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

Appendix D: Deerfield River Basin

Commonwealth of Massachusetts
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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*.

Disclaimer

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendations by the Massachusetts Department of Environmental Protection.

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1.Introduction

This appendix to the Massachusetts Statewide Total Maximum Daily Load (TMDL) for Pathogen-Impaired Waterbodies provides additional information to support the determination of the Total Maximum Daily Load (TMDL) for seven pathogen-impaired river segments in the Deerfield 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 a summary of the allocation of the current indicator bacteria 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 Tables 1-1 and 1-2.

Finally, for each impaired segment, this appendix presents existing local management efforts to reduce pathogen pollutant loading. General recommended next steps for implementation of this TMDL are provided in the Deerfield River Watershed Overview section.

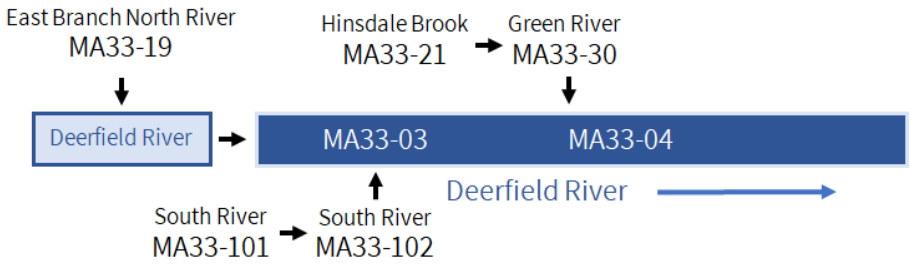


Figure 1-1. Conceptual diagram of water flow routing through the Deerfield River watershed for the seven pathogen-impaired river segments. The unimpaired mainstem of the Deerfield River is highlighted in light blue, while impaired mainstem segments of the Deerfield River are highlighted in dark blue. Tributary segments to the mainstem are shown with black arrows. 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 Deerfield 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)					
Deerfield River		R	126	2,050	94%	WLA (3%)	0.1	0.8	8.5	84.6	845.6	8,455.6
MA33-03	B (WW)			(30 day)		LA (97%)	3.0	30.0	299.8	2,998.1	29,981.2	299,812.4
Deerfield River		R	126	2,910	96%	WLA (3%)	0.1	0.9	9.4	93.6	936.0	9,360.5
MA33-04	B (WW)			(30 day)		LA (97%)	3.0	29.9	298.9	2,989.1	29,890.8	298,907.5
East Branch North River		R	126	2,420	95%	WLA (4%)	0.1	1.2	12.4	123.7	1,236.5	12,365.4
MA33-19	B (CW, HQW)			(90 day)		LA (96%)	3.0	29.6	295.9	2,959.0	29,590.3	295,902.6
Hinsdale Brook		R	126	383	67%	WLA (3%)	0.1	0.8	8.0	80.2	802.4	8,024.0
MA33-21	B (CW)			(90 day)		LA (97%)	3.0	30.0	300.2	3,002.4	30,024.4	300,244.0
Green River		R	126	1,740	93%	WLA (5%)	0.1	1.4	14.4	143.8	1,437.8	14,378.1
MA33-30	B (CW, HQW*)			(90 day)		LA (95%)	2.9	29.4	293.9	2,938.9	29,389.0	293,889.9
South River		R	126	236	47%	WLA (2%)	0.1	0.6	6.5	64.7	647.2	6,471.6
MA33-101	B (CW)			(90 day)		LA (98%)	3.0	30.2	301.8	3,018.0	30,179.6	301,796.4
South River		R	126	416	70%	WLA (2%)	0.1	0.7	6.8	68.3	682.8	6,828.1
MA33-102	B			(90 day)		LA (98%)	3.0	30.1	301.4	3,014.4	30,144.0	301,439.9

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 Deerfield 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)					
Deerfield River		P	35	NA	-	WLA (3%)	-	0.2	2.3	23.5	234.9	2,348.8
MA33-03	B (WW)					LA (97%)	0.8	8.3	83.3	832.8	8,328.1	83,281.2
Deerfield River		P	35	NA	-	WLA (3%)	-	0.3	2.6	26.0	260.0	2,600.1
MA33-04	B (WW)					LA (97%)	0.8	8.3	83.0	830.3	8,303.0	83,029.9
East Branch North River		P	35	NA	-	WLA (4%)	-	0.3	3.4	34.3	343.5	3,434.8
MA33-19	B (CW, HQW)					LA (96%)	0.8	8.2	82.2	822.0	8,219.5	82,195.2
Hinsdale Brook		P	35	NA	-	WLA (3%)	-	0.2	2.2	22.3	222.9	2,228.9
MA33-21	B (CW)					LA (97%)	0.8	8.3	83.4	834.0	8,340.1	83,401.1
Green River		P	35	NA	-	WLA (5%)	-	0.4	4.0	39.9	399.4	3,993.9
MA33-30	B (CW, HQW*)					LA (95%)	0.8	8.2	81.6	816.4	8,163.6	81,636.1
South River		P	35	NA	-	WLA (2%)	-	0.2	1.8	18.0	179.8	1,797.7
MA33-101	B (CW)					LA (98%)	0.8	8.4	83.8	838.3	8,383.2	83,832.3
South River		P	35	NA	-	WLA (2%)	-	0.2	1.9	19.0	189.7	1,896.7
MA33-102	B					LA (98%)	0.8	8.4	83.7	837.3	8,373.3	83,733.3

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).* ***CW*** *= Cold Water fishery; waters that are subject to cold water fisheries dissolved oxygen and temperature criteria*

***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*
***HQW** = High Quality Water; waters designated for protection under 314 CMR 4.04(2); (*) designation only applies to a portion of the segment*
***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. Deerfield River Watershed Overview

The Deerfield River watershed covers a total area of 665 square miles, 318 (48%) of which are in Vermont and 347 (52%) of which are in northwestern Massachusetts (Figure 2-1). The Deerfield River watershed includes the North River, Green River, Cold River, and South River. Overall, there are 149 named rivers, approximately 345 named river miles, many smaller unnamed river, and 24 named lakes, ponds, and impoundments in the watershed comprising 5,262 acres (MassDEP, 2004).

The North River begins in Leyden and flows to the south. The North River's sources are the West Branch North River, Tisdale Brook, Taylor Brook, Foundry Brook, and the East Branch North River, draining a total of 93 square miles. The South River ends at its convergence with the Deerfield River in Shelburne just below the Deerfield Hydroelectric Station Number Four Dam. There is one pathogen-impaired river segment along the East Branch North River (MassDEP, 2004).

The Green River is the easternmost major stream within the Deerfield River watershed and drains 90 square miles. The Green River begins in Marlboro, VT and enters Massachusetts in the town of Colrain, then flows south until its confluence with the Deerfield River at the Greenfield-Deerfield boundary. There are two pathogen-impaired river segments within the Green River watershed (MassDEP, 2004).

The South River begins in Ashfield and flows to the east through Conway to the border of Deerfield where the river converges with the Deerfield River mainstem. The South River watershed drains 26 square miles. There are two pathogen-impaired river segments along the South River (MassDEP, 2004).

The Cold River begins to the west of the Deerfield River mainstem in Florida and flows to the southeast to its convergence with the Deerfield River mainstem in Charlemont. The Cold River watershed drains 32 square miles. There are no pathogen-impaired river segments along the Cold River.

The Deerfield River flows approximately 70 miles from Stratton Mountain (VT). Within Massachusetts, the Deerfield River begins at the outlet of the Sherman Reservoir dam in the towns of Monroe and Rowe and flows to the east for 44 miles to its confluence with the Connecticut River in Greenfield, MA. The river course is altered by 10 dams and nine hydroelectric stations and receives effluent from 10 facilities holding NPDES permits for discharges in the watershed. Historic activities within the watershed may have lasting impacts and need to be considered. Discharges from the Greenfield wastewater treatment plant prior to 1998 were released into the Green River but are now released into the mainstem of the Deerfield River. In addition, the Yankee Nuclear Power Station once used the Sherman Reservoir to supply cooling water for the nuclear reactor (MassDEP, 2004). In addition to the dams along the mainstem of the Deerfield River, there are 45 or more dams throughout the watershed, many of which are no longer maintained (MassDEP, 2004). There are two pathogen-impaired river segments along the Deerfield River mainstem.

The Deerfield River watershed overlaps at least partially with 20 municipalities. Of these, nine were identified as being direct sources of pathogen loading to the impaired river segments in this TMDL. The efforts of these municipalities contributing to pollutant loading are described in the segment-specific sections below. For each segment, the cities and towns that contain or border the segment were identified. 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. In addition, towns which may not meet the above characteristics, but which have land area in the sub-basin near the impaired segment (e.g., Town of Charlemont for the Deerfield River MA33-03), were included on a case-by-case basis. 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.

EPA and MassDEP jointly issued the General Permits 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 2016; Appendix F).

In addition to municipalities, there are three Regional Planning Agencies (RPAs) in the Deerfield 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 such as pathogen pollutants and stormwater that cross town boundaries.

- Berkshire Regional Planning Commission (BRPC), http://www.berkshireplanning.org/ (BRPC, 2020)
- Franklin Regional Council of Governments (FRCOG), http://www.frcog.org/ (FRCOG, 2020)
- Pioneer Valley Planning Commission (PVPC), http://pvpc.org/ (PVPC, 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.
- The PVPC is a public sector agency which offers local technical assistance to the 43 cities within their jurisdiction and monitors some streams for indicator bacteria.

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:

Deerfield River Watershed Association works to provide quality information, investigative research, and the documentation of multiple ecological areas within the Deerfield River watershed, including water quality, macroinvertebrates, vernal pools, hydrology, and erosion and geomorphology, http://deerfieldriver.org/science/ (DRWA, 2020)

Deerfield River Watershed Trout Unlimited (DRWTU), chapter #349, strives to preserve the Deerfield River and surrounding tributaries as a cold-water fishery, https://www.tu.org/chapter/349-deerfield-river-watershed/ (DRWTU, 2020).

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.

- Collect additional water quality data for all segments for which existing data are older than five years.
- **Municipalities:** Continue to implement requirements of the MS4 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 Metropolitan Area Planning Council (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 (Metropolitan Area Planning Council, 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 and provide a visual screen that can reduce large aggregations of waterfowl and have many other water quality benefits at low cost.

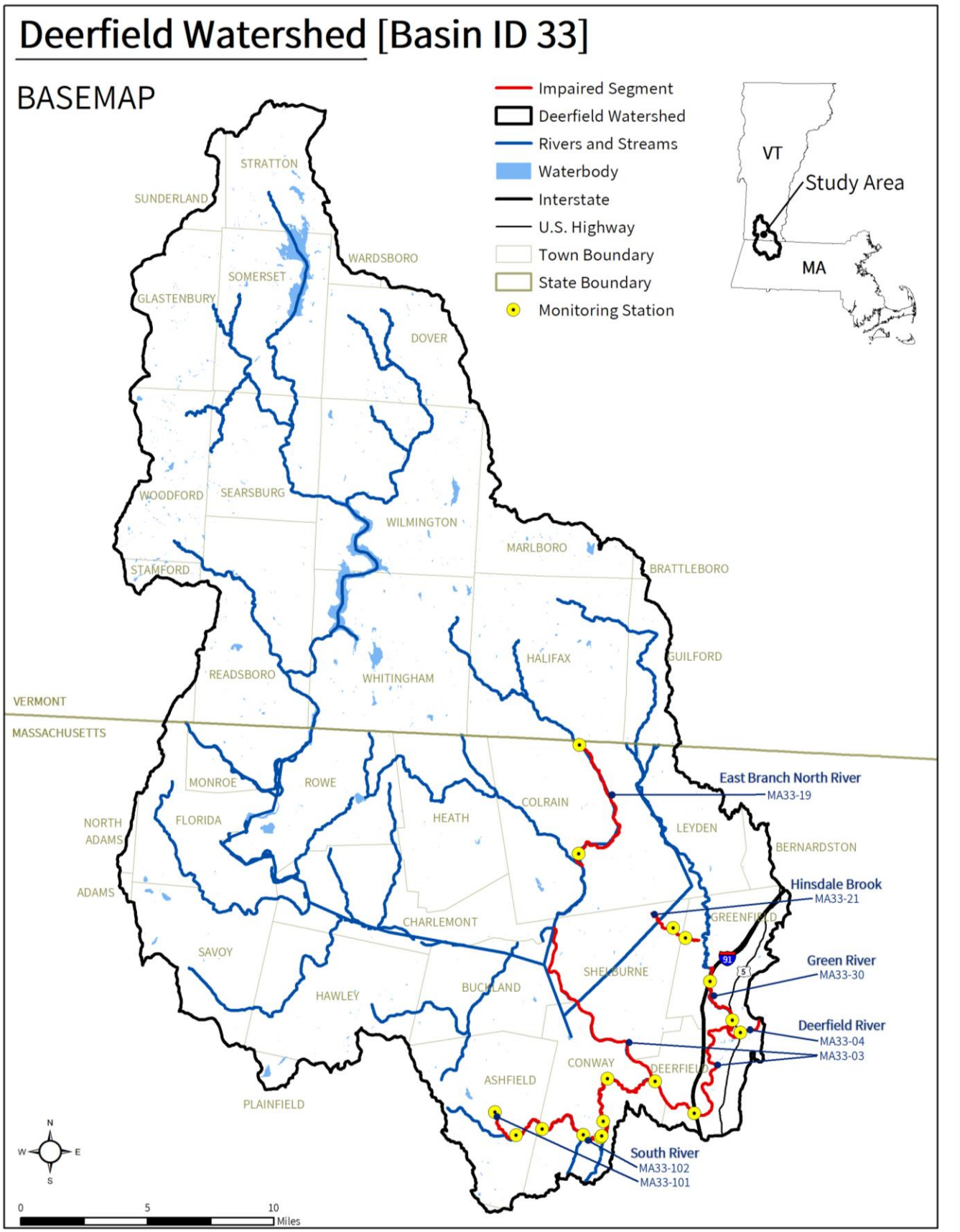


Figure 2-1: Map of all pathogen-impaired river segments, water quality monitoring stations, municipal borders, waterbodies, and roads in the Deerfield River watershed.

3. MA33-03 Deerfield River

3.1. Waterbody Overview

The Deerfield River segment MA33-03 is 16.8 miles long and begins at the confluence of the Deerfield and North Rivers along the Charlemont-Shelburne border, MA. The segment flows southeast along the town borders of Buckland-Shelburne, then Conway-Shelburne, then Conway-Deerfield, before flowing north through Deerfield, then ends at its confluence with the Green River in Greenfield, MA.

Tributaries to the Deerfield River segment MA33-03 include Sluice Brook, Schneck Brook, Bear River, Dragon Brook, Shingle Brook, pathogen-impaired South River (MA33-102, MA33-101), Hawks Brook, Mill Brook Stream, Fuller Swamp Brook, Sheldon Brook, and many smaller unnamed streams. Additional pathogen-impaired segments within the segment watershed which are not direct tributaries include the East Branch North River (MA33-19). Named lakes and ponds within the watershed include the Somerset Reservoir, Harriman Reservoir Sherman Reservoir, Pelham Lake, Lower Reservoir, and Upper Reservoir, and many additional smaller waterbodies.

Key landmarks in the VT portion of the watershed include part of the Green Mountain National Forest, the Somerset Reservoir, Mount Snow, the Harriman Reservoir, and the town centers of Somerset, Searsburg, Wilmington, Whitingham, Readsboro, and Halifax. Within MA, key landmarks include the town centers of Monroe, Rowe, Florida, Heath, Charlemont, Hawley, Buckland, Shelburne Falls, Shelburne, Ashfield, Conway, and Deerfield; and the state forests of Catamount, Mohawk Trail, and Savoy Mountain. The segment is crossed by Mohawk Trail/MA-2/MA-112 (Shelburne); and Upper Road and I-91 (Deerfield).

The Deerfield River (MA33-03) drains a total area of 571 square miles, of which 16 mi^2 (3%) is impervious and 6 mi^2 (1%) is directly connected impervious area (DCIA). Of the total watershed area of 571 mi^2, 291 mi^2 (51%) are within MA, with the remaining in VT.

Reduction from Highest Calculated Geomean: 94%

Watershed Area (Acres): 365,497

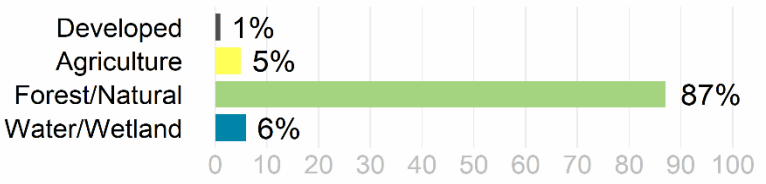
Segment Length (Miles): 16.8

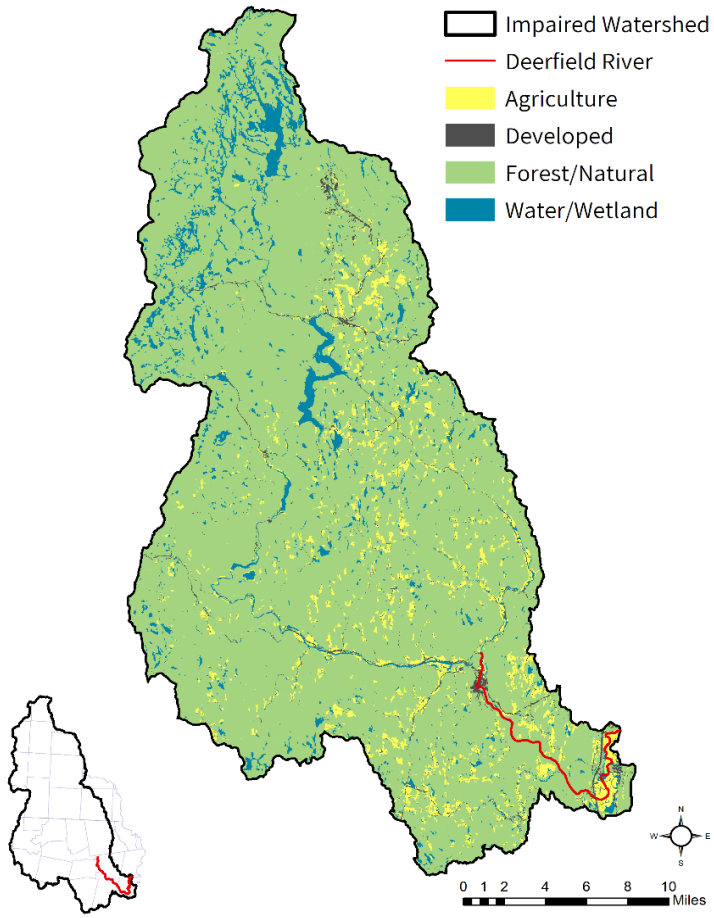
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 10,025 (3%)

DCIA Area (Acres, %): 3,590 (1%)





The watershed is partially[1] served by public sewer and <1% 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 within the MA portion of the watershed (Table 3-1), as well as one MassDEP discharge to groundwater permit for on-site wastewater discharge within the MA portion of the watershed but not the immediate drainage area. There are also no combined sewer overflows within the MA portion of the watershed, 26 landfills (19 landfills within MA), and no unpermitted land disposal dumping grounds within the MA portion of the watershed. 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.

NPDES ID	NAME	TOWN	WWTF
MA0100188	MONROE WWTF	MONROE	MUN
MAG580001	OLD DEERFIELD WW P	DEERFIELD	MUN
MAG580002	SHELBURNE FALLS WWTF	BUCKLAND	MUN
MAG580003	CHARLEMONT SEWER DISTRICT WWPT	CHARLEMONT	MUN

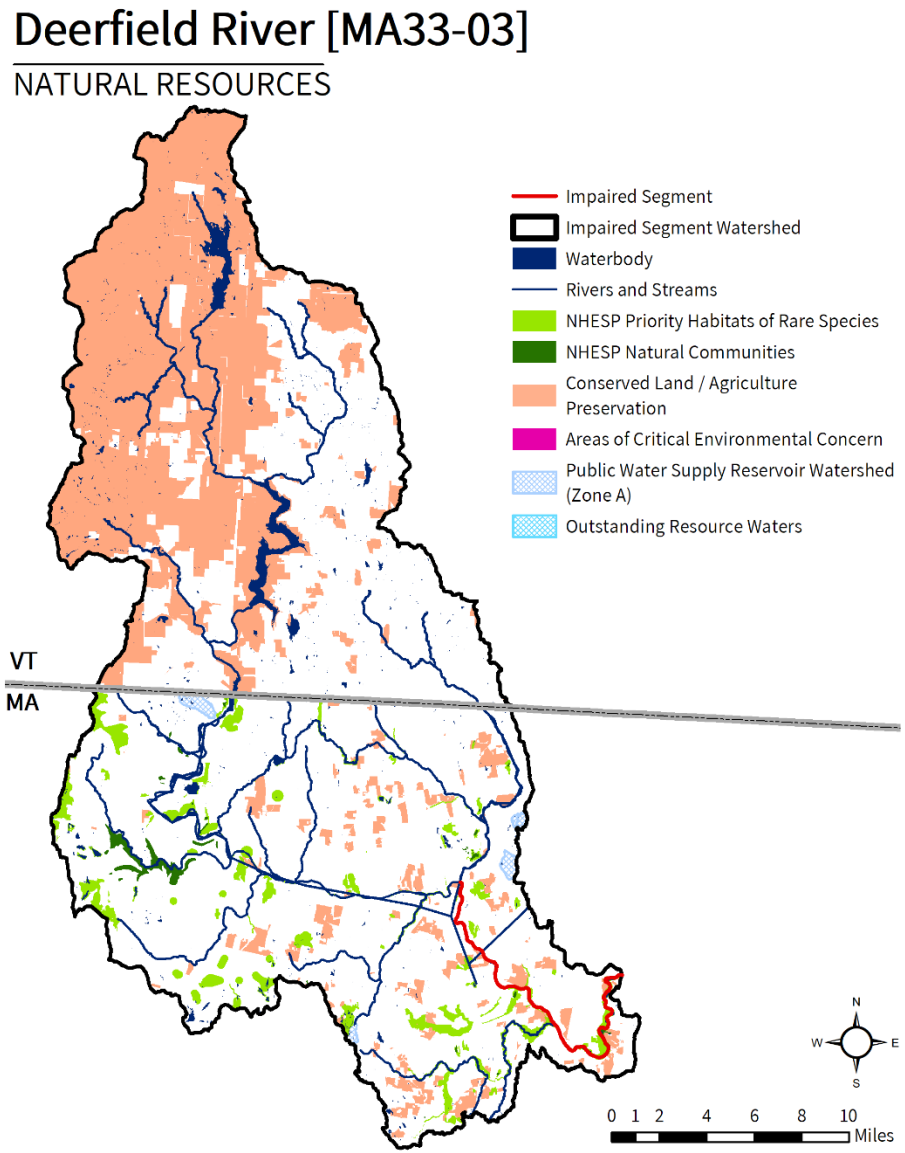
The upper watershed is mountainous and predominately forested, while the downstream portion east of I-91 is heavily agricultural, with large hayfields and row crops directly adjacent to the river. Although only 1% (4,702 acres) of the watershed area is developed, much of that development concentrates along the river, including the villages of Shelburne Falls and Deerfield and a small part of Greenfield.

In the Deerfield River (MA33-03) watershed, under the Natural Heritage and Endangered Species Program, there are 15,049 acres (4%) of Priority Habitats of Rare Species and 1,724 acres (<1%) of Priority Natural Vegetation Communities within the MA portion of the watershed. There are 1,428 acres (<1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the MA portion of the watershed. Over 106,621 acres (29%) of land protected in perpetuity[2] exist within the segment watershed (including VT), which is part of a total of 148,335 acres (41%) of Protected and Recreational Open Space[3].

[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] 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.

[3] 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).



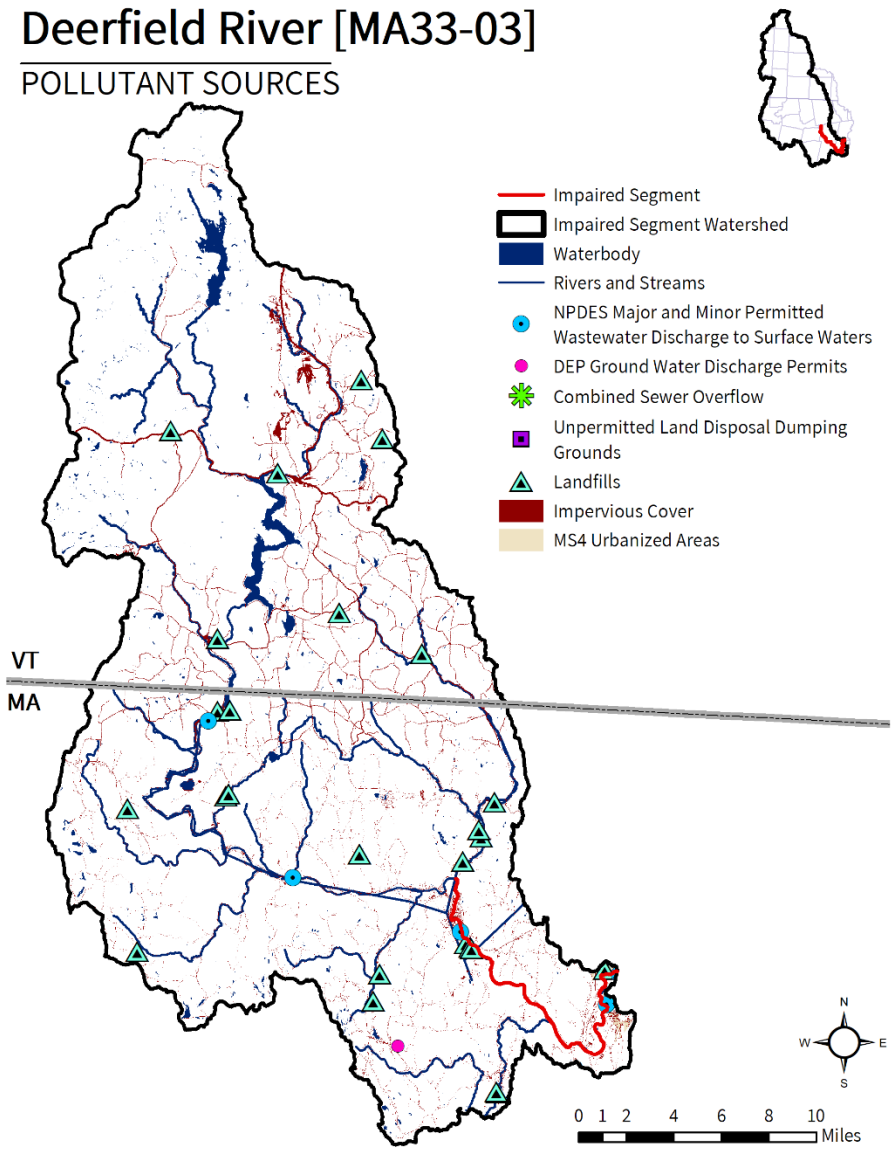


Figure 3-1. Natural resources and potential pollution sources draining to the Deerfield River segment MA33-03. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

3.2. Waterbody Impairment Characterization

The Deerfield River (MA33-03) 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 station 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, 30-day rolling basis.

- In 2005, five samples were collected at W0002, resulting in three 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 five samples, three exceeded the STV criterion during both wet and dry weather.

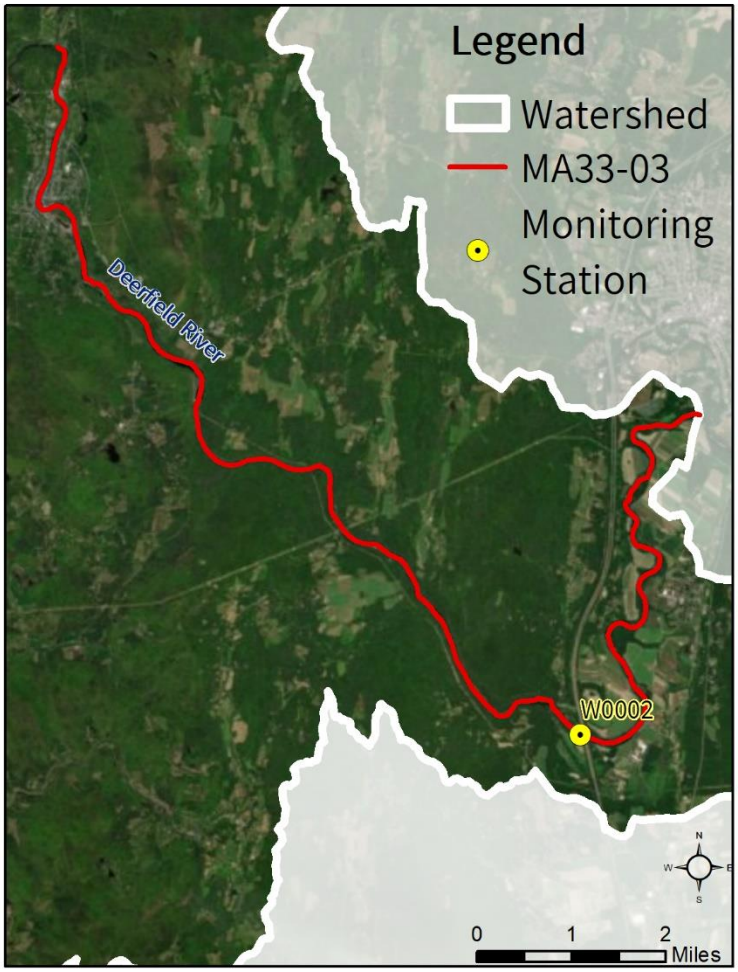


Figure 3-2. Location of monitoring station(s) along the impaired river segment.

Table 3-2. Summary of indicator bacteria sampling results by station for the Deerfield River (MA33-03). 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
W0002	5/17/2005	9/21/2005	5	2050	3	3

Table 3-3. Indicator bacteria data by station, indicator, and date for the Deerfield River (MA33-03). 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)
W0002	*E. coli*	5/17/2005	DRY	37	37	
W0002	*E. coli*	6/7/2005	DRY	435	127	
W0002	*E. coli*	7/19/2005	DRY	2050	2050	
W0002	*E. coli*	8/16/2005	WET	770	1256	
W0002	*E. coli*	9/21/2005	DRY	9	9	
W0002	Fecal Coliform	5/17/2005	DRY	50		
W0002	Fecal Coliform	6/7/2005	DRY	520		
W0002	Fecal Coliform	7/19/2005	DRY	2800		
W0002	Fecal Coliform	8/16/2005	WET	790		
W0002	Fecal Coliform	9/21/2005	DRY	10		

3.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 Deerfield River (MA33-03) 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 results 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: There are concentrated areas of medium density mixed development within the Deerfield River (MA33-03) corridor. In the overall watershed, <1% of the land area is MS4 and 1% is DCIA. The largest clusters of development occur near the Deerfield and Shelburne Falls town centers. Given the proximity of village centers to the Deerfield River, stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: The downstream portion is partially served by 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.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge within the watershed but not within the immediate drainage area. These are large-capacity septic systems (non-residential). In addition, almost all development in the upper watershed relies on 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 in the watershed account for 5% of the total land use; however, many of these agricultural lands are concentrated along the lower river segment east of I-91. Agricultural activities visible on recent aerial photos within the segment watershed include hayfields, row crops, and pastureland. Some of the large agricultural fields adjacent to the segment on Poques Hole Road in Deerfield appear to have a thin wooded buffer, and aerial photos show large ponding water on the fields which may be hydrologically connected to the Deerfield River. Those related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are several residential neighborhoods adjacent to the river segment, especially in Shelburne Falls and Deerfield. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Most of the river segment and tributaries flow through a wooded buffer, although there are areas with large fields adjacent to and within view of the river segment, such as along Mill Village Road in Deerfield. Large open mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

3.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin (excludes upstream impaired segment watersheds). For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Buckland

Buckland is not within the MS4 area.

Buckland has the following ordinance and bylaw:

- Pet waste: Chapter XI: Removal of pet waste, page 20: https://www.town.buckland.ma.us/sites/g/files/vyhlif356/f/uploads/general_bylaws_buckland.pdf (Town of Buckland, 2019)

Buckland shares a Master Plan with the Town of Shelburne, written in 1999 (Town of Shelburne, 2020a), available at https://www.townofshelburne.com/f/0/32/Planning-and-Zoning-Board-Documents

Buckland has an Open Space and Recreation Plan: https://www.town.buckland.ma.us/sites/bucklandma/files/uploads/buckland2010osrpfinalplan091313.pdf (Town of Buckland, 2020).

Town of Charlemont

Charlemont is not within the MS4 area.

Charlemont's ordinances and bylaws:

- No supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.
- Title V Supplemental Regulations: None found.
- Pet Waste Bylaw: None found.
- Stormwater Utility: None found.

The Charlemont Master Plan (https://charlemont-ma.us/p/70/Master-Plan) has a chapter on "Agriculture, Open Space, and Natural Resources" that briefly summarizes water resources in the town (Town of Charlemont, 2003). Nonpoint source pollutants are listed as a concern for the Deerfield River and for aquifers. It does not mention stormwater, impaired streams, or sewer infrastructure.

The Town of Charlemont does not have an Open Space and Recreation Plan available.

The town website is https://charlemont-ma.us/ (Town of Charlemont, 2020).

Town of Conway

Conway is not within the MS4 area.

Conway's ordinances and bylaws:

- Conway does not have any supplementary regulations beyond the MassDEP regulations for stormwater management and wetland protection.
- Title 5 Supplementary Regulations: None found.
- Pet Waste: None found.
- Stormwater Utility (or similar): None found.
- Contact Recreation Regulations or Bylaws: None found.

Conway does not have a Master Plan. Conway has a water resources section in its Open Space and Recreation Plan in the Environmental Inventory and Analysis section, starting on page 4-8. This section notes that the Mill River Watershed Protection Plan for the town identifies a goal of improving stormwater management within the watershed. All of Conway is treated by individual septic systems.

Open Space Plan: https://townofconway.com/wp-content/uploads/2017/10/Conway-OSRP-2013-Final-Compiled-1.pdf (Town of Conway and FRCOG, 2013)

Town of Conway website: https://townofconway.com/ (Town of Conway, 2020)

Town of Deerfield

Approximately 10% of the town is mapped as MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts. See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities (USEPA, 2020).

Deerfield has the following ordinances and bylaws:

- Stormwater Management Regulations: https://www.deerfieldma.us/sites/g/files/vyhlif3001/f/uploads/deerfield_stormwater_regulations.pdf (Town of Deerfield, 2011)
- Deerfield does not have any supplementary regulations beyond the MassDEP regulations for wetland protection.
- Pet Waste ordinance: https://ecode360.com/30385404 (Town of Deerfield, 2014)
- Title 5 Supplementary Regulations: None found.
- Stormwater Utility (or similar): None found.
- Contact Recreation Regulations or Bylaws: None found.

Deerfield does not have a Master Plan available.

Deerfield stormwater page: https://ecode360.com/14659832 (Town of Deerfield, 2010)

Deerfield does not have an Open Space and Recreation Plan available. Deerfield has an Open Space and Recreation Committee (https://www.deerfieldma.us/open-space-recreation-committee).but it may not be active (Town of Deerfield, 2020a)

Town website: https://www.deerfieldma.us/ (Town of Deerfield, 2020b)

Town of Greenfield

Approximately 42% of the town is mapped as MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts. See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities (USEPA, 2020).

Greenfield has the following ordinances and bylaws:

- Stormwater Ordinance: https://ecode360.com/30742035 (Town of Greenfield, 2012a)
- Wetland Protection Bylaw: https://ecode360.com/30742390 (Town of Greenfield, 2016)
- Pet Waste Bylaw: https://ecode360.com/30791277 (Town of Greenfield, 2011)
- Stormwater Utility: None found.
- Title V Supplementary Regulations: None found.

The Town of Greenfield has a Downtown Master Plan (Goody, Clancy & Associates et al, 2003) and a Comprehensive Sustainable Plan (Vanasse Hangin Brustlin, 2014). Greenfield's Master Plan provides an extensive water resources section in the Natural Resources chapter. Stormwater is mentioned in a nonpoint source pollutant section in the Natural, Historical, and Cultural Resources chapter. The Sewer Infrastructure section notes the town's plans to upgrade aging sewer and drainage infrastructure.

Town website: https://greenfield-ma.gov/

Downtown Master Plan: https://greenfield-ma.gov/files/Downtown_Master_Plan_2003.pdf (Goody, Clancy & Associates et al, 2003)

Comprehensive Sustainable Plan: https://greenfield-ma.gov/files/Sustainable_Greenfield-Greenfields_2014_Comprehensive_Sustainable_Master_Plan.pdf. (Vanasse Hangin Brustlin, 2014)

Stormwater Page: https://ecode360.com/30742035 (Town of Greenfield, 2012a)

Open Space and Recreation Plan: https://greenfield-ma.gov/files/Greenfield_Open_Space__Recreation_Plan_FINAL.pdf (Town of Greenfield, 2012b)

Town of Shelburne

The Town of Shelburne is not within the MS4 area.

Shelburne has the following ordinances and bylaws:

- Shelburne does not have any supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection. The town does provide minimal storm drainage information at https://www.townofshelburne.com/files/B_Shelburne_Subdivision_Regulation___2018.pdf (Town of Shelburne, 2018)
- Title V Supplemental Regulations: None found.
- Stormwater Utility: None found.

The Town of Shelburne uses a Master Plan for the Buckland-Shelburne area, written in 1999 (Town of Shelburne, 2020). There is a Natural Resources, Open Space, and Farmland section in Chapter 1, including a subsection on surface waters, aquifers, and groundwater. The plan recommends adopting more stringent zoning measures on aquifer protection, wetland protection, and floodplain protection. The plan mentions a recommendation of directing rain gutters to dry wells or alternative means of disposal to reduce stormwater runoff in the public infrastructure chapter. Wastewater disposal in the village of Shelburne Falls is provided by the town, and residences, businesses, and industries outside the village rely on on-site wastewater disposal.

The Master Plan is available chapter by chapter at https://www.townofshelburne.com/f/32/Planning-and-Zoning-Board-Documents (Town of Shelburne, 2020a)

Town Website: https://www.townofshelburne.com/ (Town of Shelburne, 2020b)

Open Space and Recreation Plan: https://www.townofshelburne.com/f/32/Planning-and-Zoning-Board-Documents (Town of Shelburne, 2020a)

4. MA33-04 Deerfield River

4.1. Waterbody Overview

The Deerfield River segment MA33-04 is 2.0 miles long and begins at the confluence of the Deerfield River and the Green River in Greenfield, MA. The segment flows to the west along the Greenfield-Deerfield town border before ending at its confluence with the Connecticut River in Greenfield/Deerfield, MA.

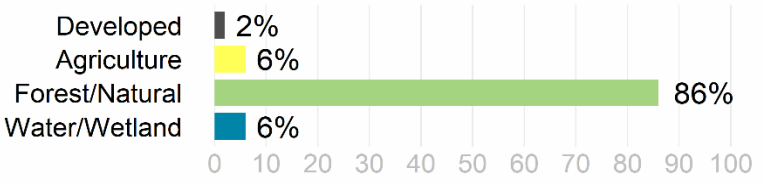
Tributaries to the Deerfield River segment MA33-04 include the pathogen-impaired Deerfield River (MA33-03) (immediately upstream), the pathogen-impaired Green River (MA33-30), and Graves Brook. The segment is the most downstream portion of the Deerfield River, and thus all other impaired segments in this appendix are upstream of this segment. Named lakes and ponds within the watershed area include the Somerset Reservoir, Harriman Reservoir, Sherman Reservoir, Greenfield Reservoir (upper and lower), and Hop Pond Brook.

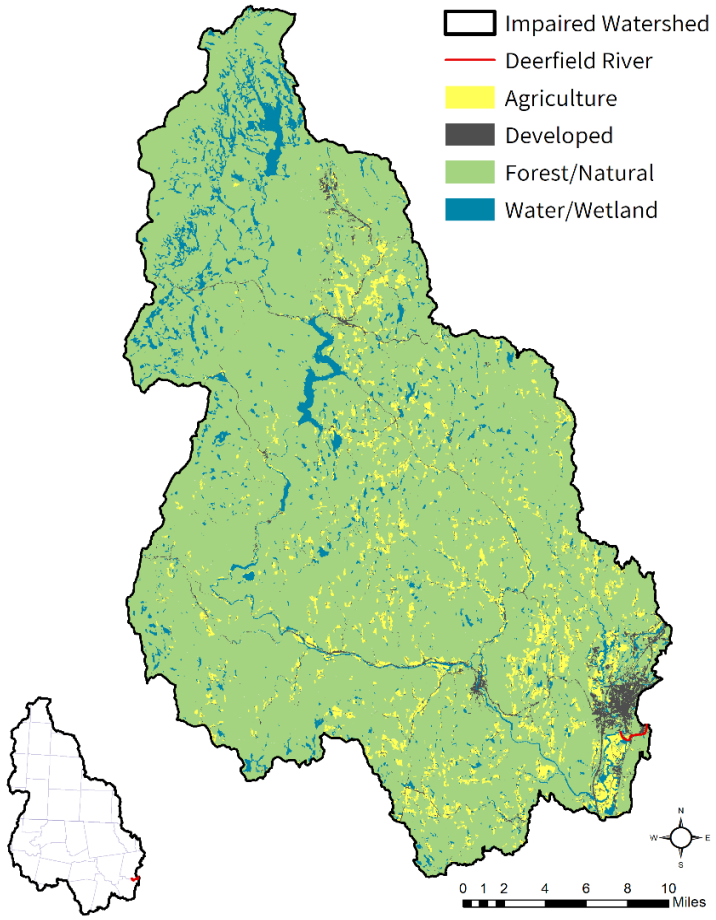
Key landmarks in the watershed within VT include part of the Green Mountain National Forest, the Somerset Reservoir, Mount Snow, the Harriman Reservoir, and the town centers of Somerset, Searsburg, Wilmington, Whitingham, Readsboro, and Halifax. Within MA, key landmarks include the town centers of Monroe, Rowe, Florida, Heath, Charlemont, Hawley, Buckland, Shelburne Falls, Shelburne, Ashfield, Conway, Deerfield, Leyden, and Greenfield, in addition to many state forests such as the Catamount, Mohawk Trail, and Savoy Mountain. The segment is crossed by the Greenfield Road/US-5/MA-10 and the Connecticut River Mainline railroad (two bridges).

The Deerfield River (MA33-04) drains a total area of 664 square miles, of which 20 mi^2 (3%) is impervious and 7 mi^2 (1%) is directly connected impervious area (DCIA). Out of the total watershed area of 664 mi^2, 347 mi^2 (52%) are within MA, with the remaining in VT.

The watershed is partially[4] served by public sewer and 1% of the watershed (3% for the area within MA) is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES permit on

Reduction from Highest Calculated Geomean: 96%
Watershed Area (Acres): 424,623
Segment Length (Miles): 2.0
Impairment(s): *E. coli* (Primary Contact Recreation)
Class (Qualifier): B (Warm Water)
Impervious Area (Acres, %): 12,894 (3%)
DCIA Area (Acres, %): 4,730 (1%)





[4] 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.

file governing point source discharges of pollutants to surface waters within the immediate MA drainage area and four additional NPDES permits within the entire watershed (Table 4-1). There is one MassDEP discharge to groundwater permit for on-site wastewater discharge within the watershed, though not within the immediate drainage area. There are no combined sewer overflows within the MA portion of the watershed, 29 landfills (20 landfills within MA), and no unpermitted land disposal dumping grounds within the MA portion of the watershed. See Figure 4-1.

Table 4-1. 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
MA0101214	GREENFIELD WPCP	GREENFIELD	MUN

Only 2% of the Deerfield River watershed is developed; however, the urban center of Greenfield is near the river segment and a large stone quarry is directly adjacent to it. Most of the watershed is forested or natural land (86%). Much of the agricultural land use (6%) is concentrated just upstream of the segment and includes large hayfields and fields of row crops.

In the Deerfield River (MA33-04) watershed, under the Natural Heritage and Endangered Species Program, there are 17,491 acres (4%) of Priority Habitats of Rare Species and 2,483 acres (1%) of Priority Natural Vegetation Communities. There are 37,882 acres (9%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. Over 113,917 acres (27%) of land protected in perpetuity[5] exist within the segment watershed (including VT), which is part of a total of 158,632 acres (37%) of Protected and Recreational Open Space[6]. See Figure 4-1.

[5] 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.

[6] 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).

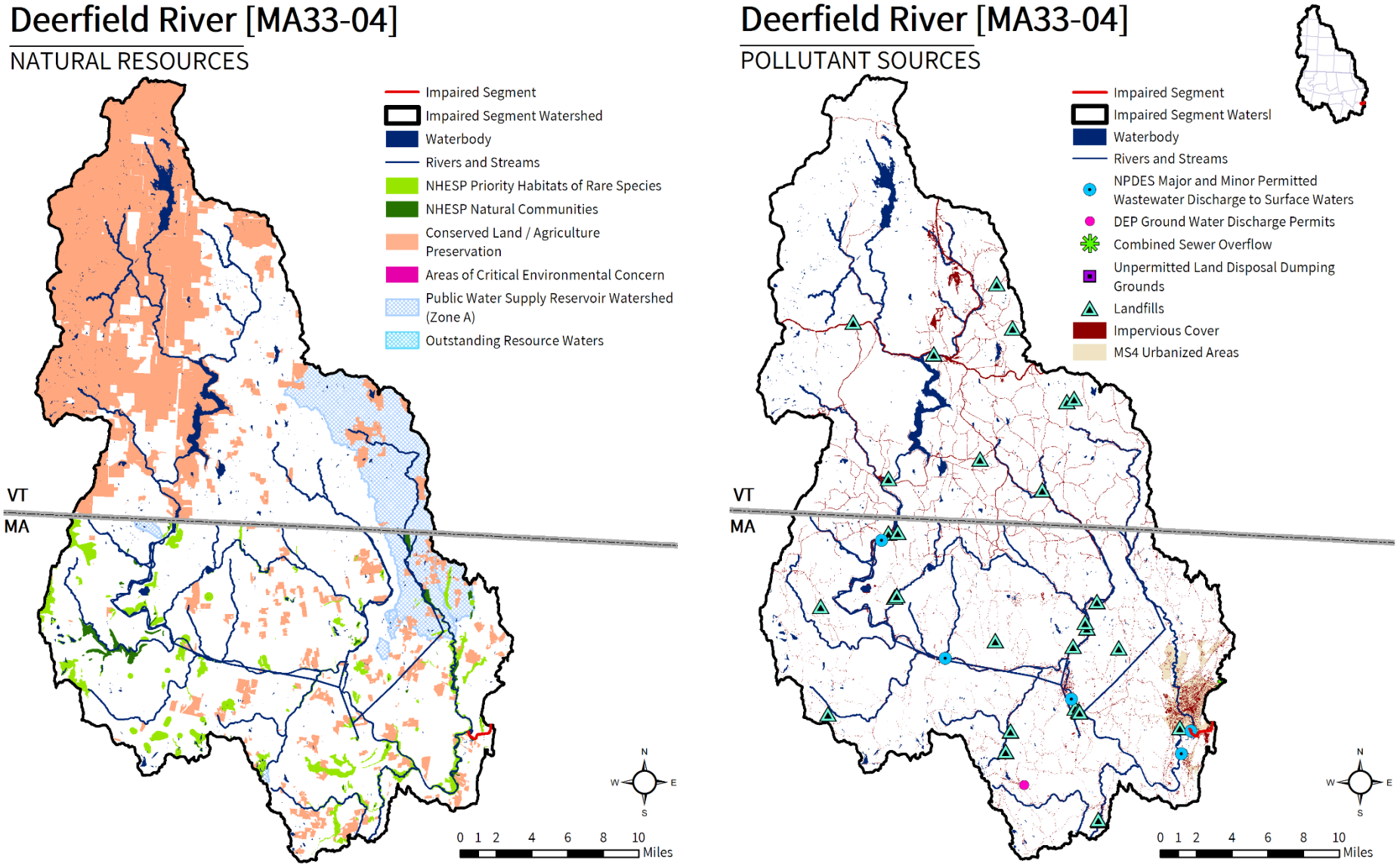


Figure 4-1. Natural resources and potential pollution sources draining to the Deerfield River segment MA33-04. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

4.2. Waterbody Impairment Characterization

The Deerfield River (MA33-04) 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 station 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.

- In 2005, five samples were collected at W0757, 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 five samples, two exceeded the STV criterion during dry weather.

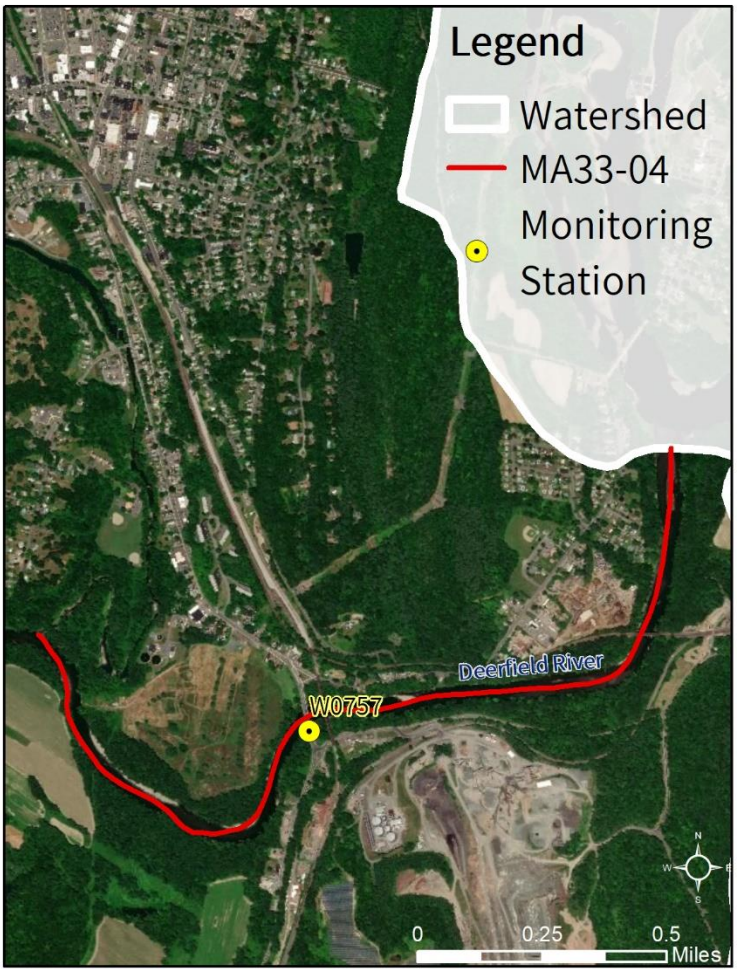


Figure 4-2. Location of monitoring station(s) along the impaired river segment.

Table 4-2. Summary of indicator bacteria sampling results by station for the Deerfield River (MA33-04). 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
W0757	5/17/2005	9/21/2005	5	2910	4	2

Table 4-3. Indicator bacteria data by station, indicator, and date for the Deerfield River (MA33-04). 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)
W0757	*E. coli*	5/17/2005	DRY	40	40	
W0757	*E. coli*	6/7/2005	DRY	777	176	
W0757	*E. coli*	7/19/2005	DRY	2910	2910	
W0757	*E. coli*	8/16/2005	WET	387	1061	
W0757	*E. coli*	9/21/2005	DRY	132	132	
W0757	Fecal Coliform	5/17/2005	DRY	60		
W0757	Fecal Coliform	6/7/2005	DRY	840		
W0757	Fecal Coliform	7/19/2005	DRY	3600		
W0757	Fecal Coliform	8/16/2005	WET	450		
W0757	Fecal Coliform	9/21/2005	DRY	150		

4.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 Deerfield River (MA33-04) were elevated during dry weather. Elevated results 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 needed under varying weather conditions to assess pollutant sources more accurately.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Although mostly forested, portions of the watershed are highly developed, with 1% of the land area as MS4 and 1% as DCIA. Although not in the immediate drainage area, the large urban area of Greenfield is just upstream of the segment and contains medium to high density mixed residential, commercial, industrial, and transportation development. Low density residential development is scattered across the watershed and connected by state highways. Stormwater runoff from urban areas is likely a significant source of pathogens to the segment.

Illicit Sewage Discharges: The downstream portion of the watershed is partially served by 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.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge within the watershed but not within the immediate drainage area. These are large-capacity septic systems (non-residential). In addition, almost all development in the upper watershed relies on 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 in the watershed account for 6% of the total land use, though much of it is concentrated along the Deerfield River just upstream of the segment. Agricultural activities visible on recent aerial photos within the segment watershed include open fields and row crops, while pasturelands exist further up in the watershed. Some of the large agricultural fields adjacent to the segment on Poques Hole Road in Deerfield appear to have a thin wooded buffer, and aerial photos show large ponding water on the fields which may be hydrologically connected to the Deerfield River. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to water bodies.

Pet Waste: Open space accounts for 37% of the watershed. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: There are large, forested lands, wetlands, and fields throughout the watershed. Large open mowed areas such as golf courses, fields, or wetlands with a clear sightline to a waterbody may attract excessive 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 (excludes upstream impaired segment watersheds). For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashfield

Ashfield is not within the MS4 area.

Ashfield's relevant ordinances and bylaws:

- No supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.
- Title V Supplemental Regulations: None found.
- Pet Waste Bylaw: None found.
- Stormwater Utility: None found.

The Town of Ashfield does not have a Master Plan or Open Space and Recreation Plan available.

The town website is https://www.ashfield.org/ (Town of Ashfield, 2020).

Town of Deerfield. See Section 3.4

Town of Greenfield. See Section 3.4

5. MA33-19 East Branch North River

5.1. Waterbody Overview

The East Branch North River segment MA33-19 is 7.5 miles long and begins at the VT border in Colrain, MA. The segment flows south through the Colrain town center before ending at its confluence with the West Branch North River in Colrain, MA.

Tributaries to the East Branch North River segment MA33-19 include Spur Brook, Foundry Brook, and other unnamed streams. No named lakes and ponds within the watershed were found.

Key landmarks in the watershed within VT include the town centers of Jacksonville, West Halifax, and Halifax; the villages of Elm Grove, Colrain and Foundry Village; and the Arthur Smith Covered Bridge (which crosses the river) in MA. The segment is crossed by Jacksonville Road/MA-112 (twice), Franklin Hill Road, Reils Lane, Foundry Village Road, and Lyonsville Road, all within Colrain.

The East Branch North River (MA33-19) drains a total area of 54 square miles, of which 2 mi^2 (4%) is impervious and 1 mi^2 (2%) is directly connected impervious area (DCIA). The East Branch North River watershed extends into VT. Of the total watershed area of 54 mi^2, 14 mi^2 (26%) are within MA.

The watershed is likely not[7] served by public sewer, and none 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 and no MassDEP discharge to groundwater permits for on-site wastewater discharge within the MA portion of the segment watershed. There are also no combined sewer overflows within the MA portion of the watershed, three landfills (1 landfill within MA), and no unpermitted land disposal dumping grounds within the MA portion of the watershed. See Figure 5-1.

Overall, the watershed is lightly developed with some areas of significant agriculture. Only 1% (411 acres) of the East Branch North River

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 34,691

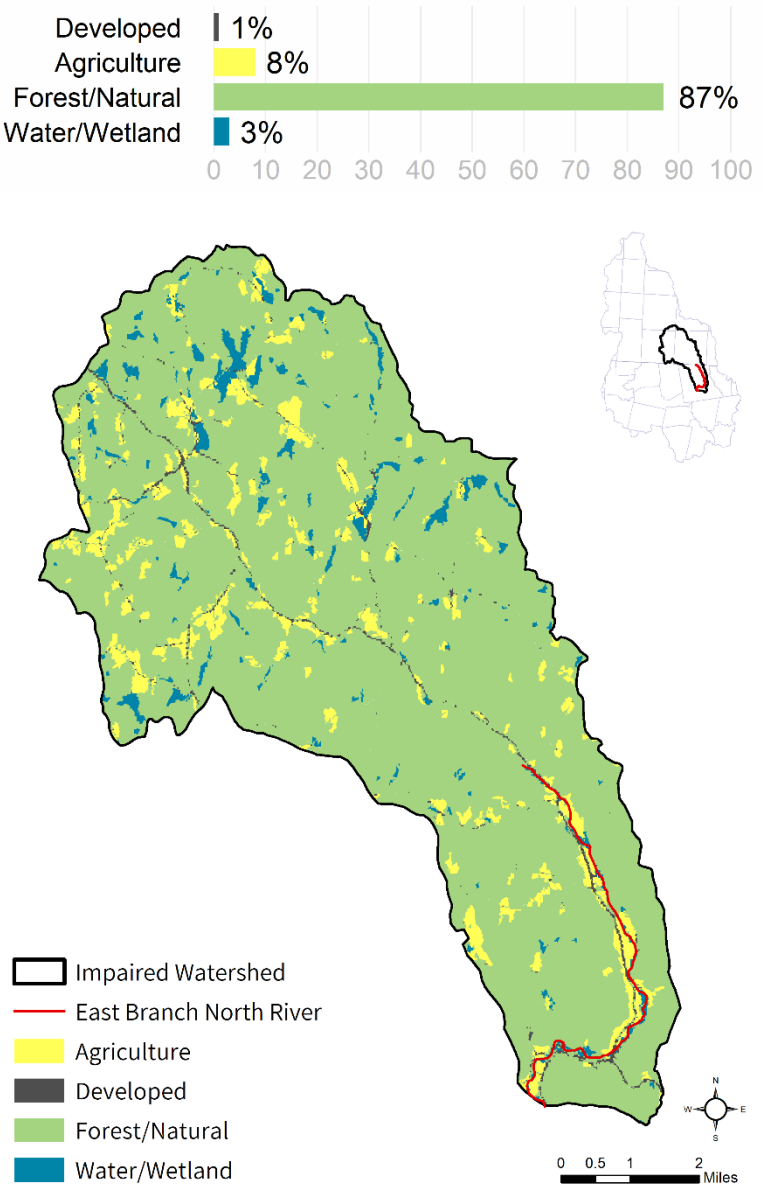
Segment Length (Miles): 7.5

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

Class (Qualifier): B (Cold Water, High Quality Water)

Impervious Area (Acres, %): 1,392 (4%)

DCIA Area (Acres, %): 568 (2%)



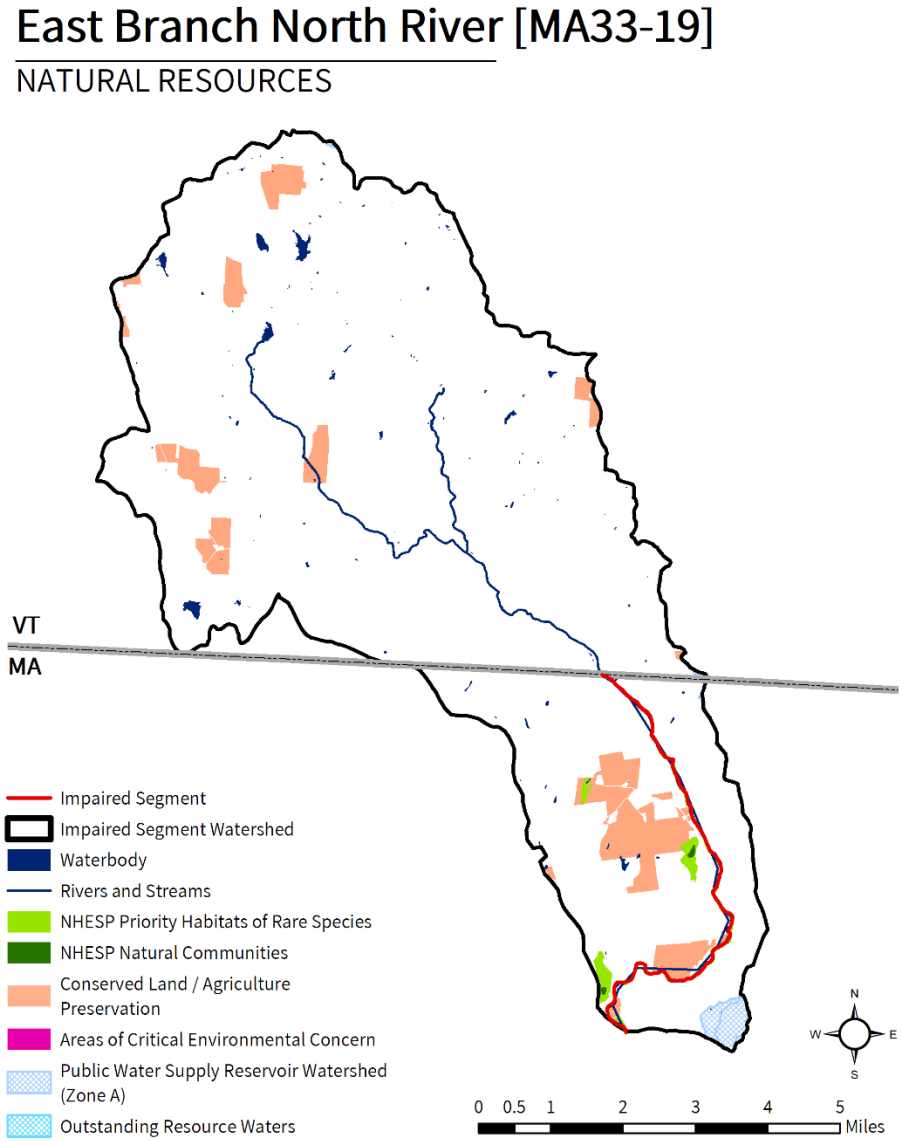
[7] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local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

watershed is developed and is characterized by low density residential, with small pockets of medium density residential and commercial in village areas. While most of the watershed area is forested or natural land (87%), the developed areas concentrate along the river corridor, especially along the state highways of VT-100, VT-8A, VT-112, and MA-112.

In the East Branch North River (MA33-19) watershed, under the Natural Heritage and Endangered Species Program, there are 393 acres (1%) of Priority Habitats of Rare Species and 11 acres (<1%) of Priority Natural Vegetation Communities in the MA portion of the watershed. There are 264 acres (1%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the MA portion of the watershed. Over 1,986 acres (6%) of land protected in perpetuity[8] exist within the segment watershed (including VT), which is part of a total of 2,123 acres (6%) of Protected and Recreational Open Space[9]. See Figure 5-1.

[8] 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.

[9] 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).



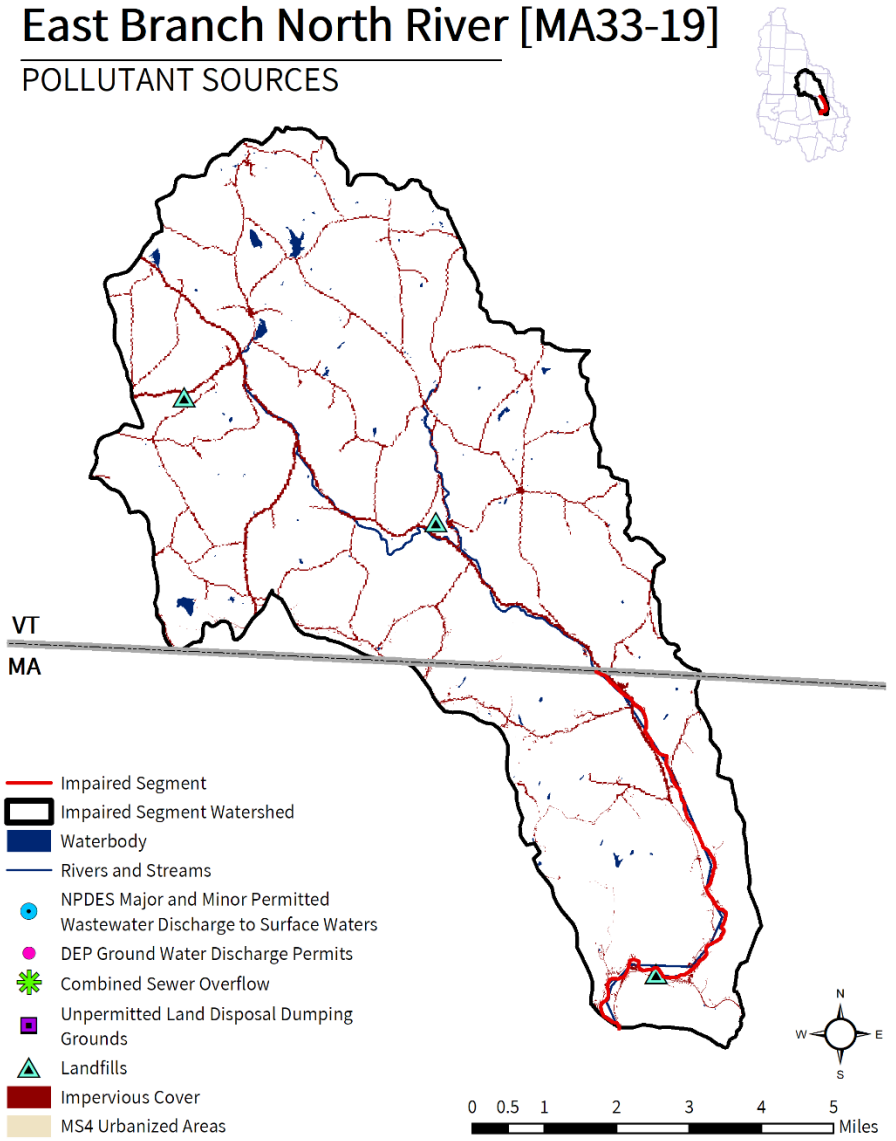


Figure 5-1. Natural resources and potential pollution sources draining to the East Branch North River segment MA33-19. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

5.2. Waterbody Impairment Characterization

The East Branch North River (MA33-19) is a Class B, Cold Water and High Quality 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 5-1, 5-2; Figure 5-2). Only the primary MassDEP monitoring stations are shown in Figure 5-2. Indicator bacteria data were sourced from MassDEP (2007), MassDEP (2008), FRCOG (2008), and Meek & O'Brien-Clayton (2012). 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. Only stations with five or more samples are described as follows:

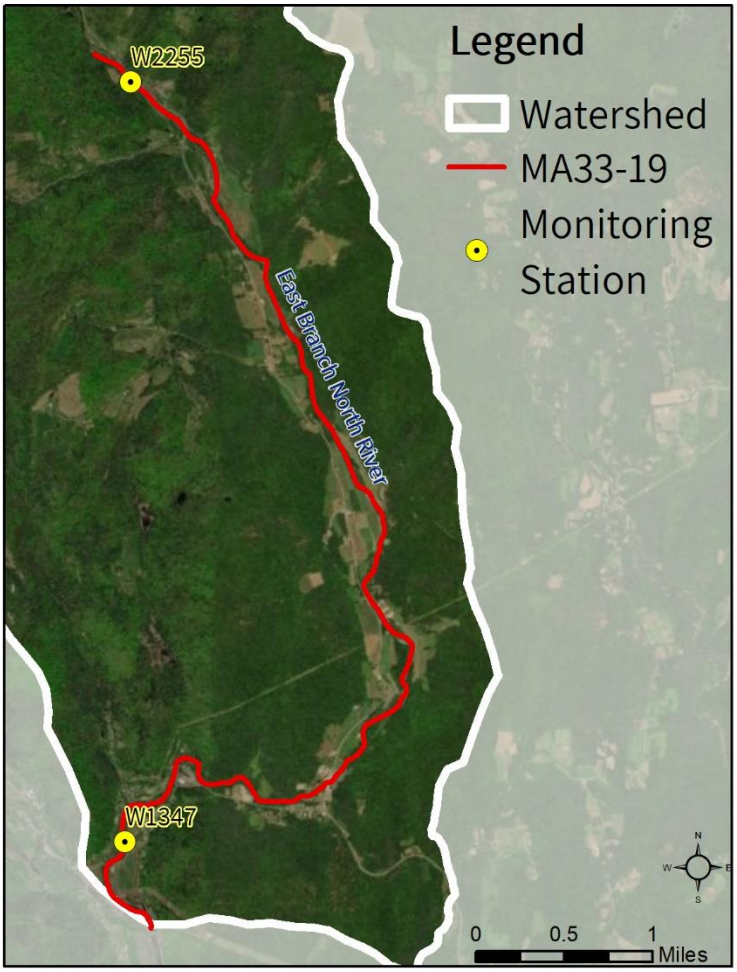


Figure 5-2. Location of monitoring station(s) along the impaired river segment.

- In 2005, six samples were collected at NOR-004, 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, one exceeded the STV criterion during dry weather.
- From 2005-2007, 18 samples were collected at NOR-005, 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 18 samples, five exceeded the STV criterion during dry weather.
- From 2005-2007, 5-6 samples were collected at NOR-005 AB-1, NOR-005B, NOR-005C, NOR-010A, NOR-010C, and NOR-010D, 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 5-6 samples at each station, none exceeded the STV criterion.
- In 2005, six samples were collected at NOR-006, 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, two exceeded the STV criterion during dry weather.
- In 2005, five samples were collected at W1347, 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 five samples, two exceeded the STV criterion during both wet and dry weather.
- In 2012, six samples were collected at W2255, 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 six samples, none exceeded the STV criterion.

Table 5-1. Summary of indicator bacteria sampling results by station for the East Branch North River (MA33-19). 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
NOR-004	6/12/2005	9/15/2005	6	120	0	1
NOR-005	6/12/2005	8/25/2007	18	578	13	5
NOR-005 AB-1	6/16/2007	8/25/2007	6	93	0	0
NOR-005B	6/17/2006	8/19/2006	6	71	0	0
NOR-005C	6/17/2006	8/19/2006	6	106	0	0
NOR-006	6/12/2005	9/15/2005	6	163	1	2
NOR-010A	6/16/2007	8/25/2007	5	74	0	0
NOR-010C	6/16/2007	8/25/2007	5	87	0	0
NOR-010D	6/16/2007	8/25/2007	5	103	0	0
NRDFLD14	6/9/2008	6/9/2008	1	88	0	0
NRDFLD14.7	6/9/2008	6/9/2008	1	138	1	0
NRDFLD16	6/9/2008	6/9/2008	1	129	1	0
NRDFLD16.3	6/9/2008	6/9/2008	1	102	0	0
NRDFLD16.5	6/9/2008	6/9/2008	1	96	0	0
NRDFLD17	6/9/2008	6/9/2008	1	62	0	0
NRDFLD18	6/9/2008	6/9/2008	1	101	0	0
NRDFLD19	6/9/2008	6/9/2008	1	21	0	0
NRVRDFLD12.0	6/11/2007	9/5/2007	2	118	0	0
NRVRDFLD13.0	6/11/2007	9/5/2007	2	7	0	0
NRVRDFLD14.0	6/11/2007	9/5/2007	2	82	0	0
NRVRDFLD15.0	6/11/2007	9/5/2007	2	32	0	0
NRVRDFLD16.0	9/5/2007	10/3/2007	3	2420	3	3
NRVRDFLD16.5	6/11/2007	10/3/2007	3	866	2	1
NRVRDFLD17.0	9/10/2007	10/3/2007	2	816	1	1
NRVRDFLD18.0	9/10/2007	10/3/2007	2	1046	2	1
NRVRDFLD19.0	10/3/2007	10/3/2007	1	56	0	0
W1347	5/17/2005	9/21/2005	5	356	3	2
W2255	5/23/2012	9/27/2012	6	196	2	0

Table 5-2. Indicator bacteria data by station, indicator, and date for the East Branch North River (MA33-19). 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)
NOR-004	*E. coli*	6/12/2005	DRY	37	37	
NOR-004	*E. coli*	7/6/2005	DRY	387	120	
NOR-004	*E. coli*	7/13/2005	DRY	11	54	
NOR-004	*E. coli*	8/14/2005	DRY	35	48	
NOR-004	*E. coli*	8/28/2005	DRY	579	80	
NOR-004	*E. coli*	9/15/2005	DRY	179	109	
NOR-005	*E. coli*	6/12/2005	DRY	138	138	
NOR-005	*E. coli*	7/6/2005	DRY	2420	578	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
NOR-005	*E. coli*	7/13/2005	DRY	62	275	
NOR-005	*E. coli*	8/14/2005	DRY	294	279	
NOR-005	*E. coli*	8/28/2005	DRY	564	321	
NOR-005	*E. coli*	9/15/2005	DRY	887	466	
NOR-005	*E. coli*	6/30/2007	DRY	219	219	
NOR-005	*E. coli*	7/15/2007	DRY	249	234	
NOR-005	*E. coli*	7/28/2007	DRY	164	208	
NOR-005	*E. coli*	8/12/2007	DRY	124	182	
NOR-005	*E. coli*	8/25/2007	DRY	749	242	
NOR-005	*E. coli*	6/17/2006	DRY	45	45	
NOR-005	*E. coli*	6/23/2006	DRY	79	60	
NOR-005	*E. coli*	7/8/2006	DRY	411	113	
NOR-005	*E. coli*	7/21/2006	DRY	135	119	
NOR-005	*E. coli*	8/6/2006	WET	186	130	
NOR-005	*E. coli*	8/19/2006	DRY	118	128	
NOR-005	*E. coli*	9/9/2006	DRY	36	107	
NOR-005 AB-1	*E. coli*	6/16/2007	DRY	93	93	
NOR-005 AB-1	*E. coli*	6/30/2007	DRY	50	68	
NOR-005 AB-1	*E. coli*	7/15/2007	DRY	72	69	
NOR-005 AB-1	*E. coli*	7/28/2007	DRY	69	69	
NOR-005 AB-1	*E. coli*	8/12/2007	DRY	36	61	
NOR-005 AB-1	*E. coli*	8/25/2007	DRY	62	61	
NOR-005B	*E. coli*	6/17/2006	DRY	47	47	
NOR-005B	*E. coli*	6/23/2006	DRY	77	60	
NOR-005B	*E. coli*	7/8/2006	DRY	92	69	
NOR-005B	*E. coli*	7/21/2006	DRY	38	60	
NOR-005B	*E. coli*	8/6/2006	WET	139	71	
NOR-005B	*E. coli*	8/19/2006	DRY	29	61	
NOR-005C	*E. coli*	6/17/2006	DRY	41	41	
NOR-005C	*E. coli*	6/23/2006	DRY	249	101	
NOR-005C	*E. coli*	7/8/2006	DRY	117	106	
NOR-005C	*E. coli*	7/21/2006	DRY	46	86	
NOR-005C	*E. coli*	8/6/2006	WET	152	96	
NOR-005C	*E. coli*	8/19/2006	DRY	37	82	
NOR-006	*E. coli*	6/12/2005	DRY	75	75	
NOR-006	*E. coli*	7/6/2005	DRY	75	75	
NOR-006	*E. coli*	7/13/2005	DRY	26	53	
NOR-006	*E. coli*	8/14/2005	DRY	90	60	
NOR-006	*E. coli*	8/28/2005	DRY	770	100	
NOR-006	*E. coli*	9/15/2005	DRY	841	163	
NOR-010A	*E. coli*	6/16/2007	DRY	42	42	
NOR-010A	*E. coli*	6/30/2007	DRY	72	55	
NOR-010A	*E. coli*	7/15/2007	DRY	96	66	
NOR-010A	*E. coli*	8/12/2007	DRY	69	67	
NOR-010A	*E. coli*	8/25/2007	DRY	111	74	
NOR-010C	*E. coli*	6/16/2007	DRY	47	47	
NOR-010C	*E. coli*	6/30/2007	DRY	70	57	
NOR-010C	*E. coli*	7/15/2007	DRY	107	71	
NOR-010C	*E. coli*	8/12/2007	DRY	83	74	
NOR-010C	*E. coli*	8/25/2007	DRY	173	87	
NOR-010D	*E. coli*	6/16/2007	DRY	64	64	
NOR-010D	*E. coli*	6/30/2007	DRY	71	67	
NOR-010D	*E. coli*	7/15/2007	DRY	114	80	
NOR-010D	*E. coli*	8/12/2007	DRY	102	85	
NOR-010D	*E. coli*	8/25/2007	DRY	219	103	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
NRDFLD14	*E. coli*	6/9/2008	DRY	88	88	
NRDFLD14.7	*E. coli*	6/9/2008	DRY	138	138	
NRDFLD16	*E. coli*	6/9/2008	DRY	129	129	
NRDFLD16.3	*E. coli*	6/9/2008	DRY	102	102	
NRDFLD16.5	*E. coli*	6/9/2008	DRY	96	96	
NRDFLD17	*E. coli*	6/9/2008	DRY	62	62	
NRDFLD18	*E. coli*	6/9/2008	DRY	101	101	
NRDFLD19	*E. coli*	6/9/2008	DRY	21	21	
NRVRDFLD12.0	*E. coli*	6/11/2007	DRY	99	99	
NRVRDFLD12.0	*E. coli*	9/5/2007	DRY	141	118	
NRVRDFLD13.0	*E. coli*	6/11/2007	DRY	6	6	
NRVRDFLD13.0	*E. coli*	9/5/2007	DRY	9	7	
NRVRDFLD14.0	*E. coli*	6/11/2007	DRY	70	70	
NRVRDFLD14.0	*E. coli*	9/5/2007	DRY	96	82	
NRVRDFLD15.0	*E. coli*	6/11/2007	DRY	23	23	
NRVRDFLD15.0	*E. coli*	9/5/2007	DRY	44	32	
NRVRDFLD16.0	*E. coli*	9/5/2007	DRY	2420	2420	
NRVRDFLD16.0	*E. coli*	9/10/2007	WET	866	1448	
NRVRDFLD16.0	*E. coli*	10/3/2007	DRY	461	989	
NRVRDFLD16.5	*E. coli*	6/11/2007	DRY	44	44	
NRVRDFLD16.5	*E. coli*	9/10/2007	WET	866	866	
NRVRDFLD16.5	*E. coli*	10/3/2007	DRY	19	128	
NRVRDFLD17.0	*E. coli*	9/10/2007	WET	816	816	
NRVRDFLD17.0	*E. coli*	10/3/2007	DRY	16	114	
NRVRDFLD18.0	*E. coli*	9/10/2007	WET	1046	1046	
NRVRDFLD18.0	*E. coli*	10/3/2007	DRY	23	155	
NRVRDFLD19.0	*E. coli*	10/3/2007	DRY	56	56	
W1347	*E. coli*	5/17/2005	DRY	28	28	
W1347	*E. coli*	6/7/2005	DRY	201	75	
W1347	*E. coli*	7/19/2005	DRY	548	146	
W1347	*E. coli*	8/16/2005	WET	411	356	
W1347	*E. coli*	9/21/2005	DRY	167	335	
W1347	Fecal Coliform	5/17/2005	DRY	30		
W1347	Fecal Coliform	6/7/2005	DRY	200		
W1347	Fecal Coliform	7/19/2005	DRY	630		
W1347	Fecal Coliform	8/16/2005	WET	470		
W1347	Fecal Coliform	9/21/2005	DRY	210		
W2255	*E. coli*	5/23/2012	DRY	111	111	
W2255	*E. coli*	6/13/2012	WET	345	196	
W2255	*E. coli*	6/28/2012	DRY	50	124	
W2255	*E. coli*	8/2/2012	DRY	238	146	
W2255	*E. coli*	8/30/2012	DRY	22	97	
W2255	*E. coli*	9/27/2012	DRY	21	48	

5.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 East Branch North River (MA33-19) were elevated primarily during dry weather. 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 watershed is lightly developed (1% of the total land area) with no MS4 area and 1% as DCIA. Nonetheless, developed areas are concentrated along the river corridor, with the state highway MA-112 running adjacent to the entire river segment, and several villages built right on the banks. Stormwater runoff from urban areas is likely a source of pathogens.

Illicit Sewage Discharges: The MA portion of the watershed is likely not served by sewer; however, there may be private wastewater infrastructure, such as building wastewater drains, which may intersect with storm drainage. Leaky wastewater lines and illicit connections are a possible source of pathogens, though not at the same scale as more urbanized environments. Other forms of illicit discharges may occur, including unauthorized dumping of wastewater from pump-out trucks, campers, or other sources.

On-Site Wastewater Disposal Systems: Nearly all development in the watershed relies on 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. Previous source tracking efforts suspected a failing septic system near the MA-112 bridge at NOR-005 (FRCOG, 2008).

Agriculture: Agricultural activities in the watershed account for 8% of the land use, much of which is concentrated along the segment. Agricultural activities visible on recent aerial within the segment watershed include open fields, row crops, and pastureland. In some areas, no natural vegetated buffer exists between agricultural areas and the impaired segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. Previous source tracking efforts identified agricultural activity between Reil Lane and Colrain Elementary School as a potential pathogen source to the segment and observed multiple areas where manure used as fertilizer was piled close to the river (FRCOG, 2008; MassDEP, 2007; MassDEP, 2008).

Pet Waste: Village centers are concentrated along the river corridor. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: There are several areas along the segment with little or no natural vegetative buffer. Large open mowed areas such as conservation and recreation lands, fields, and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water. Previous source tracking efforts also suspected pigeon use of the MA-112 bridge at NOR-005 to be a possible pathogen source to the segment (FRCOG, 2008).

5.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Colrain

Colrain is not within the MS4 area.

Colrain's relevant ordinances and bylaws:

- Colrain does not have any supplementary regulations beyond the MassDEP regulations for stormwater management and wetland protection.
- Open Space Plan: None found.
- Title 5 Supplementary Regulations: None found.
- Pet Waste: None found.
- Stormwater Utility (or similar): None found.
- Contact Recreation Regulations or Bylaws: None found.

Colrain does not have a Master Plan or other planning documents available. The town website is available at https://colrain-ma.gov/. (Town of Colrain, 2020).

A watershed-based plan has been created for this watershed by the Massachusetts Association of Conservation Districts and Geosyntec Consultants, Inc. (Geosyntec, 2021).

6. MA33-21 Hinsdale Brook

6.1. Waterbody Overview

The Hinsdale Brook segment MA33-21 is 2.8 miles long and begins east of Fiske Mill Road and north of Brook Road in Shelburne, MA. The segment flows southeast along Colrain Road into Greenfield to end at its confluence with Punch Brook in Greenfield, MA.

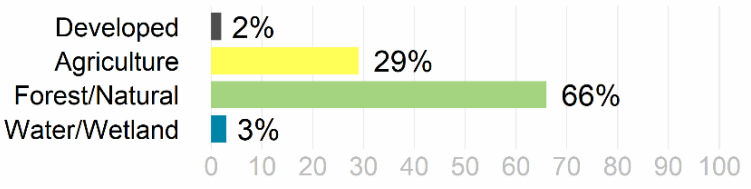
Tributaries to the Hinsdale Brook segment MA33-21 include Stewart Brook and several smaller unnamed streams. There are no other pathogen-impaired segments within the Hinsdale Brook watershed. There are no named lakes or ponds within the segment watershed.

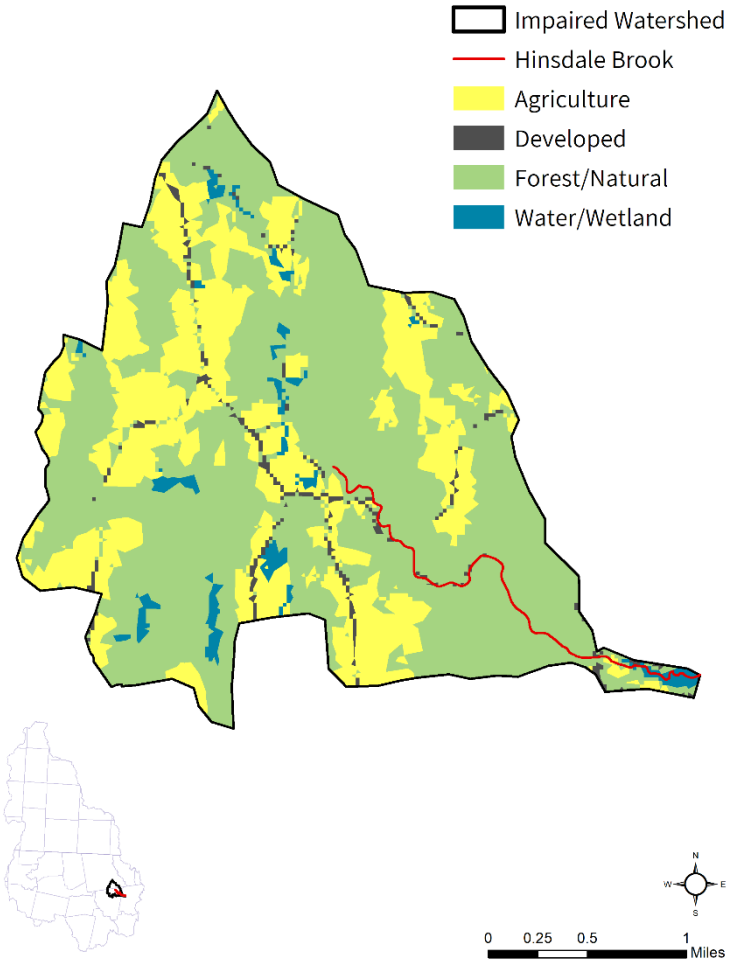
Key landmarks in the watershed include the Vipassana Meditation Center, the village of East Shelburne, and Apex Orchards. The segment is crossed by Wilson Graves Road and Brook Road (twice) in Shelburne; and Green River Road in Greenfield. Brook Road closely follows the brook's path for most of its length.

Hinsdale Brook (MA33-21) drains an area of 5.4 square miles, of which 0.1 mi^2 (3%) is impervious and 0.02 mi^2 (<1%) is directly connected impervious area (DCIA). The watershed is partially[10] served by public sewer and 2% 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 and no MassDEP discharge to groundwater permits for on-site wastewater discharge within the watershed. There are also no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 6-1.

The Hinsdale Brook watershed is predominantly forested (66%), with significant agricultural land (29%), much of which is adjacent to the brook or its tributaries. Agricultural activities are primarily orchards, hayfields, and row crops. The watershed is lightly developed (2%), with some development in the village of East Shelburne concentrated near the headwaters of the segment. Most of the

Reduction from Highest Calculated Geomean: 67%
Watershed Area (Acres): 3,426
Segment Length (Miles): 2.8
Impairment(s): *E. coli* (Primary Contact Recreation)
Class (Qualifier): B (Cold Water)
Impervious Area (Acres, %): 89 (3%)
DCIA Area (Acres, %): 13 (<1%)





[10] 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.

segment itself flows through a steep, forested valley.

In the Hinsdale Brook (MA33-21) watershed, under the Natural Heritage and Endangered Species Program, there are 37 acres (1%) of Priority Habitats of Rare Species. There are 20 acres (1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. There are 820 acres (24%) of land protected in perpetuity[11] within the segment watershed, all of which are classified as Protected and Recreational Open Space[12]. See Figure 6-1.

[11] 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.

[12] 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).

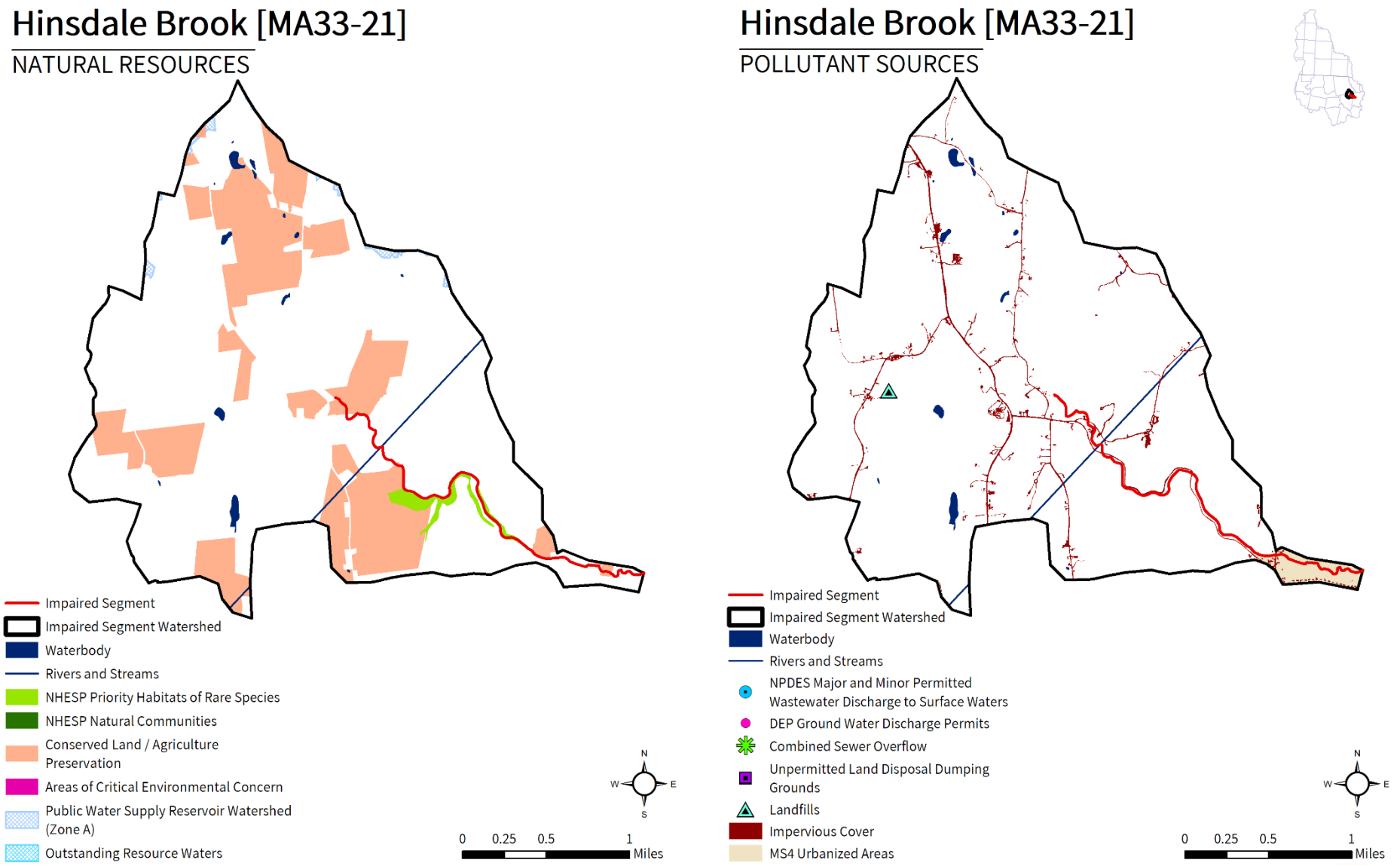


Figure 6-1. Natural resources and potential pollution sources draining to the Hinsdale Brook segment MA33-21. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

6.2. Waterbody Impairment Characterization

Hinsdale Brook (MA33-21) 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 stations listed below (refer to Tables 6-1, 6-2; 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, 90-day rolling basis.

- In 2005, five samples were collected at W1346, 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 five samples, one exceeded the STV criterion during dry weather.
- In 2012, six samples were collected at W2275, 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.

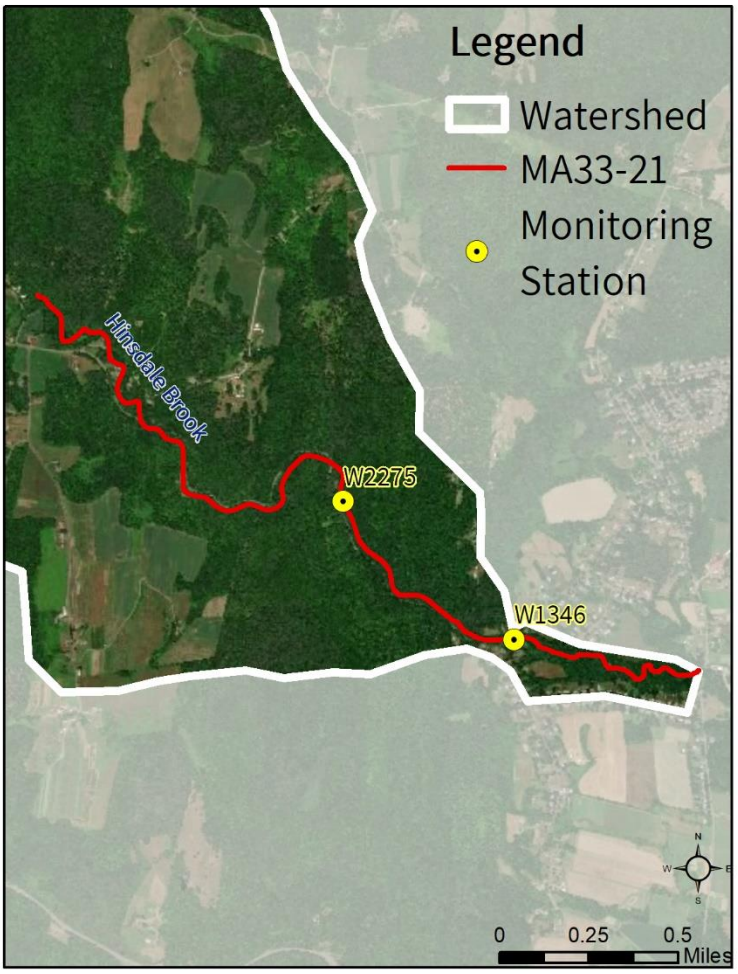


Figure 6-2. Location of monitoring station(s) along the impaired river segment.

Table 6-1. Summary of indicator bacteria sampling results by station for Hinsdale Brook (MA33-21). 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
W1346	5/17/2005	9/21/2005	5	383	3	1
W2275	5/23/2012	9/27/2012	6	47	0	0

Table 6-2. Indicator bacteria data by station, indicator, and date for Hinsdale Brook (MA33-21). 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)
W1346	*E. coli*	5/17/2005	DRY	93	93	
W1346	*E. coli*	6/7/2005	DRY	291	165	
W1346	*E. coli*	7/19/2005	DRY	921	292	
W1346	*E. coli*	8/16/2005	WET	210	383	
W1346	*E. coli*	9/21/2005	DRY	10	125	
W1346	Fecal Coliform	5/17/2005	DRY	110		
W1346	Fecal Coliform	6/7/2005	DRY	350		
W1346	Fecal Coliform	7/19/2005	DRY	1100		
W1346	Fecal Coliform	8/16/2005	WET	200		
W1346	Fecal Coliform	9/21/2005	DRY	10		
W2275	*E. coli*	5/23/2012	DRY	8	8	
W2275	*E. coli*	6/13/2012	WET	276	47	
W2275	*E. coli*	6/28/2012	DRY	17	33	
W2275	*E. coli*	8/2/2012	DRY	26	31	
W2275	*E. coli*	8/30/2012	DRY	19	39	
W2275	*E. coli*	9/27/2012	DRY	10	17	

6.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 Hinsdale Brook (MA33-21) were elevated during dry weather. 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 watershed is lightly developed with 2% of the land area in MS4, <1% as DCIA, and no major city or village centers. Nonetheless, stormwater runoff from urban areas is possibly a contributing source of pathogens.

Illicit Sewage Discharges: The downstream portion of the watershed along the segment contains some sewer service areas. 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: Nearly all development in the upstream portions of the watershed relies on 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 29% of the total land use area within the watershed (over 14 times that of developed land). Agricultural activities visible on recent aerial photos within the segment watershed include open fields, row crops, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to water bodies. Stormwater runoff from agricultural lands are likely the most significant source of pathogens to the segment.

Pet Waste: There are a few residential neighborhoods near the headwaters of the brook and in the downstream portion of the watershed. Conservation lands, parks, ballfields, and residential streets popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: There are a few open meadow wetlands in the headwaters of the brook, though most of the brook flows within a wide wooded buffer. Large open mowed areas such as conservation and recreation land, fields, and wetlands 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. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Colrain. See Section 5.4

Town of Greenfield. See Section 3.4

Town of Shelburne. See Section 3.4

7. MA33-30 Green River

7.1. Waterbody Overview

The Green River segment MA33-30 is 3.7 miles long and begins at Swimming Pool #2 Dam (National Dam ID MA02321) northwest of Nash's Mill Road in Greenfield, MA. The segment flows south through Greenfield to end at its confluence with the Deerfield River in Greenfield, MA. This segment was formerly segment MA33-10 and part of segment MA33-09. The area upstream of former Greenfield WWTF discharge (NPDES# MA0101214), corresponding to all but the last 0.5 miles of the segment, is designated High Quality Waters (HQW) by statute.

Direct tributaries to the Green River segment MA33-30 include Cherry Rum Brook, Mill Brook, Arms Brook, and Wheeler Brook. Hinsdale Brook (MA33-21) is a pathogen-impaired segment that is not a direct tributary but is upstream of this segment. Named lakes and ponds within the watershed include South Pond and Deer Park Pond in VT and Maynard Pond, Newell Pond, and the Greenfield Reservoir in MA.

Key landmarks along the segment include the Green River Conservation Land, Four Rivers Charter Public School, Greenfield town center, and the Green River Park. The segment is crossed by Nash's Mill Road, I-91/MA-2, Colrain Street, Mohawk Trail/MA-2A and adjacent railroad, Mill Street, and Meridian Street, all in Greenfield. The Riverside Community Path follows the river from Riverside Drive (Greenfield) to Greenfield Beach, crossing the river near where the segment starts.

The Green River (MA33-30) drains a total area of 89 square miles, of which 4 mi^2 (5%) is impervious and 2 mi^2 (2%) is directly connected impervious area (DCIA). The segment watershed extends into VT. Of the total watershed area of 89 mi^2, 52 mi^2 (58%) are within MA. The watershed is partially[13] served by public sewer and 9% of the watershed (15% of the area within MA) 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

Reduction from Highest Calculated Geomean: 93%

Watershed Area (Acres): 57,144

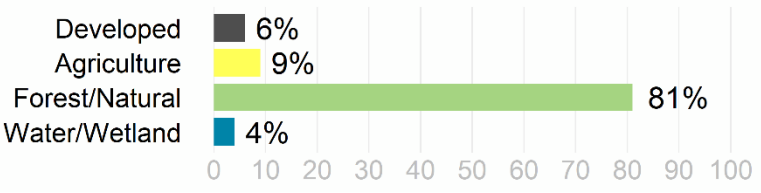
Segment Length (Miles): 3.7

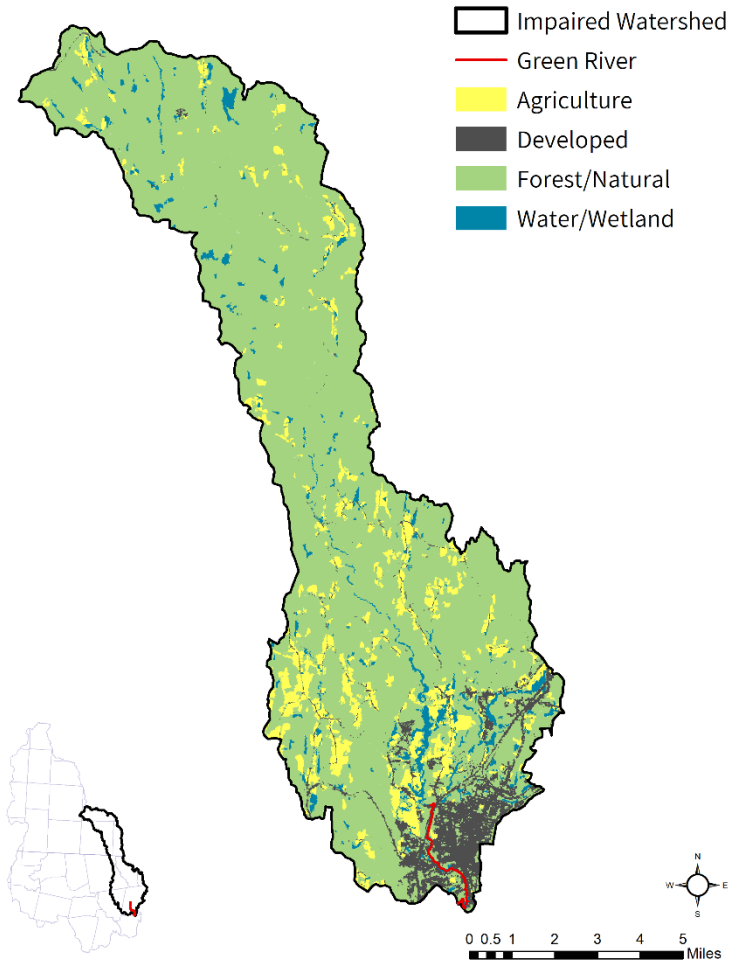
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Cold Water, High Quality Water)

Impervious Area (Acres, %): 2,665 (5%)

DCIA Area (Acres, %): 1,089 (2%)





[13] 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.

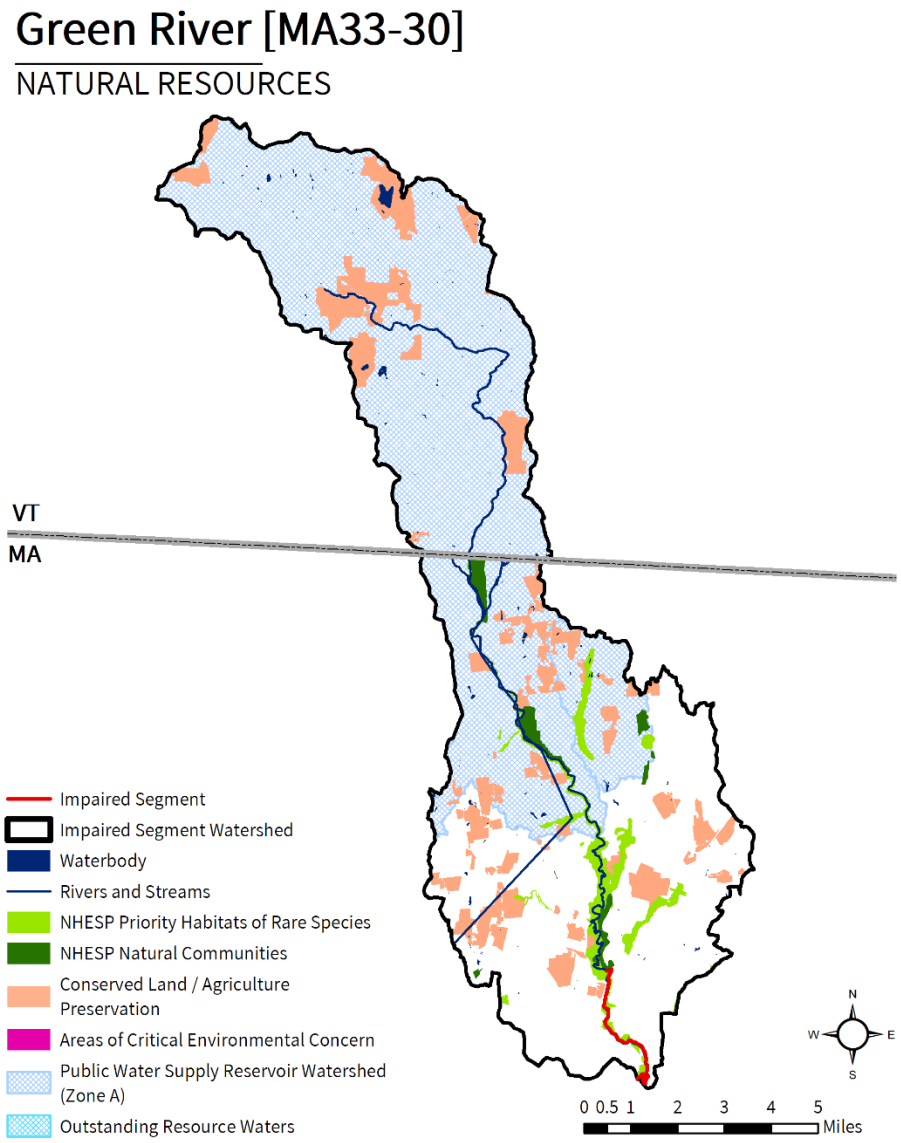
waters and no MassDEP discharge to groundwater permits for on-site wastewater discharge within the MA portion of the segment watershed. There are also no combined sewer overflows within the MA portion of the watershed, three landfills (1 landfill within MA), and no unpermitted land disposal dumping grounds within the MA portion of the watershed. See Figure 7-1.

Most of the watershed is forested (81% of land area); however, the lower portion of the watershed surrounding the segment contains the urbanized areas of Greenfield. The upper part of the segment flows between I-91 and a narrow, wooded buffer, beyond which is medium to high density residential, commercial, and transportation development. The downstream portion of the river is closely flanked by mixed urban development with minimal or no vegetative buffer. The river is channelized between cement walls for a short distance downstream of Meridian Street.

In the Green River (MA33-30) watershed, under the Natural Heritage and Endangered Species Program, there are 2,157 acres (4%) of Priority Habitats of Rare Species and 710 acres (1%) of Priority Natural Vegetation Communities in the MA portion of the watershed. There are 36,454 acres (64%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the MA portion of the watershed. Over 7,179 acres (13%) of land protected in perpetuity[14] exist within the segment watershed (including VT), which is part of a total of 9,990 acres (17%) of Protected and Recreational Open Space[15]. See Figure 7-1.

[14] 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.

[15] 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).



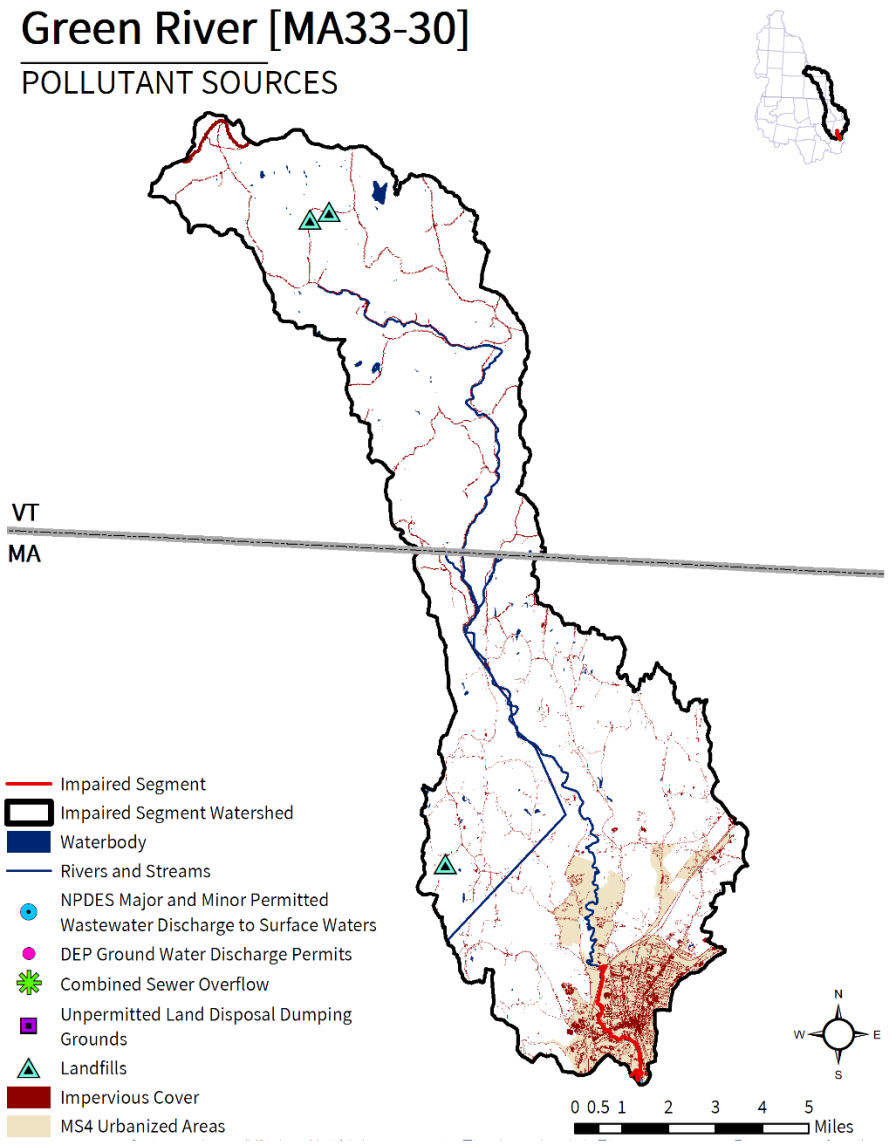


Figure 7-1. Natural resources and potential pollution sources draining to the Green River segment MA33-30. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

7.2. Waterbody Impairment Characterization

The Green River (MA33-30) is a Class B, Cold Water and High Quality Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 7-1, 7-2; 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, 90-day rolling basis.

- In 2005, five samples were collected at W0005, 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 five samples, four exceeded the STV criterion during wet and dry weather.
- In 2012, six samples were collected at W2248, 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, two exceeded the STV criterion during wet and dry weather.

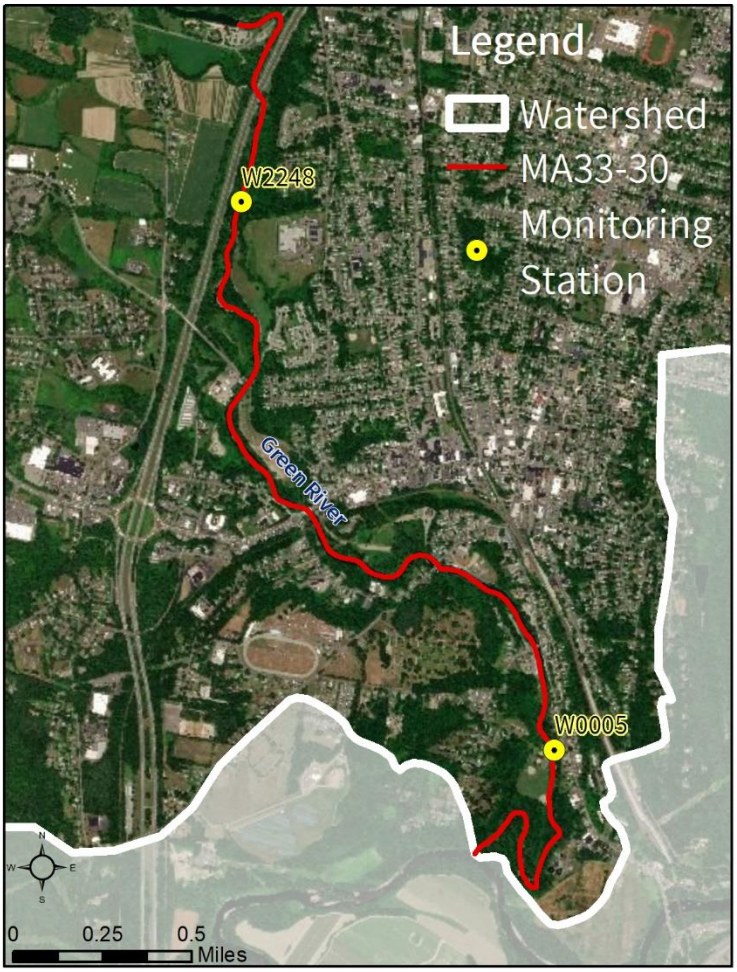


Figure 7-2. Location of monitoring station(s) along the impaired river segment.

Table 7-1. Summary of indicator bacteria sampling results by station for the Green River (MA33-30). 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
W0005	5/17/2005	9/21/2005	5	1740	4	4
W2248	5/23/2012	9/27/2012	6	330	4	2

Table 7-2. Indicator bacteria data by station, indicator, and date for the Green River (MA33-30). 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)
W0005	*E. coli*	5/17/2005	DRY	49	49	
W0005	*E. coli*	6/7/2005	DRY	1410	263	
W0005	*E. coli*	7/19/2005	DRY	2480	555	
W0005	*E. coli*	8/16/2005	WET	770	1391	
W0005	*E. coli*	9/21/2005	DRY	2760	1740	
W0005	Fecal Coliform	5/17/2005	DRY	70		
W0005	Fecal Coliform	6/7/2005	DRY	1800		
W0005	Fecal Coliform	7/19/2005	DRY	3300		
W0005	Fecal Coliform	8/16/2005	WET	860		
W0005	Fecal Coliform	9/21/2005	DRY	3300		
W2248	*E. coli*	5/23/2012	DRY	63	63	
W2248	*E. coli*	6/13/2012	WET	1730	330	
W2248	*E. coli*	6/28/2012	DRY	84	209	
W2248	*E. coli*	8/2/2012	DRY	517	262	
W2248	*E. coli*	8/30/2012	DRY	64	263	
W2248	*E. coli*	9/27/2012	DRY	49	117	

7.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 levels for the Green River (MA33-30) were elevated during both wet and dry weather. Elevated indicator bacteria levels during wet weather are 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 watershed are highly developed. Even though only 9% of the land area is mapped as MS4 and 2% as DCIA, the urban development of Greenfield is concentrated within the direct drainage area adjacent to the segment. These areas consist of medium to high density mixed residential, commercial, and transportation development, as well as an interstate corridor running parallel to the river for 0.8 miles. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: The downstream portion of the watershed along the segment is partially serviced by 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.

On-Site Wastewater Disposal Systems: All development in the upstream portion of the watershed relies on 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 in the watershed account for 9% of the total land use. Agricultural activities visible on recent aerial photos along the segment include open fields, row crops, and pastureland. 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 (including Green River Park), ballfields, and residential neighborhoods 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 such as golf courses, fields, or wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water. Lawns mowed to the water's edge are visible along Meade Street and Kimball Drive in Greenfield. Another wildlife source of pathogens to the water may be birds congregating on the underside of bridges, such as the large I-91 bridges near the upstream end of the segment.

7.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin (excludes upstream impaired segment watersheds). For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Colrain. See Section 5.4

Town of Greenfield. See Section 3.4

Town of Leyden

Leyden is not within the MS4 area.

Leyden's relevant ordinances and bylaws:

- Leyden does not have any supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.
- Title 5 Supplementary Regulations: None found.
- Stormwater Utility: None found.
- Pet Waste: None found.

The Town of Leyden does not have a Master Plan or Open Space and Recreation Plan available online. The zoning bylaws note that stormwater runoff shall be contained on site.

Town website: https://www.townofleyden.com/ (Town of Leyden, 2020)

8. MA33-101 South River

8.1. Waterbody Overview

The South River segment MA33-101 is 6.1 miles long and begins at Emmet Road, east of Conway Road/MA-116 in Ashfield, MA. The segment then flows generally west along Ashfield Road/MA-116 to end at its confluence with Johnny Bean Brook in Conway, MA. This river segment was formerly part of MA33-08.

Tributaries to the South River segment MA33-101 include the unimpaired upstream section of the South River, Creamery Brook, Poland Brook and many smaller unnamed streams. Named lakes and ponds within the watershed include Ashfield Pond and Twinning Brook Pond.

Key landmarks in the watershed include the town centers of Ashfield and South Ashfield and the Ashfield Community Golf Course. The segment is crossed by Conway Road/MA-116 (three times), Burton Hill Road, and Bullitt Road in Ashfield; and North Poland Road and Ashfield Road/MA-116 (twice) in Conway.

The South River (MA33-101) drains an area of 18 square miles, of which 0.4 mi^2 (2%) is impervious and 0.1 mi^2 (<1%) is directly connected impervious area (DCIA). The watershed is likely minimally[16] served by public sewer, and none 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 but one MassDEP discharge to groundwater permit for on-site wastewater discharge within the immediate drainage area (Table 8-1). There are also no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 8-1.

Reduction from Highest Calculated Geomean: 47%

Watershed Area (Acres): 11,525

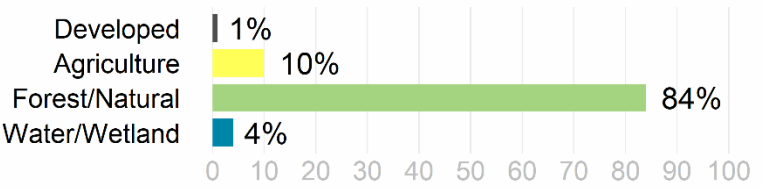
Segment Length (Miles): 6.1

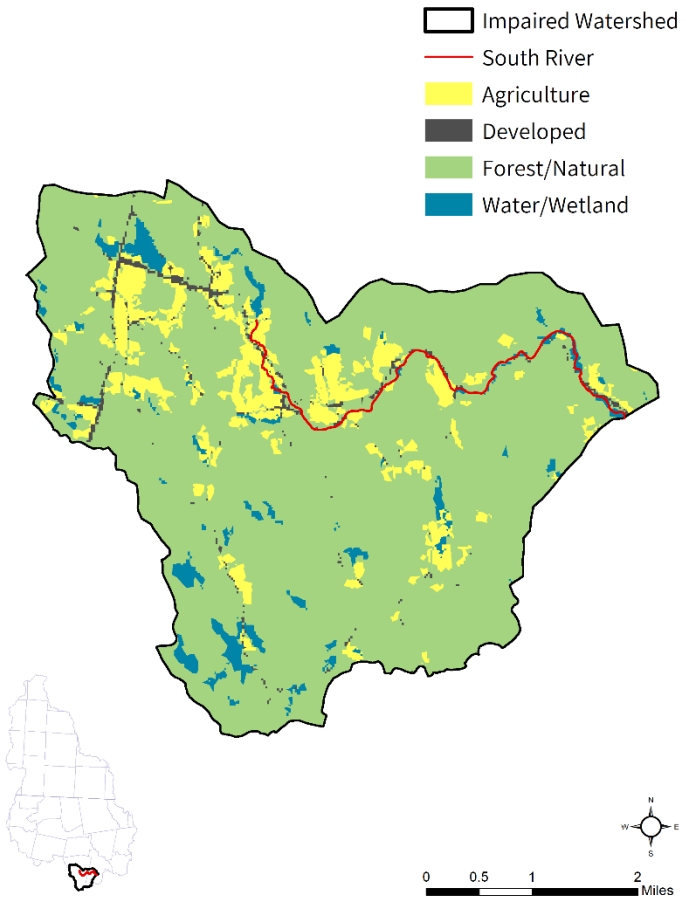
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Cold Water)

Impervious Area (Acres, %): 242 (2%)

DCIA Area (Acres, %): 47 (<1%)





[16] 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. Groundwater discharge permits in the segment watershed. Only permits unique to this segment watershed are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. Flow = permitted effluent in gallons per day (gpd).

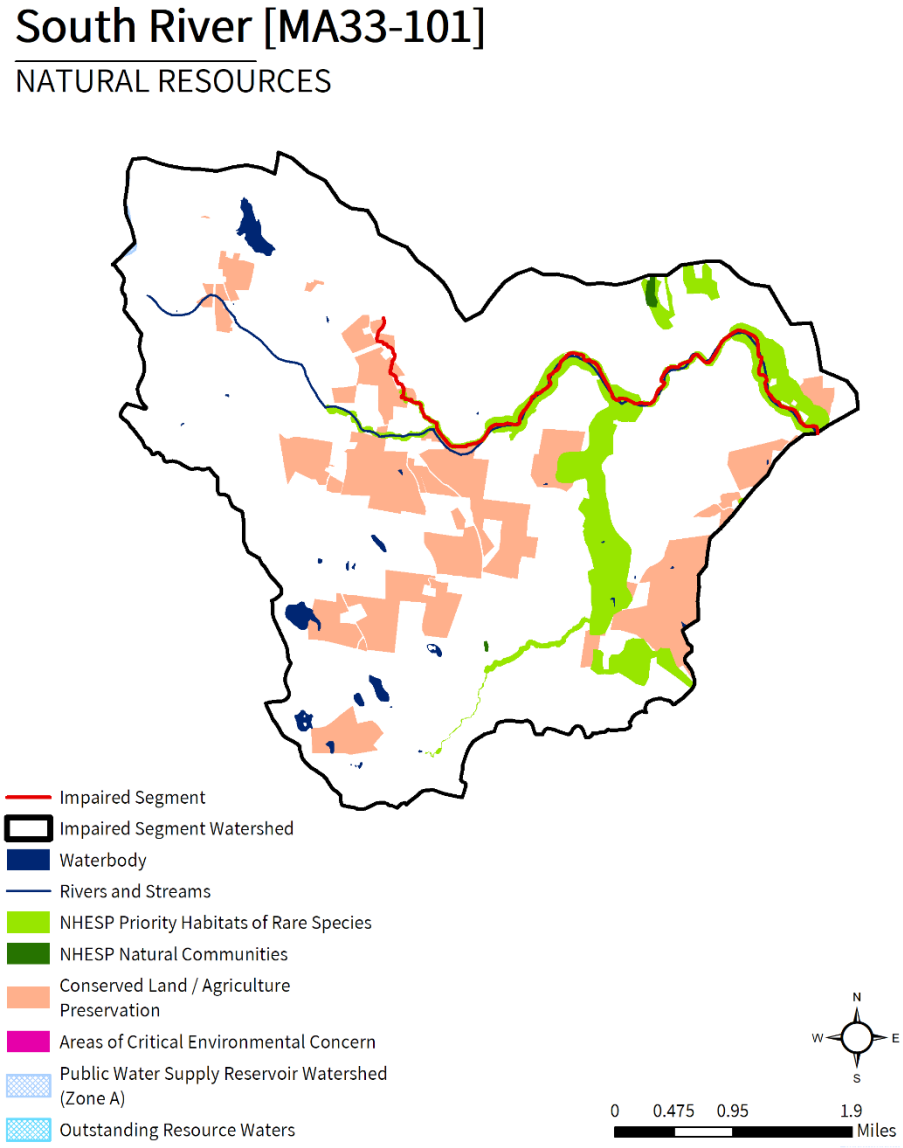
PERR	NAME	TOWN	TYPE	FLOW (GPD)
594-2	ASHFIELD WASTEWATER TREATMENT FACILITY	ASHFIELD	Sanitary Discharge	25,000

The watershed is predominantly forested (84%), with agricultural land use (10%) covering far more than developed land (1%). Agricultural activities are concentrated along the river corridor. These agricultural areas contain hayfields, row crops, and a few areas with livestock. Most of the development in the watershed is concentrated in the village of Ashfield, just upstream of the segment, though there is also scattered development along MA-116, which closely follows the segment.

In the watershed of the South River (MA33-101), under the Natural Heritage and Endangered Species Program, there are 893 acres (8%) of Priority Habitats of Rare Species and 13 acres (<1%) of Priority Natural Vegetation Communities. There are five acres (<1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. Over 1,756 acres (15%) of land protected in perpetuity[17] exist within the segment watershed, which is part of a total of 3,394 acres (29%) of Protected and Recreational Open Space[18]. See Figure 8-1.

[17] 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.

[18] 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).



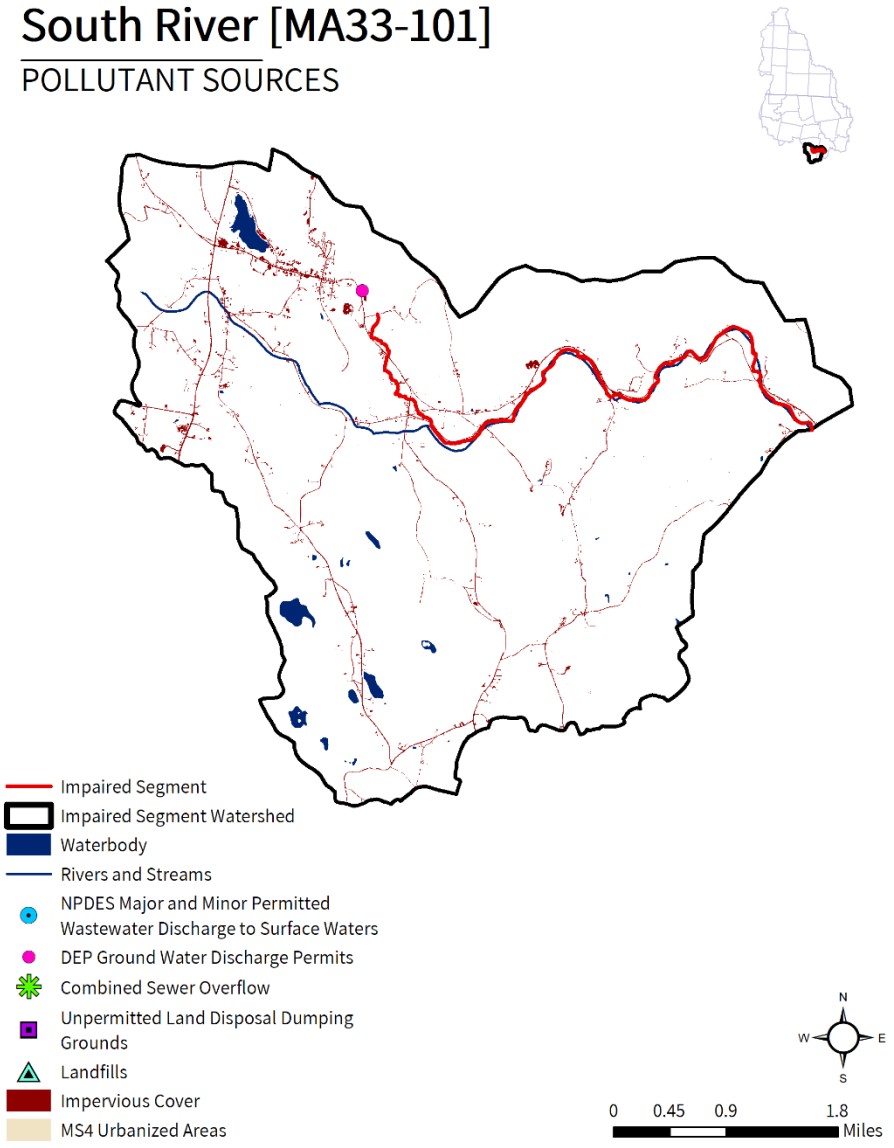


Figure 8-1. Natural resources and potential pollution sources draining to the South River segment MA33-101. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

8.2. Waterbody Impairment Characterization

The South River (MA33-101) 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 stations listed below (refer to Tables 8-2, 8-3; Figure 8-2). Only the primary MassDEP monitoring stations are shown in Figure 8-2. Indicator bacteria data were sourced from FRCOG (2008) and MassDEP. 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. Only stations with five or more samples are described as follows:

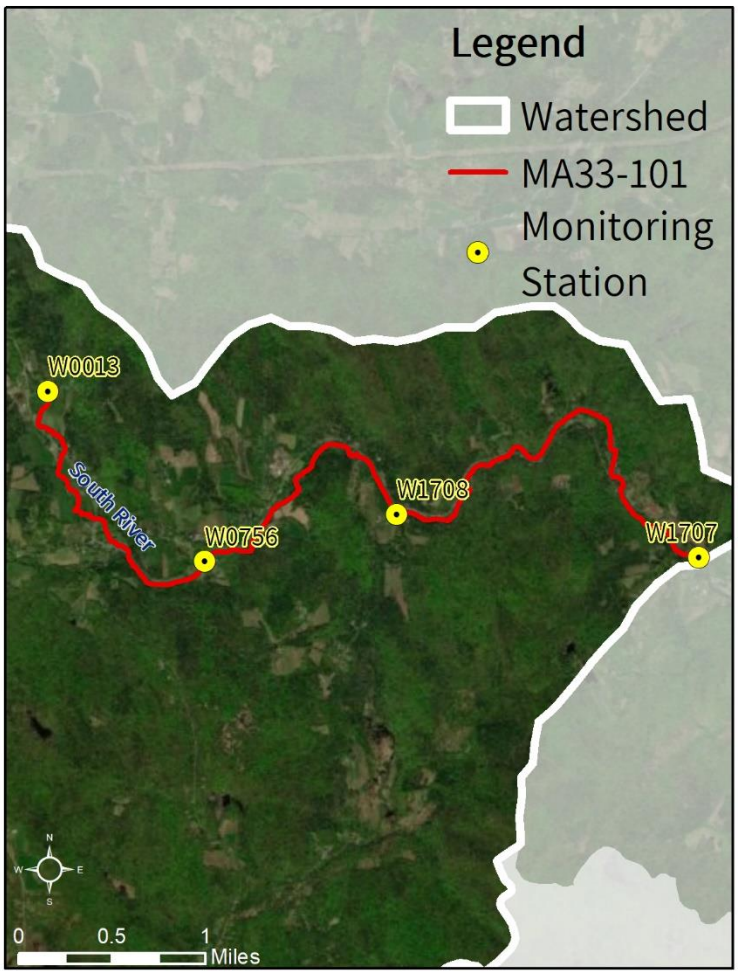


Figure 8-2. Location of monitoring station(s) along the impaired river segment.

- From 2005-2007, 17 samples were collected at SOR-006, resulting in six 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 17 samples, three exceeded the STV criterion in 2005 during dry weather.
- In 2006, six samples were collected at SOR-006A, 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 2007, five samples were collected at SOR-008, 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 five samples, two exceeded the STV criterion during dry weather.
- From 2005-2006, seven samples were collected at W0013, 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 seven samples, one exceeded the STV criterion during dry weather.

Table 8-2. Summary of indicator bacteria sampling results by station for the South River (MA33-101). 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
SOR-006	6/2/2005	8/25/2007	17	185	6	3
SOR-006A	6/17/2006	8/19/2006	6	88	0	0
SOR-008	6/16/2007	8/25/2007	5	203	3	2
W0013	5/17/2005	8/14/2006	7	236	3	1
W0756	7/20/2006	8/14/2006	2	61	0	0
W1707	7/20/2006	8/14/2006	2	78	0	0
W1708	7/20/2006	8/14/2006	2	236	1	1

Table 8-3. Indicator bacteria data by station, indicator, and date for the South River (MA33-101). 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)
SOR-006	*E. coli*	6/2/2005	DRY	12	12	
SOR-006	*E. coli*	6/12/2005	DRY	276	58	
SOR-006	*E. coli*	7/6/2005	DRY	435	113	
SOR-006	*E. coli*	7/13/2005	DRY	147	121	
SOR-006	*E. coli*	7/31/2005	DRY	529	162	
SOR-006	*E. coli*	8/14/2005	DRY	99	149	
SOR-006	*E. coli*	8/28/2005	DRY	480	176	
SOR-006	*E. coli*	6/17/2006	DRY	34	34	
SOR-006	*E. coli*	6/23/2006	DRY	30	32	
SOR-006	*E. coli*	7/8/2006	DRY	142	53	
SOR-006	*E. coli*	8/6/2006	WET	207	74	
SOR-006	*E. coli*	8/19/2006	DRY	96	78	
SOR-006	*E. coli*	6/16/2007	DRY	185	185	
SOR-006	*E. coli*	6/30/2007	DRY	141	162	
SOR-006	*E. coli*	7/15/2007	DRY	100	138	
SOR-006	*E. coli*	7/28/2007	DRY	79	120	
SOR-006	*E. coli*	8/25/2007	DRY	35	94	
SOR-006A	*E. coli*	6/17/2006	DRY	39	39	
SOR-006A	*E. coli*	6/23/2006	DRY	51	45	
SOR-006A	*E. coli*	7/8/2006	DRY	144	66	
SOR-006A	*E. coli*	7/21/2006	DRY	68	66	
SOR-006A	*E. coli*	8/6/2006	WET	276	88	
SOR-006A	*E. coli*	8/19/2006	DRY	61	83	
SOR-008	*E. coli*	6/16/2007	DRY	95	95	
SOR-008	*E. coli*	6/30/2007	DRY	77	86	
SOR-008	*E. coli*	7/15/2007	DRY	435	147	
SOR-008	*E. coli*	7/28/2007	DRY	119	139	
SOR-008	*E. coli*	8/25/2007	DRY	921	203	
W0013	*E. coli*	5/17/2005	DRY	17	17	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0013	*E. coli*	6/7/2005	DRY	133	48	
W0013	*E. coli*	7/19/2005	DRY	649	114	
W0013	*E. coli*	8/16/2005	WET	153	236	
W0013	*E. coli*	9/21/2005	DRY	77	197	
W0013	Fecal Coliform	5/17/2005	DRY	10		
W0013	Fecal Coliform	6/7/2005	DRY	150		
W0013	Fecal Coliform	7/19/2005	DRY	800		
W0013	Fecal Coliform	8/16/2005	WET	210		
W0013	Fecal Coliform	9/21/2005	DRY	100		
W0013	*E. coli*	7/20/2006	DRY	167	167	
W0013	*E. coli*	8/14/2006	DRY	57	98	
W0756	*E. coli*	7/20/2006	DRY	61	61	
W0756	*E. coli*	8/14/2006	DRY	37	48	
W1707	*E. coli*	7/20/2006	DRY	78	78	
W1707	*E. coli*	8/14/2006	DRY	64	71	
W1708	*E. coli*	7/20/2006	DRY	114	114	
W1708	*E. coli*	8/14/2006	DRY	488	236	

8.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 River (MA33-101) were elevated during dry weather. Elevated results 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 watershed is lightly developed with most concentrated in the Ashfield town center and the rest scattered along MA-116. None of the land area is in MS4 and <1% is DCIA. Development within the watershed consists primarily of low-density residential development. Stormwater runoff from urban areas is likely a small contributing source of pathogens.

Illicit Sewage Discharges: The watershed is likely not serviced by sewer; however, there may be private wastewater infrastructure, such as building wastewater drains, which may intersect with storm drainage. Leaky wastewater lines and illicit connections are a possible source of pathogens, though not at the same scale as more urbanized environments. Other forms of illicit discharges may occur, including unauthorized dumping of wastewater from pump-out trucks, campers, or other sources.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge within the immediate drainage area. Most development in the watershed relies on 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 10% of the total land use within the watershed. Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Most of the agricultural lands are concentrated along the river corridor. Those related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. Stormwater runoff from agricultural lands are likely a significant source of pathogens to the segment.

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

Wildlife Waste: There are a few areas along Conway Road in Ashfield where fields are mowed to the water's edge and there is little or no wooded buffer along the stream. Large open mowed areas such as conservation and recreation lands, fields, golf courses, and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

8.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin (excludes upstream impaired segment watersheds). For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashfield. See Section 4.4

Town of Conway. See Section 3.4

9. MA33-102 South River

9.1. Waterbody Overview

The South River segment MA33-102 is 6.8 miles long and begins at the confluence of Johnny Bean Brook with the South River in Conway, MA. The segment (formerly part of MA33-08) flows east towards Conway town center, then north along Shelburne Falls Road and Bardwells Ferry Road, then finally east along Conway Station Road. Segment MA33-102 ends at its confluence with the Deerfield River in Conway, MA.

Named tributaries to the segment include Pumpkin Hollow Brook and several smaller unnamed streams. Named lakes and ponds within the watershed include Ashfield Pond, Conway Electric Reservoir (along the segment), and Twinning Brook Pond.

Key landmarks in the watershed include the Conway town center and the Conway Electric Reservoir (GNIS-ID 00605559). The segment is crossed by Main Poland Road, Ashfield Road/MA-116, River Street/MA-116, Main Street/MA-116, Reeds Bridge Road (twice), and an abandoned railway bridge, all within Conway.

The South River (MA33-102) drains an area of 26 square miles, of which 0.6 mi^2 (2%) is impervious and 0.1 mi^2 (<1%) is directly connected impervious area (DCIA). The watershed is likely minimally[19] served by public sewer, and none 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 but one MassDEP discharge to groundwater permit for on-site wastewater discharge within the watershed (not within the immediate drainage area). There are also no combined sewer overflows, two landfills, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 9-1.

The watershed is predominantly forested (84%), with agricultural land use (10%) covering far more than developed land (2%). Agricultural activities are concentrated along the river corridor, especially along Shelburne Falls Road. These

Reduction from Highest Calculated Geomean: 70%

Watershed Area (Acres): 16,382

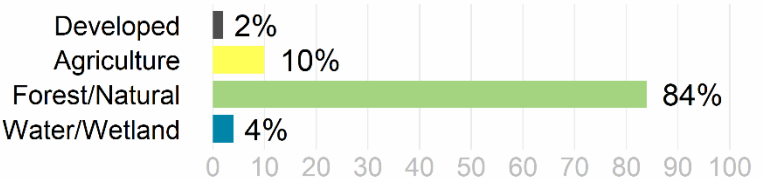
Segment Length (Miles): 6.8

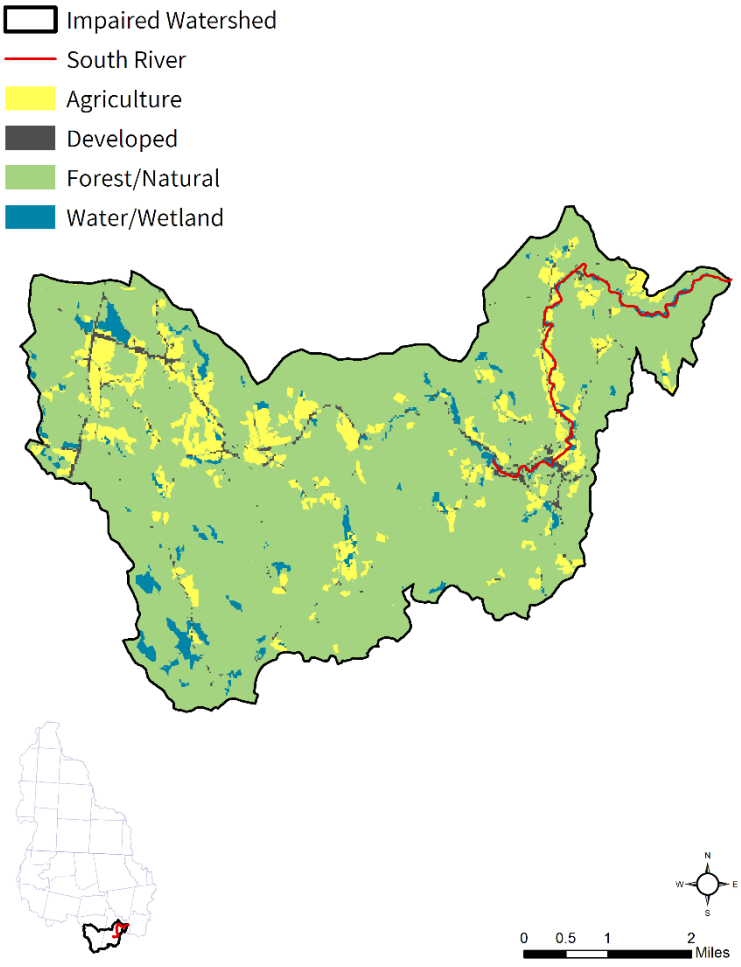
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 373 (2%)

DCIA Area (Acres, %): 70 (<1%)





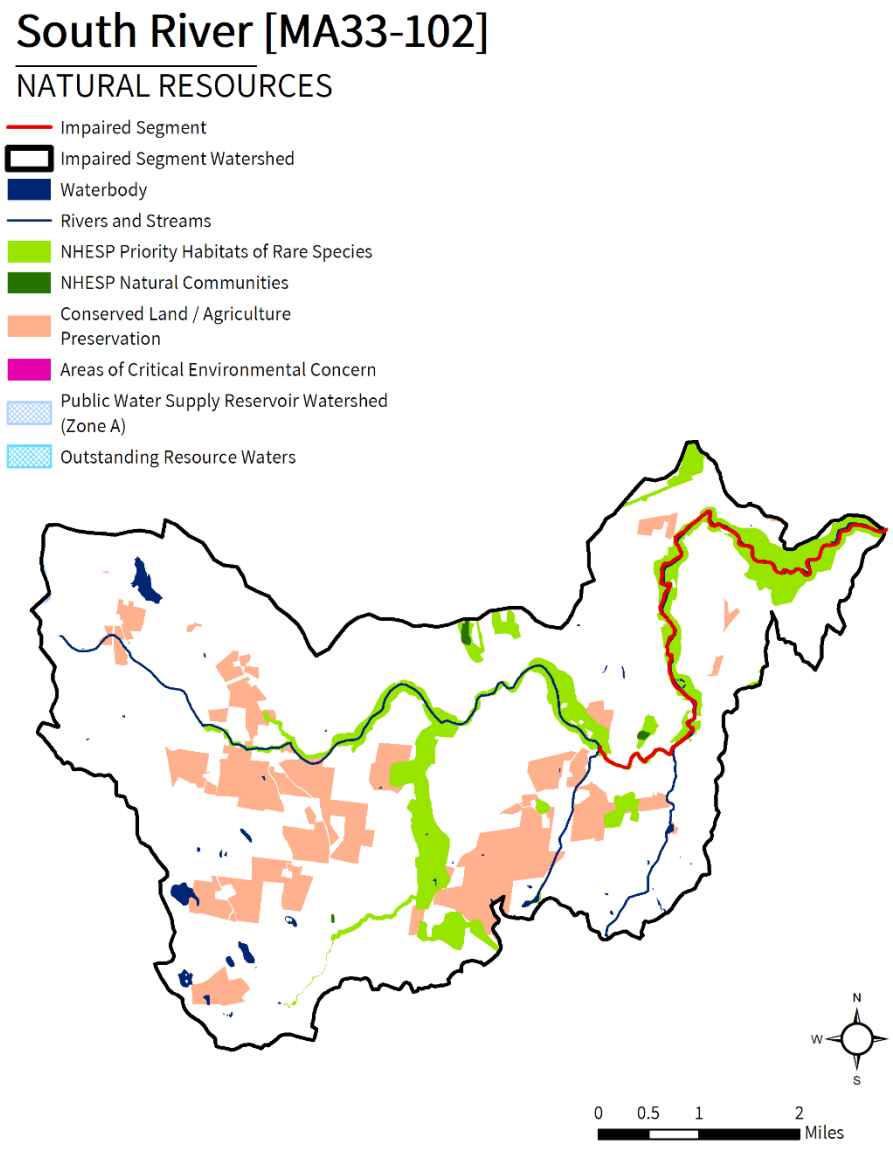
[19] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2020), MS4 reports, and local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

agricultural areas contain hayfields, row crops, and a few areas with livestock. Most of the development in the watershed is concentrated in the village of Conway, near the upper part of the segment, though there is also scattered development along Ashfield Road and Shelburne Falls Road, which follow the river.

In the watershed of the South River (MA33-102), under the Natural Heritage and Endangered Species Program, there are 1,694 acres (10%) of Priority Habitats of Rare Species and 19 acres (<1%) of Priority Natural Vegetation Communities. There are five acres (<1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. Over 2,219 acres (13%) of land protected in perpetuity[20] exist within the segment watershed, which is part of a total of 4,006 acres (24%) of Protected and Recreational Open Space[21]. See Figure 9-1.

[20] 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.

[21] 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).



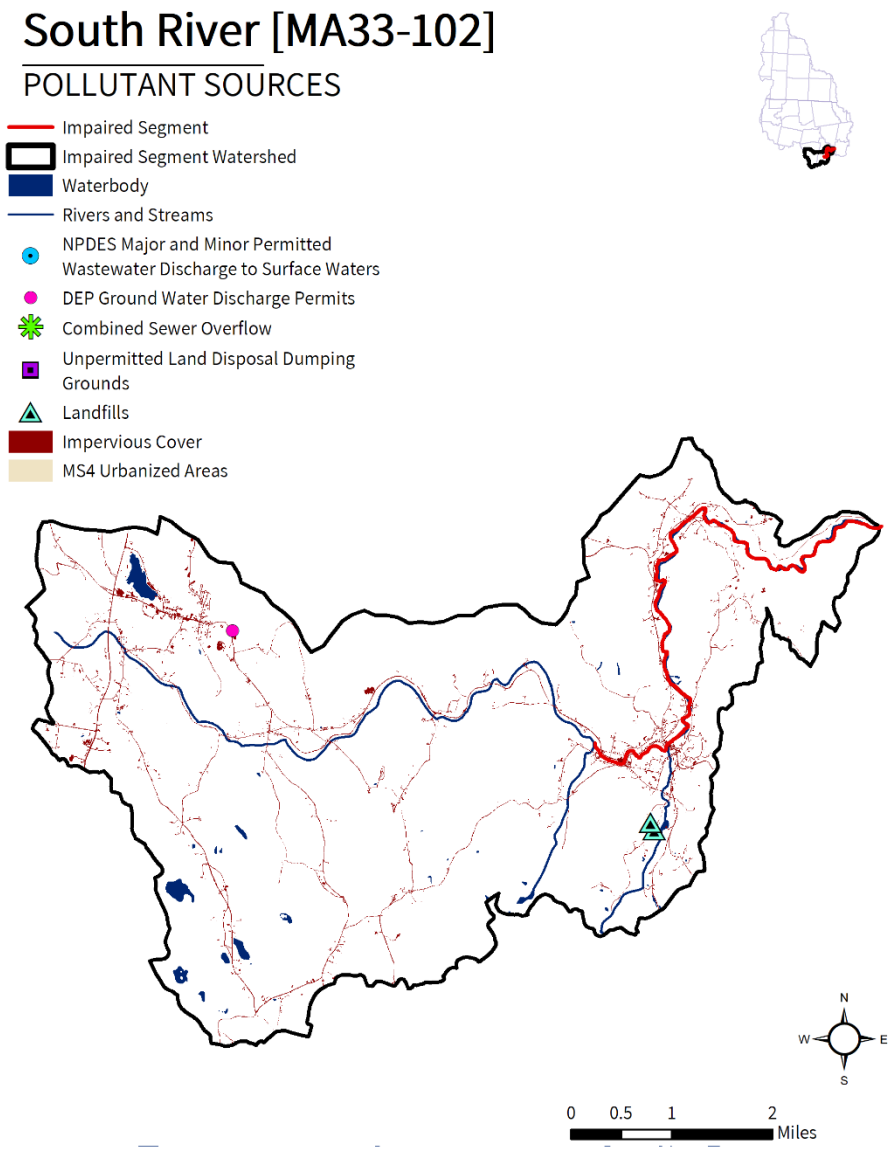


Figure 9-1. Natural resources and potential pollution sources draining to the South River segment MA33-102. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

9.2. Waterbody Impairment Characterization

The South River (MA33-102) 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). Only the primary MassDEP monitoring stations are shown in Figure 9-2. Indicator bacteria data were sourced from FRCOG (2008) and MassDEP (2012). 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. Only stations with five or more samples are described as follows:

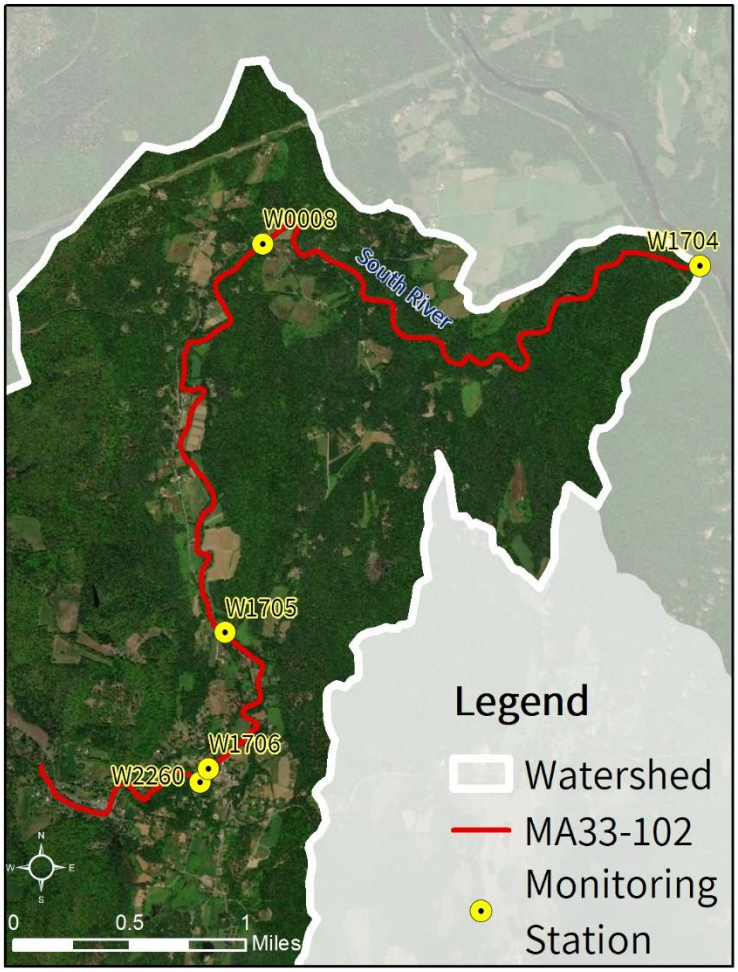


Figure 9-2. Location of monitoring station(s) along the impaired river segment.

- In 2005, six samples were collected at SOR-001, 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 during dry weather.
- In 2005, six samples were collected at SOR-002, 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, three exceeded the STV criterion during dry weather.
- In 2006, seven samples were collected at SOR-002A, 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 seven samples, one exceeded the STV criterion during wet weather.
- In 2007, six samples were collected at SOR-002B, 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 2006, seven samples were collected at SOR-002J, 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 seven samples, none exceeded the STV criterion.
- From 2005-2007, 21 samples were collected at SOR-004, resulting in seven 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 21 samples, five exceeded the STV criterion during dry weather.
- In 2007, nine samples were collected at SOR-004D, resulting in six 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 nine samples, two exceeded the STV criterion during dry weather.

- From 2005-2007, 12 samples were collected at SOR-005, resulting in six 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 12 samples, three exceeded the STV criterion during dry weather.
- From 2005-2006, seven samples were collected at W0008, 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 seven samples, two exceeded the STV criterion during both wet and dry weather.
- In 2012, six samples were collected at W2260, 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 six samples, none exceeded the STV criterion.

Table 9-1. Summary of indicator bacteria sampling results by station for the South River (MA33-102). 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
SOR-001	6/12/2005	8/28/2005	6	349	3	1
SOR-002	6/12/2005	8/28/2005	6	315	5	3
SOR-002A	6/17/2006	9/9/2006	7	211	5	1
SOR-002B	6/16/2007	8/25/2007	6	132	1	0
SOR-002J	6/17/2006	9/9/2006	7	119	0	0
SOR-004	6/2/2005	8/25/2007	21	268	7	5
SOR-004D	6/16/2007	8/25/2007	9	243	6	2
SOR-005	6/2/2005	8/25/2007	12	181	6	3
W0008	5/17/2005	8/14/2006	7	416	3	2
W1704	7/20/2006	8/14/2006	2	59	0	0
W1705	7/20/2006	8/14/2006	2	387	2	0
W1706	7/20/2006	8/14/2006	2	122	0	0
W2260	5/17/2012	9/20/2012	6	157	2	0

Table 9-2. Indicator bacteria data by station, indicator, and date for the South River (MA33-102). 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)
SOR-001	*E. coli*	6/12/2005	DRY	235	235	
SOR-001	*E. coli*	7/6/2005	DRY	517	349	
SOR-001	*E. coli*	7/13/2005	DRY	13	116	
SOR-001	*E. coli*	7/31/2005	DRY	276	144	
SOR-001	*E. coli*	8/14/2005	DRY	34	108	
SOR-001	*E. coli*	8/28/2005	DRY	99	107	
SOR-002	*E. coli*	6/12/2005	DRY	115	115	
SOR-002	*E. coli*	7/6/2005	DRY	413	218	
SOR-002	*E. coli*	7/13/2005	DRY	63	144	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
SOR-002	*E. coli*	7/31/2005	DRY	771	219	
SOR-002	*E. coli*	8/14/2005	DRY	328	238	
SOR-002	*E. coli*	8/28/2005	DRY	1302	315	
SOR-002A	*E. coli*	6/17/2006	DRY	118	118	
SOR-002A	*E. coli*	6/23/2006	DRY	77	95	
SOR-002A	*E. coli*	7/8/2006	DRY	345	146	
SOR-002A	*E. coli*	7/21/2006	DRY	260	169	
SOR-002A	*E. coli*	8/6/2006	WET	517	211	
SOR-002A	*E. coli*	8/19/2006	DRY	125	194	
SOR-002A	*E. coli*	9/9/2006	DRY	118	180	
SOR-002B	*E. coli*	6/16/2007	DRY	38	38	
SOR-002B	*E. coli*	6/30/2007	DRY	111	65	
SOR-002B	*E. coli*	7/15/2007	DRY	142	84	
SOR-002B	*E. coli*	7/28/2007	DRY	225	108	
SOR-002B	*E. coli*	8/12/2007	DRY	203	122	
SOR-002B	*E. coli*	8/25/2007	DRY	197	132	
SOR-002J	*E. coli*	6/17/2006	DRY	65	65	
SOR-002J	*E. coli*	6/23/2006	DRY	96	79	
SOR-002J	*E. coli*	7/8/2006	DRY	141	96	
SOR-002J	*E. coli*	7/21/2006	DRY	127	103	
SOR-002J	*E. coli*	8/6/2006	WET	139	109	
SOR-002J	*E. coli*	8/19/2006	DRY	140	114	
SOR-002J	*E. coli*	9/9/2006	DRY	153	119	
SOR-004	*E. coli*	6/2/2005	DRY	15	15	
SOR-004	*E. coli*	6/12/2005	DRY	1046	125	
SOR-004	*E. coli*	7/6/2005	DRY	1230	268	
SOR-004	*E. coli*	7/13/2005	DRY	70	192	
SOR-004	*E. coli*	7/31/2005	DRY	637	244	
SOR-004	*E. coli*	8/14/2005	DRY	101	210	
SOR-004	*E. coli*	8/28/2005	DRY	900	259	
SOR-004	*E. coli*	6/17/2006	DRY	93	93	
SOR-004	*E. coli*	6/23/2006	DRY	49	68	
SOR-004	*E. coli*	7/8/2006	DRY	199	97	
SOR-004	*E. coli*	7/21/2006	DRY	517	147	
SOR-004	*E. coli*	8/6/2006	WET	199	156	
SOR-004	*E. coli*	8/19/2006	DRY	14	105	
SOR-004	*E. coli*	9/9/2006	DRY	95	103	
SOR-004	*E. coli*	7/2/2007	DRY	33	33	
SOR-004	*E. coli*	7/15/2007	DRY	114	61	
SOR-004	*E. coli*	7/17/2007	DRY	62	62	
SOR-004	*E. coli*	7/22/2007	WET	150	77	
SOR-004	*E. coli*	7/28/2007	DRY	63	74	
SOR-004	*E. coli*	8/12/2007	DRY	31	64	
SOR-004	*E. coli*	8/25/2007	DRY	12	50	
SOR-004D	*E. coli*	6/16/2007	DRY	53	53	
SOR-004D	*E. coli*	6/30/2007	DRY	104	74	
SOR-004D	*E. coli*	7/2/2007	DRY	26	52	
SOR-004D	*E. coli*	7/15/2007	DRY	2420	136	
SOR-004D	*E. coli*	7/17/2007	DRY	2420	243	
SOR-004D	*E. coli*	7/22/2007	WET	142	222	
SOR-004D	*E. coli*	7/28/2007	DRY	94	196	
SOR-004D	*E. coli*	8/12/2007	DRY	96	179	
SOR-004D	*E. coli*	8/25/2007	DRY	41	152	
SOR-005	*E. coli*	6/2/2005	DRY	13	13	
SOR-005	*E. coli*	6/12/2005	DRY	74	31	

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
SOR-005	*E. coli*	7/6/2005	DRY	1120	103	
SOR-005	*E. coli*	7/13/2005	DRY	85	98	
SOR-005	*E. coli*	7/31/2005	DRY	825	150	
SOR-005	*E. coli*	8/14/2005	DRY	98	140	
SOR-005	*E. coli*	8/28/2005	DRY	866	181	
SOR-005	*E. coli*	7/17/2007	DRY	148	148	
SOR-005	*E. coli*	7/22/2007	WET	144	146	
SOR-005	*E. coli*	7/28/2007	DRY	144	145	
SOR-005	*E. coli*	8/12/2007	DRY	37	103	
SOR-005	*E. coli*	8/25/2007	DRY	48	89	
W0008	*E. coli*	5/17/2005	DRY	16	16	
W0008	*E. coli*	6/7/2005	DRY	107	41	
W0008	*E. coli*	7/19/2005	DRY	1300	131	
W0008	*E. coli*	8/16/2005	WET	435	393	
W0008	*E. coli*	9/21/2005	DRY	127	416	
W0008	Fecal Coliform	5/17/2005	DRY	30		
W0008	Fecal Coliform	6/7/2005	DRY	140		
W0008	Fecal Coliform	7/19/2005	DRY	1600		
W0008	Fecal Coliform	8/16/2005	WET	560		
W0008	Fecal Coliform	9/21/2005	DRY	170		
W0008	*E. coli*	7/20/2006	DRY	104	104	
W0008	*E. coli*	8/14/2006	DRY	63	81	
W1704	*E. coli*	7/20/2006	DRY	59	59	
W1704	*E. coli*	8/14/2006	DRY	30	42	
W1705	*E. coli*	7/20/2006	DRY	387	387	
W1705	*E. coli*	8/14/2006	DRY	75	170	
W1706	*E. coli*	7/20/2006	DRY	122	122	
W1706	*E. coli*	8/14/2006	DRY	72	94	
W2260	*E. coli*	5/17/2012	WET	152	152	
W2260	*E. coli*	5/31/2012	WET	162	157	
W2260	*E. coli*	6/21/2012	DRY	69	119	
W2260	*E. coli*	7/26/2012	WET	42	92	
W2260	*E. coli*	8/23/2012	DRY	43	67	
W2260	*E. coli*	9/20/2012	WET	186	70	

9.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and information that 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 River (MA33-102) were elevated primarily during dry weather (though few wet weather samples were collected). 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 needed under varying weather conditions to identify pollutant sources more accurately.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The watershed is lightly developed and characterized by low density residential development with some development concentrated near the segment in the Conway town center. Much of the segment also flows next to roads. None of the land area is in MS4 and <1% is DCIA. Stormwater runoff from urban areas is likely a small contributing source of pathogens.

Illicit Sewage Discharges: The watershed is likely not serviced by sewer; however, there may be private wastewater infrastructure, such as building wastewater drains, which may intersect with storm drainage. Leaky wastewater lines and illicit connections are a possible source of pathogens, though not at the same scale as more urbanized environments. Other forms of illicit discharges may occur, including unauthorized dumping of wastewater from pump-out trucks, campers, or other sources.

On-Site Wastewater Disposal Systems: Within the watershed, though not within the immediate drainage area to the segment, there is one groundwater discharge permit for on-site wastewater discharge. Most development in the watershed relies on 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 10% of the total land use area within the watershed. Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Many of these agricultural lands, especially along Shelburne Falls Road, are mowed or cultivated right to the river's edge. Activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to water bodies. Stormwater runoff from agricultural lands are likely a significant source of pathogens to the segment.

Pet Waste: Conservation lands, parks, ballfields, and residential streets 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 such as conservation and recreation lands, fields, golf courses, and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

9.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashfield. See Section 4.4

Town of Conway. See Section 3.4

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