Maine Statewide Bacteria TMDL: APPENDIX I Freshwaters

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Report #: DEPLW-1003

Freshwater Rivers & Streams

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I. INTRODUCTION

This appendix to the *Maine Bacteria Total Maximum Daily Load* Report contains watershed-specific information and bacteria data used to develop TMDLs for 22 stream segments listed for "bacteria-only" impairment. Additionally, Section III covers bacterial data collected by the Houlton Band of the Maliseet Indians in the Meduxnekeag Watershed. The 22 stream segments are situated in following eight general (HUC 8) watersheds:

- Aroostook Watershed
- Casco Bay Coastal Watershed
- Central Coastal Watershed
- Eastern Coastal Watershed
- Kennebec River Watershed
- Lower Penobscot River Watershed
- Piscataqua River Watershed
- Saco River Watershed

Figure 1 provides a map of the eight general watersheds and 22 bacteria impaired streams and Table 1 provides summary information about each of the 22 bacteria impaired streams. The basis for listing these streams as impaired originates with Maine DEP's 2004 Integrated Water Quality Monitoring and Assessment Report, which identifies river and stream segments impaired only by bacteria for low priority recreational waters. Subsequent 305(b) reports (2006 and Draft 2008) more generally identify bacteria impaired rivers and streams where TMDLs are required and use HUC 10 watershed delineations (as opposed to the HUC 8 delineations used for the 2004 305(b) report). The 2006 and Draft 2008 305(b) reports also identify more rivers and streams with bacteria impairments – 40 impaired segments in the 2006 report and 41 impaired segments in the Draft 2008 report.

The purpose of a TMDL is to calculate the amount of a pollutant receiving waters can assimilate without exceeding water quality standards or designated uses. The pollutant load is then allocated to specific sources. These TMDLs set a goal of meeting bacteria water quality criteria for all sources in order to meet water quality standards throughout the affected waterbodies. Maine DEP believes that the concentration-based TMDL approach is the most useful format for guiding both remediation and protection efforts in the impaired watersheds. A concentration target is more readily understandable to the public, and allows interested citizens and/or watershed groups to determine easily whether any particular source is exceeding its allocation. Measured bacteria concentrations in each of the impaired watersheds are used to determine the percent reduction needed to attain water quality standards.

This document provides (1) justification for the impaired listing status and need for the TMDL, (2) calculations for the percent reductions from existing data needed to meet the concentration-based target, and (3) details regarding sources of bacteria in the impaired watersheds. For information regarding the regulatory requirements of TMDLs, Maine's water quality standards, waterbody assessment approach, target concentrations, loading allocations and source specific implementation recommendations please see the *Maine Bacteria Total Maximum Daily Loads* report (October 2007).

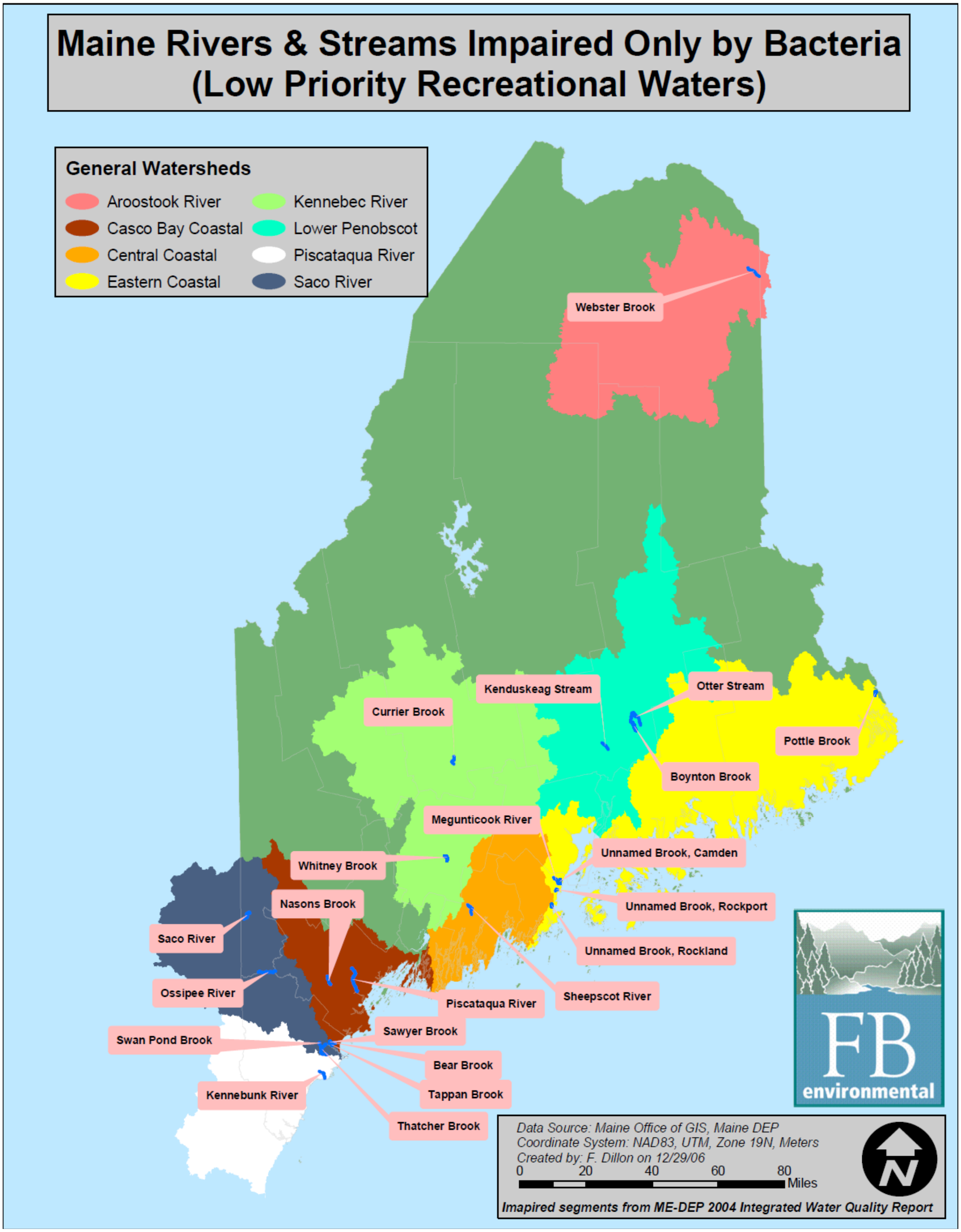


Figure 1: Rivers and Streams Impaired Only by Bacteria Low Priority Recreational Waters (Category 5-B-1 of the Maine DEP 2004 Integrated Water Quality Monitoring and Assessment Report Appendices).

Table 1: Summary information for "bacterial-only" impaired streams (Maine DEP 2004 Integrated Water Quality Monitoring and Assessment Report Appendices)

Watershed and Segment	Town	County	Segment ID	Assessment Unit (HUC10)	Segment Class	Segment Length	Watershed Area (sq. mi.)	Potential Source(s)
Aroostook River W'shed								
Webster Brook	Limestone	Aroostook	146R01	ME0101000413	B	4.9	77.1	Unknown
Casco Bay W'shed								
Piscataqua River	Falmouth	Cumberland	607R04	ME0106000103	B	11.9	21.2	NPS (unspec)
Nasons Brook	Gorham	Cumberland	607R11	ME0106000103	B	3.5	53.2	NPS (unspec)
Central Coastal W'shed								
Sheepscot River	Alna	Lincoln	528R01	ME0105000305	AA	4.8	64.8	Unknown
Eastern Coastal W'shed								
Pottle Brook	Perry	Washington	508R02	ME0105000203	B	1.3	9.6	Unknown
Megunticook River	Camden	Knox	522R01	ME0105000220	B	3.9	30.9	Urban NPS
Unnamed Brook, Camden	Camden	Knox	522R02	ME0105000220	B	1.1	10.4	Urban NPS
Unnamed Brook, Rockport	Rockport	Knox	522R03	ME0105000220	B	1.2	10.4	Urban NPS
Unnamed Brook, Rockland	Rockland	Knox	522R04	ME0105000220	B	0.9	10.4	Urban NPS
Kennebec River W'shed								
Currier Brook	Skowhegan	Somerset	320R02	ME0103000306	B	3.5	79.4	Urban NPS
Whitney Brook	Augusta	Kennebec	333R02	ME0103000312	B	2.0	45.7	Urban NPS
Lower Penobscot River W'shed								
Otter Stream	Milford	Penobscot	226R01	ME0102000509	B	11.1	47.7	Unknown
Boynton Brook	Bradley	Penobscot	226R02	ME0102000509	B	3.1	47.7	Unknown
Kenduskeag Stream	Bangor	Penobscot	224R02	ME0102000510	B, C	3.0	39.5	Unknown
Piscataqua River W'shed								
Kennebunk River	Kennebunk	York	622R01	ME0106000301	B	3.9	37.2	Urban NPS
Saco River W'shed								
Bear Brook	Saco	York	616R04	ME0106000106	B	1.2	32.9	Urban NPS, CSO
Saco River	Fryeburg	Oxford	618R01	ME0106000204	AA, A	3.8	24.1	NPS (unspec)
Ossipee River	Hiram	Oxford	614R01	ME0106000209	B	7.3	36.3	NPS (unspec)
Tappan Brook	Saco	York	616R02	ME0106000211	B	0.4	53.0	Urban NPS
Sawyer Brook	Saco	York	616R03	ME0106000211	B	0.7	53.0	Urban NPS
Thatcher Brook	Biddeford	York	616R05	ME0106000211	B	8.0	53.0	Urban NPS, CSO
Swan Pond Brook	Biddeford	York	616R06	ME0106000211	B	1.0	53.0	NPS (unspec)

II. WATERSHED-SPECIFIC DATA

1. Aroostook River Watershed

<u>1.1 Webster Brook (Limestone)</u>

Webster Brook (Segment ID 146R01) is located in the town of Limestone within the Aroostook River Watershed along the Canadian border (Figures 2 and 3). The listed segment length for Webster Brook is 4.9 miles and its total listed watershed area is 77 square miles. Until this most recent water quality assessment, its potential sources of bacteria impairment had previously been listed as unknown. However, ME-DEP staff observed considerable agricultural activities in the immediate area around the impaired segment while collecting water quality samples in support of this study. Also, a recently completed phosphorus-based TMDL for Trafton Lake, through which Webster Brook flows, identifies agriculture as the dominant land use in the surrounding area. Consequently, agricultural activities appear to be a likely source of bacteria impairment in the Webster Brook watershed.

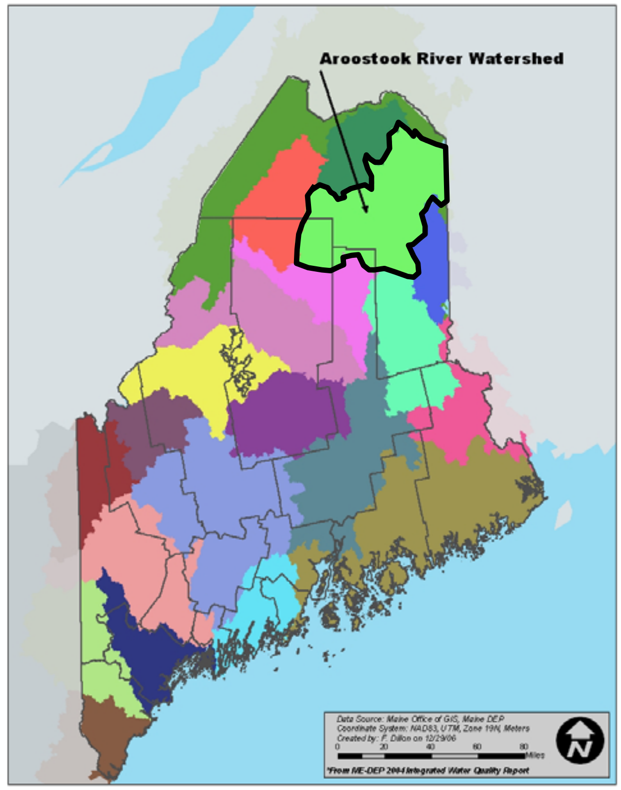


Figure 2: Aroostook River Watershed.

<u>1.1.A Bacteria Data Summary & Percent Reduction Calculations</u>

Bacteria data for the Webster Brook Watershed were collected by staff from the Maine DEP's Northern Maine Regional Office in Presque Isle in the spring and summer of 2007 and are presented in Table 2. Webster Brook was the only segment listed for "bacteria-only" impairment in the Aroostook River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Webster Brook, which is a Class B stream, is 236 most probable number (MPN) / 100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Webster Brook were observed to exceed the instantaneous standard in 2 of 9 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 393 MPN/100mL on July 11th and 276 MPN/100mL on July 19th (Table 2). Bacteria concentrations in Webster Brook met the geometric mean standard for the entire sampling period. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was met during both storm event and dry weather sampling events.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

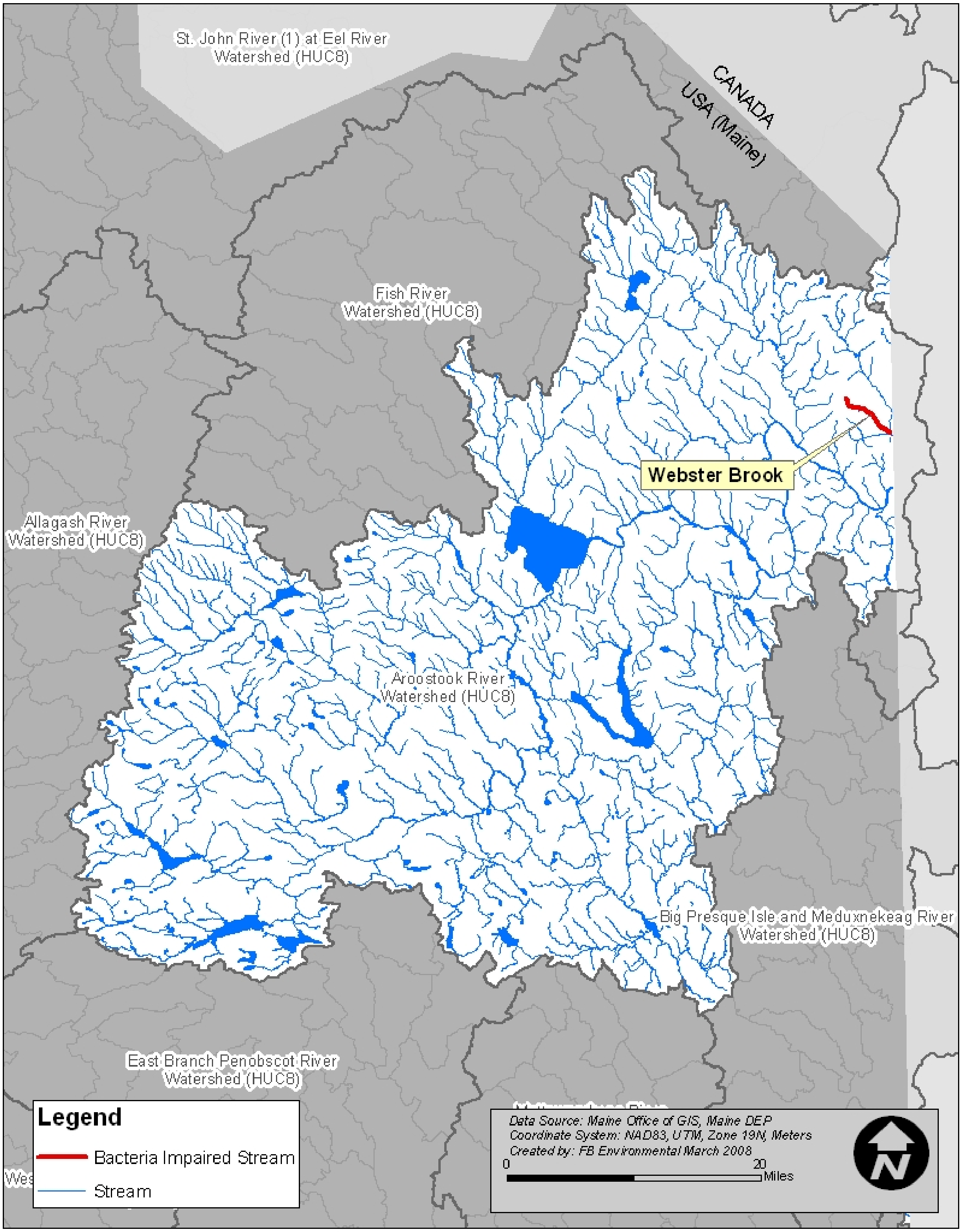


Figure 3: Aroostook River Watershed with Webster Brook indicated

The geometric mean for the overall results was below (i.e., in compliance with) the water quality standard; therefore the % reduction calculation for this criterion does not apply. This was also the case for storm and dry weather sample results. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 40% for both the overall and storm event results and 14.5% for the dry weather results.

Table 2: Bacteria data summary for Webster Brook, with wet and dry weather assessment.

Webster - Limestone	Sampler	Sample Time	Current Weather	Precip on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)*	% Reduction to Meet WQS	Comments**
Storm Samples	*Precip data for Caribou Municipal Airport (Source: NOAA / NWS)*												
30-May-07	BS	Not noted	"	0.00	0.00	1.06	0.11	0.00	y	Not noted	18		
7-Jun-07	BS	"	"	0.00	0.00	0.46	0.31	0.00	y	"	31		
20-Jun-07	BS	"	"	0.33	0.00	0.00	0.41	0.00	y	"	70		Unclear when rain intensity / duration greatest on 6/20.
28-Jun-07	BS	"	"	0.21	0.33	0.07	0.00	0.02	y	"	34		
11-Jul-07	BS	"	"	0.59	0.00	0.05	0.09	0.00	y	"	**393**		Unclear when rain intensity / duration greatest on 7/11.
									Storm Results:	Max:	**393**	40.0%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**72**	11.5%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
14-May-07	BS	Not noted	"	0.00	0.00	0.00	0.33	0.00	n	Not noted	14		
14-Jun-07	BS	"	"	0.00	0.00	0.00	0.00	0.00	n	"	41		
2-Jul-07	BS	"	"	0.10	0.01	0.05	0.00	0.21	n	"	159		
19-Jul-07	BS	"	"	0.07	0.02	0.05	0.00	0.85	n	"	**276**		
									Dry Results:	Max:	**276**	14.5%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**70**	8.9%	% reduction for geomean WQS (64 col/100 mL)
									Overall Results:	Max:	**393**	40.0%	% reduction for all samples using instant WQS (236
										Geomean:	62	na	% reduction calculation results in negative number

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

1.1.B Watershed Characterization

Figure 4 provides an aerial view of Webster Brook and its passage through Trafton Lake. There is a very large waterfowl population using Trafton Lake and some of the upstream wetlands. In the fall is a very popular goose hunting location and waterfowl could account for elevated bacterial counts. Figure 4 also clearly indicates the large expanses of agricultural activities surrounding Webster Brook. The Webster Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 5). The watershed area as delineated is approximately 6.4 square miles, less than 0.2 square miles of which consist of impervious surfaces. Stream gradient is very gradual with a slope over the segment length of less than 1%.

Agricultural land uses heavily dominate the area with over 75% of the watershed being utilized for some form of cultivation. The next most prominent land cover type is forest, which covers approximately 13% of the watershed. Wetlands and open water comprise approximately 7% of the watershed followed by some form of human development (e.g., roads, residential, developed open space) at approximately 4%.

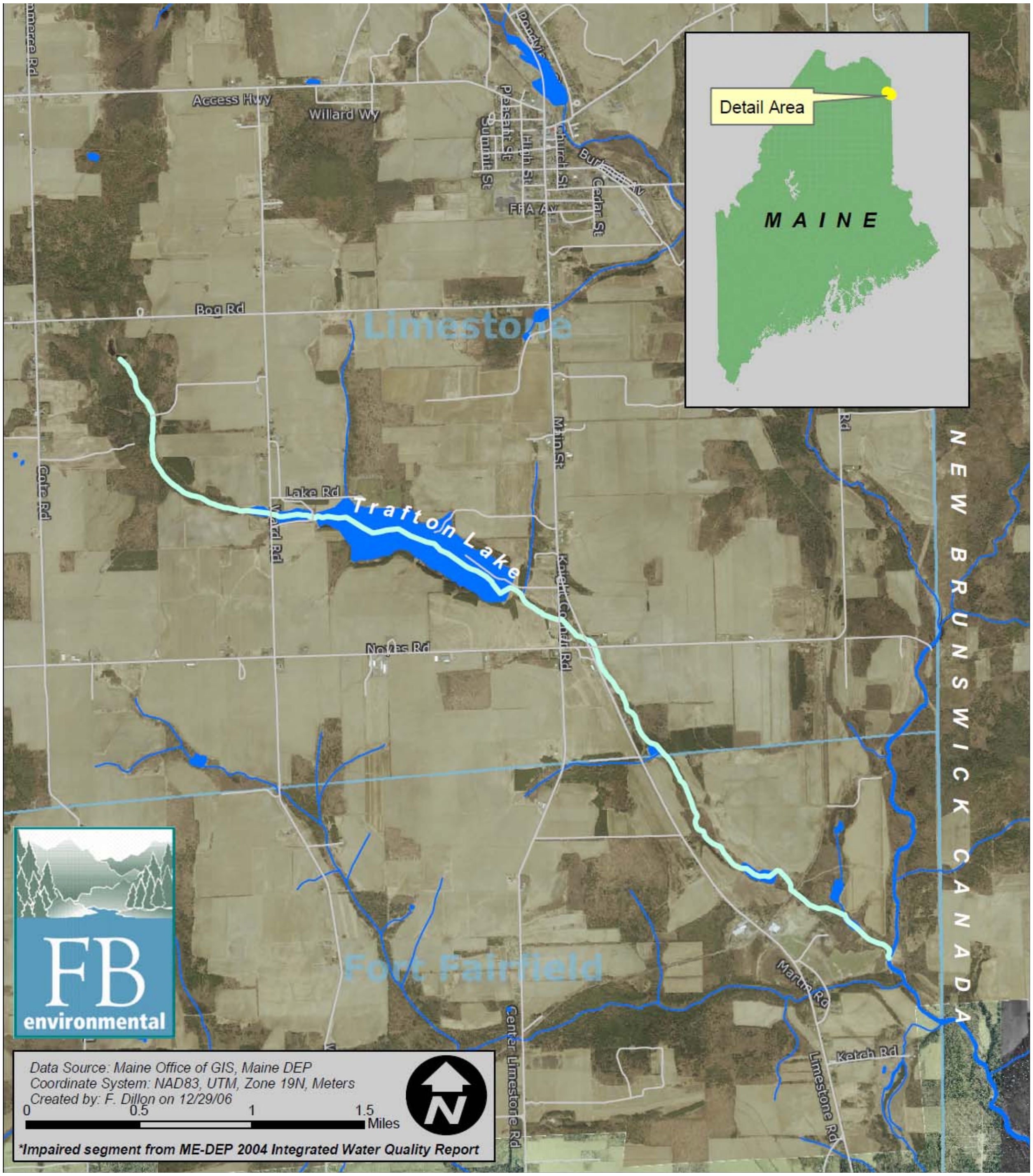


Figure 4: Aerial photograph of Webster Brook and surrounding area

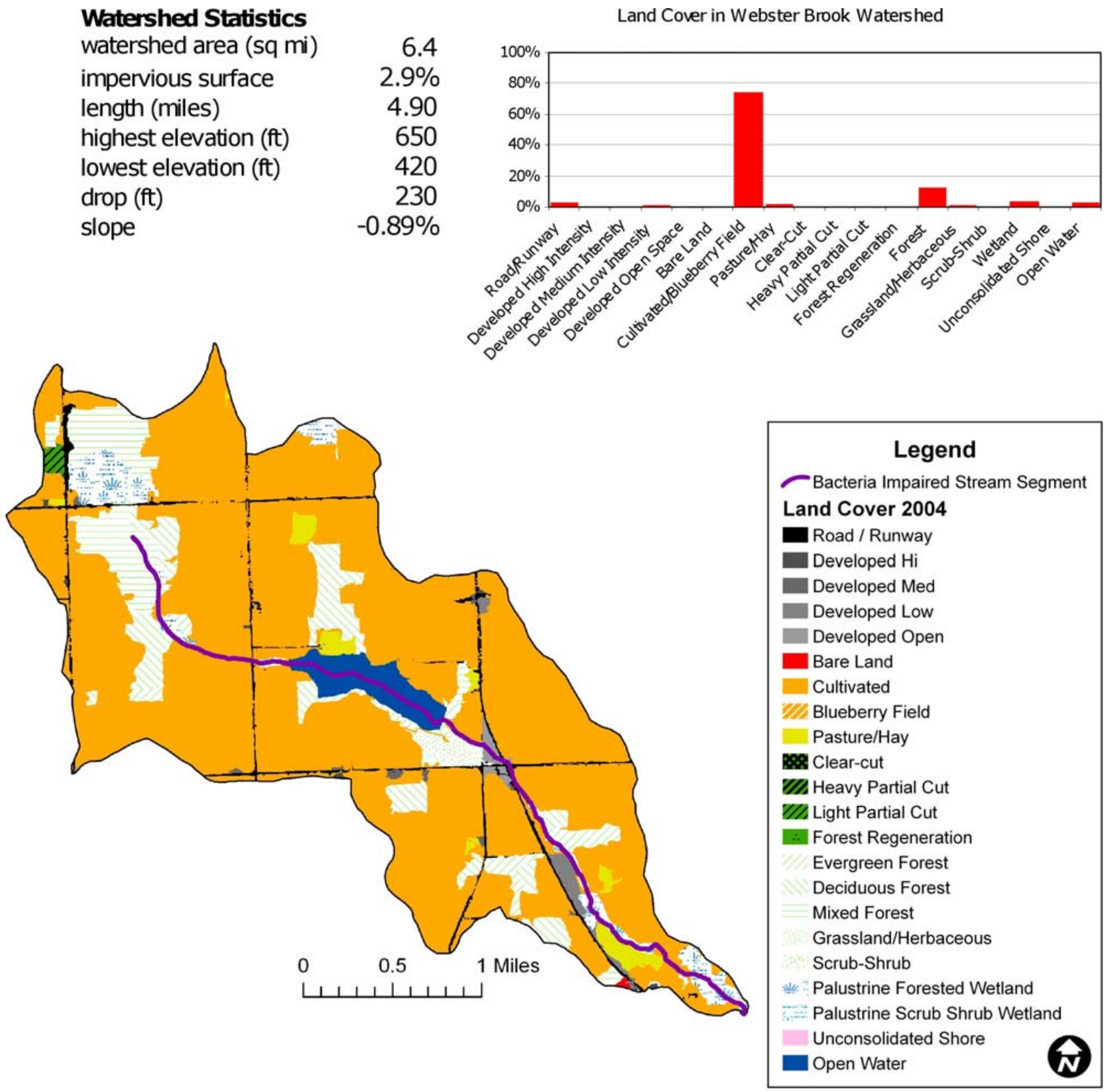


Figure 5: Webster Brook watershed land cover map and statistics.

1.1.C Recommended Mitigation Strategies

Given that the Webster Brook watershed is dominated by agricultural land uses (>75%), it appears likely that farming activities is a potential source of fecal contributions. For example, improper handling and management of animal manures used as fertilizer can contribute significantly to elevated bacteria concentrations in nearby surface waters.

A significant portion of the watershed is also comprised of forest and wetlands. Wildlife inhabiting these areas may play an important role in contributing fecal contamination to Webster Brook. Finally, even though non-farming based human development is relatively light in comparison to these other more prevalent land uses, a variety of residential and commercial activities could also be contributing fecal contamination to Webster Brook.

There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. It is likely that the Central Aroostook County Soil and Water Conservation District has established relationships with farmers in the watershed and will therefore play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

Management strategies for controlling fecal contamination from wildlife sources have generally focused on removing animals from problems areas. Fecal contamination from non-farming based human activities can derive from a variety of sources, including stormwater runoff from impervious surfaces, malfunctioning sewer and / or septic systems, and improperly managed pet waste. Section 6.1 describes mitigation strategies for addressing each of these potential fecal contamination sources, among others.

2. Casco Bay Coastal Watershed

2.1 Piscataqua River (Falmouth)

The Piscataqua River (Segment ID 607R04) is located in Falmouth within the Casco Bay Coastal Watershed (figures 6 and 7). The listed segment length for the Piscataqua River is 11.9 miles and its total listed watershed area is 21.2 square miles. Sources of potential bacteria impairment are listed as originating from nonpoint source (NPS) pollution.

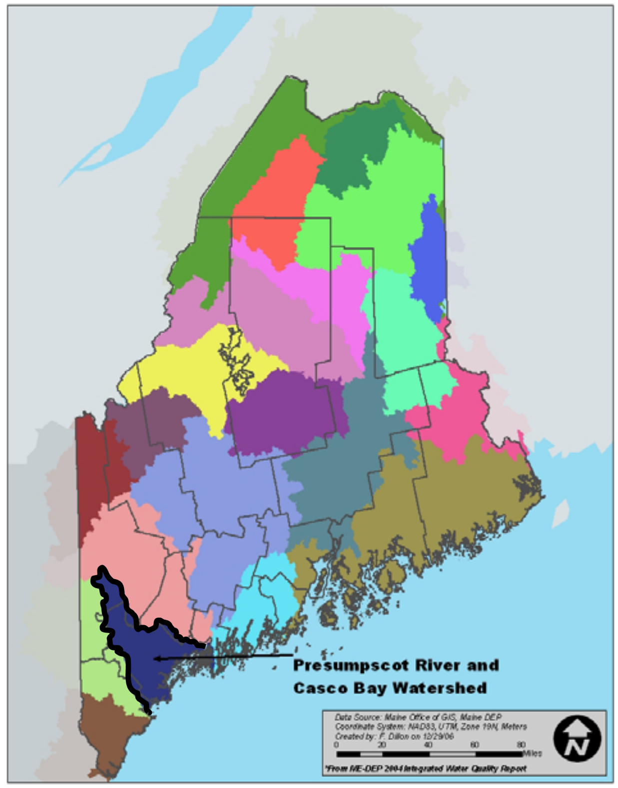


Figure 6: Casco Bay Coastal Watershed.

2.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Piscataqua River Watershed were collected by FB Environmental (FBE) staff throughout the spring and summer of 2007 and are presented in Table 3. The instantaneous bacteria standard for the Piscataqua River, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in the Piscataqua River were observed to exceed the instantaneous standard in 1 of 16 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 248 MPN/100mL on June 7th. Bacteria concentrations in the Piscataqua River met the geometric mean standard for the entire sampling period. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded during the 6 storm flow sampling events with a value of 103 MPN/100mL.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results was below (i.e., in compliance with) the water quality standard; therefore the % reduction calculation for this criterion does not apply. For storm flow samples, the % reduction required to comply with the geometric mean standard is 37.7%. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 4.9% for both the overall and storm event results.

Table 3: Bacteria data summary for Piscataqua River, with wet and dry weather assessment.

Piscataqua - Falmouth	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	14:15	Rain	0.33	0.00	0.00	0.00	0.00	y	16	41		0.33" rain on sample day.
16-May-07	TB	12:10	Rain	0.71	0.04	0.00	0.00	0.00	y	-	29		0.71" rain on sample day.
7-Jun-07	TB	14:05	Clear	0.00	0.00	0.12	2.12	0.52	y	15	**248**		2.76" rain previous 96 hrs; none previous 24 hr.
6-Jul-07	TB	9:00	Overcast	0.10	0.25	0.12	0.00	0.00	y	17	173		0.1" rain on sample day; 0.37" precip previous 48 hr.
9-Jul-07	TB	9:00	Lt rain	1.13	0.25	0.27	0.10	0.25	y	16	140		1.13" rain on sample day; 0.87" previous 96 hr.
10-Aug-07	TB	9:45	Ptly cldy	0.00	0.00	0.57	0.00	2.29	y	17	167		2.86" rain previous 96 hr; none previous 24 hr.
								Storm Results:		Max:	**248**	4.9%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**103**	37.7%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	TB	13:05	Clear	0.00	0.00	0.00	0.00	0.00	n	18	9		PRW sample taken at same location
23-May-07	TB	15:30	Overcast	0.00	0.00	0.00	0.08	0.06	n	13	31		
31-May-07	TB	12:25	Lt rain	0.01	0.01	0.00	0.28	0.00	n	16	27		
13-Jun-07	TB	12:05	Lt rain	0.10	0.00	0.00	0.00	0.00	n	-	86		0.1" precip on sample day.
21-Jun-07	TB	12:10	-	0.00	0.00	0.00	0.00	0.00	n	-	63		
29-Jun-07	TB	12:10	Clear	0.00	0.00	0.00	0.00	0.05	n	19	86		
30-Jul-07	TB	10:10	Clear	0.00	0.00	0.15	0.00	0.00	n	20	45		
20-Aug-07	TB	10:50	Clear	0.00	0.00	0.04	0.00	0.22	n	15	66		
4-Sep-07	TB	13:25	Clear	0.00	0.00	0.00	0.00	0.00	n	17	56		
17-Sep-07	TB	10:50	Clear	0.00	0.00	0.13	0.00	0.00	n	13	44		Final sample of project.
								Dry Results:		Max:	86	na	% reduction calculation results in negative number
										Geomean:	43	na	% reduction calculation results in negative number
								Overall Results:		Max:	**248**	4.9%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	60	na	% reduction calculation results in negative number

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

2.1.B Watershed Characterization

Figure 8 provides an aerial view of the Piscataqua River and a clear indication of the large expanses of forest land surrounding the river. The bacteria sampling location (PI020) for this most recent assessment is shown approximately 1 mile above the confluence with the Presumpscot River and is also a long term bacteria sampling location for the volunteer water quality monitoring group the Presumpscot River Watch (PRW). A datasonde monitoring location is also shown slightly below PI020 for the EPA-funded 2006-08 Presumpscot Watershed Initiative (PWI) project.

The Piscataqua River watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 9). The watershed area as delineated is approximately 18.8 square miles with just over 1 square mile (~6%) consisting of impervious surfaces. Stream gradient over the entire length of the segment is very gradual with a slope of less than 1%, though certain sections of the river experience steeper declines.

Forest lands comprise slightly over 72% of the watershed area followed by agriculture (mostly pastures and hayfields) at just under 10%. Non-farming human land uses (residential, commercial, roads, etc.) cover approximately 9% of the Piscataqua River's watershed area while grasslands and wetlands make up the remainder.

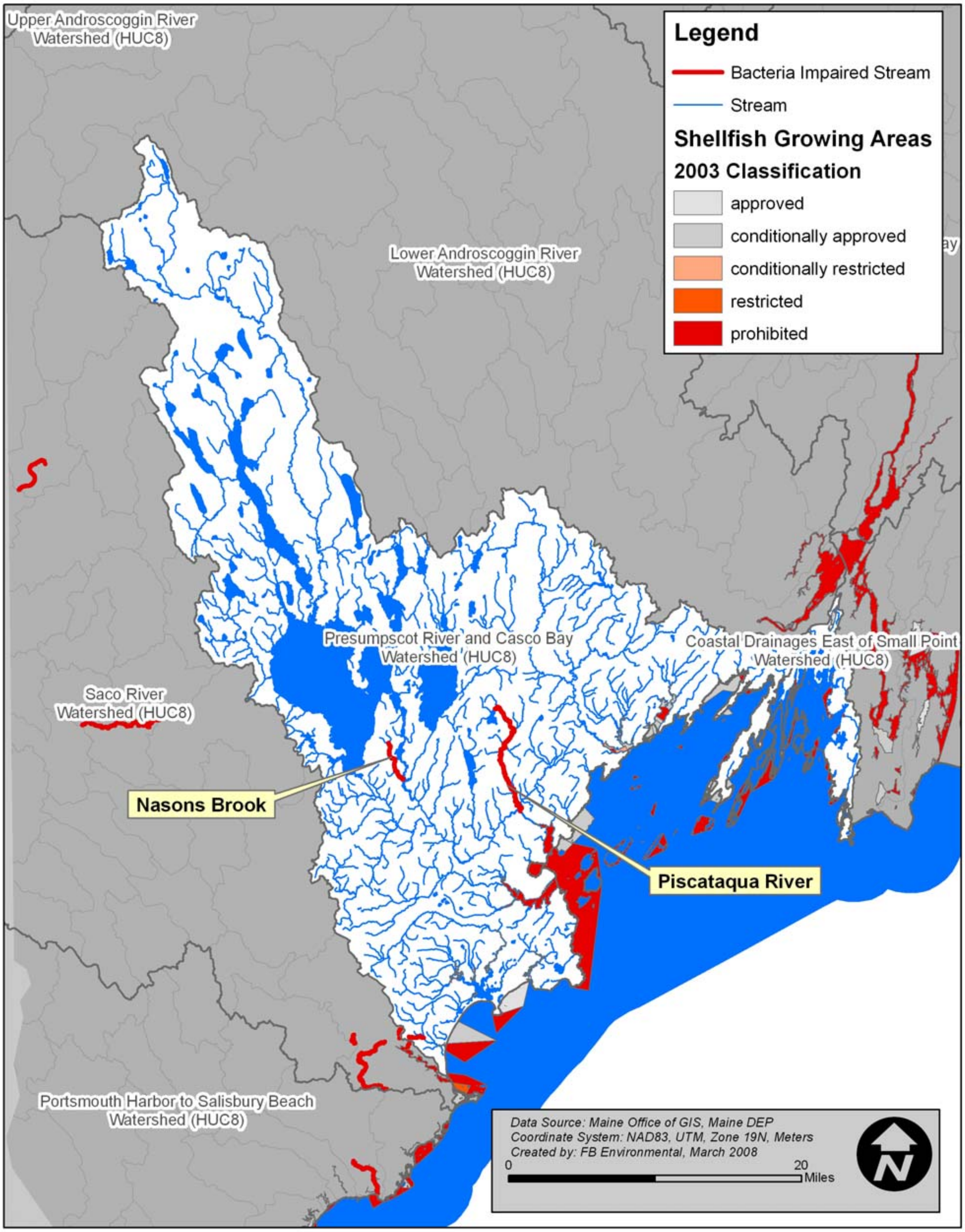


Figure 7: Casco Bay Watersheds showing the Piscataqua River.

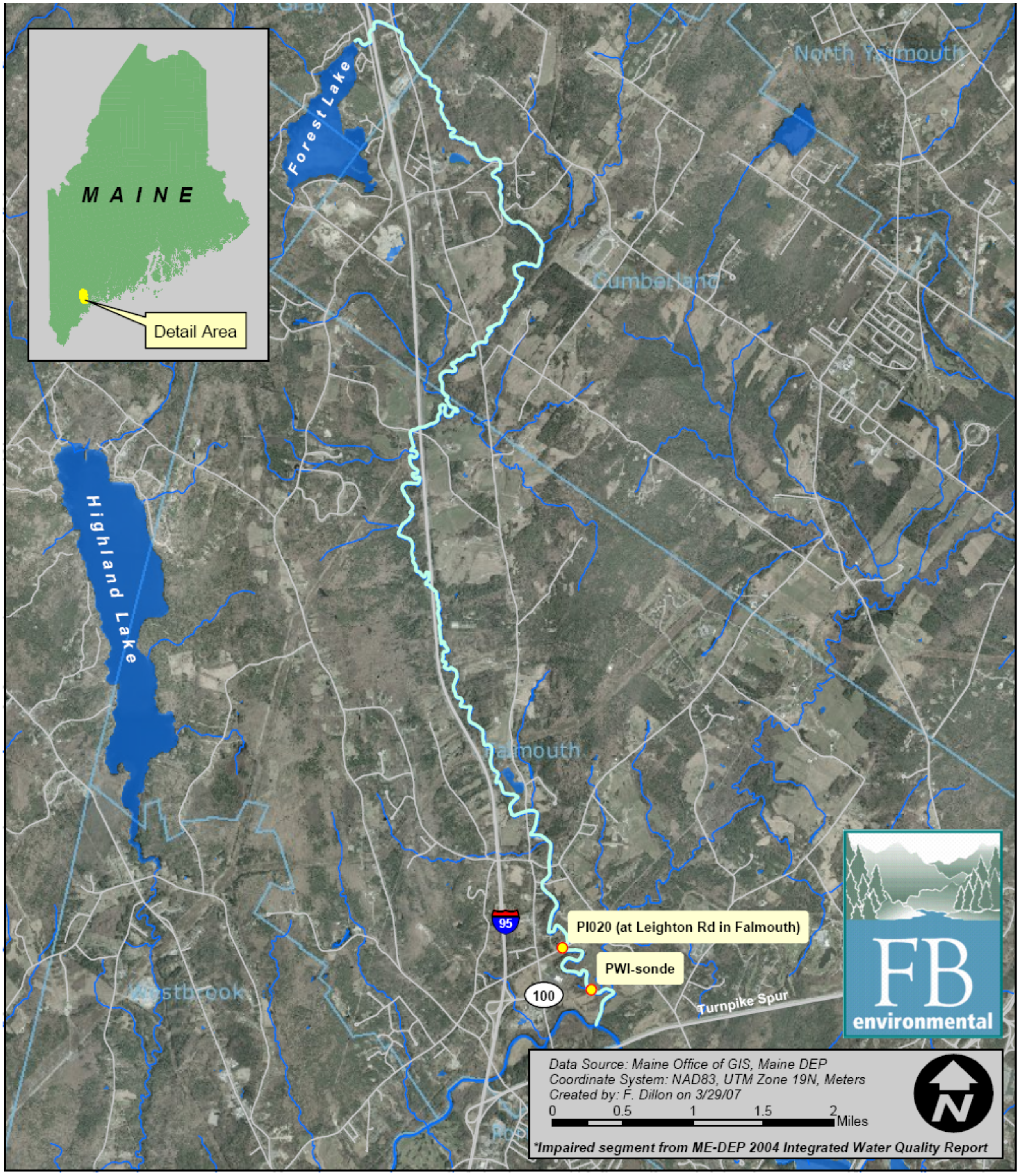


Figure 8: Aerial photograph of the Piscataqua River and surrounding area.

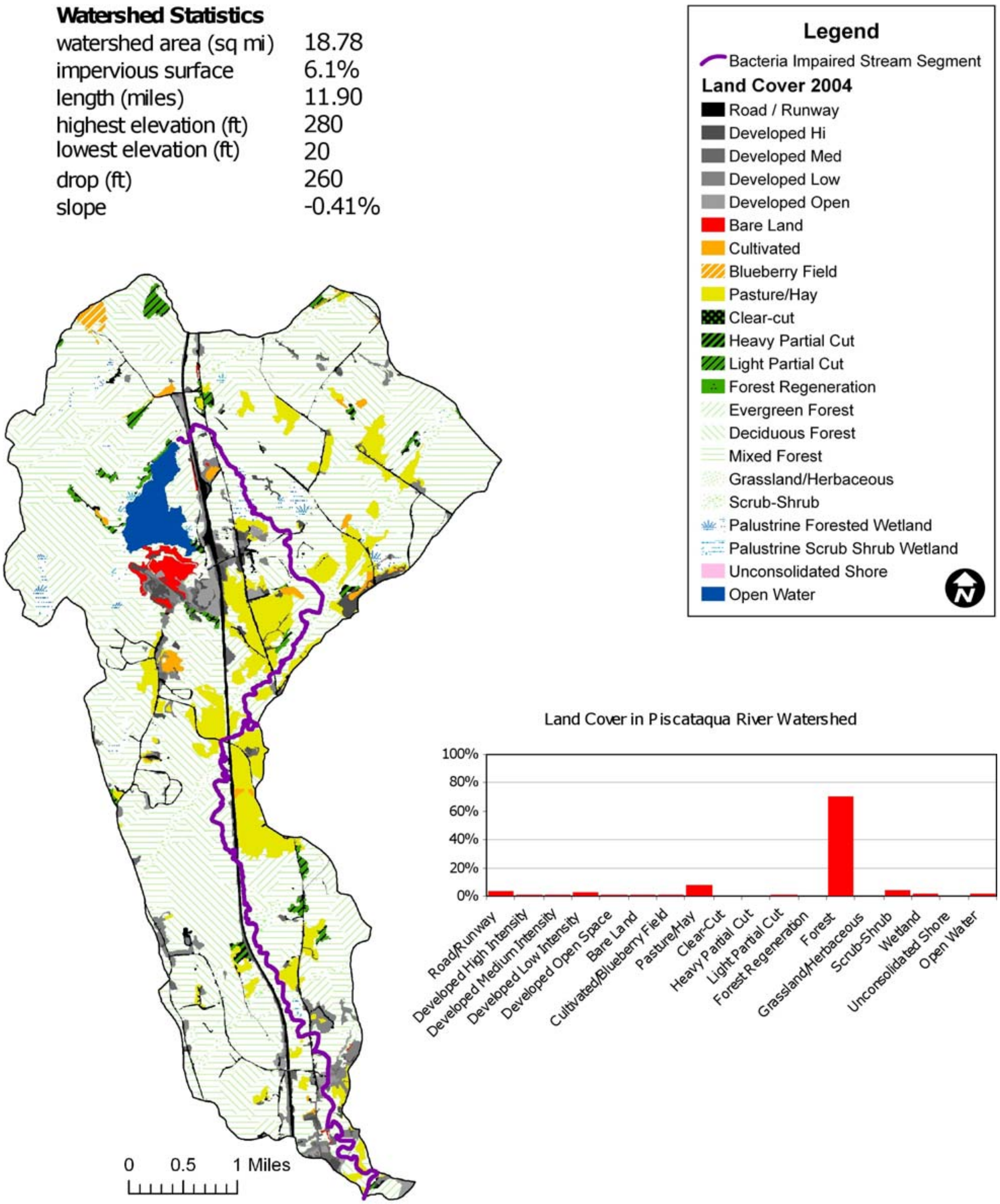


Figure 9: Piscataqua River watershed land cover map and statistics

2.1.C Recommended Mitigation Strategies

Based on the bacteria sampling conducted by FBE in 2007, the Piscataqua River met the geometric mean water quality standard and experienced a single instantaneous exceedance. Given that so much of the watershed is forested and undeveloped, low bacteria concentrations might be expected. Likewise, agriculture is fairly limited as are non-farm based human activities. However, over the past several years bacteria data collected during the summer months by the Presumpscot River Watch indicate a cause for concern. From 2000 to 2006, PRW *E. coli* results for PI020 exceeded the Class B geometric mean standard for 7 out of 8 years (2007 and 2008 results have not yet been analyzed). As a result, bacteria mitigation strategies are in order for the Piscataqua River watershed.

Based on a land use analysis, it appears that bacteria contamination may be most closely related to the agricultural activities in the Piscataqua River watershed. And while non-farming development exhibits a fairly light footprint in the Piscataqua River watershed, it is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to bacteria impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution.

Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain (as was the case for 2007 storm sampling). Since the Piscataqua River is dominated by forests, wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, an ongoing sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of a suspected area could reveal where impairment is greatest, which can also help suggest which sources (development or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning system is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to bacteria impairment (for example, dumping cat litter or other pet waste next to a stream).

There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Cumberland County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there. Finally, the Presumpscot River Watch also intends to continue bacteria monitoring on the Piscataqua River and could therefore play an important role in documenting the potential success of various management strategies.

2.2 Nasons Brook (Gorham)

Nasons Brook (Segment ID 607R11) is located in Gorham within the Casco Bay Coastal Watershed (Figures 10 and 11). The listed segment length for Nasons Brook is 3.5 miles and its total listed watershed area is 53.2 square miles. Sources of potential bacteria impairment are listed as originating from nonpoint source (NPS) pollution.

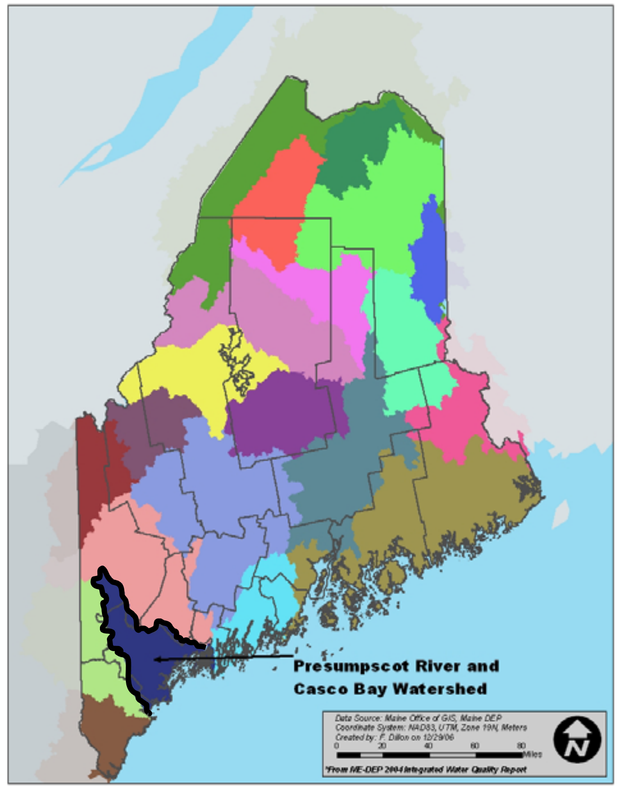


Figure 10: Casco Bay Coastal Watershed.

2.2.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Nasons Brook Watershed were collected by FB Environmental (FBE) staff throughout the spring and summer of 2007 and are presented in Table 4. The instantaneous bacteria standard for the Nasons Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria levels in Nasons Brook were observed to exceed the instantaneous standard in 7 of 16 surveys conducted throughout the 2007 sampling period. Bacteria concentrations were 1,986 MPN/100mL on May 11th, 328 MPN/100mL on May 16th, 517 MPN/100mL on June 21st, 613 MPN/100mL on June 29th, 1,203 MPN/100mL on July 9th, 248 MPN/100mL on July 30th, and 387 MPN on September 4th. The geometric mean standard for Nasons Brook was exceeded over the entire sampling period with a value of 197 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded during the 6 storm flow sampling events with a value of 390 MPN/100mL; it was also exceeded during the 10 dry weather sampling events with a value of 131 MPN/100mL.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results exceeded the water quality standard and requires a 67.5% reduction to comply with this standard. For storm flow samples, the % reduction required to comply with the geometric mean standard is 83.6% while for dry weather samples it is 51% (Table 4). Bacteria concentration reductions needed to attain the instantaneous water quality standard were 88.1% for both the overall and storm event results and 61.5% for the dry weather results.

Table 4: Bacteria data summary for Nasons Brook, with wet and dry weather assessment.

Nasons - Gorham	Sampler	Sample Time	Current Weather	Precip on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)*	% Reduction to Meet WQS	Comments**
Storm Samples													
11-May-07	TB	13:50	Overcast	0.33	0.00	0.00	0.00	0.00	y	16	**1986**		0.33" precip on sample day.
16-May-07	TB	11:00	Rain	0.71	0.04	0.00	0.00	0.00	y	12	**328**		0.71" rain on sample day.
7-Jun-07	TB	13:30	Clear	0.00	0.00	0.12	2.12	0.52	y	-	196		2.76" precip previous 96 hrs; none previous 24 hr.
6-Jul-07	TB	8:30	Clear	0.10	0.25	0.12	0.00	0.00	y	17	192		0.1" precip on sample day; 0.37" precip previous 48 hr.
9-Jul-07	TB	11:05	Lt rain	1.13	0.25	0.27	0.10	0.25	y	15	**1203**		1.13" precip on sample day; 0.87" previous 96 hr.
10-Aug-07	TB	11:10	Ptly cldy	0.00	0.00	0.57	0.00	2.29	y	18	119		2.86" previous 96 hr; none previous 24 hr.
									Storm Results:	Max:	**1986**	88.1%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**390**	83.6%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	TB	12:30	Clear	0.00	0.00	0.00	0.00	0.00	n	18	6		PRW sample taken at same location
23-May-07	TB	15:00	Overcast	0.00	0.00	0.00	0.08	0.06	n	13	127		
31-May-07	TB	12:00	Lt rain	0.01	0.01	0.00	0.28	0.00	n	15	73		
13-Jun-07	TB	11:35	Lt rain	0.10	0.00	0.00	0.00	0.00	n	-	206		0.1" precip on sample day.
21-Jun-07	TB	11:05	-	0.00	0.00	0.00	0.00	0.00	n	-	**517**		
29-Jun-07	TB	11:45	Clear	0.00	0.00	0.00	0.00	0.05	n	18	**613**		
30-Jul-07	TB	10:40	Clear	0.00	0.00	0.15	0.00	0.00	n	19	**248**		
20-Aug-07	TB	11:20	Clear	0.00	0.00	0.04	0.00	0.22	n	12	55		
4-Sep-07	TB	13:00	Clear	0.00	0.00	0.00	0.00	0.00	n	16	**387**		
17-Sep-07	TB	12:30	Clear	0.00	0.00	0.13	0.00	0.00	n	12	72		Final sample of project.
									Dry Results:	Max:	**613**	61.5%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**131**	51.0%	% reduction for geomean WQS (64 col/100 mL)
									Overall Results:	Max:	**1986**	88.1%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**197**	67.5%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

2.2.B Watershed Characterization

Figure 12 provides an aerial view of Nasons Brook and a clear indication of the dominance of forest land along with the considerable extent of agricultural land that occupies the watershed. The bacteria sampling location (N010) for this most recent assessment is shown approximately 1 mile above the confluence with the Presumpscot River and is also a long term bacteria sampling location for the volunteer water quality monitoring group the Presumpscot River Watch (PRW).

The Nasons Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 13). The watershed area as delineated is approximately 3.73 square miles with less than 0.2 square mile (~4%) consisting of impervious surfaces. Stream gradient over the entire length of the segment is very gradual with a slope of less than 1%.

Forest lands comprise just under 70% of the watershed area followed by agriculture (mostly pastures and hayfield) at just over 20%. Non-farming human land uses (residential, commercial, roads, etc.) cover approximately 7% of the Piscataqua River's watershed area while grasslands and wetlands make up the remainder.

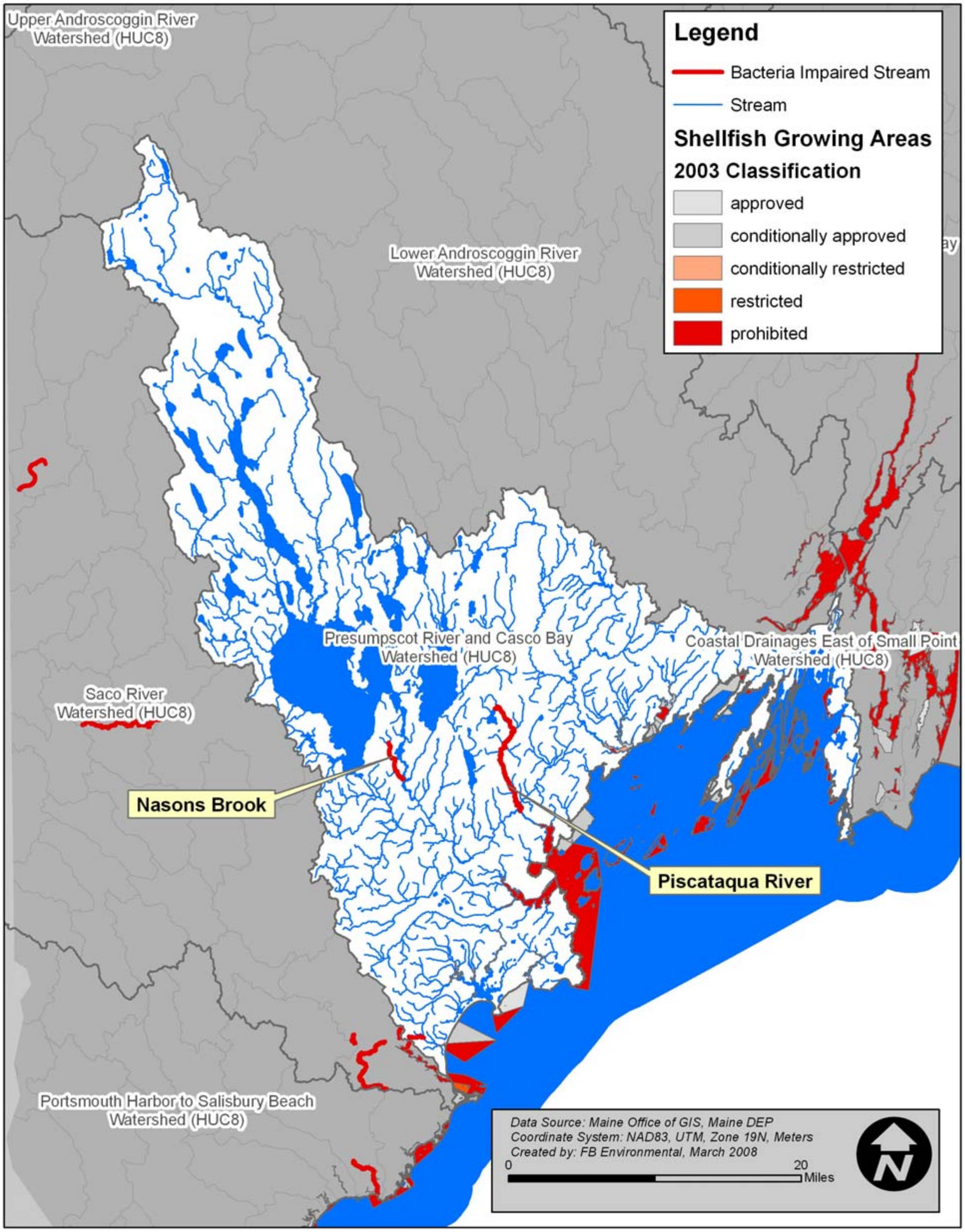


Figure 11: Casco Bay Watersheds showing Nasons Brook.

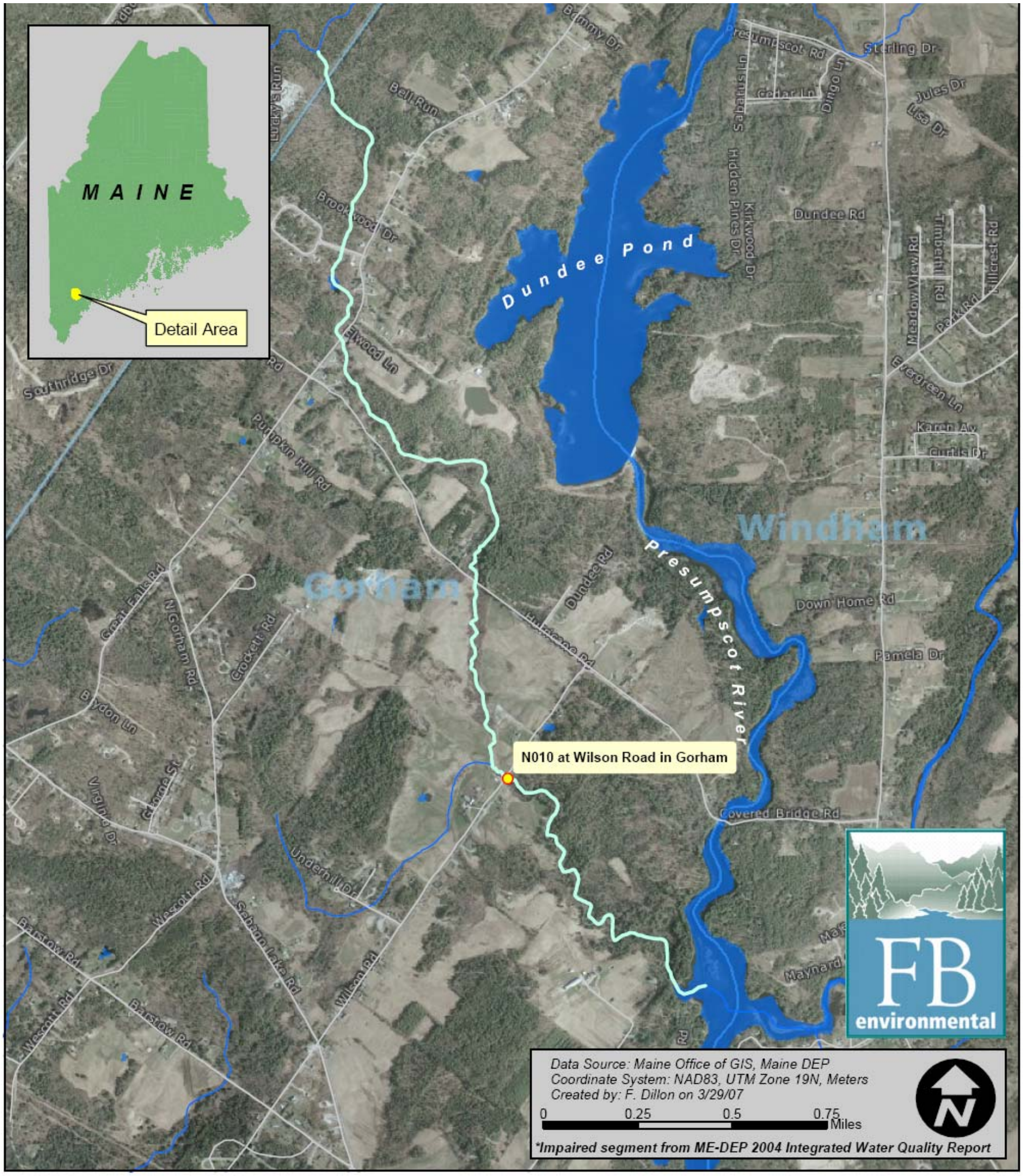


Figure 12: Aerial photograph of Nasons Brook and surrounding area.

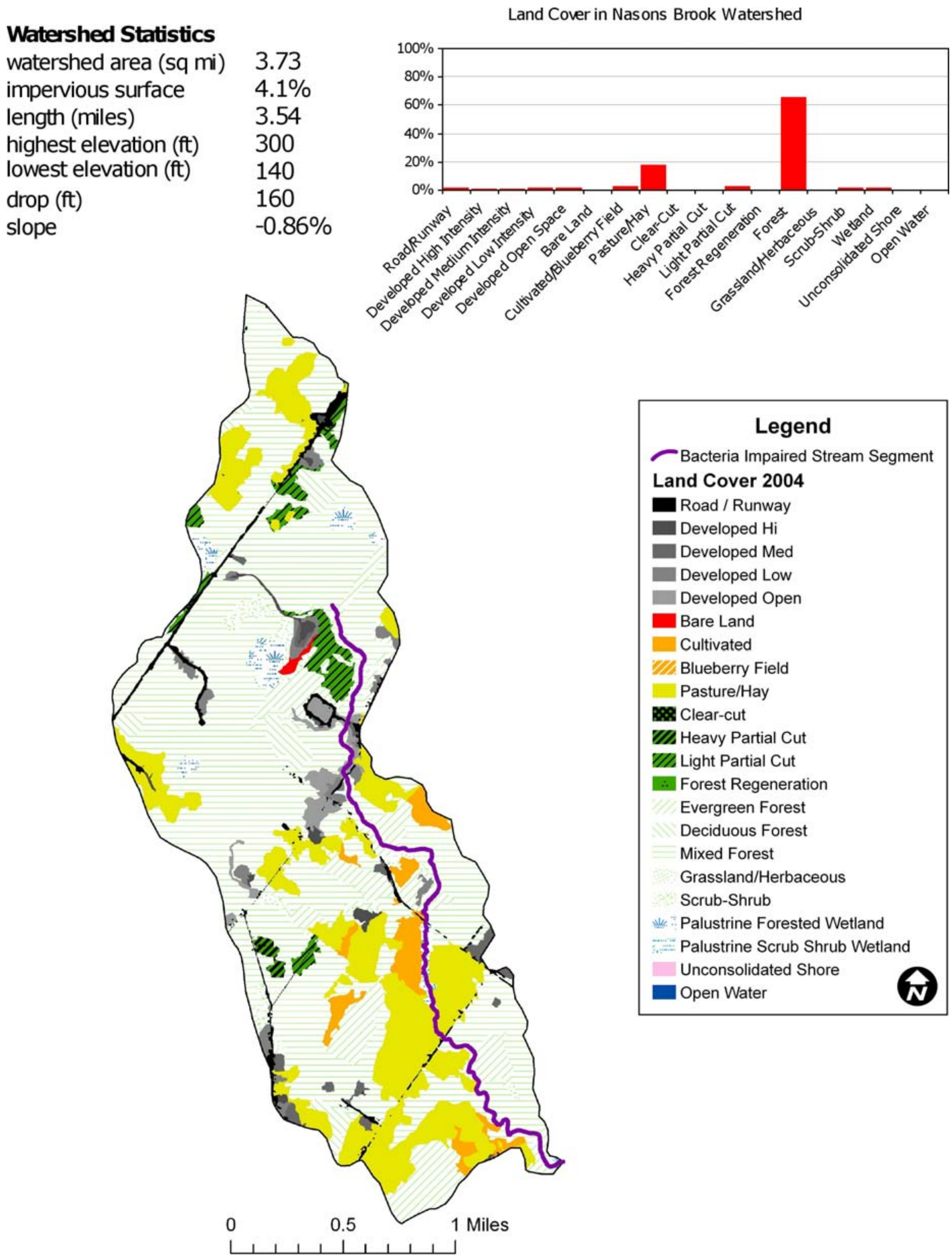


Figure 13: Nasons Brook watershed land cover map and statistics

2.2.C Recommended Mitigation Strategies

Based on the bacteria sampling conducted by FBE in 2007, Nasons Brook did not meet the geometric mean water quality standard and experienced numerous instantaneous exceedances. Based on a land use analysis, it appears that bacteria contamination may be most closely related to the agricultural activities in the Nasons Brook watershed. And while non-farming development exhibits a fairly light footprint in the Piscataqua River watershed, it is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to bacteria impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution.

Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain (as was the case for 2007 storm sampling). Since the Piscataqua River is dominated by forests, wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, an ongoing sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of a suspected area could reveal where impairment is greatest, which can also help suggest which sources (development or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning system is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to bacteria impairment (for example, dumping cat litter or other pet waste next to a stream).

There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Cumberland County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there. Finally, the Presumpscot River Watch also intends to continue bacteria monitoring on Nasons Brook and could therefore play an important role in documenting the potential success of various management strategies.

3. Central Coastal Watershed

3.1 Sheepscot River (Alna)

The Sheepscot River (Segment ID 528R01) is located in Alna within the Central Coastal Watershed (Figures 14 and 15). The listed segment length for the Sheepscot River is 4.8 miles and its total listed watershed area is 64.8 square miles. Sources of potential bacteria impairment are listed as unknown.

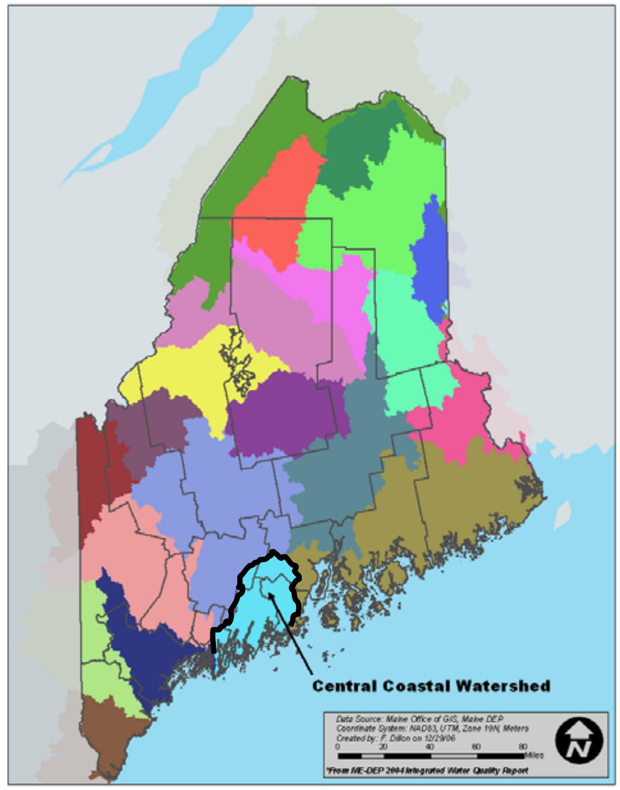


Figure 14: Central Coastal Watershed.

3.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Sheepscot River Watershed were collected by FB Environmental (FBE) staff throughout the spring and summer of 2007 and are presented in Table 5. The instantaneous and geometric mean bacteria standards for the Sheepscot River, which is a Class AA stream, are "as naturally occurs." The next most stringent standard, for class B waters, is more quantitative at 236 MPN/100mL of sample for instantaneous samples and 64 MPN/100mL of sample for the geometric mean.

Bacteria levels in the Sheepscot River did not exceed the instantaneous standard in any of 15 surveys conducted throughout the 2007 sampling period (Table 5). Likewise, the geometric mean standard for the Sheepscot River was met over the entire sampling period with a value of 48 MPN/100 mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded during the 5 storm flow sampling events with a value of 83 MPN/100 mL.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

Since the geometric mean for the overall results met the water quality standard, the % reduction calculation does not apply. For storm flow samples, the % reduction required to comply with the geometric mean standard is 22.7% and is not indicated for the dry weather samples since they complied with the standard (Table 5). Bacteria concentration reductions needed to attain the instantaneous water quality standard also do not apply. However, it is important to note that a series of samples collected over a single sampling period may not adequately characterize the nature and extent of potential bacteria contamination in a given watershed. Even though the 2007 bacteria data for the Sheepscot River indicate compliance with state standards, future (or prior) monitoring results may indicate otherwise. Therefore, ongoing monitoring may be advisable for streams with suspected bacteria contamination issues.

Table 5: Bacteria data summary for Sheepscot River, with wet and dry weather assessment.

Sheepscot - Alna	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	FD	12:20	Rain	0.84	0.10	0.00	0.00	0.00	y	15	29		
17-May-07	TR	12:30	Overcast	0.00	0.84	0.10	0.00	0.00	y	11	199		
5-Jul-07	TB	12:50	-	0.42	0.00	0.00	0.07	0.00	y	20	124		
19-Jul-07	TR	12:15	-	0.22	0.17	0.00	0.00	0.07	y	-	46		HETL# C032879-002
26-Sep-07	TR	13:15	Overcast	0.58	0.00	0.00	0.00	0.00	y	22	118		Unclear on w hether 0.1" rain fell on 9/26 before sample collected. HETL# C047606-004
									Storm Results:	Max:	199	na	% reduction calculation results in negative number
										Geomean:	**83**	22.7%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
10-May-07	TR	10:34	Clear	0.00	0.00	0.00	0.00	0.01	n	12	8		Fyke nets near sampling site.
24-May-07	FD	9:45	Ptly cldy	0.00	0.00	0.00	0.00	0.14	n	16	24		Fyke nets still set up near sampling site.
31-May-07	FD	10:20	Mstly cldy	0.00	0.02	0.00	0.04	0.01	n	19	33		Fishing net / w eir removed since last sampling event. *E. coli* result approx. because sample bottle had slow leak.
7-Jun-07	FD	8:30	Clear	0.00	0.00	0.07	0.83	0.21	n	16	53		*E. coli* result approx. because test exceeded 22-hour incubation time by 2 hrs. due to lab error.
12-Jun-07	FD	13:40	Ptly cldy	0.00	0.00	0.00	0.07	0.00	n	22	42		
21-Jun-07	FD	8:55	Clear	0.00	0.07	0.00	0.00	0.04	n	19	83		
26-Jun-07	FD	13:30	Clear	0.00	0.00	0.00	0.00	0.04	n	24	62		*E. coli* avg of 2 samples: sample 1 = 38; sample 2 = 85.
1-Aug-07	TR	11:00	Clear	0.00	0.00	0.00	0.00	0.03	n	-	20		HETL# C035456-001
28-Aug-07	JJ	12:40	Clear	0.00	0.00	0.00	0.10	0.14	n	23	201		HETL # C040987-007
18-Sep-07	TR, JJ	10:00	Clear	0.00	0.00	0.00	0.24	0.00	n	-	17		HETL # C044539-004
									Dry Results:	Max:	201	na	% reduction calculation results in negative number
										Geomean:	37	na	% reduction calculation results in negative number
									Overall Results:	Max:	201	na	% reduction calculation results in negative number
										Geomean:	48	na	% reduction calculation results in negative number

** Precip data for Augusta, ME (Source: NOAA / NWS)*

** **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

*** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

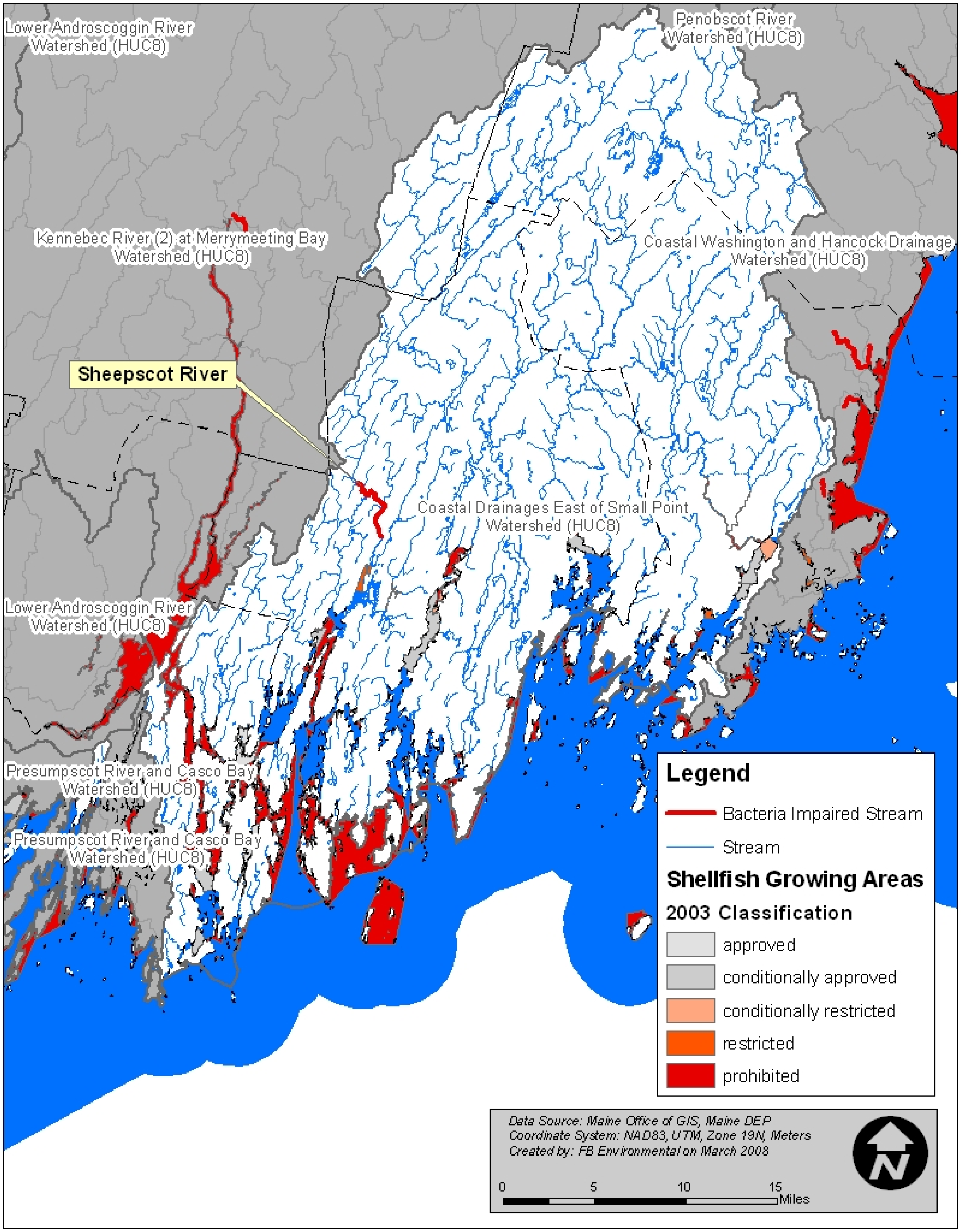


Figure 15: Central Coastal Watersheds showing the Sheepscot River.

3.1.B Watershed Characterization

Figure 16 provides an aerial view of Sheepscot River and a clear indication of the dominance of forest land along with the considerable extent of agricultural land that occupies the watershed. The Sheepscot River watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 17). The watershed area as delineated is approximately 23.16 square miles with less than 0.7 square mile (~3%) consisting of impervious surfaces. Stream gradient over the entire length of the segment is very gradual with a slope of less than 1%.

Forest lands comprise just over 75% of the watershed area followed by agriculture (mostly pastures and hayfields) at approximately 16%. Non-farming human land uses (residential, commercial, roads, etc.) cover approximately 4% of the Sheepscot River's watershed area while grasslands and wetlands make up the remainder.

3.1.C Recommended Mitigation Strategies

Based on Class B bacteria standards, the Sheepscot River complied with both the geometric mean and instantaneous water quality criteria. However, it is still important to consider potential bacteria mitigation strategies should problems arise in the future. Developed areas and impervious surfaces are relatively light in the Sheepscot River watershed (~4%). Nonetheless, it is possible that a few wastewater systems may be malfunctioning. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since this section of the Sheepscot River watershed contains extensive forests (approximately 75% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is also a fairly significant part of the watershed (~16%), and some of these lands lie very near or directly abut the river. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The local Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

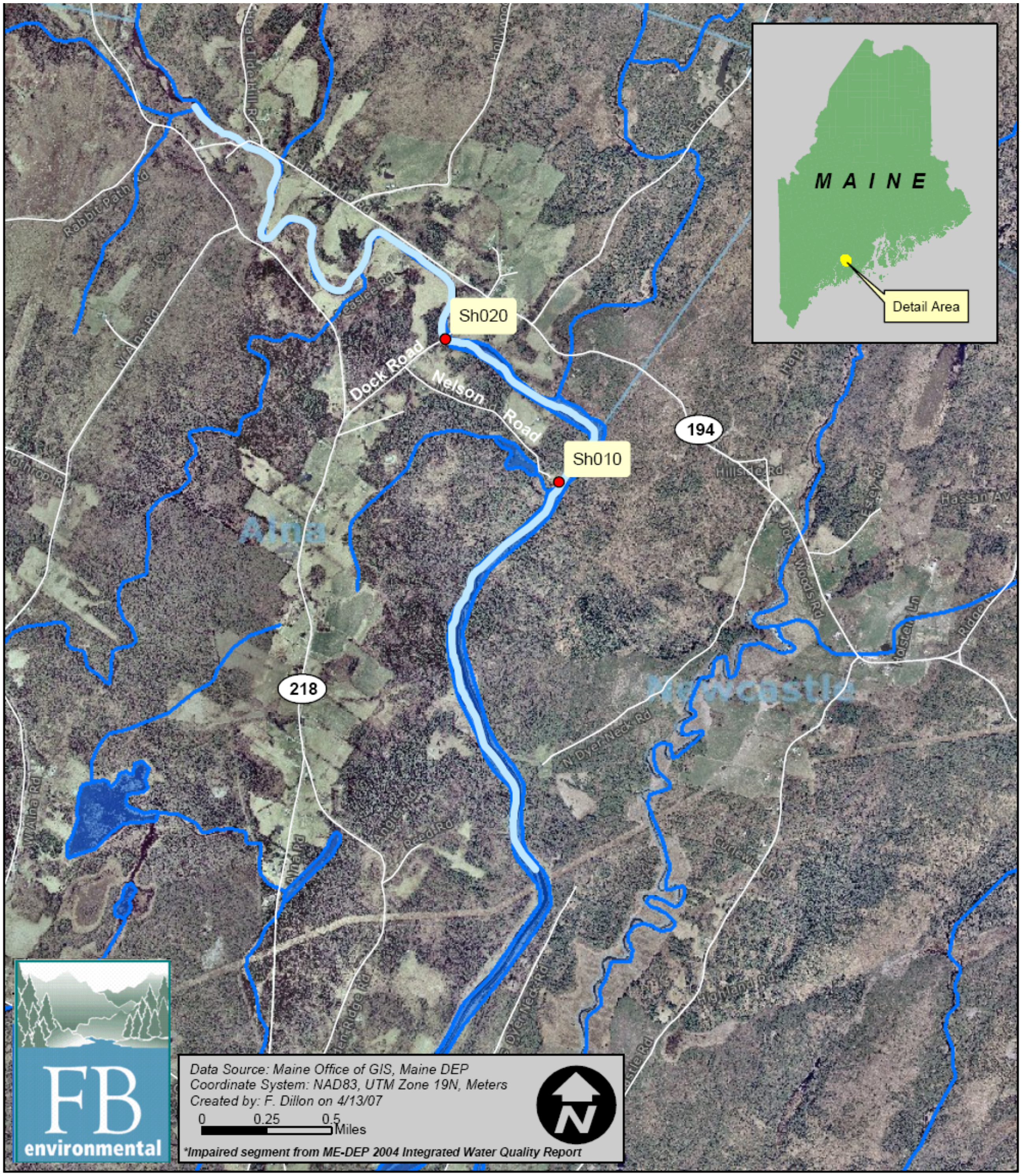


Figure 16: Aerial photograph of the Sheepscot River and surrounding area.

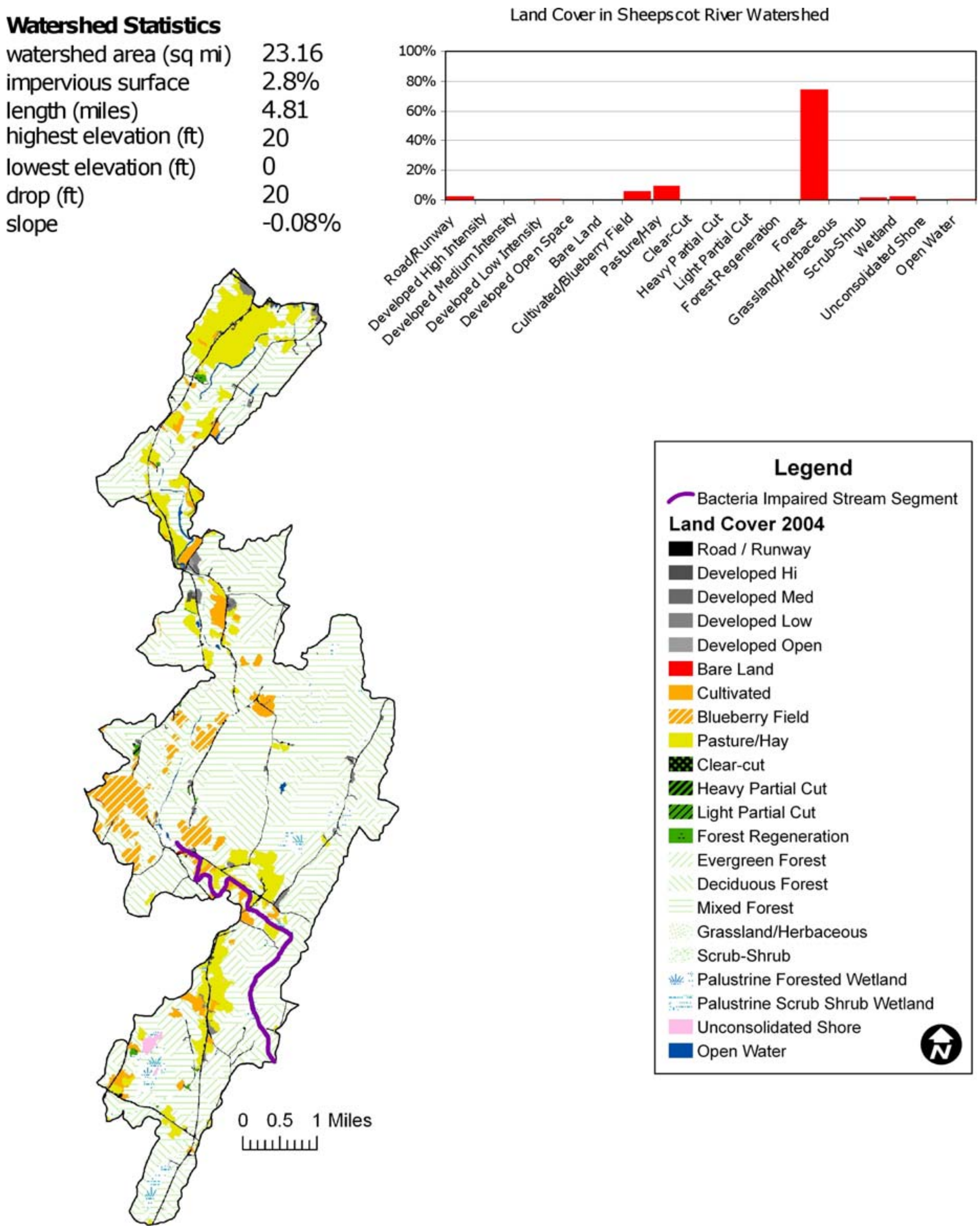


Figure 17: Sheepscot River watershed land cover map and statistics

4. Eastern Coastal Watershed

4.1 Megunticook River (Camden)

The Megunticook River (Segment ID 522R01) is located in the town of Camden at the western edge of the Eastern Coastal Watersheds region. (Figures 18 and 19). The listed segment length for the Megunticook River is 3.9 miles and its total listed watershed area is 30.9 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

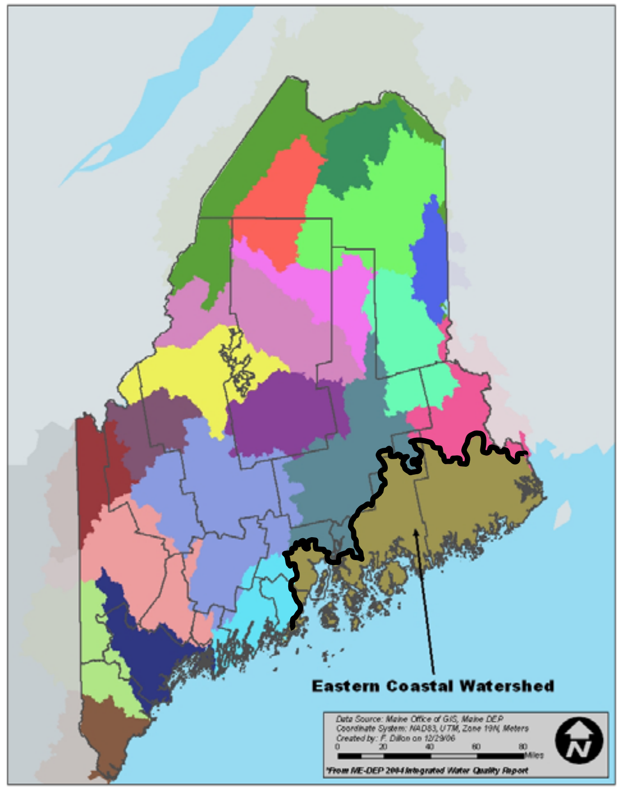


Figure 18: Eastern Coastal Watersheds

4.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Megunticook River were collected by FB Environmental staff in spring 2007 and are presented in Table 6. The Megunticook River was one of five streams listed for "bacteria-only" impairment in the Eastern Coastal Watersheds as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for the Megunticook River, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in the Megunticook River were observed to exceed the instantaneous standard in 2 of 6 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 1414 MPN/100mL on May 31st and 2420 MPN/100mL on June 7th. Bacteria concentrations in the Megunticook River did not meet the geometric mean standard for the sampling period, at 314 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset and three samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season would indicate a reduction of 79.6% needed to meet the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 86.0% and 70.3%, respectively. Bacteria concentration reductions needed to attain the instantaneous water quality standard were

90.2% for both the overall and storm event results and 83.3% for the dry weather results, based on the maxima for each respective category.

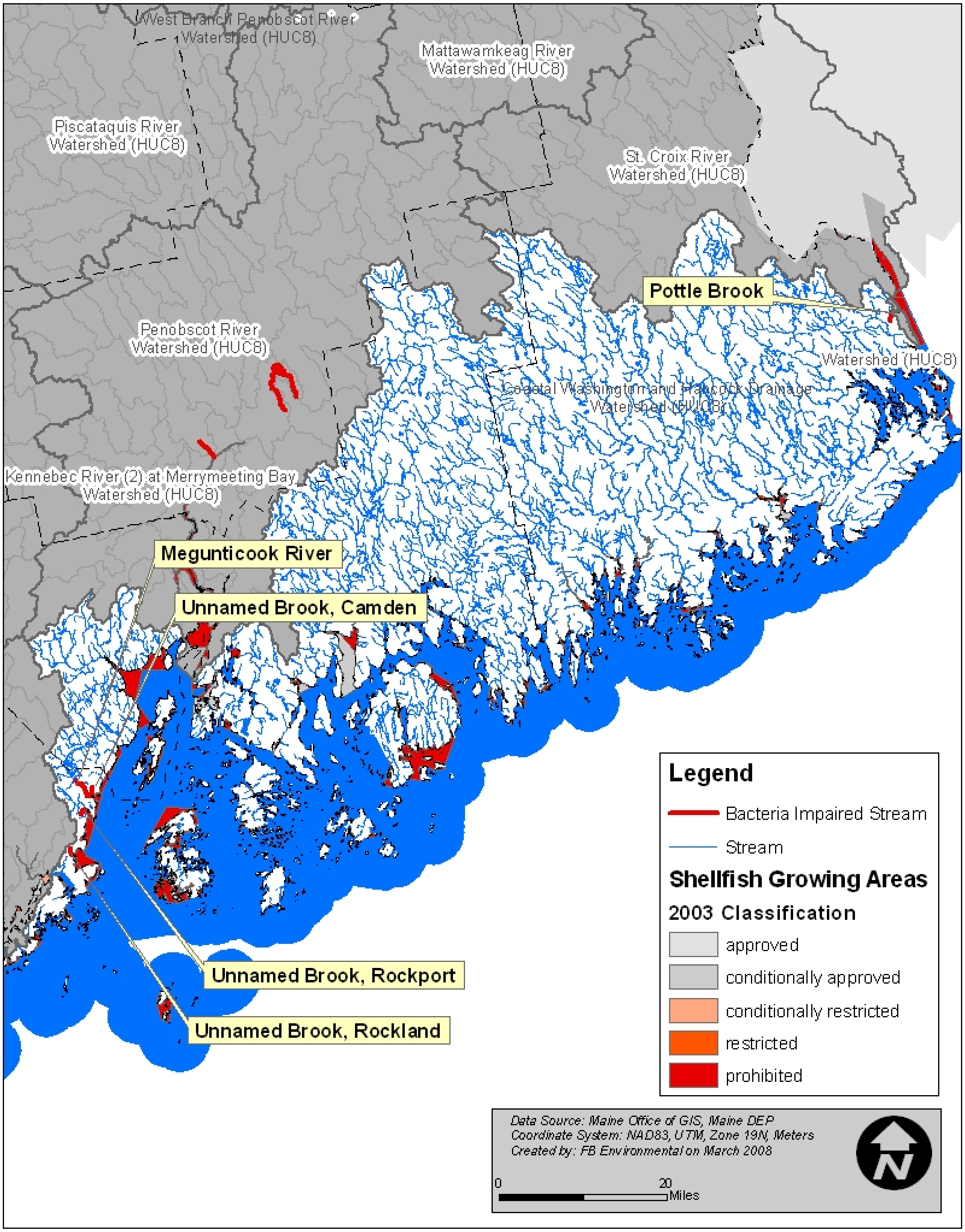


Figure 19: Eastern Coastal Watersheds showing the Megunticook River.

Table 6: Bacteria data summary for Megunticook River, with wet and dry weather assessment.

Megunti-cook - Camden	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	FD	13:40	Lt-mod rain	0.84	0.10	0.00	0.00	0.00	y	11	214		
17-May-07	TR	10:34	Overcast	0.00	0.84	0.10	0.00	0.00	y	11	184		
7-Jun-07	FD	10:00	Clear	0.00	0.00	0.07	0.83	0.21	y	18	**2420**		
								Storm Results:		Max:	**2420**	90.2%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**457**	86.0%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
10-May-07	TR	8:53	Clear	0.00	0.00	0.00	0.00	0.01	n	13	49		Clear water
24-May-07	FD	11:10	Partly clea	0.00	0.00	0.00	0.00	0.14	n	16	145		
31-May-07	FD	12:25	ostly clou	0.00	0.02	0.00	0.04	0.01	n	21	**1414**		
								Dry Results:		Max:	**1414**	83.3%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**216**	70.3%	% reduction for geomean WQS (64 col/100 mL)
								Overall Results:		Max:	**2420**	90.2%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**314**	79.6%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Augusta, ME (Source: NOAA / NWS)*

** **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

*** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

4.1.B Watershed Characterization

The aerial photo (figure 20) shows the Megunticook River as it passes through Camden. The Megunticook River watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 21). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 30.8 square miles, and impervious surfaces are estimated to total 4.6% of this area. Stream gradient is very gradual with a slope over the segment length of less than 1%.

Forest is the dominant land use at 73.2%, with open water also contributing a significant amount at 10.9%. Agricultural lands are scattered through the upper reaches of the watershed, totaling 7.9%. Development makes up the smallest of these aggregated categories at 7.2% of the watershed. While the overwhelming majority of the watershed is forested and open water, the concentration of the developed areas in the lower reaches of the stream could have a significant effect on water quality. Development of such density, in particular the oldest infrastructure that is part of the original Camden town center, suggests that aging septic or sewer infrastructure and the abundance of pet waste, are two possible sources of bacteria to the stream.

4.1.C Recommended Mitigation Strategies

Developed areas (<10%) and impervious surfaces (<5%) exhibit a fairly light footprint in the Megunticook River watershed. The nature of the development, however, is an old town center and the location of this development crowds the lower reaches of the river. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to bacteria impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution.

Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. The 2007 sampling results show high bacteria counts both after storm events and during dry weather. Since the Megunticook River is dominated by forests and open water (approximately 84% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning system is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to bacteria impairment (for example, dumping cat litter or other pet waste next to a stream).

There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Knox County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

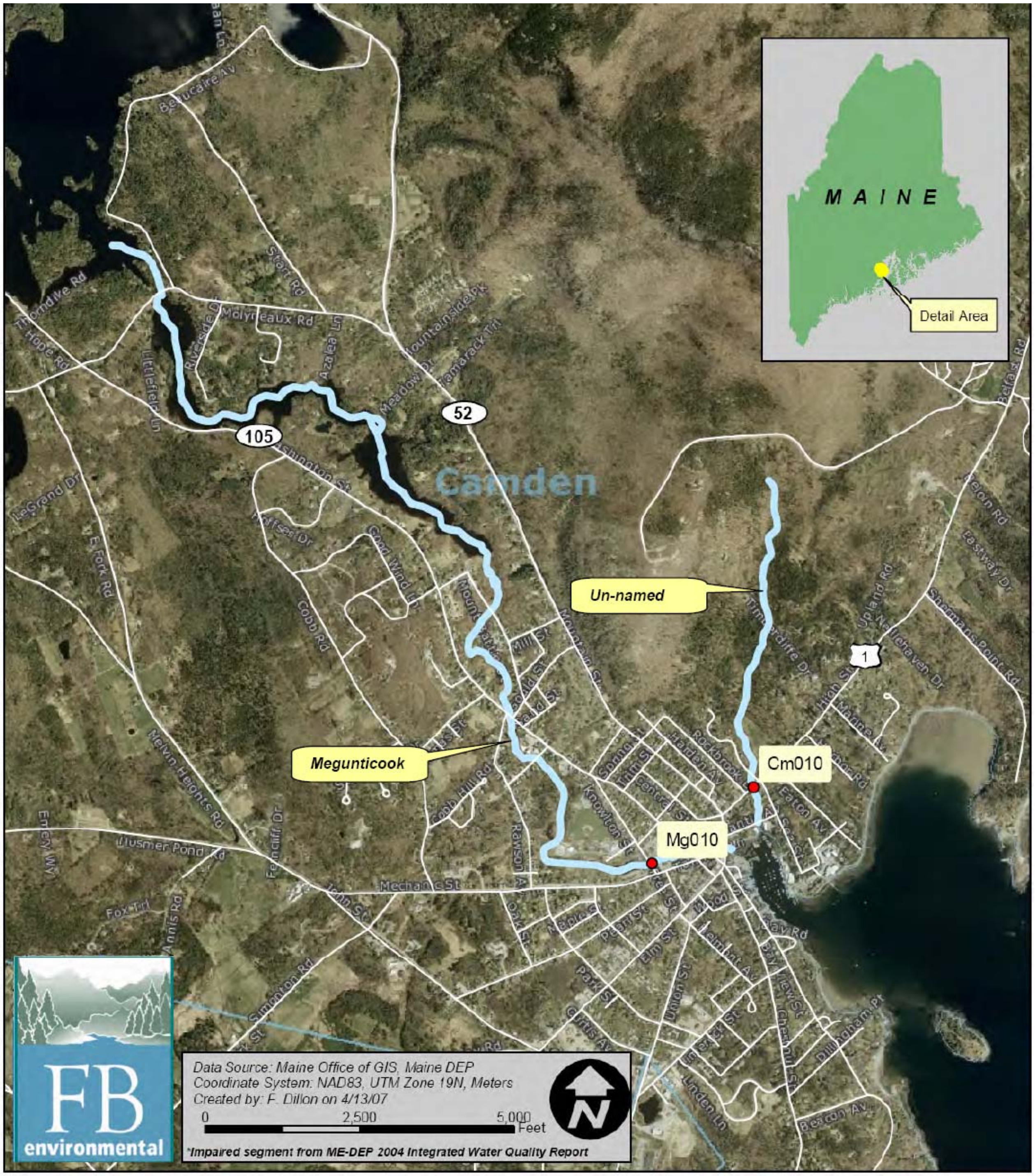


Figure 20: Aerial photograph of Megunticook River in Camden and surrounding area

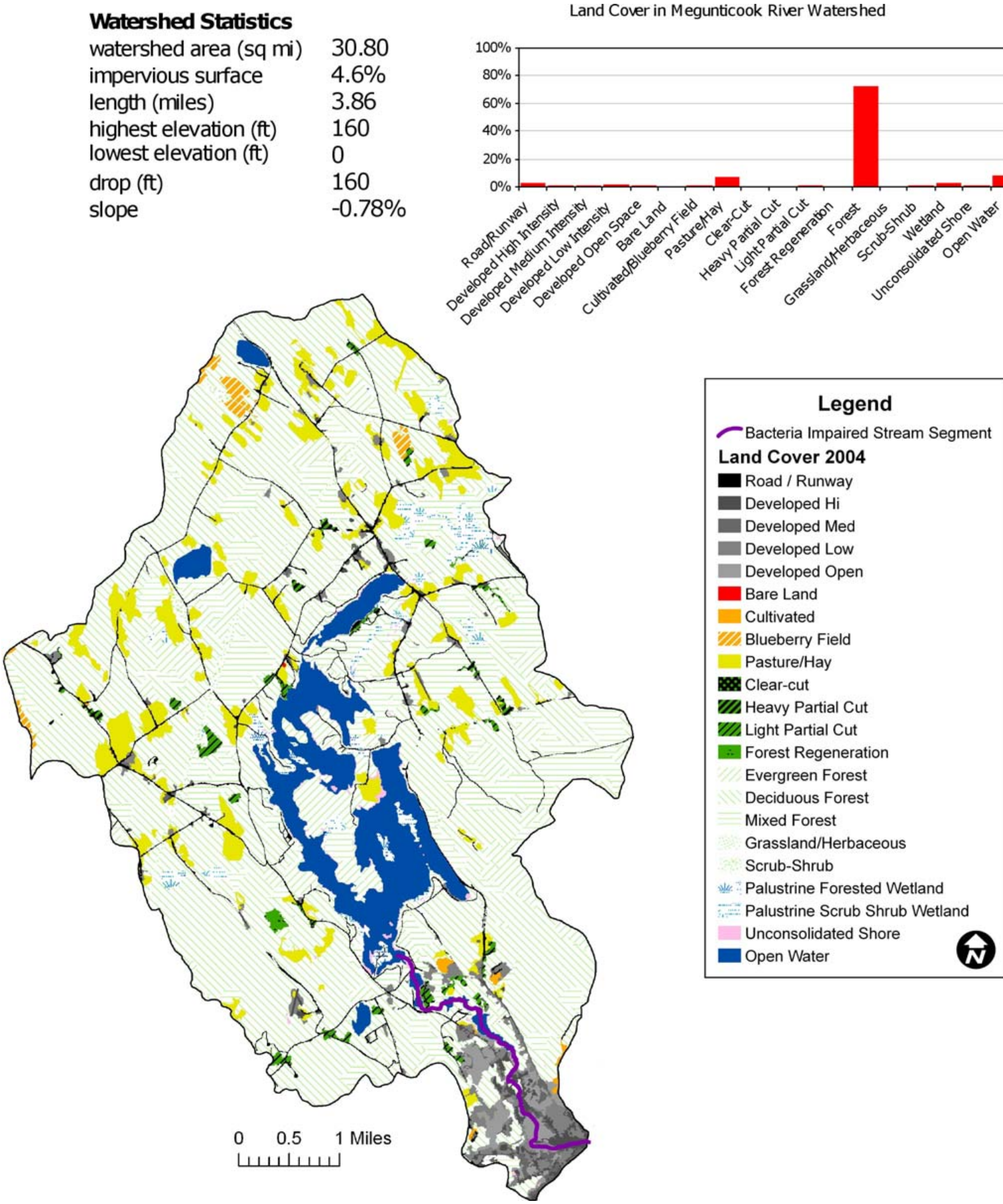


Figure 21: Megunticook River watershed land cover map and statistics.

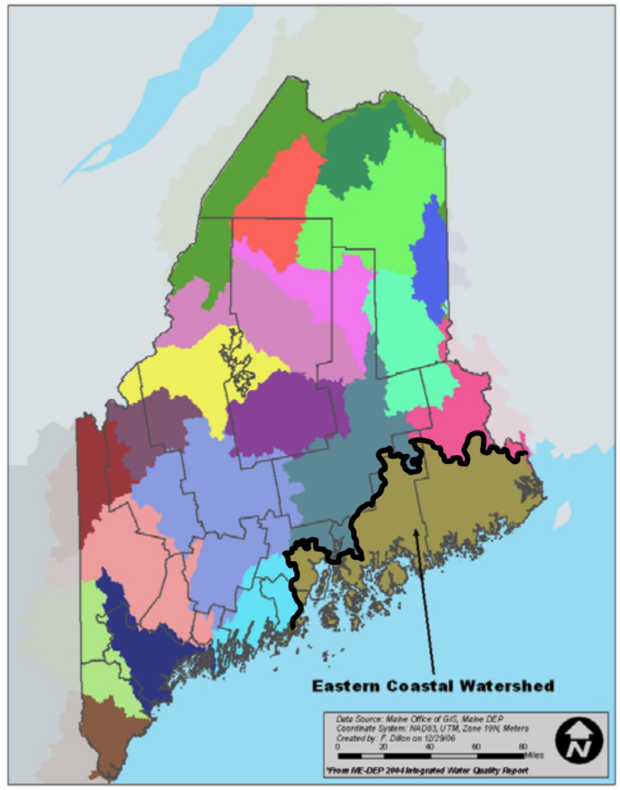


Figure 22: Eastern Coastal Watersheds

4.2 Pottle Brook (Perry)

The Pottle Brook (Segment ID 508R2) is located in the town of Perry at the eastern edge of Eastern Coastal Watersheds region near the Canadian Border. (Figures 22 and 23). The listed segment length for the Pottle Brook is 1.3 miles and its total listed watershed area is 9.6 square miles. Potential sources of bacteria impairment are listed as unknown.

4.2.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for Pottle Brook were collected by Cobscook Bay Resource Center in Eastport, Maine, in the spring of 2007 and are presented in Table 7. Pottle Brook was one of five segments listed for "bacteria-only" impairment in the Eastern Coastal Watersheds as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Pottle Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Pottle Brook were observed to exceed the instantaneous standard in 1 of 5 surveys conducted throughout the 2007 sampling period, with a bacteria concentration of 910 MPN/100mL on June 5th. Bacteria concentrations in Pottle Brook exceeded the geometric mean standard for the study period, exhibiting a geometric mean of 100 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, only storm samples exhibited a geometric mean that exceeded standard, although with merely three samples in the wet weather dataset and two samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season would indicate a reduction of 35.8% needed to meet the water quality standard. For storm samples, the % reduction required to comply with the geometric mean standards are 74.8%. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 74.1% for both the overall season, and 74.1% for the storm samples, based on the maxima for each respective category.

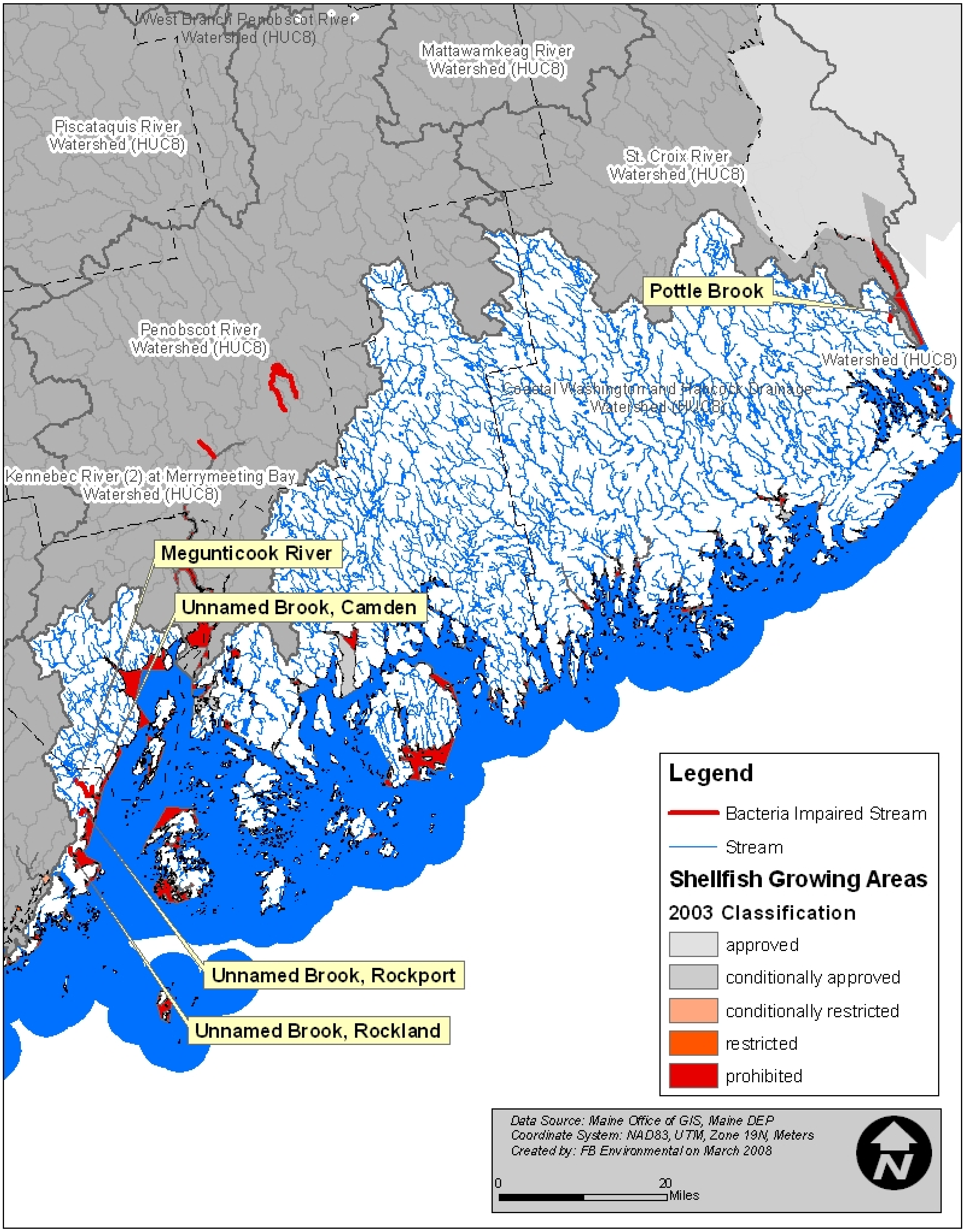


Figure 23: Eastern Coastal Watersheds showing Pottle Brook.

Table 7: Bacteria data summary for Pottle Brook, with wet and dry weather assessment.

Pottle - Perry	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	EH	7:59	Rain	0.23	0.00	0.00	0.00	0.05	y	8	180		Light rain w / little runoff w hen sample collected; unclear w hen rain intensity / duration greatest on 5/8.
29-May-07	EH	7:55	Clear	0.06	0.10	0.00	0.00	0.00	y	9	100		
5-Jun-07	EH	8:00	Lt rain	0.79	0.15	0.21	0.00	0.00	y	9	**910**		Significant runoff w hen sample collected.
								Storm Results:		Max:	**910**	74.1%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**254**	74.8%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
8-May-07	EH	7:34	Ptly cldy	0.00	0.00	0.12	0.00	0.00	n	5	40		
22-May-07	EH	7:46	Clear	0.00	0.06	0.20	1.18	0.00	n	5	15		Significant rain previous 4 days though runoff light w hen sample collected. Field duplicates = <10 MPN and 20 MPN.
								Dry Results:		Max:	40	na	% reduction calculation results in negative number
										Geomean:	24	na	% reduction calculation results in negative number
								Overall Results:		Max:	**910**	74.1%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**100**	35.8%	% reduction calculation results in negative number

** Precip data for East Machias, ME (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

4.2.B Watershed Characterization

The aerial photo (figure 24) shows Pottle Brook. Pottle Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 25). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 3.08 square miles, and impervious surfaces are estimated to total 2.4% of this area. Stream gradient is gradual with a slope over the segment length of approximately 1.7%.

Forest dominates the landscape at 82% of the watershed, with wetlands also contributing a significant amount at 8%. Agricultural lands are scattered through the upper reaches of the watershed, and along the lower reaches of the stream, totaling 3.5%. Development makes up the smallest of these aggregated categories at 2.7% of the watershed. While the overwhelming majority of the watershed is forested and wetland, some agriculture and development is concentrated in the lower reaches of the streams. The adjacency of these land uses to the stream may facilitate bacterial loading to the water, magnifying the impact of that small percentage of the watershed which is affected by human activities.

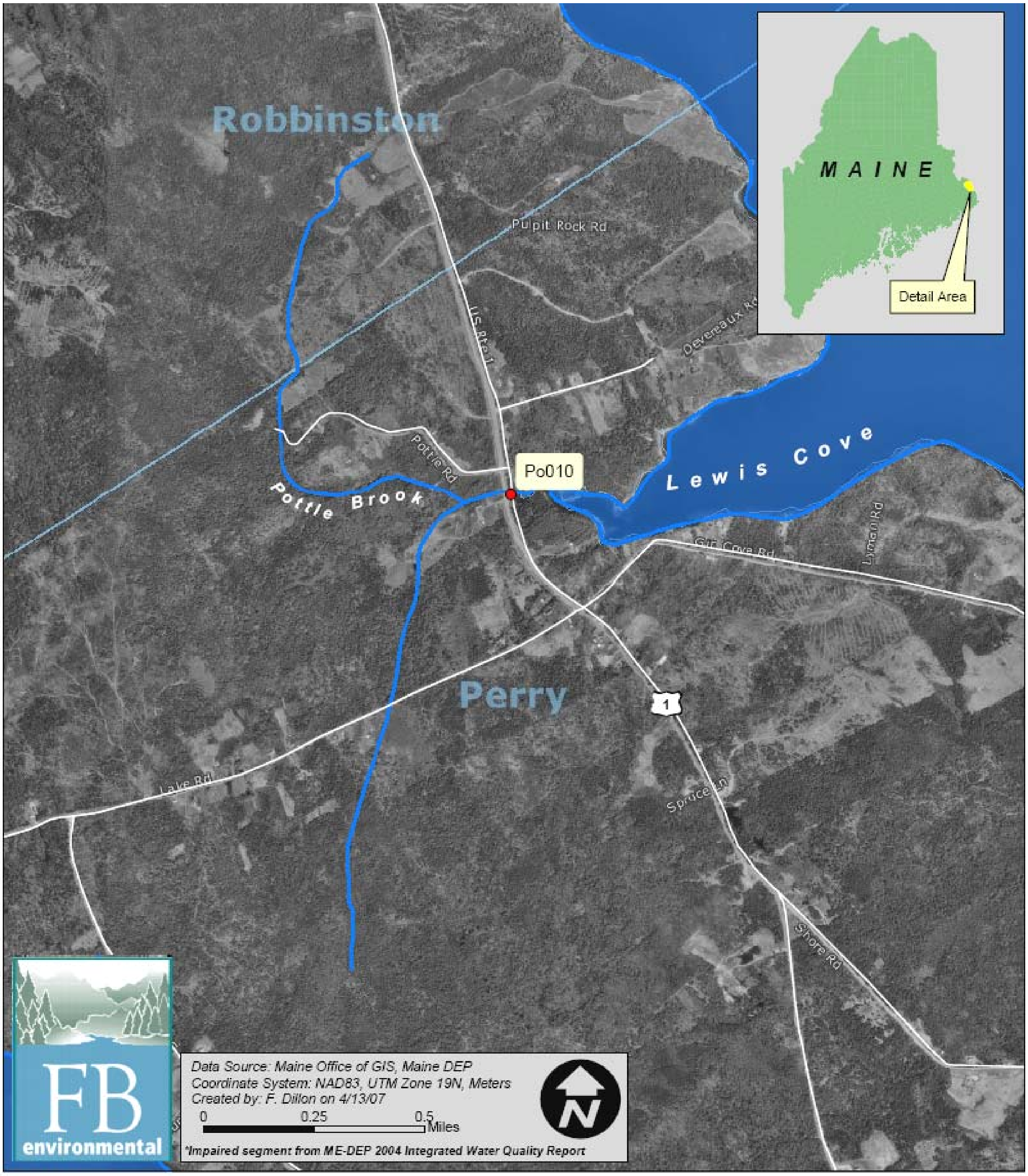
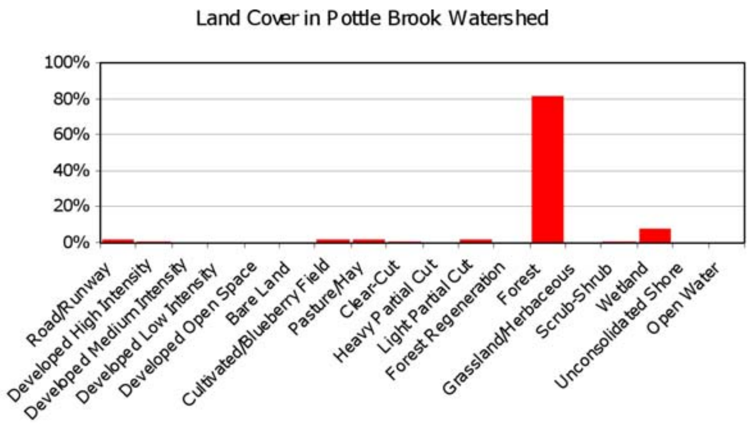


Figure 24: Aerial photograph of Pottle Brook and surrounding area.

Watershed Statistics

watershed area (sq mi)	3.08
impervious surface	2.4%
length (miles)	1.33
highest elevation (ft)	140
lowest elevation (ft)	20
drop (ft)	120
slope	-1.71%



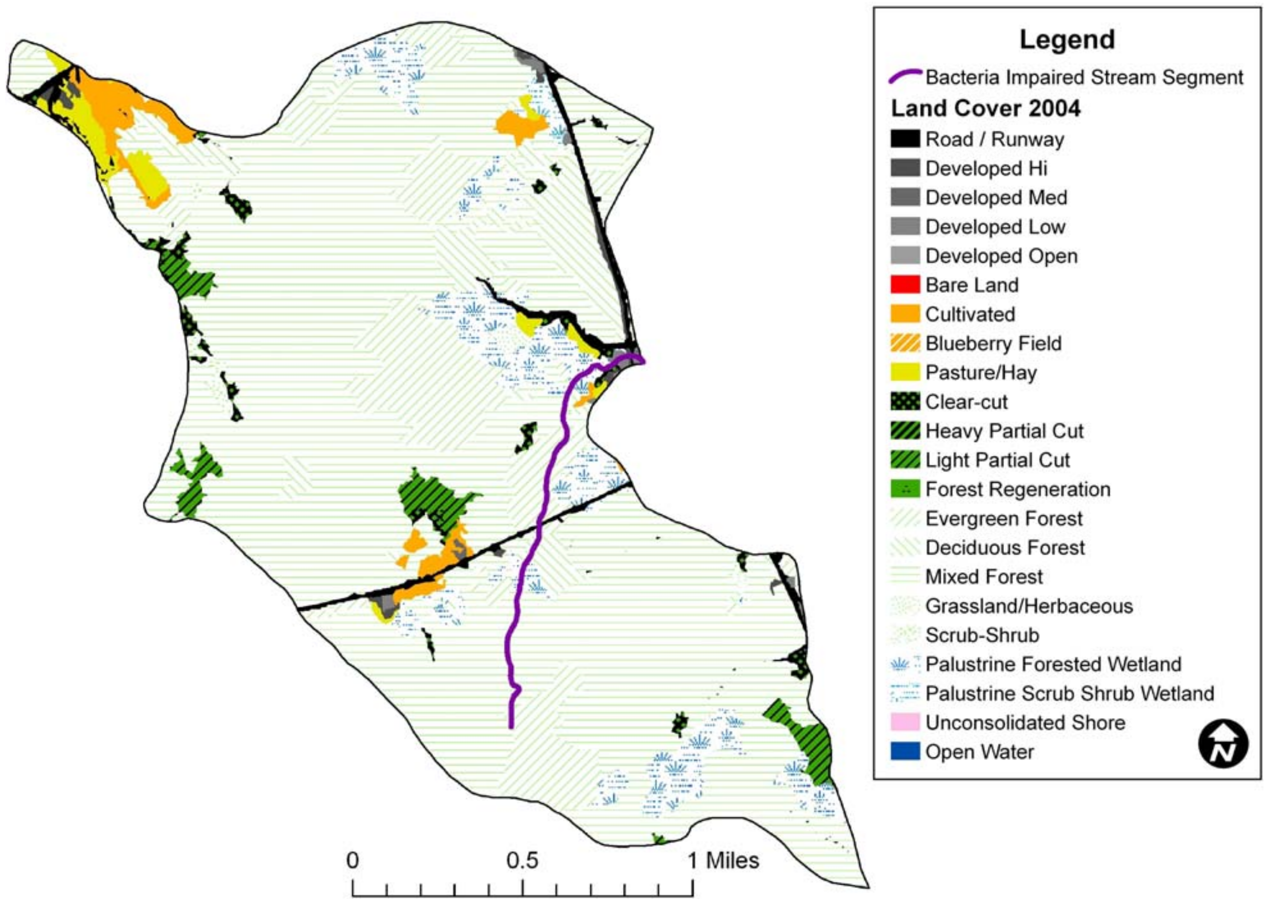


Figure 25: Pottle Brook watershed land cover map and statistics.

4.2.C Recommended Mitigation Strategies

Developed areas (<3%) and impervious surfaces (<3%) make up a very small proportion of the Pottle Brook watershed. While development of any size can result in water quality impairment if not properly managed, the more likely sources of impairment would seem to be agriculture. In particular, agricultural activities conducted adjacent to streams merit further investigation to determine if impairment is likely at those locations. Since the Pottle Brook is dominated by forests and open water (approximately 84% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of areas of agricultural activity could reveal where impairment is greatest, which can also help suggest which sources (agricultural or wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Knox County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

Even though development is minimal in the watershed, a review of wastewater treatment systems is also worthwhile. Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Pet waste is another possible source of bacteria. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks and trails can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

4.3 Unnamed Brook (Camden)

The unnamed brook in the Town of Camden, Maine, (Segment ID 522R02) is located at the western edge of the Eastern Coastal Watersheds region on Penobscot Bay's western side. (Figures 26 and 27). The listed segment length is 1.1 miles and its total listed watershed area is 10.2 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

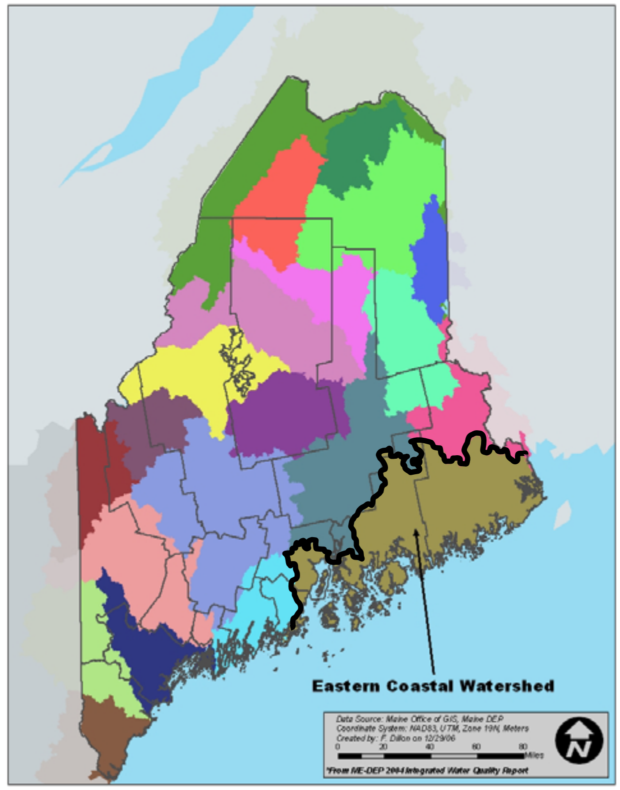


Figure 26: Eastern Coastal Watersheds

4.3.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for unnamed brook in Camden, Maine, were collected by FB Environmental staff in spring 2007 and are presented in Table 8. This brook was one of five streams listed for "bacteria-only" impairment in the Eastern Coastal Watersheds as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for the unnamed brook in Camden, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in the unnamed brook in Camden were observed to exceed the instantaneous standard in 2 of 6 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 687 MPN/100mL on May 16th and 1733 MPN/100mL on May 24th. Bacteria concentrations in the unnamed brook in Camden did not meet the geometric mean standard for the sampling period, at 105 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset and three samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season would indicate a reduction of 38.8% needed to meet the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 37.5% and 40.0%, respectively. Bacteria concentration reductions needed to attain the instantaneous water quality standard were

86.4% for the overall and storm event results and 65.6% for the dry weather results, based on the maxima for each respective category.

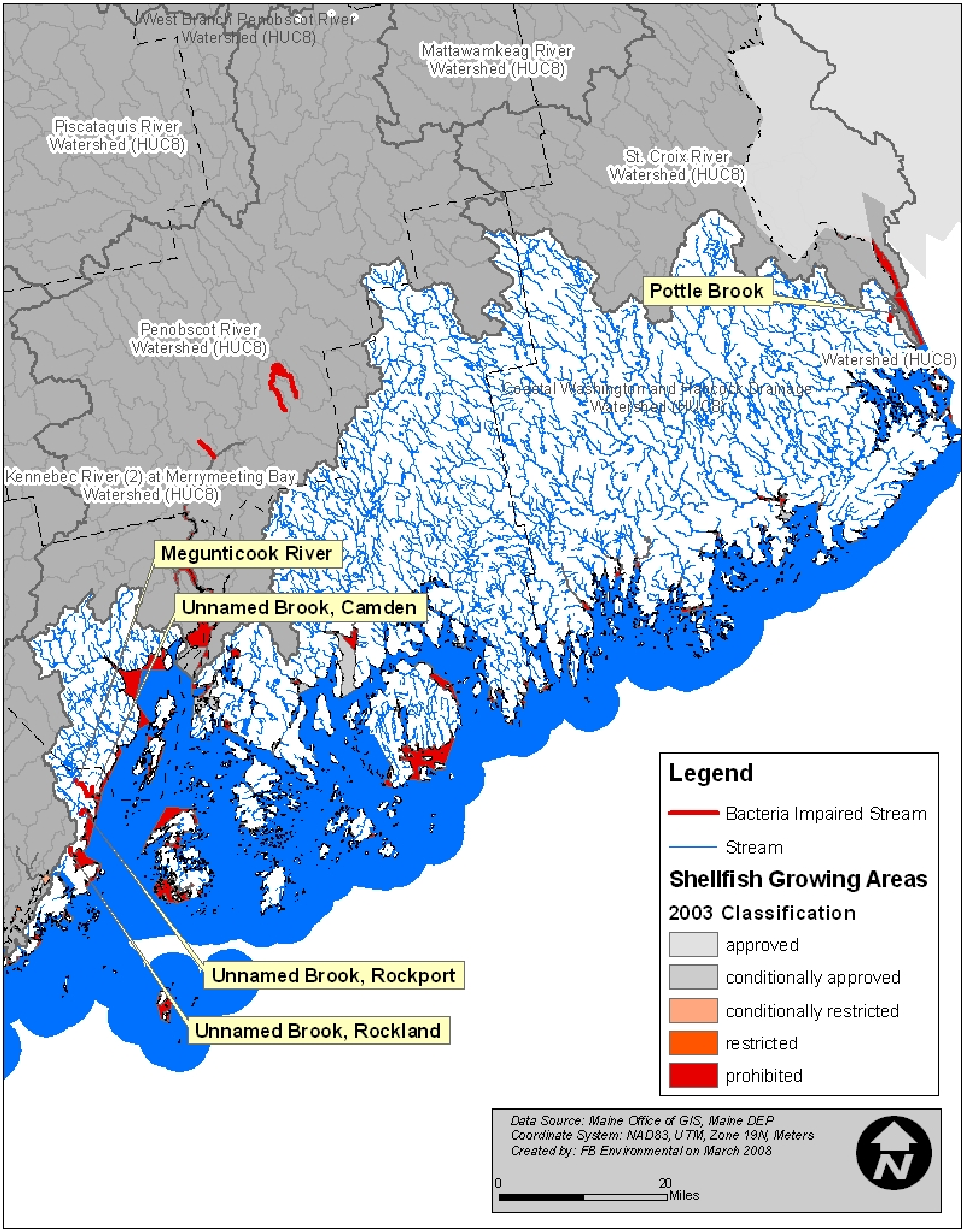


Figure 27: Eastern Coastal Watersheds showing unnamed brook in Camden.

Table 8: Bacteria data summary for unnamed brook, Camden, ME, with wet and dry weather assessment.

Unnamed - Camden	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	FD	13:50	.t-mod rai	0.84	0.10	0.00	0.00	0.00	y	15	**687**		
17-May-07	TR	10:25	Overcast	0.00	0.84	0.10	0.00	0.00	y	8	60		
7-Jun-07	FD	10:10	Clear	0.00	0.00	0.07	0.83	0.21	y	12	26		Conclude sampling for this site per Melissa Evers. *E. coli* result approx. because test exceeded 22-hour incubation time by 2 hrs. due to lab error.
									Storm Results:	Max:	**687**	65.6%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**102**	37.5%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
10-May-07	TR	8:40	Clear	0.00	0.00	0.00	0.00	0.01	n	10	13		Clear water
24-May-07	FD	11:05	Partly clea	0.00	0.00	0.00	0.00	0.14	n	11	**1733**		
31-May-07	FD	12:30	ostly clou	0.00	0.02	0.00	0.04	0.01	n	15	54		Water only ~6" deep at sample collection point.
									Dry Results:	Max:	**1733**	86.4%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**107**	40.0%	% reduction for geomean WQS (64 col/100 mL)
									Overall Results:	Max:	**1733**	86.4%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**105**	38.8%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Augusta, ME (Source: NOAA / NWS)*

** **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

*** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

4.3.B Watershed Characterization

The aerial photo (figure 28) shows the unnamed stream as it traverses the northern area of Camden. The unnamed stream's watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 29). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is a very compact 0.44 square miles, and impervious surfaces are estimated to total 5.5% of this area. Stream gradient is steep with a slope over the segment length of over 6%.

Forest is the dominant land use, calculated to be 76.4%. Developed categories combined are the second largest land use, at 13%, and agricultural land is a close third at 10.6%. The agricultural lands are clearly offset to the west of the stream, and are not adjacent to it, although the steep gradient may mean that storm water runoff is more effective at transporting bacteria from those lands to nearby surface waters. The clearest suggestion of bacterial sources, however, is the development flanking both sides of the stream in its lower reaches as it traverses a portion of the town center. Potential bacteria sources common to developed areas include septic or sewer infrastructure which due to age may be either of an obsolete design, or may simply be deteriorating, and abandoned or intentionally dumped pet wastes.

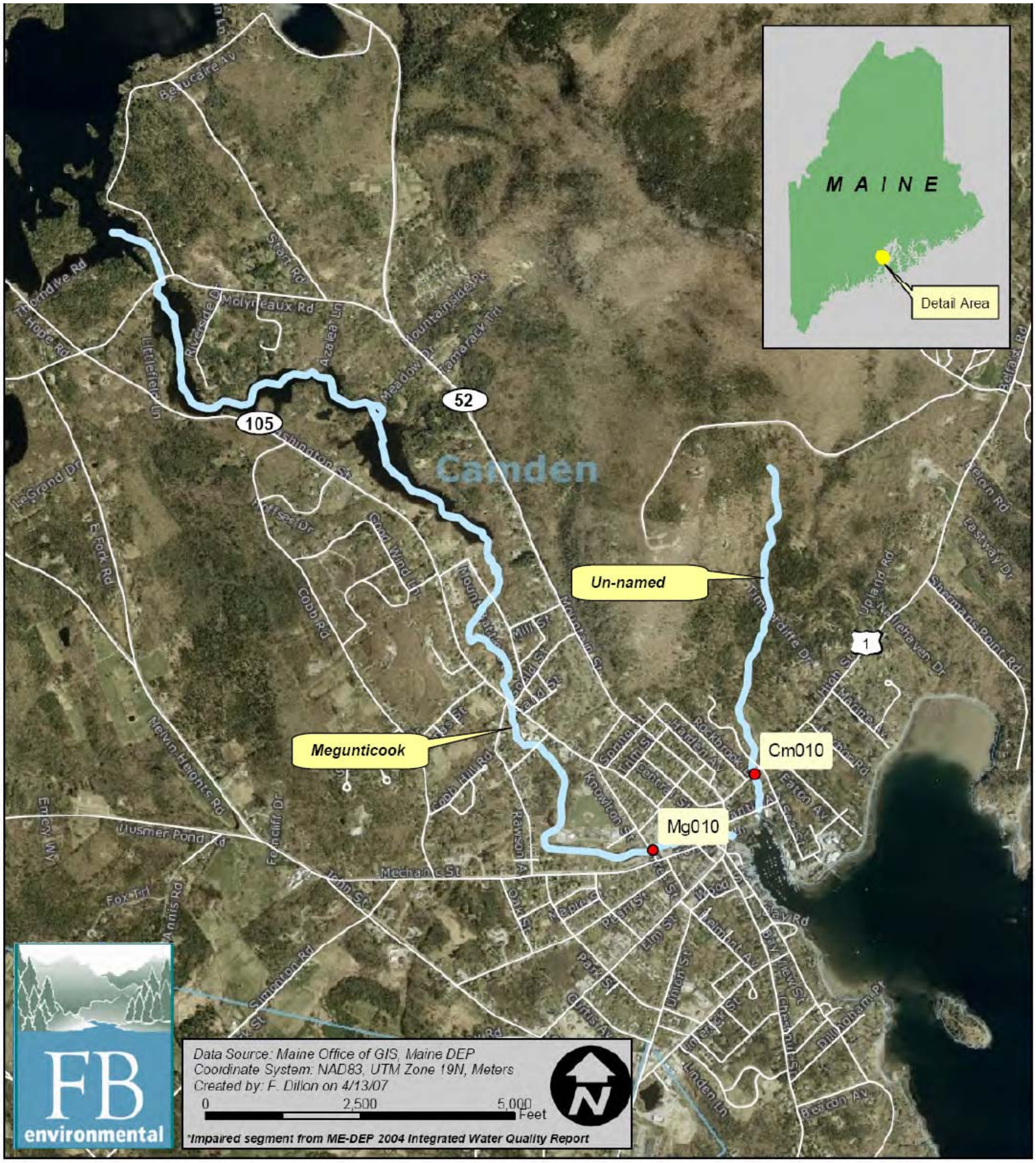


Figure 28: Aerial photograph showing the unnamed stream in Camden and surrounding area

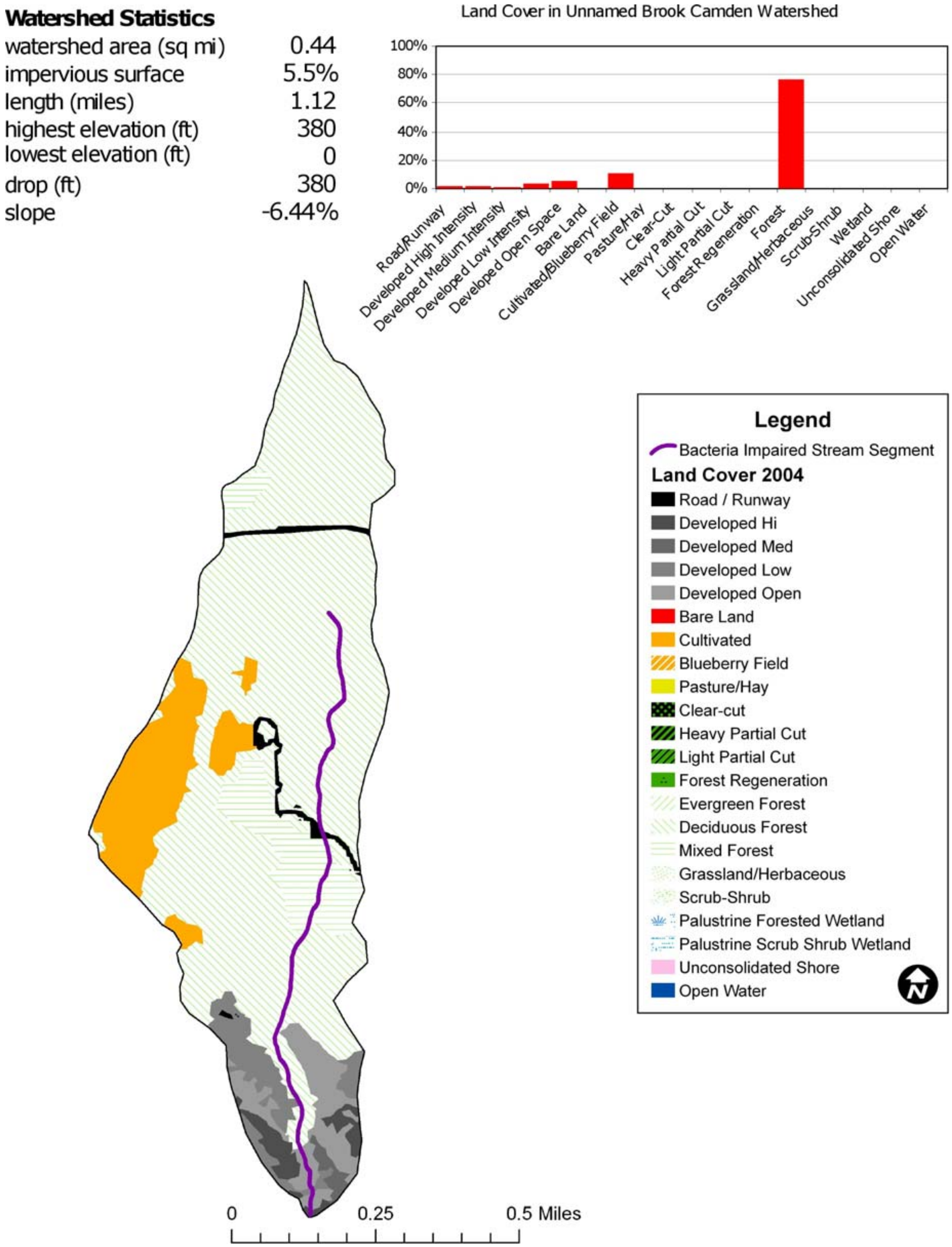


Figure 29: Unnamed Brook in Camden watershed land cover map and statistics.

4.3.C Recommended Mitigation Strategies

Developed areas (13%) and impervious surfaces (<6%) comprise a moderate proportion of the unnamed stream in Camden's watershed. The nature of the development, however, is an old town center and the location of this development crowds the lower reaches of the river. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning system is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.
Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

4.4 Unnamed Brook (Rockland)

The unnamed brook in the City of Rockland, Maine, (Segment ID 522R04) is located at the western edge of the Eastern Coastal Watersheds region on Penobscot Bay's western side. (Figures 30 and 31). The listed segment length for this unnamed brook is 0.9 miles and its total listed watershed area is 10.4 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

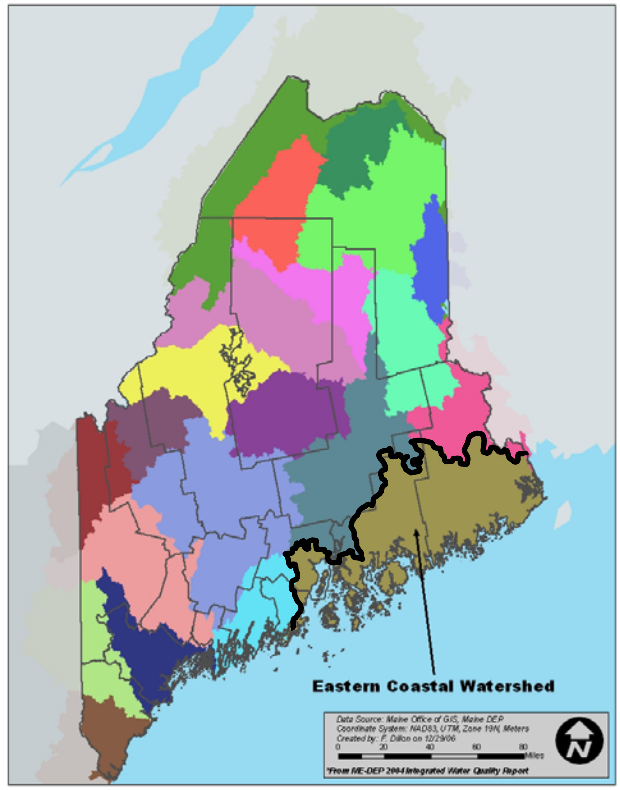


Figure 30: Eastern Coastal Watershed

4.4.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the unnamed brook in Rockland, Maine, were collected by FB Environmental staff in spring 2007 and are presented in Table 9. The unnamed brook in Rockland was one of five streams listed for "bacteria-only" impairment in the Eastern Coastal Watersheds as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for The unnamed brook in Rockland, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in the unnamed brook in Rockland were observed to exceed the instantaneous standard in 4 of 8 surveys conducted throughout the 2007 sampling period, with a maximum of 2098 MPN/100mL on June 12^{th}. Bacteria concentrations in the unnamed brook in Rockland did not meet the geometric mean standard for the sampling period, at 297 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset, the geometric mean may contain too few samples to prove adequately representative of storm flow conditions.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season would indicate a reduction of 78.5% needed to meet the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 84.6% and 67.9%, respectively. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 88.8% for the overall and dry weather results and 67.5% for the storm event results, based on the maxima for each respective category.

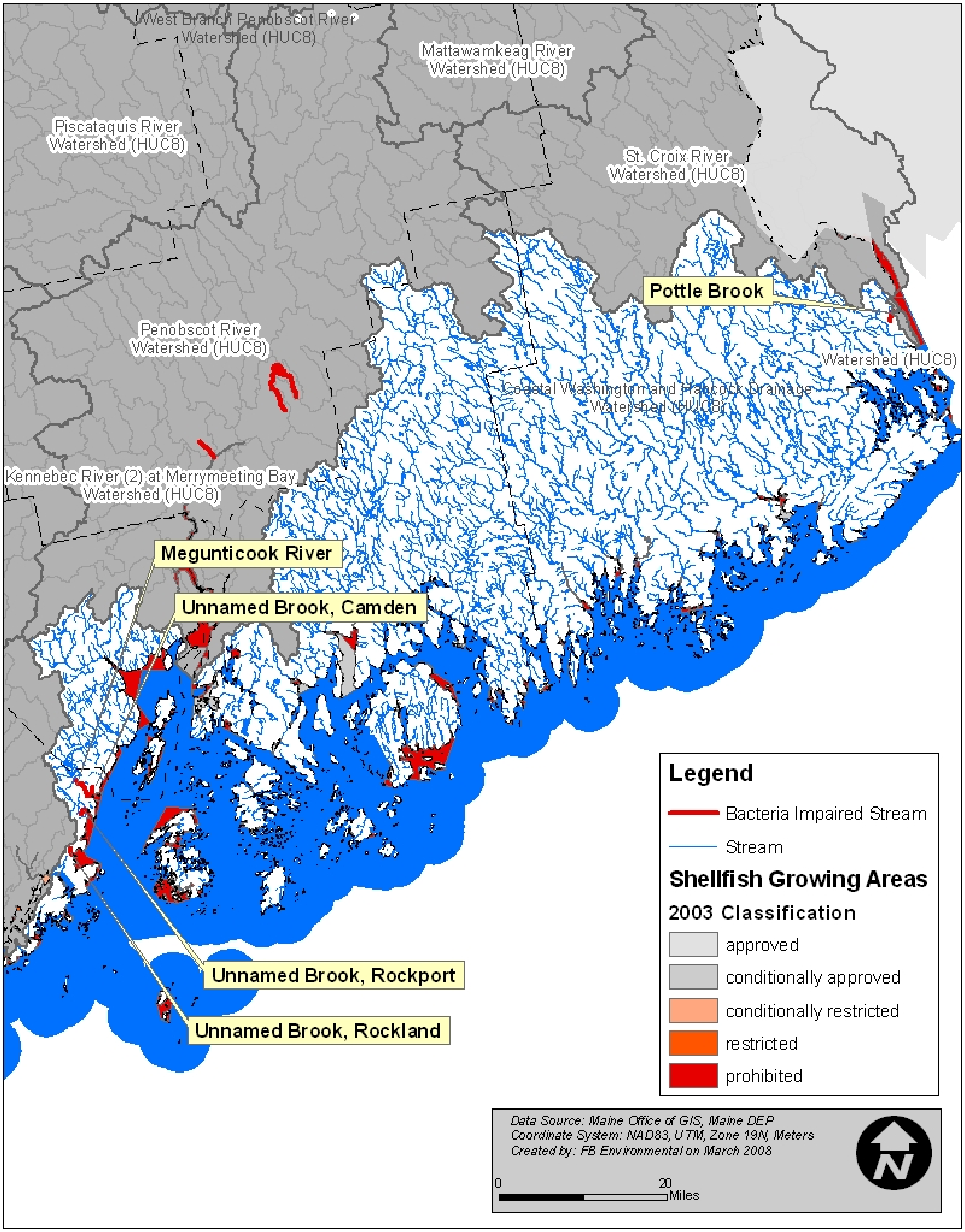


Figure 31: Eastern Coastal Watersheds showing unnamed brook in Rockland.

Table 9: Bacteria data summary for unnamed brook, Rockland, ME, with wet and dry weather assessment.

Unnamed - Rockland	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	FD	13:15	Rain	0.84	0.10	0.00	0.00	0.00	y	12	**727**		
17-May-07	TR	11:25	Overcast	0.00	0.84	0.10	0.00	0.00	y	9	**238**		
7-Jun-07	FD	9:35	Clear	0.00	0.00	0.07	0.83	0.21	y	13	**1120**		*E. coli* result approx. because test exceeded 22-hour incubation time by 2 hrs. due to lab error. Precip doesn't fall strictly w/in storm event criteria, but BPJ suggests otherwise.
								Storm Results:		Max:	**727**	67.5%	% reduction for instantaneous WQS (236 col/100 mL). Calculation may be inappropriate for only 2 samples.
										Geomean:	**416**	84.6%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
10-May-07	TR	9:37	Clear	0.00	0.00	0.00	0.00	0.01	n	15	96		
24-May-07	FD	10:40	Ptly cldy	0.00	0.00	0.00	0.00	0.14	n	13	219		Street construction / road opening ~50' upstream from stream
31-May-07	FD	11:20	Mstly cldy	0.00	0.02	0.00	0.04	0.01	n	18	105		Water only ~4" deep at sample collection point.
12-Jun-07	FD	14:45	Ptly cldy	0.00	0.00	0.00	0.07	0.00	n	19	**2098**		
21-Jun-07	FD	9:55	Clear	0.00	0.07	0.00	0.00	0.04	n	15	68		Poopy smell at site; animal scat on rock 3' below sample point.
26-Jun-07	FD	14:25	Clear	0.00	0.00	0.00	0.00	0.04	n	-	-		Stream completely dry. Woman at synagogue next to stream (Adas Yosheuron) suggested contacting Larry Pritchard (sp?) for info on stream.
28-Aug-07				0.00	0.00	0.00	0.10	0.14	n	-	-		Contact at DEP in Rockland says no water in stream. No further sampling for this site.
								Dry Results:		Max:	**2098**	88.8%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**199**	67.9%	% reduction for geomean WQS (64 col/100 mL)
								Overall Results:		Max:	**2098**	88.8%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**297**	78.5%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Augusta, ME (Source: NOAA / NWS)*

** **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

*** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

4.4.B Watershed Characterization

The aerial photo (figure 32) shows the unnamed stream as it traverses Rockland. The unnamed stream's watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 33). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is a very compact 0.34 square miles, and impervious surfaces are estimated at 32.5% of this area, which is very high relative to other streams in this study. Stream gradient was calculated as moderate at over 1.8%.

The unnamed stream in Rockland is clearly urban in character, with the developed categories comprising 96.6% of the watershed area, and agriculture (including bare land) adds 1.2%. Forest cover is barely present in the watershed at 2.2% of area. Sources of bacteria typical in such a landscape include malfunctioning septic or sewer infrastructure and pet wastes, and may be intensified by scarcity of natural vegetated buffer between the stream and the urban landscape.

Figure 32: Aerial photograph of unnamed brook in Rockland and surrounding area.

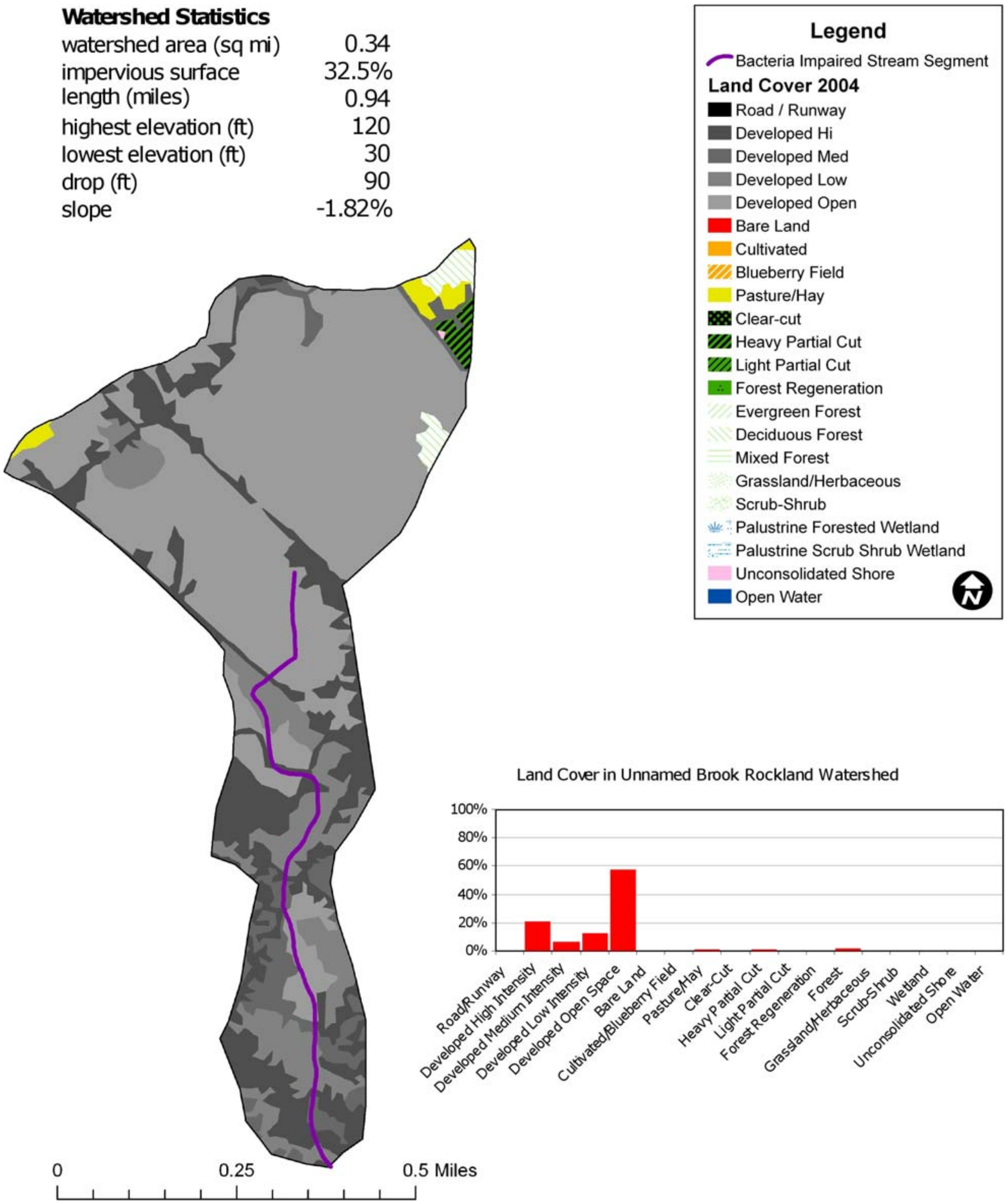


Figure 33: Unnamed Brook in Rockland watershed land cover map and statistics.

4.4.C Recommended Mitigation Strategies

Developed areas (>96%) and impervious surfaces (>32%) represent the vast majority of the unnamed stream in Rockland's watershed. Wastewater infrastructure malfunction and unmanaged pet waste are the most likely sources of impairment. It is possible that some wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

4.5 Unnamed Brook (Rockport)

The unnamed brook in the Town of Rockport, Maine, (Segment ID 522R03) is located at the western edge of the Eastern Coastal Watersheds region on Penobscot Bay's western side. (Figures 34 and 35). The listed segment length for this unnamed brook is 1.2 miles and its total listed watershed area is 10.4 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

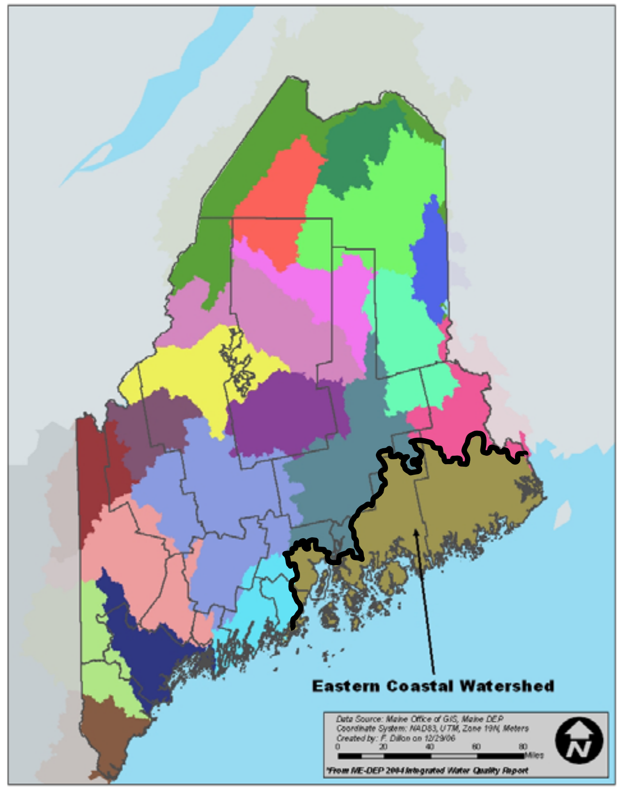


Figure 34: Eastern Coastal Watersheds.

4.5.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the unnamed brook in Rockport, Maine, were collected by FB Environmental staff in spring 2007 and are presented in Table 10. The unnamed brook in Rockport was one of five streams listed for "bacteria-only" impairment in the Eastern Coastal Watersheds as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for The unnamed brook in Rockport, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in the unnamed brook in Rockport did not exceed the instantaneous standard in the 6 surveys conducted in May 2007. Bacteria concentrations in the unnamed brook in Rockport also met the geometric mean standard for the sampling period as a whole. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was met for both categories of conditions, although with merely three samples in the wet weather dataset and two samples in the dry weather dataset, the geometric mean may contain too few samples to prove adequately representative of storm flow and dry weather conditions.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

No percent reductions are indicated for this watershed since all samples show compliance with water quality standards. However, it is important to note that a series of samples collected over a single sampling period may not adequately characterize the nature and extent of potential bacteria contamination in a given watershed. Even though the 2007 bacteria data for the unnamed brook in Rockport indicate compliance with state standards, future (or prior) monitoring results may indicate otherwise. Therefore, ongoing monitoring may be advisable for streams with suspected bacteria contamination issues.

4.5.B Watershed Characterization

The aerial photo (figure 36) shows the unnamed stream as it passes through Rockport. The unnamed stream's watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (figure 37). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is a compact 0.84 square miles, and impervious surfaces are estimated at 13.1% of this area, which is high relative to other streams in this study. Stream gradient was calculated as moderate to high at about 2.8%.

Forest covers most of the watershed at 57.1% of the area, with grass / scrub adding 5.3%. Nonetheless, the unnamed stream in Rockport can be characterized as urban in its lower half, with the developed categories comprising 31.3% of the watershed area, and agriculture (including bare land) adds 6.3%. The land cover map indicates that the stream is adjacent to developed areas in its lower half. Sources of bacteria typical in such a landscape include malfunctioning septic or sewer infrastructure and pet wastes, and may be intensified by scarcity of natural vegetated buffer between the stream and the urban landscape.

Table 10: Bacteria data summary for unnamed brook, Rockport, ME, with wet and dry weather assessment.

Unnamed - Rockport	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	FD	13:30	Lt-mod rai	0.84	0.10	0.00	0.00	0.00	y	11	22		
17-May-07	TR	11:05	Overcast	0.00	0.84	0.10	0.00	0.00	y	8	22		
7-Jun-07	FD	9:50	Clear	0.00	0.00	0.07	0.83	0.21	y	13	34		Conclude sampling for this site per Melissa Evers. *E. coli* result approx. because test exceeded 22-hour incubation time by 2 hrs. due to lab error. Precip doesn't fall strictly w/in storm event criteria, but BPJ suggests otherwise.
									Storm Results:	Max:	34	na	% reduction calculation results in negative number
										Geomean:	25	na	% reduction calculation results in negative number
Dry Weather Samples													
10-May-07	TR	9:17	Clear	0.00	0.00	0.00	0.00	0.01	n	11	6		Slightly tea colored
24-May-07	FD	10:55	Partly clea	0.00	0.00	0.00	0.00	0.14	n	13	11		Algal mats / strings in stream
31-May-07	FD	11:40	ostly clou	0.00	0.02	0.00	0.04	0.01	n	17	13		Long stringy green growth attached to stream bottom & moderate sediment deposition before culvert.
									Dry Results:	Max:	13	na	% reduction calculation results in negative number
										Geomean:	10	na	% reduction calculation results in negative number
									Overall Results:	Max:	34	na	% reduction calculation results in negative number
										Geomean:	16	na	% reduction calculation results in negative number

** Precip data for Augusta, ME (Source: NOAA / NWS)*

** **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

*** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

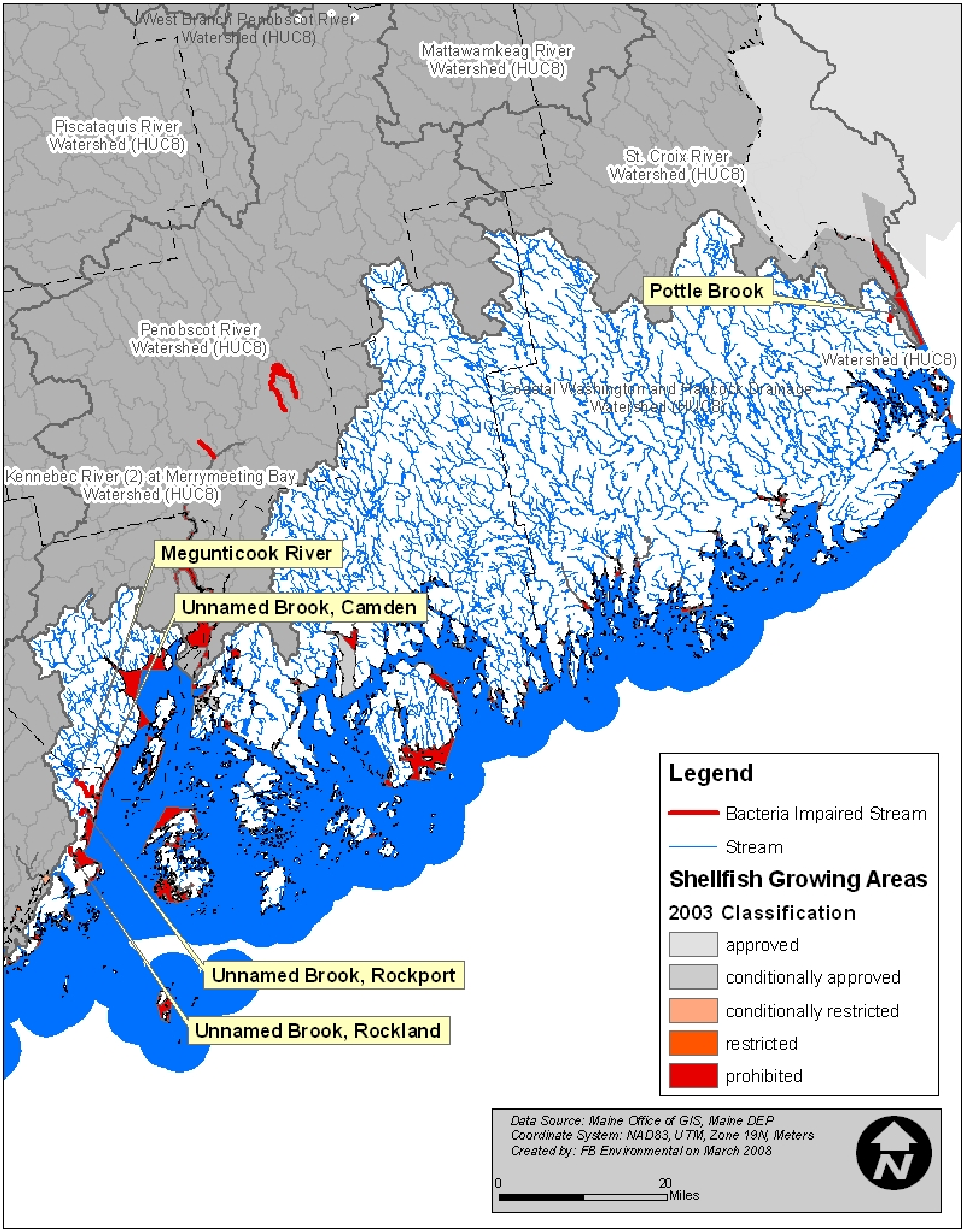


Figure 35: Eastern Coastal Watersheds showing unnamed brook in Rockport.

Figure 36: Aerial photograph of unnamed brook in Rockport and surrounding area.

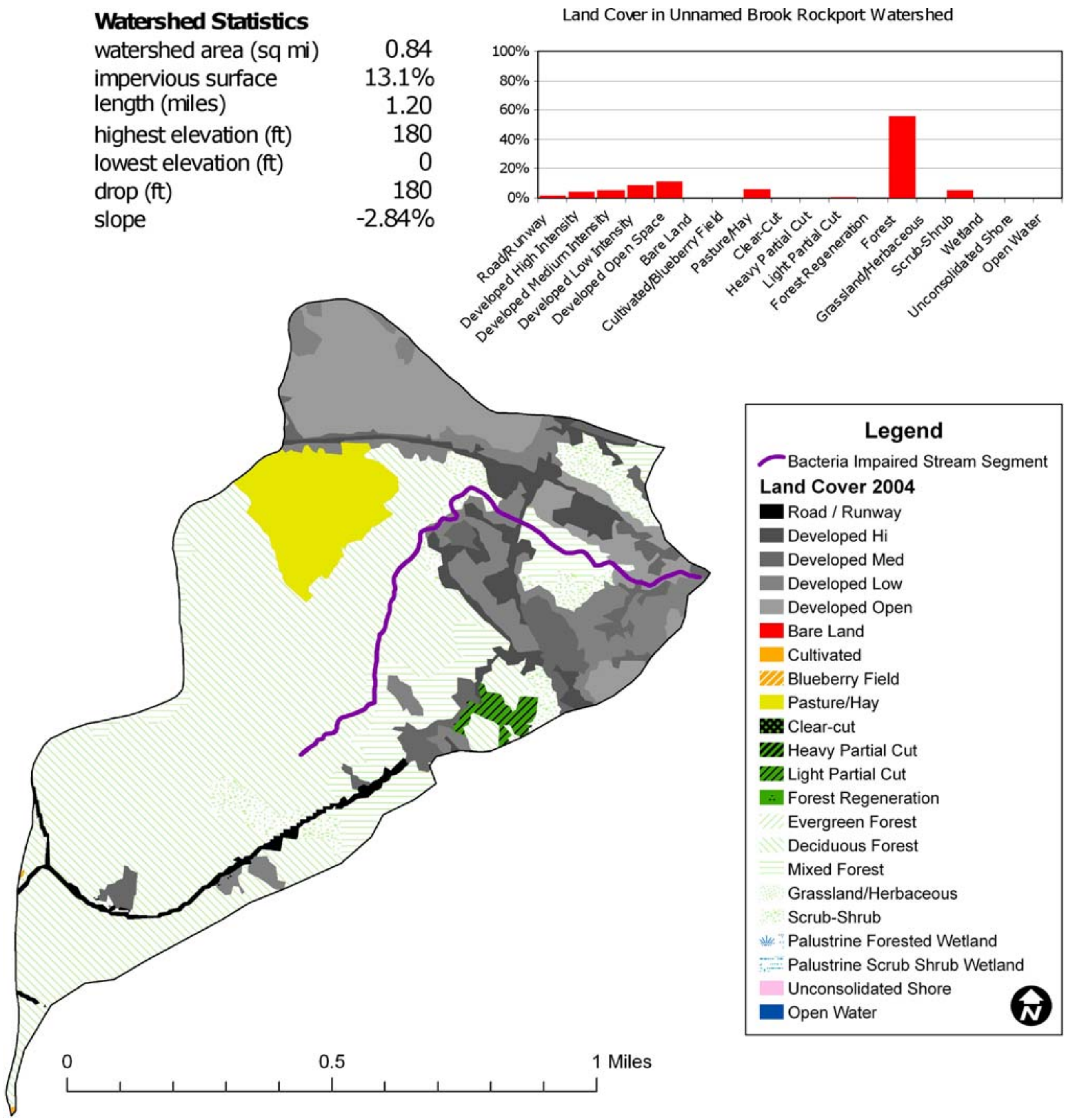


Figure 37: Unnamed Brook in Rockport watershed land cover map and statistics.

<u>4.5.C Recommended Mitigation Strategies</u>

Despite the fact that the unnamed stream in Rockport met state bacteria standards during the 2007 sampling period, it is still important to consider potential bacteria mitigation strategies should problems arise in the future. As such, given that developed areas (about 31%) and impervious surfaces (about 13%) comprise a significant proportion of the unnamed stream in Rockport's watershed, the nature of the development suggest it is a potential source of impairment, particularly since it is an old town center and the location of this development crowds the lower reaches of the river. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since there is significant forests cover (about 57%), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

5. Kennebec River Watershed

5.1 Currier Brook (Skowhegan)

Currier Brook in the Town of Skowhegan, Maine, (Segment ID 320R02) is located in the Kennebec River Watershed in the central part of the state. (Figures 38 and 39). The listed segment length for this unnamed brook is 3.5 miles and its total listed watershed area is 79.4 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

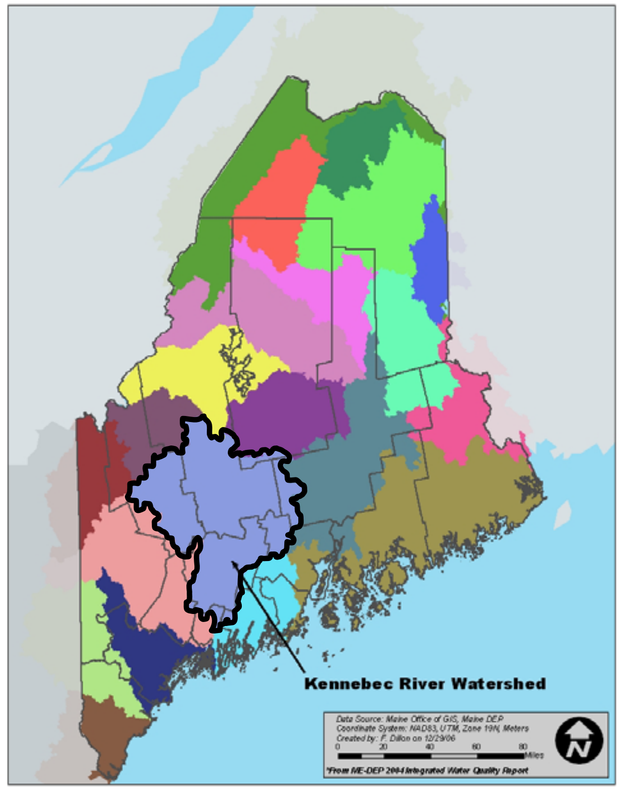


Figure 38: Kennebec River Watershed.

5.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for Currier Brook were collected by FB Environmental staff in spring 2007 and are presented in Table 11. Currier Brook was one of two streams listed for "bacteria-only" impairment in the Kennebec River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Currier Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Currier Brook were observed to exceed the instantaneous standard in 2 of 5 surveys conducted throughout the 2007 sampling period, with a maximum of 834 MPN/100mL on June 5th. Bacteria concentrations in Currier Brook did not meet the geometric mean standard for the sampling period, at 113 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for only storm conditions.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season would indicate a reduction of 43.5% needed to meet the water quality standard. For storm samples, the % reductions required to comply with the geometric mean standards are 82.4%, and not indicated for dry weather samples since they complied with the state geometric mean standard. Bacteria concentration reductions needed to attain the instantaneous water quality standard was 71.7% for the overall and storm event results, and not indicated for dry weather samples since they complied with the state instantaneous standard.

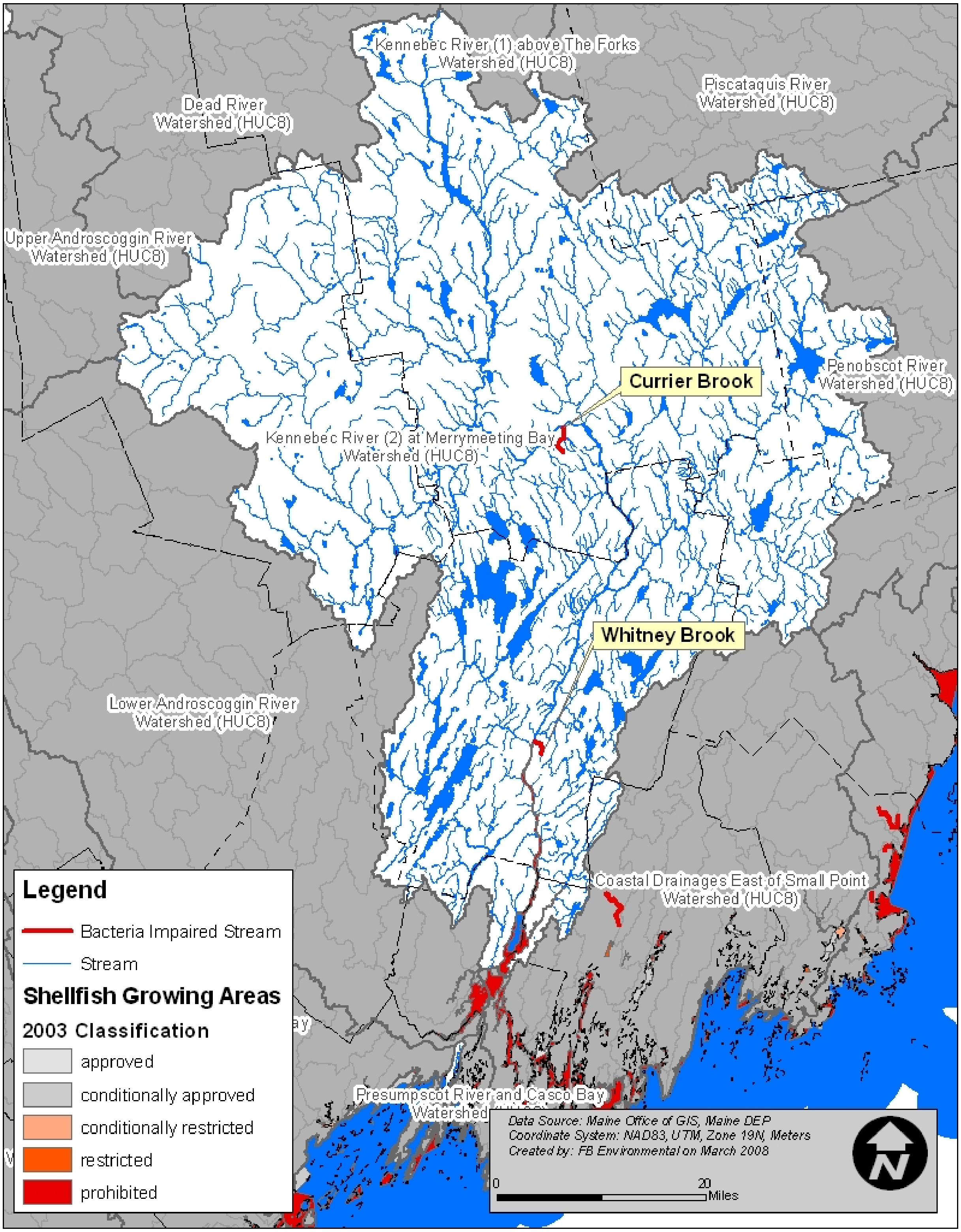


Figure 39: Kennebec River Watershed showing Currier Brook.

Table 11: Bacteria data summary for Currier Brook, Skowhegan, ME, with wet and dry weather assessment.

Currier - Skowhegan	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	TR	10:45	Rain	0.55	0.05	0.00	0.00	0.13	y	12	**548**		
5-Jun-07	TR	11:40	Clear	0.94	0.13	0.17	0.00	0.01	y	17	**834**		Average of 2 results (686.7 and 980.4)
6-Jun-07	TR	12:15	Clear	0.02	0.94	0.13	0.17	0.00	y	19	105		Conclude sampling per Melissa Evers.
								Storm Results:		Max:	**834**	71.7%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**363**	82.4%	% reduction for geomean WQS (64 col/100 mL).
Dry Weather Samples													
9-May-07	TR	11:17	Ptly Cldy	0.00	0.00	0.00	0.00	0.00	n	13	13		lab split sample results= 23.5 MPN
23-May-07	TR	10:45	Clear	0.00	0.00	0.09	0.04	0.68	n	11	29		
								Dry Results:		Max:	29	na	% reduction calculation results in negative number
										Geomean:	20	na	% reduction calculation results in negative number.
								Overall Results:		Max:	**834**	71.7%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**113**	43.5%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Harmony, ME (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

5.1.B Watershed Characterization

The aerial photo (figure 40) shows Currier Brook as it passes through Skowhegan. The Currier Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 41). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 4.97 square miles, and impervious surfaces are estimated to total 6.1% of this area. Stream gradient is moderate with a slope over the segment length of about 1.3%.

Forest is the dominant land use at 69.1%, with wetlands adding 3.4%, and grass / scrub adding 0.8%. Agricultural land uses, some of which are directly adjacent to the stream, are calculated as 18% of watershed area. Development makes up the smallest of these aggregated categories, but is still significant at 11.6% of the watershed. Agricultural lands and development would appear to be roughly equal in their likelihood of contributing to the bacterial impairment of Currier Brook. Agriculture could contribute sources through the spreading of manure or the presence of livestock directly. Development, while the smallest percentage of land cover, nonetheless dominates the lowest reaches of the stream, suggesting sources such as aging septic or sewer infrastructure and pet waste may also be present.

5.1.C Recommended Mitigation Strategies

Developed areas (about 12%) and impervious surfaces (about 6%) comprise a moderate proportion of the Currier Brook's watershed. The location and type of the development, which crowds the lower reaches of the river, suggest it may be a significant source of impairment. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain.

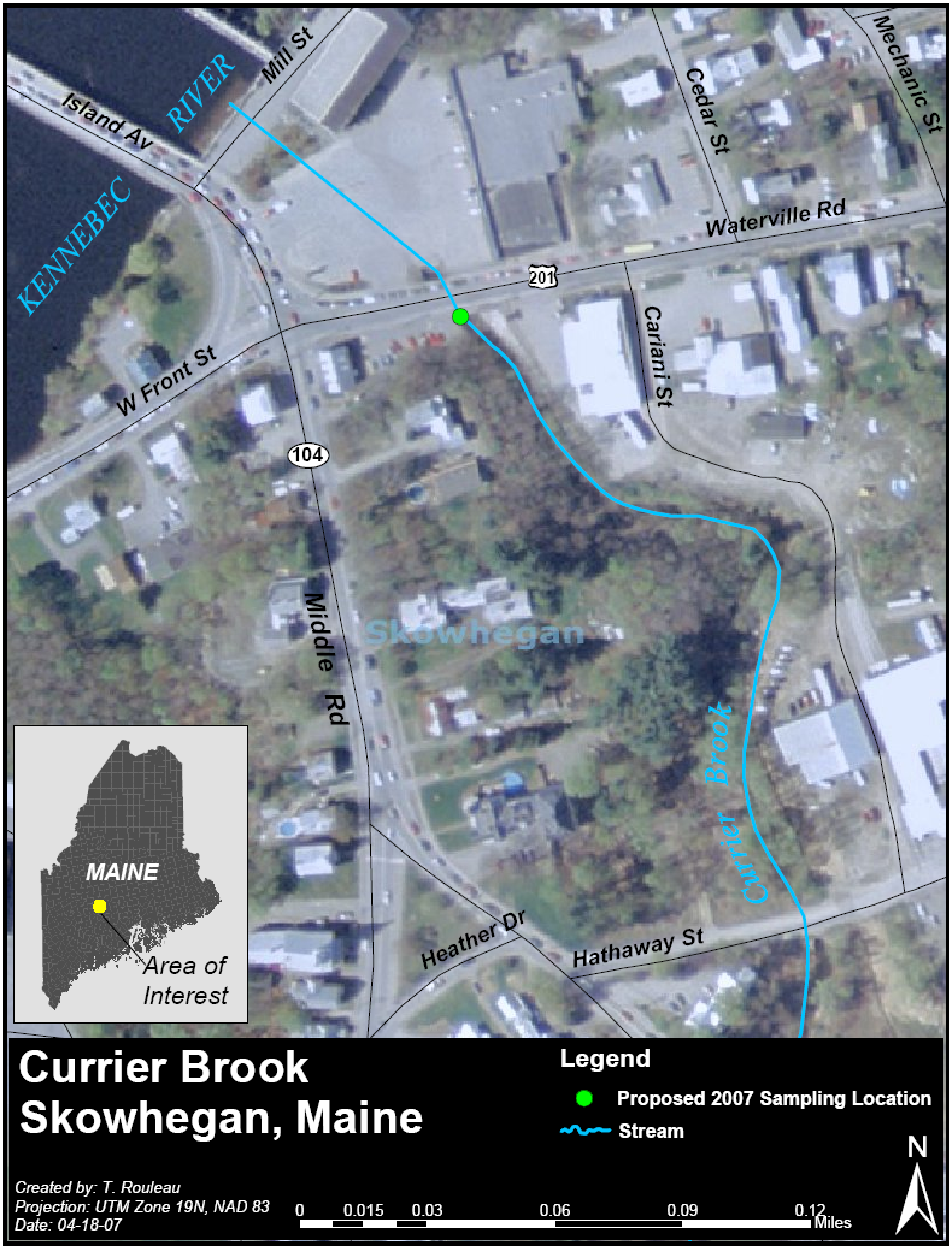
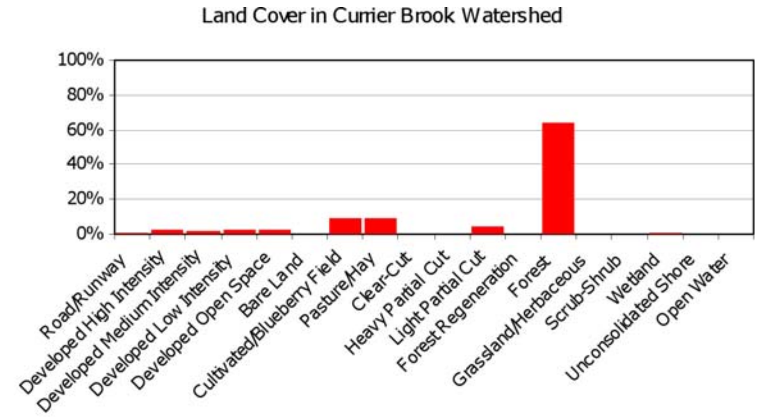


Figure 40: Aerial photograph of Currier Brook and surrounding area.

Watershed Statistics	
watershed area (sq mi)	4.97
impervious surface	6.1%
length (miles)	3.46
highest elevation (ft)	340
lowest elevation (ft)	100
drop (ft)	240
slope	-1.31%



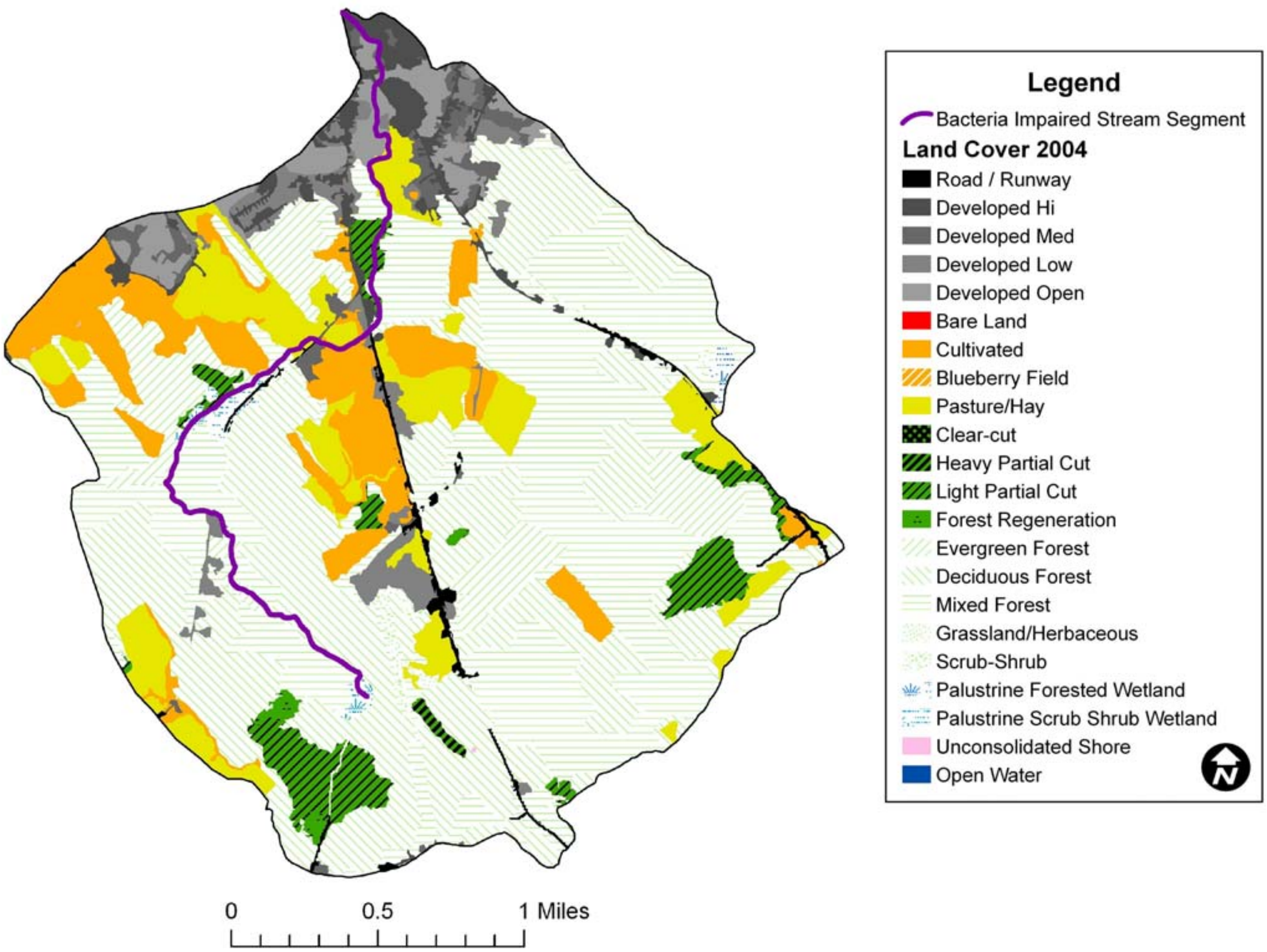


Figure 41: Currier Brook watershed land cover map and statistics.

Agriculture is a significant part of the watershed (about 18%). There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Somerset County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

5.2 Whitney Brook (Augusta)

Whitney Brook in the City of Augusta, Maine, (Segment ID 333R02) is located in the Kennebec River Watershed in central Maine. (Figures 42 and 43). The listed segment length for this unnamed brook is 2.0 miles and its total listed watershed area is 45.7 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

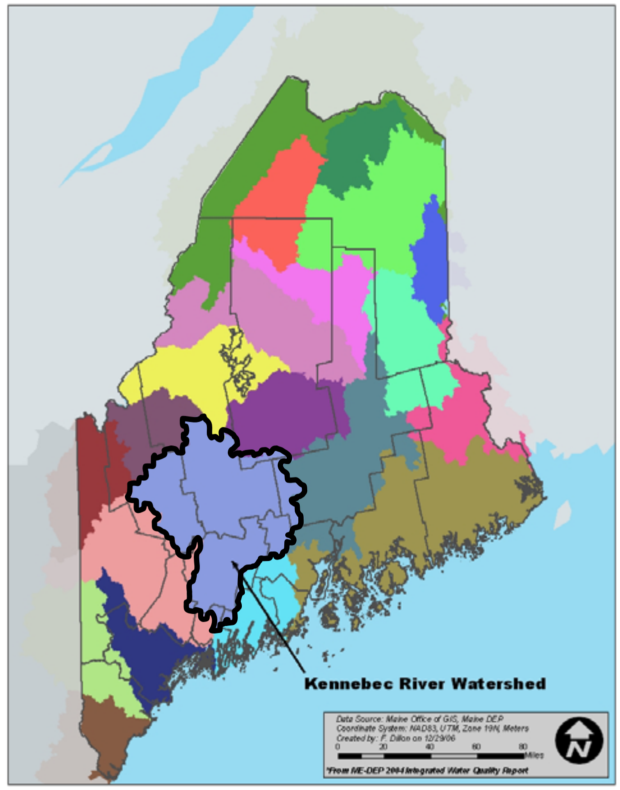


Figure 42: Kennebec River Watershed.

5.2.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for Whitney Brook were collected by FB Environmental staff in spring and summer 2007 and are presented in Table 12. Whitney Brook was one of two streams listed for "bacteria-only" impairment in the Kennebec River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Whitney Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Whitney Brook were observed to exceed the instantaneous standard in 4 of 9 surveys conducted throughout the 2007 sampling period, with a maximum of 1733 MPN/100mL on May 16th. Bacteria concentrations in Whitney Brook did not meet the geometric mean standard for the sampling period, at 151 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for only storm conditions at 596 MPN/100mL.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season would indicate a reduction of 57.6% needed to meet the water quality standard. For storm samples, the % reductions required to comply with the geometric mean standards are 89.3%. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 86.4% for the overall and storm event results.

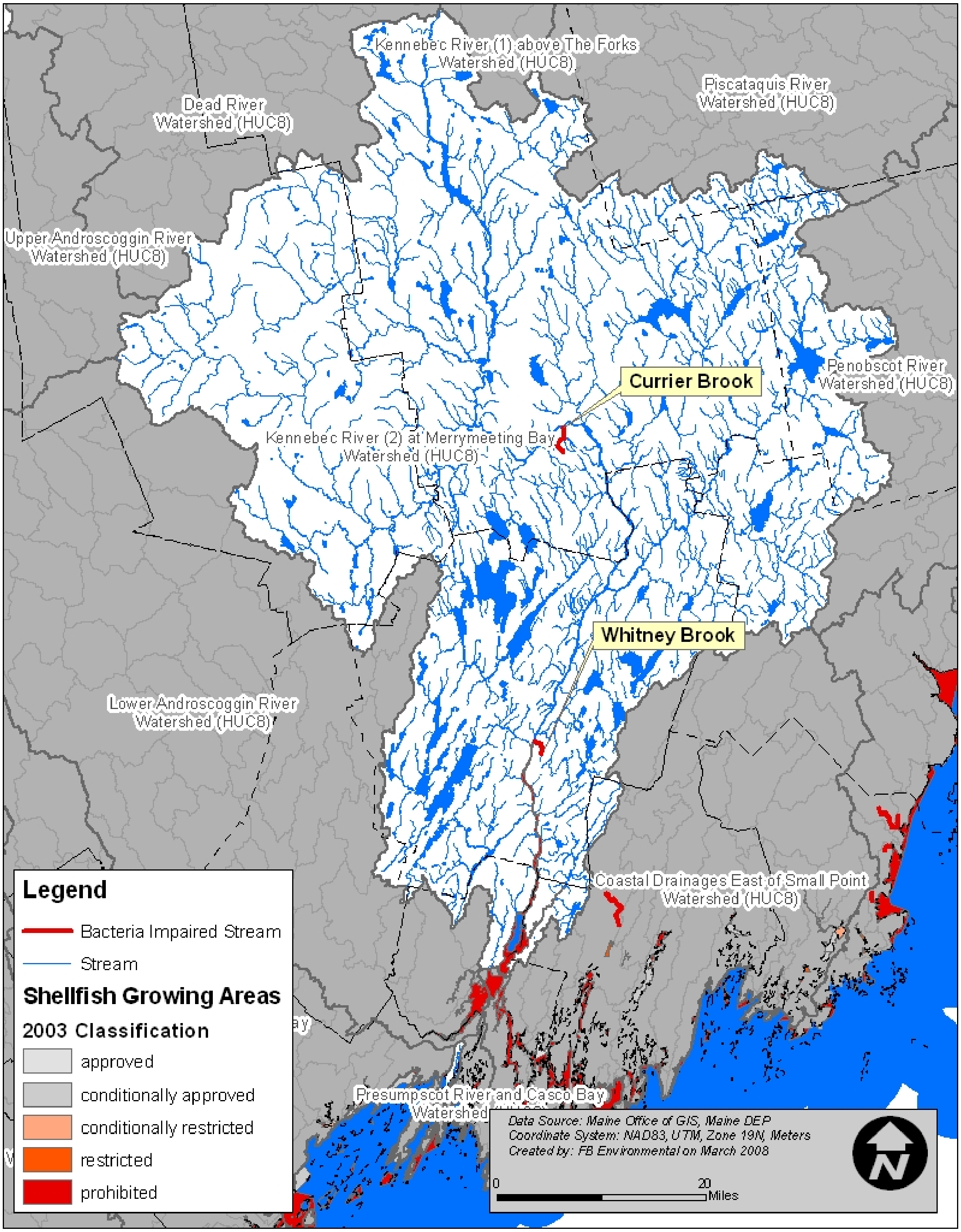


Figure 43: Kennebec River Watershed showing Whitney Brook.

Table 12: Bacteria data summary for Whitney Brook in Augusta, ME, with wet and dry weather assessment.

Whitney - Augusta	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	FD	15:05	Lt-mod rai	0.84	0.10	0.00	0.00	0.00	y	13	**1733**		
17-May-07	TR	1:15	Overcast	0.00	0.84	0.10	0.00	0.00	y	10	**365**		Collected field duplicate
7-Jun-07	FD	11:10	Clear	0.00	0.00	0.07	0.83	0.21	y	16	**326**		Bare soils patches next to stream seeded by sewer improvement contractor. *E. coli* result approx. because test exceeded 22-hour incubation time by 2 hrs. due to lab error.
19-Jul-07	TR	12:15	Overcast	0.22	0.17	0.00	0.00	0.07	y		**613**		HETL# C032879-001
									Storm Results:	Max:	**1733**	86.4%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**596**	89.3%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
10-May-07	TR	11:22	Clear	0.00	0.00	0.00	0.00	0.01	n	15	34		Trash and debris in stream, silt fences along stream as part of sewer improvement project.
24-May-07	FD	12:15	Partly clea	0.00	0.00	0.00	0.00	0.14	n	16	39		
31-May-07	FD	13:45	ostly clou	0.00	0.02	0.00	0.04	0.01	n	19	54		All rocks on stream bottom completely covered w/ attached algal growth.
21-Jun-07	FD	11:00	Clear	0.00	0.07	0.00	0.00	0.04	n	-	59		
26-Jun-07	FD	15:40	Clear	0.00	0.00	0.00	0.00	0.04	n	21	77		Flow very low. *E. coli* avg of 2 samples: sample 1 = 70; sample 2 = 83.
									Dry Results:	Max:	77	na	% reduction calculation results in negative number
										Geomean:	50	na	% reduction calculation results in negative number
									Overall Results:	Max:	**1733**	86.4%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**151**	57.6%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Augusta, ME (Source: NOAA / NWS)*

** **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

*** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

5.2.B Watershed Characterization

The aerial photo (figure 44) shows Whitney Brook as it passes through Augusta. The Whitney Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 45). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 1.61 square miles, and impervious surfaces make up a substantial portion of the watershed, calculated at 22.9% of this area. Stream gradient is moderate with a slope over the segment length of about 1.3%.

The dominant land use categories are developed at 55.6% of watershed area, with agriculture (including bare land) adding 6.2%. Forrest covers a substantial minority of the watershed area, at 38.3%. The watershed is clearly developed in character, although the distribution of forested lands appears to enhance stream protection by providing a wide buffer to over half of the stream length. Still, the developed lands present ample opportunity for such sources as aging septic or sewer infrastructure and pet waste to contribute to impaired water quality. Agriculture may also contribute to the impairment, although its location at the very edges of the watershed suggest a very minor role for agricultural sources.

5.2.C Recommended Mitigation Strategies

Developed areas (about 56%) and impervious surfaces (about 23%) dominate the Whitney Brook watershed. The nature and location of the development crowds the lower reaches of the stream. It is possible that a few wastewater systems serving aging structures in the area have an antiquated

Figure 44: Aerial photograph of Whitney Brook and surrounding area

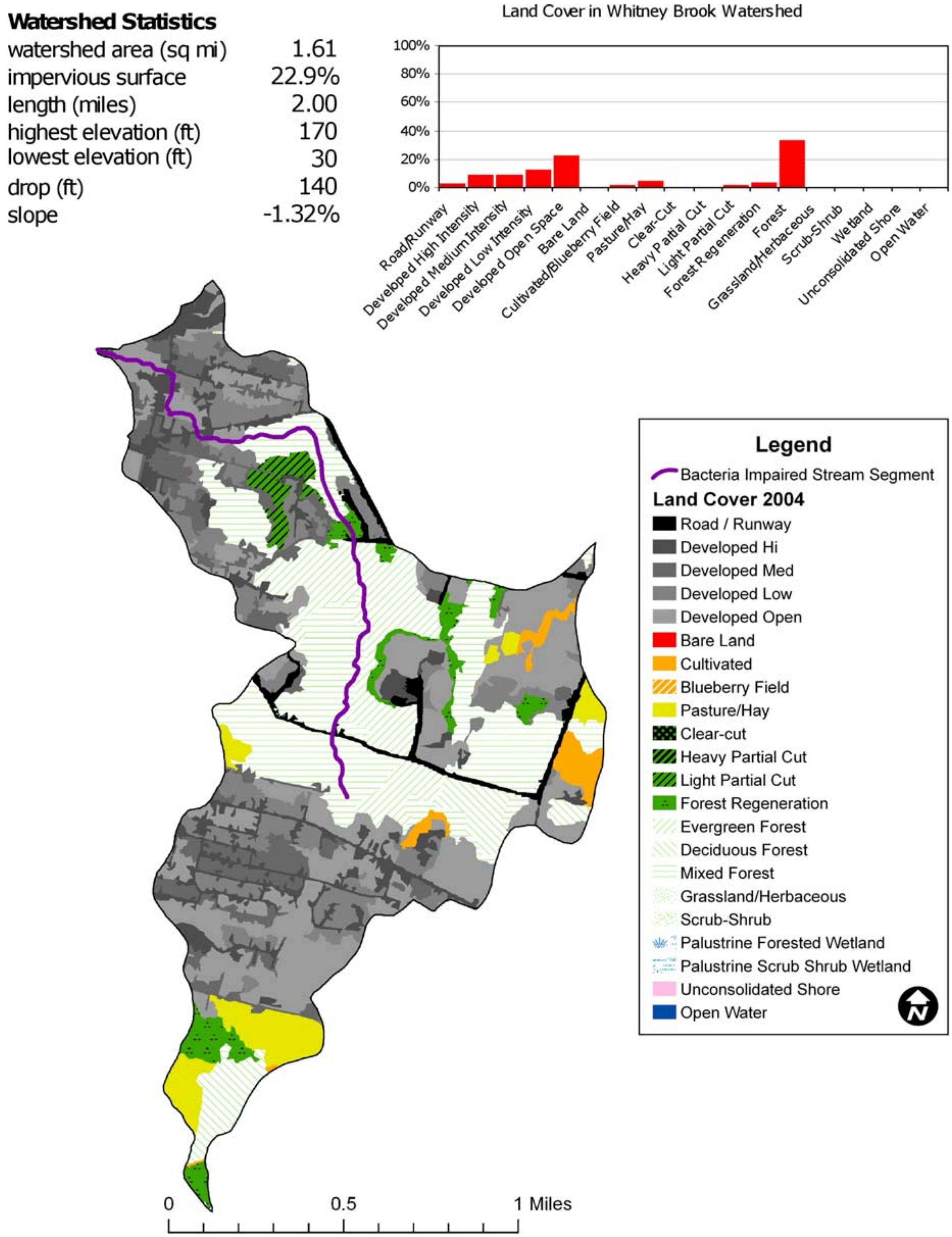


Figure 45: Whitney Brook in Rockport watershed land cover map and statistics.

design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is a small part of the watershed (about 6%). There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The -Kennebec County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

6. Lower Penobscot River Watershed

6.1 Boynton Brook (Bradley)

Boynton Brook (Segment ID 226R02) is located in the town of Bradley in the Penobscot River Watershed. (Figures 46 and 47). The listed segment length for Boynton Brook is 3.1 miles and its total listed watershed area is 47.7 square miles. Potential sources of bacteria impairment are listed as unknown.

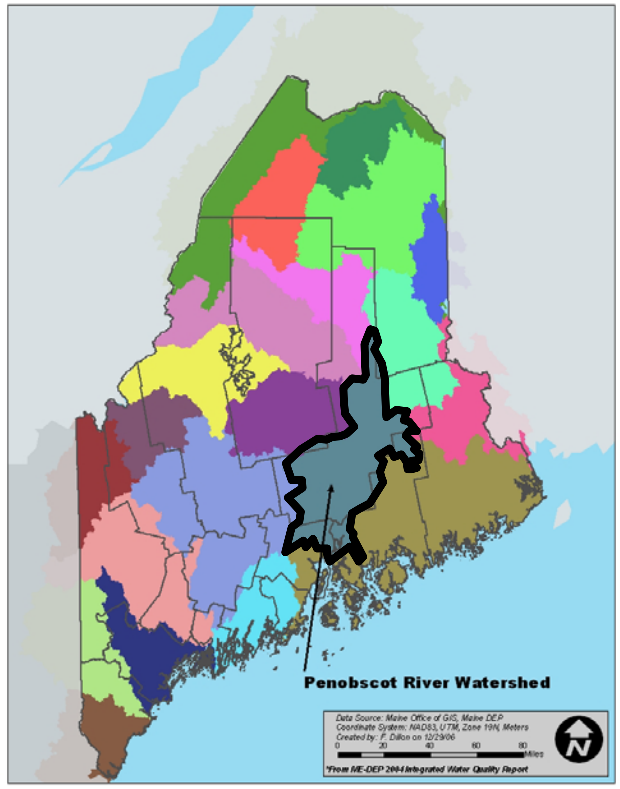


Figure 46: Penobscot River Watershed.

6.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Lower Penobscot River Watershed were collected by FB Environmental staff in the spring and summer of 2007 and are presented in Table 13. Three stream segments: Boynton Brook, Kenduskeag Stream, and Otter Stream were listed for "bacteria-only" impairment in the Lower Penobscot River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Boynton Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Boynton Brook were observed to exceed the instantaneous standard in 3 of 5 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 1,414 MPN/100mL on May 15th, 866 MPN/100mL on June 5th, and 248 MPN/100mL on June 6th. Bacteria concentrations in Boynton Brook also did not meet the geometric mean standard for the overall sampling period, at 343 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset and two samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results was above (i.e. not in compliance with) the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 90.5% and 49.0%, respectively. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 83.3% for both the overall and storm event results and non-existent for the dry weather results as they are below the standard.

Table 13: Bacteria data summary for Boynton Brook, with wet and dry weather assessment.

Boynton - Bradley	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	TR	9:10	Rain	0.55	0.05	0.00	0.00	0.13	y	13	**1414**		
5-Jun-07	TR	10:10	Clear	0.94	0.13	0.17	0.00	0.01	y	19	**866**		Sample has very dark tea color.
6-Jun-07	TR	10:45	Clear	0.02	0.94	0.13	0.17	0.00	y	20	**248**		Conclude sampling per Melissa Evers.
								Storm Results:		Max:	**1414**	83.3%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**672**	90.5%	% reduction for geomean WQS (64 col/100 mL).
Dry Weather Samples													
9-May-07	TR	9:45	Ptly Cldy	0.00	0.00	0.00	0.00	0.00	n	14	160		
23-May-07	TR	9:10	Clear	0.00	0.00	0.09	0.04	0.68	n	11	99		
								Dry Results:		Max:	160	na	% reduction calculation results in negative number
										Geomean:	**125**	49.0%	% reduction for geomean WQS (64 col/100 mL).
								Overall Results:		Max:	**1414**	83.3%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**343**	81.4%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Harmony, ME (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

6.1.B Watershed Characterization

The aerial photo (figure 48) shows Boynton Brook as it passes through Bradley. The Boynton Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 49). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 2.9 square miles, and impervious surfaces are estimated to total 2.2% of this area. Stream gradient is very low with a slope over the segment length of about 0.25%.

Forest, including areas subject to timber harvest, are the dominant land use categories by far at 93.1% of watershed area. Wetlands are an additional 3.4%. Developed land uses are very small, totaling only 2.7% of the watershed area, most of which is roads.

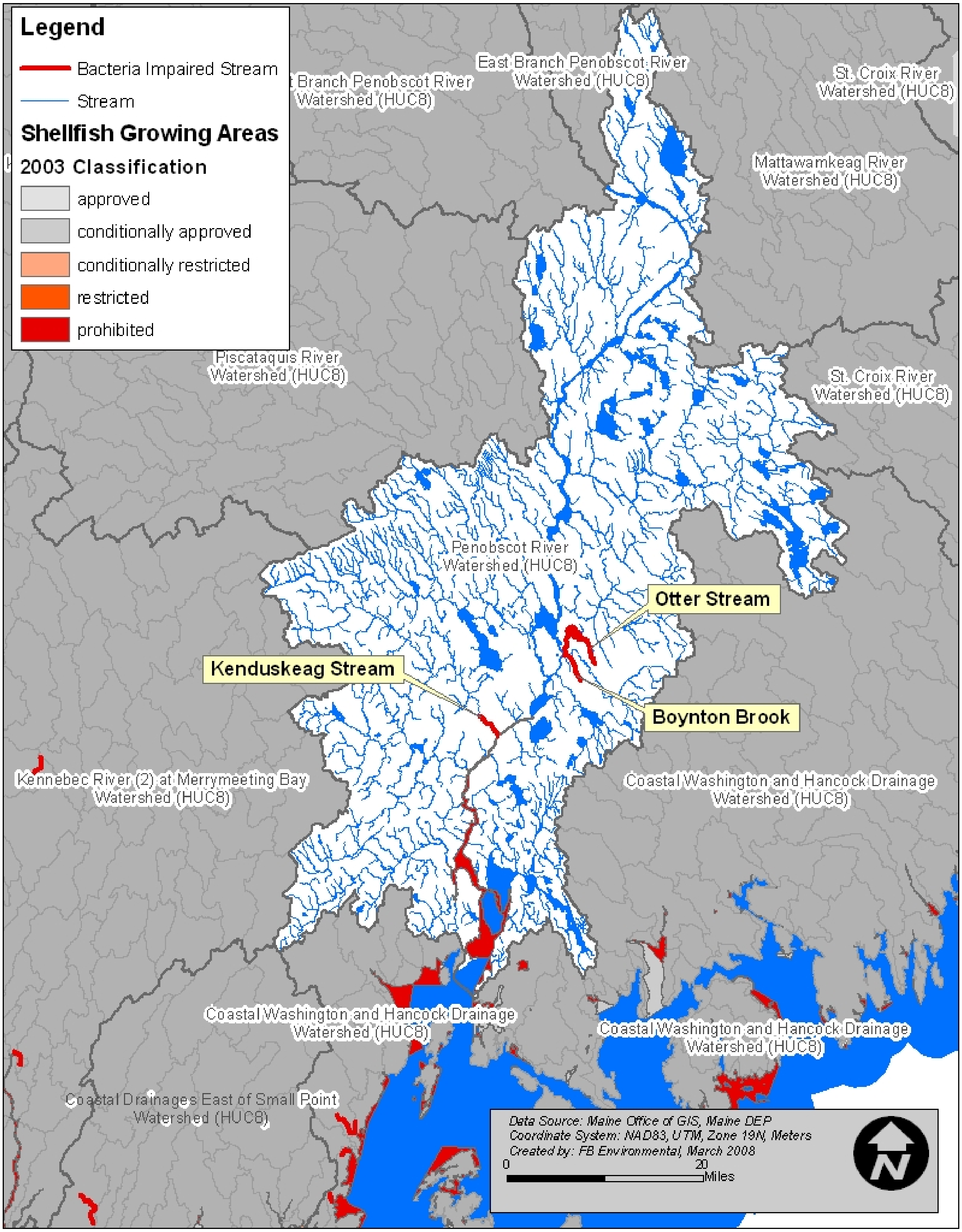


Figure 47: Penobscot River Watershed with the impaired waterways indicated.

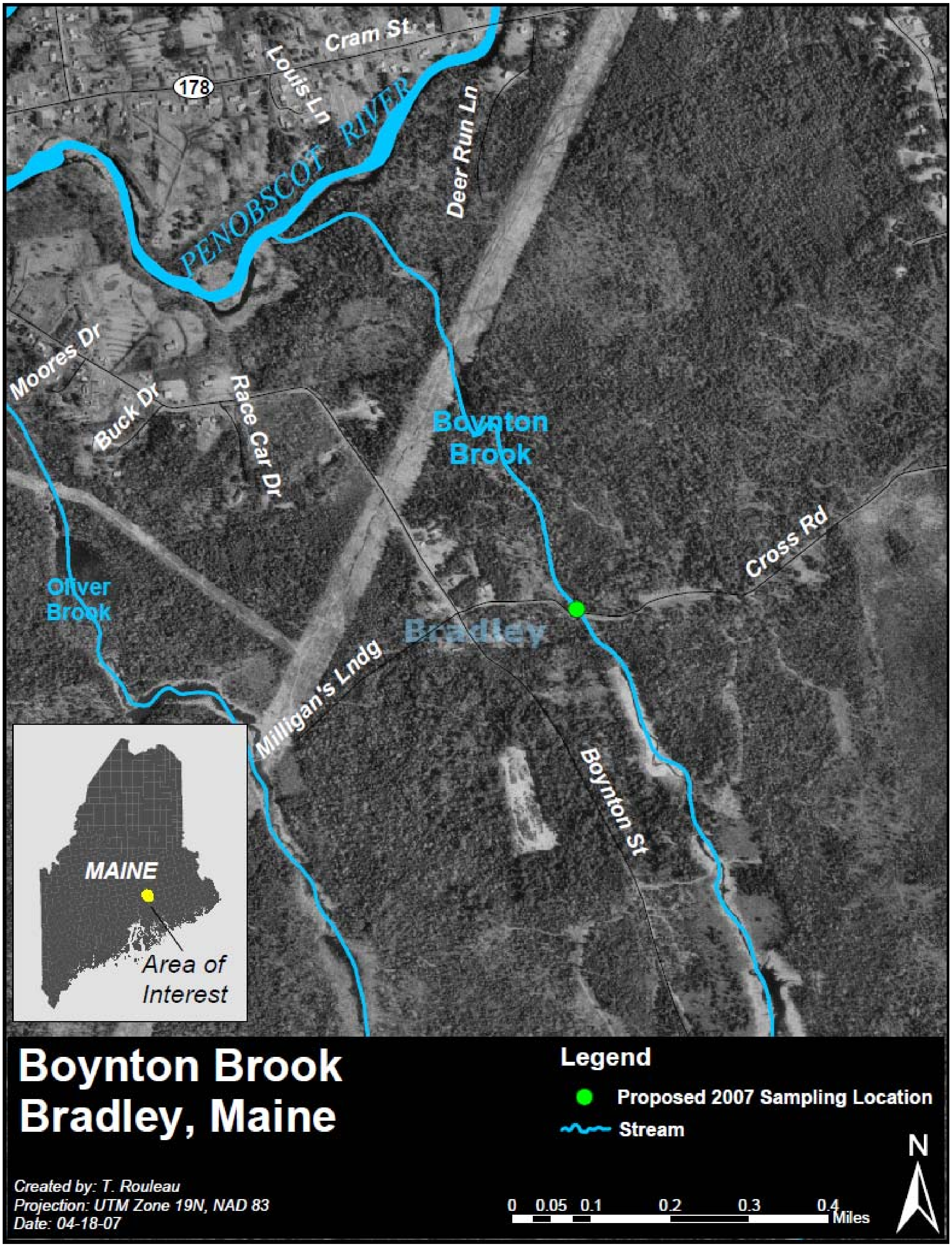


Figure 48: Aerial photograph of Boynton Brook and surrounding area.

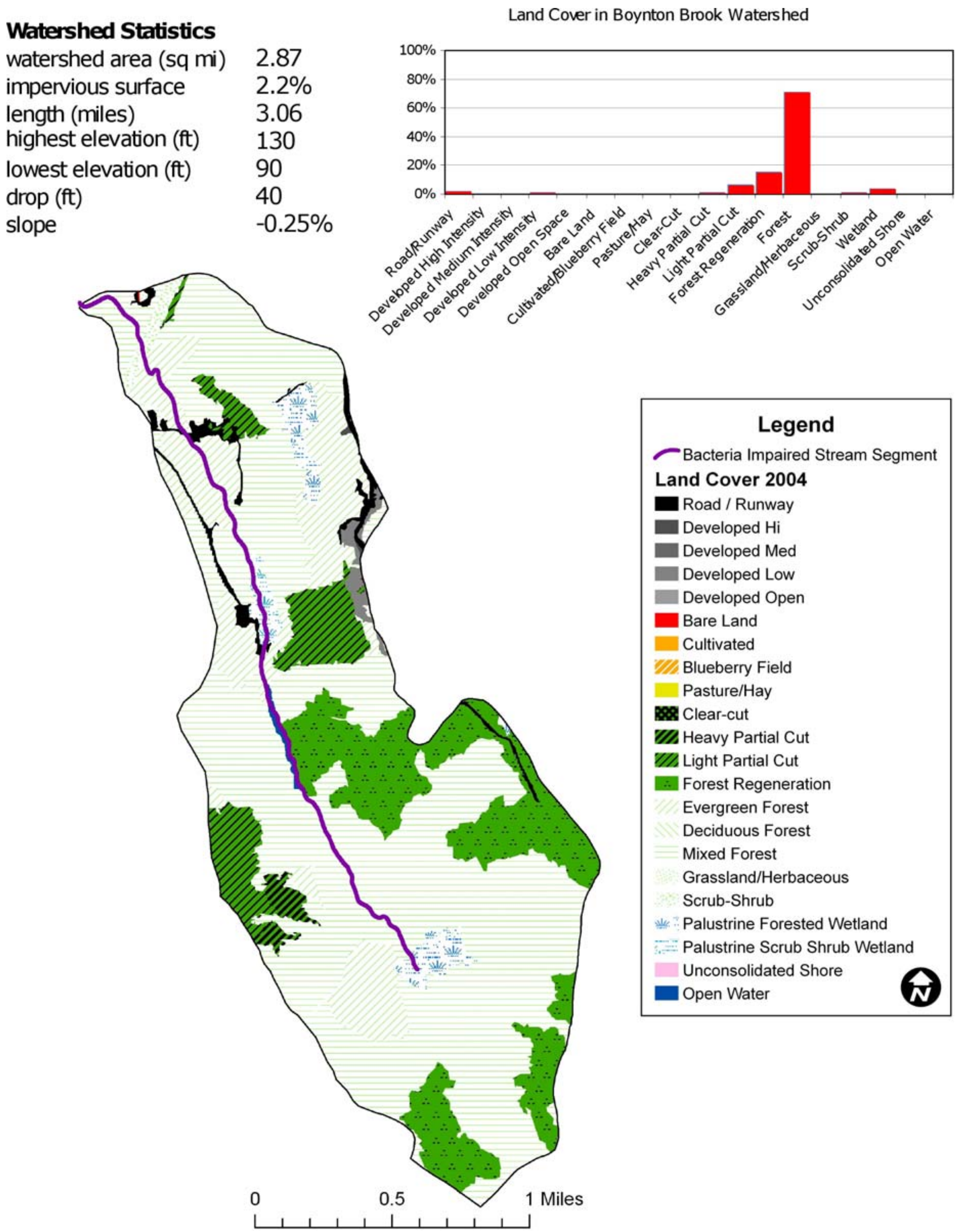


Figure 49: Boynton Brook watershed land cover map and statistics.

6.1.C Recommended Mitigation Strategies

Developed areas (2.7%) and impervious surfaces (2.2%) are present in small proportions in the Boynton Brook watershed. With so much of the land use devoted to forest, (approximately 93% of area), wildlife inhabiting these areas could very well be contributing fecal contamination to the river.

Mitigation of possible bacteria sources from developed areas in the watershed should address wastewater infrastructure and pet waste management. Given the sparse nature of development, the best approach may be a direct investigation of the ages and conditions of septic systems in the area. Further bacterial testing upstream and downstream of locations development crosses the river may assist in locating likely source areas in the watershed. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Improperly managed pet waste tends to lead to elevated bacterial concentrations after rain. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

6.2 Kenduskeag Stream (Bangor)

Kenduskeag Stream (Segment ID 224R02) is located in the town of Bangor in the Penobscot River Watershed. (Figures 50 and 51). The listed segment length for Kenduskeag Stream is 3 miles and its total listed watershed area is 39.5 square miles. Potential sources of bacteria impairment are listed as unknown.

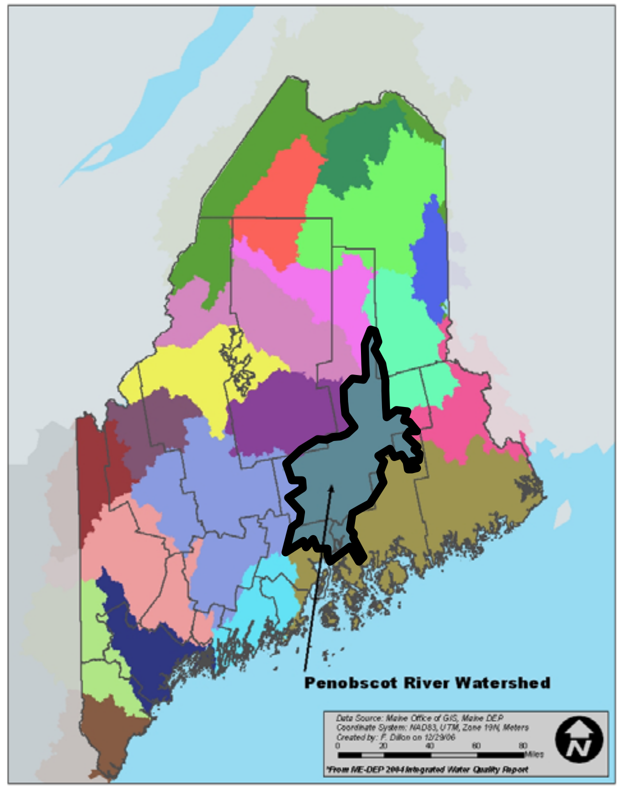


Figure 50: Penobscot River Watershed.

6.2.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Lower Penobscot River Watershed were collected by FB Environmental staff in spring and summer of 2007 and are presented in Table 14. Three stream segments: Boynton Brook, Kenduskeag Stream, and Otter Stream were listed for "bacteria-only" impairment in the Lower Penobscot River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Kenduskeag Stream, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Kenduskeag Stream were observed to exceed the instantaneous standard in 3 of 15 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 1553 MPN/100mL on June 5th, 579 MPN/100mL on June 6th, and 395 MPN/100mL on September 10th. Bacteria concentrations in Kenduskeag Stream met the geometric mean standard for the entire sampling period. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded during the storm events with 174 MPN/100mL and met during the dry weather sampling events.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

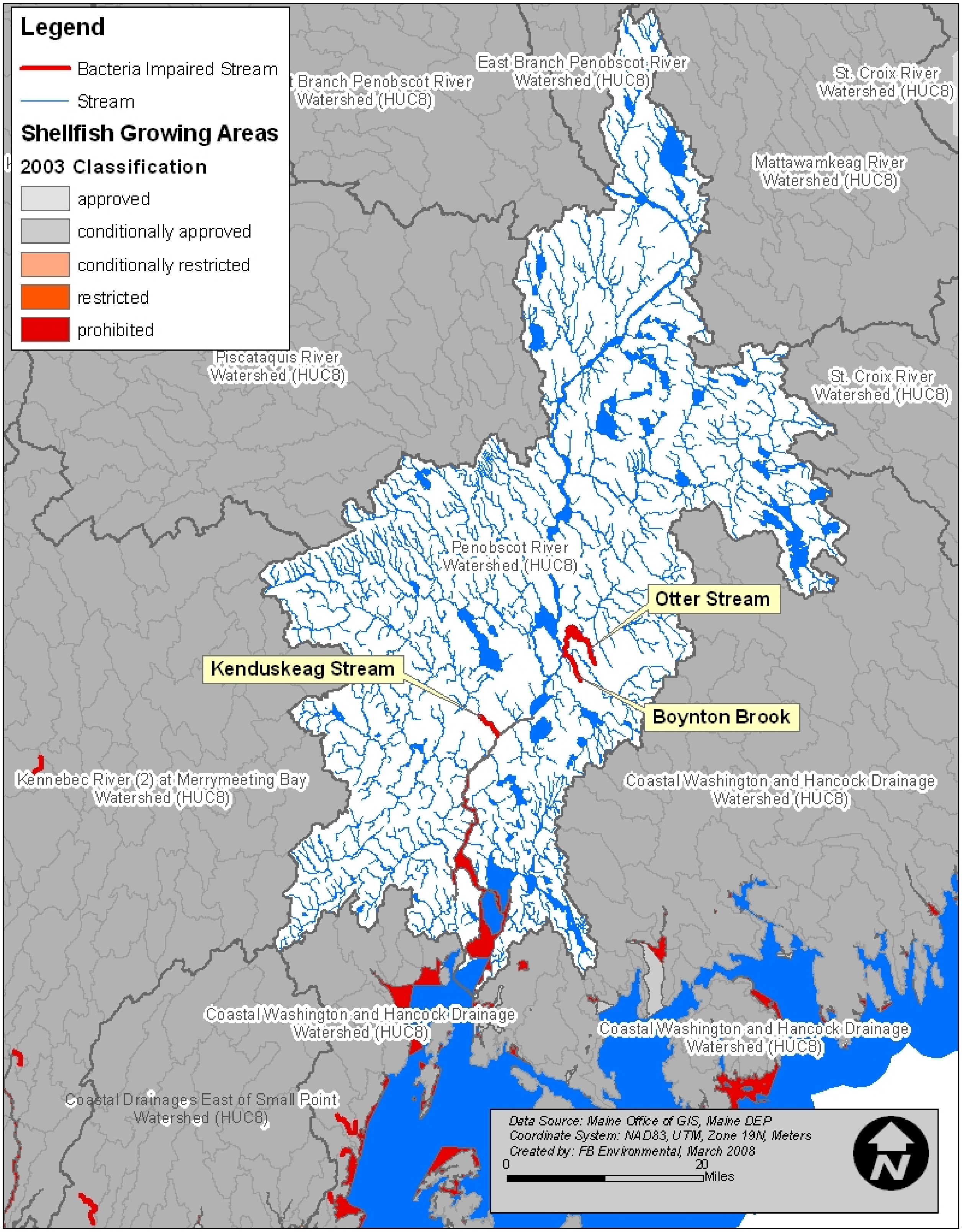


Figure 51: Penobscot River Watershed with the impaired waterways indicated.

The geometric mean for the overall results was below (i.e., in compliance with) the water quality standard; therefore the % reduction calculation for this criterion does not apply. For storm samples, the % reduction required to comply with the geometric mean standards is 63.3% (Table 14). Bacteria concentration reductions needed to attain the instantaneous water quality standard were 84.8% for both the overall and storm event results. The instantaneous result and geometric mean for dry weather conditions complied with standards and, therefore, do not require % reduction calculations.

Table 14: Bacteria data summary for Kenduskeag River, with wet and dry weather assessment.

Kenduskeag - Bangor	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples				*Precip data for Harmony, ME (Source: NOAA / NWS)*									
16-May-07	TR	12:00	Rain	0.55	0.05	0.00	0.00	0.13	y	13	126		Avg of 2 samples: 122 and 129
5-Jun-07	TR	13:00	Clear	0.94	0.13	0.17	0.00	0.01	y	19	**1553**		
6-Jun-07	TR	13:30	Clear	0.02	0.94	0.13	0.17	0.00	y	20	**579**		
5-Jul-07	TR	14:15	Overcast	0.18	0.02	0.00	0.00	0.00	y?	22	115		Storm sample
7-Aug-07	MW	9:10	-	0.90	0.00	0.00	0.77	0.00	y?	-	112		Base flow sample
10-Sep-07	MW	9:00	-	0.49	0.00	0.00	0.00	0.00	y?	-	**395**		Very low base flow
17-Sep-07	MW	13:30	-	0.00	0.18	0.05	0.00	0.00	y?	19	9		Low est level MW has seen on the Kenduskeag.
									Storm Results:	Max:	**1553**	84.8%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**174**	63.3%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	TR	12:30	Ptly cldy	0.00	0.00	0.00	0.00	0.00	n	15	7		Fyke net upstream
23-May-07	TR	11:50	Clear	0.00	0.00	0.09	0.04	0.68	n	15	20		Fyke net removed
21-Jun-07	TR	9:50	Clear	0.04	0.00	0.00	0.00	0.00	n	24	50		Average of tw o samples: 56 and 44
21-Jun-07	TR	9:50	Clear	0.04	0.00	0.00	0.00	0.00	n	24	44		Lab split
18-Jul-07	MW	14:00	Overcast	0.00	0.00	0.04	0.00	0.22	n	-	35		Base flow sample
1-Aug-07	MW	10:10	Clear	0.00	0.00	0.00	0.00	0.05	n	-	20		Base flow sample
2-Aug-07	MW	-	Clear	0.00	0.00	0.00	0.00	0.00	n	25	14		Average of tw o samples: 10.7 and 17.3. Water level very low .
21-Aug-07	MW	-	-	0.00	0.00	0.02	0.30	0.28	n	-	12		Low base flow
									Dry Results:	Max:	50	na	% reduction calculation results in negative number
										Geomean:	21	na	% reduction calculation results in negative number.
									Overall Results:	Max:	**1553**	84.8%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	56	na	% reduction calculation results in negative number.

** Precip data for Harmony, ME (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

6.2.B Watershed Characterization

The aerial photo (figure 52) shows Kenduskeag Stream as it passes through Bangor. The Kenduskeag Stream watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 53). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 43.34 square miles, and impervious surfaces are estimated to total 12% of this area. Stream gradient is low with a slope over the segment length of about 0.38%.

Forest constitutes a majority of the land use area at 57.3%. Developed uses are significant at 22%. Agricultural land uses, some of which are directly adjacent to the stream, are calculated as 11.9% of watershed area. Wetlands and open water add 7.3% of watershed area, and grass / scrub makes up the smallest of these aggregated categories at 1.5% of the watershed.

Development dominates the lowest reaches of the stream, suggesting sources such as aging septic or sewer infrastructure and pet waste may also be present. Agriculture could be source through the spreading of manure or the presence of livestock directly.

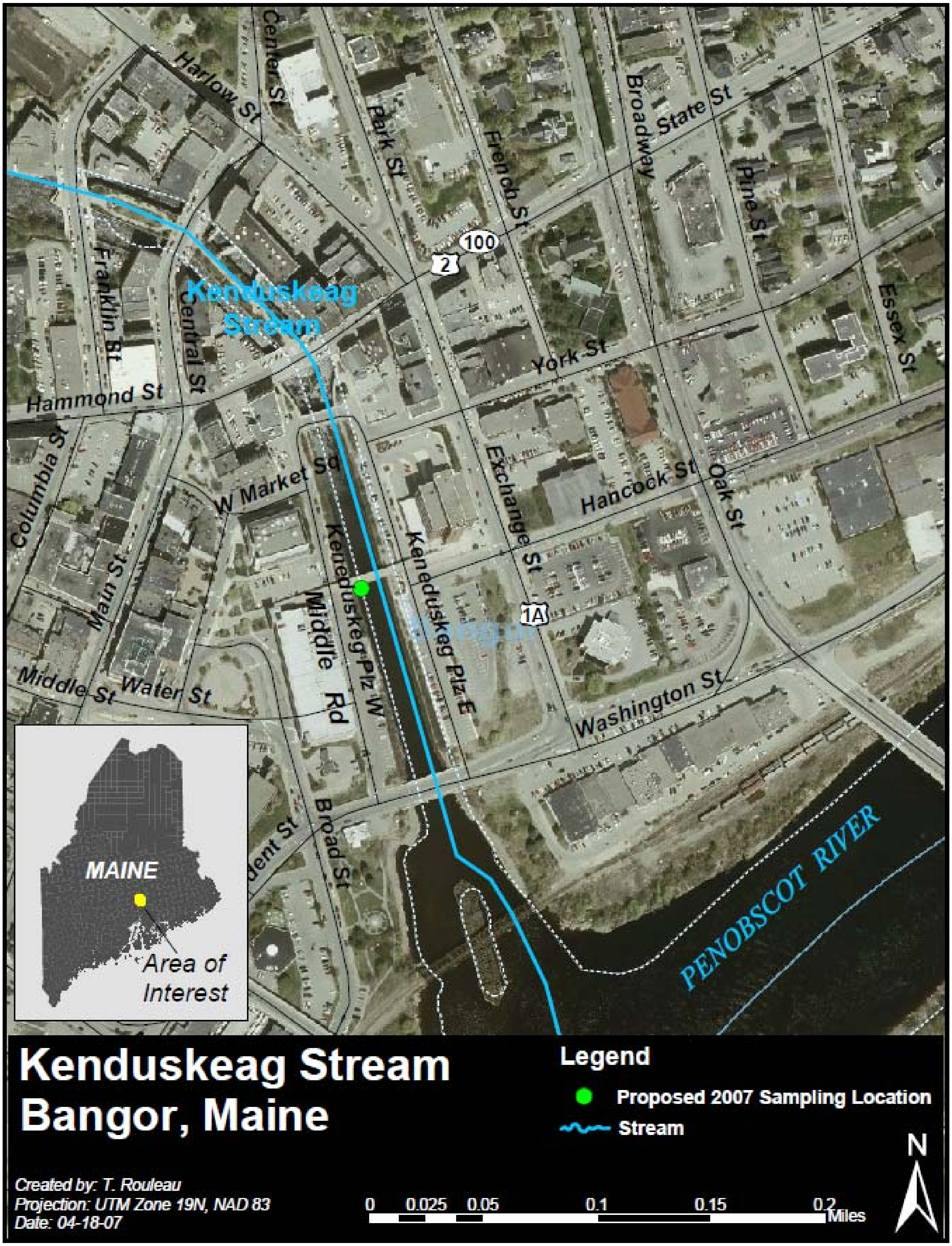


Figure 52: Aerial photograph of Kenduskeag Stream and surrounding area.

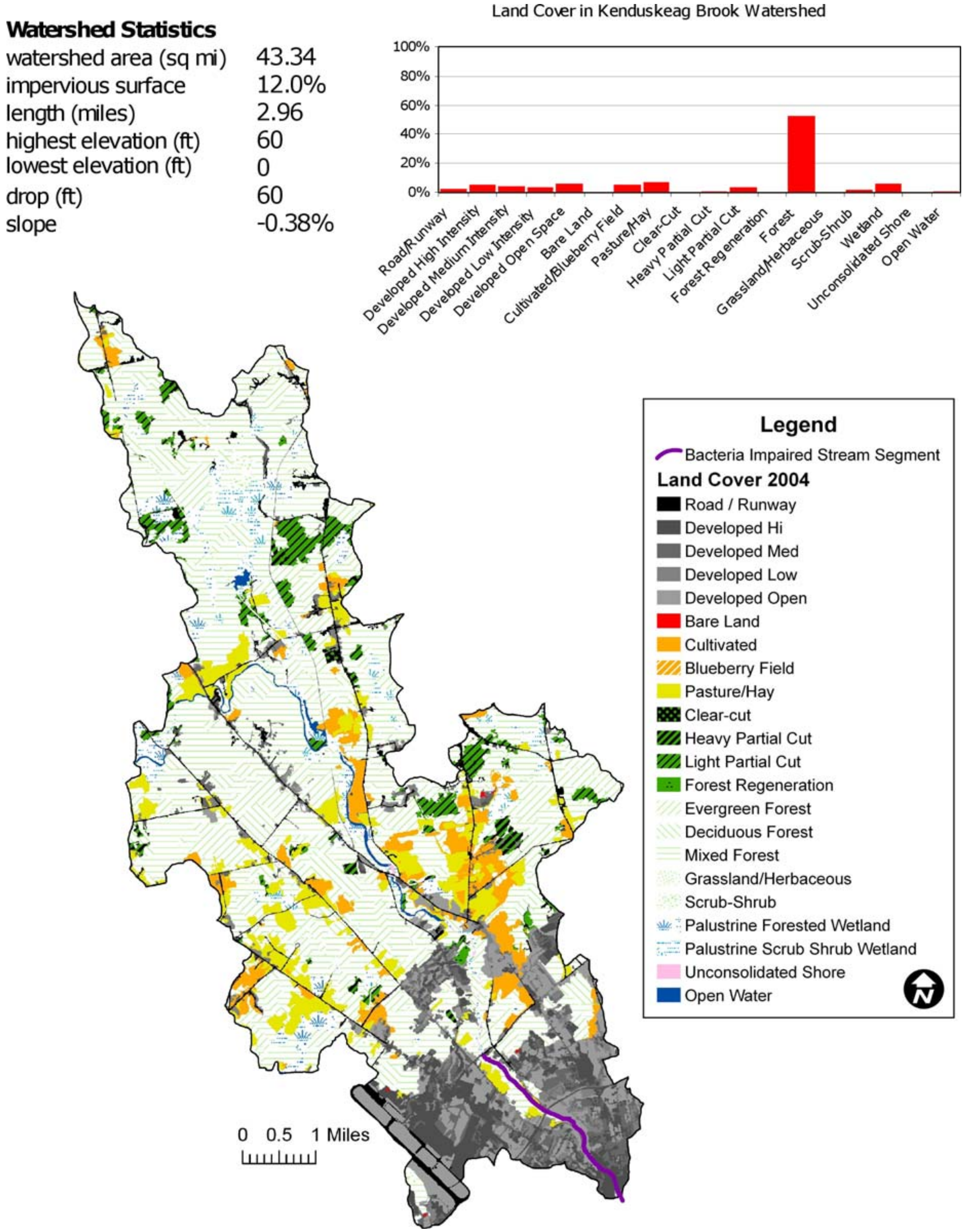


Figure 53: Kenduskeag Stream watershed land cover map and statistics.

6.2.C Recommended Mitigation Strategies

Developed areas (22%) and impervious surfaces (12%) are substantial in the Kenduskeag Stream watershed. The nature and location of the development crowds the lower reaches of the river, although there are notable reaches with forested riparian buffer. It is possible that a few wastewater systems serving structures the area may be malfunctioning. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since Kenduskeag Brook watershed contains significant amounts of forests (approximately 57% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

6.3 Otter Stream (Milford)

Otter Stream (Segment ID 226R01) is located in the town of Milford in the Penobscot River Watershed. (Figures 54 and 55). The listed segment length for Otter Stream is 11.1 miles and its total listed watershed area is 47.7 square miles. Potential sources of bacteria impairment are listed as unknown.

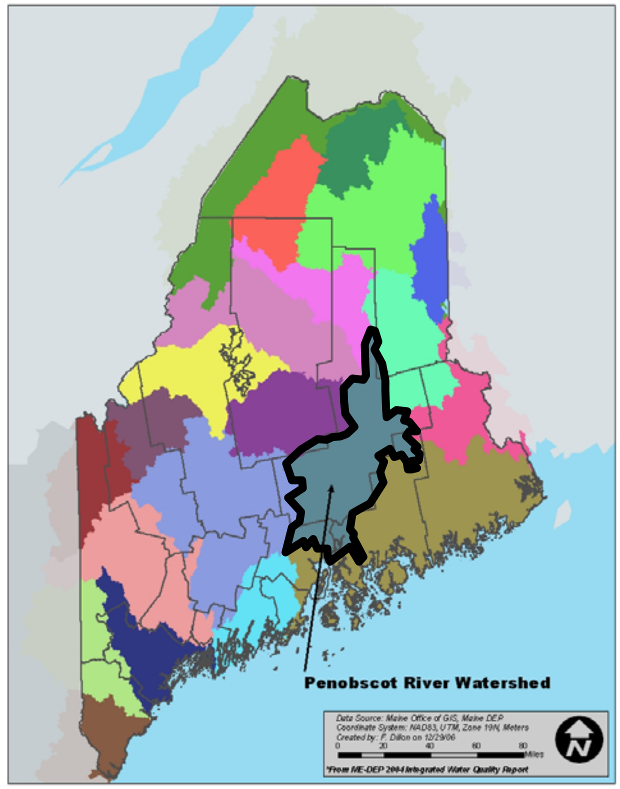


Figure 54: Penobscot River Watershed.

6.3.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Lower Penobscot River Watershed were collected by FB Environmental staff in the spring and summer of 2007 and are presented in Table 15. Three stream segments: Boynton Brook, Kenduskeag Stream, and Otter Stream were listed for "bacteria-only" impairment in the Lower Penobscot River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Otter Stream, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Otter Stream were observed to exceed the instantaneous standard in 3 of 5 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 613 MPN/100mL on May 16th, 921 MPN/100mL on June 5th, and 291 MPN/100mL on June 6th. Bacteria concentrations in the unnamed brook in Otter Stream did not meet the geometric mean standard for the overall sampling period, at 269 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset and two samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

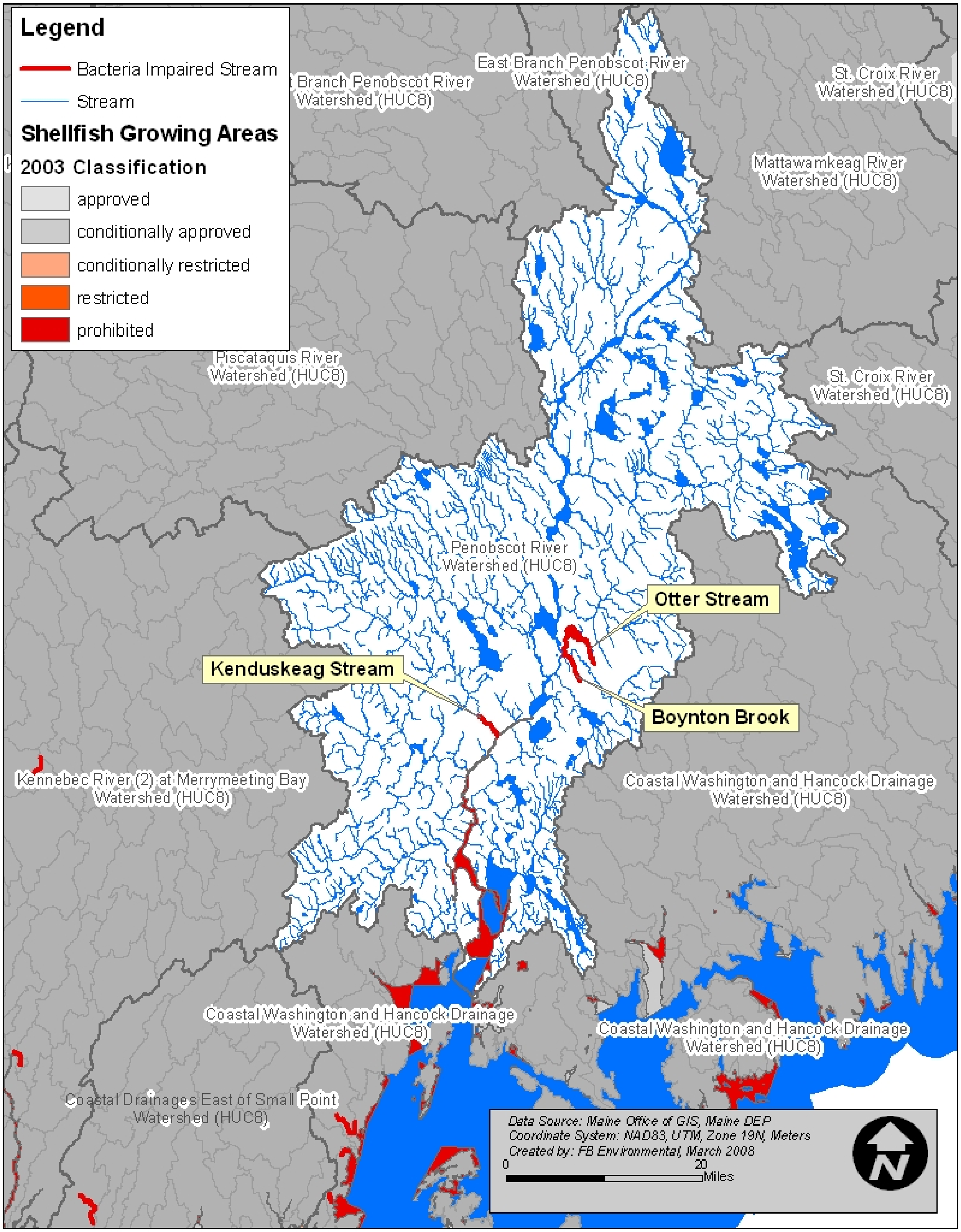


Figure 55: Penobscot River Watershed with the impaired waterways indicated.

The geometric mean for the overall results for the 2007 sampling season indicates a reduction of 76.2% is needed to meet the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 88.3% and 30.7%, respectively. (Table 15). The bacteria concentration reduction needed to attain the instantaneous water quality standard is 74.1% for both the overall season and storm samples and not indicated for dry weather samples since they met the standard.

Table 15: Bacteria data summary for Otter Stream, with wet and dry weather assessment.

Otter - Milford	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
16-May-07	TR	9:00	Rain	0.55	0.05	0.00	0.00	0.13	y	15	**613**		
5-Jun-07	TR	10:00	Clear	0.94	0.13	0.17	0.00	0.01	y	18	**921**		Sample very dark tea color; stream stagnant.
6-Jun-07	TR	10:34	Clear	0.02	0.94	0.13	0.17	0.00	y	20	**291**		Conclude sampling per Melissa Evers.
									Storm Results:	Max:	**921**	74.4%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**548**	88.3%	% reduction for geomean WQS (64 col/100 mL).
Dry Weather Samples													
9-May-07	TR	9:35	Ptly cldy	0.00	0.00	0.00	0.00	0.00	n	15	86		
23-May-07	TR	9:00	Clear	0.00	0.00	0.09	0.04	0.68	n	13	99		
									Dry Results:	Max:	99	na	% reduction calculation results in negative number
										Geomean:	**92**	30.7%	% reduction for geomean WQS (64 col/100 mL).
									Overall Results:	Max:	**921**	74.4%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**269**	76.2%	% reduction for geomean WQS (64 col/100 mL)

** Precip data for Harmony, ME (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

6.3.B Watershed Characterization

The aerial photo (figure 56) shows Otter Brook as it passes through Milford. The Otter Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 57). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 10.5 square miles, and impervious surfaces are estimated to total 4.4% of this area. Stream gradient is extremely slight with a slope over the segment length of about 0.12%.

Forest is the dominant land use at 70.8%, with wetlands adding 16.3%, and scrub / shrub adding 2.2%. land uses, some of which are directly adjacent to the stream, are calculated as _% of watershed area. Developed areas make up a relatively modest 9.3% of these aggregated categories, some areas are directly adjacent to the lower reaches of the stream. Development in that location suggests sources such as malfunctioning septic or sewer infrastructure and pet waste may be present. Agriculture is a scant 1.4% of the watershed area, however, some lands abut the lower reaches of the stream. Agriculture could be source through the spreading of manure or the presence of livestock directly.

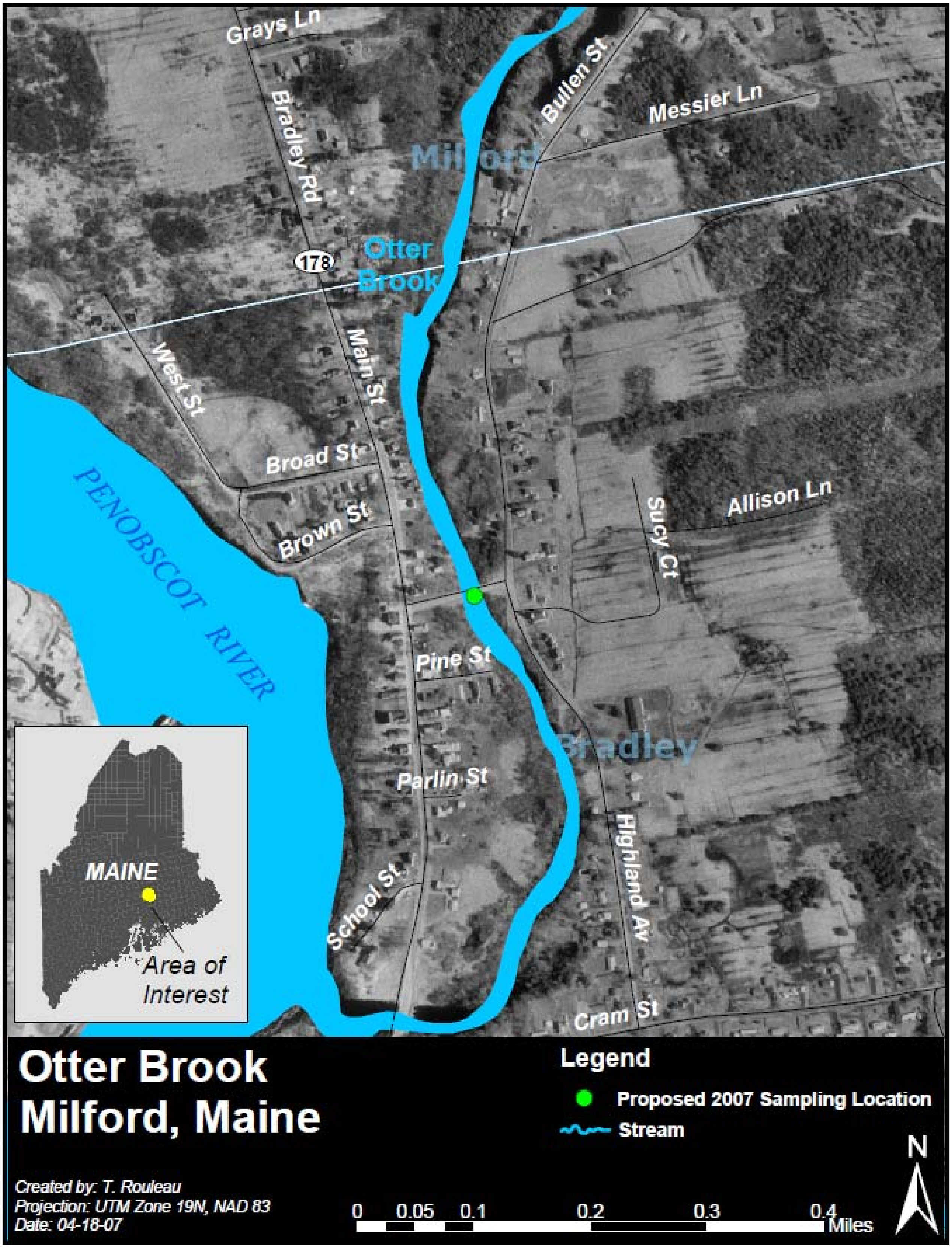
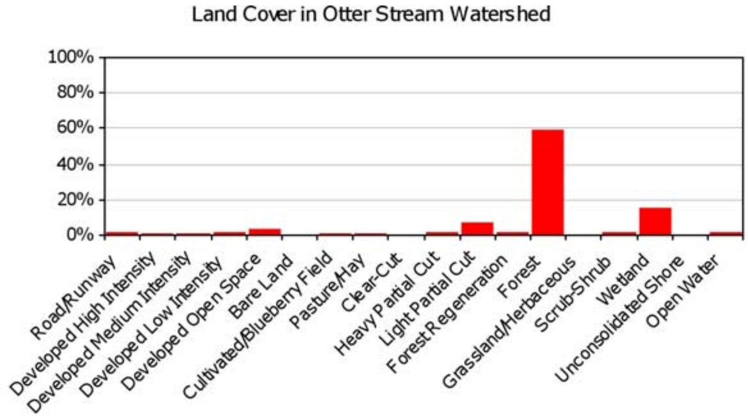


Figure 56: Aerial photograph of Otter Brook and surrounding area.

Watershed Statistics

watershed area (sq mi)	10.46
impervious surface	4.4%
length (miles)	11.13
highest elevation (ft)	150
lowest elevation (ft)	80
drop (ft)	70
slope	-0.12%



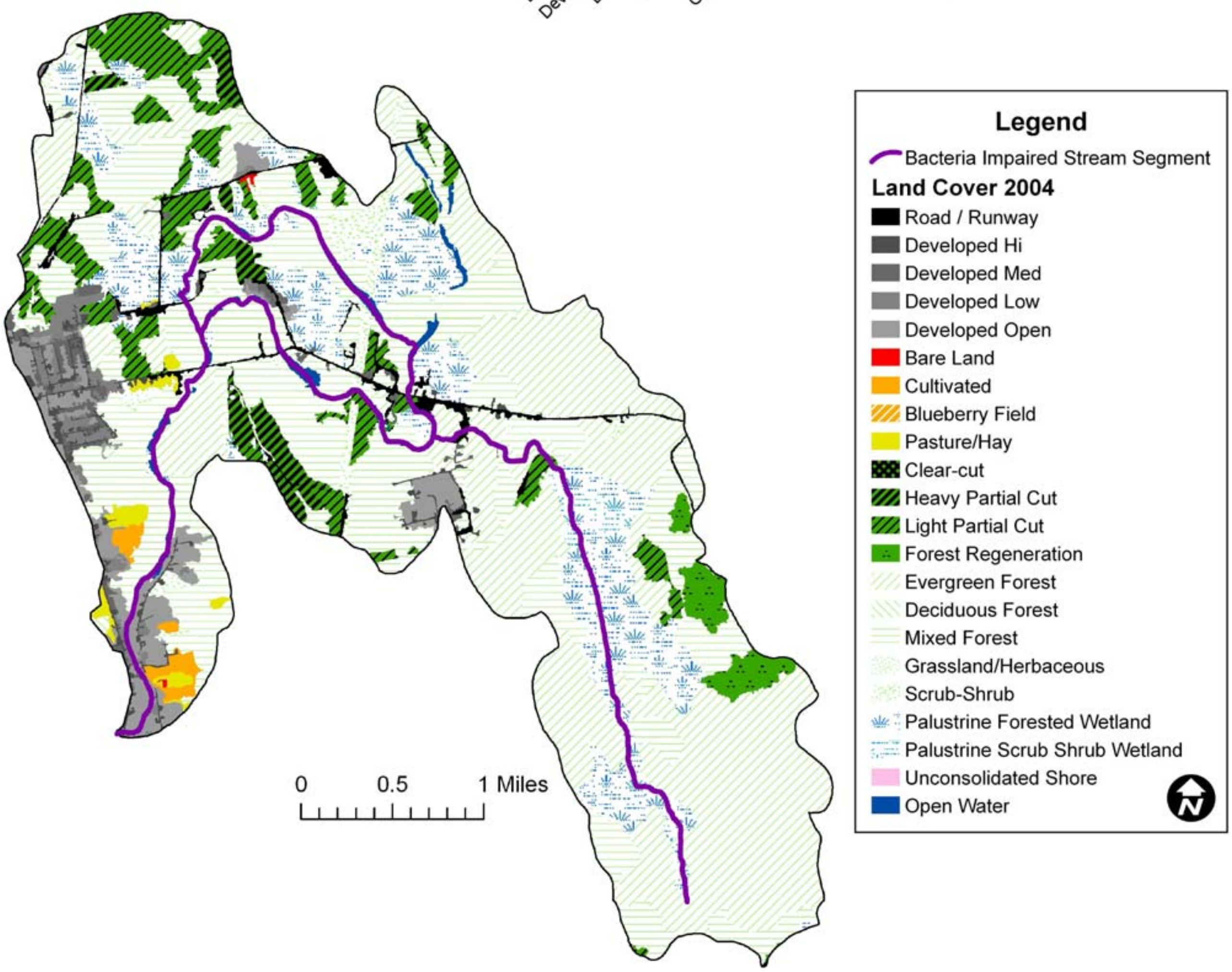


Figure 57: Otter Brook watershed land cover map and statistics.

6.3.C Recommended Mitigation Strategies

Developed areas (9.3%) and impervious surfaces (4.4%) are present at moderate levels in the Otter Brook watershed. The nature and location of the development crowds the lower reaches of the river. It is possible that a few wastewater systems serving structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since Otter Brook watershed is dominated by forests and other natural land uses (combined, approximately 89% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is a very small part of the watershed (1.4%), however, there are two locations where it is adjacent to the stream. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Penobscot County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

7. Piscataqua River Watershed

7.1 Kennebunk River (Kennebunk)

Kennebunk River (Segment ID 622R01) is located in the town of Kennebunk in the Piscataqua River Watershed. (Figures 58 and 59). The listed segment length for Kennebunk River is 3.9 miles and its total listed watershed area is 37.2 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

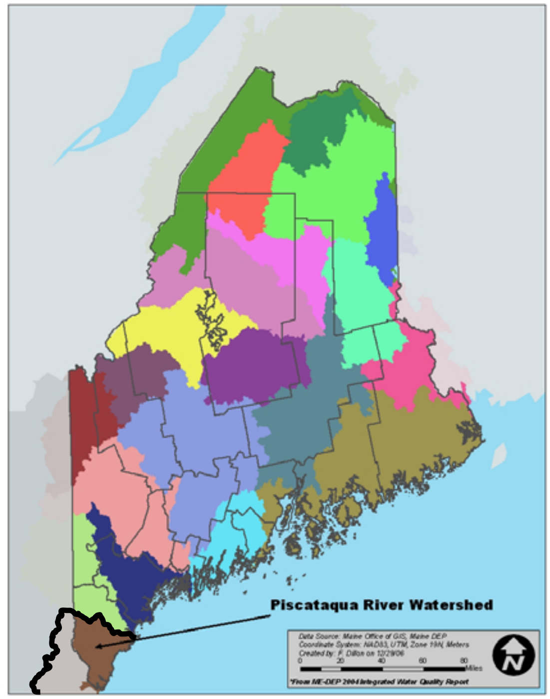


Figure 58: Piscataqua River Watershed.

7.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Kennebunk River were collected by FB Environmental staff in spring 2007 at two locations and are presented in Table 16. The initial location, KB01, was moved further upstream to KB02 after determining that tidal influence at KB01 was resulting in non-representative bacteria samples for the impaired segment. KB02 is also a sampling site for the Kennebunk River Action Coalition. The Kennebunk River was the only stream listed for "bacteria-only" impairment in the Piscataqua River Watershed as specified in Maine's 2004 305(b) report and is the only impaired segment in this study designated as Class SB (the "S" denotes estuarine and marine waters). Maine uses a different indicator organism (enterococci) and set of water quality criteria to establish bacteria impairment in tidally influenced waters. However, to maintain consistency and comparability with the other impaired segments in this study, *E. coli* was used as the indicator organism along with its corresponding Class B freshwater standards, which for instantaneous results are 236 MPN/100mL of sample and 64 MPN/100mL of sample for the geometric mean.

Bacteria levels at KB02 in the Kennebunk River were observed to exceed the instantaneous standard in 3 of 13 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 1,300 MPN/100mL on June 27th, 308 MPN/100mL on July 9th, and 1,986 MPN/100mL on July 30th (Table 16). All samples from site KB01 met water quality standards. Bacteria concentrations KB02 did not meet the geometric mean standard for the overall sampling period, at 110 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for only dry weather conditions at 182 MPN/100mL, although with merely three samples in the wet weather dataset, the geometric mean may contain too few samples to prove adequately representative of wet weather conditions. Recent water quality monitoring results from the Kennebunk River Action Coalition also indicate that bacteria levels have exceeded state standards at KB02. As a result, the Maine Healthy Beaches program (with assistance from EPA and FBE) conducted fluorometric bacteria source tracking in the late summer of 2007 that indicated humans sources were likely contributors to impairment.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

At KB02, the geometric mean for the overall results for the 2007 sampling season indicates a reduction of 41.6% is needed to meet the water quality standard. For dry weather samples, the % reduction required to comply with the geometric mean standard 64.8%. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 88.1% for the overall and dry weather results and 23.3% for the dry weather results, based on the maxima for each respective category.

Table 16: Bacteria data summary for Kennebunk River (two sample stations), with wet and dry weather assessment.

Kennebunk (KB01) - K'port	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	-	-	-	0.33	0.00	0.00	0.00	0.00	y	-	-		Didn't collect sample because tide was outgoing.
16-May-07	TB	13:50	Rain	0.71	0.04	0.00	0.00	0.00	y	10	1		
7-Jun-07	TB	10:15	Clear	0.00	0.00	0.12	2.12	0.52	y	15	19		Future sample collection moved upstream (KB02).
									Storm Results:	Max:	19	na	% reduction calculation results in negative number
										Geomean:	4	na	% reduction calculation results in negative number
Dry Weather Samples													
9-May-07	FD	10:05	Clear	0.00	0.00	0.00	0.00	0.00	n	13	3		Collected sample on outgoing tide (low ~11:00)
23-May-07	TB	10:00	Overcast	0.00	0.00	0.00	0.08	0.06	n	13	4		
31-May-07	TB	13:10	Lt rain	0.01	0.01	0.00	0.28	0.00	n	13	13		
									Dry Results:	Max:	13	na	% reduction calculation results in negative number
										Geomean:	6	na	% reduction calculation results in negative number
									Overall Results:	Max:	19	na	% reduction calculation results in negative number
										Geomean:	5	na	% reduction calculation results in negative number

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

Kennebunk (KB02) - K'port	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
6-Jul-07	TB	9:40	Overcast	0.10	0.25	0.12	0.00	0.00	y	21	11		
9-Jul-07	TB	12:55	Lt rain	1.13	0.25	0.27	0.10	0.25	y	19	**308**		
10-Aug-07	TB	13:00	Ptly cldy	0.00	0.00	0.57	0.00	2.29	y	21	32		
									Storm Results:	Max:	**308**	23.3%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	47	na	% reduction calculation results in negative number
Dry Weather Samples													
13-Jun-07	TB	13:00	Lt rain	0.10	0.00	0.00	0.00	0.00	n	18	19		Site tidally influenced and sample collected on incoming tide; result may be invalid.
21-Jun-07	TB	12:55	-	0.00	0.00	0.00	0.00	0.00	n	-	25		
29-Jun-07	TB	12:50	Clear	0.00	0.00	0.00	0.00	0.05	n	23	**1300**		
30-Jul-07	TB	12:30	Clear	0.00	0.00	0.15	0.00	0.00	n	22	**1986**		
4-Sep-07	TB	14:05	Clear	0.00	0.00	0.00	0.00	0.00	n	21	162		Final sample of project.
17-Sep-07	TB	-	-	0.00	0.00	0.13	0.00	0.00	n	-	-		Sample not collected due to incoming tide.
									Dry Results:	Max:	**1986**	88.1%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**182**	64.8%	% reduction for geomean WQS (64 col/100 mL)
									Overall Results:	Max:	**1986**	88.1%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**110**	41.6%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

7.1.B Watershed Characterization

The aerial photo (figure 60) shows the Kennebunk River as it passes through Kennebunkport. The Kennebunk River watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 61). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 37.14 square miles, and impervious surfaces are estimated to total 5.9% of this area. Stream gradient extremely slight with a slope over the segment length estimated to be near 0%, and in fact much of the lower reaches of the river are tidal.

Forest is the majority of the land use at 64.4%, with wetlands adding 9.4%, and grass / scrub adding 3%. Developed land uses, some of which are directly adjacent to the stream, are calculated as 11.1% of watershed area. Development suggests sources such as malfunctioning wastewater infrastructure and pet waste may be present. Agriculture is also significant at 12.2% of the watershed area, however, those land uses are mostly distant from the river itself. Agriculture could be a source through the spreading of manure or the presence of livestock directly.

7.1.C Recommended Mitigation Strategies

Developed areas (11.1%) and impervious surfaces (5.9%) are an important presence in the Kennebunk River watershed. The nature and location of the development crowds the lower reaches of the river. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since the watershed is dominated by forests, wetlands, and other natural land cover (approximately 77% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970’s is spotty, after which Maine’s wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

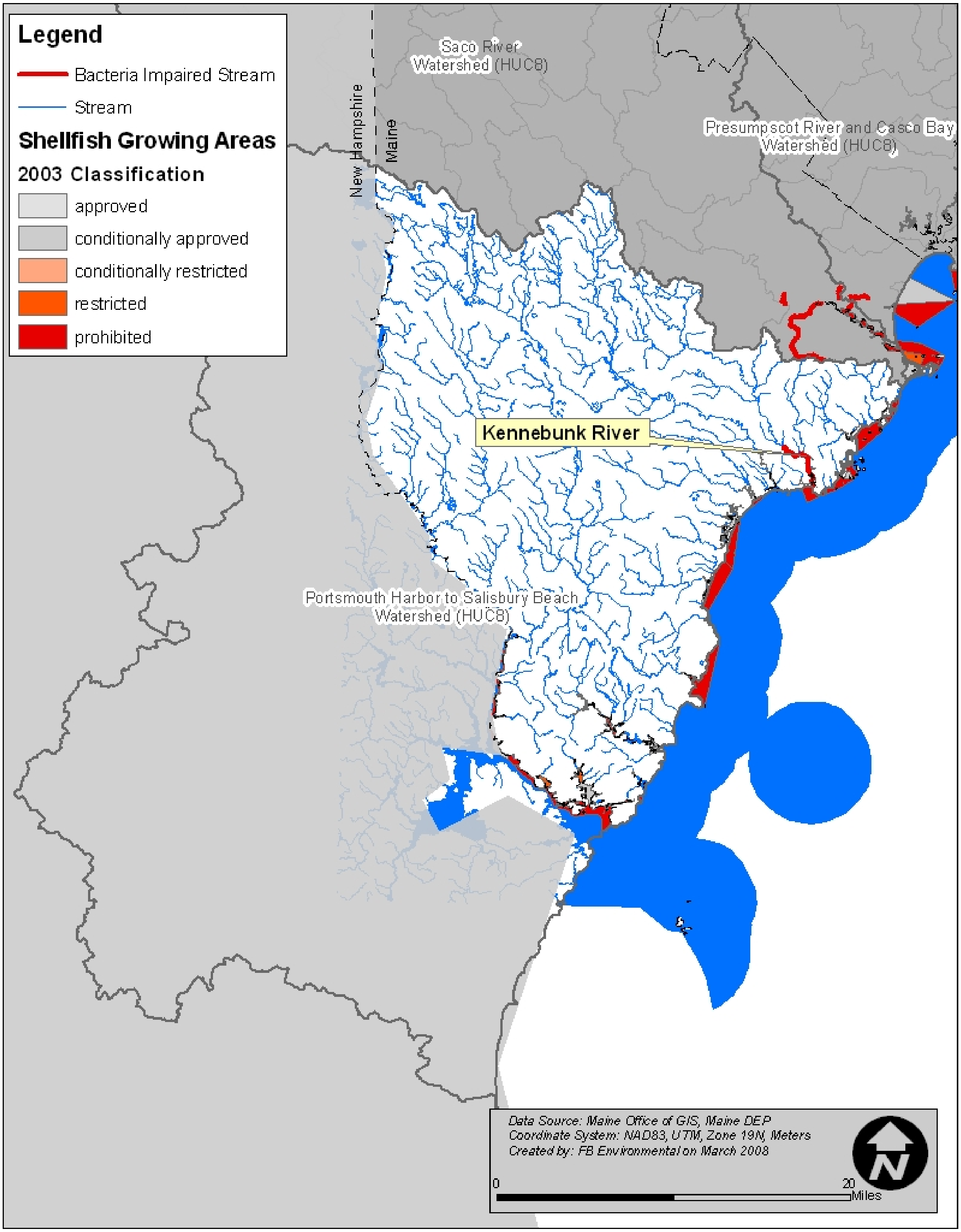


Figure 59: Piscataqua River Watershed with the Kennebunk River indicated.

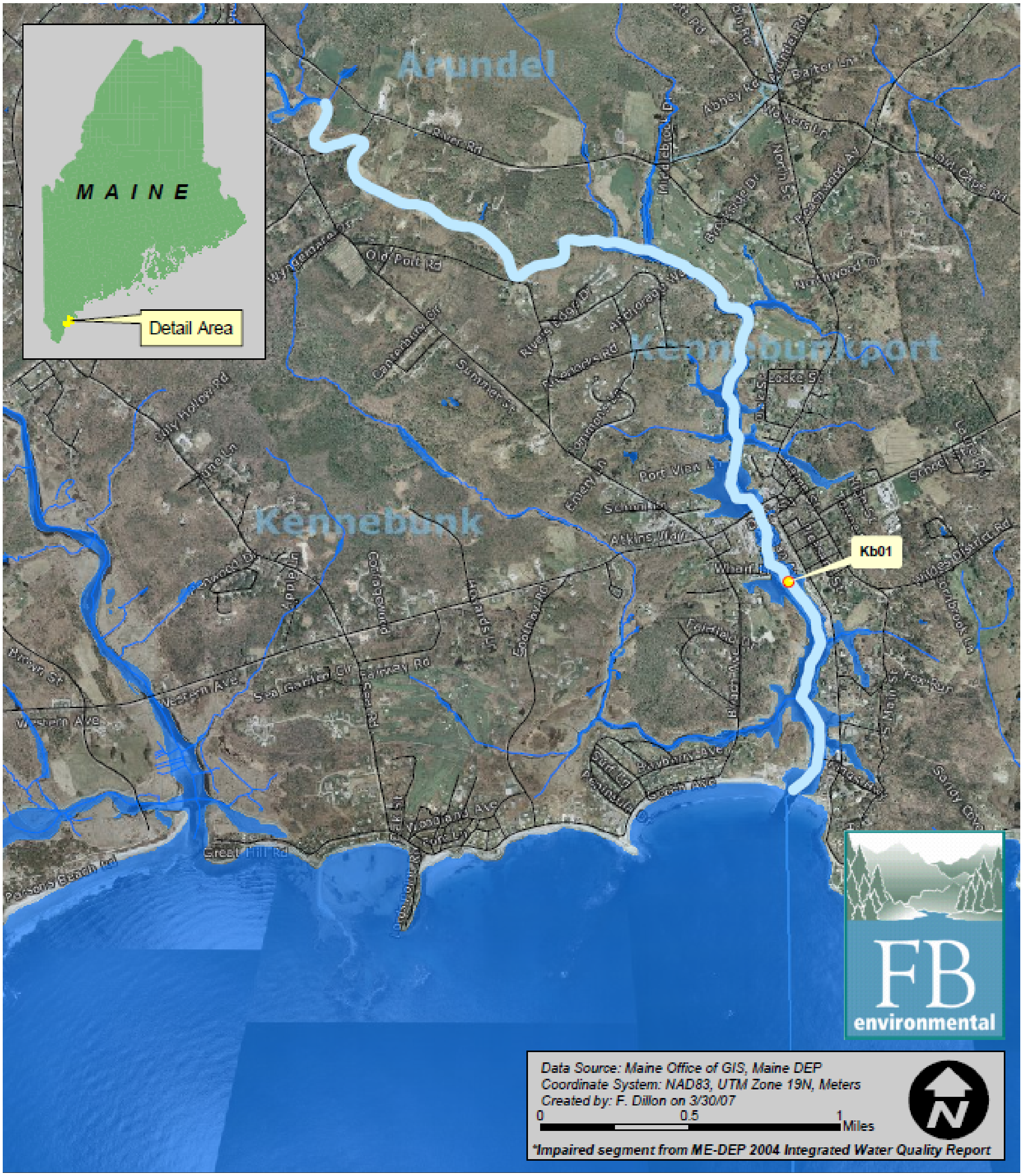


Figure 60: Aerial photograph of Kennebunk River and surrounding area.

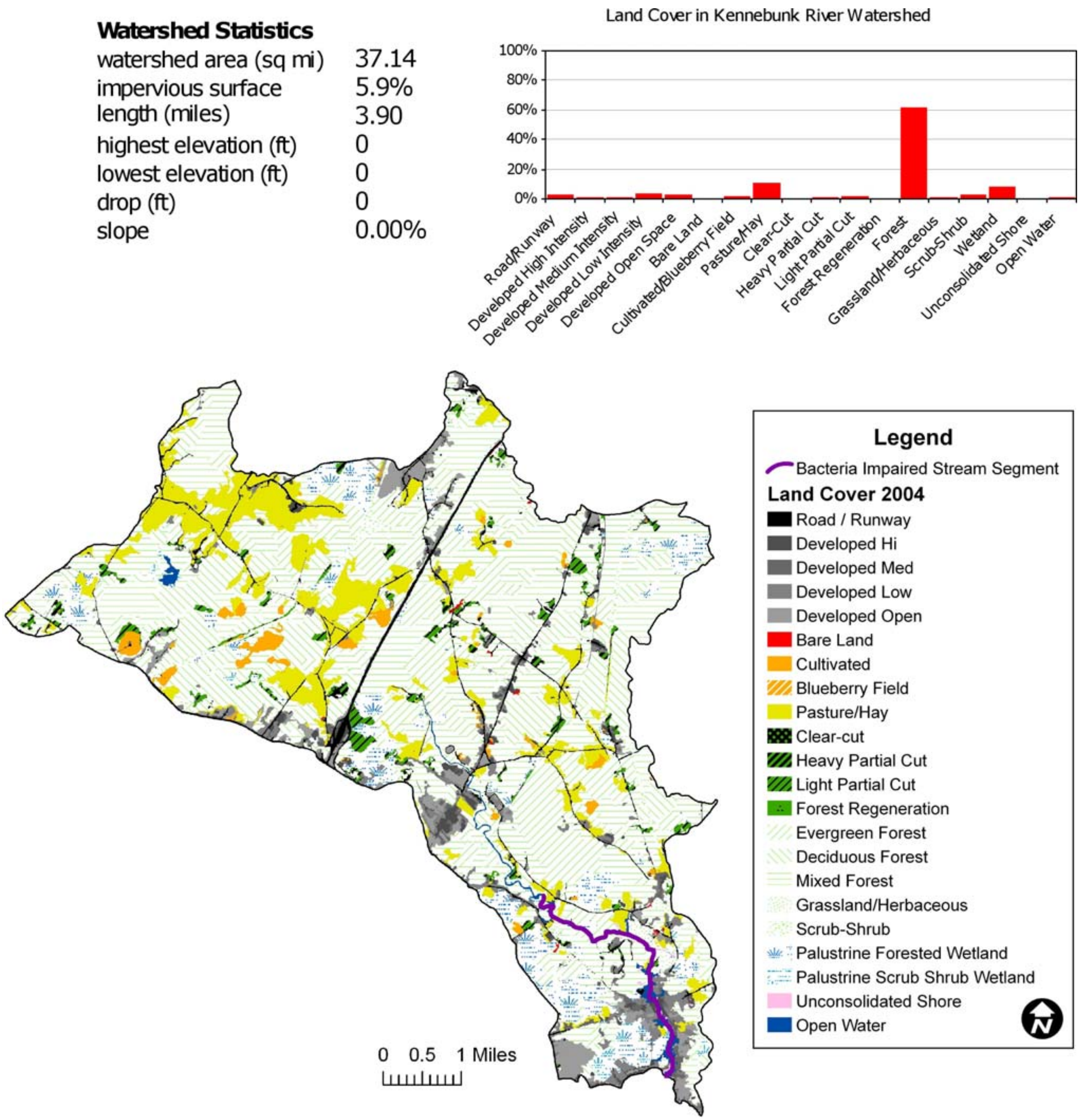


Figure 61: Kennebunk River watershed land cover map and statistics.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is a significant part of the watershed (12.2%), and a few small areas appear to abut the river. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The York County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

8. Saco River Watershed

8.1 Bear Brook (Saco)

Bear Brook (Segment ID 616R04) is located in the town of Saco in the Saco River Watershed. (Figures 62 and 63). The listed segment length for Bear Brook is 1.2 miles and its total listed watershed area is 32.9 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution and combined sewer overflows.

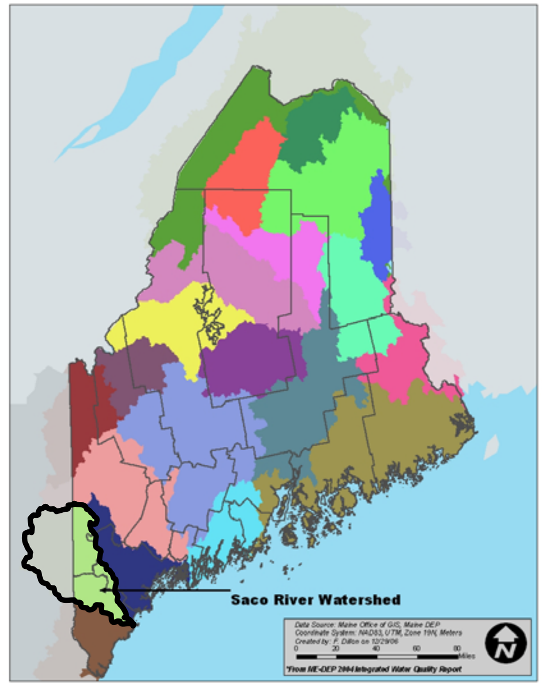


Figure 62: Saco River Watershed.

8.1.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 17. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for "bacteria-only" impairment in the Saco River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Bear Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Bear Brook were observed to exceed the instantaneous standard in 2 of 5 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 1,414 MPN/100mL on May 11th and 770 MPN/100mL on May 16th. Bacteria concentrations in Bear Brook did not meet the geometric mean standard for the overall sampling period, at 219 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset and three samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results was above (i.e. not in compliance with) the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 89.1% and 21.9%, respectively (Table 17). Bacteria concentration reductions needed to attain the instantaneous water quality standard were 83.3% for both the overall and storm event results and non-existent for the dry weather results as they are below the standard.

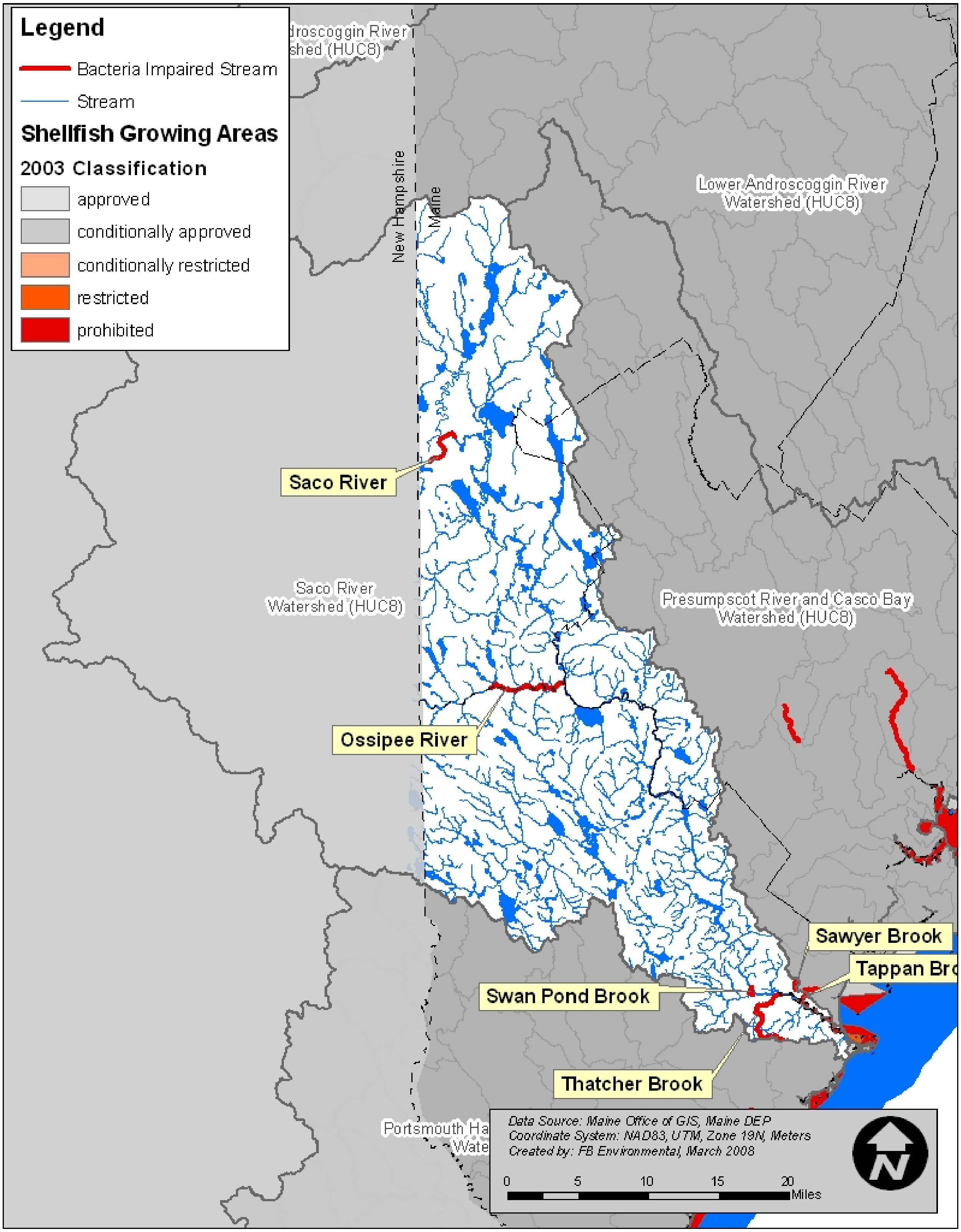


Figure 63: Saco River Watershed with the impaired waterways indicated.

Table 17: Bacteria data summary for Bear River, with wet and dry weather assessment.

Bear - Saco	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	15:41	Overcast	0.33	0.00	0.00	0.00	0.00	y	16	**1414**		Likely storm sample, though unclear on whether 0.1" rain fell on 5/11 before sample collected.
16-May-07	TB	15:10	Rain	0.71	0.04	0.00	0.00	0.00	y	12	**770**		Likely storm sample, though unclear on whether 0.1" rain fell on 5/16 before sample collected.
7-Jun-07	TB	9:35	Clear	0.00	0.00	0.12	2.12	0.52	y	12	185		Conclude sampling for this site per Melissa Evers
								Storm Results:		Max:	**1414**	83.3%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**586**	89.1%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	FD	12:40	Clear	0.00	0.00	0.00	0.00	0.00	n	16	38		Sampled ~100' above confluence with larger stream.
23-May-07	TB	11:30	Overcast	0.00	0.00	0.00	0.08	0.06	n	12	80		
31-May-07	TB	14:25	Lt rain	0.01	0.01	0.00	0.28	0.00	n	15	179		
								Dry Results:		Max:	179	na	% reduction calculation results in negative number
										Geomean:	**82**	21.9%	% reduction calculation results in negative number
								Overall Results:		Max:	**1414**	83.3%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**219**	70.8%	% reduction calculation results in negative number

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

8.1.B Watershed Characterization

The aerial photo (figure 64) shows Bear Brook as it passes through Saco. The Bear Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (figure 65). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 0.8 square miles, and impervious surfaces are estimated to total 29.8% of this area. Stream gradient is low with a slope over the segment length of about 0.61%.

Developed is the dominant land use at 75.9%. Forest makes up 22.7% of these aggregated categories, with wetlands adding 0.8% and grass / scrub adding 0.6%. There are no agricultural lands in the watershed.

8.1.C Recommended Mitigation Strategies

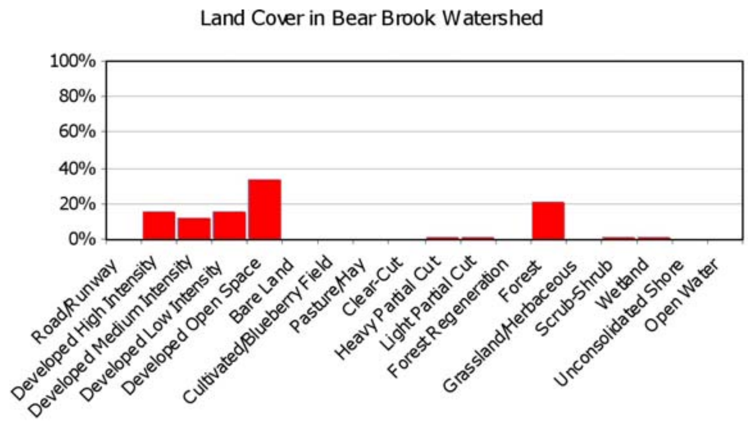
Developed areas (75.9%) and impervious surfaces (29.8%) overwhelmingly dominate the Bear Brook watershed. The nature and location of the development crowds the headwaters of the brook, while the lower reaches are forested. It is possible that some wastewater systems serving aging structures in the area are malfunctioning. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since there is also a significant amount of forest in the watershed (approximately 23% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Figure 64: Aerial photograph of Bear Brook and surrounding area.

Watershed Statistics

watershed area (sq mi)	0.80
impervious surface	29.8%
length (miles)	1.24
highest elevation (ft)	60
lowest elevation (ft)	20
drop (ft)	40
slope	-0.61%



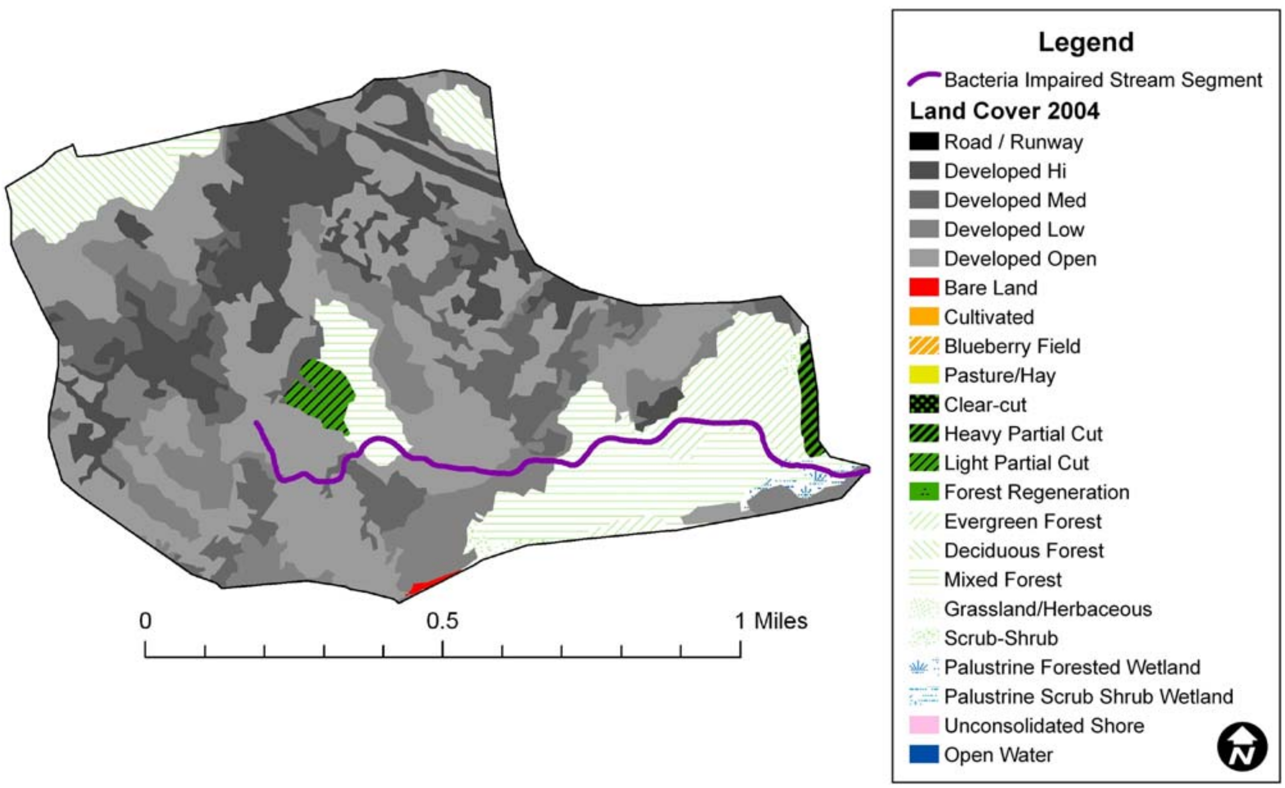


Figure 65: Bear Brook watershed land cover map and statistics.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

8.2 Ossipee River (Hiram)

The Ossipee River (Segment ID 614R01) is located in the town of Hiram in the Saco River Watershed. (Figures 66 and 67). The listed segment length for the Ossipee River is 7.3 miles and its total listed watershed area is 36.6 square miles. Potential sources of bacteria impairment are listed as unspecified non-point source pollution.

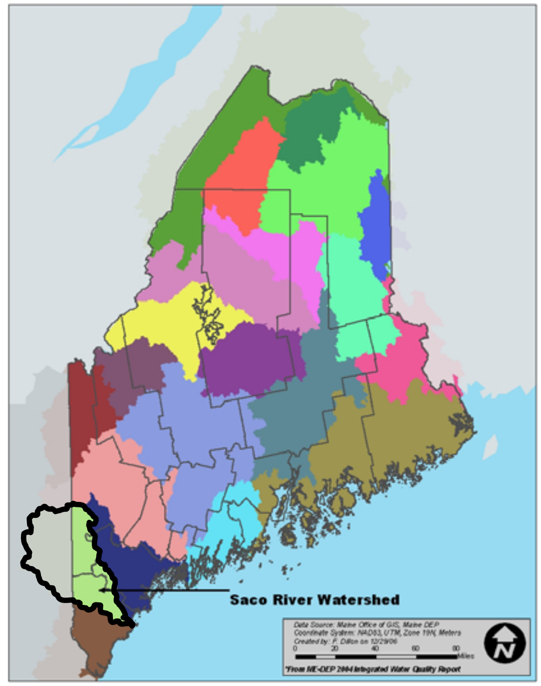


Figure 66: Saco River Watershed.

8.2.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 18. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for "bacteria-only" impairment in the Saco River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for the Ossipee River, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in the Ossipee River were not observed to exceed the instantaneous standard in any of the 5 surveys conducted throughout the 2007 sampling period. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. Bacteria concentrations in the Ossipee River met the geometric mean standard for the entire sampling period. Since 2001, the Saco River Corridor Commission has also been collecting bacteria samples at three locations along the Ossipee River (though none are located within the impaired segment) and their results generally indicate compliance with state standards.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results and the separate storm and dry weather events were below (i.e., in compliance with) the water quality standards; therefore the % reduction calculation for this criterion does not apply. However, it is important to note that a series of samples collected over a single sampling period may not adequately characterize the nature and extent of potential bacteria contamination in a given watershed. Even though the 2007 bacteria data for the Ossipee River indicate compliance with state standards, future (or prior) monitoring results may indicate otherwise. Therefore, ongoing monitoring may be advisable for streams with suspected bacteria contamination issues.

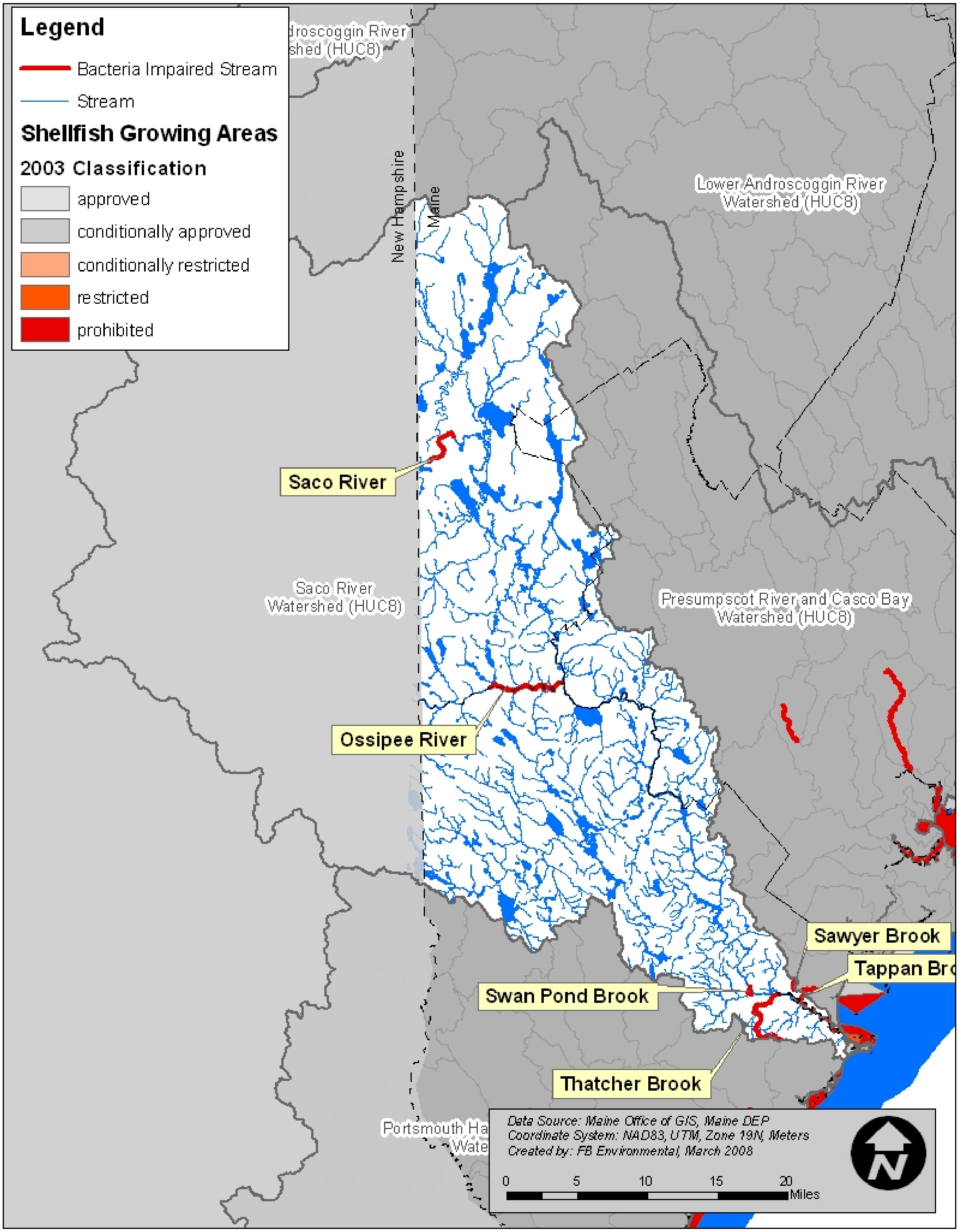


Figure 67: Saco River Watershed with the impaired waterways indicated.

Table 18: Bacteria data summary for Ossipee River, with wet and dry weather assessment.

Ossipee - Hiram	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	13:15	Overcast	0.33	0.00	0.00	0.00	0.00	y	17	12		Storm sample
16-May-07	TB	10:30	Clear	0.71	0.04	0.00	0.00	0.00	y	15	10		
7-Jun-07	TB	11:40	Clear	0.00	0.00	0.12	2.12	0.52	y	19	135		Conclude sampling for this site per Melissa Evers
									Storm Results:	Max:	135	na	% reduction calculation results in negative number
										Geomean:	25	na	% reduction calculation results in negative number
Dry Weather Samples													
9-May-07	TB	11:50	Clear	0.00	0.00	0.00	0.00	0.00	n	15	2		Sampled on downstream side of culvert.
23-May-07	TB	14:30	Overcast	0.00	0.00	0.00	0.08	0.06	n	15	82		
31-May-07	TB	11:30	Lt rain	0.01	0.01	0.00	0.28	0.00	n	19	36		
									Dry Results:	Max:	82	na	% reduction calculation results in negative number
										Geomean:	18	na	% reduction calculation results in negative number
									Overall Results:	Max:	135	na	% reduction calculation results in negative number
										Geomean:	21	na	% reduction calculation results in negative number

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

8.2.B Watershed Characterization

The aerial photo (figure 68) shows Ossipee River as it passes through Parsonsfield, Hiram and Cornish. The Ossipee River watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 69). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 36.27 square miles, and impervious surfaces are estimated to total 2.6% of this area. Stream gradient is low with a slope over the segment length of about 0.26%.

Forest is the dominant land use at 82.3%, with wetlands adding 5.6%, and grass / scrub adding 1.6%. Developed land uses, some of which are close to the stream, are calculated as 4.9% of watershed area. Agricultural lands make up 5.7% of the watershed area. Agriculture and development would appear to be roughly equal in their likelihood of contributing to the bacterial impairment of the Ossipee River.

8.2.C Recommended Mitigation Strategies

Despite the fact that the Ossipee River met state bacteria standards during the 2007 sampling period, it is still important to consider potential bacteria mitigation strategies should problems arise in the future. Developed areas (4.9%) and impervious surfaces (2.6%) are a relatively small proportion of the watershed area. The development is located near the river, although it does appear that there is some vegetated buffer between most of the town centers and the river. It is possible that some wastewater systems are malfunctioning, particularly if some of the wastewater infrastructure is older than 30 years or so. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since the Ossipee River is dominated by forests and wetlands (approximately 89% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

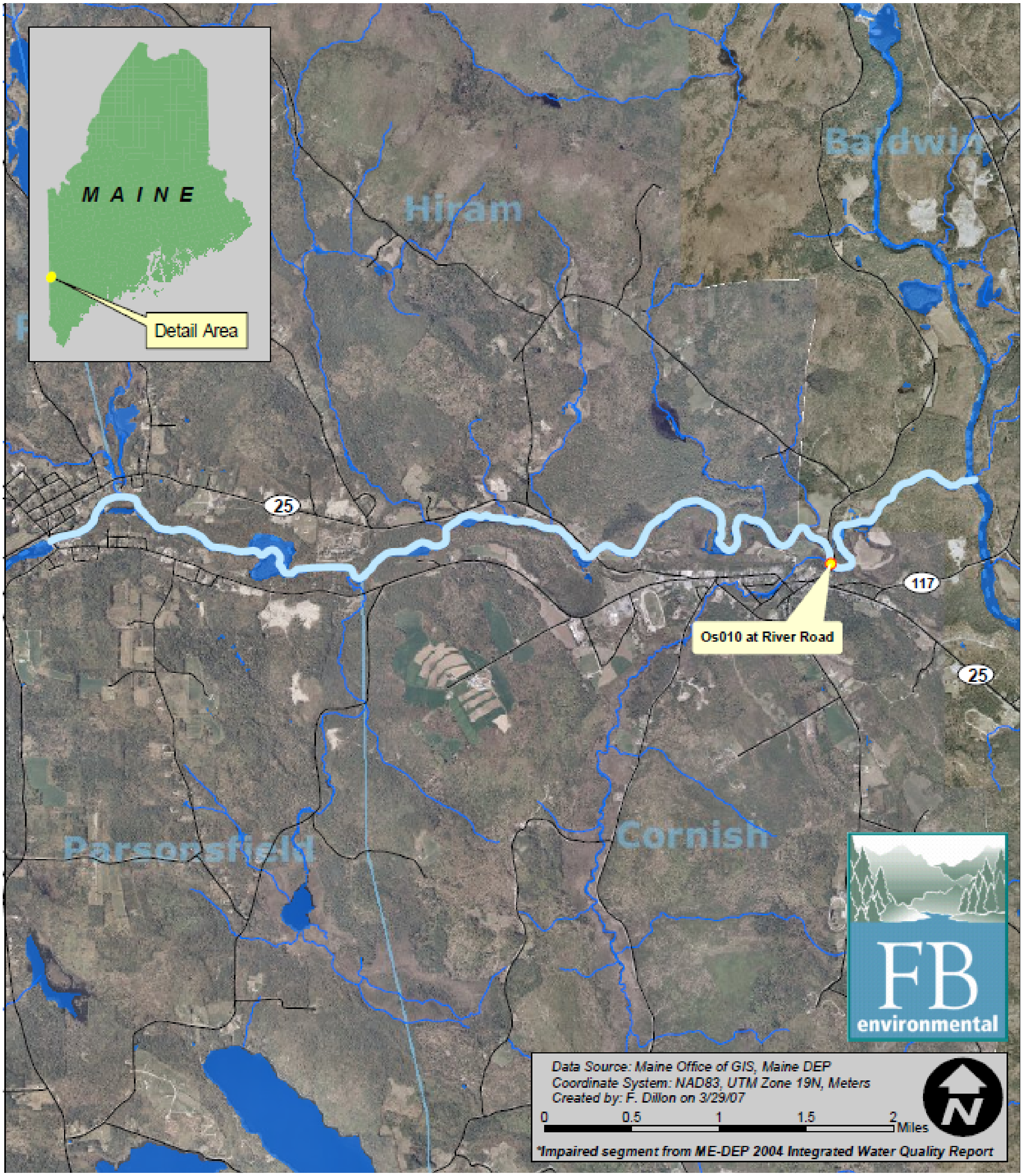


Figure 68: Aerial photograph of Ossipee River and surrounding area.

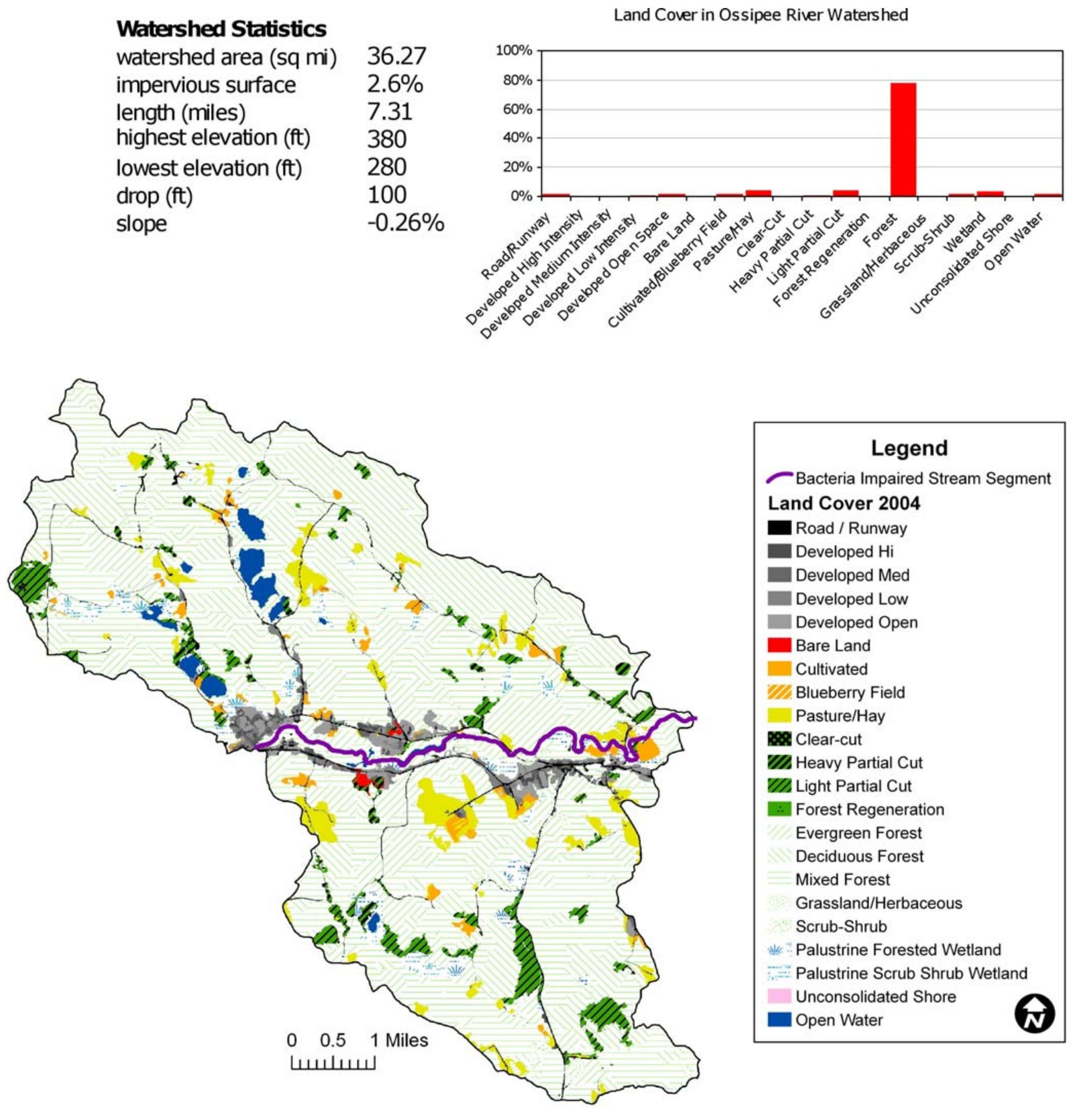


Figure 69: Ossipee River watershed land cover map and statistics.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer, if present, are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is also a significant part of the watershed (5.7%), and much of those lands are near the river. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Oxford County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

8.3 Saco River (Fryeburg)

The Saco River (Segment ID 618R01) is located in the town of Fryeburg in the Saco River Watershed. (Figures 70 and 71). The listed segment length for this section of the Saco River is 3.8 miles and its total listed watershed area is 24.1 square miles. Potential sources of bacteria impairment are listed as unspecified non-point source pollution.

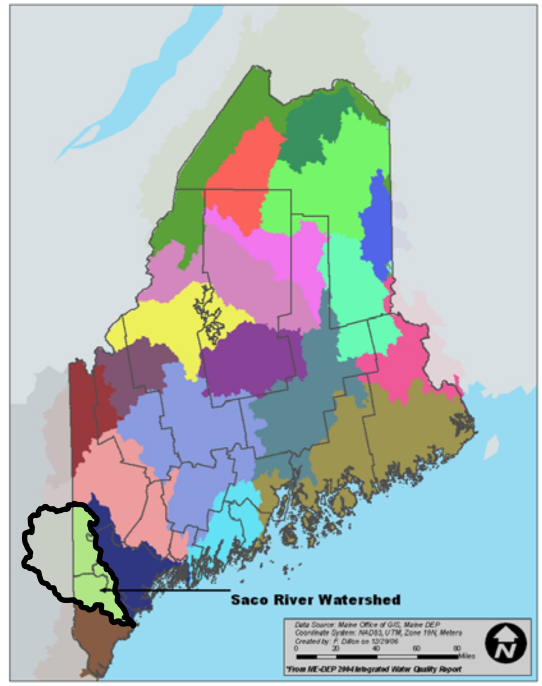


Figure 70: Saco River Watershed.

8.3.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 19. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for “bacteria-only” impairment in the Saco River Watershed as specified in Maine’s 2004 305(b) report. The bacteria standard for the Saco River, which is a Class AA and A water body, is “as naturally occurs.” The next most stringent standard, for class B waters, is more quantitative at 236 MPN/100mL of sample for instantaneous samples and 64 MPN/100mL of sample for the geometric mean.

Bacteria concentrations in the Saco River were not observed to exceed the instantaneous standard in any of the 6 surveys conducted throughout the 2007 sampling period. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. Bacteria concentrations in the Saco River met the geometric mean standard for the entire sampling period.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results and the separate storm and dry weather events were below (i.e., in compliance with) the water quality standards; therefore the % reduction calculation does not apply. However, it is important to note that a series of samples collected over a single sampling period may not adequately characterize the nature and extent of potential bacteria contamination in a given watershed. Even though the 2007 bacteria data for the Saco River indicate compliance with state standards, future (or prior) monitoring results may indicate otherwise. Therefore, ongoing monitoring may be advisable for streams with suspected bacteria contamination issues. Since at least 2001, the Saco River Corridor Commission has also been collecting bacteria samples at several locations along the Saco River (one fairly close to the impaired segment) and their results indicate a potential cause for concern.

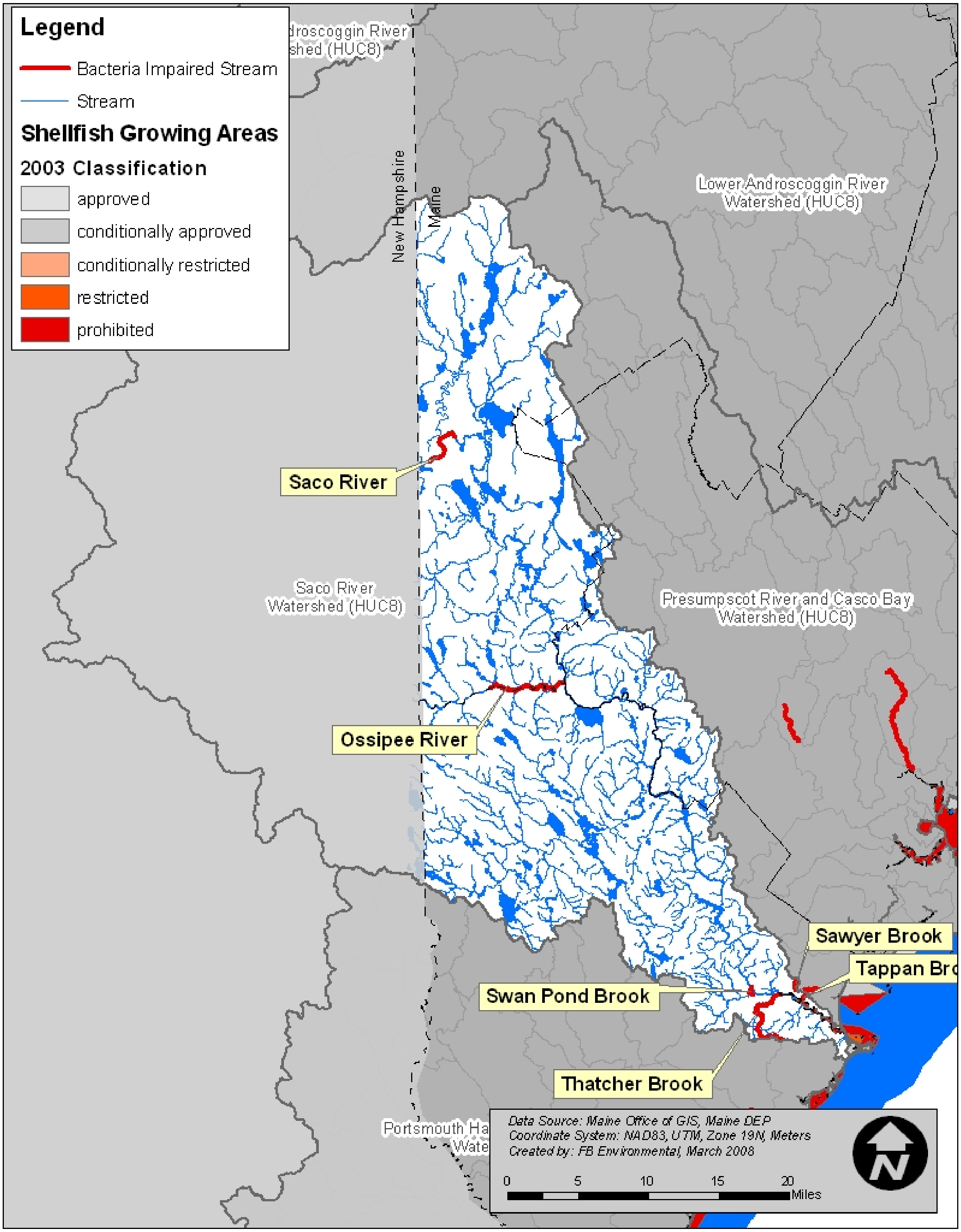


Figure 71: Saco River Watershed with the impaired waterways indicated.

Table 19: Bacteria data summary for a section of the Saco River, with wet and dry weather assessment.

Saco - Fryeburg	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	12:40	Overcast	0.33	0.00	0.00	0.00	0.00	y	12	5		Storm sample
16-May-07	TB	9:50	Rain	0.71	0.04	0.00	0.00	0.00	y	13	11		
7-Jun-07	TB	12:15	Clear	0.00	0.00	0.12	2.12	0.52	y	14	33		Conclude sampling for this site per Melissa Evers
									Storm Results:	Max:	33	na	% reduction calculation results in negative number
										Geomean:	12	na	% reduction calculation results in negative number
Dry Weather Samples													
9-May-07	TB	11:10	Clear	0.00	0.00	0.00	0.00	0.00	n	13	5		SRCC samples taken at same location
23-May-07	TB	13:45	Overcast	0.00	0.00	0.00	0.08	0.06	n	13	4		
31-May-07	TB	10:45	Lt rain	0.01	0.01	0.00	0.28	0.00	n	16	11		
									Dry Results:	Max:	11	na	% reduction calculation results in negative number
										Geomean:	6	na	% reduction calculation results in negative number
									Overall Results:	Max:	33	na	% reduction calculation results in negative number
										Geomean:	9	na	% reduction calculation results in negative number

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

8.3.B Watershed Characterization

The aerial photo (figure 72) shows the Saco River as it passes through Fryeburg. This segment of the Saco River watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (figure 73). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 4.69 square miles, and impervious surfaces are estimated to total 3.7% of this area. Stream gradient is very low with a slope over the segment length of about 0.1%.

Forest makes up a slight majority of the watershed at 54.6%, with wetlands adding 7.2%. Agriculture, however, lines one entire side of the river, and makes up 32.5% of the watershed area. Developed areas are present at 5.1%.

8.3.C Recommended Mitigation Strategies

Despite the fact that the Saco River met state bacteria standards during the 2007 sampling period, it is still important to consider potential bacteria mitigation strategies should problems arise in the future. Developed areas (5.1%) and impervious surfaces (3.7%) are present in this section of the Saco River watershed. The location of development is approximately half a mile from the river, however, which may mitigate the risk of bacterial contamination from developed sources. Nonetheless, it is possible that a few wastewater systems may be malfunctioning. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since this section of the Saco River watershed is contains extensive forests (approximately 55% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is clearly a significant part of the watershed (32.5%), and much of these lands lie very near or directly abut the river. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The Oxford County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

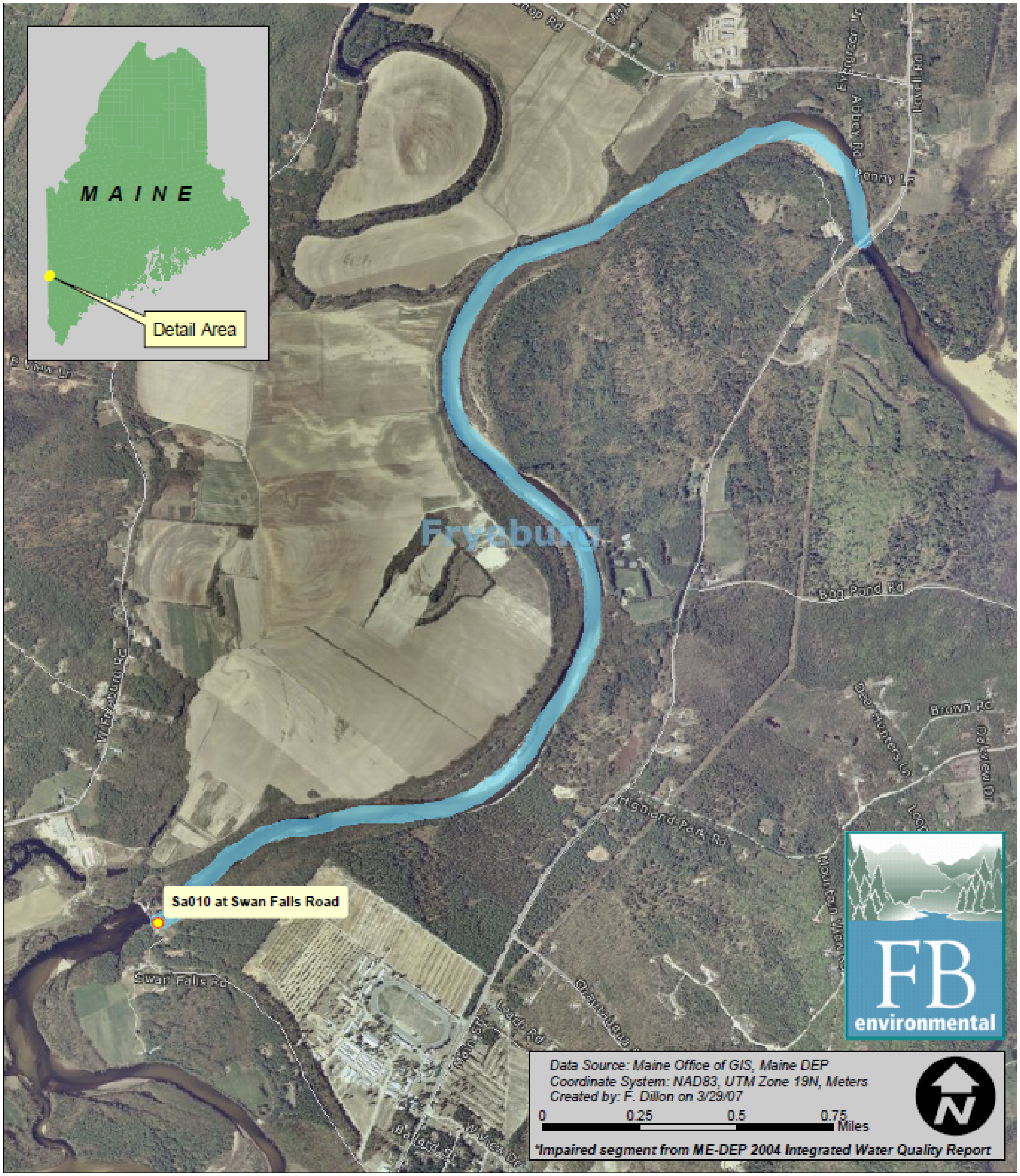
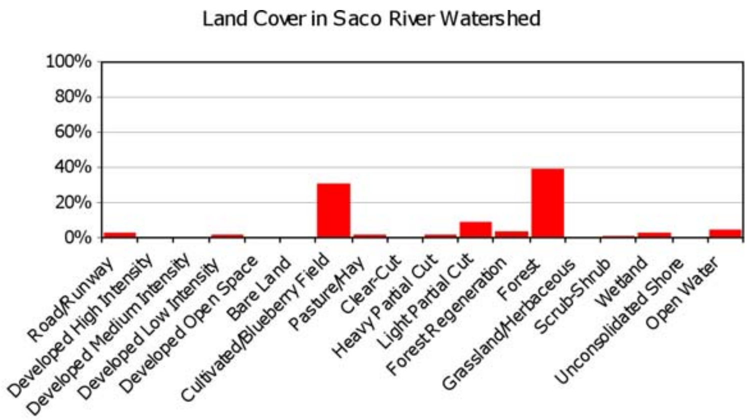


Figure 72: Aerial photograph of Saco River and surrounding area.

Watershed Statistics

watershed area (sq mi)	4.69
impervious surface	3.7%
length (miles)	3.77
highest elevation (ft)	400
lowest elevation (ft)	380
drop (ft)	20
slope	-0.10%



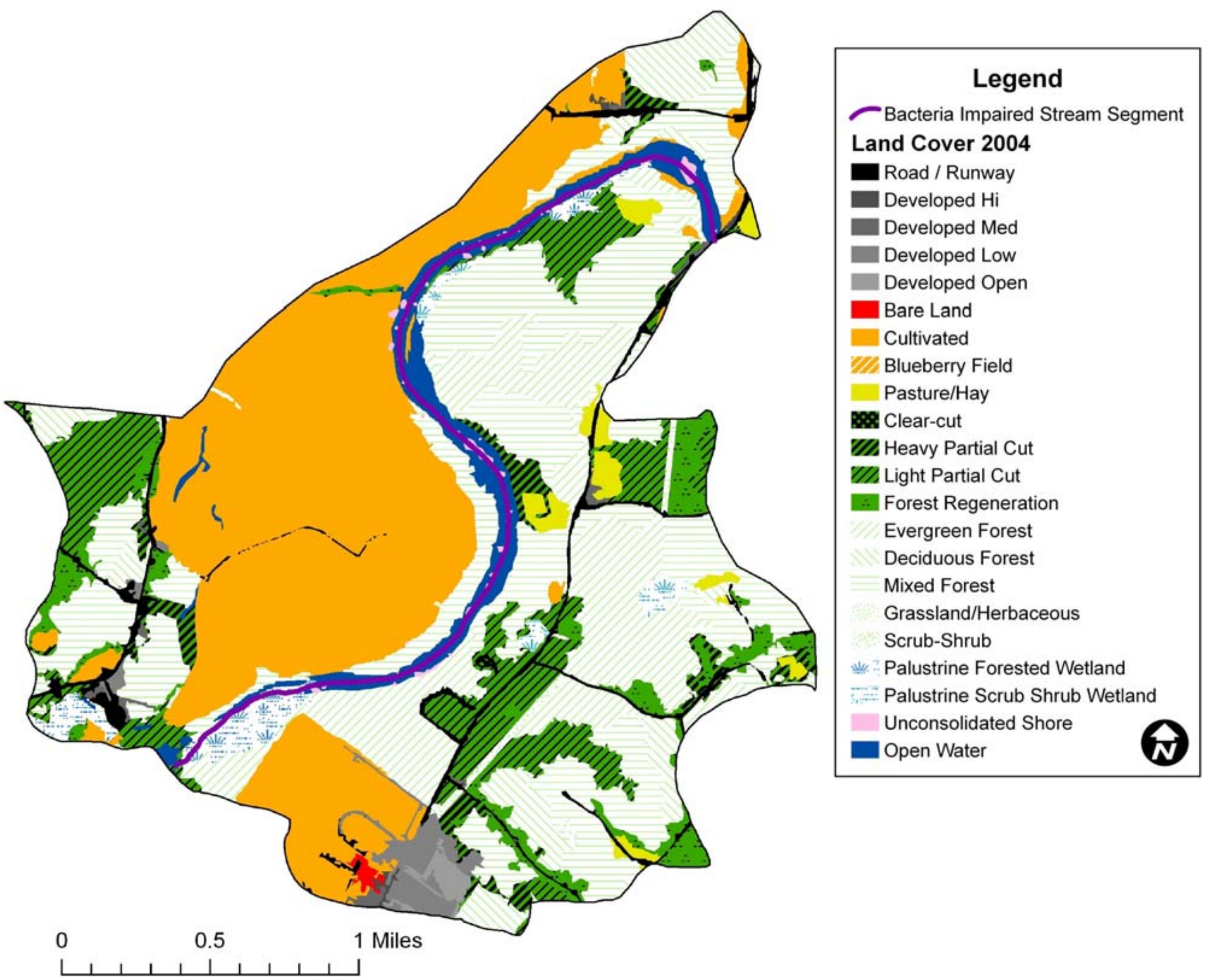


Figure 73: Saco River watershed land cover map and statistics.

8.4 Sawyer Brook (Saco)

Sawyer Brook (Segment ID 616R03) is located in the town of Saco in the Saco River Watershed. (Figures 74 and 75). The listed segment length for Sawyer Brook is 0.7 miles and its total listed watershed area is 53 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution.

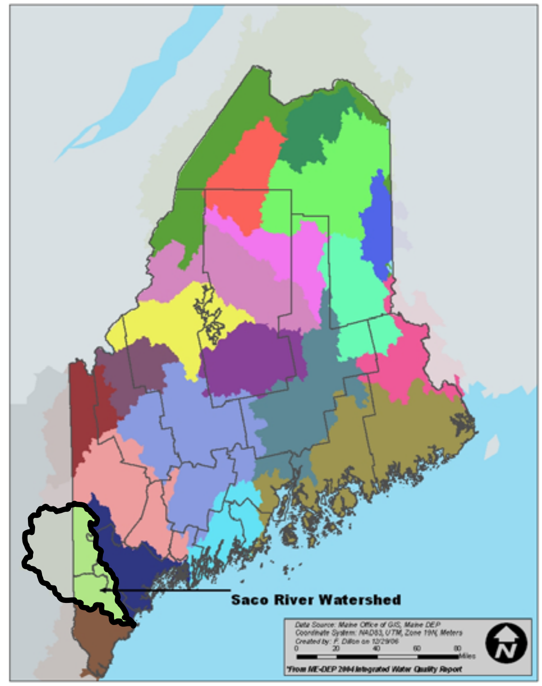


Figure 74: Saco River Watershed.

8.4.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 20. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for "bacteria-only" impairment in the Saco River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Sawyer Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Sawyer Brook were observed to exceed the instantaneous standard in 3 of 6 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 308 MPN/100mL on May 11th, 548 MPN/100mL on May 16th, and 1203 MPN/100mL on May 31st. Bacteria concentrations in Sawyer Brook did not meet the geometric mean standard for the overall sampling period, at 285 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions, although with merely three samples in the wet weather dataset and three samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition. Since 2001, the Saco River Corridor Commission has also been collecting bacteria samples at locations along Sawyer Brook (though none are located within the impaired segment) and their results generally indicate a cause for concern due to noncompliance with state standards.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results for the 2007 sampling season indicates a reduction of 77.6% is needed to meet the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 78.3% and 76.9%, respectively. The bacteria concentration reduction needed to attain the instantaneous water quality standard was 80.4% for the overall and dry weather event results and 56.9% for storm sample results, based on the maxima for each respective category.

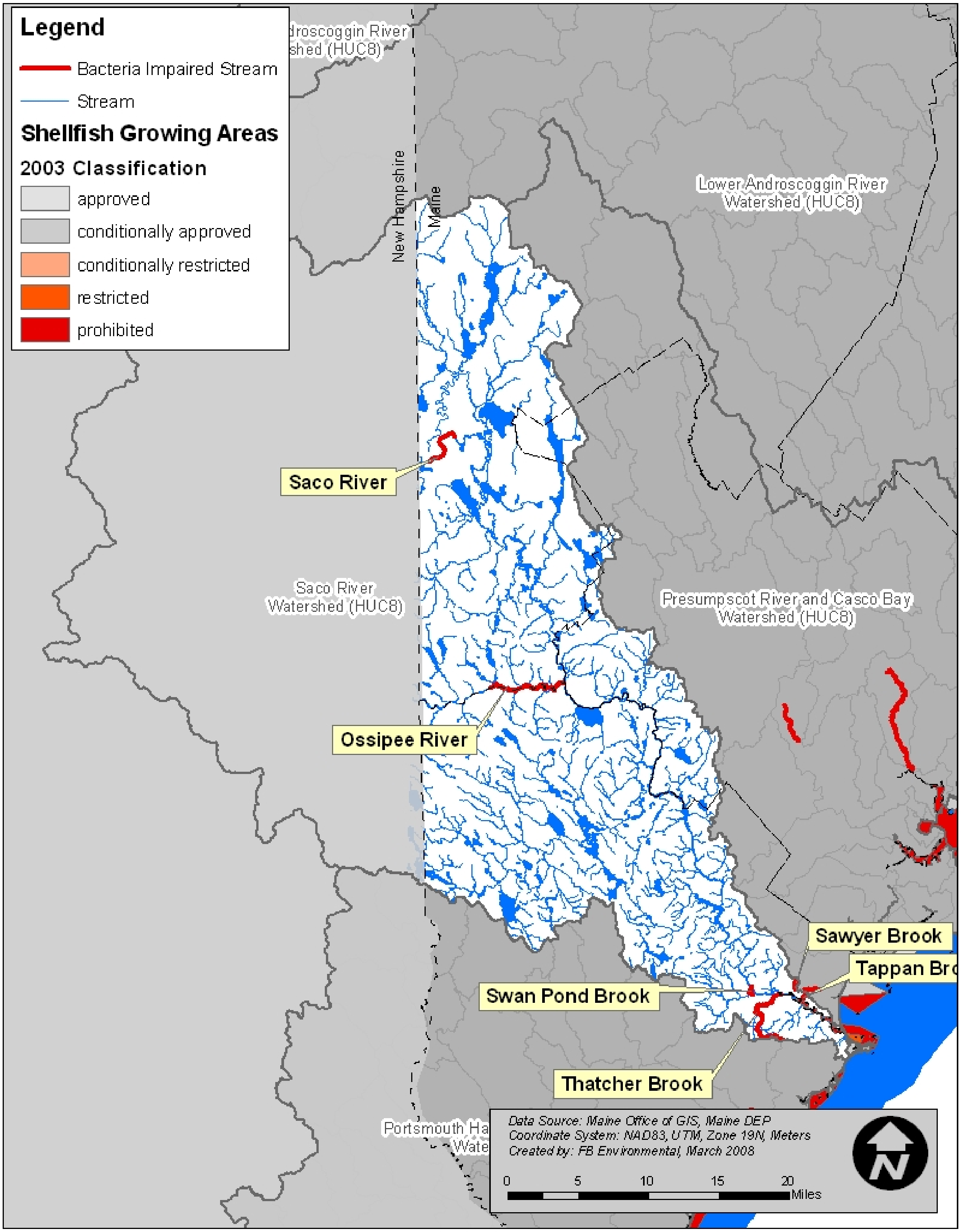


Figure 75: Saco River Watershed with the impaired waterways indicated.

Table 20: Bacteria data summary for Sawyer Brook, with wet and dry weather assessment.

Sawyer - Saco	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	15:22	Overcast	0.33	0.00	0.00	0.00	0.00	y	16	**308**		Storm sample
16-May-07	TB	14:50	Rain	0.71	0.04	0.00	0.00	0.00	y	11	**548**		
7-Jun-07	TB	9:15	Clear	0.00	0.00	0.12	2.12	0.52	y	11	152		Conclude sampling for this site per Melissa Evers
								Storm Results:		Max:	**548**	56.9%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**294**	78.3%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	FD	12:05	Clear	0.00	0.00	0.00	0.00	0.00	n	15	142		Sampled on downstream side of and directly from culvert.
23-May-07	TB	11:10	Overcast	0.00	0.00	0.00	0.08	0.06	n	11	124		
31-May-07	TB	14:05	Lt rain	0.01	0.01	0.00	0.28	0.00	n	14	**1203**		
								Dry Results:		Max:	**1203**	80.4%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**276**	76.9%	% reduction for geomean WQS (64 col/100 mL)
								Overall Results:		Max:	**1203**	80.4%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**285**	77.6%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

8.4.B Watershed Characterization

The aerial photo (figure 76) shows Sawyer Brook as it passes through the City of Saco. The Sawyer Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (Figure 77). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 0.35 square miles, and impervious surfaces are estimated to total 25.2% of this area. Stream gradient is moderate with a slope over the segment length of about 1.07%.

Developed land dominants the watershed at 79.7%of watershed area. Development directly abuts the entire length of the stream. Forest makes up the remaining 20.3%, and is located entirely above the headwaters.

8.4.C Recommended Mitigation Strategies

Developed areas (about 80%) and impervious surfaces (25.2%) are dominant in the Sawyer Brook watershed. The nature and location of the development crowds the lower reaches of the river. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since the watershed also contains some forest, (approximately 20% of area), wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river, although that contribution would be expected to be relatively minimal.

Figure 76: Aerial photograph of Sawyer Brook and surrounding area.

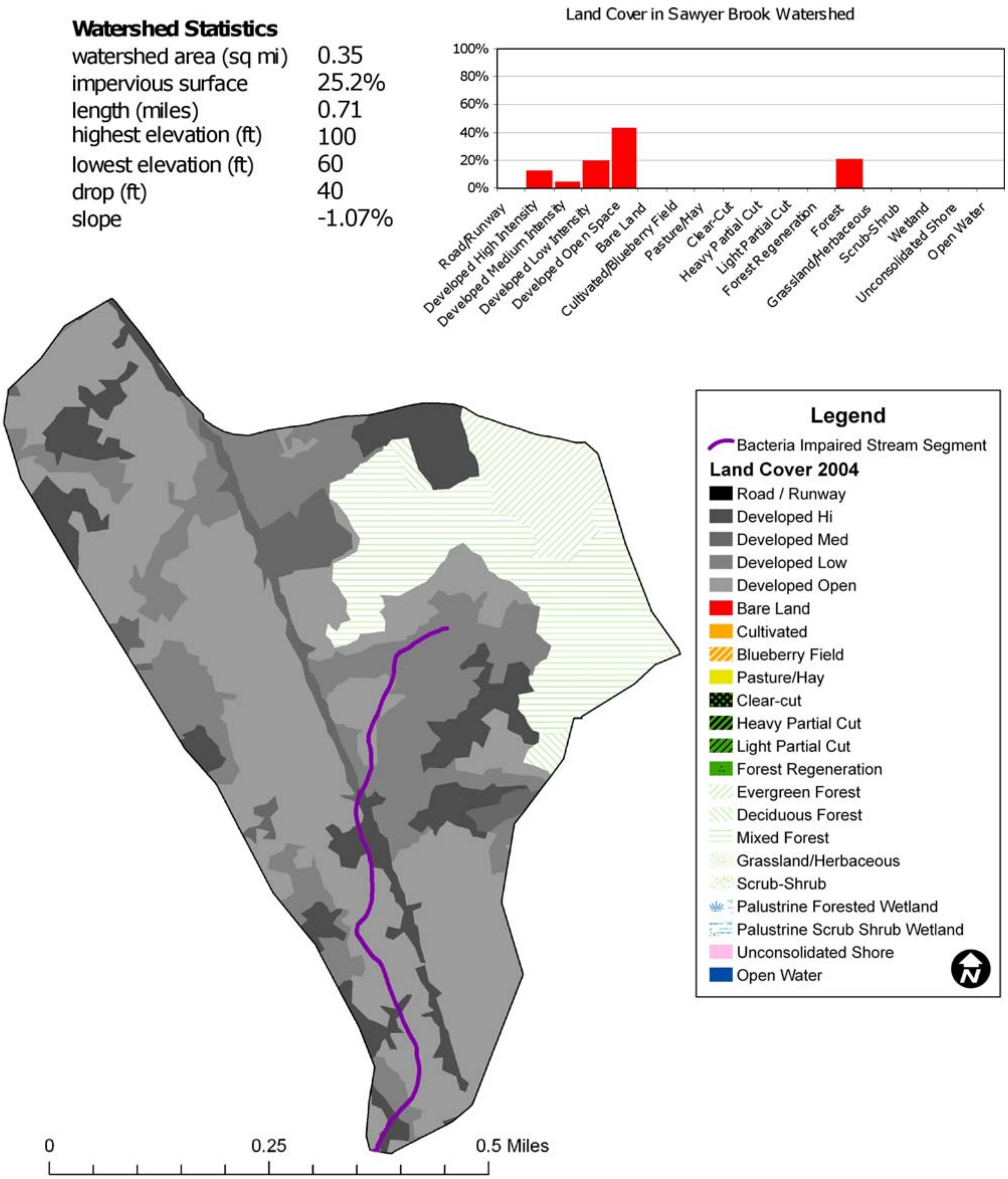


Figure 77: Sawyer Brook watershed land cover map and statistics.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples at several locations along the stream could reveal where impairment is greatest, which can help focus mitigation efforts more closely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

8.5 Swan Pond Brook (Biddeford)

Swan Pond Brook (Segment ID 616R06) is located in the town of Biddeford in the Saco River Watershed. (Figures 78 and 79). The listed segment length for Swan Pond Brook is 1.0 miles and its total listed watershed area is 53 square miles. Potential sources of bacteria impairment are listed as non-point source pollution.

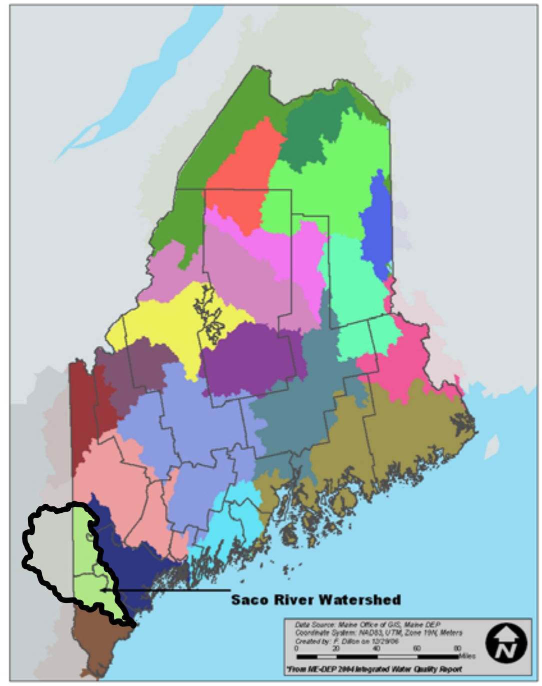


Figure 78: Saco River Watershed.

8.5.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 21. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for "bacteria-only" impairment in the Saco River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Swan Pond Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Swan Pond Brook were observed to exceed the instantaneous standard in 3 of 16 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 692 MPN/100mL on May 16th, 249 MPN/100mL on July 6th, and 649 MPN/100mL on July 9th. Bacteria concentrations in Swan Pond Brook did not meet the geometric mean standard for the overall sampling period, at 140 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions at 278 MPN/100mL for storm sample results and 92 MPN/100mL for dry weather results. Since 2001, the Saco River Corridor Commission has also been collecting bacteria samples at three locations along the Ossipee River (though none are located within the impaired segment) and their results indicate a cause for concern / compliance with state standards.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

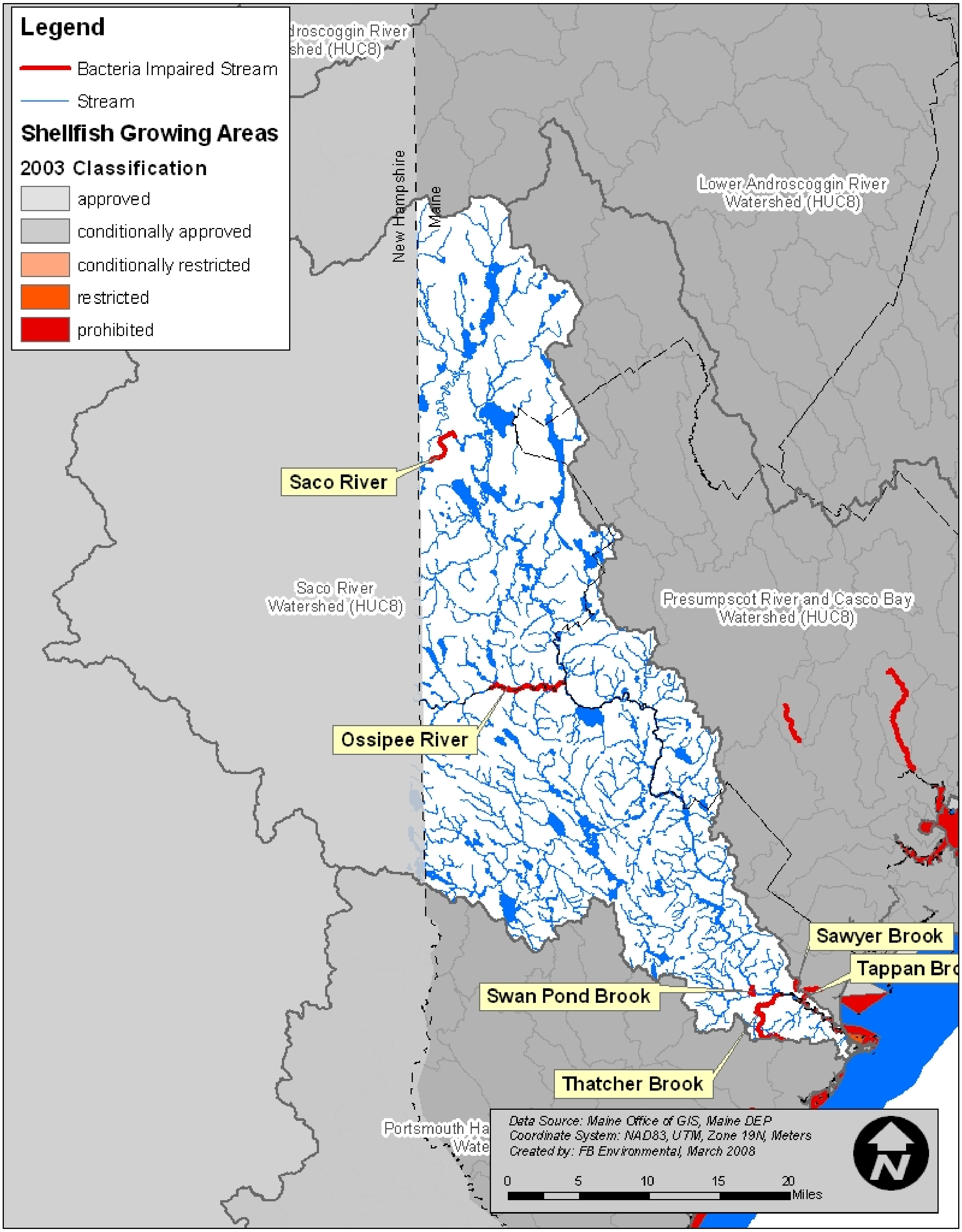


Figure 79: Saco River Watershed with the impaired waterways indicated.

The geometric mean for the overall results was above (i.e. not in compliance with) the water quality standard with a 54.2% needed reduction in order to comply. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 77.0% and 30.7%, respectively (Table 21). The bacteria concentration reduction needed to attain the instantaneous water quality standard were 65.9% for both the overall and storm event results and not indicated for the dry weather results as they are below the standard.

Table 21: Bacteria data summary for Swan Pond Brook, with wet and dry weather assessment.

Swan Pond - Biddeford	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	15:00	Overcast	0.33	0.00	0.00	0.00	0.00	y	18	140		Storm sample
16-May-07	TB	14:30	Rain	0.71	0.04	0.00	0.00	0.00	y	14	**692**		Collected field duplicate: results = 770.1 and 613.1 MPN.
7-Jun-07	TB	10:45	Clear	0.00	0.00	0.12	2.12	0.52	y	15	185		
6-Jul-07	TB	10:15	Clear	0.10	0.25	0.12	0.00	0.00	y	19	**249**		
9-Jul-07	TB	12:15	Lt rain	1.13	0.25	0.27	0.10	0.25	y	17	**649**		
10-Aug-07	TB	12:30	Ptly cldy	0.00	0.00	0.57	0.00	2.29	y	19	162		
									Storm Results:	Max:	**692**	65.9%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**278**	77.0%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	FD	11:20	Clear	0.00	0.00	0.00	0.00	0.00	n	15	84		SRCC sample taken at same location. Sampled on downstream side of bridge; still evidence of high flows from Patriot's Day Nor'easter.
23-May-07	TB	10:45	Overcast	0.00	0.00	0.00	0.08	0.06	n	13	33		
31-May-07	TB	13:45	Lt rain	0.01	0.01	0.00	0.28	0.00	n	17	26		
13-Jun-07	TB	13:25	Lt rain	0.10	0.00	0.00	0.00	0.00	n	17	62		
21-Jun-07	TB	13:20	-	0.00	0.00	0.00	0.00	0.00	n	-	173		
29-Jun-07	TB	13:20	Clear	0.00	0.00	0.00	0.00	0.05	n	23	214		
30-Jul-07	TB	11:50	Clear	0.00	0.00	0.15	0.00	0.00	n	24	219		
20-Aug-07	TB	12:20	Clear	0.00	0.00	0.04	0.00	0.22	n	18	167		
4-Sep-07	TB	14:40	Clear	0.00	0.00	0.00	0.00	0.00	n	20	44		
17-Sep-07	TB	13:20	Clear	0.00	0.00	0.13	0.00	0.00	n	14	166		Final sample of project.
									Dry Results:	Max:	219	na	% reduction calculation results in negative number
										Geomean:	**92**	30.7%	% reduction for geomean WQS (64 col/100 mL)
									Overall Results:	Max:	**692**	65.9%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**140**	54.2%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

8.5.B Watershed Characterization

The aerial photo (figure 80) shows Swan Pond Brook as it passes through a rural portion of the City of Biddeford to its confluence with the Saco River. The Swan Pond Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (figure 81). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 0.26 square miles, and impervious surfaces are estimated to total 5.6% of this area. Stream gradient is extremely slight with a slope over the segment length of about 0%.

Agriculture is the largest land use category at 49.1%, and some of these areas are directly adjacent to the stream. Developed areas make up 6.1% of the watershed. Forest at 35.8%, wetland at 6%, and grass / scrub at 3% make up the rest of the land area.

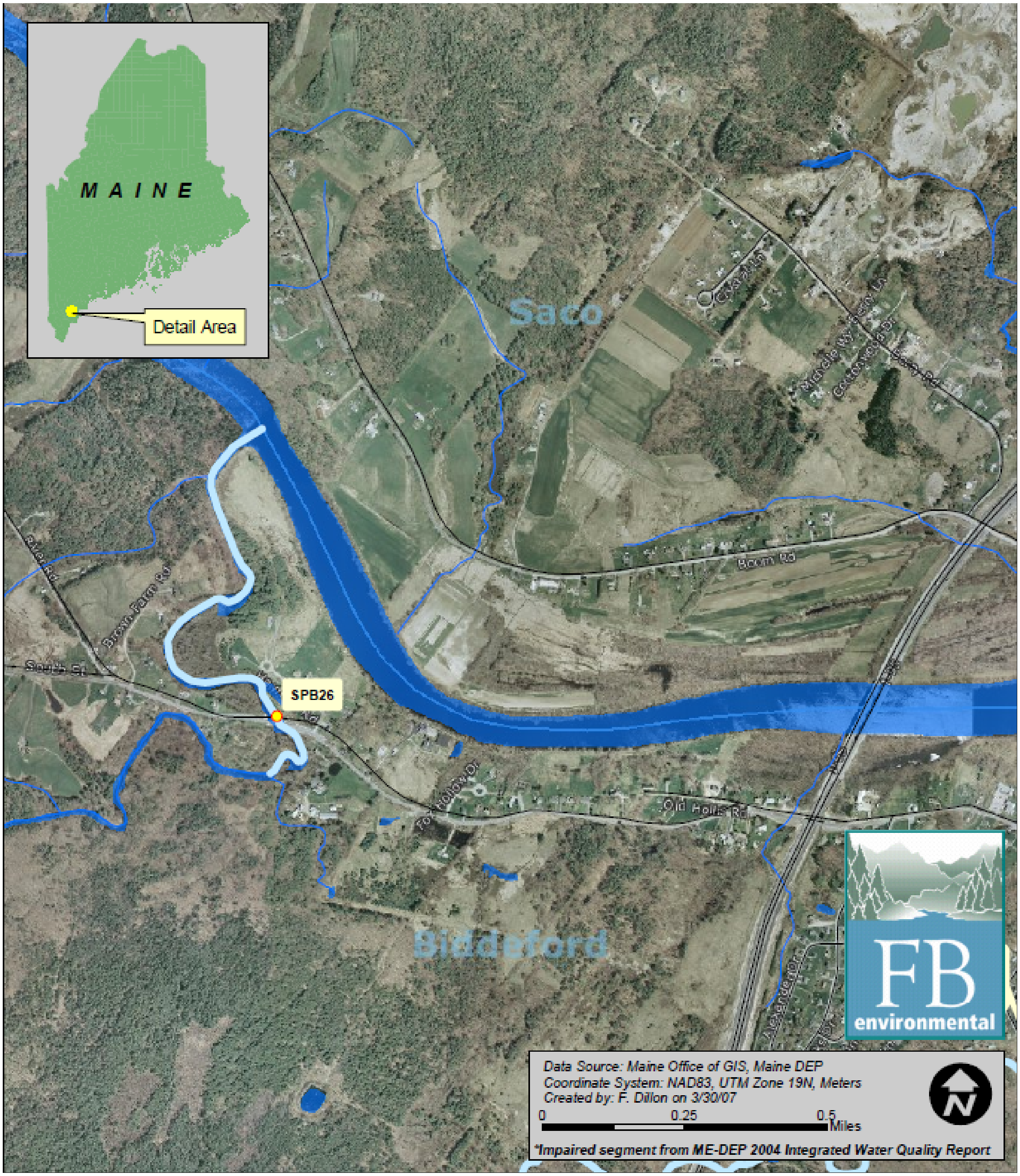


Figure 80: Aerial photograph of Swan Pond Brook and surrounding area.

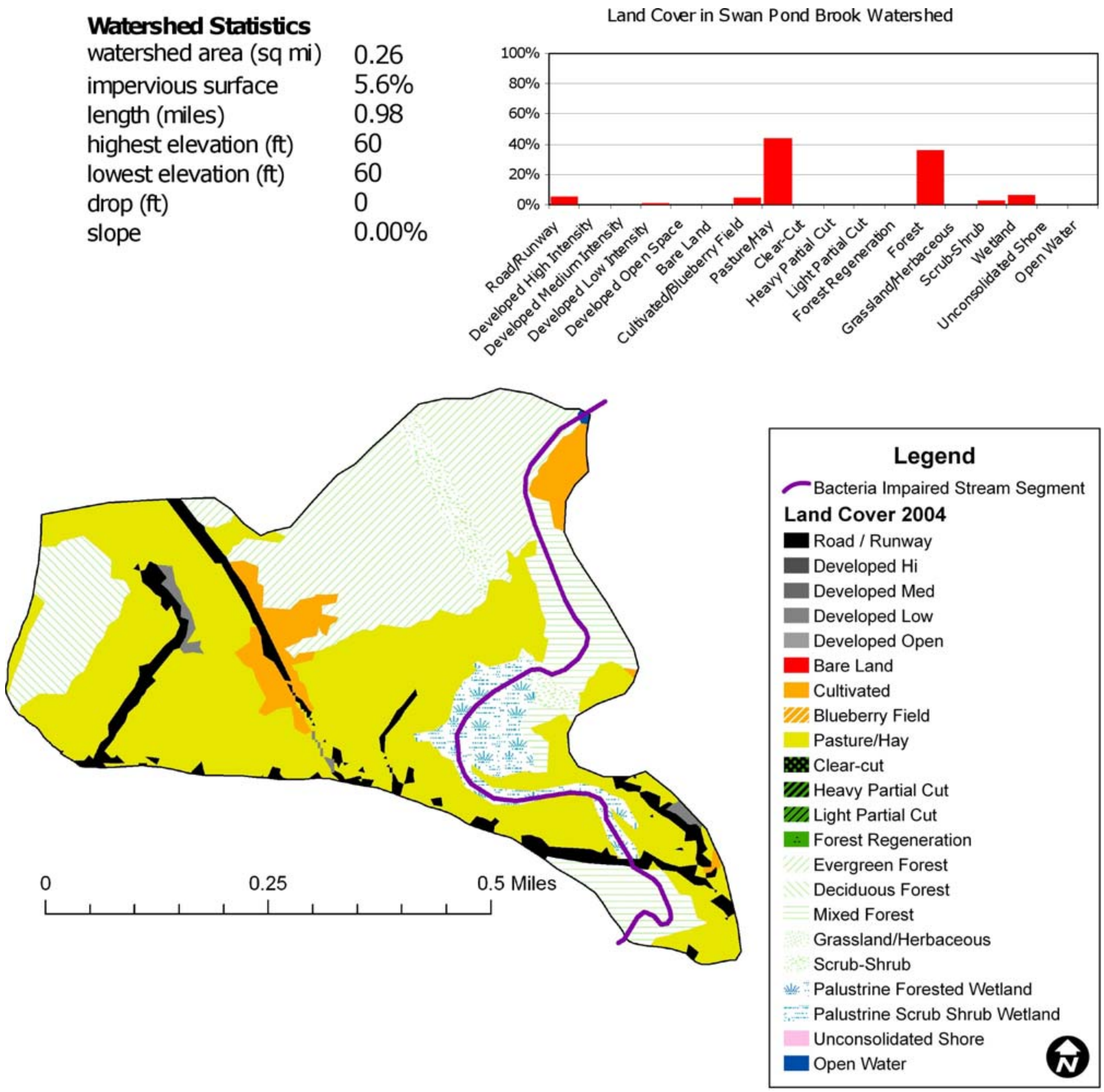


Figure 81: Swan Pond Brook watershed land cover map and statistics.

<u>8.5.C Recommended Mitigation Strategies</u>

Developed areas (6.1%) and impervious surfaces (5.6%) are present in the Swan Pond Brook watershed, although most of the impervious areas appear to be roads, and development is not adjacent to the brook. Agriculture is clearly a major part of the watershed (about 49%), and its location near the upper reaches of the brook represents a risk of impairment. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The York County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

It is possible that a few wastewater systems in the area may be malfunctioning. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since the watershed contains significant forests and wetlands (approximately 42% of area), and these areas abut the lower portions of the watershed, wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the agricultural areas could reveal where impairment is greatest, which can also help suggest which sources (agricultural or wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

8.6 Tappan Brook (Saco)

Tappan Brook (Segment ID 616R03) is located in the town of Saco in the Saco River Watershed. (Figures 82 and 83). The listed segment length for Tappan Brook is 0.4 miles and its total listed watershed area is 53 square miles. Potential sources of bacteria impairment are listed as non-point source pollution.

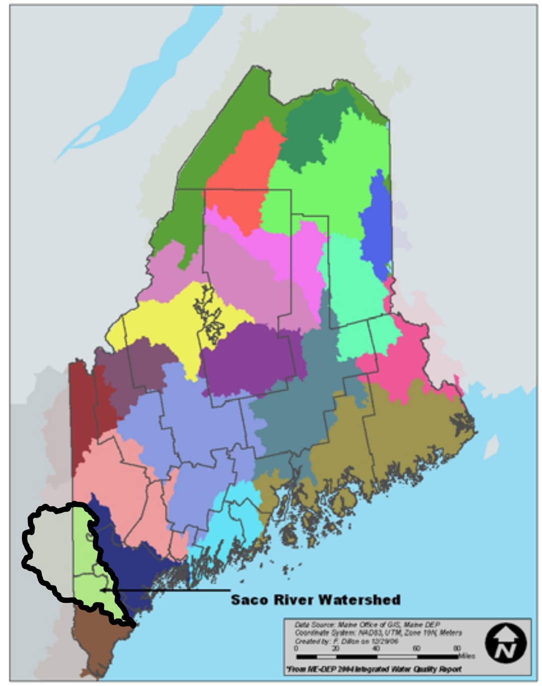


Figure 82: Saco River Watershed

8.6.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 22. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for "bacteria-only" impairment in the Saco River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Tappan Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Tappan Brook were observed to exceed the instantaneous standard in 1 of 6 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 1,553 MPN/100mL on June 7th. Bacteria concentrations in Tappan Brook did not meet the geometric mean standard for the entire sampling period, at 126 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded during the storm events and met during dry weather sampling events, although with merely three samples in the wet weather dataset and three samples in the dry weather dataset, these geometric means may contain too few samples to prove adequately representative of either condition. Since 2001, the Saco River Corridor Commission has also been collecting bacteria samples at locations along the Ossipee River (though none are located within the impaired segment) and their results generally indicate a cause for concern / compliance with state standards.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

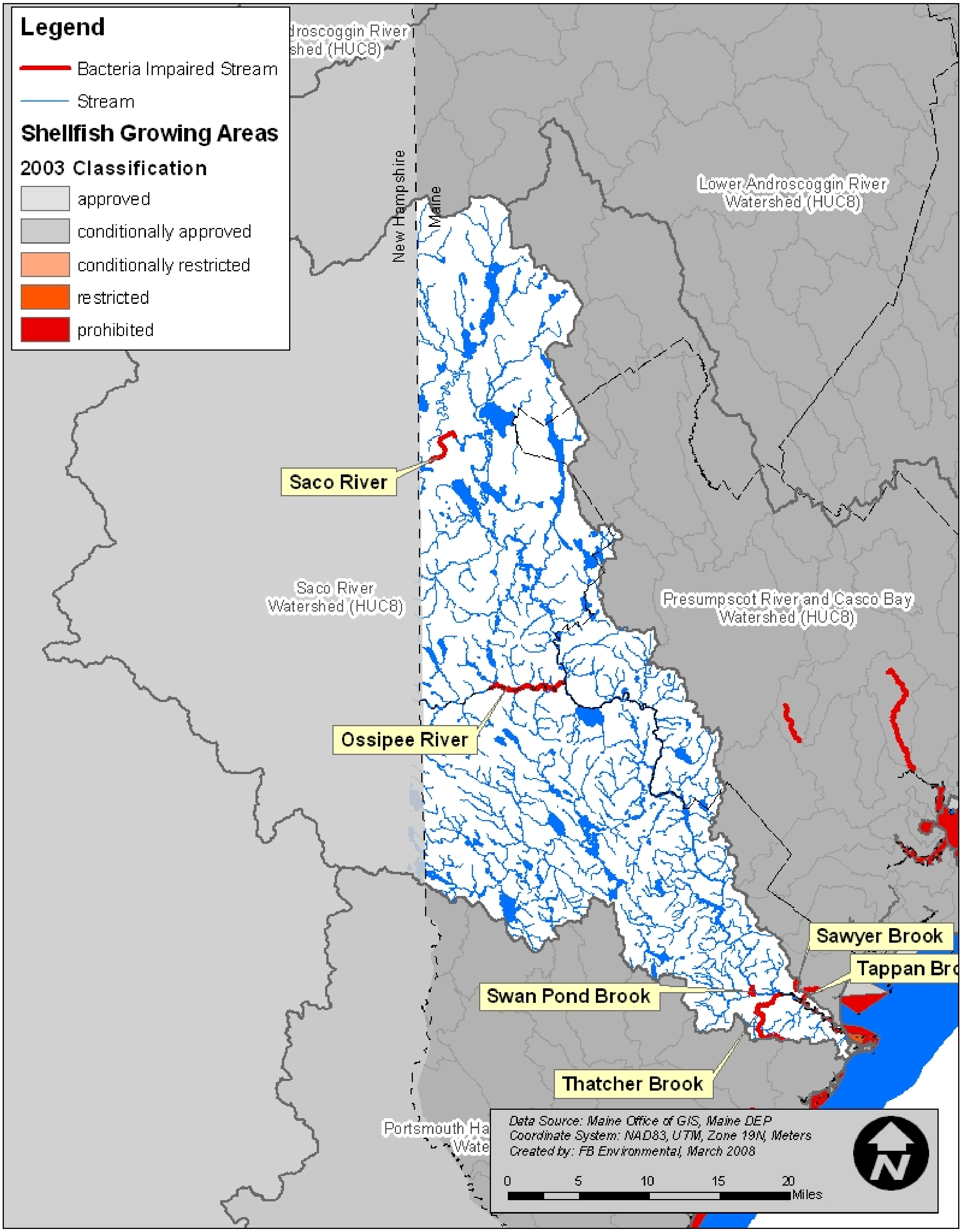


Figure 83: Saco River Watershed with the impaired waterways indicated.

The geometric mean for the overall results was above (i.e. not in compliance with) the water quality standard. For storm samples the % reductions required to comply with the geometric mean standard is 77.7%. Bacteria concentration reductions needed to attain the instantaneous water quality standard were 84.8% for both the overall and storm event results and non-existent for the dry weather results as they are below the standard.

Table 22: Bacteria data summary for Tappan Brook, with wet and dry weather assessment.

Tappan - Saco	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	15:30	Overcast	0.33	0.00	0.00	0.00	0.00	y	17	173		Storm sample
16-May-07	TB	15:00	Rain	0.71	0.04	0.00	0.00	0.00	y	11	88		
7-Jun-07	TB	9:25	Clear	0.00	0.00	0.12	2.12	0.52	y	11	**1553**		Conclude sampling for this site per Melissa Evers
								Storm Results:		Max:	**1553**	84.8%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**287**	77.7%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	FD	12:20	Clear	0.00	0.00	0.00	0.00	0.00	n	16	50		Sampled on downstream side of culvert.
23-May-07	TB	11:20	Overcast	0.00	0.00	0.00	0.08	0.06	n	12	20		
31-May-07	TB	14:15	Lt rain	0.01	0.01	0.00	0.28	0.00	n	15	172		
								Dry Results:		Max:	172	na	% reduction calculation results in negative number
										Geomean:	55	na	% reduction calculation results in negative number
								Overall Results:		Max:	**1553**	84.8%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**126**	49.2%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

8.6.B Watershed Characterization

The aerial photo (figure 84) shows Tappan Brook as it passes through the City of Saco. The Tappan Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (figure 85). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated a very compact 0.17 square miles, and impervious surfaces are estimated to total 22.9% of this area. Stream gradient is high with a slope of about 3.24%.

Development is clearly the dominant land use at 77.2%, with almost the entire length of the brook flanked by this land use. Agriculture adds 6.1%, but is not adjacent to the river. Forest is present at 15%, with wetlands and grass / scrub making up about 1.2% and 0.4%, respectively.

8.6.C Recommended Mitigation Strategies

Developed areas (77.2%) and impervious surfaces (22.0%) are heavily present in the Tappan Brook watershed, and they abut most of the brook's length. It is possible that a few wastewater systems serving aging structures in the area are malfunctioning. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since forest and wetlands are also present (approximately 15% of area), including a small section at the lower reaches of the brook, wildlife inhabiting these areas also could conceivably contribute fecal contamination to the river.

Figure 84: Aerial photograph of Tappan Brook and surrounding area.

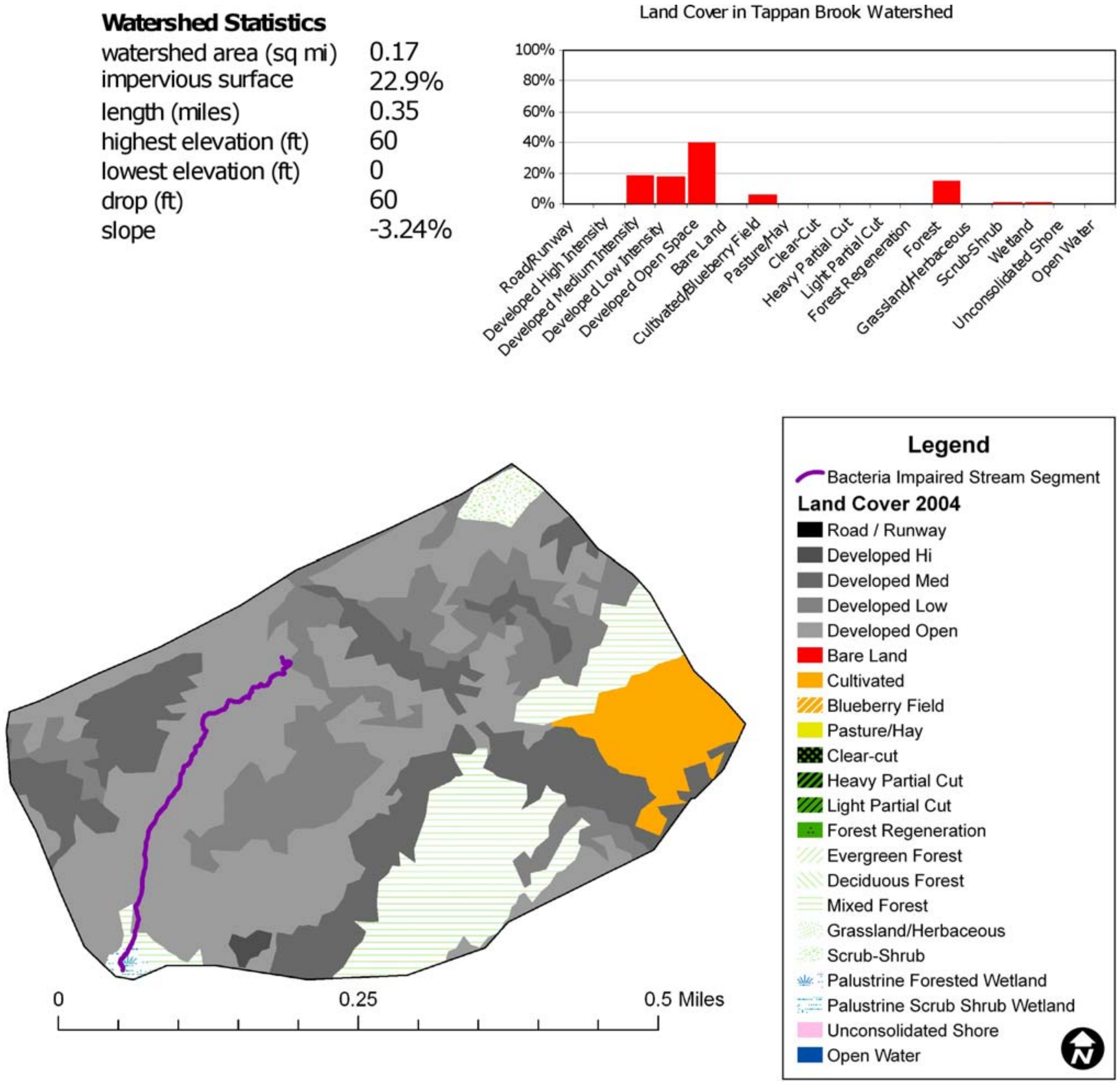


Figure 85: Tappan Brook watershed land cover map and statistics.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometime stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is a small part of the watershed (6.1%), and is located at the edge of the watershed about 0.2 miles from the stream. While this potential source of bacteria may appear a much smaller risk, it may still be considered. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The York County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

8.7 Thatcher Brook (Biddeford)

Thatcher Brook (Segment ID 616R05) is located in the town of Biddeford in the Saco River Watershed. (Figures 86 and 87). The listed segment length for Thatcher Brook is 8 miles and its total listed watershed area is 53 square miles. Potential sources of bacteria impairment are listed as urban non-point source pollution and combined sewer overflow.

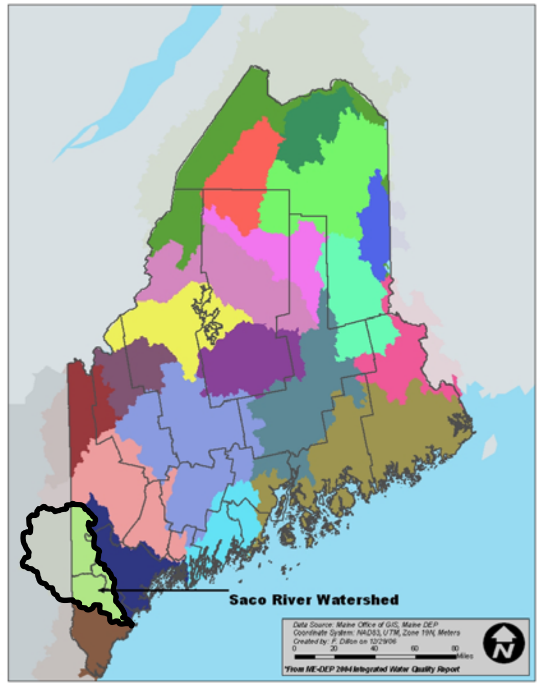


Figure 86: Saco River Watershed.

8.7.A Bacteria Data Summary & Percent Reduction Calculations

Bacteria data for the Saco River Watershed were collected by FB Environmental staff in the spring of 2007 and are presented in Table 23. Six stream segments: Bear Brook, Ossipee River, Saco River, Sawyer Brook, Swan Pond Brook, Tappan Brook, and Thatcher Brook were listed for "bacteria-only" impairment in the Saco River Watershed as specified in Maine's 2004 305(b) report. The instantaneous bacteria standard for Thatcher Brook, which is a Class B stream, is 236 MPN/100mL of sample while the geometric mean standard is 64 MPN/100mL of sample.

Bacteria concentrations in Thatcher Brook were observed to exceed the instantaneous standard in 5 of 15 surveys conducted throughout the 2007 sampling period, with bacteria concentrations of 548 MPN/100mL on May 11th, 1120 MPN/100mL on May 16th, 348 MPN/100mL on July 6th, 328 MPN/100mL on July 9th, and 411 MPN/100mL on July 30th . Bacteria concentrations in Thatcher Brook did not meet the geometric mean standard for the sampling period, at 199 MPN/100mL. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, the geometric mean standard was exceeded for both categories of conditions. Since 2001, the Saco River Corridor Commission has also been collecting bacteria samples at locations along Thatcher Brook (though none are located within the impaired segment) and their results generally indicate a cause for concern / compliance with state standards.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

The geometric mean for the overall results was above (i.e. not in compliance with) the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 81.0% and 54.2%, respectively . Bacteria concentration reductions needed to attain the instantaneous water quality standard were 78.9% for both the overall and storm event results and 42.5% for the dry weather results.

The geometric mean for the overall results for the 2007 sampling season indicates a reduction of 67.8% is needed to meet the water quality standard. For storm and dry weather samples, the % reductions required to comply with the geometric mean standards are 81% and 54.2%, respectively . The bacteria concentration reduction needed to attain the instantaneous water quality standard was 78.9% for the overall and dry weather event results and 42.5% for storm sample results, based on the maxima for each respective category.

Table 23: Bacteria data summary for Thatcher Brook, with wet and dry weather assessment.

Thatcher - Biddeford	Sampler	Sample Time	Current Weather	Precip* on sampling day	Precip 1 day prior	Precip 2 days prior	Precip 3 days prior	Precip 4 days prior	Storm Sample?	Water temp	*E. coli* (MPN)**	% Reduction to Meet WQS	Comments***
Storm Samples													
11-May-07	TB	15:10	Overcast	0.33	0.00	0.00	0.00	0.00	y	17	**548**		Storm sample
16-May-07	TB	14:40	Rain	0.71	0.04	0.00	0.00	0.00	y	14	**1120**		
7-Jun-07	TB	10:50	Clear	0.00	0.00	0.12	2.12	0.52	y	15	142		
6-Jul-07	TB	10:15	Clear	0.10	0.25	0.12	0.00	0.00	y	18	**348**		Duplicates: sample 1 = 387.3; sample 2 = 307.6
9-Jul-07	TB	12:25	Lt rain	1.13	0.25	0.27	0.10	0.25	y	18	**328**		
10-Aug-07	TB	12:20	Ptly cldy	0.00	0.00	0.57	0.00	2.29	y	20	148		
								Storm Results:		Max:	**1120**	78.9%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**337**	81.0%	% reduction for geomean WQS (64 col/100 mL)
Dry Weather Samples													
9-May-07	FD	11:40	Clear	0.00	0.00	0.00	0.00	0.00	n	17	70		SRCC sample taken at same location. Sampled on upstream side of bridge.
23-May-07	TB	11:00	Overcast	0.00	0.00	0.00	0.08	0.06	n	13	70		
31-May-07	TB	13:50	Lt rain	0.01	0.01	0.00	0.28	0.00	n	17	166		
13-Jun-07	TB	13:30	Lt rain	0.10	0.00	0.00	0.00	0.00	n	-	140		
21-Jun-07	TB	13:30	-	0.00	0.00	0.00	0.00	0.00	n	-	127		
29-Jun-07	TB	13:25	Clear	0.00	0.00	0.00	0.00	0.05	n	21	166		
30-Jul-07	TB	12:00	Clear	0.00	0.00	0.15	0.00	0.00	n	22	**411**		
20-Aug-07	TB	12:40	Clear	0.00	0.00	0.04	0.00	0.22	n	16	161		Temp reading seems too low .
4-Sep-07	TB	14:50	Clear	0.00	0.00	0.00	0.00	0.00	n	18	127		Final sample of project.
17-Sep-07	TB	-	-	0.00	0.00	0.13	0.00	0.00	n	-	-		Site inaccessible due to road construction.
								Dry Results:		Max:	**411**	42.5%	% reduction for instantaneous WQS (236 col/100 mL)
										Geomean:	**140**	54.2%	% reduction for geomean WQS (64 col/100 mL)
								Overall Results:		Max:	**1120**	78.9%	% reduction for all samples using instant WQS (236 col/100 mL)
										Geomean:	**199**	67.8%	% reduction for all samples using geomean WQS (64 col/100 mL)

** Precip data for Portland Int'l Jetport (Source: NOAA / NWS)*

* **Bold red values** indicate exceedance of instantaneous of Maine Class B WQS (236 col/100 mL sample) or geometric mean WQS (64 col/100 mL sample).

** Storm event defined as 0.1" in previous 24 hr of sample collection; 0.25" in previous 48 hours; or 2" in previous 96 hours.

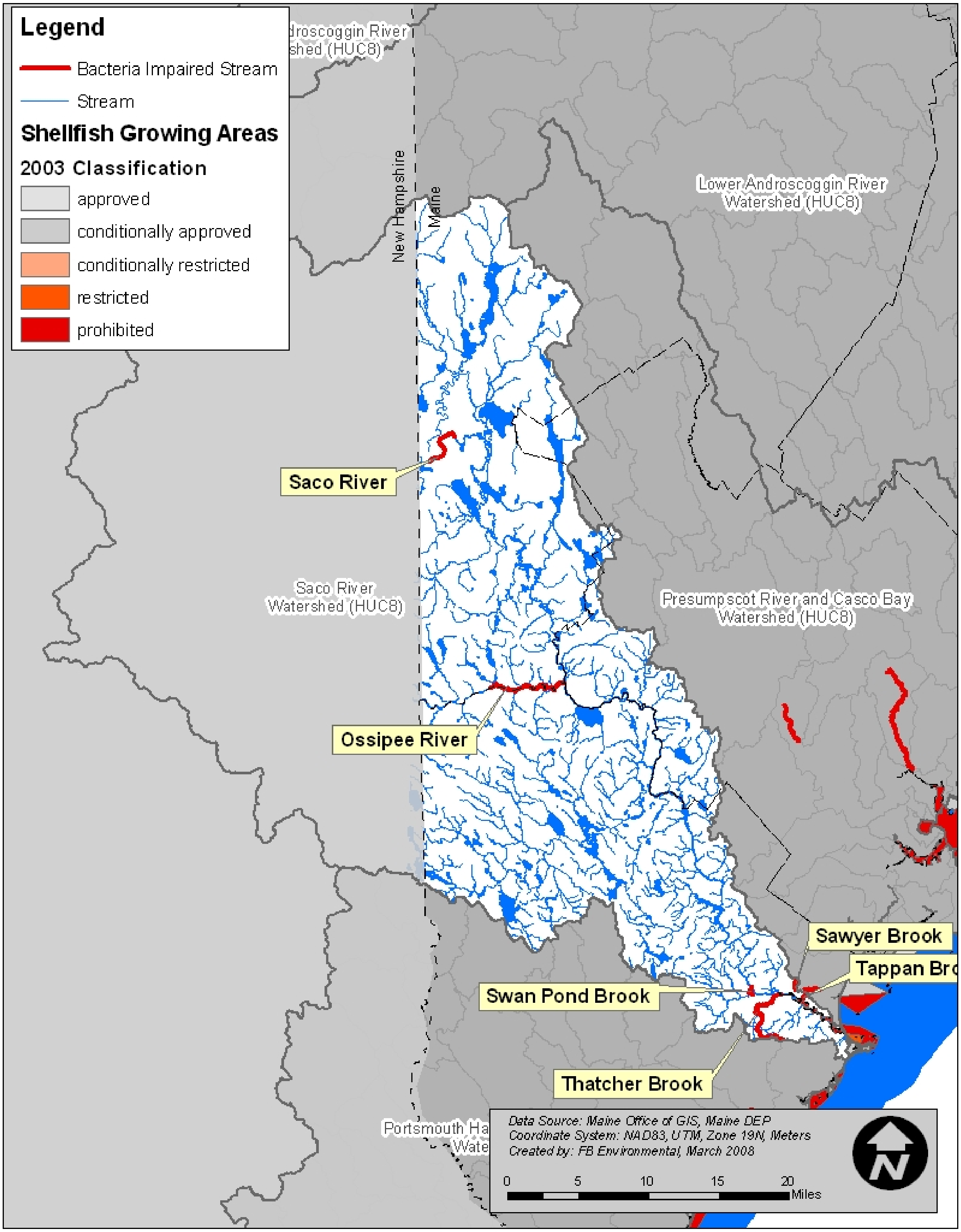


Figure 87: Saco River Watershed with the impaired waterways indicated.

8.7.B Watershed Characterization

The aerial photo (figure 88) shows Thatcher Brook as it passes through parts of rural Arundel and the City of Biddeford. The Thatcher Brook watershed was delineated for the area directly draining to the impaired segment to indicate the surrounding land cover types potentially affecting bacteria concentrations in this vicinity (figure 89). A view of the larger watershed is shown in the land cover map and statistics on the following page. The watershed area as delineated is approximately 6.3 square miles, and impervious surfaces are estimated to total 14.9% of this area. Stream gradient is low with a slope over the segment length of about 0.24%.

Forest makes up the majority of the land use at 56.4%, with wetlands adding 5.3%, and grass / scrub adding 3.7%. Developed lands present at 29.2% of area. Agricultural land uses represent 5.5% of watershed area, some of which are directly adjacent to the stream.

8.7.C Recommended Mitigation Strategies

Developed areas (29.2%) and impervious surfaces (14.9%) have a moderately heavy presence in the Thatcher Brook watershed. The nature and location of the development crowds the lower reaches of the river. It is possible that a few wastewater systems serving aging structures in the area have an antiquated design, or may simply be deteriorating with age. Leaking pipes or obsolete cesspool systems, if hydrologically connected to a stream, can lead to impairment. This pollution may be exacerbated by rain, which can essentially wash wastewater out of containment systems and into streams. Alternately, a constant volume of wastewater discharge from a structure into a stream may result in more severe impairments during dry conditions, when there is less stream water to dilute the incoming pollution. Another possible source of pollution from the developed areas is improperly managed pet waste, which tends to lead to elevated bacterial concentrations after rain. Since the watershed also contains significant amounts of forest (approximately 56% of area), wildlife inhabiting these areas could potentially contribute fecal contamination to the river.

There are several approaches to mitigation. First, a sampling plan can be designed to better pinpoint the location and weather conditions of impairment. For example, collecting samples both upstream and downstream of the developed area could reveal where impairment is greatest, which can also help suggest which sources (urban or agricultural/wildlife) are more likely. Several sampling events would be needed in order to provide a representative view of conditions and overcome the natural variability of bacterial concentrations in streams.

Fecal contamination from wastewater system malfunction can require considerable effort to locate and correct. Record-keeping before the mid-1970's is spotty, after which Maine's wastewater permitting system began to become progressively more stringent. Both the municipality and the state keep records of septic system permits, although they are not necessarily digitized or entered into a database. Once a malfunctioning systems is located, enforcement of repair may require extensive follow-up by the municipality. The expense of wastewater system repair or replacement can sometimes stall efforts at enforcement if a municipality is reluctant to make a special assessment against the property and supplemental financing is not available.

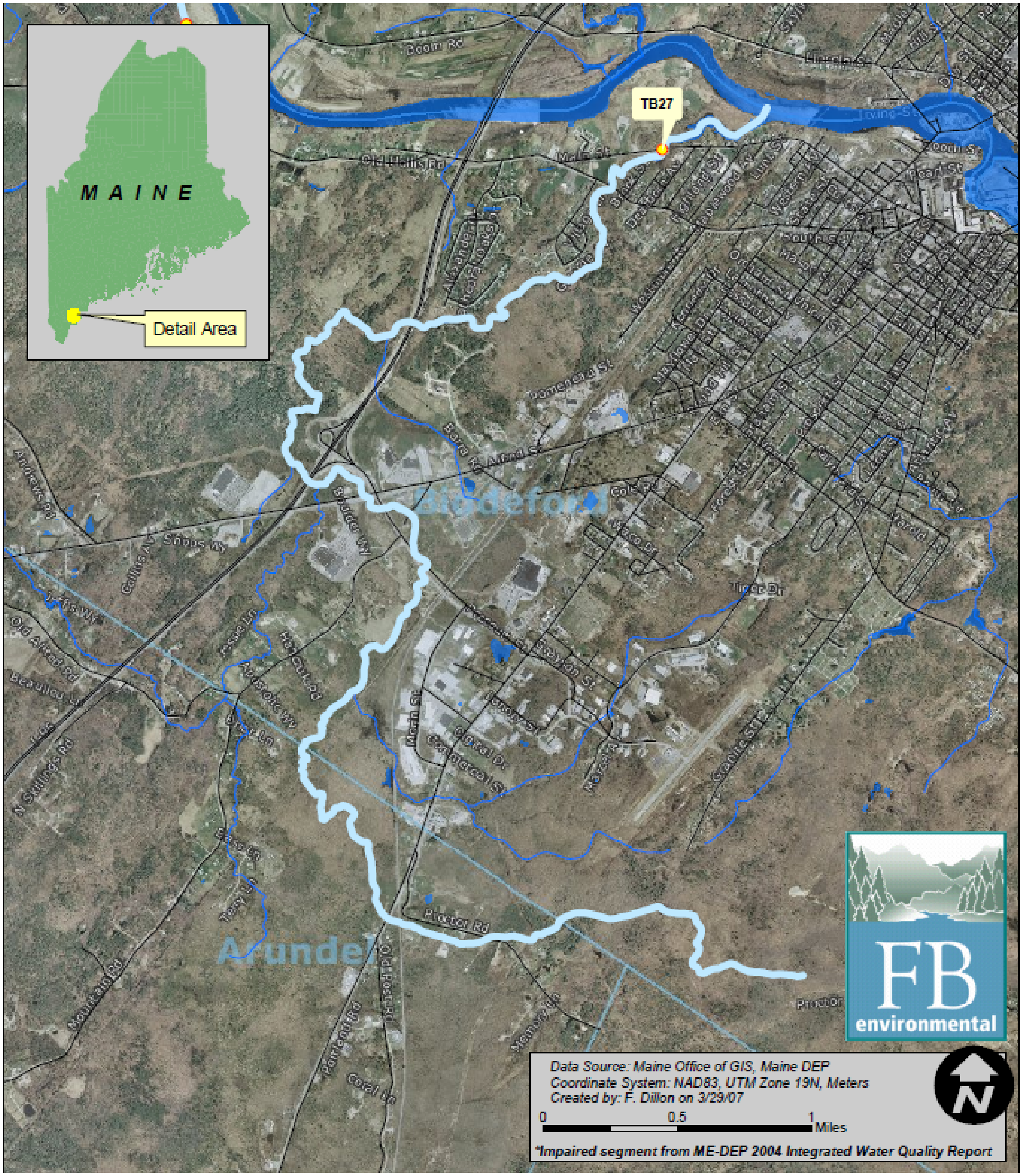
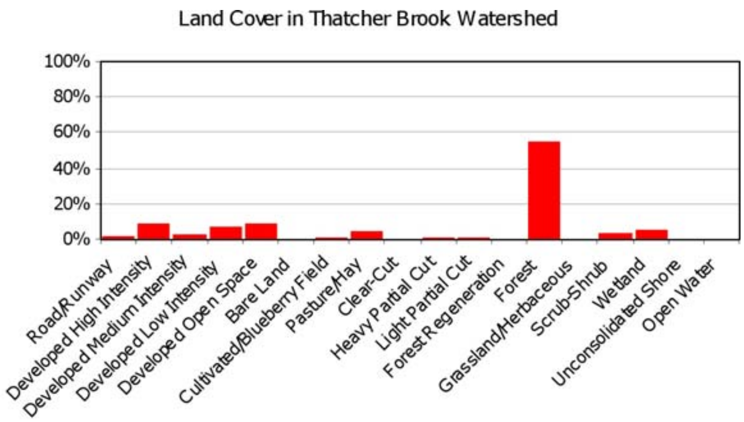


Figure 88: Aerial photograph of Thatcher Brook and surrounding area.

Watershed Statistics

watershed area (sq mi)	6.63
impervious surface	14.9%
length (miles)	7.95
highest elevation (ft)	160
lowest elevation (ft)	60
drop (ft)	100
slope	-0.24%



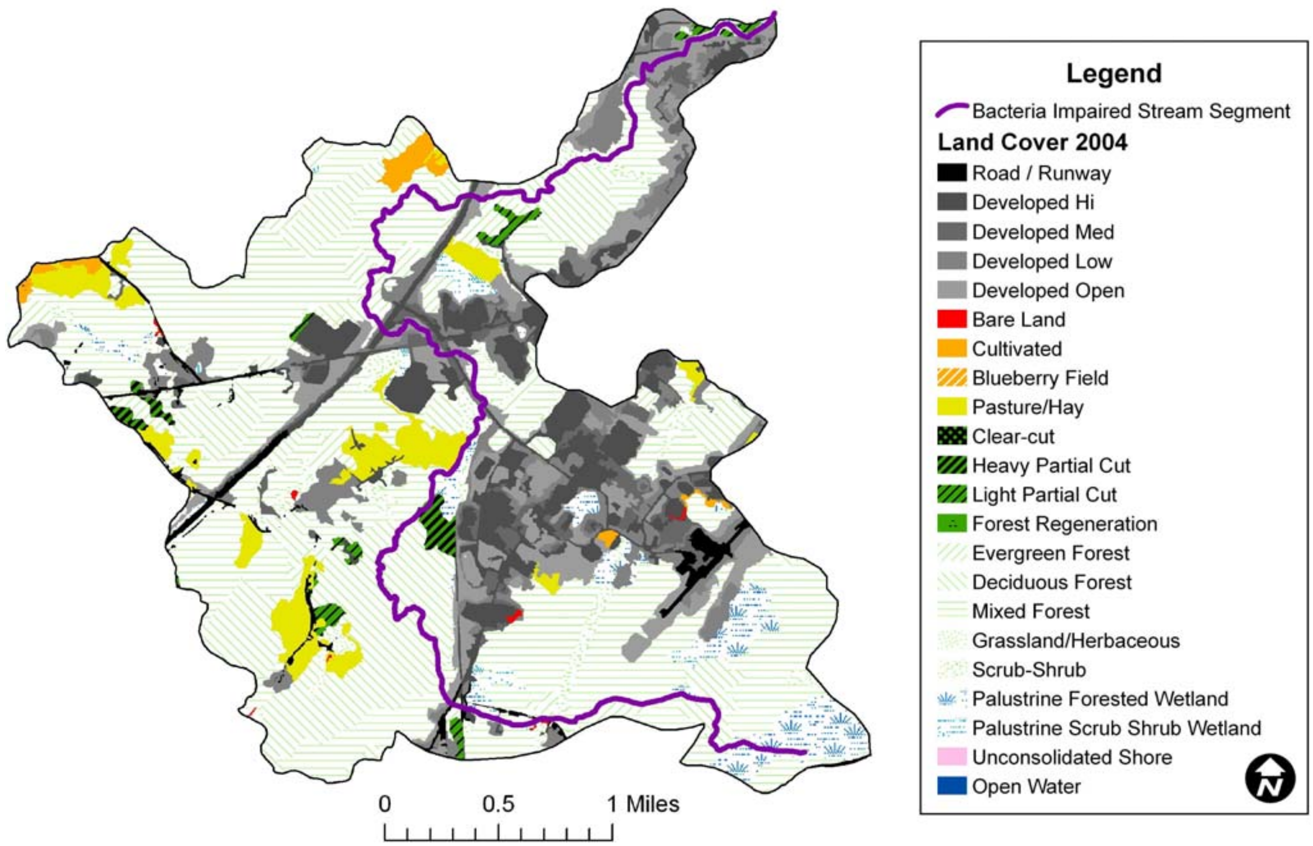


Figure 89: Thatcher Brook watershed land cover map and statistics.

Areas served by sewer are generally easier to assess for potential malfunctions, and repair is more generally prompt when a problem is found. A complicating factor may be property owners who have been granted waivers from connecting to the public sewer, and research of municipal records may be needed to identify these gaps in service. A comprehensive analysis of wastewater systems, both private and public, conducted in close collaboration with the sewer district and municipal officials is the best approach to locating and fixing infrastructure problems which are contributing to stream impairment, because it is comprehensive and builds awareness of the impairment among a variety of stakeholders.

Pet waste is another likely source of bacteria in developed areas. Reduction of this impairment can be achieved by conducting detailed sanitary survey along the stream corridor to document pet waste management problems. Parks can be equipped with sanitary bags to assist pet owners in cleaning up after their pets, and a variety of educational outreach activities, from mailing brochures or postcards to publishing a slideshow on local access cable TV can result in greater public awareness and eventually help change habits. It is also possible for a single individual to contribute greatly to an impairment (for example, dumping cat litter or other pet waste next to a stream).

Agriculture is a small part of the watershed (5.5%), however, the location of some fields next to the stream heightens the risk of bacterial contamination. There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities, as well, which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. The York County Soil and Water Conservation District likely has established relationships with farmers in the watershed and will play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

III. Meduxnekeag River Watershed

The Meduxnekeag and its tributaries are not included on the 2008 303d list due to an administrative oversight of the part of MDEP. Some of the river and tributary segments described in this section of the report do not meet Maine's water quality standards for bacteria. These segments are considered impaired and will require restoration, as long as the sources of bacteria remain active. All the water quality data presented in this section are based on sampling results of the Water Resources Department of the Houlton Band of Maliseet Indians (HBMI). Sampling methods and laboratory analysis are described in a water quality monitoring report (O'Donnell, 2008)[1.] .

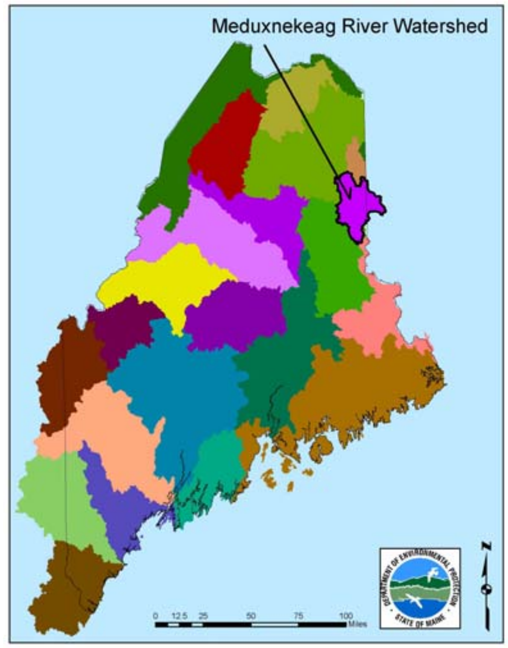


Figure 90: Meduxnekeag River Watershed.

1. Mainstem (Houlton)

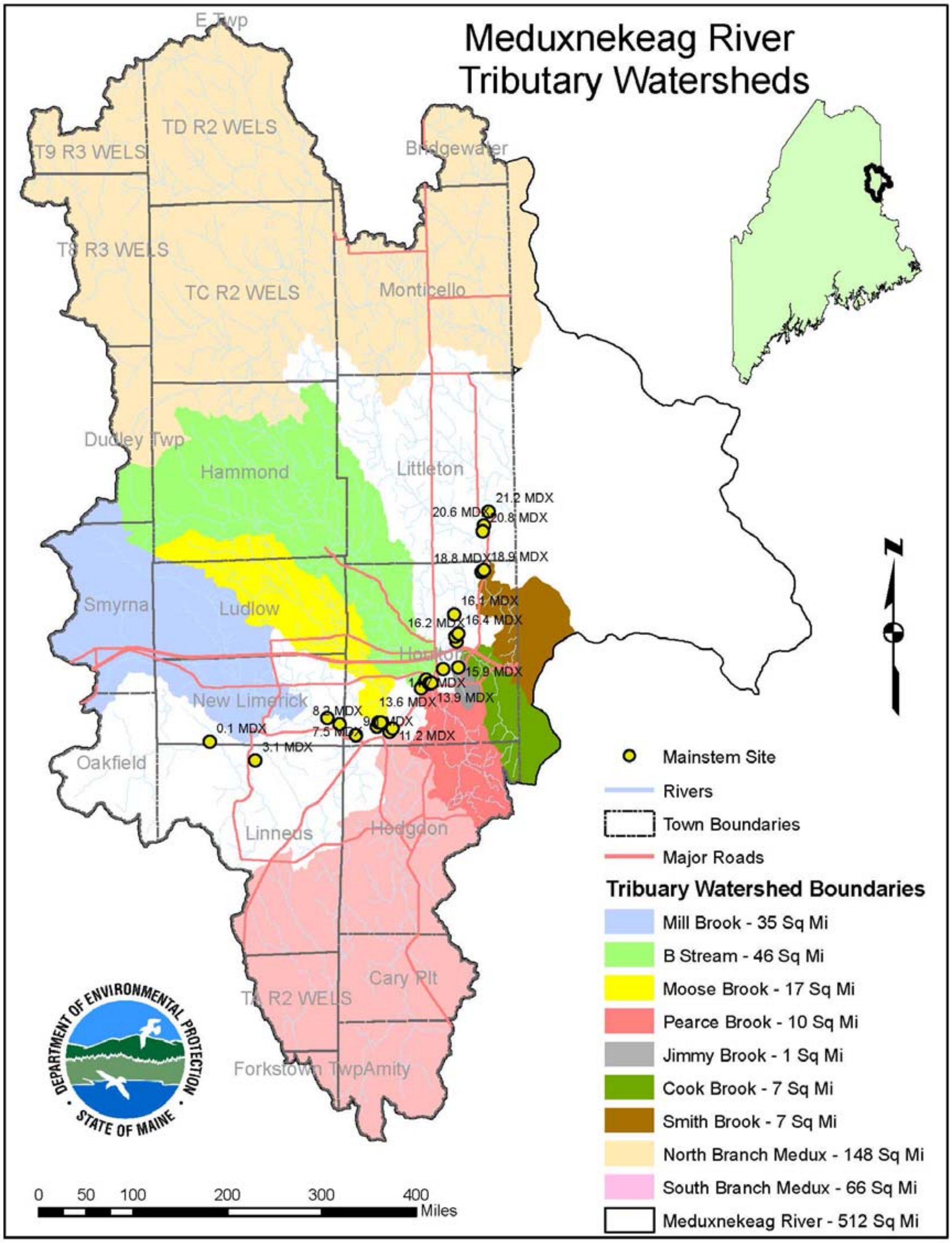
The mainstem of the Meduxnekeag is defined as Class B under Maine's Water Quality Classification and runs through New Limerick, Houlton and Littleton before flowing into Canada (Figure 91). The sites in Table 24, begin upstream and move downstream to cover 21 miles of river that has a watershed area of 512 square miles. The river flows through a mix of agricultural lands and community development which potentially contributes bacteria of human and domestic sources. O'Donnell 2008 described the sources of bacteria exceedances as follows-

*'The 236 instantaneous standards were exceeded at river-miles **10.4, 11.1, 14.7, and 18.9.** This occurred after rain events, and it is likely due to sources from agriculture, septic systems, faulty sewer lines, and beaver activity. The source of bacteria at 18.9 is clearly from the tributary 1 LOW, which deposits just upstream. The tributary 1 LOW has a cow pasture on the tributary banks, and is need of updated best management practices. Smith Brook, also contributes bacteria to site 18.9, most likely from beaver activity.*

It is unusual for sites 10.4 to have high bacteria counts. Site 10.4 is directly below the treatment plant; however the source of the high levels is unknown, and will be monitored in 2007. There is a new land spreading practice at the treatment plant that may potentially be the cause. Site 11.1 is located in an area of town where homes are known to be within the floodplain of the river, and have outdated septic systems. These systems are the most likely cause of high bacteria levels at this site. The likely contribution of bacteria to site 14.7 is input from the storm drain 1RIV, which has had 2 homes connected to it, that were fixed in 2004. There are likely more homes connected still to 1 RIV. The 2006 summer season had bacteria levels exceeding instantaneous bacteria criteria at sites 0.1, 3.1, 11.5 and 18.9.'

[1.] *O'Donnell, C.M. 2008. Houlton Band of Maliseet Indians, Water Quality Monitoring, Final Report 2007. Houlton Band of Maliseet Indians, Water Resources Department, Houlton, ME. 20pp.*

Figure 91: Sampling locations along the mainstem of the Meduxnekeag River.



1.1 Bacteria Data Summary & Percent Reduction Calculations

The instantaneous bacteria standard for a Class B stream, is 236 most probable number (MPN) / 100mL of sample while the geometric mean standard is 64 MPN/100mL of sample. Three exceedances of the instantaneous standard were observed and the geometric mean was exceeded in 4 different segments of the river. Bacteria data were also evaluated on the basis of storm flow and dry weather sampling events. From this perspective, all instantaneous and most geomean exceedances occurred during wet weather, with one segment violating the geomean during dry weather sampling events. In general, storm weather exceedances indicate non-point source runoff and dry weather exceedances usually indicate a point source, such as sewage.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only).

Table 24: Bacteria data summary for Mainstem Meduxnekeag River, with wet and dry weather assessment.

Meduxnekeag	Mainstem Mileage/ Site**	Precip 1 day prior	Precip 2 day prior	Storm Sample?	Avg EColi (MPN)*	% Reduction to Meet WQS	
Storm Samples							
06/13/06	0.2	0	0.21	Y	3		
7/12/2007	0.2	0.75	0.75	Y	1		
06/13/06	3.1	0	0.21	Y	20		
06/13/06	9.1	0	0.21	Y	57		
			Storm Results:	Max:	57	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	13	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/09/06	0.1	0	0.19	N	14		
08/30/06	0.1	0.02	0.03	N	11		
08/09/06	3.1	0	0.19	N	62		
08/30/06	3.1	0.02	0.03	N	57		
6/13/2007	3.1	0	0.02	N	4		
8/1/2007	3.1	0	0	N	2		
8/1/2007	4.5	0	0	N	4		
08/09/06	9.1	0	0.19	N	13		
6/13/2007	9.1	0	0.02	N	1		
8/1/2007	9.1	0	0	N	0		
8/23/2007	9.1	0	0	N	26		
			Dry Results:	Max:	62	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	19	na	% reduction for geomean WQS (64 col/100 ml)
Storm Samples							
7/12/2007	10.4	0.75	0.75	Y	**464**		
06/13/06	10.6	0	0.21	Y	48		
7/12/2007	11.1	0.75	0.75	Y	234		
			Storm Results:	Max:	**464**	49%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**330**	81%	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/09/06	10.4	0	0.19	N	14		
08/30/06	10.4	0.02	0.03	N	16		
08/09/06	11.1	0	0.19	N	18		
6/13/2007	11.1	0	0.02	N	0		
8/1/2007	11.1	0	0	N	0		
8/23/2007	11.1	0	0	N	12		
08/09/06	11.5	0	0.19	N	31		
6/13/2007	11.5	0	0.02	N	23		
			Dry Results:	Max:	31	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	18	na	% reduction for geomean WQS (64 col/100 ml)
Storm Samples							
06/13/06	14.7	0	0.21	Y	55		
7/12/2007	14.7	0.75	0.75	Y	**284**		
			Storm Results:	Max:	**284**	17%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**125**	49%	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/09/06	13.9	0	0.19	N	113		
08/30/06	13.9	0.02	0.03	N	52		
08/09/06	14.7	0	0.19	N	81		
08/30/06	14.7	0.02	0.03	N	82		
6/13/2007	14.7	0	0.02	N	44		
			Dry Results:	Max:	**113**	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**71**	9%	% reduction for geomean WQS (64 col/100 ml)
Storm Samples							
06/13/06	18.9	0	0.21	Y	54		
7/12/2007	18.9	0.75	0.75	Y	**778**		
			Storm Results:	Max:	**778**	70%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**205**	69%	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/09/06	21.2	0	0.19	N	37		
08/09/06	18.9	0	0.19	N	60		
8/1/2007	18.9	0	0	N	6		
8/23/2007	18.9	0	0	N	85		
			Dry Results:	Max:	**85**	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	56	na	% reduction for geomean WQS (64 col/100 ml)
			Overall Results:	Max:	**778**	70%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	23	na	% reduction for geomean WQS (64 col/100 ml)
* Number colonies per 100 ml, averaged for each site visit							
** Mainstem broken into logical segments, based on proximity and observation values							
Bold Values exceed instantanteous (236 col/100ml) or geomean (64 col/100ml) WQS							

2. Tributaries

Eleven tributaries (Figure 92) were sampled in the watershed and are Class B except as follows:

- Moose Brook and its tributaries, upstream of the Ludlow Road in Ludlow - Class A.
- South Branch of the River and its tributaries, upstream of the Oliver Road in Cary - Class A.
- B Stream and tributaries upstream of the Burnt Brow Bridge in Hammond - Class A.

The tributaries are listed in Table 25 alphabetically along with the watershed areas. Similar to the mainstem, these streams flow through a mix of agricultural and community lands which potentially contributes bacteria of human and domestic sources. The headwaters of these streams areas are likely to be dominated by forested lands. O'Donnell 2008 described the sources of bacteria exceedances on the Tributaries as follows-

'Tributary sites that exceeded both the 236 and the geometric mean, in 2007 are: 2 B Stream, 1 Bailey Brook, 2 South Branch, 1 Lowery, 1 Mill Brook, 1 and 2 Pearce Brook, 2 Big Brook, 2 Cook Brook, 2 Moose Brook, 2 Smith Brook (not geo mean), and 3 Jimmy Brook. Most likely causes are:

B Stream - combination of small pastures and homes
Bailey Brook - urban area, failing septic systems
South Branch - nearby horse pasture
Lowery - intensively grazed cow pasture
Mill Brook - unknown, nearby houses possibly failing septics or nearby mill
Pearce Brook - urban area, likely failing septic or faulty sewer connections
Big Brook - unknown, agriculture far upstream
Cook Brook - unknown
Moose Brook - 1 possible failing septic system or manure spreading
Smith Brook - beaver activity
Jimmy Brook - possibly some influence from septics and storm drains'

2.1. Bacteria Data Summary & Percent Reduction Calculations

The instantaneous bacteria standard for a Class B stream, is 236 most probable number (MPN) / 100mL of sample while the geometric mean standard is 64 MPN/100mL of sample. Only Cook Brook did not violate bacterial standards, all the other tributaries either violated the instantaneous or geomean standards. Bacteria data were evaluated on the basis of storm flow and dry weather sampling events. From this perspective, instantaneous exceedances occurred during 7 wet weather and 4 dry weather samples, while only the Lowery Trib had exceedances during both conditions. Even with all the instantaneous exceedances, only 5 streams violated geomean standards. In general, storm weather exceedances indicate non-point source runoff and dry weather exceedances usually indicate a point source, such as sewage.

Bacteria loading reductions required to meet water quality standards were determined for all data throughout the entire sampling period as well as separately for storm flow and dry weather sampling events. These determinations were made for both maximum instantaneous sample results and geometric mean values. (Since it is unlikely that a stream would be listed for impairment based on a single maximum instantaneous sample, % reduction calculations for instantaneous results are presented for illustrative purposes only). The percent reductions also provide a way to prioritize which problem tributaries to follow up on for source determination and remediation.

Figure 92: Sampling Locations and Tributaries within the Meduxnekeag Watershed.

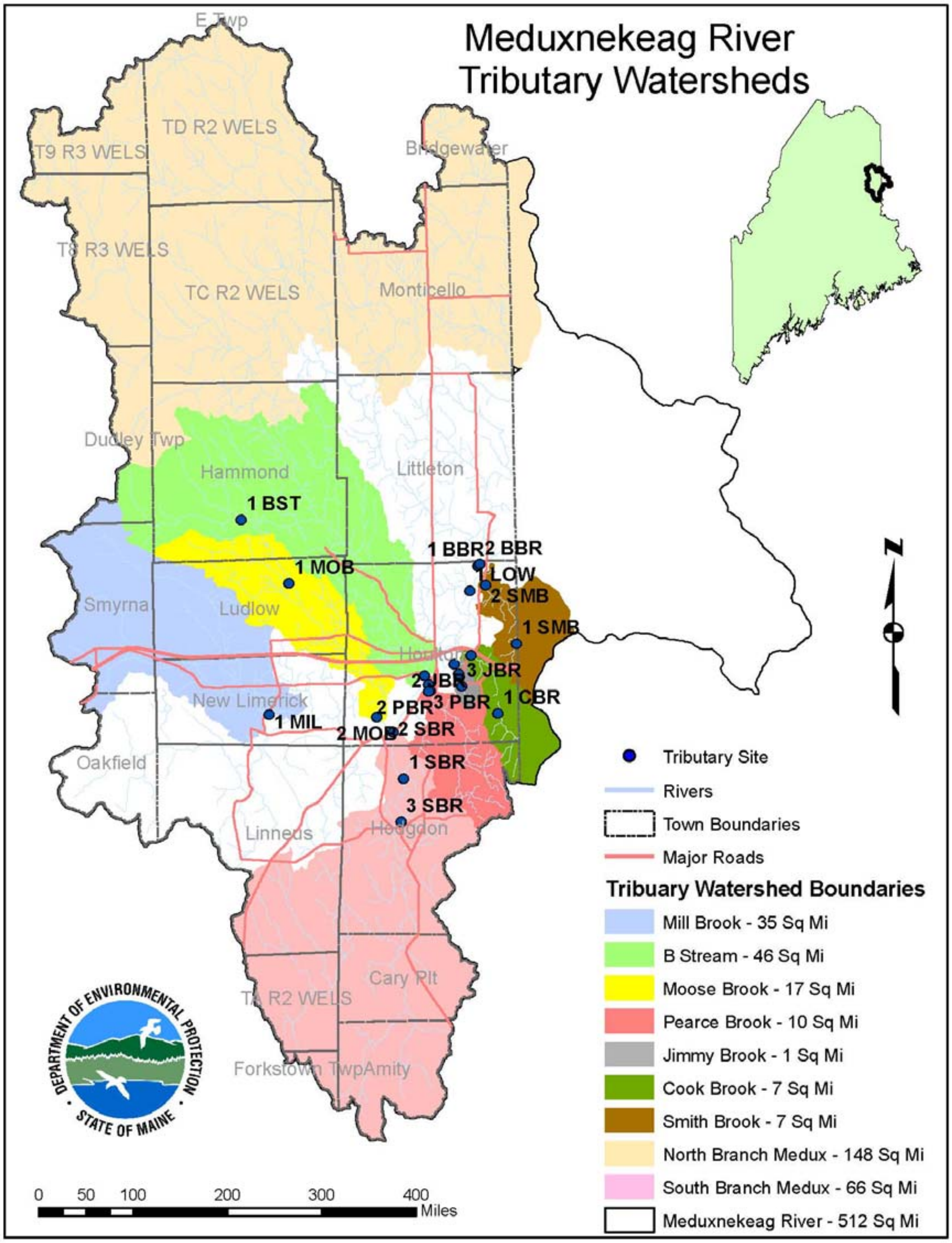


Table 25: Bacteria data summary for Tributaries to the Meduxnekeag River, with wet and dry weather assessment.

Meduxnekeag Tribs	Site Code	Precip 1 day prior	Precip 2 day prior	Storm Sample?	Avg EColi (MPN)*	% Reduction to Meet WQS	Comments
B Stream							
Storm Samples							
06/13/06	2 BST	0	0.21	Y	42		
07/12/07	2 BST	0.75	0.75	Y	**559**		
			Storm Results:	Max:	**559**	58%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**153**	58%	% reduction for geomean WQS (64 col/100 ml)
Bailey Brook							
Dry Weather Samples							
08/01/07	1 BAB	0	0	N	96		
08/23/07	1 BAB	0	0	N	**3300**		TNTC**
			Dry Results:	Max:	**3300**	93%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**563**	89%	% reduction for geomean WQS (64 col/100 ml)
Big Brook							
Storm Samples							
07/12/07	2 BBR	0.75	0.75	Y	**551**		
			Storm Results:	Max:	**551**	57%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/30/06	2 BBR	0.02	0.03	N	26		
08/01/07	2 BBR	0	0	N	3		
			Dry Results:	Max:	26	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	19	na	% reduction for geomean WQS (64 col/100 ml)
Cook Brook							
Storm Samples							
06/13/06	2 CBR	0	0.21	Y	11		
			Storm Results:	Max:	11	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/01/07	2 CBR	0	0	N	1		
			Dry Results:	Max:	1	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Jimmy Brook							
Storm Samples							
07/12/07	3 JBR	0.75	0.75	Y	**451**		
			Storm Results:	Max:	**451**	48%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/30/06	2 JBR	0.02	0.03	N	17		
08/01/07	3 JBR	0	0	N	7		
08/23/07	3 JBR	0	0	N	37		
			Dry Results:	Max:	37	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	25	na	% reduction for geomean WQS (64 col/100 ml)
Lowery Rd Trib							
Storm Samples							
6/13/2006	1 LOW	0	0.21	Y	**4800**		TNTC**
			Storm Results:	Max:	**4800**	95%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
8/9/2006	1 LOW	0	0.19	N	20		
8/30/2006	1 LOW	0.02	0.03	N	**419**		
06/13/07	1 LOW	0	0.02	N	112		
8/1/2007	1 LOW	0	0	N	14		
8/23/2007	1 LOW	0	0	N	105		
			Dry Results:	Max:	**419**	44%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	46	na	% reduction for geomean WQS (64 col/100 ml)
Mill Brook							
Storm Samples							
7/12/2007	1 MIL	0.75	0.75	Y	**246**		
			Storm Results:	Max:	**246**	4%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Moose Brook							
Storm Samples							
07/12/07	2 MOB	0.75	0.75	Y	**771**		
			Storm Results:	Max:	**771**	69%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/30/06	2 MOB	0.02	0.03	N	22		
08/01/07	2 MOB	0	0	N	3		
08/23/07	2 MOB	0	0	N	38		
			Dry Results:	Max:	38	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	29	na	% reduction for geomean WQS (64 col/100 ml)
Pearce Brook							
Storm Samples							
06/13/06	3 PBR	0	0.21	Y	99		
			Storm Results:	Max:	99	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/09/06	3 PBR	0	0.19	N	4		
08/09/06	2 PBR	0	0.19	N	61		
08/09/06	1 PBR	0	0.19	N	**975**		
08/30/06	3 PBR	0.02	0.03	N	12		
08/30/06	2 PBR	0.02	0.03	N	11		
08/30/06	1 PBR	0.02	0.03	N	8		
06/13/07	7 PBR	0	0.02	N	18		
06/13/07	3 PBR	0	0.02	N	24		
06/13/07	2 PBR	0	0.02	N	7		
06/13/07	1 PBR	0	0.02	N	11		
08/01/07	2 PBR	0	0	N	12		
08/23/07	2 PBR	0	0	N	**1680**		TNTC**
			Dry Results:	Max:	**1680**	86%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**82**	22%	% reduction for geomean WQS (64 col/100 ml)
Smith Brook							
Storm Samples							
06/13/06	2 SMB	0	0.21	Y	32		
			Storm Results:	Max:	32	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/30/06	1 SMB	0.02	0.03	N	31		
08/23/07	2 SMB	0	0	N	**241**		
			Dry Results:	Max:	**241**	2%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**86**	26%	% reduction for geomean WQS (64 col/100 ml)
South Branch							
Storm Samples							
07/12/07	2 SBR	0.75	0.75	Y	**614**		
			Storm Results:	Max:	**614**	62%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	na	na	% reduction for geomean WQS (64 col/100 ml)
Dry Weather Samples							
08/30/06	1 SBR	0.02	0.03	N	118		
08/23/07	2 SBR	0	0	N	59		
			Dry Results:	Max:	118	na	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	27	na	% reduction for geomean WQS (64 col/100 ml)
			Combined Tribs Results:	Max:	**4800**	95%	% reduction for intantaneous WQS (236 col/100 ml)
				Geomean:	**100**	36%	% reduction for geomean WQS (64 col/100 ml)

* Number colonies per 100 ml, averaged for each site visit

**TNTC number were estimated using the maximum observed for each year for a 5 ml sample, 2006=4800 col/100 ml & 2007= 3300 col/100 ml

Bold Values exceed instantanteous (236 col/100ml) or geomean (64 col/100ml) WQS

3. Watershed Characterization

The Meduxnekeag Watershed is characterized in an aerial view in Figure 93 and land cover is summarized in Figure 94. The large area of the watershed provides shows a wide range of land coverage and land that surrounds and drains to a segment may directly impact bacterial concentrations. The agriculture and developed land coverage which is concentrated along the mainstem and the downstream portions of the tributaries have the greatest potential to contribute non-point source bacteria to the observed violations in water quality standards. The upstream portions of the tributaries are dominated by forested land, in which wildlife is the probable source of any observed exceedances. Exceedances attributed to wildlife do not violate water quality standards, since only human and domestic sources are covered under Maine law.

4. Recommended & Past Mitigation Strategies

Past Mitigation

The HBMI has been in engaged in a variety of bacterial mitigation efforts over the years that may be continued to abate bacterial contamination, Brenda Commander, Tribal Chief wrote-

> *'In the early 1990's we applied for and received EPA funding to support a cattle exclusion demonstration project with a local farmer in a subwatershed where MDEP had identified bacterial contamination of agricultural origin. In 2003, in partnership with MDEP and others, we were awarded EPA funding that we used in part to address illicit sewer connections on a storm drain in the Town of Houlton identified by our water quality monitoring program. We are currently engaged in a soon-to-be-finalized bacteria source tracking study with USGS. Over the years we have discussed our concerns regarding bacterial contamination with many local stakeholders and continue to do so.'* [2.]

Recommended Mitigation Strategies

Given that the Meduxnekeag watershed has a large degree of agricultural lands in close proximity to the impaired sites in the watershed; it appears probable that farming activities are a source of fecal contributions. For example, improper handling and management of animal manures used as fertilizer can contribute significantly to elevated bacteria concentrations in nearby surface waters. A significant portion of the watershed is also comprised of forest and wetlands. Wildlife inhabiting these areas may play an important role in contributing fecal contamination to the Meduxnekeag and its tributaries.

Even though non-farming based human development occupies a relatively small percentage of the watershed, a variety of residential and commercial activities could also be contributing fecal contamination to the impaired sites. The intense development associated with the community of Houlton has the potential to contribute both non-point and point sources of bacterial pollution. The Maliseet's sampled storm drains in the Houlton area to track likely sources of bacteria and found 7 locations that exceeded the instantaneous standards. The sources in the storm drains were attributed to illicit discharges or leaking sewer lines (O'Donnell 2008).

There are a variety of mitigation strategies to reduce fecal contamination from agricultural activities which generally relate to proper manure storage and handling techniques along with keeping farm animals away from surface waters. It is likely that the Central Aroostook County Soil and Water Conservation District has established relationships with farmers in the watershed and will therefore play an important role in addressing any potential fecal contamination issues arising from agricultural land uses there.

Management strategies for controlling fecal contamination from wildlife sources have generally focused on removing animals from problems areas. Fecal contamination from non-farming based human activities can derive from a variety of sources, including stormwater runoff from impervious surfaces, malfunctioning sewer and / or septic systems, and improperly managed pet waste. Section 6.1 describes mitigation strategies for addressing each of these potential fecal contamination sources, among others.

[2.] *2008. Commander, B. Personal Communition, Houlton Band of the Maliseet Indians Comment Letter on the Bacteria TMDL.*

Figure 93: Aerial photograph of the Meduxnekeag Watershed with sampling sites overlayed.

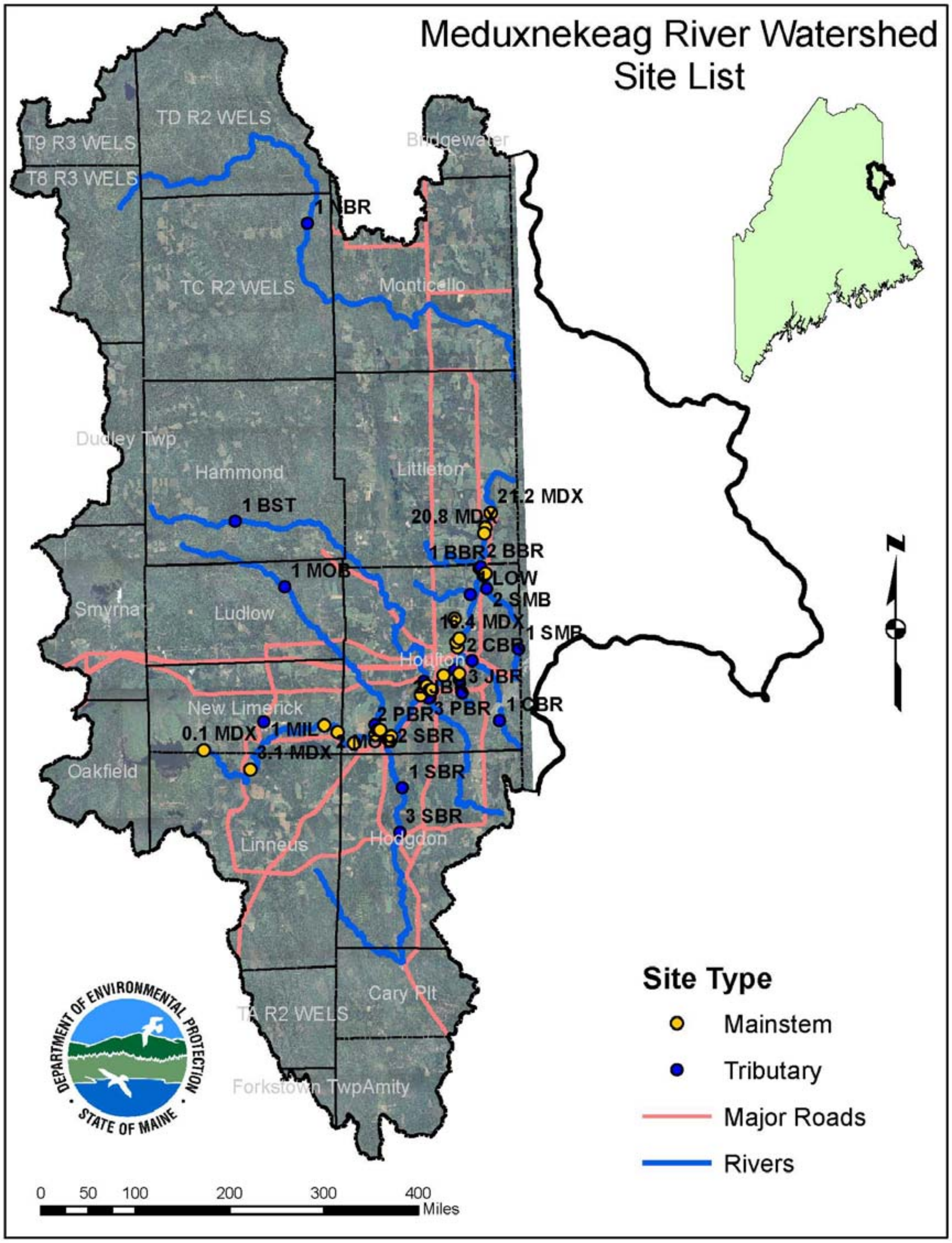


Figure 94: The Meduxnekeag Watershed land cover map.