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

Appendix H: Quinebaug 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 Quinebaug 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 Quinebaug River Watershed Overview section.

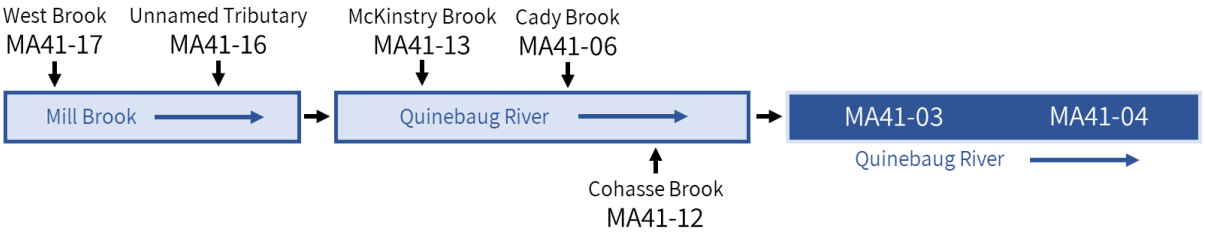


Figure 1-1. Conceptual diagram of water flow routing through the Quinebaug River watershed for the seven pathogen-impaired river segments. Unimpaired mainstem segments of major rivers (i.e., Mill Brook and the Quinebaug River) are highlighted in light blue while the impaired mainstem segments of the Quinebaug River are highlighted in dark blue. Tributary segments to the major rivers 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 Quinebaug 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)					
Quinebaug River MA41-03	B (WW)	R	126	980 (30 day)	87%	WLA (5%)	0.2	1.6	15.9	158.9	1,589.5	15,895.0
						LA (95%)	2.9	29.2	292.4	2,923.7	29,237.3	292,373.0
Quinebaug River MA41-04	B (WW)	R*	126	2,420 (30 day)	95%	WLA (5%)	0.2	1.6	15.8	157.6	1,576.4	15,764.2
						LA (95%)	2.9	29.3	292.5	2,925.0	29,250.4	292,503.8
Cady Brook MA41-06	B (WW)	R	126	1,990 (30 day)	94%	WLA (9%)	0.3	2.8	28.1	281.5	2,814.6	28,146.5
						LA (91%)	2.8	28.0	280.1	2,801.2	28,012.2	280,121.5
Cohasse Brook MA41-12	B	R	126	NA	-	WLA (6%)	0.2	2.0	19.5	195.1	1,950.5	19,505.3
						LA (94%)	2.9	28.9	288.8	2,887.6	28,876.3	288,762.7
Mckinstry Brook MA41-13	B	R	126	NA	-	WLA (6%)	0.2	1.8	18.1	181.4	1,813.6	18,136.2
						LA (94%)	2.9	29.0	290.1	2,901.3	29,013.2	290,131.8
Unnamed Tributary MA41-16	B	R	126	NA	-	WLA (4%)	0.1	1.2	12.0	119.9	1,198.5	11,985.4
						LA (96%)	3.0	29.6	296.3	2,962.8	29,628.3	296,282.6
West Brook MA41-17	B	R	126	204 (90 day)	38%	WLA (6%)	0.2	1.8	18.1	181.1	1,810.5	18,105.3
						LA (94%)	2.9	29.0	290.2	2,901.6	29,016.3	290,162.7

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 Quinebaug 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)					
Quinebaug River MA41-03	B (WW)	P	35	NA	-	WLA (5%)	-	0.4	4.4	44.2	441.5	4,415.3
						LA (95%)	0.8	8.1	81.2	812.1	8,121.5	81,214.7
Quinebaug River MA41-04	B (WW)	P	35	NA	-	WLA (5%)	-	0.4	4.4	43.8	437.9	4,379.0
						LA (95%)	0.8	8.1	81.3	812.5	8,125.1	81,251.0
Cady Brook MA41-06	B (WW)	P	35	NA	-	WLA (9%)	0.1	0.8	7.8	78.2	781.8	7,818.5
						LA (91%)	0.8	7.8	77.8	778.1	7,781.2	77,811.5
Cohasse Brook MA41-12	B	P	35	NA	-	WLA (6%)	0.1	0.5	5.4	54.2	541.8	5,418.1
						LA (94%)	0.8	8.0	80.2	802.1	8,021.2	80,211.9
Mckinstry Brook MA41-13	B	P	35	NA	-	WLA (6%)	0.1	0.5	5.0	50.4	503.8	5,037.8
						LA (94%)	0.8	8.1	80.6	805.9	8,059.2	80,592.2
Unnamed Tributary MA41-16	B	P	35	NA	-	WLA (4%)	-	0.3	3.3	33.3	332.9	3,329.3
						LA (96%)	0.8	8.2	82.3	823.0	8,230.1	82,300.7
West Brook MA41-17	B	P	35	NA	-	WLA (6%)	0.1	0.5	5.0	50.3	502.9	5,029.2
						LA (94%)	0.8	8.1	80.6	806.0	8,060.1	80,600.8

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).*
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 TMDL** 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. Quinebaug River Watershed Overview

The Quinebaug River flows 28 miles drains 148 square miles within Massachusetts. The headwaters are in Union, Connecticut, normally at the outlet of Goodhall Pond, though the source extends upstream to Mashapaug Lake when its northern outlet is open. From there, the river flows north into the Hamilton Reservoir and crosses into Massachusetts. The river flows northeast, east, then southeast to cross back into Connecticut, where it joins the Shetucket River in Norwich, which then joins the Thames River to empty into Long Island Sound (Figure 1-1). The total length of the river is 76 miles from Goodhall Pond to the Shetucket River (MassDEP, 2016).

The Quinebaug River in Massachusetts flows through a series of US Army Corps of Engineers flood control projects created in the 1960s in the wake of Hurricane Diane in 1955. These flood control systems typically allow run-of-the-river flow and consist of the East Brimfield Reservoir in Sturbridge and Westville Lake in Southbridge. In addition, there are two hydropower operations: Old Sturbridge Village (Project Number 6077) and West Dudley (Project Number 7254) (MassDEP, 2016).

The major pathogen-impaired tributaries to the Quinebaug River in Massachusetts include McKinstry and Cady Brooks, both beginning in Charlton and flowing south to meet the Quinebaug River in Southbridge; and Cohasse Brook, joining the river from the south, also in Southbridge. Mill Brook, which joins the Quinebaug River in Brimfield has two pathogen-impaired tributaries in its upper reaches: West Brook and an unnamed tributary (MassDEP, 2016).

The Quinebaug River watershed overlaps at least partially with 14 municipalities. Of these, six 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 impaired 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 Southbridge for Cady Brook MA41-06), 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, 2020, Appendix F).

In addition to municipalities, there are two Regional Planning Agencies (RPAs) in the Quinebaug 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.

- Central Massachusetts Regional Planning Commission: http://www.cmrpc.org/ (CMRPC, 2021)
- Pioneer Valley Planning Commission: http://pvpc.org/ (PVPC, 2021)

The following RPA initiatives and tools are especially noteworthy:

- The CMRPC offers local technical assistance to municipalities within their jurisdiction, can aid in the creation of master plans, new zoning bylaws, green energy technical assistance, and GIS mapping.

- 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. https://www.thinkbluemassachusetts.org/about-us (Think Blue Massachusetts, 2019).

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

The Governor's Greenway Council designates areas of conservation and recreation to contribute to the East Coast Greenway. Areas within the Quinebaug River watershed under this designation include the Air Line Trail, the Putnam River Trail, and the Little River State Greenway http://www.ct.gov/deep/lib/deep/water/nps/annualreports/2009annualreport.pdf (CT DEEP, 2021).

The Rivers Alliance of Connecticut includes the Quinebaug River watershed in their area of conservation. The Rivers Alliance strives to protect waterbodies and wetlands by assisting local private and municipal groups and individuals with their water quality improvement efforts, https://www.riversalliance.org/main.php (Rivers Alliance of Connecticut, 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, MAPC, 2014).
        - MAPC and the Neponset River Watershed Association created a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit (Metropolitan Area Planning Council, MAPC, 2018).
- **USDA NRCS and landowners:** Develop comprehensive nutrient management plans for agriculture, using local connections to farmers for outreach.
- **Parks departments, schools, private landowners, and others** who maintain large, mowed fields with direct access to water should consider maintaining a vegetative buffer along the water's edge. Buffers slow and filter stormwater runoff, provide a visual screen that can reduce large aggregations of waterfowl, and have many other water quality benefits at low cost.

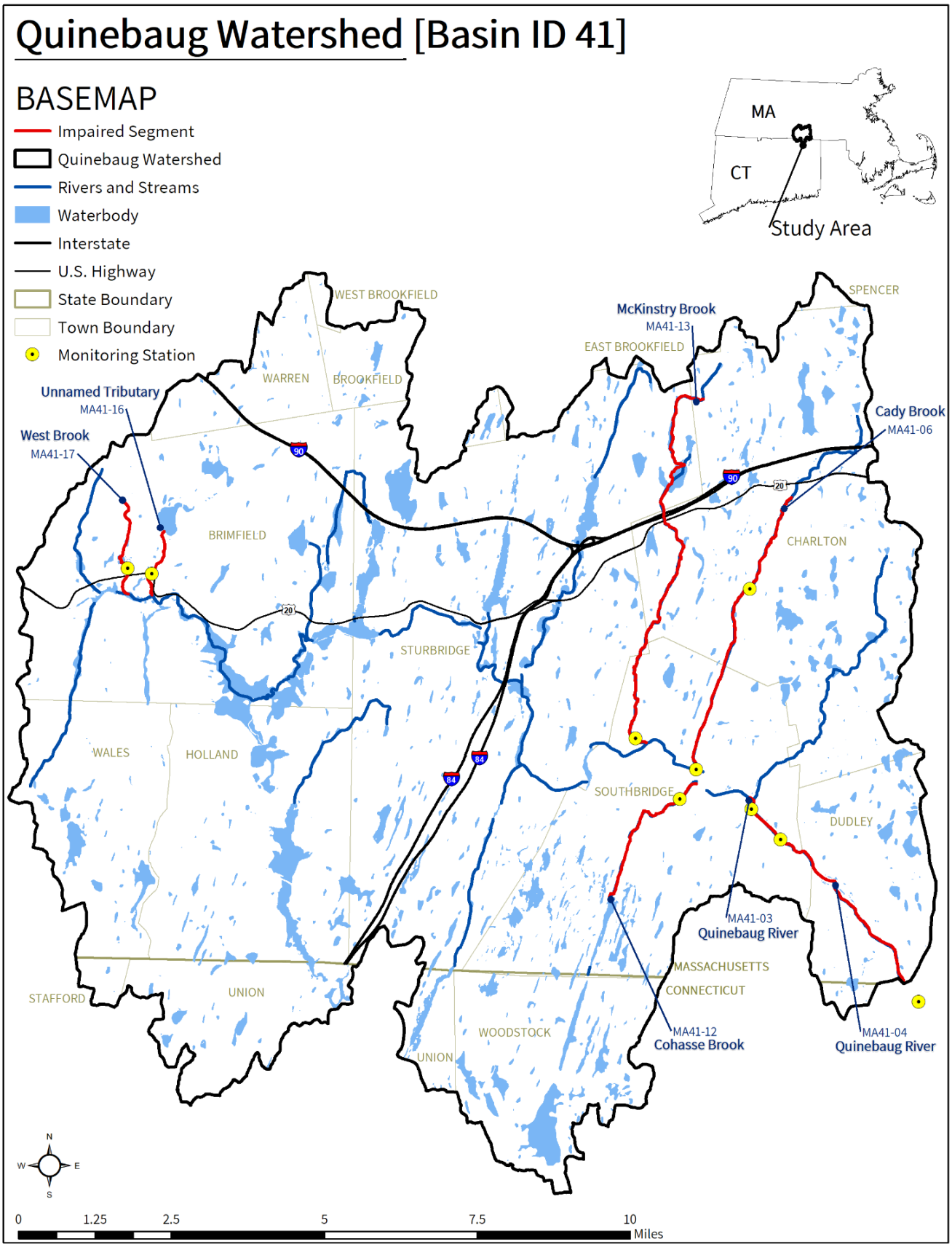


Figure 2-1: Map of all pathogen-impaired river segments, water quality monitoring stations, municipal borders, waterbodies, and roads in the Quinebaug River watershed.

3. MA41-03 Quinebaug River

3.1. Waterbody Overview

The Quinebaug River segment MA41-03 is 2.2 miles long and begins at the Southbridge WWTP outfall (NPDES: MA0100901) in Southbridge, MA. The segment flows southeast and is bound at its downstream end by the dam (NAT ID: MA00114) just upstream of West Dudley Road in Dudley, MA.

There are no named tributaries to the segment, though Lebanon Brook enters the river just upstream of the segment and is mapped as hydrologically connected with the segment by an additional unnamed stream channel along Village Drive in Southbridge. There are several other unnamed tributaries to the segment. The segment watershed encompasses the following pathogen-impaired streams: Cady Brook (MA41-06), Cohasse Brook (MA41-12), McKinstry Brook (MA41-13), an Unnamed Tributary (MA41-16), and West Brook (MA41-17).

Named lakes and ponds within the segment watershed include the East Brimfield Reservoir, Walker Pond, Little Alum Pond, the Hamilton Reservoir, Sylvestri Pond, and the Cohasse Brook Reservoir. Key landmarks near the segment include the Sandersdale town center at the upstream end of the segment; state highway MA-131 which parallels this portion of the Quinebaug River; and the village of Dudley, MA at the downstream end of the segment. The segment is crossed by Dresser Hill Road in Southbridge.

The Quinebaug River (MA41-03) drains a total area of 147 square miles, of which 7.6 mi^2 (5%) is impervious and 3.4 mi^2 (2%) is directly connected impervious area (DCIA). The Quinebaug River (MA41-03) watershed extends into CT. Out of the total watershed area of 147 mi^2, 131 mi^2 (89%) are within MA. The watershed is partially[1] served by public sewer and 11% of the watershed (13% of the area within MA) is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). Within the MA portion of the watershed, there are three NPDES permits on file governing point source discharges of pollutants to surface waters (2 within the immediate drainage area) (Table 3-1); there are three MassDEP discharge to groundwater permits

Reduction from Highest Calculated Geomean: 87%

Watershed Area (Acres): 93,943

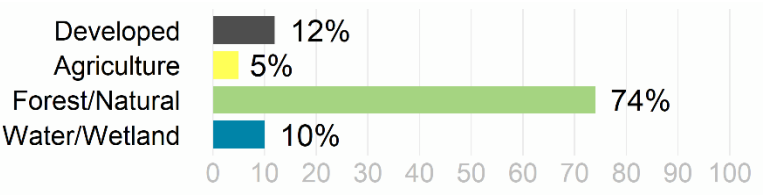
Segment Length (Miles): 2.2

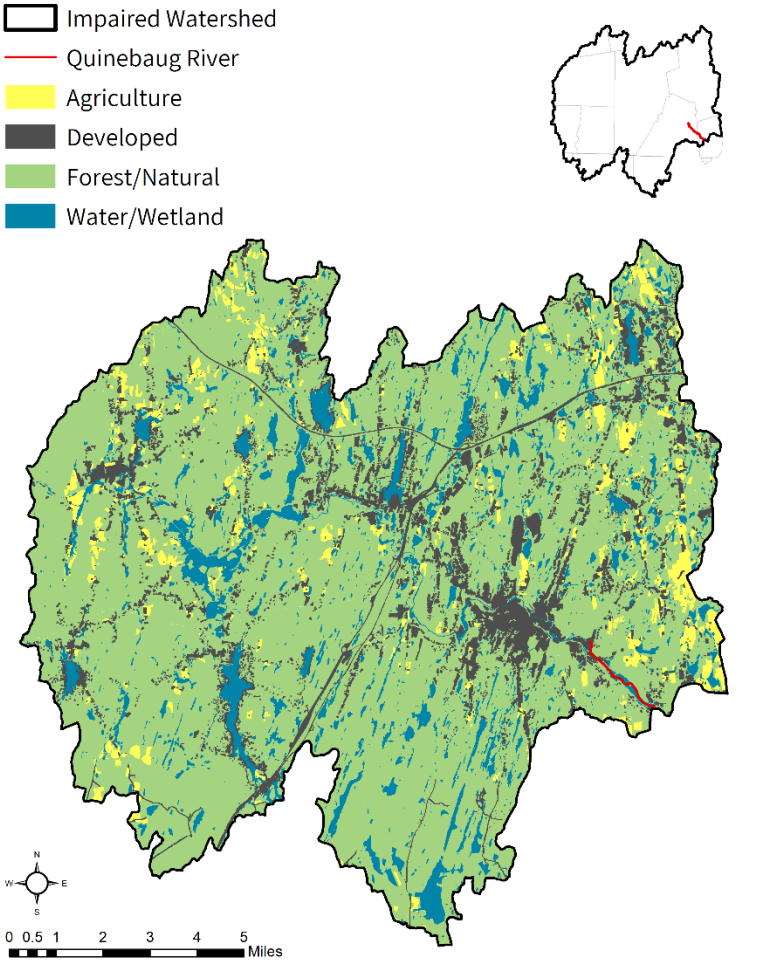
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 4,844 (5%)

DCIA Area (Acres, %): 2,155 (2%)





[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, 2021b), MS4 reports, and local knowledge.

for on-site wastewater discharge (Table 3-2); and there are no combined sewer overflows, 13 landfills, and two unpermitted land disposal dumping grounds. 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
MA0100421	STURBRIDGE WPCF	STURBRIDGE	MUN
MA0100901	SOUTHBRIDGE WWTP	SOUTHBRIDGE	MUN

Table 3-2. 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).

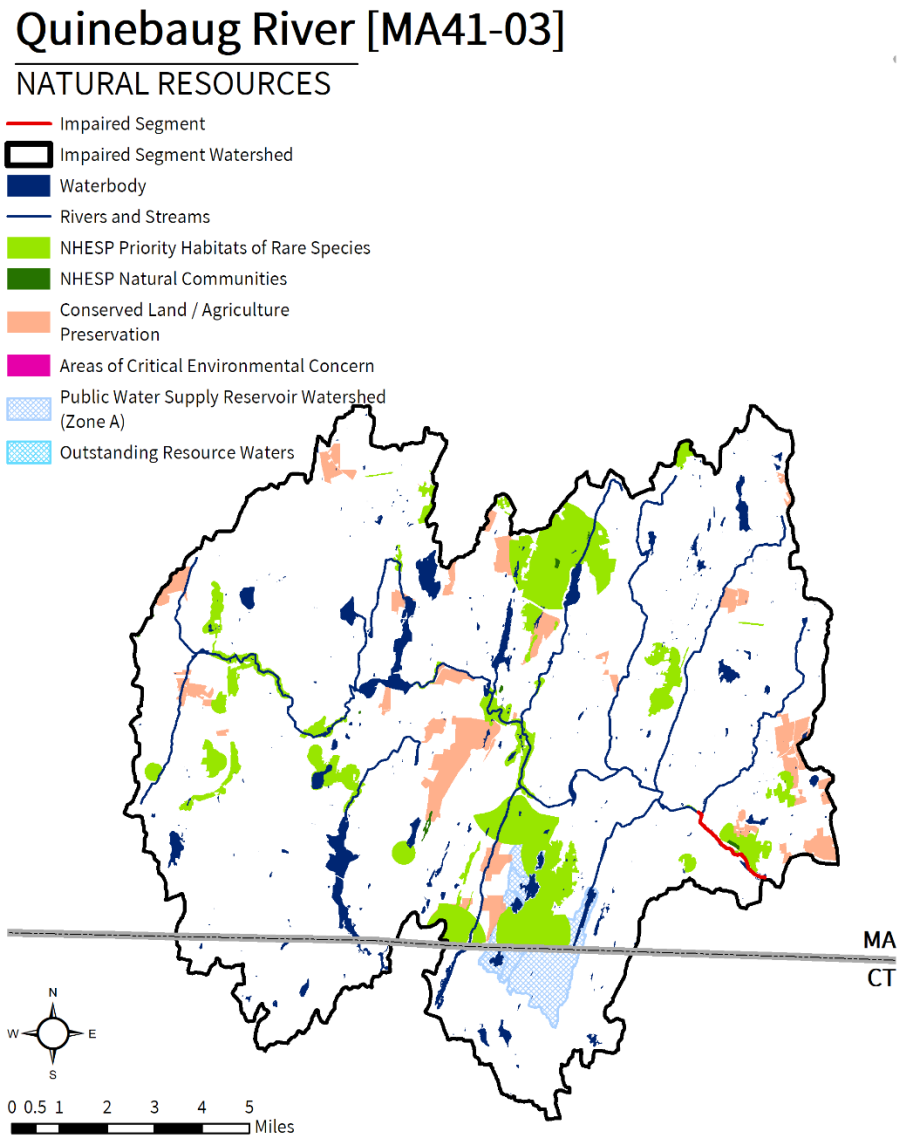
PERR	NAME	TOWN	TYPE	FLOW (GPD)
249-4	PILOT TRAVEL CENTER	STURBRIDGE	Sanitary Discharge	37,000
630-2	OUTDOOR WORLD CAMPGROUND	STURBRIDGE	Sanitary Discharge	25,000
775-0	STURBRIDGE RETIREMENT CORP.	STURBRIDGE	Sanitary Discharge	23,171

The watershed is predominantly forested (74%); however, developed land (12%) is concentrated in urbanized Southbridge, about one mile upstream from the segment's start point. The segment begins adjacent to a large commercial development with an expansive parking lot and flows though forested and low density mixed residential and commercial areas. There are agricultural lands scattered throughout the watershed, making up 5% of the land area, though none immediately adjacent to the segment.

Within the MA portion of the Quinebaug River (MA41-03) watershed (percentages out of entire watershed), under the Natural Heritage and Endangered Species Program, there are 8,093 acres (9%) of Priority Habitats of Rare Species and 59 acres (<1%) of Priority Natural Vegetation Communities. There are 2,847 acres (3%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters. Over 8,859 acres (9%) of land protected in perpetuity[2] exist within the segment watershed, which is part of a total of 22,509 acres (24%) of Protected and Recreational Open Space[3]. See Figure 3-1.

[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).



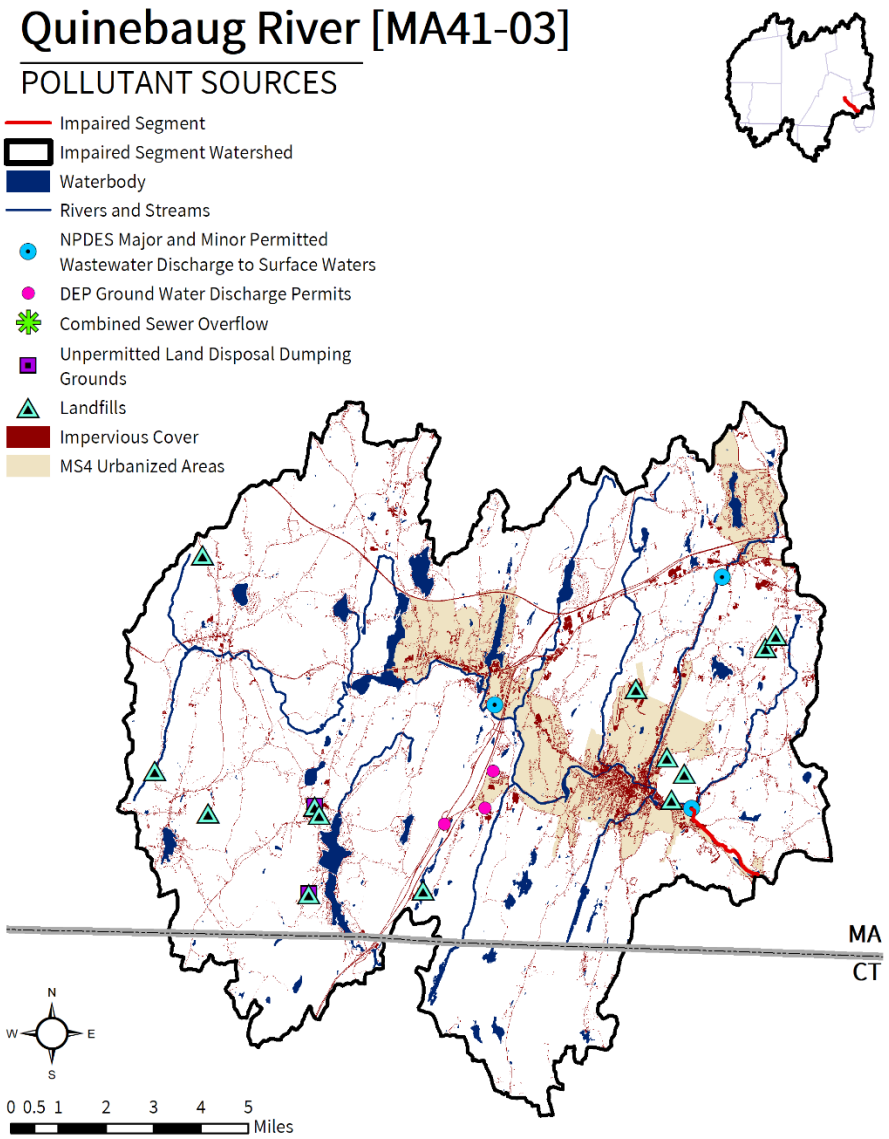


Figure 3-1. Natural resources and potential pollution sources draining to the Quinebaug River segment MA41-03. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities

3.2. Waterbody Impairment Characterization

The Quinebaug River (MA41-03) is a Class B, Warm Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* (fecal coliform data unavailable) at the stations listed below (refer to Tables 3-3, 3-4; 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 2011, seven samples were collected at W0058, resulting in six days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of seven samples, three exceeded the STV criterion during both wet and dry weather.
- In 2011, seven samples were collected at W2234, resulting in five 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 seven samples, three exceeded the STV criterion during both wet and dry weather.

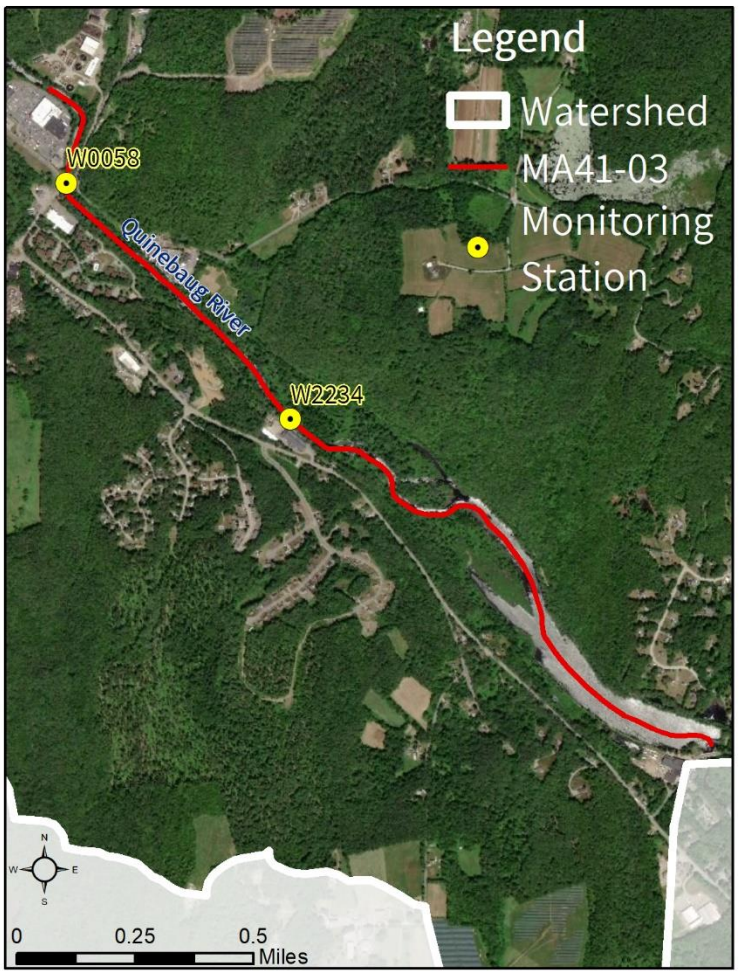


Figure 3-2. Location of monitoring station(s) along the impaired river segment.

Table 3-3. Summary of indicator bacteria sampling results by station for the Quinebaug River (MA41-03). 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
W0058	5/5/2011	10/12/2011	7	980	6	3
W2234	5/5/2011	10/12/2011	7	770	5	3

Table 3-4. Indicator bacteria data by station, indicator, and date for the Quinebaug River (MA41-03). 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)
W0058	*E. coli*	5/5/2011	DRY	99	99	
W0058	*E. coli*	6/9/2011	DRY	980	980	
W0058	*E. coli*	7/7/2011	DRY	276	520	
W0058	*E. coli*	7/21/2011	DRY	727	448	
W0058	*E. coli*	8/29/2011	WET	727	727	
W0058	*E. coli*	9/15/2011	DRY	219	399	
W0058	*E. coli*	10/12/2011	DRY	119	161	
W2234	*E. coli*	5/5/2011	DRY	120	120	
W2234	*E. coli*	6/9/2011	DRY	687	687	
W2234	*E. coli*	7/7/2011	DRY	308	460	
W2234	*E. coli*	7/21/2011	DRY	687	460	
W2234	*E. coli*	8/29/2011	WET	770	770	
W2234	*E. coli*	9/15/2011	DRY	138	326	
W2234	*E. coli*	10/12/2011	DRY	99	117	

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 Quinebaug River (MA41-03) 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 of pollutants. 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, such as the Southbridge, Sturbridge, and Brimfield town centers. Much of the development is concentrated around portions of the Quinebaug River that are immediately upstream of the segment. Eleven percent (11%) of the land area is in MS4, 2% is DCIA, and development within the watershed ranges from low density residential to high density mixed development including expansive parking lots and interstate highways. Thus, stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: The downstream (southeast) portions of the watershed are mostly 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. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are three groundwater discharge permits for on-site wastewater discharge within the watershed, which are large-capacity septic systems (non-residential). Development largely 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 5% of the total land use. Agricultural activities visible on recent aerial photos within the segment watershed include open fields, row crops, and pastureland. Activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Open space accounts for 24% of the watershed. There are a few residential neighborhoods adjacent to the segment. 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: While most of the segment flows through a narrow wooded buffer, any 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.

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 Brimfield

The Town of Brimfield is not within the MS4 area.

Brimfield has the following 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 Brimfield does not have a Master Plan or Open Space and Recreation Plan available. The town website is https://www.brimfieldma.org/. (Town of Brimfield, 2021).

Town of Charlton

Seven percent (7%) of Charlton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Charlton (Permit ID #MAR041183) has an EPA approved Notice of Intent (NOI). Town of Charlton has a stormwater page, https://www.townofcharlton.net/282/Stormwater-MS4, (Town of Charlton, 2019) and Stormwater Management Plan. Charlton has mapped all of its MS4 stormwater systems and has adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations. There are four stormwater outfalls to pathogen-impaired Cady Brook.

Charlton has the following relevant ordinances and bylaws:

- Stormwater management bylaw: Chapter 175, https://ecode360.com/27313158?highlight=stormwater&searchId=5728833369906822#27313158 (Town of Charlton, 2011)

- Sewer Use regulation: Chapter 165 https://ecode360.com/27071213 (Town of Charlton, 2005)

Charlton had no Master Plan available.

Charlton has an Open Space and Recreation Plan: http://www.townofcharlton.net/DocumentCenter/View/764/Final-Plan-2017-PDF (Town of Charlton, 2017).

Town of Dudley

About a third of Dudley is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Dudley (Permit ID #MAR041108) has an EPA approved Notice of Intent (NOI). Dudley does not have a Stormwater Management Plan available. The town has mapped all of its MS4 stormwater system, which is available online. It plans to adopt illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2020. According to the NOI, there are no stormwater outfalls to impaired segments in the Quinebaug River watershed.

Dudley has the following relevant ordinances and bylaws:

- Stormwater Ordinance and/or Bylaws, Chapter 254 Stormwater Management: https://ecode360.com/36744460 (Town of Dudley, 2020)
- Stormwater Utility: None found.
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title V Regulations.
- Wetland Protection Bylaw: Chapter 294 Wetlands Protections. Article 23 of Dudley By Laws: https://ecode360.com/33932206 (Town of Dudley, 2008)
  Pet Waste Ordinance: None found.
- Recreation Ordinance, Chapter 85 Recreation Commission. https://ecode360.com/33951065 (Town of Dudley, 2018)
- The Dudley Master Plan Natural Features chapter includes information on Dudley's water resources, including watersheds, surface waters, and water quality. The water quality subsection includes information on previous high levels of coliform bacteria in the French and Quinebaug Rivers due to industrial discharge and that current discharges require a NPDES permit. There are no impaired segments within its town's boundaries. The Facilities and Services chapter notes that Dudley's sewage is treated at the Dudley/Webster Treatment Plant and that Dudley is working on sewer line expansion.

Dudley Town Website: https://dudleyma.gov/ (Town of Dudley, 2021)

Master Plan: https://dudleyma.gov/master-plan-from-2000-now-online/ (Town of Dudley, 2000)

Stormwater Web Page: https://dudleyma.gov/document-category/stormwater-management/ (Town of Dudley, 2019)

Open Space and Recreation Plan: https://dudleyma.gov/wp-content/uploads/Space.pdf (Town of Dudley, n.d.)

Town of Southbridge

More than 30% of Southbridge is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Southbridge (Permit ID #MAR041161) has an EPA approved Notice of Intent (NOI). Southbridge has a Stormwater Management Plan filed with its Department of Public Works Operations Center. The town has mapped all of its MS4 stormwater systems and has submitted the map electronically with the NOI. It will adopt the illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2020. According to the NOI, there are 13 stormwater outfalls into pathogen-impaired Cohasse Brook MA41-12, seven stormwater outfalls into Hatchet Brook MA41-14, and 16 stormwater outfalls into pathogen-impaired McKinstry Brook.

Southbridge has the following relevant ordinances and bylaws:

- Bylaw to update SWMP: https://www.ci.southbridge.ma.us/department-of-public-works/pages/stormwater-management-program (Town of Southbridge, 2019)
- Sewer regulations in the Code of Bylaws, Section 8-301: https://www.codepublishing.com/MA/Southbridge/#!/Southbridge08/Southbridge08.html#8-301 (Town of Southbridge, 1990)
- Pet waste regulations in the Code of Bylaws. Section 6-203 Removal of Dog Litter: https://www.codepublishing.com/MA/Southbridge/#!/Southbridge06/Southbridge06.html#6-203 (Town of Southbridge, n.d., a)
- Draft Wetlands Protection Bylaw: Available at the outhbridge town office. Also available pamphlet "What you Need to Know About Wetlands Protection in Southbridge" https://www.ci.southbridge.ma.us/conservation-commission/slideshows/what-you-need-to-know-about-wetlands-protection-in-southbridge (Town of Southbridge, n.d., c)

Stormwater Management plan: https://www.ci.southbridge.ma.us/department-of-public-works/pages/stormwater-pollution-prevention (Town of Southbridge, n.d., b)

Southbridge's Master Plan also includes a Water Resources section on page 21. The Master Plan states that an objective is to adopt green infrastructure stormwater management provisions. https://www.ci.southbridge.ma.us/sites/g/files/vyhlif5016/f/file/file/southbridge_master_plan_volume_1.pdf (Town of Southbridge, 2013)

Southbridge's Open Space and Recreation Plan: https://www.ci.southbridge.ma.us/sites/southbridgema/files/uploads/southbridge_open_space_rec_plan_-_may_2017.pdf (Town of Southbridge, 2017)

Town of Sturbridge

Nearly 20% of Sturbridge is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Sturbridge (Permit ID #MAR041240) has an EPA approved Notice of Intent (NOI). Sturbridge has a Stormwater Management Plan on file at the Sturbridge Department of Public Works (link below) and has mapped all of its MS4 stormwater system. It has not adopted illicit discharge detection and elimination (IDDE) regulations but had adopted erosion and sediment control (ESC) and post-construction stormwater regulations in 2011. There is one stormwater outfall reported to the Quinebaug River MA41-01.

Sturbridge Stormwater Management Plan: https://www.sturbridge.gov/public-works/pages/stormwater-management (Town of Sturbridge, n.d.)

Sturbridge has the following relevant ordinances and bylaws:

- Stormwater regulations: https://www.sturbridge.gov/public-works/pages/stormwater-management (Town of Sturbridge, n.d.)
- IDDE Plan-Non-Stormwater Discharge Bylaw: https://www.sturbridge.gov/public-works/pages/sturbridge-idde-plan (Town of Sturbridge, 2019)
- Wetland Protection bylaw: https://www.sturbridge.gov/sites/g/files/vyhlif3881/f/uploads/swb_regulations_2018_version.pdf (Town of Sturbridge, 2018)
- Pet waste: Chapter 5, Animal Control, Section 5.1, Prohibition: https://www.sturbridge.gov/sites/g/files/vyhlif3881/f/uploads/sturbridge_general_bylaws_2019_updated_7-2019_1.pdf (Town of Sturbridge, 2019)

Sturbridge Master Plan: https://www.sturbridge.gov/master-plan-project (Town of Sturbridge, 2011)

Sturbridge's Open Space and Recreation Plan: https://www.sturbridge.gov/open-space-committee/pages/open-space-and-recreation-plan-2018 (Town of Sturbridge, 2018)

4. MA41-04 Quinebaug River

4.1. Waterbody Overview

The Quinebaug River segment MA41-04 is 2.2 miles long and begins at the dam (NAT ID: MA00114) just upstream of West Dudley Road in Dudley, MA. The segment flows southeast through Dudley to end at the CT state line in Dudley.

There are several small unnamed tributaries to the Quinebaug River segment MA41-04. This segment is at the downstream-most end of the Quinebaug River in Massachusetts and therefore encompasses all other pathogen-impaired segments in the basin: Quinebaug River (MA41-03), Cady Brook (MA41-06), Cohasse Brook (MA41-12), McKinstry Brook (MA41-13), the Unnamed Tributary (MA41-16), and West Brook (MA41-17).

Named lakes and ponds within the segment watershed include the East Brimfield Reservoir, Walker Pond, Long Pond, Little Alum Pond, the Hamilton Reservoir, and the Cohasse Brook Reservoir, though none are adjacent to the segment itself. Key landmarks near the impaired segment include state highway MA-131 and the Quinebaug Valley Rail Trail, both of which run parallel to the segment; the Southbridge Tool & Manufacturing Facility; and Stevens Park. The segment is crossed by West Dudley Road, an abandoned railroad bridge, and Southbridge Road/Quinebaug Road/MA-131, all in Dudley.

The Quinebaug River (MA41-04) drains a total area of 150 square miles, of which 7.7 mi^2 (5%) is impervious and 3.4 mi^2 (2%) is directly connected impervious area (DCIA). The segment watershed extends into CT. Out of the total watershed area of 150 mi^2, 134 mi^2 (89%) are within MA. The watershed is partially[4] served by public sewer and 11% of the watershed (13% of the area within MA) is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). Within the MA portion of the watershed, there are three NPDES permits on file governing point source discharges of pollutants to surface waters; there are three MassDEP discharge to groundwater permits for on-site wastewater discharge; and there are no combined

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 96,297

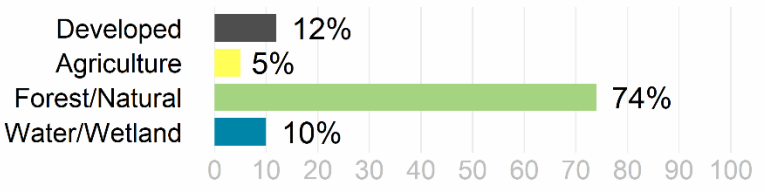
Segment Length (Miles): 2.2

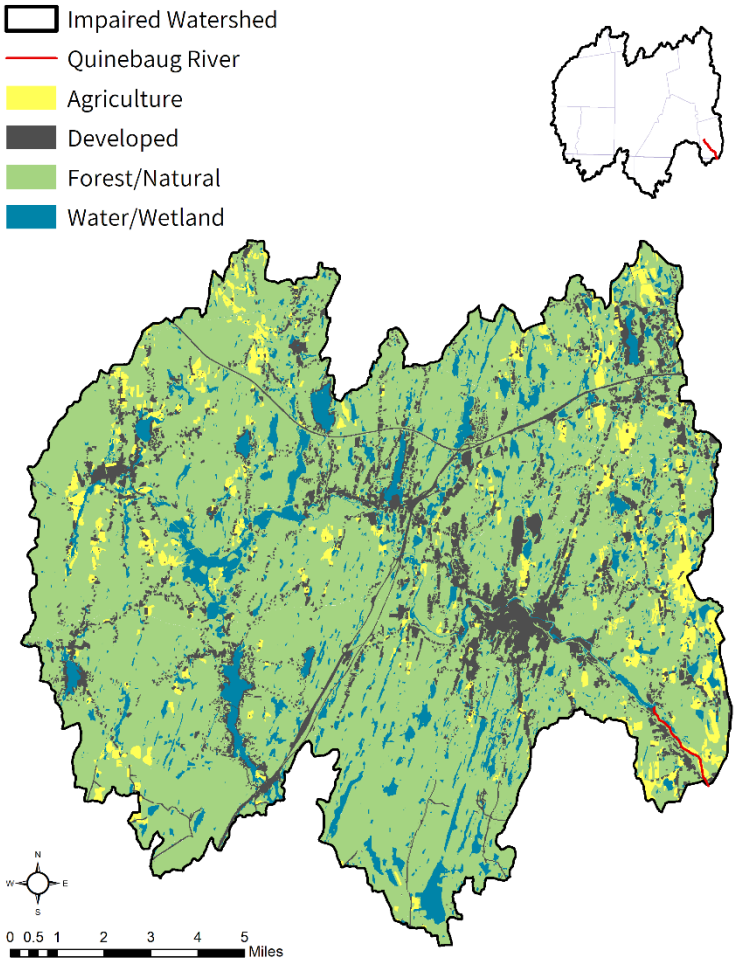
Impairment(s): Fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 4,924 (5%)

DCIA Area (Acres, %): 2,178 (2%)





[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, 2021b), MS4 reports, and local knowledge.

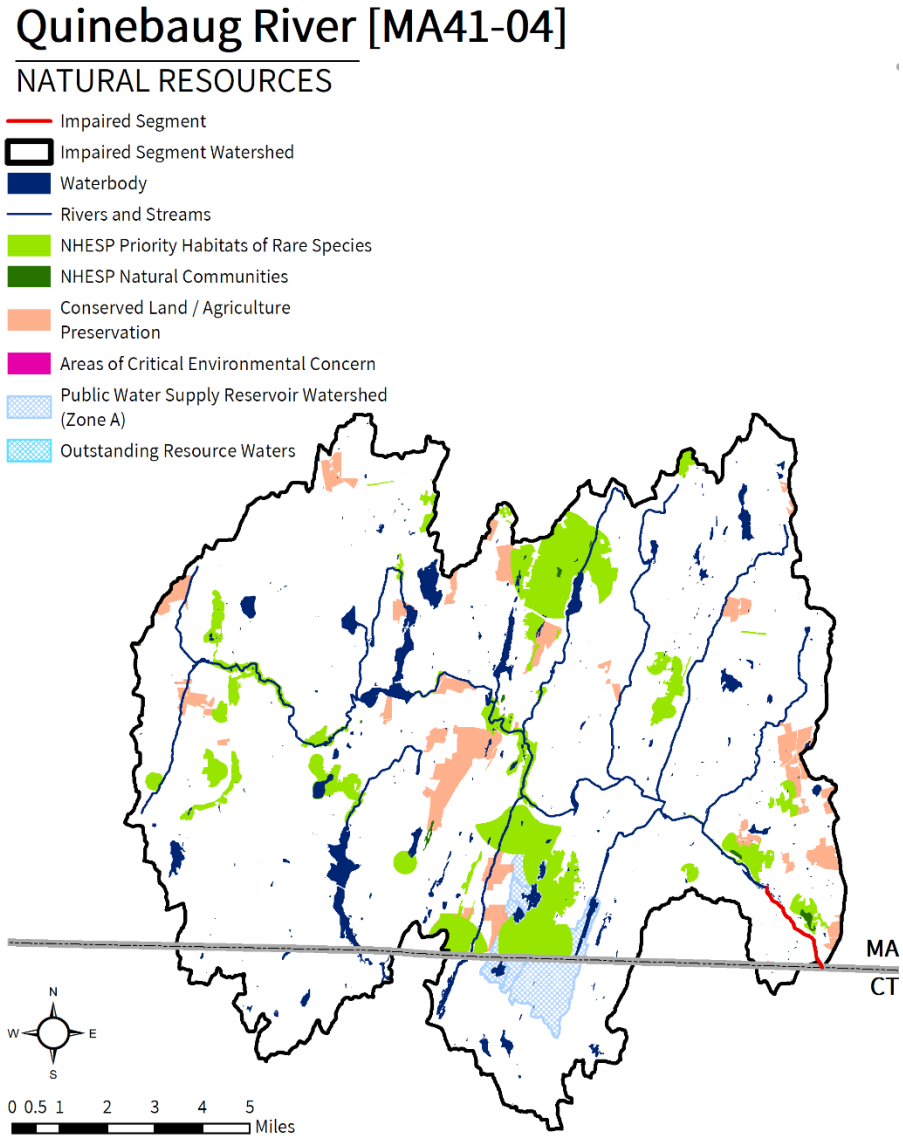
sewer overflows, 13 landfills, and two unpermitted land disposal dumping grounds (none within the immediate drainage area to the segment). See Figure 4-1.

The watershed is predominantly forested (74%; however, developed land (12%) is concentrated along the Quinebaug River in Southbridge and Sturbridge upstream from the segment. The segment itself flows through a forested corridor, beyond which is low density residential development and about one river mile of hayfields.

Within the MA portion of the Quinebaug River (MA41-04) watershed (percentages out of entire watershed), under the Natural Heritage and Endangered Species Program, there are 8,272 acres (9%) of Priority Habitats of Rare Species and 96 acres (<1%) of Priority Natural Vegetation Communities. There are 2,847 acres (3%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters. Over 8,972 acres (9%) of land protected in perpetuity[5] exist within the segment watershed, which is part of a total of 22,632 acres (24%) 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).



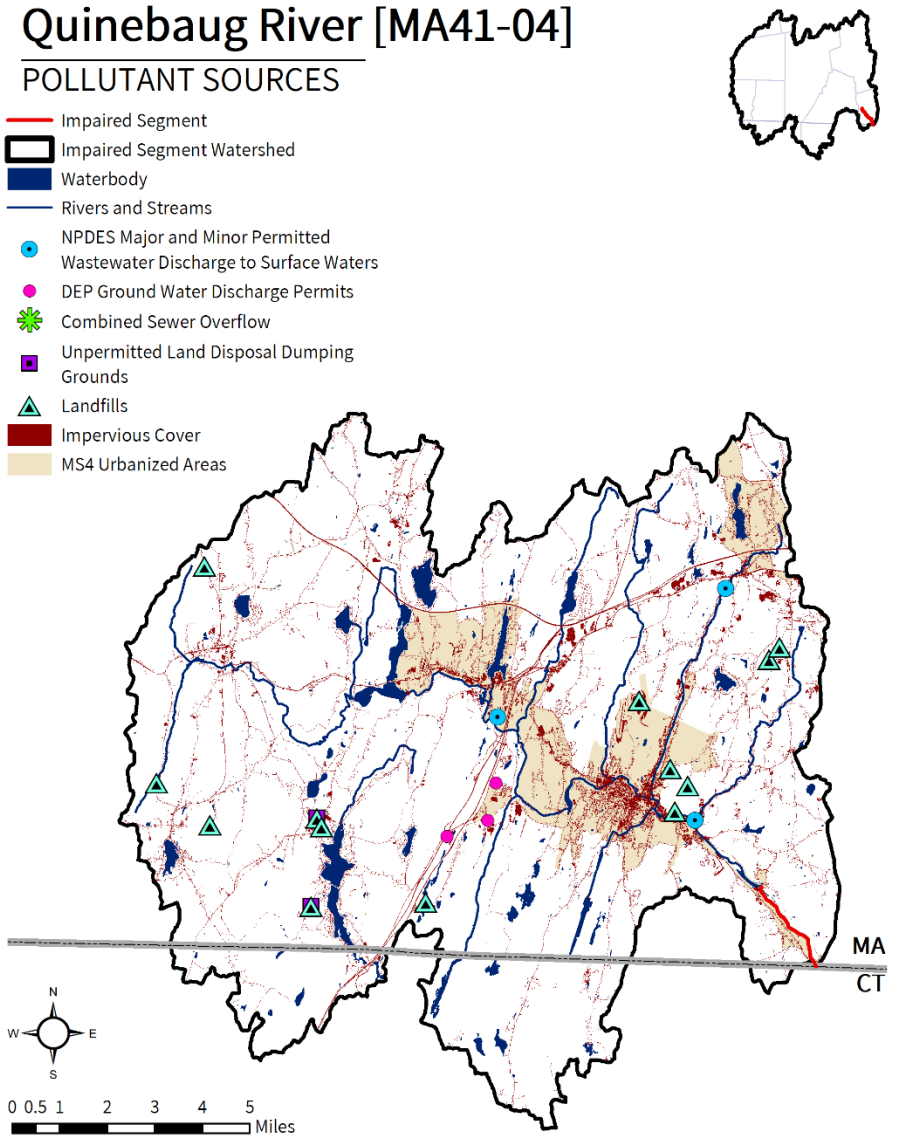


Figure 4-1. Natural resources and potential pollution sources draining to the Quinebaug River segment MA41-04. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities

4.2. Waterbody Impairment Characterization

The Quinebaug River (MA41-04) is a Class B, Warm Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* (fecal coliform data unavailable) at the station listed below (refer to Tables 4-1, 4-2; 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.

- From 2007-2013, 32 samples were collected at W0600, resulting in 14 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 32 samples, seven exceeded the STV criterion in 2008-2010 and 2013 during both wet and dry weather.

The original impairment decision was carried forward based on fecal coliform bacteria counts between 1996 and 2000 (Kennedy et al., 2002; data not shown) because there were insufficient *E. coli* data during the bathing season to make an assessment using the previous SWQS.

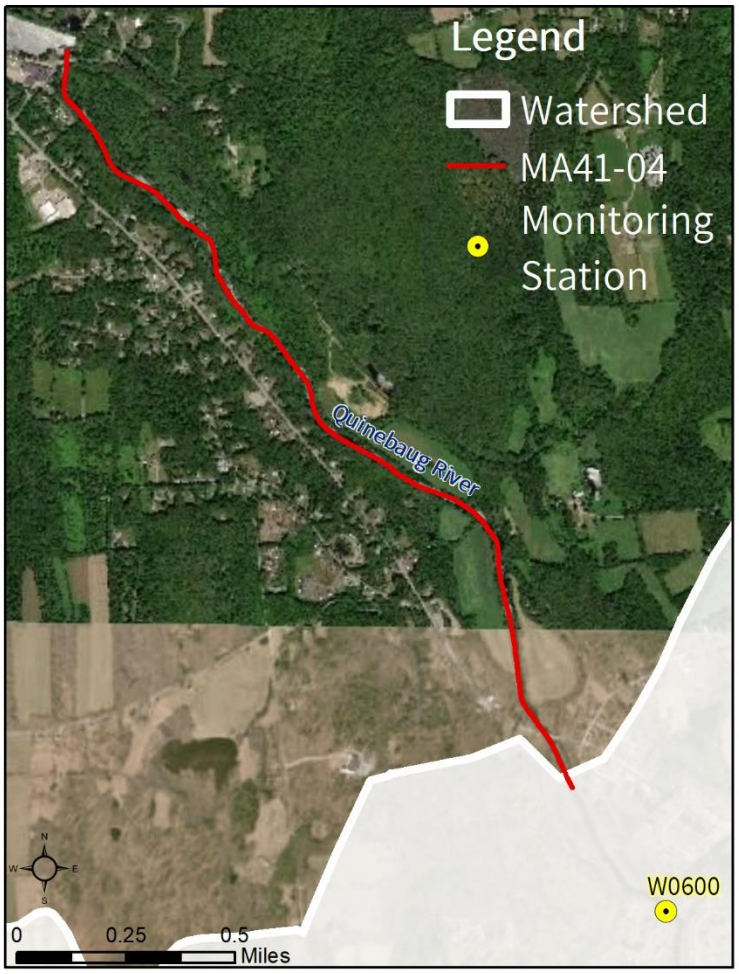


Figure 4-2. Location of monitoring station(s) along the impaired river segment.

Table 4-1. Summary of indicator bacteria sampling results by station for the Quinebaug River (MA41-04). 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
W0600	8/29/2007	9/23/2013	32	2420	14	7

Table 4-2. Indicator bacteria data by station, indicator, and date for the Quinebaug River (MA41-04). 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)
W0600	*E. coli*	8/29/2007	DRY	63	63	
W0600	*E. coli*	10/17/2007	DRY	118	118	
W0600	*E. coli*	1/30/2008	DRY	770	770	
W0600	*E. coli*	3/26/2008	DRY	55	55	
W0600	*E. coli*	5/21/2008	DRY	52	52	
W0600	*E. coli*	7/23/2008	WET	2420	2420	
W0600	*E. coli*	9/24/2008	DRY	91	91	
W0600	*E. coli*	11/19/2008	DRY	1410	1410	
W0600	*E. coli*	2/24/2009	WET	1050	1050	
W0600	*E. coli*	4/29/2009	DRY	18	18	
W0600	*E. coli*	6/24/2009	DRY	179	179	
W0600	*E. coli*	8/26/2009	DRY	140	140	
W0600	*E. coli*	10/28/2009	DRY	46	46	
W0600	*E. coli*	2/23/2010	DRY	461	461	
W0600	*E. coli*	7/21/2010	DRY	65	65	
W0600	*E. coli*	10/6/2010	WET	135	135	
W0600	*E. coli*	11/17/2010	WET	238	238	
W0600	*E. coli*	3/23/2011	DRY	111	111	
W0600	*E. coli*	4/27/2011	DRY	19	19	
W0600	*E. coli*	6/22/2011	DRY	111	111	
W0600	*E. coli*	8/31/2011	WET	172	172	
W0600	*E. coli*	10/26/2011	DRY	58	58	
W0600	*E. coli*	1/25/2012	DRY	23	23	
W0600	*E. coli*	3/28/2012	DRY	32	32	
W0600	*E. coli*	5/29/2012	DRY	152	152	
W0600	*E. coli*	7/25/2012	DRY	96	96	
W0600	*E. coli*	9/26/2012	DRY	68	68	
W0600	*E. coli*	11/14/2012	DRY	77	77	
W0600	*E. coli*	2/27/2013	WET	345	345	
W0600	*E. coli*	4/24/2013	DRY	20	20	
W0600	*E. coli*	8/27/2013	WET	2420	2420	
W0600	*E. coli*	9/23/2013	WET	435	1026	

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).

Indicator bacteria data from the Quinebaug River (MA41-04) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Urbanized areas are concentrated along the Quinebaug River in the town centers of Southbridge, Sturbridge, and Brimfield, just upstream from the segment. With 11% of the land area in MS4, 2% as DCIA, and development ranging from low density residential to high density mixed development, stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: The downstream (southeast) portion of the watershed is mostly 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. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are three groundwater discharge permits for on-site wastewater discharge within the watershed (not in the immediate drainage area), which are large-capacity, non-residential septic systems. Nearly all residential 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 5% of the total land use. Agricultural activities visible on recent aerial photos within the segment watershed include open fields, row crops, and pastureland. About one mile of the segment near the downstream end is adjacent to large hayfields with a thin wooded buffer. 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, 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: While most of the segment flows through a narrow wooded buffer, any 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.

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 Brimfield. See Section 3.4

Town of Charlton. See Section 3.4

Town of Dudley. See Section 3.4

Town of Southbridge. See Section 3.4

Town of Sturbridge. See Section 3.4

5. MA41-06 Cady Brook

5.1. Waterbody Overview

The Cady Brook segment MA41-06 is 5.1 miles long and begins at the Charlton WWTP outfall (NPDES: MA0101141) in Charlton, MA. The segment flows south into Southbridge where it ends at its confluence with the Quinebaug River.

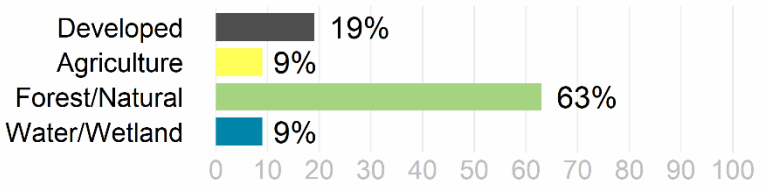
Tributaries to Cady Brook include several unnamed streams, including those draining Sibley Pond and Prindle Lake. Other named lakes and ponds within the segment watershed include Lambs Pond, Railroad Pond, and Glen Echo Lake.

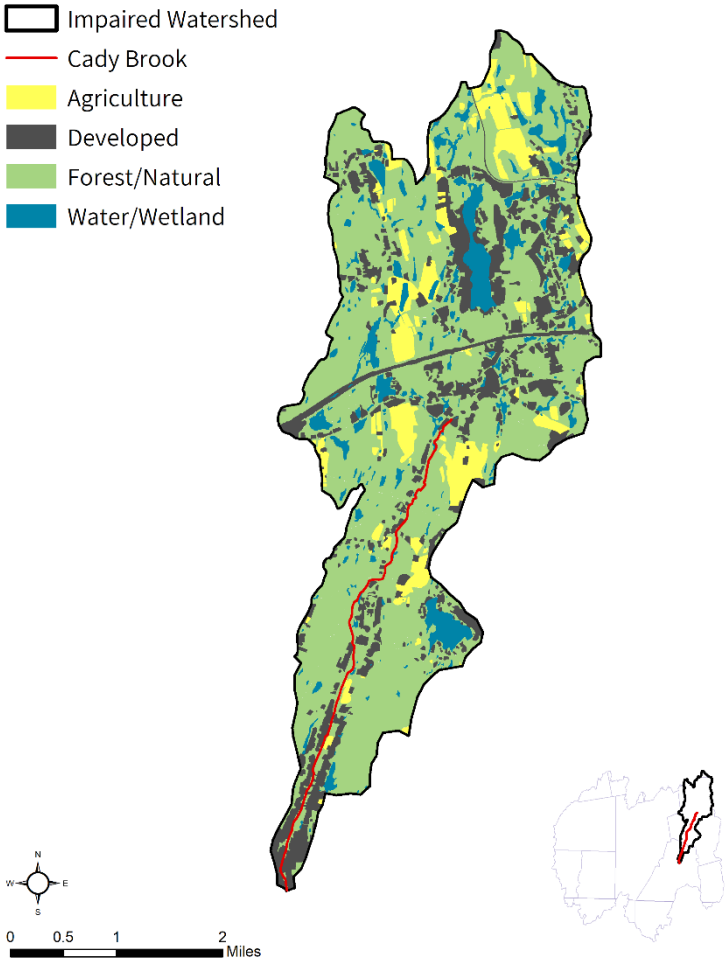
Key landmarks in the watershed include the I-90 and US-20 corridors just upstream of the segment; Charlton City; and a small section of urbanized Southbridge. The segment is crossed by Snake Hill Road and Southbridge Road/MA-169 (twice) in Charlton; and Brookside Road, Vinton Road, Randolph Street, and Charlton Street in Southbridge. State highway MA-169 runs parallel to the segment.

Cady Brook (MA41-06) drains an area of 12.3 square miles, of which 1.1 mi^2 (9%) is impervious and 0.6 mi^2 (5%) is directly connected impervious area (DCIA). The watershed is partially[7] served by public sewer and 28% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES permit on file governing point source discharges of pollutants to surface waters within the watershed (Table 5-1). There are no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 5-1.

The watershed is mostly forested (63%) and moderately developed (12%), with development patterns concentrated heavily around the segment and its tributaries. In the watershed, development ranges from low density residential to high density mixed residential, commercial, and industrial development. The segment itself flows along state highway MA-169, with medium to high density mixed development along about one third of the segment in Southbridge. In addition, there is high

Reduction from Highest Calculated Geomean: 94%
Watershed Area (Acres): 7,846
Segment Length (Miles): 5.1
Impairment(s): *E. coli* (Primary Contact Recreation)
Class (Qualifier): B (Warm Water)
Impervious Area (Acres, %): 716 (9%)
DCIA Area (Acres, %): 356 (5%)





[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, 2021b), MS4 reports, and local knowledge.

density residential development along the shores of Glen Echo Lake, which is directly upstream of Cady Brook. Developed land north of I-90 is primarily residential communities, while the land surrounding US-20 is largely industrial. This watershed also contains many large ground mounted solar installations. Agricultural fields within the segment watershed are used as hayfields, with a few farms owning livestock. Minimal agricultural land is adjacent to the segment.

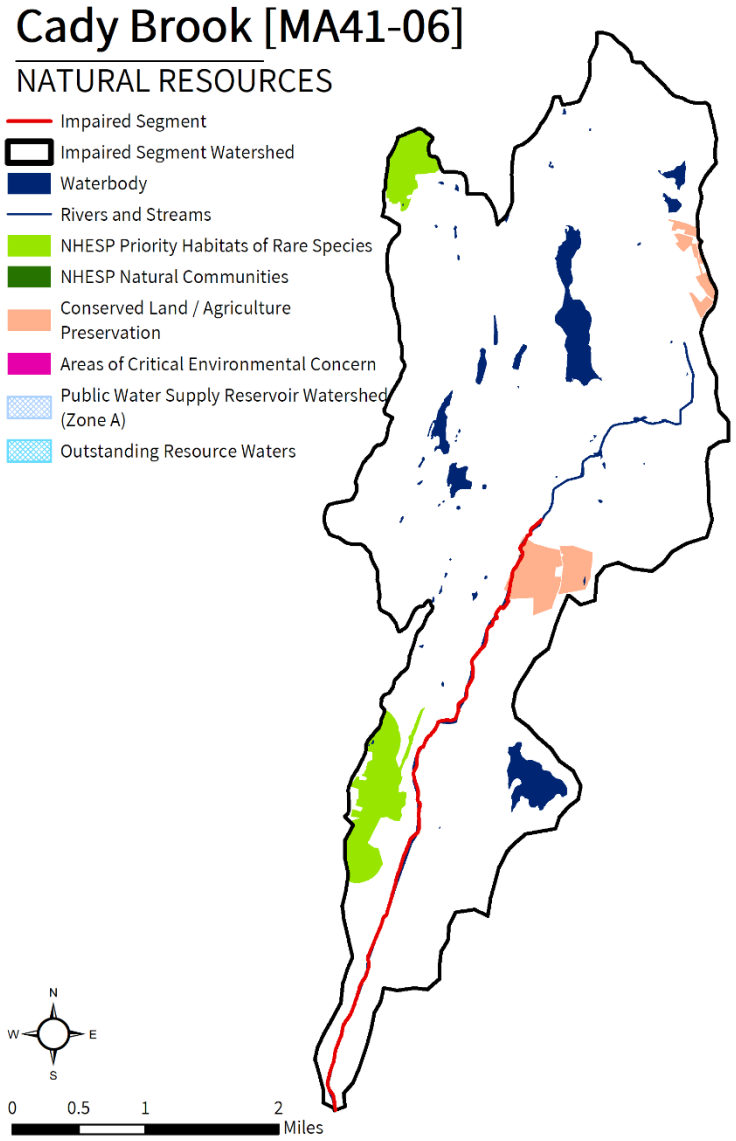
Table 5-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0101141	CHARLTON WWTP	CHARLTON	MUN

In the Cady Brook (MA41-06) watershed, under the Natural Heritage and Endangered Species Program, there are 298 acres (4%) of Priority Habitats of Rare Species. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters identified in this watershed. Over 189 acres (2%) of land protected in perpetuity[8] exist within the segment watershed, which is part of a total of 442 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).



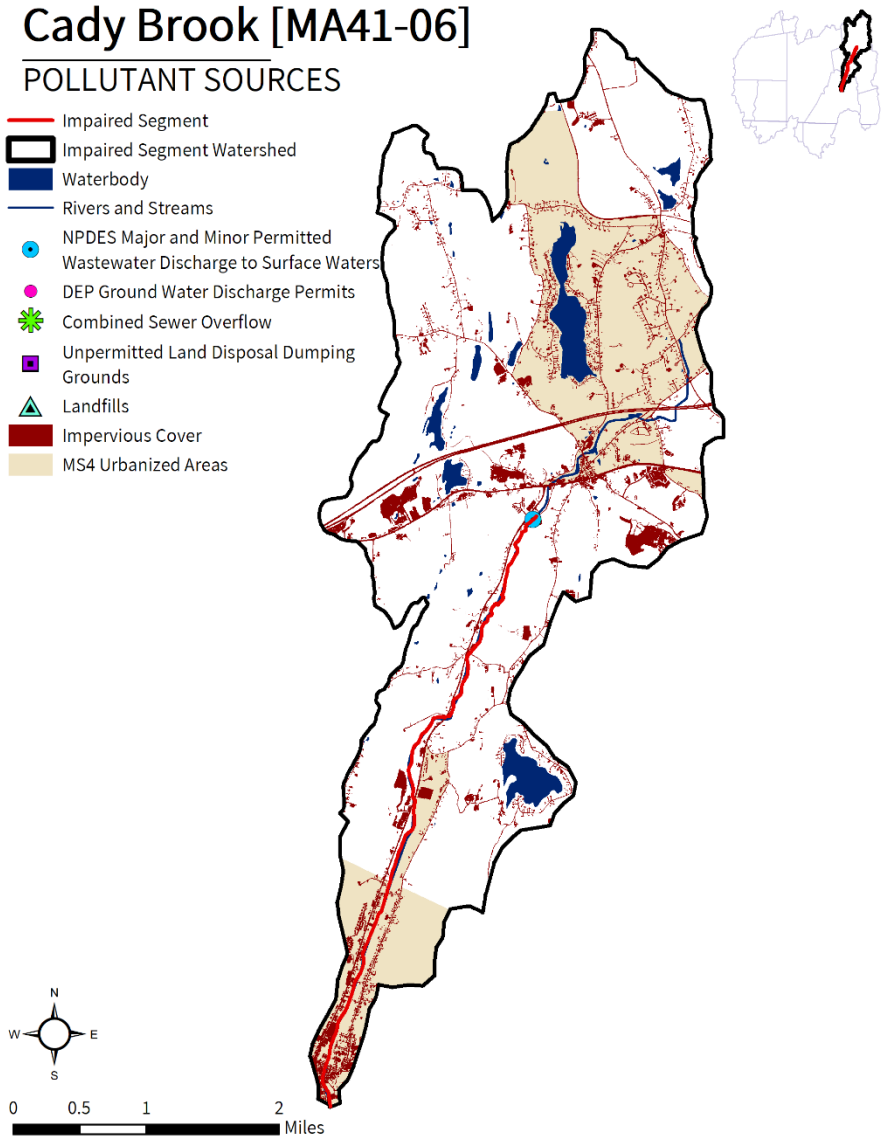


Figure 5-1. Natural resources and potential pollution sources draining to the Cady Brook segment MA41-06. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities

5.2. Waterbody Impairment Characterization

Cady Brook (MA41-06) is a Class B, Warm Water (MassDEP, 2021a).

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

- From 2007-2013, 30 samples were collected at W0615, resulting in eight days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of 30 samples, four exceeded the STV criterion in 2008, 2010, and 2012 during both wet and dry weather.
- In 2011, six samples were collected at W2189, resulting in five days when the 30-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during dry weather.

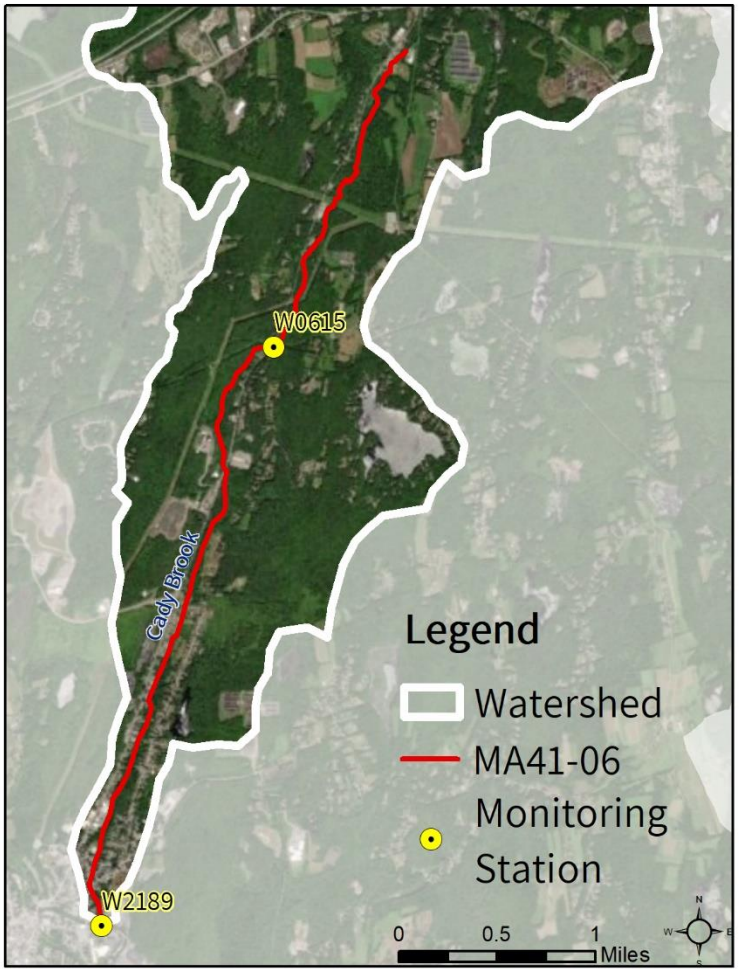


Figure 5-2. Location of monitoring station(s) along the impaired river segment.

Table 5-2. Summary of indicator bacteria sampling results by station for Cady Brook (MA41-06). 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
W0615	8/29/2007	4/24/2013	30	1990	8	4
W2189	5/24/2011	10/3/2011	6	980	5	1

Table 5-3. Indicator bacteria data by station, indicator, and date for Cady Brook (MA41-06). 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)
W0615	*E. coli*	8/29/2007	DRY	69	69	
W0615	*E. coli*	10/17/2007	DRY	64	64	
W0615	*E. coli*	1/30/2008	DRY	770	770	
W0615	*E. coli*	3/26/2008	DRY	101	101	
W0615	*E. coli*	5/21/2008	DRY	19	19	
W0615	*E. coli*	7/23/2008	WET	1990	1990	
W0615	*E. coli*	9/24/2008	DRY	54	54	
W0615	*E. coli*	11/19/2008	DRY	19	19	
W0615	*E. coli*	2/24/2009	WET	291	291	
W0615	*E. coli*	4/29/2009	DRY	28	28	
W0615	*E. coli*	6/24/2009	DRY	147	147	
W0615	*E. coli*	8/26/2009	DRY	76	76	
W0615	*E. coli*	10/28/2009	DRY	32	32	
W0615	*E. coli*	2/23/2010	DRY	1300	1300	
W0615	*E. coli*	7/21/2010	DRY	76	76	
W0615	*E. coli*	10/6/2010	WET	72	72	
W0615	*E. coli*	11/17/2010	WET	167	167	
W0615	*E. coli*	3/23/2011	DRY	16	16	
W0615	*E. coli*	4/27/2011	DRY	2	2	
W0615	*E. coli*	6/22/2011	DRY	118	118	
W0615	*E. coli*	8/31/2011	WET	93	93	
W0615	*E. coli*	10/26/2011	DRY	8	8	
W0615	*E. coli*	1/25/2012	DRY	47	47	
W0615	*E. coli*	3/28/2012	DRY	5	5	
W0615	*E. coli*	5/29/2012	DRY	135	135	
W0615	*E. coli*	7/25/2012	DRY	488	488	
W0615	*E. coli*	9/26/2012	DRY	37	37	
W0615	*E. coli*	11/14/2012	DRY	24	24	
W0615	*E. coli*	2/27/2013	WET	35	35	
W0615	*E. coli*	4/24/2013	DRY	23	23	
W2189	*E. coli*	5/24/2011	DRY	128	128	
W2189	*E. coli*	6/16/2011	WET	248	178	
W2189	*E. coli*	6/28/2011	WET	236	242	
W2189	*E. coli*	8/2/2011	DRY	980	980	
W2189	*E. coli*	8/30/2011	WET	192	434	
W2189	*E. coli*	10/3/2011	DRY	76	76	

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 Cady Brook (MA41-06) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather is consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed include areas of high density mixed residential, commercial, and industrial development, including expansive parking lots and an interstate highway corridor. The watershed has 28% of the land area in MS4 and 5% as DCIA. The impaired segment flows near Southbridge Road/MA-169 for its entire length. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: The downstream portion of the watershed is almost entirely 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. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: Most 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 within the segment watershed include open fields and livestock areas. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: The lower third of the segment is flanked by medium to high density residential development. 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: Most of the segment flows through wooded buffer, though the buffer appears narrow around Brookside Road in Southbridge and is absent at a driving range near the upstream end of the segment. 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.

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 Charlton. See Section 3.4

Town of Southbridge. See Section 3.4

6. MA41-12 Cohasse Brook

6.1. Waterbody Overview

The Cohasse Brook segment MA41-12 is 2.7 miles long and begins at the outlet of the Cohasse Brook Reservoir in Southbridge, MA. The segment flows northeast through Wells Pond (formerly segment MA41053), toward the Southbridge town center, to end at its confluence with the Quinebaug River in Southbridge, MA.

There are several unnamed tributary streams to the segment, some draining small unnamed ponds. Key landmarks within the segment watershed include the Cohasse Country Club and Oak Ridge Cemetery, through which the segment flows. The segment is crossed by Eastford Road/MA-198 (twice), Durfee Street, Elm Street, Laurel Hill Road, Cisco Street, and Chestnut Street. Near the downstream end, the segment is culverted for about 150 meters under a gas station and the Southbridge Rotary/Main Street/MA-131/MA-169.

Cohasse Brook (MA41-12) drains a total area of 4.1 square miles, of which 0.3 mi^2 (6%) is impervious and 0.2 mi^2 (4%) is directly connected impervious area (DCIA). The segment watershed extends into CT. Out of the total watershed area of 4.1 mi^2, 2.7 mi^2 (67%) are within MA. The watershed is partially[10] served by public sewer and 18% of the watershed area (27% of the Massachusetts portion) is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). Within the MA portion of the watershed, there are no NPDES permits on file governing point source discharges of pollutants to surface waters, no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds. See Figure 6-1.

The watershed is primarily forested (76% of watershed area) and moderately developed (15%). There is minimal agriculture in the watershed (1%). The upstream half of the watershed is only lightly developed. The segment itself flows through the most densely developed portion of the watershed in urbanized Southbridge. Land use around the segment includes medium to

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 2,609

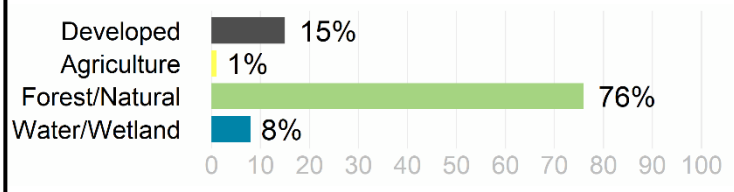
Segment Length (Miles): 2.7

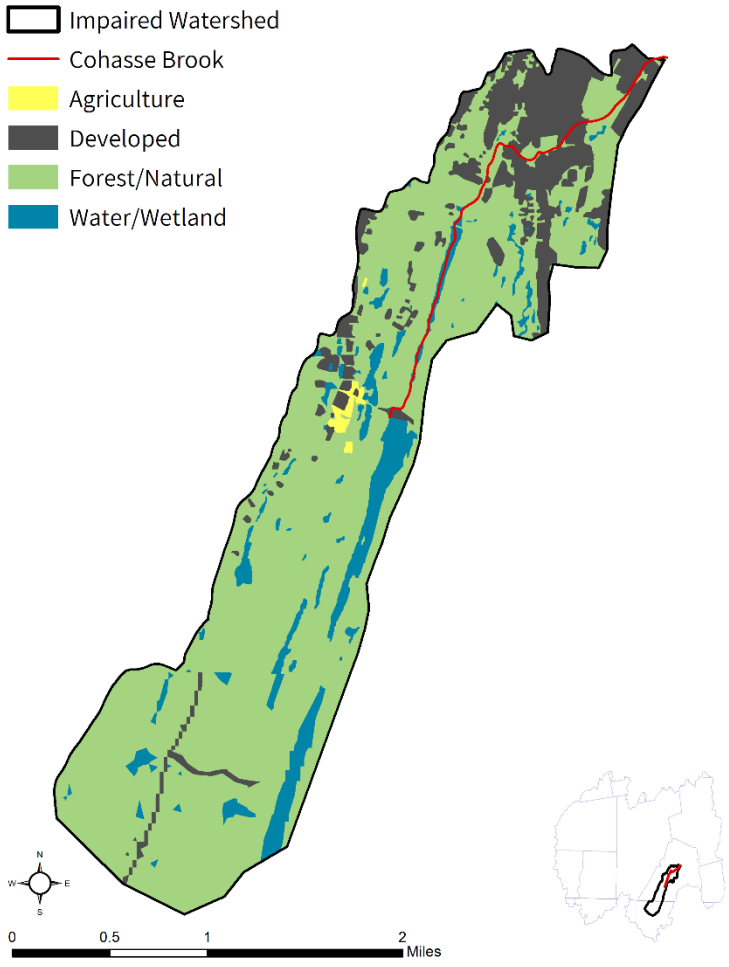
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 165 (6%)

DCIA Area (Acres, %): 97 (4%)





[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 2021), MS4 reports, and local knowledge.

high density mixed residential, commercial, and industrial development, though most of the segment flows within a narrow, wooded buffer.

Within the MA portion of the Cohasse Brook (MA41-12) watershed, under the Natural Heritage and Endangered Species Program, there are 287 acres (11%) of Priority Habitats of Rare Species. There are 1,181 acres (45%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in the watershed. Over 139 acres (5%) of land protected in perpetuity[11] exist within the segment watershed, which is part of a total of 982 acres (38%) of 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).

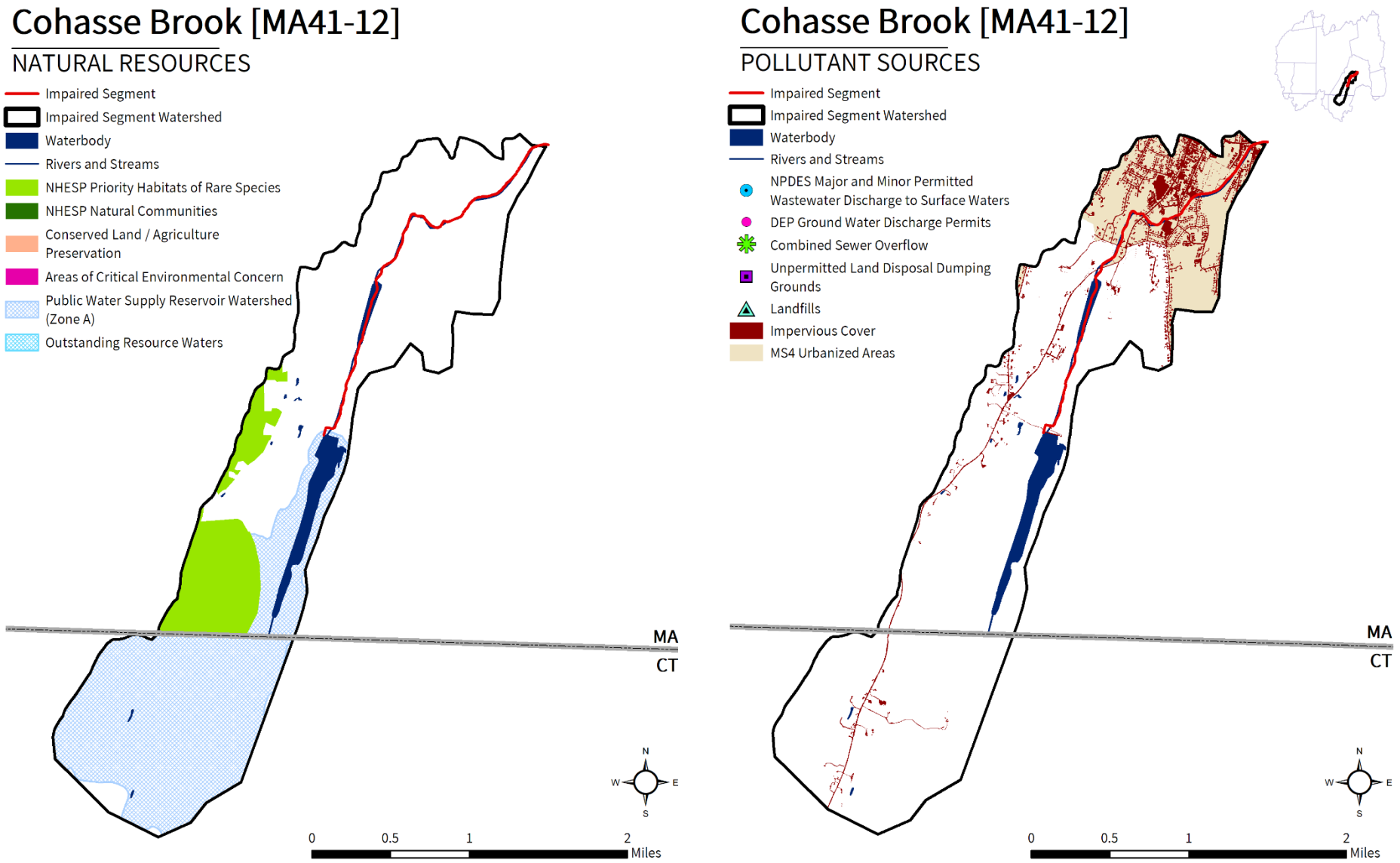


Figure 6-1. Natural resources and potential pollution sources draining to the Cohasse Brook segment MA41-12. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

6.2. Waterbody Impairment Characterization

Cohasse Brook (MA41-12) is a Class B Water (MassDEP, 2021a).

There were no recent data available to assess the Primary Contact Use. The impairment decision was carried forward from 2004 *E. coli* data collected in the lower 1.6-mile reach of the segment (downstream from Wells Pond) at Station W1169 located upstream from Cisco Street at the Oak Ridge Cemetery in Southbridge. Counts were elevated under both wet and dry sampling conditions (MassDEP, 2009).

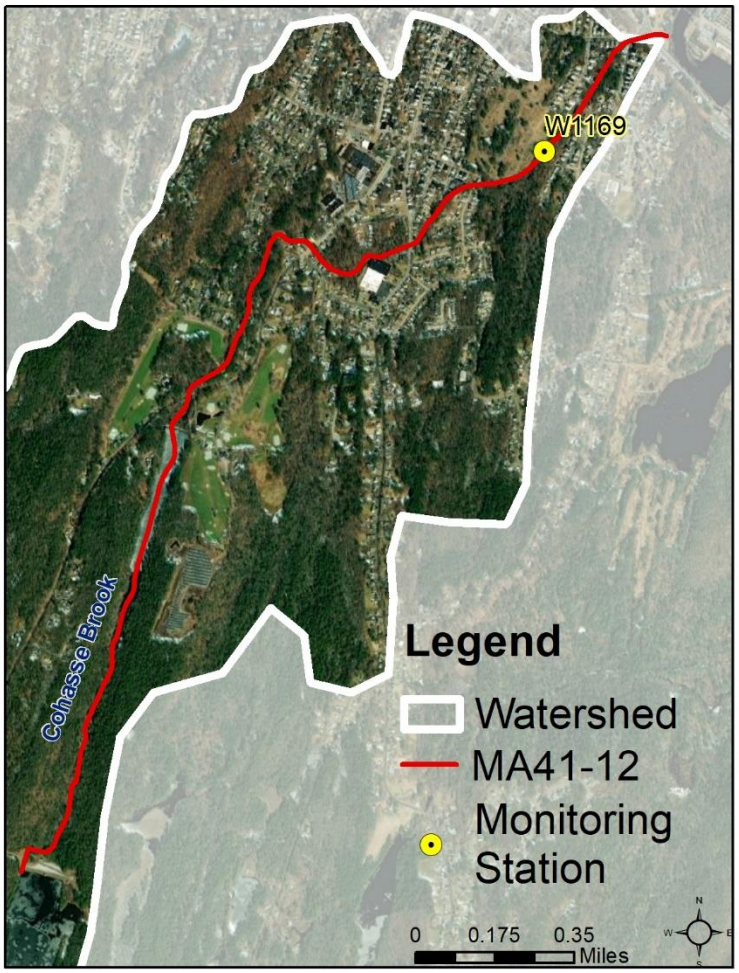


Figure 6-2. Location of monitoring station(s) along the impaired river segment.

6.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are highly developed and include the Southbridge town center where there are areas of medium to high density mixed residential, commercial, and industrial development. The watershed has 18% of the land area in MS4 and 4% as DCIA. Thus, stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: The portion of the watershed within MA is largely serviced by sewer, especially in the urbanized area of Southbridge. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: Some of the residential development in both the upstream and downstream portions of the watershed rely 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 only account for 1% of the total land use. Agricultural activities visible on recent aerial photos within the watershed appear as open fields adjacent to residential buildings. Stormwater runoff from agricultural lands are likely a negligible source of pathogens to the segment.

Pet Waste: Open space accounts for 38% of the segment watershed. The segment flows through several residential neighborhoods in Southbridge. 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: The segment flows through a cemetery and a golf course, though most the stream corridor through the golf course is wooded. The rest of the segment benefits from a narrow, wooded buffer. Any 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.

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 Southbridge. See Section 3.4

7. MA41-13 McKinstry Brook

7.1. Waterbody Overview

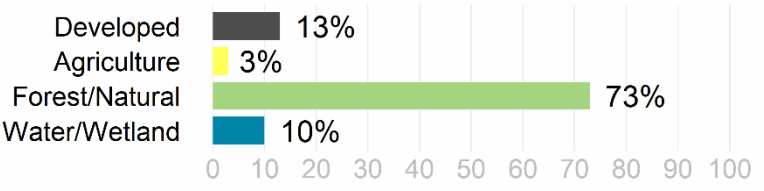
The McKinstry Brook segment MA41-13 is 7.3 miles long and begins at the headwaters of the brook (excluding the intermittent portion) east of Brookfield Road in Charlton, MA, near the border with Sturbridge, MA. The segment flows south through Sturbridge and Charlton to end at its confluence with a section of the Quinebaug River in Southbridge, MA.

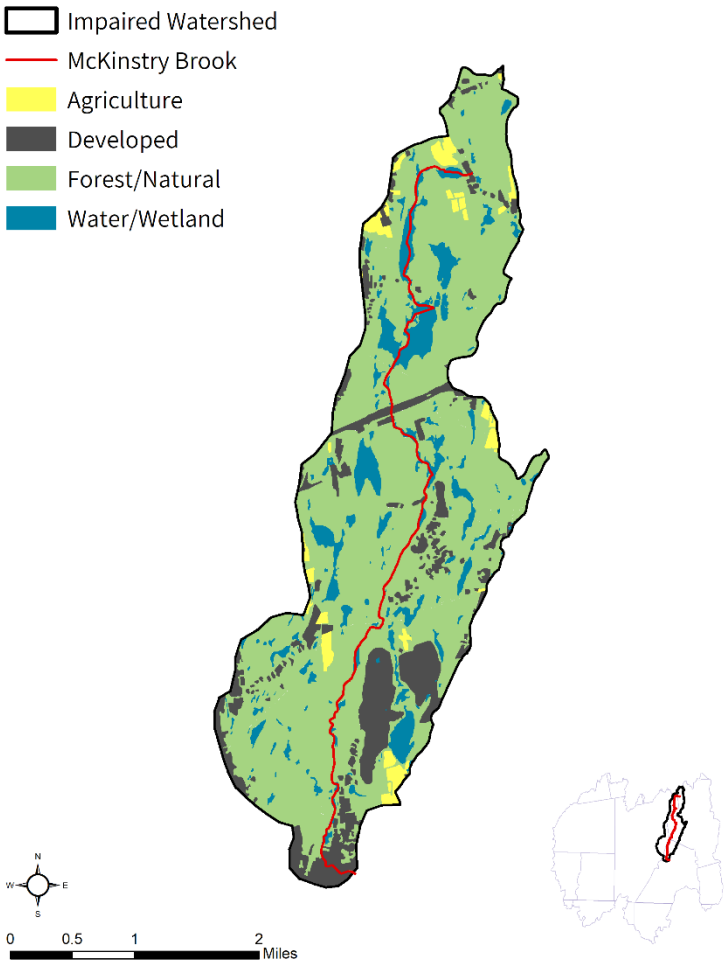
There are several unnamed tributary streams to McKinstry Brook, most of which drain unnamed wetlands or small ponds. Key landmarks in the watershed include the I-90 corridor, the Heritage Country Club, and the Southbridge Municipal Airport. The segment is crossed by Brookfield Road, Ladd Road, the Massachusetts Turnpike/I-90, Sturbridge Road/US-20, Hill Road, and Berry Corner Road (trail) in Charlton; and Plimpton Street, Pleasant Street, and Mill Street in Southbridge.

McKinstry Brook (MA41-13) drains an area of eight square miles, of which 0.5 mi^2 (6%) is impervious and 0.2 mi^2 (3%) is directly connected impervious area (DCIA). The watershed is mostly[13] served by public sewer and 14% 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, no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 7-1.

The watershed is predominantly forested (73%), with many wetlands (10%), many of which are open meadow wetlands along the stream corridor. The watershed is moderately developed (13%), mostly concentrated in the southern, downstream portion of the watershed, except for the I-90 and US-20 highway corridors, which occur roughly halfway along the segment. Developed land south of I-90 consists of medium density residential development, with high density mixed commercial and residential

Reduction from Highest Calculated Geomean: NA
Watershed Area (Acres): 5,129
Segment Length (Miles): 7.3
Impairment(s): *E. coli* (Primary Contact Recreation)
Class (Qualifier): B
Impervious Area (Acres, %): 302 (6%)
DCIA Area (Acres, %): 138 (3%)





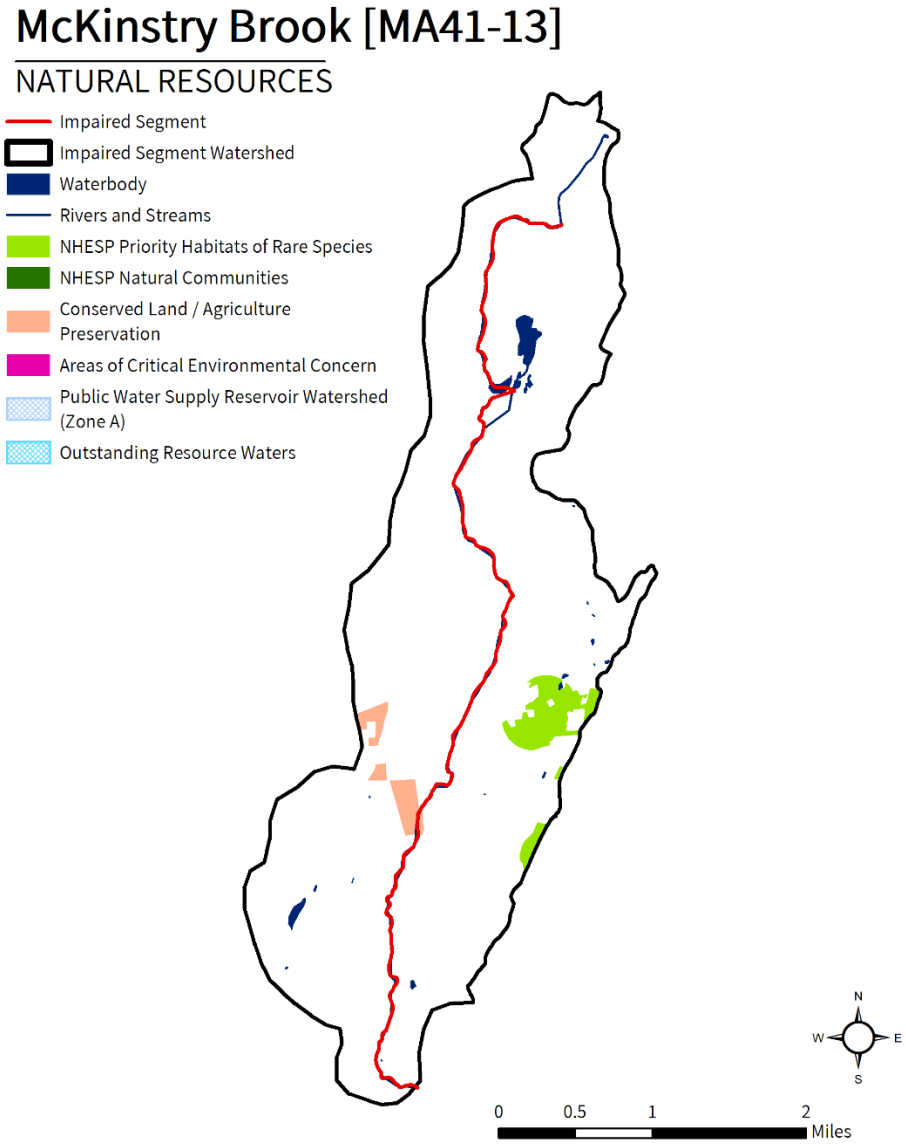
[13] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program (MassDEP, 2021b), MS4 reports, and local knowledge.

development along the last 0.3 miles of the segment, as well as a municipal airport and large quarry in the southeastern portion of the watershed. Agricultural fields in the watershed appear to be primarily used as hayfields, few of which are adjacent to the stream.

In the watershed of McKinstry Brook (MA41-13), under the Natural Heritage and Endangered Species Program, there are 113 acres (2%) of Priority Habitats of Rare Species. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters identified in the watershed. Over 58 acres (1%) of land protected in perpetuity[14] exist within the segment watershed, which is part of a total of 574 acres (11%) 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).



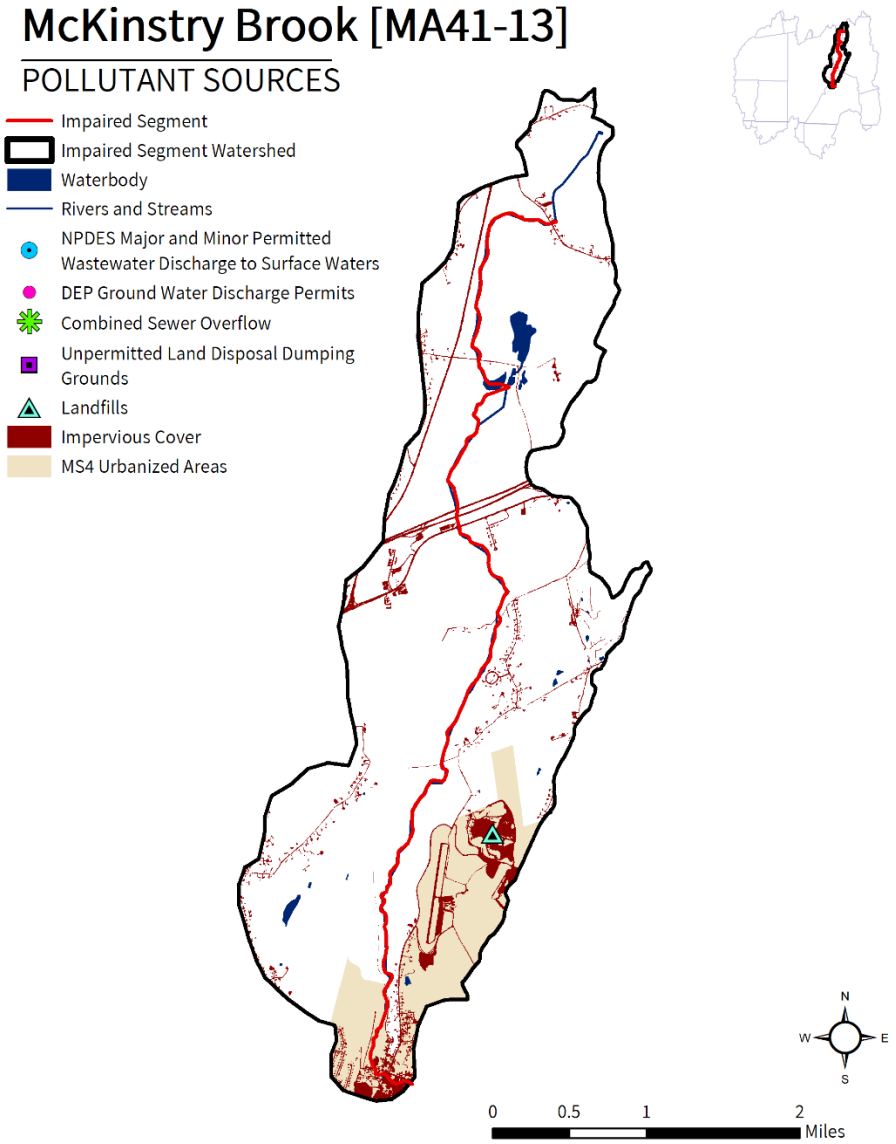


Figure 7-1. Natural resources and potential pollution sources draining to the McKinstry Brook segment MA41-13. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

7.2. Waterbody Impairment Characterization

McKinstry Brook (MA41-13) is a Class B Water (MassDEP, 2021a).

There were no recent data available to assess the Primary Contact Use. The impairment decision was carried forward from 2004 *E. coli* data collected in the lower 0.3-mile reach of the segment (MassDEP, 2009). Station W1170 was sampled on five occasions between May and September 2004. The geometric mean of *E. coli* was reported as 492 CFU/100mL (MassDEP, 2009).

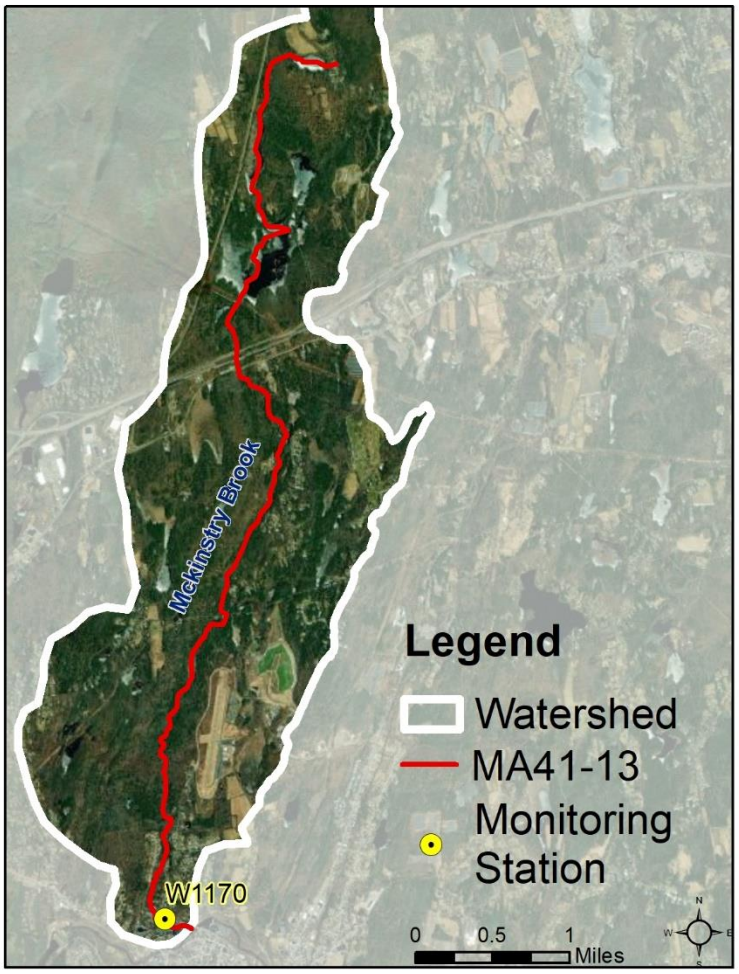


Figure 7-2. Location of monitoring station(s) along the impaired river segment.

7.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are highly developed and include areas of medium to high density mixed residential and commercial development, as well as the Southbridge Municipal Airport and a major highway corridor for I-90 and US-20. The watershed has 14% of the land area in MS4 and 3% as DCIA. Thus, stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: Some of the upstream portion of the watershed and nearly all of the downstream portions are served by municipal 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: Most of the residential development in the upstream portion of the watershed rely 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 only account for 3% of the total land use, though very few areas appear adjacent to the segment. Agricultural activities visible on recent aerial photos are mostly hayfields. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Most of the upper portion of the segment flows through a wooded wildlife management area, with trails leading to the brook, while the lower portion of the segment flows through residential neighborhoods. 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: McKinstry Brook flows through several large open meadow wetlands in the upper watershed. Large open mowed areas such as conservation and recreation land, fields, golf courses, and wetlands with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

7.4. Existing Local Management

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

Town of Charlton. See Section 3.4

Town of Southbridge. See Section 3.4

Town of Sturbridge. See Section 3.4

8. MA41-16 Unnamed Tributary

8.1. Waterbody Overview

The Unnamed Tributary segment MA41-16 is 1.2 miles long and begins at the outlet of Sherman Pond in Brimfield, MA. The segment flows south toward the Brimfield town center to end at its confluence with Mill Brook in Brimfield.

Tributaries to the Unnamed Tributary (known as East Brook in the National Hydrologic Database) includes three unnamed streams. Sessions Brook is a tributary to the portion of the stream above Sherman Pond. There are not additional named lakes or ponds beyond Sherman Pond.

Key landmarks in the watershed include the I-90 corridor in the upper watershed, Sherman Lake Conservation Area, most of Brimfield town center including the Town Commons and Hitchcock Free Academy, and Brimfield Cemetery. The segment is crossed by Cubles Drive, East Hill Road, Sturbridge Road/US-20, and the access road to the Brimfield Cemetery.

The Unnamed Tributary (MA41-16) drains an area of 6.1 square miles, of which 0.2 mi^2 (4%) is impervious and 0.1 mi^2 (2%) is directly connected impervious area (DCIA). The watershed is partially[16] served by public sewer and is not 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, no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 8-1.

The watershed is mostly forested (76%) and lightly developed (11%). Developed land south of Sherman Pond consists mostly of low density residential and commercial development, with a small area of medium density development near the downstream end of the segment in Brimfield. Agricultural land use (8%) within the watershed appears to be primarily hayfields, most of which are not adjacent to the segment. There are a few areas where lawns and fields are mowed close

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 3,915

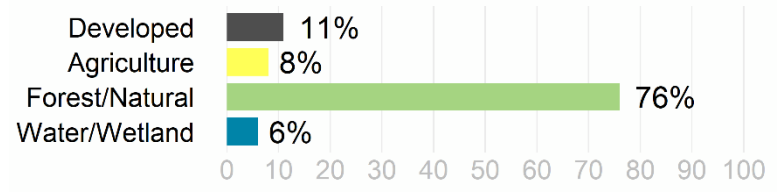
Segment Length (Miles): 1.2

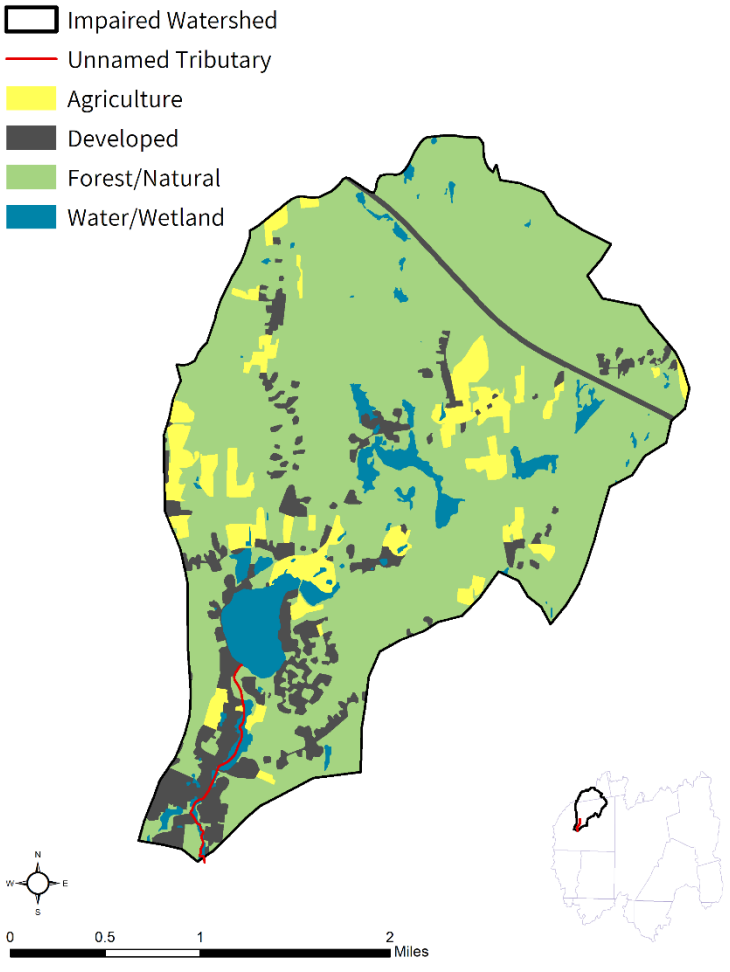
Impairment(s): *E.coli* (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 152 (4%)

DCIA Area (Acres, %): 61 (2%)





[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, 2021b), MS4 reports, and local knowledge.

to the banks of the upstream (unimpaired) section of the stream, especially along Little Rest Road. There are extensive open meadow wetlands along the segment and its tributaries.

In the watershed of the Unnamed Tributary (MA41-16), under the Natural Heritage and Endangered Species Program, there are 1.3 acres (<1%) of Priority Habitats of Rare Species. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters identified in the watershed. There are no areas of land protected in perpetuity[17] within the segment watershed, which would otherwise be part of a total of 20 acres (1%) 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).

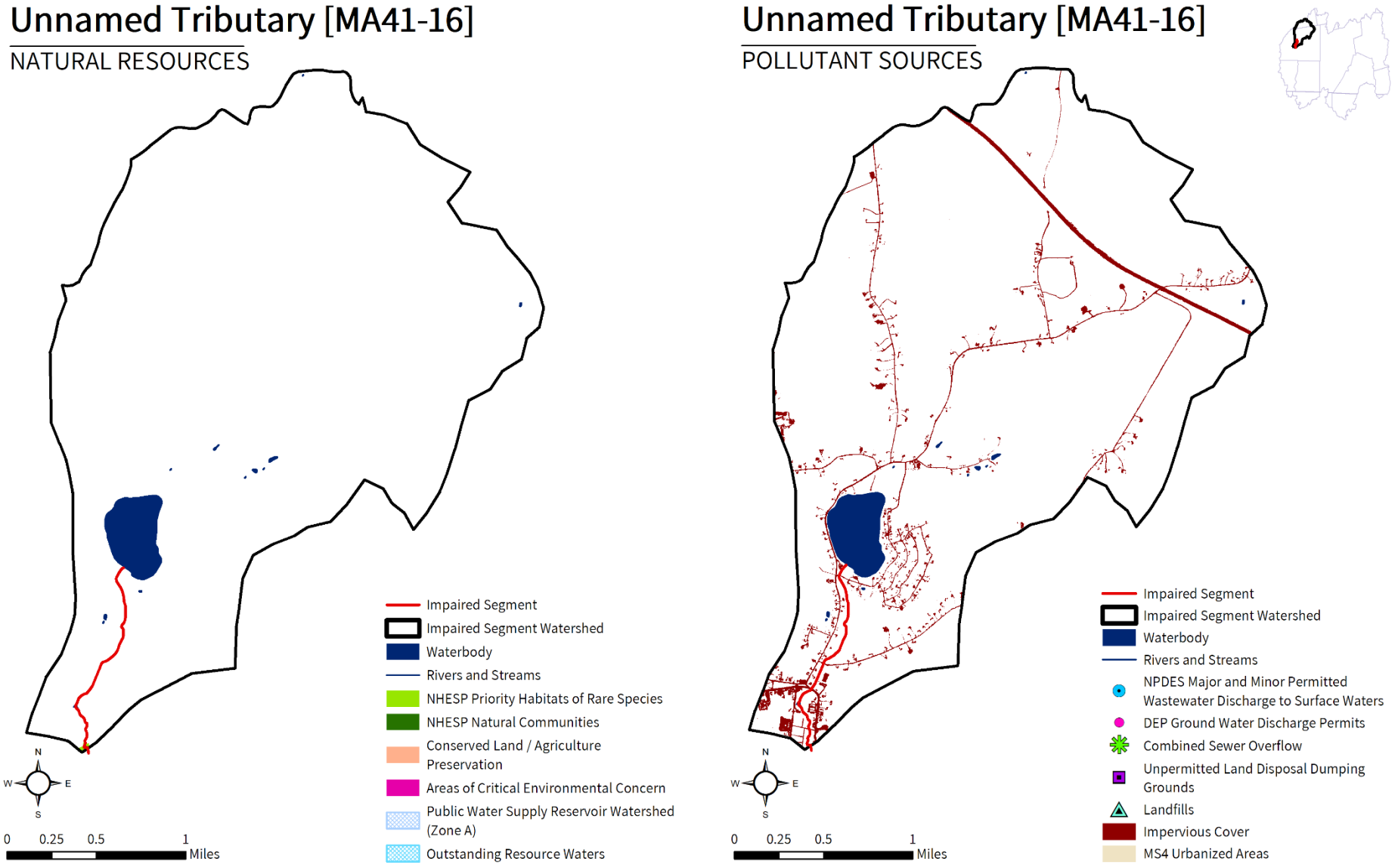


Figure 8-1. Natural resources and potential pollution sources draining to the Unnamed Tributary segment MA41-16. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

8.2. Waterbody Impairment Characterization

The Unnamed Tributary (MA41-16) is a Class B Water (MassDEP, 2021a).

There were no recent data available to assess the Primary Contact Use. The impairment decision was carried forward from 2004 *E. coli* and fecal coliform data collected at the US-20 road crossing with the segment (MassDEP, 2009). Station W1183 was sampled on five occasions between May and September 2004. The geometric mean of *E. coli* was reported as 971 CFU/100mL (MassDEP, 2009).

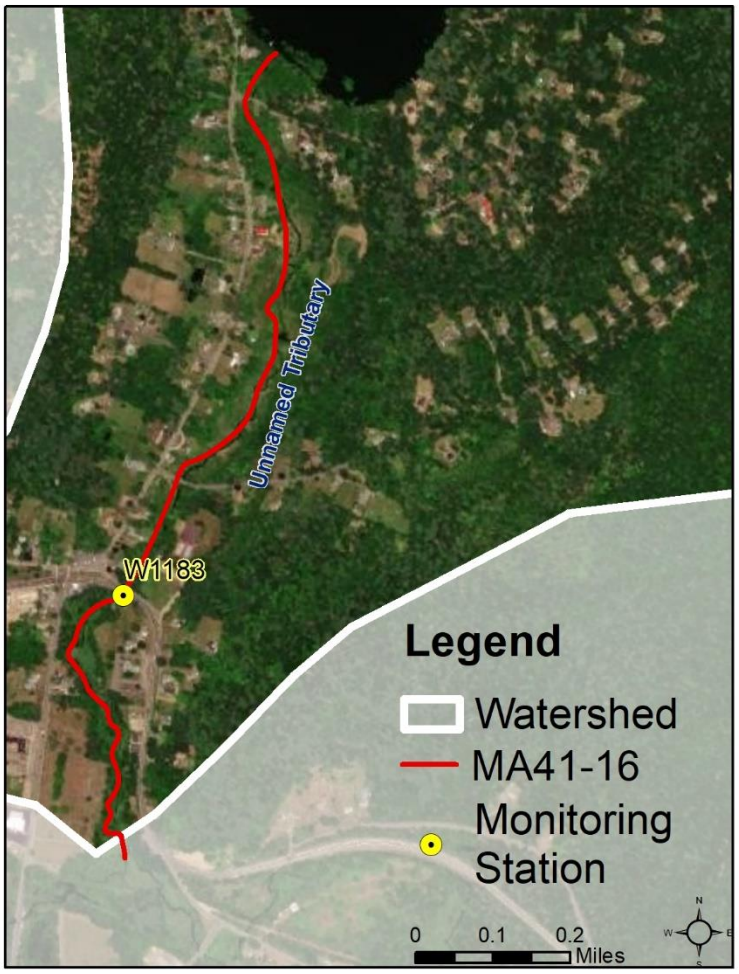


Figure 8-2. Location of monitoring station(s) along the impaired river segment.

8.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: Most of the watershed is lightly developed, with small areas of medium density mixed development in village center of Brimfield, and the segment flows adjacent to those more developed areas. The I-90 corridor is near the headwaters of the tributary, far upstream of the segment. The watershed is not within the MS4 area, and 2% of the land area is DCIA. Stormwater runoff from urban areas is likely a source of pathogens.

Illicit Sewage Discharges: The watershed is likely partially serviced by sewer in Warren. There may also 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: 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 in the watershed account for 8% of the total land use. Those visible on recent aerial photos within the segment watershed appear to be primarily hayfields and small garden plots. Some of these lands, especially near Little Rest Road, are directly adjacent to the upstream (unimpaired) section of the stream. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Most of the segment flows along low to medium density residential development. Conservation and recreation 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: The stream, both the impaired and unimpaired portions, flows through several large open meadow wetlands. 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.

8.4. 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 Brimfield. See Section 3.4

Town of Warren

Warren is not within the MS4 area.

Warren has the following relevant ordinances and bylaws:

- Stormwater Management bylaw: none found
- Warren's Master Plan also includes a section on "Topography, Geology, Hydrology" in Chapter 4, pg. 34. The Master Plan also has a section on the sewer department on pg. 75 and mentions stormwater. https://www.warren-ma.gov/sites/g/files/vyhlif3996/f/uploads/wmass.pdf (Town of Warren, 2006)

Warren Open Space and Recreation Plan. Town of Warren Master Plan Phase III Final Draft. March 2006. Chapter 4 pg. 32. https://www.warren-ma.gov/sites/g/files/vyhlif3996/f/uploads/wmass.pdf (Town of Warren, 2006)

9. MA41-17 West Brook

9.1. Waterbody Overview

West Brook segment MA41-17 is 1.8 miles long and begins at the brook's headwaters (excluding the intermittent portion) west of Dix Hill Road and Warren Road/MA-19 in Brimfield, MA. The segment flows south to end at its confluence with Mill Brook in Brimfield, MA.

Tributaries to West Brook are several unnamed streams, most draining unnamed ponds or wetlands. Key landmarks in the watershed include the John W. Brown Conservation Area, the Brimfield Public Library, and parts of a large antiques and outdoor market district along US-20 in Brimfield. The segment is crossed by Main Street/US-20 (Brimfield).

West Brook (MA41-17) drains an area of 1.4 square miles, of which 0.1 mi^2 (6%) is impervious and 0.03 mi^2 (2%) is directly connected impervious area (DCIA). The watershed is likely not[19] served by public sewer and is not 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, no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds within the watershed. See Figure 9-1.

Most of the watershed, especially the upper north and western parts, is forested (68%). The watershed is moderately developed (20%), with low density mixed residential and commercial development along state highway MA-19 in the eastern portion of the watershed, and medium density residential and high density commercial development (antiques show fairgrounds and outdoor market stalls) in the southern, downstream portion of the watershed in Brimfield. The upper portion of the brook flows through a forested and wetland corridor, while the downstream portion of the brook flows through mowed fields dedicated to outdoor markets, usually but not always within a narrow wooded buffer. Agricultural lands (8%) within the watershed appear to be primarily

Reduction from Highest Calculated Geomean: 38%

Watershed Area (Acres): 907

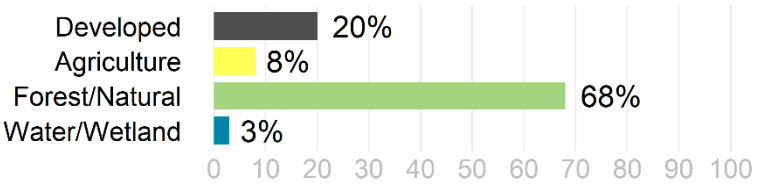
Segment Length (Miles): 1.8

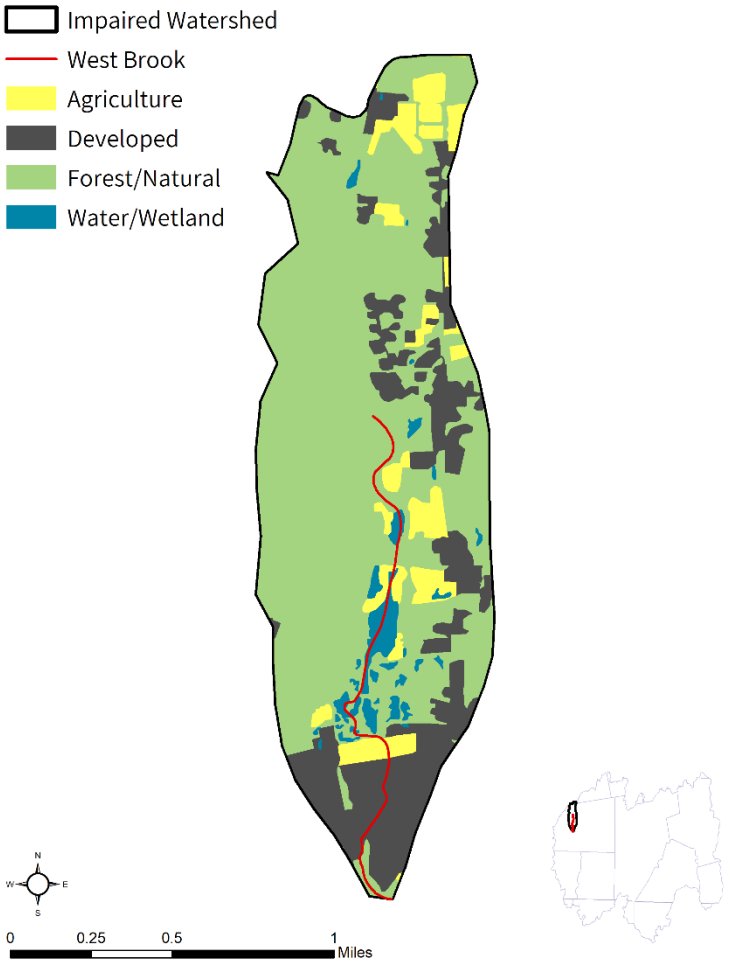
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 53 (6%)

DCIA Area (Acres, %): 17 (2%)





[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, 2021b), MS4 reports, and local knowledge.

hayfields, and the segment flows through one immediately north of the outdoor markets.

In the West Brook (MA41-17) watershed, under the Natural Heritage and Endangered Species Program, there are 183 acres (20%) of Priority Habitats of Rare Species. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters identified in the watershed. There are no areas of land protected in perpetuity[20] within the segment watershed, which would otherwise be part of a total of six acres (1%) 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).

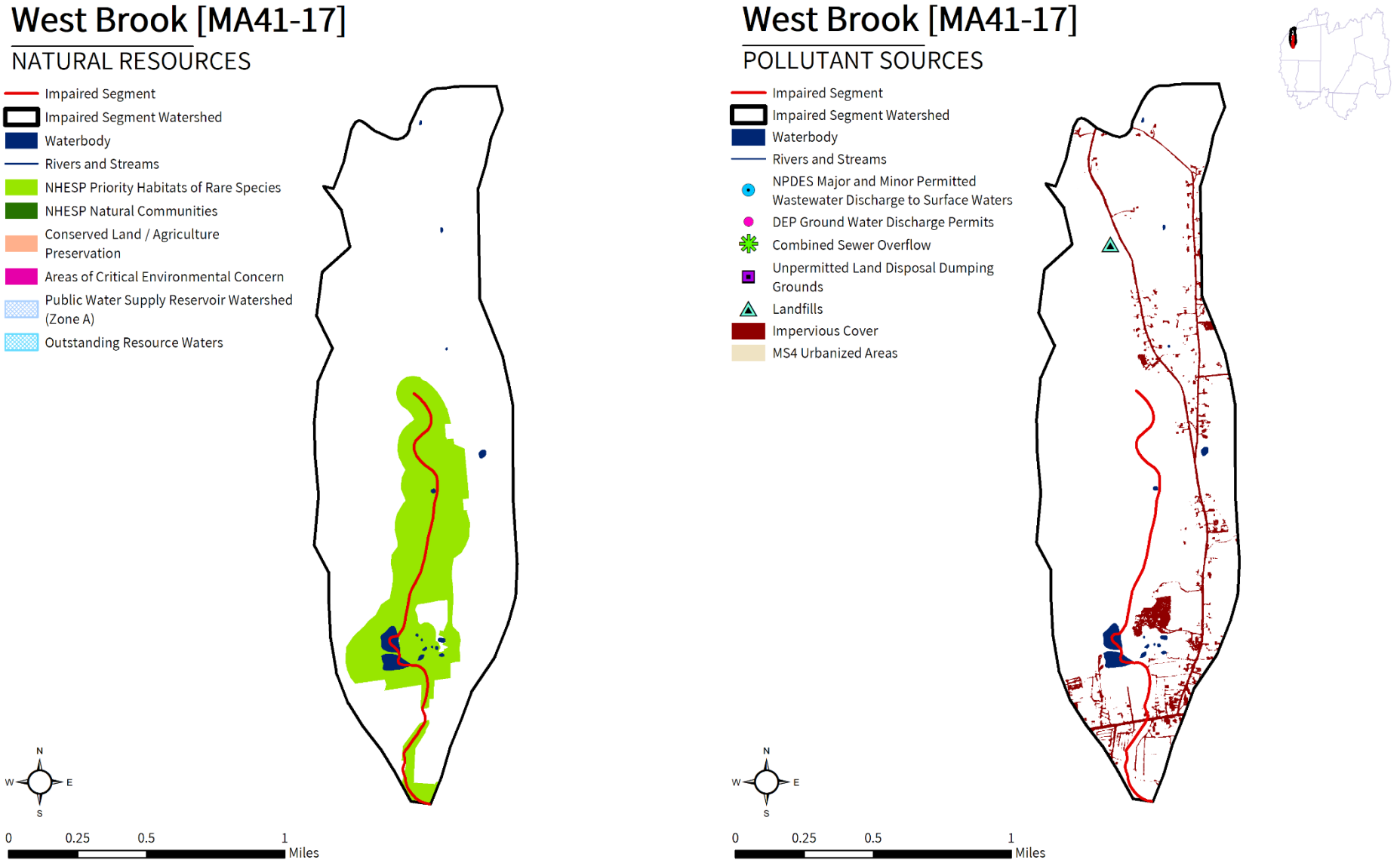


Figure 9-1. Natural resources and potential pollution sources draining to the West Brook segment MA41-17. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

9.2. Waterbody Impairment Characterization

West Brook (MA41-17) is a Class B Water (MassDEP, 2021a).

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 9-1, 9-2; Figure 9-2). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2011, six samples were collected at W2198, 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, two exceeded the STV criterion during wet weather.

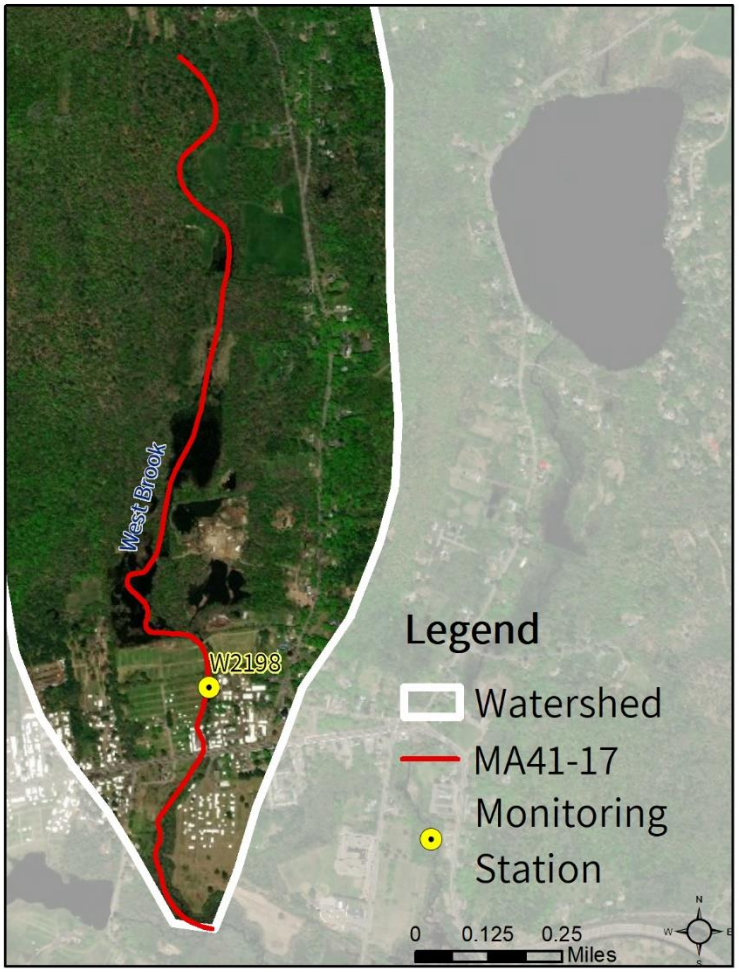


Figure 9-2. Location of monitoring station(s) along the impaired river segment.

Table 9-1. Summary of indicator bacteria sampling results by station for West Brook (MA41-17). 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
W2198	5/24/2011	10/3/2011	6	204	2	2

Table 9-2. Indicator bacteria data by station, indicator, and date for West Brook (MA41-17). 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)
W2198	*E. coli*	5/24/2011	DRY	31	31	
W2198	*E. coli*	6/16/2011	DRY	25	28	
W2198	*E. coli*	6/28/2011	WET	816	86	
W2198	*E. coli*	8/2/2011	DRY	105	90	
W2198	*E. coli*	8/30/2011	WET	816	204	
W2198	*E. coli*	10/3/2011	WET	79	189	

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 West Brook (MA41-17) were elevated during wet weather, indicating urban stormwater, pet waste, and wildlife pathogen sources of pollutants. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Overall, the watershed is moderately developed with low to medium density residential development in most areas, while the lower portion of the watershed is impacted by high density commercial activity (antiques fairs and outdoor markets). The watershed is not within the MS4 area, but 2% is DCIA. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: Almost none of the watershed has sewer service, and there is no MS4 area. 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: Almost all the residential 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 in the watershed account for 8% of the total land use. Those visible on recent aerial photos within the segment watershed area appear to be hayfields. The brook flows through one hayfield just north of the outdoor market area where only a sparse vegetated buffer around the stream channel exists with two motor vehicle crossings of the stream. Agricultural activities 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 in the watershed, and the area experiences a large influx of visitors to outdoor market stalls. The segment flows through or next to several of these fields dedicated to market stalls, including one just south of Main Street/US-20 where grass is mowed to the water's edge. Conservation and recreation lands, parks, ballfields, outdoor areas, 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: The upper portion of the segment flows through several large meadow wetlands, and there are mowed areas that lead to the water's edge just upstream of the outdoor market area and downstream of US-20. 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.

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 Brimfield. See Section 3.4

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