Maine Statewide
Total Maximum Daily Load (TMDL)

for Nonpoint Source (NPS) Pollution

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Cover photos: Top left – Brook trout in Burnham Brook, Garland, ME; Middle left - Dyer River, Newcastle, ME; Bottom left – Jock Stream, Wales, ME; Top right – Merritt Brook, Presque Isle, ME; Bottom right – Stetson Brook, Lewiston, ME (Photo credits: Merritt Brook photo by Kathy Hoppe, Maine DEP; all others by FB Environmental).

Executive Summary

This *Maine Statewide Total Maximum Daily Load (TMDL) for Nonpoint Source (NPS) Pollution* report has been developed to address water quality impairments in 21 rural/suburban streams in Maine that are affected by nonpoint source (NPS) runoff. This report is issued to satisfy Section 303(d) of the Federal Clean Water Act and 40 CFR § 130.7 that require states to establish the total maximum daily load of pollutants for those impaired waters. These waterbodies were listed as impaired in *Maine's 2012 Integrated Water Quality Monitoring and Assessment Report* and have been assessed as not meeting the criteria in Maine's water quality standards (WQS) for aquatic life protection. The TMDL is an assessment of the maximum loading that a waterbody can receive without exceeding its WQS. NPS pollution, which includes stormwater runoff, cannot readily be traced back to a specific source within a watershed. One of the major constituents of NPS pollution is sediment, which contains nutrients that stimulate algal growth. Excessive algal growth depresses dissolved oxygen (DO) and sedimentation impacts stream habitat suitability for aquatic life.

This TMDL evaluates NPS pollution using a regionally calibrated land-use model that calculates pollutant loads for nutrients (nitrogen and phosphorus) and sediment. Maine's WQS do not contain numeric criteria for nutrients and sediment, therefore a comparative attainment approach was used to establish pollution reduction targets for impaired waters. This approach requires identical modeling procedures be applied to both impaired watersheds and corresponding watersheds that attain WQS. Pollutant load reductions are then calculated based on the difference between impaired and attainment watersheds. The pollutant reductions needed to attain WQS vary greatly with watershed condition and the ranges are: sediment from 0% to 94%, nitrogen from 0% to 70% and phosphorus from 0% to 78%. Watersheds that needed no reductions in pollutants were dominated by forested lands and the observed impairments are likely due to natural conditions, such as the presence of wetlands. The overall median reduction values were 24% for sediment, 26% for nitrogen and 24% for phosphorus.

Each watershed in this TMDL underwent a field assessment that included documenting conditions within the stream and on the surrounding terrain that may contribute to the observed impairment. These assessments included measuring instream habitat, sampling water quality and documenting areas of significant runoff (hot spots) in the watershed. A detailed description of these assessments and the modelling results are presented for each watershed in a separate appendix. The information in each appendix is designed to support communities and stakeholders in developing a Watershed Management Plan (WMP) that will describe the steps needed to achieve pollution reduction targets and to attain WQS.

DEP received extensive comments on the TMDL, which are detailed in Appendix 5. Many stakeholders were concerned about the implications of MS4 regulations that may result from the approval of the TMDL. In response, DEP decided to map the overlap between these watersheds and regulated MS4 areas, as shown in Appendix 4. The result is that many of these watersheds have a small overlap between the two areas, while only one stream is completely contained in the regulated area. This information may have implications for setting stream restoration priorities under the MS4 program.

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1. Introduction

This *Maine Statewide Total Maximum Daily Load (TMDL) for Nonpoint Source (NPS) Pollution* report has been developed to address water quality impairments in multiple small rural/suburban streams in Maine that are affected by nonpoint source (NPS) runoff and accompanying pollutants. The waterbodies in this report, as listed in Table 1, have been assessed as not meeting the criteria for aquatic life use protection contained within Maine's water quality standards (WQS). The waterbodies were included on the 2012 list of impaired waters based on the results of various assessment criteria for aquatic life use support in freshwater streams. This report is issued to satisfy Section 303(d) of the Federal Clean Water Act and 40 CFR § 130.7 that require states to establish the total maximum daily load of pollutants for those impaired waters previously identified in the state. The TMDL represents the maximum loading that a waterbody can receive without exceeding water quality standards.

The waterbodies addressed in this document are impaired by NPS pollution as a result of anthropogenic activities within their watersheds. NPS pollution, also known as stormwater runoff, cannot be traced back to a specific source; rather it often comes from a number of diffuse sources within a watershed. Stormwater runoff is water that doesn't soak into the ground during a rain storm and instead flows over the surface of the ground until it reaches a stream, lake, estuary, or the ocean, picking up pollutants such as soil, fertilizers, pesticides, manure, and petroleum products along the way. One of the major constituents of NPS pollution is sediment, which contains a mixture of nutrients (such as phosphorus and nitrogen), inorganic and organic material that stimulate algal growth. Excess algal growth consumes oxygen during respiration and leads to a decrease in levels of dissolved oxygen (DO) in a stream. Phosphorus and nitrogen are the limiting nutrients for algal growth and sediment-laden runoff carries these nutrients into streams.

This TMDL addresses nutrients (nitrogen and phosphorus) and sediment in NPS pollution, which have been identified as the primary contributors to the observed and measured degradation of aquatic life use in the impaired waterbodies. Because Maine's WQS do not contain numeric criteria specifically for phosphorus, nitrogen, or sediment, a regionally calibrated land-use model known as MapShed, and a comparative attainment approach were used to establish pollution reduction targets for each of the impaired waterbodies, with pollutant loads estimates listed in Appendix 1.

The comparative attainment approach to TMDL development requires identical modeling procedures be applied to impaired watersheds and corresponding watersheds that attain WQS for aquatic life and DO. The attainment watersheds share similar characteristics to the impaired watersheds regarding geographic area, climate, soil, topography, watershed size, landscape, development, and land-use patterns. TMDL loading capacity for each of the three surrogate pollutants for each waterbody is calculated by comparing loading results for impaired streams to the appropriate attainment stream values.

TMDLs provide a scientific basis for the development and application of a Watershed Management Plan (WMP), which describes the control measures necessary to achieve WQS. Public participation during the subsequent preparation of the WMPs is vital to the success of resolving water quality impairments. This report includes recommended next steps and contains information to support communities and stakeholders in developing a WMP in a phased manner that will ultimately result in attainment of water quality standards.

2. Aquatic-Life Impaired Waters and Priority Ranking

This Maine Statewide TMDL for NPS Pollution report serves as TMDL documentation for multiple fresh waters in Maine impaired for aquatic life use. The report addresses impairments in 21 streams that have varying attainment goals (Class A, B, or C) and are located in different geographic areas across the state. Figure 1 shows the locations of the impaired segments by major river basin, with the highest number of impaired segments in the Kennebec and Androscoggin river basins. Table 1 lists watershed and waterbody information for each impaired segment. Watershed-specific TMDL summaries containing watershed descriptions, maps and calculations to support the TMDL for each of these impaired streams are included in Appendix 6 of this report.

Priority Ranking and TMDL Schedules

Section 303(d) of the Clean Water Act requires that waters on the 303(d) list be ranked in order of TMDL development priority. The Maine Department of Environmental Protection (Maine DEP) sets priority rankings based on a variety of factors, including severity of degradation, duration of the impairment, and opportunities for remediation. Maine DEP has designated the streams in this TMDL report for completion in 2016 (Table 1).

Future TMDL Applicability

Under appropriate circumstances in the future, Maine DEP may submit additional TMDLs to the U.S. Environmental Protection Agency (USEPA) for specific waterbodies to be added for NPS TMDL coverage without resubmitting the approved core document (i.e. this document) at such times. The future submittals will provide detailed information on the additional impaired waterbodies and their TMDLs. Maine will provide public notice for review of the additional TMDLs either alone, or as part of the public notice process associated with the biannual review of the State's Integrated Water Quality Monitoring and Assessment Report. If previously unlisted waterbodies are involved, Maine DEP will clearly state its intent to list the newly assessed waterbodies as impaired, and to apply the appropriate waterbody-specific TMDLs.
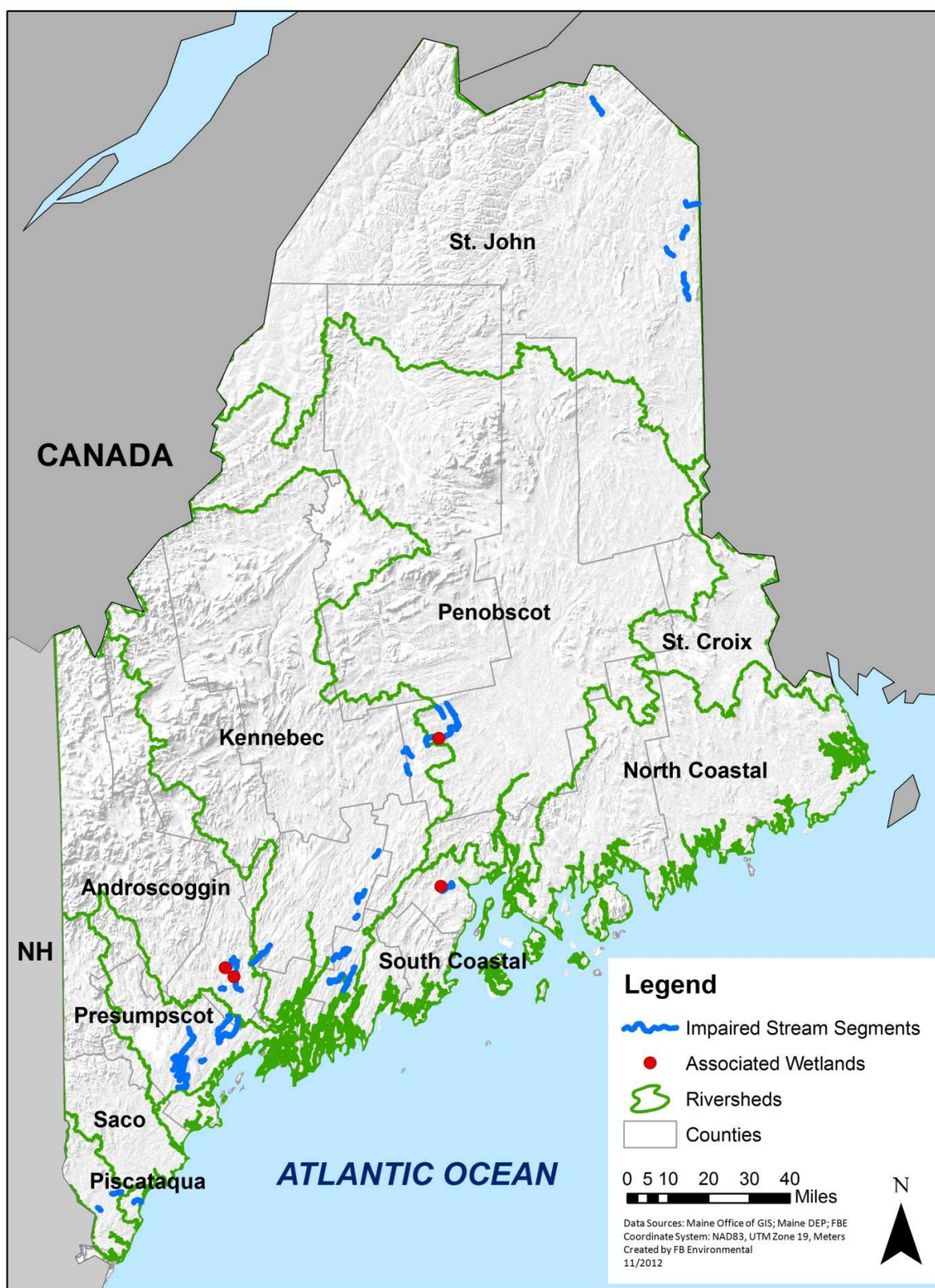
Figure 1: *Locations of impaired waterbody segments included in this report*

Table 1. *TMDL waterbody and watershed information*

Note that only the towns in which the impaired waterbodies are located are listed here. Other towns that have portions of a watershed are noted in the stream appendices.

Stream	Town	ADB#	Receiving Waterbody	Listing Cause	Size (miles)	Class	TMDL Priority	TMDL Schedule
St. John								
Coloney Brook	Fort Fairfield	ME0101000413_146R02	Limestone Stream	Benthic-Macroinvertebrate Bioassessments and Periphyton (Aufwuchs) Indicator Bioassessments	4.5	B	H	2016
Everett Brook	Fort Fairfield	ME0101000412_143R01	Aroostook River	Dissolved Oxygen	3.53	B	H	2016
Merritt Brook	Presque Isle	ME0101000412_143R02	Aroostook River	Benthic-Macroinvertebrate Bioassessments and Periphyton (Aufwuchs) Indicator Bioassessments	2.8	B	H	2016
Penobscot / North Coastal								
Burnham Brook	Garland	ME0102000510_224R01	Kenduskeag Stream	Dissolved Oxygen	3.73	B	H	2016
Crooked Brook	Charleston / Corinth	ME0102000510_224R07	Kenduskeag Stream	Periphyton (Aufwuchs) Indicator Bioassessments	10.6	B	H	2016
Warren Brook	Morrill / Belmont / Belfast	ME0105000218_521R01	Passagassawakeag River	Dissolved Oxygen	6.04	B	H	2016
Kennebec								
Brackett Brook	Palmyra / Newport	ME0103000308_325R02	East Branch Sebasticook River	Dissolved Oxygen	2.74	B	H	2016
Carlton Brook	Whitefield	ME0105000305_528R06	Sheepscot River	Dissolved Oxygen	5.5	B	H	2016

Stream	Town	ADB#	Receiving Waterbody	Listing Cause	Size (miles)	Class	TMDL Priority	TMDL Schedule
Chamberlain Brook	Whitefield / Pittston	ME0105000305_528R08_01	Sheepscot River	Dissolved Oxygen	3.7	B	H	2016
Choate Brook	Windsor	ME0105000305_528R07	West Branch Sheepscot River	Dissolved Oxygen	1.33	A	H	2016
Dyer River	Jefferson / Newcastle	ME0105000305_528R03	Sheepscot River	Dissolved Oxygen	9.35	B	H	2016
Jock Stream	Wales / Monmouth	ME0103000311_334R03	Cobbossecontee Lake	Nutrient/Eutrophication Biological Indicators & Dissolved Oxygen	9.43	B	H	2016
Meadow Brook	China	ME0105000305_528R05	West Branch Sheepscot River	Dissolved Oxygen	5.94	B	H	2016
Mill Stream	Albion	ME0103000309_327R01	Fifteenmile Stream	Dissolved Oxygen	2.17	B	H	2016
Mulligan Stream	St. Albans / Corinna / Newport	ME0103000308_325R03	Sebasticook Lake	Dissolved Oxygen	4.8	B	H	2016
Trout Brook	Alna / Wiscasset	ME0105000305_528R04	Sheepscot River	Dissolved Oxygen	7.7	A	H	2016
Piscataqua / Saco / Presumpscot / Androscoggin								
Chandler River	Duram / Pownal / North Yarmouth	ME0106000102_603R02	Royal River	Dissolved Oxygen	27.19	B	H	2016
Hobbs Brook	Cumberland / Falmouth	ME0106000103_607R06	Piscataqua River	Dissolved Oxygen	1.54	B	H	2016
Penley Brook	Auburn	ME0104000210_413R02	Androscoggin River	Dissolved Oxygen	1.57	B	H	2016
Thayer Brook	Gray	ME0106000103_607R10	Pleasant River	Dissolved Oxygen	4.7	B	H	2016
West Brook	Wells / North Berwick	ME0106000304_625R03	Great Works River	Dissolved Oxygen	3.22	B	H	2016

Maine's Nonpoint Source Program and Rural/Suburban Impaired Streams

Maine's NPS Management Program works toward protecting and restoring surface and groundwater impaired by pollutants associated with both nonpoint sources and stormwater runoff. The overall objective of the NPS Program is to prevent, control, or abate NPS pollution to lakes, streams, rivers and coastal waters so that beneficial uses of those waters are maintained or improved.

Through this program, Maine DEP funds and administers grant projects to prevent or reduce NPS pollutants from entering Maine's water resources. Projects are funded with grant money provided to Maine DEP by the (USEPA) under Section 319 of the Clean Water Act. Maine public organizations such as state agencies, soil and water conservation districts, regional planning agencies, watershed districts, municipalities, and nonprofit [501(c)(3)] organizations are eligible to receive NPS grants. Annually in April, the NPS Program issues a Request for Proposals (RFP) for competitive NPS Water Pollution Control Projects. NPS projects help local communities recognize water pollution sources in watersheds and take action to restore impaired waterbodies. Projects geared toward restoring impaired waters may include:

- *Watershed Surveys* - A watershed survey is designed to identify NPS pollution sources (primarily soil erosion) in a watershed.

- *Watershed-Based Planning.* A watershed-based plan (WBP) describes overall actions and pollution reduction measures needed in a watershed to help restore water quality. Planning organizes public and private sector efforts to identify, prioritize, and then implement activities to address priority water-related problems within the watershed. Active participation in the WBP process will include evaluating how to best restore the stream, identify critical source areas needing best management practices (BMPs), and identify the most appropriate funding mechanisms.

- *Implementing Pollution Reduction Measures.* Communities, agencies, and individuals take action to apply conservation practices or BMPs to eliminate or control sources of NPS pollution. Usually work needs to be focused within a watershed over five to 10 years or more to restore an impaired waterbody. Maine DEP can provide technical assistance and limited financial assistance through opportunity for NPS water pollution control grants to help communities improve watersheds and restore NPS impaired waters.

More information about the Maine NPS Program can be found at Maine DEP's website:
http://www.maine.gov/dep/water/grants/319.html.

3. Pollutant Sources and Description of Impairments

This TMDL addresses waterbodies impaired by NPS runoff primarily from anthropogenic activities within the watershed. All land disturbances have the potential to contribute runoff, but the degree of disturbance associated with agricultural and some suburban land uses is likely the greatest contributor of silt and nutrient enrichment to the waters. The close proximity of these land uses to the stream increases the likelihood that the disturbed and bare soil, containing phosphorus, nitrogen and sediment will reach the waterbody. Three common

Sediment from Merritt Brook in Presque Isle flows into the Aroostook River after a rain storm in September 2012. (Photo: Sean Bernard, Maine DEP)

pollutants in nonpoint source runoff [total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS)] serve as surrogates for the stressors that contribute to the impairment of aquatic life use in the waterbodies addressed by this TMDL.

Elevated nutrient loading and sediment accumulation contribute to excess algal growth, which consumes oxygen during respiration and depresses DO levels. Excess soil runoff provides sediment that contains a mixture of nutrients, and inorganic and organic material which contributes to enriched macroinvertebrate communities. Phosphorus and nitrogen are the limiting nutrients for algal growth and sediment-laden runoff carries these adsorbed nutrients into streams.

Excess sediment contributions to streams may lead to habitat degradation and reduced suitability for a wide spectrum of aquatic life. Over time sedimentation alters habitat by filling in pools, embedding substrate in riffles and contributing nutrients. These factors change the habitat suitability, which in turn shifts the composition of organisms adapted to living in the stream. While sediment is not the only factor affecting habitat in a dynamic stream environment, it is a significant contributor and provides a reasonable surrogate for aquatic habitat degradation in this TMDL.

Maine DEP uses a variety of assessment methods and criteria to determine whether a waterbody supports aquatic life use in a stream or wetland. For example, measurements of dissolved oxygen or temperature and surveys of habitat suitability provide physical and chemical assessments of waterbody health. Biomonitoring techniques are used to evaluate the structure and function of a resident biological

community in a stream or wetland. For example, analyzing samples of benthic macroinvertebrates or algae in streams provides different ways to assess the extent to which a waterbody supports aquatic life use.

Atmospheric Deposition

Atmospheric deposition of nutrients that fall within a watershed will reach a waterbody through runoff from land-deposited material, and direct contact with rain and dry airborne material that settles on the waterbody surface. It is assumed that the soil serves to buffer and absorb most atmospherically deposited nutrients before they reach the waterbody through the runoff processes.

Natural Background Levels

As is true of all watersheds with a history of human habitation, the stream watersheds included in this TMDL are not pristine and NPS loading has resulted from human activities. Natural environmental background levels for the impaired streams were not separated from the total NPS load because of the limited and general nature of available information. Without more and detailed site-specific information on NPS loading, it is very difficult to separate natural background from the total NPS load (USEPA, 1999).

4. Applicable Water Quality Standards and Numeric Water Quality Target

Water quality standards for all surface waters of the State of Maine have been established by the Maine Legislature (Title 38 MRSA §464-470). Maine's WQS are composed of three parts: classification and designated uses, criteria, and antidegradation regulations. Each of these parts is described below as it pertains to the impaired waters included in this report.

Under Maine's Water Classification Program, the State of Maine has four tiers of water quality classifications for freshwater rivers and streams and associated wetlands (AA, A, B, C), each with designated uses and water quality criteria providing different levels of protection.

The designated uses for each classification of freshwater rivers and streams, according to State statute, are described in Table 2.

Table 2: *Designated uses for each classification of Maine's fresh surface waters*

Water Class	Designated Uses
Class AA	Drinking water supply after disinfection, recreation in and on the water, fishing, agriculture, navigation and habitat for fish and other aquatic life.
Class A	Drinking water supply after disinfection, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation[1], navigation and habitat for fish and other aquatic life.
Class B	Drinking water supply after treatment, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation[1], navigation and habitat for fish and other aquatic life.
Class C	Drinking water supply after treatment, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation[1], navigation and habitat for fish and other aquatic life.

The water quality standards relevant to this TMDL report include the designated use of "habitat for fish and other aquatic life" (aquatic life use support) for each of the classification levels, and the relevant water quality criteria assigned to each class, as summarized in Table 3. For example, narrative criteria for aquatic life use support differ for each water quality classification level. The standards for habitat range from the highest goal (AA, "free flowing and natural"; A, "natural"), to allowing some level of risk from discharges (B, "unimpaired"), to allowing an increased level of risk from discharges with some impact (C, as long as aquatic life habitat is maintained). The classes providing the most protection and least risk of impairment have the most stringent water quality criteria.

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[1] Except as prohibited under Title 12, section 403

Table 3: Applicable narrative and numeric water quality standards for Maine's fresh surface waters

Water Class	Dissolved Oxygen Numeric Criteria	Habitat Narrative Criteria	Aquatic Life (Biological) Narrative Criteria[1]
Class AA	As naturally occurs	Free flowing and natural	No direct discharge of pollutants; as naturally occurs
Class A	7 ppm; 75% saturation	Natural	As naturally occurs
Class B	7 ppm; 75% saturation	Unimpaired	Discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.
Class C	5 ppm; 60% saturation; 6.5 ppm (monthly average) at 22° and 24°F	Habitat for fish and other aquatic life	Discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

[1] *Numeric biocriteria in Maine rule Chapter 579; Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.*

In addition, Maine WQS have an antidegradation provision designed to protect and maintain all water uses and water quality whether or not stated in the waterbody's classification as of November 28, 1975 [38 MRSA §464.4.F.]. Uses include aquatic life, habitat, recreation, water supply, commercial activity, and ecological, historical or social significance. The antidegradation provision ensures that waste discharge licenses or a water quality certification are issued only when there will be no significant impact on the existing use or failure of the waterbody to meet standards of classification.

5. Loading Capacity: Linking Water Quality and Pollutant Sources

Loading Capacity & Linking Pollutant Loading to a Numeric Target

The loading capacity of a waterbody is the mass of constituent pollutants that the water can receive over time and still meet WQS. Loading capacity for nonpoint source pollutants is best expressed as an annual load, in order to normalize the spatial and temporal variation associated with instream NPS pollutant concentrations. The loading capacity for the impaired streams is based on a comparative reference approach to set the allotment for existing and future nonpoint sources that will ensure support for existing and designated aquatic life uses. The MapShed model output (Appendix 2) expresses pollutants in terms of land-based loads which have been broken down into a unit area basis for comparative purposes. Appendix 1 lists the estimated pollutant loads in the NPS-impaired waters, compared to TMDL load allocations in attainment watersheds shown below in Table 4. The comparison of modeled pollutant loads

in impaired waters to the modeled pollutant loads in the appropriate attainment watershed(s) provides the essential link between pollutant loadings in impaired waters to the numeric targets for TP, TN, and TSS associated with the appropriate attainment watershed(s). Eventual attainment of WQS will be assessed according to Maine's current listing methodology and use of the appropriate assessment indicators for aquatic life use support, as defined in Maine's water quality standards (see Table 3 above).

Table 4: *Numeric loading estimates for pollutants of concern in attainment watersheds based on MapShed modeling results (Appendix 2)*

Stream	Region	POLLUTANTS[1] (Annual Unit Area Loads)		
		Phosphorus Load (kg/ha/yr)	Nitrogen Load (kg/ha/yr)	Sediment Load (1000kg /ha/yr)
Martin Stream	Kennebec	0.14	3.37	0.01
Footman Brook	Penobscot / North Coastal	0.33	6.40	0.06
Upper Kenduskeag Stream	Penobscot / North Coastal	0.29	5.60	0.05
Upper Pleasant River	South Coastal / Piscataqua / Saco / Presumpscot / Androscoggin	0.22	4.64	0.02
Moose Brook	St. John	0.25	5.90	0.02
Statewide TMDL: Average of Attainment Streams--> (Applicable to both WLAs and LAs)		**0.24**	**5.18**	**0.03**

[1] *The TMDL loads can be expressed as a daily maximum load by dividing the numeric targets above by 365.*

Supporting Documentation - TMDL Approach

This NPS TMDL approach includes measuring various environmental assessment parameters, and developing a water quality model for each watershed to estimate pollutant loadings, comparing modeled loading levels of TP, TN, and TSS in impaired and attainment watersheds, and calculating reductions that will ensure attainment of Maine's WQS. The Maine NPS TMDL analysis uses the MapShed model to estimate pollutant loadings. MapShed is an established midrange modeling tool first developed as the Generalized Watershed Loading Function (GWLF) model by Haith and Shoemaker (1987), and Haith et al. (1992). The model was refined regularly by Evans and others at Penn State into a ArcView GIS-based model called AVGWLF (Evans et al., 2002); it has recently transitioned to the open-source MapWindow GIS and is now called MapShed (Evans& Corradini, 2012). A key benefit of using MapShed is the availability of a high quality data set developed under a Quality Assurance Project Plan (NEIWPCC,

2005), and calibrated to the New England region (Penn State University, 2007).

The model uses geographic data (e.g. soils, watershed boundaries, land uses), land-use runoff coefficients, daily weather (temperature and rainfall), and universal soil loss equations, to compute flow and pollutant loads. The model was run for each of the 21 impaired stream segments and five attainment streams for a 10 to 15 year period (depending on weather data availability). Running the model over this time span covered a wide range of hydrologic conditions to account for variations in nutrient and sediment loading over time. To estimate the TMDL reductions needed to attain WQS, the MapShed model results are used to estimate the existing load in each of the impaired stream segments and the attainment streams. The difference in estimated pollutant loads between the impaired and attainment watersheds is the reduction needed to achieve WQS for all NPS pollutants of concern.

Strengths and Limitations:

Model Strengths:
- MapShed is an established midrange model that is commonly accepted to estimate pollutant loads in river and stream TMDLs.

- The MapShed model was created using regional input data to reflect local watershed conditions to the greatest extent possible.

- The model makes best use of available GIS land-use coverages to estimate NPS loads.

- The model was run for a 10 to 15 year period to account for a wide range of hydrologic conditions among years.

- A reference approach is a reasonable mechanism to establish criteria for pollutants of concern, where no regulatory numeric criteria exist.

- The MapShed model and data set have been calibrated at the New England regional scale.

- The model allows for the manual input of values based on field observations.

Model Limitations:
- The MapShed model is a screening-level model that provides a general estimate of watershed nutrient-loading conditions.

- The model and data set have not been calibrated to the watershed-specific scale.

General Critical Assumptions Used in the MapShed Modeling Report:
- All land use of the same category is assumed to have the same phosphorus and nitrogen loading coefficients.

- If no meteorological data are available from within the watershed, the average values from the two nearest weather stations are assumed to be representative of the watersheds.

- Land uses were reviewed in the field. However, no changes were made to the GIS land-use coverage.

- Limited field reconnaissance was undertaken to develop estimates of livestock, pasture, and agricultural practices. The associated input parameters could be improved by additional observation and surveying natural resource agencies or farmers.

- Streams in agricultural areas were assumed to be reaches of the stream that directly abutted agricultural land on at least one bank.

Critical Conditions

The loading capacity for the impaired segments is set to protect water quality and support uses during critical conditions, which are defined as environmental conditions that induce a stress response in aquatic life. Environmentally stressful conditions involving nonpoint sources may occur throughout the year and depend on the biological requirements of the life stage of resident aquatic organisms. Traditionally, summer low flow periods are considered critical for aquatic organisms due the combination of low velocity, high temperatures and low dissolved oxygen. However, aquatic organisms that reside in streams often confront harsh winter conditions and winter often determines the success or failure of native salmonid species, such as brook trout. Seasonally, low flows occur in the winter and native fish are under stress as they compete for limited winter habitat, as defined by water velocity and unembedded substrate. Additionally, trout eggs are incubating in the gravel during the winter and have specific velocity and dissolved oxygen requirements that may be compromised by the addition of excess sediment. Some species of stoneflies emerge and develop during the winter and remain vulnerable to chronic sediment input. In summary, critical conditions are complex in flowing water and a major consideration in using an average annual load approach for these NPS TMDLs.

TMDL Loading Calculations

The existing loads for nutrients (kg/ha/year) and sediments (1000 kg/ha/year) in the impaired segments are listed in Appendix 1 ('Table of Estimated Pollutant Loads (TMDL Allocations)'). Appendix 2, the 'Modeling Report to Support TMDL Development', describes the MapShed modeling results and calculations used to define TMDL reductions, and compares existing nutrient and sediment loads in the impaired streams to TMDL endpoints (loading capacities) derived from the attainment streams listed in Table 4. An annual time frame provides a mechanism to address the daily and seasonal variability associated with NPS loads. As previously mentioned, it was not possible to separate natural background from nonpoint pollution sources in any watersheds because of the limited and general nature of the available information.

The reduction in pollutants discussed in this TMDL reflects reductions from estimated existing conditions. Expansion of agricultural and other development activities in watersheds have the potential to

increase runoff and associated pollutants. To ensure that the TMDL targets are attained, future activities will need to meet the TMDL targets. Future population growth should be assessed and addressed on a watershed-basis to account for new development.

Seasonal Analysis

Seasonal variation is considered in the allowable annual loads of nutrients and sediment which protect macroinvertebrates and other aquatic life under the influence of seasonal fluctuations in environmental conditions such as flow, rainfall and runoff. All unregulated streams in Maine experience seasonal fluctuations in flow, which influences the concentration of nutrients and sediment. Typically, high flows occur during spring and fall, and low flows occur during the summer and winter. Snow and rainfall runoff may contribute variable amounts of nutrients and sediment. Large volumes of runoff may also dilute instream nutrients and sediment concentrations, depending on the source.

NPS pollution events that occur over the entire year contribute to the aquatic life impairments documented in the impaired streams. Therefore, the numeric targets are applicable year round. Furthermore, benefits realized from pollutant reductions will occur in all seasons. There is no need to apply different targets on a seasonal basis because the measures implemented to meet the numeric targets will reduce adverse impacts for the full spectrum of storms throughout the year. Therefore, the TMDL adequately accounts for all seasons.

6. TMDL Allocations and Margin of Safety

According to the Code of Federal Regulations (CFR) that govern water quality and management [40 CFR Part 130.2], the TMDL for a waterbody is equal to the sum of the individual loads from point or National Pollutant Discharge Elimination System (NPDES[2]) regulated sources (i.e., waste load allocations, WLAs), and load allocations (LAs) from nonpoint or non-NPDES regulated sources (including natural background conditions). Section 303(d) of the Clean Water Act also states that the TMDL must be established at a level necessary to implement the applicable WQS with seasonal variations and a margin of safety (MOS) which takes into account any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality.

> *The* **Maine Pollutant Discharge Elimination System (MEPDES)** *permit program controls water pollution by regulating point sources that discharge pollutants into surface waters. (**Point sources** are any single identifiable source of pollution from which pollutants are discharged.)*

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[2] Maine is delegated to issue its own NPDES permits, which are then called "MEPDES".

In equation form, a TMDL is expressed as follows:

TMDL   =   WLA + LA + MOS

where:

WLA	=	Waste Load Allocation (i.e. loadings from point sources or NPDES/MEPDES regulated sources)
LA	=	Load Allocation (i.e., loadings from nonpoint sources or non-NPDES/MEPDES regulated sources including natural background)
MOS	=	Margin of Safety

TMDLs may be expressed in terms of either mass per time, concentration or other appropriate measure [40 CFR Part 130.2 (i)].

Margin of Safety

TMDL analyses are required by law to include a MOS to account for uncertainties regarding the relationship between load and wasteload allocations, and water quality. The MOS can either be explicit or implicit. If an explicit MOS is used, a portion of the total allowable loading is actually allocated to the MOS. If the MOS is implicit, a specific value is not assigned to the MOS. Use of an implicit MOS is appropriate when assumptions used to develop the TMDL are believed to be so conservative that they are sufficient to account for the MOS.

An implicit margin of safety was incorporated into the NPS TMDL through conservative assumptions associated with the selection of the numeric water quality targets based on watersheds that attain Maine WQS: (1) MapShed calculates pollutant loads with minimal losses to the absorptive capacity of landscape conditions that reduces the runoff the stream receives; (2) Some of the impaired watersheds contain riparian buffers and undocumented agricultural BMPs, which effectively reduce loading, but were not factored into the modeling process; (3) A land-use runoff model, like MapShed, also does not account for instream processes that attenuate nutrients and settle sediments during transit, which reduce the pollutant load that moves through the system. These factors provide a MOS to account for uncertainty and reasonably ensure that WQS will be attained in the impaired streams.

Load Allocation (LA) and Wasteload Allocation (WLA)

For each impaired waterbody addressed by these TMDLs, LAs (for background sources, nonpoint sources, and non-regulated stormwater) are given the same TP, TN, and TSS allocations as the WLAs (for MEPDES regulated sources) because the TMDLs are expressed in terms of annual unit area loads. (Nutrients are expressed in terms of kg/ha/year; sediment is expressed in terms of 1,000 kg/ha/year.)

This approach is used because, while WLAs and LAs must be accounted for, it is not feasible to separate the loading contributions from nonpoint sources, non-regulated stormwater, and natural background. Since the streams addressed by this TMDL are small and do not have MEPDES regulated discharges, source-specific WLAs are not needed, and gross allocations for the WLAs and LAs can be used. The appropriate loads for TP, TN, and TSS for each impaired waterbody segment are listed in Appendix 1, and each is applicable to both WLAs and LAs. In response to public comments, a new Appendix 4 explains the overlap between NPS TMDL watersheds and regulated MS4 areas. Information is presented in a tabular form, listed both by town and by stream watershed name, and maps are also provided. Those streams with overlap were originally proposed to be included in this TMDL, but have been removed for further consideration as to how to account for the WLA contributions. The Department does expect to include these in a future update to this TMDL.

7. Implementation and Reasonable Assurance

Water Quality Monitoring Plan

Addressing water quality impairments in these streams will require the identification and assessment of individual NPS pollution sites in the watershed. Once sites are identified, but before Best Management Practices (BMPs) have been applied, stream monitoring should be conducted to establish pre application conditions. Additional water quality monitoring should be conducted following BMP implementation to gauge the effectiveness of the BMPs or engineered design solutions, as recommended in the 'Future Actions' section below. As restoration plans proceed, Maine Department of Environmental Protection (Maine DEP) staff will check on the progress towards attainment of Maine's Water Quality Standards (WQS) with both water chemistry and biological monitoring evaluations. Also, Maine DEP's Biological Monitoring Program should check on water quality status or improvement in the future under the existing rotating basin sampling schedule.

Benthic macroinvertebrates are excellent indicators of water quality. The number of different kinds of organisms and the abundance of different groups provide information about a waterbody's health. The Biological Monitoring Program of Maine DEP analyzes macroinvertebrate data using a statistical model that incorporates 30 variables, including macroinvertebrate richness and abundance, to determine the probability of a sample attaining statutory Class A, B, or C conditions. Combining the model results with supporting information, biologists determine if streams and rivers are attaining the aquatic life goals assigned to them (Davies and Tsomides, 2002).

An ongoing monitoring program is critical to assess the effectiveness of implementation efforts. Implementation is expected to continue until monitoring shows attainment of aquatic life use goals (macroinvertebrates and/or algae) or dissolved oxygen (DO) WQS. Maine DEP will evaluate progress towards WQS attainment by monitoring aquatic communities and DO in the impaired streams. Depending on the existing impairment(s), benthic macroinvertebrates and/or algae, or DO will provide the primary

metric to measure progress towards attaining WQS.

Recommended Future Actions

The goal of the *Maine Statewide Total Maximum Daily Load (TMDL) for Nonpoint Source (NPS) Pollution* is to use a water quality model, MapShed (Appendix 2), to define pollutant loads and set water quality targets that will ensure compliance with Maine's WQS. The nutrient and sediment reductions listed in the TMDL Allocations (Appendix 1) represent averages over the year (given the seasonal variation of runoff and ambient conditions), and demonstrate the need to reduce nutrient and sediment loads as the key to water quality restoration. The load reductions provide a guide for restoration plans and engineered solutions that will lower the content of nutrient and sediment reaching the impaired streams, by either reducing the nutrient and sediment content of the runoff or by reducing the overall amount of runoff reaching the stream.

Watershed Inventory and Developing a Watershed Plan

While TMDLs focus on specific waterbody segments and specific pollutant sources, watershed-based plans (WBP) should be holistic, incorporating the pollutant- and site-specific TMDLs into the larger context of the watershed, including additional water quality threats, pollutants, and sources. It is recommended that a detailed watershed plan be developed for each impaired waterbody to focus and prioritize appropriate restoration measures. Plans should incorporate on-the-ground mitigation measures and practices that will reduce pollutant loads and contribute in measurable ways to reducing impairments and to meeting WQS. WBPs should be designed to take into account information provided in this TMDL, particularly in the stream-specific appendices.

To begin the restoration process, additional investigation is necessary for all impaired watersheds to fully document problem areas for each WBP or restoration strategy. The usual strategy includes:

1) Conducting parcel-level field work to locate NPS pollution problems and identify sources of nutrient and sediment inputs;

2) Minimizing additional disturbance to maintain existing natural buffering capacity and/or reestablishing buffers where necessary; and

3) Installing BMPs and incorporating Low Impact Development (LID) techniques for future development to reduce the impact of NPS pollution on water hydrology and water quality.

Local stakeholders need to choose the appropriate BMPs and stream restoration techniques to reduce NPS runoff on a case-by case-basis. This TMDL report provides the following information, tools, and contacts for taking action:

➢ Results of preliminary watershed assessment results, including pollutant load reductions needed for nutrients and sediment (see Appendix 6).

➢ Information on watershed restoration projects, including watershed surveys, watershed-based planning, implementing pollution reduction measures, and grant funding opportunities from Maine's NPS Program: http://www.maine.gov/dep/water/grants/319.html.

➢ Examples of agricultural BMPs (see Appendix 3) and The Pollution Reduction Impact Comparison Tool (PRedICT) to estimate load reductions and their associated cost. More information about this tool can be found at: http://www.predict.psu.edu/. Sub-watershed models (using MapShed) have been developed for each impaired waterbody addressed by this TMDL (see Appendix 2). Once more detailed data for site-specific land uses are entered into the base model, various BMP scenarios can be generated by the PRedICT portion of the model. Copies of the model and technical support are available upon request from Maine DEP.

➢ NPS site tracking tool: The NPS Site Tracker, used to record and track watershed inventory or survey information about NPS sites identified in a watershed over time. Electronic copies of the MS Excel templates and technical support are available from ME DEP upon request.

8. Public Participation

USEPA regulations [40 CFR § 130.7(c)(1)(ii)] require that calculations to establish TMDLs be subject to public review. A description of the public participation process and response to public comments will be provided after the public comment period for this TMDL has ended. Paper and electronic forms of the report will be made available for public review (for a period of at least 30 days) on Maine DEP's website. Electronic notification will be sent to interested parties and ads will be placed in the legal advertising section of local papers regarding the comment period and a public meeting sponsored by Maine DEP. The TMDL and response to all comments will be sent to USEPA Region 1 in Boston for final approval. The following is the public notification used for this TMDL:

PUBLIC NOTICE FOR MAINE STATEWIDE NONPOINT SOURCE (NPS) POLLUTION TMDL – In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130, the Maine Department of Environmental Protection (DEP) has prepared a Total Maximum Daily Load (TMDL) report for waters in the State of Maine with dissolved oxygen and/or aquatic life impairments associated with NPS pollution. The TMDL report establishes the target nutrient and sediment loads for the watersheds of the impaired surface waters, provides documentation of impairment, and outlines the reductions needed to meet water quality standards. The report is posted at the Maine DEP website: http://www.maine.gov/dep/blwq/comment.htm. To receive hard copies, please contact Melissa Evers at 207-287-3901 or melissa.evers@maine.gov.

Send all comments by January 29, 2016 to Melissa Evers, DEP, State House Station #17, Augusta, ME 04333, or email: melissa.evers@maine.gov.

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Appendix 1: Table of Estimated Pollutant Loads (TMDL Allocations)

For each of the impaired waterbodies included in this TMDL, the table below lists the estimated pollutant loads (TMDL load allocations) and the numeric target (based on modeling results for attainment watersheds).

Waterbody Name	ADB#	Town	ESTIMATED LOADS (Annual Unit Area Loads)			TMDL % REDUCTIONS		
			Phosphorus (kg/ha/yr)	Nitrogen (kg/ha/yr)	Sediment (1000 kg/ha/yr)	Phosphorus (kg/ha/yr)	Nitrogen (kg/ha/yr)	Sediment (1000 kg/ha/yr)
State-wide Target: Attainment Stream Land-based Loading Average			**0.244**	**5.185**	**0.03**			
St. John								
Coloney Brook	ME0101000413_146R02	Fort Fairfield	**0.838**	**17.4**	**0.237**	71%	70%	87%
Everett Brook	ME0101000412_143R01	Fort Fairfield	**0.801**	**16.2**	**0.175**	70%	68%	83%
Merritt Brook	ME0101000412_143R02	Presque Isle	**0.527**	**12.8**	**0.100**	54%	59%	70%
Penobscot / North Coastal								
Burnham Brook	ME0102000510_224R01	Garland	**0.476**	**5.8**	**0.037**	49%	10%	18%
Crooked Brook	ME0102000510_224R07	Charleston/ Corinth	**0.330**	**5.6**	**0.065**	26%	7%	54%
Warren Brook	ME0105000218_521R01	Morrill/Belmont/ Belfast	**0.313**	**6.5**	**0.022**	22%	21%	no reduction
Kennebec								
Brackett Brook	ME0103000308_325R02	Palmyra/Newport	**0.393**	**11.13**	**0.045**	38%	53%	33%
Carlton Brook	ME0105000305_528R06	Whitefield	**0.171**	**4.42**	**0.012**	no reduction	no reduction	no reduction
Chamberlain Brook	ME0105000305_528R08_01	Whitefield/ Pittston	**0.212**	**5.70**	**0.015**	no reduction	9%	no reduction
Choate Brook	ME0105000305_528R07	Windsor	**0.140**	**3.32**	**0.005**	no reduction	no reduction	no reduction
Dyer River	ME0105000305_528R03	Jefferson/ Newcastle	**0.241**	**4.31**	**0.015**	no reduction	no reduction	no reduction
Jock Stream	ME0103000311_334R03	Wales/Monmouth	**0.274**	**6.69**	**0.028**	11%	23%	no

Waterbody Name	ADB#	Town	ESTIMATED LOADS (Annual Unit Area Loads)			TMDL % REDUCTIONS		
			Phosphorus (kg/ha/yr)	Nitrogen (kg/ha/yr)	Sediment (1000 kg/ha/yr)	Phosphorus (kg/ha/yr)	Nitrogen (kg/ha/yr)	Sediment (1000 kg/ha/yr)
State-wide Target: Attainment Stream Land-based Loading Average			**0.244**	**5.185**	**0.03**			
								reduction
Meadow Brook	ME0105000305_528R05	China	**0.289**	**5.01**	**0.008**	16%	no reduction	no reduction
Mill Stream	ME0103000309_327R01	Albion	**0.267**	**7.70**	**0.011**	9%	33%	no reduction
Mulligan Stream	ME0103000308_325R03	St. Albans/ Corinna/Newport	**0.370**	**7.94**	**0.038**	34%	35%	20%
Trout Brook	ME0105000305_528R04	Alna/Wiscasset	**0.163**	**3.35**	**0.010**	no reduction	no reduction	no reduction
Piscataqua / Saco / Presumpscot / Androscoggin								
Chandler River	ME0106000102_603R02	Duram/Pownal/ North Yarmouth	**0.291**	**5.88**	**0.054**	16%	12%	45%
Hobbs Brook	ME0106000103_607R06	Cumberland/ Falmouth	**0.679**	**10.46**	**0.051**	64%	50%	41%
Penley Brook	ME0104000210_413R02	Auburn	**0.170**	**7.65**	**0.022**	no reduction	32%	no reduction
Thayer Brook	ME0106000103_607R10	Gray	**0.368**	**7.94**	**0.074**	34%	35%	60%
West Brook	ME0106000304_625R03	Wells/North Berwick	**0.273**	**6.05**	**0.036**	11%	14%	17%

Appendix 2: Modeling Methodology & Attainment Stream Details **to Support TMDL Development**

MapShed Nutrient Loading Model Overview

MapShed is an established midrange modeling tool first developed as the Generalized Watershed Loading Function (GWLF-E) model by Haith and Shoemaker in 1987, and Haith et al. in 1992. The model was refined regularly by Evans, Corradini, and Lehning at Penn State University into an ArcView GIS-based model called AVGWLF (Evans et al., 2002); it has recently transitioned to the open-source MapWindow GIS and now is now called MapShed (Evans & Corradini, 2012). A key feature of MapShed is the availability of a high quality data set developed under a Quality Assurance Project Plan (NEIWPCC 2005), and both model and data were calibrated to the New England region (Penn State University 2008).

MapShed is an aggregate distributed/lumped parameter watershed model that generates loading estimates for the surface water pollutants of phosphorus, nitrogen, total dissolved solids, and fecal coliform bacteria. The model is distributed in that it allows multiple land use/cover scenarios. However, loads originating from the watershed are lumped by land use category, and spatial routing of nutrient and sediment loads within each watershed is not available. For example, all farmland is lumped together and defined by one set of parameter values, and all forested land is lumped together and defined by a different set of parameter values. The model does not account for active forest operations within forested areas. Other factors that affect the nutrient balance of a watershed such as livestock numbers and practices, soil and groundwater nutrient loads, point-sources, and septic systems are also lumped together, with each group treated as a unique source.

MapShed consists of three components. Note that "MapShed" refers both to the overall model (all three components), as well as the first of the three individual components. Each is a standalone executable file which can be independently run.

- **MapShed**, a MapWindow-based interface using GIS to generate model inputs, (*executable: PrjMngr.exe*);
- **Generalized Watershed Loading Model (GWLF-E)**, the hydrology and nutrient loading model, (*executable: GWLF-E.exe*); and
- **PRedICT**, software to examine various best management practice (BMP) scenarios, (*executable: PRedICT.exe*)

The first component (MapShed) generates a data file that is used as an input by the second component (GWLF-E), which in turn generates a data file used as an input by the third component (PRedICT). In practice, the first component requires much more computer run-time than the following two. MapShed takes about 15 minutes to execute, while GWLF and PRedICT are nearly instantaneous.

The overall MapShed model uses well established soil and hydrologic equations along with GIS and weather data to model surface runoff and soil erosion. The Soil Conservation Service Curve Number (SCS-CN) coupled with daily precipitation and temperature from the National Climatic Data Center (NCDC) is used to model surface runoff and streamflow. Evapotranspiration is determined using daily

weather data and a cover factor dependent on land use/cover type. The Universal Soil Loss Equation (USLE) is used to model monthly erosion and sediment loss. Nutrients (nitrogen, phosphorus, and total suspended solids) are modeled using export coefficients for both the dissolved and solid phases from each type of land use. (Evans et al. 2002, 2008, 2012). The model uses geographic data (e.g. soils, watershed boundaries, land uses), land use runoff coefficients, daily weather (temperature and rainfall), and universal soil loss equations, estimates of livestock animal units, and best management practices (current and future) to compute pollutant loads in terms of daily mass and concentration.

The model was run for each of the thirty-four impaired stream segments and ten attainment streams for a 15 year period, determined by weather data availability. Running the model over this time span covered a wide range of hydrologic conditions, accounting for variations in nutrient and sediment loading over time. To estimate the TMDL reductions needed to attain water quality standards, the GWLF model results are used to estimate the existing load in each of the impaired stream segments and in respective attainment watersheds. The difference in estimated pollutant loads between the impaired and attainment watersheds is the reduction needed to achieve water quality criteria for all nonpoint source pollutants of concern. It is assumed that the reference watersheds are in attainment by a margin greater than zero. In other words, they are not at the border between attainment and impairment. By setting the TMDL target equal to the reference watershed nutrient load, an implicit margin of safety is therefore in place.

Software

The following software is downloaded from http://www.mapshed.psu.edu/download.htm:

- MapWindow v4.6.602 (this specific version, do not update)
- MapShed v1.0.8 or higher
- MapShed and PRedICT user manuals, plus other supporting documentation

Model Input Data Overview

In MapShed, there are two data entry phases. The first phase, called MapShed, is when GIS layers and weather data are entered using the GIS interface. The second phase, called GWLF-E, is when additional data can be entered by typing numbers directly into a series of data entry screens. Overall, a vast amount of data are entered and processed through the model. Many of these data consist of well-established soil equations and constants which were reviewed, but not adjusted. Others, such as number of livestock, agricultural stream miles, and amount of vegetative buffer in agricultural areas, were reviewed in detail through a combination of in-office and on-site methods. Each data source is described below.

Most geographic data used in the modeling were produced for the New England Interstate Water Pollution Control Commission (NEIWIPCC), are covered by an existing Quality Assurance Project Plan, and were used in model calibration for the northeast region. These data sources were downloaded from the MapShed website at Penn State, and reprojected into the standard ME Office of GIS projection (UTM NAD83 Zone 19N) by FB Environmental using ArcMap 9. Large files (all grids, plus streams) were also trimmed using ArcMap 9 to a rectangle slightly larger than the watershed extent, which greatly reduced computer processing time. These datasets are:

- New York/New England Regional data, v1.0.0 or higher
- New York/New England Sections 8 and 9, v1.0.0 or higher

Other data sets specific to this project were provided by Maine DEP, the Natural Resource Conservation Service, and/or FB Environmental, and are described below.

Input Parameters to the GIS Portion of MapShed

There are seven required input data sources, plus up to twelve additional optional sources, which are selected during the GIS portion of MapShed. Most data sources chosen were those developed and calibrated for the northeast region for NEIWPCC. Note that the Soil Phosphorus layer uses "Total P" units (not "Test P" units).

The watershed boundaries were provided by Maine DEP. The default streams layer was initially used, however, it was discovered that the original stream data showed inconsistent resolution across the state. As seen in Figure 1, there were rectangular areas in which many ephemeral streams were included, and others where they were omitted. The border between these areas corresponds to USGS quadrangles, and is believed to be an artificial boundary inherent in older source data. Stream length is a critical model parameter affecting among other things streambank erosion, therefore an older streams shapefile was adopted which provided a much more consistent stream resolution across the state. Table 1 presents all GIS level inputs and sources. Many are further described below in the GWLF-E portion of this report.
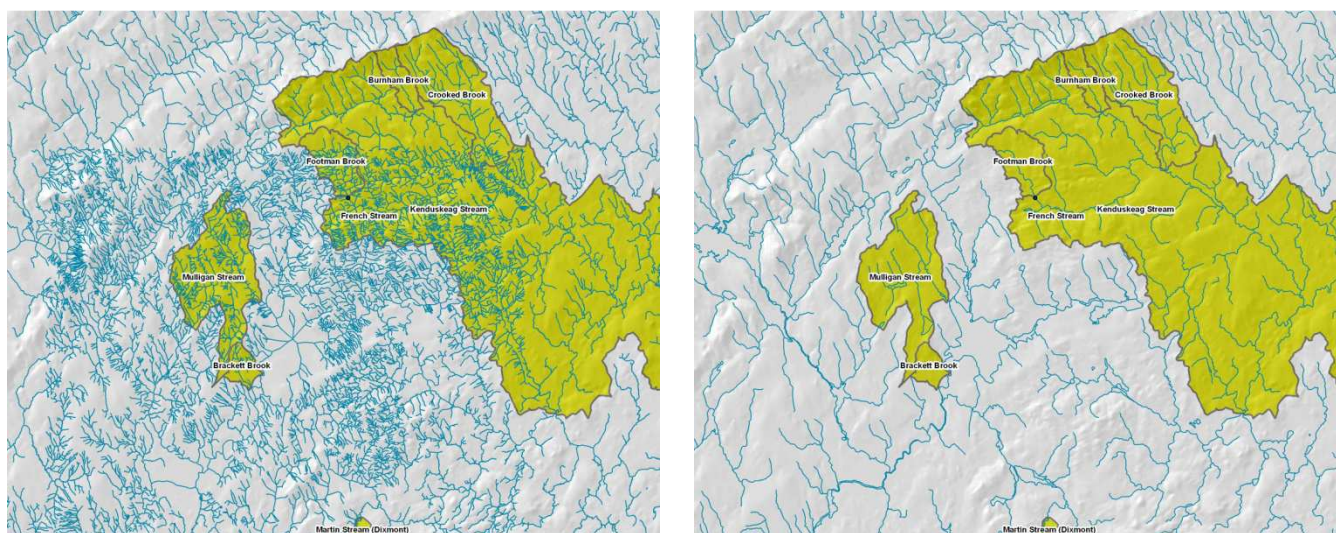
Figure 1: *The image on the left shows the default streams layer provided by MapShed. The image on the right shows a shapefile (hydrol_04202006.shp) from Maine Office of GIS used in this modeling.*

Minor changes to the weather data were also necessary. Weather data consists of a GIS shapefile (weather_station.shp) and an associated folder of weather data (one .csv file for each weather station). The weather data file for Madison, Maine, (sta4927.csv) was found to have columns out of order. This weather data was formatted of the other weather data files. Likewise, Station 860 was found to have formatting errors in the data file (sta860.csv) when the model attempted to use it for Moose Brook in Aroostook County. This station was labeled within the shapefile as "Brockton," although no town or weather station of that name could be found in that vicinity. The temperatures in the file were much different than nearby Houlton, Maine, for the dates in question, therefore this station was deleted from the GIS shapefile, allowing other nearby weather stations to be used. The edited weather shapefile was renamed "weather_station_bugfix.shp."

Table 1: GIS Level Input Parameters (Shaded Rows are Required by the Model)

Data Layers	Short Description	File Type	Required	File Name	Notes and Source
Weather Stations	Weather station locations	Point	Yes	Weather_station_ bugfix.shp	Source: MapShed / NEIWPCC, edited by FBE to correct formatting issues for two stations
Weather Directory	Weather station directory	CSV-files	Yes	Individually named by weather station	Formatting corrections to Station 4927 by FBE Source: MapShed / NEIWPCC
Point Sources	Point source discharge locations	Point	No	Newwtps.shp	No point sources identified in the project area. Possible future point sources can be entered via shapefile, or manually using GWLF-E.
Basins	Basin boundary used for modeling	Polygon	Yes	Individually named by watershed	Source: Maine DEP
Streams	Map of stream network	Line	Yes	hydrol_04202006.shp	More consistent resolution than default layer. Source: ME Office of GIS
Counties	County boundaries - for USLE data	Polygon	No	Counties.shp	Source: MapShed / NEIWPCC
Septic Systems	Septic system numbers and types	Polygon	No	Census.shp	Source: MapShed / NEIWPCC
Soils	Contains various soil-related data	Polygon	Yes	Soils.shp	Source: MapShed / NEIWPCC
Physiographic Provinces	Contains hydrologic parameter data	Polygon	No	Physprov.shp	Source: MapShed / NEIWPCC
Urban Areas	Map of urban areas boundaries	Polygon	No	UrbanAreas_ME_2010 .shp	Only used if one wants to re-distribute loads for urban watershed across MS4 boundaries. Source: US Census
Land Use/Cover	Map of land use/cover (16 classes)	Grid	Yes	Section > Landuse > sta	Source: MapShed / NEIWPCC
DEM	Elevation grid	Grid	Yes	Section > DEM > sta	DEM with 30 meter resolution used. Some watersheds overlapped the section boundaries, so statewide DEM used in those cases. Source: MapShed / NEIWPCC
Groundwater-N	Background estimate of N in mg/l	Grid	No	Section > GWN > sta	Source: MapShed / NEIWPCC
Soil-P	Estimate of soil P in mg/kg of "Total P" (not "Test P")	Grid	No	Section > SoilP > sta	Based on soil texture and land use layers. Source: MapShed / NEIWPCC

Nutrient runoff concentrations and volumes in MapShed are based in large part on land uses, which are contained within a grid file. These land use categories are described below. FB Environmental focused field reconnaissance efforts on land uses identified as hay/pasture, cropland, and open land when estimating livestock (described in the GWLF-E section below), since this land use is subject to relatively frequent changes and may be miscategorized in the source data. While the land use grid was not edited, field observations were recorded, and observations are reflected in the livestock figures entered later in the model.

> *Water:* *Water bodies such as lakes, ponds, large streams, etc. Grid cell value 1.*

> *Hay/Pasture:* *Hay or pasture areas where low-lying grassy vegetation is predominant. Grid cell value 4.*

> *Cropland:* *This category refers primarily to row crops. Cover crops may be included depending upon how closely surface erosion and nutrient runoff characteristics resemble row crops or hay/pasture. Use grid cell values of either 5 or 6 (both are treated the same in GWLF-E).*

> *Forest:* *This category includes areas of coniferous, deciduous or mixed woodlands. Grid cell values of 7, 8 or 9 (all are treated the same in GWLF-E).*

> *Wetland:* *This category includes both woody and emergent wetlands, and grid cell values of either 10 or 11 may be used (both are treated the same in GWLF-E).*

> *Disturbed:* *Includes land such as coal mines, quarries, gravel pits, transitional land, etc. These types are treated as "non-vegetated, disturbed" land types in GWLF-E, and may be depicted with grid cell values 12, 13 or 15 (all of these are treated the same in GWLF-E).126*

> *Turf/Golf:* *Any highly-managed, intensively-fertilized areas with turfgrass-type vegetation (e.g., golf courses and sod farms) may be included in this category. Grid cell value of 16 for this category.*

> *Open Land:* *This category is intended to depict such land types similar to "open range" or "grassland", such as found in the western part of the Unites States. These essentially "natural" areas are typically not cultivated or heavily pastured. Grid cell value of 21.*

> *Bare Rock:* *Non-vegetated rocky areas such as found in mountainous areas. Grid cell value 22.*

> *Sandy Areas:* *Use this category for land types such as beaches and deserts with little or no vegetation. Grid cell value 14.*

> *Low-Density Residential:* *Areas with a mixture of constructed materials, with vegetation mostly in the form of lawn grasses, shrubs and/or trees. Impervious surfaces account for less than 30% of the total cover. These areas most commonly include large-lot, single-family housing units. Grid cell value 17.*

> *Medium-Density Residential:* *Areas with a mixture of constructed materials, with vegetation mostly in the form of lawn grasses, shrubs and/or trees. Impervious surfaces account for 30-75% of the total cover. These areas commonly include low and medium density housing in suburban or smaller urban areas. Grid cell value 18.*

> *High-Density Residential:* *Areas with a mixture of constructed materials, with vegetation mostly in the form of lawn grasses, shrubs and/or trees. Impervious surfaces account for greater than 75% of the total cover. These areas most commonly include small-lot housing or row houses. Some commercial uses,*

usually converted residences, may be present but represent less than 20% of the total area. Grid cell value 19.

Low-Density Mixed Urban: *Areas with a mixture of constructed materials, with vegetation mostly in the form of lawn grasses, shrubs and/or trees. Impervious surfaces account for less than 30% of the total cover. These areas commonly include schools, hospitals, commercial areas and industrial parks with extensive, surrounding open land. Grid cell value 2.*

Medium-Density Mixed Urban: *Areas with a mixture of constructed materials, with vegetation mostly in the form of lawn grasses, shrubs and/or trees. Impervious surfaces account for 30-75% of the total cover. These areas are typically found in smaller cities and suburban locations. Grid cell value 20.*

High-Density Mixed Urban: *Areas with a mixture of constructed materials, with vegetation mostly in the form of lawn grasses, shrubs and/or trees. Impervious surfaces account for greater than 75% of the total cover. These areas are typically high-intensity commercial/industrial/institutional zones in large and small urban areas. They may include some dense residential development which should not exceed 20% of the total area. Grid cell value 3.*

The GIS portion of the model was run by selecting all available weather years, selecting May through October as the growing season, and leaving the default return flow of 0.4 (fraction of irrigation water estimated to return to surface/subsurface flow). Each watershed was run individually (without sub-basins or flowlines). For each watershed, a source file was saved to facilitate re-running the model if and when necessary. Note that when running MapShed, it was found that clipping the higher resolution shapefiles and grids to the project area greatly reduced model processing time. When the GIS portion of the model was completed, a .gsm file was generated, which was used by the GWLF-E section below.

Input Parameters for the GWLF-E Portion of MapShed

The GWLF-E component of MapShed starts with the .gsm file generated above. This file consists of a large number of input parameters dealing with soil character, hydrology, weather patterns, nutrient transport, animal and human populations, and agricultural practices, which were calculated for each specific watershed based on the GIS data inputs described above. Virtually every parameter can be viewed and most can be directly overwritten through an extensive series of data entry forms. The soil, nutrient transport, and hydrology parameters are based on decades of research by Penn State, including model calibration specific to the northeast region under the NEIWPCC project. Therefore, these parameters were generally accepted. FB Environmental focused on those parameters for which accuracy could be best improved through desktop research and in-field observations. These adjusted parameters are the following.

Livestock Estimates

MapShed uses the number and type of livestock to estimate manure production within the watershed. Animals are converted to animal units with corresponding nutrient loading rates within the model. During the pollution source identification phase of this project, FB Environmental reviewed the land use shapefile as well as recent aerial photos available through Google Maps and other public sources to identify farm fields, pasture, and other open fields which could potentially be used for livestock. Given the high resolution of modern aerial photos, signs of livestock were often easy to find. In several cases, areas where livestock had direct access to streams were clearly identified.

Researchers then visited each watershed and counted livestock, or the clear evidence of livestock, to the extent possible. Many direct observations of animals at pasture were made, but in other cases, other indications were used to count livestock, such as new electric fencing, freshly trodden fields and paddocks, livestock paths, extensive hoof prints, and barns with well-tended feed and water troughs were all used to indicate the presence of livestock. Farm animal estimates were generally conservative. For example, a small paddock and barn was usually counted as one horse. Large farms were research online after field visits for additional indication of livestock type and number. All livestock estimates are well-documented in each watershed specific appendix, as well as in the submitted source identification reports. Within MapShed, the animal units per type of livestock (correlated to much each animal weighs), as well as manure production per animal unit, were left at the default values.

MapShed uses an involved set of algorithms to simulate nutrient loading from livestock. It considers monthly time spent grazing, at pasture, direct access to stream, daily accumulation on the landscape, runoff to streams based on daily weather conditions, and certain livestock and agricultural practices such as plowing manure into the soil and manure management plans. The default values were accepted for each watershed, unless otherwise noted in the watershed appendix. There were a few watersheds in which livestock access to streams was clearly impairing water quality.

It is important to note that MapShed treats all manure produced in the watershed as remaining in the watershed in some form. The model does not directly include a mechanism for manure export out of or import into the watershed. For example, a watershed containing a large farm which produces and sells liquid manure from its livestock would probably experience lower nutrient loading in reality than what the model predicts, since much of the manure is shipped out of the drainage area. Conversely, large farms which import manure onto their fields from outside the watersheds could result in higher nutrient loading to streams than the model predicts. Whenever this import/export issue seemed likely, it was noted in the summary, although a detailed estimate of the effects on nutrient loading are probably best handled when doing individual watershed based plans.

Percent of Watershed Draining to Ponds or Wetlands

MapShed considers depositional environments such as ponds and wetland to attenuate watershed sediment loading. The degree of attenuation is entered into the model by a simple percentage of watershed draining to a pond or a wetland. Although MapShed uses GIS to calculate many variable (including slope), it is not capable of delineating flow networks. Therefore, it is necessary to enter this variable manually. FB Environmental estimated the percent of watershed draining to a pond or wetland based on visual inspection of the watershed in GIS. This estimate made a noticeable difference to the resulting sediment load estimates in many cases.

Stream Miles and Buffers Within Agricultural Land Uses

MapShed uses GIS data to calculate stream miles within agricultural land uses, and allows for manual entry of the stream miles within agricultural land uses with vegetative buffers. Vegetative buffers along streams in agricultural areas attenuate nutrient loading by about 40% for N and P, and 50% for sediment (those attenuation factors, like most, can be modified within MapShed). FB Environmental reviewed recent, detailed aerial photos from Google Maps and other publicly available sources to determine the agricultural stream miles with buffers, as well as total agricultural stream miles which were used to override the GIS calculation in the GWLF-E BMP data entry screen.

Existing Agricultural Best Management Practices

MapShed allows data on existing nutrient reduction BMPs to be entered into the model. There are twelve rural BMPs possible within MapShed, each with adjustable reduction coefficients for N, P, and Sediment. For this modeling effort, four commonly used BMPs were entered using literature values. More localized data on agricultural practices would improve this component of the model.

- *Cover Crops:* Cover crops are the use annual or perennial crops to protect soil from erosion during time periods between harvesting and planting of the primary crop. The percent of agricultural acres cover crops are used within the watersheds in this TMDL is estimated at 4% This figure is based on information from the 2007 USDA Census stating that 4.1% of cropland acres is left idle or used for cover crops or soil improvement activity, and not pastured or grazed (USDA, 2007).

- *Conservation Tillage:* Conservation tillage is any kind of system that leaves at least 30% of the soil surface covered with crop residue after planting. This reduces soil erosion and runoff and is one of the most commonly used BMPs. This BMP was assumed to occur in 42% of agricultural land. This figure is based on a number given by the Conservation Tillage Information Center's 2008 Crop Residue Management Survey stating that 41.5% of U.S. acres are currently in conservation tillage (CTIC, 2000).

- *Strip Cropping / Contour Farming:* This BMP involves tilling, planting and harvesting perpendicular to the gradient of a hill or slope using high levels of plant residue to reduce soil erosion from runoff. This BMP was assumed to occur in 38% of agricultural lands, based on a study done at the University of Maryland (Lichtenberg, 1996).

- *Grazing Land Management:* This BMP consists of ensuring adequate vegetation cover on grazed lands to prevent soil erosion from overgrazing or other forms of over-use. This usually employs a rotational grazing system where hays or legumes are planted for feed and livestock is rotated through several fenced pastures. In this TMDL, a figure of 75% of hay and pasture land is assumed to utilize grazing land management. This figure is based on a study by Farm Environmental Management Systems of farming operations in Canada (Rothwell, 2005).

The remaining possible BMPs within MapShed include crop residue management, stream fencing, vegetated buffer strips (within farm fields, not along streams), animal waste management systems (AWMS), phytase in poultry feed, confined feeding area runoff controls, and agricultural land retirement. These BMPs were not assumed to occur within the watershed. Improved data on agricultural and livestock practices could be rapidly incorporated into the model as they become available.

Adjusting Slope Length (LS)

When reviewing the model results, an apparent error with the slope length (LS) calculation for certain watersheds was discovered. LS is calculated from elevations, watershed area, and stream length, and typically ranges from 0.1 to 1.5. Slope length is part of the Universal Soil Loss Equation. LS was zero for five watersheds (Carlton, Coloney, Mosher, Penley, and Thayer Brooks), and very close to zero for three additional watersheds (Adams, Chamberlain, and Hobbs Brooks). These zero and near-zero results were viewed as likely errors, and a second method of calculating LS was found.

An alternative digital elevation model (DEM) layer was substituted in MapShed for these watersheds. This DEM was a clip of the AVGWLF DEM30 developed for use with the NEIWPCC project a few years ago. Two clips were made (northern and southern Maine watersheds) in order to reduce computer processing time and to deal with watersheds which overlapped the Section 8 and Section 9 boundary in in the new MapShed dataset. It therefore matched the 30 meter pixel size and used the recommended "flow accumulation" method for that resolution. Based on visual inspection, the alternate DEM appeared to be virtually identical to the default DEM, however, the resulting LS figures were quite different and within the expected range. These LS figures were typed into the Transport Data Editor in GWLF-E, changes were saved in a new .gsm file, and GWLF-E was re-run. This revision partially resolves concerns about sediment estimates, although it remains the most variable of the three pollutants within the model. FB Environmental will communicate these findings to Penn State for model improvement.

Other Input Parameters

There is a vast number of soil, hydrological, and pollutant transport parameters which operate within the MapShed model. A brief overview of most of these is provided below. Within the "Transport Data" group, the figure for "Sediment A Adjustment," which relates to the lateral erosion rate, was manually changed from 1.0 to 0.1 to match the New England-specific value determined when MapShed was run for NEIWPCC (Penn State, 2007). All of the remaining parameters were left at the default values.

- Transport Data
    - Percentage of impervious areas are associated with each land use.
    - Curve numbers (CNI and CNP and CN) are empirically-derived values that reflect that relative amounts of surface runoff and infiltration occurring at a given location based on combination of soil and land cover and the user-defined impervious cover estimate.
    - The soil erodibility (K) factor is a measure of inherent soil erosion potential as a function of soil texture and composition and is pre-determined for every soil type.
    - Slope-length (LS) factor is a function of overland runoff and slope and uses a NRCS equation for estimating the relationship between slope length and slope gradient for a given area derived from the DEM and stream layers. The LS numbers were run a second time for certain watersheds, see section "Adjusting Slope Length" above
    - Cropping Management (C) factor represents the effect of ground cover conditions, soil conditions, and general management practices on soil erosion. Erosion Control Practice (P) factors depict the effectiveness of various structural and non-structural control practices such as terracing and crop residue management in reducing soil erosion on cultivated land. Both are derived from the *county.shp* layer based on mean values for field crops and slope characteristics. This is a representative value that may differ from actual C and P values based on local agricultural practices such as use of BMPs and crop rotations. If more accurate information on cropping practices is known during the model time period, the user can edit this information to better reflect local conditions.
    - ET Cover Coefficients are based on land use and area-weighted potential evapotranspiration (PET) values computed by the model as a function of the number of daylight hours per day, the saturated water vapor pressure, and the mean daily temperature on a given day.
    - Daylight hours are calculated using the latitude of the centroid of a given watershed and the growing season is specified directly by the user.

- o Rainfall Erosivity Coefficients estimate the rainfall intensity factor and vary with season and geographic location.
- o The Groundwater Seepage Coefficient (related to the fraction of infiltrated water lost to an underlying aquifer or deep saturated zone) is set to zero, because it is assumed that the water table does not fluctuate appreciably from year to year.
- o Groundwater Recession Coefficient values can be estimated from historical stream flow records using standard hydrograph separation techniques. A value of 0.06 is common in the northeast (Haith *et al.*, 1992), and typically range nationwide from 0.01 to 0.2.
- o Unsaturated Available Water-Holding Capacity is calculated using the soils data layer.
- o Sediment Delivery Ratio is based on the premise that a certain percentage of material eroded from the land surface is deposited prior to reaching nearby waterbodies and is related to the amount that reaches the outlet of a given watershed (sediment yield).
- o Lateral erosion rate (Sediment A Factor and Sed A Adjustment) estimates streambank erosion based on animal density, curve number, soil erodibility, mean watershed slope, and percent of developed land in the watershed.
- o Stream and Ground Extract factors are based on the Water Extraction layer for surface and groundwater withdrawals. If no water extraction layer is provided, inputs can be entered manually if known sources of irrigation or snowmaking activities may be affecting the water budget.
- o Percent of Tile Drained area is specified by the user for input to a tile drain flow equation that assumes 50% of the surface and subsurface flow each month are redistributed to tile drain flow in areas identified as being served by such systems. This volume is multiplied by the event mean concentrations provided by literature for N, P, and sediment to calculate loads for each in kg/month.
- Nutrient Data
  - o Rural runoff nutrient concentrations are associated with overland runoff, point sources, and subsurface discharges to the stream. Nutrient loads from non-urban areas are transported in runoff water and eroded soil from sources areas. Default dissolved N and P concentrations are based on literature sources.
  - o Urban runoff nutrient accumulation rates use the concept of nutrient build-up and wash-off to estimate nutrient loads from urban areas. It is assumed that nutrients accumulate on urban surfaces over time from various inputs (atmospheric deposition, animal litter, street refuse, etc.) and are washed off by periodic rainfall events. Default values for different urban categories are derived primarily from the literature.
  - o Point Source Discharges is provided by the user or taken directly from the Point Source layer that contains information on estimated monthly N and P loads from major industrial and municipal wastewater treatment plants. It is possible for the user to specify variable effluent flows and nutrient concentrations on a monthly basis for any point source discharge using the Point Source Editor Tool.
  - o N and P in groundwater are automatically calculated using a regression equation and area-weighted values of N and P concentrations in groundwater based on land use and rock type.
  - o The default value of 2000 mg/kg is estimated for N in sediment. The user can specify more accurate local information. The P in sediment is estimated using a soil P grid for soil test P or total P and the area-weighted value of P concentration.

- Septic system loads are based on the number of persons served by septic systems in the watershed derived from the census tract layer. Once the nitrogen loads from septic systems for a given watershed have been determined, this total load is reduced by a factor (about 61%) to account for losses in subsurface and in-stream flow due to denitrification. Per capita values for nutrient loads in septic tank effluent and values for nutrient uptake by plants are based on suggested literature values.
- Tile drain nutrient concentrations are derived using estimated tile drain water volumes and typical in-drain concentrations drawn from the literature. These are default concentrations for N, P, and sediment.
- Animal Data
  - No confined animal feeding areas (AFO) were entered.
  - The loss rate values for manure from pasture, feedlot, and field spreading for N, P, and sediment.
  - For grazing animals, the percent of time spent grazing and percent of time spent in stream are based on literature values.
  - All values related to pathogen loadings were left unchanged.

Determining the TMDL

MapShed was run according to the detailed instruction manual provided by Penn State (Evans & Corradini 2012), using the input parameters stated above. Nutrient loading estimates in terms of mass per unit watershed area per year for total phosphorus (TP), total nitrogen (TN), and sediment were calculated for impaired streams.

The TMDL was generated by determining loading values in attainment stream watersheds. A set of attainment streams for possible use in developing the TMDL was provided to FB Environmental by Maine DEP. Both impaired and attainment watersheds had similar overall characteristics with the same range of land uses. Specifically, both groups had a meaningfully high level of agriculture, and little to no urbanized areas. From this larger list of attainment streams, a set of five representative attainment watersheds were selected from across the state based on similar watershed size and land use as the impaired streams, along with the quantity and quality of assessment data. Figure 2 indicates the locations of each attainment stream watershed used in this TMDL. A statewide TMDL was set as the average loading value of these five streams (Table 2). The difference between pollutant loading in impaired and attainment watersheds represented the percent reduction needed in each impaired watershed.
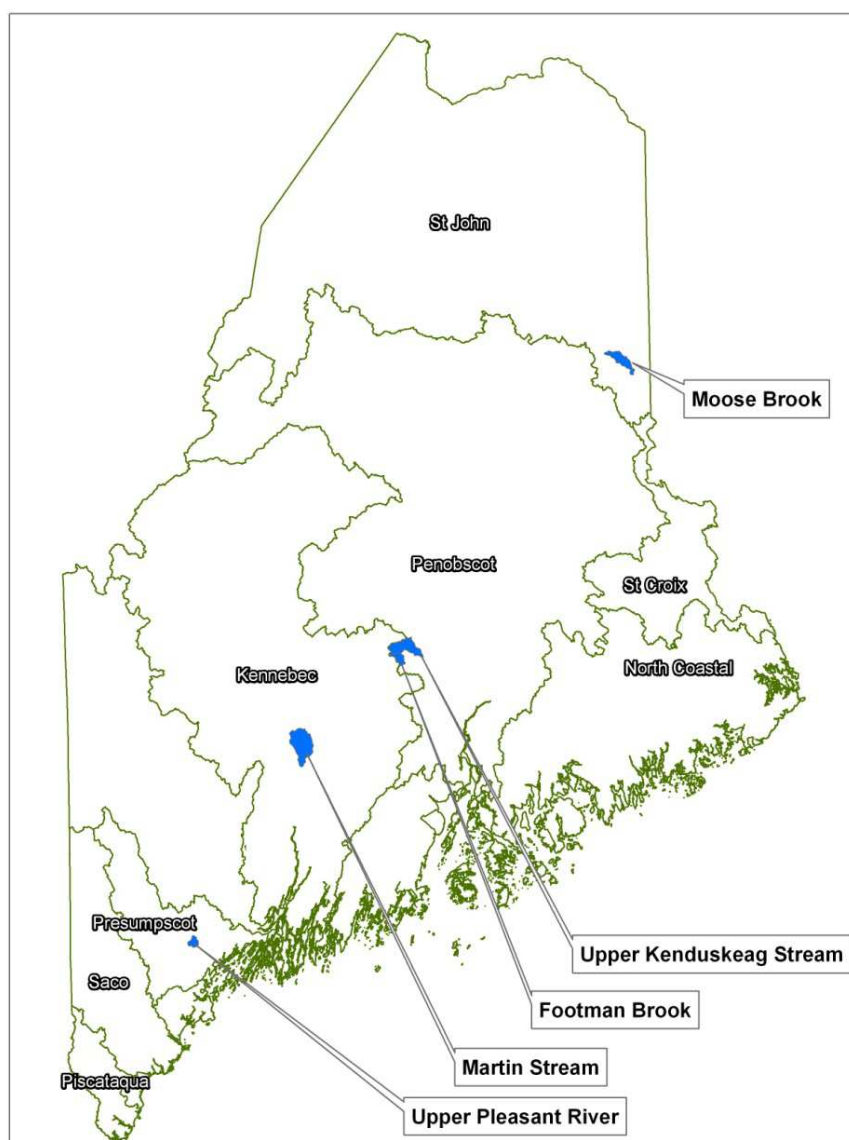
Figure 2: *Attainment streams used in this TMDL.*

Table 2: Attainment Streams and the TMDL Figures

Attainment Streams	Town	TP load (kg/ha/yr)	TN load (kg/ha/yr)	Sediment load (1000 kg/ha/yr)
Martin Stream	Fairfield	0.14	3.4	0.008
Footman Brook	Exeter	0.33	6.4	0.058
Upper Kenduskeag Stream	Corinth	0.29	5.6	0.047
Upper Pleasant River	Gray	0.22	4.6	0.016
Moose Brook	Houlton	0.25	5.9	0.022
Total Maximum Daily Load:		**0.24**	**5.2**	**0.030**

FOOTMAN BROOK DESCRIPTION

Footman Brook is located in the Penobscot Rivershed in the towns of Corinna and Exeter, Maine, with small portions of the watershed within the surrounding towns of Garland and Dexter. Covering an area of approximately 6.7 square miles, the watershed is predominantly forested (77%). Agricultural areas (15%) are located throughout the watershed and are concentrated along major roadways. The watershed is 3.6% developed, with development observed as low density rural-residential such as farm houses. Wetlands account for about 4% of the watershed and a little over 1% of the watershed consists of impervious cover.

Footman Brook is a statutory Class B stream that attained Class A numeric aquatic life criteria for benthic macroinvertebrates in 2001 at Station 309. Dissolved oxygen during the 2001 sampling event was above the Class B criterion of 7 ppm (1 data point).

Footman Brook at Station 309
Photo: FB Environmental

Footman Brook originates in a wetland area in Corinna and flows southeast through Corinna and Exeter. Sampling was conducted at Station 309, where Footman Brook crosses Exeter Road. The immediate surrounding landscape is forested, but there are corn fields just to the north of the sampling location.

Agricultural activities in the watershed are dominated by large hayfields, some of which appeared to be unmanaged. Row crops (primarily corn) are found in the southern portion of the watershed along Cider Hill Road and Exeter Road, and in the northeast section of the watershed at the intersection of Pullen and Otis Roads. Large hay fields were noted along Atkins Road and Airport Road. The only livestock observed were a few cows and a bull located on Atkins Road. Figure 3 (below) displays land use in the Footman Brook watershed.
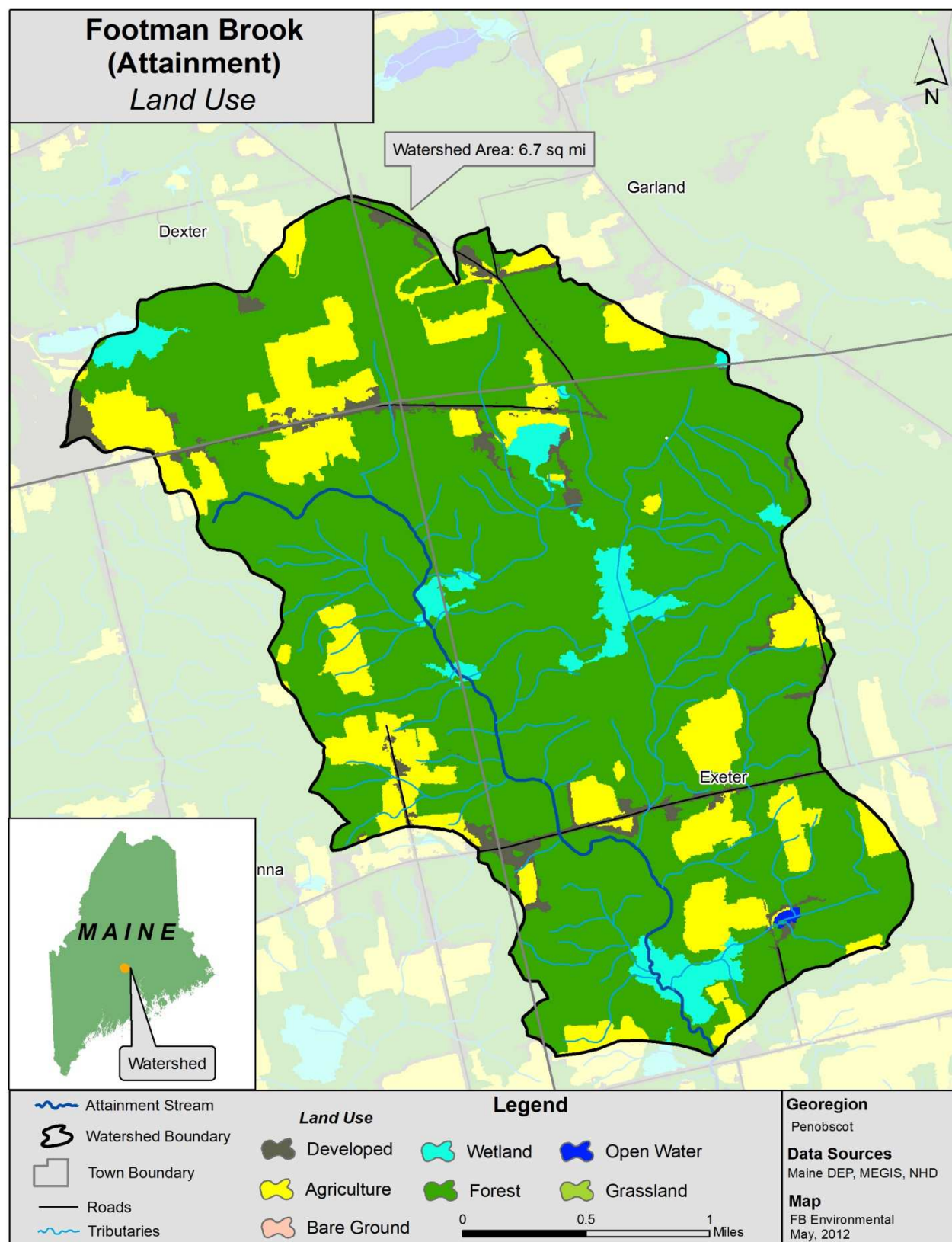
No portions of Footman Brook flow through or within 75 feet of agricultural areas. The entire length of Footman Brook is very well buffered, excluding the two road crossings on Cider Hill Road and Exeter Road which were also observed as well vegetated.

Figure 3: Land Use in the Footman Brook Watershed

MARTIN STREAM DESCRIPTION

Martin Stream is located in the Kennebec Rivershed in the towns of Fairfield, Norridgewock and Oakland. The majority of the watershed is located within the town of Fairfield but small portions of the watershed are located within the surrounding towns of Skowhegan, Norridgewock Smithfield and Oakland. The watershed covers approximately 42 square miles and is composed primarily of forest (82%) and wetland (9%) with some areas of development (3%) and agriculture (6%).

Martin Stream is a statutory Class B stream that attained Class B numeric aquatic life criteria for benthic macroinvertebrates in 2012 at Station 609, and narrative aquatic life standards for algae in 2002 and 2012. Dissolved oxygen measured twice in 2012 at Station 609 was once slightly below the Class B criterion of 7 ppm (at 6.7 ppm) and once above the criterion. No major hotspots were found during the NPS survey.

Martin Stream begins just south of Hussey Hill Road in Oakland, ME, continues north through forested land, crosses the Oakland-Fairfield border, turns northwest to follow parallel to and cross Martin

Martin Stream *near Station 609*
and the Middle Road (Route 104) Crossing
Photo: FB Environmental

Stream Road in Fairfield, flows east at the confluence with Alder Brook, crosses Norridgewock Road (Route 139) in Fairfield, flows southeast, and ends near the sampling site (Station 609) at the Middle Road (Route 104) crossing in Fairfield. Multiple tributaries flow into Martin Stream, particularly Alder Brook and Tobey Brook in Norridgewock, and Lost Brook in Fairfield.
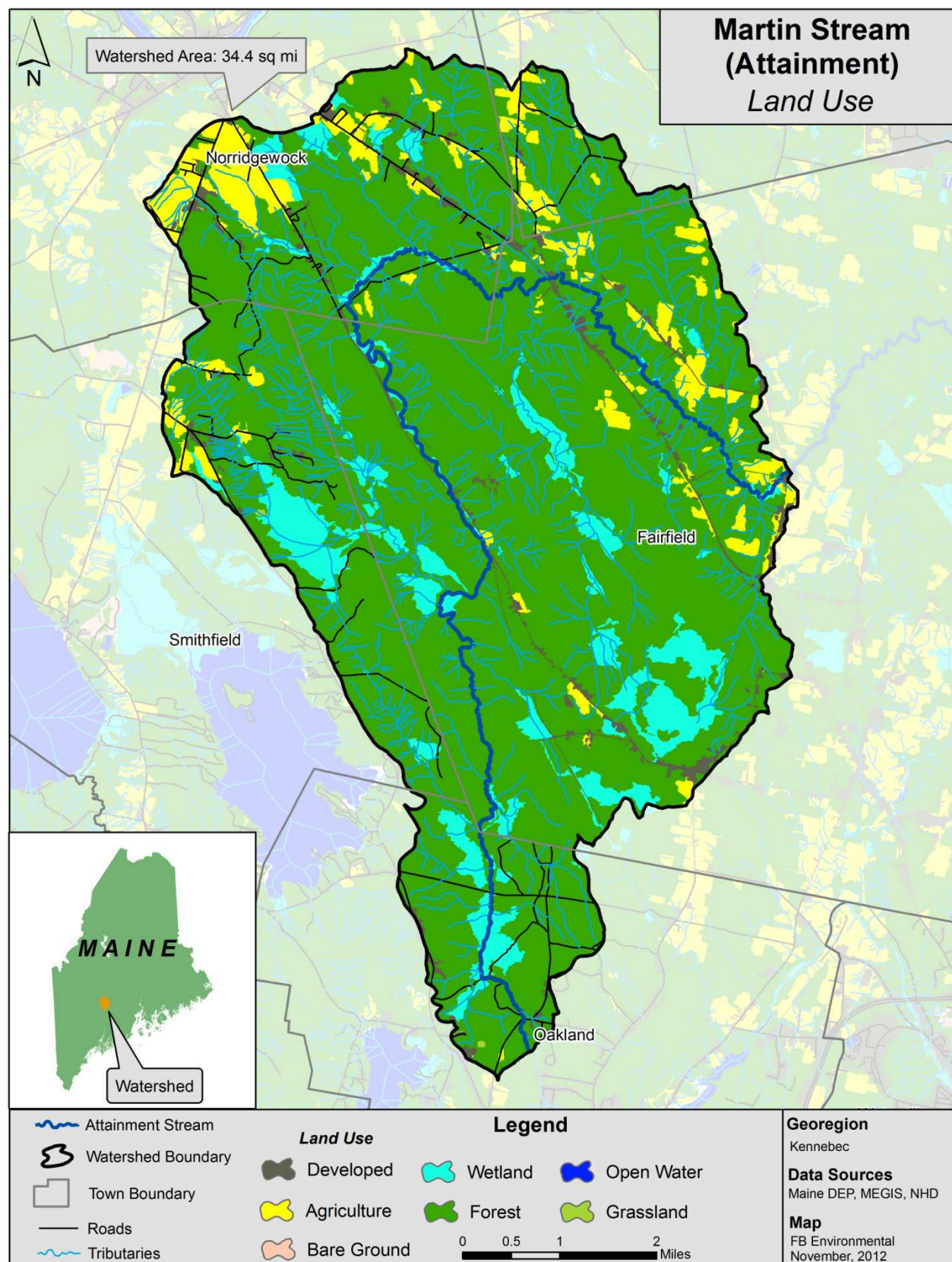
Low-density residential development is found along Martin Stream Road and Norridgewock Road. Some agricultural areas, mainly hayfields and some livestock, were observed on the northern end of Martin Stream Road and along Covell Road in Norridgewock and Fairfield, respectively. Figure 5 (below) displays land use in the Martin Stream watershed.

As shown in Figure 6, 1.2 miles of Martin Stream and tributaries flow through or within 75 feet of agricultural areas, and 1.1 miles, or 92%, of these areas have vegetative buffers.
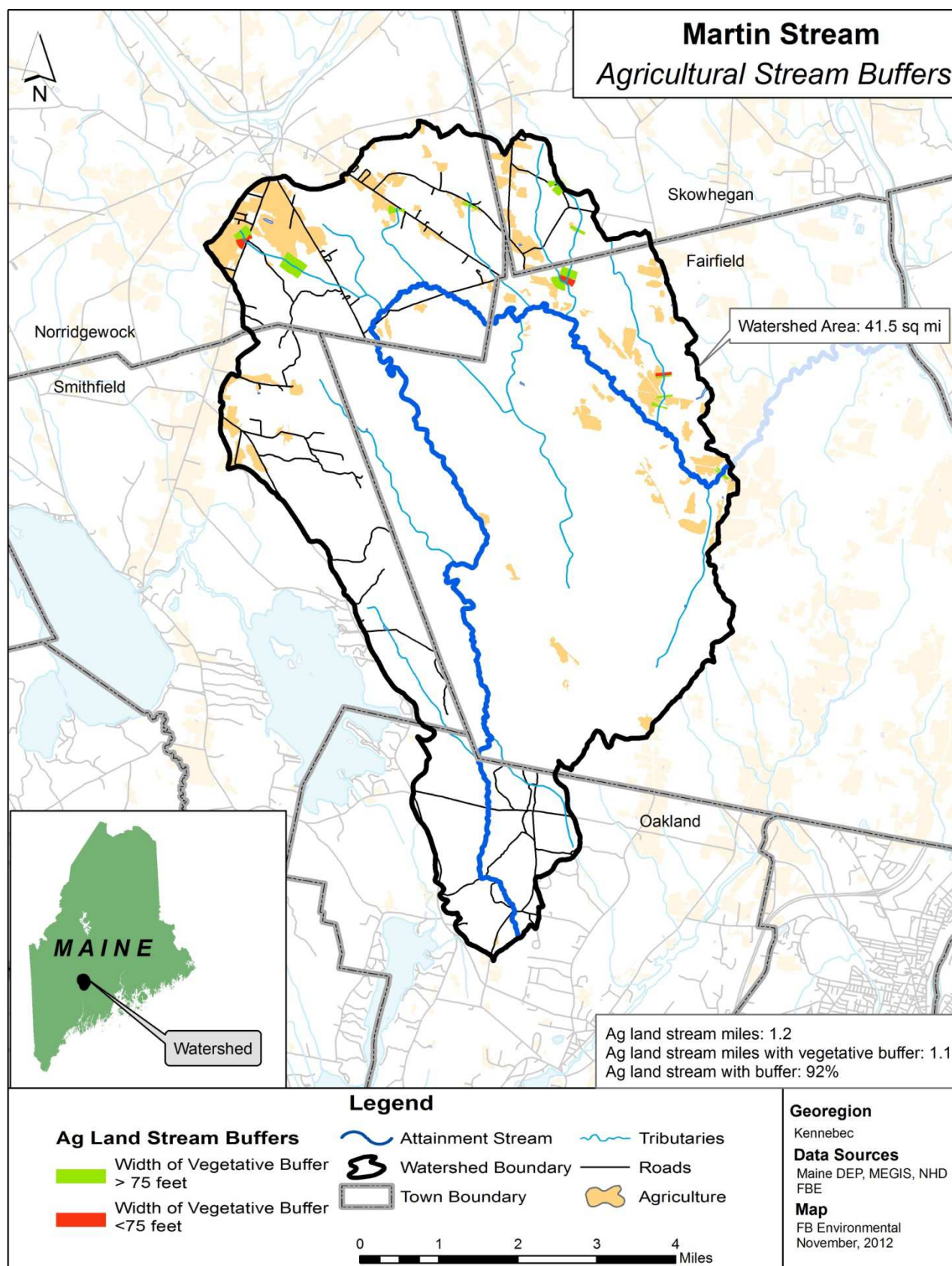
Figure 5: Land Use in the Martin Stream Watershed. Note that the watershed size is incorrectly indicated as 34.4 square miles. Martin Stream Description, above, and Figure 6, below, provide the correct size of 41.5 square miles.

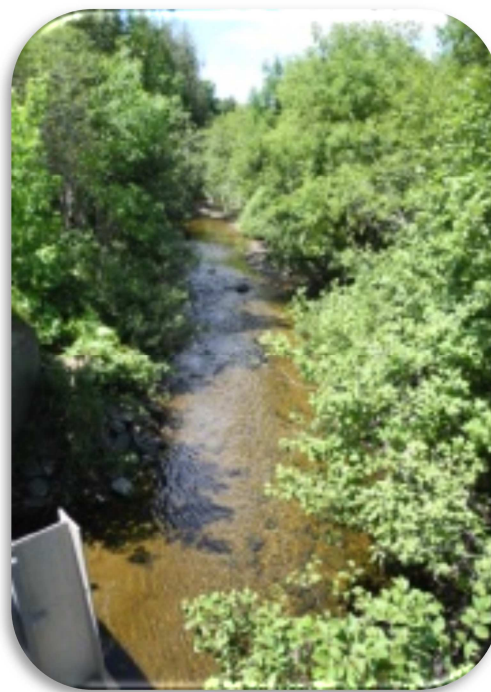**Figure 6:** Agricultural Stream Buffers in the Martin Stream Watershed

MOOSE BROOK DESCRIPTION

Moose Brook located in the St. John Rivershed in the towns of Hammond, Ludlow, Houlton and New Limerick, Maine. The majority of the watershed is located within the town of Ludlow but small portions of the watershed are located within the surrounding towns of Hammond, Houlton and New Limerick. The watershed covers an area of 17.2 square miles and is mainly forested (63%) with large agricultural areas (18%) concentrated in the downstream or south-eastern portion of the watershed. The upstream forested areas and wetland complexes (16%) likely help maintain a healthy stream as it moves though more agriculturally developed areas. The stream is mostly well buffered by natural vegetation. The Moose Brook watershed has minimal development (3%).

Moose Brook is a statutory Class B stream that attained Class B numeric aquatic life criteria for benthic macroinvertebrates in 1999 and 2000 at Stations 466 and 467. It also attained narrative aquatic life standards for algae in 1999 at Stations 466 and 467, and in 2004 at Station 467. Dissolved oxygen measured on three occasions in 2004 and 2005 at Stations 466 and 467 was above the Class B criterion of 7 ppm.

Moose Brook at the
Route 2 crossing.
Photo: FB Environmental

Large areas of crop land in the lower watershed contain potential for erosion and runoff, but may be well buffered by the large amount of forested land within the watershed. Only 10 cows were observed in the watershed during the NPS survey. Figure 7 (below) shows land use in the Moose Brook watershed.
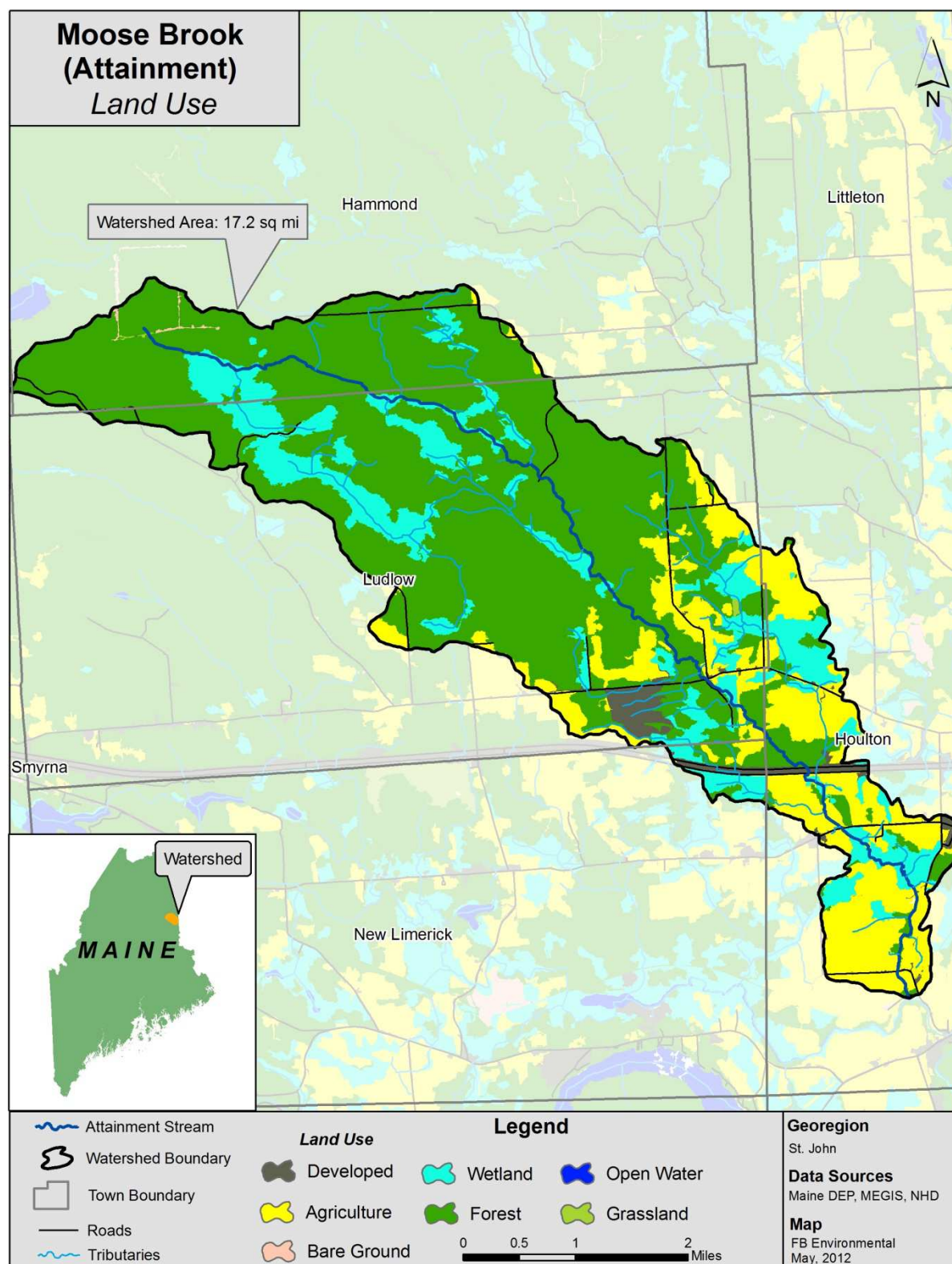
As shown in Figure 8, 1.2 miles of Moose Brook and tributaries flow through or within 75 feet of agricultural areas, and 0.9 miles, or 75%, of these portions have vegetative buffers.
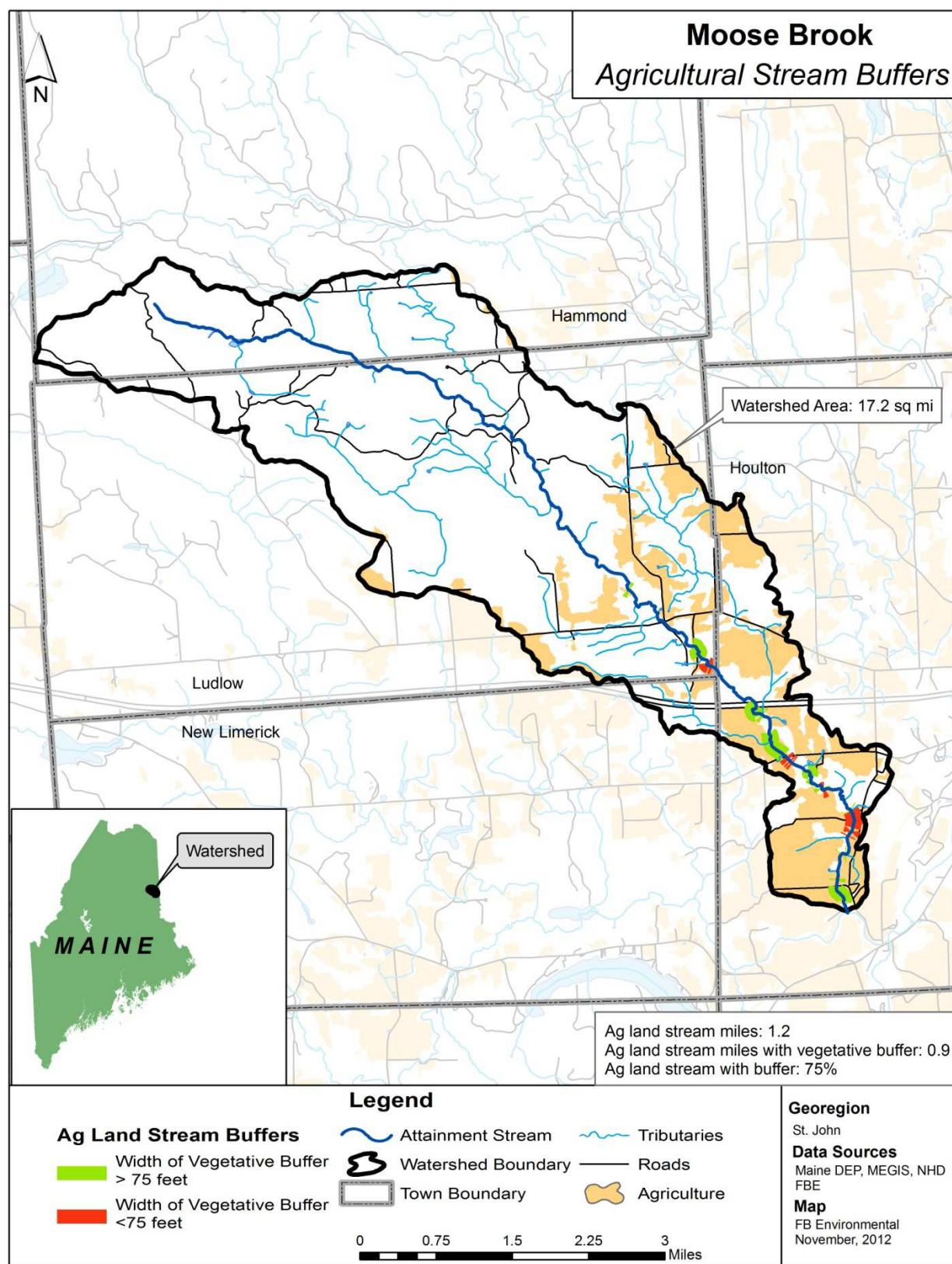
Figure 7: Land Use in the Moose Brook Watershed

Figure 8: Agricultural Stream Buffers in the Moose Brook Watershed

UPPER KENDUSKEAG STREAM DESCRIPTION

The Upper Kenduskeag Stream is located the Penobscot Rivershed in the towns of Dexter, Garland, Exeter, and Corinth, with the majority of the watershed located within Garland; a small portion of the watershed is also located within the town of Charleston. The watershed covers approximately 26 square miles, and is predominantly forested (74%), with large agricultural fields (13%) scattered throughout and rural residential development along roadways. The Upper Kenduskeag Stream watershed is lightly developed (6%) and has some wetlands (6.5%) concentrated primarily in the downstream eastern portion of the watershed. See Figure 9 (below) for land use in the Upper Kenduskeag watershed.

Upper Kenduskeag Stream at Station 508
Photo: FB Environmental

The Upper Kenduskeag Stream originates in a wetland area in Dexter and flows east and southeast crossing multiple roads to its endpoint at the Exeter Road crossing in Corinth (DEP Station 508). A total of 60 cows, 9 horses and 4 goats were observed within the watershed.
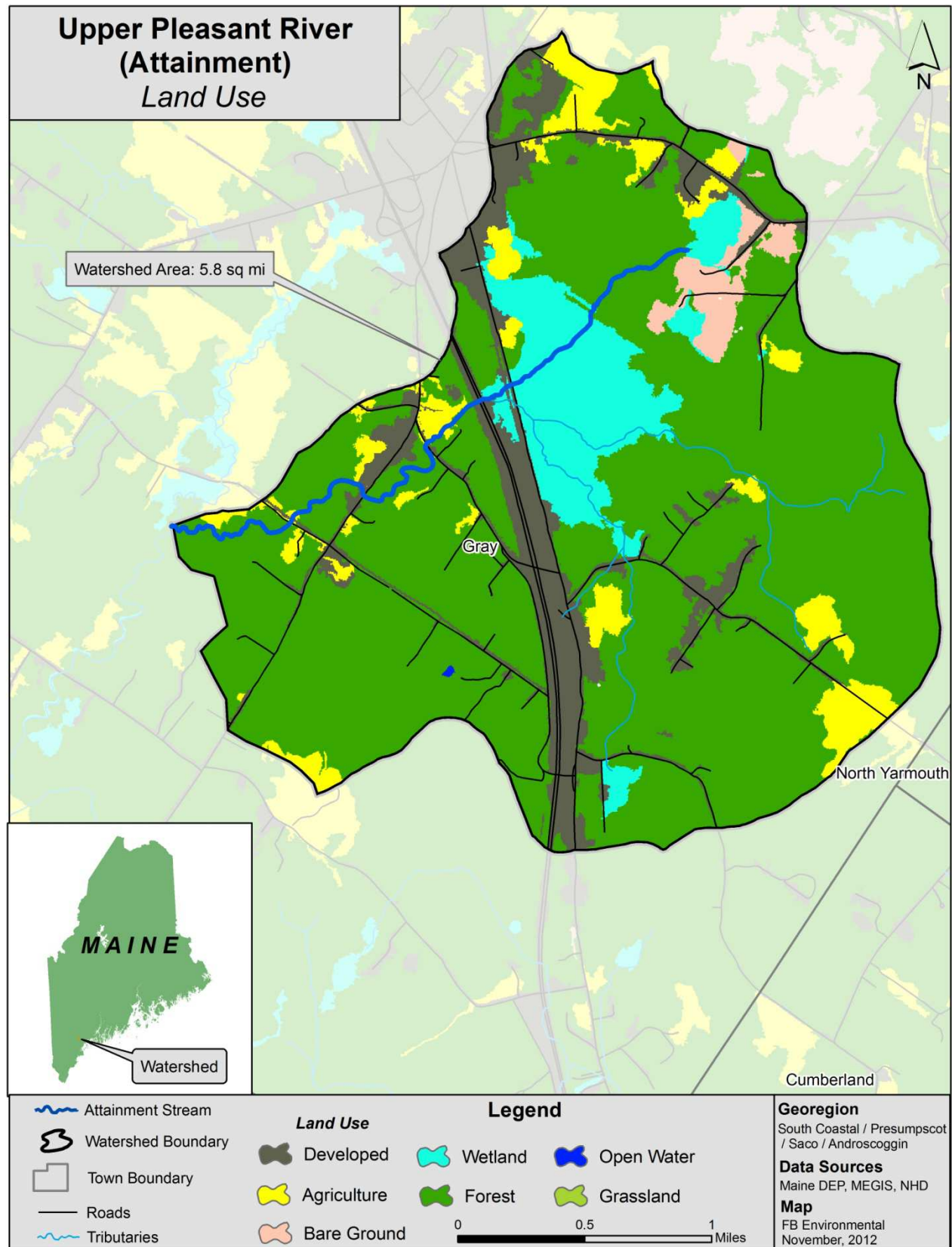
Upper Kenduskeag Stream is a statutory Class B stream that attained Class A numeric aquatic life criteria for benthic macroinvertebrates in 2001 and in 2011 at Station 508 in Corinth. The stream did not meet narrative aquatic life standards for algae in 2001 but attained Class A standards in 2011 at Station 508. Dissolved oxygen measured on six occasions in 2001, 2005 and 2011 at Station 508 was above the Class B criterion of 7 ppm.

As shown in Figure 10, 2.3 miles of Upper Kenduskeag Stream and tributaries flow through or within 75 feet of agricultural areas, and 0.8 miles, or 35%, of these portions have vegetative buffers.
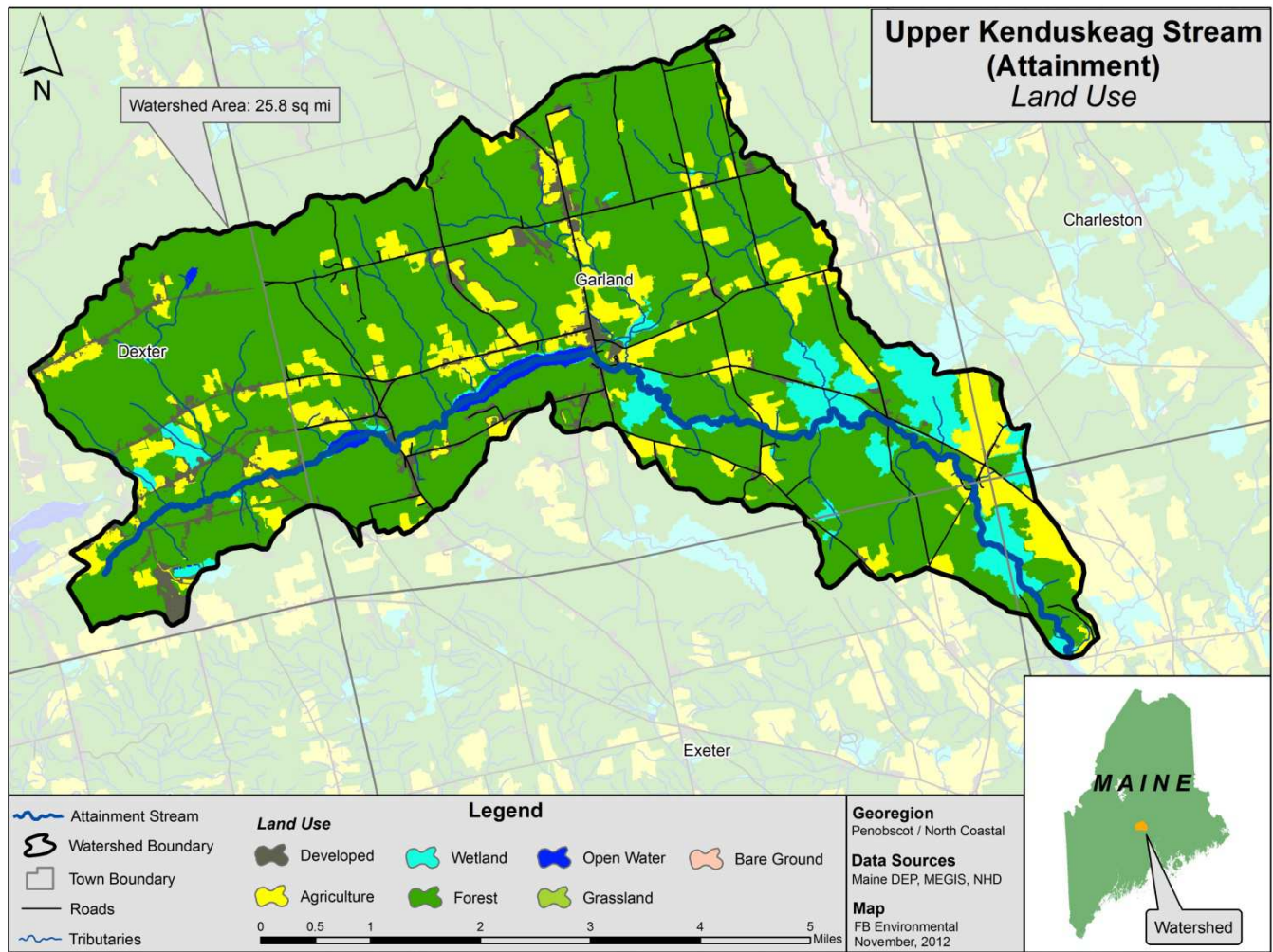
Figure 9: Land Use in the Upper Kenduskeag Stream Watershed
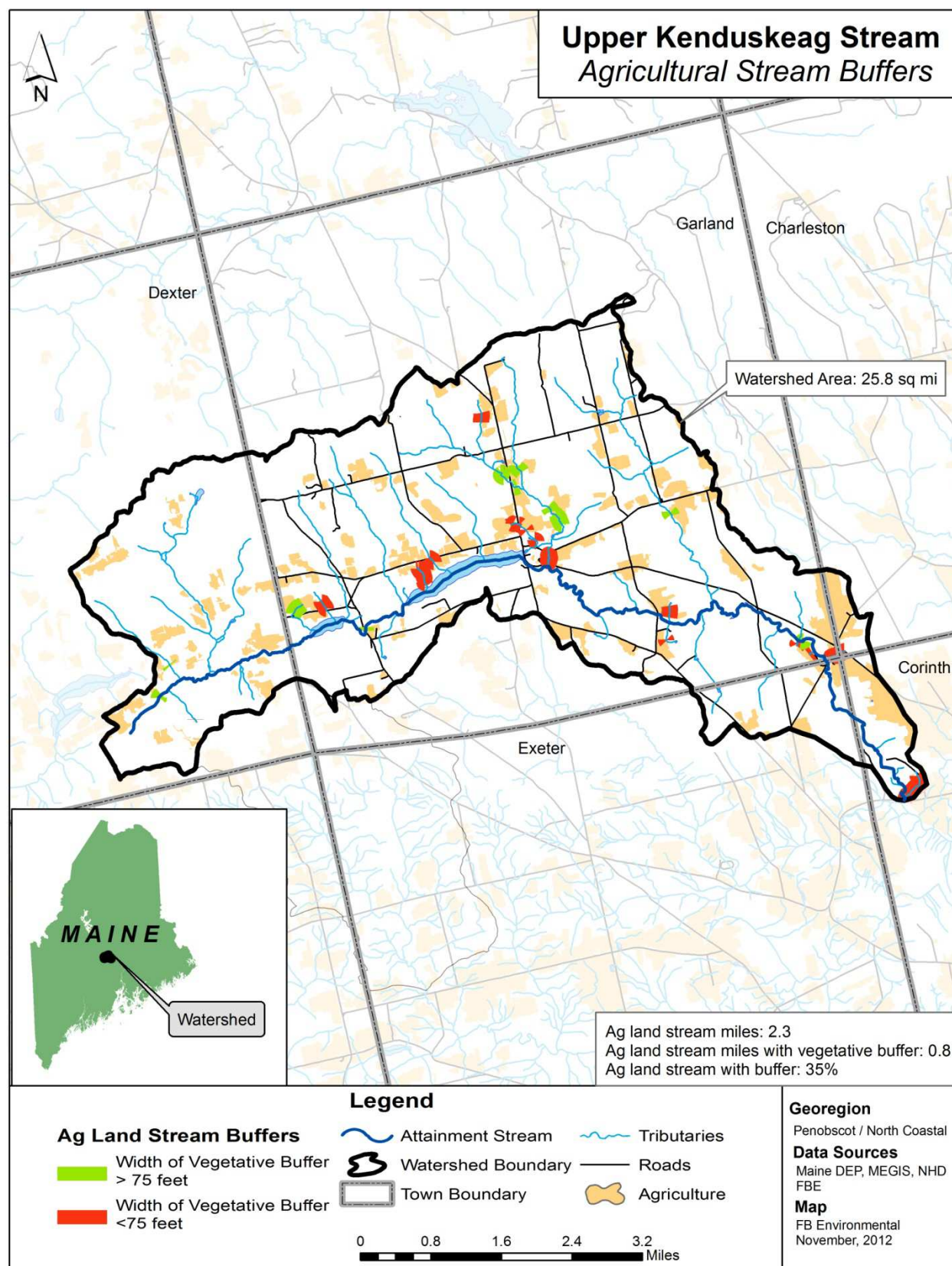
Figure 10: Agricultural Stream Buffers in the Upper Kenduskeag Stream Watershed

UPPER PLEASANT RIVER DESCRIPTION

The Upper Pleasant River is located in the south coastal region and covers 5.8 square miles in the town of Gray, Maine. The watershed is predominantly forested (71.3%), but has some agricultural areas (6.4%) and developed land (11.9%). See Figure 11 (below) for land use in the Upper Pleasant River watershed.

The river originates in a forested area in the northern portion of the watershed. It then flows southwest through a wetland and across two major roadways (Interstate 95 and Portland Road) that run north-south bisecting the watershed. The Upper Pleasant River then continues east into a low density residential area, intersects three roadways (Hunt's Hill Road, Barker Avenue, and Totten Road) before its confluence with the Pleasant River.

Upper Pleasant River at Station 394 on Totten Road in Gray. Photo: FB Environmental

Upper Pleasant River is a statutory Class B stream that attained Class B numeric aquatic life criteria for benthic macroinvertebrates in 1999, 2005 and 2010 at Station 394. It also attained narrative aquatic life standards for algae at Station 394 in 1999, 2000, 2005, and 2010. Dissolved oxygen measured on seven occasions in 2005 and 2010 at Station 394 was below the Class B criterion of 7 ppm (at 6.5 ppm) on two occasions but above the criterion on five occasions. Maine DEP staff attributed the low values to the effects of the large wetland at Gray Meadows rather than nonpoint source pollution (Evers, personal communication).

As shown in Figure 12, 0.2 miles of Upper Pleasant River and tributaries flow through or within 75 feet of agricultural areas, and 0.09 miles, or 45%, of these portions have vegetative buffers.
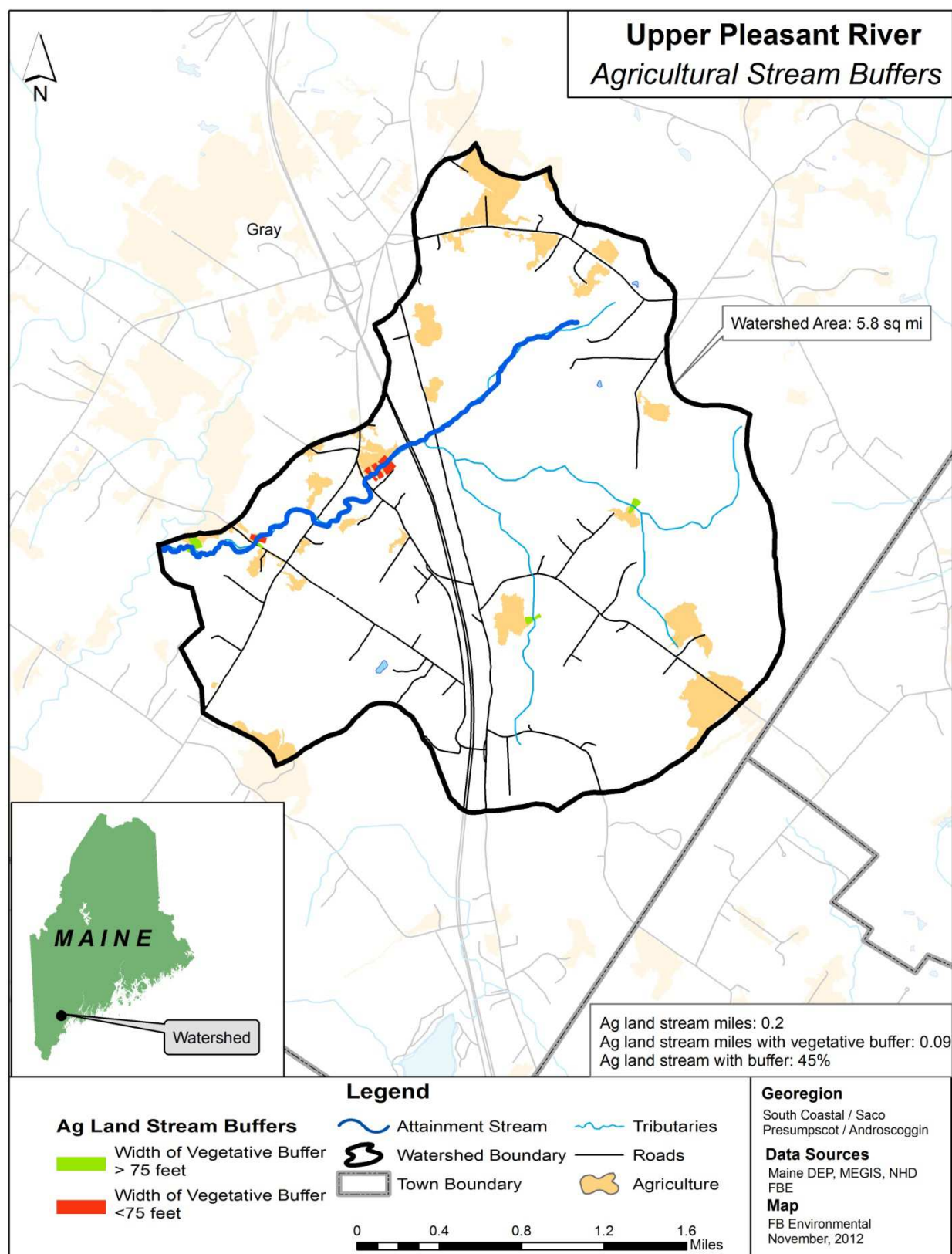
**Figure 11:** Land Use in the Upper Pleasant River Watershed

Figure 12: Agricultural Stream Buffers in the Upper Pleasant River Watershed

RAPID HABITAT ASSESSMENT

A Habitat Assessment survey was conducted on both the impaired and attainment streams. The assessment approach is based on the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et al., 1999), which integrates various parameters relating to the structure of physical habitat. The habitat assessments include a general description of the site, physical characterization and visual assessment of in-stream and riparian habitat quality.

Based on Rapid Bioassessment protocols for low or high gradient streams, each attainment reach was given a score from 0 to 200. Higher scores indicate better quality of habitat. The range of habitat assessment scores for attainment streams was 155 to 179.

Habitat assessments were conducted on a relatively short sample reach (about 100-200 meters for a typical small stream) that was located near the most downstream Maine DEP sample station in the watershed. For both impaired and attainment streams, the assessment location was usually near a road crossing for ease of access. Further assessment of this parameter, including effects of proximity to road crossings and regional variation, is recommended. Figure 13 (right) shows habitat assessment scores for all attainment and impaired streams.
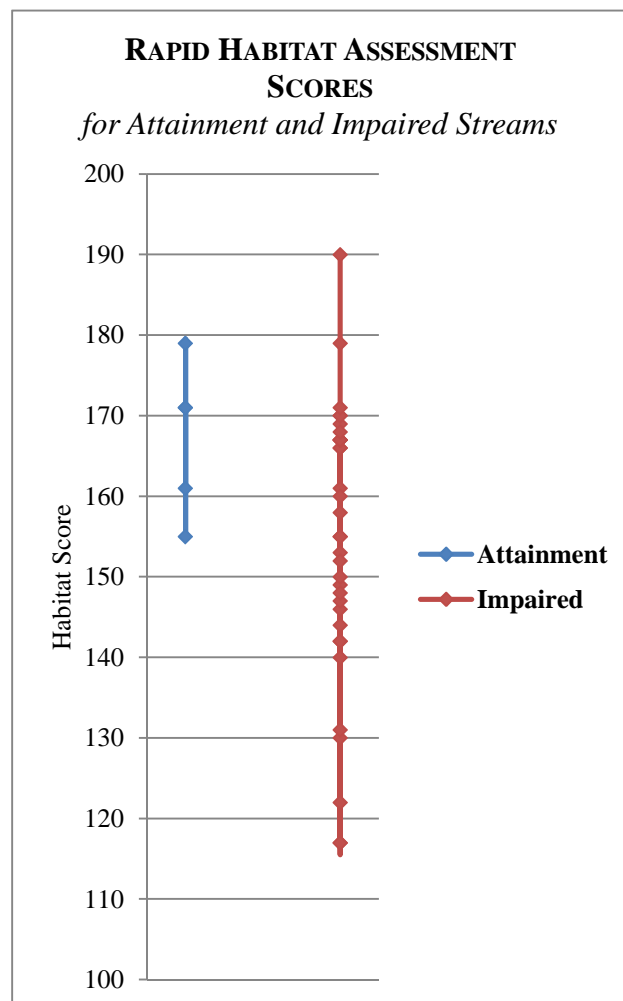
Figure 13: Habitat Assessment Scores

Livestock Estimates

MapShed automatically converts animal numbers into animal units (equal to 1000 kg of livestock), which have associated animal-specific nutrient production rates by livestock type. Manure and nutrient generation by livestock is added to nutrient runoff figures specific to each land use type. Manure is routed through three primary transport mechanisms: (1) Runoff from confined spaces, such as barnyards, (2) runoff from crop and pasture lands were animal waste has been applied, and (3) runoff from pasture from grazing animals. Pollutant loading due to livestock is provided in the MapShed results. Table 3 (below) provides estimates of livestock (numbers of animals) in the attainment stream watersheds.

The attainment streams, in general, show lower livestock numbers than in the majority of the impaired stream watersheds. Per square miles of watershed area, the figures remain very low and average just under 2 animals per square mile. In impaired watersheds, livestock numbers ranged from zero to 44 per square mile, with an average of 7.0 per square mile.

Table 3: Livestock Estimates in Attainment Stream Watersheds

Type	Footman Brook	Martin Stream	Moose Brook	Upper Kenduskeag Stream	Upper Pleasant River	Total
Dairy Cows			10	50	15	**75**
Beef Cows	5			10		**15**
Broilers						
Layers						
Hogs/Swine						
Sheep						
Horses				9		**9**
Turkeys						
Other				4		**4**
Total	**5**	**0**	**10**	**73**	**15**	**103**
						Average
Animals/sq. mi.	**1**	**0**	**1**	**3**	**3**	**1.6**

Vegetated Stream Buffer in Agricultural Areas

Vegetated stream buffers are areas of trees, shrubs, and/or grasses adjacent to streams, lakes, ponds or wetlands which provide nutrient loading attenuation (Evans & Corradini, 2012). MapShed considers natural vegetated stream buffers within agricultural areas as providing nutrient load attenuation. The width of buffer strips is not defined within the MapShed manual, and was considered to be 75 feet for this analysis. Geographic Information System (GIS) analysis of recent aerial photos along with field reconnaissance observations were used to estimate the number of agricultural stream miles with and without vegetative buffers, and these estimates were directly entered into the model.

As discussed in the attainment stream watershed descriptions above, very few portions of the attainment streams flow through or within 75 feet of agricultural lands. In cases where portions of the stream do flow near agricultural areas, the attainment streams are commonly very well buffered from agricultural runoff. Table 4 (below) displays agricultural stream miles and agricultural stream buffer miles for all attainment streams. Agricultural stream miles (as modeled) with a 75-foot vegetated buffer in the attainment stream watersheds ranged from 34% to 92% with an average of 61% buffered stream miles. By contrast, agricultural stream miles with buffers ranged from 6 to 100%, with an average of 49% in impaired watersheds.

Table 4: Vegetative Buffers to Agricultural Lands in Attainment Stream Watersheds

	Footman Brook	Martin Stream	Moose Brook	Upper Kenduskeag Stream	Upper Pleasant River	Average
Total Stream Miles* (As Modeled)	3.9	73.2	23.1	38.3	7.6	29.2
Agricultural Stream Miles	0	1.2	1.2	2.3	0.22	1.0
Percent Agricultural Stream Miles Buffered	n/a	92%	75%	35%	41%	61%

* Including tributaries.

Attenuation by Lakes, Ponds and Wetlands

MapShed considers depositional environments such as ponds and wetlands to attenuate watershed sediment loading. This information is entered into the model by a simple percentage of watershed draining to a pond or a wetland. The percent of watershed draining to a wetland in the attainment watersheds ranged from 15% to 60% with an average of 35% (Table 5, below). By comparison, the percent of watershed draining to a wetland in impaired stream watersheds ranged from 0% to 75%, with an average of 12%.

Table 5: Attenuation by Lakes, Ponds and Wetlands in the Attainment Stream Watersheds

	Footman Brook	**Martin Stream**	**Moose Brook**	**Upper Kenduskeag Stream**	**Upper Pleasant River**	**Average**
Watershed Area that is Wetland	4%	9%	16%	7%	9%	**9%**
Watershed Area Draining to Wetlands	18%	60%	20%	15%	60%	**35%**

NUTRIENT MODELING RESULTS

The MapShed model simulates surface runoff using daily weather inputs of rainfall and temperature. Erosion and sediment yields are estimated using monthly erosion calculations based on land use, soil composition, and slope values for each source area. A sediment delivery ratio based on the area of the watershed and a transport capacity based on average daily runoff is then applied to the calculated erosion figures. Sediment loading for each source area (i.e., land cover category) is then determined (Evans & Corradini, 2012).

Below in Tables 6, 7, and 8, loading for phosphorus, nitrogen, and sediment are presented for each of the attainment stream watersheds. There are two categories of loads: sources and pathways. The pathways represent additional loads which, according to MapShed developers, originally are derived from the same source categories, and in the same proportions, as the source loads (Evans, personal communication).

The MapShed output data selected for this TMDL is expressed as kilograms per hectare per year by source and land use category. The TMDL is the average of five attainment stream loading values for each pollutant, defining a single statewide TMDL. Daily values may be derived by dividing the annual figure by 365.

Table 6: Total Phosphorus Results and Total Maximum Daily Load Calculations for Attainment Streams

Total Phosphorus kg/yr					
Sources/Pathways	**Footman Brook**	**Martin Stream**	**Moose Brook**	**Upper Kenduskeag Stream**	**Upper Pleasant River**
Source Loads					
Hay/Pasture	57.1	93.8	36.5	204.4	47.3
Crop land	236.6	156.1	468.1	520.2	17.1
Forest	37.5	122.9	49.3	140.9	34.4
Wetland	3.4	28.5	27.0	20.7	6.5
Disturbed Land	0	0.3	3.5	0	0
Sandy Areas	0	0			
Low Density Mixed	0.3	9.1	7.8	3.9	10.7
Medium Density Mixed	0	0	0	0	0
High Density Mixed	28.0	86.7	23.1	175.2	28.0
Low Density Residential	0	0	0.3	0	2.7
Medium Density Residential	0	0	0	0	0
High Density Residential	0	0	0	0	0
Farm Animals	7.0	0.0	17.4	146.1	28.7
Septic Systems	0.8	19.4	0.8	3.2	4.2
Source Load Total:	370.6	516.9	633.7	1214.5	179.4
Pathway Load					
Stream Banks	1.0	13.2	5.7	20.1	1.7
Subsurface / Groundwater	197.4	953.9	496.2	718.5	142.9
Total Watershed Mass Load:	569.0	1484.1	1135.6	1953.1	323.9
Total Watershed area (ha):	1741	10,753	4564	6686	1504
Loading by Watershed	**0.33** kg/ha/yr	**0.14** kg/ha/yr	**0.25** kg/ha/yr	**0.29** kg/ha/yr	**0.22** kg/ha/yr
Total Maximum Daily Load (average of watersheds):	**0.24** kg/ha/yr				

Table 7: Total Nitrogen Results and Total Maximum Daily Load Calculations for Attainment Streams

Total Nitrogen kg/yr					
Sources/Pathways	Footman Brook	Martin Stream	Moose Brook	Upper Kenduskeag Stream	Upper Pleasant River
Source Loads					
Hay/Pasture	140.3	277.8	94.6	541.2	157.5
Crop land	1820.0	1609.8	4598.7	4646.7	180.2
Forest	646.2	2246.5	878.9	2404.6	644.8
Wetland	64.5	600.8	522.1	394.1	136.4
Disturbed Land	0	0.8	7.9	0	0
Sandy Areas		0.1			
Low Density Mixed	2.5	90.6	71.4	35.4	105.8
Medium Density Mixed	0	0	0	0	0
High Density Mixed	275.4	927.9	227.6	1713.6	299.6
Low Density Residential	0	0	2.6	0	26.5
Medium Density Residential	0	0	0	0	0
High Density Residential	0	0	0	0	0
Farm Animals	20.4	0	93.4	753.2	153.6
Septic Systems	112.2	1518.0	138.4	272.2	140.4
Source Load Total:	3081.5	7272.3	6635.3	10761.1	1844.8
Pathway Load					
Stream Banks	2.0	46.4	15.6	55.0	7.4
Subsurface / Groundwater	8128.8	28926.3	20255.3	26458.9	5132.0
Total Watershed Mass Load:	11212.2	36245.0	26906.2	37274.9	6984.2
Total Watershed area (ha):	1741	10,753	4564	6686	1504
Loading by Watershed	**6.44** kg/ha/yr	**3.37** kg/ha/yr	**5.90** kg/ha/yr	**5.58** kg/ha/yr	**4.64** kg/ha/yr
Total Maximum Daily Load (average of watersheds):	**5.2** kg/ha/yr				

Table 8: Total Sediment Results and Total Maximum Daily Load Calculations for Attainment Streams

Total Sediment 1000 kg/yr					
Sources/Pathways	**Footman Brook**	**Martin Stream**	**Moose Brook**	**Upper Kenduskeag Stream**	**Upper Pleasant River**
Source Loads					
Hay/Pasture	2.80	4.00	1.48	12.56	2.47
Crop land	82.76	21.50	59.92	149.85	4.76
Forest	5.51	16.92	6.06	24.72	4.87
Wetland	0.10	0.36	0.64	0.65	0.07
Disturbed Land	0	0.03	1.15	0	0
Sandy Areas		0.02			
Low Density Mixed	0.08	1.81	2.31	1.19	2.26
Medium Density Mixed	0	0	0	0	0
High Density Mixed	6.16	12.77	0.08	39.30	4.13
Low Density Residential	0	6.59	0	0	0.56
Medium Density Residential	0	0	0	0	0
High Density Residential	0	0	0	0	0
Farm Animals	0	0	0	0	0
Septic Systems	0	0	0	0	0
Source Load Total:	97.4	64.0	71.6	228.3	19.1
Pathway Load					
Stream Banks	2.89	26.78	22.75	87.74	4.43
Subsurface / Groundwater	0	0	0	0	0
Total Watershed Mass Load:	100.3	90.8	94.4	316.0	23.6
Total Watershed area (ha):	1741	10,753	4564	6686	1504
Loading by Watershed	**0.06** **1000 kg/ha/yr**	**0.01** **1000 kg/ha/yr**	**0.02** **1000 kg/ha/yr**	**0.05** **1000 kg/ha/yr**	**0.02** **1000 kg/ha/yr**
Total Maximum Daily Load (average of watersheds):	**0.030** **1000 kg/ha/yr**				

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Appendix 3: Agricultural Best Management Practices (BMPs) & Environmental Regulations

BEST MANAGEMENT PRACTICES

The following list of agricultural best management practices (BMPs) is based primarily on the '*User Guide for the Pollutant Reduction Impact Comparison Tool (PRedICT)*', and includes additional information specific to Maine. PRedICT is a software application developed for use in evaluating the implementation of both rural and urban pollution reduction strategies at the watershed level. This tool allows the user to create various "scenarios" in which current landscape conditions and pollutant loads (both point and nonpoint) can be compared against "future" conditions that reflect the use of different pollution reduction strategies such as agricultural and urban best management practices (BMPs), stream protection activities, the conversion of septic systems to centralized wastewater treatment, and upgrading of treatment plants from primary to secondary to tertiary.

Cover Crops

Involve the use of annual or perennial crops to reduce the amount of nutrient runoff and soil loss from fields during the time period between the harvesting and planting of the primary crop. Typically legumes are planted to cover the bare soil and replenish nitrogen to the cropland.

Conservation Tillage

Refers to the planned use of crop residue to protect the soil surface. There are many forms of this management practice including no-till planting, mulch tillage, and other tillage techniques. In general, conservation tillage is defined as any production system that leaves at least 30% of the soil surface covered with crop residue after planting. This BMP reduces soil disturbance and conserves the soil allowing for greater movement of water, less fertilizer use, and less soil compaction.

Strip-Cropping/Contour Farming

Contour farming refers to the practice of conducting tillage, planting and harvesting operations perpendicular to the gradient of a hill or slope in order to reduce erosion. This practice is usually most effective on moderate slopes of 3-8% when there are measurable ridges left from tillage and/or planting operations that serve as miniature terraces, retarding runoff and increasing infiltration. Strip-cropping refers to the system of placing crops in strips or bands on or near the contour. This practice involves alternating strips with high-residue cover or perennial crops with strips with low residue cover.

Conservation Plan

A plan designed to help better manage the natural resources of a farm. A conservation plan includes: an aerial photo or diagram of agricultural fields, a list of management decisions, the location of and schedule for applying new conservation practices, a soil map and soil descriptions, information sheets explaining how to carry out the specific management decisions, and a plan for operation and maintenance of practices, if needed. A conservation plan is required if a farm is participating in any of NRCS's programs.

Nutrient Management

Controlling the timing, amount, application method, source and placement of plant nutrients through the use of nutrient enhancers (fertilizers). Augmenting nutrients in soils increases the chance of higher nutrient outputs to groundwater and other basins. By controlling application variables, a landowner can limit the amount of non-point source enriched runoff. Entails a farm-wide nutrient management plan that is based on established Maine Department of Agriculture, Conservation, and Forestry criteria.

Grazing Land Management

Refers to the utilization of practices that ensure adequate vegetation cover in order to prevent excessive soil erosion due to over-grazing and other forms of overuse. This is usually achieved by rotating animals, changing feeding locations, alternating crops with grazing, etc. Grazing land management practices, such as rotational grazing, protect land areas from excessive soil erosion and add needed nitrogen to the soil base.

Agricultural Land Retirement

Involves allowing cultivated land to revert back to a "natural" state of vegetative cover to reduce the export of sediment and nutrients due to agricultural activities. Includes the conversion of agricultural land to both forest and wetlands.

Livestock AWMS (Animal Waste Management Systems)

May include a variety of practices, including techniques to (1) limit waste runoff, such as cementing and curbing animal confinement areas or planting grassed buffers around these areas; (2) collect and store waste, such as scraping or flushing systems and storage tanks or retention ponds; or (3) alter or treat waste, such as reformulating feed mixes or composting, among others. A farmer's selection of a particular practice or system of practices depends on site-specific factors, the type and volume of waste to be managed and the proximity of the production facility to surface water or groundwater, cost considerations, and state and local regulations.

Runoff Control

Runoff management allows farmers to direct rainwater and/or other runoff water away from their manure storage facilities and confined animal feeding areas. Techniques include roof gutters, surface water diversions, drip trenches, grass filter buffers, sediment basins, subsurface drainage, and evaporative or shallow holding ponds in drier conditions.

Phytase in Feed

Phytase is a naturally produced enzyme that targets phytic acid. Breaking down phytic acid from feed allows inorganic phosphorus to be absorbed by the stomach and not excreted into the environment. Supplementing phytase in feed further increases phosphorus uptake.

Streambank Vegetated Buffer Strips

Planted vegetation to be used for filtering of runoff, wind relief, detoxifying properties, crop separation, stream erosion prevention, etc. Streambank buffers should consist of native plants. Some buffers are used to reduce wind on flat crop land. All buffers are aimed at reducing nutrient and soil runoff and pollutants from activities.

Streambank Stabilization and Fencing

Collectively refers to several practices that can be employed for the purpose of mitigating the effects that eroding or slumping stream banks have on adjacent streams. The most frequently used form of protection is fencing that prohibits livestock from trampling stream banks, destroying protective vegetation, and stirring up sediment in the streambed. In addition to reducing direct soil loss caused by stream bank degradation, fencing also reduces nutrient loads caused by defecation and urination of the animals in the stream. *Streambank protection* also often involves the use of *stable crossings* and/or *streambank stabilization* measures such as the rip-rap, gabion walls, or bioengineered solutions.

REGULATIONS

There exist a number of federal and state laws designed to protect the environment. These laws are intended to be incorporated into local town ordinances, providing protection for wildlife habitat, water and air quality, and endangered and threatened species. Major laws pertaining to habitat conservation and local land-use planning include the Federal Endangered Species Act and the Clean Water Act, both of which are federally mandated laws. Additional laws mandated by the state of Maine include:

- **The Protection and Improvement of Waters Law** regulates activities which discharge or could potentially discharge materials into waters of the state (rivers, streams, brooks, lakes and ponds and tidal waters). This law requires that a license be obtained before directly or indirectly discharging any pollutant. **Source:** http://www.maine.gov/dep/water/laws/index.html

- **The Erosion and Sedimentation Control Law** regulates activities involving filling, displacing or exposing soil. Erosion is one of the primary sources of nutrients leading to degraded water quality in

lakes, streams, and coastal waters. This law provides a brief and basic standard requiring that erosion control practices be in place prior to earthmoving, and that erosion and sedimentation must not leave the project site. **Source:** http://www.maine.gov/dep/land/erosion/index.html

- **The Natural Resources Protection Act** (NRPA) regulates activities in, on, over or adjacent to lakes, ponds, rivers, streams, brooks, freshwater wetlands and tidal areas. Activities regulated under the NRPA include disturbing soil, placing fill, dredging, removing or displacing soil, sand or vegetation, draining or dewatering, and building permanent structures, in, on, over or adjacent to these areas. **Source:** http://www.maine.gov/dep/land/nrpa/

- **Shoreland Zoning** was enacted to prevent water pollution, and damage to the natural beauty and habitat provided by Maine's surface waters. The law targets development along the immediate shoreline of these resources and requires towns to enact a Shoreland zoning ordinance at least as stringent as a model ordinance developed by the state. **Source:** http://www.maine.gov/dep/land/slz/

- **The Maine Endangered Species Act** was passed in 1975 by the State Legislature. The Act provides the Maine Department of Inland Fisheries & Wildlife with a mandate to conserve all of the species of fish and wildlife found in the State, as well as the ecosystems upon which they depend. Source: http://maine.gov/ifw/wildlife/species/endangered_species/es_act_part13.htm

- **The Wetlands and Waterbodies Protection** rule recognizes important roles of wetlands in our natural environment and supports the nation-wide goal of no net loss of wetland functions and values. In some cases, however, the level of mitigation necessary to achieve no net loss of wetland functions and values through construction of replacement wetlands will not be practicable, or will have an insignificant effect in protecting the State's wetlands resources. In other cases, the preservation of unprotected wetlands or adjacent uplands may achieve a greater level of protection to the environment than would be achieved by strict application of a no net loss standard through construction of replacement wetlands. Therefore, the rule recognizes that a loss in wetland functions and values may not be avoided in every instance. The purpose of this rule is to ensure that the standards set forth in Section 480-D of the NRPA, Section 464, Classification of Maine Waters and Section 465, Standards for Classification of Fresh Surface Waters are met by applicants proposing regulated activities in, on, over or adjacent to a wetland or water body. **Source:** http://www.maine.gov/dep/land/nrpa/ip-wetl.html

- **The Maine Nutrient Management Law (1998)** requires that a farm have and implement an approved nutrient management plan if it meets one or more of the following criteria, (a) farm confines and feeds 50 or more animal units (50,000 lbs.) at any one time, (b) farm utilizes more than 100 tons of manure per year not generated on that farm, (c) farm is the subject of a verified improper manure handling complaint, and (d) farm stores and utilizes residuals (materials generated as a byproduct of a nonagricultural production or treatment process that have value as a source of crop nutrients or soil amendments). **Source:** http://www.maine.gov/agriculture/narr/nutrientmanagement.html

- **Maine Site Location of Development Law** recognizes that some developments because of their size and nature are capable of causing irreparable damage to the natural environment of the state. The law's intent is to address the adverse environmental effects of development and to minimize these

effects. The Board of Environmental Protection reviews each development on a case-by-case basis and issues permits for certain activities and developments. In order to obtain a permit, a storm water management plan designed to control a 25 year, 24-hour storm is required.
Source: http://www.maine.gov/dep/land/sitelaw/index.html

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Appendix 4: Overlap between Initially Proposed NPS TMDL Watersheds and Regulated MS4 Areas

Introduction

DEP received extensive comments on the TMDL, which are detailed in Appendix 5. Many stakeholders were concerned about the implications of MS4 regulations that may result from the approval of the TMDL. In response, DEP decided to map the overlap between these watersheds and regulated MS4 areas, as shown in Figures 1-3 and Table 1, which gives the percentage overlap. The result is that many of these watersheds have a small overlap between the two areas, while only Mosher Brook is completely contained in the regulated area. None of the streams listed in this appendix are currently proposed to be included in the NPS TMDL. This information may have implications for setting stream restoration priorities under the in MS4 program.

Table 1. Percent of overlap between NPS TMDL watersheds and MS4 regulated areas, by town and county.

TOWN	COUNTY	Watershed Name	ADB_ID	Total Watershed Area (sq. mi.)	Watershed Area within MS4 (sq. mi.)	Percent Area in MS4
Berwick	York	Adams Brook	ME0106000304_625R01	1.1	0.0	3.7
South Berwick	York	Adams Brook	ME0106000304_625R01	1.1	0.0	1.2
Gorham	Cumberland	Mosher Brook	ME0106000103_607R08	1.3	1.3	100.0
Westbrook	Cumberland	Inkhorn Brook	ME0106000103_607R07	3.9	0.1	2.9
Windham	Cumberland	Black Brook	ME0106000103_607R01	3.9	0.6	15.2
Windham	Cumberland	Colley Wright Brook	ME0106000103_607R03	7.7	1.6	21.0
Windham	Cumberland	Inkhorn Brook	ME0106000103_607R07	3.9	0.0	0.7
Windham	Cumberland	Otter Brook	ME0106000103_607R09	2.1	1.4	66.7
Windham	Cumberland	Pleasant River	ME0106000103_607R12	49.1	4.8	9.7
Lewiston	Androscoggin	No Name Brook	ME0104000210_418R02	15.4	7.6	49.2
Lewiston	Androscoggin	Stetson Brook	ME0104000208_413R03	14.9	1.7	11.1
Sabattus	Androscoggin	No Name Brook	ME0104000210_418R02	15.4	0.7	4.5

Figure 1. Adams Brook watershed and MS4 regulated area overlap in Berwick and South Berwick.
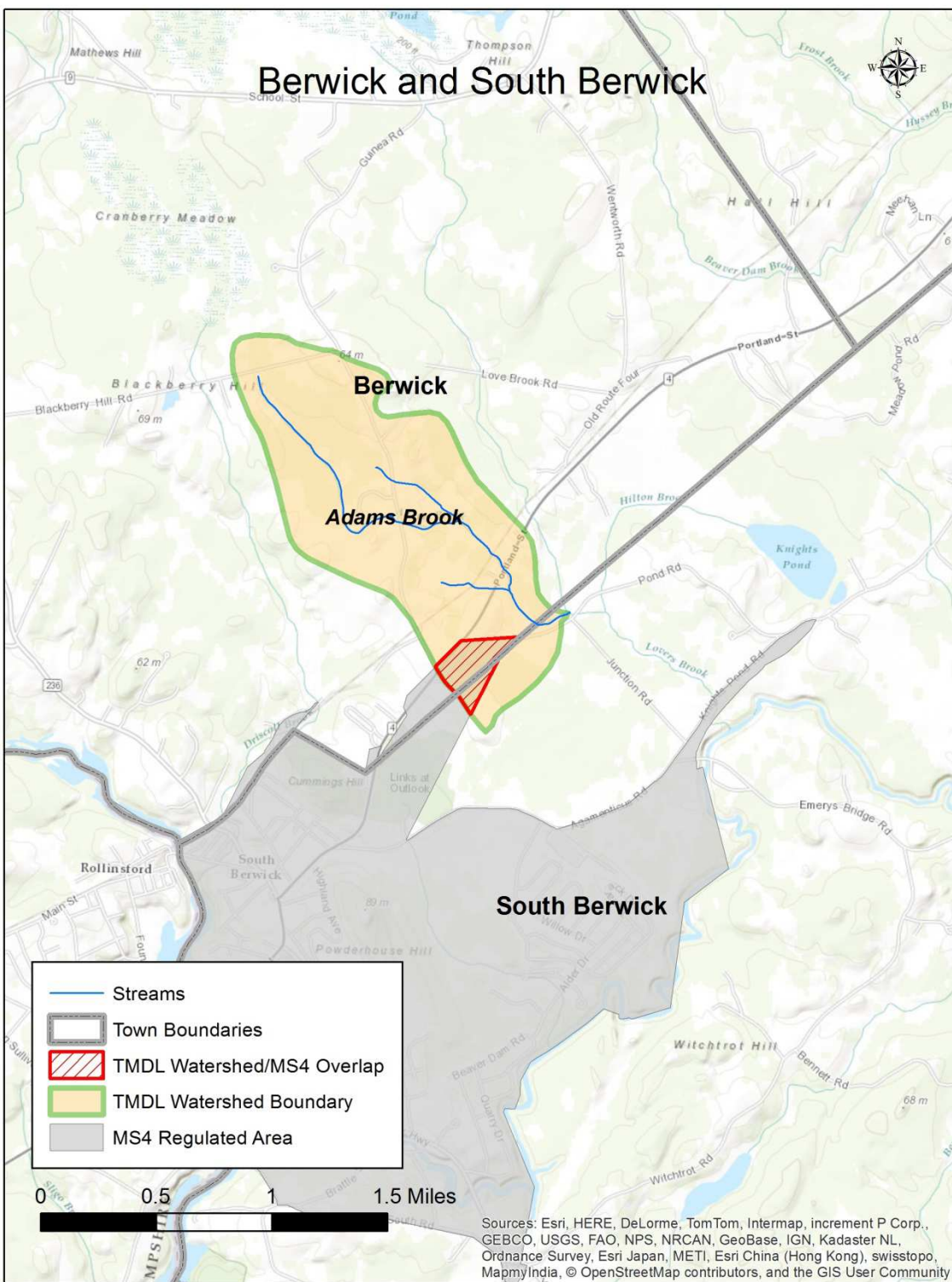
Figure 2. MS4 regulated area and NPS TMDL overlap in Windham, Gorham and Westbrook.
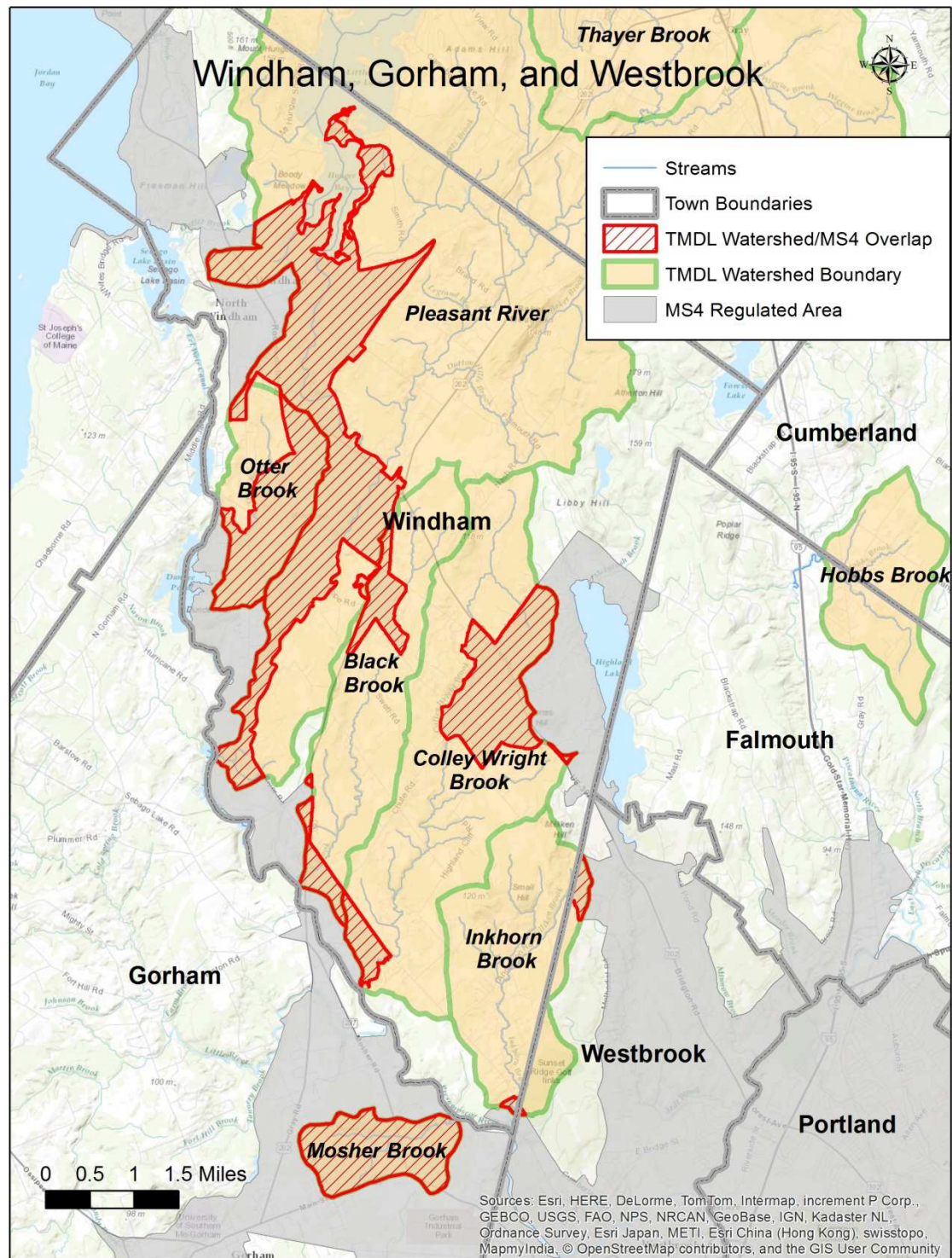
Figure 3. MS4 regulated area and NPS TMDL overlap in Lewiston and Sabattus.
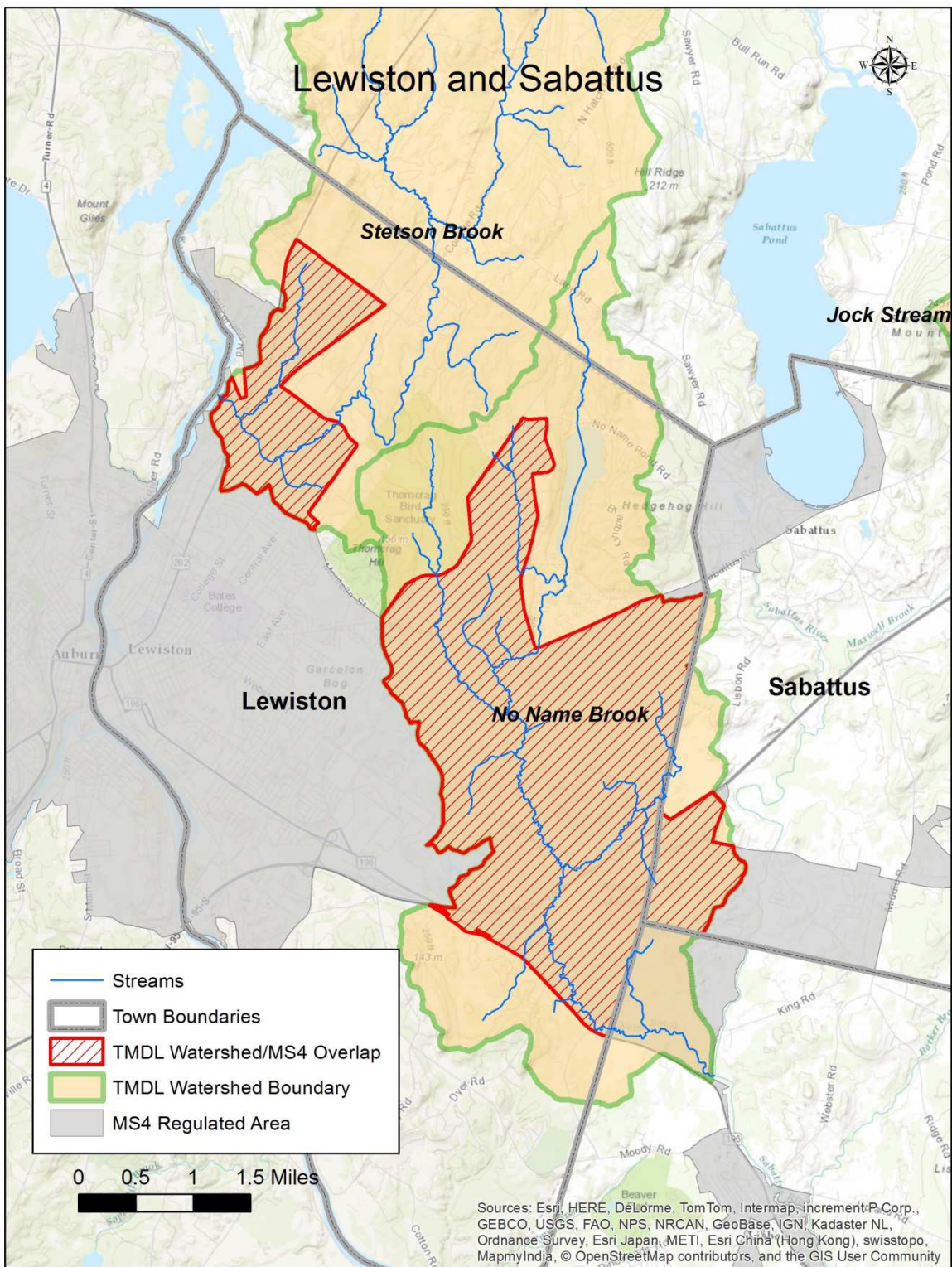
Appendix 5: Public Review Comments and Responses

Introduction

The Department received comments from eleven individuals or organizations on the NPS TMDL during the official public comment period from December 22, 2015 to January 29, 2016 and wishes to thank all persons who provided input. DEP received substantive comments from the parties listed below, and those comments are either quoted or paraphrased and presented in italic typeface. A DEP response follows each comment. The responses to comments do not include responses to editorial comments or errors, such as misidentified towns and watersheds listings; those issues were reviewed and corrected.

Almost all commenters requested more time to review the TMDL. DEP decided to not grant this request as the traditional 30-day review period had already been extended to 39 days. During that period stakeholders were able to make comments and had the opportunity to attend a public comment event. Many commenters were concerned about the implications for MS4-regulated communities that may result from the approval of the TMDL. DEP mapped the overlap between these NPS TMDL watersheds and regulated MS4 areas, as shown in Appendix 4. The DEP is continuing to assess how to account for the stormwater discharges from these regulated MS4s and has therefore removed those streams listed in Appendix 4 from this TMDL. The DEP does expect to include these in a future update to this TMDL. Any proposed revisions to the TMDL would only be made after providing opportunity for additional public comment.

Responses to Comments

Watershed Selection

Paraphrased comments from:

- Robyn Saunders, Cumberland County Soil and Water Conservation District (CCSWCD)
  Jami Fitch, CCSWCD – Interlocal Stormwater Working Group (ISWG) Facilitator
  Damon Yakovleff, CCSWCD Watershed Analyst
  These commenters will subsequently be referred to as 'CCSWCD/ISWG'
- Town of Falmouth
- Town of Windham
- Town of Gorham
- Albert Mosher, Gorham

What process was used to guide DEP's selection of the watersheds?

The process begins with a determination that a waterbody is impaired when monitoring results show that Maine's water quality standards (WQS) are not met. Waters that do not meet WQS are placed on the 303(d) list of impaired waters in Maine's biennial *Integrated Water Quality Monitoring and Assessment Report* (IR). The Clean Water Act (CWA) requires the development of TMDLs for impaired waters, and

USEPA requires states to set priorities and a timeline for TMDL development in the IR. Each stream-specific appendix in the NPS TMDL notes the data that was used to list the waterbody as impaired. In the 2008 IR, these streams were identified for TMDL development by 2009, but the process was delayed until 2015. The streams were included in the NPS TMDL because DEP's analysis indicated that the impairments were caused by nutrient enrichment and sedimentation issues.

Coordination of Watershed Sampling

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Town of Windham
- Town of Gray
- Town of Gorham
- Albert Mosher, Gorham
- Town of Raymond

What is DEP's protocol for coordinating and proactively communicating with municipalities and landowners on these TMDL efforts?

DEP relied on the public comment period to communicate with the public about the TMDL because the Department did not anticipate any regulatory effects. The information regarding impairment status of all Maine waters can be found in the IR, available on DEP's website. DEP also responds to specific requests for information from the public and proactively coordinates sampling efforts with stakeholders during the development of watershed management plans (WMPs).

Unintended Consequences

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Town of Windham
- Town of Gray
- Town of Gorham
- Albert Mosher, Gorham

Has DEP evaluated the possible unintended consequences of this TMDL and other regulatory requirements that could be contributing? Expectation that municipalities will become 'enforcers' of water quality standards. Impacts on family farming.

The current MS4 permit states that channelized stormwater runoff (a point source) from designated MS4 areas cannot cause or contribute to an impairment. The responsibility to address regulated stormwater runoff begins with the original 303(d) listing. The TMDL, which pertains to waters principally affected by

nonpoint sources (not regulated under the CWA), follows up on the impaired listing by identifying pollutant sources and estimating the pollutant reductions needed to meet water quality standards (WQS), as required by the CWA. The TMDL is a technical document that does recommend future actions to achieve healthy waters and this information is provided as guidance, not a regulatory prescription

The presence of a TMDL tends to increase community awareness of existing stream impairments and sometimes stimulates stakeholders to take action. There are no apparent unintended consequences on the streams covered by the Percent Impervious Cover (IC) TMDL, Statewide Bacteria TMDL (which included several streams also included in the NPS TMDL), Prestile Stream TMDL or the Dudley Brook TMDL. Progress is being made, with the assistance of 319 grants, to develop WMPs and implement BMPs on a subset of the streams covered by these TMDLs.

The NPS TMDL identifies pollutant sources and the reduction in pollutants needed to achieve WQS. Reductions will occur through the implementation of voluntary BMPs, not through enforcement of pollutant load limits. Responsibility for restoring impaired streams is not confined to a specific level of government and any successful restoration effort requires a partnership among stakeholders.

NPS TMDLs using this model have been approved in three other Maine agricultural watersheds and have existed for more than a decade, beginning with Fish Brook in Fairfield in 2005. These TMDLs rely on voluntary implementation of agricultural BMPs and do not deter farming activities. An approved TMDL generally increases eligibility for funding for farming practices through the Natural Resource Conservation Service (NRCS) and other agricultural funding agencies. If a municipality feels that these traditional sources of funding for agricultural BMPs may not be available to local farmers, it is a challenge that would be best explored during the development of a WMP.

With respect to regulatory impacts from regulated MS4 discharges, the DEP is continuing to assess how to account for those stormwater discharges and has therefore removed those streams listed in Appendix 4 from this TMDL.The DEP does expect to include these in a future update to this TMDL. Any proposed revisions to the TMDL would only be made after providing opportunity for additional public comment.

Communicating Financial Implications

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Town of Windham
- Town of Gray
- Town of Gorham
- Albert Mosher, Gorham
- Town of Raymond

How can lines of communication regarding natural resource priorities and financial implications be improved? Request that DEP conduct financial impact assessment for this TMDL, as would be done for

any other DEP rulemaking.

There is a cost associated with developing WMPs and there is a cost to having polluted waters flowing through our communities. There are financial challenges associated with cleaning up Maine's impaired waters and DEP has worked with municipalities to develop WMPs over the last decade to find reasonable solutions to meet these challenges, including providing funding. It is in the municipality's best interest to spearhead watershed planning because they have the local knowledge needed to integrate economic growth and community needs with water quality improvement projects. Through the WMP process the town has the ability to develop a reasonable timeline for implementation projects and seek grants that will in aid in accomplishing plan objectives,

Maine DEP has been developing TMDLs for at least two decades and they have never resulted in rulemaking for a variety of legal reasons and potential conflicts with the CWA. These TMDLs are not appropriate for Maine rulemaking because a rule (from the Secretary of State's website) 'is intended to have the same legal force as a statute, so that compliance could be compelled'. The NPS TMDL is not a document designed to measure compliance with the nutrient and sediment goals. DEP anticipates that compliance will be voluntary through the implementation of BMPs. Rulemaking would circumvent the flexibility in the stream restoration process, initiate a legal burden on implementation plans and alter the nature of WMPs.

Use of MapShed

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Garrison Beck, Midcoast Conservancy

Has DEP used this model before in ME? Request that DEP consider providing more information on limitations associated with the model and the data, especially with respect to buffers and landuse. How does DEP plan to share and distribute the watershed-specific information with each watershed and community? What does DEP see as their role in this data distribution effort?

In the event that other watersheds are added to the list of 30 streams included in this TMDL, how does DEP plan to make the public aware of the addition to the list of watersheds? What are the public notice requirements for adding watersheds to the list of 30 in the future?

DEP used MapShed for TMDLs on Prestile Stream and Dudley Brook, both of which have been approved by USEPA. The MapShed model was calibrated using data from Maine and the other New England states through a project sponsored by the New England Interstate Water Pollution Control Commission (NEIWPCC). As stated in the TMDL, the model does have assumptions, which is true of all models, and these assumptions have been documented in the MapShed literature (see TMDL Appendix 2). MapShed is a mid-range model that has been used for TMDLs in other states and the output is suitable for calculating

NPS load reductions that will result in the application of BMPs.

With respect to the use of stream buffers in the model, buffers on agricultural lands are treated as BMPs and used to adjust nutrient and sediment results from contributing landuses. Essentially, the model produces the nutrient and sediment values without riparian buffers, and then model runoff loads are adjusted based on the length and width of the riparian buffers. Riparian areas in agricultural lands that have no buffers do not contribute towards the load reductions. Additionally, buffer reductions do not apply on forested land. In the TMDLs, all appropriate reductions were made based on riparian condition, including buffers in excess of 75 feet.

As is customary with TMDLs, DEP will place all TMDL documents on the DEP website for use by the affected communities. If new waterbodies are proposed to be added to the NPS TMDL, the Department will notify stakeholders as appropriate. In addition, the standard public notice process for any draft TMDLs will be followed.

Selection of Attainment Streams

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Garrison Beck, Midcoast Conservancy

How did DEP choose the number and location of the five attainment sites? The list of five attainment streams is not representative of streams throughout the state, nor is it a large enough sample size.

DEP and the contract consultant, FB Environmental, reviewed DEP databases and GIS maps to find attainment streams whose watersheds had similar overall characteristics as the watersheds of the impaired streams. Attainment waters needed to have meaningful levels of agriculture and little urbanized area, and be known to attain WQS. It was challenging to find five attainment streams with agricultural development that could be used to set realistic water quality goals. The alternative would have been to use attainment streams with watersheds dominated by forested lands, which would have resulted in lower nutrient and sediment goals. Appendix 2 on the MapShed Model goes into depth on the characteristics of the attainment streams.

Water Quality Monitoring Stations

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Town of Cumberland
- Garrison Beck, Midcoast Conservancy

Where are the water quality (WQ) monitoring stations located within the watersheds? What was the

rationale for choosing the monitoring station locations?

Request that maps should be finished to professional standards and at higher resolution.

Monitoring and assessment stations for this TMDL were chosen based on access and representativeness. The same criteria are used for DEP WQ sampling in general.

Formatting watershed maps to fit on a single page does mean some details may be lost, but the maps provide reasonable depictions of the information in the TMDL report. Interested parties that are interested in more details may contact DEP for specifics.

WQ Monitoring Data

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Town of Cumberland
- Garrison Beck, Midcoast Conservancy

Data used in the TMDL are out of date and come from a limited number of monitoring stations. All data referenced in this draft TMDL report should be provided immediately for review.

The TMDL presents documentation of the impairment, and is a process that comes after an impairment determination has been made. The documentation for the impairment is done through the 303(d) listing process and the listing methodology is described in the IR. In essence, DEP adheres to quality-assured methods and employs a peer-reviewed approached consistent with current scientific standards. An impaired stream is placed on the 303(d) list (Category 5-A in the IR) and is moved off the list (to Category 4-A) once the TMDL is completed, regardless of recent WQ monitoring data. Ideally, DEP would collect current data on all TMDL streams, but resources are limited and it is technically not a requirement of a TMDL assessment. A TMDL's primary purpose is to assess pollutants and estimate the load reductions needed to achieve WQS. The Habitat Assessment described in each watershed-specific report was conducted to provide a broad indicator of stream condition that integrates a set of observations, beyond a simple data measurement. Some data can be found on DEP's website for the Biological Monitoring Program (aquatic life data) and the Volunteer River Monitoring Program. WQ data stored in DEP's Environmental and Geographic Analysis Database (EGAD) can also be requested through the Department's [Sampling Data Google Earth project](#).

TMDL Calculations and Assumptions

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth

Why are natural background sources omitted from DEP's TMDL calculation equation?

The explanation for the omission of natural background sources can be found on page 12 of the TMDL.

TMDL Implementation

Paraphrased comments from:
- CCSWCD/ISWG
- Town of Falmouth
- Town of Windham

Request that DEP provide information on how WQS are expected to be attained through the proposed implementation. What happens if a WMP is developed as proposed in this draft TMDL report, but WQS are not achieved?

DEP anticipates that over time WMPs for each watershed will be developed and define what is needed to achieve WQ goals. Stakeholders would then implement the plan over time. If a community has reasonably implemented a WMP and made all feasible efforts to restore a waterbody and attainment is still not possible, then a Use Attainability Analysis (UAA) would likely be the next step. Under the CWA, a UAA is the process that enables a community to end the pursuit of rigorous restoration activities.

Overlap Between NPS TMDL Watersheds and Regulated MS4 Areas

The following information is supplied in response to general concerns voiced by commenters regarding the overlap between the NPS TMDL watersheds and MS4 areas. The DEP is continuing to assess how to account for the stormwater discharges from these regulated MS4s and has therefore removed those streams listed in Appendix 4 from this TMDL. The DEP does expect to include these in a future update to this TMDL. Any proposed revisions to the TMDL would only be made after providing opportunity for additional public comment.

Please see Appendix 4 for further details. Commenters were:
- Town of Falmouth
- Town of Windham
- Town of Gray
- Town of Gorham
- Town of Raymond
- Town of Cumberland
- Kristie Rabasca, Integrated Environmental Engineering

There are no watersheds that overlap with the regulated MS4 areas in Falmouth. The runoff in the Hobbs Brook watershed is not covered by the MS4 program.

There are five watersheds that overlap with the regulated MS4 areas in Windham, and all overlap to varying degrees. Overlaps range from less than 1% (Inkhorn Brook) to 67% (Otter Brook).

There are no watersheds that overlap with the regulated MS4 areas in Gray. The runoff in the Pleasant River watershed and Thayer Brook watershed are not covered by the MS4 program.

The Mosher Brook watershed in Gorham is 100% within the regulated MS4 area.

There are no watersheds that overlap with a regulated MS4 areas in Raymond. This is expected because Raymond is not covered by the MS4 program.

There are no watersheds that overlap with the regulated MS4 areas in Cumberland. The runoff in the Hobbs Brook watershed is not covered by the MS4 program.

Phosphorus and Nitrogen Data

Paraphrased comment from:

- Town of Cumberland

Were phosphorus and nitrogen data collected on Hobbs Brook?

No, no such data is available.

Pollution Source Assessment

Paraphrased comment from:

- Town of Cumberland

Pollution source IDs 5, 7, 8 and 9 are omitted from Table 2 in the Hobbs Brook appendix. What were the results for these IDs, and were the observations from those locations used in the analysis?

The Pollution Source ID Assessment only contributes livestock numbers to the MapShed model. The assessment was conducted to provide a survey of potential pollutant sources that could aid in understanding watershed conditions and in the development of WMP. The nutrient and sediments values are derived solely from the MapShed model, which uses many factors including: landuse runoff coefficients, soils, groundwater inputs, rainfall, elevation, septics, livestock counts and riparian condition. The non-sequential Source ID numbers do not mean significant data is missing.

Habitat Assessment

Paraphrased comment from:

- Town of Cumberland

Please describe how the habitat assessment was used in developing pollution load reduction targets.

The Habitat Assessment was conducted to provide a broad indicator of stream condition that integrates a set of observations beyond a simple dissolved oxygen measurement. It does not contribute input data to the MapShed model so the choice of the site where the assessment was conducted does not affect TMDL

nutrient and sediment loading values.

Stream Buffers and the MapShed Model

Paraphrased comment from:

- Town of Cumberland

Please describe how the model accounted for stream segments that have neither more than, nor less than, 75 feet of vegetated buffer. Were accommodations made in the model to account for the stream areas with more than 75 feet of vegetated buffer?

As described in Appendix 2 on MapShed Methodology, buffers on agricultural lands are treated as BMPs and used to adjust nutrient and sediment results from contributing landuses. Essentially, the model produces the nutrient and sediment values without riparian buffers, then model runoff loads are adjusted based on the length and width of the riparian buffers. The riparian areas in agricultural lands that have no buffers do not contribute towards the load reductions. Additionally buffer reductions do not apply on forested land and all appropriate accommodations and reductions were made based on riparian condition.

Livestock Counts and Modeling Methodology

Paraphrased comment from:

- Town of Cumberland

Were nitrogen and phosphorus modeling based on the assumed livestock counts? Did the model account for reduced loads from segments with more than 75-foot buffers? Please describe hay/pasture nutrient inputs and address the potential for double-counting. We are concerned that the required nutrient reductions are mostly based on one livestock observation in the lower third of the watershed.

The 50 cows were not assumed to be present, but were actually observed in the watershed. All observed livestock was used in the model, so 50 cows and 27 horses were used as input parameters. It was noted that the cows were in close proximity to the brook, but all livestock documented in the watershed are included in the model. Yes, the model accounted for reduced loads from segments with more than 75-foot buffers.

Describing the hay/pasture inputs requires a basic understanding of how the MapShed model works, basic model assumptions and how nutrient runoff coefficients are derived. This information is described in depth in Appendix 2 and on the MapShed Model website. Animal unit inputs are independent of landuse runoff coefficients and are not double-counted.

The livestock numbers are estimated due to the degree of difficulty of getting accurate numbers in any given watershed. It was decided to survey the watershed and count the animals that could be observed and use those numbers in the modeling. However, this approach has limitations and likely underestimates the actual numbers of animals in the watershed, which may result in lower nutrient load calculations. The

survey was not limited to the lower portion of the watershed and the assessment ID #s represent the results of observations made.

Interpretation of the TMDL/Waste Load Allocation Equations

Paraphrased comments from:
- Town of Cumberland
- Kristie Rabasca, Integrated Environmental Engineering

Please correct the TMDL discussion of Load Allocations versus Wasteload Allocations in this NPS TMDL, which does not address point-source pollution.

This usage of Load Allocations versus Wasteload Allocations in a TMDL is one that is open to interpretation. DEP's interpretation of the TMDL equation has been vetted by USEPA through the approval of past NPS TMDLs. We acknowledge the comment and thoughtful interpretation, but see no technical advantage to making the changes requested.

Description of Measures that Need to be Taken

Paraphrased comments from:
- Town of Cumberland

Please describe the measures that need to be taken by MEPDES permittees and include them in each watershed-specific appendix.

The TMDL does not require measures by MEPDES permittees. The 'Recommendation' section in each watershed specific summary describes the next steps towards implementation of the TMDL. Definitive measures need to be determined through a stakeholder process rather than as a prescription arising from DEP assessment and modeling efforts.

Natural Impairment

Paraphrased comments from:
- City of Lewiston
- Garrison Beck, Midcoast Conservancy

The MapShed modelling results found that no TMDL reductions were needed for a number of waterbodies (including No Name Brook and some Sheepscot Rivers tributaries) and only minimal reductions for others (including Stetson Brook). Given these results, the necessity of the TMDL and potential regulations are unclear. DEP should comment on the potential for natural impairments of these waterbodies.

All streams documented as impaired on Maine's 303(d) list are required to undergo a TMDL assessment

or demonstrate that they attain WQS. Prior to conducting the TMDL study, DEP did not know that the MapShed model would find that some streams would not needed any, or only small, pollutant reductions. These modeling results are unusual and DEP is weighing the best course of action. For some time, DEP has been looking into whether low DO levels in some waters are the result of natural conditions, but proving this condition is challenging. Where evidence exists that low DO is natural, DEP would consider listing these waters as natural, subject to approval by USEPA. In February 2015, USEPA developed a framework for defining and documenting natural conditions. This framework requires the development of site-specific WQS. Alternatively, gathering information and preparing the TMDL for USEPA approval is part of a process that will lead to removing these waters from the 303(d) list.

NPS Priority Watershed

Paraphrased comments from:
- City of Lewiston

Why are No Name and Stetson Brooks, which require no or only small pollution reductions, on the NPS priority list? Notification for the review of the NPS TMDLs should have occurred prior to the request for the removal of waters from, or addition to, the NPS Priority Watershed list.

These brooks have been on the NPS Priority Watershed list based on the original impairment listings due to low DO, and MapShed modeling results were not known prior to the TMDL study. The NPS Priority Watershed list sets priorities for eligible waters to receive 319 grant funds, and there are no regulatory implications for a stream that is on the list. The NPS TMDL has implications for the way DEP will manage and approach these waters in the future. From DEP's perspective, the timing of the release of the NPS TMDLs versus the NPS Priority Watershed list should not have any significant effect.

Watershed Source Assessment

Paraphrased comments from:
- Garrison Beck, Midcoast Conservancy

Please develop more accurate estimates for livestock, fertilizer application variability and hay field information, and revise Total Phosphorus loads.

This project employed peer-reviewed, quality-assured methods to collect field data. The concern that the field assessments do not accurately represent the actual conditions in the watershed has merit since an increase in time and efforts results in better values. Most field assessments face time constraints along with the pressure to summarize results for subsequent analysis and reporting; this project is no different. The results generated by the MapShed model are meaningful when compared to other watersheds and they provide a reasonable way to estimate the relative values of nutrients and sediments. This means the

project needed a consistent approach for data collection to minimize bias in the subsequent comparisons. Collecting the data in the manner the commenter suggests would introduce bias, unless it was done in all 30 watersheds. There is no logistical opportunity to collect more data on all the streams and revise the model for the purpose of the TMDL.

While revising the TMDL is not feasible, developing a watershed management plan (WMP) provides an opportunity to collect more accurate data and take an in-depth look at landuse conditions in the watershed. The WMP also has the advantage of being done with input from local stakeholders who are vested in the long-term health of the streams. The MapShed model could be revised for the WMP and has an add-on model called PRedICT (see Appendix 2), which estimates nutrient and sediment reductions from the application of BMPs.

Focus on Agriculture

Paraphrased comments from:

- Garrison Beck, Midcoast Conservancy

We request that DEP provide further comment on how agriculture can be presumed to be a leading cause of NPS pollution.

The NPS TMDL does presume agriculture is the source of the observed impairments and this relationship is described on page 12 of the TMDL. The connection between nutrient and sediment-laden runoff and impairment is well-documented (see Introduction section in the TMDL) for truly impaired waters, but this connection does not exist in waters that are not truly impaired. These are waters that may have low DO as a result of natural conditions, as is the case in some Sheepscot Rivers tributaries. TMDL assessments are not designed to accurately describe natural waters and attributing impairments to pollutant loads coming from forested areas is a symptom of this problem.

Watershed Management Collaboration

Paraphrased comment from:

- Garrison Beck, Midcoast Conservancy

It appears that WQ data from local stakeholders were largely disregarded. Please provide guidance on the applicability (implementation), severity and enforceability of this TMDL.

Stakeholders were not disregarded, but WQ data collection is a minimal part of the TMDL, which is based on information contained in the 303(d) list of impaired waters in Maine's biennial IR. Some data cited in the TMDL were collected by stakeholders, for example data from Chamberlain Brook, Whitefield at station CHABK001-F.

Section 7, Implementation and Reasonable Assurance in the TMDL document goes into details on what a

WMP entails and how to get started. The best place to start is by communicating with DEP staff involved with the 319 grant program, and more information can be found at http://www.maine.gov/dep/water/grants/319.html. Regarding the enforceability of the TMDL, please see DEP's response to 'Unintended Consequences', above.

Nutrient Management Ordinance

Paraphrased comment from:

- Garrison Beck, Midcoast Conservancy

We request that DEP provide further information on nutrient management ordinances.

Resources to pursue this recommendation are available through the Nutrient Management Program at the Maine Department of Agriculture, Conservation and Forestry.