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

Appendix L: Narragansett Bay (Shore) Coastal Drainage Area

Commonwealth of Massachusetts
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December 2024

CN 515.1.12

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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

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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 TMDL for the three pathogen-impaired segments in the Narragansett Bay (Shore) Coastal Drainage Area, hereinafter referred to as the Narragansett Bay (Shore) watershed (Figure 1-1). The core document and appendix together complete the TMDL for each of these pathogen-impaired 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.

This appendix also includes a summary of the allocation of the current indicator bacteria load in 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 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, if applicable. The TMDLs for the three Narragansett Bay (Shore) segments were calculated with the flow-based equation. 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 Narragansett Bay (Shore) Watershed Overview section.

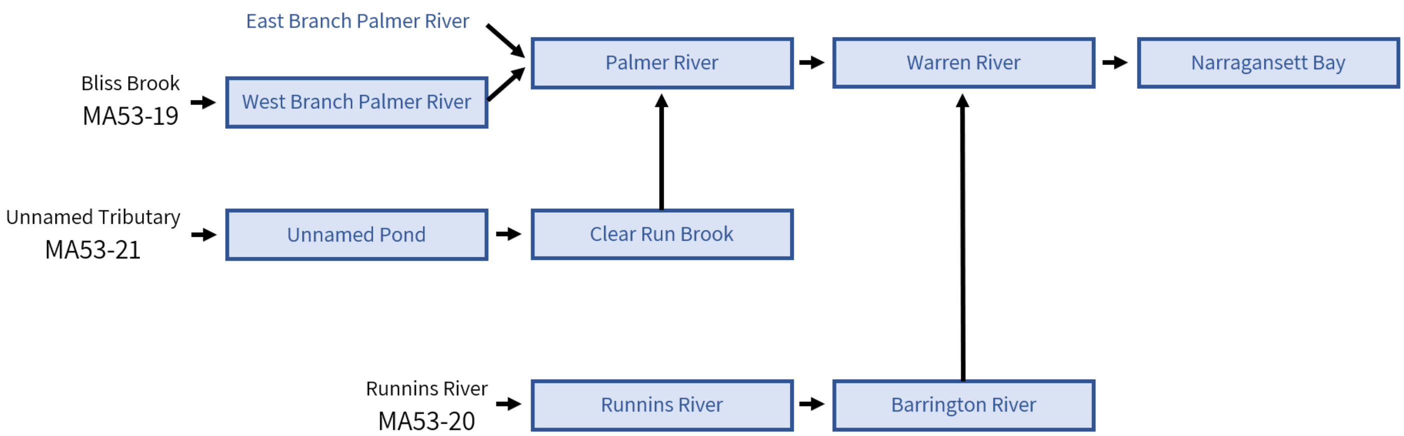


Figure 1-1. Conceptual diagram of water flow through the Narragansett Bay (Shore) watershed for the three pathogen-impaired segments. Connections between waterbodies are shown with black arrows. Not to scale. Impaired segments are shown with the assessment unit.

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 Narragansett Bay Coastal Drainage Area

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)					
Bliss Brook		R	126	663	81%	WLA (5%)	0.2	1.6	16.3	163.2	1,632.4	16,324.4
MA53-19	B			(90 day)		LA (95%)	2.9	29.2	291.9	2,919.4	29,194.4	291,943.7
Runnins River		R	126	2,420	95%	WLA (8%)	0.2	2.5	25.0	249.9	2,498.9	24,988.9
MA53-20	B			(90 day)		LA (92%)	2.8	28.3	283.3	2,832.8	28,327.9	283,279.1
Unnamed Tributary		R	126	940	87%	WLA (17%)	0.5	5.2	51.8	517.6	5,176.3	51,763.5
MA53-21	B			(90 day)		LA (83%)	2.6	25.7	256.5	2,565.0	25,650.5	256,504.6

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 Narragansett Bay Coastal Drainage Area

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)					
Bliss Brook		P	35	NA	-	WLA (5%)	-	0.5	4.5	45.3	453.5	4,534.5
MA53-19	B					LA (95%)	0.8	8.1	81.1	811.0	8,109.5	81,095.5
Runnins River		P	35	1,800	98%	WLA (8%)	0.1	0.7	6.9	69.4	694.1	6,941.4
MA53-20	B			(90 day)		LA (92%)	0.8	7.9	78.7	786.9	7,868.9	78,688.6
Unnamed Tributary		P	35	NA	-	WLA (17%)	0.1	1.4	14.4	143.8	1,437.9	14,378.7
MA53-21	B					LA (83%)	0.7	7.1	71.3	712.5	7,125.1	71,251.3

Class *defined in the Massachusetts Surface Water Quality Standards (SWQS) at 314 CMR 4.02.*
Qualifiers *that identify segments with special characteristics are defined at 314 CMR 4.06(1)(d).*
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 use.*
- ***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. Narragansett Bay (Shore) Watershed Overview

The Narragansett Bay (Shore) watershed covers an area of approximately 68 square miles (mi^2) in southeastern Massachusetts and eastern Rhode Island (Figure 2-1). Two major rivers are located within the watershed: the Runnins River which drains into the Barrington River in Rhode Island, and the Palmer River which drains into the Warren River in Rhode Island. These rivers subsequently drain into the greater Narragansett Bay Estuary, which in 1987 the EPA designated as an “Estuary of National Significance” (MassDEP, 2009). Narragansett Bay has approximately 256 miles of shoreline, a surface area of 147 mi^2, an average depth of 26 feet, and a maximum depth of 184 feet (MassDEP, 2009). Roughly 60% of the total Narragansett Bay watershed is located in Massachusetts while the remaining 40% is located in Rhode Island (MassDEP, 2009).

The Narragansett Bay (Shore) watershed overlaps a portion of five municipalities in Massachusetts and three municipalities in Rhode Island. Of the five municipalities in Massachusetts, the majority of Rehoboth and Seekonk are located in the watershed, as well as small portions of Attleboro, Dighton, and Swansea. See Figure 2-1 for a map showing impaired segments and watershed municipalities.

All municipalities in the watershed operate and maintain municipal separate storm sewer systems (MS4s) in urban areas. The networks of drains and pipes in MS4 systems convey polluted runoff from streets and developed areas to waterbodies. 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 on July 1, 2018, with modifications effective on January 6, 2021 (USEPA, 2020). 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 MS4 requirement to reduce pollutants to the Maximum Extent Practicable (USEPA, 2020).

The geographic range of one Regional Planning Agency (RPA), the Southeast Regional Planning and Economic Development District, or SRPEDD, includes the Narragansett Bay (Shore) watershed (SRPEDD, 2022). RPAs are public organizations advising municipalities, private business groups, and state and federal governments on a range of matters. Their research, coordination and technical assistance are especially valuable in addressing watershed-level issues such as pathogen pollutants and stormwater that cross town boundaries.

The following RPA initiatives and tools utilized in the Narragansett Bay watershed are especially noteworthy:

- SRPEDD assists in developing watershed management plans for waterbodies in the region (SRPEDD, 2022)
- SRPEDD is involved in watershed enhancement through a grant from the Southeast New England Coastal Watershed Restoration Program (SNEP)

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 through their “Think Blue” campaign (Think Blue Massachusetts, 2019).

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

- **Narragansett Bay Estuary Program** (NBEP) whose mission is to “catalyze scientific inquiry and collective action to restore and protect our water quality, wildlife, and quality of life” (NBEP, 2022)
- **Massachusetts Office of Coastal Zone Management** (MA CZM) has a South Coastal Regional office that “serves the coastal communities from Wareham to Seekonk located in the Buzzards Bay, Mt. Hope Bay, Taunton, and Narragansett Bay watersheds.” (MA CZM, 2022a).
- **National Water Quality Initiative** (NWQI) abates fecal contamination through the installation of agricultural conservation practices or BMPs. In 2012, the Palmer River watershed was included in the

NWQI. In the same year, MassDEP, RI Department of Environmental Management (RIDEM), and US EPA Region 1 began a joint project to further investigate water pollution sources to the Palmer River. By 2015, agricultural BMPs were being installed throughout the southern portion of the watershed and have continued to be installed up to present day. Beginning in 2016, MassDEP, RIDEM, and US EPA Region 1 have collected monthly water quality samples at twelve fixed stations or "core" sites within the lower Palmer River watershed to determine the effectiveness of remediation efforts with agricultural BMP installations. The "core" sites included six saline and six freshwater stations, with three stations on Clear Run sampled for *E. coli*, three stations on the mainstem sampled for Enterococci, and the remaining six stations sampled for both parameters. Beginning in 2017, samples were collected for ribonucleic acid (RNA) microarray analysis using PhyloChip®[1] to determine fecal sources. None of the twelve stations correspond to the direct watersheds of the segments listed in this appendix.

- **Save The Bay** (STB) is an independent, nonprofit organization whose mission is "to protect and improve Narragansett Bay" (STB, 2022).
- **Trout Unlimited** (TU) operates two chapters in the geographic area of the Narragansett Bay watershed in Massachusetts, including the Narragansett and Southeastern Mass (SEMASS). Their mission is to conserve, protect and restore our country's coldwater fisheries and their watersheds; some of their activities include river cleanups, scientific assessments (e.g., trout habitat, culvert connectivity) and restoration projects (TU, 2022).
- **USEPA Southeast New England Program** (SNEP) whose mission is to "foster collaboration among regional partners across southeast New England's coastal watersheds to protect and restore water quality, ecological health, and diverse habitats by sharing knowledge and resources, promoting innovative approaches, and leveraging economic and environmental investments to meet the needs of current and future generations" (USEPA, 2022).

The following actions by identified stakeholders will help reduce pathogen loads to the impaired segments. The list represents a starting point and is not intended to be comprehensive. For a more detailed discussion of pollutant reduction actions, see Section 5, "Implementation" of the Pathogen TMDL core document.

- **Municipalities:** Continue to implement the MS4 permit, which includes specific requirements for waterbodies with an approved Bacteria/Pathogen TMDL, such as prioritization and reporting, enhanced BMPs, IDDE, and education (USEPA, 2020).
- **Regional Planning Agencies (RPAs) and municipalities:** Continue and expand collaboration on MS4 and stormwater issues. Cooperatively develop tools and share knowledge to reduce costs, increase innovation, and generate consistent and effective stream restoration efforts at the watershed scale.
  - Two tools developed by MAPC are potentially valuable in all MS4 communities across the state; municipalities and other RPAs (with permission from MAPC) should consider adapting and/or expanding these tools in their area:
    - Stormwater Utility/Funding Starting Kit (MAPC, 2014); and
    - a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit, created by MAPC and the Neponset River Watershed Association (MAPC, 2018).
- **USDA NRCS and landowners:** Develop comprehensive nutrient management plans for agriculture, reaching farmers through local connections.
- **Parks departments, schools, private landowners, and others** who maintain large, mowed fields with direct connections to surface water should consider maintaining a vegetated buffer along the shoreline. Buffers slow and filter stormwater runoff, provide a visual screen that can discourage large aggregations of waterfowl, and offer many other water quality benefits at low cost.

Sanitary wastes associated with boating activities are a potential source of pathogens to surface waters. Since 2014, all Massachusetts waters are designated as a No-Discharge Zone (NDZ) in which the discharge of boat sewage is prohibited (MA CZM, 2022b). Many free boat pump-out services are available at various

[1] The PhyloChip is a rapid, high throughput, DNA microarray based on probing environmental samples for the 16S rRNA gene. The main benefits of using the PhyloChip over traditional culturing techniques are its speed, accuracy, and inclusivity of organisms that cannot survive culturing.

sites along the coast, funded by the Clean Vessel Act. The MA CZM webpage maintains online maps of these boat pump-out facilities, and the Clean Vessel Act Program offers a *Boaters Pocket Guide to Pumpout Facilities*. Any sewage discharges from boats or boating infrastructure in the waters covered by this TMDL are therefore illicit discharges.

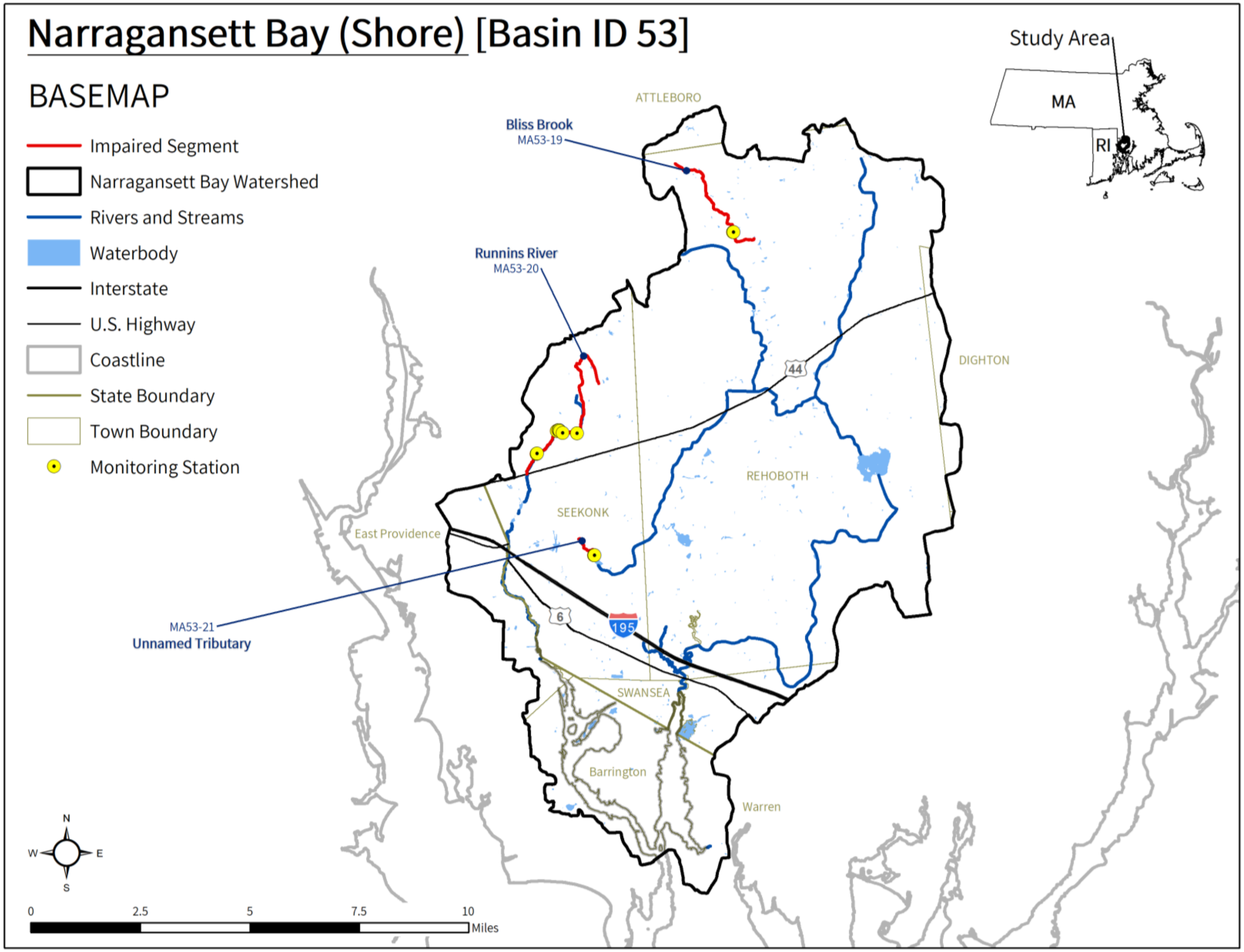


Figure 2-1: Map of all pathogen-impaired segments, water quality monitoring stations, municipal borders, waterbodies, and major roads in the Narragansett Bay (Shore) watershed. Massachusetts municipalities are shown in upper case text while Rhode Island municipalities are shown in lower case text.

3. MA53-19 Bliss Brook

3.1. Waterbody Overview

Bliss Brook segment MA53-19 is 2.4 miles long and begins at its headwaters north of Tremont Street in Rehoboth, MA. The segment flows southeast before ending at its confluence with the West Branch Palmer River in Rehoboth, MA.

There are numerous unnamed tributaries to Bliss Brook segment MA53-19. Lakes and ponds in the watershed include a few small unnamed waterbodies. Much of the segment flows through wetland areas.

Key landmarks in the watershed include Flatlands Equestrian Center, Satori Farm, and Rebello Farms. From upstream to downstream, segment MA53-19 is crossed by Tremont Street, Agricultural Avenue, and Ash Street, all in Rehoboth.

Bliss Brook (MA53-19) drains a total area of 2.2 square miles (mi^2), of which 0.1 mi^2 (5%) are impervious and 0.05 mi^2 (2%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in Rehoboth[2]; and 25% of the total land area 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, MassDEP discharge-to-groundwater permits for on-site wastewater discharge, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds either. See Figure 3-1.

The Bliss Brook segment MA53-19 watershed is located in a moderately-developed part of Massachusetts. Over half of the watershed consists of forest and natural lands (53%) and 26% consists of wetland areas. There is a moderate amount of agriculture in the watershed (6%), most of which consists of horse farms and pasture/hay fields. The remainder of the watershed is covered by development (15%), predominately residential neighborhoods.

In the Bliss Brook (MA53-19) watershed, there are 58 acres (4%) of Priority Habitats of Rare Species

Reduction from Highest Calculated Geomean: 81%

Watershed Area (Acres): 1,394

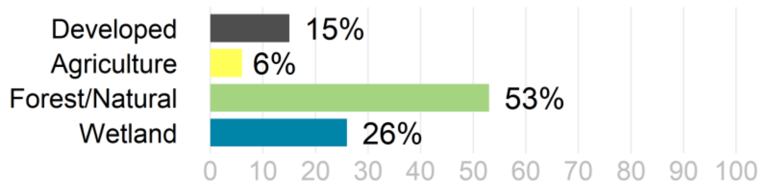
Segment Length (Miles): 2.4

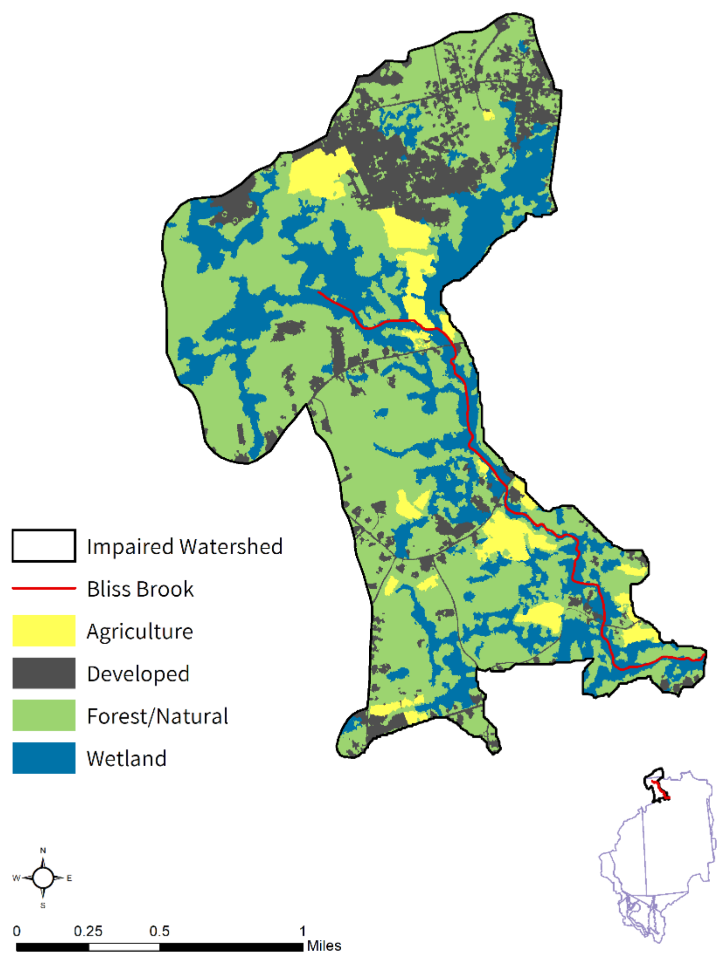
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 74 (5%)

DCIA Area (Acres, %): 32 (2%)





[2] 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 (MassDEP, 2021b), MS4 reports, and local knowledge.

and no Priority Natural Vegetation Communities, as defined by the Natural Heritage and Endangered Species Program. There are also no acres under Public Water Supply protection, within Areas of Critical Environmental Concern, or qualified as Outstanding Resource Waters. Overall, there are 37 acres (3%) of land protected in perpetuity[3], part of 40 acres (3%) of Protected and Recreational Open Space[4]. See Figure 3-1.

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

[4] All Protected and Recreational Open Space land is shown on the natural resources map.

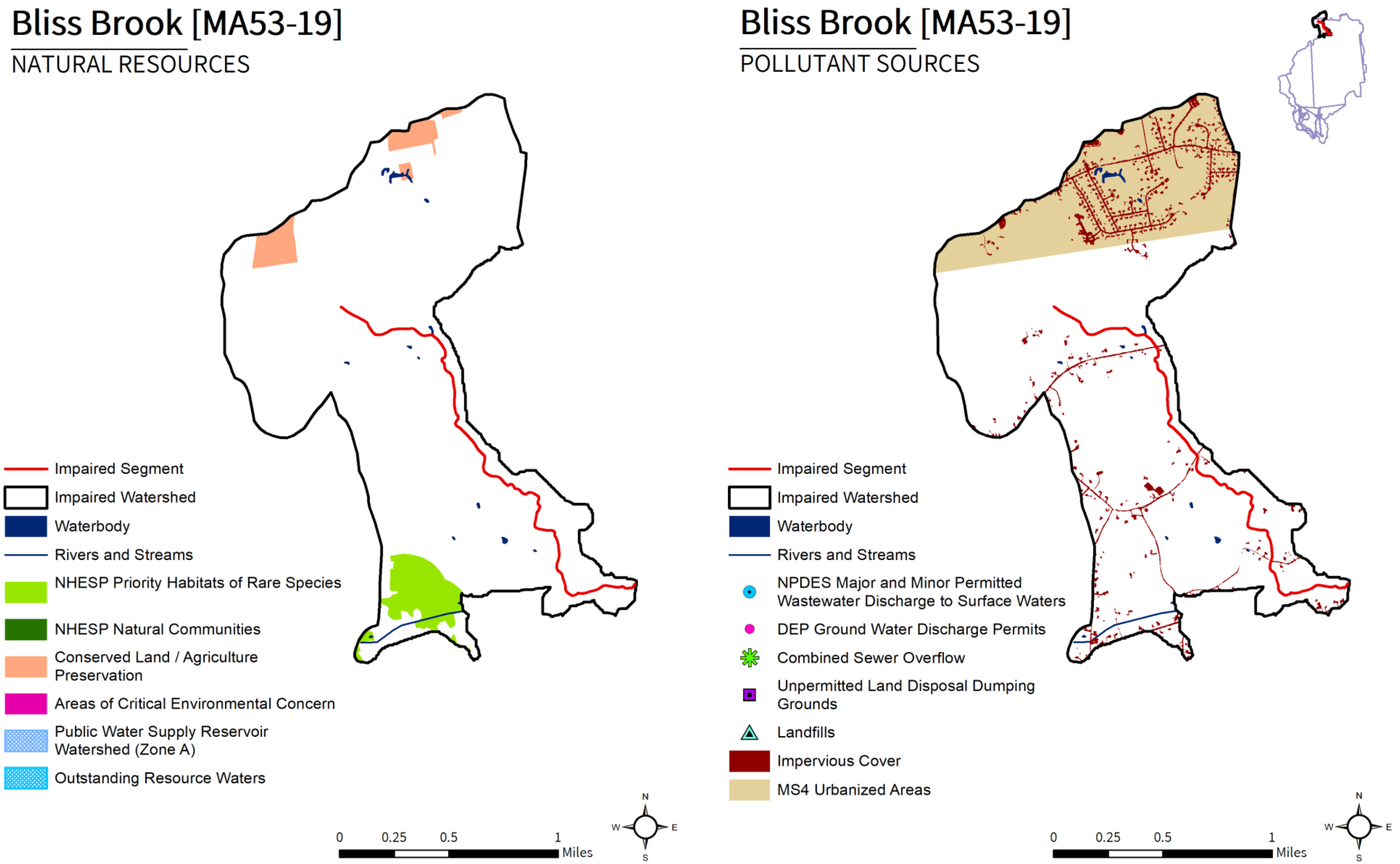


Figure 3-1. Natural resources and potential pollution sources draining to the Bliss Brook segment MA53-19. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

3.2. Waterbody Impairment Characterization

Bliss Brook (MA53-19) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 3-1, 3-2; Figure 3-2) using the indicator bacteria *E. coli*. 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 2009, six samples were collected at W1957; data indicated three days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, three exceeded the STV criterion, one during wet weather and two during dry weather.
- From 2012 to 2013, three samples were collected at WB34; data indicated 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 three samples, one exceeded the STV criterion dry weather.

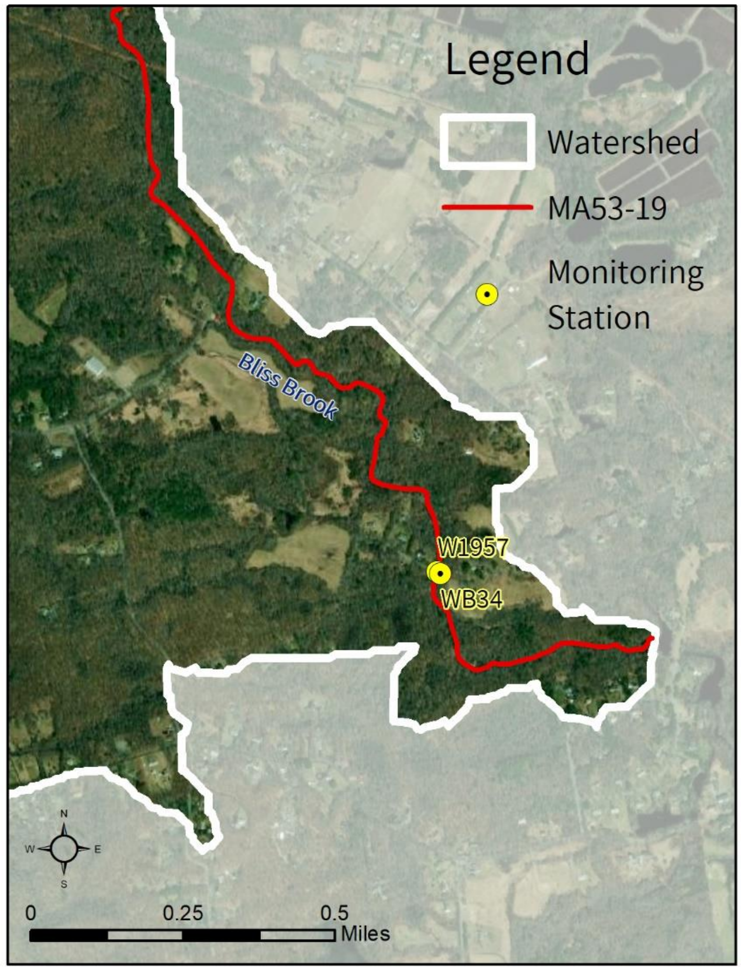


Figure 3-2. Location of monitoring station(s) along the impaired segment.

Table 3-1. Summary of indicator bacteria sampling results by station for Bliss Brook (MA53-19). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the 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 site 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
W1957	5/12/2009	9/29/2009	6	485	3	3
WB34	10/23/2012	9/25/2013	3	663	2	1

Table 3-2. Indicator bacteria data by station, indicator, and date for Bliss Brook (MA53-19). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column 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 STV) for *E. coli* indicator bacteria; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (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)
W1957	*E. coli*	5/12/2009	DRY	10*	10	
W1957	*E. coli*	6/16/2009	DRY	50	22	
W1957	*E. coli*	7/21/2009	WET‡	490	63	
W1957	*E. coli*	8/25/2009	DRY	730	262	
W1957	*E. coli*	9/17/2009	DRY	130	360	
W1957	*E. coli*	9/29/2009	WET	1,190	485	
WB34	*E. coli*	10/23/2012	DRY	64	64	
WB34	*E. coli*	7/9/2013	DRY	663	663	
WB34	*E. coli*	9/25/2013	DRY	80	230	

* Value below the Method Detection Limit (MDL) of 10 CFU/100mL; the MDL is reported and used to calculate the geometric means for *E. coli*.

‡ Note: manually changed from "DRY" to "WET" classification because a second proximal weather station (Taunton Municipal) showed antecedent precipitation totaling 0.97" and was determined as likely more representative of true conditions at the site.

3.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information 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 surface waters 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 sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for Bliss Brook (MA53-19) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources.

Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated levels of indicator bacteria during wet weather events. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. Additional sampling under wet conditions would likely help identify pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The watershed is lightly developed (15%), consisting almost exclusively of moderate-density residential areas as well as industrial and commercial development. 25% of the land area is subject to MS4 permit conditions, 5% is classified as impervious area, and 2% is classified as DCIA. Stormwater runoff from urban areas is a likely source of pathogens.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within Rehoboth. Sewer-related risks to water quality include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows (SSOs), 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 conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Some development in the watershed is likely utilizing on-site septic systems for wastewater treatment. It is also likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for a moderate portion (6%) of the total land use. This agricultural land is comprised predominately of horse farms and other pasture/hay fields, a small portion of which border the upper reach of the segment. Manure storage and spreading activities, if not properly conducted, are possible sources of pathogens to waterbodies.

Pet Waste: There are a few residential neighborhoods near Bliss Brook segment MA53-19. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths or residential neighborhoods are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: A few open fields and wetland areas are located directly adjacent to the impaired segment. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

3.4. Existing Local Management

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

City of Attleboro

The entirety of Attleboro is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041087), and the town has an EPA-approved Notice of Intent (NOI). The city has mapped 100% of its MS4 system and the year-one and year-two Annual Reports have been submitted. Attleboro completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations, all in 2008. No pathogen-impaired waterbodies within the Narragansett Bay (Shore) watershed were reported on the city's NOI.

Attleboro has the following ordinances and bylaws, mostly accessible online via the city website https://www.cityofattleboro.us/ (City of Attleboro, 2022):

- Wetland protection bylaw;
- Stormwater bylaw;
- Pet waste control bylaw; and
- Stormwater Utility: None found.

Attleboro has a 2012 comprehensive plan that contains a section on threats to environmental resources and a separate section on goals to enhance environmental protection. In the Environmental Resources section, there is a large subsection on water resources due to the quantity of surface waters within the city. Nonpoint source discharge is identified as an area of particular concern to water resource protection. Recommendations to protect water resources include acquiring more conservation land, limiting sewer expansion in environmentally sensitive areas, modifying local regulations to better protect water resources, and adopting best management practices for water protection in areas of municipal jurisdiction (City of Attleboro, 2022).

Town of Rehoboth

Only about 16% of Rehoboth is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041152), and the town has an EPA-approved Notice of Intent (NOI). The town has mapped 80% of its MS4 system and the year-one and year-two Annual Reports have been submitted. Rehoboth completed an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2008 but has not completed an illicit discharge detection and elimination (IDDE) plan. According to Rehoboth's NOI, there are five stormwater outfalls to the *E. coli*-impaired Palmer River (Assessment Unit not indicated on NOI).

Rehoboth has the following ordinances and bylaws, mostly accessible online via the town website https://www.rehobothma.gov/ (Town of Rehoboth, 2022):

- Wetland protection bylaw;
- Stormwater bylaw;
- Pet waste control bylaw; and
- Stormwater Utility: None found.

No master plan or open space plan was found on the town's website.

4. MA53-20 Runnins River

4.1. Waterbody Overview

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 2,630

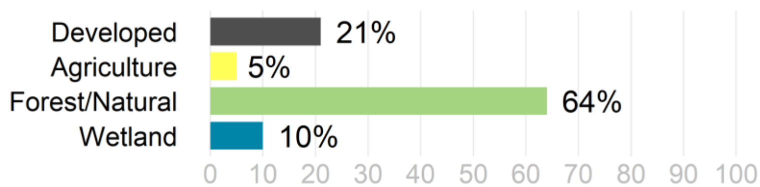
Segment Length (Miles): 3.5

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

Class (Qualifier): B

Impervious Area (Acres, %): 213 (8%)

DCIA Area (Acres, %): 105 (4%)



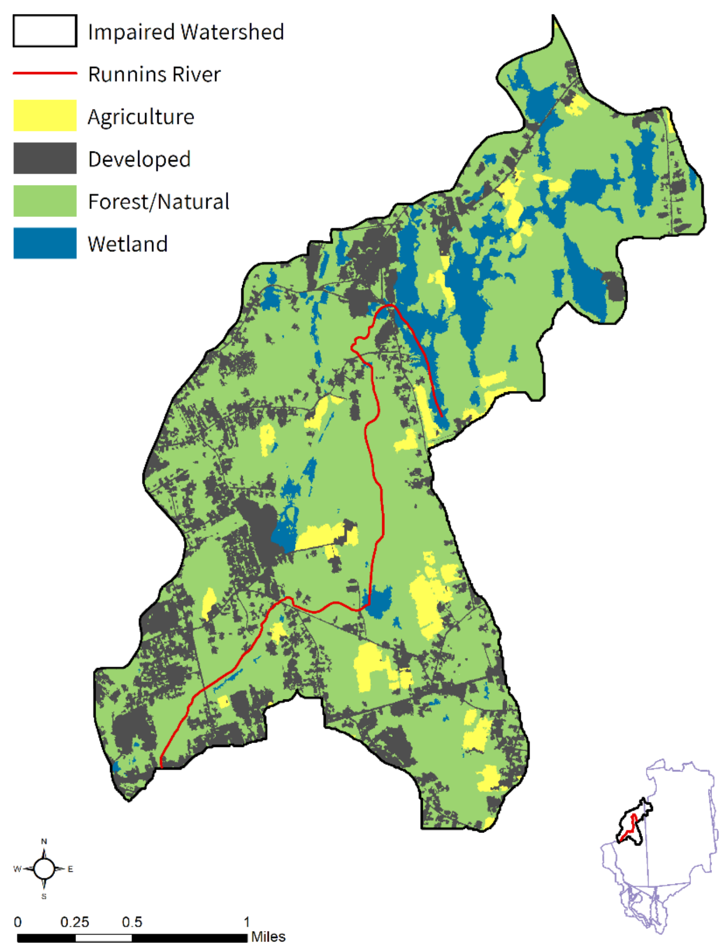
The Runnins River segment MA53-20 is 3.5 mile long and begins at its headwaters north of Walnut Street in Rehoboth, MA. The segment flows northwest, then southwest, before ending at Route 44 in Seekonk, MA.

There are a few unnamed tributaries to the Runnins River segment MA53-20. Lakes and ponds in the watershed include a few small unnamed waterbodies. Much of the river flows through wetland and forested areas.

Key landmarks in the watershed include the town center of Seekonk, Seekonk High School, The Wheeler School – Seekonk Campus, Osamequin Farm, and Five Bridge Inn. From upstream to downstream, segment MA53-20 is crossed by Prospect Street, Woodward Avenue, Greenwood Avenue, Ledge Road, and Arcade Avenue, all in Seekonk.

The Runnins River (MA53-20) drains a total area of 4.1 square miles (mi^2), of which 0.3 mi^2 (8%) are impervious and 0.2 mi^2 (4%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in Rehoboth [5]; and 55% of the total land area 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, MassDEP discharge-to-groundwater permits for on-site wastewater discharges, or combined sewer overflows (CSOs) within the watershed. There are two landfills and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 4-1.

The Runnins River segment MA53-20 watershed is located in a moderately-developed part of Massachusetts. Roughly three quarters of the watershed consists of forest and natural lands (64%) and wetland areas (10%). There is a moderate amount of agriculture in the watershed (5%), most of which is pasture/hay fields with some cultivated fields as well. The remainder of the watershed is covered by development (21%).



[5] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

This development consists mostly of residential neighborhoods with some commercial and industrial development along U.S. Route 44 in the lower watershed.

In the Runnins River (MA53-20) watershed, there are no Priority Habitats of Rare Species or Priority Natural Vegetation Communities, as defined by the Natural Heritage and Endangered Species Program. There are also no acres in Public Water Supply protection, within Areas of Critical Environmental Concern, or qualified as Outstanding Resource Waters. Overall, there are 428 acres (16%) of land protected in perpetuity[6], part of 440 acres (17%) of Protected and Recreational Open Space[7]. See Figure 4-1.

[6] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.
[7] All Protected and Recreational Open Space land is shown on the natural resources map.

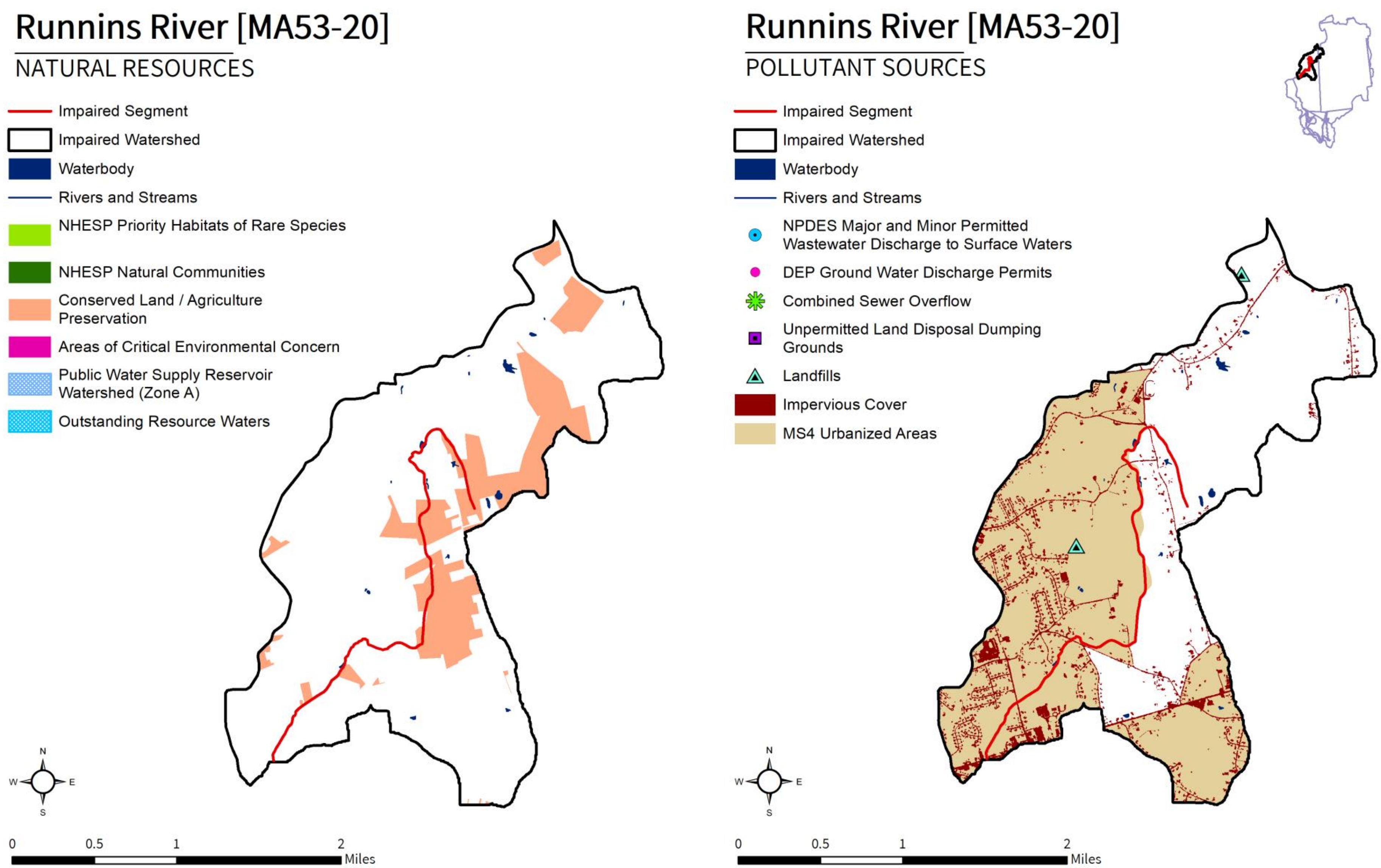


Figure 4-1. Natural resources and potential pollution sources draining to the Runnins River segment MA53-20. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

4.2. Waterbody Impairment Characterization

The Runnins River (MA53-20) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 4-1, 4-2; Figure 4-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

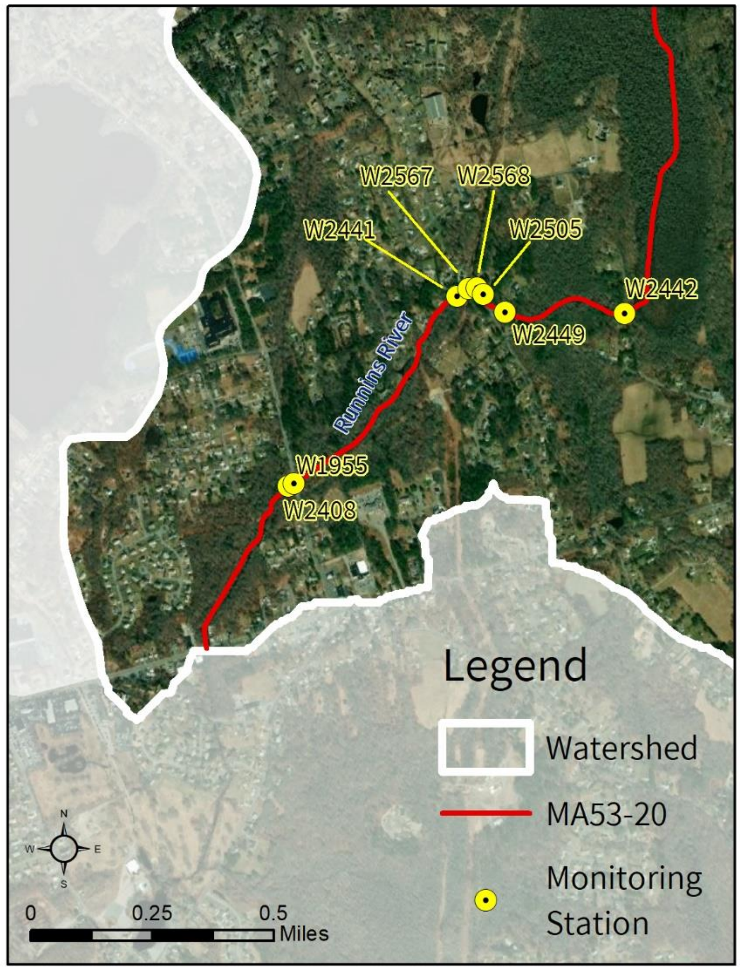


Figure 4-2. Location of monitoring station(s) along the impaired segment.

- In 2013, two samples were collected at W2442; data indicated one day when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the Statistical Threshold Value (STV) criterion was applied to single sample results. Out of two samples, none exceeded the STV criterion.
- In 2013, two samples were collected at W2449; data indicated that the 90-day rolling geomean did not exceed the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of two samples, none exceeded the STV criterion.
- From 2014 to 2015, four samples were collected at W2505; data indicated three days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of four samples, one exceeded the STV criterion during dry weather.
- In 2015, two samples were collected at W2568; data indicated one day when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of two samples, one exceeded the STV criterion during dry weather.
- In 2015, two samples were collected at W2567; data indicated one day when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of two samples, none exceeded the STV criterion.
- From 2013 to 2015, six samples were collected at W2441; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of six samples, three exceeded the STV criterion during dry weather.
- From 2009 to 2013, seven samples were collected at W1955; data indicated seven days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of seven samples, six exceeded the STV criterion, one during wet weather and two during dry weather.
- In 2013, five samples were collected at W2408; data indicated one day when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV

criterion was applied to single sample results. Out of five samples, one exceeded the STV criterion during dry weather.

Table 4-1. Summary of indicator bacteria sampling results by station for the Runnins River (MA53-20). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the 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 site 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
W2442	9/9/2013	10/22/2013	2	166	1	0
W2449	10/22/2013	11/6/2013	2	23	0	0
W2505	6/9/2014	7/7/2015	4	669	3	1
W2568	5/7/2015	7/7/2015	2	162	1	1
W2567	5/7/2015	7/7/2015	2	161	1	0
W2441	9/9/2013	7/7/2015	6	2,420	4	3
W1955	5/12/2009	9/9/2013	7	986	7	3
W2408	5/16/2013	9/11/2013	5	240	1	1

Table 4-2. Indicator bacteria data by station, indicator, and date for the Runnins River (MA53-20). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL for *E. coli* and 130 CFU/100 mL for enterococci indicator bacteria (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV); and red text in the Geomean column highlights exceedances of 126 CFU/100 mL for *E. coli* and 35 CFU/100 mL for enterococci indicator bacteria (applied to rolling 90-day geomean).

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W2442	*E. coli*	9/9/2013	DRY	166	166	
W2442	*E. coli*	10/22/2013	DRY	7	34	
W2449	*E. coli*	10/22/2013	DRY	14	14	
W2449	*E. coli*	11/6/2013	DRY	39	23	
W2505	*E. coli*	6/9/2014	DRY	185	185	
W2505	*E. coli*	7/31/2014	DRY	2,420*	669	
W2505	*E. coli*	5/7/2015	DRY	68	68	
W2505	*E. coli*	7/7/2015	DRY	261	133	
W2568	*E. coli*	5/7/2015	DRY	48	48	
W2568	*E. coli*	7/7/2015	DRY	548	162	
W2567	*E. coli*	5/7/2015	DRY	71	71	
W2567	*E. coli*	7/7/2015	DRY	365	161	
W2441	*E. coli*	9/9/2013	DRY	2,420*	2,420	
W2441	*E. coli*	10/22/2013	DRY	816	1,405	
W2441	*E. coli*	6/9/2014	DRY	199	199	
W2441	*E. coli*	7/31/2014	DRY	7,270	1,203	
W2441	Enterococci	8/19/2014	DRY	1,800	1,800	
W2441	*E. coli*	5/7/2015	DRY	49	49	
W2441	*E. coli*	7/7/2015	DRY	286	118	
W1955	*E. coli*	5/12/2009	DRY	210	210	
W1955	*E. coli*	6/16/2009	DRY	340	267	
W1955	*E. coli*	7/21/2009	WET‡	1,720	497	
W1955	*E. coli*	8/25/2009	DRY	310	566	
W1955	*E. coli*	9/29/2009	WET	1,800	986	
W1955	*E. coli*	7/18/2013	DRY	738	738	
W1955	*E. coli*	9/9/2013	DRY	291	463	
W2408	*E. coli*	5/16/2013	DRY	36	36	
W2408	*E. coli*	6/13/2013	WET	30	33	
W2408	*E. coli*	7/18/2013	DRY	417	77	
W2408	*E. coli*	8/15/2013	DRY	121	115	
W2408	*E. coli*	9/11/2013	DRY	275	240	

* Value above the Method Detection Limit (MDL) of 2,419.6 CFU/100mL; the MDL is reported and used to calculate the geometric means for *E. coli*.

‡ Note: manually changed from "DRY" to "WET" classification because a second proximal weather station (Taunton Municipal) showed antecedent precipitation totaling 0.97" and was determined as likely more representative of true conditions at the site.

4.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information 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 surface waters 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 sanitary sewer overflows (SSOs).

In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for the Runnins River (MA53-20) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources, as are certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be the major sources of pathogens. Although MassDEP conducted Bacteria Source Tracking surveys in this segment watershed from 2009-2019, no distinct sources were identified; elevated levels appear to be limited to the lower watershed. Additional sampling under wet conditions would likely help identify pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: There is a moderate amount of development in the watershed (21%), which consists of residential areas as well as industrial and commercial development. 55% of the land area is subject to MS4 permit conditions, 8% is classified as impervious area, and 4% is classified as DCIA. Stormwater runoff from urban areas is a likely source of pathogens.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within Rehoboth. Sewer-related risks to water quality include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows (SSOs), 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 conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Most of the development in the watershed utilizes on-site systems for wastewater treatment. It is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for a moderate portion (5%) of the total land use. This agricultural land is comprised of pasture/hay fields and cultivated fields. Manure storage and spreading activities, if not properly conducted, are possible sources of pathogens to waterbodies.

Pet Waste: There are a few residential neighborhoods near the Runnins River segment MA53-20. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths or residential neighborhoods are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are a few open fields and wetland areas directly adjacent to the impaired segment. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

4.4. Existing Local Management

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

Town of Seekonk

About 94% of Seekonk is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041156), and the town has an EPA approved Notice of Intent (NOI). The town has mapped 70% of its MS4 system. The year-two Annual Report has been submitted, but no link to the year-one Annual Report could be located. Seekonk completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations, all in 2017. According to Seekonk's NOI, there are 46 stormwater outfalls to the fecal coliform-impaired Runnins River (MA53-01) and 16 outfalls to the Palmer River (MA53-03).

Seekonk has the following ordinances and bylaws, mostly accessible online via the town website https://www.seekonk-ma.gov/ (Town of Seekonk, 2022):

- Wetland protection bylaw;
- Stormwater bylaw;
- Pet Waste Control bylaw: None found; and
- Stormwater Utility: None found.

Seekonk has a 2012 master plan that does not contain a section specific to environmental resources. The town does have a 2022 Open Space and Recreation Plan (OSRP), which contains a comprehensive Environmental Inventory and Analysis, as well as a goals and objectives section. The Environmental Inventory section briefly discusses water resources, but does not mention specific impairments. Recommendations to protect water resources include increased water quality testing, implementation of best management practices in specific areas and/or town owned properties that are contributing to water quality issues, and the addition of signage in areas with threatened water quality (Town of Seekonk, 2022).

5. MA53-21 Unnamed Tributary

5.1. Waterbody Overview

The unnamed tributary segment MA53-21 is 0.6 miles long and begins at its headwaters east of Agawam Court in Seekonk, MA. The segment flows southeast before ending at the inlet of an unnamed pond south of Sagamore Road in Seekonk, MA.

There is one unnamed tributary to the unnamed tributary segment MA53-21; it appears to be mostly culverted and underground in the neighborhood northeast of the segment. Lakes and ponds in the watershed include a small unnamed waterbody. All of the segment flows through a forested stream corridor surrounded by residential development.

Key landmarks in the watershed include residential neighborhoods located off Chestnut Hill Drive, Cynthia Road, Jean Drive, Pimental Drive, and Sagamore Road. Segment MA53-21 is crossed once by Sagamore Road in Seekonk.

The unnamed tributary (MA53-21) drains a total area of 0.3 square miles (mi^2), of which 0.05 mi^2 (17%) are impervious and 0.03 mi^2 (10%) are directly connected impervious area (DCIA). The watershed is not served by a public sewer system[8], and 100% of the total land area 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, MassDEP discharge-to-groundwater permits for on-site wastewater discharge, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 5-1.

The unnamed tributary segment MA53-21 watershed is located in a moderately-developed part of Massachusetts. More than half of the watershed consists of forest and natural lands (62%) while the remainder consists of developed areas (38%). There are no agricultural or wetland areas in the watershed. Most of the development consists of residential areas with some

Reduction from Highest Calculated Geomean: 87%

Watershed Area (Acres): 208

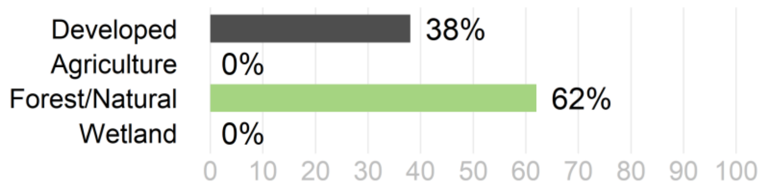
Segment Length (Miles): 0.6

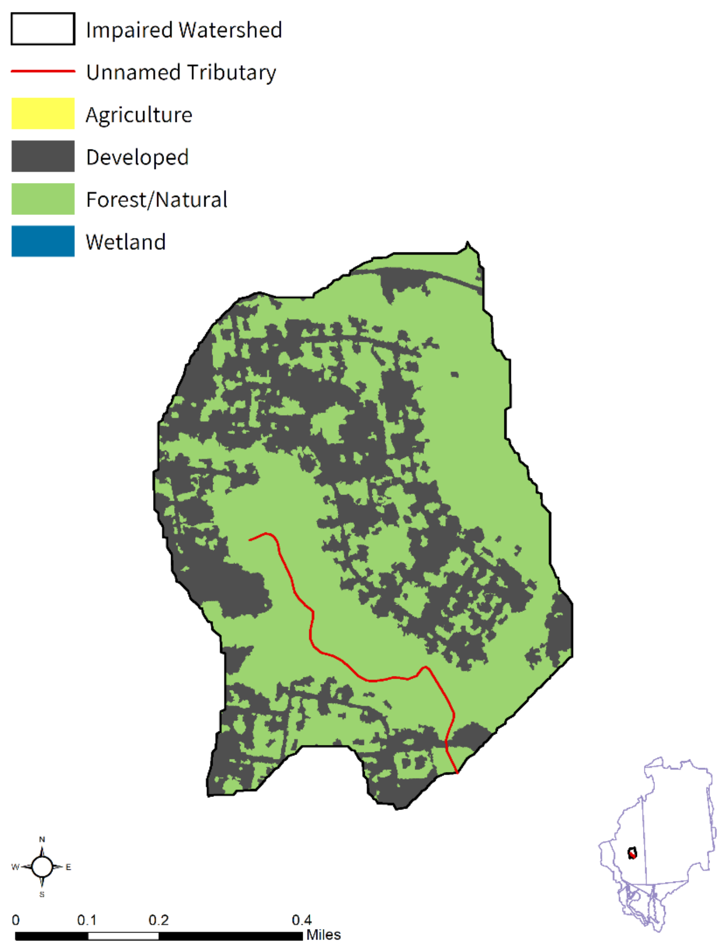
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 35 (17%)

DCIA Area (Acres, %): 21 (10%)





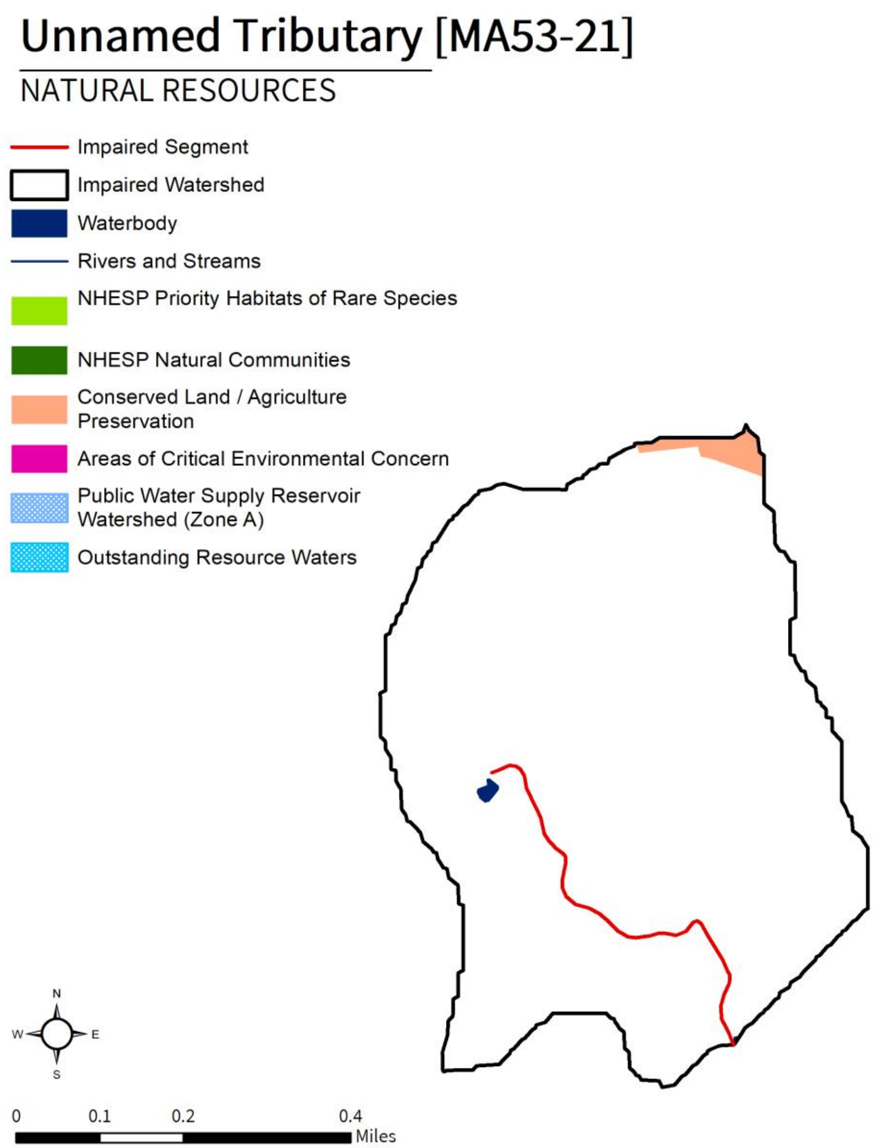
[8] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

commercial buildings located near major roads in the upper watershed.

In the unnamed tributary (MA53-21) watershed, there are no Priority Habitats of Rare Species or Priority Natural Vegetation Communities, as defined by the Natural Heritage and Endangered Species Program. There are also no acres under Public Water Supply protection, within Areas of Critical Environmental Concern, or Outstanding Resource Waters. Overall, there are two acres (1%) of land protected in perpetuity[9], consisting of two acres (1%) of Protected and Recreational Open Space[10]. See Figure 5-1.

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

[10] All Protected and Recreational Open Space land is shown on the natural resources map.



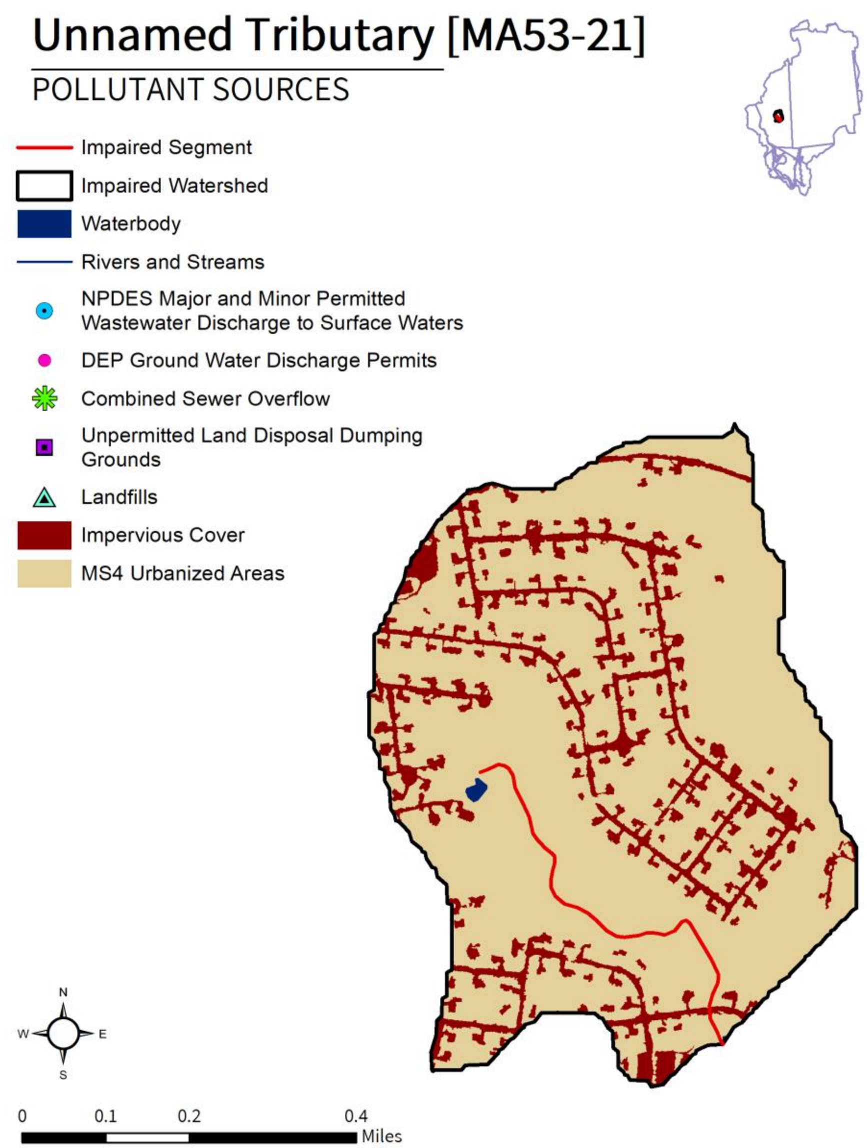


Figure 5-1. Natural resources and potential pollution sources draining to the unnamed tributary segment MA53-21. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

5.2. Waterbody Impairment Characterization

The unnamed tributary (MA53-21) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 5-1, 5-2; Figure 5-2) using the indicator bacteria *E. coli*. 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 2006, five samples were collected at W1532; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the Statistical Threshold Value (STV) criterion was applied to single sample results. Out of five samples, one exceeded the STV criterion during dry weather.
- From 2012 to 2013, three samples were collected at CR04; data indicated that the 90-day rolling geomean did not exceed the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of three samples, none exceeded the STV criterion.

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

Table 5-1. Summary of indicator bacteria sampling results by station for the unnamed tributary (MA53-21). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the 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 site 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
W1532	5/11/2006	9/25/2006	5	940	5	1
CR04	10/23/2012	9/25/2013	3	125	0	0

Table 5-2. Indicator bacteria data by station, indicator, and date for the unnamed tributary (MA53-21). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column 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 STV) for *E. coli* indicator bacteria; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (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)
W1532	*E. coli*	5/11/2006	WET	365	365	
W1532	*E. coli*	6/8/2006	DRY	2,420*	940	
W1532	*E. coli*	7/18/2006	DRY	123	477	
W1532	*E. coli*	8/21/2006	WET	152	356	
W1532	*E. coli*	9/25/2006	DRY	108	126	
CR04	*E. coli*	10/23/2012	DRY	8	8	
CR04	*E. coli*	7/9/2013	DRY	73	73	
CR04	*E. coli*	9/25/2013	DRY	215	125	

* Value above the Method Detection Limit (MDL) of 2,419.6 CFU/100mL; the MDL is reported and used to calculate the geometric means for *E. coli*.

5.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information 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 surface waters 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 sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted during periods of precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for the unnamed tributary (MA53-21) were elevated during both dry and wet weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources, as are certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be the major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: There is a substantial amount of development in the watershed (38%), most of which consists of residential areas with some commercial development as well. The entire land area is subject to MS4 permit conditions, 17% is classified as impervious area, and 10% is classified as DCIA. Stormwater runoff from urban areas is a likely source of pathogens.

Illicit Sewage Discharges: Public sewer service is not available in the watershed. Sewer-related risks to water quality include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows (SSOs), 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 conveyances are also a potential source.

On-Site Wastewater Disposal Systems: All of the development in the watershed utilizes on-site systems for wastewater treatment. It is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Land use maps indicate no agricultural activity in the watershed. As a result, stormwater runoff from agricultural land is not a likely source of pathogens to the impaired segment.

Pet Waste: Residential neighborhoods completely surround the unnamed tributary segment MA53-21. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths or residential neighborhoods are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are no large open fields directly adjacent to the impaired segment, although some lawns appear to be mowed close to the shoreline. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

5.4. Existing Local Management

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

Town of Seekonk. See Section 4.4

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