



Moshassuck River (Segment 1A)

Watershed Description

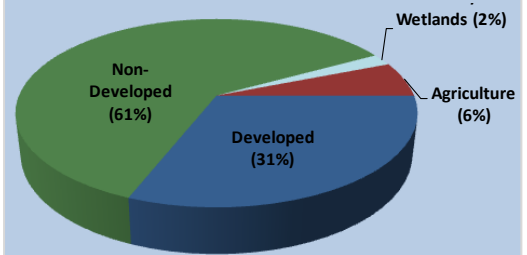
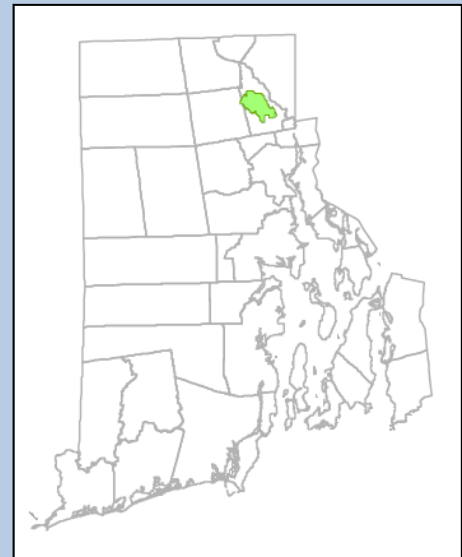
This **TMDL** applies to the Moshassuck River assessment unit (RI0003008R-01A), a 12.6-mile long stream located in Lincoln, RI (Figure 1). The Town of Lincoln is located in the northeastern corner of the state and the impaired segment is situated near the center of the town. The Moshassuck River watershed is presented in Figure 2 with land use types indicated.

The main branch of the Moshassuck River begins near the intersection of Routes 116 and 146. The river flows through the North Central Conservation Area before crossing Route 146. The Moshassuck River then flows along the western edge of the Conklin Limestone Company and adjacent ponds. Multiple tributaries originating in mostly low-density residential areas to the west and east join the main stem of the Moshassuck River below this point at various locations. The river continues southeast, crossing Route 123, and entering Butterfly Pond, just upstream of an agricultural area that includes a horse farm and the town-owned Chase Farm, which has been preserved as open space. The Moshassuck River then enters Lincoln Woods State Park and empties into Barney Pond.

This segment of the Moshassuck River watershed (Segment 1A) covers 5.8 square miles and is largely non-developed, as shown in Figures 2 and 3. Non-developed land accounts for 61% of watershed area, including the North Central Conservation Area and Lincoln Woods State Park. Developed areas occupy 31% of the land area and consist of mostly low-density residential neighborhoods. Commercial development includes sections of the Lincoln Mall and buildings associated with the North Central State Airport. Agricultural uses occupy 6% of the land area and wetland and surface waters occupy 2%.

Assessment Unit Facts *(RI0003008R-01A)*

- **Town:** Lincoln
- **Impaired Segment Length:** 12.6 miles
- **Classification:** Class B
- **Direct Watershed:** 5.8 mi² (3,702 acres)
- **Impervious Cover:** 14.6%
- **Watershed Planning Area:** Moshassuck (#9)



Watershed Land Uses

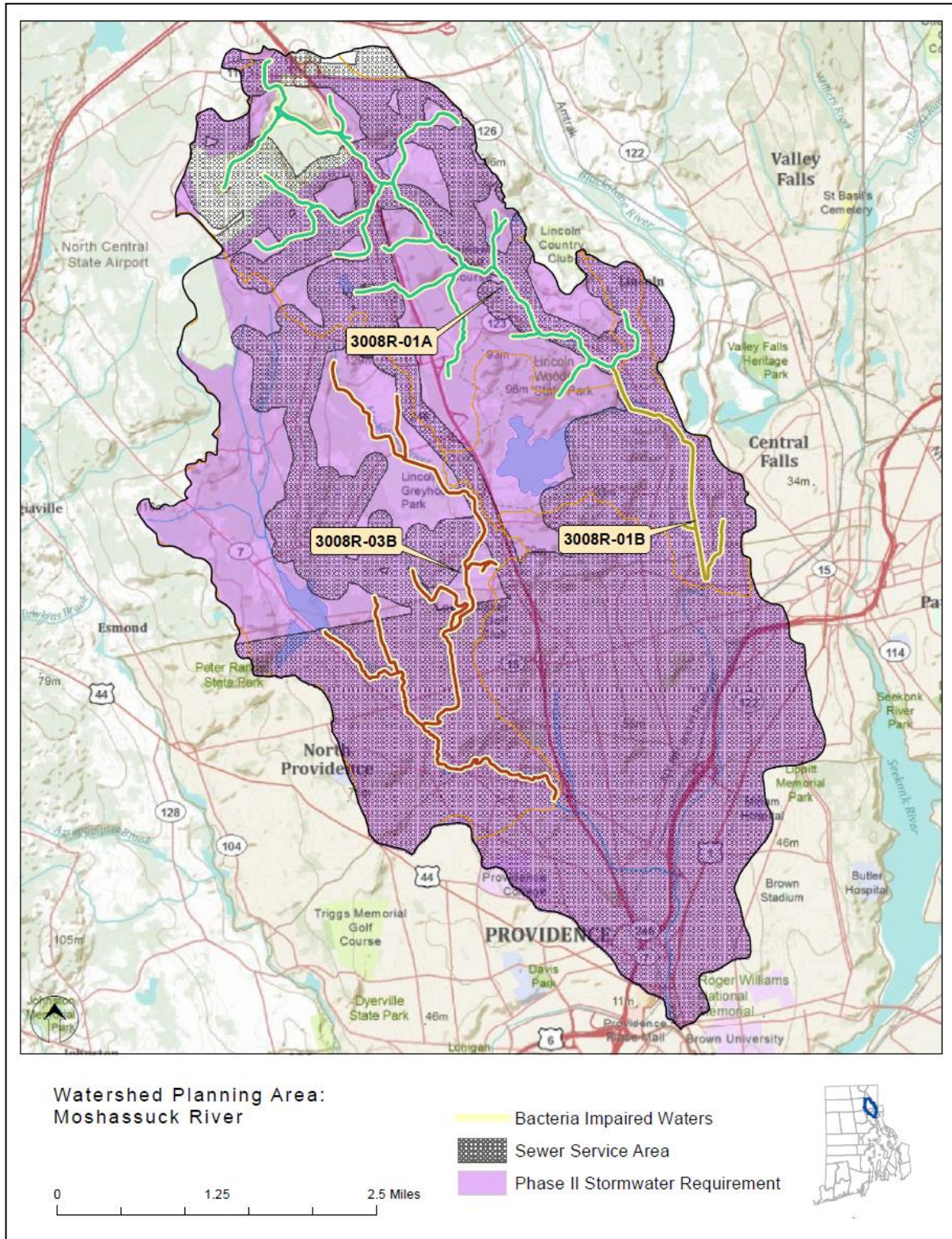


Figure 1: Map of Moshassuck River Watershed Planning Area with impaired segments addressed by the Statewide Bacteria TMDL, sewer service areas, and stormwater regulated zones.



Figure 2: Map of the Moshassuck River Segment 1A watershed with impaired segment, sampling locations, and land cover indicated.

Why is a TMDL Needed?

The Moshassuck River (Segment 1A) is a Class B freshwater stream with designated uses of primary and secondary contact recreation and fish and wildlife habitat (RIDEM, 2009). From 2008-2009, water samples were collected from two sampling locations (MSK01 and MSK09) and analyzed for the indicator bacteria, enterococci. The water quality criteria for enterococci, along with bacteria sampling results from 2008-2009 and associated statistics are presented in Table 1. The geometric mean was calculated for both stations and exceeded the water quality criteria for enterococci.

To aid in identifying possible bacteria sources, the geometric mean value was also calculated for wet and dry-weather sample days for both stations. Both wet and dry-weather geometric mean values exceeded the water quality criteria for enterococci, with wet-weather values higher than dry-weather values.

Due to the elevated bacteria measurements presented in Table 1, the Moshassuck River assessment unit does not meet Rhode Island's water quality standards. The segment was identified as impaired and placed on the 303(d) list (RIDEM, 2008). The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes impairments and identifies measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards.

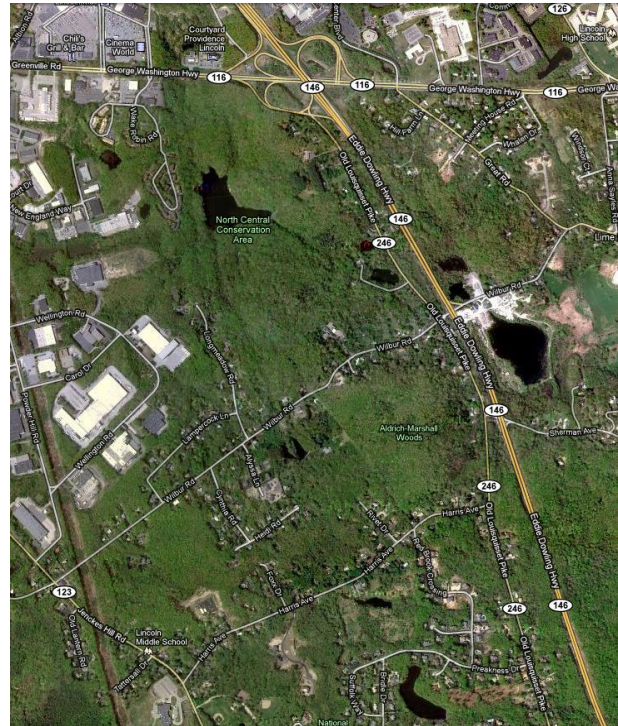


Figure 3: *Partial aerial view of the Moshassuck River watershed (Source: Google)*

Potential Bacteria Sources

Previous investigations have concluded that there are several potential sources of bacteria in the Moshassuck River watershed including stormwater runoff from developed areas, illicit discharges, malfunctioning onsite wastewater treatment systems, agricultural activities, and wildlife and domestic animal waste (C&E, 2004). Each type of potential bacteria sources is described briefly below.

Developed Area Stormwater Runoff

Though the majority of the Moshassuck River watershed is non-developed, impervious surfaces cover approximately 15% and are located primarily in commercial areas in the northern portion of the watershed. Impervious cover is defined as land surface areas, such as roofs and roads that force water to run off land surfaces, rather than infiltrating into the soil. Impervious cover provides a useful metric for the potential for adverse stormwater impacts. As discussed in Section 6.3 of the Core TMDL Document, as a general rule, impaired streams with watersheds having higher than 10% impervious cover are assumed to be affected by stormwater runoff.

As part of Phase II requirements for Lincoln's Municipal Separate Storm Sewer System (MS4), the Town has mapped outfalls to surface water bodies in its regulated area. The Rhode Island Department of Transportation (RIDOT) has also mapped stormwater outfalls within the Moshassuck River watershed. Multiple outfalls have been identified within the watershed, particularly along Route 146 (Figure 2). As stormwater is known to carry a suite of pollutants, including bacteria and wet-weather geometric mean values exceeded the water quality criteria for enterococci in the watershed, stormwater runoff is a likely source of bacteria to the Moshassuck River.

Onsite Wastewater Treatment Systems

The Moshassuck River watershed is mostly sewered, but also relies partially on onsite wastewater treatment systems (OWTS), such as septic systems and cesspools. Failing OWTS can be significant sources of bacteria by allowing improperly treated waste to reach surface waters (RI HEALTH, 2003). Soils in the watershed allow for infiltration, increasing the potential for seepages to travel quickly, undetected underground, and contaminate groundwater.

Sewer Leaks

As shown in Figure 1, sewered areas follow major roadways. Municipal wastewater is treated within the Narragansett Bay Commission system and discharged to the Providence River (Berger, 2004). The extensive sewage collection system within the watershed increases the risk of sewer system leaks and subsequent contamination.

Agricultural Activities

Agricultural operations are an important economic activity and landscape feature in the state's rural areas. Agricultural land use occupies 6% of the land area of the Moshassuck River watershed. However, approximately 150 acres of farmland lie at the intersection of Route 146 and Great Road, on the east bank of the Moshassuck River. This farmland consists of a horse farm and the town-owned Chase Farm that is now preserved as open space and a historic area. Agricultural runoff, particularly from farms with animals such as horses, may contain multiple pollutants, including bacteria, and may be contributing bacteria in the Moshassuck River.

Waterfowl, Wildlife, and Domestic Animal Waste

Non-developed land accounts for 61% of the watershed area. The Moshassuck River flows through the North Central Conservation Area and the Lincoln Woods State Park, which are home to multiple species of wildlife and waterfowl. Continued development and encroachment into wildlife areas can cause densities to increase and animal waste to be more prevalent closer to the river. Wildlife, including waterfowl, may be a significant bacteria source to surface waters. With the construction of roads and drainage systems, these wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface water. As such these physical land alterations can exacerbate the impact of these natural sources on water quality.

Domestic animals are also potential sources of bacteria to the Moshassuck River. Low-density residential developments are common in the northern portion of the watershed. If residents are not properly disposing of pet waste, the bacteria associated with that waste could enter and contaminate the stream.

Existing Local Management and Recommended Next Steps

The Town of Lincoln has developed and implemented programs to protect water quality from bacterial contamination. Future mitigative activities are necessary to ensure the long-term protection of the Moshassuck River. Additional bacteria data collection would be beneficial to support identification of sources of potentially harmful bacteria in the Moshassuck River watershed. These activities could include sampling at several different locations and under different weather conditions (e.g., wet and dry). Field reconnaissance surveys focusing on stream buffers, stormwater runoff, and other source identification would also be beneficial.

The town's existing Comprehensive Plan provides a strong technical basis for beginning to reduce a suite of pollutants, including bacteria. A brief description of existing local programs and recommended next steps from the town's Stormwater Phase II report, Wastewater Facilities Plan, a Source Water

Assessment Report, and other documents are provided below. Stakeholders should review these documents directly for more detailed information.

Stormwater Management

The Town of Lincoln (RIPDES permit RIR040021) and RIDOT (RIPDES permit RIR040036) are municipal separate storm sewer (MS4) operators in the Moshassuck River watershed and have prepared Phase II Stormwater Management Plans (SWMPP). The regulated area in Lincoln includes most of the Moshassuck River watershed.

Lincoln's SWMPP outlines goals for the reduction of stormwater runoff to the Moshassuck River through the implementation of Best Management Practices (BMPs). Many of these BMPs are now in place, including mapping all stormwater outfalls, instituting annual inspections and cleaning of the town's catch basins, implementing an annual street sweeping program, adopting construction erosion and sediment control and post-construction stormwater control ordinances, and conducting public education activities (RIDEM, 2010a).

In 2005, the Town of Lincoln adopted an illicit discharge detection and elimination ordinance, based on the model ordinance developed by the Center for Watershed Protection (Berger, 2004). This ordinance prohibits illicit discharges to the MS4 and provides an enforcement mechanism. The town should prioritize areas to identify and eliminate illicit discharges in the Moshassuck River watershed. Illicit discharges can be identified through continued dry-weather outfall sampling and microbial source tracking.

RIDOT also has completed a SWMPP for state-owned roads in the watershed. RIDOT's SWMPP and its 2011 Compliance Update outline its goals for compliance with the General Permit statewide. It should be noted that RIDOT has chosen to enact the General Permit statewide, not just for the urbanized and densely populated areas that are required by the permit. RIDOT has finished mapping its outfalls throughout the state and is working to better document and expand its catch basin inspection and maintenance programs along with its BMP maintenance program. Stormwater Management Pollution Prevention Plans (SWPPPs) are being utilized for RIDOT construction projects. RIDOT also funds the University of Rhode Island Cooperative Extension's Stormwater Phase II Public Outreach and Education Project, which provides participating MS4s with education and outreach programs that can be used to address TMDL public education recommendations.

While these first steps are important to reduce the effects of stormwater runoff to the Moshassuck River, additional efforts are needed to restore the river's water quality. As mentioned previously, the Moshassuck River watershed has an impervious cover of 14.6%, a level where stormwater impacts are expected. RIDEM requires the MS4 operators to continue to comply with and adapt their minimum

measures to reflect the bacteria impairments in regulated areas. Lincoln and RIDOT should also ensure that their post-construction ordinances are consistent with Section 6.2 of the Core TMDL Document.

Information regarding plans to revise the post construction ordinance should be documented in a TMDL Implementation Plan (TMDL IP). Unless otherwise noted in this waterbody summary, any other TMDL IP requirements described in Section 6.2 of the Core TMDL Document are not applicable to the MS4 operators for watershed areas having impervious cover between 10 and 15 %. Information regarding how the MS4 operators' minimum measures are addressing the pollutant of concern (i.e. bacteria) should be documented in the MS4 operator's annual report, consistent with Part IV.G.2.d of the RIPDES General Permit (RIDEM, 2010b). Further detail is also included in Sections 6.3 of the Core TMDL Document.

The Town of Lincoln should continue to implement the goals of its Phase II SWMPP including dry-weather sampling, extensive street and catch basin cleaning, and public education activities. RIDOT should also continue to implement the goals of its Phase II SWMPP.

Onsite Wastewater Management

Though a large portion of the Moshassuck River watershed is sewerred, a portion of the watershed relies on OWTS (Figure 1). Currently, the Town of Lincoln does not have an Onsite Wastewater Management Plan or a septic system ordinance. As part of the onsite wastewater planning process, Lincoln should adopt ordinances to establish enforceable mechanisms to ensure that existing OWTS are properly operated and maintained. RIDEM recommends that all communities create an inventory of onsite systems through mandatory inspections. Inspections encourage proper maintenance and identify failed and sub-standard systems. Policies that govern the eventual replacement of sub-standard OWTS within a reasonable time frame should be adopted. The Rhode Island Wastewater Information System (RIWIS) can help develop an initial inventory of OWTS and can track voluntary inspection and pumping programs (RIDEM, 2010b).

The Town of Lincoln is currently not eligible for Rhode Island's Community Septic System Loan Program (CSSLP). The CSSLP program provides low-interest loans to residents to help with maintenance and replacement of OWTS. It is recommended that the town develop a program to assist citizens with the replacement of older and failing systems.

Sewer Leaks

Wastewater from the Town of Lincoln is treated by the Narragansett Bay Commission (NBC) (C&E, 2006). The system should be monitored for overextension and capacity limitations with a growing population. Aging wastewater infrastructure tasked with increasing loads is at a higher risk of rupture.

While no leaks have been reported in the town sewer line, it is important for the town to conduct inspections and follow-up on observations (Berger, 2004).

Agricultural Activities

If not already in place, agricultural producers should work with the RIDEM Division of Agriculture and the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) to develop conservation plans for farming activities in the Moshassuck River watershed. NRCS and the RIDEM Division of Agriculture should continue to work with local agricultural operations, particularly near the intersection of Route 146 and Great Road, to ensure that there are sufficient stream buffers, that fencing exists to restrict access of livestock and horses to streams and wetlands, and that animal waste handling, disposal, and other appropriate BMPs in place. A plan should be developed to evaluate the contributions of horse farms and other sites to the bacterial contamination in the Moshassuck River.

Waterfowl, Wildlife, and Domestic Animal Waste

Lincoln's education and outreach programs currently highlight the importance of picking up after dogs and other pets (Town of Smithfield, 2006). The town should also incorporate educational materials focused on not feeding waterfowl, particularly around the small impoundments within the watershed, as part of their Phase II plan. Animal wastes should be disposed of away from any waterway or stormwater drainage system. Lincoln should work with volunteers from the town to map locations where animal waste is a significant and chronic problem. This work should be incorporated into the municipalities' Phase II plans and should result in an evaluation of strategies to reduce the impact of animal waste on water quality. This may include installing signage, providing pet waste receptacles or digester systems in high-use areas, enacting ordinances requiring clean-up of pet waste, and targeting educational and outreach programs in problem areas.

Towns and residents can also take several measures to minimize waterfowl-related impacts. They can allow tall, coarse vegetation to grow in areas along the shores of the many small impoundments along the streams course, which are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to the water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. With few exceptions, Part XIV, Section 14.13, of Rhode Island's Hunting Regulations prohibits feeding wild waterfowl at any time in the state of Rhode Island. Educational programs should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in Moshassuck River and can harm human health and the environment.

Land Use Protection

Many protected areas in the headwaters are habitats for numerous rare plants and animals (Town of Lincoln, 2003). Woodland and wetland areas within the Moshassuck River watershed, including the North Central Conservation Area and the Lincoln Woods State Park, also absorb and filter pollutants from stormwater runoff, and help protect both water quality in the stream and stream channel stability. As these areas represent approximately 63% of the land use in the Moshassuck River watershed, it is important to preserve these undeveloped areas, and to institute controls on development in Moshassuck River watershed.

The steps outlined above will support the goal of mitigating bacteria sources and meeting water quality standards in the Moshassuck River.

Table 1: Moshassuck River (Segment 1A) Bacteria Data

Waterbody ID: RI0003008R-01A

Watershed Planning Area: 9 – Moshassuck River

Characteristics: Freshwater, Class B, Primary and Secondary Contact Recreation, Fish and Wildlife Habitat

Impairment: Enterococci (colonies/100mL)

Water Quality Criteria for Enterococci: Geometric Mean: 54 colonies/100 mL

Percent Reduction to meet TMDL: 83% (Includes 5% Margin of Safety)

Data: 2008-2009 from RIDEM

Single Sample Enterococci (colonies/100 mL) Results for the Moshassuck River (Segment 1A) (2008-2009) with Geometric Mean Statistics

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean
MSK09	Moshassuck River at Sherman Ave off of 146N above Fairlawn Golf course	8/17/2009	548	Dry	251[†] (83%)*
MSK09	Moshassuck River at Sherman Ave off of 146N above Fairlawn Golf course	8/5/2009	579	Wet	
MSK09	Moshassuck River at Sherman Ave off of 146N above Fairlawn Golf course	7/7/2009	387	Wet	
MSK09	Moshassuck River at Sherman Ave off of 146N above Fairlawn Golf course	5/12/2009	30	Dry	
MSK09	Moshassuck River at Sherman Ave off of 146N above Fairlawn Golf course	9/18/2008	272	Dry	

Single Sample Enterococci (colonies/100 mL) Results for the Moshassuck River (Segment 1A) (2008-2009) with Geometric Mean Statistics (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean
MSK01	Moshassuck River at corner of Great Road and (123) Breakneck Hill Road (Lime Rock)	8/17/2009	186	Dry	118
MSK01	Moshassuck River at corner of Great Road and (123) Breakneck Hill Road (Lime Rock)	8/5/2009	204	Wet	
MSK01	Moshassuck River at corner of Great Road and (123) Breakneck Hill Road (Lime Rock)	7/7/2009	140	Wet	
MSK01	Moshassuck River at corner of Great Road and (123) Breakneck Hill Road (Lime Rock)	5/12/2009	49	Dry	
MSK01	Moshassuck River at corner of Great Road and (123) Breakneck Hill Road (Lime Rock)	9/18/2008	91	Dry	

Shaded cells indicate an exceedance of water quality criteria
 * Includes a 5% Margin of Safety
 † Geometric mean used to calculate percent reduction

Wet and Dry Weather Geometric Mean Enterococci Values for all Stations

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
MSK09	Moshassuck River at Sherman Ave off of 146N above Fairlawn Golf course	2008-2009	2	3	251	474	164
MSK01	Moshassuck River at corner of Great Road and (123) Breakneck Hill Road (Lime Rock)	2008-2009	2	3	118	169	94

Shaded cells indicate an exceedance of water quality criteria
 Weather condition determined from Weather Underground rain gage in Lincoln, RI

References

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