures as a result of this stream.

Slaigo Brook on 06/28/2018. Photo credit: Margaret Mills FBE.

West Side

NMETTWA00 (formerly NMECH01, VA-3A): This site was an additional site sampled for the first time in 2018. The sample was taken downstream of the apartment complex before the tributary outlet to the main stem. It was only sampled before the storm and was missed during the peak- and post-storm sampling. It was below the state threshold before the storm, with a value of 167 MPN/100ml.

NMETTWA02 (formerly NMECH02, Vil12): Located just upstream of Main Street, this site was elevated at all three sampling times. However, the day one post-storm sample was below the pre-storm condition (pre-storm 516 MPN/100ml; post-storm 313 MPN/100ml). Elevated levels before the storm suggest a potential groundwater contamination source during baseflow conditions. Because the site is located upstream of Main Street, the peak-storm spike is most-likely a result of localized stormwater inputs upstream in the Bremen Road area that immediately delivered contaminants to the stream, but further diluted concentrations following the storm. A 2017 survey by DEP staff identified no malfunctioning systems upstream of this location, however, a newly installed leach field was identified on a property above this site.

NMETTWB00 (formerly NMEUK00): This site is sampled at the outlet of a small stream adjacent to the Town Landing. This site had persistent elevated bacteria across five of the six sampling events in 2015 (the sixth sampling event was dry), but microbial source tracking only revealed a general mammalian marker (i.e. no hits for human, dog, or gull sources). This site was dry at the pre-and peak-storm sampling times, and post-sampling *E. coli* was 80.3 MPN/100mL. This ephemeral pattern is consistent with a record of being dry if preceded by dry conditions. Because this site is consistently dry even during large precipitation events and the post-storm *E. coli* result was low, the contribution of any fecal contamination from this tributary is most likely a minor component of contamination to the estuary.

NMETTWC00 (formerly NMEUJ00): This stream was highlighted as an area for concern in the 2015 tidewater tributaries study. In this study, four of the five samples taken (the sixth sample was dry), were greater than 1,000 MPN/100mL, indicating a consistent source of fecal contamination. Additional focused sampling and smoke testing in 2015 revealed no apparent issues with the upstream Pine Street properties connected to town sewer. This stream was dry in the 2016 testing round. In 2018, this site was dry at the pre-storm sampling time but exceeded the detection limit (2,420 MPN/100mL) during the peak of the storm and remained elevated at the post-storm sampling event (416 MPN/100mL). The contributing area includes development on Pine Street and land associated with Cider Hill Farm, a former farm now serving as an Event Center and Disc Golf Course. This site had no flow for any of the four sampling events in 2016.

NMETTWK00 (formerly WS0New5, DMR5): This site was originally sampled as part of the 2015 tidewater tributaries study. In 2015, it was highest during the August storm event, the storm with the smallest rain total and dry antecedent conditions. This site was dry pre-storm but exceeded the maximum detection limit (2,420 MPN/100mL) in the peak of the storm and had the highest post-storm count (1,011 MPN/100mL). This suggests that fecal contamination could be originating from both groundwater and surface water (runoff sources). The upstream area on Bremen Road contains significant mowed, open land, primarily the vegetated buffer along the stream where it mirrors the edge of mowed field both north and south of Bremen Road just south of its intersection with Laila Lane. 2016 MST testing was completed four times during dry and wet weather. Of the four tests, two wet weather tests were positive for human sources.

NMETTWL00 (formerly WS0New6, DMR6): Just downstream from NMETTWK00, this site is located at the mouth of a second tributary entering the estuary just north of Meetinghouse Cove. It was also first sampled as part of the 2015 tidewater tributaries study. In 2018, this site was dry pre-storm but exceeded the maximum detection limit (2,420 MPN/100mL) in the peak of the storm and was elevated at the post-storm sample (602 MPN/100mL). MST results in 2016 were completed following a 1.88"/24hr rain-storm on 10/29/2016 tested positive for human source Bacteroides.

Upstream Tributaries

NMEUH00 *(formerly Stream by M16L4, Brook by Tonken):* This stream enters the Medomak River upstream of head-of-tide from the east. It is approximately 0.5 miles upstream of the main stem site (NME04). Historically, it has shown elevated *E. coli* and has tested positive for human and dog markers using MST. In 2018, it was below state criteria during pre-storm conditions (179 MPN/100mL) but reached maximum detection limit (2,420 MPN/100mL) during the peak of the storm and was elevated above initial conditions in the post-storm sample (361 MPN/100mL). This indicates fecal contamination primarily originating from surface water runoff.

NMEOB00 *(formerly Vil07, FBE-7, Orff Brook):* This site is located at the outlet of Orff Brook and enters the Medomak River upstream of head-of-tide and downstream of sampling station NME04. It emerged as one of the most elevated sites in the 2018 testing with a result at the maximum detection limit for pre- and peak-storm sampling (2,420

MPN/100mL). The post-storm sample remained elevated (436 MPN/100mL) but was significantly lower. This suggests serious groundwater contamination to the stream that is most-likely diluted in the post-storm sample from rain water. Historical results have also shown intermittent high *E. coli* and positive human markers using MST. Surveying above the Town Office in 2017 did not reveal any potential pollution sources.

NMEUC00 *(formerly NMEHS, Vil10, FBE-2, Hannaford Stream):* Historically, this stream has tested positive for human markers using MST, but surveying has revealed no apparent human sources of contamination. 2018 results remained elevated across pre-, peak-, and post-storm sampling, indicating a persistent fecal contamination source across dry and wet weather antecedent conditions.

NMEUL00: This new site was added at the culvert discharging into the Medomak main stem directly adjacent to the main stem (NME04) site. It is off Winslows Mills Road, just above the intersection with Route 1 and is located beside "The Look" hair salon. This site was elevated in pre- and peak-storm conditions but was dry for the post-storm sampling. However, *E. coli* concentrations were lower during the peak-storm, suggesting that dilution of the baseflow could be decreasing fecal contamination from base conditions.

Gabby Hillyer (top) and Margaret Mills (bottom) on the fan boat during sampling on 6/28/2018. Photo credit: Julie Keizer.

NMEUB00 *(formerly NMESP01, Vil11, FBE-4, VA-5A, NME02):* This site is located at the outlet of the "Skating Pond" adjacent to the Medomak Mobile Home Park (MMHP) just southeast of Hannaford. The MMHP is connected to the WUD sewer system so any contamination from the park would be a result of faulty connections or broken pipes. Historically, this site has had elevated *E. coli* levels, however, canine detection in 2014 did not identify this site as having fecal contamination from humans. Task force staff also contacted the management and they confirmed that they have a strict internal ordinance controlling pets within the park. For these reasons, sampling at this site was discontinued for 2015 and 2016. This site was added in 2018 by field staff Glen Melvin during the pre-, and peak-storm sampling. No sample was taken in the post-storm. Consistent with past results, this site was elevated during both the dry and wet conditions (616.7 MPN/100mL and 960.6 MPN/100mL, respectively).

Main Stem

NME04 *(formerly UP01):* This site is located on the main stem of the Medomak River, upstream of head-of-tide. It was well below state criteria during pre-storm sampling (73 MPN/100mL) and displayed a delayed response to the storm, with increasingly elevated *E. coli* results during peak- and post-storm sampling (549 MPN/100mL and 602 MPN/100mL, respectively). This is most-likely dominated by fecal contamination from upstream tributaries, such as NMEUH00.

NME02: This site is located below the park across from Hannaford on the main stem above head of tide. It was only sampled during post-storm conditions and was elevated above the state criteria (396.8 MPN/100mL).

NME-03: This site is located at the Waldoboro Village River Park on the main stem below head of tide. It was only sampled during post-storm conditions and was elevated above the state criteria (344.1MPN/100mL).

NME-04: This site is located at the River Falls on the main stem below head of tide. It was only sampled during post-storm conditions and was elevated above the state criteria (343.6 MPN/100mL).

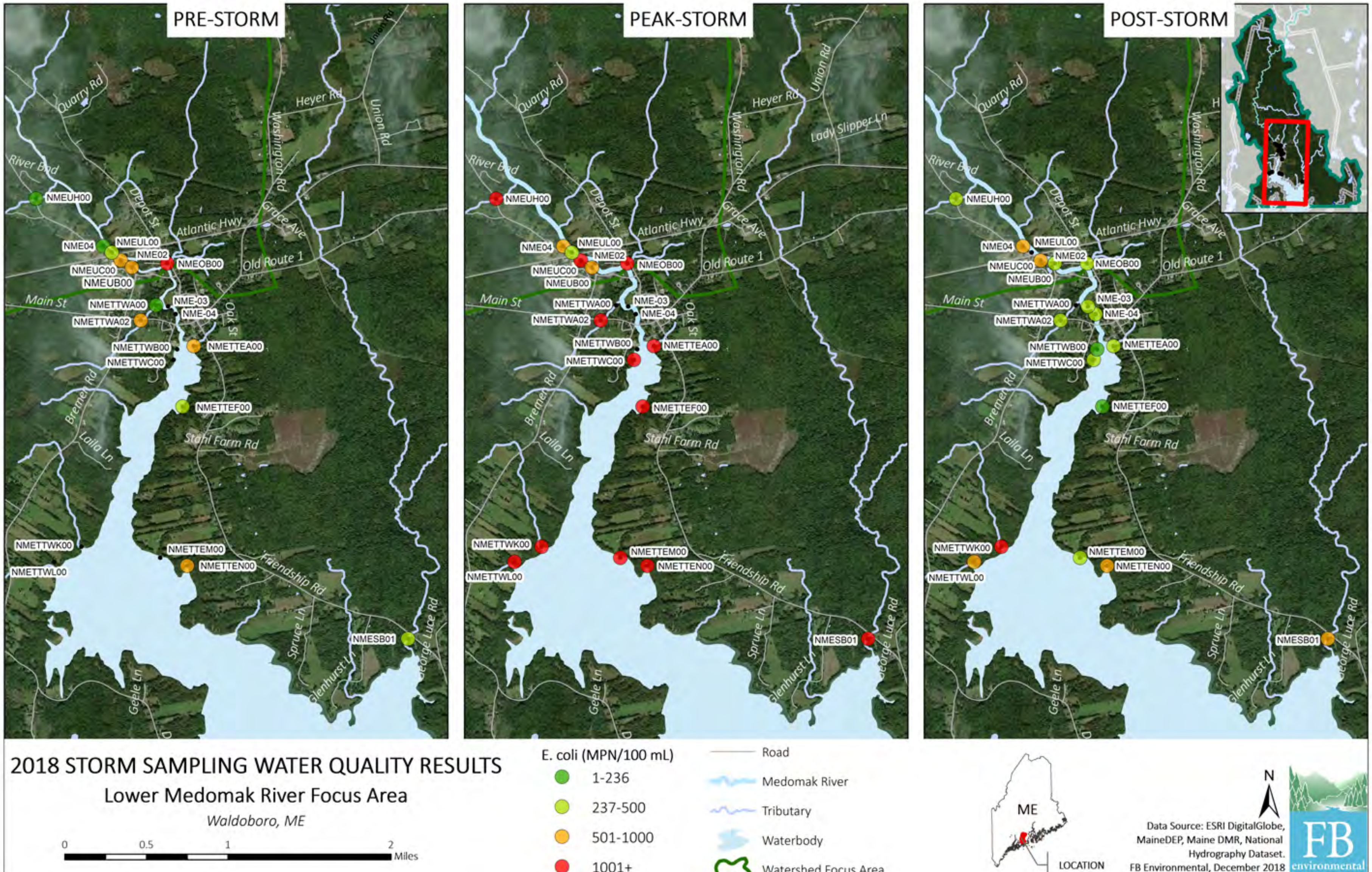


Figure 4-7. Sampling results in the Lower Medomak River watershed. Samples taken from a total of 20 sites over the course of a storm on 6/28/18 and 6/29/2018. Dark green symbols indicate fecal indicator bacteria (*E. coli)* concentrations below the state threshold (236 CFU per 100mL).

4.4 UNIVERSITY OF MAINE DRIFTER STUDY

The following information is provided by Gabrielle Hillyer (Hillyer, McGreavy, & Melvin, 2018) as an update to the ongoing study being conducted on the Medomak River. This section summarizes a portion of this study conducted in the summer of 2017 where "drifter" buoys were released into the river with GPS tracking-devices that provided a high-frequency view of water movement within the estuary. These data are then entered into a dynamic Finite Volume Community Ocean Model (FVCOM) where they will could inform future management decisions of shellfish beds.

Gabrielle Hillyer taking field readings while deploying the drifters. Photo credit: Glen Melvin.

The drifter study showed how the water is generally moving in the estuary, showing that wind, cross sectional area, and tidal scheme have the biggest impacts on where the drifters land.

Slack vs. Running Tide

Slack tide is defined here as either the high or low peak of tides, where the water is no longer moving but switching directions between tides. Running tide is defined here as the water moving either in or out of the estuary. For tidal stages, drifters were deployed at both slack and running tide.

During releases at slack tide, drifters did not move as far. They floated away from the channel running through the center of estuary and hit land. When drifters spread from the channel, either by an incoming tide, or changes in cross-sectional area, they beached themselves, coincidently around areas that have had high scores (see Appendix B, Figure B-1).

Wind Direction & Schema

For the deployment of drifters, there is a pattern from changes in wind direction. At this point in the study there are not strong quantitative correlations, though wind direction and strength can create vorticity currents, or eddies, which are seen in other estuaries nearby. Eddies are spiral currents that break off from major waterways (Figure 4-8). With different directions of wind, drifters either get trapped in spirals and move towards shore or continue along the major path of water (see Appendix B, Figure B-2 and B-3).

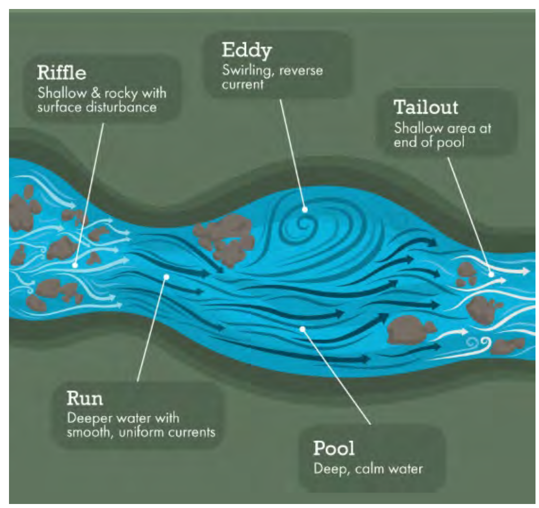


Figure 4-8. Schematic showing water dynamics in a typical river system.

Modelling Progress

Drifter data is being incorporated into a FVCOM hydrodynamic model designed by Wei Liu – a computer model that will be able to take in new data, like bacterial scores, landings, seed counts, or other environmental factors, and create an updated picture of what is going on in the Medomak Estuary. Currently, this model is up and running, and working through kinks, and will be used to calculate residence time of freshwater (polluted waters) as well as hopefully tracking where pollution may be coming from. This model may be able to track seed movement and spawning of clams.

4.5 WATER QUALITY SUMMARY

Through thorough investigative work and sampling conducted over the years, it’s evident that bacteria are the primary pollutant of concern. At this point, this investigative work has been successful at identifying sources, utilizing support from the appropriate agencies (Town Utility District, DACF or DEP) and working with landowners in efforts to abate NPS pollution sources. However, the river is still suffering from frequently elevated bacteria counts resulting in closures. Based on honing investigative work at 20 freshwater sites in 2018, the primary potential sources are likely from agricultural runoff (manure piles, manure spreading, farm animals in streams, etc.), waterfowl, groundwater contamination, and unknown sources from humans. These sources have the potential to contribute bacteria to the local waterbody through both surface water runoff (e.g. agricultural runoff from manure) and groundwater contamination (e.g. leaking septic system). Identifying and mitigating these sources of bacteria is important to protect human health as well as preventing the closing of shellfish beds. While some potential sources have been identified at this time, continuous investigation and remediation will be ongoing to identify new sources and determine appropriate BMPs.

5. BACTERIA SOURCE IDENTIFICATION

Given the ongoing water quality concerns outlined in Section 4, this Plan aims to identify actions that build on previous efforts to remediate nonpoint sources of fecal waste in the Lower Medomak River watershed. As discussed in Section 1.2, identifying sources of fecal waste is challenging because of the limitations of the indicator bacteria used to identify fecal contamination. Despite these limitations, scientists continue to do thier best to identify and remediate sources using available tools, while maintaining an understanding of the current state of the science as new and evolving methods for fecal contamination tracking are identified. This section provides an estimation of total annual bacteria loading to the river and identifies the most likely sources of bacteria in the watershed; (1) runoff from developed land, (2) livestock and agriculture, (3) septic system failure, and (4) wildlife and waterfowl. To create tangible measurable milestones for tracking the success of water quality restoration and remediation of fecal contamination, this Plan has estimated the contribution of each of these sources to the estuary using a preliminary pollutant load model. This model is discussed in the following Section 5.1. Analysis and summary material were provided by the Maine DEP.

5.1 ESTIMATION OF POLLUTANT LOADS

Estimates of indicator bacteria were calculated for fecal coliform, the fecal indicator bacteria used for management of shellfish flats by the State of Maine. Pollutant loads and sources in the Lower Medomak River watershed were calculated by the Maine DEP using a bacteria source loading estimates calculator created by FBE in collaboration with the New Hampshire Beaches Program in 2010. This calculator uses the same area-based method as the ArcView Generalized Watershed Loading Function (AVGWLF) pollution loading model (later named MapShed) in a simplified spreadsheet model (Bell & Dalton, 2010; Evans & Corradini, 2012). This spreadsheet model incorporates user-generated, watershed-specific inputs, including land use distribution, livestock, wildlife, and human population estimates, to calculate yearly bacterial loadings. In the Lower Medomak River watershed, yearly bacterial loads estimated in the spreadsheet model from all sources totaled 848 trillion fecal colonies per year. Although land use data and additional model inputs gathered for the Lower Medomak River watershed are as accurate as possible given all the available information and resources utilized, final numbers are approximate and should be viewed only as gross estimations of real-world conditions.

5.2 MODEL LIMITATIONS

There are significant challenges with modeling the loading of bacteria to surface waters from the landscape. Most significant are the diversity of source types (e.g. livestock, wildlife, human) and bacteria type present as well as the dramatic changes in ambient bacteria counts based on environmental conditions. These challenges increase model uncertainty and therefore the resulting estimates should be considered rough order of magnitude estimates. Specifically, key source characteristics, such as magnitude of sources, proximity to streams, and key transport information, such as bacteria die-off rates, cannot be accurately quantified. The bacteria load estimates provided herein are screening level and are intended to support watershed planning and prioritizing remediation efforts (Bell & Dalton, 2010).

5.3 POTENTIAL SOURCES OF BACTERIA

5.3.1 Developed Area Runoff

Runoff (i.e. stormwater) is surface water flowing from developed (generally impervious) surfaces during rainfall events. As rain water moves over the land and into local surface waters, it can pick up and transport pollutants (including bacteria) from various sources across the landscape. In the absence of vegetated buffers or other treatment practices, this stormwater runoff flows untreated into nearby storm drains or directly into surface waters and can cause elevated bacteria concentrations. Developed land use included in our analysis includes roadways, parking lots, roofs, and lawns. Developed area within the Lower Medomak River watershed is primarily concentrated around the Route 1 corridor and Waldoboro downtown. Two major roads run on either side of the estuary, Route 32 (Bremen Road) to the west and Route 220 (Friendship Road) to the east.

5.3.2 Livestock and Agriculture

Agricultural activities and livestock can impact water quality by contributing nutrients and bacteria from sources such as fertilizer application, uncovered manure piles, manure spreading, and livestock access to stream channels. Delivery of nutrients and bacteria from agricultural land is exacerbated in areas with poor riparian buffers, causing the delivery of untreated runoff to surface waters. Maine DEP estimated 40 farms in the shoreland zone of the Lower Medomak River watershed that have the potential to contribute nonpoint source pollution to the watershed, and 12 of these farms were identified using aerial imagery as potentially having exposed manure piles.

5.3.3 Septic Systems

Once Maine DEP identified the gross estimation of total septic system load in the watershed, they aimed to determine where in the watershed there was the most likely potential for these systems to be impacting the health of the river. This was done by looking at sensitive soils, proximity to surface waters, and individual parcels that are vulnerable to malfunctioning septic systems. Sensitive soils were first identified within the 150-foot buffer of the Medomak River and its tributaries. When septic systems are designed properly, the surrounding soils act as a filter and can remove pollutants from water passing through (e.g. phosphorus and bacteria). However, septic systems designed before 1995, when subsurface wastewater rules were amended to prevent septic system construction on sensitive soils, may not have been adequately designed to address issues posed from sensitive soils (such as those with coarse soil texture and shallow depth to bedrock). Soils that are coarse, very stony or sandy cause rapid permeability because the soils are porous and allow the effluent to move through them quickly, therefore limiting the amount of filtering that can occur, and potentially contaminating the groundwater or local surface waterbodies.

The most at risk soils are those that are shallow to bedrock. There are fifty-eight (58) parcels in the Lower Medomak River watershed that contain soils with rock-outcrops, indicating areas of land where bedrock is close to the surface and soil cover is limited. Septic systems need a minimum of four feet of vertical separation between the bottom of a leach field and the seasonable high groundwater table and/or impervious layer (such as bedrock, fractured or weathered bedrock) to adequately filter the effluent. Otherwise, effluent can move rapidly through the soils with minimal natural filtration and may pollute local surface waterbodies or groundwater.

After parcels with underlying sensitive soils were identified in the watershed, Maine DEP determined which parcels have buildings and if those buildings were built between 1974-1995. (Using the Maine Septic System Permit Search[8]). Sensitive soils with Lyman Rock Outcrops were prioritized as the highest priority for follow-up. From these criteria, Maine DEP identified 46 parcels on sensitive soils in the Lower Medomak River watershed. This Plan recommends on-the-ground follow-up at these 46 parcels to identify likely areas of malfunctioning septic systems.

5.3.4 Wildlife and Waterfowl

Wildlife and waterfowl have the potential to contribute bacteria to local waterbodies. This includes large mammal (e.g. deer), small mammal (e.g. racoon and beaver) as well as waterfowl (e.g. geese). Wildlife and waterfowl are notoriously difficult to quantify but can have an impact on fecal contamination in nearby waterbodies. In the Medomak River watershed, a series of freshwater tributaries have beaver dams. These beaver dams can significantly influence both water quality and the local hydrology. Beaver dams can create quality wetlands that can serve as a

[8] https://www1.maine.gov/cgi-bin/online/mecdc/septicplans/index.pl

habitat for dozens of bird species, mammals, amphibians, invertebrates, and fish, including those that are threatened or endangered[9]. However, this habitat can also increase fecal contamination in local waterbodies from both the beavers themselves, as well as the wildlife and waterfowl gathering in that area. Additionally, these dams can influence the local hydrology by causing flooding and ponding upstream, as well as restricting downstream flows. Large precipitation events can cause overtopping of the dams and release the ponded water to downstream waters. The benefits and conflicts from beavers can be difficult to resolve. It is important to work with State Fish and Wildlife staff to identify the appropriate methods to mitigating the conflicts with beaver dams as many actions require permitting and state officials can guide locals in appropriate management. See the Inland Fish & Wildlife website for more details: https://www.maine.gov/ifw/fish-wildlife/wildlife/wildlife-human-issues/living-with-wildlife/beavers.html.

[9] https://www.maine.gov/ifw/fish-wildlife/wildlife/wildlife-human-issues/living-with-wildlife/beavers.html

6. MANAGEMENT STRATEGIES

6.1 GOALS AND OBJECTIVES FOR RESTORATION

6.1.1 Action Plan to Restore Water Quality

The Town of Waldoboro in coordination with the Medomak Task Force set the following goals for this WBMP:

- Open all conditionally closed shellfish beds in the Medomak River estuary. When all conditionally closed beds have been reopened, work to open the prohibited area in the upper estuary.
- Restore in-stream habitat through strategic restoration of altered stream reaches focusing on high priority sites identified in the stream corridor survey and fluvial geomorphic assessment.
- Identify, and if necessary, reduce sediment and nutrient inputs to the stream caused by erosion from agriculture and development.

These ambitious goals can only be achieved through the energy and commitment of a coordinated group of local community leaders who manage and partner with conservation groups, state and federal partners, and citizens of the watershed.

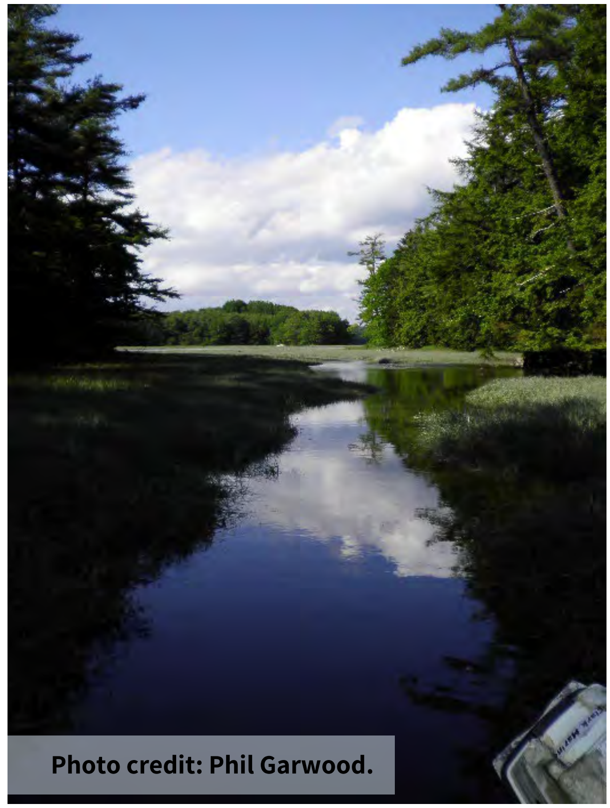


Photo credit: Phil Garwood.

6.1.2 Actions to Raise Public Awareness and Community Support

Further actions are needed to continue to reduce fecal contamination to the estuary and to restore water quality in the river. Through this planning project and considerable discussion by the Medomak Task Force, we have identified action items necessary for restoration of the river (Table 5-1).

River restoration actionable items include structural and non-structural management practices. Structural BMPs are those that involve construction, installation, or other physical changes to landscape. Typically, structural BMPs focus on reduction or treatment of stormwater by directing or redirecting stormwater drainage to engineered soil and/or vegetative filter systems or natural vegetated areas, pervious pavement, or detention and retention ponds. These structural BMPs can reduce runoff to the river that carries harmful pollutants and bacteria. Non-structural BMPs are those which involve operational changes, such as litter and animal waste control, yard waste management, septic tank management, repair of exposed soils, native landscaping, and healthy lawns (Minnesota Stormwater Design Team, 2013). A combination of structural and non-structural BMPs is usually the most effective and both will be needed to restore the Medomak River.

Table 6-1. Table of recommended action items for restoring water quality in the Medomak River and its estuary. Action items all include a detailed description, responsible party(s), timeline for completion, and an estimated 10-year cost. Estimated 10-year costs in the context of this plan represent our suggestion for funding allocation to complete the tasks. Due to the investigative nature of source-identification, identifying fixed costs for implementation is not feasible.

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
MONITORING + SURVEYING					
Follow-up at freshwater tributary sites that are persistent hotspots for elevated bacteria in the watershed through investigative sampling and/or surveys.	Various – See Appendix C	See Appendix C for details of each site and the associated follow-up recommendations.	Medomak Task Force	Beginning in 2019 and continue until water quality meets class.	$10,000/yr. (estimate) for monitoring costs ($100,000 over ten years)
Continue monitoring fecal coliform in the main stem of the Medomak River.	Various	Continue routine monitoring in the main stem of the river coordinated with Maine DMR random runs (fecal coliform).	Medomak Task Force	Ongoing	Internal Maine DMR Cost
Continue to support the University of Maine in their drifter project to quantify flow dynamics in the Medomak River.	NA	Maintain connection with Gabrielle Hillyer and/or Damian Brady. Include UMaine at the stakeholder table for all project meetings. Encourage UMaine representatives to present their findings to the public periodically.	Town of Waldoboro/ Medomak Task Force/UMaine	Ongoing	NA
		Work with Maine DMR to determine the applicability of the hydrographic model in decision-making for shellfish closures.	UMaine		

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
Revisit Maine DMR sites currently listed as "questionable" due to lack of access	WS034-96 (upstream of site NMEUH00)	Cesspool with hole in front yard covered with plywood and PVC pipes. Could be contributing to Brook by Tonken (note GPS point not plotted correctly so location based on address).	Maine DMR	2019-2020	Internal Maine DMR Cost
	WS034-112	In-ground septic system (tank and field) visible but could not access (gated property).			
	WS034-95 (upstream of site NMEUH00)	Possible animal waste but access denied. Could be contributing to Brook by Tonken.			
	WS029-98 (upstream of site NMETTWK00)	In-ground septic system (tank and field visible) but could not access (gated property). Phil's annual report notes this "...stream enters conditional area just below upper boundary, bacteria scores were moderately elevated in all samples, including dry weather. Human marker detected in two October events; bird marker evident from qPCR analysis in all rain events. Large watershed that should be re-surveyed in late summer and sampled at multiple sites"			
	WS030-114	Drainage behind Deb's Diner in Waldoboro Village (follow-up stream monitoring has occurred at this site.)			
	WS032-43 (upstream of site NMETTEM00)	Alpaca farm with in-ground septic system (tank and field) visible. No access (landowner not home.) High priority, coincides with high fecal indicator bacteria scores in neighboring stream. A follow-up showed no issues from houses. Locals say lots of wildlife, geese, turkeys. Farm fields are used for haying.			
Update Maine DMR internal database with	WS034-94	Remediated and filed with Maine DMR in paper records. Database needs updating.	Maine DMR	2019	Internal Maine DMR Cost
	WS030-3	Remediated and filed with Maine DMR in paper records. Database needs updating.			

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
remediated properties	WS030-2	Remediated and filed with Maine DMR in paper records. Database needs updating.			
	WS030-116	Remediated and filed with Maine DMR in paper records. Database needs updating.			
	WS030-118	Remediated and filed with Maine DMR in paper records. Database needs updating.			
	WS030-120	Remediated and filed with Maine DMR in paper records. Database needs updating.			
	WS030-112	Remediated and filed with Maine DMR in paper records. Database needs updating.			
File records noting remediation of outstanding sites	WS030-113	Site remediation confirmed by Waldoboro Local Plumbing Inspector (Stan Waltz).	Town of Waldoboro	2019	In-house
	WS030-2	Site remediation confirmed by Waldoboro Local Plumbing Inspector (Stan Waltz).			
EDUCATION + OUTREACH					
Educate watershed landowners about septic system maintenance.	NA	Create septic system maintenance flyer and distribute to all residents in the town.	Town of Waldoboro	2019-2022	$2,500 - $5,000
		Host neighborhood "septic socials" where residents can gain information on septic system care and available funds to help with septic replacements and/or repairs.			
		Identify properties with septic systems with high potential of problems using GIS (soils, age, proximity to water) and target one on one outreach or testing at high priority sites.	Town of Waldoboro/ Consultant	2019-2022	$10,000 - $15,000

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
Maintain an ongoing dialogue with large agricultural landowners.	NA	Include large agricultural landowners in strategic and comprehensive planning. Encourage agricultural landowners to improve manure storage and manage nutrients to prevent pollution to local surface waters. Use at a minimum a three-year crop rotation cycle. Install grass or rock-lined waterways to reduce erosion where there is concentrated flow.	Maine DACF / Knox-Lincoln Soil and Water Conservation District	Ongoing	$2,500 - $5,000
ADMINISTRATION + FUNDING					
Maintain a consistent funding mechanism for the project.	NA	Apply for state and federal grants and/or seek other funding to support implementation of planning recommendations. **See section 7.1 for a list of applicable state and federal grants.**	Town of Waldoboro	2019-2029	NA
Ensure Maine DEP and Maine DMR continue to provide a dedicated staff member to the task force.	NA	Continue to work with Maine DEP and Maine DMR to maintain a dedicated staff member. At the time of this plan, the Maine DEP staff member is Pam Parker and the Maine DMR appointed staff is Geoff Shook.	Medomak Task Force	2019-2029	NA
Ensure that there is sufficient support to enact the plan	NA	Host an annual meeting to ensure support for the Medomak River. Implement programs, enforce ordinances, oversee construction, and implement educational programs.	Town of Waldoboro	Annually	$1,000

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
		Work with UMaine and the Darling Marine Center to encourage undergraduate research projects targeting fecal contamination in shellfish beds, including projects focused on maintaining the GIS records.			
Ensure that there is sufficient organizational structure to enact plan	NA	Formally adopt the Lower Medomak River Watershed-Based Management Plan.	Town of Waldoboro	Spring 2020	NA
Update Comprehensive Plan	NA	The most recent comprehensive plan for the town of Waldoboro was written in 1998 (Town of Waldoboro, 1998). We recommend a full update to the comprehensive plan. Ensure that the Medomak River Action Plan is incorporated into this Comprehensive Plan update.	Town of Waldoboro	ASAP	In-house
MAINTENANCE + STRUCTURAL BMPs					
Map stormwater and sewer infrastructure	NA	Map all stormwater and sewer infrastructure in the Town of Waldoboro and create a GIS layer file.	Waldoboro Utility District/Town of Waldoboro	By 2020	$7,500 - $10,000
Address Medomak Mobile Home Park sewer lines	NA	Fix sewer lines in the Medomak Mobile Home Park.	Waldoboro Utility District/Town of Waldoboro	By 2020	$500,000 - $750,000
Inspect sewer lines	NA	Use closed camera TV (CCTV) to inspect sewer lines in the Town.	Waldoboro Utility District	By 2020	$10,000 - $15,000
Investigate septic systems in sensitive soil areas	See Appendix A Map 8	Follow-up with the 46 parcels identified as possibly having septic systems at-risk for failure/contamination (see Section 5.3.3).	Town of Waldoboro	By 2025	In-house

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
Inventory and encourage increased frequency of street sweeping	NA	Identify current street sweeping practices at commercial businesses and encourage increased sweeping if needed. Continue annual street sweeping ASAP in spring on Town/DOT maintained roadways and increase in areas of high sediment accumulation and bacteria hotspots. Increase frequency as needed.	Waldoboro Public Works/DOT	Annually	In-house
Inspect potential manure piles and provide technical assistance and funding to cover manure piles and install treatment BMPs in areas with animals	NA	Twelve potential manure piles were identified in the watershed using Google Earth aerial imagery. Inspect these sites and work with landowners to cover any manure piles exposed to precipitation.	Town of Waldoboro/ DACF/Consultant + Contractor	Inspect by 2020; Remediate by 2029	$120,000 - $150,000 (for six sites)
Improve riparian buffers at areas identified with a "Lack of Buffer" and ensure livestock fencing	NA	Ten potential areas lacking a riparian buffer were identified in the watershed using Google Earth aerial imagery. Inspect these areas and plant appropriate vegetation to vegetate shoreline. Total identified length of area with lack of buffer = 5,256 feet	Town of Waldoboro/ DACF/Consultant + Contractor	Inspect by 2020; Remediate by 2025	$10,000 - $15,000
Improve riparian buffers at areas identified with a "Reduced Buffer" and ensure livestock fencing	NA	Four potential areas lacking a full riparian buffer were identified in the watershed using Google Earth aerial imagery. Inspect these buffers and work with landowners to enhance and improve buffer. Total identified length of area with lack of buffer = 535 feet	Town of Waldoboro/ DACF/Consultant + Contractor	Inspect by 2020; Remediate by 2025	$5,000 - $10,000

ACTION	SITE	HOW	WHO	WHEN	ESTIMATED 10-YR COST
LAND USE PLANNING + CONSERVATION					
Maintain Shellfish Conservation Ordinance	NA	Enacted in 1992, the Town of Waldoboro has a Shellfish Conservation ordinance that protects and optimizes utilization of shellfish resources within the Town. Continue to support and revise this ordinance as necessary.	Shellfish Conservation Committee	Ongoing	In-house
Enforce shoreland zoning requirements	NA	Continue to enforce shoreland zoning requirements for new and retrofitted development. Ensure agricultural setbacks are sufficient to prevent runoff (explore new ordinances if necessary to achieve).	Town Enforcement	Ongoing	In-house
Conserve land with intent to protect water resources	NA	Create land conservation plan for the Lower Medomak River watershed in collaboration with Midcoast Conservancy. Prioritize water quality protection in land acquisition plan (sp. Riparian areas, land overlaying sand and gravel aquifer). Estimate for plan ONLY, does not include land purchase or acquisition.	Midcoast Conservancy/ Consultants	Meet and Review by 2020	$15,000 - $25,000 (if hire contractor)
	NA	Create fund for future land acquisition opportunities in the Lower Medomak River watershed so the land trust is prepared if a property becomes available that provides critical water quality protection.	Midcoast Conservancy	Contribute Annually	NA

6.2 BACTERIA TARGETS

6.2.1 Fecal Coliform

The Maine DMR determines shellfish growing area classifications using results from fecal coliform sampling at fixed stations, as well as from shoreline surveys in the adjacent 500 feet of land. The sites listed in Table 6-2, below, are water quality sampling stations located in the Upper Medomak River estuary (growing area WS) and are used to determine classification of the shellfish beds in growing area WS. The most recent 30 fecal coliform scores at each site are used to calculate the P90 score (a statistical calculation representing the 90th percentile) and the geometric mean.

Table 6-2 shows the P90 statistic and the geometric mean for each of these sites through the 2018 sampling season. Each statistical calculation contains a percent difference column showing the change in each statistic needed to meet approved classification criteria. Highlighted in red are any sites not meeting Approved standards (P90 score of 31; Geometric Mean of 14 CFU/100mL). Highlighted in green are any sites meeting Approved standards. As mentioned above, calculations use the most recent 30 fecal coliform scores and are valid through the 2018 sampling season.

In 2018, all P90 scores and geometric means in the upper Medomak River estuary met approved classification standards, except for site WS043.90 located in the prohibited area. Correspondence with Maine DMR suggests that conditional classifications will be revisited if 2019 scores remain below Approved standards.

Table 6-2. P90 and geometric mean scores for 13 Maine DMR sites located in the upper Medomak River estuary. Highlighted in red are any sites not meeting Approved standards (P90 score of 31; Geometric Mean of 14 CFU/100mL). Highlighted in green are any sites meeting Approved standards. Calculations use the most recent 30 fecal coliform scores through the 2018 sampling season.

	P90			GEOMETRIC MEAN*		
SITE	2018	STANDARD	% DIFFERENCE	2018	STANDARD	% DIFFERENCE
WS043.90	218.6	31	85.8	26.2	14	46.6
WS041.00	25.9	31	-19.7	4.7	14	-197.9
WS047.30	11.5	31	-169.6	3.3	14	-324.2
WS040.00	23	31	-34.8	5.5	14	-154.5
WS039.00	21.9	31	-41.6	4.5	14	-211.1
WS038.50	18.2	31	-70.3	4	14	-250.0
WS038.00	6.3	31	-392.1	2.5	14	-460.0
WS048.00	8	31	-287.5	2.8	14	-400.0
WS048.40	8.6	31	-260.5	2.9	14	-382.8
WS049.00	17.8	31	-74.2	4.4	14	-218.2
WS049.20	5.6	31	-453.6	2.6	14	-438.5
WS050.00	9.1	31	-240.7	3.2	14	-337.5
WS037.00	8	31	-287.5	2.7	14	-418.5
Both calculations are determined using the most recent 30 fecal coliform scores. P90 scores represent the 90th percentile.						
Listed standards represent the Maine DMR criteria for an area approved for shellfish harvesting.						
**Geometric means are in CFU/100 mL (CFU = colony forming units).*						

6.2.2 Dissolved Oxygen

The Medomak River (Maine DEP Waterbody ID 726-11) is listed in the 2016 Integrated Report as impaired for Marine Life Use Support because of dissolved oxygen (Maine DEP, 2016). The cause of low dissolved oxygen was a spray irrigation system which has been removed. This is noted in the 2016 Integrated Report and the river is placed under the category "Pollution Control Requirements Reasonably Expected to Result in Attainment". As such, this Plan recommends measuring for dissolved oxygen when taking fecal coliform samples in the estuary to obtain data to support attainment of this river section. (The 2016 Integrated Report notes that the last year dissolved oxygen was sampled in the estuary was 2003.)

The Medomak River upstream of its crossing with Main Street. Photo credit: Margaret Mills.

7. RESTORATION PLAN

7.1 PLAN OVERSIGHT AND ADOPTION

It is the recommendation of this plan that the Medomak Task Force continue to direct and administer the Medomak River WBMP over the course of the next 10 years, 2019-2029. This committee will be guided by the Town of Waldoboro and will continue to be formed from members of representatives from Maine DEP, Maine DACF, Maine DMR, the Town of Waldoboro, the Waldoboro Shellfish Committee, the Waldoboro Utility District, and the Midcoast Conservancy. Other stakeholders to involve include local clammers and business owners within the shellfish community, land owners, elected officials, and the general public of Waldoboro and surrounding towns to the Lower Medomak River watershed. This Plan recommends the committee meet twice annually to provide periodic updates to the plan, track and record progress made, maintain and sustain action items, and make the plan relevant on an ongoing basis by adding new tasks as needed.

Restoration of water quality in impaired watersheds requires a long-term and dedicated effort. The success of the goal of this plan is to restore water quality to levels acceptable by the NSSP for open harvesting will be dependent on community involvement, landowner commitment to preventing nonpoint source pollution, funding sources, and staff availability. A vested environmental and economic interest in the health of the Medomak River and estuary, cooperation by property owners, sustainable funding, and good administration are factors that will lead to success of the plan. If the ultimate goal of removing conditional closures in the estuary is met before implementation of recommended actions are complete, then the goal of the plan has been met. However, the Medomak Task Force should continue their efforts to protect their community resources and strengthen the long-term health of the Medomak River. Actions to build climate resiliency, restore water quality, and protect aquatic habitat will help maintain watershed health.

Broad community engagement and support is a major strength for a successful WBMP implementation and is critical to long term success. The Task Force should continue to include collaboration and support of the entire community, including local businesses and property owners, community groups, conservation groups, corporate sponsors, and municipalities. Property owner collaboration is especially important within the Medomak River estuary, as the sampling has indicated NPS pollution and Fecal Indicator Bacteria occurs at many locations from unknown sources and properties. A funding plan is also crucial for success. Additional state and federal grants can help implement the plan. In addition, broad community support is a major strength when applying for such funding. Adoption of the WBMP by the Town is highly recommended to help raise local awareness about the need for restoration efforts and to garner support needed to implement various aspects of the plan.

7.2 ESTIMATED COSTS AND TECHNICAL ASSISTANCE NEEDED

The total cost of successfully implementing the Lower Medomak River Watershed Based Management Plan is estimated at approximately $688,500 - $1,010,000 over the next ten years (2019 – 2029) based on the recommended action items listed in Section 6, Table 6-1 (see Table 7-1 for cost breakdown).

Table 7-1. Estimated 10-YR Costs for Plan Implementation

ITEM	10-YR COST
Monitoring and Surveying	
Investigative Monitoring	$100,000
Maine DMR Fecal Coliform	Maine DMR
Support University of Maine Research	NA
Revisit Questionable Sites	Maine DMR
Update Maine DMR Internal Database	Maine DMR
File Outstanding Records	In-house
Education and Outreach	
Educate Residents on Septic Maintenance	$2,500 - $5,000
Maintain Dialogue with Agricultural Community	$2,500 - $5,000
Administration and Funding	
Maintain Funding Mechanism	NA
Ensure DEP, DMR, and DACF Support	NA
Ensure Sufficient Support to Enact Plan	$1,000
Adopt Plan	NA
Update Comprehensive Plan	In-house
Maintenance + Structural BMPs	
Map Stormwater and Sewer Infrastructure	$7,500 - $10,000
Repair MMHP Sewer Lines	$500,000 - $750,000
Inspect Sewer Lines	$10,000 - $15,000
Create Municipal Maintenance Plan	$5,000 - $10,000
Encourage Street Sweeping	In-house
Inspect + Cover Potential Manure Piles	$120,000 - $150,000
Improve Riparian Buffers in Areas Lacking Full Buffer	$10,000 - $15,000
Improve Riparian Buffers in Areas with No Buffer	$5,000 - $10,000
Land Use Planning and Conservation	
Enforce Stormwater Management Law	In-house
Maintain Shellfish Ordinance	In-house
Enforce Shoreland Zoning	In-house
Incorporate LID into Ordinances	$10,000 - $15,000
Plan to Identify Conservation Priorities to Protect Water Resources	$15,000 - $25,000
Total Estimated 10-YR Cost:	**$688,500 - $1,010,000**

Funding will be needed from state and federal grants, and private investments including local businesses and property owners, community groups, conservation groups, and corporate sponsors. The Medomak River Task Force will take the lead on seeking funding from outside sources and coordinating with landowners and cost-share opportunities.

Water Quality Restoration, Septic Infrastructure Repair & Riparian Buffer Improvement: Federal and state agencies, such as the US EPA, Maine DEP, and the Maine Office of Community Development offer competitive grant programs to implement water quality restoration projects, as well as education and outreach activities. See "Maintaining a Funding Mechanism in Section 7.1 "Adaptive Management Approach" for specific grant opportunities.

Municipal Maintenance: Actions such as increased street sweeping, stormwater catch basins, and ordinance revisions and enforcements should be supported by the Town of Waldoboro. These best practices can help to reduce input of runoff that can carry bacteria and other pollution to the estuary. Other funding sources, such as local planning grants, may help supplement these projects.

Shoreline Surveying and Monitoring: Future monitoring and surveying and assessment efforts will require a variety of funding sources, including the continuation of using existing Maine Sea Grant funds, as well as other state agency grants.

8. MEASURING SUCCESS

While this plan provides specific goals and key actions needed to restore water quality, aquatic habitat, and the shellfish harvesting community in the Medomak River, it is inevitable that new information, technology, and techniques will be learned and developed in the years to come that may change the priorities of identified goals and actions. Therefore, the goals and priority of actions identified in this plan should be revisited and revised on an annual basis using an adaptive management approach.

8.1 ADAPTIVE MANAGEMENT APPROACH

Using an adaptive management approach assists stakeholders in conducting an ongoing watershed restoration in an evolving and iterative manner. An adaptive management approach is widely recommended for restoring watersheds, as it allows using available resources efficiently through BMP performance testing and restoration monitoring activities. Restoration actions can be evaluated for effectiveness and modified or adopted by stakeholders prior to implementing the next round of restoration actions. This tactic recognizes that the entire watershed cannot be restored with a single action or within a short-time frame (e.g., 2 years). Instead, adaptive management creates an ongoing program that includes stakeholder involvement, adequate funding, and an efficient coordination of restoration activities. This will ensure that necessary and required restoration actions are implemented and the Medomak River is monitored to document restoration over an extended period.

The adaptive management components of the Medomak River WBMP will include:

Creating an Organizational Structure for Implementation – The Medomak Task Force will include stakeholders from the shellfish community, members of the Town of Waldoboro, business owners, agricultural land owners, residents, state, and federal partners, and other interested community groups. An organizational structure will help continue the successful collaboration of stakeholders that has occurred in the past to continue improving the Medomak Project.

Maintaining A Funding Mechanism – The following list summarizes nine possible outside funding options available to the Medomak River Project. A combination of grant funding, private donations, and municipal funding must be used to ensure completion of the plan. Table 8-1 and Figure 8-1 outline application timelines for each funding source.

- **US EPA/Maine DEP 319 Grants** – This grant is designed to assist municipalities with restoring waters named as NPS Priority Watersheds and are available for the implementation of WBMP. The Medomak River is an impaired marine water, eligible for the EPA's grant funds for implementing a nine-element plan. http://www.maine.gov/dep/water/grants/319.html. Contact the DEP regional office for more information 207-764-0477.
- **Small Community Grant Program** – Maine DEP provides funds through this grant to help replace malfunctioning septic systems that are polluting a waterbody or causing a public nuisance, with priority given to problems affecting public drinking water supply, a shellfishing area, and water protection projects. Individual families may qualify for the grant program if their federal taxable income for the previous year was $40,000 or less. Commercial establishments may qualify if their gross profit for the previous year was $100,000 or less. The application is ongoing. https://www.maine.gov/dep/water/grants/scgp.html
- **Coastal Communities Grant Program** – Run by the Maine Coastal Program through the Department of Agriculture Conservation and Forestry, the Coastal Communities Grant Program is a competitive grant program that funds regional organizations for projects around public access, water quality improvements, storm hazard resiliency, and marine-related economic development. All grant recipients must provide a minimum of 25% in matching funds or services. More details can be found here: https://www.maine.gov/dacf/municipalplanning/index.shtml

- **Broad Reach Grant Program** – A grant program through Maine Philanthropy Center that supports non-profit organizations across Maine related to social justice, economic opportunity, environmental health, and sustainable food systems. Grants are generally released in the fall and are between $15,000 and $25,000. Details can be found here: https://www.mainephilanthropy.org/redhen/org/307
- **Community Block Development Grant** – The Maine Department of Economic and Community Development, through the Office of Community Development, offers programs to assist municipalities in achieving their community and economic development objects. Grants are designed to meet objectives of benefiting low- and moderate-income persons, preventing poor living conditions, and meeting urgent community development needs. The home repair network section of this grant provides funds up to $2,700,000 and the public infrastructure section provides maximum funds of $1,000,000. Other grants are available for application as well under the CBDG, and are offered annually. https://www.maine.gov/decd/meocd/cdbg/statement.shtml
- **Sea Grant** – The Maine Sea Grant is a state-federal partnership providing funds for marine research projects that are responsive to the needs of Maine's communities. Grant competition occurs every two years and is open to faculty and staff at any public or private research or higher education institution in the state. Grant award amounts are up to $150,00. http://www.seagrant.umaine.edu/funding/research
- **Healthy Watersheds Consortium** – The HWC grant provides grants for actions that enhance or improve aquatic ecosystems and supporting natural landscape and watershed processes in larger watersheds. This grant supports local protection and projects that can be sustained in the future, with federal funding from a partnership between the US Endowment for Forestry and Communities, the US EPA, and the USDA Natural Resources and Conservation Service. Funding usually ranges from $50,000 to $150,000. https://www.epa.gov/hwp/healthy-watersheds-consortium-grants-hwcg
- **United States Department of Agriculture – Natural Resources Conservation Service** (all quoted text from the USDA NRCS webpage for the State of Maine). While links to the national websites are provided, the local USDA office can be contacted at 207-764-4155.

  Agricultural Management Assistance – *Monies from this program provide cost share assistance to "…agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations."* *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/me/programs/financial/?cid=nrcs141p2_002873*

  Conservation Innovation Grants – *"Voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies…".* *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/me/programs/financial/cig/?cid=nrcs141p2_002875*

  Conservation Stewardship Program – *"NRCS provides financial and technical assistance to eligible producers to conserve and enhance soil, water, air, and related natural resources on their land."*

  https://www.nrcs.usda.gov/wps/portal/nrcs/main/me/programs/financial/csp/

  Environmental Quality Incentives Program – *"…provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat."* *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/me/programs/financial/eqip/?cid=nrcs141p2_002867*

- **Clean Water State Revolving Fund** –The CWSRF is a low interest loan program which can be used to control NPS pollution, improve wastewater infrastructure, and protect estuaries. Funds come from a combination of federal and state funds, as a partnership between the EPA and state CWSRF programs. https://www.maine.gov/dep/water/grants/srfparag.html

Table 8-1. Potential funding sources for the Lower Medomak River project, listed by the calendar month they are typically due.

FUNDING SOURCES	
Month Application is Due	**Grant**
January	Five Star and Urban Waters Grant
	Community Block Development Grant: Public Infrastructure
February	Healthy Watersheds Consortium
	Community Block Development Grant: Economic Development
March	Maine Sea Grant
	Agriculture: Conservation Stewardship Program
April	Clean Water State Revolving Fund (CWSRF)*
	Agriculture: Conservation Innovation Grant
	Coastal Communities Grant
June	319 NPS Pollution Control
August	Agricultural Management Assistance
	Agriculture: Environmental Quality Incentives Program
Ongoing/Unknown	Urban Waters Small Grants
	Small Communities Grant
	Broad Reach Fund

Determining Restoration Actions – This plan provides the Lower Medomak watershed restoration strategy with prioritized recommendations for eliminating NPS pollution, and improving water quality, aquatic habitat, and the shellfish community. A variety of methods are recommended, including continued investigative monitoring, surveying, and other structural and non-structural action items. The Medomak Task Force should use the proposed actions as a starting point for implementing the plan.

Improving the Community Participation Process – Implementation of this plan will require ongoing community outreach efforts to involve local citizens in improving and maintaining watershed health, especially as the Medomak River is a vital resource to the Waldoboro community. Landowner cooperation is a key aspect to reducing and eliminating NPS pollution in this community. Ultimately, a sustained public awareness and outreach campaign is essential to secure the long-term community support that will be necessary to successfully implement this project.

MEDOMAK RIVER: GRANT OPPORTUNITIES

SUBMISSION DATE	GRANT DETAILS
January 2020	**Final Watershed Based Management Plan Finished**
Jan - Feb 2020	**Community Block Development Grant: Economic Development –*Maine Office of Community Development*** **Healthy Watersheds Consortium Application - *EPA*** • Applications due early-mid February • Apply for CBDG grant for further funding for municipality public infrastructure projects – such as rehabilitation of stormwater system • Apply for HWC grant for funds for environmental flow assessments, public outreach on importance of watershed, etc.

March- June 2020	**319 Funds Application – *Maine DEP***
	• Application released mid April, due June
	• Funds can be used for:
	  ◦ Agricultural improvements
	  ◦ Watershed buffer improvements
	  ◦ Technical assistance for designs of improved septic systems
	• Use information gathered from past year for application, including:
	  ◦ Collaboration with specific landowners
	  ◦ Locations for buffer improvement for tracked hotspots
	Note: these funds cannot be used for septic repairs or issues that would generally be considered enforcement responsibility of the municipality.

June-July 2020	**Maine Sea Grant: Existing Funds – *University of Maine*** • Use existing Sea Grant funds to investigate hotspots and follow up past problems areas (use MST, *E.coli*, and co-indicators) • Focus on agricultural and buffer zones: information on specific areas and specific landowners will help in applications for future 319 grant
July – Aug 2020	**Agricultural Management Assistance and Environmental Quality Assistance Program Application – *USDA NRCS*** • Applications for both AMA and EQIP due by August 16th, 2019 • Grants provide financial and technical assistance for addressing environmental concerns such as water quality • Specific agricultural landowners are eligible to apply
Nov 2020 – Jan 2021	**Community Block Development Grant: Public Infrastructure – *Maine Office of Community Development*** **Five Star and Urban Waters Grant Applications - *EPA*** • Applications due mid-late January • Apply for CBDG grant for further funding for fixing MMHP septic lines, updating the town sewer system, etc. • Apply for FSUWG for funds for on-the-ground habitat restoration (such as stream buffers) and educational outreach

DEP = Department of Environmental Protection
USDA NRCS = United States Dept. of Agriculture: Natural Resources Conservation Service
EPA = US Environmental Protection Agency

Figure 8-1. Recommended grant application timeline for the 2019-2020 plan implementation.

The US EPA has developed an excellent stormwater outreach program, Soak Up the Rain, which is intended to help municipalities educate the community about the effects of stormwater and ways to eliminate the volume of water (i.e. "soak up") reaching the stream channel. Their website offers customizable tools and program material. https://www.epa.gov/soakuptherain

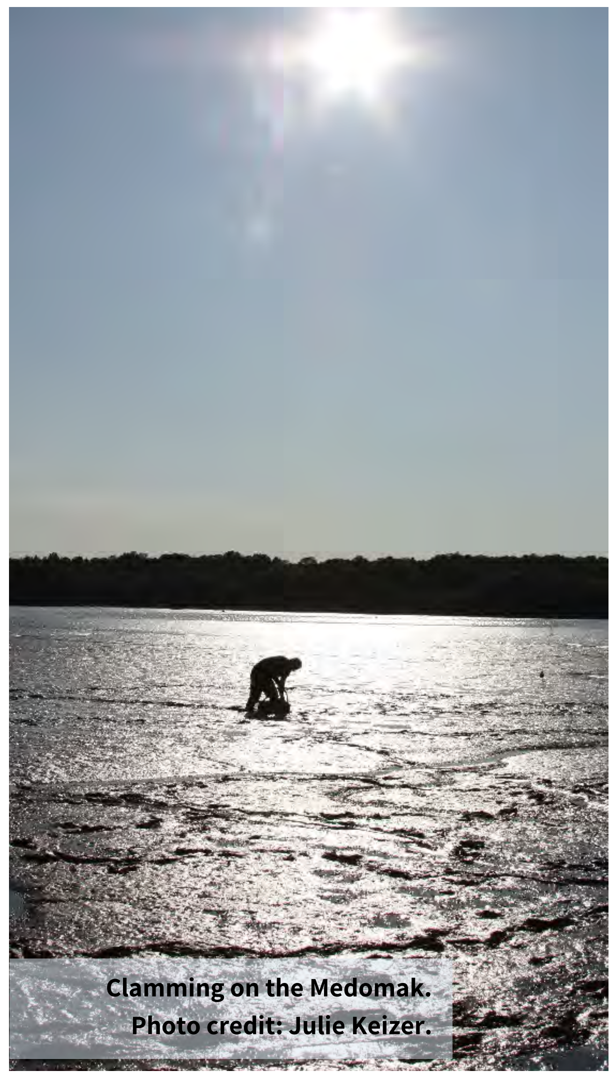
Maintaining a Field Monitoring Program – A field monitoring program is necessary to the take advantage of and continue the rich history of data collection that has occurred in efforts to restore water quality in the Medomak River and eliminate closures of productive shellfish beds. A standardized monitoring program will provide feedback on the effectiveness of Medomak River improvement actions at the catchment and sub-watershed level and will support optimization of restoration actions through an adaptive management approach.

Establishing Measurable Milestones – A schedule which includes milestones for measuring the implementation of monitoring and restoration activities in the Lower Medomak River watershed is critically important. Once funding sources have been secured, the Medomak Task Force can detail a schedule of iterative implementation actions and monitoring activities.

8.2 MONITORING PROGRAM

An overall goal of the monitoring program is continuing to track the improvement of the Medomak River and its estuary, as has been done by different stakeholders prior to and during the Medomak Task Force existence. A representative set of aquatic health indicators should be measured and interpreted on a predetermined timeframe and should take advantage of both using past information from and contributing to the comprehensive database. Regularly measuring, recording, and analyzing these characteristics will support accurate assessment of the restorative actions. The monitoring program should include the following components:

- Monitor water quality conditions before and after any structural management changes in the watershed, such as BMP implementation. When a BMP implementation project is selected, identify appropriate parameters to monitor the impact of implementation on water quality.
- Monitor water quality conditions before, during, and after storm events to continue tracking locations with high runoff contamination.
- Continue to support and foster the research being conducted on the Medomak River through the University of Maine School of Marine Sciences by Gabrielle Hillyer and Damian Brady.
- Analyze and compare monitoring results to previous data. This data collection program and data analysis and interpretation protocol will support assessment of progress in restoring the Medomak River.



Clamming on the Medomak. Photo credit: Julie Keizer.

8.3 MEASURABLE MILESTONES

It is important that a watershed restoration project schedule be established that provides clear and measurable milestones for success. These include environmental milestones, which measure response of the river (Table 8-2), as well as programmatic milestones, which measure actions taken and financial support (Table 8-3), and social milestones, which measure community support (Table 8-4). Once additional funding mechanisms and oversight authority have been established for the Medomak River restoration effort, a more detailed list and schedule of measurable milestones may be developed. Measurable milestones are presented based on three "benchmarks" at 2023, 2026, and 2029 that represent estimated completion by the benchmark date.

Environmental Milestones are a direct measure of environmental conditions which can evaluate the relationship between pollutant sources and environmental conditions (Table 8-2).

Table 8-2. Environmental milestones and interim benchmarks used to monitor the progress and success of the Medomak River restoration project.

Indicator	Interim Targets and Benchmarks		
	2023	**2026**	**2029**
Water Quality Benchmarks			
Reduce sample concentrations of fecal coliform at site WS043.90 *Goal: Eliminate fecal indicator bacteria in the Medomak River estuary to meet Class SB criterion*	P90 score < 100 CFU/100mL (current = 218.6) and geomean < 20 CFU/100mL (current = 26.2 CFU/100mL)	Meet DMR P90 and geomean standards (31 CFU/100mL and 14 CFU/100mL, respectively) during dry weather	Meet DMR P90 standard of 31 CFU/100mL and geomean of 14 CFU/100mL
Reduce sample concentrations of *E. coli* in freshwater tributaries *Goal: Eliminate fecal indicator bacteria in the Medomak River freshwater tributaries and meet Class A criterion (based on probability of meeting)*	50%	75%	100% - Meet Class A criterion in all freshwater tributaries (236 CFU/100mL short-term; 64 CFU/100mL geomean)
Open all areas of the Medomak River estuary to shellfish harvesting *Goal: Remove remaining conditional and prohibited shellfish closures*	Conditional closures removed from growing areas WS26C1 and WS26D	Prohibited area (WS26A1) promoted to conditional	Prohibited area (WS26A1) promoted to approved
Remove dissolved oxygen impairment *Goal: Remove the Medomak River from the impaired waters NPS Priority Watershed list*	Meet Class B dissolved oxygen criteria at 50% of sites (> 7 mg/L and 75% saturation)	Meet Class B dissolved oxygen criteria at 100% of sites (> 7 mg/L and 75% saturation)	Impairment removed
Structural Milestones			
Perform bracket sampling on freshwater tributaries identified as hotspots in Appendix C. *Goal: Continue to isolate hotspot sources.*	Bracket sample on 5 tributaries	Bracket sample on 8 tributaries	Bracket sample on all 11 high priority tributaries

Indicator	Interim Targets and Benchmarks		
	2023	**2026**	**2029**
Continue shoreline surveys *<u>Goal:</u> Identify and eliminate sources of NPS pollution*	Follow up with questionable sites identified by Maine DMR (see Table 6-1)	Resurvey all properties in 500-ft buffer (following Maine DMR rotation)	Resurvey all properties in 500-ft buffer (following Maine DMR rotation)
Repair Medomak Mobile Home Park sewer lines *<u>Goal:</u> Correct septic NPS pollution from MMHP*	Funding obtained and contractor identified	Obtain final plans for repair	Complete sewer line repair
Continue and improve municipal maintenance practices *<u>Goal:</u> Implement successful and timely maintenance practices that prevents pollution*	Review municipal maintenance practices, such as street sweeping and catch basin cleaning, and develop plan	Implement plan, such as repairing and maintain catch basins needing maintenance	Evaluate and continue plan
Improve estuary, river, and stream riparian buffers *<u>Goal:</u> Reduce pollutant load in stormwater runoff and increase climate resiliency*	Identify sites that need improved buffers, gather resources and volunteers	Improve 50% of buffer zones	Evaluate effectiveness of previous buffer zone improvement, and implement further riparian zone improvement

Non-structural Milestones are indirect measures of watershed protection and restoration activities. These programmatic measurements list actions that will help meet the water quality goal (Table 8-3).

Table 8-3. Non-structural milestones and interim benchmarks used to monitor the progress and success of the Medomak River restoration project.

INDICATOR	INTERIM TARGETS AND BENCHMARKS		
	2023	**2026**	**2029**
Non-Structural Milestones			
Continue the Medomak River Task Force *<u>Goal:</u> An active committee that guides and promotes water quality improvement and protection. Meets twice annually.*	Meet prior to 2019 monitoring season and plan completion	Ongoing	Ongoing
Amount of funding secured for monitoring and surveying *<u>Goal:</u> Maintain a consistent funding mechanism and town support for structural project implementations*	$50,000	$80,000	$100,000

INDICATOR	INTERIM TARGETS AND BENCHMARKS		
	2023	2026	2029
Secure funding for Medomak Mobile Home Park sewer line repair *Goal: Reduce fecal coliform concentrations at downstream station*	Secure funding for design	Secure funding for installation/repair	Complete installation/repair
Involve public in planning and implementation of plan *Goal: Ensure there is sufficient support to enact the plan*	Develop a plan for annual meetings, draft educational programs and ordinances	Continue annual meetings, implement educational programs, implement and enforce ordinances	Continue all actions, and evaluate and modify as needed
Develop & implement social marketing outreach plan(s) for the following target audiences: residential, business/commercial, and institutional. *Goal: To encourage and support behaviors that will help protect and restore water quality.*	Plans for all 3 audiences completed	Implementation of all 3 plans	Evaluation of impact of effort and development of new plan
Develop & implement landowner outreach plan(s) for BMPs in private property to reduce and eliminate NPS pollution. *Goal: Reduce pollutant load from NPS pollution and from stormwater runoff.*	Develop plan/agreement with landowners, including funding options	Inspection of problem spots on landowner properties	Problems are corrected
Develop & implement agricultural landowner outreach plan(s) for BMPs in their agricultural practices to reduce and eliminate NPS pollution. *Goal: Reduce pollutant load from NPS pollution and from stormwater runoff.*	Maintain an ongoing dialogue with landowners and develop outreach material	Maintain dialogue and correct problems if they arise	Maintain dialogue and correct problems if they arise
Continue to support and encourage marine research from higher education institutions and research organizations *Goal: Take advantage or rich history of data collection and current research to inform decisions*	Maintain connection with UMaine and include them at the stakeholder table	Work with Maine DMR to include research findings into decision-making for shellfish closures	Implement research

Social Milestones measure changes in social practices and behavior that lead to implementation of management measures and water quality improvements (Table 8-4).

Table 8-4. Social milestones and interim benchmarks used to monitor the success of the Medomak River restoration project.

INDICATOR	INTERIM TARGETS AND BENCHMARKS		
	2023	**2026**	**2030**
Non-Structural Milestones			
Number of volunteers participating in outreach sponsored activities buffer plantings, or storm drain stenciling *Goal: Build strong local support for improving Medomak River water quality*	10	20	30
Number of businesses participating in restoration activities. *Goal: Engage local business in watershed restoration.*	1	2	4

8.4 CONCLUSION

The Medomak River and its estuary represent many of Waldoboro's most valuable natural and economic resources. As such, the Town of Waldoboro has taken a proactive and unprecedented approach to restoring the river and its valuable shellfish beds. This effort by the Medomak Task Force brought together collaborators across municipal officials and the clamming community, three State departments, local land trusts, citizens and volunteers. Significant achievements have been made by this coalition; however, continued restoration and preservation of clean water can only be achieved through ongoing dedication and commitment to the river. The Medomak River WBMP lays out activities and steps that can be taken to protect and restore the health of the estuary to meet Maine DEP Class SB and Maine DMR NSSP fecal coliform standards.

Many of the actions outlined in this plan have minimal cost associated with them but can have a large impact on water quality. These activities include encouraging new development to be smarter by utilizing LID practices, establishing wooded riparian areas (particularly around agricultural and developed land), protecting existing buffers, putting an extra effort into maintaining the municipal storm water system including catch basin cleaning, and river and estuary clean-ups. Other actions can be quite costly, will likely require grants and other financial assistance, and will take longer to implement; particularly restoration and repair of the MMHP sewer system.

Full implementation of the recommendations outlined in this plan will cost roughly $688,500 - $1,010,000 over the next 10 years. Rough cost estimates are based on tasks identified in the action plan, which will need to be updated as the plan is implemented and as new actions are added and further surveys of the land reveal potential nonpoint sources. Implementation of this plan over the next 10 years and beyond will require continued dedication by the Medomak Task Force and the Waldoboro community.

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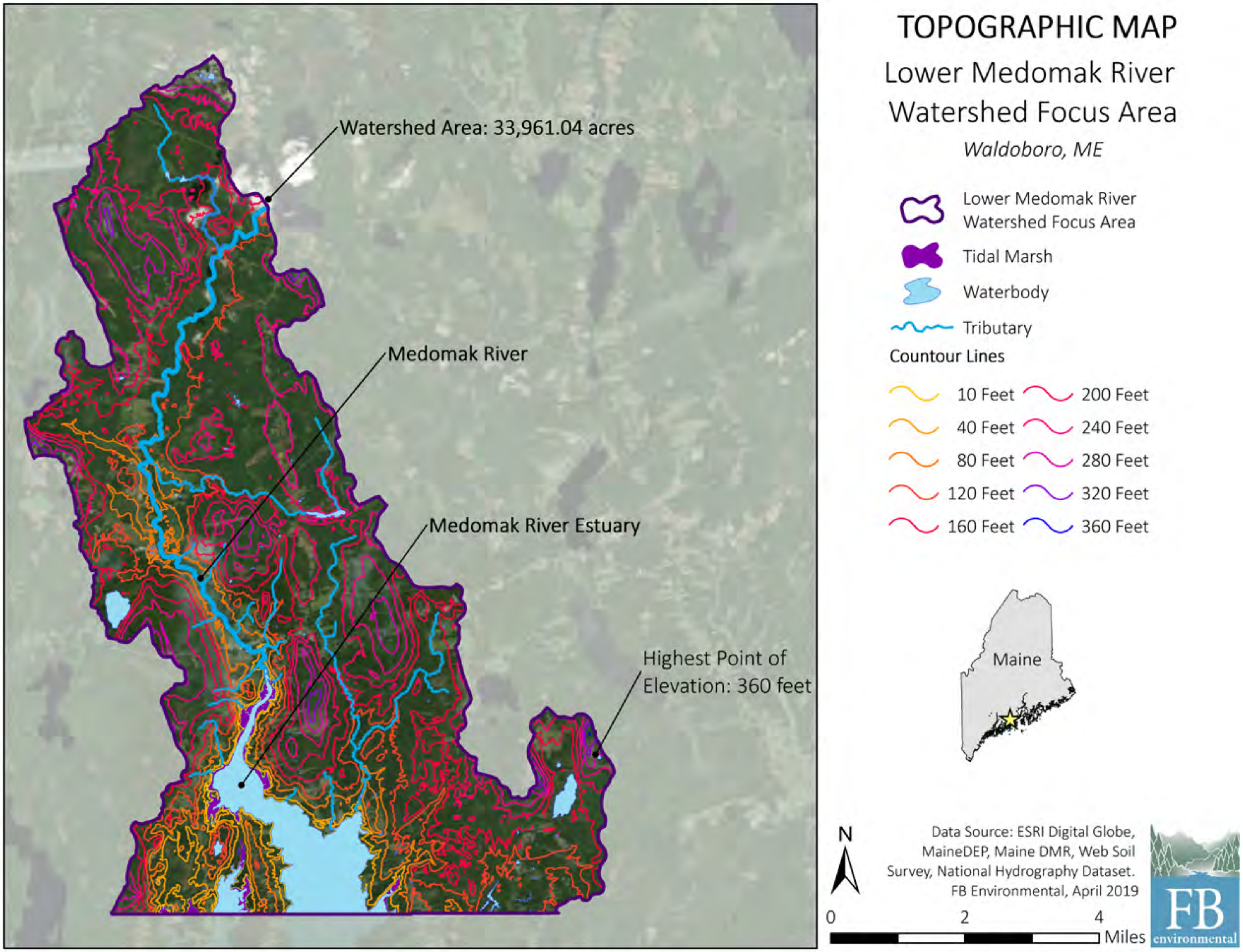
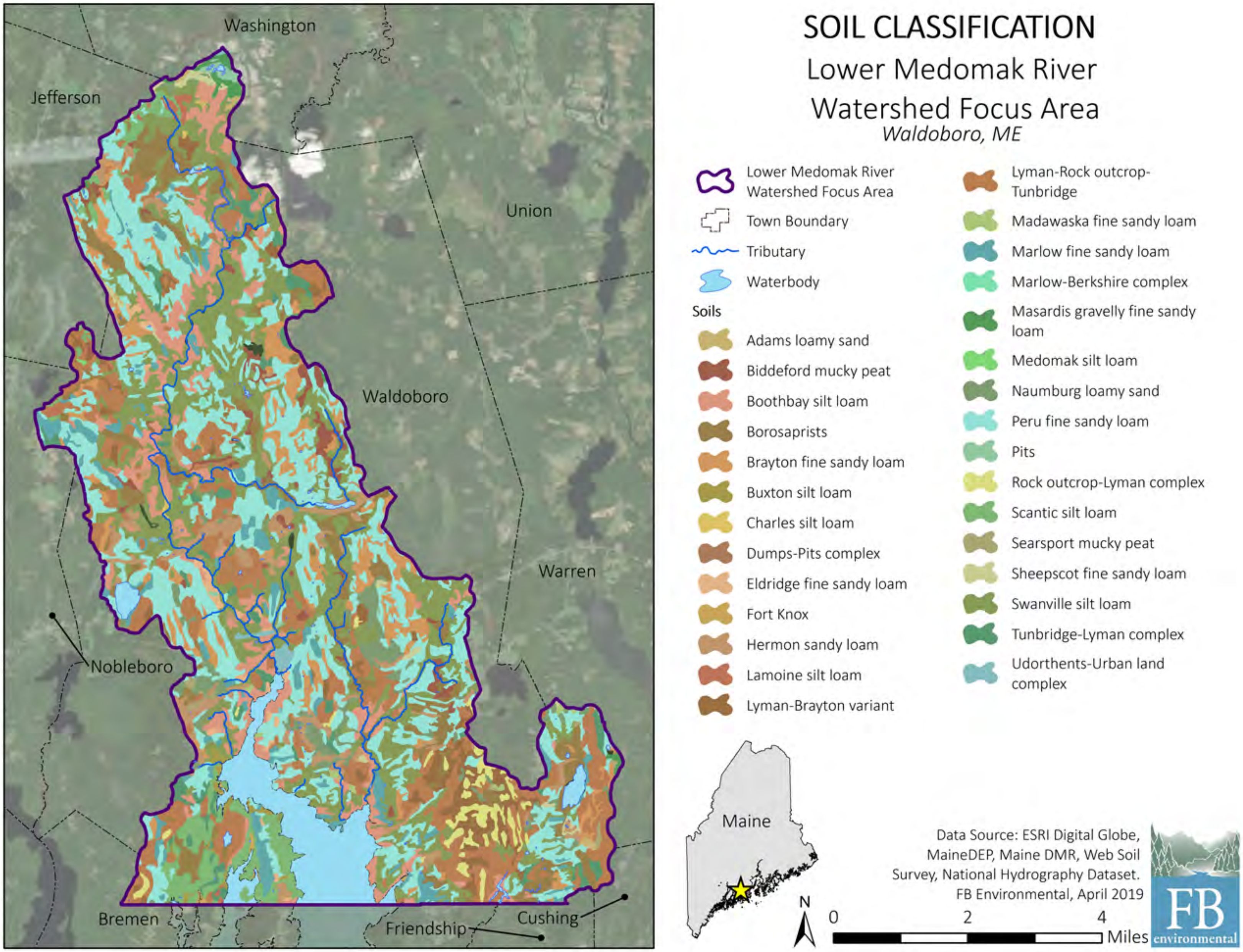
10. APPENDIX A: MAPS

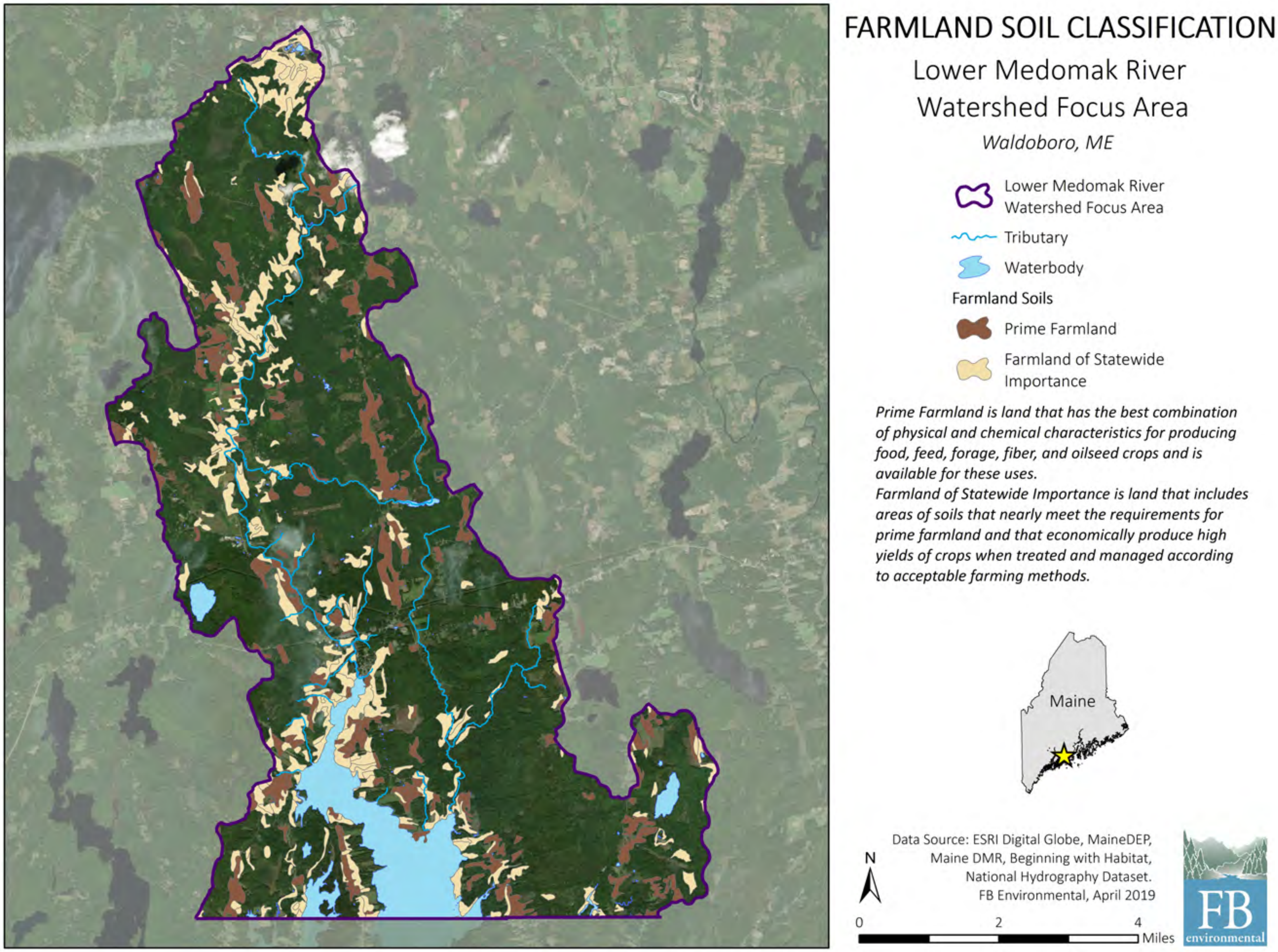
Map 1: Topography Map



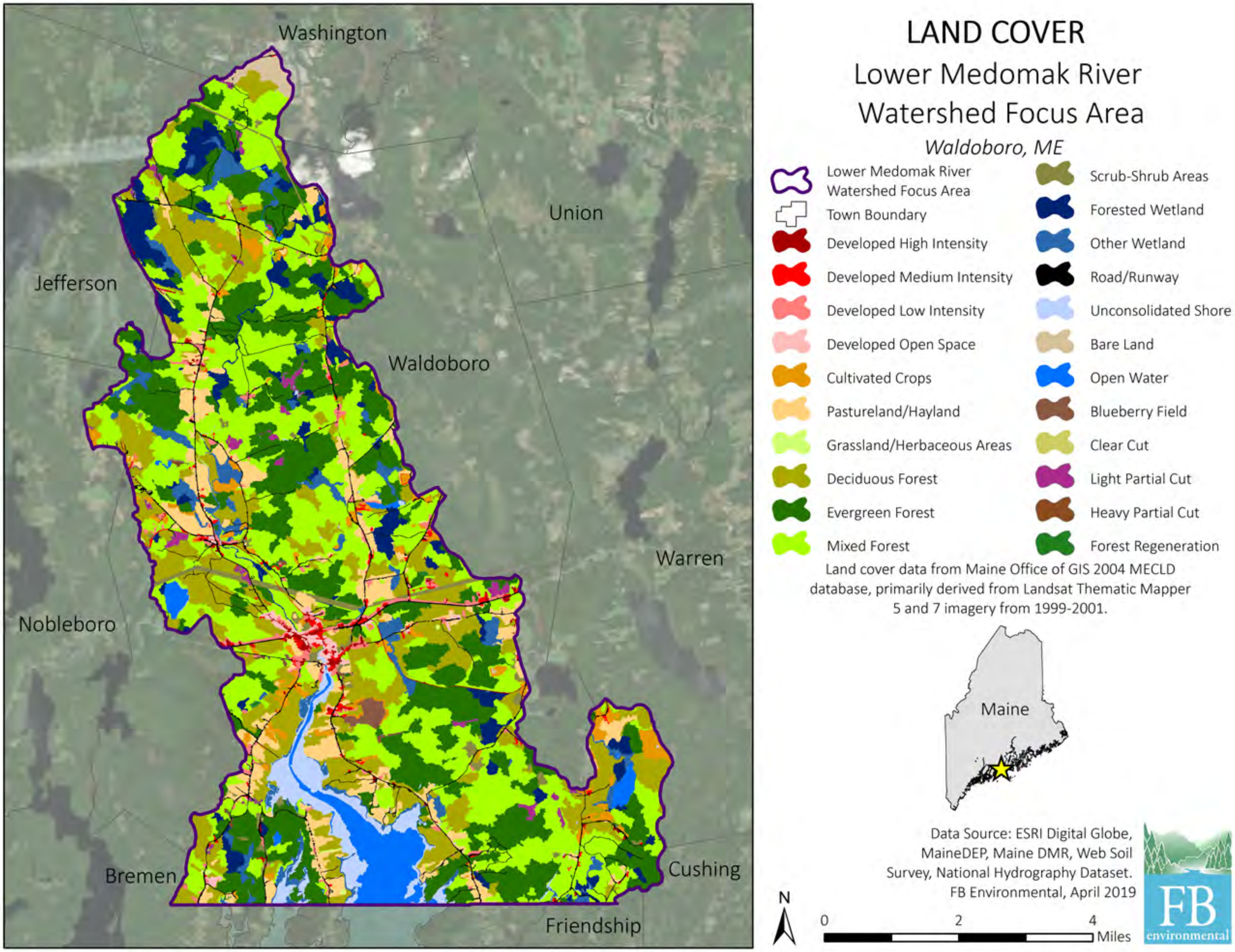
Map 2: Soil Classification



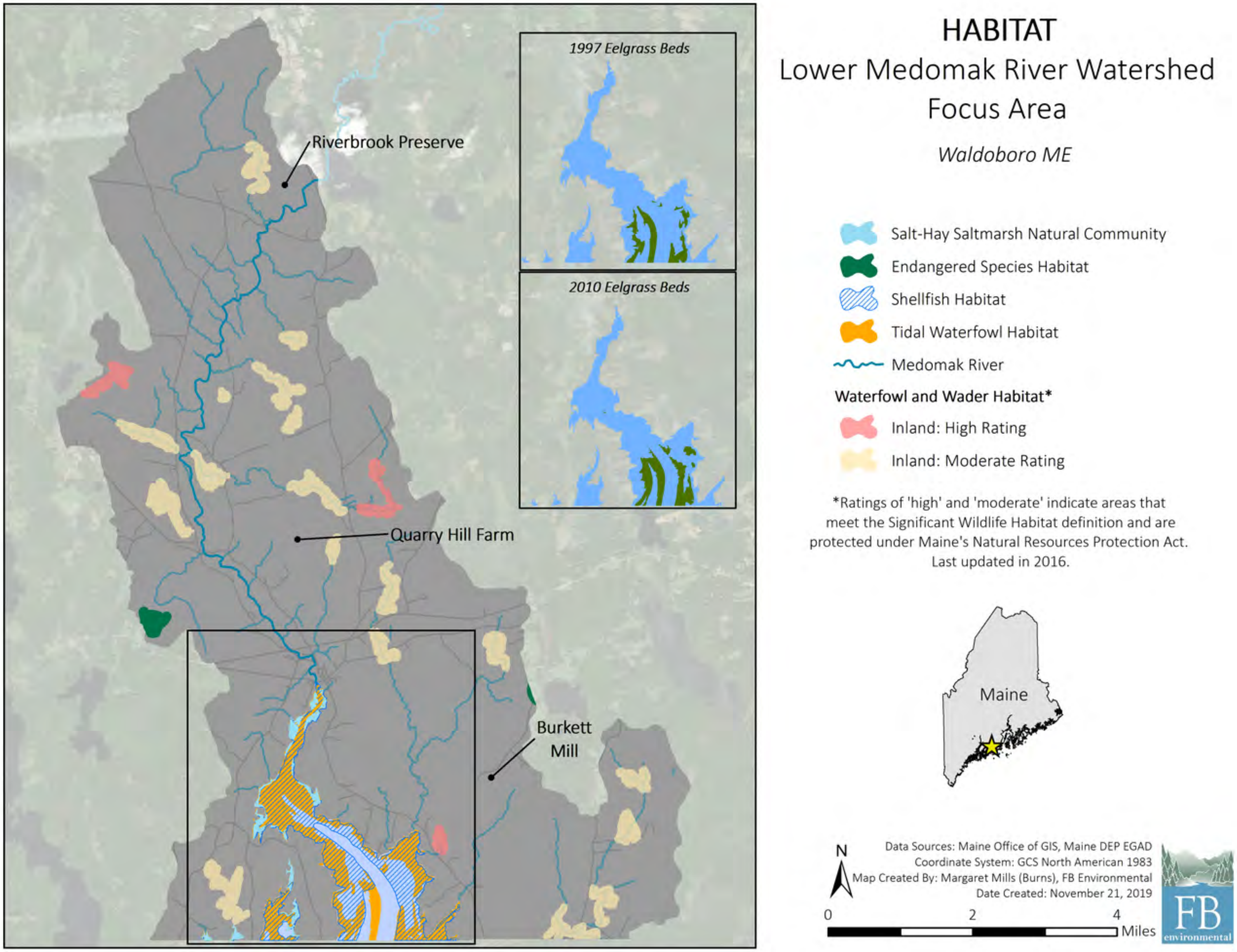
Map 3: Farmland Classification



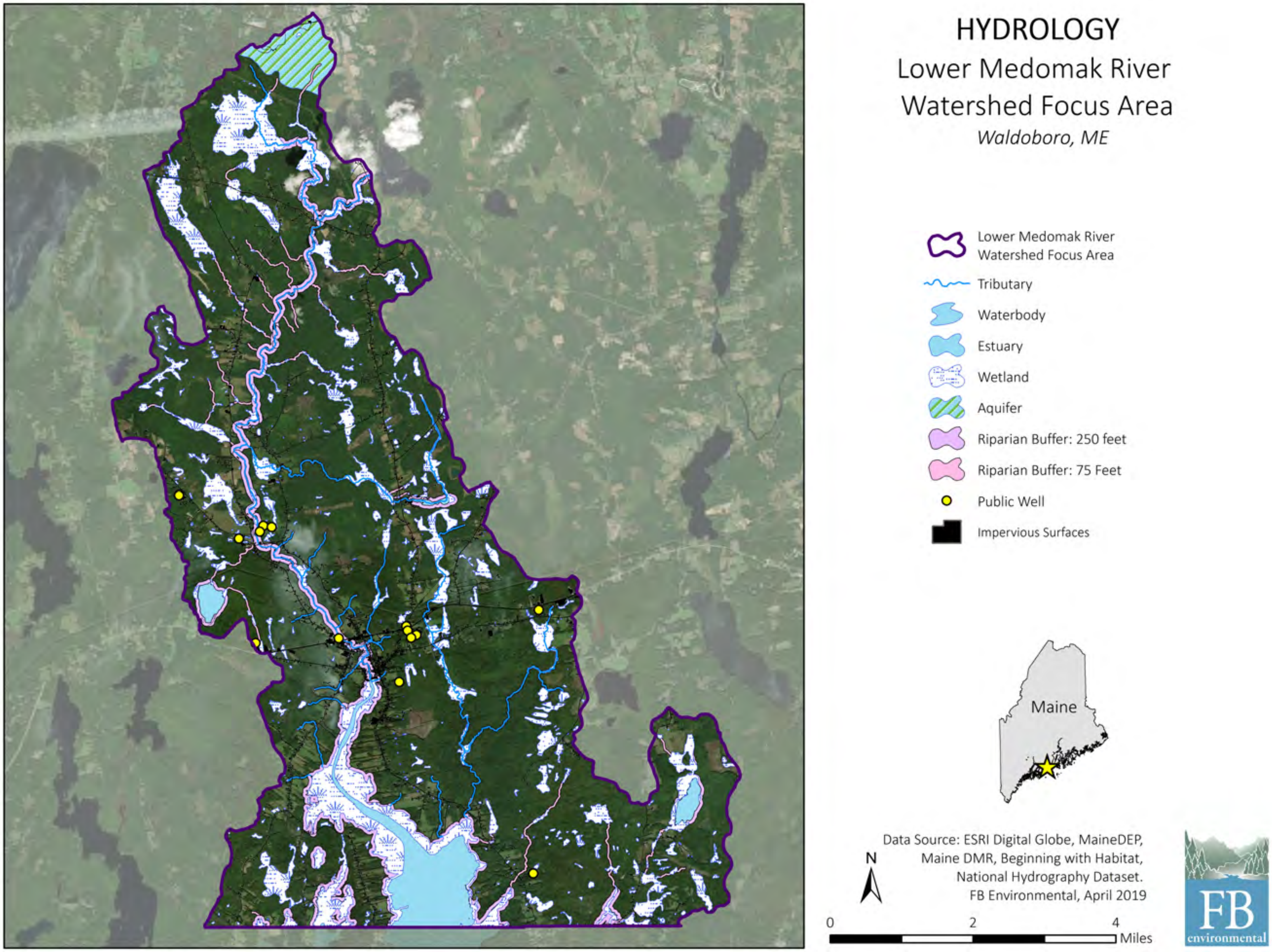
Map 4: Land Cover



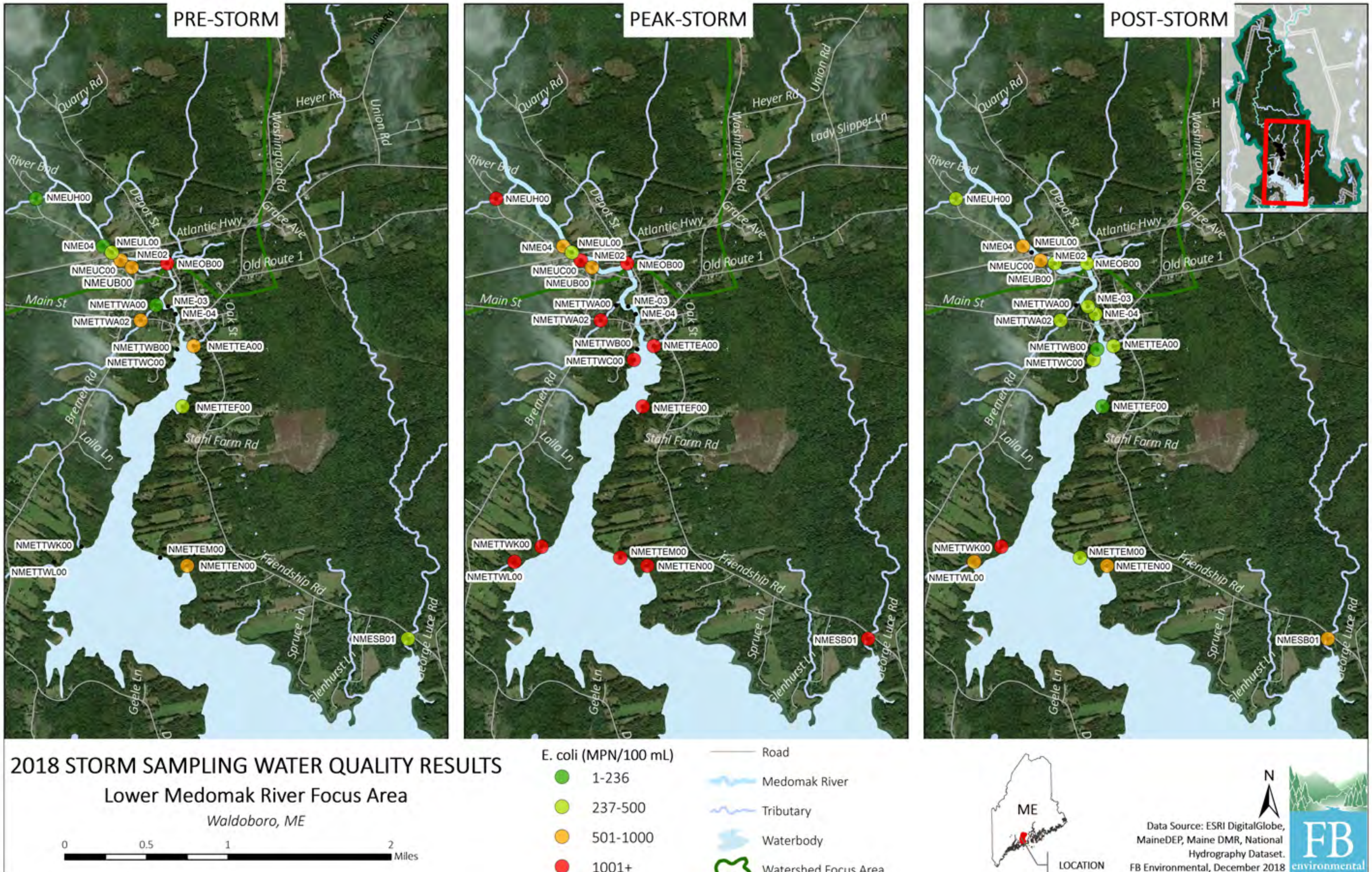
Map 5: Habitat Conservation



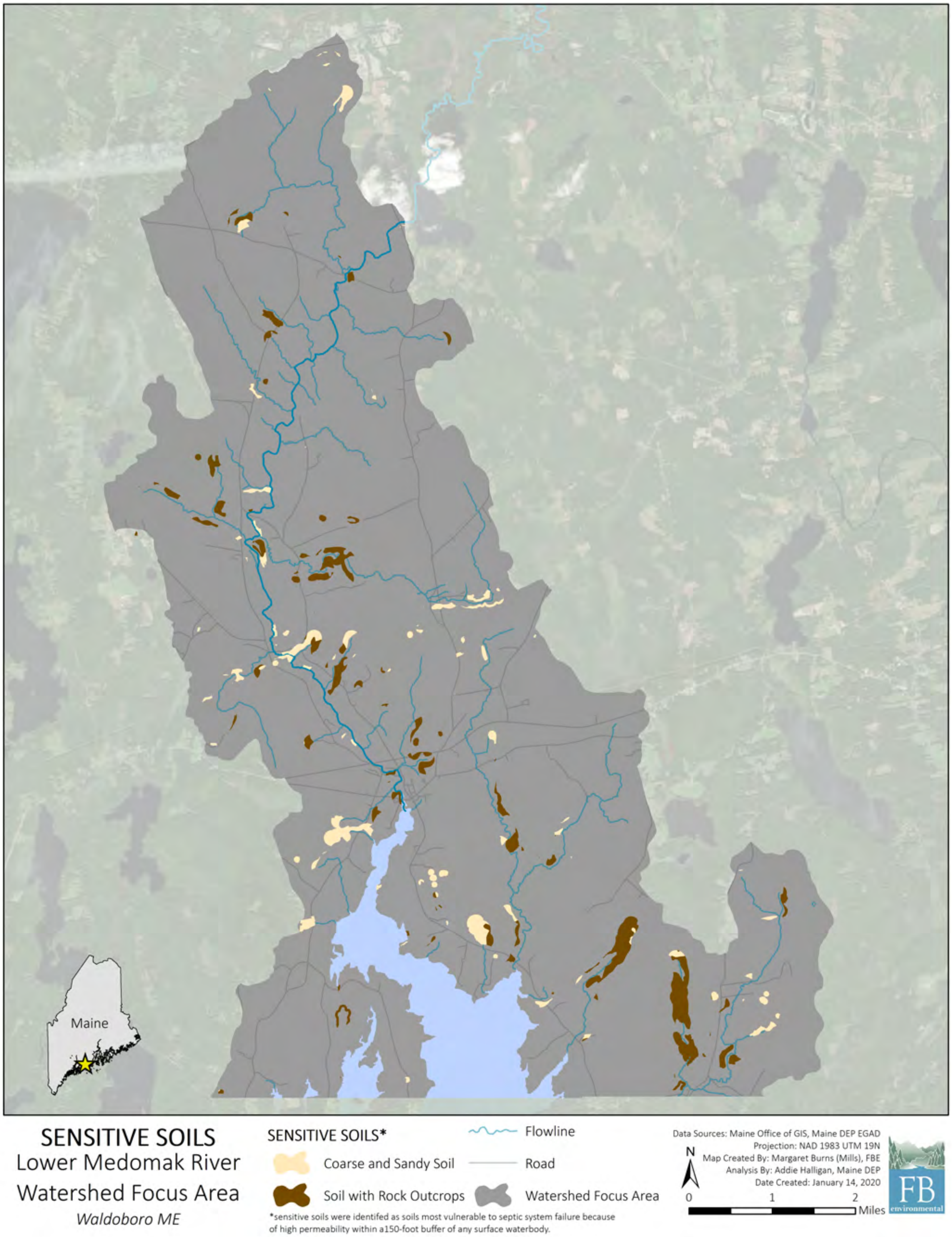
Map 6: Hydrology



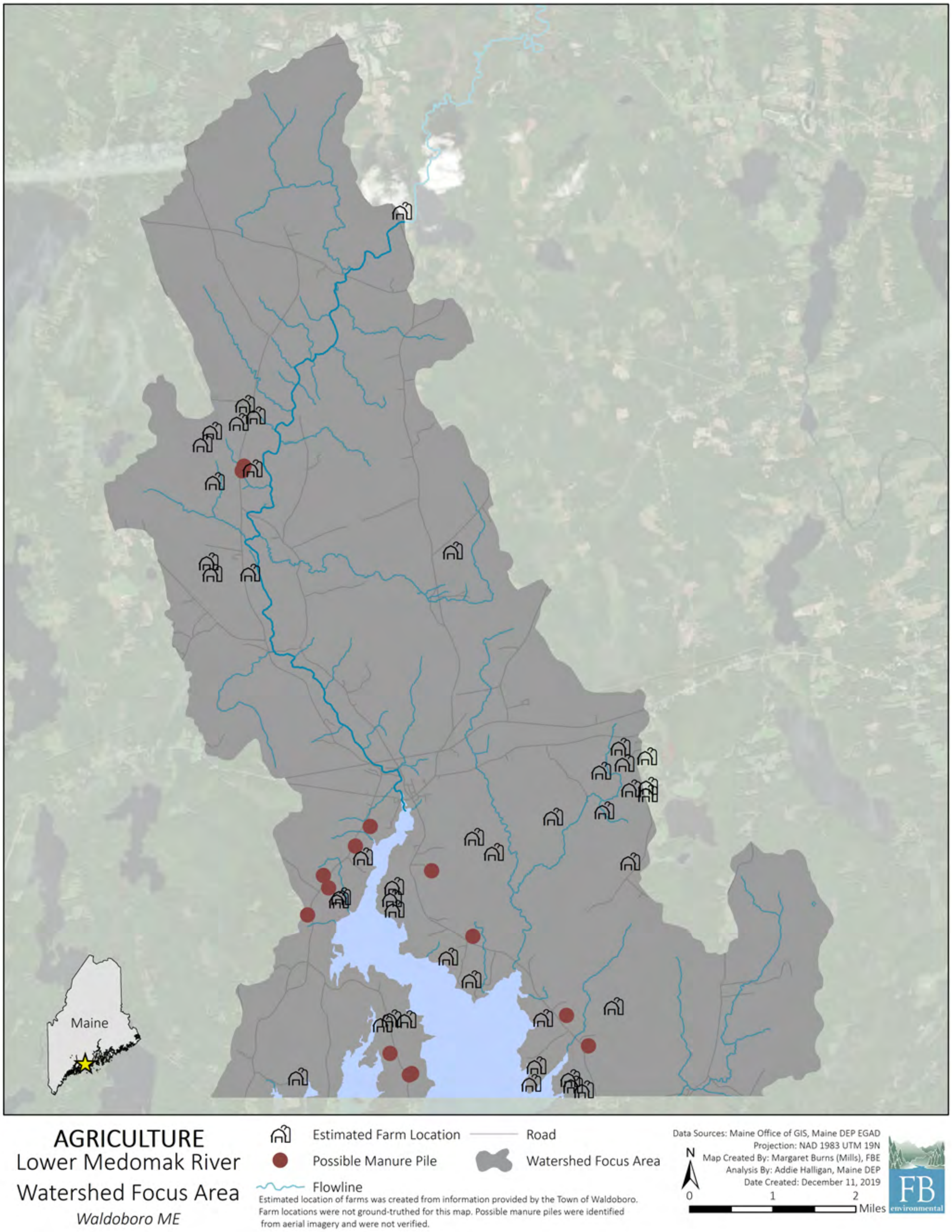
Map 7: Storm Sampling Water Quality Results



Map 8: Sensitive Soils



Map 9: Farm and potential manure pile site locations. (Manure pile locations are approximated via aerial imagery.)



11. APPENDIX B: DRIFTER STUDY FIGURES

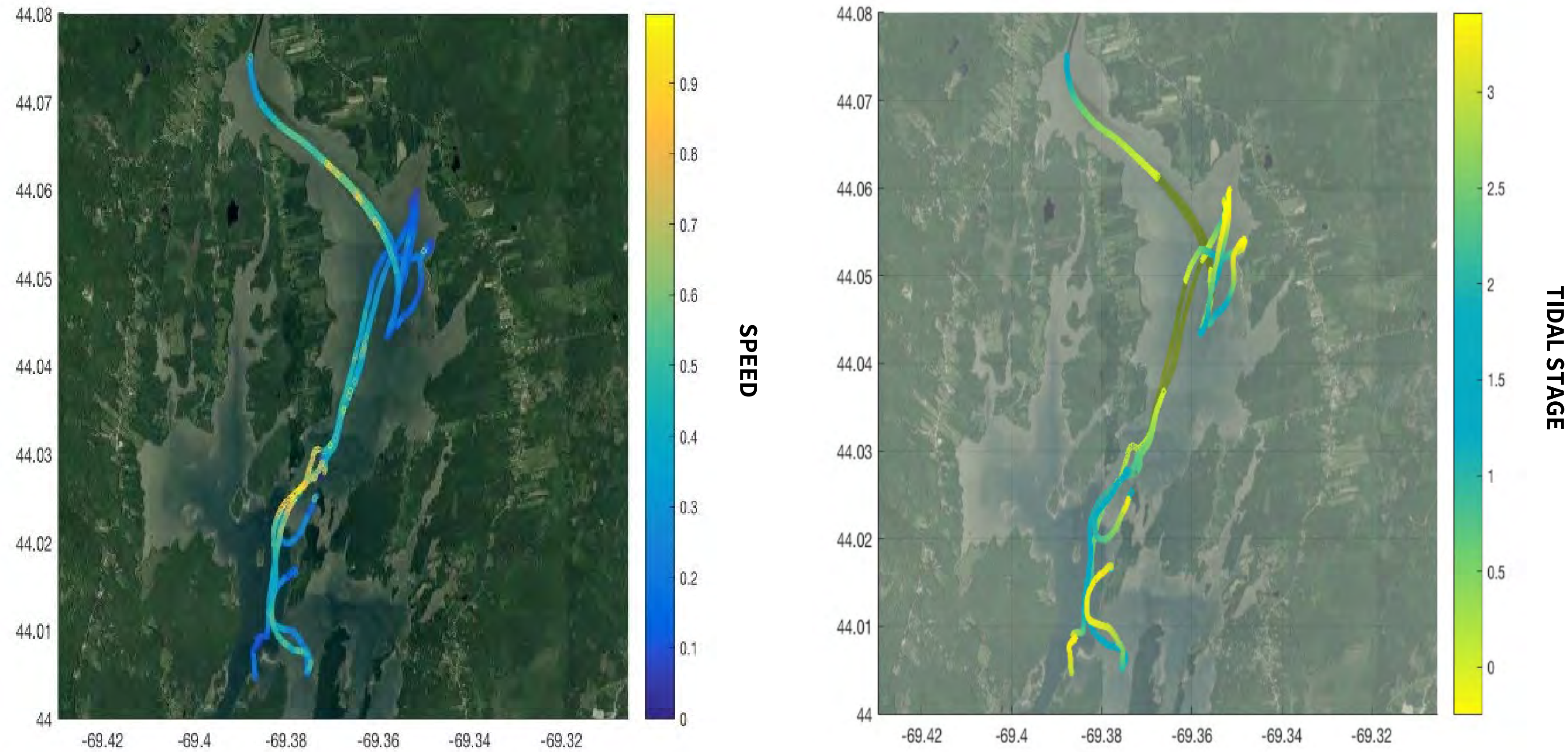


Figure B-1: Left: Three drifter tracks s colored by speed, with yellow colors indicated faster speeds (m/s). Right: Three drifter tracks, colored by tidal stage, with yellow indicating slack tide and blue-green indicating running tide. Figures made by Gabrielle Hillyer, University of Maine.

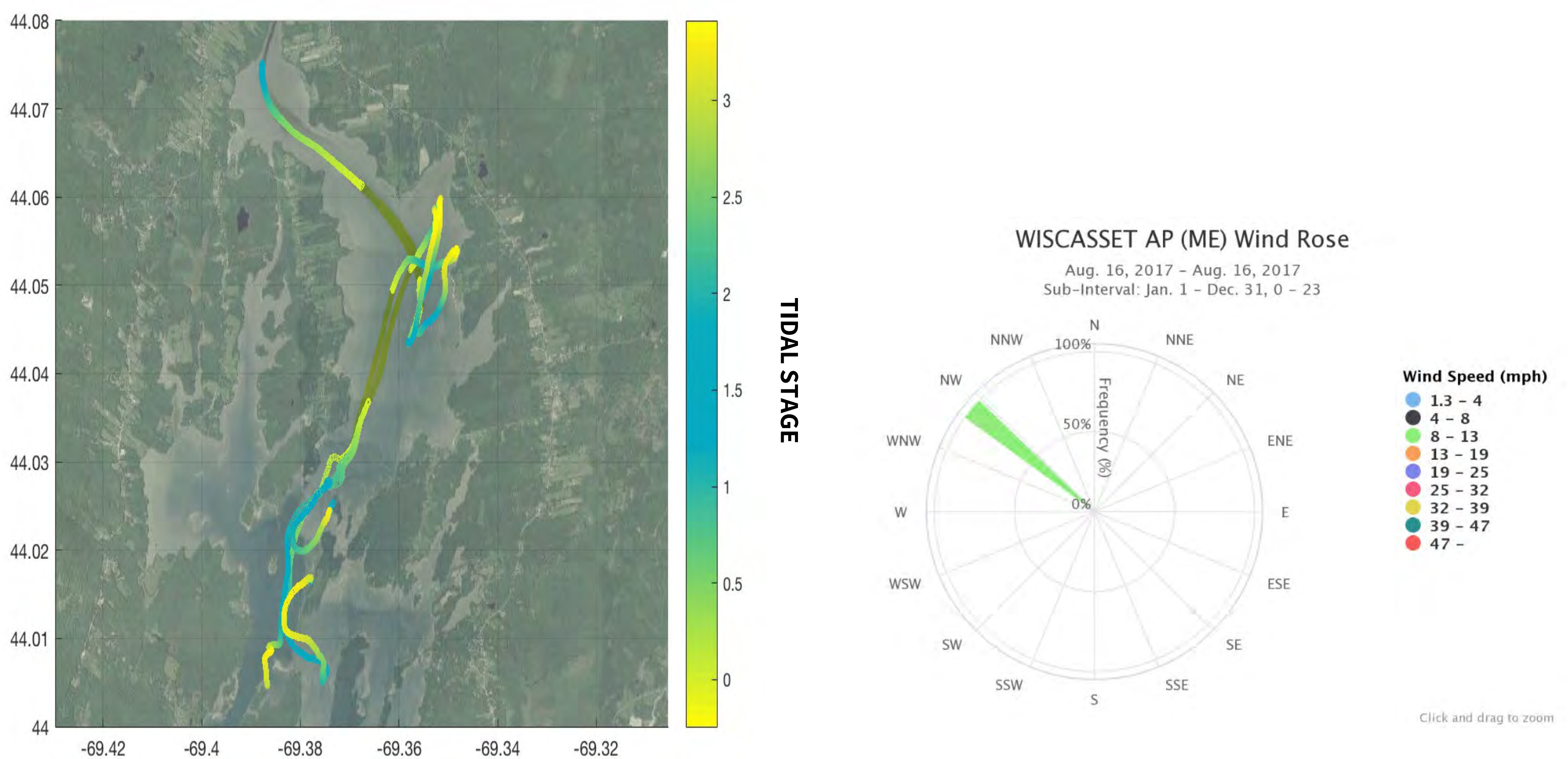
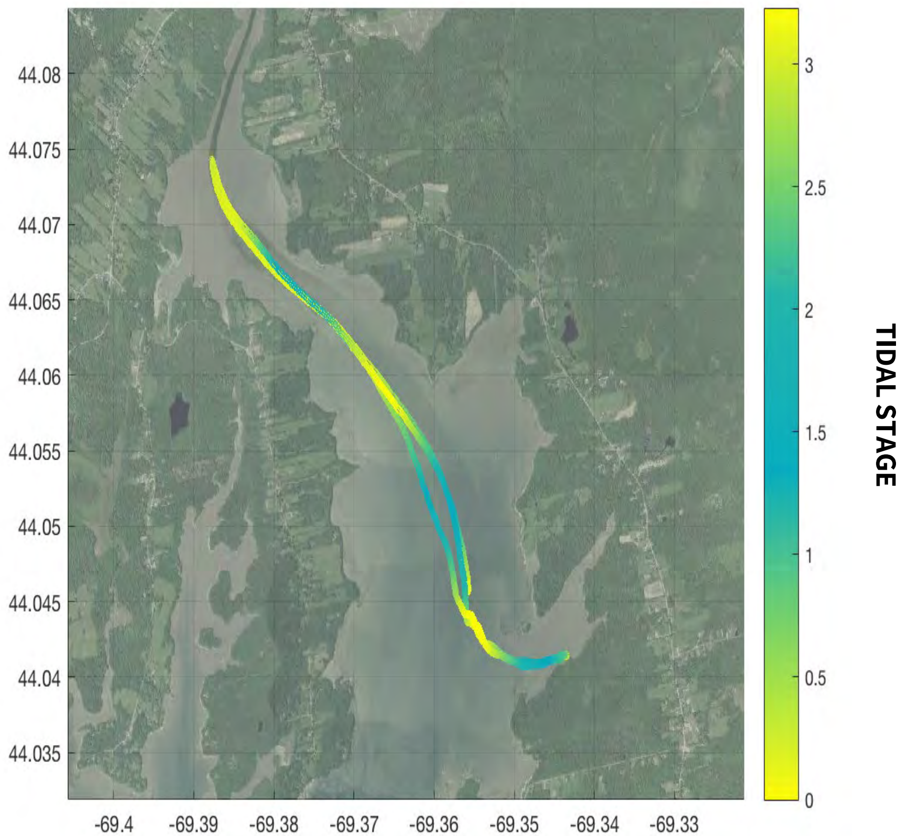


Figure B-2: Left: Drifter track with yellow indicating slack tide and blue-green indicating running tide. Figure made by Gabrielle Hillyer, University of Maine. Right: Wind rose at the time of the drifter track on August 16, 2017. Source = Weather Underground.



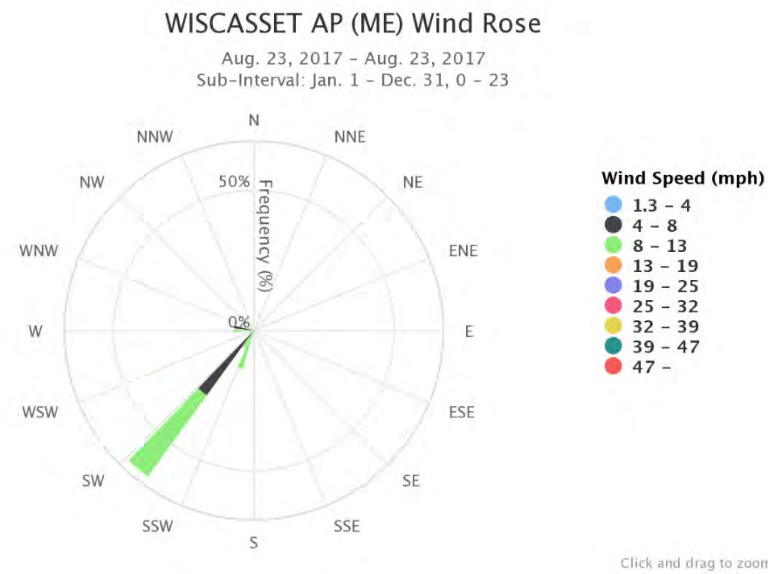


Figure B-2: Left: Drifter track with yellow indicating slack tide and blue-green indicating running tide. Figure made by Gabrielle Hillyer, University of Maine. Right: Wind rose at the time of the drifter track on August 23, 2017. Source = Weather Underground.

12. APPENDIX C: SPECIFIC RECOMMENDATIONS FOR FRESHWATER TRIBUTARY MONITORING

ACTION	SITE	HOW
MONITORING + SURVEYING	NMETTEA00	Follow-up dry weather bracket sampling; further MST testing if dry weather sampling reveals elevated *E. coli*. MST testing could identify if the fecal contamination continued to be human-sourced.
	NMETTEF00	Thorough survey of the area above this stream with an initial focus on any sources of agricultural runoff, poor buffers adjacent to agriculture, and/or animal grazing in or around waterbodies.
	NMETTEM00	Survey of the stream buffers in this watershed to identify areas where waterfowl could easily migrate from the stream to the open agricultural land. An increase in stream buffer could lessen the movement of waterfowl through this corridor. If waterfowl are visually identified in this watershed and buffers are minimal, we recommend wet weather PCR testing for avian markers to confirm that they are the only source.
	NMETTEN00	Follow-up survey for waterfowl in conjunction with the recommendations made for the upstream watershed of NMETTEM00 (discussed above). Strongly recommend follow-up property surveys and septic/sewer inspection in this watershed area. We also recommend continued dry weather testing and MST testing following any remedial actions taken in the watershed.
	NMESB01	Follow-up to 2017 survey.
	NMETTWK00	Detailed surveys of all structures, septic systems, and sewer lines in this sub-watershed. Additionally, we recommend a stream walk to identify poor riparian stream buffers.
	NMETTWL00	Continued monitoring and property surveys in the sub-watershed above this site.
	NMEUH00	Bracket testing in this stream during wet weather conditions and surveying for sources of pet waste. Additional property surveying is also recommended.
	NMEOB00	We recommend this as a high priority site for follow-up, beginning with dry weather bracket sampling on this stream and detailed property surveys in this watershed.
	NMEUC00	Further property surveying is warranted in addition to dry weather bracket sampling to identify the specific watershed area to focus surveying efforts.
	NMEUB00	While the source of this fecal contamination is still outstanding, we do not recommend this is a high priority as significant resources have been used at this site without success. However, the Town should remain aware of any changes in management or site use at the MMHP.