Final Massachusetts Statewide Total Maximum Daily Load for Pathogen-Impaired Waterbodies

Appendix S: Nashua River Basin

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Rebecca L. Tepper, Secretary
Massachusetts Department of Environmental Protection
Bonnie Heiple, Commissioner
Bureau of Water Resources
Kathleen M. Baskin, Assistant Commissioner

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Prepared by:
TMDL Section, Watershed Planning Program
Division of Watershed Management, Bureau of Water Resources
Massachusetts Department of Environmental Protection

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Massachusetts Department of Environmental Protection

The mission of the Massachusetts Department of Environmental Protection (MassDEP) is to protect and enhance the Commonwealth's natural resources – air, water, and land – to provide for the health, safety, and welfare of all people, and to ensure a clean and safe environment for future generations. In carrying out this mission MassDEP commits to address and advance environmental justice and equity for all people of the Commonwealth; provide meaningful, inclusive opportunities for people to participate in agency decisions that affect their lives; and ensure a diverse workforce that reflects the communities we serve.

Watershed Planning Program

The mission of the Watershed Planning Program (WPP) in the Massachusetts Department of Environmental Protection is to protect, enhance, and restore the quality and value of the waters of the Commonwealth. Guided by the federal Clean Water Act, WPP implements this mission statewide through five Sections that each have a different technical focus: (1) Surface Water Quality Standards; (2) Surface Water Quality Monitoring; (3) Data Management and Water Quality Assessment; (4) Total Maximum Daily Load; and (5) Nonpoint Source Management. Together with other MassDEP programs and state environmental agencies, WPP shares in the duty and responsibility to secure the environmental, recreational, and public health benefits of clean water for all people of the Commonwealth.

Acknowledgements

FB Environmental Associates, under contractual agreements with MassDEP, previously prepared two separate documents for the Watershed Planning Program: (1) *Massachusetts TMDL for Pathogen-Impaired Inland Fresh Water Rivers* and (2) *Massachusetts Statewide TMDL for Pathogen-Impaired Coastal Waterbodies*. MassDEP combined these two documents into a single statewide approach encompassing both inland fresh water and coastal impairments to prepare the *Final Massachusetts Statewide Total Maximum Daily Load for Pathogen-Impaired Waterbodies*.

Contact Information

Watershed Planning Program
Division of Watershed Management, Bureau of Water Resources
Massachusetts Department of Environmental Protection
8 New Bond Street, Worcester, MA 01606
Website: https://www.mass.gov/guides/watershed-planning-program
Email address: dep.wpp@mass.gov

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1. Introduction

This appendix to the Massachusetts Statewide Total Maximum Daily Load (TMDL) for Pathogen-Impaired Waterbodies Rivers provides additional information to support the determination of the Total Maximum Daily Load (TMDL) for 18 pathogen-impaired river segments in the Nashua River Basin, hereinafter referred to as the Nashua River watershed (Figure 1-1). The core document and appendix together complete the TMDL for each of these pathogen-impaired river segments.

This appendix includes a description of the watershed and maps to identify the segments of focus for the TMDLs; the impaired uses, and the water classification and qualifiers as designated by the Massachusetts Surface Water Quality Standards (SWQS, 314 CMR 4.00); the water quality standards applicable to the impaired uses; the data supporting the pathogen impairment determination; and a description of the sources of pathogen loading with supporting maps. For water quality data, the Method Detection Limit (MDL) is reported and used for values below the MDL when calculating geometric means.

This appendix includes the allocation of the pollutant load into two categories: point sources (waste load allocation, WLA) and nonpoint sources (load allocation, LA), based on an analysis of watershed percent impervious cover. This appendix also identifies the percent reduction in indicator bacteria pollutant load from current conditions required to meet the TMDL, based on the highest levels of indicator bacteria recorded in the monitoring data. Refer to Table 1-1 and Table 1-2.

Finally, for each impaired segment, this appendix documents list existing local management efforts to reduce pathogen pollutant loading, as well as recommended next steps to bring each pathogen-impaired river segment into attainment of SWQS.

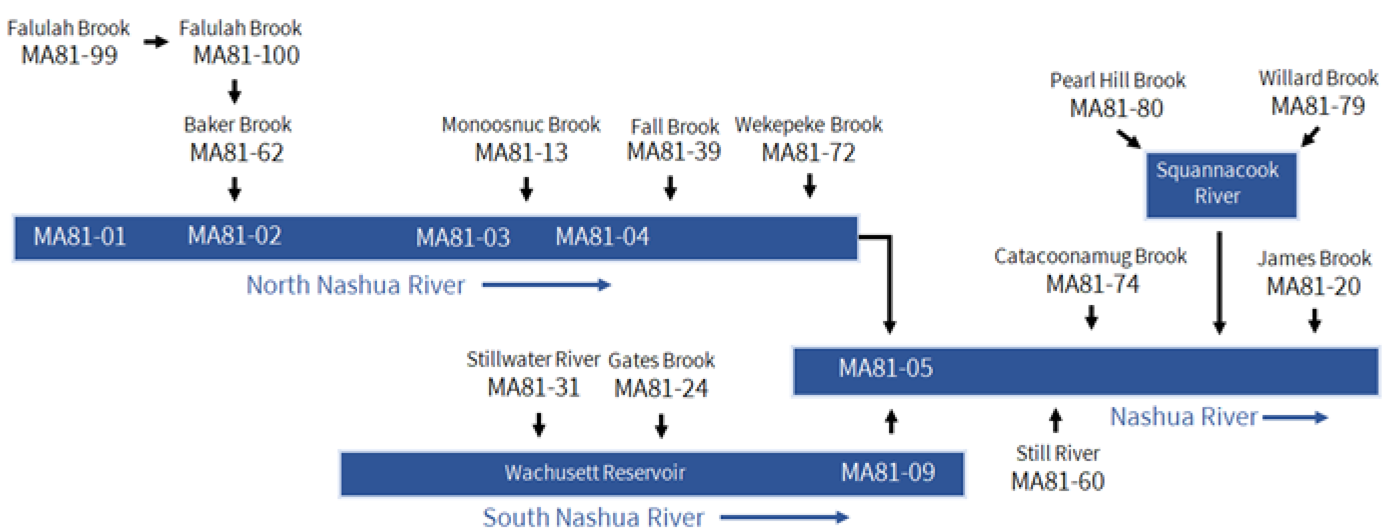


Figure 1-1. Conceptual diagram of water flow routing through the Nashua River watershed for the 18 pathogen-impaired river segments. Mainstem segments of major rivers (i.e., the North Nashua River and the Nashua River) or reservoirs (i.e., the Wachusett Reservoir) are highlighted in blue. Tributary segments to the major rivers are shown with black arrows to the mainstem. Not to scale.

Table 1-1. ***E. Coli*** Total Maximum Daily Loads (TMDLs), the percent reductions needed to meet the TMDL target (126 CFU/100ml) based on the Massachusetts Surface Water Quality Standards (SWQS), and the flow-based TMDL allocations for pathogen-impaired **freshwater** assessment units in the Nashua River Basin

Waterbody & Assessment Unit	Class (Qualifier)	TMDL Type	SWQS-Based TMDL target (CFU/100ml)	Maximum Geomean (CFU/100ml)	Geomean Percent Reduction	TMDL Allocation	Flow (cfs) *1*	*10*	*100*	*1,000*	*10,000*	*100,000*
							Flow-Based Target TMDL (CFU/day*10^9)					
North Nashua River		R	126	11,000	99%	WLA (6%)	0.2	2.0	19.5	195.4	1,954.2	19,541.8
MA81-01	B (WW, CSO)			(30 day)		LA (94%)	2.9	28.9	288.7	2,887.3	28,872.6	288,726.2
North Nashua River		R	126	3,600	96%	WLA (10%)	0.3	2.9	29.5	294.9	2,948.6	29,485.9
MA81-02	B (WW, CSO)			(30 day)		LA (90%)	2.8	27.9	278.8	2,787.8	27,878.2	278,782.2
North Nashua River		R	126	2,420	95%	WLA (10%)	0.3	3.2	31.9	318.9	3,188.8	31,888.2
MA81-03	B (WW, CSO)			(30 day)		LA (90%)	2.8	27.6	276.4	2,763.8	27,638.0	276,379.8
North Nashua River		R	126	2,420	95%	WLA (11%)	0.3	3.3	32.9	329.5	3,295.0	32,949.9
MA81-04	B (WW)			(30 day)		LA (89%)	2.8	27.5	275.3	2,753.2	27,531.8	275,318.1
Nashua River		R	126	1,441	91%	WLA (9%)	0.3	2.7	27.1	271.1	2,711.1	27,110.9
MA81-05	B (WW)			(30 day)		LA (91%)	2.8	28.1	281.2	2,811.6	28,115.7	281,157.1
Nashua River		R	126	2,420	95%	WLA (6%)	0.2	2.0	19.8	198.5	1,984.6	19,845.8
MA81-09	B (WW)			(30 day)		LA (94%)	2.9	28.8	288.4	2,884.2	28,842.2	288,422.2
Monoosnoc Brook		R	126	2,420	95%	WLA (11%)	0.3	3.5	34.9	349.4	3,494.1	34,940.7
MA81-13	B			(90 day)		LA (89%)	2.7	27.3	273.3	2,733.3	27,332.7	273,327.3
James Brook		R	126	2,420	95%	WLA (9%)	0.3	2.7	26.7	267.0	2,669.9	26,698.6
MA81-20	B			(90 day)		LA (91%)	2.8	28.2	281.6	2,815.7	28,156.9	281,569.4
Gates Brook		R	126	85	-	WLA (17%)	0.5	5.2	52.4	524.3	5,242.6	52,425.6
MA81-24	A (PWS, ORW)			(90 day)		LA (83%)	2.6	25.6	255.8	2,558.4	25,584.2	255,842.4
Stillwater River		R	126	306	59%	WLA (4%)	0.1	1.2	12.1	120.8	1,208.1	12,080.7
MA81-31	A (PWS, ORW)			(90 day)		LA (96%)	3.0	29.6	296.2	2,961.9	29,618.7	296,187.3
Fall Brook		R	126	177	29%	WLA (18%)	0.5	5.5	54.9	549.4	5,493.7	54,937.2
MA81-39	B			(90 day)		LA (82%)	2.5	25.3	253.3	2,533.3	25,333.1	253,330.8
Still River		R	126	176	28%	WLA (10%)	0.3	3.0	30.0	300.2	3,001.5	30,015.4
MA81-60	B (CW)			(90 day)		LA (90%)	2.8	27.8	278.3	2,782.5	27,825.3	278,252.6
Baker Brook		R	126	291	57%	WLA (10%)	0.3	3.0	29.8	297.7	2,976.7	29,766.6
MA81-62	B (CSO)			(30 day)		LA (90%)	2.8	27.9	278.5	2,785.0	27,850.1	278,501.4
Wekepeke Brook		R	126	2,420	95%	WLA (9%)	0.3	2.8	27.8	277.7	2,777.3	27,773.2
MA81-72	B			(90 day)		LA (91%)	2.8	28.0	280.5	2,804.9	28,049.5	280,494.8
Catacoonamug Brook		R	126	833	85%	WLA (9%)	0.3	2.6	26.3	262.6	2,626.5	26,264.8
MA81-74	B			(90 day)		LA (91%)	2.8	28.2	282.0	2,820.0	28,200.3	282,003.2
Willard Brook		P	126	330	62%	WLA (4%)	0.1	1.2	12.3	123.2	1,231.7	12,317.4
MA81-79	B (ORW)			(30 day)		LA (96%)	3.0	29.6	296.0	2,959.5	29,595.1	295,950.6
Pearl Hill Brook		P	126	26	-	WLA (3%)	0.1	0.9	9.3	92.6	926.4	9,264.2
MA81-80	B (ORW)			(30 day)		LA (97%)	3.0	29.9	299.0	2,990.0	29,900.4	299,003.8
Falulah Brook		R	126	NA	-	WLA (2%)	0.1	0.6	5.6	55.8	558.5	5,584.9
MA81-99	A (PWS, ORW)					LA (98%)	3.0	30.3	302.7	3,026.8	30,268.3	302,683.1
Falulah Brook		R	126	NA	-	WLA (7%)	0.2	2.0	20.3	202.8	2,027.9	20,278.8
MA81-100	B					LA (93%)	2.9	28.8	288.0	2,879.9	28,798.9	287,989.2

Table 1-2. Enterococci Total Maximum Daily Loads, the percent reductions needed to meet the TMDL target (35 CFU/100ml) based on the Massachusetts Surface Water Quality Standards (SWQS), and the flow-based TMDL allocations for pathogen-impaired **freshwater** assessment units in the Nashua River Basin

Waterbody & Assessment Unit	Class (Qualifier)	TMDL Type	SWQS-Based TMDL target (CFU/100ml)	Maximum Geomean (CFU/100ml)	Geomean Percent Reduction	TMDL Allocation	*Flow (cfs)* *1*	*10*	*100*	*1,000*	*10,000*	*100,000*
							Flow-Based Target TMDL (CFU/day*10^9)					
North Nashua River		P	35	NA	-	WLA (6%)	0.1	0.5	5.4	54.3	542.8	5,428.3
MA81-01	B (WW, CSO)					LA (94%)	0.8	8.0	80.2	802.0	8,020.2	80,201.7
North Nashua River		P	35	NA	-	WLA (10%)	0.1	0.8	8.2	81.9	819.1	8,190.5
MA81-02	B (WW, CSO)					LA (90%)	0.8	7.7	77.4	774.4	7,743.9	77,439.5
North Nashua River		P	35	NA	-	WLA (10%)	0.1	0.9	8.9	88.6	885.8	8,857.8
MA81-03	B (WW, CSO)					LA (90%)	0.8	7.7	76.8	767.7	7,677.2	76,772.2
North Nashua River		P	35	NA	-	WLA (11%)	0.1	0.9	9.2	91.5	915.3	9,152.7
MA81-04	B (WW)					LA (89%)	0.8	7.6	76.5	764.8	7,647.7	76,477.3
Nashua River		P	35	NA	-	WLA (9%)	0.1	0.8	7.5	75.3	753.1	7,530.8
MA81-05	B (WW)					LA (91%)	0.8	7.8	78.1	781.0	7,809.9	78,099.2
Nashua River		P	35	NA	-	WLA (6%)	0.1	0.6	5.5	55.1	551.3	5,512.7
MA81-09	B (WW)					LA (94%)	0.8	8.0	80.1	801.2	8,011.7	80,117.3
Monoosnoc Brook		P	35	NA	-	WLA (11%)	0.1	1.0	9.7	97.1	970.6	9,705.7
MA81-13	B					LA (89%)	0.8	7.6	75.9	759.2	7,592.4	75,924.3
James Brook		P	35	NA	-	WLA (9%)	0.1	0.7	7.4	74.2	741.6	7,416.3
MA81-20	B					LA (91%)	0.8	7.8	78.2	782.1	7,821.4	78,213.7
Gates Brook		P	35	NA	-	WLA (17%)	0.1	1.5	14.6	145.6	1,456.3	14,562.7
MA81-24	A (PWS, ORW)					LA (83%)	0.7	7.1	71.1	710.7	7,106.7	71,067.3
Stillwater River		P	35	NA	-	WLA (4%)	-	0.3	3.4	33.6	335.6	3,355.8
MA81-31	A (PWS, ORW)					LA (96%)	0.8	8.2	82.3	822.7	8,227.4	82,274.2
Fall Brook		P	35	NA	-	WLA (18%)	0.2	1.5	15.3	152.6	1,526.0	15,260.3
MA81-39	B					LA (82%)	0.7	7.0	70.4	703.7	7,037.0	70,369.7
Still River		P	35	NA	-	WLA (10%)	0.1	0.8	8.3	83.4	833.8	8,337.6
MA81-60	B (CW)					LA (90%)	0.8	7.7	77.3	772.9	7,729.2	77,292.4
Baker Brook		P	35	NA	-	WLA (10%)	0.1	0.8	8.3	82.7	826.9	8,268.5
MA81-62	B (CSO)					LA (90%)	0.8	7.7	77.4	773.6	7,736.2	77,361.5
Wekepeke Brook		P	35	NA	-	WLA (9%)	0.1	0.8	7.7	77.1	771.5	7,714.8
MA81-72	B					LA (91%)	0.8	7.8	77.9	779.2	7,791.5	77,915.2
Catacoonamug Brook		P	35	NA	-	WLA (9%)	0.1	0.7	7.3	73.0	729.6	7,295.8
MA81-74	B					LA (91%)	0.8	7.8	78.3	783.3	7,833.4	78,334.2
Willard Brook		R	35	NA	-	WLA (4%)	-	0.3	3.4	34.2	342.2	3,421.5
MA81-79	B (ORW)					LA (96%)	0.8	8.2	82.2	822.1	8,220.8	82,208.5
Pearl Hill Brook		R	35	NA	-	WLA (3%)	-	0.3	2.6	25.7	257.3	2,573.4
MA81-80	B (ORW)					LA (97%)	0.8	8.3	83.1	830.6	8,305.7	83,056.6
Falulah Brook		P	35	NA	-	WLA (2%)	-	0.2	1.6	15.5	155.1	1,551.4
MA81-99	A (PWS, ORW)					LA (98%)	0.8	8.4	84.1	840.8	8,407.9	84,078.7
Falulah Brook		P	35	NA	-	WLA (7%)	0.1	0.6	5.6	56.3	563.3	5,633.0
MA81-100	B					LA (93%)	0.8	8.0	80.0	800.0	7,999.7	79,997.0

***Class** defined in the Massachusetts Surface Water Quality Standards (SWQS) at 314 CMR 4.02.*

Qualifiers *that identify segments with special characteristics are defined at 314 CMR 4.06(1)(d).*

- ***CSO*** *= Combined Sewer Overflow; waters identified as impacted by the discharge of CSOs without a long-term control plan approved or fully implemented*
- ***CW*** *= Cold Water; waters that meet the cold water fisheries (CWF) definition at 314 CMR 4.02 and are subject to CWF dissolved oxygen and temperature criteria*
- ***ORW*** *= Outstanding Resource Waters; waters designated for protection under 314 CMR 4.04(2);*
- ***PWS*** *=Public Water Supply; may be subject to more stringent criteria in accordance with 310 CMR 22.00, and may have restricted use;*
- ***WW*** *= Warm Water; waters that meet the warm water fisheries (WWF) definition at 314 CMR 4.02 and are subject to WWF dissolved oxygen and temperature criteria*

Pathogen bacteria units are presented in colony-forming units or CFU per 100 milliliter or ml.

TMDL Type *identifies the restorative or protective action approach:*

- ***R*** *= Restorative TMDL addressing a pathogen impairment identified in the 2018/2020 Integrated List of Waters*
- ***R**** *= Restorative TMDL addressing a historic impairment of former indicator bacteria for which no current applicable criteria are available See Section 2.3 of the core document for summary of water quality criteria and designated uses.*
- ***P*** *= Protective TMDL addressing all applicable uses, regardless of impairment status, for the associated pathogen (refer to the Massachusetts SWQS:314 CMR 4.00)*

Target TMDL or Total Maximum Daily Load is presented as both SWQS-Based and Flow-Based.

- ***SWQS-Based TMDL Target*** *is the target concentration applicable to the TMDL pollutant indicator bacteria based on the Surface Water Quality Standards (314 CMR 4.00).*
- ***Flow-Based Target TMD****L is the target concentration (CFU/100mL) multiplied by the standard flow volume (cubic feet per second or cfs). See Section 4.2.2 in core document for full equation and conversion factors.*

Maximum Geomean *is the highest calculated 30- or 90- day rolling geometric mean for TMDL pollutant indicator bacteria associated with the segment.*

Geomean Percent Reduction *is the percent reduction from the highest calculated 30- or 90- day rolling geomean needed to achieve the target concentration. Percent reductions are for planning purposes only.*

2. Nashua River Watershed Overview

The Nashua River watershed covers an area of approximately 530 square miles primarily in Worcester and Middlesex counties in north central Massachusetts and southern New Hampshire (Figure 2-1). It includes the North and South Nashua Rivers, as well as the Squannacook and Nissitissit Rivers. The mainstem of the Nashua River flows 37 miles to the northeast. There are 76 named rivers, approximately 667 river miles, many smaller unnamed rivers, and 109 named lakes, ponds, and impoundments in the watershed (USGS, 2019; MassDEP, 2008).

The North Nashua River, which begins at the confluence of the Whitman River and Flag Brook in Fitchburg, MA, generally flows to the southeast (MassDEP, 2008). The North Nashua River drains approximately 134 square miles, flowing about 19 miles before its confluence with the South Nashua River and the Nashua River mainstem in Lancaster, MA. The river course is slowed and altered by many dams and receives effluent from four major wastewater treatment facilities (WWTF) (MassDEP, 2008). There are four pathogen-impaired river segments along the North Nashua River and five pathogen-impaired tributary segments draining to the North Nashua River.

The South Nashua River, which begins at the Lancaster Millpond outlet in Clinton, MA, generally flows from the south to the north (MassDEP, 2008). The South Nashua River drains approximately 131 square miles, flowing about 1.84 miles before its confluence with the North Nashua River and the Nashua River mainstem in Lancaster, MA. The river course receives effluent from one WWTF. There is one pathogen-impaired river segment along the South Nashua River and two pathogen-impaired tributary segments draining to the South Nashua River.

The Nashua River mainstem begins at the confluence of the North and South Nashua Rivers in Lancaster, MA and generally flows from the south to the north. The Nashua River mainstem to the downstream end of segment MA81-05 drains approximately 344 square miles, flowing about 14 miles and encompassing a total of 15 pathogen-impaired river segments before its confluence with the Squannacook River at the border of Shirley, Groton, and Ayer. The river course is slowed and altered by the Ice House Dam in Ayer and receives effluent from one WWTF. There is one pathogen-impaired river segment along the Nashua River mainstem and two pathogen-impaired tributary segments draining to the Nashua River. The remaining twelve pathogen-impaired river segments come from the North and South Nashua Rivers.

Two pathogen-impaired river segments (Willard Brook MA81-79 and Pearl Hill Brook MA81-80) drain to the Squannacook River, which flows to the Nashua River at the dividing point between segments MA81-05 (impaired) and MA81-06 (unimpaired). James Brook (MA81-20) flows to the Nashua River a short distance downstream along MA81-06 (unimpaired).

The Nashua River watershed is characterized by long stretches of rivers and large impoundments. Many of these impoundments can be found along the mainstem (four dams) and both the North and South Nashua Rivers. Of the four mainstem impoundments, the Pepperell Paper Company Dam spans 296 acres and the Ice House Dam covers 137 acres. The Wachusett Reservoir contributes to 35% of the 11,293-lake acreage within the watershed. The Nashua River watershed encompasses mostly rural areas within Massachusetts and New Hampshire with some areas of concentrated development. The Nashua River was designated as a Wild and Scenic River on March 12, 2019, under the Nashua Wild and Scenic River Act (NRWA, 2018).

The Nashua River watershed overlaps at least partially with 21 towns and three cities. Of these, 18 were identified as being direct sources of pathogen loading to the impaired river segments in this TMDL. The efforts of these municipalities to reduce pollutant loading are described in the segment-specific sections below. For each segment, the cities and towns that contain or border the impaired segment were included. Towns comprising more than 10% of the impaired stream segment's sub-basin (that portion of its watershed not shared with upstream segments) were also included. See Figure 2-1 for a map showing impaired segments and municipalities.

Many municipalities operate and maintain municipal separate storm sewer systems (MS4s) in urban areas. These networks of drains and pipes convey polluted runoff from streets and developed areas to streams. In addition, these networks are sometimes subject to direct wastewater inflows through illegal cross-connections, leaks from sewer pipes or septic systems, dumping, or other unauthorized wastewater sources, and together these sources are termed illicit discharges. Municipalities with MS4 systems in urban areas are coming under gradually increasing regulation to improve and protect water quality (for more detailed history, see Section 5.2 and 7.4 of the core document).

EPA and MassDEP jointly issue the General Permit for Stormwater Discharges from MS4s, which became effective July 1, 2018. Communities that discharge to pathogen-impaired waterbodies with approved TMDLs are required to implement enhanced best management practices (BMPs) for public education and designate the catchments as Problem Catchments or High Priority under the Illicit Discharge Detection and Elimination (IDDE) Program, in addition to the requirement to reduce pollutants to the Maximum Extent Practicable (USEPA, 2020, Appendix F).

In addition to municipalities, there are three Regional Planning Agencies (RPAs) in the Nashua River watershed. These are public organizations advising municipalities, private business groups, and state and federal governments on a range of matters. Their research, coordination, and technical assistance is especially valuable on watershed issues that cross town boundaries, such as pathogen pollutants and stormwater.

- Montachusett Regional Planning Commission (MRPC), http://www.mrpc.org/ (MRPC, 2020)
- Central Massachusetts Regional Planning Commission (CMRPC), http://www.cmrpc.org/ (CMRPC, 2020)
- Metropolitan Area Planning Council (MAPC), http://www.mapc.org/ (MAPC, 2020)

The following RPA initiatives and tools are especially noteworthy:

- There are regional stormwater coalitions within some RPAs, and these are noted in the segment-specific sections below.
- MAPC created a Stormwater Utility/Funding Starting Kit (MAPC, 2014).
- MAPC and the Neponset River Watershed Association created a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit (MAPC, 2018).

Beyond these activities, the Massachusetts Statewide Municipal Stormwater Coalition (MSMSC), composed of about 10 stormwater groups around the state, further coordinates with and assists municipalities on pathogen pollutant concerns in the "Think Blue" campaign (Think Blue Massachusetts, 2019).

Additional watershed scale initiatives are carried out by several organizations including:

Nashua River Watershed Association (NRWA) promotes conservation and aims to restore the waterways within the watershed while protecting water quality and quantity for the community and natural environment. The NRWA works to monitor river water quality and quantity while encouraging land stewardship and environmental education.Water quality data generated by NRWA and submitted to MassDEP as part of the Integrated List of Waters development was used in this appendix (MassDEP, n.d.).

The Northeast Rural Water Association (NERWA) has been working with seven towns within the Nashua River watershed to develop comprehensive source water protection plans for unconfined sand gravel aquifers contributing to public water supplies.

The following actions will help reduce pathogen loads to the streams. The list is a starting point and is not comprehensive. For a more detailed discussion of pollutant reduction actions, see Section 5 "Implementation" of the core TMDL document.

- Removal of all CSOs in the watershed is a top priority.
- **Municipalities:** Continue to implement requirements of the MS4 General Permit, which includes specific requirements for waterbodies with an approved Bacteria/Pathogen TMDL, such as prioritization and reporting, enhanced BMPs, IDDE work, and education (USEPA, 2020).
- **Regional Planning Agencies (RPAs) and municipalities:** Continue and expand collaboration on MS4 and stormwater issues. Cooperatively developing tools and sharing knowledge has many advantages, including reduced costs, increased innovation, and more consistent and effective stream restoration efforts at the watershed scale.
  - Two tools developed by MAPC are potentially valuable in all MS4 communities in the state. Municipalities and other RPAs (with permission from MAPC) should consider adapting and/or expanding on these tools in their area:

  - Stormwater Utility/Funding Starting Kit (MAPC, 2014).
  - MAPC and the Neponset River Watershed Association created a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit (MAPC, 2018).
- **USDA NRCS and landowners:** Develop comprehensive nutrient management plans for agriculture, using local connections to farmers for outreach.
- **Parks departments, schools, private landowners, and others** who maintain large, mowed fields with direct access to water should consider maintaining a vegetative buffer along the water's edge. Buffers slow and filter stormwater runoff, provide a visual screen that can reduce large aggregations of waterfowl, and have many other water quality benefits at low cost.

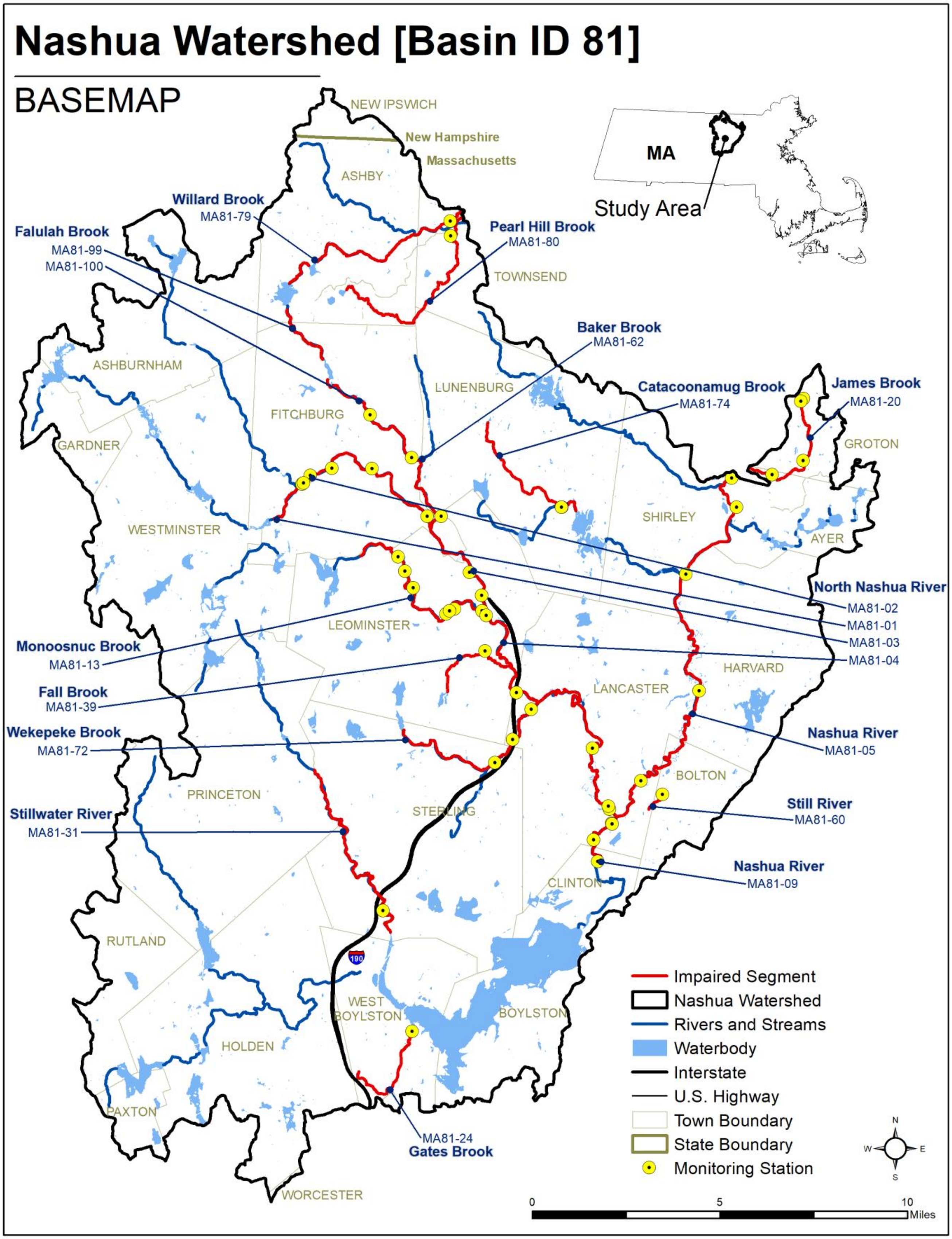


Figure 2-1: Map of all pathogen-impaired river segments, water quality monitoring stations, municipal borders, waterbodies, and roads in the Nashua River watershed.

3. MA81-01 North Nashua River

3.1. Waterbody Overview

Reduction from Highest calculated Geomean: 99%

Watershed Area (Acres): 37,669

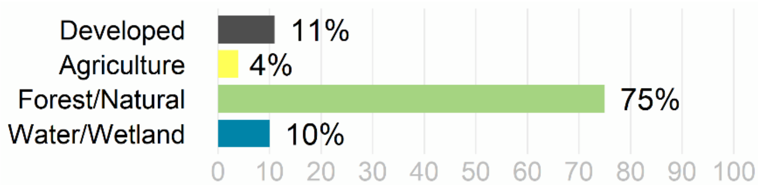
Segment Length (miles): 1.7

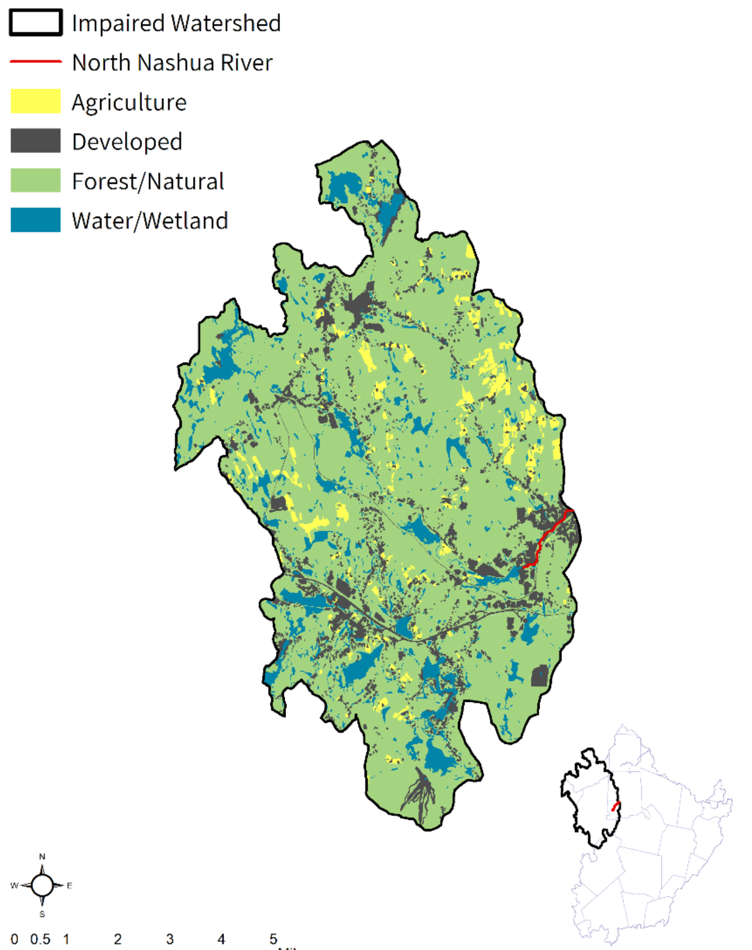
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water, CSO Receiving Water)

Impervious Area (Acres, %): 2,388 (6%)

DCIA Area (Acres, %): 1,097 (3%)





The North Nashua River segment MA81-01 is 1.7 miles long and begins at the outlet of Snows Millpond in Fitchburg, MA. From Snows Millpond, segment MA81-01 flows northeast along Route 2A, before being bound at its downstream end by the Fitchburg Paper Company Dam #1 (NATID: MA00877). The segment is located entirely within the town of Fitchburg.

Named tributaries to North Nashua River segment MA81-01 include Whitman River, Flag Brook, and Philips Brook. Major lakes and reservoirs within the segment watershed include Winnekeag Lake, Lake Wampanoag, Whitmanville Pond, and Wyman Pond.

Key landmarks in the watershed include the town centers of Ashburnham, South Ashburnham and Westminster, the Woods of Westminster Golf Course, Westminster Country Club and golf course, and Mount Wachusett ski resort. This segment flows beneath Princeton Road/MA-31 and Depot Street in Fitchburg near the start and end of its reach, respectively.

The North Nashua River (MA81-01) drains an area of 59 square miles, of which 4 mi^2 (6%) is impervious and 2 mi^2 (3%) is directly connected impervious area (DCIA). The watershed is served partially[1] by public sewer and 17% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES wastewater treatment facility permit on file governing point source discharges of pollutants to surface waters within the immediate drainage area to the impaired segment (Table 3-1); although the West Fitchburg WWTF is permitted to discharge to this segment, as of December 2003 all domestic wastewater flows were diverted to the East Fitchburg Wastewater Treatment Plant. There are no MassDEP discharge to groundwater permits within the watershed or the immediate drainage area. There are no active combined sewer overflows[2], six landfills, and 2 unpermitted land disposal dumping grounds in the western part of the watershed. The inactive N Central Correction Institute Dump (Solid

[1] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

[2] MassDEP maintains a CSO qualifier for the North Nashua River from source to Leominster POTW discharge.

Waste Facility ID: 332.006, Westminster, MA) and the closed High Ridge Wildlife Management Area (Solid Waste Facility ID: 103.007, Gardner, MA) are both state run organizations which received construction and demolition waste and municipal solid waste, respectively. See Figure 3-1.

Table 3-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable. As of December 2003, all domestic wastewater flows from the West Fitchburg WWTF were diverted to the East Fitchburg Wastewater Treatment Plant.

NPDES ID	NAME	TOWN	WWTF
MA0101281	WEST FITCHBURG WWTF	FITCHBURG	MUN

The entire segment flows through a patchwork of land uses ranging from forested and natural areas to agriculture and dense commercial and residential development. Most of the developed land exists in the western part of the segment watershed near the impaired segment and increases in density closer to Fitchburg town center. Development along the segment consists of residential communities and commercial buildings.

In the watershed of the North Nashua River (MA81-01), under the Natural Heritage and Endangered Species Program, there are 312 acres (1%) of Priority Natural Vegetation Communities and 1,424 acres (4%) of Priority Habitats of Rare Species. There are 2,117 acres (6%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 2,082 acres (6%) of land protected in perpetuity[3] exist within the segment watershed, which is part of a total of 10,089 acres (27%) of Protected and Recreational Open Space[4]. See Figure 3-1.

[3] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[4] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

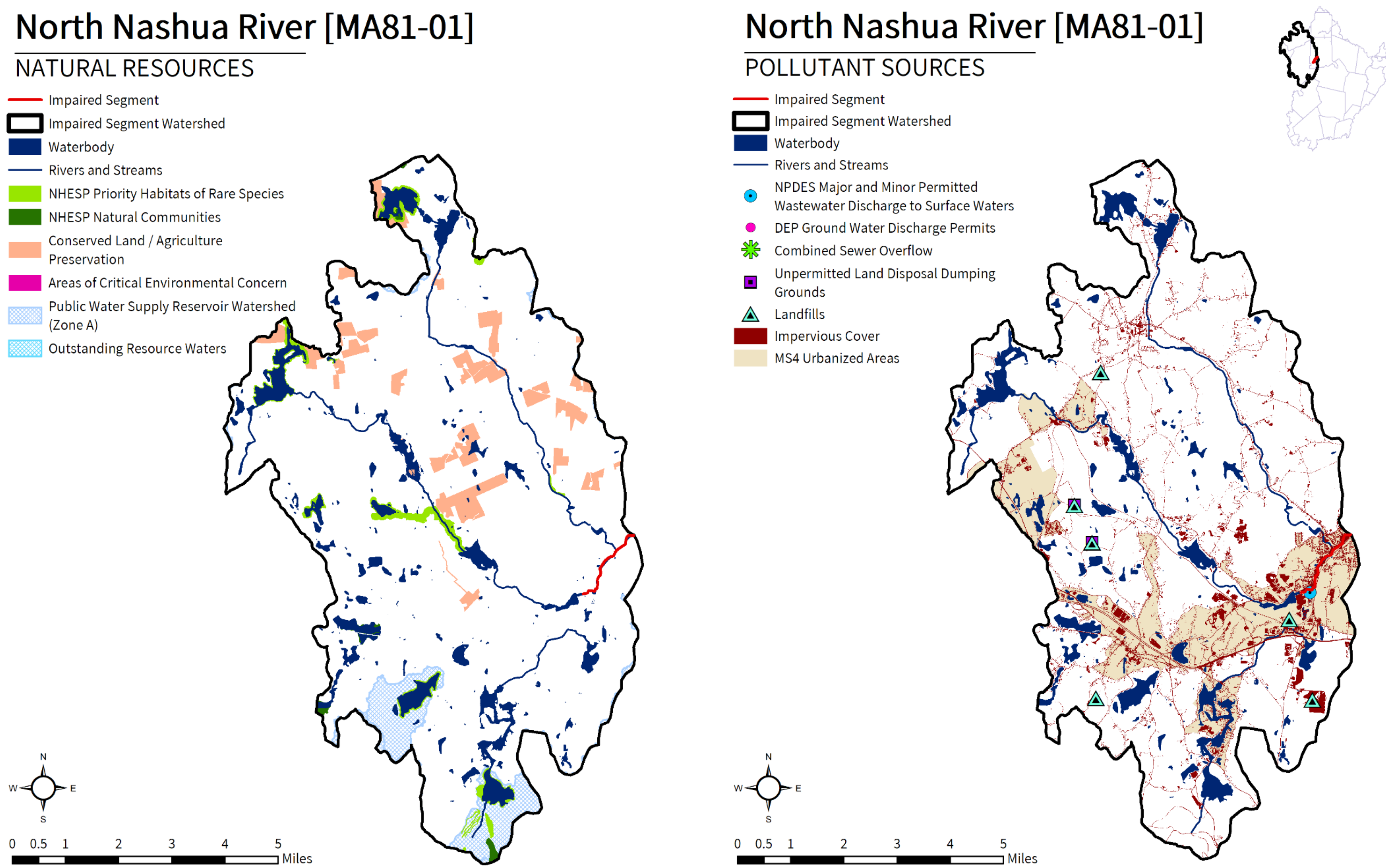


Figure 3-1. Natural resources and potential pollution sources draining to the North Nashua River segment MA81-01. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities

3.2. Waterbody Impairment Characterization

The North Nashua River (MA81-01) is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 3-2, 3-3; Figure 3-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- From 2010-2017, 55 samples were collected at NN3071, resulting in 12 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the Statistical Threshold Value (STV) criterion was applied to single sample results. Out of 55 samples, six exceeded the STV criterion in 2010, 2012, 2014, 2015, and 2016 during both wet and dry weather.
- In 2008, six samples were collected at W1780, resulting in three days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion in 2008 during dry weather only.

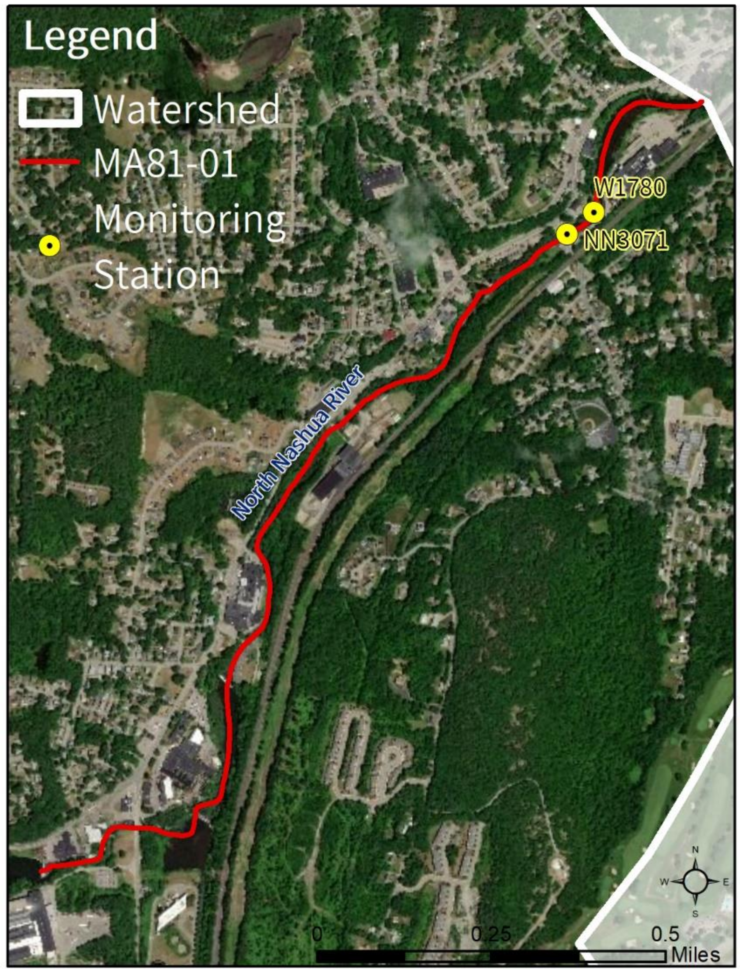


Figure 3-2. Location of monitoring station(s) along the impaired river segment.

Table 3-2. Summary of indicator bacteria sampling results by station for the North Nashua River (MA81-01). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
NN3071	4/17/2010	10/21/2017	55	575	12	6
W1780	5/15/2008	9/18/2008	6	11000	3	1

Table 3-3. Indicator bacteria data by station, indicator, and date for the North Nashua River (MA81-01). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
NN3071	*E. coli*	4/17/2010	WET	5	5	
NN3071	*E. coli*	5/15/2010	DRY	22	10	
NN3071	*E. coli*	6/19/2010	DRY	387	35	
NN3071	*E. coli*	7/17/2010	DRY	387	149	
NN3071	*E. coli*	8/21/2010	DRY	84	233	
NN3071	*E. coli*	9/18/2010	DRY	102	149	
NN3071	*E. coli*	10/16/2010	WET	1046	208	
NN3071	*E. coli*	4/16/2011	WET	20	20	
NN3071	*E. coli*	5/21/2011	DRY	54	33	
NN3071	*E. coli*	6/18/2011	DRY	86	45	
NN3071	*E. coli*	7/16/2011	DRY	43	58	
NN3071	*E. coli*	8/20/2011	DRY	38	52	
NN3071	*E. coli*	9/17/2011	DRY	78	50	
NN3071	*E. coli*	10/15/2011	WET	365	103	
NN3071	*E. coli*	4/21/2012	DRY	17	17	
NN3071	*E. coli*	5/19/2012	DRY	345	77	
NN3071	*E. coli*	6/16/2012	DRY	91	81	
NN3071	*E. coli*	7/21/2012	DRY	61	124	
NN3071	*E. coli*	8/18/2012	WET	548	145	
NN3071	*E. coli*	9/15/2012	DRY	96	148	
NN3071	*E. coli*	10/20/2012	WET	291	248	
NN3071	*E. coli*	4/20/2013	DRY	7	7	
NN3071	*E. coli*	5/18/2013	DRY	23	13	
NN3071	*E. coli*	6/15/2013	WET	52	20	
NN3071	*E. coli*	7/20/2013	DRY	108	51	
NN3071	*E. coli*	8/17/2013	DRY	31	56	
NN3071	*E. coli*	9/21/2013	DRY	155	80	
NN3071	*E. coli*	10/19/2013	DRY	29	52	
NN3071	*E. coli*	4/19/2014	DRY	8	8	
NN3071	*E. coli*	5/17/2014	WET	326	51	
NN3071	*E. coli*	6/21/2014	DRY	78	59	
NN3071	*E. coli*	7/19/2014	DRY	31	92	
NN3071	*E. coli*	8/16/2014	DRY	146	71	
NN3071	*E. coli*	9/20/2014	DRY	225	101	
NN3071	*E. coli*	10/18/2014	WET	770	294	
NN3071	*E. coli*	4/20/2015	WET	9	9	
NN3071	*E. coli*	5/16/2015	DRY	18	13	
NN3071	*E. coli*	6/20/2015	DRY	79	23	
NN3071	*E. coli*	7/18/2015	DRY	238	42	
NN3071	*E. coli*	8/15/2015	DRY	81	115	
NN3071	*E. coli*	9/19/2015	DRY	816	251	
NN3071	*E. coli*	10/17/2015	DRY	63	161	
NN3071	*E. coli*	4/16/2016	DRY	17	17	
NN3071	*E. coli*	5/21/2016	DRY	50	29	
NN3071	*E. coli*	6/18/2016	DRY	54	36	
NN3071	*E. coli*	7/16/2016	DRY	285	92	
NN3071	*E. coli*	8/20/2016	DRY	75	105	
NN3071	*E. coli*	9/17/2016	DRY	1046	282	
NN3071	*E. coli*	10/15/2016	DRY	2420	575	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
NN3071	*E. coli*	4/15/2017	DRY	17	17	
NN3071	*E. coli*	5/20/2017	DRY	47	28	
NN3071	*E. coli*	6/17/2017	WET	9	19	
NN3071	*E. coli*	7/15/2017	DRY	34	24	
NN3071	*E. coli*	9/16/2017	DRY	73	50	
NN3071	*E. coli*	10/21/2017	DRY	108	89	
W1780	*E. coli*	5/15/2008	DRY	11000	11000	
W1780	*E. coli*	6/12/2008	DRY	170	1367	
W1780	*E. coli*	7/17/2008	DRY	45	438	
W1780	*E. coli*	8/14/2008	WET	45	70	
W1780	*E. coli*	9/4/2008	DRY	130	82	
W1780	*E. coli*	9/18/2008	DRY	55	62	

3.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for the North Nashua River (MA81-01) were elevated during both wet and dry weather at station NN3071 and during dry weather at station W1780. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the North Nashua River (MA81-01) watershed are highly developed, with 17% of the land area in MS4, 3% as DCIA, and a dense urban fabric which has hardened the riverbanks as the segment flows toward Fitchburg. There is a large portion of the watershed that extends far upstream of the segment and about 11% of the watershed is categorized as developed land. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed serviced by sewer and some (17%) of the watershed designated as MS4 area, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are likely a significant source of pathogens.

On-Site Wastewater Disposal Systems: There are no groundwater discharge permits for on-site wastewater discharge. Much of the residential development in the watershed uses septic systems for wastewater treatment; it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural areas are scattered throughout the watershed. One small area of agricultural land is situated near the central portion of the impaired river segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. Additionally, any areas adjacent to upstream tributaries or storm drains could also provide a direct conduit to the river.

Pet Waste: Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water, as found near the MA-31 road crossing.

3.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashburnham

Ashburnham had an MS4 General Permit waiver, approved on February 14, 2019: https://www3.epa.gov/region1/npdes/stormwater/ma/waivers/ashburnham-epa-waiver-response.pdf (Moraff, 2019)

Ashburnham has the following relevant ordinances and bylaws:

- The town has a joint Water-Sewer Commission with the Town of Winchendon
- Sewer Regulations: Chapter XX Rules & Regulations for Municipal Sewer Collection Disposal System: https://www.ashburnham-ma.gov/sites/g/files/vyhlif266/f/uploads/general_bylaws_revised_november_17_2010.pdf (Town of Ashburnham, 2010)
- Wetlands Protection bylaw: https://www.ashburnham-ma.gov/conservation-commission/pages/ashburnham-wetlands-protection-bylaw (Town of Ashburnham, 2019)

Ashburnham's Master Plan mentions "the problem of septic disposal" on page 13: https://www.ashburnham-ma.gov/sites/g/files/vyhlif266/f/uploads/master_plan_1986.pdf (Town of Ashburnham, 1986)
Ashburnham's Open Space and Recreation Plan was last updated in 2014 (not found online), and the next revision is estimated for completion in 2021.

City of Fitchburg

Almost half of Fitchburg is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Fitchburg (Permit ID #MAR041189) has an EPA approved Notice of Intent (NOI), as well as a Stormwater Management Plan, available at www.fitchburgma.gov (City of Fitchburg, 2020). The city has mapped its stormwater outfall system (http://www.ci.fitchburg.ma.us/DocumentCenter/View/6893/Fitchburg-Stormwater-System-Map-Arcadis-2020; Arcadis, 2020). It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 1999. According to the NOI, there are six stormwater outfalls into the pathogen-impaired Monoosnuc Brook MA81-13. There are 24 stormwater outfalls into the uppermost segment of the North Nashua River (MA81-01), and 90 stormwater outfalls into the next downstream segment (MA81-02), both of which are impaired for *E. coli*.

Fitchburg has the following relevant ordinance and bylaws:

- Stormwater Ordinance: https://ecode360.com/10431661 (City of Fitchburg, 2019)
- Wetland Protection Ordinance: http://www.ci.fitchburg.ma.us/DocumentCenter/View/601/Fitchburg-Wetlands-Protection-Ordinance-PDF (City of Fitchburg, n.d., a)
- Title 5 Supplementary Regulations: None found.
- Pet Waste: None found.

- Stormwater Utility (or similar): None found.
- Contact Recreation Regulations or Bylaws: None found.

Fitchburg's Master Plan (http://www.ci.fitchburg.ma.us/153/Vision2020) has a Water Resources section in the Natural Resources chapter (page 76; City of Fitchburg, 1998). It is an extensive section on waterways, reservoirs, and wetlands. In addition, the Watershed Protection section in the Land Use chapter mentions protecting the city's drinking water supply as a focus. This section also mentions the Nashua River, an impaired waterbody within the Town of Fitchburg. In the Capital Facilities chapter, the plan mentions that improving the sewer service in areas where septic systems are failing is a recommendation.

Fitchburg town website: http://www.ci.fitchburg.ma.us/ (City of Fitchburg, 2020)

Fitchburg stormwater page: https://www.fitchburgma.gov/463/Stormwater (City of Fitchburg, n.d., b.)

Open Space and Recreation Plan: http://www.fitchburgma.gov/DocumentCenter/View/1715/Open-Space-and-Recreation-Plan-update-2014-2021 (City of Fitchburg, 2014)

Town of Westminster

Fifteen percent of Westminster is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Westminster (Permit ID #MAR041233) has an EPA approved Notice of Intent (NOI). Westminster has a stormwater management plan. Westminster has mapped all of its MS4 stormwater systems and adopted illicit discharge detection and elimination (IDDE) regulations in 2006, erosion and sediment control (ESC) regulations in 2013, and post-construction stormwater regulations in 2006. There are no reported stormwater outfalls resulting in impairments.

Stormwater Management Plan: https://www.westminster-ma.gov/sites/westminsterma/files/uploads/2019_westminster_swmp_plan.pdf (CEI, 2019)

Westminster has the following relevant ordinances and bylaws:

- Sewer Regulation: Chapter 161 https://www.ecode360.com/10451372?highlight=sewers&searchId=6917818213261665#10451372 (Town of Westminster, 1987)

Westminster's Master Plan has a section on Water Resources (Part C) under Section 4 Environmental Inventory and Analysis. The Master Plan also has a section on Municipal Sewer (page 27) in the Open Space and Recreation Chapter: https://www.westminster-ma.gov/planning-department/pages/master-plan (Town of Westminster, 2014). Westminster does not have a standalone Open Space and Recreation Plan available.

4. MA81-02 North Nashua River

4.1. Waterbody Overview

The North Nashua River segment MA81-02 is 6.9 miles long and begins at the outlet of the Fitchburg Paper Company Dam #1 (NATID: MA00877) in Fitchburg, MA. Segment MA81-02 flows southeast to be bound at the downstream end by the Fitchburg East Wastewater Treatment Plant (WWTP) outfall (NPDES: MA0100986), Fitchburg, MA.

Tributaries to North Nashua River segment MA81-02 include Sand Brook, Falulah Brook, and Baker Brook, in addition to those mentioned for MA81-01. Major lakes and ponds in the segment watershed include Fitchburg and Lovell Reservoirs. Impaired segment tributaries include the North Nashua River (MA81-01), Baker Brook (MA81-62), and Falulah Brook (MA81-99 and MA81-100, formerly MA81-63).

Key landmarks in the watershed include the town center and commercial district of Fitchburg, Fitchburg State University, and the Fitchburg Municipal Airport, plus those mentioned for segment MA81-01. Segment MA81-02 crosses underneath Kimball Street/MA-2A/MA-12, River Street/MA-31 twice, Laurel Street/MA-2A/MA-12, Water Street/MA-12, and other streets, all within Fitchburg.

The North Nashua River watershed (MA81-02) drains an area of 87 square miles, of which 8 mi^2 (10%) is impervious and 5 mi^2 (6%) is directly connected impervious area (DCIA). The watershed is served partially[5] by public sewer and 27% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES permit on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed, but none within the immediate drainage area to the impaired segment. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed. There are 11 combined sewer overflows (Table 4-1) and 8 landfills. Two

Reduction from Highest Calculated Geomean: 97%

Watershed Area (Acres): 55,453

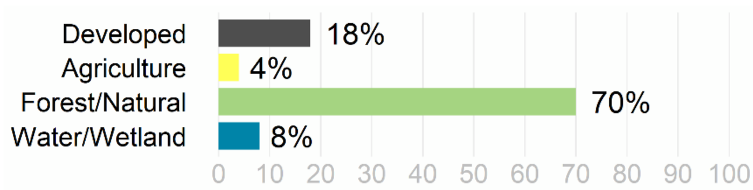
Segment Length (miles): 6.9

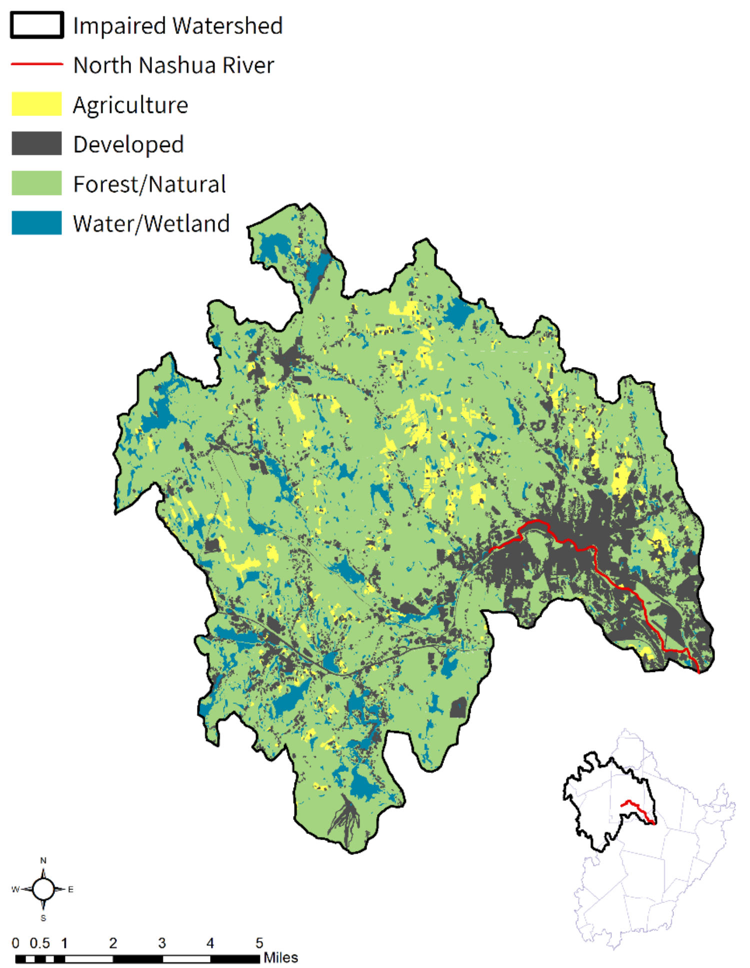
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water, CSO Receiving Water)

Impervious Area (Acres, %): 5,304 (10%)

DCIA Area (Acres, %): 3,123 (6%)





[5] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

unpermitted land disposal dumping grounds are located in the western part of the watershed (Solid Waste Facility ID 332.006 and 103.007). See Figure 4-1.

The entire segment flows through a patchwork of land uses ranging from forested and natural areas to dense commercial and residential development. Most of the developed land exists in the eastern part of the segment watershed along the impaired segment, such as the commercial and residential districts of Fitchburg in the upstream portion of the segment, and the Fitchburg Municipal Airport along the downstream portion.

In the watershed of the North Nashua River (MA81-02), under the Natural Heritage and Endangered Species Program, there are 317 acres (1%) of Priority Natural Vegetation Communities and 2,334 acres (4%) of Priority Habitats of Rare Species. There are 6,368 acres (11%) under Public Water Supply protection, 12 acres (<1%) identified as Outstanding Resource Waters, and 19 acres (<1%) of Areas of Critical Environmental Concern in this watershed. Over 4,311 acres (8%) of land protected in perpetuity[6] exist within the segment watershed, which is part of a total of 14,338 acres (26%) of Protected and Recreational Open Space[7]. See Figure 4-1.

Table 4-1. Combined Sewer Overflows (CSOs) discharging to the segment.

NPDES ID	NAME	TOWN	DEP OUTFALL ID
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT004
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT010
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT032
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT039
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT041
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT045A
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT045B
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT048
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT064
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT076
MA0100986	CITY OF FITCHBURG	FITCHBURG	FIT083

[6] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[7] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

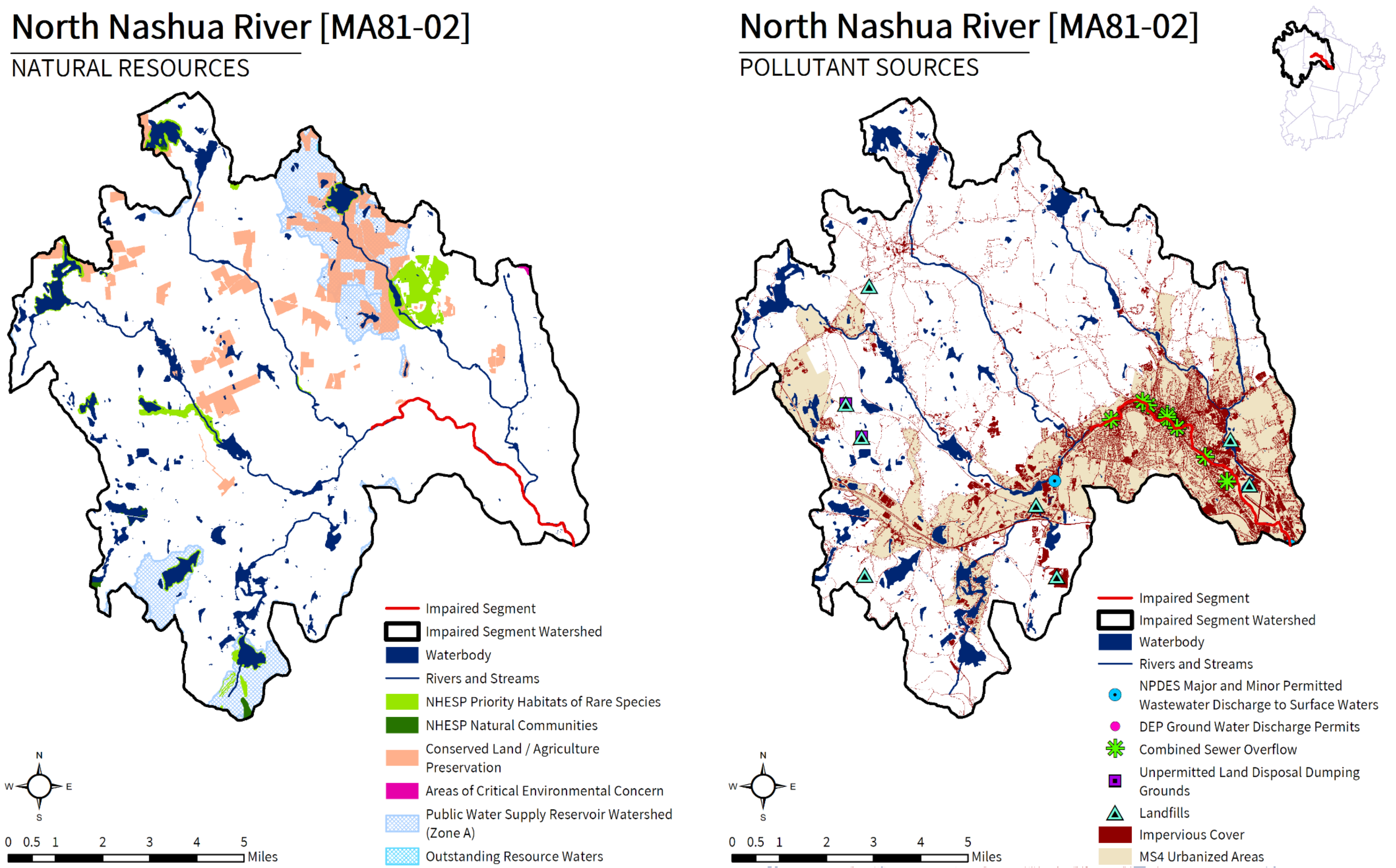


Figure 4-1. Natural resources and potential pollution sources draining to the North Nashua River segment MA81-02. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities

4.2. Waterbody Impairment Characterization

The North Nashua River (MA81-02) is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 4-2, 4-3; Figure 4-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

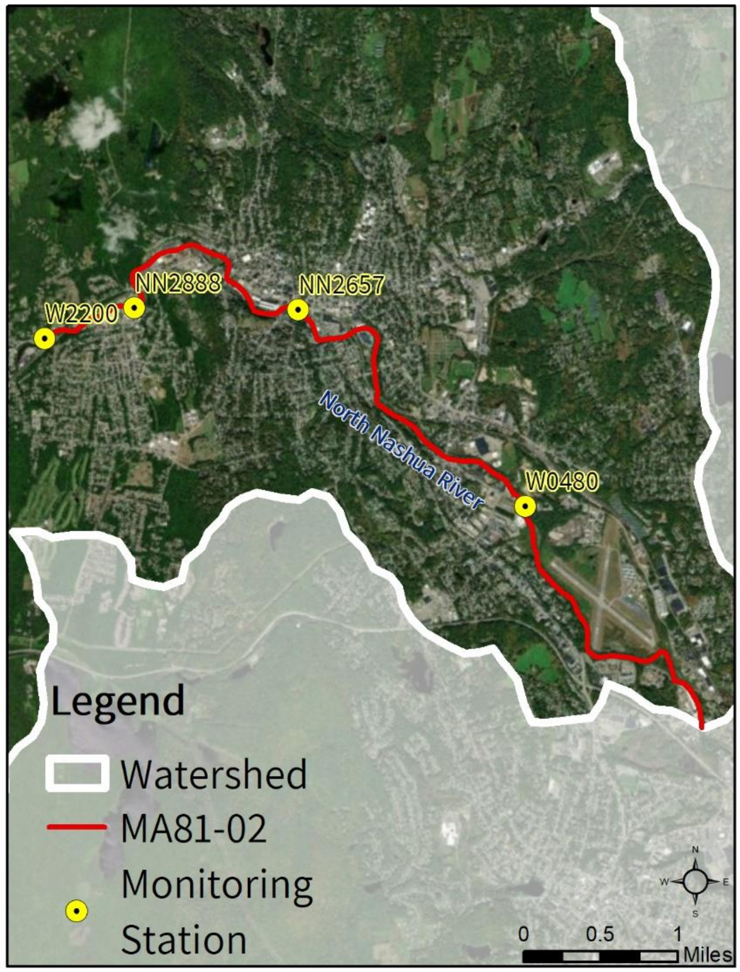


Figure 4-2. Location of monitoring station(s) along the impaired river segment.

- From 2008-2017, 66 samples were collected at NN2657, resulting in 46 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 66 samples, 24 exceeded the STV criterion in 2008-2012 and 2014-2017 during both wet and dry weather.
- From 2008-2017, 66 samples were collected at NN2888, resulting in 45 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 66 samples, 25 exceeded the STV criterion from 2008-2017 during both wet and dry weather.
- In 2008, six samples collected at W048, resulting in six days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, four exceeded the STV criterion during dry weather only.
- In 2011, six samples collected at W2200, resulting in two days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather only.

Table 4-2. Summary of indicator bacteria sampling results by station for the North Nashua River (MA81-02). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
NN2657	4/19/2008	10/21/2017	66	2420	46	24
NN2888	4/19/2008	10/21/2017	66	2420	45	25
W0480	5/15/2008	9/18/2008	6	3600	6	4
W2200	5/10/2011	9/19/2011	6	297	2	1

Table 4-3. Indicator bacteria data by station, indicator, and date for the North Nashua River (MA81-02). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN2657	*E. coli*	4/19/2008	DRY	1120	1120	
NN2657	*E. coli*	5/17/2008	WET	1553	1319	
NN2657	*E. coli*	7/19/2008	DRY	249	249	
NN2657	*E. coli*	8/16/2008	DRY	172	207	
NN2657	*E. coli*	9/20/2008	DRY	260	260	
NN2657	*E. coli*	10/18/2008	DRY	727	435	
NN2657	*E. coli*	4/18/2009	DRY	602	602	
NN2657	*E. coli*	5/16/2009	DRY	1046	794	
NN2657	*E. coli*	6/20/2009	WET	1733	1733	
NN2657	*E. coli*	7/18/2009	DRY	263	675	
NN2657	*E. coli*	8/15/2009	DRY	263	263	
NN2657	*E. coli*	9/1/2009	DRY	2420	798	
NN2657	*E. coli*	4/17/2010	WET	1120	1120	
NN2657	*E. coli*	5/15/2010	DRY	173	440	
NN2657	*E. coli*	6/19/2010	DRY	1986	1986	
NN2657	*E. coli*	7/17/2010	DRY	1986	1986	
NN2657	*E. coli*	8/21/2010	DRY	2420	2420	
NN2657	*E. coli*	9/18/2010	DRY	2420	2420	
NN2657	*E. coli*	10/16/2010	WET	1986	2192	
NN2657	*E. coli*	4/16/2011	WET	211	211	
NN2657	*E. coli*	5/21/2011	DRY	687	687	
NN2657	*E. coli*	6/18/2011	DRY	387	516	
NN2657	*E. coli*	7/16/2011	DRY	250	311	
NN2657	*E. coli*	8/20/2011	DRY	178	178	
NN2657	*E. coli*	9/17/2011	DRY	291	228	
NN2657	*E. coli*	10/15/2011	WET	1203	592	
NN2657	*E. coli*	4/21/2012	DRY	1046	1046	
NN2657	*E. coli*	5/19/2012	DRY	579	778	
NN2657	*E. coli*	7/21/2012	DRY	2420	2420	
NN2657	*E. coli*	8/18/2012	WET	1203	1706	
NN2657	*E. coli*	9/15/2012	DRY	81	312	
NN2657	*E. coli*	10/20/2012	WET	248	248	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN2657	*E. coli*	4/20/2013	DRY	32	32	
NN2657	*E. coli*	5/18/2013	DRY	12	20	
NN2657	*E. coli*	6/15/2013	WET	122	38	
NN2657	*E. coli*	7/20/2013	DRY	129	129	
NN2657	*E. coli*	8/17/2013	DRY	44	75	
NN2657	*E. coli*	9/21/2013	DRY	32	32	
NN2657	*E. coli*	10/19/2013	DRY	33	32	
NN2657	*E. coli*	4/19/2014	DRY	60	60	
NN2657	*E. coli*	5/17/2014	WET	2420	381	
NN2657	*E. coli*	6/21/2014	DRY	76	76	
NN2657	*E. coli*	7/19/2014	DRY	19	38	
NN2657	*E. coli*	8/16/2014	DRY	261	70	
NN2657	*E. coli*	9/20/2014	DRY	33	33	
NN2657	*E. coli*	10/18/2014	WET	214	84	
NN2657	*E. coli*	4/20/2015	WET	25	25	
NN2657	*E. coli*	5/16/2015	DRY	40	32	
NN2657	*E. coli*	6/20/2015	DRY	84	84	
NN2657	*E. coli*	7/18/2015	DRY	945	282	
NN2657	*E. coli*	8/15/2015	DRY	99	306	
NN2657	*E. coli*	9/19/2015	DRY	261	261	
NN2657	*E. coli*	10/17/2015	DRY	137	189	
NN2657	*E. coli*	4/16/2016	DRY	28	28	
NN2657	*E. coli*	5/21/2016	DRY	111	111	
NN2657	*E. coli*	6/18/2016	DRY	179	141	
NN2657	*E. coli*	7/16/2016	DRY	461	287	
NN2657	*E. coli*	8/20/2016	DRY	299	299	
NN2657	*E. coli*	9/17/2016	DRY	63	137	
NN2657	*E. coli*	10/15/2016	DRY	2420	390	
NN2657	*E. coli*	5/20/2017	DRY	291	291	
NN2657	*E. coli*	6/17/2017	WET	18	72	
NN2657	*E. coli*	7/15/2017	DRY	197	60	
NN2657	*E. coli*	8/19/2017	DRY	727	727	
NN2657	*E. coli*	9/16/2017	DRY	119	294	
NN2657	*E. coli*	10/21/2017	DRY	54	54	
NN2888	*E. coli*	4/19/2008	DRY	727	727	
NN2888	*E. coli*	5/17/2008	WET	1733	1122	
NN2888	*E. coli*	7/19/2008	DRY	2420	2420	
NN2888	*E. coli*	8/16/2008	DRY	2420	2420	
NN2888	*E. coli*	9/20/2008	DRY	2420	2420	
NN2888	*E. coli*	10/18/2008	DRY	2420	2420	
NN2888	*E. coli*	4/18/2009	DRY	299	299	
NN2888	*E. coli*	5/16/2009	DRY	201	245	
NN2888	*E. coli*	6/20/2009	WET	173	173	
NN2888	*E. coli*	7/18/2009	DRY	980	412	
NN2888	*E. coli*	8/15/2009	DRY	980	980	
NN2888	*E. coli*	9/19/2009	DRY	1733	1733	
NN2888	*E. coli*	4/17/2010	WET	21	21	
NN2888	*E. coli*	5/15/2010	DRY	2420	225	
NN2888	*E. coli*	6/19/2010	DRY	2420	2420	
NN2888	*E. coli*	7/17/2010	DRY	2420	2420	
NN2888	*E. coli*	8/21/2010	DRY	2420	2420	
NN2888	*E. coli*	9/18/2010	DRY	2420	2420	
NN2888	*E. coli*	10/16/2010	WET	921	1493	
NN2888	*E. coli*	4/16/2011	WET	291	291	
NN2888	*E. coli*	5/21/2011	DRY	365	365	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN2888	*E. coli*	6/18/2011	DRY	365	365	
NN2888	*E. coli*	7/16/2011	DRY	387	376	
NN2888	*E. coli*	8/20/2011	DRY	201	201	
NN2888	*E. coli*	9/17/2011	DRY	122	157	
NN2888	*E. coli*	10/15/2011	WET	613	273	
NN2888	*E. coli*	4/21/2012	DRY	122	122	
NN2888	*E. coli*	5/19/2012	DRY	93	107	
NN2888	*E. coli*	7/21/2012	DRY	2420	2420	
NN2888	*E. coli*	8/18/2012	WET	2420	2420	
NN2888	*E. coli*	9/15/2012	DRY	236	756	
NN2888	*E. coli*	10/20/2012	WET	225	225	
NN2888	*E. coli*	4/20/2013	DRY	8	8	
NN2888	*E. coli*	5/18/2013	DRY	649	72	
NN2888	*E. coli*	6/15/2013	WET	108	265	
NN2888	*E. coli*	7/20/2013	DRY	345	345	
NN2888	*E. coli*	8/17/2013	DRY	76	162	
NN2888	*E. coli*	9/21/2013	DRY	69	69	
NN2888	*E. coli*	10/19/2013	DRY	53	60	
NN2888	*E. coli*	4/19/2014	DRY	49	49	
NN2888	*E. coli*	5/17/2014	WET	1986	312	
NN2888	*E. coli*	6/21/2014	DRY	152	152	
NN2888	*E. coli*	7/19/2014	DRY	21	56	
NN2888	*E. coli*	8/16/2014	DRY	178	61	
NN2888	*E. coli*	9/20/2014	DRY	86	86	
NN2888	*E. coli*	10/18/2014	WET	517	211	
NN2888	*E. coli*	4/20/2015	WET	26	26	
NN2888	*E. coli*	5/16/2015	DRY	126	57	
NN2888	*E. coli*	6/20/2015	DRY	196	196	
NN2888	*E. coli*	7/18/2015	DRY	914	423	
NN2888	*E. coli*	8/15/2015	DRY	108	314	
NN2888	*E. coli*	9/19/2015	DRY	365	365	
NN2888	*E. coli*	10/17/2015	DRY	35	113	
NN2888	*E. coli*	4/16/2016	DRY	31	31	
NN2888	*E. coli*	5/21/2016	DRY	59	59	
NN2888	*E. coli*	6/18/2016	DRY	125	86	
NN2888	*E. coli*	7/16/2016	DRY	727	301	
NN2888	*E. coli*	8/20/2016	DRY	326	326	
NN2888	*E. coli*	9/17/2016	DRY	139	213	
NN2888	*E. coli*	10/15/2016	DRY	2420	580	
NN2888	*E. coli*	5/20/2017	DRY	115	115	
NN2888	*E. coli*	6/17/2017	WET	21	49	
NN2888	*E. coli*	7/15/2017	DRY	185	62	
NN2888	*E. coli*	8/19/2017	DRY	461	461	
NN2888	*E. coli*	9/16/2017	DRY	59	165	
NN2888	*E. coli*	10/21/2017	DRY	66	66	
W0480	*E. coli*	5/15/2008	DRY	3600	3600	
W0480	*E. coli*	6/12/2008	DRY	1400	2245	
W0480	*E. coli*	7/17/2008	DRY	970	970	
W0480	*E. coli*	8/14/2008	WET	390	615	
W0480	*E. coli*	9/4/2008	DRY	280	330	
W0480	*E. coli*	9/18/2008	DRY	650	427	
W2200	*E. coli*	5/10/2011	DRY	84	84	
W2200	*E. coli*	6/14/2011	DRY	240	240	
W2200	*E. coli*	6/30/2011	DRY	61	121	
W2200	*E. coli*	7/19/2011	DRY	110	82	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W2200	*E. coli*	8/16/2011	WET	800	297	
W2200	*E. coli*	9/19/2011	DRY	32	32	

4.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for North Nashua River (MA81-02) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Combined Sewer Overflow (CSO): There are 11 CSOs in the direct drainage area to the segment, which by design release untreated wastewater to surface waters when flows exceed system capacity, and therefore must be eliminated. For this reason, it is set as the highest priority pathogen source.

Urban Stormwater: Large portions of the North Nashua River (MA81-02) watershed are highly developed, with 27% of the land area in MS4 and 6% as DCIA. The segment is surrounded by mixed residential, commercial, and industrial development, and much of the rest of the watershed in is residential and forested/natural land use. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed (27%) designated as MS4 area and most of the area adjacent to the segment likely in sewer service, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are likely a significant source of pathogens.

On-Site Wastewater Disposal Systems: There are no groundwater discharge permits for on-site wastewater discharge within the watershed. Given the large portion of the watershed not covered by sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are large agriculture activities in the headwaters to the impaired segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens. These locations adjacent to the segment include but are not limited to Gateway Park, Crocker Field, and Fitchburg Riverfront Park.

Wildlife Waste: Conservation lands, parks, and airfields with large open mowed areas with a clear sightline to a waterbody, along with open meadow wetlands, may attract large amounts waterfowl and elevate indicator bacteria counts in the water.

4.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

City of Fitchburg. See Section 3.4

Town of Ashburnham. See Section 3.4

Town of Westminster. See Section 3.4

5. MA81-03 North Nashua River

5.1. Waterbody Overview

The North Nashua River segment MA81-03 is 1.6 miles long and begins at the outfall of the Fitchburg East WWTP (NPDES: MA0100986) in Leominster, MA. Segment MA81-03 flows to the south and is bound at the downstream end by the Leominster WWTP outfall (NPDES: MA0100617) in Leominster.

Tributaries to the North Nashua River segment MA81-03 include the impaired North Nashua River segments MA81-01 and MA81-02 (and their impaired tributaries), as well as Monoosnuc Brook (MA81-13). Major lakes and ponds in the segment watershed include the Fitchburg and Lovell Reservoirs.

Key landmarks in the watershed include those mentioned for segment MA81-02 in addition to the town center and commercial district of Leominster, the Mall at Whitney Field, and the Monoosnock Country Club and golf course. Segment MA81-03 flows through a forested corridor and only crosses three roadways: Hamilton Street, Main Street/MA-13, and the Concord Turnpike/MA-13, all within Leominster.

The North Nashua River (MA81-03) drains an area of 100 square miles, of which 10 mi^2 (10%) is impervious and 6 mi^2 (6%) is directly connected impervious area (DCIA). The watershed is served partially[8] by public sewer and 29% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are two NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed (one within the immediate drainage area to the impaired segment) (Table 5-1). There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed. There are 11 combined sewer overflows within the segment watershed (none within the direct drainage area, see Table 4-1) and eight landfills. Two unpermitted land disposal dumping grounds are located in the western part

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 64,031

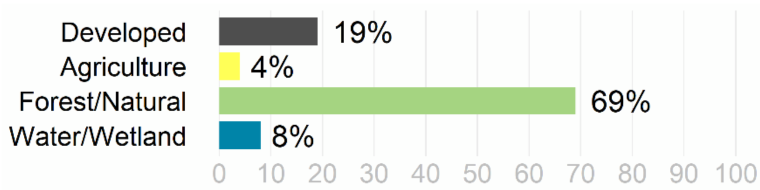
Segment Length (miles): 1.6

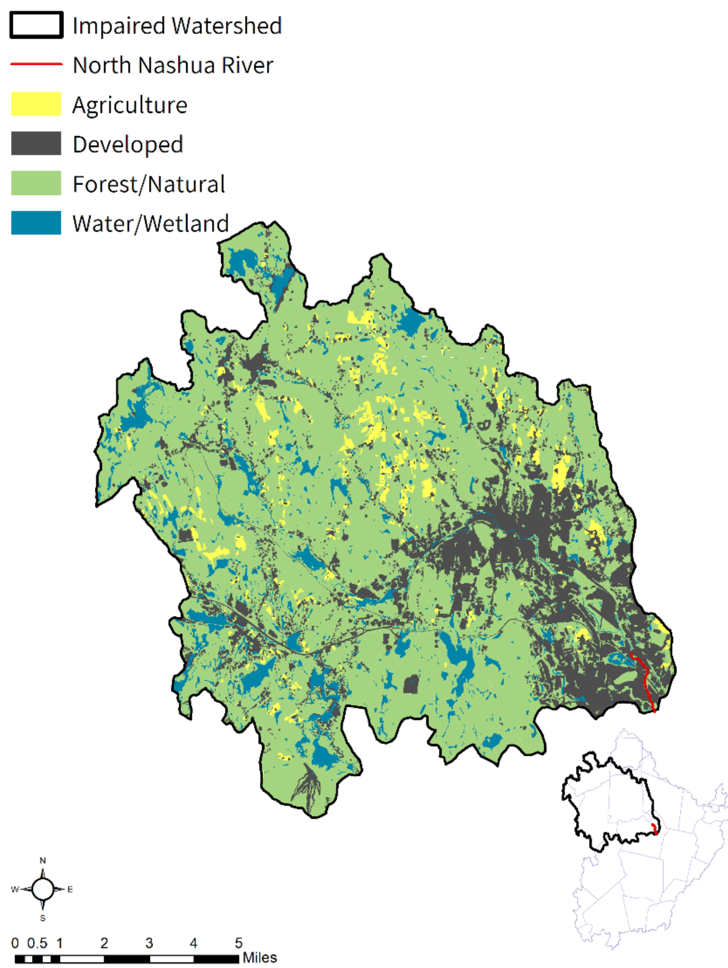
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water, CSO Receiving Water)

Impervious Area (Acres, %): 6,624 (10%)

DCIA Area (Acres, %): 4,070 (6%)





[8] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

of the watershed (Solid Waste Facility ID 332.006 and 103.007). See Figure 5-1.

Table 5-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0100986	FITCHBURG EAST WWTF	FITCHBURG	MUN

The entire segment flows through a narrow forested corridor adjacent to a patchwork of land uses ranging from forested and natural areas to densely developed commercial and residential development. Most of the developed land exists in the southwestern part of the segment watershed along the roadway connectors from Fitchburg to Leominster. This includes residential communities, along with the commercial Mall at Whitney Field.

In the watershed of the North Nashua River (MA81-03), under the Natural Heritage and Endangered Species Program, there are 317 acres (<1%) of Priority Natural Vegetation Communities and 2,943 acres (5%) of Priority Habitats of Rare Species. There are 10,640 acres (17%) under Public Water Supply protection, 12 acres (<1%) of Outstanding Resource Waters, and 19 acres (<1%) of Areas of Critical Environmental Concern in the watershed. Over 4,356 acres (7%) of land protected in perpetuity[9] exist within the segment watershed, which is part of a total of 18,153 acres (28%) of Protected and Recreational Open Space[10]. See Figure 5-1.

[9] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[10] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

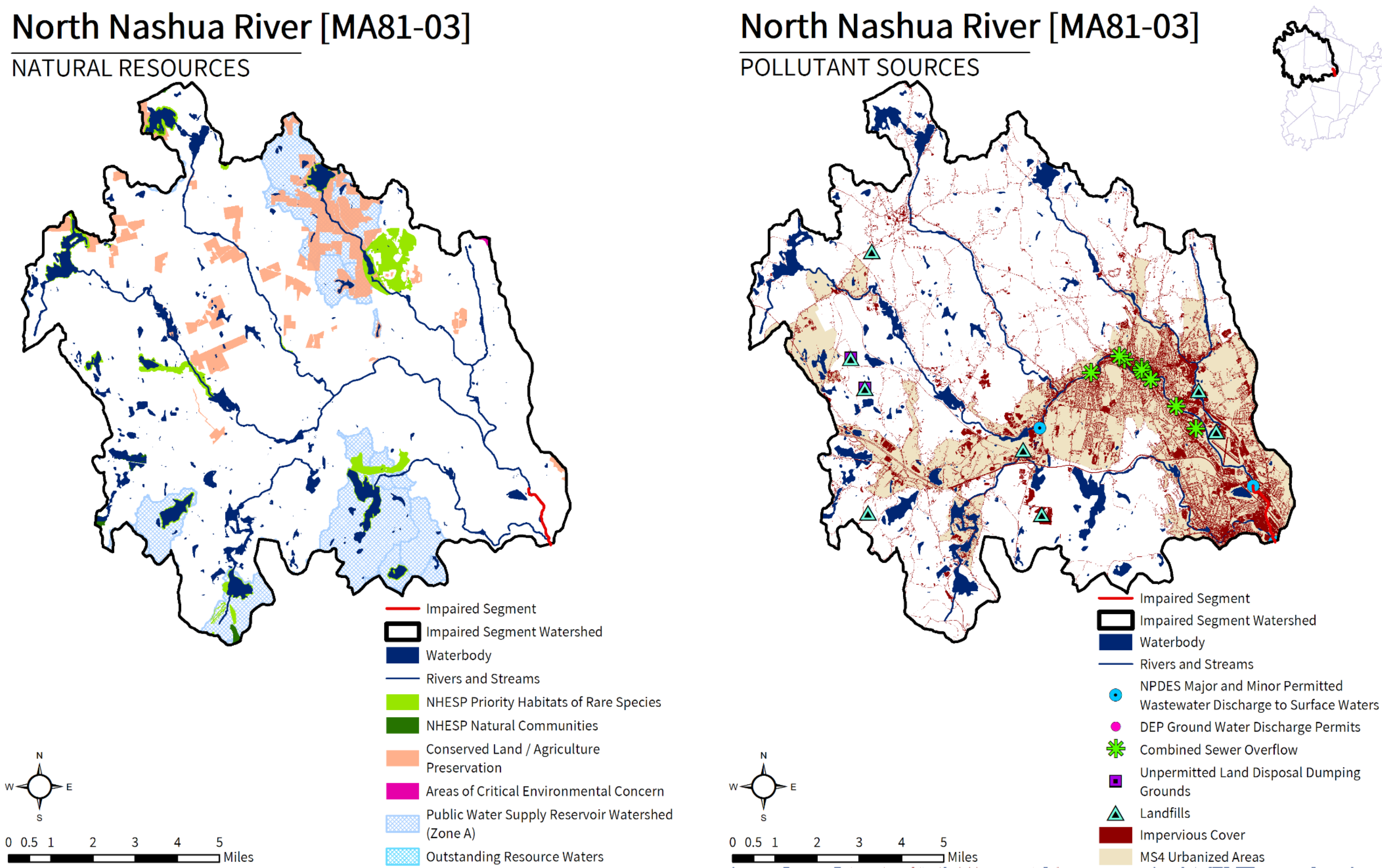


Figure 5-1. Natural resources and potential pollution sources draining to the North Nashua River segment MA81-03. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

5.2. Waterbody Impairment Characterization

The North Nashua River (MA81-03) is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 5-2, 5-3; Figure 5-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

- From 2008-2017, 67 samples were collected at NN1905, resulting in 53 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 67 samples, 34 exceeded the STV criterion in 2008-2012 and in 2014-2016 during both dry and wet weather.
- In 2008, six samples were collected at W0993, resulting in six days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, four exceeded the STV criterion during both wet and dry weather.

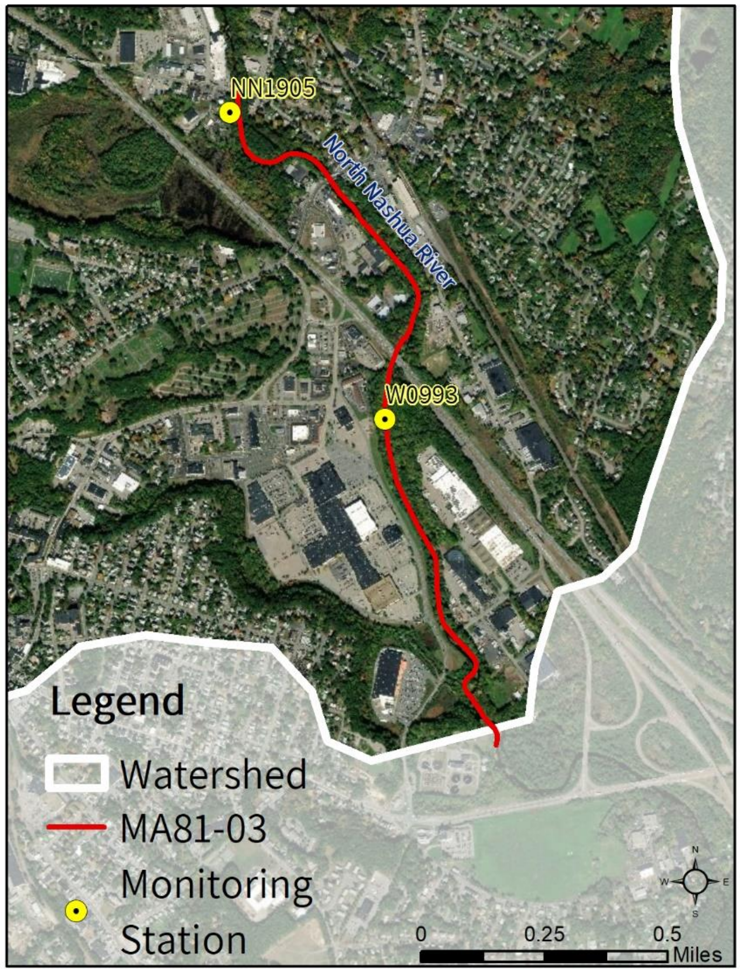


Figure 5-2. Location of monitoring station(s) along the impaired river segment.

Table 5-2. Summary of indicator bacteria sampling results by station for the North Nashua River (MA81-03). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
NN1905	4/19/2008	10/21/2017	67	2420	53	34
W0993	5/15/2008	9/18/2008	6	1400	6	4

Table 5-3. Indicator bacteria data by station, indicator, and date for the North Nashua River (MA81-03). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN1905	*E. coli*	4/19/2008	DRY	1300	1300	
NN1905	*E. coli*	5/17/2008	WET	2420	1774	
NN1905	*E. coli*	7/19/2008	DRY	866	866	
NN1905	*E. coli*	8/16/2008	DRY	579	708	
NN1905	*E. coli*	9/20/2008	DRY	184	184	
NN1905	*E. coli*	4/18/2009	DRY	1203	1203	
NN1905	*E. coli*	5/16/2009	DRY	456	741	
NN1905	*E. coli*	6/20/2009	WET	411	411	
NN1905	*E. coli*	7/18/2009	DRY	1986	903	
NN1905	*E. coli*	8/15/2009	DRY	1986	1986	
NN1905	*E. coli*	9/19/2009	DRY	2420	2420	
NN1905	*E. coli*	10/17/2009	DRY	2420	2420	
NN1905	*E. coli*	4/17/2010	WET	167	167	
NN1905	*E. coli*	5/15/2010	DRY	866	380	
NN1905	*E. coli*	6/19/2010	DRY	2420	2420	
NN1905	*E. coli*	7/17/2010	DRY	2420	2420	
NN1905	*E. coli*	8/21/2010	DRY	345	345	
NN1905	*E. coli*	9/18/2010	DRY	1733	773	
NN1905	*E. coli*	10/16/2010	WET	548	975	
NN1905	*E. coli*	4/16/2011	WET	1733	1733	
NN1905	*E. coli*	5/21/2011	DRY	2420	2420	
NN1905	*E. coli*	6/18/2011	DRY	2420	2420	
NN1905	*E. coli*	7/16/2011	DRY	2420	2420	
NN1905	*E. coli*	8/20/2011	DRY	160	160	
NN1905	*E. coli*	9/17/2011	DRY	770	351	
NN1905	*E. coli*	10/15/2011	WET	866	817	
NN1905	*E. coli*	4/21/2012	DRY	162	162	
NN1905	*E. coli*	5/19/2012	DRY	501	285	
NN1905	*E. coli*	6/16/2012	DRY	816	639	
NN1905	*E. coli*	7/21/2012	DRY	2420	2420	
NN1905	*E. coli*	8/18/2012	WET	816	1405	
NN1905	*E. coli*	9/15/2012	DRY	179	382	
NN1905	*E. coli*	10/20/2012	WET	1986	1986	
NN1905	*E. coli*	4/20/2013	DRY	51	51	
NN1905	*E. coli*	5/18/2013	DRY	79	63	
NN1905	*E. coli*	6/15/2013	WET	201	126	
NN1905	*E. coli*	7/20/2013	DRY	326	326	
NN1905	*E. coli*	8/17/2013	DRY	93	174	
NN1905	*E. coli*	9/21/2013	DRY	104	104	
NN1905	*E. coli*	10/19/2013	DRY	59	78	
NN1905	*E. coli*	4/19/2014	DRY	50	50	
NN1905	*E. coli*	5/17/2014	WET	2420	348	
NN1905	*E. coli*	6/21/2014	DRY	96	96	
NN1905	*E. coli*	7/19/2014	DRY	70	82	
NN1905	*E. coli*	8/16/2014	DRY	770	232	
NN1905	*E. coli*	9/20/2014	DRY	548	548	
NN1905	*E. coli*	10/18/2014	WET	345	435	
NN1905	*E. coli*	4/20/2015	WET	8	8	
NN1905	*E. coli*	5/16/2015	DRY	54	21	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN1905	*E. coli*	6/20/2015	DRY	335	335	
NN1905	*E. coli*	7/18/2015	DRY	525	419	
NN1905	*E. coli*	8/15/2015	DRY	365	438	
NN1905	*E. coli*	9/19/2015	DRY	365	365	
NN1905	*E. coli*	10/17/2015	DRY	84	175	
NN1905	*E. coli*	4/16/2016	DRY	85	85	
NN1905	*E. coli*	5/21/2016	DRY	128	128	
NN1905	*E. coli*	6/18/2016	DRY	199	160	
NN1905	*E. coli*	7/16/2016	DRY	488	312	
NN1905	*E. coli*	8/20/2016	DRY	248	248	
NN1905	*E. coli*	9/17/2016	DRY	517	358	
NN1905	*E. coli*	10/15/2016	DRY	2420	1119	
NN1905	*E. coli*	4/15/2017	DRY	23	23	
NN1905	*E. coli*	5/20/2017	DRY	248	248	
NN1905	*E. coli*	6/17/2017	WET	36	94	
NN1905	*E. coli*	7/15/2017	DRY	250	95	
NN1905	*E. coli*	9/16/2017	DRY	222	222	
NN1905	*E. coli*	10/21/2017	DRY	64	64	
W0993	*E. coli*	5/15/2008	DRY	1400	1400	
W0993	*E. coli*	6/12/2008	DRY	270	615	
W0993	*E. coli*	7/17/2008	DRY	550	550	
W0993	*E. coli*	8/14/2008	WET	570	560	
W0993	*E. coli*	9/4/2008	DRY	160	302	
W0993	*E. coli*	9/18/2008	DRY	1900	551	

5.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for North Nashua River (MA81-03) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Combined Sewer Overflow (CSO): There are 11 CSOs in the segment watershed (none within the direct drainage area, see Section 4.1), which by design release untreated wastewater to surface waters when flows exceed system capacity, and therefore must be eliminated. For this reason, it is set as the highest priority pathogen source.

Urban Stormwater: Portions of the North Nashua River (MA81-03) watershed are fully developed, with 29% of the land area in MS4 and 6% as DCIA. There are commercial developments along the entire segment but are most prominent along the downstream reaches. The watershed extends far upstream of the segment, with areas of developed land use. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed (29%) designated as MS4 area and most of the area adjacent to the segment in sewer service, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are likely a significant source of pathogens.

On-Site Wastewater Disposal Systems: There are no groundwater discharge permits for on-site wastewater discharge, which are large-capacity, non-residential septic systems. Given the portion of the watershed not covered by sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are no agricultural fields adjacent to the impaired segment, although 4% of the watershed is classified as agricultural land. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. In addition, any agricultural lands adjacent to upstream tributaries or storm drains could also provide a direct conduit to the river.

Pet Waste: Parks, conservation areas, and wetlands throughout the watershed, although not adjacent to the river, can be possible sources of pathogens. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands having large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

5.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

***City of Fitchburg*.** See Section 3.4

City of Leominster

More than half of Leominster is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Leominster (Permit ID #MAR041203) has an EPA approved Notice of Intent (NOI). The city has a draft copy of their Stormwater Management Plan on file at the Department of Public Works. The city has mapped all of its stormwater outfall system. Leominster adopted illicit discharge detection and elimination (IDDE) regulations in 2005, as well as erosion and sediment control and post-construction stormwater regulations in 2014. According to the NOI, there are five stormwater outfalls to the North Nashua River (MA81-02), six stormwater outfalls to the North Nashua River (MA81-03), and 6 stormwater outfalls to the North Nashua River (MA81-04), all impaired for *E. coli*. In addition, there are 60 stormwater outfalls into Monoosnuc Brook (MA81-13), impaired for *E. coli*.

Leominster has the following relevant ordinance and bylaws:

- Stormwater Ordinance: http://www.leominster-ma.gov/gov/boardcomm/conservation/stormwater/forms.asp (City of Leominster, 2015)
- Wetland Protection information is available, but no city-specific ordinance: http://www.leominster-ma.gov/gov/boardcomm/conservation/involve/living.asp (City of Leominster, n.d., a)
- Title 5 Supplementary Regulations: None found.
- Stormwater Utility: None found.
- Pet Waste: None found.

Leominster does not have a Master Plan available. The Open Space and Recreation Plan, written in 2014, has a Water Resources section in the Environmental Inventory and Analysis chapter (City of Leominster). This section discusses pollutant problems and stormwater remediation efforts in the North Nashua River, an impaired segment in the city. The plan mentions the city's MS4 work and participation in NPDES Phase II in the Environmental Challenges section. It also notes that combined sewers have contributed to high indicator bacteria counts, and the Leominster Department of Public Works has fixed sewer leaks and drainage problems to help with this issue. The western portion of the city does not have municipal sewer service. The city provides a Community Guide to Growing Greener with a section on stormwater management (MWI, Inc., 2011).

Town website: http://www.leominster-ma.gov/ (City of Leominster, 2020)

Stormwater page: http://www.leominster-ma.gov/gov/boardcomm/conservation/stormwater/default.asp (City of Leominster, n.d., b)

A Community Guide to Growing Greener: http://www.leominster-ma.gov/civicax/filebank/blobdload.aspx?BlobID=27693 (MWI, Inc., 2011)

Open Space and Recreation Plan: http://www.leominster-ma.gov/depts/programs/recreation/space.asp (City of Leominster, 2014)

Town of Ashburnham. See Section 3.4

***Town of Westminster*.** See Section 3.4

6. MA81-04 North Nashua River

6.1. Waterbody Overview

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 85,951

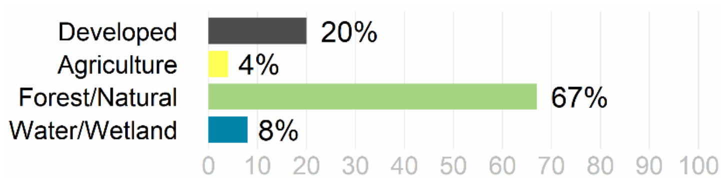
Segment Length (miles): 10.3

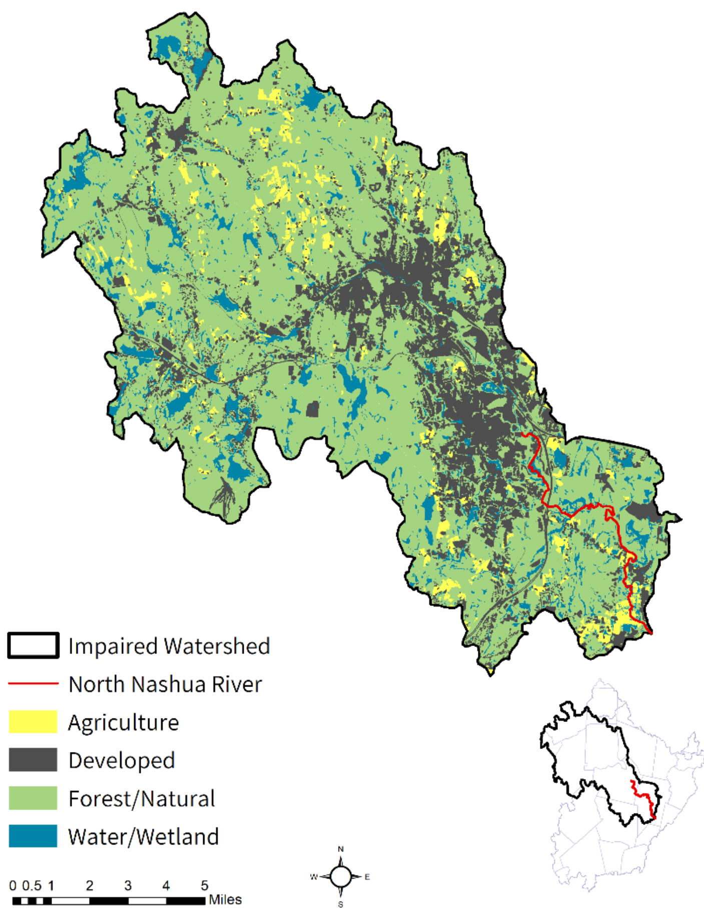
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 9,187 (11%)

DCIA Area (Acres, %): 5,501 (6%)





The North Nashua River segment MA81-04 is 10.4 miles long and begins at the outfall of the Leominster WPCF outfall (NPDES: MA0100617) in Leominster, MA. Segment MA81-04 flows south from Leominster to Lancaster to end at its confluence with the South Nashua River and the Nashua River mainstem in Lancaster, MA.

Tributaries to the North Nashua River segment MA81-04 include Fall Brook, McGovern Brook, Spectacle Brook, and Ponakin Brook, in addition to many other unnamed streams. Impaired segment tributaries to the North Nashua River segment MA81-04 include the North Nashua River segments (MA81-01, MA81-02 and MA81-03) and their impaired tributaries, as well as Fall Brook (MA81-39) and Wekepeke Brook (MA81-72). Major lakes and ponds in the segment watershed include Fitchburg, Notown, Fall Brook, and Lovell Reservoirs.

Key landmarks in the watershed include the town center and commercial district of Lancaster, the Lancaster State Forest, and the Cosimi Conservation area, as well as those mentioned for upstream segment MA81-03. Segment MA81-04 crosses the Leominster Connector (Leominster), I-190 (Lancaster), Main Street/MA-117 (Lancaster), Main Street/MA-70 (Lancaster), and other smaller streets.

The North Nashua River (MA81-04) drains an area of 134 square miles, of which 14 mi^2 (11%) is impervious and 9 mi^2 (6%) is directly connected impervious area (DCIA). The watershed is served partially[11] by public sewer and 30% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are four NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed, including 2 within the direct drainage area to the impaired segment (Table 6-1). There is one Industrial Stormwater discharge within the segment watershed (Table 6-2). There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this

[11] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

watershed. There are 11 combined sewer overflows (none within the direct watershed, see Section 4.1) and 13 landfills. MassDEP maintains a CSO qualifier for the North Nashua River from source to Leominster POTW discharge, which does not include waters downstream of segment MA81-03. Two unpermitted land disposal dumping grounds are in the western part of the watershed (Solid Waste Facility ID 332.006 and 103.007). See Figure 6-1.

Table 6-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0025763	RIVER TERRACE HEALTHCARE	LANCASTER	OTH
MA0100617	LEOMINSTER WPCF	LEOMINSTER	MUN

Table 6-2. National Pollutant Discharge Elimination System (NPDES) permits for Industrial Discharges in the segment watershed. Only permits unique to this segment watershed are shown.

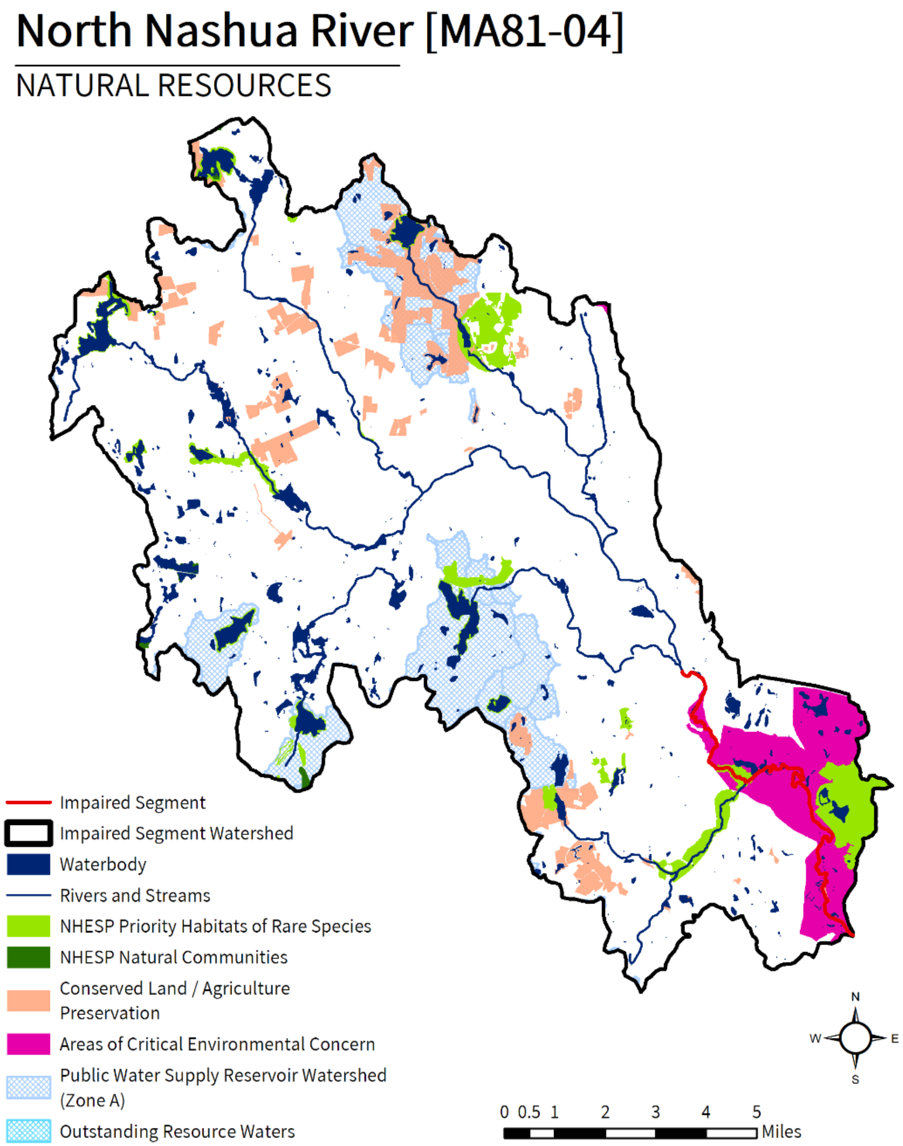
NPDES ID	NAME	TOWN
MA0025763	RIVER TERRACE HEALTHCARE	LANCASTER

The entire segment predominantly flows through forested and natural landscapes. Developed land uses remain clustered around the town centers and sprawled development from Fitchburg and Leominster, while agricultural fields flank the segment in its southern third near the town center of Lancaster.

In the watershed of the North Nashua River (MA81-04), under the Natural Heritage and Endangered Species Program, there are 318 acres (<1%) of Priority Natural Vegetation Communities and 4,765 acres (6%) of Priority Habitats of Rare Species. There are 11,524 acres (13%) under Public Water Supply protection, 5,412 acres (6%) of Areas of Critical Environmental Concern, but no areas of Outstanding Resource Waters in the watershed. Over 5,559 acres (6%) of land protected in perpetuity[12] exist within the segment watershed, which is part of a total of 22,231 acres (26%) of Protected and Recreational Open Space[13]. See Figure 6-1.

[12] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[13] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



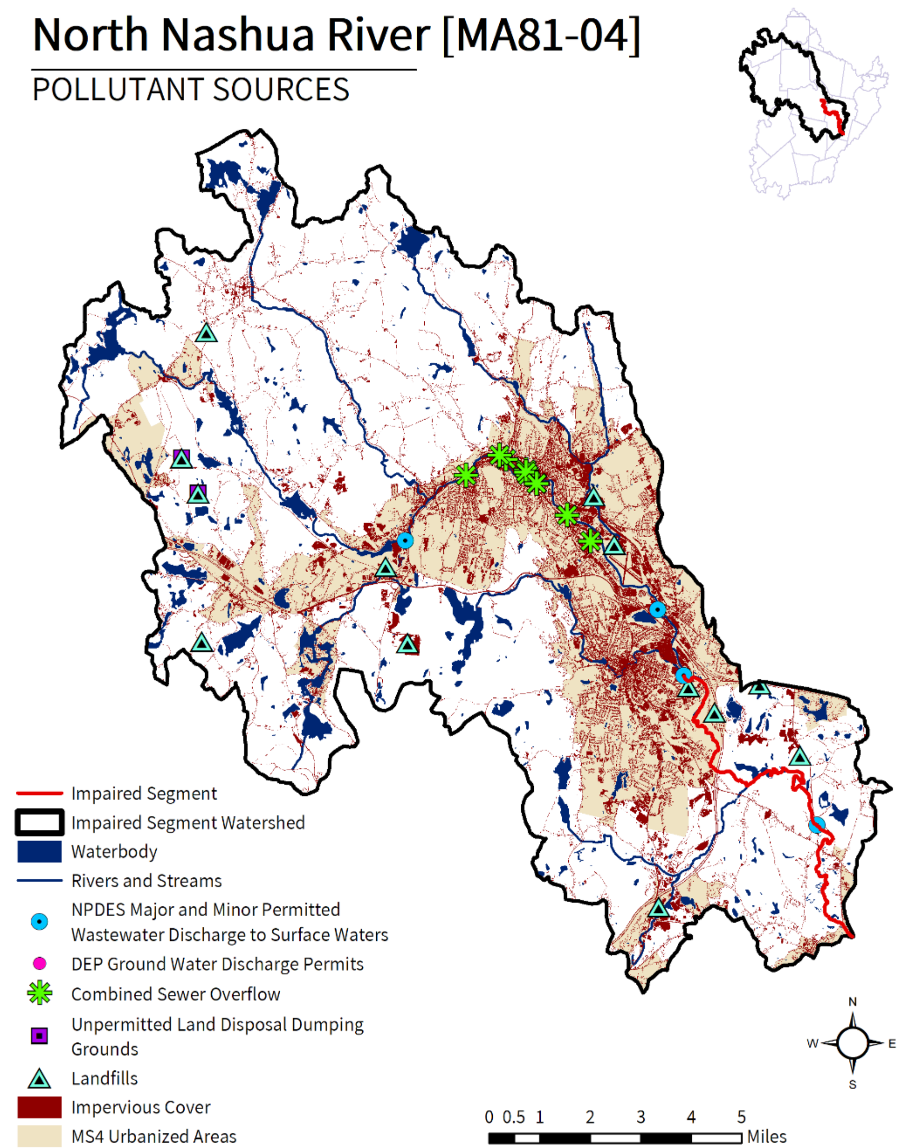


Figure 6-1. Natural resources and potential pollution sources draining to the North Nashua River segment MA81-04. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

6.2. Waterbody Impairment Characterization

The North Nashua River (MA81-04) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 6-3, 6-4; Figure 6-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

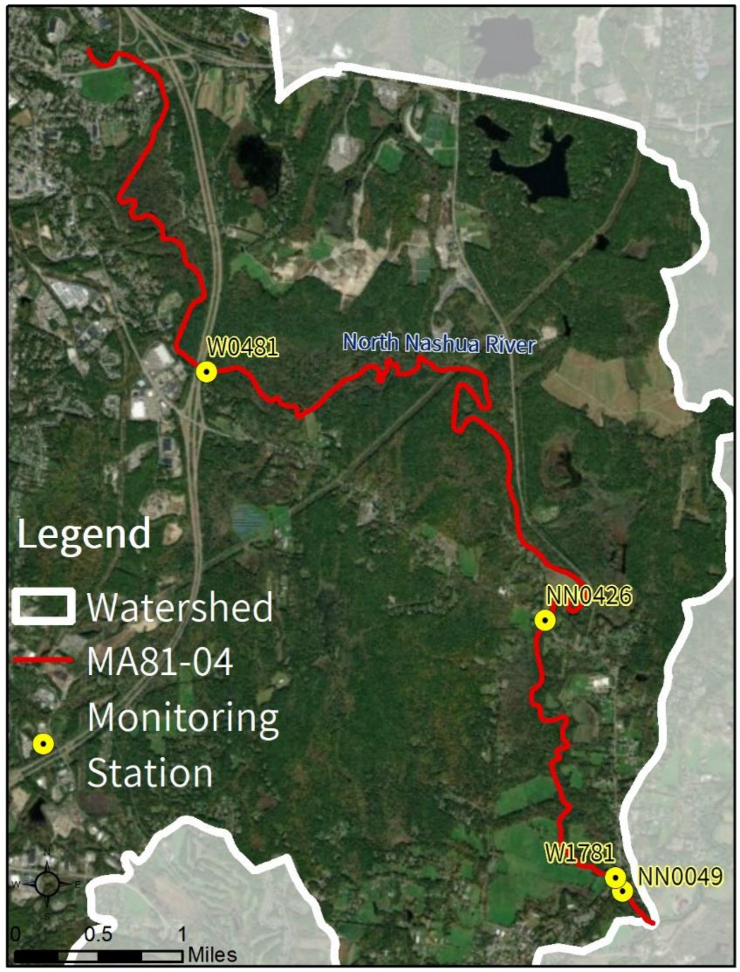


Figure 6-2. Location of monitoring station(s) along the impaired river segment.

- From 2008-2017, 68 samples were collected at NN0049, resulting in 43 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 68 samples, 15 exceeded the STV criterion in years 2008-2012 and 2014 during both wet and dry weather.
- From 2008-2017, 67 samples were collected at NN0426, resulting in 34 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples the STV criterion was applied to single sample results. Out of 67 samples, 17 exceeded the STV criterion in years 2008-2014 and 2017 during both wet and dry weather.
- From 2007-2017, 102 samples were collected at W0481, resulting in 83 days when the 30-day rolling geomean exceeded the criterion. Since there were more than 10 samples collected in each year from 2008-2013, the STV criterion was applied to the 30-day rolling 90th percentile. From 2007-2017, 102 samples were collected at W0481, resulting in 58 days when the 30-day rolling 90th percentile exceeded the STV criterion. Note: the number of days that exceeded the STV criterion also includes the number of single samples exceeding the STV criterion for 2007 and 2014-2017 (years with less than 10 samples).
- In 2008, six samples were collected at W1781, resulting in four days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during dry weather.

Table 6-3. Summary of indicator bacteria sampling results by station for the North Nashua River (MA81-04). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
NN0049	4/19/2008	10/21/2017	68	2420	43	15
NN0426	4/19/2008	10/21/2017	67	2420	34	17
W0481	8/22/2007	10/21/2017	102	2420	83	58*
W1781	5/15/2008	9/18/2008	6	247	4	1

**Since more than 10 samples were available in each year from 2008-2013, this value represents the number of days exceeding the STV criterion for the 30-day rolling 90th percentile from 2008-2013 plus the number of single samples exceeding the STV criterion for 2007 and 2014-2017.*

Table 6-4. Indicator bacteria data by station, indicator, and date for the North Nashua River (MA81-04). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN0049	*E. coli*	4/19/2008	DRY	153	153	
NN0049	*E. coli*	5/17/2008	WET	50	87	
NN0049	*E. coli*	7/19/2008	DRY	613	613	
NN0049	*E. coli*	8/16/2008	DRY	2420	1218	
NN0049	*E. coli*	9/20/2008	DRY	308	308	
NN0049	*E. coli*	10/18/2008	DRY	108	182	
NN0049	*E. coli*	4/18/2009	DRY	2420	2420	
NN0049	*E. coli*	5/16/2009	DRY	345	914	
NN0049	*E. coli*	6/20/2009	WET	727	727	
NN0049	*E. coli*	7/18/2009	DRY	261	436	
NN0049	*E. coli*	8/15/2009	DRY	261	261	
NN0049	*E. coli*	9/19/2009	DRY	68	68	
NN0049	*E. coli*	10/17/2009	DRY	135	96	
NN0049	*E. coli*	4/17/2010	WET	144	144	
NN0049	*E. coli*	5/15/2010	DRY	119	131	
NN0049	*E. coli*	6/19/2010	DRY	2420	2420	
NN0049	*E. coli*	7/17/2010	DRY	2420	2420	
NN0049	*E. coli*	8/21/2010	DRY	161	161	
NN0049	*E. coli*	9/18/2010	DRY	178	169	
NN0049	*E. coli*	10/16/2010	WET	2420	656	
NN0049	*E. coli*	4/16/2011	WET	1120	1120	
NN0049	*E. coli*	5/21/2011	DRY	2420	2420	
NN0049	*E. coli*	6/18/2011	DRY	2420	2420	
NN0049	*E. coli*	7/16/2011	DRY	84	451	
NN0049	*E. coli*	8/20/2011	DRY	167	167	
NN0049	*E. coli*	9/17/2011	DRY	179	173	
NN0049	*E. coli*	10/15/2011	WET	2420	658	
NN0049	*E. coli*	4/21/2012	DRY	58	58	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN0049	*E. coli*	5/19/2012	DRY	613	189	
NN0049	*E. coli*	6/16/2012	DRY	131	283	
NN0049	*E. coli*	7/21/2012	DRY	79	79	
NN0049	*E. coli*	8/18/2012	WET	194	124	
NN0049	*E. coli*	9/15/2012	DRY	147	169	
NN0049	*E. coli*	10/20/2012	WET	2420	2420	
NN0049	*E. coli*	4/20/2013	DRY	115	115	
NN0049	*E. coli*	5/18/2013	DRY	87	100	
NN0049	*E. coli*	7/20/2013	DRY	88	88	
NN0049	*E. coli*	8/17/2013	DRY	47	64	
NN0049	*E. coli*	9/21/2013	DRY	77	77	
NN0049	*E. coli*	10/19/2013	DRY	36	53	
NN0049	*E. coli*	4/19/2014	DRY	81	81	
NN0049	*E. coli*	5/17/2014	WET	1414	338	
NN0049	*E. coli*	6/21/2014	DRY	155	155	
NN0049	*E. coli*	7/19/2014	DRY	172	163	
NN0049	*E. coli*	8/16/2014	DRY	65	106	
NN0049	*E. coli*	9/20/2014	DRY	135	135	
NN0049	*E. coli*	10/18/2014	WET	1120	389	
NN0049	*E. coli*	4/20/2015	WET	35	35	
NN0049	*E. coli*	5/16/2015	DRY	41	38	
NN0049	*E. coli*	6/20/2015	DRY	225	225	
NN0049	*E. coli*	7/18/2015	DRY	121	165	
NN0049	*E. coli*	8/15/2015	DRY	185	150	
NN0049	*E. coli*	9/19/2015	DRY	326	326	
NN0049	*E. coli*	10/17/2015	DRY	36	108	
NN0049	*E. coli*	4/16/2016	DRY	24	24	
NN0049	*E. coli*	5/21/2016	DRY	186	186	
NN0049	*E. coli*	6/18/2016	DRY	86	126	
NN0049	*E. coli*	7/16/2016	DRY	93	89	
NN0049	*E. coli*	8/20/2016	DRY	115	115	
NN0049	*E. coli*	9/17/2016	DRY	161	136	
NN0049	*E. coli*	10/15/2016	DRY	55	94	
NN0049	*E. coli*	4/15/2017	DRY	190	190	
NN0049	*E. coli*	5/20/2017	DRY	72	72	
NN0049	*E. coli*	6/17/2017	WET	41	54	
NN0049	*E. coli*	7/15/2017	DRY	135	74	
NN0049	*E. coli*	8/19/2017	DRY	231	231	
NN0049	*E. coli*	9/16/2017	DRY	214	222	
NN0049	*E. coli*	10/21/2017	DRY	104	104	
NN0426	*E. coli*	4/19/2008	DRY	152	152	
NN0426	*E. coli*	5/17/2008	WET	2420	606	
NN0426	*E. coli*	7/19/2008	DRY	80	80	
NN0426	*E. coli*	8/16/2008	DRY	2420	440	
NN0426	*E. coli*	9/20/2008	DRY	488	488	
NN0426	*E. coli*	10/18/2008	DRY	201	313	
NN0426	*E. coli*	4/18/2009	DRY	2420	2420	
NN0426	*E. coli*	5/16/2009	DRY	365	940	
NN0426	*E. coli*	6/20/2009	WET	548	548	
NN0426	*E. coli*	7/18/2009	DRY	186	319	
NN0426	*E. coli*	8/15/2009	DRY	186	186	
NN0426	*E. coli*	9/19/2009	DRY	1	1	
NN0426	*E. coli*	10/17/2009	DRY	99	10	
NN0426	*E. coli*	5/15/2010	DRY	127	127	
NN0426	*E. coli*	6/19/2010	DRY	2420	2420	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NN0426	*E. coli*	7/17/2010	DRY	2420	2420	
NN0426	*E. coli*	8/21/2010	DRY	153	153	
NN0426	*E. coli*	9/18/2010	DRY	248	195	
NN0426	*E. coli*	10/16/2010	WET	2420	775	
NN0426	*E. coli*	4/16/2011	WET	980	980	
NN0426	*E. coli*	5/21/2011	DRY	2420	2420	
NN0426	*E. coli*	6/18/2011	DRY	2420	2420	
NN0426	*E. coli*	7/16/2011	DRY	119	537	
NN0426	*E. coli*	8/20/2011	DRY	172	172	
NN0426	*E. coli*	9/17/2011	DRY	326	237	
NN0426	*E. coli*	10/15/2011	WET	2420	888	
NN0426	*E. coli*	4/21/2012	DRY	31	31	
NN0426	*E. coli*	5/19/2012	DRY	260	90	
NN0426	*E. coli*	6/16/2012	DRY	122	178	
NN0426	*E. coli*	7/21/2012	DRY	68	68	
NN0426	*E. coli*	8/18/2012	WET	160	104	
NN0426	*E. coli*	9/15/2012	DRY	365	242	
NN0426	*E. coli*	10/20/2012	WET	2420	2420	
NN0426	*E. coli*	4/20/2013	DRY	82	82	
NN0426	*E. coli*	5/18/2013	DRY	184	123	
NN0426	*E. coli*	6/15/2013	WET	579	326	
NN0426	*E. coli*	7/20/2013	DRY	72	72	
NN0426	*E. coli*	8/17/2013	DRY	39	53	
NN0426	*E. coli*	9/21/2013	DRY	73	73	
NN0426	*E. coli*	10/19/2013	DRY	91	82	
NN0426	*E. coli*	4/19/2014	DRY	16	16	
NN0426	*E. coli*	5/17/2014	WET	816	114	
NN0426	*E. coli*	6/21/2014	DRY	77	77	
NN0426	*E. coli*	7/19/2014	DRY	74	75	
NN0426	*E. coli*	8/16/2014	DRY	23	41	
NN0426	*E. coli*	9/20/2014	DRY	56	56	
NN0426	*E. coli*	10/18/2014	WET	1046	242	
NN0426	*E. coli*	4/20/2015	WET	39	39	
NN0426	*E. coli*	5/16/2015	DRY	22	29	
NN0426	*E. coli*	6/20/2015	DRY	167	167	
NN0426	*E. coli*	7/18/2015	DRY	108	134	
NN0426	*E. coli*	8/15/2015	DRY	194	145	
NN0426	*E. coli*	9/19/2015	DRY	186	186	
NN0426	*E. coli*	10/17/2015	DRY	70	114	
NN0426	*E. coli*	4/16/2016	DRY	24	24	
NN0426	*E. coli*	5/21/2016	DRY	76	76	
NN0426	*E. coli*	6/18/2016	DRY	131	100	
NN0426	*E. coli*	7/16/2016	DRY	84	105	
NN0426	*E. coli*	8/20/2016	DRY	93	93	
NN0426	*E. coli*	9/17/2016	DRY	152	119	
NN0426	*E. coli*	10/15/2016	DRY	68	102	
NN0426	*E. coli*	4/15/2017	DRY	99	99	
NN0426	*E. coli*	5/20/2017	DRY	56	56	
NN0426	*E. coli*	6/17/2017	WET	46	51	
NN0426	*E. coli*	7/15/2017	DRY	167	88	
NN0426	*E. coli*	8/19/2017	DRY	1300	1300	
NN0426	*E. coli*	10/21/2017	DRY	328	328	
W0481	*E. coli*	8/22/2007	DRY	201	201	
W0481	*E. coli*	10/10/2007	WET	2420	2420	
W0481	*E. coli*	1/16/2008	DRY	299	299	299

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0481	*E. coli*	3/19/2008	WET	1050	1050	1050
W0481	*E. coli*	4/19/2008	DRY	548	548	548
W0481	*E. coli*	5/15/2008	DRY	866	689	834
W0481	*E. coli*	5/17/2008	WET	2420	1047	2109
W0481	*E. coli*	6/12/2008	DRY	132	652	2109
W0481	*E. coli*	7/17/2008	DRY	1300	1300	1300
W0481	*E. coli*	7/19/2008	DRY	1733	1501	1690
W0481	*E. coli*	8/14/2008	WET	1120	1361	1646
W0481	*E. coli*	8/16/2008	DRY	613	1115	1603
W0481	*E. coli*	9/18/2008	DRY	1410	1410	1410
W0481	*E. coli*	9/20/2008	DRY	1203	1302	1389
W0481	*E. coli*	10/18/2008	DRY	613	1013	1369
W0481	*E. coli*	11/12/2008	DRY	308	435	583
W0481	*E. coli*	2/18/2009	DRY	816	816	816
W0481	*E. coli*	4/18/2009	DRY	1414	1414	1414
W0481	*E. coli*	4/22/2009	WET	345	698	1307
W0481	*E. coli*	5/16/2009	DRY	548	644	1241
W0481	*E. coli*	6/17/2009	DRY	613	613	613
W0481	*E. coli*	6/20/2009	WET	411	502	593
W0481	*E. coli*	7/18/2009	DRY	249	320	395
W0481	*E. coli*	8/15/2009	DRY	249	249	249
W0481	*E. coli*	9/2/2009	DRY	387	310	373
W0481	*E. coli*	9/19/2009	DRY	345	365	383
W0481	*E. coli*	10/17/2009	DRY	1414	698	1307
W0481	*E. coli*	10/21/2009	DRY	866	1107	1359
W0481	*E. coli*	2/4/2010	DRY	461	461	461
W0481	*E. coli*	4/17/2010	WET	345	345	345
W0481	*E. coli*	5/15/2010	DRY	272	306	338
W0481	*E. coli*	6/19/2010	DRY	2420	2420	2420
W0481	*E. coli*	7/15/2010	WET	816	1405	2260
W0481	*E. coli*	7/17/2010	DRY	2420	1684	2420
W0481	*E. coli*	8/21/2010	DRY	153	153	153
W0481	*E. coli*	9/18/2010	DRY	185	168	182
W0481	*E. coli*	9/22/2010	DRY	326	246	312
W0481	*E. coli*	10/16/2010	WET	1733	471	1452
W0481	*E. coli*	11/9/2010	WET	816	1189	1641
W0481	*E. coli*	3/9/2011	WET	1990	1990	1990
W0481	*E. coli*	4/16/2011	WET	980	980	980
W0481	*E. coli*	4/25/2011	WET	921	950	974
W0481	*E. coli*	5/21/2011	DRY	1203	1053	1175
W0481	*E. coli*	6/15/2011	DRY	1990	1547	1911
W0481	*E. coli*	6/18/2011	DRY	2420	1796	2334
W0481	*E. coli*	7/16/2011	DRY	1120	1646	2290
W0481	*E. coli*	8/20/2011	DRY	248	248	248
W0481	*E. coli*	8/24/2011	DRY	166	203	240
W0481	*E. coli*	9/17/2011	DRY	231	212	245
W0481	*E. coli*	10/15/2011	WET	727	410	677
W0481	*E. coli*	10/19/2011	WET	365	515	691
W0481	*E. coli*	3/20/2012	DRY	313	313	313
W0481	*E. coli*	4/21/2012	DRY	49	49	49
W0481	*E. coli*	5/19/2012	DRY	770	194	698
W0481	*E. coli*	5/22/2012	WET	435	579	737
W0481	*E. coli*	6/16/2012	DRY	326	478	703
W0481	*E. coli*	7/18/2012	DRY	179	179	179
W0481	*E. coli*	7/21/2012	DRY	144	161	176

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0481	*E. coli*	8/18/2012	WET	218	177	211
W0481	*E. coli*	9/15/2012	DRY	146	178	211
W0481	*E. coli*	9/19/2012	WET	2420	594	2193
W0481	*E. coli*	10/20/2012	WET	2420	2420	2420
W0481	*E. coli*	11/7/2012	DRY	219	728	2200
W0481	*E. coli*	3/6/2013	DRY	48	48	48
W0481	*E. coli*	4/17/2013	DRY	68	68	68
W0481	*E. coli*	4/20/2013	DRY	1203	286	1090
W0481	*E. coli*	5/18/2013	DRY	517	789	1134
W0481	*E. coli*	5/22/2013	WET	2420	1119	2230
W0481	*E. coli*	6/15/2013	WET	179	607	2039
W0481	*E. coli*	7/20/2013	DRY	152	152	152
W0481	*E. coli*	8/17/2013	DRY	61	96	143
W0481	*E. coli*	9/21/2013	DRY	71	71	71
W0481	*E. coli*	9/24/2013	WET	365	161	336
W0481	*E. coli*	10/19/2013	DRY	60	116	306
W0481	*E. coli*	4/19/2014	DRY	45	45	
W0481	*E. coli*	5/17/2014	WET	2420	330	
W0481	*E. coli*	6/21/2014	DRY	113	113	
W0481	*E. coli*	7/19/2014	DRY	65	86	
W0481	*E. coli*	8/16/2014	DRY	103	82	
W0481	*E. coli*	9/20/2014	DRY	138	138	
W0481	*E. coli*	10/18/2014	WET	548	275	
W0481	*E. coli*	4/20/2015	WET	25	25	
W0481	*E. coli*	5/16/2015	DRY	33	29	
W0481	*E. coli*	6/20/2015	DRY	88	88	
W0481	*E. coli*	7/18/2015	DRY	194	131	
W0481	*E. coli*	8/15/2015	DRY	281	233	
W0481	*E. coli*	9/19/2015	DRY	387	387	
W0481	*E. coli*	10/17/2015	DRY	147	239	
W0481	*E. coli*	4/16/2016	DRY	31	31	
W0481	*E. coli*	5/21/2016	DRY	86	86	
W0481	*E. coli*	6/18/2016	DRY	770	257	
W0481	*E. coli*	7/16/2016	DRY	172	364	
W0481	*E. coli*	8/20/2016	DRY	461	461	
W0481	*E. coli*	9/17/2016	DRY	548	503	
W0481	*E. coli*	10/15/2016	DRY	613	580	
W0481	*E. coli*	4/15/2017	DRY	38	38	
W0481	*E. coli*	5/20/2017	DRY	115	115	
W0481	*E. coli*	6/17/2017	WET	38	66	
W0481	*E. coli*	7/15/2017	DRY	816	176	
W0481	*E. coli*	8/19/2017	DRY	980	980	
W0481	*E. coli*	9/16/2017	DRY	201	444	
W0481	*E. coli*	10/21/2017	DRY	93	93	
W1781	*E. coli*	5/15/2008	DRY	90	90	
W1781	*E. coli*	6/12/2008	DRY	45	64	
W1781	*E. coli*	7/17/2008	DRY	160	160	
W1781	*E. coli*	8/14/2008	WET	380	247	
W1781	*E. coli*	9/4/2008	DRY	110	204	
W1781	*E. coli*	9/18/2008	DRY	470	227	

6.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for the North Nashua River (MA81-04) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Combined Sewer Overflow (CSO): There are 11 CSOs in the segment watershed (none within the direct drainage area, see Section 4.1), which by design release untreated wastewater to surface waters when flows exceed system capacity, and therefore must be eliminated. For this reason, it is set as one of the highest priority pathogen sources.

Urban Stormwater: The areas around the North Nashua River (MA81-04) are much less developed than the immediate upstream impaired segment (MA81-03), but 30% of the entire watershed area is MS4 and 6% is DCIA. There are areas of dense urban development just upstream of the segment in Fitchburg and Leominster. This segment is surrounded mostly by forested and other undeveloped land in its upstream section. Agricultural and forested lands surround the downstream half of the impaired segment. These factors indicate that stormwater runoff is likely a large source of pathogens to the impaired segment.

Illicit Sewage Discharges: A portion of the watershed is served by public sewer (nearly the entire area immediately surrounding the segment is served by sewer), and almost one third of the watershed (30%) is designated as MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are no groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the upstream watershed is served by septic systems. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: The downstream half of the segment flows past agricultural fields used for hayfields and row crops, such as corn and other vegetables. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. In addition, any agricultural lands adjacent to upstream tributaries or storm drains could also provide a direct conduit to the river.

Pet Waste: There is a large area of land designated as the Lancaster State Forest within the immediate drainage area to the impaired segment. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

6.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

City of Fitchburg. See Section 3.4

Town of Ashburnham. See Section 3.4

Town of Lancaster

Approximately 16% of Lancaster is within the MS4 area. The EPA initially denied the Town of Lancaster coverage under the MS4 General Permit in August 2019 due to an incomplete NOI submitted by the town in 2018; however, an authorization letter from EPA to the Town of Lancaster was issued on February 20, 2020, providing MS4 General Permit coverage until mid-2022.

Lancaster has the following relevant ordinances and bylaws:

- Stormwater Management bylaw: https://ecode360.com/13322969 (Town of Lancaster, 2018a)
- Title 5 Supplemental Regulations: https://ecode360.com/LA2689/laws/LF1083409.pdf (Town of Lancaster, 2018b)
- Wetland Protection Bylaw: https://ecode360.com/11813507#11813507 (Town of Lancaster, 2007a)
- Pet Waste Bylaw: None found.
- Stormwater Utility: None found.

The Lancaster Master Plan has a Waterbodies and Water Resources section within the Open Space, Natural Resources, and Recreation chapter, which notes the town's location in the Nashua River watershed (Town of Lancaster 2007b). The plan also notes the Area of Critical Environmental Concern (ACEC) that lies within Lancaster's boundaries. This state designation helps protect important natural resources. The section on wastewater within the Community Facilities chapter notes that about 60% of Lancaster properties are on town sewer and the rest are served by individual septic systems. Finally, the plan mentions a town goal of strengthening stormwater controls (page V-12). The Open Space and Recreation Plan was updated in 2017 and is now a stand-alone document (Town of Lancaster).

Town Website: https://www.ci.lancaster.ma.us/ (Town of Lancaster, 2020)

Master Plan: https://www.ci.lancaster.ma.us/administration-board-selectmen/pages/master-plan (Town of Lancaster, 2007b)

Open Space and Recreation Plan:
https://www.ci.lancaster.ma.us/sites/g/files/vyhlif4586/f/uploads/section_1-5.pdf (Town of Lancaster, 2017)

City of Leominster. See Section 5.4

Town of Westminster. See Section 3.4

7. MA81-05 Nashua River

7.1. Waterbody Overview

The Nashua River segment MA81-05 is 14.2 miles long and begins at the confluence of the North Nashua River segment (MA81-04) and South Nashua River segment (MA81-09) in Lancaster, MA. Segment MA81-05 flows to the north into Bolton before serving as the town boundary between Lancaster and Harvard, then Shirley and Ayer. Segment MA81-05 ends at its confluence with the Squannacook River at the town boundary between Shirley, Groton, and Ayer, MA.

Major tributaries to the Nashua River segment MA81-05 include the Still River, Catacoonamug Brook, Trout Brook, Morse Brook, Walker Brook, Nonacoicus Brook, and Mulpus Brook. Impaired tributaries to segment MA81-05 include the North Nashua River segments (MA81-01, MA81-02, MA81-03 and MA81-04) and their impaired tributaries, South Nashua River (MA81-09) and its impaired tributaries, Still River (MA81-60), and Catacoonamug Brook (MA81-74). Major lakes and ponds in the segment watershed include Fitchburg, Notown, Fall Brook, Lovell, and Wachusett Reservoirs.

Key landmarks in the watershed include the town centers of Holden, West Boylston, Sterling, Clinton, Devens, and Shirley, plus those mentioned for MA81-04. Landmarks along the Nashua River segment MA81-05 include a canoe launch at the segment intersection with MA-117, the Bolton Flats Wildlife Management Area, the Oxbow National Wildlife Refuge, and the Moore Army Airfield. Segment MA81-05 crosses Center Bridge Road (Lancaster) 0.02 miles from the river's start. Between Center Bridge Road and Seven Bridge Road/MA-117 (Lancaster), the stream follows a buffered corridor through the Bolton Flats Wildlife Management Area and under a railroad trestle. Segment MA81-05 also crosses the Concord Turnpike/MA-2 (Harvard), Great Road/MA2A (Shirley), among other smaller roads.

The Nashua River (MA81-05) drains an area of 344 square miles, of which 30 mi^2 (9%) is impervious and 16 mi^2 (5%) is directly connected impervious area (DCIA). The watershed is

Reduction from Highest Calculated Geomean: 91%

Watershed Area (Acres): 219,874

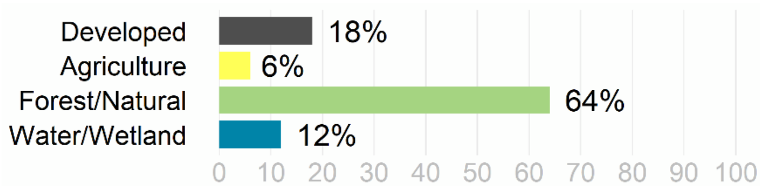
Segment Length (miles): 14.2

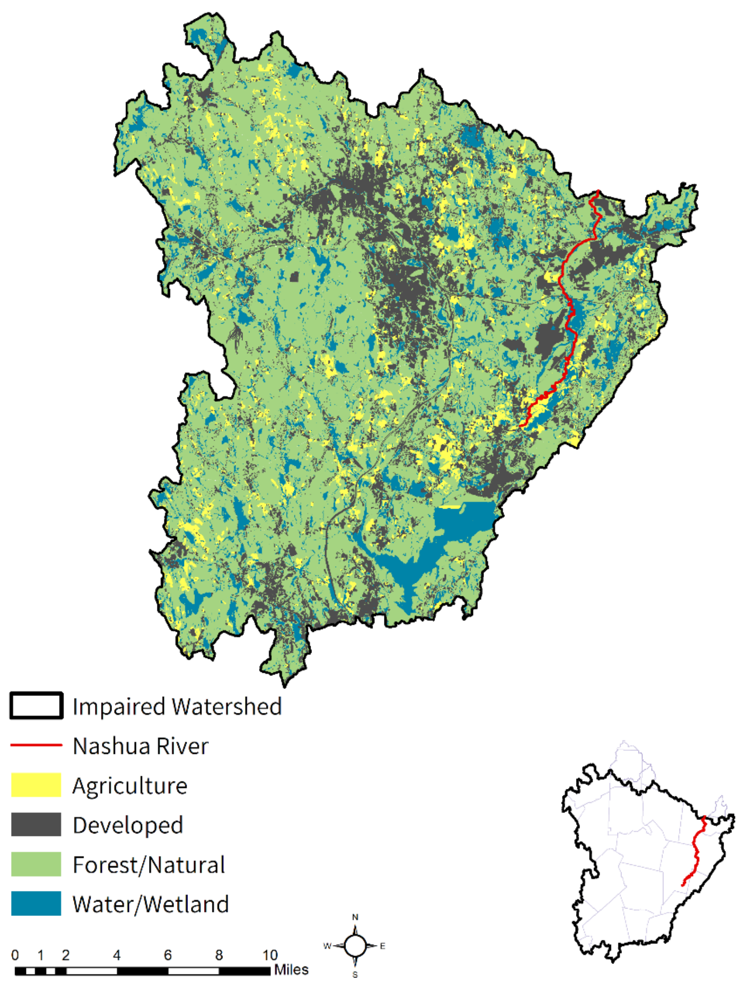
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 19,337 (9%)

DCIA Area (Acres, %): 10,057 (5%)





served partially[14] by public sewer and 28% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are six NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed, including one within the immediate drainage area to the impaired segment (Table 7-1). There are seven MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (4 within the immediate drainage area) (Table 7-2). There are 11combined sewer overflows (see Section 4.1) and 24 landfills. MassDEP maintains a CSO qualifier for the North Nashua River from source to Leominster POTW discharge, which does not include waters downstream of segment MA81-03. Three unpermitted land disposal dumping grounds are located in the western part of the watershed (Solid Waste Facility ID 332.006, 103.007, and 19.003). Solid waste facility 19.003, the Ayer Demolition Landfill (Ayer, MA), received construction and demolition waste and is currently inactive with an incomplete cap. See Figure 7-1.

Table 7-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0100013	AYER WWTF	AYER	MUN

Table 7-2. Groundwater discharge permits in the segment watershed. Groundwater discharge permits are not duplicated for larger segment watersheds that include this segment watershed. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

PERR	NAME	TOWN	TYPE	FLOW (GPD)
723-1	HARVARD PUBLIC SCHOOLS	HARVARD	Sanitary Discharge	23,000
362-4	LAKESHORE VIL/WOODLANDS	LUNENBURG	Sanitary Discharge	12,500
733-2	VILLAGE @ FLATHILL	LUNENBURG	Sanitary Discharge	14,850
657-2	DEVENS WWTF	SHIRLEY	Sanitary Discharge	6,000,000

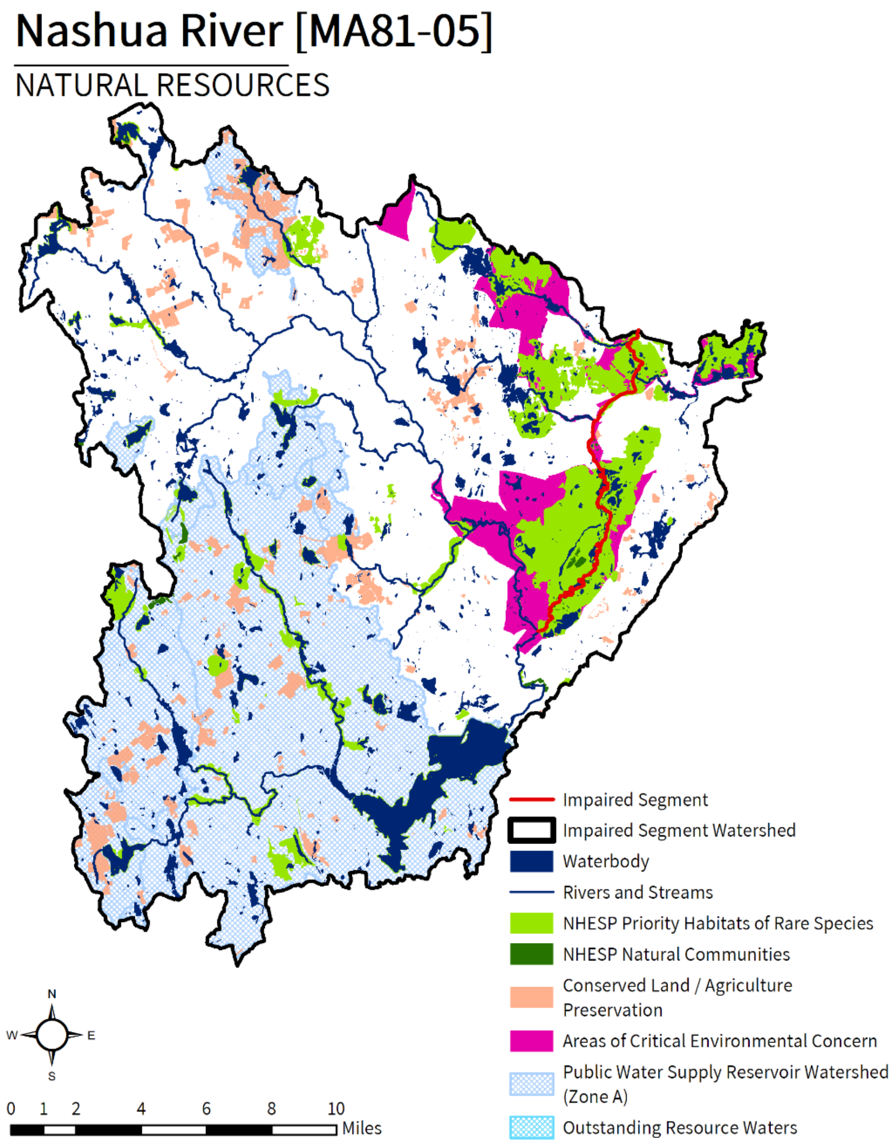
The entire segment flows through a patchwork of landscapes ranging from forested and natural landscapes to agricultural fields and areas of residential and commercial development. Developed areas are clustered within the center of the watershed around the town centers, in addition to sprawled development from Fitchburg and Leominster. Developed land uses adjacent to the impaired segment are primarily from the town centers of Shirley to the west and Devens to the east.

In the watershed of the Nashua River (MA81-05), under the Natural Heritage and Endangered Species Program, there are 693 acres (<1%) of Priority Natural Vegetation Communities and 28,941 acres (13%) of Priority Habitats of Rare Species. There are 86,986 acres (40%) under Public Water Supply protection, 41 acres (<1%) identified as Outstanding Resource Waters, and 22,380 acres (10%) identified as Areas of Critical Environmental Concern in the watershed. Over 13,084 acres (6%) of land protected in perpetuity[15] exist within the segment watershed, which is part of a total of 67,860 acres (31%) of Protected and Recreational Open Space[16]. See Figure 7-1.

[14] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

[15] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[16] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



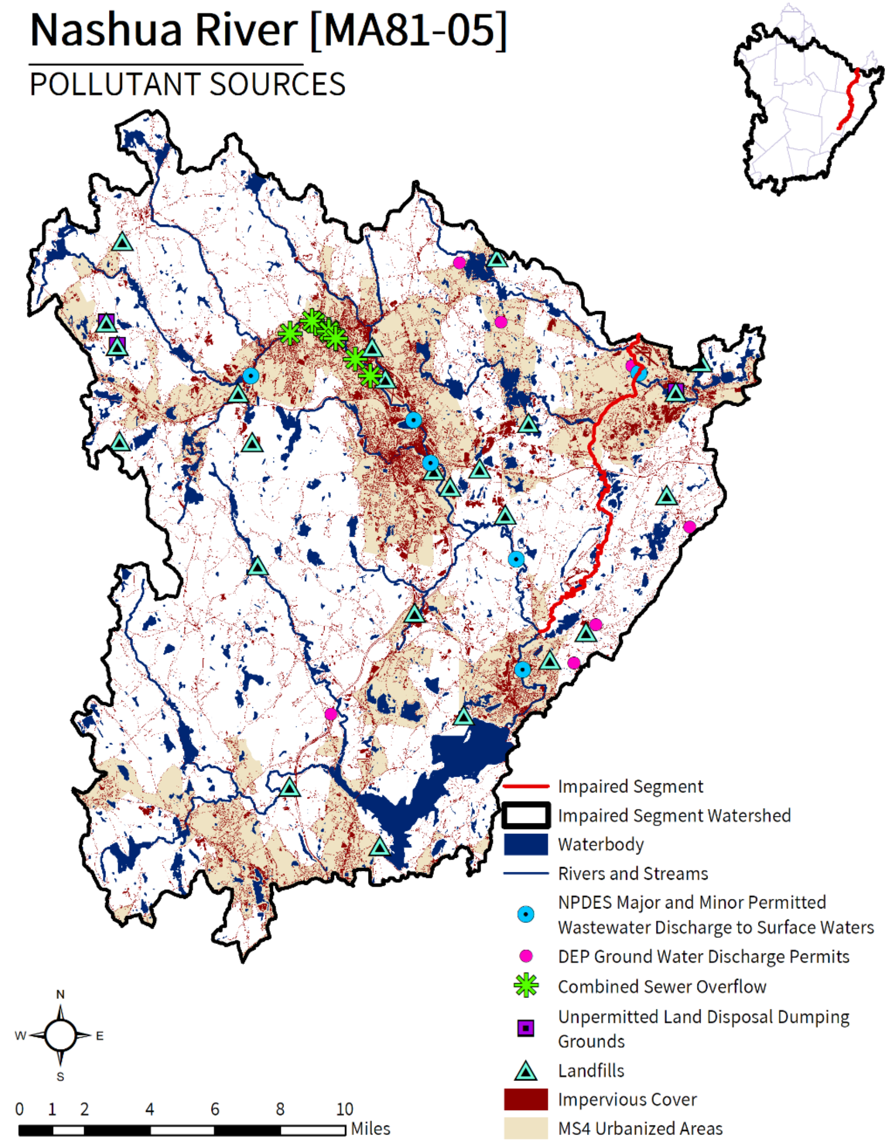


Figure 7-1. Natural resources and potential pollution sources draining to the North Nashua River segment MA81-05. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

7.2. Waterbody Impairment Characterization

The Nashua River (MA81-05) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 7-3, 7-4; Figure 7-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

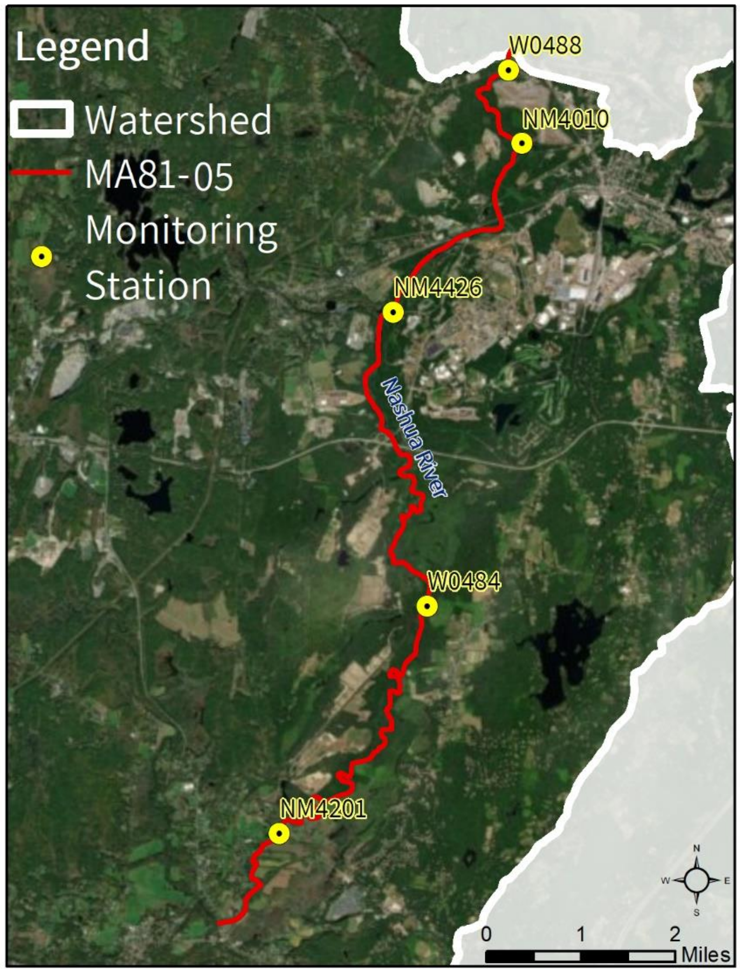


Figure 7-2. Location of monitoring station(s) along the impaired river segment.

- In 2017, seven samples were collected at NM4010, resulting in one day when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of seven samples, none exceeded the STV criterion.
- From 2008-2017, 69 samples were collected at NM4201, resulting in 27 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 69 samples, 11 exceeded the STV criterion in 2008-2012 and 2014 during both wet and dry weather.
- From 2015-2017, 16 samples were collected at NM4426, resulting in one day when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 16 samples, none exceeded the STV criterion.
- In 2008, 25 samples were collected at W0484, resulting in eight days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 25 samples, none exceeded the STV criterion.
- In 2008, six samples were collected at W0488, resulting in no days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.

Table 7-3. Summary of indicator bacteria sampling results by station for the Nashua River (MA81-05). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
NM4010	4/15/2017	10/21/2017	7	326	1	0
NM4201	4/19/2008	10/21/2017	69	1441	27	11
NM4426	7/18/2015	10/21/2017	16	154	1	0
W0484	5/15/2008	10/21/2017	25	268	8	0
W0488	5/15/2008	9/18/2008	6	99	0	0

Table 7-4. Indicator bacteria data by station, indicator, and date for the Nashua River (MA81-05). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NM4010	*E. coli*	4/15/2017	DRY	20	20	
NM4010	*E. coli*	5/20/2017	DRY	326	326	
NM4010	*E. coli*	6/17/2017	WET	9	54	
NM4010	*E. coli*	7/15/2017	DRY	28	16	
NM4010	*E. coli*	8/19/2017	DRY	49	49	
NM4010	*E. coli*	9/16/2017	DRY	82	63	
NM4010	*E. coli*	10/21/2017	DRY	82	82	
NM4201	*E. coli*	4/19/2008	DRY	50	50	
NM4201	*E. coli*	5/17/2008	WET	366	136	
NM4201	*E. coli*	7/19/2008	DRY	260	260	
NM4201	*E. coli*	8/16/2008	DRY	190	222	
NM4201	*E. coli*	9/20/2008	DRY	435	435	
NM4201	*E. coli*	10/18/2008	DRY	131	239	
NM4201	*E. coli*	4/18/2009	DRY	1056	1056	
NM4201	*E. coli*	5/16/2009	DRY	175	430	
NM4201	*E. coli*	6/20/2009	WET	733	733	
NM4201	*E. coli*	7/18/2009	DRY	89	255	
NM4201	*E. coli*	8/15/2009	DRY	89	89	
NM4201	*E. coli*	9/19/2009	DRY	93	93	
NM4201	*E. coli*	10/17/2009	DRY	76	84	
NM4201	*E. coli*	4/17/2010	WET	54	54	
NM4201	*E. coli*	5/15/2010	DRY	121	81	
NM4201	*E. coli*	6/19/2010	DRY	500	500	
NM4201	*E. coli*	7/17/2010	DRY	500	500	
NM4201	*E. coli*	8/21/2010	DRY	69	69	
NM4201	*E. coli*	9/18/2010	DRY	108	87	
NM4201	*E. coli*	10/16/2010	WET	1706	430	
NM4201	*E. coli*	4/16/2011	WET	183	183	
NM4201	*E. coli*	5/21/2011	DRY	1441	1441	
NM4201	*E. coli*	6/18/2011	DRY	303	661	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NM4201	*E. coli*	7/16/2011	DRY	81	156	
NM4201	*E. coli*	8/20/2011	DRY	149	149	
NM4201	*E. coli*	9/17/2011	DRY	166	157	
NM4201	*E. coli*	10/15/2011	WET	1540	505	
NM4201	*E. coli*	4/21/2012	DRY	76	76	
NM4201	*E. coli*	5/19/2012	DRY	163	111	
NM4201	*E. coli*	6/16/2012	DRY	115	137	
NM4201	*E. coli*	7/21/2012	DRY	67	67	
NM4201	*E. coli*	8/18/2012	WET	135	95	
NM4201	*E. coli*	9/15/2012	DRY	218	171	
NM4201	*E. coli*	10/20/2012	WET	620	620	
NM4201	*E. coli*	4/20/2013	DRY	11	11	
NM4201	*E. coli*	5/18/2013	DRY	66	27	
NM4201	*E. coli*	6/15/2013	WET	148	99	
NM4201	*E. coli*	7/20/2013	DRY	135	135	
NM4201	*E. coli*	8/17/2013	DRY	45	78	
NM4201	*E. coli*	9/21/2013	DRY	48	48	
NM4201	*E. coli*	10/19/2013	DRY	73	59	
NM4201	*E. coli*	4/19/2014	DRY	8	8	
NM4201	*E. coli*	5/17/2014	WET	316	50	
NM4201	*E. coli*	6/21/2014	DRY	61	61	
NM4201	*E. coli*	7/19/2014	DRY	34	46	
NM4201	*E. coli*	8/16/2014	DRY	89	55	
NM4201	*E. coli*	9/20/2014	DRY	53	53	
NM4201	*E. coli*	10/18/2014	WET	1493	281	
NM4201	*E. coli*	4/20/2015	WET	49	49	
NM4201	*E. coli*	5/16/2015	DRY	59	54	
NM4201	*E. coli*	6/20/2015	DRY	104	104	
NM4201	*E. coli*	7/18/2015	DRY	87	95	
NM4201	*E. coli*	8/15/2015	DRY	77	82	
NM4201	*E. coli*	9/19/2015	DRY	113	113	
NM4201	*E. coli*	10/17/2015	DRY	73	91	
NM4201	*E. coli*	4/16/2016	DRY	20	20	
NM4201	*E. coli*	5/21/2016	DRY	108	108	
NM4201	*E. coli*	6/18/2016	DRY	69	86	
NM4201	*E. coli*	7/16/2016	DRY	60	64	
NM4201	*E. coli*	8/20/2016	DRY	39	39	
NM4201	*E. coli*	9/17/2016	DRY	69	52	
NM4201	*E. coli*	10/15/2016	DRY	49	58	
NM4201	*E. coli*	4/15/2017	DRY	155	155	
NM4201	*E. coli*	5/20/2017	DRY	75	75	
NM4201	*E. coli*	6/17/2017	WET	34	50	
NM4201	*E. coli*	7/15/2017	DRY	195	81	
NM4201	*E. coli*	8/19/2017	DRY	299	299	
NM4201	*E. coli*	9/16/2017	DRY	770	480	
NM4201	*E. coli*	10/21/2017	DRY	99	99	
NM4426	*E. coli*	7/18/2015	DRY	18	18	
NM4426	*E. coli*	8/15/2015	DRY	44	28	
NM4426	*E. coli*	4/16/2016	DRY	10	10	
NM4426	*E. coli*	5/21/2016	DRY	154	154	
NM4426	*E. coli*	6/18/2016	DRY	24	61	
NM4426	*E. coli*	7/16/2016	DRY	50	35	
NM4426	*E. coli*	8/20/2016	DRY	44	44	
NM4426	*E. coli*	9/17/2016	DRY	43	43	
NM4426	*E. coli*	10/15/2016	DRY	35	39	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
NM4426	*E. coli*	4/15/2017	DRY	71	71	
NM4426	*E. coli*	5/20/2017	DRY	91	91	
NM4426	*E. coli*	6/17/2017	WET	12	33	
NM4426	*E. coli*	7/15/2017	DRY	57	26	
NM4426	*E. coli*	8/19/2017	DRY	84	84	
NM4426	*E. coli*	9/16/2017	DRY	119	100	
NM4426	*E. coli*	10/21/2017	DRY	79	79	
W0484	*E. coli*	5/15/2008	DRY	38	38	
W0484	*E. coli*	6/12/2008	DRY	52	44	
W0484	*E. coli*	7/17/2008	DRY	240	240	
W0484	*E. coli*	8/14/2008	WET	300	268	
W0484	*E. coli*	9/4/2008	DRY	200	245	
W0484	*E. coli*	9/18/2008	DRY	280	237	
W0484	*E. coli*	4/20/2015	WET	20	20	
W0484	*E. coli*	5/16/2015	DRY	36	27	
W0484	*E. coli*	6/20/2015	DRY	201	201	
W0484	*E. coli*	7/18/2015	DRY	65	114	
W0484	*E. coli*	8/15/2015	DRY	84	74	
W0484	*E. coli*	4/16/2016	DRY	29	29	
W0484	*E. coli*	5/21/2016	DRY	205	205	
W0484	*E. coli*	6/18/2016	DRY	84	131	
W0484	*E. coli*	7/16/2016	DRY	93	88	
W0484	*E. coli*	8/20/2016	DRY	108	108	
W0484	*E. coli*	9/17/2016	DRY	88	97	
W0484	*E. coli*	10/15/2016	DRY	49	66	
W0484	*E. coli*	4/15/2017	DRY	150	150	
W0484	*E. coli*	5/20/2017	DRY	107	107	
W0484	*E. coli*	6/17/2017	WET	22	49	
W0484	*E. coli*	7/15/2017	DRY	76	41	
W0484	*E. coli*	8/19/2017	DRY	84	84	
W0484	*E. coli*	9/16/2017	DRY	118	100	
W0484	*E. coli*	10/21/2017	DRY	61	61	
W0488	*E. coli*	5/15/2008	DRY	33	33	
W0488	*E. coli*	6/12/2008	DRY	67	47	
W0488	*E. coli*	7/17/2008	DRY	39	39	
W0488	*E. coli*	8/14/2008	WET	250	99	
W0488	*E. coli*	9/4/2008	DRY	16	63	
W0488	*E. coli*	9/18/2008	DRY	93	39	

7.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for the Nashua River (MA81-05) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Combined Sewer Overflow (CSO): There are 11 CSOs in the segment watershed (none within the direct drainage area, see Section 4.1), which by design release untreated wastewater to surface waters when flows exceed system capacity, and therefore must be eliminated. For this reason, it is set as one of the highest priority pathogen sources.

Urban Stormwater: The areas around the Nashua River (MA81-05) are less developed compared to other segments within the Nashua River watershed. In terms of the entire watershed, 28% of the land area is MS4 area and 5% is DCIA. This segment is surrounded mostly by forested, natural, and agricultural land in its upstream section and then passes through a forested corridor in the towns of Shirley and Devens in its downstream half. Although the area adjacent to this segment is relatively undeveloped, the MS4 areas and DCIA indicate that stormwater runoff is likely a source of pathogens to the impaired segment.

Illicit Sewage Discharges: A portion of the watershed is served by public sewer. These sewer lines are not concentrated in the direct drainage area to the impaired segment but occur in the segment watershed. Overall, 28% of the watershed is MS4 area, including large areas around the segment itself. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are seven groundwater discharge permits for on-site wastewater discharge in the segment watershed and four within the direct drainage area. These systems are large-capacity, non-residential septic systems. Much of the direct drainage area is served by septic systems. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: The agricultural areas along the upstream half of the segment are predominantly hayfields and row crops (corn and other vegetables). Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. In addition, any agricultural lands adjacent to upstream tributaries or storm drains could also provide a direct conduit to the river.

Pet Waste: Although there appear to be no large areas of open space popular for dog walking directly on the shoreline of the segment, any conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens to the impaired segment.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

7.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ayer

Nearly all of Ayer is covered by stormwater regulations under the NPDES General MS4 Stormwater Permit. Ayer (Permit ID #MAR041179) has an EPA approved Notice of Intent (NOI). According to the 2018 annual report, Ayer has mapped all of its stormwater outfalls (Town of Ayer, 2020a). It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2005. The NOI shows six outfalls to James Brook (MA81-20) and 6 outfalls to Bennetts Brook (MA84B-06), both impaired for *E. coli*.

Ayer has the following relevant ordinances and bylaws:

- Stormwater management bylaw: https://www.ayer.ma.us/town-bylaws#anchor_xlvii (Town of Ayer, 2008)
- Wetland protection bylaw: https://www.ayer.ma.us/town-bylaws#anchor_xxvi (Town of Ayer, 2020b)
- Title 5 Supplemental Regulations: No, town bylaw simply references MA Title 5.
- Pet Waste Bylaw: None found.
- Stormwater Utility: None found.

Ayer's Master Plan (https://www.ayer.ma.us/master-plan-committee/pages/master-plan-documents) contains a brief section on "Ayer's Water Resources," pages 60-61 (Community Opportunities Group, Inc., 2017). The plan mentions stormwater. The plan also mentions the Nashua River and its impairment for *E. coli* (though Ayer's NOI does not identify any outfalls discharging to the Nashua River, James Brook is a tributary). The plan also mentions a town beach and Ayer's sewer/septic infrastructure. The official website for the town of Ayer is https://www.ayer.ma.us/ (Town of Ayer, 2021)

Ayer's Open Space and Recreation Plan: https://www.ayer.ma.us/conservation-commission/files/open-space-recreation-plan (Conway School of Landscape Design, 2019)

Town of Bolton

A small portion of Bolton is situated within the MS4 area. The town was granted a MS4 General Permit waiver by the EPA. Bolton received an MS4 waiver on August 19, 2015, which is available online at https://www3.epa.gov/region1/npdes/stormwater/ma/waivers/bolton-epa-waiver-response.pdf (Moraff, 2015a)

Bolton has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws: Section 4270 in Subdivision Rules and Regulations: https://www.ecode360.com/BO3017/laws/LF867678.pdf (Town of Bolton, 2015)
- Stormwater Utility: None found.
- Wetland Protection Bylaw: https://www.townofbolton.com/conservation-commission/pages/wetland-bylaw-regulations (Town of Bolton, 2013)
- Pet Waste Ordinance: None found.
- Contact Recreation Ordinance: None found.

The Bolton Master plan does provide a map of the town water resources in the Land Use Maps chapter (town of Bolton, 2006). It does note that while private wells currently provide the water source for Bolton's drinking water needs, the town has identified an underground aquifer at Bolton Flats for future use. The plan does not provide information on bacteria or pathogen impairment. It does note that the Site Plan Review requirement allows the Planning board to review stormwater management practices for future development. Bolton does not utilize a sewer system as noted in the master plan.

Bolton Town Website: https://www.townofbolton.com/ (Town of Bolton, 2021)

Master Plan: https://www.townofbolton.com/town-administrator/pages/master-plan (Town of Bolton, 2006)

Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.

Open Space and Recreation Plan: https://www.townofbolton.com/conservation-commission/pages/open-space-and-recreation-plan (Town of Bolton, 2017)

Town of Harvard

Harvard received an MS4 General Permit waiver on August 15, 2019: https://www3.epa.gov/region1/npdes/stormwater/ma/waivers/harvard-epa-waiver-response.pdf (Moraff, 2015b)

Harvard has a webpage dedicated to the three-year stormwater management project in the Bare Hill Pond Watershed from 2010-2013: https://www.harvard.ma.us/bare-hill-pond-watershed-management/pages/stormwater-management-project (Town of Harvard, 2010).

Harvard has the following relevant ordinance and bylaw:

- Wetlands Protection bylaw: Chapter 119: https://ecode360.com/13695448 (Town of Harvard, 2006)

Harvard's Master Plan mentions stormwater and has a section on Water and Sewer Services (page 96) in Chapter 7, Community Services and Facilities. The Master Plan also has a dedicated section on Water Resources (Chapter 3 Section 2, pg. 26):https://www.harvard.ma.us/master-plan (Town of Harvard, 2016a).

Harvard has an Open Space and Recreation Plan: https://www.harvard.ma.us/sites/harvardma/files/uploads/2016_osrp_final.pdf (Town of Harvard 2016b)

Town of Lancaster. See Section 6.4

Town of Shirley

Nearly 40% of Shirley is covered by stormwater regulations under the NPDES General MS4 Stormwater Permit. Shirley (Permit ID #MAR041221) has an EPA approved Notice of Intent (NOI). Shirley has mapped all of its MS4 stormwater systems and adopted illicit discharge detection and elimination (IDDE) regulations in 2007, as well as erosion and sediment control (ESC) and post-construction stormwater regulations in 2008. There are an unknown number of stormwater outfalls to the Squannacook River (MA81-19, unimpaired for pathogens) and to the Nashua River (MA81-05, impaired for pathogens).

Shirley has the following relevant ordinances and bylaws:

- Stormwater Management Control bylaw: Article XXXII, https://www.shirley-ma.gov/sites/g/files/vyhlif5001/f/uploads/general_town_bylaws.pdf (Town of Shirley, 2015)
- Sewer Regulations: Article XXVI Sewer System page 42
- Non-Zoning Wetlands bylaw: Article XIX page 32
- Pet waste bylaw: Article VI Health and Sanitation Section 9.8

Shirley Stormwater Management webpage: https://www.shirley-ma.gov/department-public-works/pages/stormwater-noi-and-authoriztion-discharge (Town of Shirley, n.d.)

Shirley Master Plan references stormwater, *E. coli*, and fecal coliform concerns. The town's Master Plan has a section on Water Resources (page 117) in the Environmental Inventory and Analysis section. It also discusses the impaired waters of the Nashua River confluence with the Squannacook River (page 117-118). The Master Plan also has a section (3) on Water Supply and Sewer System Analysis (page 95). The Town of Shirley Master Plan is available online, as shown below (Town of Shirley and MRPC, 2018).

Shirley Master Plan: https://www.shirley-ma.gov/sites/g/files/vyhlif5001/f/uploads/final_shirley_master_plan_2018.pdf (Town of Shirley and MRPC, 2018)

Shirley Open Space and Recreation Plan: https://www.shirley-ma.gov/conservation-commission (Town of Shirley, 2019)

8. MA81-09 Nashua River

8.1. Waterbody Overview

The "South Branch" or South Nashua River segment MA81-09 is 1.8 miles long and begins where the Clinton WWTP discharge (NPDES: MA0100404) in Clinton, MA. The segment flows to the north and ends at its confluence with the North Nashua River (MA81-04) and the Nashua River (MA81-05) in Lancaster, MA.

Major tributaries to the South Nashua River segment MA81-09 include Goodridge Brook. Major lakes and ponds within the segment watershed include the Pine Hill, Quinapoxet, and Wachusett Reservoirs. Impaired segment tributaries to MA81-09 include Gates Brook (MA81-24) and Stillwater River (MA81-31).

Key landmarks in the watershed include the town centers of Princeton, Rutland, West Boylston, Sterling, Boylston, and Clinton; the International Golf Club & Resort; Holden Town Forest; Kinney Woods; and part of the Minns Wildlife Sanctuary. Segment MA81-09 crosses High Street/MA-110 (Clinton), Mill Street Extension (Lancaster), and Bolton Road (Lancaster).

The South Nashua River (MA81-09) drains an area of 131 square miles, of which 8 mi^2 (6%) is impervious and 4 mi^2 (3%) is directly connected impervious area (DCIA). The watershed is served partially[17] by public sewer and 23% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES permit on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed close to the segment itself (Table 8-1). There are 2 MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 8-2). There are five landfills, and no combined sewer overflows or unpermitted land disposal dumping grounds (Figure 8-1).

Reduction from Highest calculated Geomean: 95%

Watershed Area (Acres): 83,894

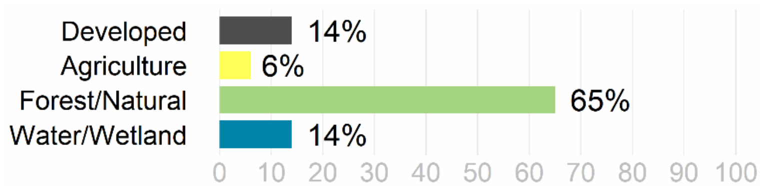
Segment Length (miles): 1.8

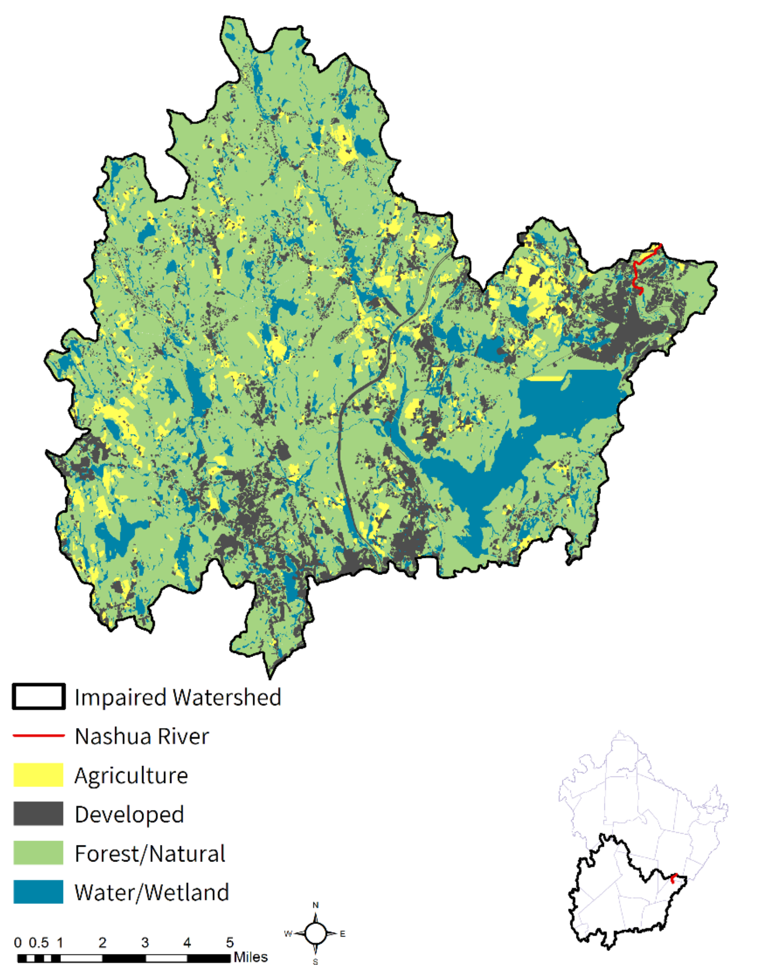
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 5,401 (6%)

DCIA Area (Acres, %): 2,327 (3%)





[17] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

Table 8-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0100404	MWRA - CLINTON STP	CLINTON	MUN

Table 8-2. Groundwater discharge permits in the segment watershed. Groundwater discharge permits are not duplicated for larger segment watersheds that include this segment watershed. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

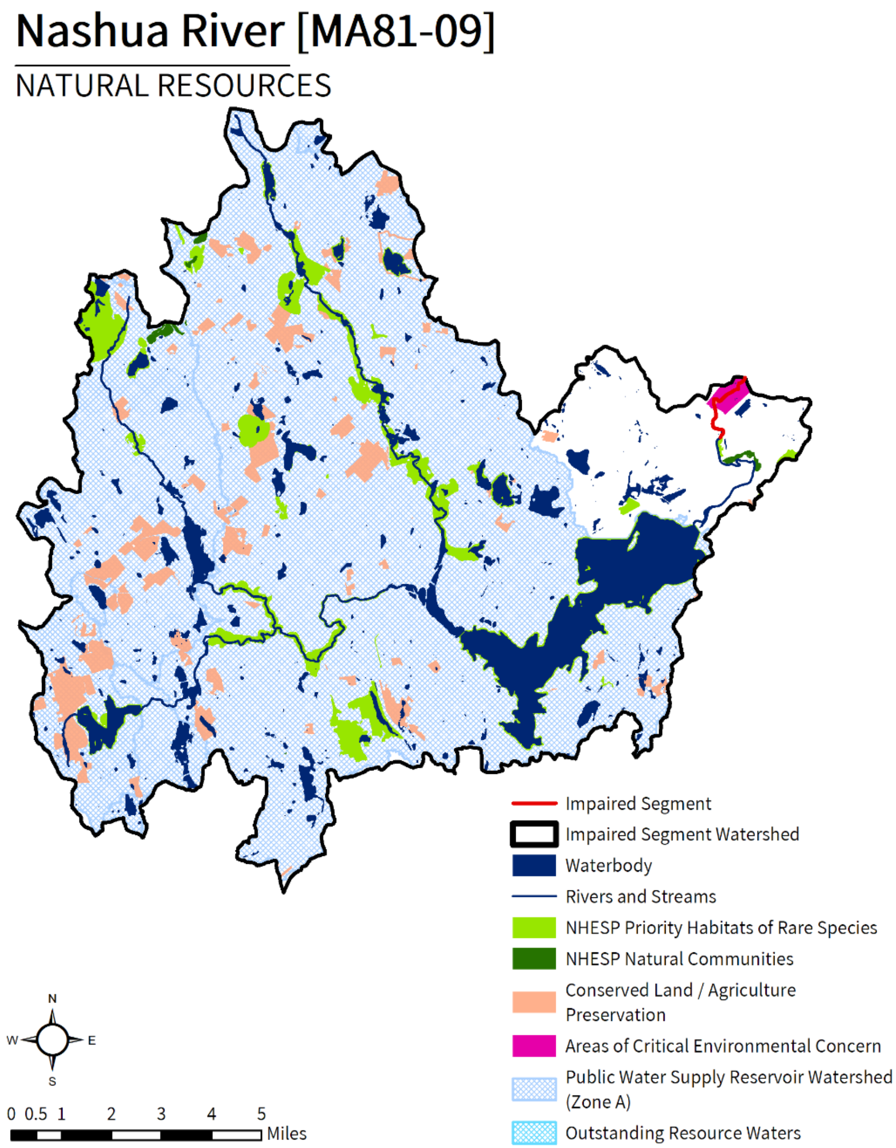
PERR	NAME	TOWN	TYPE	FLOW (GPD)
562-3	THE INTERNATIONAL	BOLTON	Sanitary Discharge	22,549

The entire segment flows through a patchwork of landscapes ranging from forested and natural landscapes to agricultural fields and areas of residential and commercial development. The Wachusett Reservoir occupies a large area of the western part of the watershed. Developed land uses, primarily residential, are clustered around the town of Clinton upstream of the impaired segment. Agricultural fields are concentrated in the far west of the segment watershed near the headwaters, as well as west of Clinton and Chace Hill Road where row crops are present.

In the watershed of the South Nashua River (MA81-09), under the Natural Heritage and Endangered Species Program, there are 189 acres (<1%) of Priority Natural Vegetation Communities and 9,319 acres (11%) of Priority Habitats of Rare Species. There are 75,470 acres (90%) under Public Water Supply protection, 224 acres (<1%) identified as Areas of Critical Environmental Concern, but no areas identified as Outstanding Resource Waters in the watershed. Over 4,914 acres (6%) of land protected in perpetuity[18] exist within the segment watershed, which is part of a total of 34,428 acres (41%) of Protected and Recreational Open Space[19]. See Figure 8-1.

[18] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[19] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



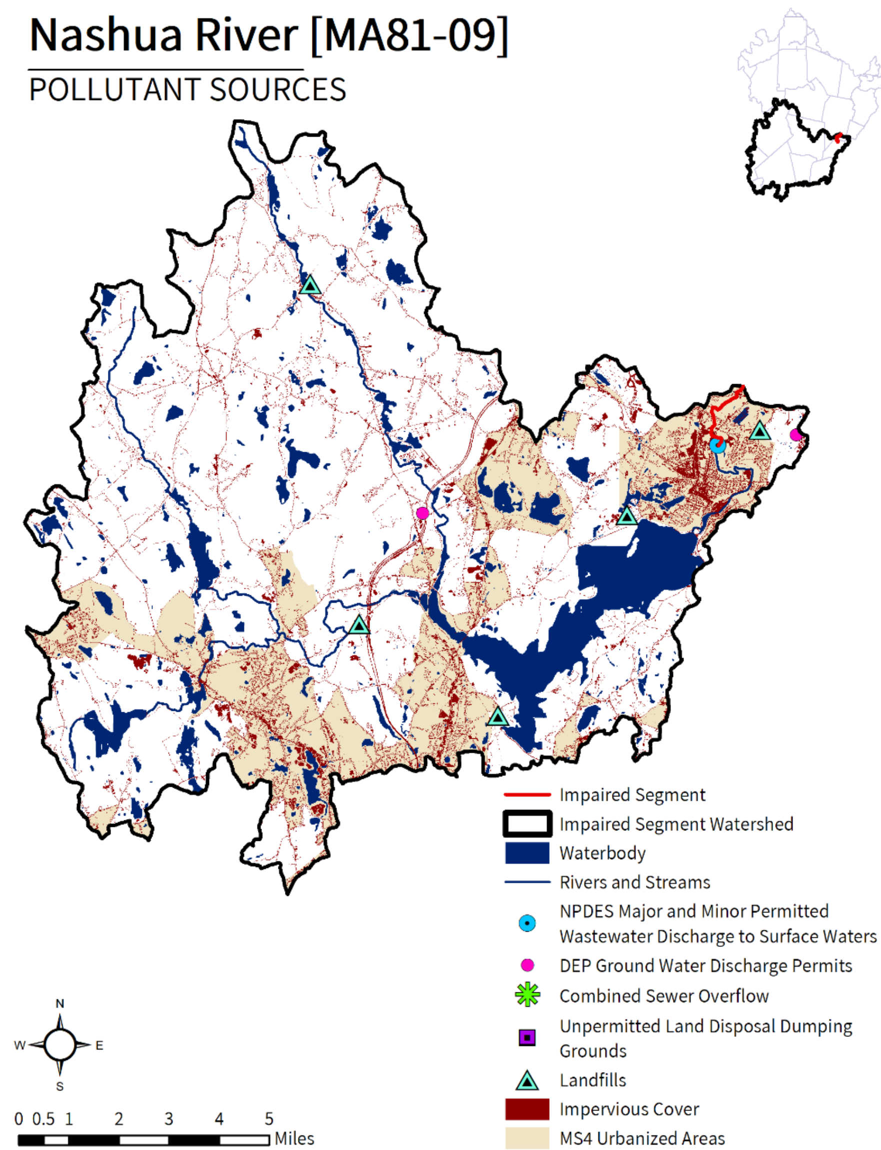


Figure 8-1. Natural resources and potential pollution sources draining to the Nashua River segment MA81-09. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

8.2. Waterbody Impairment Characterization

The South Nashua River (MA81-09) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 8-3, 8-4; Figure 8-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli*. The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

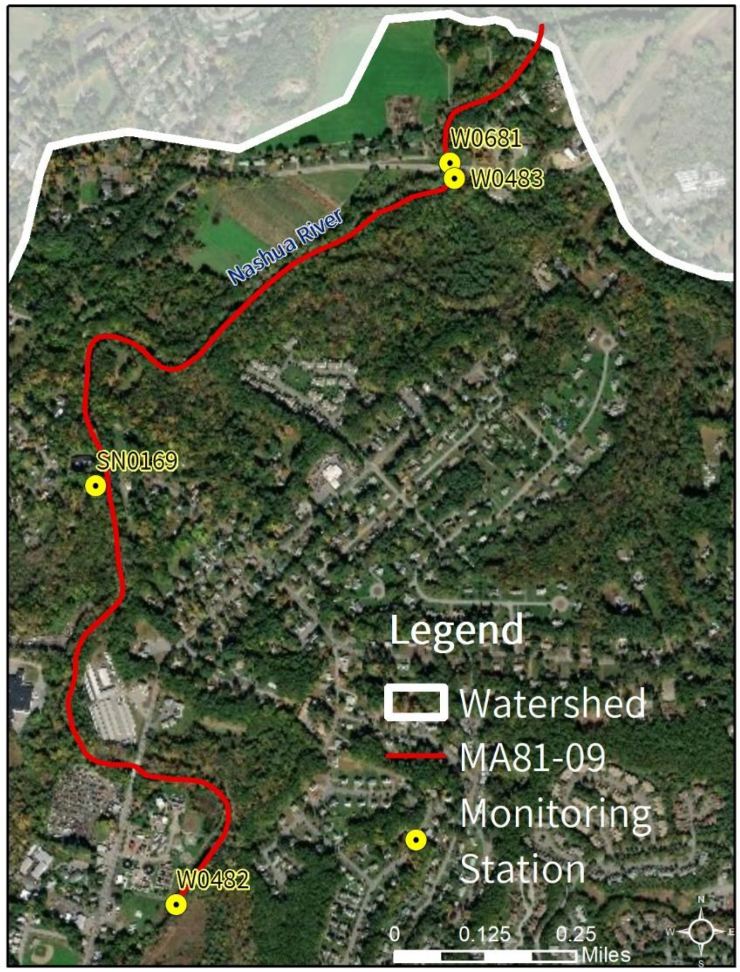


Figure 8-2. Location of monitoring station(s) along the impaired river segment.

- From 2008-2017, 69 samples were collected at SN0169, resulting in 43 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 69 samples, 21 exceeded the STV criterion in years 2008-2015 and 2017 during both wet and dry weather.
- In 2008, six samples were collected at W0482, resulting in no days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.
- From 2007-2013, 14 samples were collected at W0483, resulting in six days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 14 samples, one exceeded the STV criterion in 2013 during wet weather.
- From 2007-2013, 19 samples were collected at W0681, resulting in 11 days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 19 samples, two exceeded the STV criterion in 2011 and 2012 during wet weather.

Table 8-3. Summary of indicator bacteria sampling results by station for the South Nashua River (MA81-09). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
SN0169	4/19/2008	10/21/2017	69	2420	43	21
W0482	5/15/2008	9/18/2008	6	105	0	0
W0483	10/10/2007	9/24/2013	14	1730	6	1
W0681	8/22/2007	3/6/2013	19	2420	11	2

Table 8-4. Indicator bacteria data by station, indicator, and date for the South Nashua River (MA81-09). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
SN0169	*E. coli*	4/19/2008	DRY	7	7	
SN0169	*E. coli*	5/17/2008	WET	980	83	
SN0169	*E. coli*	7/19/2008	DRY	152	152	
SN0169	*E. coli*	8/16/2008	DRY	2420	606	
SN0169	*E. coli*	9/20/2008	DRY	435	435	
SN0169	*E. coli*	10/18/2008	DRY	150	255	
SN0169	*E. coli*	4/18/2009	DRY	2420	2420	
SN0169	*E. coli*	5/16/2009	DRY	186	671	
SN0169	*E. coli*	6/20/2009	WET	461	461	
SN0169	*E. coli*	7/18/2009	DRY	727	579	
SN0169	*E. coli*	8/15/2009	DRY	727	727	
SN0169	*E. coli*	9/19/2009	DRY	71	71	
SN0169	*E. coli*	10/17/2009	DRY	37	51	
SN0169	*E. coli*	4/17/2010	WET	29	29	
SN0169	*E. coli*	5/15/2010	DRY	921	163	
SN0169	*E. coli*	6/19/2010	DRY	1553	1553	
SN0169	*E. coli*	7/17/2010	DRY	1553	1553	
SN0169	*E. coli*	8/21/2010	DRY	921	921	
SN0169	*E. coli*	9/18/2010	DRY	328	550	
SN0169	*E. coli*	10/16/2010	WET	517	412	
SN0169	*E. coli*	4/16/2011	WET	99	99	
SN0169	*E. coli*	5/21/2011	DRY	45	45	
SN0169	*E. coli*	6/18/2011	DRY	137	79	
SN0169	*E. coli*	7/16/2011	DRY	57	88	
SN0169	*E. coli*	8/20/2011	DRY	488	488	
SN0169	*E. coli*	9/17/2011	DRY	86	205	
SN0169	*E. coli*	10/15/2011	WET	96	91	
SN0169	*E. coli*	4/21/2012	DRY	160	160	
SN0169	*E. coli*	5/19/2012	DRY	47	87	
SN0169	*E. coli*	6/16/2012	DRY	47	47	
SN0169	*E. coli*	7/21/2012	DRY	326	326	
SN0169	*E. coli*	8/18/2012	WET	387	355	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
SN0169	*E. coli*	9/15/2012	DRY	1300	709	
SN0169	*E. coli*	10/20/2012	WET	2420	2420	
SN0169	*E. coli*	4/20/2013	DRY	206	206	
SN0169	*E. coli*	5/18/2013	DRY	161	182	
SN0169	*E. coli*	6/15/2013	WET	88	119	
SN0169	*E. coli*	7/20/2013	DRY	770	770	
SN0169	*E. coli*	8/17/2013	DRY	21	127	
SN0169	*E. coli*	9/21/2013	DRY	214	214	
SN0169	*E. coli*	10/19/2013	DRY	84	134	
SN0169	*E. coli*	4/19/2014	DRY	5	5	
SN0169	*E. coli*	5/17/2014	WET	1013	71	
SN0169	*E. coli*	6/21/2014	DRY	47	47	
SN0169	*E. coli*	7/19/2014	DRY	35	41	
SN0169	*E. coli*	8/16/2014	DRY	17	24	
SN0169	*E. coli*	9/20/2014	DRY	179	179	
SN0169	*E. coli*	10/18/2014	WET	127	151	
SN0169	*E. coli*	4/20/2015	WET	8	8	
SN0169	*E. coli*	5/16/2015	DRY	19	12	
SN0169	*E. coli*	6/20/2015	DRY	179	179	
SN0169	*E. coli*	7/18/2015	DRY	575	321	
SN0169	*E. coli*	8/15/2015	DRY	517	545	
SN0169	*E. coli*	9/19/2015	DRY	216	216	
SN0169	*E. coli*	10/17/2015	DRY	56	110	
SN0169	*E. coli*	4/16/2016	DRY	133	133	
SN0169	*E. coli*	5/21/2016	DRY	165	165	
SN0169	*E. coli*	6/18/2016	DRY	214	188	
SN0169	*E. coli*	7/16/2016	DRY	291	250	
SN0169	*E. coli*	8/20/2016	DRY	261	261	
SN0169	*E. coli*	9/17/2016	DRY	261	261	
SN0169	*E. coli*	10/15/2016	DRY	70	135	
SN0169	*E. coli*	4/15/2017	DRY	17	17	
SN0169	*E. coli*	5/20/2017	DRY	55	55	
SN0169	*E. coli*	6/17/2017	WET	43	49	
SN0169	*E. coli*	7/15/2017	DRY	91	63	
SN0169	*E. coli*	8/19/2017	DRY	411	411	
SN0169	*E. coli*	9/16/2017	DRY	517	461	
SN0169	*E. coli*	10/21/2017	DRY	125	125	
W0482	*E. coli*	5/15/2008	DRY	14	14	
W0482	*E. coli*	6/12/2008	DRY	42	24	
W0482	*E. coli*	7/17/2008	DRY	61	61	
W0482	*E. coli*	8/14/2008	WET	67	64	
W0482	*E. coli*	9/4/2008	DRY	150	100	
W0482	*E. coli*	9/18/2008	DRY	73	105	
W0483	*E. coli*	10/10/2007	WET	365	365	
W0483	*E. coli*	1/16/2008	DRY	49	49	
W0483	*E. coli*	6/12/2008	DRY	260	260	
W0483	*E. coli*	7/17/2008	DRY	104	104	
W0483	*E. coli*	9/18/2008	DRY	155	155	
W0483	*E. coli*	2/18/2009	DRY	14	14	
W0483	*E. coli*	10/21/2009	DRY	23	23	
W0483	*E. coli*	2/4/2010	DRY	86	86	
W0483	*E. coli*	7/15/2010	WET	387	387	
W0483	*E. coli*	4/25/2011	WET	111	111	
W0483	*E. coli*	11/7/2012	DRY	119	119	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0483	*E. coli*	4/17/2013	DRY	46	46	
W0483	*E. coli*	5/22/2013	WET	1730	1730	
W0483	*E. coli*	9/24/2013	WET	387	387	
W0681	*E. coli*	8/22/2007	DRY	57	57	
W0681	*E. coli*	3/19/2008	WET	202	202	
W0681	*E. coli*	5/15/2008	DRY	260	260	
W0681	*E. coli*	8/14/2008	WET	162	162	
W0681	*E. coli*	11/12/2008	DRY	96	96	
W0681	*E. coli*	4/22/2009	WET	128	128	
W0681	*E. coli*	6/17/2009	DRY	152	152	
W0681	*E. coli*	9/2/2009	DRY	129	129	
W0681	*E. coli*	9/22/2010	DRY	397	397	
W0681	*E. coli*	11/9/2010	WET	291	291	
W0681	*E. coli*	3/9/2011	WET	2420	2420	
W0681	*E. coli*	6/15/2011	DRY	121	121	
W0681	*E. coli*	8/24/2011	DRY	152	152	
W0681	*E. coli*	10/19/2011	WET	36	36	
W0681	*E. coli*	3/20/2012	DRY	12	12	
W0681	*E. coli*	5/22/2012	WET	69	69	
W0681	*E. coli*	7/18/2012	DRY	53	53	
W0681	*E. coli*	9/19/2012	WET	2420	2420	
W0681	*E. coli*	3/6/2013	DRY	46	46	

8.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for the South Nashua River (MA81-09) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. Station W0482, near the segment's upstream boundary, did not have indicator bacteria results exceeding the SWQS during either wet or dry weather, indicating the sources of pathogens to the segment are likely to occur downstream of W0482.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the South Nashua River (MA81-09) watershed are highly developed, with 23% of the land area in MS4 and 3% as DCIA, including large parking lots and high-density residential development adjacent to the segment. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed in sewer service and 23% of the watershed designated as MS4 area, including the area surrounding the segment itself, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are 2 groundwater discharge permits for on-site wastewater discharge within the segment watershed (1 within the immediate drainage area), which are large-capacity septic systems (non-residential). Given the portion of the watershed not covered by sewer service, malfunctioning septic systems are also a possible source of pathogen pollutants. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are two agricultural fields along the impaired segment near the downstream end. These fields appear to be used primarily for growing hay and row crops. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: In general, conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens. There are no parks and ballfields adjacent to the river; however, the segment flows along residential neighborhoods where dogs are certainly present. These nonpoint sources of pathogens can be carried into surface waters during rain events.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water. There are open fields near the start of the impaired segment and Fuller Field along MA-110 slightly southwest of the start of the segment.

8.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Clinton

Most of Clinton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Clinton (Permit ID #MAR041186) has an EPA approved Notice of Intent (NOI). Clinton has a Stormwater Management Plan, available at https://www.clintonma.gov/DocumentCenter/View/1675/Clinton-Stormwater-Managment-Plan?bidId= (Comprehensive Environmental, Inc., 2019). The town has mapped all of its MS4 stormwater system. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2006. According to the NOI, there are 35 outfalls into the South Nashua River (MA81-09), impaired for *E. coli*.

Clinton has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws: Referenced in Zoning By-Laws, but is not available: https://www.clintonma.gov/DocumentCenter/View/1595/Zoning-By-Law-PDF (Town of Clinton, 2018)
- Stormwater Utility: None found.
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Open Space and Recreation Plan: https://www.clintonrec.com/wp-content/uploads/2012/11/2016-OSRP-Complete_reduced.pdf (Town of Clinton, 2016)
- Wetland Protection Bylaw: Nothing beyond State of Massachusetts wetland protection regulations.
- Pet Waste Ordinance: https://www.clintonma.gov/DocumentCenter/View/1550/By-Laws-For-Dog-Owners-PDF (Town of Clinton, n.d.)

The Existing Conditions and Trends chapter of the Clinton Master Plan has information on water resources within Clinton. This section mentions the Nashua River, an impaired segment within the town's boundaries, noting that the Clinton Department of Public Works has incorporated several best management practices into NPDES Phase

II work to address the impairments. Clinton has a sewer service and water filtration plan which is detailed in the Public Works section of the Existing Conditions and Trends chapter.

Clinton Town Website: https://www.clintonma.gov/ (Town of Clinton, 2021)

Master Plan: https://www.clintonma.gov/DocumentCenter/View/971/2012-Clinton-Master-Plan-PDF?bidId= (Town of Clinton et al, 2009)

Stormwater Management Program Plan: https://www.clintonma.gov/DocumentCenter/View/1675/Clinton-Stormwater-Managment-Plan?bidId= (Comprehensive Environmental, Inc., 2019)

Town of Holden

Almost half of Holden is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Holden (Permit ID #MAR041121) has an EPA approved Notice of Intent (NOI). Holden has a Stormwater Management Plan, which is available online at https://www.holdenma.gov/sites/g/files/vyhlif4526/f/uploads/2020_swmp-3.pdf (Town of Holden, 2019). The town has mapped all of its MS4 stormwater system, which is available online. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2011. According to the NOI, there are no stormwater outfalls into impaired segments in the Nashua River watershed.

Holden has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws: Nothing beyond state regulations.
- Stormwater Utility: None found.
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Wetland Protection Bylaw: https://www.holdenma.gov/department-of-public-works/pages/chapter-61-wetlands-act (Town of Holden, n.d., a)
- Pet Waste Ordinance: None found.
- Contact Recreation Ordinance: None found.

The Holden Master Plan Natural Resources Chapter has an extensive section on water resources. The plan does not mention stormwater or bacteria or pathogen impairments. While the town of Holden does utilize sewer in some sections of the town, the plan does not have a section on their sewer system.

Holden Town Website: https://www.holdenma.gov/ (Town of Holden, 2021)

Master Plan: https://www.holdenmasterplan.com/the-master-plan (CMRPC et al, 2019)
Stormwater Web Page: https://www.holdenma.gov/department-of-public-works/pages/stormwater-information (Town of Holden, n.d., b)

The 2020 Open Space and Recreation Plan for the Town of Holden, which replaces and supersedes the 2012 Plan, is not available online (Town of Holden, 2020).
https://www.holdenma.gov/sites/holden/files/file/file/updated_plan-1_open_space_recreation_plan.pdf

Town of Lancaster. See Section 5.4

Town of Princeton

Princeton is not within the MS4 area.

Princeton did not have any relevant ordinances or bylaws.

The Town of Princeton Master Plan references *E. coli*, fecal coliform, and the impaired headwaters northeast of Little Wachusett Mountain (page 52). The Open Space and Recreation Plan was updated in 2014, and a more recent update is underway (Town of Princeton, 2020).

Princeton Master Plan:
https://www.town.princeton.ma.us/sites/princetonma/files/uploads/princeton_town_plan_master_final.pdf (Community Opportunities Group, Inc. et al, 2007)

Princeton Open Space and Recreation Plan: https://www.town.princeton.ma.us/open-space-committee (Town of Princeton, 2020)

Town of Sterling

Nearly 20% of Sterling is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Sterling (Permit ID #MAR041222) has an EPA approved Notice of Intent (NOI). The town of Sterling has mapped all of its MS4 stormwater system, with a map attached to its NOI. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2007-2009. There were no reported outfalls to waterbodies.

Sterling's Stormwater Management Plan is on file with the Department of Public Works, and information about the Sterling Stormwater Management Plan can be found at https://www.sterling-ma.gov/dept-public-works/pages/stormwater-information-0 (Town of Sterling, n.d.).

Sterling has the following relevant ordinances and bylaws:

- Stormwater Management Bylaw: Chapter 164 https://ecode360.com/15005430 (Town of Sterling, 2012a)
- Title 5 / Sewer System: Chapter 162 https://ecode360.com/12404486?highlight=sewer&searchId=6052104090168968#12404486 (Town of Sterling, 2012b)
- Pet Waste: Chapter 18 Animal Control > Nuisance https://ecode360.com/11816055?highlight=nuisance,waste&searchId=6052028105374970#11816055 (Town of Sterling, 2012c)

Sterling is in the process of updating its 1962 Master Plan; updates on this ongoing initiative are available at https://www.sterling-ma.gov/sterling-master-plan-committee (Town of Sterling, 2021)

Sterling's Open Space and Recreation Plan was updated in 2019: https://www.sterling-ma.gov/open-space-implementation-committee/pages/open-space-recreation-plan-2010-update (Town of Sterling, 2019).

9. MA81-13 Monoosnuc Brook

9.1. Waterbody Overview

The Monoosnuc Brook segment MA81-13 is 6.1 miles long and begins at the outlet of Simonds Pond in Leominster, MA. The segment flows east into Fitchburg (for 0.24 miles) then southeast back into Leominster, through Pierce Pond (segment MA8110) and Rockwell Pond (segment MA81112), before ending at its confluence with the North Nashua River (MA81-03) in Leominster.

Major tributaries to Monoosnuc Brook segment MA81-13 include approximately 10 miles of unnamed streams and the Notown Reservoir in the western part of the segment watershed.

Key landmarks in the watershed include the Leominster State Forest, Nashua Valley Conservation Area, Fitchburg City Forest, Gardner Hill, part of the Oak Hill Country Club golf course, and the Leominster town center. Segment MA81-13 crosses many small residential roadways along its path in addition to major road crossings including two along George W Stanton Hwy/MA-2 (Fitchburg), and Monument Square/MA-12 (Leominster).

Monoosnuc Brook (MA81-13) drains an area of 11 square miles, of which 1.3 mi^2 (11%) is impervious and 0.9 mi^2 (8%) is directly connected impervious area (DCIA). The watershed is served mostly[20] by public sewer and 30% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed. There are no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 9-1.

The upstream portion of the segment flows through a large, forested area, along the divided highway MA-2, then through residential neighborhoods of Leominster along Merriam Avenue. A portion of Monoosnuc Brook appears to be channelized within vertical concrete banks

Reduction from the Highest calculated Geomean: 95%

Watershed Area (Acres): 7,147

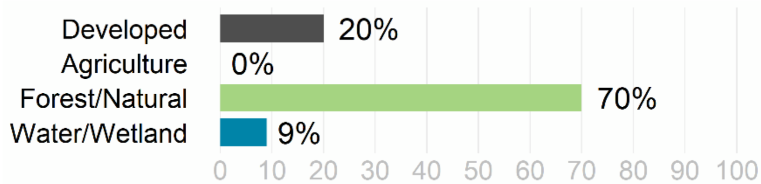
Segment Length (miles): 6.1

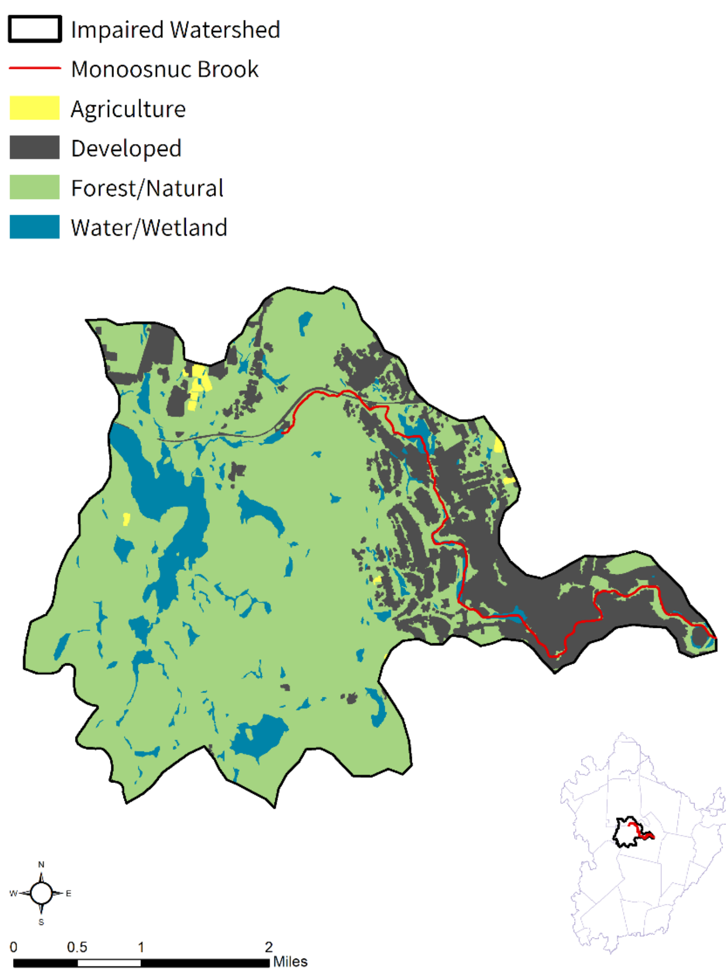
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 810 (11%)

DCIA Area (Acres, %): 552 (8%)





[20] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

downstream of Rockwell Pond through dense mixed residential and commercial land use. The most downstream portion of the stream flows adjacent to the expansive parking lots of Mall and Whitney Field, though with a relatively wide (approximately 50 meters) forested buffer on river right at the edge of residential development.

In the watershed of Monoosnuc Brook (MA81-13), under the Natural Heritage and Endangered Species Program, there are no areas of Priority Natural Vegetation Communities, but there are 609 acres (9%) of Priority Habitats of Rare Species. There are 4,272 acres (60%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. There are no areas of land protected in perpetuity[21] within the segment watershed, which would otherwise be part of a total of 3,622 acres (51%) of Protected and Recreational Open Space[22]. See Figure 9-1.

[21] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[22] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

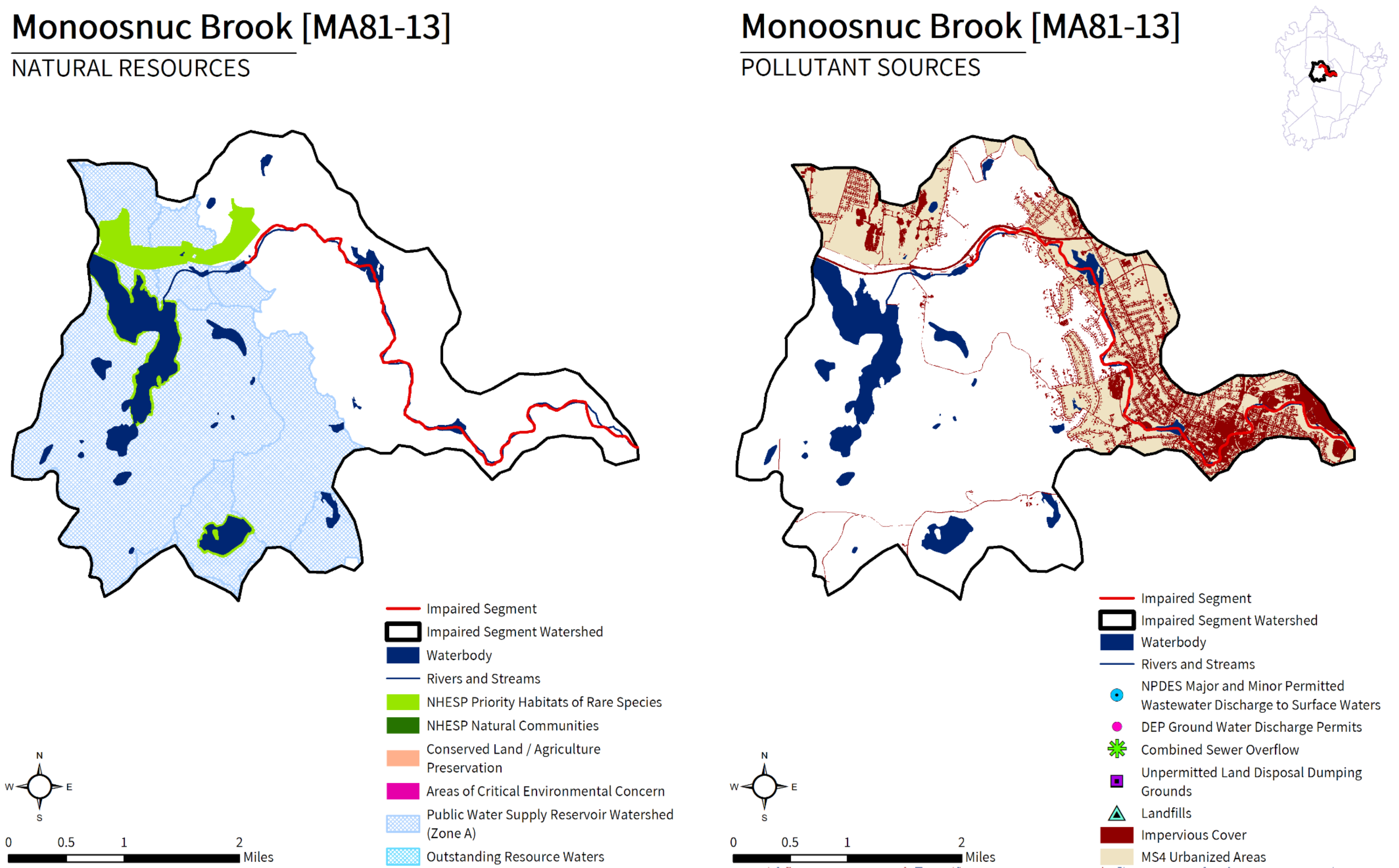


Figure 9-1. Natural resources and potential pollution sources draining to the Monoosnuc Brook River segment MA81-13. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

9.2. Waterbody Impairment Characterization

Monoosnuc Brook (MA81-13) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 9-1, 9-2; Figure 9-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli*. The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

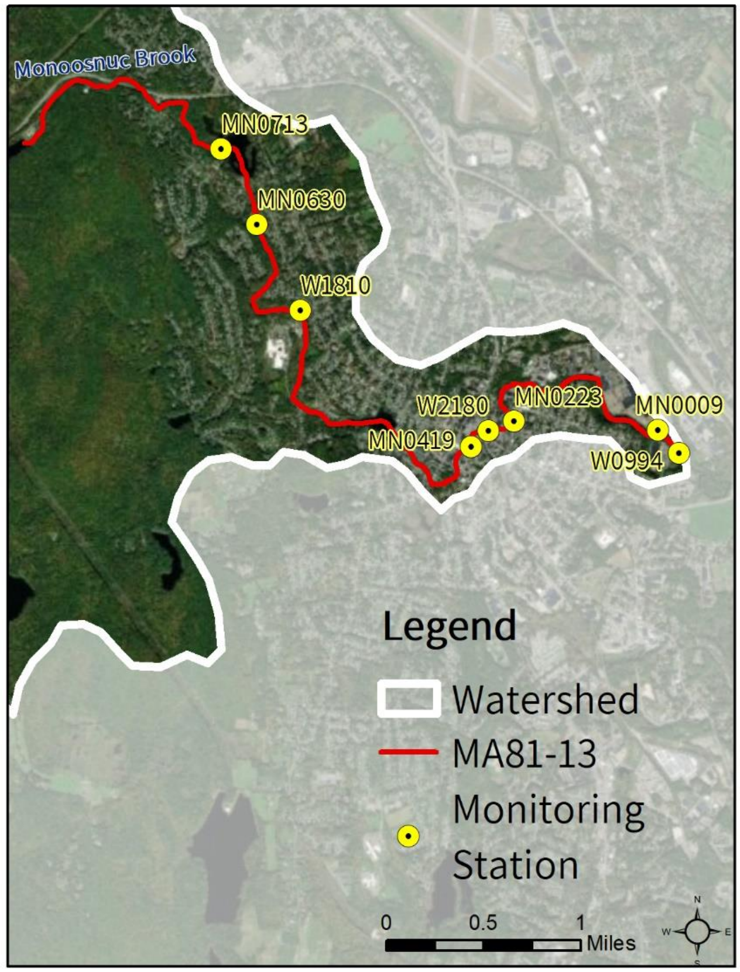


Figure 9-2. Location of monitoring station(s) along the impaired river segment.

- From 2008-2017, 63 samples were collected at MN0009, resulting in 36 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 63 samples, 15 exceeded the STV criterion from 2009-2015 and 2017 during both wet and dry weather.
- From 2008-2017, 63 samples were collected at MN0223, resulting in 47 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 63 samples, 34 exceeded the STV criterion from 2008-2017 during both wet and dry weather.
- From 2008-2013, 22 samples were collected at MN0419, resulting in 11 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 22 samples, six exceeded the STV criterion in 2010 and 2011 during both wet and dry weather.
- In 2017, five samples were collected at MN0630, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, none exceeded the STV criterion.
- In 2008, six samples were collected at MN0713, resulting in one day when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.
- In 2008, six samples were collected at W0994, resulting in three days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during both wet and dry weather.
- From 2008-2017, 57 samples were collected at W1810, resulting in 27 days when the 90-day rolling geomean exceeded the criterion. Since there were more than 10 samples collected in 2008, the STV criterion was applied to the 90-day rolling 90th percentile. From 2008-2017, 57 samples were collected at W1810, resulting in 16 days when the 90-day rolling 90th percentile exceeded the STV criterion. Note: the number of days that exceeded the STV criterion also includes the number of single samples exceeding the STV criterion for 2010, 2012, and 2014-2016 (years with less than 10 samples).

- In 2011, six samples were collected at W2180, resulting in four days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather.

Table 9-1. Summary of indicator bacteria sampling results by station for Monoosnuc Brook (MA81-13). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
MN0009	4/19/2008	10/21/2017	63	1120	36	15
MN0223	4/19/2008	10/21/2017	63	2420	47	34
MN0419	5/17/2008	10/19/2013	22	1203	11	6
MN0630	6/17/2017	10/21/2017	5	34	0	0
MN0713	4/19/2008	10/18/2008	6	136	1	0
W0994	5/13/2008	9/16/2008	6	412	3	2
W1810	5/13/2008	4/15/2017	57	1203	27	16*
W2180	5/10/2011	9/19/2011	6	270	4	1

**Since more than 10 samples were available in 2008, this value represents the number of days exceeding the STV criterion for the 90-day rolling 90th percentile in 2008 plus the number of single samples exceeding the STV criterion for 2010, 2012, and 2014-2016.*

Table 9-2. Indicator bacteria data by station, indicator, and date for Monoosnuc Brook (MA81-13). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
MN0009	*E. coli*	4/19/2008	DRY	32	32	
MN0009	*E. coli*	5/17/2008	WET	162	72	
MN0009	*E. coli*	7/19/2008	DRY	345	236	
MN0009	*E. coli*	8/16/2008	DRY	119	203	
MN0009	*E. coli*	9/20/2008	DRY	38	116	
MN0009	*E. coli*	10/18/2008	DRY	76	70	
MN0009	*E. coli*	4/18/2009	DRY	649	649	
MN0009	*E. coli*	5/16/2009	DRY	108	265	
MN0009	*E. coli*	7/18/2009	DRY	70	87	
MN0009	*E. coli*	8/15/2009	DRY	70	70	
MN0009	*E. coli*	9/19/2009	DRY	73	71	
MN0009	*E. coli*	10/17/2009	DRY	36	57	
MN0009	*E. coli*	4/17/2010	WET	107	107	
MN0009	*E. coli*	6/19/2010	DRY	1120	346	
MN0009	*E. coli*	7/17/2010	DRY	1120	1120	
MN0009	*E. coli*	8/21/2010	DRY	129	545	
MN0009	*E. coli*	9/18/2010	DRY	613	446	
MN0009	*E. coli*	4/16/2011	WET	96	96	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
MN0009	*E. coli*	5/21/2011	DRY	272	162	
MN0009	*E. coli*	6/18/2011	DRY	248	186	
MN0009	*E. coli*	7/16/2011	DRY	75	172	
MN0009	*E. coli*	8/20/2011	DRY	276	173	
MN0009	*E. coli*	9/17/2011	DRY	166	151	
MN0009	*E. coli*	10/15/2011	WET	649	310	
MN0009	*E. coli*	4/21/2012	DRY	125	125	
MN0009	*E. coli*	6/16/2012	DRY	201	159	
MN0009	*E. coli*	7/21/2012	DRY	75	123	
MN0009	*E. coli*	8/18/2012	WET	250	156	
MN0009	*E. coli*	9/15/2012	DRY	816	248	
MN0009	*E. coli*	10/20/2012	WET	1733	707	
MN0009	*E. coli*	4/20/2013	DRY	38	38	
MN0009	*E. coli*	5/18/2013	DRY	96	60	
MN0009	*E. coli*	6/15/2013	WET	387	112	
MN0009	*E. coli*	8/17/2013	DRY	548	461	
MN0009	*E. coli*	9/21/2013	DRY	93	226	
MN0009	*E. coli*	10/19/2013	DRY	228	226	
MN0009	*E. coli*	4/19/2014	DRY	13	13	
MN0009	*E. coli*	5/17/2014	WET	1733	150	
MN0009	*E. coli*	6/21/2014	DRY	73	118	
MN0009	*E. coli*	7/19/2014	DRY	84	220	
MN0009	*E. coli*	8/16/2014	DRY	201	107	
MN0009	*E. coli*	9/20/2014	DRY	59	100	
MN0009	*E. coli*	10/18/2014	WET	435	173	
MN0009	*E. coli*	4/20/2015	WET	46	46	
MN0009	*E. coli*	5/16/2015	DRY	91	65	
MN0009	*E. coli*	6/20/2015	DRY	222	98	
MN0009	*E. coli*	7/18/2015	DRY	914	171	
MN0009	*E. coli*	8/15/2015	DRY	272	381	
MN0009	*E. coli*	9/19/2015	DRY	488	495	
MN0009	*E. coli*	10/17/2015	DRY	107	242	
MN0009	*E. coli*	5/21/2016	DRY	160	160	
MN0009	*E. coli*	6/18/2016	DRY	214	185	
MN0009	*E. coli*	7/16/2016	DRY	249	204	
MN0009	*E. coli*	8/20/2016	DRY	248	236	
MN0009	*E. coli*	9/17/2016	DRY	201	232	
MN0009	*E. coli*	10/15/2016	DRY	32	117	
MN0009	*E. coli*	4/15/2017	DRY	25	25	
MN0009	*E. coli*	5/20/2017	DRY	70	42	
MN0009	*E. coli*	6/17/2017	WET	30	37	
MN0009	*E. coli*	7/15/2017	DRY	579	107	
MN0009	*E. coli*	8/19/2017	DRY	727	233	
MN0009	*E. coli*	9/16/2017	DRY	435	568	
MN0009	*E. coli*	10/21/2017	DRY	118	334	
MN0223	*E. coli*	4/19/2008	DRY	24	24	
MN0223	*E. coli*	5/17/2008	WET	119	53	
MN0223	*E. coli*	7/19/2008	DRY	980	341	
MN0223	*E. coli*	8/16/2008	DRY	115	336	
MN0223	*E. coli*	9/20/2008	DRY	12	111	
MN0223	*E. coli*	10/18/2008	DRY	261	71	
MN0223	*E. coli*	4/18/2009	DRY	921	921	
MN0223	*E. coli*	5/16/2009	DRY	115	325	
MN0223	*E. coli*	6/20/2009	WET	548	387	
MN0223	*E. coli*	7/18/2009	DRY	268	257	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
MN0223	*E. coli*	8/15/2009	DRY	268	340	
MN0223	*E. coli*	9/19/2009	DRY	2420	558	
MN0223	*E. coli*	10/17/2009	DRY	52	323	
MN0223	*E. coli*	4/17/2010	WET	50	50	
MN0223	*E. coli*	6/19/2010	DRY	2420	348	
MN0223	*E. coli*	7/17/2010	DRY	2420	2420	
MN0223	*E. coli*	8/21/2010	DRY	2420	2420	
MN0223	*E. coli*	9/18/2010	DRY	816	1684	
MN0223	*E. coli*	4/16/2011	WET	41	41	
MN0223	*E. coli*	5/21/2011	DRY	238	99	
MN0223	*E. coli*	6/18/2011	DRY	649	185	
MN0223	*E. coli*	7/16/2011	DRY	2420	720	
MN0223	*E. coli*	8/20/2011	DRY	1011	1167	
MN0223	*E. coli*	9/17/2011	DRY	299	901	
MN0223	*E. coli*	10/15/2011	WET	1046	681	
MN0223	*E. coli*	4/21/2012	DRY	228	228	
MN0223	*E. coli*	6/16/2012	DRY	299	261	
MN0223	*E. coli*	7/21/2012	DRY	2420	851	
MN0223	*E. coli*	8/18/2012	WET	1203	955	
MN0223	*E. coli*	9/15/2012	DRY	2420	1917	
MN0223	*E. coli*	10/20/2012	WET	1300	1558	
MN0223	*E. coli*	4/20/2013	DRY	17	17	
MN0223	*E. coli*	5/18/2013	DRY	238	64	
MN0223	*E. coli*	6/15/2013	WET	194	92	
MN0223	*E. coli*	8/17/2013	DRY	1120	466	
MN0223	*E. coli*	9/21/2013	DRY	416	683	
MN0223	*E. coli*	10/19/2013	DRY	1046	787	
MN0223	*E. coli*	4/19/2014	DRY	52	52	
MN0223	*E. coli*	5/17/2014	WET	1203	250	
MN0223	*E. coli*	6/21/2014	DRY	488	313	
MN0223	*E. coli*	7/19/2014	DRY	1046	850	
MN0223	*E. coli*	8/16/2014	DRY	866	762	
MN0223	*E. coli*	9/20/2014	DRY	687	854	
MN0223	*E. coli*	10/18/2014	WET	980	835	
MN0223	*E. coli*	4/20/2015	WET	60	60	
MN0223	*E. coli*	5/16/2015	DRY	167	100	
MN0223	*E. coli*	6/20/2015	DRY	365	154	
MN0223	*E. coli*	7/18/2015	DRY	1011	247	
MN0223	*E. coli*	8/15/2015	DRY	159	389	
MN0223	*E. coli*	9/19/2015	DRY	727	489	
MN0223	*E. coli*	10/17/2015	DRY	192	281	
MN0223	*E. coli*	5/21/2016	DRY	365	365	
MN0223	*E. coli*	6/18/2016	DRY	461	410	
MN0223	*E. coli*	7/16/2016	DRY	816	516	
MN0223	*E. coli*	8/20/2016	DRY	687	637	
MN0223	*E. coli*	9/17/2016	DRY	2420	1107	
MN0223	*E. coli*	10/15/2016	DRY	291	785	
MN0223	*E. coli*	4/15/2017	DRY	19	19	
MN0223	*E. coli*	5/20/2017	DRY	105	45	
MN0223	*E. coli*	6/17/2017	WET	15	31	
MN0223	*E. coli*	8/19/2017	DRY	2420	191	
MN0223	*E. coli*	9/16/2017	DRY	980	1540	
MN0223	*E. coli*	10/21/2017	DRY	727	1199	
MN0419	*E. coli*	5/17/2008	WET	308	308	
MN0419	*E. coli*	9/20/2008	DRY	7	7	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
MN0419	*E. coli*	10/18/2008	DRY	78	23	
MN0419	*E. coli*	4/18/2009	DRY	214	214	
MN0419	*E. coli*	5/16/2009	DRY	106	151	
MN0419	*E. coli*	7/18/2009	DRY	119	112	
MN0419	*E. coli*	8/15/2009	DRY	119	119	
MN0419	*E. coli*	9/19/2009	DRY	73	101	
MN0419	*E. coli*	10/17/2009	DRY	32	65	
MN0419	*E. coli*	6/19/2010	DRY	1203	1203	
MN0419	*E. coli*	7/17/2010	DRY	1203	1203	
MN0419	*E. coli*	8/21/2010	DRY	133	577	
MN0419	*E. coli*	9/18/2010	DRY	548	444	
MN0419	*E. coli*	4/16/2011	WET	16	16	
MN0419	*E. coli*	5/21/2011	DRY	222	60	
MN0419	*E. coli*	6/18/2011	DRY	146	80	
MN0419	*E. coli*	7/16/2011	DRY	1414	358	
MN0419	*E. coli*	8/20/2011	DRY	461	457	
MN0419	*E. coli*	9/17/2011	DRY	150	461	
MN0419	*E. coli*	10/15/2011	WET	1203	437	
MN0419	*E. coli*	4/21/2012	DRY	74	74	
MN0419	*E. coli*	10/19/2013	DRY	79	79	
MN0630	*E. coli*	6/17/2017	WET	5	5	
MN0630	*E. coli*	7/15/2017	DRY	19	10	
MN0630	*E. coli*	8/19/2017	DRY	60	18	
MN0630	*E. coli*	9/16/2017	DRY	35	34	
MN0630	*E. coli*	10/21/2017	DRY	11	28	
MN0713	*E. coli*	4/19/2008	DRY	1	1	
MN0713	*E. coli*	5/17/2008	WET	199	14	
MN0713	*E. coli*	7/19/2008	DRY	93	136	
MN0713	*E. coli*	8/16/2008	DRY	68	80	
MN0713	*E. coli*	9/20/2008	DRY	1	18	
MN0713	*E. coli*	10/18/2008	DRY	12	9	
W0994	*E. coli*	5/13/2008	DRY	24	24	
W0994	*E. coli*	6/10/2008	DRY	340	90	
W0994	*E. coli*	7/15/2008	DRY	140	105	
W0994	*E. coli*	8/12/2008	WET	1000	362	
W0994	*E. coli*	9/2/2008	DRY	530	399	
W0994	*E. coli*	9/16/2008	WET	390	412	
W1810	*E. coli*	5/13/2008	DRY	5	5	5
W1810	*E. coli*	6/10/2008	DRY	120	24	109
W1810	*E. coli*	7/15/2008	DRY	360	60	312
W1810	*E. coli*	7/19/2008	DRY	119	71	288
W1810	*E. coli*	8/12/2008	WET	550	231	493
W1810	*E. coli*	8/16/2008	DRY	225	229	474
W1810	*E. coli*	9/2/2008	DRY	65	186	455
W1810	*E. coli*	9/16/2008	WET	61	166	455
W1810	*E. coli*	9/20/2008	DRY	6	103	436
W1810	*E. coli*	10/18/2008	DRY	816	116	683
W1810	*E. coli*	4/18/2009	DRY	260	260	
W1810	*E. coli*	5/16/2009	DRY	144	193	
W1810	*E. coli*	7/18/2009	DRY	36	72	
W1810	*E. coli*	8/15/2009	DRY	36	36	
W1810	*E. coli*	10/17/2009	DRY	22	28	
W1810	*E. coli*	4/17/2010	WET	16	16	
W1810	*E. coli*	6/19/2010	DRY	1203	139	
W1810	*E. coli*	7/17/2010	DRY	1203	1203	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1810	*E. coli*	8/21/2010	DRY	308	764	
W1810	*E. coli*	9/18/2010	DRY	411	534	
W1810	*E. coli*	4/16/2011	WET	22	22	
W1810	*E. coli*	5/21/2011	DRY	36	28	
W1810	*E. coli*	6/18/2011	DRY	261	59	
W1810	*E. coli*	7/16/2011	DRY	261	135	
W1810	*E. coli*	8/20/2011	DRY	150	217	
W1810	*E. coli*	9/17/2011	DRY	66	137	
W1810	*E. coli*	10/15/2011	WET	172	119	
W1810	*E. coli*	4/21/2012	DRY	26	26	
W1810	*E. coli*	6/16/2012	DRY	157	64	
W1810	*E. coli*	7/21/2012	DRY	361	238	
W1810	*E. coli*	8/18/2012	WET	1203	409	
W1810	*E. coli*	9/15/2012	DRY	661	660	
W1810	*E. coli*	10/20/2012	WET	649	802	
W1810	*E. coli*	4/20/2013	DRY	56	56	
W1810	*E. coli*	5/18/2013	DRY	25	37	
W1810	*E. coli*	6/15/2013	WET	55	43	
W1810	*E. coli*	8/17/2013	DRY	44	49	
W1810	*E. coli*	9/21/2013	DRY	51	47	
W1810	*E. coli*	10/19/2013	DRY	119	64	
W1810	*E. coli*	4/19/2014	DRY	7	7	
W1810	*E. coli*	5/17/2014	WET	2420	130	
W1810	*E. coli*	6/21/2014	DRY	70	106	
W1810	*E. coli*	7/19/2014	DRY	93	251	
W1810	*E. coli*	8/16/2014	DRY	167	103	
W1810	*E. coli*	9/20/2014	DRY	54	94	
W1810	*E. coli*	10/18/2014	WET	145	109	
W1810	*E. coli*	4/20/2015	WET	93	93	
W1810	*E. coli*	6/20/2015	DRY	268	158	
W1810	*E. coli*	7/18/2015	DRY	722	262	
W1810	*E. coli*	9/19/2015	DRY	261	434	
W1810	*E. coli*	10/17/2015	DRY	38	100	
W1810	*E. coli*	5/21/2016	DRY	161	161	
W1810	*E. coli*	6/18/2016	DRY	488	280	
W1810	*E. coli*	7/16/2016	DRY	365	306	
W1810	*E. coli*	9/17/2016	DRY	236	293	
W1810	*E. coli*	10/15/2016	DRY	260	248	
W1810	*E. coli*	4/15/2017	DRY	6	6	
W2180	*E. coli*	5/10/2011	DRY	97	97	
W2180	*E. coli*	6/14/2011	DRY	140	117	
W2180	*E. coli*	6/30/2011	DRY	150	127	
W2180	*E. coli*	7/19/2011	DRY	180	138	
W2180	*E. coli*	8/16/2011	WET	1400	270	
W2180	*E. coli*	9/19/2011	DRY	73	229	

9.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for Monoosnuc Brook (MA81-13) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Monoosnuc Brook (MA81-13) watershed has 30% of its area in MS4 and 8% as DCIA. Although the watershed overall is mostly forested/natural land, the land adjacent to the impaired segment is mainly medium to high density mixed residential and commercial development, with large, paved parking lots along the downstream end. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With most of the watershed in sewer service and much of the watershed (30%) designated as MS4, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are no groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). A portion of the watershed is serviced by septic systems. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are only 35 acres (<1%) of agricultural land within the segment watershed, and there are no agricultural fields directly adjacent to the impaired segment. Agricultural sources are likely not a major source of pathogens to segment MA81-13. Nonetheless, any manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are large conservation and city forests in the watershed, especially around the upstream portions of the river segment. Smaller parks and fields are concentrated along the downstream portions of the segment in the densely developed Leominster residential neighborhoods. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation, recreational lands, and city parks with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water. There appear to be some areas of open land (a mix of paved and grassed) next to the commercial shopping mall along the left bank of lower Monoosnuc Brook.

9.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Fitchburg. See Section 2.4

City of Leominster. See Section 4.4

10. MA81-20 James Brook

10.1. Waterbody Overview

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 2,808

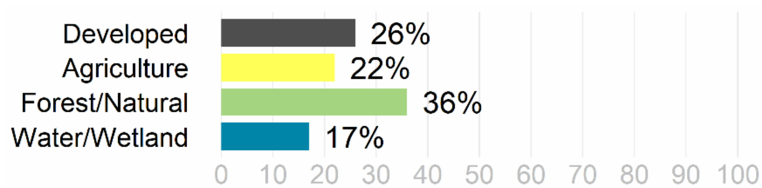
Segment Length (miles): 3.9

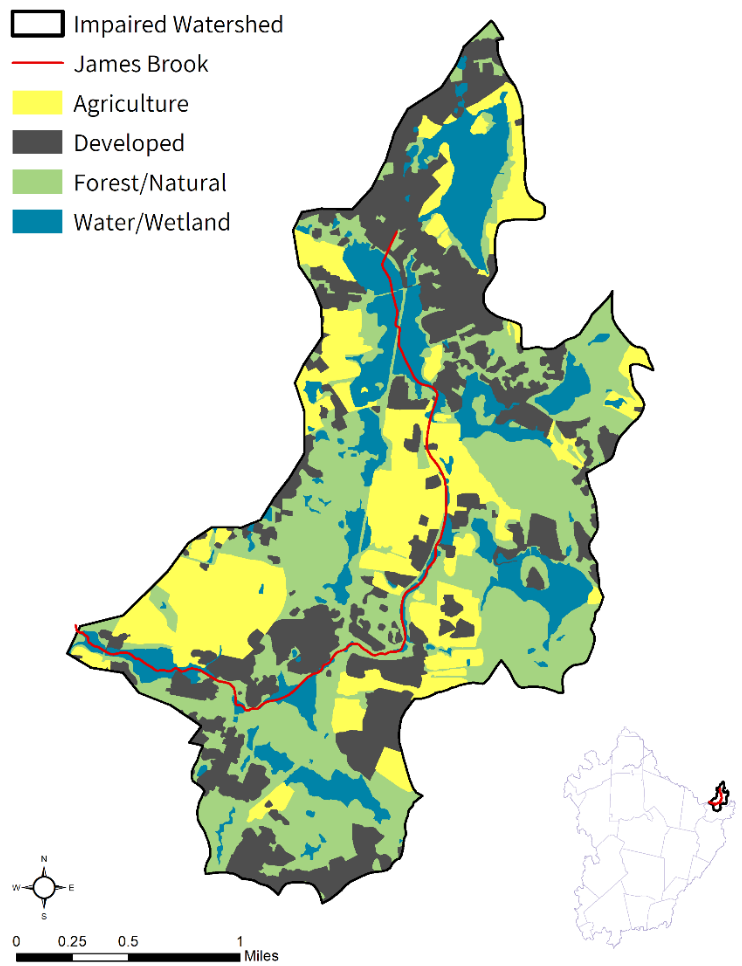
Impairment(s): *E. Coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 243 (9%)

DCIA Area (Acres, %): 100 (4%)





The James Brook segment MA81-20 is 3.9 miles long and begins 0.05 miles southwest of the Main Street/Court Street intersection in Groton, MA. Segment MA81-20 flows south through Groton and west through Ayer to end at its confluence with the Nashua River (MA81-06, unimpaired) at the Ayer and Groton town line, MA. Tributaries to James Brook segment MA81-20 include approximately 4 miles of unnamed streams.

Key landmarks in the segment watershed include Groton town center, Lawrence Academy, Ayer High School, and the Groton Golf Center and Country Club, Segment MA81-20 crosses Groton School Road/MA-111 (Ayer), Nashua River Rail Trail (twice), and other smaller streets in Ayer and Groton. Lakes and ponds within the watershed include Groton School Pond and Cady Pond.

James Brook (MA81-20) drains an area of 4.4 square miles, of which 0.4 mi^2 (9%) is impervious and 0.2 mi^2 (4%) is directly connected impervious area (DCIA). The watershed is likely partially[23] served by public sewer and 37% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed. There are no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 10-1.

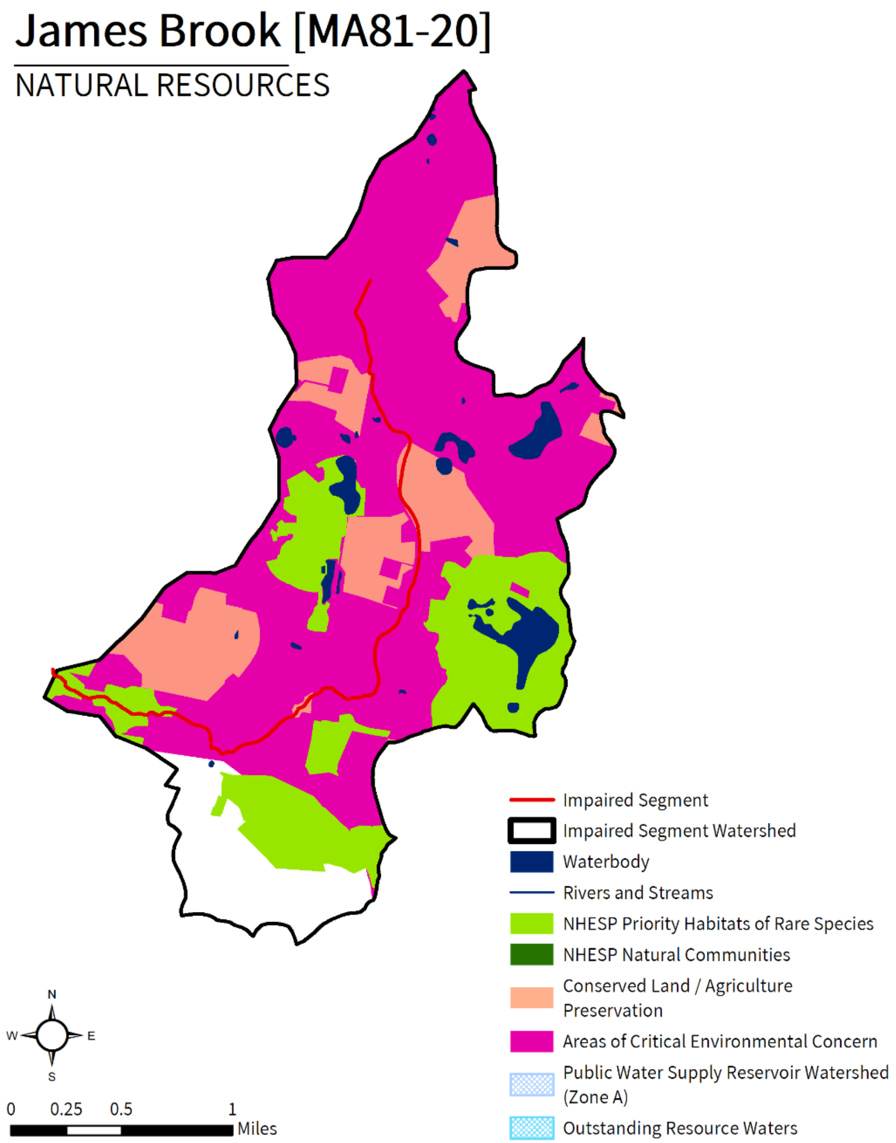
The entire segment flows through a patchwork of landscapes ranging from forested and natural lands to agricultural fields and areas of residential development. Agricultural fields can be found within the center of the segment watershed and are within proximity to the segment along Old Ayer Road. The most common agricultural land uses appear to be row crops, hay, and orchards, several of which are adjacent to the brook. In the watershed of James Brook (MA81-20), under the Natural Heritage and Endangered Species Program, there are no areas of Priority Natural Vegetation Communities, but

[23] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

there are 591 acres (21%) of Priority Habitats of Rare Species. There are 2,502 acres (89%) identified as Areas of Critical Environmental Concern but no areas under Public Water Supply protection or identified as Outstanding Resource Waters in the watershed. Over 427 acres (15%) of land protected in perpetuity[24] exist within the segment watershed, which is part of a total of 720 acres (26%) of Protected and Recreational Open Space[25]. See Figure 10-1.

[24] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[25] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



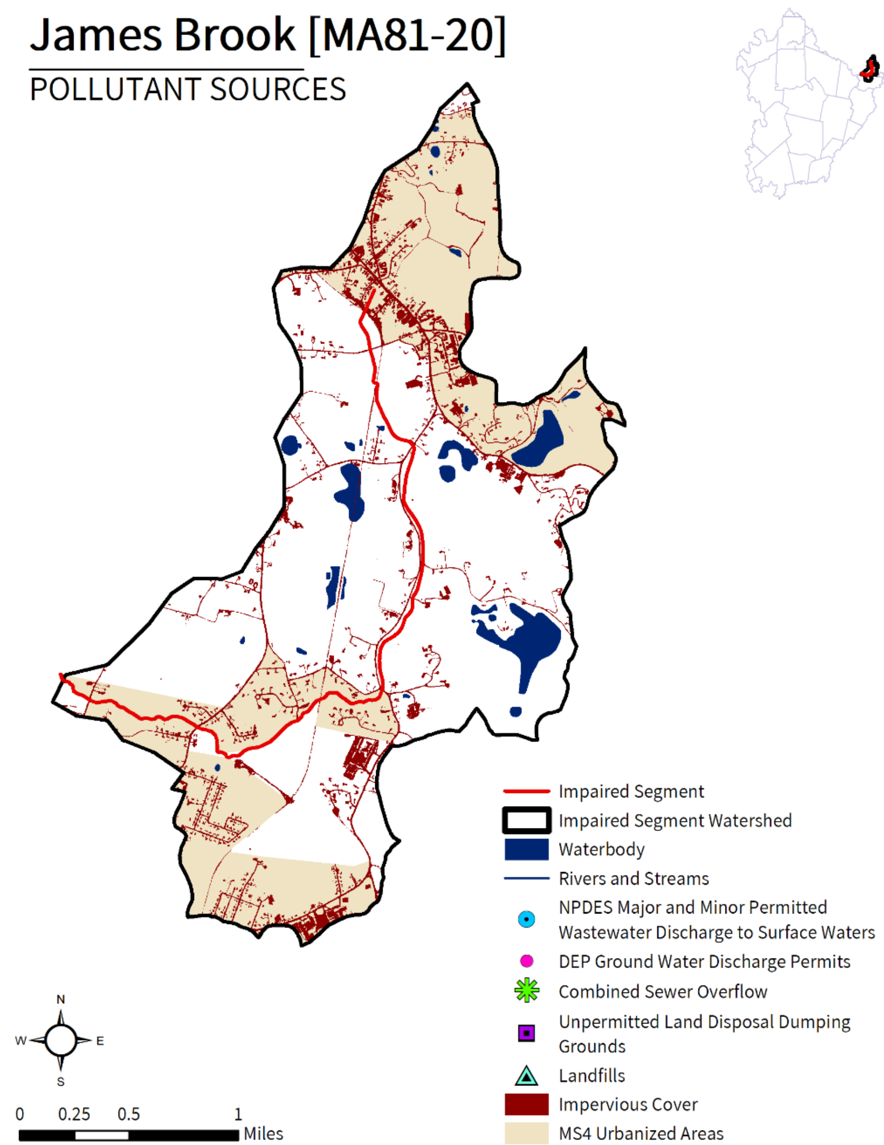


Figure 10-1. Natural resources and potential pollution sources draining to the James Brook segment MA81-20. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

10.2. Waterbody Impairment Characterization

James Brook (MA81-20) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 10-1, 10-2; Figure 10-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

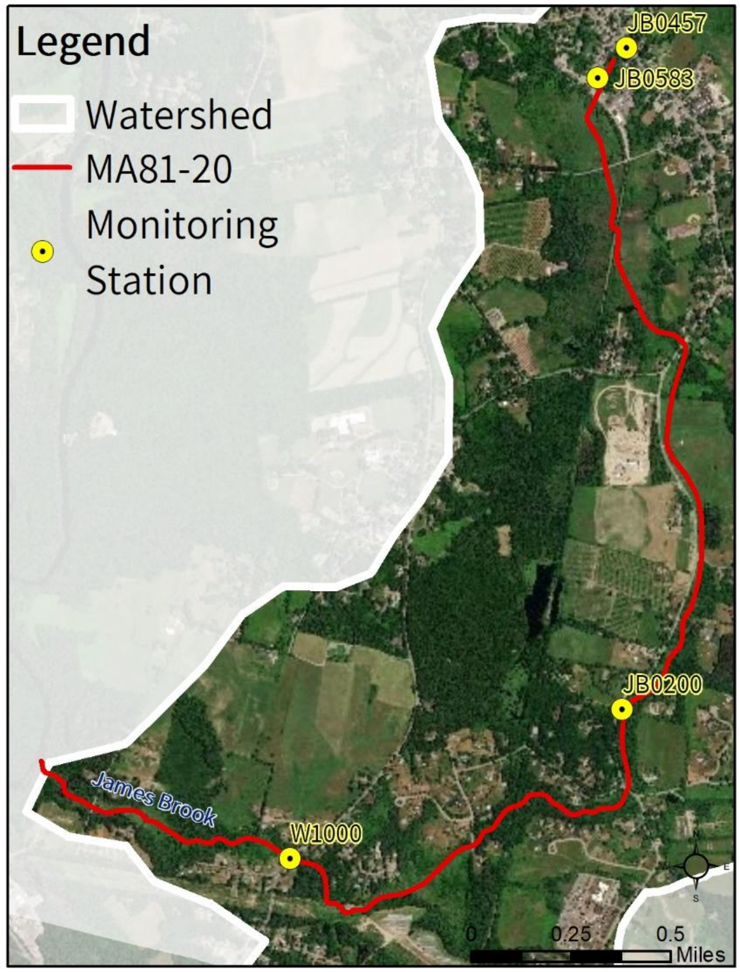


Figure 10-2. Location of monitoring station(s) along the impaired river segment.

- From 2012-2016, 31 samples were collected at JB0200, resulting in 13 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 31 samples, seven exceeded the STV criterion in 2012-2014 and 2016 during both wet and dry weather.
- In 2009, one sample was collected at JB0457, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. The one sample did not exceed the STV criterion.
- From 2008-2011, 25 samples were collected at JB0583, resulting in 14 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 25 samples, six exceeded the STV criterion in 2008-2011 during both wet and dry weather.
- From 2008-2017, 54 samples were collected at W1000, resulting in 29 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 54 samples, 13 exceeded the STV criterion in 2010-2012, 2014, and 2016-2017 during both wet and dry weather.

Table 10-1. Summary of indicator bacteria sampling results by station for James Brook (MA81-20). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
JB0200	4/21/2012	8/20/2016	31	529	13	7
JB0457	5/16/2009	5/16/2009	1	66	0	0

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
JB0583	4/19/2008	10/15/2011	25	2420	14	6
W1000	5/15/2008	10/21/2017	54	1733	29	13

Table 10-2. Indicator bacteria data by station, indicator, and date for James Brook (MA81-20). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
JB0200	*E. coli*	4/21/2012	DRY	26	26	
JB0200	*E. coli*	5/19/2012	DRY	214	75	
JB0200	*E. coli*	6/16/2012	DRY	75	75	
JB0200	*E. coli*	7/21/2012	DRY	30	78	
JB0200	*E. coli*	8/18/2012	WET	488	103	
JB0200	*E. coli*	9/15/2012	DRY	117	120	
JB0200	*E. coli*	10/20/2012	WET	770	353	
JB0200	*E. coli*	4/20/2013	DRY	313	313	
JB0200	*E. coli*	5/18/2013	DRY	225	265	
JB0200	*E. coli*	6/15/2013	WET	579	344	
JB0200	*E. coli*	7/20/2013	DRY	816	474	
JB0200	*E. coli*	9/21/2013	DRY	37	174	
JB0200	*E. coli*	10/19/2013	DRY	26	31	
JB0200	*E. coli*	4/19/2014	DRY	50	50	
JB0200	*E. coli*	5/17/2014	WET	2420	348	
JB0200	*E. coli*	6/21/2014	DRY	517	397	
JB0200	*E. coli*	7/19/2014	DRY	118	529	
JB0200	*E. coli*	8/16/2014	DRY	155	211	
JB0200	*E. coli*	9/20/2014	DRY	21	73	
JB0200	*E. coli*	10/18/2014	WET	326	102	
JB0200	*E. coli*	4/20/2015	WET	7	7	
JB0200	*E. coli*	5/16/2015	DRY	20	12	
JB0200	*E. coli*	6/20/2015	DRY	185	30	
JB0200	*E. coli*	7/18/2015	DRY	144	44	
JB0200	*E. coli*	8/15/2015	DRY	367	214	
JB0200	*E. coli*	9/19/2015	DRY	326	258	
JB0200	*E. coli*	10/17/2015	DRY	93	223	
JB0200	*E. coli*	4/16/2016	DRY	20	20	
JB0200	*E. coli*	5/21/2016	DRY	184	61	
JB0200	*E. coli*	6/18/2016	DRY	435	117	
JB0200	*E. coli*	8/20/2016	DRY	34	122	
JB0457	*E. coli*	5/16/2009	DRY	66	66	
JB0583	*E. coli*	4/19/2008	DRY	64	64	
JB0583	*E. coli*	5/17/2008	WET	687	210	
JB0583	*E. coli*	7/19/2008	DRY	53	191	
JB0583	*E. coli*	8/16/2008	DRY	260	117	
JB0583	*E. coli*	9/20/2008	DRY	93	109	
JB0583	*E. coli*	10/18/2008	DRY	120	143	
JB0583	*E. coli*	4/18/2009	DRY	1986	1986	
JB0583	*E. coli*	5/16/2009	DRY	31	248	
JB0583	*E. coli*	6/20/2009	WET	187	226	
JB0583	*E. coli*	7/18/2009	DRY	179	101	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
JB0583	*E. coli*	8/15/2009	DRY	179	182	
JB0583	*E. coli*	9/19/2009	DRY	65	128	
JB0583	*E. coli*	10/17/2009	DRY	38	76	
JB0583	*E. coli*	4/17/2010	WET	55	55	
JB0583	*E. coli*	5/15/2010	DRY	276	123	
JB0583	*E. coli*	6/19/2010	DRY	921	241	
JB0583	*E. coli*	7/17/2010	DRY	921	616	
JB0583	*E. coli*	10/16/2010	WET	2420	2420	
JB0583	*E. coli*	4/16/2011	WET	23	23	
JB0583	*E. coli*	5/21/2011	DRY	74	41	
JB0583	*E. coli*	6/18/2011	DRY	84	52	
JB0583	*E. coli*	7/16/2011	DRY	291	122	
JB0583	*E. coli*	8/20/2011	DRY	345	204	
JB0583	*E. coli*	9/17/2011	DRY	199	271	
JB0583	*E. coli*	10/15/2011	WET	2420	550	
W1000	*E. coli*	5/15/2008	DRY	62	62	
W1000	*E. coli*	6/12/2008	DRY	200	111	
W1000	*E. coli*	7/17/2008	DRY	220	140	
W1000	*E. coli*	8/14/2008	WET	58	137	
W1000	*E. coli*	9/4/2008	DRY	110	129	
W1000	*E. coli*	9/18/2008	DRY	58	95	
W1000	*E. coli*	4/17/2010	WET	28	28	
W1000	*E. coli*	5/15/2010	DRY	102	53	
W1000	*E. coli*	6/19/2010	DRY	1986	178	
W1000	*E. coli*	7/17/2010	DRY	1986	738	
W1000	*E. coli*	10/16/2010	WET	1733	1733	
W1000	*E. coli*	4/16/2011	WET	40	40	
W1000	*E. coli*	5/21/2011	DRY	55	47	
W1000	*E. coli*	6/18/2011	DRY	1120	135	
W1000	*E. coli*	7/16/2011	DRY	82	172	
W1000	*E. coli*	9/17/2011	DRY	308	159	
W1000	*E. coli*	10/15/2011	WET	2420	863	
W1000	*E. coli*	4/21/2012	DRY	37	37	
W1000	*E. coli*	5/19/2012	DRY	63	48	
W1000	*E. coli*	6/16/2012	DRY	148	70	
W1000	*E. coli*	7/21/2012	DRY	326	145	
W1000	*E. coli*	8/18/2012	WET	365	260	
W1000	*E. coli*	9/15/2012	DRY	461	380	
W1000	*E. coli*	10/20/2012	WET	185	315	
W1000	*E. coli*	4/20/2013	DRY	32	32	
W1000	*E. coli*	5/18/2013	DRY	210	82	
W1000	*E. coli*	6/15/2013	WET	285	124	
W1000	*E. coli*	7/20/2013	DRY	387	285	
W1000	*E. coli*	8/17/2013	DRY	96	220	
W1000	*E. coli*	9/21/2013	DRY	403	246	
W1000	*E. coli*	10/19/2013	DRY	77	144	
W1000	*E. coli*	5/17/2014	WET	1151	1151	
W1000	*E. coli*	6/21/2014	DRY	613	840	
W1000	*E. coli*	7/19/2014	DRY	19	238	
W1000	*E. coli*	8/16/2014	DRY	201	133	
W1000	*E. coli*	9/20/2014	DRY	727	141	
W1000	*E. coli*	10/18/2014	WET	687	465	
W1000	*E. coli*	4/20/2015	WET	16	16	
W1000	*E. coli*	5/16/2015	DRY	70	33	
W1000	*E. coli*	6/20/2015	DRY	104	49	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1000	*E. coli*	7/18/2015	DRY	150	65	
W1000	*E. coli*	8/15/2015	DRY	166	137	
W1000	*E. coli*	9/19/2015	DRY	70	120	
W1000	*E. coli*	10/17/2015	DRY	33	73	
W1000	*E. coli*	4/16/2016	DRY	21	21	
W1000	*E. coli*	5/21/2016	DRY	411	93	
W1000	*E. coli*	6/18/2016	DRY	613	174	
W1000	*E. coli*	7/16/2016	DRY	192	364	
W1000	*E. coli*	4/15/2017	DRY	21	21	
W1000	*E. coli*	5/20/2017	DRY	248	72	
W1000	*E. coli*	6/17/2017	WET	41	60	
W1000	*E. coli*	7/15/2017	DRY	126	109	
W1000	*E. coli*	8/19/2017	DRY	411	129	
W1000	*E. coli*	10/21/2017	DRY	157	254	

10.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for James Brook (MA81-20) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the James Brook (MA81-20) watershed are moderately developed as medium to low density residential development, with 37% of the land area in MS4 and 4% as DCIA. Stormwater runoff from urban areas is likely a source of pathogens.

Illicit Sewage Discharges: With the watershed partially serviced by sewer and 37% the watershed designated as MS4 area, sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: Most of the watershed uses on-site wastewater disposal systems. There are no groundwater discharge permits for on-site wastewater discharge, which is a large-capacity septic system (non-residential). Given the reliance on on-site wastewater systems in the watershed, it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities visible on recent aerial photos include row crops and pasture near segment MA81-20. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: The immediate watershed area contains ballfields and wetlands while the full watershed has scattered residential development where dogs are likely present. Much of the segment is near the Nashua River Rail Trail. Conservation lands, parks, ballfields, and yards popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody in addition to wetlands may attract excessive waterfowl and elevate indicator bacteria counts in the water.

10.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ayer. See Section 6.4

Town of Groton

About one third of Groton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Groton (Permit ID #MAR041193) has an EPA approved Notice of Intent (NOI). Groton does not have a Stormwater Management Plan available. The town has mapped 90% of its MS4 stormwater system, which was planned to be completed by 7/01/19 and will be available online. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2006. According to the NOI, there are three outfalls into James Brook (MA81-20, pathogen-impaired), 2 outfalls into Martins Pond Brook (segment number not listed), and one outfall into the Squannacook River (segment number not listed; MA81-19, not impaired).

Groton has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws: https://ecode360.com/9081802 (Town of Groton, 2016)
- Stormwater Utility: None found.
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Wetland Protection Bylaw: https://ecode360.com/9078449 (Town of Groton, 2014)
- Pet Waste Ordinance: None found.
- Contact Recreation Ordinance: None found.

The Groton Master Plan Natural Resources, Water, and Energy chapter notes that while Groton has achieved water conservation goals as defined by the state, controlling stormwater runoff has been difficult. The plan also has a stormwater management and low-impact development section in this chapter. Waterbody impairments are discussed. Only a portion of Groton has sewer service, and the rest of the town uses septic systems.

Groton Town Website: https://www.grotonma.gov/ (Town of Groton, 2021)

Master Plan:
https://portal.grotonma.gov/storage/Planning_Board/Groton%20Master%20Plans/Groton_Master_Plan_2011.pdf (Community Opportunities Group, Inc., et al, 2011)

Open Space and Recreation Plan:
https://portal.grotonma.gov/storage/Conservation_Commission/2012_Groton_Open_Space_&_Recreation_Plan_(19MB).pdf (Town of Groton, 2012)

11. MA81-24 Gates Brook

11.1. Waterbody Overview

The Gates Brook segment MA81-24 is 3.4 miles long and begins in a wetland west of Prospect Street in West Boylston, MA. Segment MA81-24 flows southeast to West Boylston Street/MA-12 before changing direction to flow north to end at the inlet to Wachusett Reservoir (Gates Cove), West Boylston.

There are no named tributaries to this section of Gates Brook nor any named lakes or ponds within the segment watershed. Major landmarks in the watershed include the Wachusett Country Club and the commercial district along MA-12. Segment MA81-24 crosses West Boylston Street/MA-12, Maple Street/MA-140, and other smaller streets, all within West Boylston.

Gates Brook (MA81-24) drains an area of 3 square miles, of which 0.5 mi^2 (17%) is impervious and 0.3 mi^2 (10%) is directly connected impervious area (DCIA). The watershed is served partially[26] by public sewer and 79% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed. There are no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 11-1.

The entire segment flows through a patchwork of landscapes ranging from forested and natural landscapes to agricultural fields and areas of mixed residential and small commercial development. Forest and wetlands cover the northwestern sections between the residential communities along MA-12 and agricultural fields along Prospect Street. To the west of I-190 there are other medium density residential areas. The downstream half of the segment flows through mixed residential and small commercial development. In total, developed areas are the

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 2,003

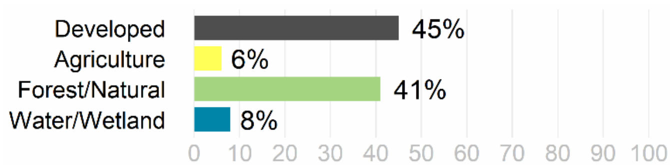
Segment Length (miles): 3.4

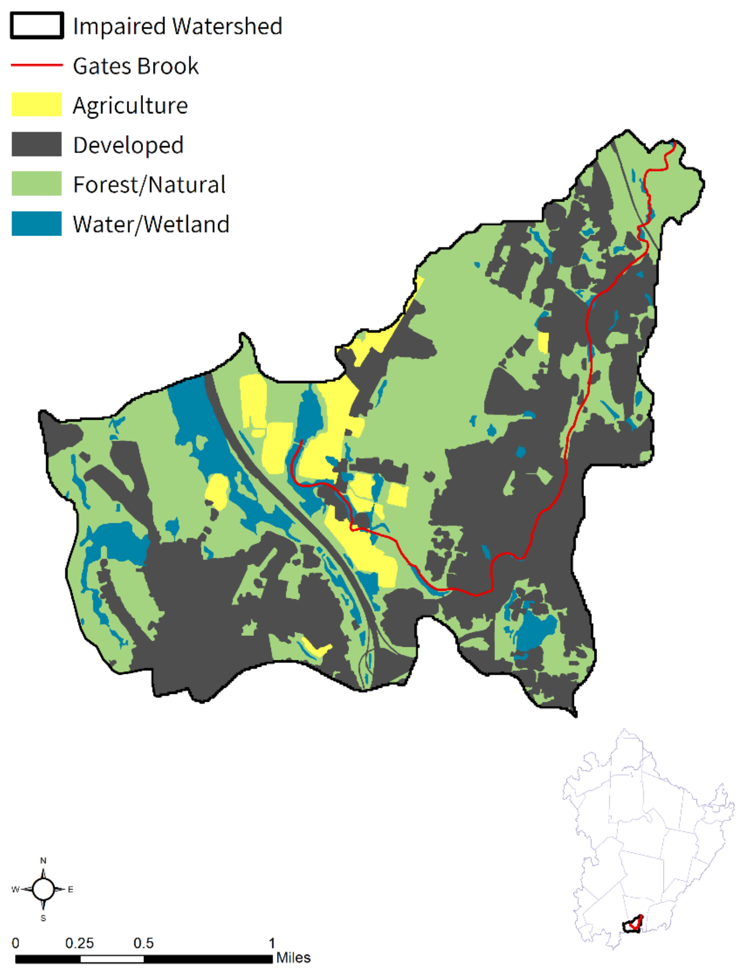
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): A (Public Water Supply, Outstanding Resource Water)

Impervious Area (Acres, %): 341 (17%)

DCIA Area (Acres, %): 205 (10%)





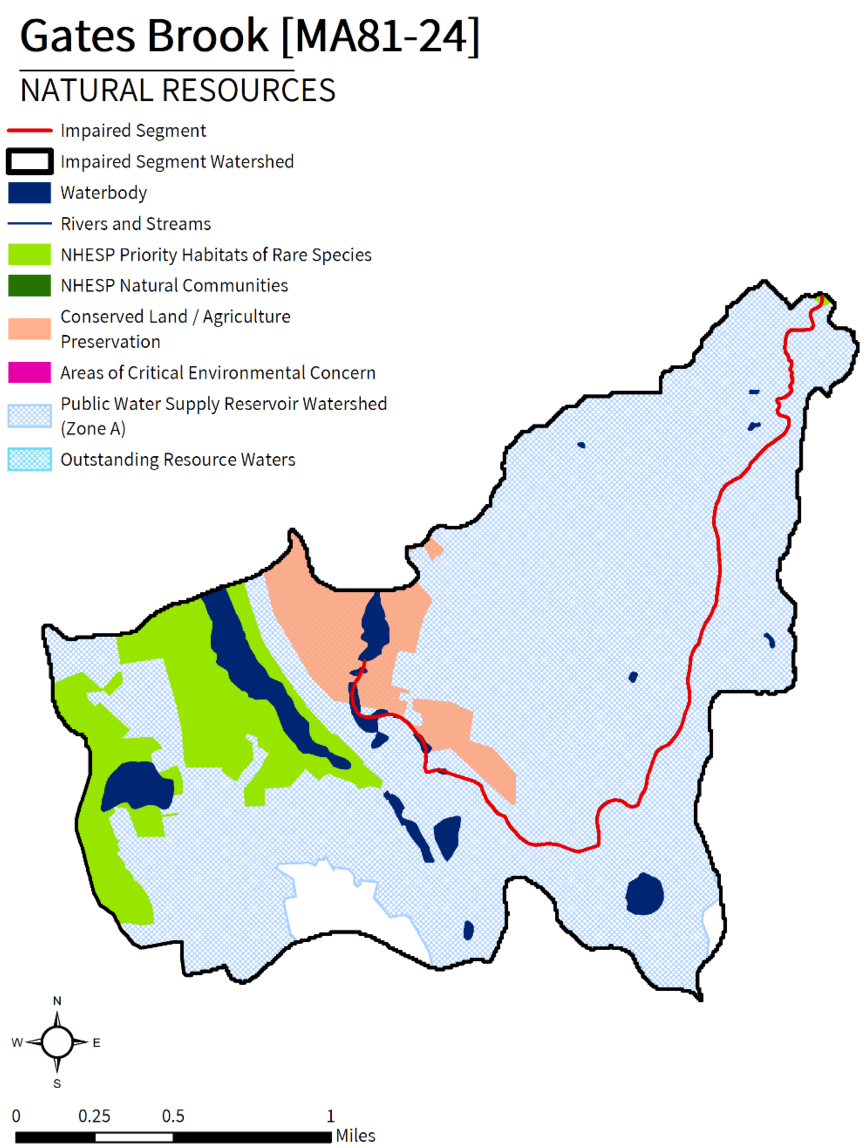
[26] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

largest category (45%) of land use, followed closely by forest (41%).

In the watershed of Gates Brook (MA81-24), under the Natural Heritage and Endangered Species Program, there are 256 acres (13%) of Priority Habitats of Rare Species. There are 1,948 acres (97%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. Over 131 acres (7%) of land protected in perpetuity[27] exist within the segment watershed, which is part of a total of 614 acres (31%) of Protected and Recreational Open Space[28]. See Figure 11-1.

[27] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[28] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



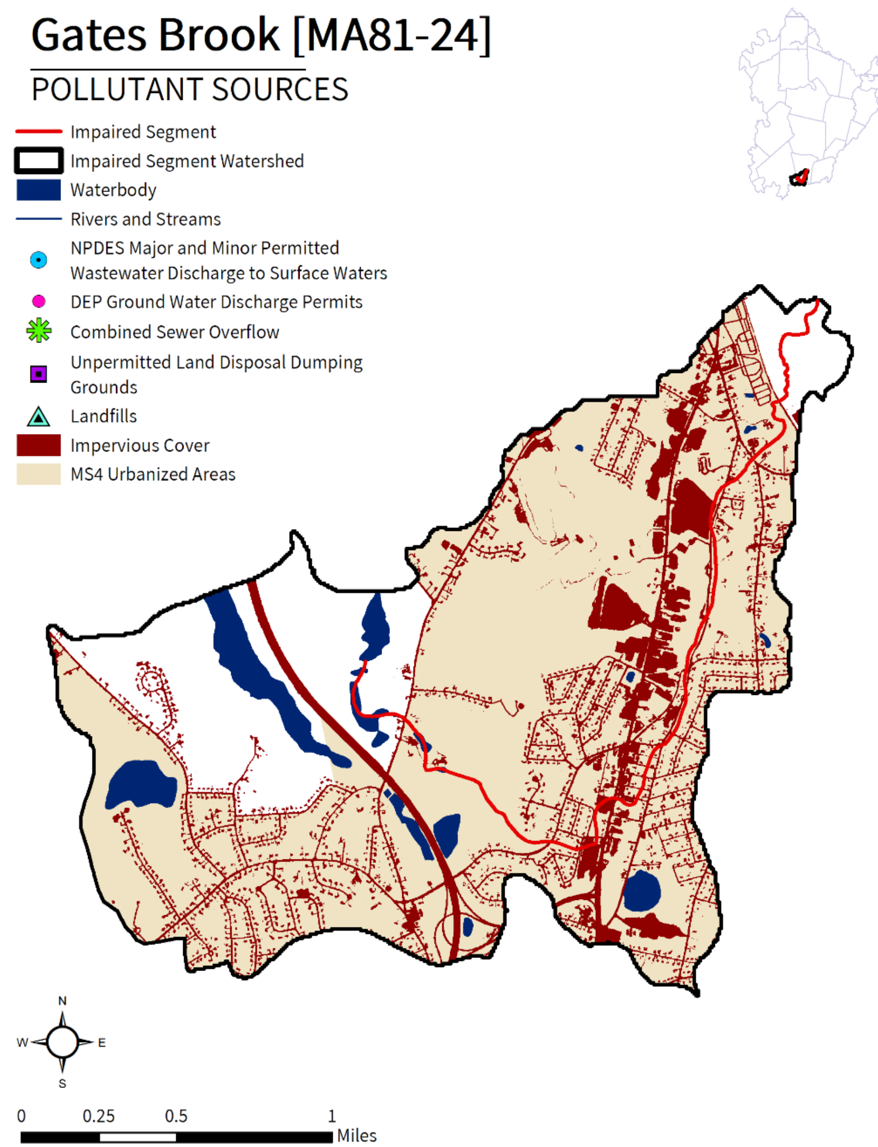


Figure 11-1. Natural resources and potential pollution sources draining to the Gates Brook segment MA81-24. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

11.2. Waterbody Impairment Characterization

Gates Brook (MA81-24) is a Class A, Public Water Supply and Outstanding Resource Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 11-1, 11-2; Figure 11-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis. SWQS for the impaired segment apply to data on a year-round, 90-day rolling geometric mean (geomean) and a year-round, 90-day rolling 90th percentile (for stations and years with more than 10 samples, otherwise singe sample results). While the data and calculations presented in Table 11-2 show only sample event days, the SWQS are applied to the rolling geomean or 90th percentile (if applicable) for all days in a given year within a 90-day window from the first sample event to 89 days after the last sample event.

- In 2008, four samples were collected at W1817, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of four samples, one exceeded the STV criterion during wet weather.

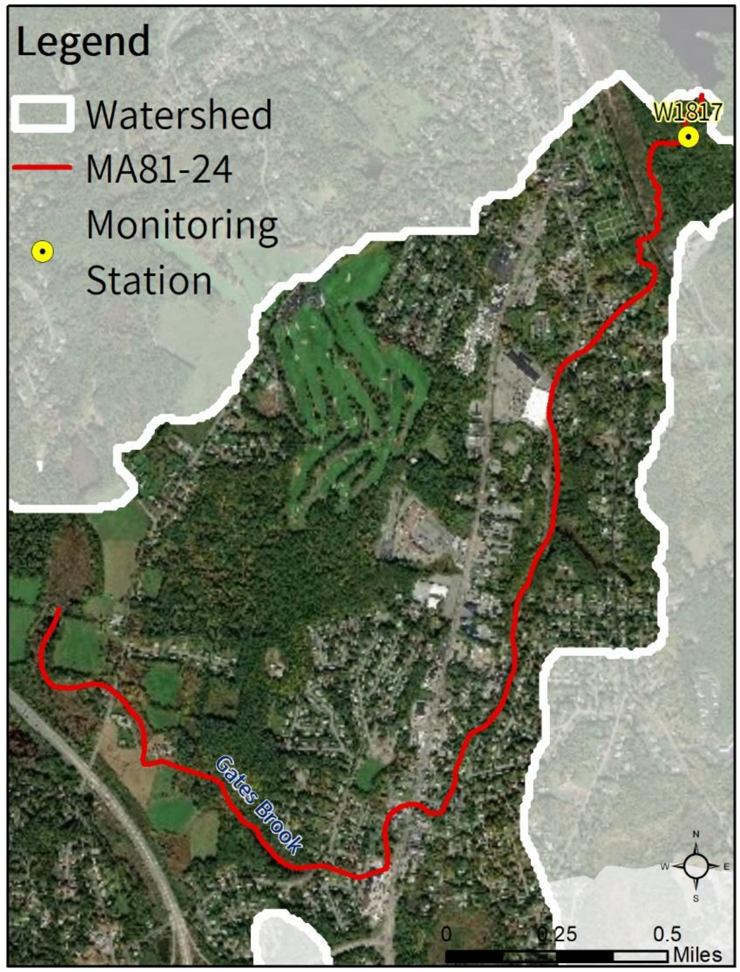


Figure 11-2. Location of monitoring station(s) along the impaired river segment.

Table 11-1. Summary of indicator bacteria sampling results by station for Gates Brook (MA81-24). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1817	5/22/2008	8/21/2008	4	85	0	1

Table 11-2. Indicator bacteria data by station, indicator, and date for Gates Brook (MA81-24). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1817	*E. coli*	5/22/2008	DRY	10	10	
W1817	*E. coli*	6/19/2008	DRY	13	11	
W1817	*E. coli*	7/24/2008	WET	1200	54	
W1817	*E. coli*	8/21/2008	DRY	39	85	

11.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for Gates Brook (MA81-24) were elevated during wet weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Each potential pathogen source is described in further detail below.

Urban Stormwater: Most of the Gates Brook (MA81-24) watershed is highly developed, with 79% of the land area in MS4, 10% as DCIA, and a few areas of dense commercial and residential development along the portion of the segment which parallels MA-12. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: Some of the watershed is serviced by sewer and most (79%) of the watershed is designated as MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: With some of the land area served by on-site wastewater disposal systems, it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are only 112 acres (6%) of agricultural land within the segment watershed. Agricultural activities visible on recent aerial photos include open fields likely used as hayfields, as well as pastureland with horse corrals directly adjacent to the impaired segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. Agricultural sources are likely a significant source of pathogens to segment MA81-24.

Pet Waste: Much of the middle and downstream part of the segment is flanked by dense residential neighborhoods. Conservation lands, parks, ballfields, and yards popular for dog-walking, especially where paths and yards are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation or recreational lands and fields with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

11.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Holden. See Section 7.4

Town of West Boylston

Less than half of West Boylston is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. West Boylston (Permit ID #MAR041171) has an EPA approved Notice of Intent (NOI). The town has a Stormwater Management Plan and has mapped all of its MS4 stormwater system. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2003-2007. There are 10 stormwater outfalls reported to Gates Brook (MA81-24, pathogen-impaired) and several stormwater outfalls into Poor Farm Brook (MA51-17, pathogen-impaired).

West Boylston has the following relevant ordinances and bylaws:

- Pet Waste: Article XIX Dog Control, Section 6 Removal of Dog Litter, p. 28: https://www.westboylston-ma.gov/sites/westboylstonma/files/uploads/zoning_bylaws_2018.10.15-_6_14.pdf (Town of West Boylston, 2020)
- Sanitary Sewer Connection Loan and Zoning bylaws: Article XXVII pg. 58 https://www.westboylston-ma.gov/sites/westboylstonma/files/uploads/zoning_bylaws_2018.10.15-_6_14.pdf (Town of West Boylston, 2020)
- Stormwater bylaw: Article XXXIII, pg. 63: https://www.westboylston-ma.gov/sites/westboylstonma/files/uploads/zoning_bylaws_2018.10.15-_6_14.pdf (Town of West Boylston, 2020)

West Boylston has Master Plan. https://www.westboylston-ma.gov/sites/g/files/vyhlif1421/f/uploads/wb_mpfinal.pdf (Town of West Boylston and CMRPC, 2005)

The West Boylston Stormwater Management Plan is available online only to users with a Town of West Boylston account (Town of West Boylston, n.d.).

West Boylston's Open Space and Recreation Plan: https://www.westboylston-ma.gov/sites/westboylstonma/files/uploads/2018_west_boylston_open_space_plan.pdf (Town of West Boylston and CMRPC, 2018)

The Watershed Protection Act regulates land use and activities within critical areas of the Quabbin Reservoir, Ware River and Wachusett Reservoir watersheds for the purpose of protecting the source supply of drinking water that is treated and distributed by the MA Water Resources Authority. The law is administered by the Department of Conservation and Recreation, Division of Water Supply Protection. The towns in this watershed are affected by the Watershed Protection Act (MA DCR, 2023).

12. MA81-31 Stillwater River

12.1. Waterbody Overview

The Stillwater River segment MA81-31 is 6.7 miles long and begins at the confluence with Justice Brook and Keys Brook at the Princeton and Sterling town border. From here, the river flows south along the Princeton-Sterling town border toward and under I-190 to end at an inlet to the Wachusett Reservoir (Stillwater Basin), Sterling.

Tributaries to this section of Stillwater River include Justice Brook, Keyes Brook, Bailey Brook, Rocky Brook, East Wachusett Brook, Ball Brook, Scanlon Brook, and Houghton Brook. Major lakes and ponds within the watershed include Paradise Pond, Rocky Pond, Bartlett Pond, Hy-Crest Pond, and Snow Pond.

Major landmarks in the watershed include the East Princeton town center, part of the Wachusett Mountain State Reservation, and a portion of the I-190 corridor near Exit 5. Segment MA81-31 intersects Redemption Rock Trail South/MA-140 (Princeton), Princeton Road/MA-62 (Sterling), I-90 (Sterling), and other smaller streets in Princeton and Sterling.

The Stillwater River (MA81-31) drains an area of 29 square miles, of which 1.2 mi^2 (4%) is impervious and 0.3 mi^2 (1%) is directly connected impervious area (DCIA). The watershed is served partially[29] by public sewer and <1% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There is one MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 12-1). There are no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds (Figure 12-1).

Reduction from Highest calculated Geomean: 59%

Watershed Area (Acres): 18,849

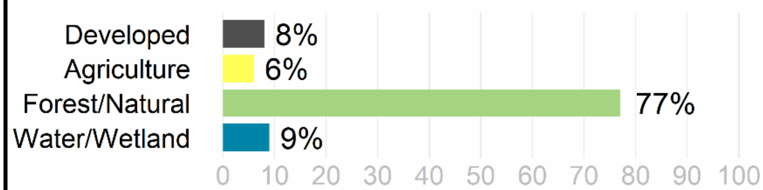
Segment Length (miles): 6.7

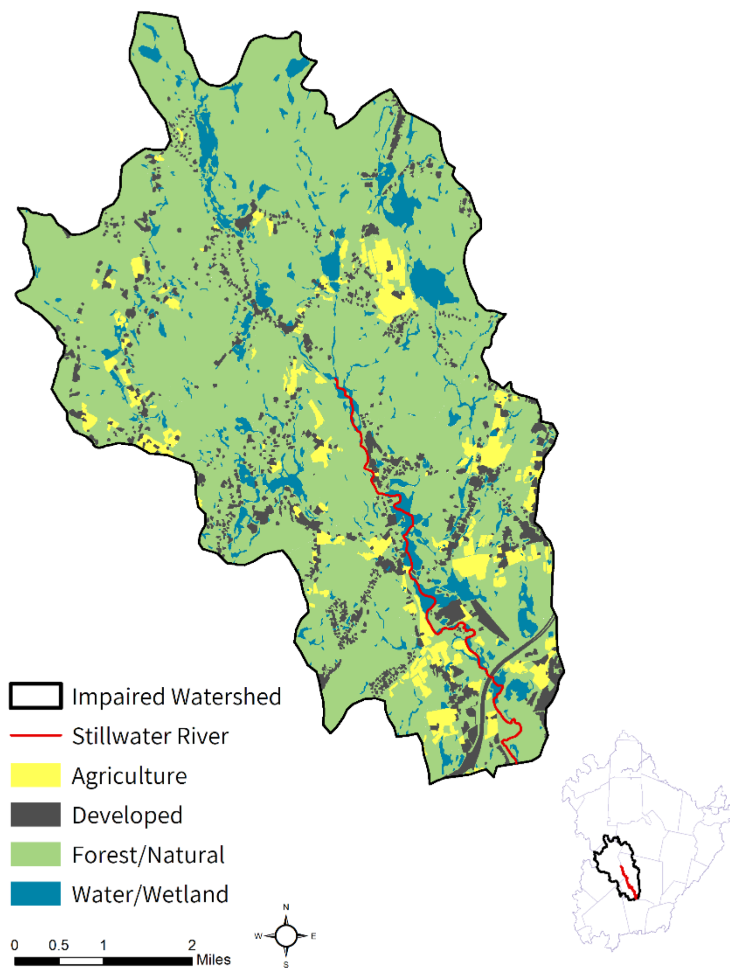
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): A (Public Water Supply, Outstanding Resource Water)

Impervious Area (Acres, %): 739 (4%)

DCIA Area (Acres, %): 201 (1%)





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[29] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

Table 12-1. Groundwater discharge permits in the segment watershed. Groundwater discharge permits are not duplicated for larger segment watersheds that include this segment watershed. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

PERR	NAME	TOWN	TYPE	FLOW (GPD)
616-3	STERLING NURSING HOME	STERLING	Sanitary Discharge	22,000

The entire segment flows through a varied landscape that is predominately forest (77%). The river flows through several wetlands, with patchy agricultural fields, low density residential development, and sparse commercial development. Agricultural lands and development are somewhat concentrated in the southern part of the segment watershed along the impaired segment. The most common agricultural land use appears to be row crops and hay, based on recent aerial photos.

In the watershed of the Stillwater River (MA81-31), under the Natural Heritage and Endangered Species Program, there are 1,783 acres (9%) of Priority Habitats of Rare Species and 49 acres (<1%) of Priority Natural Vegetation Communities. There are 18,818 acres (nearly 100%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. Over 1,323 acres (7%) of land protected in perpetuity[30] exist within the segment watershed, which is part of a total of 10,186 acres (54%) of Protected and Recreational Open Space[31]. See Figure 12-1.

[30] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[31] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

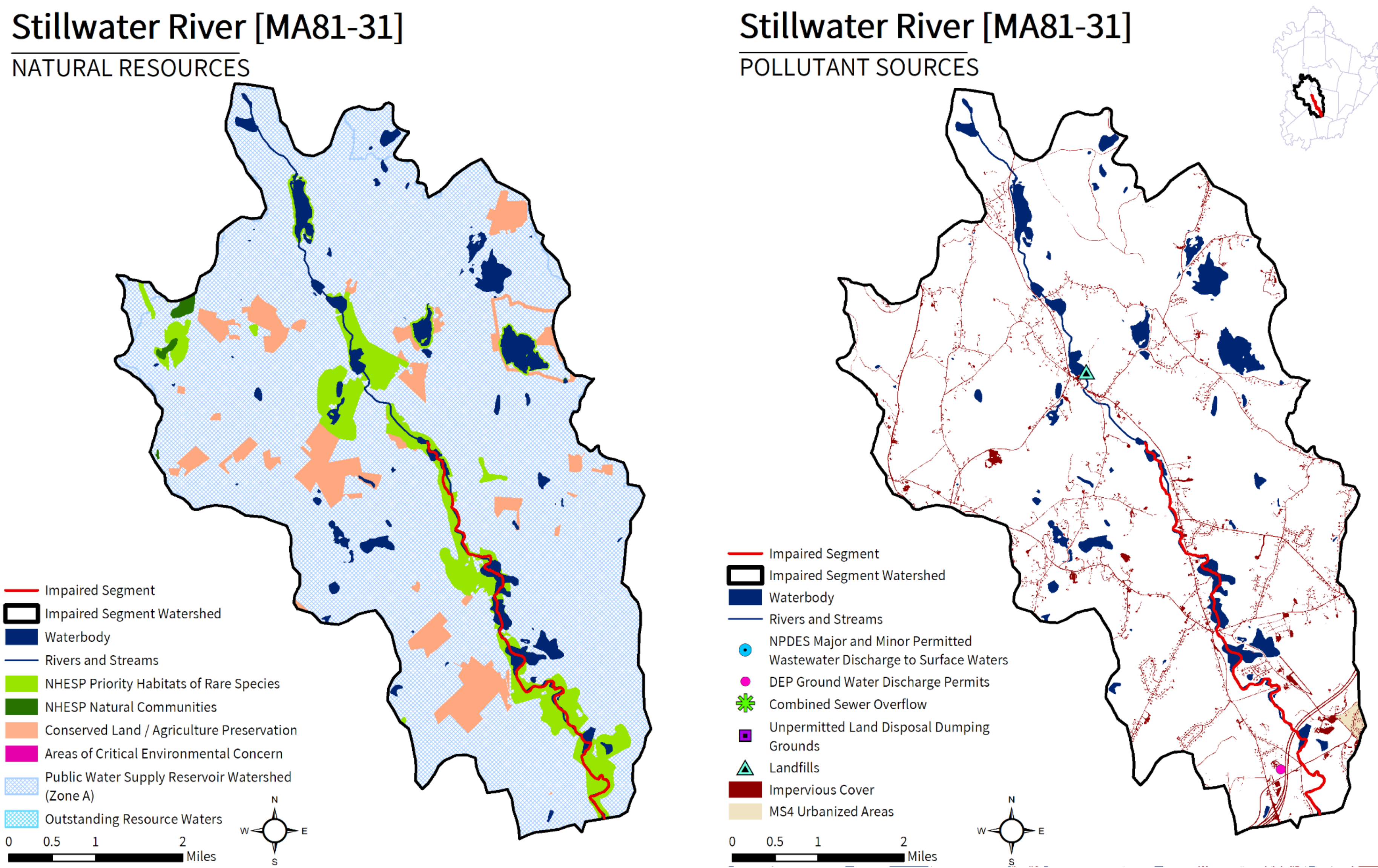


Figure 12-1. Natural resources and potential pollution sources draining to the Stillwater River segment MA81-31. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

12.2. Waterbody Impairment Characterization

The Stillwater River (MA81-31) is a Class A, Public Water Supply and Outstanding Resource Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 12-2, 12-3; Figure 12-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2008, four samples were collected at W1820, resulting in two days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of four samples, one exceeded the STV criterion during wet weather.

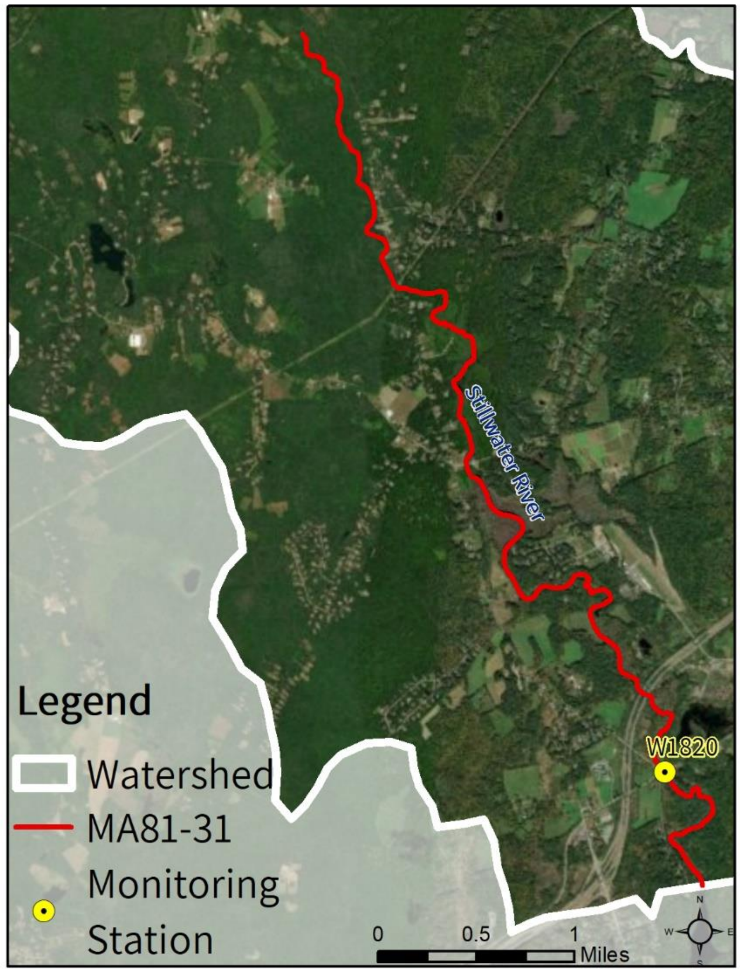


Figure 12-2. Location of monitoring station(s) along the impaired river segment.

Table 12-2. Summary of indicator bacteria sampling results by station for the Stillwater River (MA81-31). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1820	5/22/2008	8/21/2008	4	306	2	1

Table 12-3. Indicator bacteria data by station, indicator, and date for the Stillwater River (MA81-31). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1820	*E. coli*	5/22/2008	DRY	33	33	
W1820	*E. coli*	6/19/2008	DRY	100	57	
W1820	*E. coli*	7/24/2008	WET	3300	222	
W1820	*E. coli*	8/21/2008	DRY	87	306	

12.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for the Stillwater River (MA81-31) were elevated during wet weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Stillwater River (MA81-31) is lightly developed with <1% of the land area in MS4 and 1% as DCIA. Low density development is scattered throughout the watershed and along the segment, though a large interstate highway (I-190) crosses the river. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: With some sewer services in the segment watershed and <1% of the watershed designated as MS4 area, leaky sewer lines and illicit connections of wastewater to stormwater drains are a possible source of pathogens, but likely not significant.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit in the direct drainage area for on-site wastewater discharge, which is a large-capacity septic system (non-residential). Given the small amount of public sewer, most development in the watershed uses septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Based on land use data, agriculture accounts for about 6% of land area. Agricultural activities visible on recent aerial photos include open fields, hayfields, row crops, pastureland, and orchards throughout the watershed. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are large conservation lands and wetlands in the segment watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation or recreational lands and wetlands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

12.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Princeton. See Section 7.4

Town of Sterling. See Section 7.4

The Watershed Protection Act regulates land use and activities within critical areas of the Quabbin Reservoir, Ware River and Wachusett Reservoir watersheds for the purpose of protecting the source supply of drinking water that is treated and distributed by the MA Water Resources Authority. The law is administered by the Department of Conservation and Recreation, Division of Water Supply Protection. The towns in this watershed are affected by the Watershed Protection Act (MA DCR, 2023).

13. MA81-39 Fall Brook

13.1. Waterbody Overview

Fall Brook segment MA81-39 is 3 miles long and begins at the outlet of Lake Samoset in Leominster, MA, before flowing to the north and then east through developed portions of Leominster areas, ending at its confluence with the North Nashua River (MA81-04), Leominster. Fall Brook was formerly part of segment MA81-14.

Tributaries to this section of Fall Brook include 8 miles of unnamed streams. Lakes and ponds within the watershed are Lake Samoset, the Fall Brook Reservoir, and Lower Otter Pond. Colburn Pond is in the northern edge of the watershed, but appears to drain to a wetland, and thus does connect to Fall Brook through surface flow.

Major landmarks in the watershed include the Grand View Country Club and Golf Course, Fournier Park, Barrett Park, Massachusetts Audubon's Lincoln Woods, and Basset Forest Conservation Land. Segment MA81-39 intersects five roadways including Central Street/MA-12 and Lancaster Street/MA-117, all within Leominster. In addition, it is crossed by the Fitchburg Secondary Railroad between MA-12 and MA-117.

Fall Brook (MA81-39) drains an area of 7.2 square miles, of which 1.3 mi^2 (18%) is impervious and 0.8 mi^2 (12%) is directly connected impervious area (DCIA). The watershed is served entirely[32] by public sewer and 69% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds (Figure 13-1). The segment flows through medium density residential development, then high density mixed residential, commercial, and light industrial development. Although forest (50%) is the largest land use category in the watershed, developed

Reduction from Highest Calculated Geomean: 29%

Watershed Area (Acres): 4,605

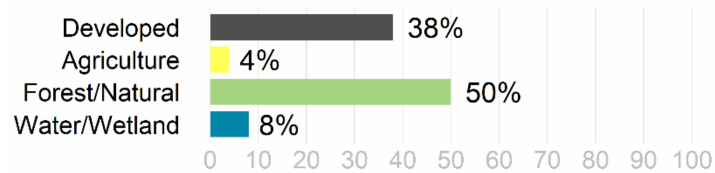
Segment Length (miles): 3.0

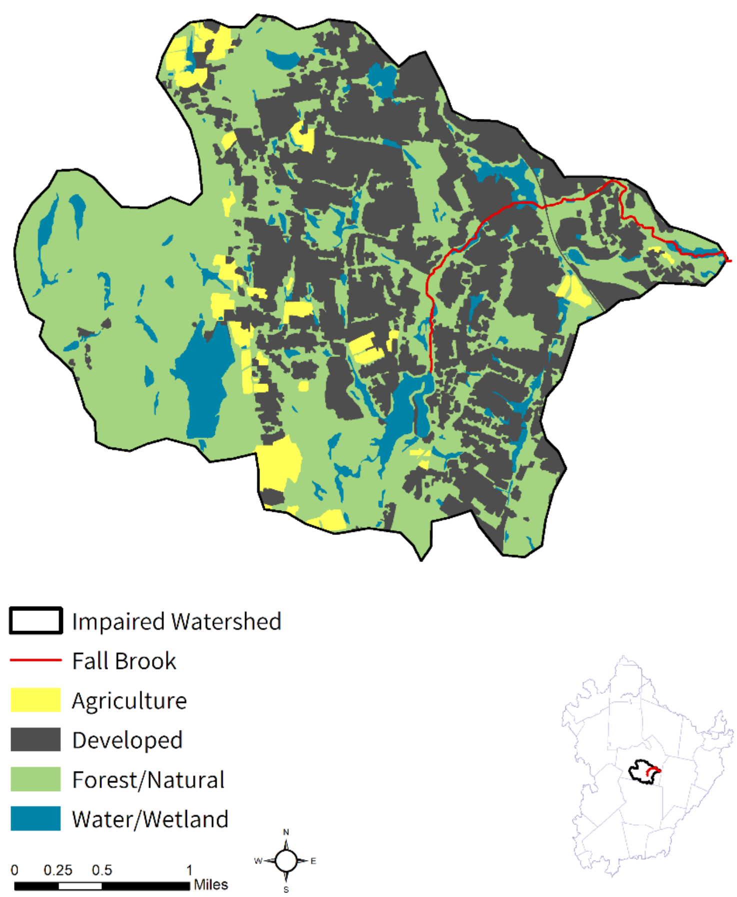
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 821 (18%)

DCIA Area (Acres, %): 530 (12%)





[32] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

areas surround the brook in the eastern two thirds of the segment watershed.

In the watershed of Fall Brook (MA81-39), under the Natural Heritage and Endangered Species Program, there are 128 acres (3%) of Priority Habitats of Rare Species. There are 825 acres (18%) under Public Water Supply protection and 39 acres (1%) of Areas of Critical Environmental Concern but no areas of Outstanding Resource Waters identified in the watershed. Over 298 acres (6%) of land protected in perpetuity[33] exist within the segment watershed, which is part of a total of 1,221 acres (27%) of Protected and Recreational Open Space[34]. See Figure 13-1.

[33] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[34] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

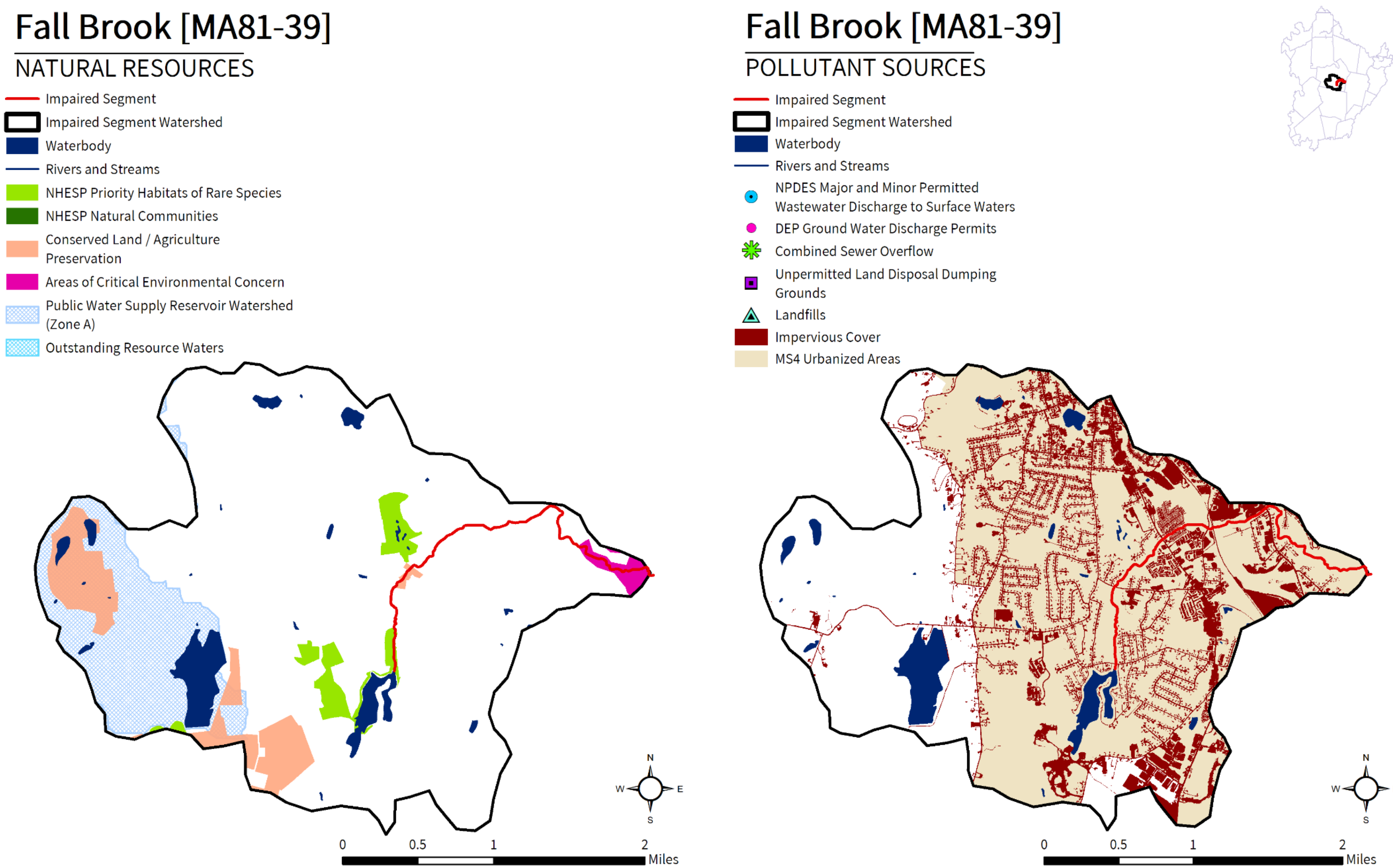


Figure 13-1. Natural resources and potential pollution sources draining to the Fall Brook segment MA81-39. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities

13.2. Waterbody Impairment Characterization

Fall Brook (MA81-39) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 13-1, 13-2; Figure 13-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2008, six samples were collected at W1826, resulting in five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.

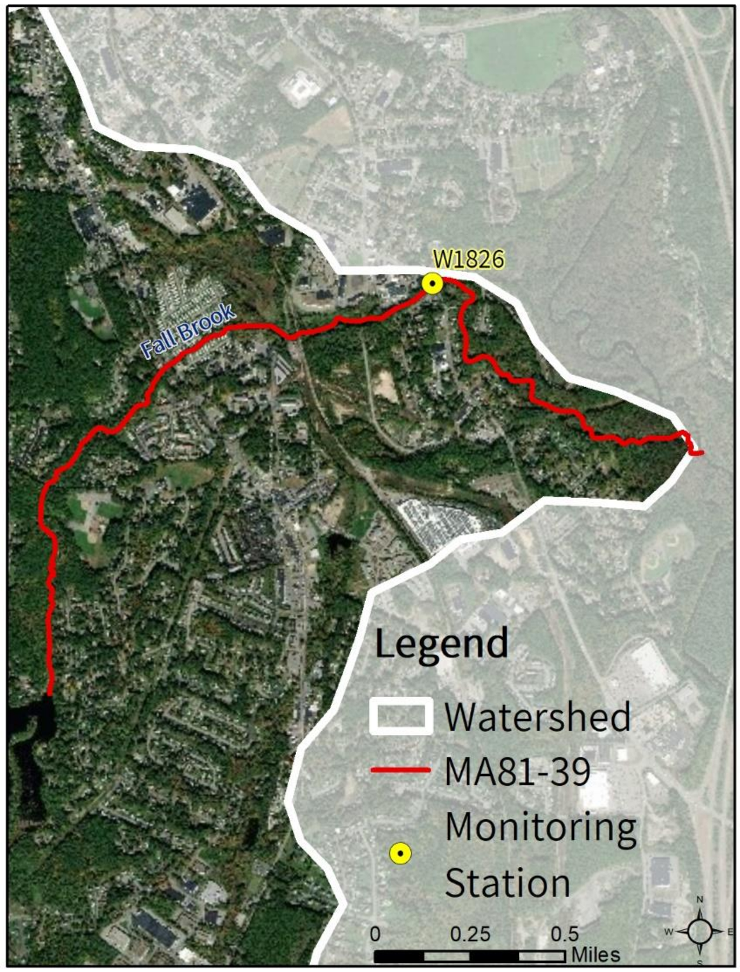


Figure 13-2. Location of monitoring station(s) along the impaired river segment.

Table 13-1. Summary of indicator bacteria sampling results by station for Fall Brook (MA81-39). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1826	5/13/2008	9/16/2008	6	177	5	0

Table 13-2. Indicator bacteria data by station, indicator, and date for Fall Brook (MA81-39). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1826	*E. coli*	5/13/2008	DRY	150	150	
W1826	*E. coli*	6/10/2008	DRY	200	173	
W1826	*E. coli*	7/15/2008	DRY	61	122	
W1826	*E. coli*	8/12/2008	WET	250	145	
W1826	*E. coli*	9/2/2008	DRY	320	177	
W1826	*E. coli*	9/16/2008	WET	140	162	

13.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for Fall Brook (MA81-39) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Large portions of the Fall Brook (MA81-39) watershed are highly developed, with 69% of the land area in MS4 and 12% as DCIA. The densest development is concentrated around the brook. The upstream area of the segment consists of medium-density residential development mixed with forested and natural areas. The downstream portion east of Central Street flows through a high-density residential trailer park and flows behind commercial and industrial land uses. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With all the land area in sewer service and most (69%) of the watershed designated as MS4 area, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity.

On-Site Wastewater Disposal Systems: Some of the residential development in the watershed may still use septic systems for wastewater treatment; it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Pet Waste: Parks and ballfields in proximity to the river, such as Fournier Park, as well as conservation land and residential yards in the watershed, may be popular for dog-walking, especially where paths or yards are adjacent to rivers, ponds, or wetlands. Unmanaged pet waste represents a likely source of pathogens.

Agriculture: While only 4% of the watershed is classified as agricultural land, agricultural activities remain a possible contributing source of pathogens. Agricultural activities visible on recent aerial photos include open fields and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

13.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

City of Leominster. See Section 4.4

14. MA81-60 Still River

14.1. Waterbody Overview

The Still River segment MA81-60 is 0.6 miles long and begins 0.3 miles north of the Still River Road/ MA-110 and Forbush Mill Road intersection in Lancaster, MA, before flowing northeast to end at the MA-117 bridge in Bolton, MA.

Tributaries to this section of the Still River (formerly the upstream portion of MA81-15) include 8 miles of unnamed streams (indicated as part of the Still River on some maps), which are mostly draining small, fringing wetlands. The Still River impaired segment itself flows entirely within a large forested and emergent wetland. There are no named lakes or ponds within the segment watershed.

Major landmarks in the watershed include the Twin Springs Golf Course, the Bolton Transfer and Recycling Center, Nashoba Regional High School, and a large ground mounted solar farm. There are no road crossings, except at the segment's end at MA-117.

The Still River (MA81-60) drains an area of 2.4 square miles, of which 0.2 mi^2 (10%) is impervious and 0.1 mi^2 (4%) is directly connected impervious area (DCIA). The watershed is partially[35] served by public sewer and 6% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There is one MassDEP discharge to groundwater permit for on-site wastewater discharge within this watershed (Table 14-1). There are no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds. See Figure 14-1.

Reduction from Highest Calculated Geomean: 28%

Watershed Area (Acres): 1,524

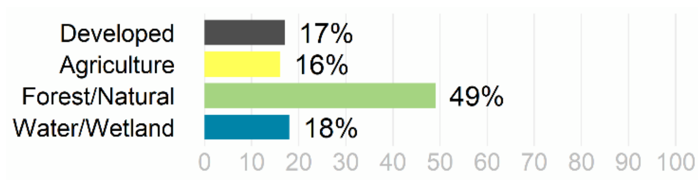
Segment Length (miles): 0.6

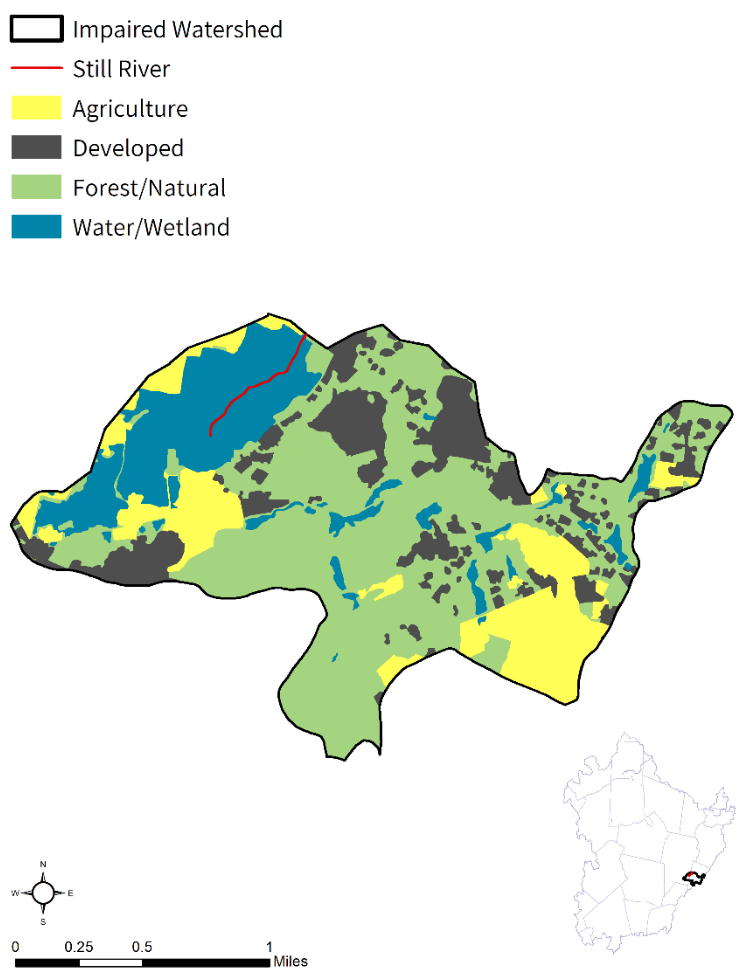
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Cold Water)

Impervious Area (Acres, %): 148 (10%)

DCIA Area (Acres, %): 66 (4%)





35 Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

Table 14-1. Groundwater discharge permits in the segment watershed. Permits are not duplicated for larger segment watersheds that include this segment watershed. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

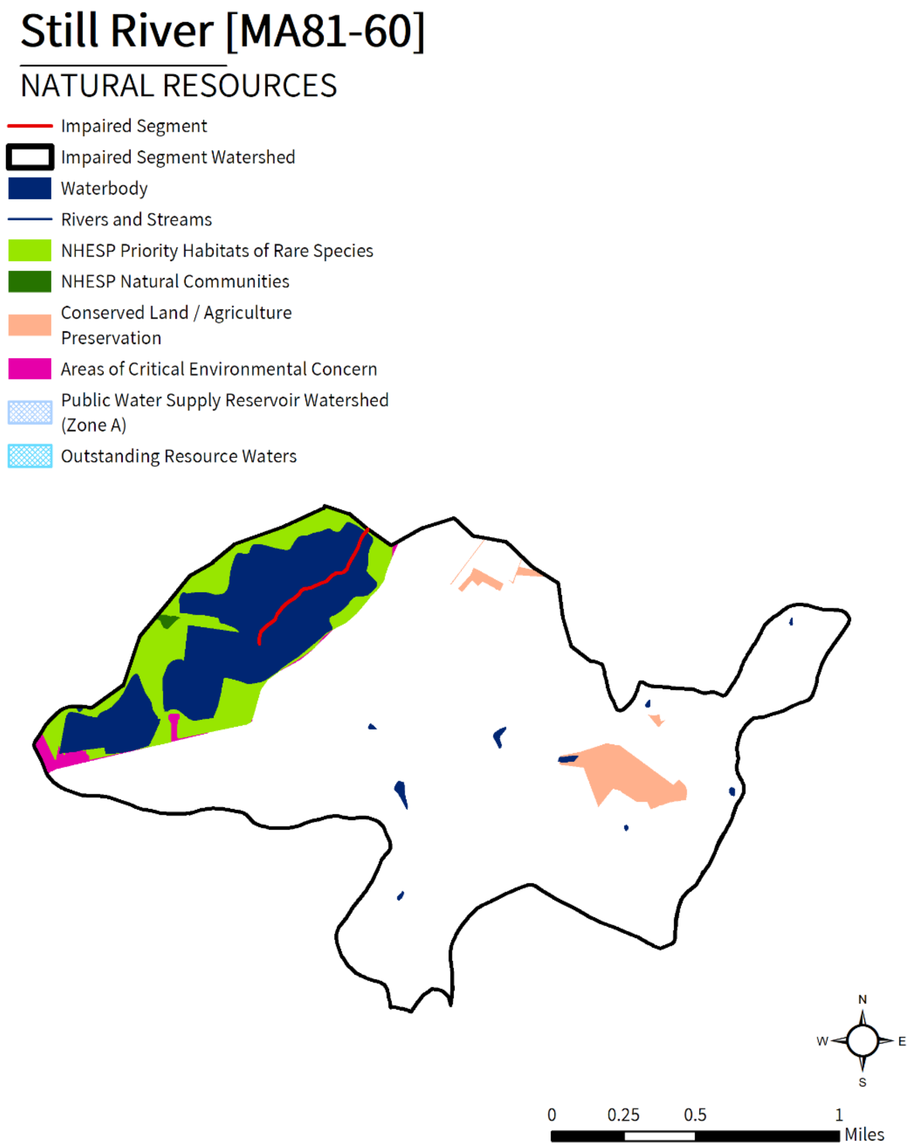
PERR	NAME	TOWN	TYPE	FLOW (GPD)
691-2	NASHOBA REG. HIGHSCHOOL	BOLTON	Sanitary Discharge	12,000

Forested areas (49%) account for the largest category of land use within the watershed, followed by nearly equal parts agriculture (16%), development (17%), and water/wetlands (18%). The impaired segment is flanked entirely by vegetated wetlands, which are in turn surrounded by agriculture, forest, and a small amount of low-density residential development.

In the Still River (MA81-60) watershed, under the Natural Heritage and Endangered Species Program, there are 302 acres (20%) of Priority Habitats of Rare Species and 2 acres (<1%) of Priority Natural Vegetation Communities. There are 310 acres (20%) identified as Areas of Critical Environmental Concern but no areas under Public Water Supply protection or identified as Outstanding Resource Waters in the watershed. Over 38 acres (3%) of land protected in perpetuity[36] exist within the segment watershed, which is part of a total of 520 acres (34%) of Protected and Recreational Open Space[37]. See Figure 14-1.

[36] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[37] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



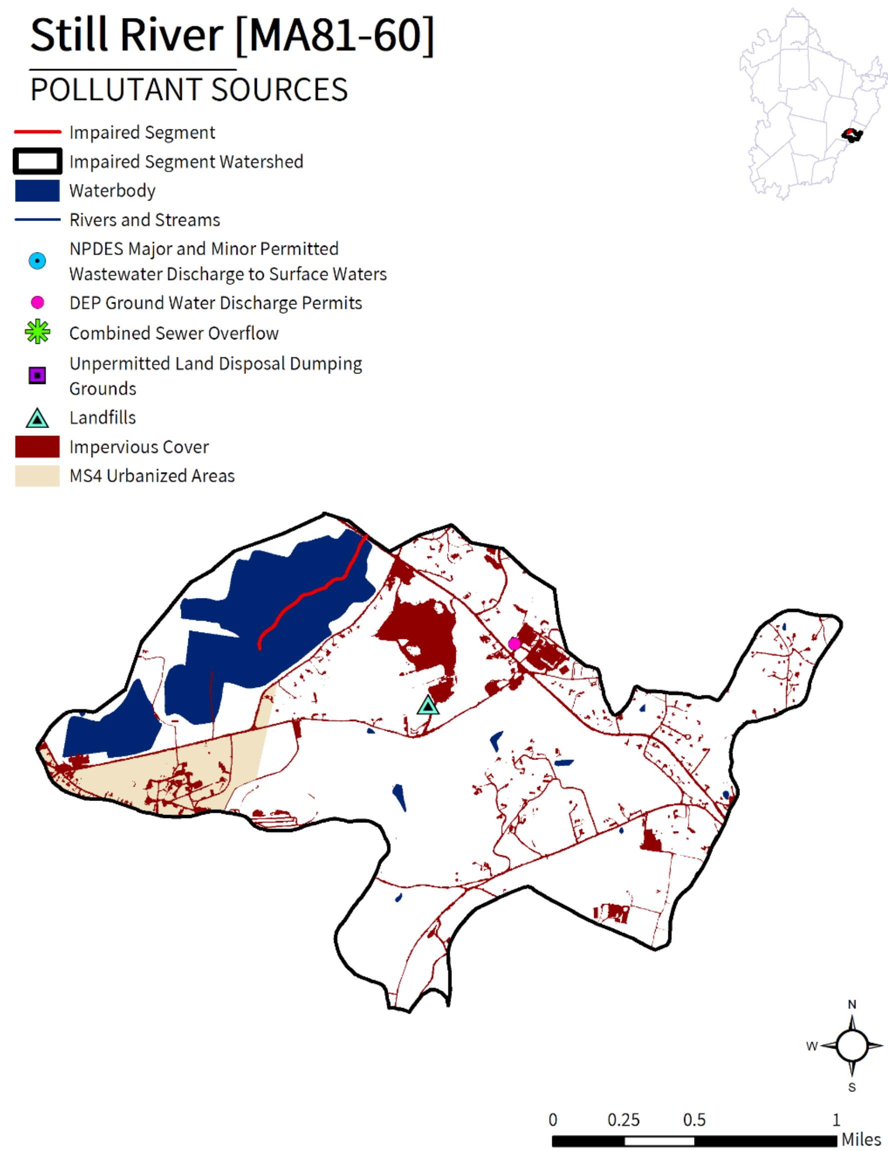


Figure 14-1. Natural resources and potential pollution sources draining to the Still River segment MA81-60. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

14.2. Waterbody Impairment Characterization

The Still River (MA81-60) is a Class B, Cold Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 14-2, 14-3; Figure 14-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2008, six samples were collected at W0995, resulting in three days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. None of the six samples exceeded the STV criterion.

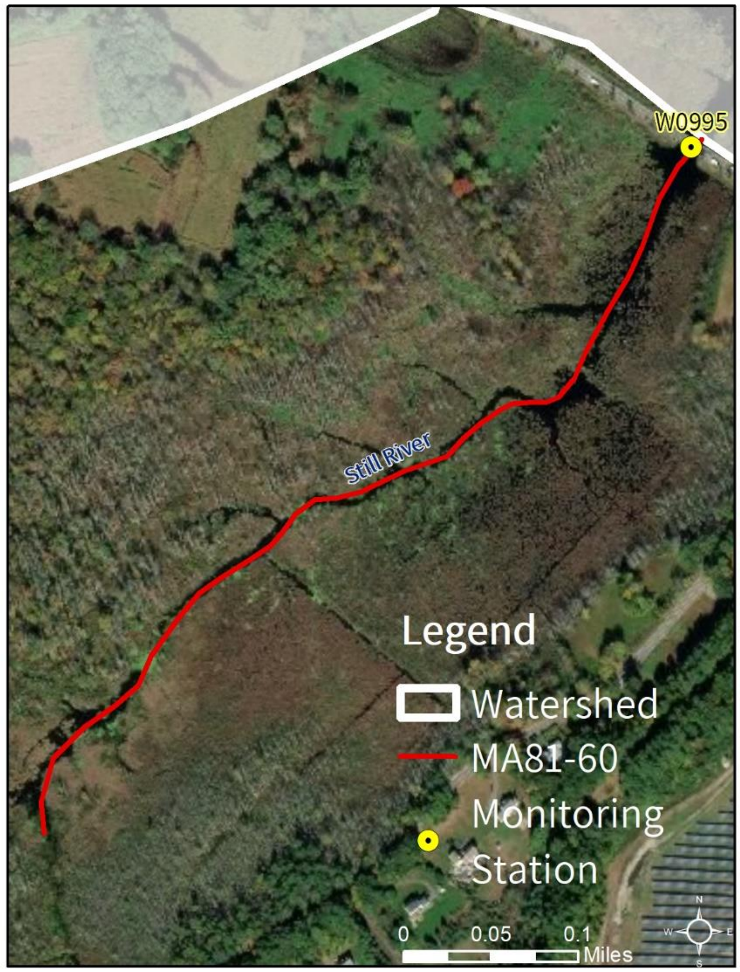


Figure 14-2. Location of monitoring station(s) along the impaired river segment.

Table 14-2. Summary of indicator bacteria sampling results by station for the Still River (MA81-60). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0995	5/15/2008	9/18/2008	6	176	3	0

Table 14-3. Indicator bacteria data by station, indicator, and date for the Still River (MA81-60). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0995	*E. coli*	5/15/2008	DRY	100	100	
W0995	*E. coli*	6/12/2008	DRY	160	126	
W0995	*E. coli*	7/17/2008	DRY	100	117	
W0995	*E. coli*	8/14/2008	WET	120	124	
W0995	*E. coli*	9/4/2008	DRY	200	140	
W0995	*E. coli*	9/18/2008	DRY	400	176	

14.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for the Still River (MA81-60) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. More data are necessary during varied conditions, such as wet weather, to better determine the sources of pollutants to the Still River.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Still River (MA81-60) watershed has 6% of the land area in MS4, 4% as DCIA, and some low-density residential neighborhoods scattered throughout the watershed. Although the impaired stream segment is surrounded by vegetated wetlands, stormwater sources to the edge of the wetland may be hydrologically connected to the impaired segment, and there are upstream tributaries that flow through more developed areas. Therefore, stormwater runoff from urban areas is a possible contributing source of pathogens.

Illicit Sewage Discharges: Most of the land area is not in sewer service and very little (6%) of the watershed is designated as MS4 area; however, there may be private sewage infrastructure such as building drains which may intersect with storm drains. Leaky sewer lines and illicit connections are potentially a small contributing source. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge, which is a large-capacity septic system (non-residential), within the immediate drainage area to segment MA81-60. Most of the residential development in the watershed uses septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There is almost as much agricultural land (247 acres) present within the watershed as developed land (264 acres). Agricultural activities visible on recent aerial photos include open fields, row crops, pastureland, and orchards throughout the watershed, including some adjacent to the wetland where the impaired segment is located. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are about 520 acres of Open Space land for Conservation or Recreation activities within the watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody along with large open wetlands may attract excessive waterfowl and elevate indicator bacteria counts in the water.

14.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Bolton. See Section 6.4

Town of Lancaster. See Section 5.4

15. MA81-62 Baker Brook

15.1. Waterbody Overview

The Baker Brook segment MA81-62 is 2.5 miles long and begins at the confluence of Pearl Hill (unimpaired) and Falulah Brook (MA81-99 and MA81-100, formerly MA81-63, pathogen-impaired) in Fitchburg, MA. Baker Brook then flows south through Fitchburg, Lunenburg, and Leominster, and back into Fitchburg to end at its confluence with the North Nashua River (MA81-02) in Fitchburg. Baker Brook is labeled Laurel Brook on some maps.

There are no tributaries entering Baker Brook, though there are several tributaries, as well as the Lowell and Scott Reservoirs, in the upstream reaches of Falulah Brook, far upstream of the impaired segment. Major lakes and ponds within the watershed include the Fitchburg, Lovell, and Scott Reservoirs.

Major landmarks in the watershed include the western half of Fitchburg, Saint Bernard's Cemetery, Eliot Athletic Complex, Laurel Bank Conservation Area, Falulah Park, and the Fitchburg Municipal Airport. Segment MA81-62 flows adjacent to John Fitch Highway, then is crossed by Youngs Road, Summer Street, and the Fitchburg Main Line railroad, all in Fitchburg, and Crawford Street in Lunenburg about 0.5 miles upstream of the segment's end.

Baker Brook (MA81-62) drains an area of 18 square miles, of which 2 mi^2 (10%) is impervious and 1 mi^2 (6%) is directly connected impervious area (DCIA). The watershed is partially[38] served by public sewer and 29% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no active combined sewer overflows[39], 2 landfills, and no unpermitted land disposal dumping grounds. See Figure 15-1.

Reduction from Highest Calculated Geomean: 57%

Watershed Area (Acres): 11,684

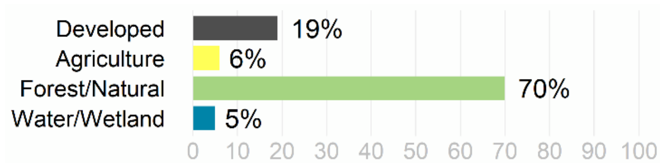
Segment Length (miles): 2.5

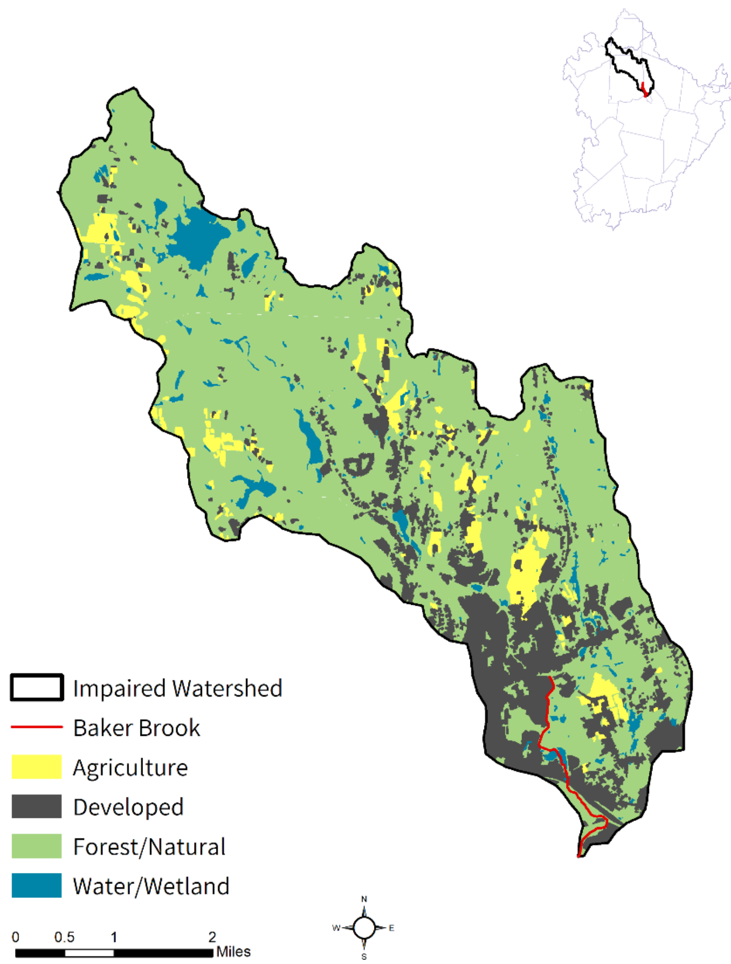
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (CSO Receiving Water)

Impervious Area (Acres, %): 1,128 (10%)

DCIA Area (Acres, %): 685 (6%)





[38] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

[39] MassDEP maintains a CSO qualifier for the entire length of Baker Brook.

Forest (70%) accounts for most of the land use within the segment watershed. Most of the developed land is concentrated along the southwestern part of the watershed along the impaired segment and is comprised of residential development for the town of Fitchburg and commercial development along Summer Street.

In the watershed of Baker Brook (MA81-62), under the Natural Heritage and Endangered Species Program, there are 909 acres (8%) of Priority Habitats of Rare Species and five acres (<1%) of Priority Natural Vegetation Communities. There are 4,160 acres (36%) under Public Water Supply protection, 11 acres (<1%) identified as Outstanding Resource Waters, and 19 acres (<1%) of Areas of Critical Environmental Concern in the watershed. Over 2,191 acres (19%) of land protected in perpetuity[40] exist within the segment watershed, which is part of a total of 3,329 acres (28%) of Protected and Recreational Open Space[41]. See Figure 15-1.

[40] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[41] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

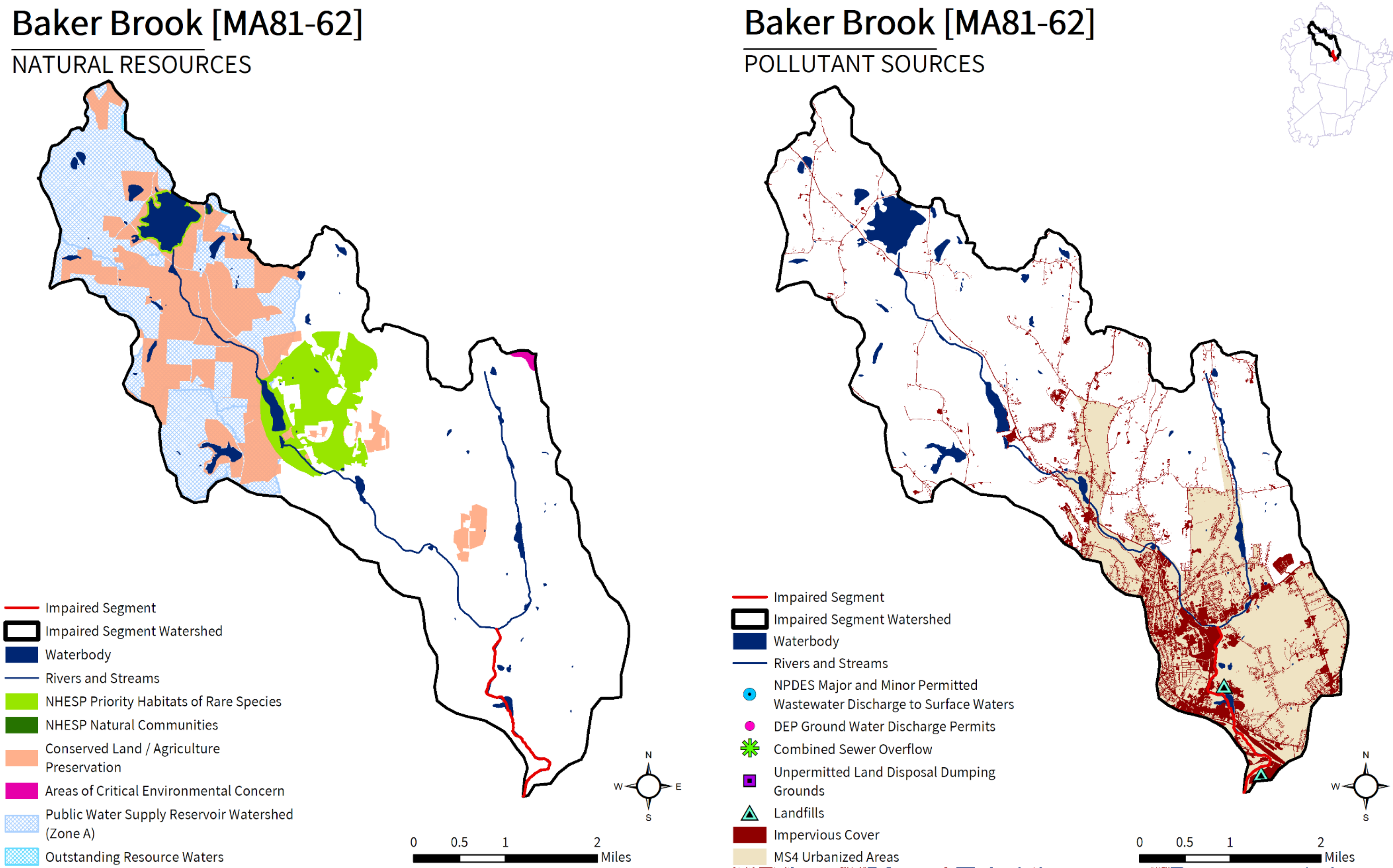


Figure 15-1. Natural resources and potential pollution sources draining to the Baker Brook segment MA81-62. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

15.2. Waterbody Impairment Characterization

Baker Brook (MA81-62) is a Class B, CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 15-1, 15-2; Figure 15-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

- In 2008, six samples were collected at W1836, resulting in four days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather.

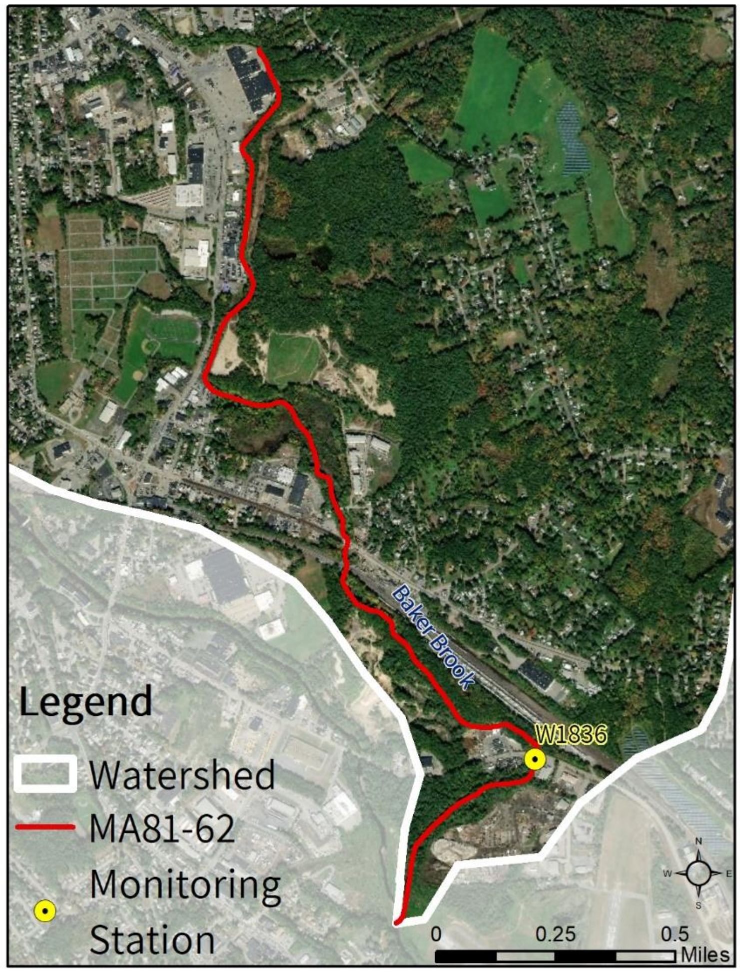


Figure 15-2. Location of monitoring station(s) along the impaired river segment.

Table 15-1. Summary of indicator bacteria sampling results by station for Baker Brook (MA81-62). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1836	5/13/2008	9/16/2008	6	291	4	1

Table 15-2. Indicator bacteria data by station, indicator, and date for Baker Brook (MA81-62). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1836	*E. coli*	5/13/2008	DRY	38	38	
W1836	*E. coli*	6/10/2008	DRY	310	109	
W1836	*E. coli*	7/15/2008	DRY	180	180	
W1836	*E. coli*	8/12/2008	WET	470	291	
W1836	*E. coli*	9/2/2008	DRY	80	194	
W1836	*E. coli*	9/16/2008	WET	220	133	

15.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for the Baker Brook (MA81-62) were elevated during wet weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Baker Brook (MA81-62) watershed are highly developed, with 29% of the land area in MS4 and 6% as DCIA. These urbanized areas are concentrated in the area around the impaired segment. In some locations, the river is flanked by large commercial properties with expansive parking lots, and in others, there are dense residential street networks. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With only some of the land area in sewer service and a portion (29%) of the watershed designated as MS4 area, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: Some of the residential development in the watershed use septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities account for 6% of the land use within the watershed. Agricultural activities visible on recent aerial photos include open fields, row crops, orchards, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are many parks and ballfields along the segment. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

15.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashby

Ashby received a MS4 General Permit waiver on August 19, 2015: https://www3.epa.gov/region1/npdes/stormwater/ma/waivers/ashby-epa-waiver-response.pdf (Moraff, 2015c)

Ashby's Stormwater Management Plan: http://www.ci.ashby.ma.us/plan/subdivision%20docs/breitmaier/160923%20plans-docs/Stormwater%20Report/18131%20-%20Operations%20&%20Maintenance%20Plan.pdf (Hancock Associates, n.d.)

Ashby's Open Space and Recreation Plan: https://www.ci.ashby.ma.us/document/plans&reports/osrp-2018/FINAL-DRAFT12-04-18.pdf (Town of Ashby, 2018)

Ashby did not have any relevant ordinances or bylaws.

Ashby had no Master Plan available.

Town of Fitchburg. See Section 2.4

Town of Lunenburg

About a third of Lunenburg is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Lunenburg (Permit ID #MAR041206) has an EPA approved Notice of Intent (NOI). Lunenburg has a Stormwater Management Plan available at the Lunenburg Land Use Department. The town has mapped all of its MS4 stormwater system, which is available online. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2007. According to the NOI, there are no stormwater outfalls into impaired segments in the Nashua River watershed.

Lunenburg has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws: https://ecode360.com/29816242 (Town of Lunenburg, 2014, a)
- Stormwater Utility: None found.
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Wetland Protection Bylaw: https://ecode360.com/29816063 (Town of Lunenburg, 2014, b)
- Pet Waste Ordinance: None found.
- Contact Recreation Ordinance: None found.

The Lunenburg Master Plan has a water resources section within the Open Space, Natural and Cultural Resources, and Recreation Elements chapter. The town does not have any impaired segments within the town's boundaries. The Community Facilities and Services Element Chapters has a brief section on town Sewer, noting there have been connections to adjacent towns.

Lunenburg Town Website: https://www.lunenburgma.gov/ (Town of Lunenburg, 2021)

Master Plan: https://www.lunenburgma.gov/sites/default/files/field/files-docs/master_plan_2002.pdf (Town of Lunenburg et al, 2002)

Stormwater Web Page: https://www.lunenburgma.gov/departments/public-works/stormwater-management (Town of Lunenburg, 2019)

Open Space and Recreation Plan: https://www.lunenburgma.gov/sites/default/files/field/files-docs/open_space_section_1_-_final.pdf (Town of Lunenburg, 2011)

16. MA81-72 Wekepeke Brook

16.1. Waterbody Overview

The Wekepeke Brook segment MA81-72 is 5.8 miles long and begins at the outlet of Heywood Reservoir in Sterling, MA. Segment MA81-72 flows west through Sterling, then northeast through Lancaster (this segment includes former segments Bartlett Pond MA81008 and Unnamed Tributary MA81-61) to end at its confluence with the North Nashua River (MA81-04), Lancaster.

Tributaries to this section of the Wekepeke Brook include many unnamed streams. Additional waterbodies in the watershed include Upstream Lynde Basin Reservoir, Fitch Basin, and many smaller ponds and wetlands.

Major landmarks in the watershed include Bartlett Pond Conservation Area, Lancaster State Forest, Exits 6 and 7 of I-190, and low-density residential neighborhoods and commercial development north of downtown Sterling, MA. Segment MA81-72 is crossed by nine roads including I-190 and Main Street/MA-117 in Lancaster; and Leominster Road/MA-12 and the Fitchburg Secondary railroad in Sterling.

Wekepeke Brook (MA81-72) drains an area of 12 square miles, of which 1 mi^2 (9%) is impervious and 0.5 mi^2 (5%) is directly connected impervious area (DCIA). The watershed is partially[42] served by public sewer and 16% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the segment watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds. See Figure 16-1.

The segment flows through varied land uses, including forest (70%) and conservation lands, low density residential and commercial development, and the interstate highway corridor. Most of the developed land, including light industrial and commercial uses, is clustered

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 7,500

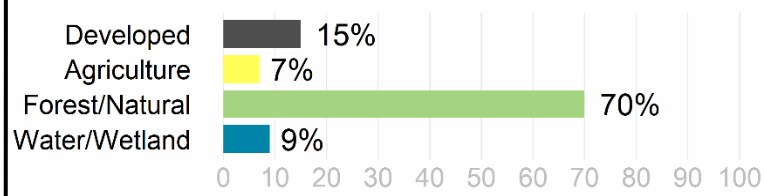
Segment Length (miles): 5.8

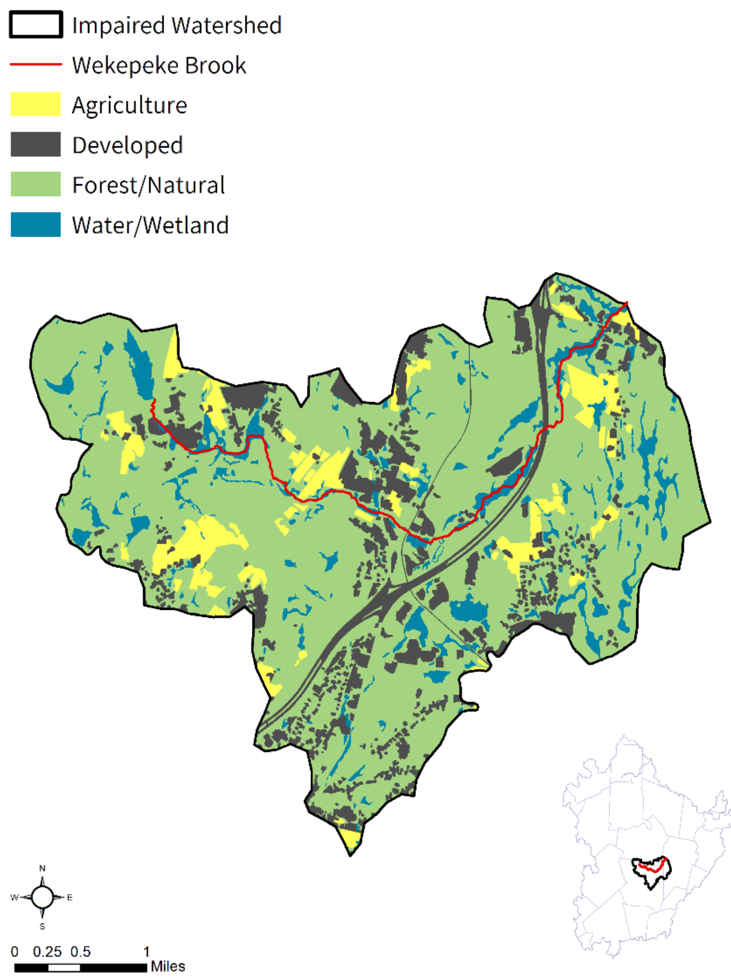
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 676 (9%)

DCIA Area (Acres, %): 343 (5%)





[42] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

in the center of the watershed. There are large areas of bare soil due to excavation visible on recent aerial photos.

In the watershed of Wekepeke Brook (MA81-72), under the Natural Heritage and Endangered Species Program, there are 520 acres (7%) of Priority Habitats of Rare Species. There are 60 acres (1%) under Public Water Supply protection and 101 acres (1%) of Areas of Critical Environmental Concern but no areas of Outstanding Resource Waters identified in the watershed. Over 896 acres (12%) of land protected in perpetuity[43] exist within the segment watershed, which is part of a total of 1,695 acres (23%) of Protected and Recreational Open Space[44]. See Figure 16-1.

[43] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[44] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

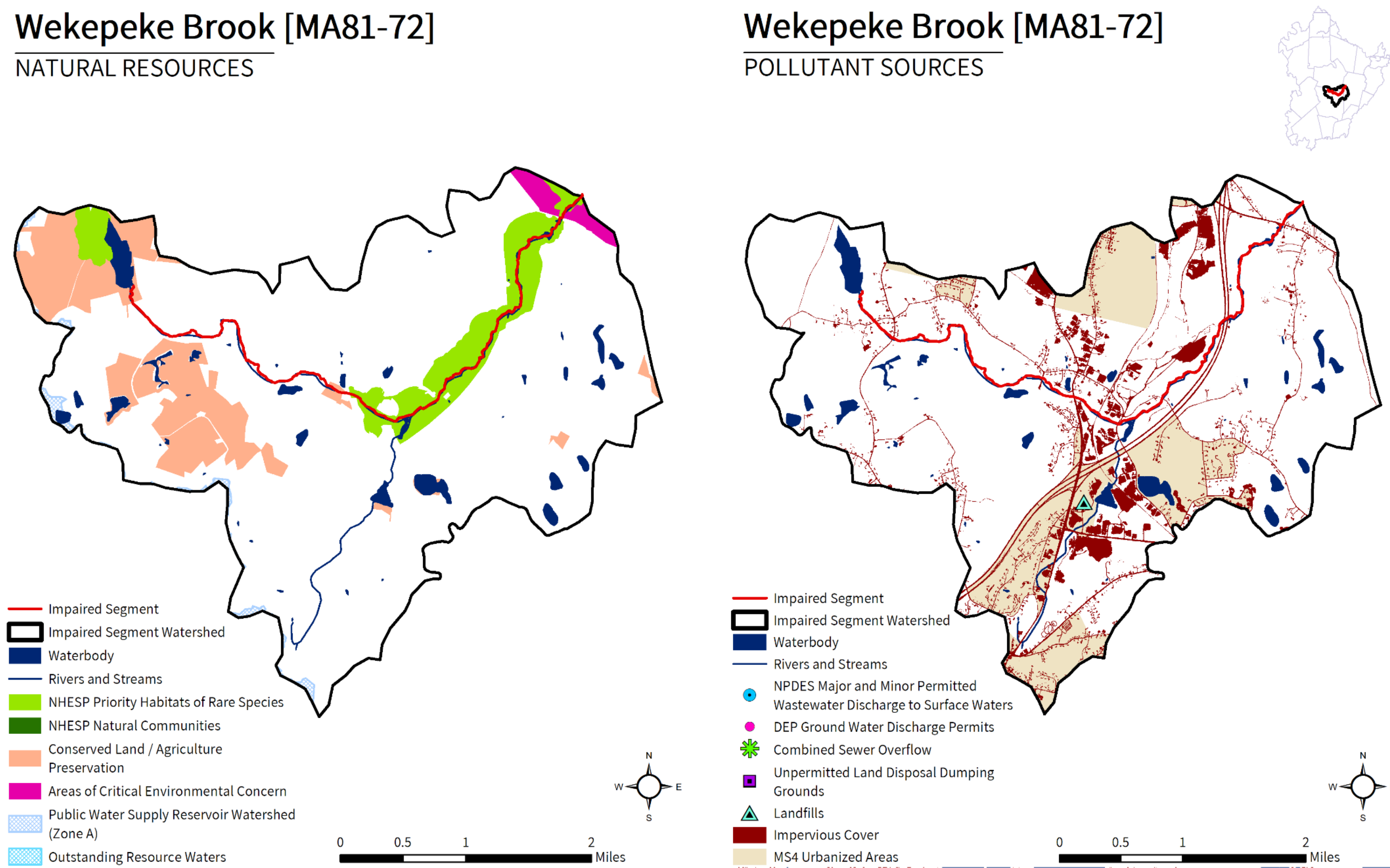


Figure 16-1. Natural resources and potential pollution sources draining to the Wekepeke Brook segment MA81-72. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

16.2. Waterbody Impairment Characterization

Wekepeke Brook (MA81-72) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 16-1, 16-2; Figure 16-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

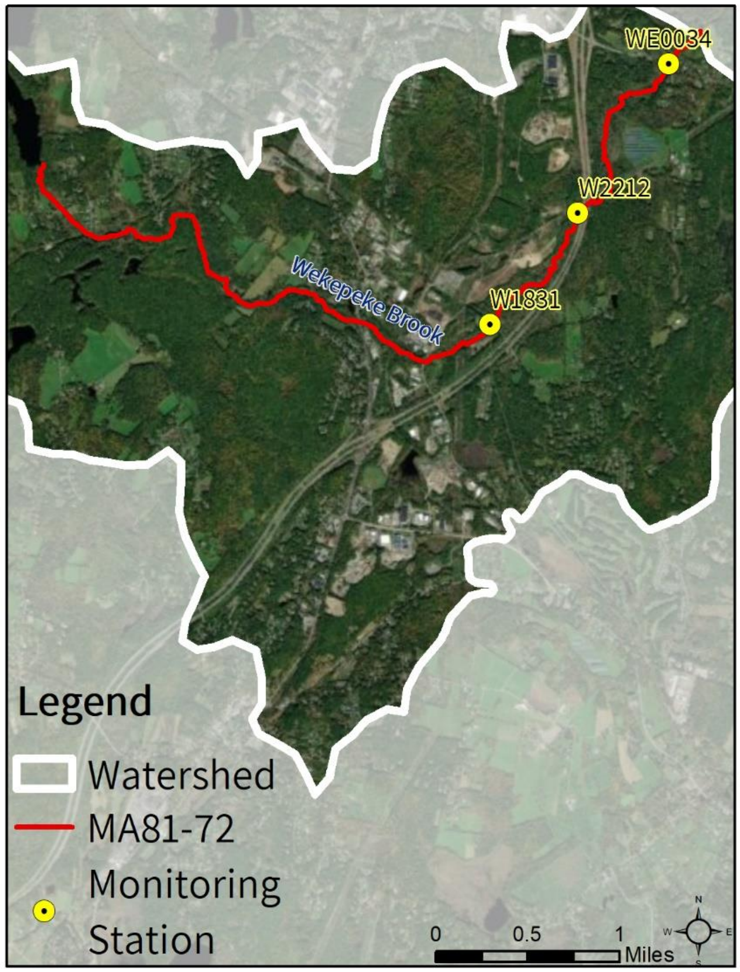


Figure 16-2. Location of monitoring station(s) along the impaired river segment.

- In 2008, six samples were collected at W1831, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.
- In 2011, six samples were collected at W2212, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.
- From 2008-2017, 67 samples were collected at WE0034, resulting in 40 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 67 samples, 18 exceeded the STV criterion in 2008-2014 and 2017 during both wet and dry weather.

Table 16-1. Summary of indicator bacteria sampling results by station for Wekepeke Brook (MA81-72). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1831	5/13/2008	9/16/2008	6	79	0	0
W2212	5/17/2011	9/19/2011	6	114	0	0
WE0034	5/17/2008	10/21/2017	67	2420	40	18

Table 16-2. Indicator bacteria data by station, indicator, and date for Wekepeke Brook (MA81-72). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1831	*E. coli*	5/13/2008	DRY	29	29	
W1831	*E. coli*	6/10/2008	DRY	80	48	
W1831	*E. coli*	7/15/2008	DRY	73	55	
W1831	*E. coli*	8/12/2008	WET	83	79	
W1831	*E. coli*	9/2/2008	DRY	32	63	
W1831	*E. coli*	9/16/2008	WET	19	44	
W2212	*E. coli*	5/17/2011	WET	86	86	
W2212	*E. coli*	6/9/2011	WET	144	111	
W2212	*E. coli*	6/21/2011	DRY	46	83	
W2212	*E. coli*	7/19/2011	DRY	95	86	
W2212	*E. coli*	8/16/2011	WET	270	114	
W2212	*E. coli*	9/19/2011	DRY	26	74	
WE0034	*E. coli*	5/17/2008	WET	236	236	
WE0034	*E. coli*	7/19/2008	DRY	157	192	
WE0034	*E. coli*	8/16/2008	DRY	2420	616	
WE0034	*E. coli*	9/20/2008	DRY	328	499	
WE0034	*E. coli*	10/18/2008	DRY	940	907	
WE0034	*E. coli*	4/18/2009	DRY	2420	2420	
WE0034	*E. coli*	5/16/2009	DRY	6	120	
WE0034	*E. coli*	6/20/2009	WET	2420	328	
WE0034	*E. coli*	7/18/2009	DRY	146	128	
WE0034	*E. coli*	8/15/2009	DRY	146	372	
WE0034	*E. coli*	9/19/2009	DRY	4	44	
WE0034	*E. coli*	10/17/2009	DRY	49	31	
WE0034	*E. coli*	4/17/2010	WET	313	313	
WE0034	*E. coli*	5/15/2010	DRY	365	338	
WE0034	*E. coli*	6/19/2010	DRY	2420	651	
WE0034	*E. coli*	7/17/2010	DRY	2420	1288	
WE0034	*E. coli*	8/21/2010	DRY	411	1340	
WE0034	*E. coli*	9/18/2010	DRY	141	520	
WE0034	*E. coli*	10/16/2010	WET	2420	520	
WE0034	*E. coli*	4/16/2011	WET	93	93	
WE0034	*E. coli*	5/21/2011	DRY	1414	363	
WE0034	*E. coli*	6/18/2011	DRY	2420	683	
WE0034	*E. coli*	7/16/2011	DRY	261	963	
WE0034	*E. coli*	8/20/2011	DRY	986	854	
WE0034	*E. coli*	9/17/2011	DRY	157	343	
WE0034	*E. coli*	10/15/2011	WET	2420	721	
WE0034	*E. coli*	4/21/2012	DRY	61	61	
WE0034	*E. coli*	5/19/2012	DRY	240	121	
WE0034	*E. coli*	6/16/2012	DRY	130	124	
WE0034	*E. coli*	7/21/2012	DRY	249	198	
WE0034	*E. coli*	8/18/2012	WET	260	203	
WE0034	*E. coli*	9/15/2012	DRY	345	282	
WE0034	*E. coli*	10/20/2012	WET	613	380	
WE0034	*E. coli*	4/20/2013	DRY	1300	1300	
WE0034	*E. coli*	5/18/2013	DRY	96	353	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
WE0034	*E. coli*	6/15/2013	WET	115	243	
WE0034	*E. coli*	7/20/2013	DRY	96	102	
WE0034	*E. coli*	8/17/2013	DRY	67	90	
WE0034	*E. coli*	9/21/2013	DRY	43	65	
WE0034	*E. coli*	10/19/2013	DRY	1	14	
WE0034	*E. coli*	4/19/2014	DRY	35	35	
WE0034	*E. coli*	5/17/2014	WET	2420	291	
WE0034	*E. coli*	6/21/2014	DRY	172	244	
WE0034	*E. coli*	7/19/2014	DRY	54	282	
WE0034	*E. coli*	8/16/2014	DRY	40	72	
WE0034	*E. coli*	9/20/2014	DRY	411	96	
WE0034	*E. coli*	10/18/2014	WET	179	143	
WE0034	*E. coli*	4/20/2015	WET	67	67	
WE0034	*E. coli*	5/16/2015	DRY	152	101	
WE0034	*E. coli*	6/20/2015	DRY	104	102	
WE0034	*E. coli*	7/18/2015	DRY	210	122	
WE0034	*E. coli*	8/15/2015	DRY	148	148	
WE0034	*E. coli*	9/19/2015	DRY	111	151	
WE0034	*E. coli*	10/17/2015	DRY	40	87	
WE0034	*E. coli*	4/16/2016	DRY	35	35	
WE0034	*E. coli*	5/21/2016	DRY	99	59	
WE0034	*E. coli*	7/16/2016	DRY	236	153	
WE0034	*E. coli*	8/20/2016	DRY	78	136	
WE0034	*E. coli*	9/17/2016	DRY	72	110	
WE0034	*E. coli*	10/15/2016	DRY	30	55	
WE0034	*E. coli*	4/15/2017	DRY	74	74	
WE0034	*E. coli*	5/20/2017	DRY	291	147	
WE0034	*E. coli*	6/17/2017	WET	45	99	
WE0034	*E. coli*	7/15/2017	DRY	59	92	
WE0034	*E. coli*	8/19/2017	DRY	411	103	
WE0034	*E. coli*	9/16/2017	DRY	687	255	
WE0034	*E. coli*	10/21/2017	DRY	52	245	

16.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for Wekepeke Brook (MA81-72) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Wekepeke Brook (MA81-72) watershed are highly developed, with 16% of the land area in MS4 and 5% as DCIA. Transportation corridors pass through the segment watershed and are adjacent to the segment in places, including I-190 and MA-12. While the overall level of residential development is moderate, much of the development consists of commercial and industrial infrastructure, including large parking lots and arterial roads. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some portion of the land area in sewer service and some (16%) of the watershed designated as MS4 area, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: Most of the residential development in the watershed uses septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture accounts for 7% of land area, predominantly hayfields. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are over 1,695 acres of open space in the watershed. Conservation lands, parks, ballfields, and residential yards popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

16.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Lancaster. See Section 5.4

City of Leominster. See Section 4.4

Town of Sterling. See Section 7.4

The removal of the Bartlett Dam Pond, an impoundment of Wekepeke Brook in June 2014, may improve water quality in the downstream portion of the brook.

17. MA81-74 Catacoonamug Brook

17.1. Waterbody Overview

The Catacoonamug Brook segment MA81-74 is 4.5 miles long and begins northwest of Chestnut Street from the outlet of an unnamed impoundment north of Paton's Lumber Mill in Lunenburg, MA. From this outlet, the Catacoonamug Brook segment flows southeast and ends at a northern inlet of Lake Shirley in Lunenburg, MA. Flow from Catacoonamug Brook eventually drains to the impaired Nashua River mainstem (MA81-05).

Tributaries to this section of the Catacoonamug Brook include approximately 7.6 miles of unnamed streams. Major lakes and ponds within the Catacoonamug Brook segment watershed are Massapoag Pond, Lake Whalom, Turkey Hill Pond, and Dead Pond.

Major landmarks in the watershed include the Lunenburg Town Hall, Lunenburg High School, Turkey Hill Middle School, and Thomas C Passions Elementary School. Segment MA81-74 is crossed by seven roads including Massachusetts Avenue/MA-2A, Leominster Road, Lancaster Avenue, and Reservoir Road, all in Lunenburg.

Catacoonamug Brook (MA81-74) drains an area of 9 square miles, of which 0.7 mi^2 (9%) is impervious and 0.3 mi^2 (4%) is directly connected impervious area (DCIA). The watershed is partially[45] served by public sewer and 46% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities in the watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds in the watershed. See Figure 17-1.

The segment flows through varied land uses, predominantly forest, with several fringing wetlands along the brook. There are also low to medium density residential areas and row crops,

Reduction from Highest Calculated Geomean: 85%

Watershed Area (Acres): 5,470

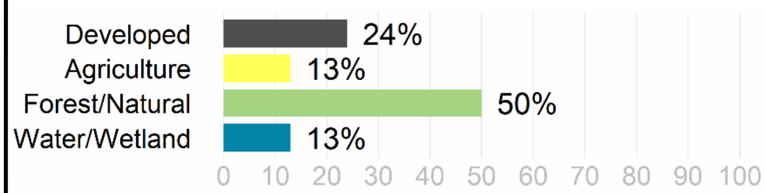
Segment Length (miles): 4.5

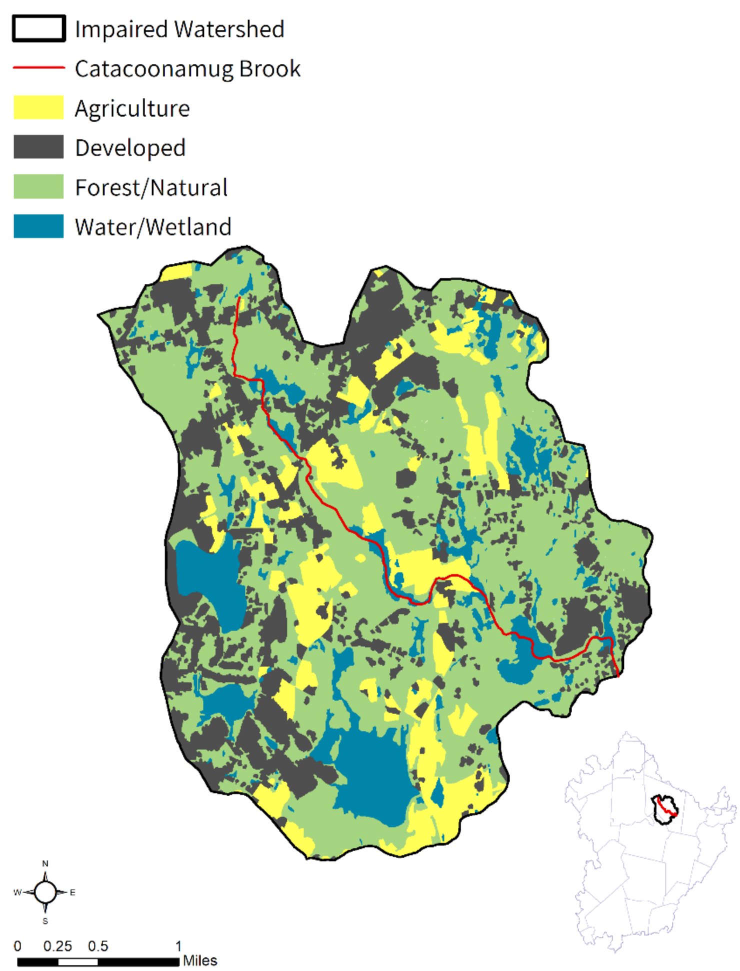
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 466 (9%)

DCIA Area (Acres, %): 194 (4%)





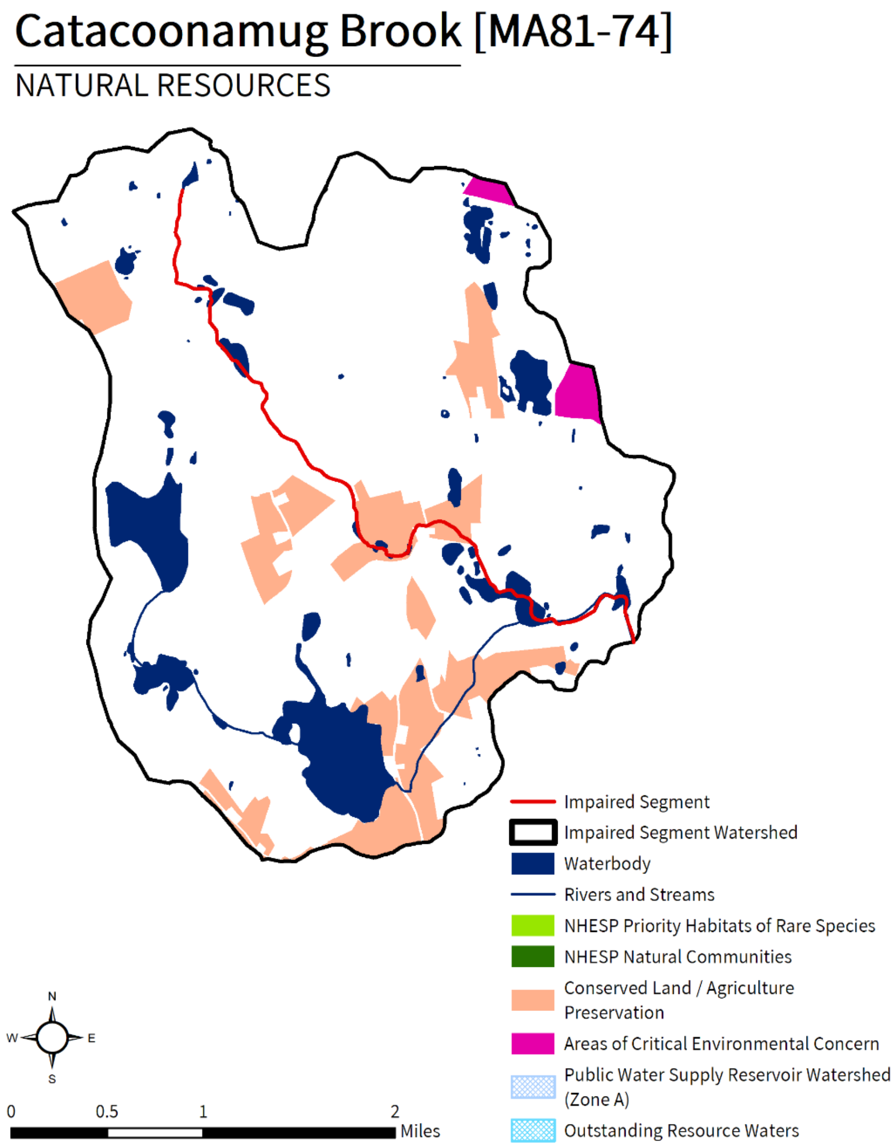
[45] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

orchards, and hayfields along the stream. In the watershed, forest is the largest land use (50%) followed by developed areas (24%), including the outer edges of Fitchburg and Leominster. Agriculture (13%) is a prominent land use within the center of the watershed, including livestock, row crops, and orchards.

In the watershed of Catacoonamug Brook (MA81-74), under the Natural Heritage and Endangered Species Program, there no areas of Priority Habitats of Rare Species or Priority Natural Vegetation Communities. There are 52 acres (1%) of Areas of Critical Environmental Concern but no areas under Public Water Supply protection or identified as Outstanding Resource Waters in the watershed. Over 644 acres (12%) of land protected in perpetuity[46] exist within the segment watershed, which is part of a total of 1,009 acres (18%) of Protected and Recreational Open Space[47]. See Figure 17-1.

[46] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[47] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



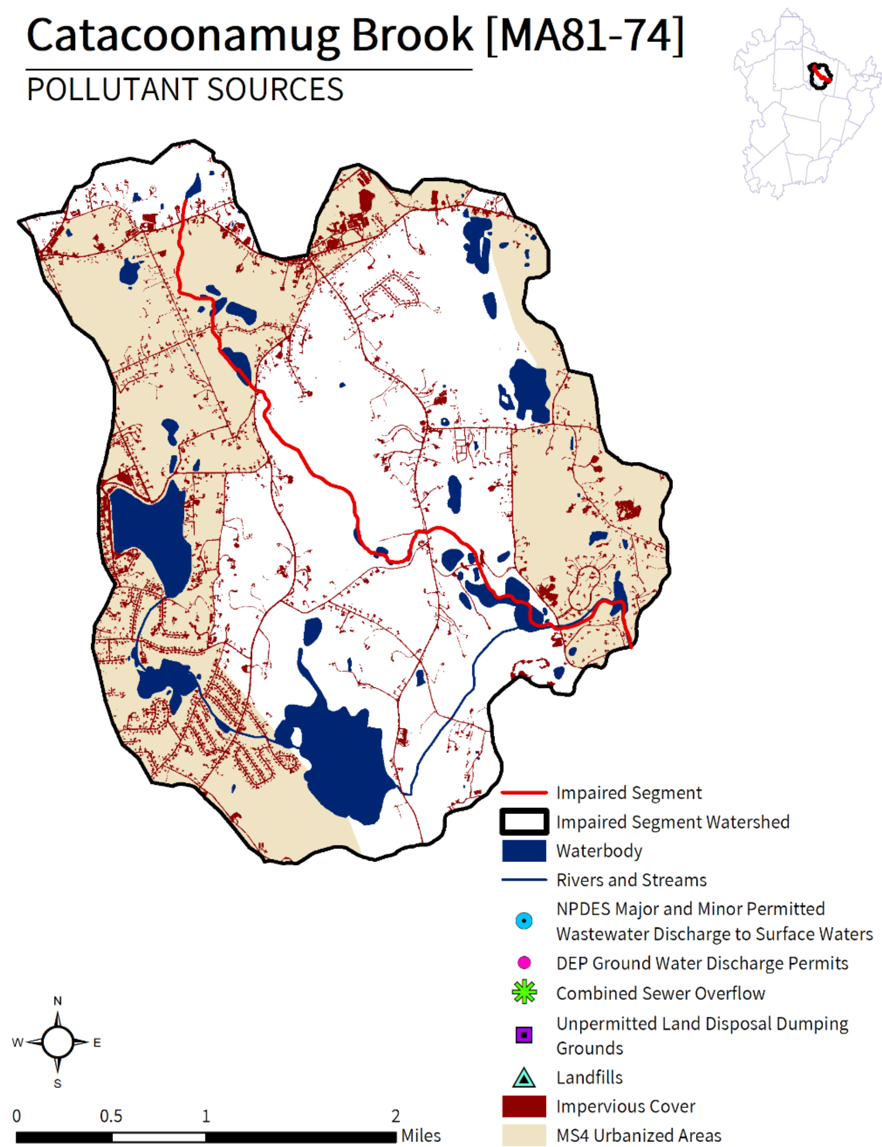


Figure 17-1. Natural resources and potential pollution sources draining to the Catacoonamug Brook segment MA81-74. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

17.2. Waterbody Impairment Characterization

Catacoonamug Brook (MA81-74) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 17-1, 17-2; Figure 17-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- From 2008-2009, two samples were collected at CT0743, resulting in 2 days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of two samples, none exceeded the STV criterion.
- In 2008, six samples were collected at W1843, resulting in five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during both wet and dry weather.

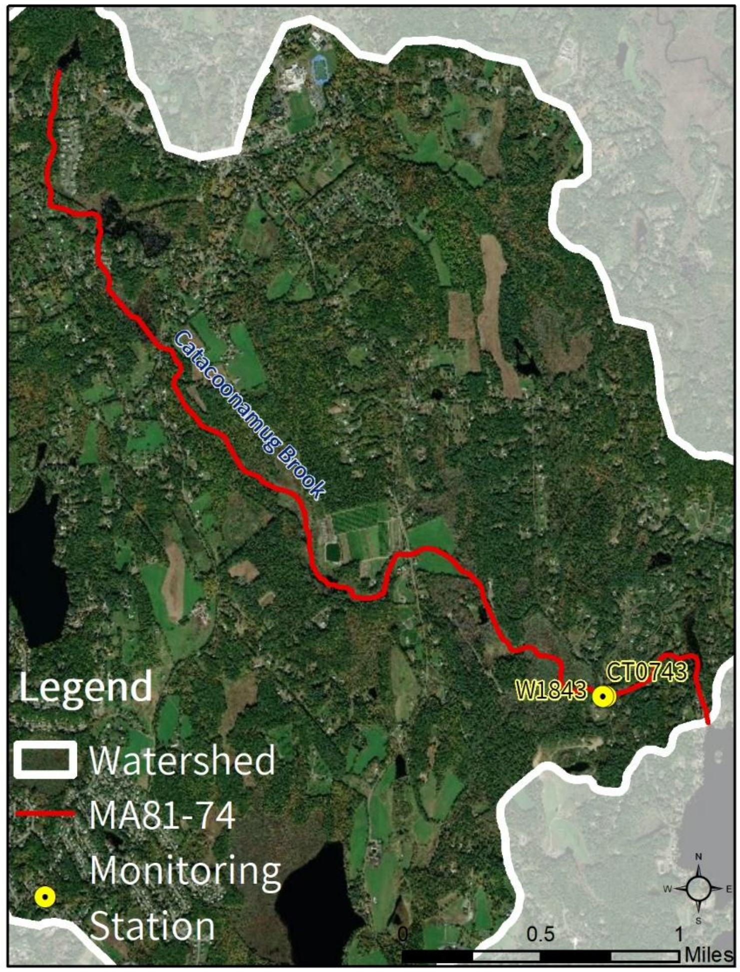


Figure 17-2. Location of monitoring station(s) along the impaired river segment.

Table 17-1. Summary of indicator bacteria sampling results by station for Catacoonamug Brook (MA81-74). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
CT0743	8/16/2008	6/20/2009	2	219	2	0
W1843	5/13/2008	9/16/2008	6	833	5	2

Table 17-2. Indicator bacteria data by station, indicator, and date for Catacoonamug Brook (MA81-74). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
CT0743	*E. coli*	8/16/2008	DRY	210	210	
CT0743	*E. coli*	6/20/2009	WET	219	219	
W1843	*E. coli*	5/13/2008	DRY	110	110	
W1843	*E. coli*	6/10/2008	DRY	200	148	
W1843	*E. coli*	7/15/2008	DRY	300	188	
W1843	*E. coli*	8/12/2008	WET	280	256	
W1843	*E. coli*	9/2/2008	DRY	1300	384	
W1843	*E. coli*	9/16/2008	WET	4400	833	

17.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

The indicator bacteria data for Catacoonamug Brook (MA81-74) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Catacoonamug Brook (MA81-74) watershed is generally developed, with 46% of the land area in MS4, 4% as DCIA, and residential neighborhoods adjacent to the segment in some locations. Stormwater runoff from urban areas is likely one of the most significant sources of pathogens.

Illicit Sewage Discharges: With a portion of the land area in sewer service and 46% of the watershed designated as MS4 area, sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: With large portions of the watershed served by septic systems, it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture accounts for 13% of land area and includes areas of row crops, open fields, hayfields, orchards, and pastureland, some adjacent to the brook. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are conservation and recreational lands and ballfields in the watershed. Conservation lands, parks, ballfields, and yards popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

17.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Lunenburg. See Section 14.4

18. MA81-79 Willard Brook

18.1. Waterbody Overview

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 10,984

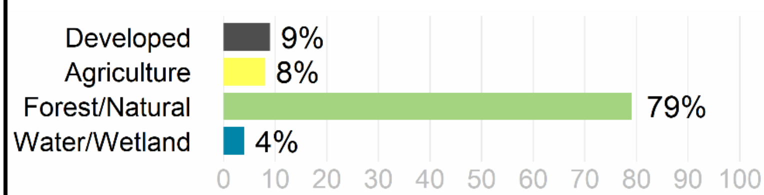
Segment Length (miles): 6.2

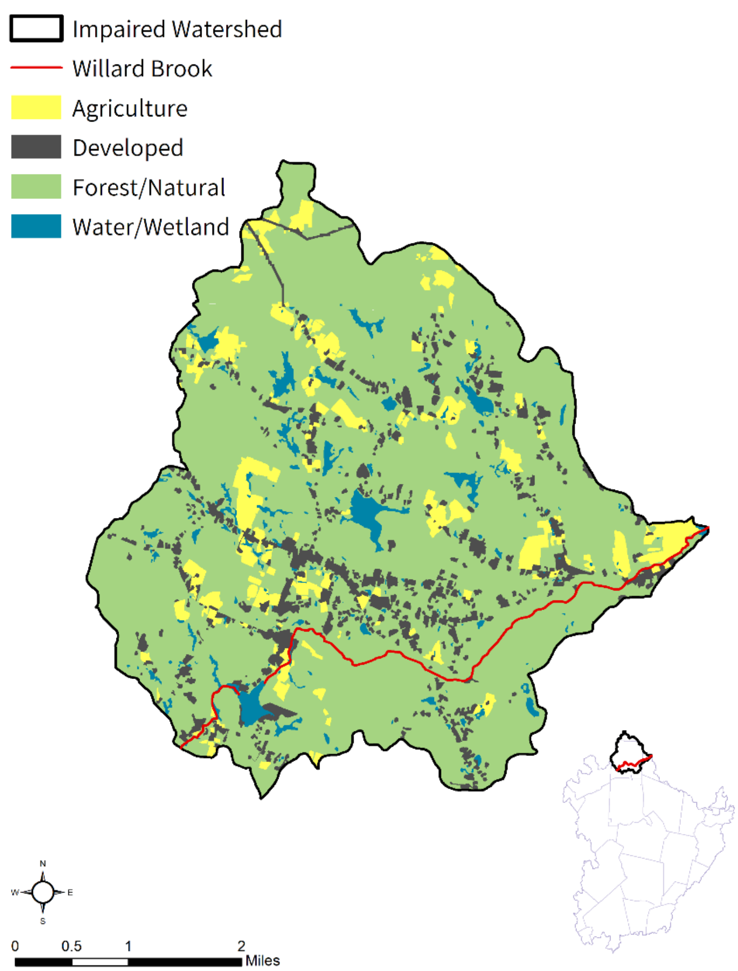
Impairment(s): Enterococci (Primary Contact Recreation)

Class (Qualifiers): B (Outstanding Resource Water)

Impervious Area (Acres, %): 439 (4%)

DCIA Area (Acres, %): 122 (1%)





The Willard Brook segment MA81-79 is 6.2 miles long and begins at the outlet of the Fitchburg Reservoir in Ashby, MA. The segment flows east through Ashby and into Townsend where approximately 0.3 miles through Ashby Reservoir (segment MA81001) is excluded from segment MA81-79. Although the brook is entirely within the state of Massachusetts, the watershed extends to the north to cover 1.7 square miles in Mason and New Ipswich, New Hampshire. Segment MA81-79 ends at its confluence with Mason Brook in Townsend, MA, forming the headwaters of the Squannacook River that flows to the unimpaired Nashua River mainstem (MA81-06).

Tributaries to this section of Willard Brook include Trapfall Brook, Locke Brook, and other unnamed streams. Major lakes and ponds include Ashby Reservoir and Damon Pond.

Major landmarks in the watershed include Ashby town center, Ashby South Village, the Ashby Elementary School, Glenwood Cemetery, and the Willard Brook State Forest. Segment MA81-79 crosses eight roadways including Fitchburg State Road/MA-31 (Ashby) and Townsend Road/Main Street/MA-119 (Ashby and Townsend), which runs adjacent to the brook for over two miles.

Willard Brook (MA81-79) drains an area of 17 square miles, of which 0.7 mi^2 (4%) is impervious and 0.2 mi^2 (1%) is directly connected impervious area (DCIA). The watershed also extends to the north into New Hampshire. Out of the total watershed area (17 mi^2), 15 mi^2 (90%) is within Massachusetts. The watershed is likely not[48] served by public sewer and 4% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the watershed. There are three landfills, no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no combined

[48] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local knowledge.

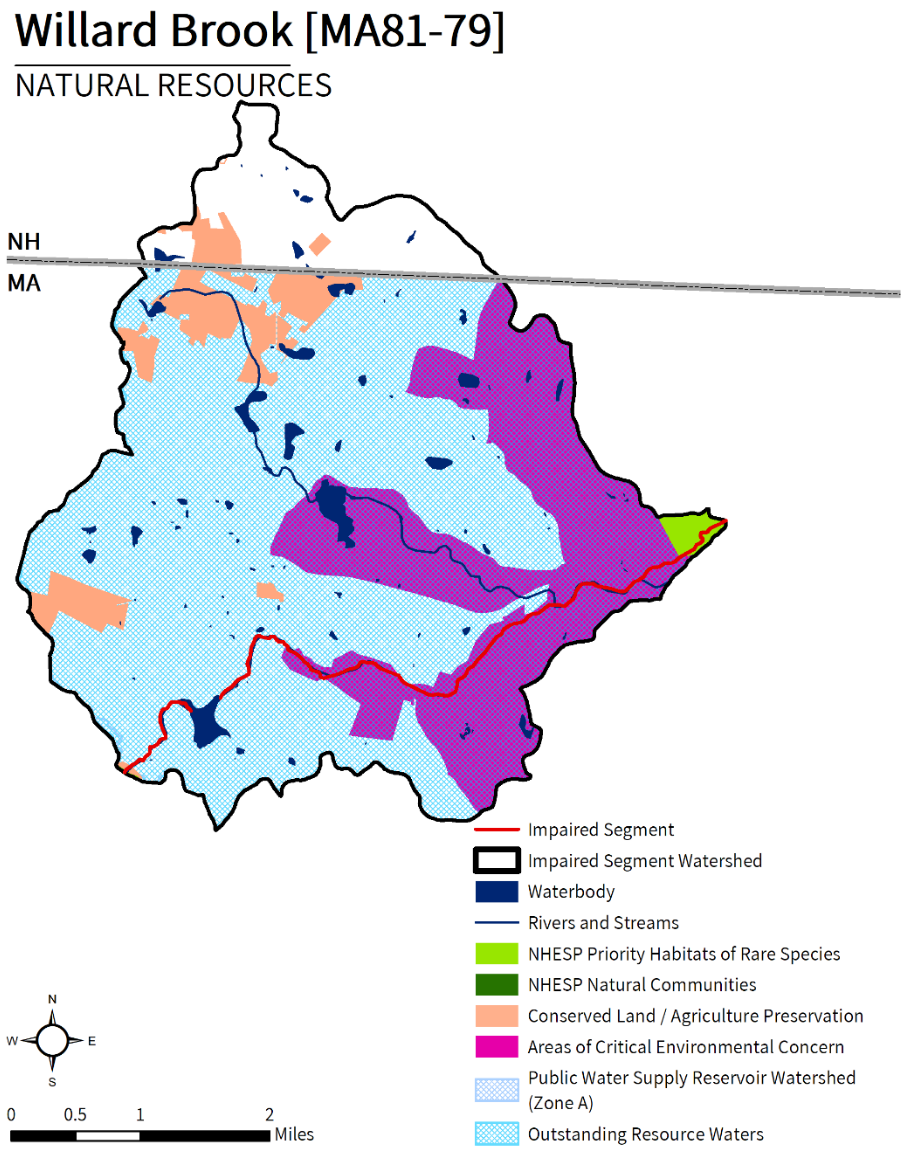
sewer overflows, and no unpermitted land disposal dumping grounds. See Figure 18-1.

The segment flows primarily through forest. There is some low-density residential areas near the upstream end of the segment, as well as small areas of row crops near the upstream and downstream portions of the brook. Forest (79%) accounts for most of the land use within the segment watershed. Developed areas (9%), which are primarily low density residential, as well as agricultural lands (8%), are the next most prominent land uses.

In the watershed of Willard Brook (MA81-79), under the Natural Heritage and Endangered Species Program, there are 75 acres (1%) of Priority Habitats of Rare Species. There are 19 acres (<1%) under Public Water Supply protection, 9,888 acres (90%) identified as Outstanding Resource Waters, and 2,955 acres (27%) of Areas of Critical Environmental Concern in the watershed. Over 698 acres (6%) of land protected in perpetuity[49] exist within the segment watershed, which is part of a total of 1,944 acres (18%) of Protected and Recreational Open Space[50]. See Figure 18-1.

[49] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[50] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).



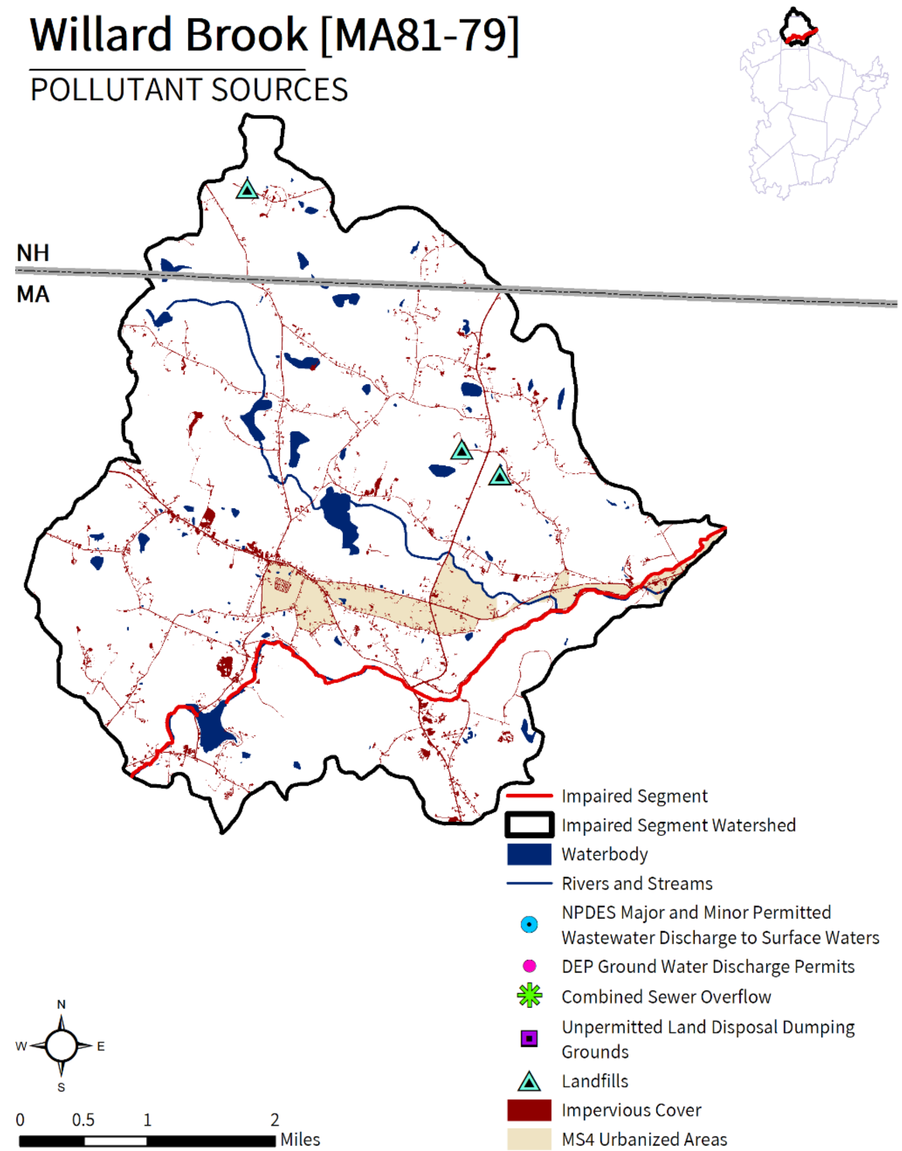


Figure 18-1. Natural resources and potential pollution sources draining to the Willard Brook segment MA81-79. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

18.2. Waterbody Impairment Characterization

Willard Brook (MA81-79) is a Class B, Outstanding Resource Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria Enterococci sampled at the MA DPH station #4531, which is located at a designated public bathing beach known as Damon Pond Beach. MassDEP assessed the Primary Contact Recreational use as not supporting since beach swimming advisory postings frequently exceeded 10% of the seasons during six of the nine years (Table 18-1). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis (Tables 18-2 and 18-3).

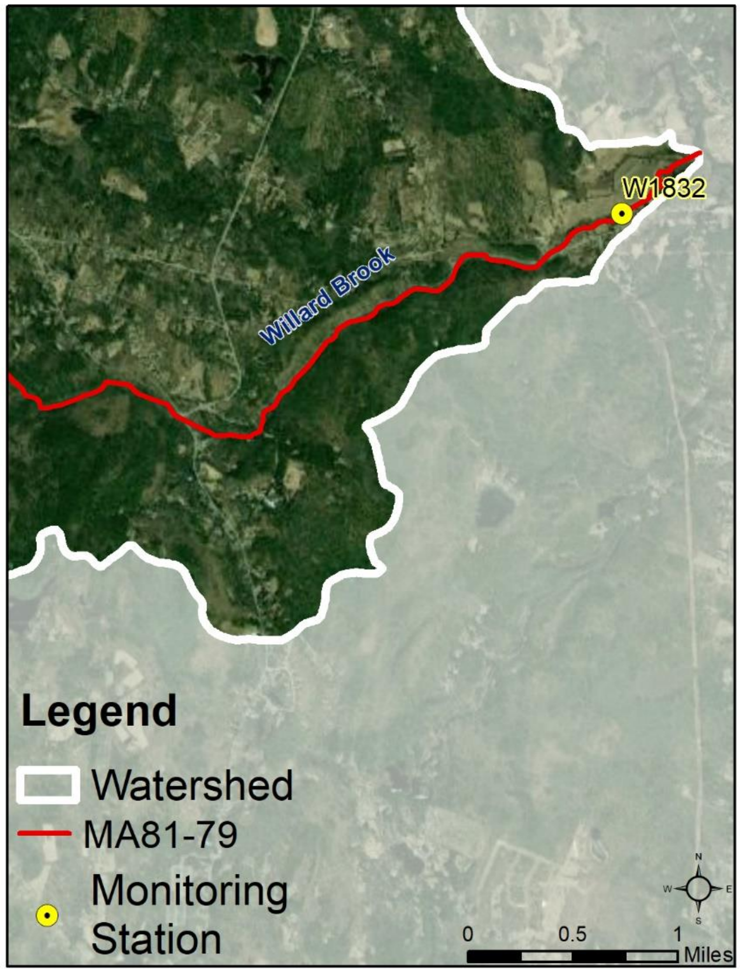


Figure 18-2. Location of monitoring station(s) along the impaired river segment.

Table 18-1. Summary of MA DPH beach posting data for 2005-2013 by station for Damon Pond Beach along Willard Brook (MA81-79). Percentages indicate the portion of Enterococci sample results that exceeded MA DPH beach criteria for the bathing season in each year. No more than 10% of samples within a season can exceed SWQS.

ID	Name	Town	2005	2006	2007	2008	2009	2010	2011	2012	2013	Beach Decision
4531	Damon Pond Beach	Ashby	62%	39%	14%	11%	0%	3%	20%	8%	60%	Impair

Table 18-2. Summary of indicator bacteria sampling results by station for Willard Brook (MA81-79). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1832	5/15/2008	9/18/2008	6	330	2	0

Table 18-3. Indicator bacteria data by station, indicator, and date for Willard Brook (MA81-79). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1832	*E. coli*	5/15/2008	DRY	52	52	
W1832	*E. coli*	6/12/2008	DRY	260	116	
W1832	*E. coli*	7/17/2008	DRY	330	330	
W1832	*E. coli*	8/14/2008	WET	140	215	
W1832	*E. coli*	9/4/2008	DRY	45	79	
W1832	*E. coli*	9/18/2008	DRY	23	32	

18.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Willard Brook (MA81-79) watershed contains scattered low-density residential development throughout the watershed. Although only 4% of the land area is in MS4, the downstream third of Willard Brook is in the MS4 area. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: None of the watershed is likely serviced by public sewer, although private wastewater infrastructure such as building drains may be present. Illicit connections of wastewater to stormwater drains are a small but present risk. Swimmers at the public beach may represent a direct illicit source of pathogens if restrooms are not used or available.

On-Site Wastewater Disposal Systems: With nearly all the watershed likely served by septic systems, it is likely that a portion of these septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture accounts for 8% of land area, including areas of row crops, hayfields, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are conservation and recreational lands and ballfields in the watershed, as well as low density residential areas. Conservation lands, parks, ballfields, and yards popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens. Pets may be allowed at the public beach and thus may be a direct source of pathogens to the segment.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water. Waterfowl may utilize the public beach area to eat any food left by visitors.

18.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashby. See Section 14.4

Town of Townsend

About a third of Townsend is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Townsend (Permit ID #MAR041228) has an EPA approved Notice of Intent (NOI). Townsend has a Stormwater Management Plan available at the Town Highway Department. The town has mapped all of its MS4 stormwater system, which is available online. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2007. According to the NOI, there are 153 outfalls into the Squannacook River (MA81-18).

Townsend has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws: https://www.ecode360.com/11243412 (Town of Townsend, 2007)
- Stormwater Utility: None found.
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Wetland Protection Bylaw: https://www.ecode360.com/9541945 (Town of Townsend, 1987)
- Pet Waste Ordinance: https://www.ecode360.com/9541692 (Town of Townsend, 2006)
- Contact Recreation Ordinance: None found.

The Townsend Master Plan provides no information on current water resources but lists a goal of the plan to establish water protections. The plan does not mention the impaired segments within its borders, nor stormwater or other pollutants. The plan does not have a sewer, septic, or wastewater section. It identifies a goal of improving septic system maintenance awareness and exploring shared septic systems in village areas.

Townsend Town Website: https://www.townsendma.gov/ (Town of Townsend, 2021)

The most recent Townsend Master Plan was completed in 2001, but a major initiative is underway to update it: http://www.townsendmasterplan.com/ (Town of Townsend, 2019)

Stormwater Web Page: https://www.townsend.ma.us/planning-board/pages/stormwater-bylaw-regulations-epa-information (Town of Townsend, n.d.)

Open Space and Recreation Plan: https://www.townsend.ma.us/conservation-commission/pages/2013-final-open-space-recreation-plan (Town of Townsend, 2012)

19. MA81-80 Pearl Hill Brook

19.1. Waterbody Overview

The Pearl Hill Brook segment MA81-80 is 6.7 miles long and begins at the outlet of Wright Ponds in Ashby, MA. Segment MA81-60 flows southeast, then northeast briefly through Lunenburg, then Townsend, to end at its confluence with the Squannacook River in Townsend, MA, just downstream of the impaired Willard Brook (MA81-79) inflow. The Squannacook River then flows to the unimpaired Nashua River mainstem (MA81-06).

Tributaries include approximately 10 miles of unnamed streams. The brook flows through Pearl Hill Brook Pond. Vinton Pond and Wright Ponds are also found within the watershed.

Major landmarks in the watershed include the Pearl Hill State Park and Willard Brook State Forest in the western half of the watershed. Segment MA81-80 crosses Fitchburg State Road/MA-31 (Ashby) and Main Street/MA-119 (Townsend) about 0.25 miles upstream of the segment's end. The brook runs along New Fitchburg Road (Townsend) for almost 2 miles.

Pearl Hill Brook (MA81-80) drains an area of seven square miles, of which 0.2 mi^2 (3%) is impervious and 0.1 mi^2 (1%) is directly connected impervious area (DCIA). The watershed may be partially[51] served by public sewer and 4% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA. 2016). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 19-1.

Forested areas (87%) account for most of the land use within the watershed. Developed areas (6%) consist of low-density residential and commercial areas, mostly along MA-31 (Ashby), and W Elm Street and Main Street in the village of West Townsend.

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 4,643

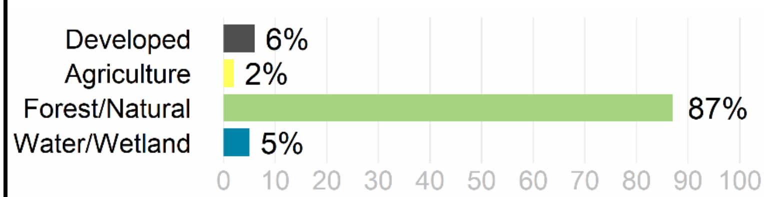
Segment Length (miles): 6.7

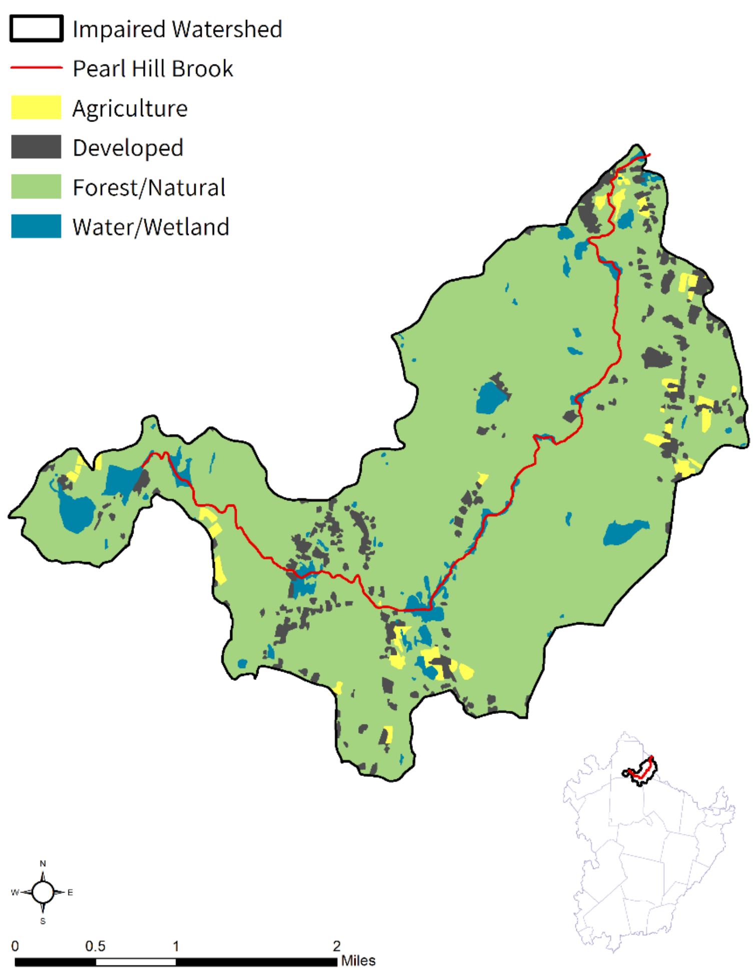
Impairment(s): Enterococci (Primary Contact Recreation)

Class (Qualifiers): B (Outstanding Resource Water)

Impervious Area (Acres, %): 140 (3%)

DCIA Area (Acres, %): 35 (1%)





[51] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP. 2020), MS4 reports, and local knowledge.

In the Pearl Hill Brook (MA81-80) watershed, under the Natural Heritage and Endangered Species Program, there are 481 acres (10%) of Priority Habitats of Rare Species. There are five acres (<1%) under Public Water Supply protection, 4,131 acres (89%) identified as Outstanding Resource Waters, and 2,869 acres (62%) of Areas of Critical environmental Concern in the watershed. Over 99 acres (2%) of land protected in perpetuity[52] exist within the segment watershed, which is part of a total of 2,357 acres (51%) of Protected and Recreational Open Space[53]. See Figure 19-1.

[52] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[53] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

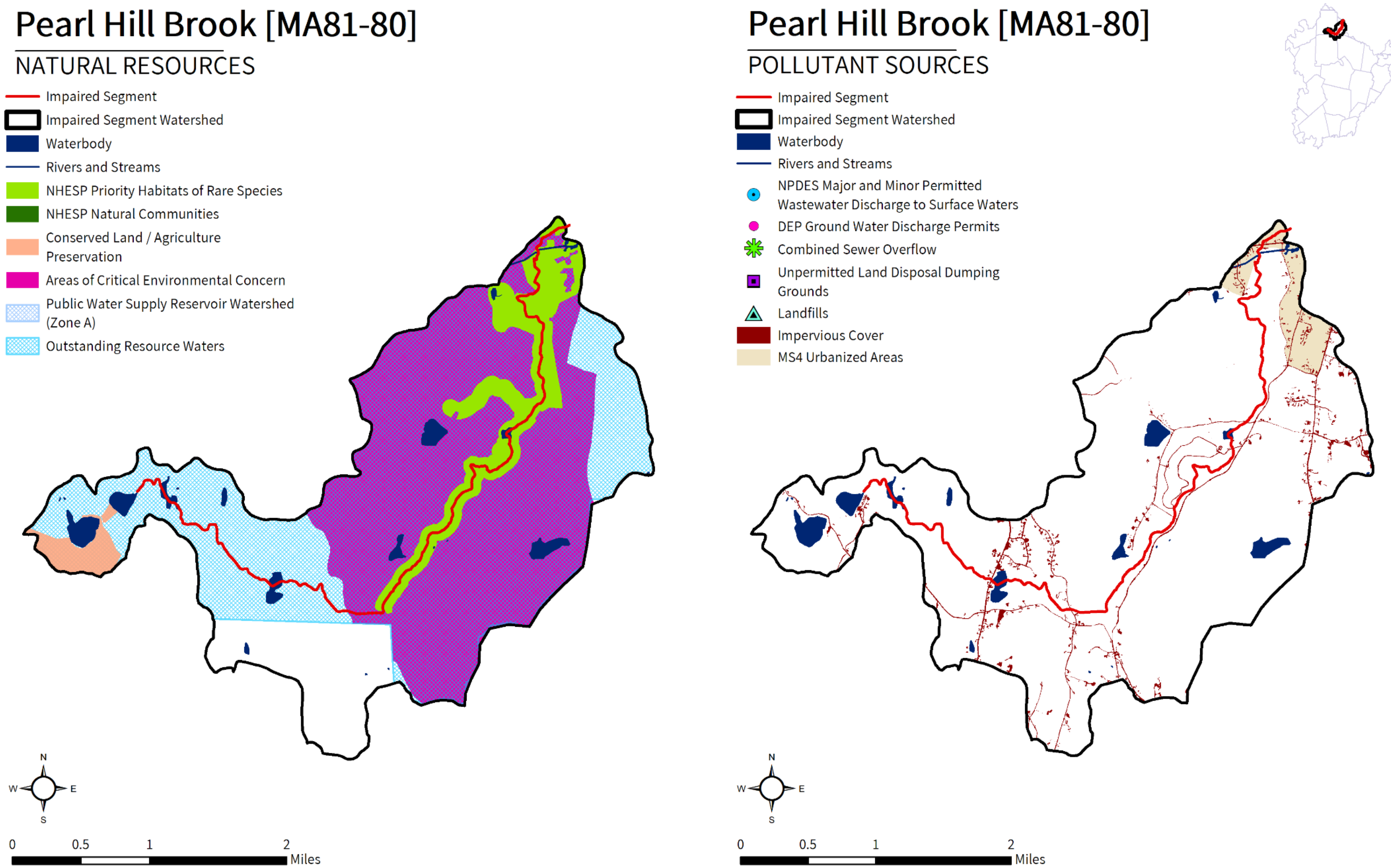


Figure 19-1. Natural resources and potential pollution sources draining to the Pearl Hill Brook segment MA81-80. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

19.2. Waterbody Impairment Characterization

Pearl Hill Brook (MA81-80) is a Class B, Outstanding Resource Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria Enterococci sampled at the MA DPH station #4966, which is located at a designated public bathing beach known as Pearl Hill Pond Beach. MassDEP assessed the Primary Contact Recreational use as not supporting since beach swimming advisory postings frequently exceeded 10% of the seasons during six of the nine years (Table 19-1). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis (Tables 19-2 and 19-3).

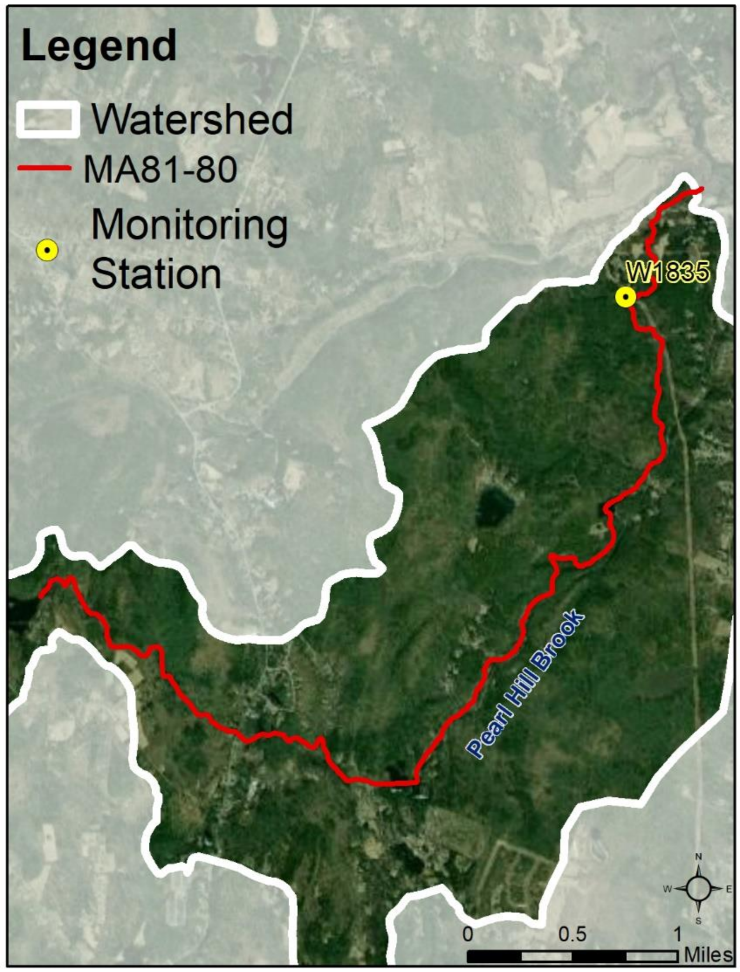


Figure 19-2. Location of monitoring station(s) along the impaired river segment.

Table 19-1. Summary of MA DPH beach posting data for 2005-2013 by station for Pearl Hill Pond Beach along Pearl Hill Brook (MA81-80). Percentages indicate the portion of Enterococci sample results that exceeded MA DPH beach criteria for the bathing season in each year. No more than 10% of samples within a season can exceed SWQS.

ID	Name	Town	2005	2006	2007	2008	2009	2010	2011	2012	2013	Beach Decision
4966	Pearl Hill Pond Beach	Townsend	12%	42%	11%	0%	3%	0%	13%	14%	23%	Impair

Table 19-2. Summary of indicator bacteria sampling results by station for Pearl Hill Brook (MA81-80). The maximum 30-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 30-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1835	5/15/2008	9/18/2008	6	26	0	0

Table 19-3. Indicator bacteria data by station, indicator, and date for Pearl Hill Brook (MA81-80). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1835	*E. coli*	5/15/2008	DRY	10	10	
W1835	*E. coli*	6/12/2008	DRY	10	10	
W1835	*E. coli*	7/17/2008	DRY	26	26	
W1835	*E. coli*	8/14/2008	WET	13	18	
W1835	*E. coli*	9/4/2008	DRY	19	16	
W1835	*E. coli*	9/18/2008	DRY	10	14	

19.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Pearl Hill Brook (MA81-80) watershed is largely undeveloped but contains some scattered rural residential development throughout the watershed with 4% of the land area in MS4 and 1% as DCIA. Stormwater runoff from urban areas likely contributes some level of pathogens to the brook.

Illicit Sewage Discharges: A portion of the watershed may be serviced by public sewer. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk. Swimmers at the public beach may represent a direct illicit source of pathogens if restrooms are not used or available.

On-Site Wastewater Disposal Systems: With nearly all the watershed likely served by septic systems, it is likely that a portion of these septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture accounts for 2% of land area, including areas of row crops, hayfields, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are major conservation and recreational lands in the watershed, including Pearl Hill State Park with picnic areas at the water's edge. Conservation lands, parks, ballfields, and yards popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens. Pets may be allowed at the public beach and thus may be a direct source of pathogens to the segment.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water. Waterfowl may utilize the public beach area to eat any food left by visitors.

19.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ayer. See Section 6.4

Town of Groton. See Section 9.4

20. MA81-99 Falulah Brook

20.1. Waterbody Overview

Falulah Brook, formerly one segment (MA81-63), now consists of two segments, MA81-99 and MA81-100. The upper portion of Falulah Brook, segment MA81-99, is 2 miles long and begins 0.02 miles northeast of Rindge Road and 0.1 miles south of the Fitchburg Reservoir in Ashby, MA. Falulah Brook flows southeast through Fitchburg, MA and excludes approximately 0.6 miles which flows through the Lovell Reservoir (segment MA81074). Segment MA81-100 (see Section 21.1) begins from the outlet of Lovell Reservoir and ends at its confluence with Pearl Hill and Baker Brook (MA81-62, pathogen-impaired) in Fitchburg.

Tributaries to Falulah Brook include Scott Brook and many smaller unnamed streams. Major lakes and ponds within the watershed include the Fitchburg, Lovell, and Scott Reservoirs.

Falulah Brook (MA81-99) drains an area of four square miles, of which 0.1 mi^2 (2%) is impervious and 0.02 mi^2 (0.4%) is directly connected impervious area (DCIA). The watershed is likely partially[54] served by public sewer and 0% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 20-1.

Forested areas (81%) account for most of the land use within the segment watershed. Mixed residential and commercial land uses of urban Fitchburg are concentrated in the lower portion of Falulah Brook (MA81-100).

In the watershed of Falulah Brook (MA81-99), under the Natural Heritage and Endangered Species Program, there are 909 acres (11%) of Priority Habitats of Rare Species and five acres (<1%) of Priority Natural Vegetation Communities.

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 2,645

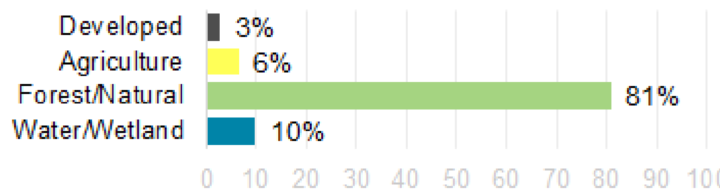
Segment Length (miles): 2.0

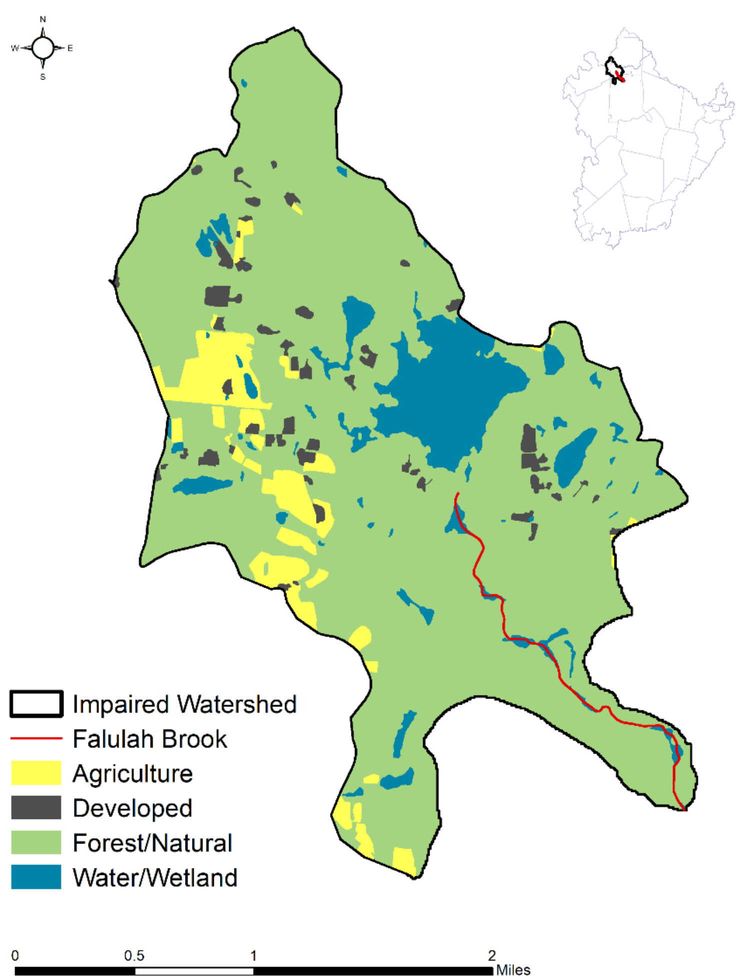
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 48 (2%)

DCIA Area (Acres, %): 11 (0%)





[54] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP 2020), MS4 reports, and local knowledge.

There are 4,159 acres (51%) under Public Water Supply protection and 12 acres (<1%) identified as Outstanding Resource Waters but no Areas of Critical Environmental Concern in the watershed. Over 2,184 acres (27%) of land protected in perpetuity[55] exist within the segment watershed, which is part of a total of 2,925 acres (36%) of Protected and Recreational Open Space[56]. See Figure 20-1.

[55] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[56] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

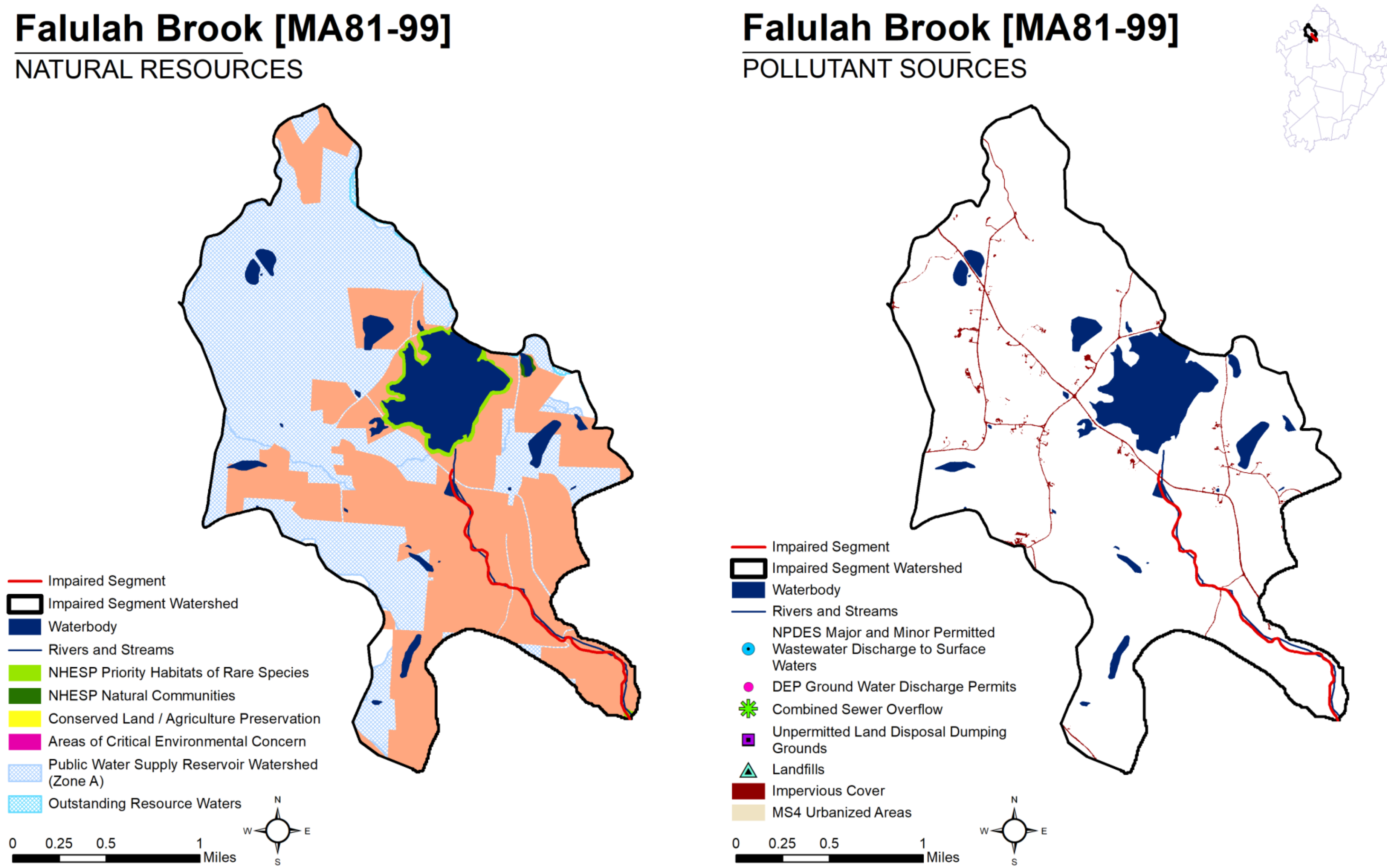


Figure 20-1. Natural resources and potential pollution sources draining to the Falulah Brook segment MA81-99. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

20.2. Waterbody Impairment Characterization

Falulah Brook (MA81-99, formerly MA81-63) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations identified in the lower portion, see Section 21.2. One permittee, MA0100986 (two outfalls), discharges to the lower segment MA81-100. A presumptive impairment decision is being applied for this use since this waterbody does not have a CSO variance in place. The impairment was retained for both upper and lower segments of Falulah Brook.

20.3. Potential Pathogen Sources

The data and sources of pathogens to Falulah Brook are primarily in the lower portion, MA81-100. See Section 21.3 for detailed description of each potential pathogen source in the entire Falulah Brook watershed.

20.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashby. See Section 14.4

Town of Fitchburg. See Section 2.4

21. MA81-100 Falulah Brook

21.1. Waterbody Overview

Falulah Brook was formally one segment (MA81-63), and recently re-segmented into two segments. The upper portion of Falulah Brook, segment MA81-99, is described in Section 20.1. Segment MA81-100 is 4 miles long and begins from the outlet of Lovell Reservoir and ends at its confluence with Pearl Hill and Baker Brook (MA81-62, pathogen-impaired) in Fitchburg.

Tributaries to Falulah Brook include Scott Brook and many smaller unnamed streams. Major lakes and ponds within the watershed include the Fitchburg, Lovell, and Scott Reservoirs.

Major landmarks in the watershed include the Eliot Athletic Complex, Falulah Park, Coolidge Park and ballfields, Fitchburg State University, Fitchburg High School, and Crocker Elementary School. The segment watershed contains a total of 12 road crossings including Ashby State Road/MA-31 (Fitchburg) and Lunenburg Street/MA-2A (Fitchburg).

Falulah Brook (MA81-100) drains an area of 13 square miles, of which 0.8 mi^2 (7%) is impervious and 0.4 mi^2 (3%) is directly connected impervious area (DCIA). The watershed is likely partially[57] served by public sewer and 14% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters from wastewater treatment facilities within the watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed, no active combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 21-1.

Forested areas (74%) account for most of the land use within the segment watershed. Mixed residential and commercial land uses of urban Fitchburg are concentrated in the southern part of the watershed.

In the watershed of Falulah Brook, under the Natural Heritage and Endangered Species Program, there are 909 acres (11%) of Priority Habitats of Rare Species and five acres (<1%) of Priority Natural

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 8,080

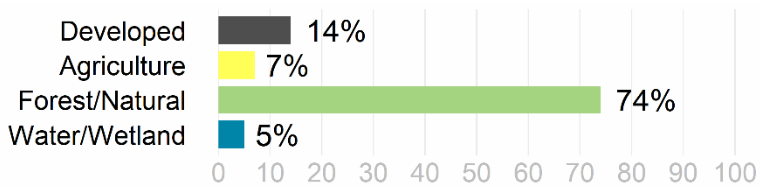
Segment Length (miles): 4.0

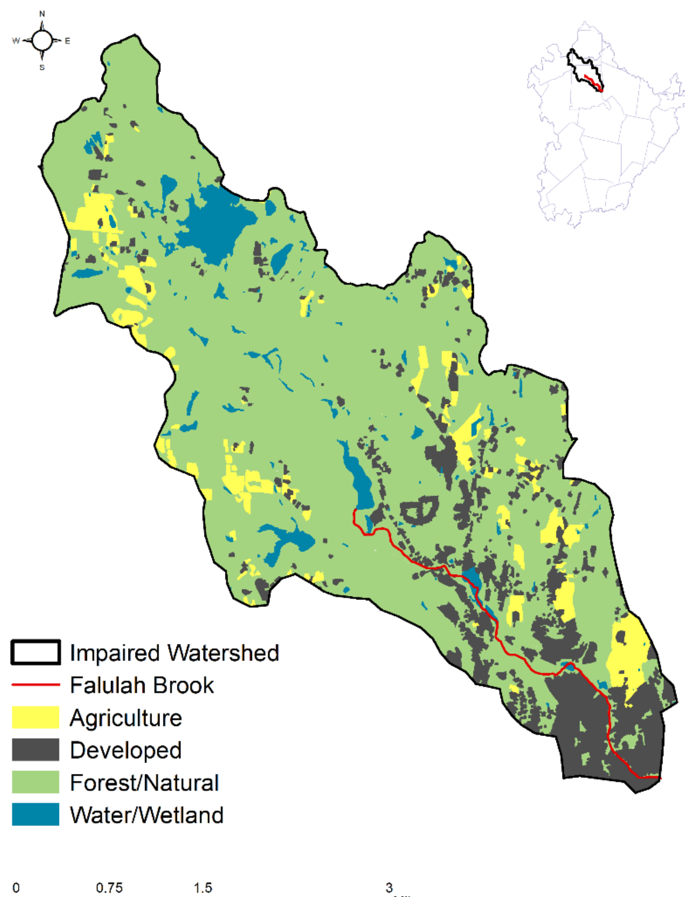
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 532 (7%)

DCIA Area (Acres, %): 271 (3%)





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57 Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP 2020), MS4 reports, and local knowledge.

Vegetation Communities. There are 4,159 acres (51%) under Public Water Supply protection and 12 acres (<1%) identified as Outstanding Resource Waters but no Areas of Critical Environmental Concern in the watershed. Over 2,184 acres (27%) of land protected in perpetuity[58] exist within the segment watershed, which is part of a total of 2,925 acres (36%) of Protected and Recreational Open Space[59]. See Figure 21-1.

[58] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[59] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside the State of Massachusetts).

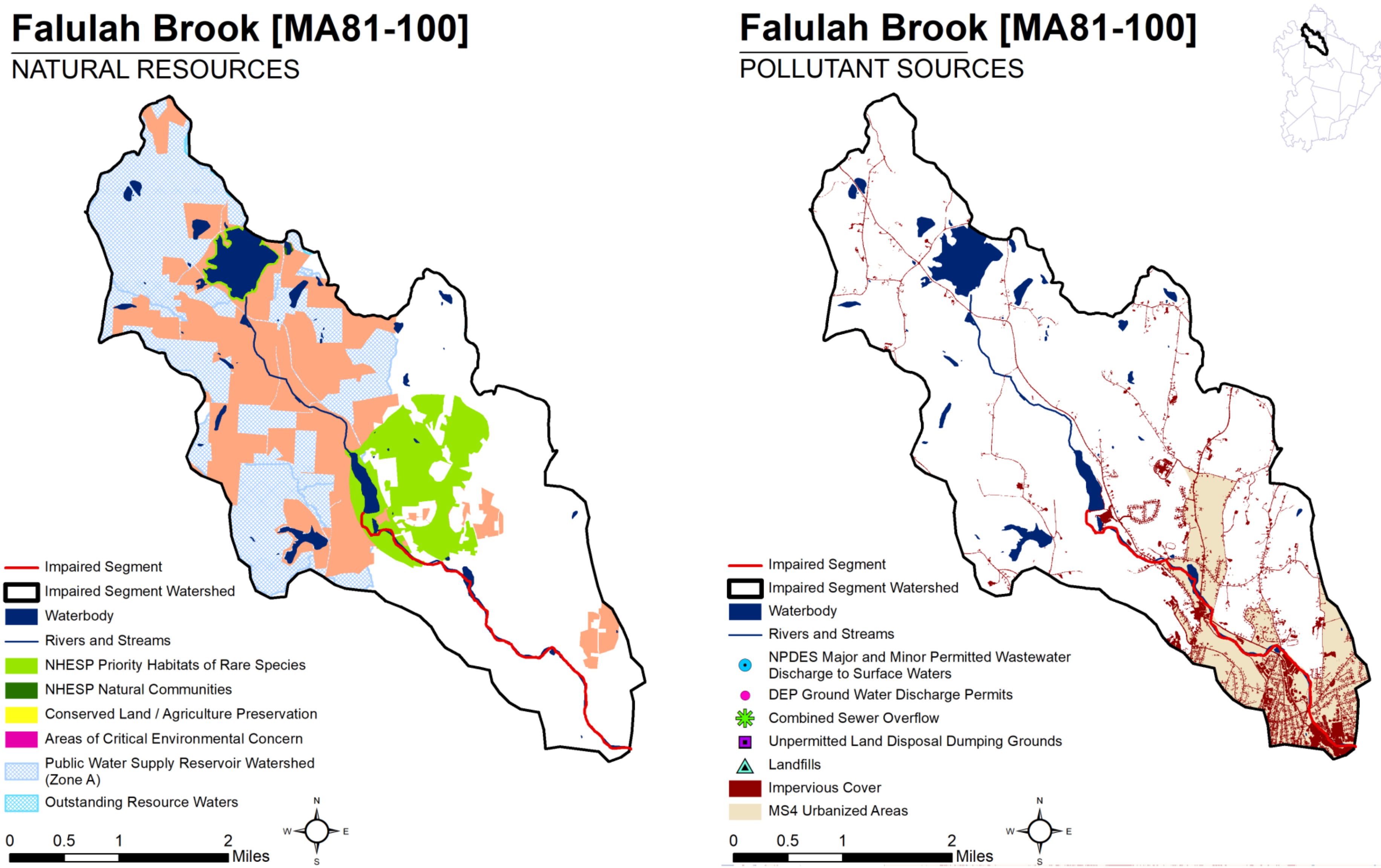

Figure 21-1. Natural resources and potential pollution sources draining to the Falulah Brook segment MA81-100. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

21.2. Waterbody Impairment Characterization

Falulah Brook (MA81-100, formerly MA81-63) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations identified below (refer to Tables 21-1, 21-2; Figure 21-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2013, three samples were collected at BK0430, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of three samples, none exceeded the STV criterion.
- In 2008, six samples were collected at W1837, resulting in no days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.

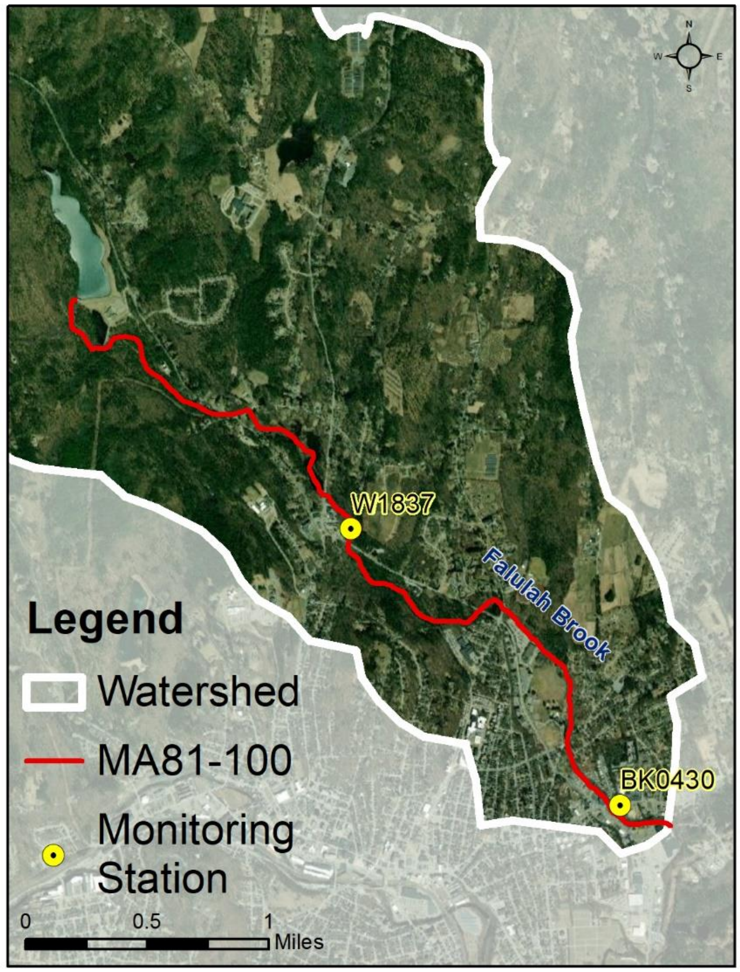

Figure 21-2. Location of monitoring station(s) along the impaired river segment.

One permittee, MA0100986 (two outfalls), have permitted discharges to the lower segment MA81-100. A presumptive impairment decision was applied for this use since this waterbody does not have a CSO variance in place. The impairment was retained for both upper and lower segments of Falulah Brook. Both City of Fitchburg outfalls (#024, #072) to this segment have been reported as inactive as of August 2021.

Table 21-1. Summary of indicator bacteria sampling results by station for Falulah Brook (MA81-100). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
BK0430	5/18/2013	10/19/2013	3	115	0	0
W1837	5/15/2008	9/18/2008	6	81	0	0

Table 21-2. Indicator bacteria data by station, indicator, and date for Falulah Brook (MA81-100). Each sample date was designated wet or dry weather, with wet weather defined as more than 0.5 inches of precipitation in

the previous 72 hours. Red text highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
BK0430	*E. coli*	5/18/2013	DRY	48	48	
BK0430	*E. coli*	6/15/2013	WET	75	60	
BK0430	*E. coli*	10/19/2013	DRY	115	115	
W1837	*E. coli*	5/15/2008	DRY	81	81	
W1837	*E. coli*	6/12/2008	DRY	55	67	
W1837	*E. coli*	7/17/2008	DRY	87	73	
W1837	*E. coli*	8/14/2008	WET	58	65	
W1837	*E. coli*	9/4/2008	DRY	16	46	
W1837	*E. coli*	9/18/2008	DRY	16	34	

21.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Falulah Brook (MA81-100) watershed are highly developed, with 14% of the land area in MS4 and 3% as DCIA. Although the development density is relatively light in the upstream portion of the segment, the amount of development increases greatly toward the end of the segment. This densely developed area along the downstream end of the segment includes low to medium density residential neighborhoods and some large commercial properties. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: The watershed is partially covered by public sewer and is located within MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections from private wastewater infrastructure such as building drains may also be present. A presumptive impairment was placed on this segment because one permittee, MA0100986 (2 outfalls), have permitted discharges to this segment.

On-Site Wastewater Disposal Systems: Some of the residential development in the watershed uses septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities account for 7% of the land use within the watershed and those visible on recent aerial photos include open fields. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are 2,925 acres of open space in the watershed, including the Fitchburg Dog Park, which is adjacent to the impaired segment. Conservation lands, parks, ballfields, and residential yards popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas and wetlands with a clear sightline to a waterbody, such as Coolidge Park and Greens Pond, may attract excessive waterfowl and elevate indicator bacteria counts in the water.

21.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashby. See Section 14.4

Town of Fitchburg. See Section 2.4

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