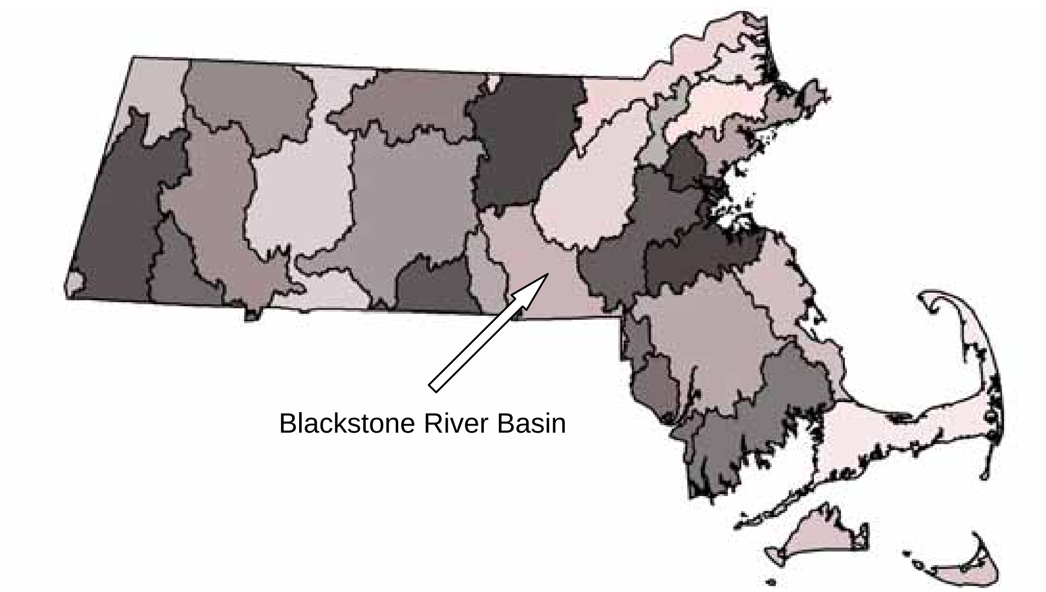
Draft Pathogen TMDL for the Blackstone River Watershed



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NOTICE OF AVAILABILITY

Limited copies of this report are available at no cost by written request to:

Massachusetts Department of Environmental Protection (MADEP)
Division of Watershed Management
627 Main Street
Worcester, Massachusetts 01608

This report is also available from MADEP's home page on the World Wide Web.

A complete list of reports published since 1963 is updated annually and printed in July. This list, titled "Publications of the Massachusetts Division of Watershed Management (DWM) – Watershed Planning Program, 1963-(current year)", is also available by writing to the DWM in Worcester.

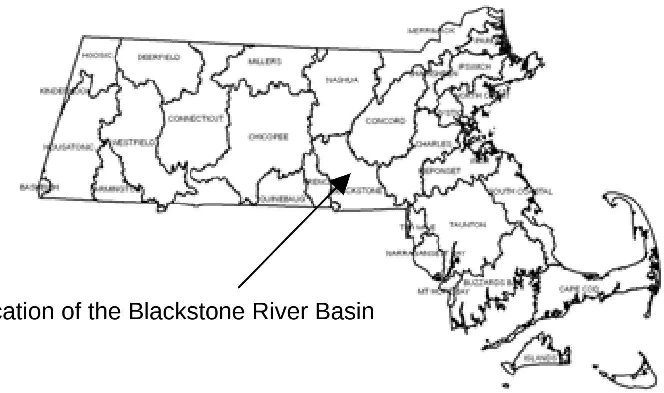
DISCLAIMER

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendations by the Division of Watershed Management for use.

Much of this document was prepared using text and general guidance from the previously approved Neponset River Basin and the Palmer River Basin Bacteria Total Maximum Daily Load documents.

Acknowledgement
This report was developed by ENSR through a partnership with Resource Triangle Institute (RTI) contracting with the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection Agency under the National Watershed Protection Program.

Draft Total Maximum Daily Loads for Pathogens within the Blackstone River Watershed



Location of the Blackstone River Basin

Key Features: Pathogen TMDL for the Blackstone River Watershed
Location: EPA Region 1
Land Type: New England Upland
303(d) Listings: Pathogens

Kettle Brook (MA51-01);
Middle River (MA51-02);
Blackstone River (MA51-03; MA51-04; MA51-05; MA51-06);
Beaver Brook (MA51-07);
Unnamed tributary (MA51-08);
West River (MA51-11);
Mumford River (MA51-14); and
Peters River (MA51-18)

Data Sources:

- MADEP Blackstone River Basin 1998 Water Quality Assessment Report
- Wright R.M., P.M. Nolan, D. Pincumbe, E. Hartman and O.J. Viator, 2001. Blackstone River Initiative: Water Quality Analysis of the Blackstone River Under Wet and Dry Weather Conditions. USEPA New England, Boston, MA.
- Blackstone River Coalition 2004. Watershed-wide Volunteer Water Quality Monitoring Program

Data Mechanism: Massachusetts Surface Water Quality Standards for Fecal Coliform; Massachusetts Department of Public Health Bathing Beaches

Monitoring Plan: Massachusetts Watershed Five-Year Cycle

Control Measures: Watershed Management; Storm Water Management (e.g., illicit discharge removals, public education/behavior modification); CSO & SSO Abatement; BMPs; By-laws; Ordinances; Septic System Maintenance/Upgrades

Executive Summary

Purpose and Intended Audience

This document provides a framework to address bacterial and other fecal-related pollution in surface waters of Massachusetts. Fecal contamination of our surface waters is most often a direct result of the improper management of human wastes, excrement from barnyard animals, pet feces and agricultural applications of manure. It can also result from large congregations of birds such as geese and gulls. Illicit discharges of boat waste are of particular concern in coastal areas. Inappropriate disposal of human and animal wastes can degrade aquatic ecosystems and negatively affect public health. Fecal contamination can also result in closures of shellfish beds, beaches, swimming holes and drinking water supplies. The closure of such important public resources can erode quality of life and diminish property values.

Who should read this document?

The following groups and individuals can benefit from the information in this report:

a) towns and municipalities, especially Phase I and Phase II storm water communities, that are required by law to address storm water and/or combined sewage overflows (CSOs) and other sources of contamination (e.g., broken sewerage pipes and illicit connections) that contribute to a waterbody's failure to meet Massachusetts Water Quality Standards for pathogens;

b) watershed groups that wish to pursue funding to identify and/or mitigate sources of pathogens in their watersheds;

c) public health officials and/or municipalities that are responsible for monitoring, enforcing or otherwise mitigating fecal contamination that results in beach closures or results in the failure of other surface waters to meet Massachusetts standards for pathogens;

d) citizens that wish to become more aware of pollution issues and may be interested in helping build local support for funding remediation measures.

TMDL Overview

The Massachusetts Department of Environmental Protection (MADEP) is responsible for monitoring the waters of the Commonwealth, identifying those waters that are impaired, and developing a plan to bring them back into compliance with the Massachusetts Water Quality Standards (WQS). The list of impaired waters, better known as the "303d list" identifies problem lakes, coastal waters and specific segments of rivers and streams and the reason for impairment.

Once a water body is identified as impaired, the MADEP is required by the Federal Clean Water Act (CWA) to develop a “pollution budget” designed to restore the health of the impaired body of water. The process of developing this budget, generally referred to as a Total Maximum Daily Load (TMDL), includes identifying the source(s) of the pollutant from direct discharges (point sources) and indirect discharges (non-point sources), determining the maximum amount of the pollutant that can be discharged to a specific water body to meet water quality standards, and assigning pollutant load allocations to the sources. A plan to implement the necessary pollutant reductions is essential to the ultimate achievement of meeting the water quality standards.

Pathogen TMDL: This report represents a TMDL for pathogen indicators (e.g. fecal coliform, *E. coli*, and enterococcus bacteria) in the Blackstone River watershed. Certain bacteria, such as coliform, *E. coli*, and enterococcus bacteria, are indicators of contamination from sewage and/or the feces of warm-blooded wildlife (mammals and birds). Such contamination may pose a risk to human health. Therefore, in order to prevent further degradation in water quality and to ensure that waterbodies within the watershed meet state water quality standards, the TMDL establishes indicator bacteria limits and outlines corrective actions to achieve that goal.

Sources of indicator bacteria in the Blackstone River watershed were found to be many and varied. Most of the bacteria sources are believed to be storm water related. Table ES-1 provides a general compilation of likely bacteria sources in the Blackstone River watershed including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland storm water runoff. Note that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. A discussion of pathogen related control measures and best management practices are provided in the companion document: “*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*”.

This TMDL applies to the eleven pathogen impaired segments of the Blackstone River watershed that are currently listed on the CWA § 303(d) list of impaired waters. MADEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 6-1).

This Blackstone River watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical storm water bacteria concentrations. These data indicate that in general two to three orders of magnitude (i.e., greater than 90%) reductions in storm water fecal coliform loading will be necessary, especially in developed areas. This goal is expected to be accomplished through implementation of best management practices, such as those associated with the Phase II control program for storm water.

TMDL goals for each type of bacteria source are provided in Table ES-1. Municipalities are the primary responsible parties for eliminating many of these sources. TMDL implementation to achieve these goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate storm water runoff volume. Certain towns in the watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. Combined sewer overflows will be addressed through the on-going long-term control plans.

In most cases, authority to regulate non-point source pollution and thus successful implementation of this TMDL is limited to local government entities and will require cooperative support from local volunteers, watershed associations, and local officials in municipal government. Those activities can take the form of expanded education, obtaining and/or providing funding, and possibly local enforcement. In some cases, such as subsurface disposal of wastewater from homes, the Commonwealth provides the framework, but the administration occurs on the local level. Among federal and state funds to help implement this TMDL are, on a competitive basis, the Non-Point Source Control (CWA Section 319) Grants, Water Quality (CWA Section 604(b)) Grants, and the State Revolving (Loan) Fund Program (SRF). Most financial aid requires some local match as well. The programs mentioned are administered through the MADEP. Additional funding and resources available to assist local officials and community groups can be referenced within the Massachusetts Non-point Source Management Plan-Volume I Strategic Summary (2000) "Section VII Funding / Community Resources". This document is available on the MADEP's website at: www.state.ma.us/dep/brp/wm/wmpubs.htm, or by contacting the MADEP's Nonpoint Source Program at (508) 792-7470 to request a copy.

Table ES-1. Sources and Expectations for Limiting Bacterial Contamination in the Blackstone River Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
A & B	Illicit discharges to storm drains	0	N/A
A & B	Leaking sanitary sewer lines	0	N/A
A & B	Failing septic systems	N/A	0
A	NPDES – WWTP	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[2]	N/A
A	Storm water runoff Phase I and II	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]	N/A
A	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]
B	CSOs	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[4]	N/A
B	NPDES – WWTP	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[2]	N/A
B	Storm water runoff Phase I and II	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]	N/A
B	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
Fresh Water Beaches[5]	All Sources	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies

N/A means not applicable

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.

[2] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.

[3]The expectation for WLAs and LAs for storm water discharges is that they will be achieved through the implementation of BMPs and other controls.

[4] Or shall be consistent with an approved Long Term Control Plan (LTCP) for Combined Sewer Overflow (CSO) abatement. If the level of control specified in the LTCP is less than what is necessary to attain Class B water quality standards, then the above criteria apply unless MADEP has proposed and EPA has approved water quality standards revisions for the receiving water.

[5] Massachusetts Department of Public Health regulations (105 CMR Section 445)

Note: this table represents waste load and load reductions based on water quality standards current as of the publication date of these TMDLs, any future changes made to the Massachusetts water quality standards will become the governing water quality standards for these TMDLs.

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1.0 Introduction

Section 303(d) of the Federal Clean Water Act (CWA) and Environmental Protection Agencies (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to place waterbodies that do not meet established water quality standards on a list of impaired waterbodies (commonly referred to as the “303d List”) and to develop Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant(s) contributing to the impairment. In Massachusetts, impaired waterbodies are included in Category 5 of the “*Massachusetts Year 2002 Integrated List of Water: Part 2- Final Listing of Individual Categories of Waters*” (*2002 List*; MADEP 2003). Figure 1-1 provides a map of the Blackstone River watershed with pathogen impaired segments indicated. Please note that not all segments have been assessed by the Massachusetts Department of Environmental Protection (MADEP) for pathogen impairment. As shown in Figure 1-1, much of the Blackstone River waterbodies are listed as a Category 5 “impaired or threatened for one or more uses and requiring a TMDL” due to excessive indicator bacteria concentrations.

TMDLs are to be developed for water bodies that are not meeting designated uses under technology-based controls. TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating water quality standards. The TMDL process establishes the maximum allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollutant sources and instream conditions. The TMDL process is designed to assist states and watershed stakeholders in the implementation of water quality-based controls specifically targeted to identified sources of pollution in order to restore and maintain the quality of their water resources (USEPA 1999). TMDLs allow watershed stewards to establish measurable water quality goals based on the difference between site-specific instream conditions and state water quality standards.

A major goal of this TMDL is to achieve meaningful environmental results with regard to the designated uses of the Blackstone River watershed waterbodies. These include water supply, fishing, boating, and swimming. This TMDL establishes the necessary pollutant load to achieve designated uses and water quality standard and the companion document entitled; “*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*” provides guidance for the implementation of this TMDL.

Historically, water and sediment quality studies have focused on the control of point sources of pollutants (i.e., discharges from pipes and other structural conveyances) that discharge directly into well-defined hydrologic resources, such as lakes, ponds, or river segments. While this localized approach may be appropriate under certain situations, it typically fails to characterize the more subtle and chronic sources of pollutants that are widely scattered throughout a broad geographic region such as a watershed (e.g., roadway runoff, failing septic systems in high groundwater, areas of concentrated wildfowl use, fertilizers, pesticides, pet waste, and certain agricultural sources). These so called nonpoint sources of pollution often contribute significantly to the decline of water quality through their cumulative impacts. A watershed-level approach that uses the surface drainage area as the basic study unit enables managers to gain a more complete understanding of the potential pollutant sources impacting a waterbody and increases the precision of identifying local

Figure 1-1. Blackstone River Watershed and Pathogen Impaired Segments

problem areas or "hot spots" which may detrimentally affect water and sediment quality. It is within this watershed-level framework that the MADEP commissioned the development of watershed based TMDLs.

1.1. Pathogens and Indicator Bacteria

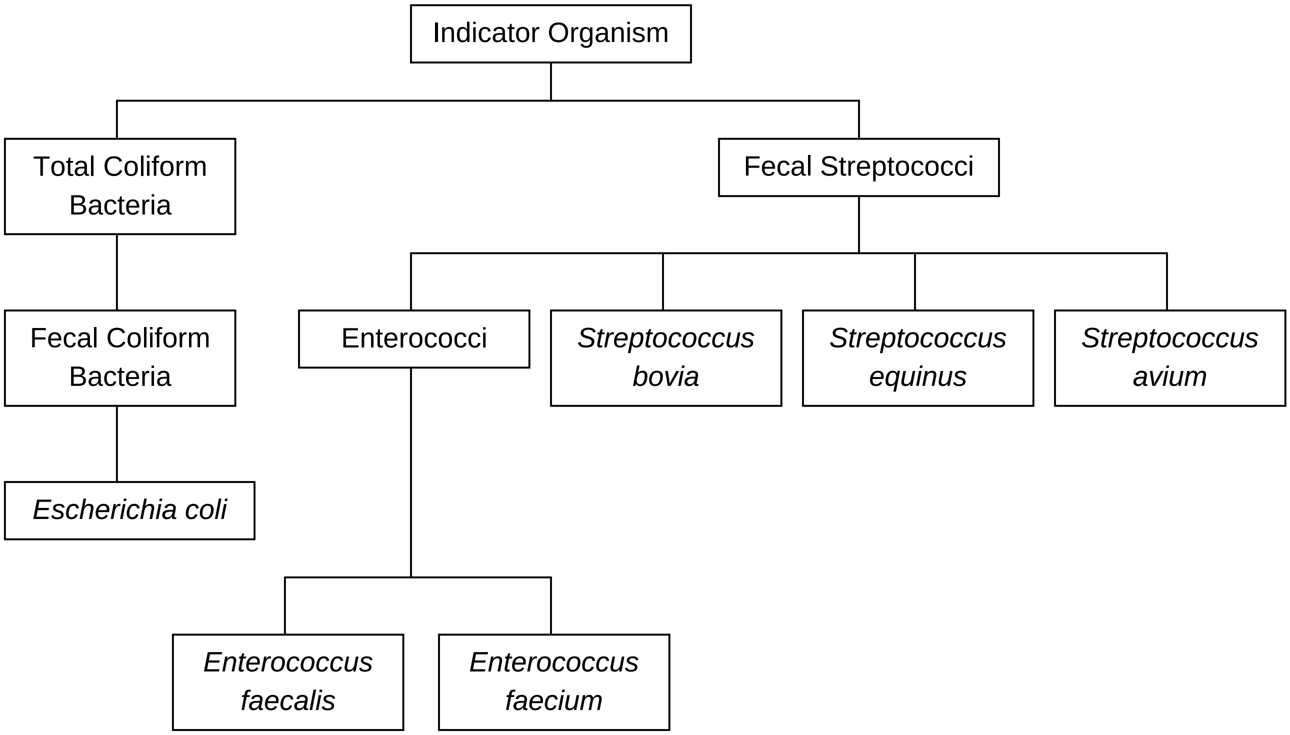
The Blackstone River pathogen TMDL is designed to support reduction of waterborne disease-causing organisms, known as pathogens, to reduce public health risk. Waterborne pathogens enter surface waters from a variety of sources including sewage and the feces of warm-blooded wildlife. These pathogens can pose a risk to human health due to gastrointestinal illness through exposure via ingestion and contact with recreational waters, ingestion of drinking water, and consumption of filter-feeding shellfish.

Waterborne pathogens include a broad range of bacteria and viruses that are difficult to identify and isolate. Thus, specific nonpathogenic bacteria have been identified that are typically associated with harmful pathogens in fecal contamination. These associated nonpathogenic bacteria are used as indicator bacteria as they are easier to identify and measure in the environment. High densities of indicator bacteria increase the likelihood of the presence of pathogenic organisms.

Selection of indicator bacteria is difficult as new technologies challenge current methods of detection and the strength of correlation of indicator bacteria and human illness. Currently, coliform and fecal streptococci bacteria are commonly used as indicators of potential pathogens (i.e., indicator bacteria). Coliform bacteria include total coliforms, fecal coliform and *Escherichia coli* (*E. coli*). Fecal coliform (a subset of total coliform) and *E. coli* (a subset of fecal coliform) bacteria are present in the intestinal tracts of warm blooded animals. Presence of coliform bacteria in water indicates fecal contamination and the possible presence of pathogens. Fecal streptococci bacteria are also used as indicator bacteria, specifically enterococci a subgroup of fecal streptococci. These bacteria also live in the intestinal tract of animals, but their presence is a better predictor of human gastrointestinal illness than fecal coliform since the die-off rate of enterococci is much lower (i.e., enterococci bacteria remain in the environment longer) (USEPA 2001). The relationship of indicator organisms is provided in Figure 1-2. The EPA, in the "*Ambient Water Quality Criteria for Bacteria – 1986*" document, recommends the use of *E. coli* or enterococci as potential pathogen indicators in fresh water and enterococci in marine waters (USEPA 1986).

Massachusetts uses fecal coliform and enterococci as indicator organisms of potential harmful pathogens. The WQS that apply to fresh water are currently based on fecal coliform concentration but will be replaced with *E. coli.* Fecal coliform are also used by the Massachusetts Division of Marine Fisheries (DMF) in their classification of shellfish growing areas. Fecal coliform as the indicator organism for shellfish growing area status is not expected to change at this time. Enterococci are used as the indicator organism for marine beaches, as required by the Beaches Environmental Assessment and Coastal Act of 2000 (BEACH Act), an amendment to the CWA.

Figure 1-2. Relationships among Indicator Organisms (USEPA 2001).



The Blackstone River watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for fresh waters. Any changes in the Massachusetts pathogen water quality standard will apply to this TMDL at the time of the standard change. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

1.2. Comprehensive Watershed-based Approach to TMDL Development

Consistent with Section 303(d) of the CWA, the MADEP has chosen to complete pathogen TMDLs for all waterbodies in the Blackstone River watershed at this time, regardless of current impairment status (i.e., for all waterbody categories in the *2002 List*). MADEP believes a comprehensive management approach carried out by all watershed communities is needed to address the ubiquitous nature of pathogen sources present in the Blackstone River watershed. Watershed-wide implementation is needed to meet WQS and restore designated uses in impaired segments while providing protection of desirable water quality in waters that are not currently impaired or not assessed.

As discussed below, this TMDL applies to the eleven pathogen impaired segments of the Blackstone River watershed that are currently listed on the CWA § 303(d) list of impaired waters and determined to be pathogen impaired in the "*Blackstone River Basin 1998 Water Quality Assessment Report*" (WQA; MADEP 2001) (see Figure 1-1, Table 4-3). MADEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 6-1).

This Blackstone River watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

There are 151 waterbody segments assessed by the MADEP in the Blackstone River watershed (MassGIS 2005). These segments consist of 19 river segments, eleven of which are pathogen impaired and appear as such on the official impaired waters list (303(d) List) (Figure 1-1). None of the 132 lake segments are pathogen impaired. Pathogen impairment has been documented by the MADEP in previous reports, including the MADEP WQA, resulting in the impairment determination. In this TMDL document, an overview of pathogen impairment is provided to illustrate the nature and extent of the pathogen impairment problem. Additional data, not collected by the MADEP or used to determine impairment status, may also be provided in this TMDL to illustrate the pathogen problem. Since pathogen impairment has been previously established only a summary is provided herein.

The watershed based approach applied to complete the Blackstone River watershed pathogen TMDL is straightforward. The approach is focused on identification of sources, source reduction, and implementation of appropriate management plans. Once identified, sources are required to meet applicable WQS for indicator bacteria or be eliminated. This approach does not include water quality analysis or other approaches designed to link ambient concentrations with source loadings. For pathogens and indicator bacteria, water quality analyses are generally resource intensive and provide results with large degrees of uncertainty. Rather, this approach focuses on sources and required load reductions, proceeding efficiently toward water quality restoration activities.

The implementation strategy for reducing indicator bacteria is an iterative process where data are gathered on an ongoing basis, sources are identified and eliminated if possible, and control measures including Best Management Practices (BMPs) are implemented, assessed and modified as needed. Measures to abate probable sources of waterborne pathogens include everything from public education, to improved storm water management, to reducing the influence from inadequate and/or failing sanitary sewer infrastructure.

1.3. TMDL Report Format

This document contains the following sections:

- Watershed Description (Section 2) – provides watershed specific information
- Water Quality Standards (Section 3) – provides a summary of current Massachusetts WQS as they relate to indicator bacteria
- Problem Assessment (Section 4) – provides an overview of indicator bacteria measurements collected in the Blackstone River watershed
- Identification of Sources (Section 5) – identifies and discusses potential sources of waterborne pathogens within the Blackstone River watershed
- TMDL Development (Section 6) – specifies required TMDL development components including:
    - Definitions and Equation
    - Loading Capacity
    - Load and Waste Load Allocations
    - Margin of Safety
    - Seasonal Variability
- Implementation Plan (Section 7) – describes specific implementation activities designed to remove pathogen impairment. This section and the companion "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" document should be used together to support implementing management actions
- Monitoring Plan (Section 8) – describes recommended monitoring activities
- Reasonable Assurances (Section 9) – describes reasonable assurances the TMDL will be implemented
- Public Participation (Section 10) – describes the public participation process, and
- References (Section 11)

2.0 Watershed Description

The Blackstone River watershed drains approximately 640 square miles, 382 of which are in Massachusetts (EOEA 2003). The remaining 258 square miles are located in Rhode Island. The watershed includes portions of 29 cities and towns within central Massachusetts. The Blackstone River begins in the Town of Worcester at approximately 1,400 feet above mean sea level and drains southeast to Narragansett Bay in Rhode Island.

Land use within the watershed is primarily forest and residential areas (Table 2-1). Most of the residential developed areas lie within the upper portion of the watershed whereas forested areas are located in the lower portion (Figure 2-1). A discussion of land use characteristics and associated indicator bacteria levels are provided in Section 4.0 of this document.

The Blackstone River hydrology is impacted by 19 dams along the length of the river and substantial natural storage in the upper and middle watershed. It has been estimated that it takes three to four days for peak flows in the upper portion to reach the Lower Blackstone (Wright et al. 2001). These areas also allow for the release of stored water during periods of low flow.

The Blackstone River is characterized by numerous impoundments formed by the remains of old mill-dams historically used for water power. Only two of these dams are still used to generate power: Riverdale and Synergics (Tupperware). Water levels in the river fluctuate rapidly over short periods of time due to a combination of storm impacts and water flow regulations. The storm flows are compounded by a predominance of impervious surfaces in the Worcester area (MADEP 2001). As the river flows through Worcester, combined sewer overflows (CSOs) and illicit sewer connections add waters to the urban river. In recent years, the Worcester Department of Public Works (DPW) has been actively investigating and repairing these connections (City of Worcester, DPW 2000).

In the past, the Blackstone River was known as the “world’s busiest river” as waste discharges from the area’s burgeoning textile industries were discharged into the river (Tennant et al. 1975). During wet weather, resuspension of contaminated sediments in the river has been shown to be a source of water quality criteria violations (Wright et al. 2001). During dry weather, the Blackstone River is characterized by the effluent from many treatment plants. Today, the Blackstone River and its tributaries are commonly used for primary and secondary contact recreation (swimming and boating), fishing, wildlife viewing, habitat for aquatic life, and potable water. The river is also major source of freshwater to Rhode Island’s Narraganset Bay, a productive and diverse estuary used for fishing, tourism and recreation.

Table 2-1. Blackstone River Watershed Land Use as of 1999.

Land Use Category	% of Total Watershed Area
Pasture	1.4
Urban Open	2.0
Open Land	3.1
Cropland	4.2
Woody Perennial	.3
Forest	53.8
Wetland	1.8
Water Based Recreation	<0.1
Water	3.1
General Undeveloped Land	**69.8**
Spectator Recreation	<0.1
Participation Recreation	1.3
> 1/2 acre lots Residential	10.8
1/4 - 1/2 acre lots Residential	7.1
< 1/4 acre lots Residential	4.2
Multi-family Residential	1.3
Mining	0.6
Commercial	1.5
Industrial	1.5
Transportation	1.6
Waste Disposal	0.3
General Developed Land	**30.2**

Figure 2-1. Blackstone River Watershed Land Use as of 1999.

3.0 Water Quality Standards

The Surface Water Quality Standards (WQS) for the Commonwealth of Massachusetts establish chemical, physical, and biological standards for the restoration and maintenance of the most sensitive uses (MADEP 2000a). The WQS limit the discharge of pollutants to surface waters for the protection of existing uses and attainment of designated uses in downstream and adjacent segments.

Fecal coliform, enterococci, and *E. coli* bacteria are found in the intestinal tract of warm-blooded animals, soil, water, and certain food and wood processing wastes. "Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems" (USEPA 2004a). These bacteria are often used as indicator bacteria since it is expensive and sometimes difficult to test for the presence of individual pathogenic organisms.

Massachusetts is planning to revise its freshwater WQS by replacing fecal coliform with *E. coli* and enterococci as the regulated indicator bacteria, as recommended by the EPA in the "*Ambient Water Quality Criteria for Bacteria – 1986*" document (USEPA 1986). The state has already done so for public beaches through regulations of the Massachusetts Department of Public Health as discussed below. Currently, Massachusetts uses fecal coliform as the indicator organism for all waters except for marine bathing beaches, where the Federal BEACH Act requires the use of enterococci. Massachusetts anticipates adopting *E. coli* and enterococci for all fresh waters and enterococci for all marine waters, including non bathing marine beaches. Fecal coliform will remain the indicator organism for shellfishing areas, however. The Blackstone River watershed pathogen TMDL has been developed using fecal coliform as the pathogen indicator for fresh waters, but the goal of removing pathogen impairment of this TMDL will remain applicable when Massachusetts adopts new indicator bacteria criteria into its WQS. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

Pathogens can significantly impact humans through ingestion of, and contact with recreational waters, ingestion of drinking water, and consumption of filter-feeding shellfish. In addition to contact recreation, excessive pathogen numbers impact potable water supplies. The amount of treatment (i.e., disinfection) required to produce potable water increases with increased pathogen contamination. Such treatment may cause the generation of disinfection by-products that are also harmful to humans. Further detail on pathogen impacts can be accessed at the following EPA websites:

- Water Quality Criteria: Microbial (Pathogen)
  http://www.epa.gov/ost/humanhealth/microbial/microbial.html
- Human Health Advisories:
  - Fish and Wildlife Consumption Advisories
    http://www.epa.gov/ebtpages/humaadvisofishandwildlifeconsumption.html

- o Swimming Advisories
  http://www.epa.gov/ebtpages/humaadvisoswimmingadvisories.html

The Blackstone River watershed contains waterbodies classified as Class A and Class B. The corresponding WQS for each class are as follows:

> Class A waterbodies - fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.
>
> Class B waterbodies - the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 mL and no more than 10% of the samples shall exceed 400 organisms per 100 mL. The MADEP may apply these standards on a seasonal basis.

In addition to the WQS, the Commonwealth of Massachusetts Department of Public Health (MADPH) has established minimum standards for bathing beaches (105 CMR 445.000) under the State Sanitary Code, Chapter VII (www.mass.gov/dph/dcs/bb4_01.pdf). These standards will soon be adopted by the MADEP as state surface WQS for fresh water and these standards will subsequently apply to this TMDL. The MADPH bathing beach standards are generally the same as those which were recommended in the "*Ambient Water Quality Criteria for Bacteria – 1986"* document published by the EPA (USEPA 1986). In the above referenced document, the EPA recommended the use of enterococci as the indicator bacterium for marine recreational waters and enterococci or *E. coli* for fresh waters. As such, the following MADPH standards have been established for bathing beaches in Massachusetts:

> Marine Waters - (1) No single enterococci sample shall exceed 104 colonies per 100 mL and the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 35 colonies per 100 mL.
>
> Freshwaters - (1) No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or (2) No single enterococci sample shall exceed 61 colonies per 100 mL and the geometric mean of the most recent five enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

The Federal BEACH Act of 2000 established a Federal standard for marine beaches. These standards are essentially the same as the MADPH marine beach standard (i.e., single sample not to exceed 104 cfu/100mL and geometric mean of a statistically sufficient number of samples not to exceed 35 cfu/100mL). The Federal BEACH Act and MADPH standards can be accessed on the worldwide web at http://www.epa.gov/waterscience/beaches/act.html and www.mass.gov/dph/dcs/bb4_01.pdf, respectively.

There are no marine bathing beaches in the Massachusetts portion of the Blackstone River watershed. However, there are numerous freshwater beaches located within the watershed. A list of fresh (and marine) beaches by community with bacteria data can be found in the annual reports on the testing of public and semi-public beaches provided by the MADPH. These reports are available for download from the MADPH website located at http://www.mass.gov/dph/beha/tox/reports/beach/beaches.htm.

4.0 Problem Assessment

Pathogen impairment has been documented at numerous locations throughout the Blackstone River watershed, as shown in Figure 1-1. Excessive concentrations of indicator bacteria (e.g., fecal coliform, enterococci, *E. coli* etc.) can indicate the presence of sewage contamination and possible presence of pathogenic organisms. The amount of indicator bacteria and potential pathogens entering waterbodies is dependent on several factors including watershed characteristics and meteorological conditions. Indicator bacteria levels generally increase with increasing development activities, including increased impervious cover, illicit sewer connections, and failed septic systems.

Indicator bacteria levels also tend to increase with wet weather conditions as storm sewer systems overflow and/or storm water runoff carries fecal matter that has accumulated to the river via overland flow and storm water conduits. In some cases, dry weather bacteria concentrations can be higher when there is a constant source that becomes diluted during periods of precipitation, such as with illicit connections. The magnitude of these relationships is variable, however, and can be substantially different temporally and spatially throughout the United States or within each watershed.

Tables 4-1 and 4-2 provide ranges of fecal coliform concentrations in storm water associated with various land use types. Pristine areas are observed to have low indicator bacteria levels and residential areas are observed to have elevated indicator bacteria levels. Development activity generally leads to decreased water quality (e.g., pathogen impairment) in a watershed. Development-related watershed modification includes increased impervious surface area, which can (USEPA 1997):

- Increase flow volume,
- Increase peak flow,
- Increase peak flow duration,
- Increase stream temperature,
- Decrease base flow, and
- Change sediment loading rates.

Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, storm water drainage systems and associated storm water culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.

Table 4-1 Wachusett Reservoir Storm Water Sampling (as reported in MADEP 2002) original data provided in MDC Wachusett Storm Water Study (June 1997).

Land Use Category	Fecal Coliform Bacteria[1] Organisms / 100 mL
Agriculture, Storm 1	110 – 21,200
Agriculture, Storm 2	200 – 56,400
"Pristine" (not developed, forest), Storm 1	0 – 51
"Pristine" (not developed, forest), Storm 2	8 – 766
High Density Residential (not sewered, on septic systems), Storm 1	30 – 29,600
High Density Residential (not sewered, on septic systems), Storm 2	430 – 122,000

[1] Grab samples collected for four storms between September 15, 1999 and June 7, 2000

Table 4-2. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002)[1].

Land Use Category	Fecal Coliform (CFU/100 mL)	Enterococcus Bacteria (CFU/100 mL)	Number of Events
Single Family Residential	2,800 – 94,000	5,500 – 87,000	8
Multifamily Residential	2,200 – 31,000	3,200 – 49,000	8
Commercial	680 – 28,000	2,100 – 35,000	8

[1] An Event Mean Concentration (EMC) is the concentration of a flow proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler which can proportion sample aliquots based on flow.

Pathogen impaired river segments represent 56.6% of the total river miles assessed (64.4 miles of 113.8 assessed). One hundred thirty-two segments are classified as lakes, none of which are pathogen impaired. In total, eleven segments, each in need of a TMDL, contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A or B waterbodies (314 CMR 4.05)[1] and/or the MADPH standard for bathing beaches[2]. The basis for impairment listings is provided in the *2002 List* (MADEP 2003). Data presented in the WQA and other data collected by the MADEP were used to generate the *2002 List*. For more information regarding the basis for listing particular segments for pathogen impairment, please see the Assessment Methodology section of the MADEP WQA for this watershed.

A list of pathogen impaired segments requiring TMDLs is provided in Table 4-3. Segments are listed and discussed in hydrologic order (upstream to downstream) in the following sections. Additional details regarding each impaired segment including water withdrawals, discharges, use assessments and recommendations to meet use criteria are provided in the MADEP WQA.

This TMDL was based on the current WQS using fecal coliform as an indicator organism for fresh and marine waters and enterococci for marine beaches. The MADEP is in the process of developing new WQS incorporating *E. coli* and enterococci as indicator organisms for all waters other than shellfishing and potable water intake areas.

An overview of the Blackstone River watershed pathogen impairment is provided in this section to illustrate the nature and extent of the impairment. Since pathogen impairment has been previously established and documented on the *2002 List,* it is not necessary to provide detailed documentation of pathogen impairment herein.

Data from the MADEP, the Blackstone River Initiative (BRI), the Blackstone River Coalition (BRC), and the EPA Region 1 were reviewed and are summarized by segment below for illustrative purposes. Not all data presented herein were used to determine impairment listing due to a variety of reasons (including data quality assurance and quality control). The MADEP used only a subset of the available data to generate the *2002 List*. Other data presented in this section are for illustrative purposes only.

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[1] Class A: Fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.
Class B, Class SA & Class SB (waters not designated for shellfishing): Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 400 organisms per 100 mL. The MADEP may apply these standards on a seasonal basis.

[2] Freshwater bathing beaches: No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or No single enterococci sample shall exceed 61 colonies per 100 mL and the geometric mean of the most recent five (5) enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

Table 4-3. Blackstone River Pathogen Impaired Segments Requiring TMDLs (adapted from MADEP 2003 and MassGIS 2005).

Segment ID	Segment Name	Length (miles)	Segment Description
MA51-01	Kettle Brook	8.0	Outlet Waite Pond, Leicester through Leesville Pond Auburn/Worcester to inlet Curtis Pond, Worcester.
MA51-02	Middle River	2.5	Outlet Coes Pond to confluence with Mill Brook (Just downstream of American Steel Dam), Worcester.
MA51-07	Beaver Brook	3.0	Outlet of small unnamed impoundment north of Beth Israel School and Flag Street School to confluence with Middle River, Worcester. (Includes underground portion)
MA51-08	Unnamed Tributary	3.0	(Also known as "Mill Brook") Outlet Indian Lake to confluence with Middle River at the downstream side of American Steel Dam, Worcester.
MA51-03	Blackstone River	9.0	Confluence of Middle River and Mill Brook (Just downstream of American Steel Dam), Worcester to Fisherville Dam, Grafton.
MA51-04	Blackstone River	8.7	Fisherville Dam, Grafton to outlet Rice City Pond, Uxbridge.
MA51-05	Blackstone River	7.4	Outlet Rice City Pond, Uxbridge to the old Water Quality Monitor (at the Conrail Railroad trestle due north of Collins Drive), Millville.
MA51-14	Mumford River	9.0	Douglas WWTP, Douglas to confluence with Blackstone River, Uxbridge
MA51-11	West River	3.0	Outlet Silver Lake, Grafton to Upton WWTP, Upton.
MA51-06	Blackstone River	3.7	From the Water Quality Monitor, Millville to the Rhode Island Border west of Route 122 (Main St.), Blackstone, MA/(Harris Avenue) North Smithfield RI.
MA51-18	Peters River	7.1	Outlet Curtis Pond to Rhode Island state line, Bellingham.

Data summarized in the following subsections may be found at:

- **MADEP WQA** – Blackstone River Basin 1998 Water Quality Assessment Report available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.
- **BRC 2004** – Blackstone River Coalition Watershed-wide Volunteer Water Quality Monitoring Program. Contact EPA Region 1 Office.
- **BRI** – Blackstone River Initiative: Water Quality Analysis of the Blackstone River Under Wet and Dry Weather Conditions. Wright et al. 2001. Published by EPA Region 1.

The MADPH publishes annual reports on the testing of public and semi-public beaches for both marine and fresh waters. These documents provide water quality data for each bathing beach by community and note if there were exceedances of water quality criteria. There is also a list of communities that did not report testing results. These reports can be downloaded from http://www.mass.gov/dph/beha/tox/reports/beach/beaches.htm. Marine and freshwater beach status is highly variable and is therefore not provided in each segment description. Please see the MADPH annual beach report for specific details regarding swimming beaches.

Data are broken down into two weather conditions: wet and dry. When data were not categorized as such in individual reports, data collected on days when there was measurable precipitation were considered wet weather conditions and data collected on days when no or "trace" amounts of precipitation were reported were considered dry weather conditions. It should be noted that some reporting entities require a minimum amount of precipitation (i.e. 0.1 or 0.2 inches) before it is considered wet weather. Therefore data between reporting entities may not be directly comparable, but overall conclusions for each segment are consistent.

Data from the Blackstone River Initiative and Blackstone River Coalition are presented in tables at the end of this section. These tables contain the following information:

- "Segment" - column identifies the segment where the samples were collected.
- "Dry Weather Station ID" and "Wet Weather Station ID" - columns display the sampling location identifier issued by the sampling organization during dry and wet weather respectively
- "Location" - column identifies the waterbody from which the sample was taken.
- "Town" - column provides the town name in which samples were collected.
- The other columns provide statistics relating to sampling conducted during wet weather. The wet weather data may be a single value from a single sampling event, the average of a sample and duplicate, or the Event Mean Concentration (EMC) values may be given. Columns with an "EMC" label provide the event mean concentration for samples collected at that station. A label of the type of indicator bacteria measured is provided above each column. The next columns contain dry weather data. Dry weather data may be a single value from a single sampling event or the average of a sample and duplicate. The dry weather data may also be presented under "Min" and "Max" columns where the minimum and maximum dry weather values are given, respectively.

The purpose of this section of the report is to briefly describe the impaired waterbody segments in the Blackstone River watershed. Figure 4-1 is the sample location map for the WQA data presented in the following river segment subsections. Figure 4-2 is the sample locations map for the Blackstone River Initiative data presented in the following river segment subsections. For more information on any of these segments, see the "*Blackstone River Basin 1998 Water Quality Assessment Report*" on the MADEP website http://www.mass.gov/dep/brp/wm/wqassess.htm.

Figure 4-1. Blackstone DWM 1998 Sample Location Map (MADEP 2001).

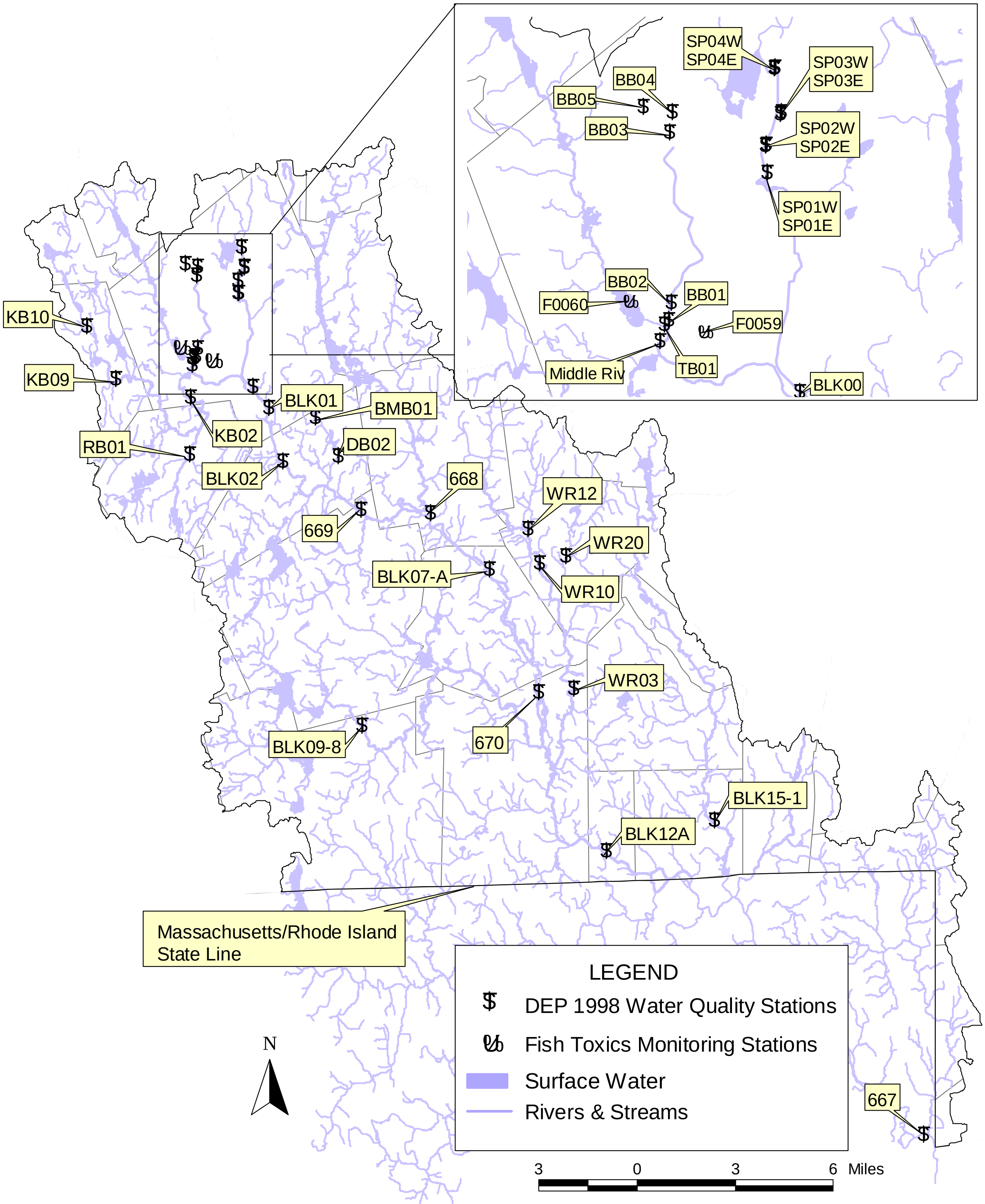
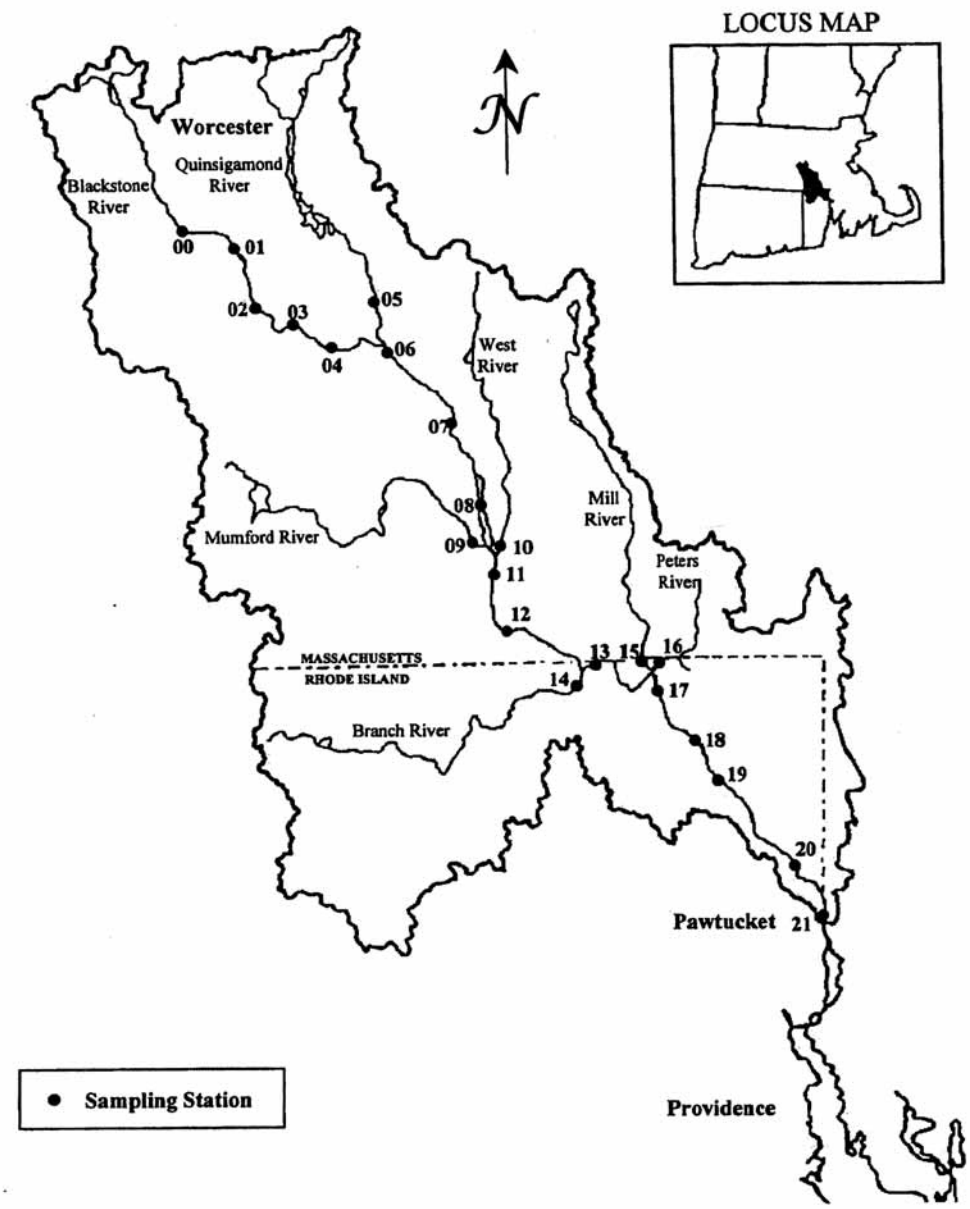


Figure 4-2. Blackstone River Initiative Sample Locations (Wright et al., 2001).



Kettle Brook Segment MA51-01

This segment is an 8.0 mile long Class B warm water fishery extending from Leicester to the inlet to Curtis Pond in Worcester. There are two groundwater withdrawals and one surface water withdrawal in this area:

1. The Auburn Water Department has eight groundwater wells, and is permitted to withdraw 1.75 MGD,
2. The Leicester Water Supply district operates four wells and is permitted to withdraw 0.19 MGD.
3. The Worcester DPW has a surface water permit that extends to seven surface water bodies in the Blackstone River Valley. The Lynde Brook Reservoir withdrawal is located within this segment. The total withdrawal limit for the Blackstone River Valley for the Worcester DPW is 14.22 million gallons per day (MGD).

There are no wastewater National Pollutant Discharge Elimination System (NPDES) permits in this segment according to the WQA. There are seven storm water NPDES permits within this subwatershed, including the City of Worcester. This City of Worcester permit, issued to the DPW in September 1998, gives authorization to discharge storm water from the municipal separate storm sewer system (MS4) into Leesville Pond and Kettle Brook. A listing of all the NPDES permittees can be found in the WQA, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

MADEP WQA water quality sampling for bacteria in this segment is limited to grab samples for fecal coliform collected during dry periods in the summer of 1998. Five samples were collected at three locations (3 samples at KB02 and 1 sample at KB09 and at KB10) which ranged from <20 to 880 cfu (colony forming units) per 100ml. For a complete listing of these data please see Appendix B of the WQA (MADEP 2001).

Middle River Segment MA51-02

This segment is a 2.5 mile long Class B warm water fishery extending from the outlet of Coes Pond to the American Steel Dam in Worcester. There are no permitted groundwater or surface water withdrawals in the area. There are six NPDES storm water permits listed in the MADEP WQA, including the City of Worcester. This City of Worcester permit, issued to the DPW in September 1998, gives authorization to discharge storm water from the MS4 into Coes Pond and the Middle River. The MADEP noted in the WQA that there are additional industrial storm water dischargers in the watershed that are operating without a NPDES storm water permit. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

MADEP WQA water quality sampling for bacteria in this segment is limited to grab samples for fecal coliform collected during dry periods in the summer of 1998. Six samples were collected at two locations (three samples at each location - TB01 and BLK00) and ranged from 33 to 2400 cfu per 100ml. For a complete listing of these data please see Appendix B of the WQA (MADEP 2001).

The BRI water quality sampling for bacteria in this segment during 1991-1993 was conducted during wet and dry weather and included data for both fecal coliform and *E. coli*. Event mean concentrations of bacteria for three storms at three stations ranged from 0.55 – 9,120 cfu/ 100 ml of *E. coli* and 340 – 22,200 cfu/ 100 ml of fecal coliform. Dry weather fecal coliform data were collected during three surveys at two stations (six samples total) and ranged from 0 to 3500 cfu/100 ml. The BRI data are summarized in Tables 4-4 and 4-5 following the segment narratives.

Beaver Brook Segment MA51-07

This segment is a 3.0 mile long Class B waterbody extending through Worcester. The brook begins at an impoundment north of the Beth Israel and Flagg Street schools and runs through increasingly developed and commercial areas. The brook is culverted underground through the first 2.7 miles of the segment with a breach in Beaver Brook Park. There are no permitted withdrawals in the area. The City of Worcester has a NPDES storm water permit, issued to the DPW in September 1998, which gives authorization to discharge storm water from the MS4 into Beaver Brook. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

Five illicit sewer connections were identified as discharging into Beaver Brook. All five of these connections were repaired between June and September 1999 (City of Worcester DPW 2000).

MADEP WQA water quality sampling for bacteria in this segment is limited to grab samples for fecal coliform collected during dry periods in the summer of 1998. Six samples were collected in the Beaver Brook subwatershed (2 samples from each station BB03, BB04 and BB05). Fecal coliform counts from these stations ranged from <16 to 790 cfu per 100 ml. Seven samples were collected at two locations (2 samples at BB02 and 5 samples at BB01) along the Beaver Brook segment and ranged from 880 to 9500 cfu per 100ml. For a complete listing of these data please see Appendix B of the WQA (MADEP 2001).

Unnamed Tributary MA51-08

This unnamed tributary, also known as “Mill Brook” is a 3.0 mile long Class B, CSO, warm water fishery beginning at the outlet of Indian Lake extending through Worcester to the confluence with Middle River. There is one groundwater withdrawal in the area: The Norton Company has five groundwater wells, and is permitted to withdraw 0.57 MGD. There are two NPDES wastewater permits were listed in the MADEP WQA. The Worcester CSO Treatment Facility is authorized to discharge a maximum of 350 MGD of screened and disinfected (chlorine) combined sewer overflow to “Mill Brook”.

> “Just downstream from Lincoln Square, the “Old Mill Brook” culvert receives combined sewer inflow. The combined sewer flow is shunted at Grabowski Square out of the “Old Mill Brook” culvert to the CSO Plant. The flow is typically (dry weather) pumped to the Upper Blackstone WPAD [Water Pollution Abatement District] for treatment. When necessary (storm events >0.5 inches of rain), the CSO facility provides primary treatment, and treated CSO is discharged into Mill Brook“ (MADEP 2001).

The second wastewater NPDES is held by the New England Plating Company, which is authorized to discharge treated wastewater with a maximum daily flow of 0.20 MGD to Mill Brook. NPDES storm water permits have been issued to Romtek/Kervick, Wright Line and the City of Worcester. The City of Worcester's NPDES permit, issued to the DPW in September 1998, gives authorization to discharge storm water from the MS4 into Indian Lake, "Mill Brook" and its tributaries. The Norton Company has a permit to discharge cooling water via seven outfalls in the Weasel Brook, a tributary to "Mill Brook". See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

Five illicit sewer connections were identified by the Worcester DPW, of which the largest was repaired in October 1999 (City of Worcester DPW, 2000).

Blackstone River Segment MA51-03

This segment is a 9.0 mile long Class B, CSO, warm water fishery extending from Worcester to Grafton. The segment begins at the confluence of the Middle River and "Mill Brook" and ends at the Fisherville Dam in Grafton. There are six permitted water withdrawals in the area: The Wilkonsville Water District, the Grafton Water District, Mass American Water Company, Concrete Services Inc., Polyclad Laminates, Inc., and Pleasant Valley Country Club. There are three wastewater NPDES permits listed in the MADEP WQA including: treated wastewater permits for the Upper Blackstone WPAD (56 MGD) and Millbury Waste Water Treatment Permit (WWTP; 1.2 MGD) and a non-contact cooling water discharge from the Lewott Corporation.

A NPDES storm water permit was issued to the Worcester DPW in September 1998, providing authorization to discharge storm water from the MS4 into the Blackstone River. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

MADEP WQA water quality sampling for bacteria in this segment is limited to grab samples for fecal coliform collected during dry periods in the summer of 1998. A total of four samples were collected at two locations (3 samples at BLK01 and 1 sample at BLK02) and ranged from 840 to 2040 cfu per 100ml. For a complete listing of these data please see Appendix B of the WQA (MADEP 2001).

The BRI water quality sampling for bacteria in this segment during 1991-1993 was conducted during wet and dry weather and included data for both fecal coliform and *E. coli*. Event mean concentrations of bacteria for three storms ranged from 88.5 – 4,840 cfu/ 100 ml of *E. coli* and 735 – 26,100 cfu/ 100 ml of fecal coliform. Dry weather fecal coliform data were collected during three surveys at two stations (six samples total) and ranged from 20 to 2300 cfu/100 ml. The BRI data are summarized in Tables 4-4 and 4-5 following the segment narratives.

Blackstone River Segment MA51-04

This segment is an 8.7 mile long Class B warm water fishery extending from Grafton to Uxbridge. The segment begins at the Fisherville Dam and ends at the outlet to Rice City Pond in Uxbridge. There are three groundwater withdrawals in the area; The Riverdale Mills Corporation, the South

Grafton Water District, and the Coz Realty Trust. The Rice City Pond was created in 1860's to provide power with a 14 foot high dam impounding 96 acres. The original dam was breached in 1995 with Hurricane Diane and was replaced by a 9 foot dam impounding only 20 acres. Four NPDES wastewater permits were listed in the MADEP WQA:

1. The Grafton WWTP is authorized to discharge 2.4 MGD of treated wastewater to the Blackstone River,
2. The Northbridge WWTP is authorized to discharge 2.0 MGD of treated wastewater to an unnamed tributary of the Blackstone River,
3. COZ Plastics is authorized to discharge non-contact and contact cooling water and vacuum pump seal water to the Blackstone River, and
4. Riverdale Mills Corporation is authorized to discharge non-contact cooling water to the Blackstone River.

No NPDES storm water permits were listed in the MADEP WQA. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

MADEP WQA water quality sampling for bacteria in this segment is limited to one grab sample for fecal coliform collected during a dry period in the summer of 1998. A sample was collected at BLK07A, 1020 cfu per 100ml. For a complete listing of these data please see Appendix B of the 1998 WQA (MADEP 2001).

The BRI water quality sampling for bacteria in this segment during 1991-1993 was conducted during wet and dry weather and included data for both fecal coliform and *E. coli*. Event mean concentrations of bacteria for three storms at three stations ranged from 41.5 – 3,500 cfu/ 100 ml of *E. coli* and 189 – 17,400 cfu/ 100 ml of fecal coliform. Dry weather fecal coliform data were collected during three surveys at one station and ranged from 120 to 900 cfu/100 ml. The BRI data are summarized in Tables 4-4 and 4-5 following the segment narratives.

Blackstone River Segment MA51-05

This segment is a 7.4 mile long Class B warm water fishery extending from Uxbridge to Millville. The segment starts at the outlet to the Rice City Pond and ends at the Conrail Railroad trestle due north of Collins Drive in Millville. There is one permitted groundwater withdrawal in the area. The Uxbridge Water Department operates two groundwater wells and is permitted to withdraw a system wide total of 1.24 MGD. There is one NPDES wastewater permit is listed in the MADEP WQA for this segment. The Uxbridge WWTP is permitted to discharge 2.5 MGD into the Blackstone River. There were no NPDES storm water permits listed in the MADEP WQA. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

MADEP WQA water quality sampling for bacteria in this segment is limited to a grab samples for fecal coliform collected during a dry period in the summer of 1998. One sample was collected at BLK12A, 460 cfu per 100ml. For a complete listing of these data please see Appendix B of the

WQA (MADEP 2001). The WQA also cites sampling results conducted by the USGS (Socolow et al. 1996, 1997, 1998, 1999 and 2000):

> "Between 1994 and 1999 a total of 29 fecal coliform bacteria samples were analyzed with counts ranging from 26 to 7,800 cfu/100mLs. During the primary contact recreation season (April 1 to October 15th) only one of 15 counts (6%) exceeded 400 cfu/100 mLs. In the entire data set (secondary contact recreation season) four of 29 counts (13%) exceeded 2,000 cfu/100mLs and two counts exceeded 4,000 cfu/100mLs."

The BRI water quality sampling for bacteria in this segment during 1991-1993 was conducted during wet and dry weather and included data for both fecal coliform and *E. coli*. Event mean concentrations of bacteria for three storms from one station ranged from 105 – 350 cfu/ 100 ml of *E. coli* and 228 – 3,030 cfu/ 100 ml of fecal coliform. Dry weather data were not collected for this segment. The BRI data are summarized in Tables 4-4 and 4-5 following the segment narratives.

Mumford River Segment MA51-14

This segment is a 9.0 mile long Class B warm water fishery extending from Douglas to Uxbridge. The segment begins at the Douglas WWTP and ends at the confluence with the Blackstone River in Uxbridge. There are three permitted groundwater withdrawals in the area; Guilford of ME Finishing Services, Whitinsville Water Company and Whitinsville Golf Club. Two NPDES wastewater permits are listed in the MADEP WQA. The Douglas WWTP is permitted to discharge 0.18 MGD of treated wastewater and Guilford of Maine, Inc is permitted to discharge 1.25 MGD into this segment of the Mumford River. No NPDES storm water permits were listed in the MADEP WQA. However, the MADEP WQA notes that the subdivision on Country Club Lane, Northbridge discharges storm water directly into the Linwood impoundment. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

West River Segment MA51-11

This segment is a 3.0 mile long Class B cold water fishery extending from Grafton to Upton. The segment begins at the outlet to Silver Lake and ends at the Upton WWTP in Upton. There is one permitted groundwater withdrawals in the area; The Upton DPW has a wellfield on Glen Avenue and a groundwater well on West River Street. The Upton DPW is permitted to withdraw 0.48 MGD. There are no active NPDES permits listed in the MADEP WQA. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

MADEP WQA water quality sampling for bacteria in this segment is limited to grab samples for fecal coliform collected during dry periods in the summer of 1998. A sample was collected at one location (WR12) 2200 cfu per 100ml. For a complete listing of these data please see Appendix B of the WQA (MADEP 2001).

Blackstone River Segment MA51-06

This segment is a 3.7 mile long Class B warm water fishery extending from Millville to Blackstone at the Massachusetts/Rhode Island border. Downstream from Millville, the Blackstone River flows southeast and becomes impounded by the Tupperware Dam, known as the Millville Pond Impoundment. The natural course of the river is south through the Blackstone Gorge. Through the Gorge, the river runs wild through steep cliffs of up to sixty feet. Downstream from the Gorge, the Blackstone River is joined by the Branch River and turns northeast and flows back into Massachusetts. There are no regulated water withdrawals or NPDES discharges in this segment. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

The WQA provides a summary of data collected by the USGS for this segment (Socolow *et al.* 1996, 1997, 1998, 1999 and 2000):

> "In this dataset, 6% of the [fecal coliform] samples collected during the primary contact recreation season exceeded 400 cfu/100mls while 13% of the samples collected year-round exceeded 2,000 cfu/100mLs and two counts exceeded 4,000 cfu/100mLs"

The BRI water quality sampling for bacteria in this segment during 1991-1993 was conducted during wet and dry weather and included data for both fecal coliform and *E. coli*. Event mean concentrations of bacteria for three storms ranged from 120 – 328 cfu/ 100 ml of *E coli* and 201 – 764 cfu/ 100 ml of fecal coliform. Dry weather fecal coliform data were collected during three surveys at two stations (total of six samples) and ranged from 140 to 1060 cfu/100 ml. The BRI data are summarized in Tables 4-4 and 4-5 following the segment narratives.

Peters River Segment MA51-18

This segment is a 7.1 mile long Class B extending through Bellingham. The segment begins at the outlet to Curtis Pond in Bellingham and ends at the Rhode Island/Massachusetts border in Bellingham. There is one permitted groundwater and one surface water withdrawal in the area; The Bellingham Water Department has five groundwater wells, and is permitted to withdraw 1.74 MGD and The New England Country Club has a surface water permit with a withdrawal limit of 0.31 MGD (180 days). There are no active NPDES permits listed in the MADEP WQA. See MADEP WQA for more information regarding this segment, available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm.

Table 4-4. Wet and Dry Weather Bacteriological Data from the Blackstone River Initiative (Wright et al., 2001).

			Wet weather						Dry weather	
Impaired Segment	Dry Weather Station ID	Wet Weather Station ID	EMC Storm 1		EMC Storm 2		EMC Storm 3		Fecal Coliform	
			EC	FC	EC	FC	EC	FC	min	max
MA51-02	--	BWW00	2690	6190	2780	4900	9120	22200		
MA51-02	BLK01	BWW01	3850	11400	3570	5800	5590	9850	1800	3500
MA51-02	BLK02	BWW02	0.55	340	8160	22200	781	5910	0	20
MA51-03	BLK03	--							20	1060
MA51-03	BLK04	BWW04	88.5	735	4840	26100	2040	5280	300	2300
MA51-04	BLK06	BWW06	173	607	3500	17400	1510	3170	120	900
MA51-04	BLK07	BWW07	182	784	1580	8350	315	2350		
MA51-04	BLK08	BWW08	we	189	1250	7240	486	2250		
MA51-05	BLK11	BWW11	105	228	350	3030	239	807		
MA51-06	BLK13	BWW14	139	594	328	764	120	201		
--	BLK16	BWW16							260	1060
--	BLK17	BWW17	958	2230	402	836	722	1490		
--	BLK18	BWW18	49.1	394	215	895	282	2460		
--	BLK20	BWW20	40.2	117	88.8	409	291	728		
--	BLK21	BWW21	319	2290	516	2110	1090	1480	140	460

Notes:

Data presented represents event mean concentrations (EMC) in cfu/100ml for samples collected at the same location during the sampling event.
Dry weather data presented represents grab samples collected once during each dry survey, collected at the same location in cfu/100ml.
Dry weather data collected during three surveys: July 10-11, 1991, August 14-15, 1991 and October 2-3, 1991.
Wet weather data collected during three storm events: September 22-24, 1992, November 2-5, 1993 and October 12-16, 1993.
FC= Fecal coliform; EC= *E. coli*

Additional Data

Additional data on seven of the segments described above have been provided by BRC. These data represents the most recent data collected at the time of the writing of this report, collected in fall 2004.

Table 4-6. BRC, Wet and Dry *E. coli* Data for the Blackstone River Drainage Basin.

Segment	Location	Town	Wet Weather *E. coli* (MPN/100 mL)	Dry Weather *E. coli* (MPN/100 mL)			
			9/28/04	10/12/04	10/28/04	11/4/04	11/11/04
MA51-01	Leesville Pond	Worcester		7.35			8.65
MA51-02	Middle River	Worcester		400.3			219.5
MA51-07	Beaver Brook	Worcester		>2419.6			1699.9
MA51-08	Mill Brook	Worcester		>2419.6			
MA51-14	Mumford River	Uxbridge			27.4		
MA51-18	Peters River	Bellingham	579.4			68.0	

MPN = most probable number

Where duplicates were taken values were averaged.

5.0 Potential Sources

The Blackstone River watershed has eleven segments, located throughout the watershed, that are listed as pathogen impaired requiring a TMDL. These segments represent 56.6% of the river miles assessed. Sources of indicator bacteria in the Blackstone River watershed are many and varied. A significant amount of work has been done in the last decade to improve the water quality in the Blackstone River watershed.

Largely through the efforts of the EPA, MADEP field staff and the Worcester Department of Public Works (DPW), numerous point and non-point sources of pathogens have been identified. Table 5-1 summarizes the river segments impaired due to measured indicator bacteria densities and identifies some of the suspected and known sources described in past literature.

Some dry weather sources include:

- leaking sewer pipes,
- storm water drainage systems (illicit connections of sanitary sewers to storm drains),
- failing septic systems,
- recreational activities, and
- wildlife, including birds.

Some wet weather sources include:

- wildlife and domesticated animals (including pets),
- storm water runoff including municipal separate storm sewer systems (MS4),
- combined sewer overflows (CSOs), and
- sanitary sewer overflows (SSOs).

It is difficult to provide accurate quantitative estimates of indicator bacteria contributions from the various sources in the Blackstone River watershed because many of the sources are diffuse and intermittent, and extremely difficult to monitor or accurately model. Therefore, a general level of quantification according to source category is provided (e.g., see Tables 5-2 and 5-3). This approach is suitable for the TMDL analysis because it indicates the magnitude of the sources and illustrates the need for controlling them. Additionally, many of the sources (failing septic systems, leaking sewer pipes, sanitary sewer overflows, and illicit sanitary sewer connections) are prohibited because they indicate a potential health risk and, therefore, must be eliminated. However, estimating the magnitude of overall indicator bacteria loading (the sum of all contributing sources) is achieved for wet and dry conditions using the extensive ambient data available that define baseline conditions (see segment summary tables and WQA).

Table 5-1. Some of the Potential Sources of Bacteria in Pathogen Impaired Segments in the Blackstone River Basin.

Segment	Potential Sources
MA51-07 Beaver Brook	urban runoff, illicit sewer connections
MA51-02 Middle River	urban runoff, illicit sewer connections
MA51-08 Unnamed Tributary	urban runoff, illicit sewer connections
MA51-03 Blackstone River	urban runoff, illicit sewer connections, trash/debris, turbidity
MA51-04 Blackstone River	Municipal point sources, CSO, urban runoff
MA51-05 Blackstone River	Municipal point sources, urban runoff
MA51-06 Blackstone River	Municipal point sources, urban runoff
MA51-01 Kettle Brook	Unknown
MA51-11 West River	Unknown
MA51-14 Mumford River	Unknown
MA51-18 Peters River	Unknown

Potential sources identified in the WQA

Sanitary Waste

Leaking sewer pipes, illicit sewer connections, sanitary sewer overflows (SSOs), combined sewer overflows (CSOs) and failing septic systems represent a direct threat to public health since they result in discharge of partially treated or untreated human wastes to the surrounding environment. Quantifying these sources is extremely speculative without direct monitoring of the source because the magnitude is directly proportional to the volume of the source and its proximity to the surface water. Typical values of fecal coliform in untreated domestic wastewater range from 10^4 to 10^6 MPN/100mL (Metcalf and Eddy 1991).

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. The existence of illicit sewer connections to storm drains is well documented in many urban drainage systems, particularly older systems that may have once been combined. The Worcester DPW and MADEP and many towns in the Blackstone River watershed have been active in the identification and mitigation of these sources. Additionally, reductions of CSO discharges have decreased due to the $54 million dollar CSO abatement work in the Unnamed Tributary segment known as “Mill brook” (MA51-08). It is probable that numerous other illicit sewer connections exist in storm drainage systems serving the older developed portions of the basin.

Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Much of the Blackstone River watershed (47.47%) is classified as Urban Areas by the United States Census Bureau and is therefore subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. See Section 7.0 of this TMDL for information regarding illicit discharge detection guidance.

Septic systems designed, installed, operated and maintained in accordance with 310 CMR 15.000: Title 5, are not significant sources of fecal coliform bacteria. Studies demonstrate that wastewater located four feet below properly functioning septic systems contain on average less than one fecal coliform bacteria organism per 100 mL (Ayres Associates 1993). Failed or non-conforming septic systems, however, can be a major contributor of fecal coliform to the Blackstone River and tributaries. Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Wet weather events typically increase the rate of transport of pollutant loadings from failing septic systems to surface waters because of the wash-off effect from runoff and the increased rate of groundwater recharge.

Recreational use of waterbodies is a source of pathogen contamination. Swimmers themselves may contribute to pathogen impairment at swimming areas. When swimmers enter the water, residual fecal matter may be washed from the body and contaminate the water with pathogens. In addition, small children in diapers may contribute to contamination of the recreational waters. These sources are likely to be particularly important when the number of swimmers is high and the flushing action of waves is low.

Wildlife and Pet Waste

Animals that are not pets can be a potential source of pathogens. Geese, gulls, and ducks are speculated to be a major pathogen source, particularly at lakes and storm water ponds where large resident populations have become established (Center for Watershed Protection 1999).

Household pets such as cats and dogs can be a substantial source of bacteria – as much as 23,000,000 colonies/gram, according to the Center for Watershed Protection (1999). A rule of thumb estimate for the number of dogs is ~1 dog per 10 people producing an estimated 0.5 pound of feces per dog per day. Uncollected pet waste is then flushed from the parks, beaches and yards where pets are walked and transported into nearby waterways during wet-weather.

Storm Water

Storm water runoff is another significant contributor of pathogen pollution. As discussed above, during rain events fecal matter from domestic animals and wildlife are readily transported to surface waters via the storm water drainage systems and/or overland flow. The natural filtering capacity provided by vegetative cover and soils is dramatically reduced as urbanization occurs because of the increase in impervious areas (i.e., streets, parking lots, etc.) and stream channelization in the watershed.

Extensive storm water data have been collected and compiled both locally and nationally (e.g., Tables 4-1, 4-2, 5-2 and 5-3) in an attempt to characterize the quality of storm water. Bacteria are easily the most variable of storm water pollutants, with concentrations often varying by factors of 10 to 100 during a single storm. Considering this variability, storm water bacteria concentrations are difficult to accurately predict. Caution must be exercised when using values from single wet weather grab samples to estimate the magnitude of bacteria loading because it is often unknown whether the sample is representative of the "true" mean. To gain an understanding of the magnitude of bacterial loading from storm water and avoid overestimating or underestimating bacteria loading, event mean concentrations (EMC) are often used. An EMC is the concentration of a flow proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler which can proportion sample aliquots based on flow. Typical storm water event mean densities for various indicator bacteria in a Massachusetts watershed and nationwide are provided in Tables 5-2 and 5-3. These EMCs illustrate that storm water indicator bacteria concentrations from certain land uses (i.e., residential) are typically at levels sufficient to cause water quality problems.

Table 5-2. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002) and Necessary Reductions to Meet Class B WQS.

Land Use Category	Fecal Coliform EMC (CFU/100 mL)	Number of Events	Class B WQS[1]	Reduction to Meet WQS (%)
Single Family Residential	2,800 – 94,000	8	10% of the samples shall not exceed 400 organisms/ 100 mL	2,400 – 93,600 (85.7 – 99.6)
Multifamily Residential	2,200 – 31,000	8		1,800 – 30,600 (81.8 – 98.8)
Commercial	680 – 28,000	8		280 – 27,600 (41.2 – 98.6)

[1] Class B Standard: Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. Used 400 to illustrate required reductions since a geometric mean of the samples were not provided.

Table 5-3. Storm Water Event Mean Fecal Coliform Concentrations (as reported in MADEP 2002; original data provided in Metcalf & Eddy, 1992) and Necessary Reductions to Meet Class B WQS.

Land Use Category	Fecal Coliform[1] Organisms / 100 mL	Class B WQS[2]	Reduction to Meet WQS (%)
Single Family Residential	37,000	10% of the samples shall not exceed 400 organisms/ 100 mL	36,600 (98.9)
Multifamily Residential	17,000		16,600 (97.6)
Commercial	16,000		15,600 (97.5)
Industrial	14,000		13,600 (97.1)

[1] Derived from NURP study event mean concentrations and nationwide pollutant buildup data (USEPA 1983).

[2] Class B Standard: Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. Used 400 to illustrate required reductions since a geometric mean of the samples were not provided.

6.0 Pathogen TMDL Development

Section 303 (d) of the Federal Clean Water Act (CWA) requires states to place water bodies that do not meet the water quality standards on a list of impaired waterbodies. The most recent impairment list, *2002 List*, identifies eleven segments within the Blackstone River watershed for use impairment caused by excessive indicator bacteria concentrations.

The CWA requires each state to establish Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant contributing to the impairment(s). TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating the water quality standards. Both point and non-point pollution sources are accounted for in a TMDL analysis. Point sources of pollution (those discharges from discrete pipes or conveyances) subject to NPDES permits receive a waste load allocation (WLA) specifying the amount of pollutant each point source can release to the waterbody. Non-point sources of pollution (all sources of pollution other than point) receive a load allocation (LA) specifying the amount of a pollutant that can be released to the waterbody by this source. In accordance with the CWA, a TMDL must account for seasonal variations and a margin of safety, which accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality. Thus:

$$\text{TMDL} = \text{WLAs} + \text{LAs} + \text{Margin of Safety}$$

Where:

WLA = Waste Load Allocation which is the portion of the receiving water’s loading capacity that is allocated to each existing and future point source of pollution.

LA = Load Allocation which is the portion of the receiving water’s loading capacity that is allocated to each existing and future non-point source of pollution.

This TMDL uses an alternative standards-based approach which is based on indicator bacteria concentrations, but considers the terms of the above equation. This approach is more in line with the way bacterial pollution is regulated (i.e., according to concentration standards) and achieves essentially the same result as if the equation were to be used.

6.1. Indicator Bacteria TMDL

Loading Capacity

The pollutant loading that a waterbody can safely assimilate is expressed as either mass-per-time, toxicity or some other appropriate measure (40 CFR § 130.2). Typically, TMDLs are expressed as total maximum daily loads. Expressing the TMDL in terms of daily loads is difficult to interpret given the very high numbers of indicator bacteria and the magnitude of the allowable load is dependent on flow conditions and, therefore, will vary as flow rates change. For example, a very high load of indicator bacteria are allowable if the volume of water that transports indicator bacteria is also high. Conversely, a relatively low load of indicator bacteria may exceed water quality standard if flow rates are low. Therefore, the MADEP believes it is appropriate to express indicator bacteria TMDLs in terms of a concentration because the water quality standard is also expressed in terms of the concentration of organisms per 100 mL. Since source concentrations may not be directly added due to varying flow conditions, the TMDL equation is modified and reflects a margin of safety in the case of this pathogen concentration based TMDL. To ensure attainment with Massachusetts' WQS for indicator bacteria, all sources (at their point of discharge to the receiving water) must be equal to or less than the WQS for indicator organisms. For all the above reasons the TMDL is simply set equal to the concentration-based standard and may be expressed as follows:

$$\text{TMDL} = \text{State Standard} = \text{WLA}_{(p1)} = \text{LA}_{(n1)} = \text{WLA}_{(p2)} = \text{etc.}$$

Where:

$\text{WLA}_{(p1)}$ = allowable concentration for point source category (1)
$\text{LA}_{(n1)}$ = allowable concentration for nonpoint source category (1)
$\text{WLA}_{(p2)}$ = allowable concentration for point source category (2) etc.

For Class A surface waters (1) *the arithmetic mean of a representative set of fecal coliform samples shall not exceed 20 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 100 organisms per 100 mL.*

For Class B surface waters (1) *the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 400 organisms per 100 mL*.

For freshwater bathing beaches (MADPH standard, not yet adopted by the MADEP) (1) *the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 33 colonies per 100 mL* and (2) *no single enterococci sample shall exceed 61 colonies per 100 mL*. – OR – (1) *the geometric mean of the most recent five E. coli levels within the same bathing season shall not exceed 126 colonies per 100 mL* and (2) *no single E. coli sample shall exceed 235 colonies per 100 mL.*

Waste Load Allocations (WLAs) and Load Allocations (LAs).

There are eight municipal WWTPs, one CSO, and other NPDES-permitted wastewater discharges within the Blackstone River Drainage Basin. NPDES wastewater discharge WLAs are set at the WQS. In addition there are numerous storm water discharges from storm drainage systems throughout the watershed. All piped discharges are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore, a WLA set equal to the WQS will be assigned to the portion of the storm water that discharges to surface waters via storm drains.

WLAs and LAs are identified for all known source categories including both dry and wet weather sources for Class A and Class B segments within the Blackstone River Basin. Establishing WLAs and LAs that only address dry weather indicator bacteria sources would not ensure attainment of standards because of the significant contribution of wet weather indicator bacteria sources to WQS exceedances. Illicit sewer connections and deteriorating sewers leaking to storm drainage systems represent the primary dry weather point sources of indicator bacteria, while failing septic systems and possibly leaking sewer lines represent the non-point sources. Wet weather point sources include discharges from storm water drainage systems (including MS4s), sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs). Wet weather non-point sources primarily include diffuse storm water runoff.

Table 6-1 presents the indicator bacteria WLAs and LAs for the various source categories. WLAs and LAs will change to reflect the revised indicator organisms (*E. coli* and enterococci) when the updated WQS have been finalized (See Section 3.0 of this report). Source categories representing discharges of untreated sanitary sewage to receiving waters are prohibited, and therefore, assigned WLAs and LAs equal to zero. There are three sets of WLAs and LAs: Class A waters, Class B waters and Freshwater Beaches.

The TMDL should provide a discussion of the magnitudes of the pollutant reductions needed to attain the goals of the TMDL. Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources including failing septic systems, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical storm water bacteria concentrations, as presented in the "*Blackstone River Basin Watershed Water Quality Assessment Rep*ort" and additional data reports from the MADEP, Wright et al., and BRC (see Section 4.0 of this report for data resources). These data indicate that up to two to three orders of magnitude (i.e., greater than 90%) reductions in storm water fecal coliform loadings generally will be necessary, especially in developed areas. This goal is expected to be accomplished through implementation of the best management practices (BMPs) associated with the Phase II control program in designated Urban Areas. The specific goal for controlling discharges from combined sewer overflows (CSOs) will be based on the site specific studies embodied in the Long Term Control Plan being developed by each community with combined sewers.

The expectation to attain WQS at the point of discharge is environmentally protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and individuals responsible for monitoring activities.

This TMDL applies to the eleven pathogen impaired segments of the Blackstone River watershed that are currently listed on the CWA § 303(d) list of impaired waters. MADEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3).

Table 6-1. Indicator Bacteria Waste Load Allocations (WLAs) and Load Allocations (LAs) for the Blackstone River Basin.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
A & B	Illicit discharges to storm drains	0	N/A
A & B	Leaking sanitary sewer lines	0	N/A
A & B	Failing septic systems	N/A	0
A	NPDES – WWTP	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[2]	N/A
A	Storm water runoff Phase I and II	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]	N/A
A	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]
B	CSOs	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[4]	N/A
B	NPDES – WWTP	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[2]	N/A
B	Storm water runoff Phase I and II	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]	N/A
B	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
Fresh Water Beaches[5]	All Sources	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies

N/A means not applicable

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.

[2] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.

[3]The expectation for WLAs and LAs for storm water discharges is that they will be achieved through the implementation of BMPs and other controls.

[4] Or shall be consistent with an approved Long Term Control Plan (LTCP) for Combined Sewer Overflow (CSO) abatement. If the level of control specified in the LTCP is less than what is necessary to attain Class B water quality standards, then the above criteria apply unless MADEP has proposed and EPA has approved water quality standards revisions for the receiving water.

[5] Massachusetts Department of Public Health regulations (105 CMR Section 445)

Note: this table represents waste load and load reductions based on water quality standards current as of the publication date of these TMDLs, any future changes made to the Massachusetts water quality standards will become the governing water quality standards for these TMDLs.

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 6-1).

This Blackstone River watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

6.2. Margin of Safety

This section addresses the incorporation of a Margin of Safety (MOS) in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can either be implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Realistically, influent water will mix with the receiving water and become diluted below the water quality standard, provided that the receiving water concentration does not exceed the TMDL concentration. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

6.3. Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Pathogen sources to Blackstone River waters arise from a mixture of continuous and wet-weather driven sources, and there may be no single critical condition that is protective for all other conditions. This TMDL has set WLAs and LAs for all known and suspected source categories equal to the Massachusetts WQS independent of seasonal and climatic conditions. This will ensure the attainment of water quality standards regardless of seasonal and climatic conditions. Controls that are necessary will be in place throughout the year, protecting water quality at all times. However, for discharges that do not affect intakes for water supplies and primary contact recreation is not taking place (i.e., during the winter months), seasonal disinfection is permitted for NPDES point source discharges.

7.0 Implementation Plan

Setting and achieving TMDLs should be an iterative process, with realistic goals over a reasonable timeframe and adjusted as warranted based on ongoing monitoring. The concentrations set out in the TMDL represent reductions that will require substantial time and financial commitment to be attained. A comprehensive control strategy is needed to address the numerous and diverse sources of pathogens in the Blackstone River watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the Blackstone River watershed including sewer connections to drainage systems, leaking sewer pipes, sanitary sewer overflows, and failing septic systems, are prohibited and must be eliminated. Individual sources must be first identified in the field before they can be abated. Pinpointing sources typically requires extensive monitoring of the receiving waters and tributary storm water drainage systems during both dry and wet weather conditions. A comprehensive program is needed to ensure illicit sources are identified and that appropriate actions will be taken to eliminate them. The MADEP has been successful in carrying out such monitoring, identifying sources, and, in some cases mobilizing the responsible municipality and other entities to begin to take corrective actions.

Storm water runoff represents another major source of pathogens in the Blackstone River watershed, and the current level of control is inadequate for standards to be attained. Improving storm water runoff quality is essential for restoring water quality and recreational uses. At a minimum, intensive application of non-structural BMPs is needed throughout the watershed to reduce pathogen loadings as well as loadings of other storm water pollutants (e.g., nutrients and sediments) contributing to use impairment in the Blackstone River watershed. Depending on the degree of success of the non-structural storm water BMP program, structural controls may become necessary.

For these reasons, a basin-wide implementation strategy is recommended. The strategy includes a mandatory program for implementing storm water BMPs and eliminating illicit sources. The "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" was developed to support implementation of pathogen TMDLs. TMDL implementation-related tasks are shown in Table 7-1. The MADEP working with EPA and other team partners shall make every reasonable effort to assure implementation of this TMDL. These stakeholders can provide valuable assistance in defining hot spots and sources of pathogen contamination as well as the implementation of mitigation or preventative measures.

Table 7-1. Tasks.

Task	Organization
Writing TMDL	MADEP
TMDL public meeting	MADEP
Response to public comment	MADEP
Organization, contacts with volunteer groups	MADEP/Blackstone River Watershed Association (BRWA)/Blackstone River Coalition (BRC)
Development of comprehensive storm water management programs including identification and implementation of BMPs	Blackstone River Basin Communities
Illicit discharge detection and elimination	Blackstone River Basin Communities
Leaking sewer pipes and sanitary sewer overflows	Blackstone River Basin Communities
CSO management	Blackstone River Basin Communities
Inspection and upgrade of on-site sewage disposal systems as needed	Homeowners and Blackstone River Basin Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	MADEP, BRWA, BRC and Blackstone River Basin Communities
Organize and implement education and outreach program	MADEP, BRWA, BRC and Blackstone River Basin Communities
Write grant and loan funding proposals	BRWA, BRC and Blackstone River Basin Communities and Planning Agencies with guidance from MADEP
Inclusion of TMDL recommendations in Executive Office of Environmental Affairs (EOEA) Watershed Action Plan	EOEA
Surface Water Monitoring	MADEP, BRWA and BRC
Provide periodic status reports on implementation of remedial activities	BRWA, BRC and Blackstone River Basin Communities

7.1. Summary of Activities within the Blackstone River Watershed

The implementation strategy of this pathogen TMDL is consistent with the "*2004 Blackstone River Watershed Five-Year Action Plan*" (Action Plan) prepared by GeoSyntec Consultants (GeoSyntec 2004). The Action Plan provides a priority list of watershed action items for the Blackstone River and its tributaries. These items include:

1. Water Quality Improvements and Protection
2. Water Quantity/Streamflow Protection & Management
3. Habitat Improvement & Protection
4. Open Space Acquisition, Protection & Planning
5. Recreational Use & Access
6. Local Capacity Building
7. Public Education & Outreach
8. Sustainable Development

Of these action items, Water Quality Improvements and Protection was listed as the highest priority. Six objectives were established for Water Quality Improvements and Protection action:

1. Improve bacteria and toxicity monitoring throughout the watershed
2. Improve watershed planning through development of modeling tools
3. Construct/restore riverine wetlands designed for water quality improvements
4. Promote watershed-wide application and enforcement of regulatory tools for water quality protection
5. Repair leaking sewers, particularly in urban areas
6. Improve scale and coordination of water quality monitoring efforts

Details regarding these objectives and responsible parties are available in the Action Plan, available on the worldwide web at http://www.mass.gov/envir/water/publications.htm.

There several not-for-profit organizations in the Blackstone River watershed. The three major organizations geared to protection and enhancements of the watershed as a whole are the Blackstone River Coalition (BRC), Blackstone River Watershed Association (BRWA) and Blackstone Headwater Coalition (BHWC).

The BRC is comprised of state and federal agencies, municipalities, businesses and non-profit organizations with a common concern "with the regeneration of the Blackstone River and the health of the Blackstone River Watershed" (BRC 2005). A listing of organizations within the BRC is provided in the Action Plan prepared by GeoSyntec.

The BRC focus is on education and outreach, supporting river restoration efforts and the renewal of the community and commerce within the watershed. The BRC accomplishes this task by (BRC 2005):

- continuing to build a system of river access points where people will have opportunities to fish, canoe, and enjoy passive recreation; create constituencies to maintain and support river access sites, support partner activities, like the Blackstone Valley Council, to build river landings for the Blackstone Valley Explorer.

- signing waterways and stenciling storm drains to raise public consciousness of the extent and location of the Blackstone's complex tributary system.
- coordinating nature programming, including Big Night, and hiking opportunities with nature centers, such as those operated by the Audubon Society of Rhode Island and Massachusetts.
- providing planning and financial assistance to targeted communities that support downtown revitalization through the redevelopment of waterfront properties, e.g. the State pier renovation and riverwalk concept in Pawtucket; other riverfront park and commercial opportunities.
- working collaboratively with government agencies and organizations on river recovery programs that support improvements in water quality and quantity, habitat restoration, reintroduction of migratory fish [development of fish ladders at least up to Lonsdale Marsh] and local efforts in environmental education, stream monitoring, and land protection along the River.

The following description of the BRWA was provided on the BRC website (http://zaptheblackstone.org/):

> The Blackstone River Watershed Association was formed to clean up the Blackstone River. In the past 20 years we have continued with this grassroots tradition of local action and hands-on projects. We continue our long tradition of clean-ups and are also building a love of the river though recreation. To celebrate a cleaner Blackstone and to get more people to use the River, we sponsor a canoe race every spring. Every year this event draws more racers, sponsors, press, and river supporters. But promoting recreation is the just the beginning. We completed a 5-year strategic plan in 1999 and many of our goals involve building on the enthusiasm we foster in people through the canoe race. We were part of a team of organizations on a citizen monitoring storm water project this winter. Our Earth Day Clean-ups and Storm Drain Stenciling Projects attracted over 300 volunteers working in nearly every community in our watershed.

The BRWA has established goals for the watershed and a strategy to achieve them. Specific information regarding this organization can be obtained from their website at http://www.thebrwa.org/.

The goals of the BRWA organization are to (BRWA 2005):

- Restore the waters of the Blackstone and its tributaries to their highest possible quality and protect their shores and floodplains from inappropriate uses;
- Provide recreational opportunities for canoeing, fishing and other natural resource based activities;

- Preserve the rural and forested character of the Blackstone Valley and protect lands with ecological, recreational and/or scenic value;
- Educate and involve diverse interests in managing and protecting the natural resources of the Blackstone watershed;
- Sponsoring the mid-reach team of the Blackstone River Coalition's watershed-wide volunteer water quality monitoring program;
- Partnering with the Blackstone River Coalition's Campaign for a Fishable/Swimmable Blackstone River by 2015.

In order to obtain these goals, the BRWA is (BRWA 2005):

- Planning for the creation of a permanently protected greenway along the entire length of the Blackstone and its tributaries;
- Sponsoring activities along the river to raise public awareness of the river's existing and potential recreational and natural value;
- Providing public workshops and school curricula which explain the geography and history of the Blackstone Valley as well as the causes of and potential solutions to water pollution;
- Sponsoring the mid-reach team of the Blackstone River Coalition's watershed-wide volunteer water quality monitoring program;
- Partnering with the Blackstone River Coalition's Campaign for a Fishable/Swimmable Blackstone River by 2015.

Data supporting this TMDL indicate that indicator bacteria enter the Blackstone River watershed from a number of contributing sources, under a variety of conditions. Activities that are currently ongoing and/or planned to ensure that the TMDL can be implemented include and are summarized in the following subsections. The "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" provides additional details on the implementation of pathogen control measures summarized below as well as additional measures not provided herein, such as by-law, ordinances and public outreach and education.

7.2. Illicit Sewer Connections, Failing Infrastructure and CSOs

Elimination of illicit sewer connections, repairing failing infrastructure and controlling impacts associated with CSOs are of extreme importance. Several steps are currently underway in this regard. The Worcester DPW and MADEP have been active in the identification and mitigation of these sources.

The following text was quoted in the MADEP WQA 2001:

> The city of Worcester has completed considerable work with regard to CSO abatement including the construction of a CSO treatment facility and ongoing sewer separation. At this time, there is a single CSO discharge point, and all CSO discharges receive screening and disinfection with some solids removal in detention tanks prior to discharge. As a result of an Administrative Order issued by EPA on 19 September 2000, the City of Worcester will continue to move forward with a two-phased Long-

term CSO Control Plan. Phase one will involve characterizing the combined sewer system, establishing baseline conditions for CSO and non-CSO pollutant loads, and developing costs for a range of CSO control alternatives (approximately one year). Phase two will focus on the development of a final Long-term CSO Control Plan (approximately one year). If non-CSO loads are determined to be a predominant contributor to violations of SWQS, then the final strategy for CSO abatement will likely be meshed with storm water management strategies in order to maximize the cost-effectiveness of the overall program.

The treated CSO discharges flow to Mill Brook and the Blackstone River. These segments are both presently designated Class B. A CSO-impacted segment can be reclassified to B(CSO), B(partial), C, or a CSO Variance can be issued only where a CSO facilities plan demonstrates that elimination of CSOs is not feasible. In those instances, the highest feasible level of CSO control must be implemented and the receiving water may be reclassified accordingly. The technical and cost information included in the CSO Facilities Plan forms the basis of these determinations and must support a Use Attainability Analysis where a downgrade to B(CSO), B(partial), or C is being considered. A CSO Variance may be issued to allow continued discharge of CSOs while additional data and information are developed to make a final determination on the appropriate water quality standard. As the City of Worcester has not completed the planning process, a final determination on the level of CSO control to be required and the associated water quality standard have not yet been made. Until such time, the receiving waters will continue to be designated Class B.

Guidance for the illicit discharge detection and elimination has been developed by EPA New England (USEPA 2004b). The guidance document provides a plan, available to all Commonwealth communities, to identify and eliminate illicit discharges (both dry and wet weather) to their separate storm sewer systems. Implementation of the protocol outlined in the guidance document satisfies the Illicit Discharge Detection and Elimination requirement of the NPDES program. A copy of the guidance document is provided in Appendix A.

7.3. Storm Water Runoff

Storm water runoff can be categorized in two forms; 1) point source discharges and 2) non-point source discharges (includes sheet flow or direct runoff). Many point source storm water discharges are regulated under the NPDES Phase I and Phase II permitting programs when discharged to a Waters of the United States. Municipalities that operate regulated municipal separate storm sewer systems (MS4s) must develop and implement a storm water management plan (SWMP), which must employ and set measurable goals for the following six minimum control measures:

1. public education and outreach particularly on the proper disposal of pet waste,
2. public participation/involvement,
3. illicit discharge detection and elimination,
4. construction site runoff control,
5. post construction runoff control, and
6. pollution prevention/good housekeeping.

Portions of towns in this watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule. This rule requires the development and implementation of an illicit discharge detection and elimination plan.

The NPDES permit does not, however, establish numeric effluent limitations for storm water discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals.

Non-point source discharges are generally characterized as sheetflow runoff and are not categorically regulated under the NPDES program and can be difficult to manage. However, some of the same principles for mitigating point source impacts may be applicable. Individual municipalities not regulated under the Phase I or II should implement the exact same six minimum control measures minimizing storm water contamination.

7.4. Failing Septic Systems

Septic system bacteria contributions to the Blackstone River and its tributaries may be reduced in the future through septic system maintenance and/or replacement. Additionally, the implementation of Title 5, which requires inspection of private sewage disposal systems before property ownership may be transferred, building expansions, or changes in use of properties, will aid in the discovery of poorly operating or failing systems. Because systems which fail must be repaired or upgraded, it is expected that the bacteria load from septic systems will be significantly reduced in the future. Regulatory and educational materials for septic system installation, maintenance and alternative technologies are provided by the MADEP on the worldwide web at http://www.mass.gov/dep/brp/wwm/t5pubs.htm.

7.5. Wastewater Treatment Plants

WWTP discharges are regulated under the NPDES program when the effluent is released to surface waters. Each WWTP has an effluent limit included in its NPDES or groundwater permit. Some NPDES permits are listed on the following website: www.epa.gov/region1/npdes/permits_listing_ma.html. Groundwater permits are available at http://www.mass.gov/dep/brp/gw/gwhome.htm.

7.6. Recreational Waters Use Management

Recreational waters receive pathogen inputs from swimmers. To reduce swimmers' contribution to pathogen impairment, shower facilities can be made available, and bathers should be encouraged to shower prior to swimming. In addition, parents should check and change young children's diapers when they are dirty.

7.7. Funding/Community Resources

A complete list of funding sources for implementation of nonpoint source pollution is provided in Section VII of the Massachusetts Nonpoint Source Management Plan Volume I (MADEP 2000b) available on line at http://www.mass.gov/dep/brp/wm/nonpoint.htm. This list includes specific programs available for non-point source management and resources available for communities to manage local growth and development. The State Revolving Fund (SRF) provides low interest loans to communities for certain capital costs associated with building or improving wastewater treatment facilities. In addition, many communities in Massachusetts sponsor low cost loans through the SRF for homeowners to repair or upgrade failing septic systems.

7.8. Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts

For a more complete discussion on ways to mitigate pathogen water pollution, see the "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" accompanying this document.

8.0 Monitoring Plan

The long term monitoring plan for the Blackstone Watershed includes several components:

1. continue with the current monitoring of the Blackstone River Drainage Basin (BRC),
2. continue with MADEP watershed five-year cycle monitoring,
3. monitor areas within the watershed where data are lacking or absent to determine if the waterbody meets the use criteria,
4. monitor areas where BMPs and other control strategies have been implemented or discharges have been removed to assess the effectiveness of the modification or elimination,
5. assemble data collected by each monitoring entity to formulate a concise report where the basin is assessed as a whole and an evaluation of BMPs can be made, and
6. add/remove/modify BMPs as needed based on monitoring results.

The monitoring plan is an ever changing document that requires flexibility to add, change or delete sampling locations, sampling frequency, methods and analysis. At the minimum, all monitoring should be conducted with a focus on:

- capturing water quality conditions under varied weather conditions;
- establishing sampling locations in an effort to pin-point sources;
- researching new and proven technologies for separating human from animal bacteria sources; and
- assessing efficacy of BMPs.

9.0 Reasonable Assurances

Reasonable assurances that the TMDL will be implemented include both enforcement of current regulations, availability of financial incentives including low or no-interest loans to communities for wastewater treatment facilities through the State Revolving Fund (SRF), and the various local, state and federal programs for pollution control. Storm water NPDES permit coverage will address discharges from municipal owned storm water drainage systems. Enforcement of regulations controlling non-point discharges includes local enforcement of the states Wetlands Protection Act and Rivers Protection Act; Title 5 regulations for septic systems and various local regulations including zoning regulations. Financial incentives include Federal monies available under the CWA Section 319 NPS program and the CWA Section 604 and 104b programs, which are provided as part of the Performance Partnership Agreement between MADEP and the EPA. Additional financial incentives include state income tax credits for Title 5 upgrades, and low interest loans for Title 5 septic system upgrades through municipalities participating in this portion of the state revolving fund program.

10.0 Public Participation

To be added later….

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Appendix A

Lower Charles River Illicit Discharge Detection & Elimination (IDDE) Protocol
Guidance for Consideration - November 2004