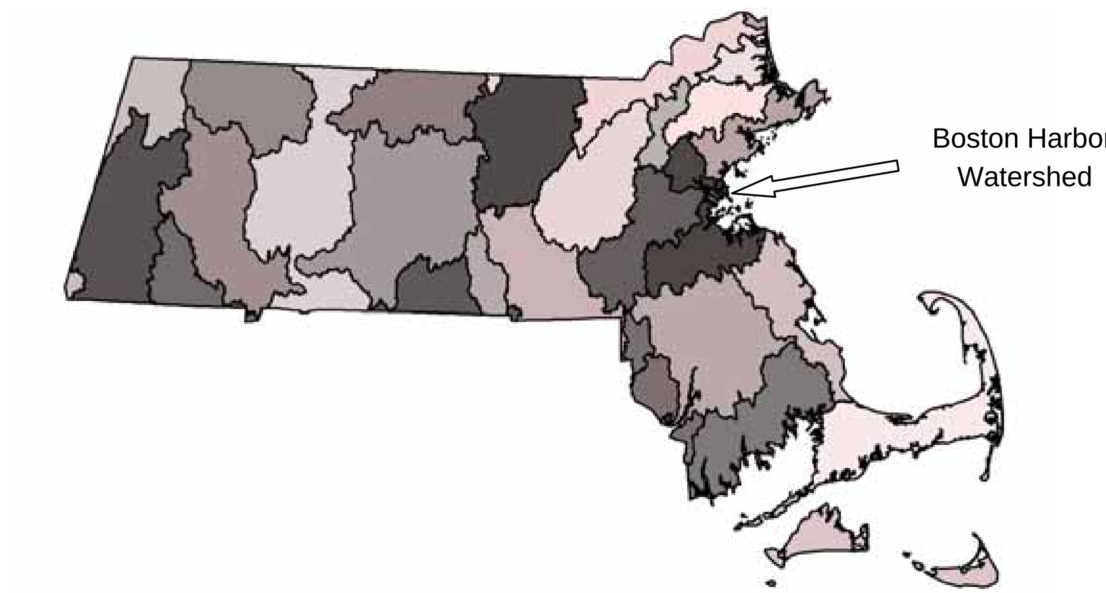
Draft Pathogen TMDL for the Boston Harbor Watershed (excluding the Neponset River sub-basin)



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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.

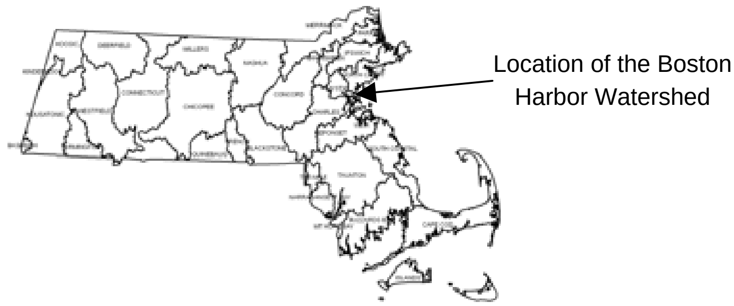
DISCLAIMER

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 Boston Harbor Watershed (excluding the Neponset River sub-basin)



Key Features: Pathogen TMDL for the Boston Harbor Watershed (excluding the Neponset River sub-basin)

Location: EPA Region 1

Land Type: New England Coastal

303(d) Listings: Pathogens

Mystic River Sub-basin:
- Aberjona River (MA71-01);
- Mystic River (MA71-02; MA71-03);
- Alewife Brook (MA71-04);
- Malden River (MA71-05);
- Mill Brook (MA71-07);
- Chelsea River (MA71-06);
- Ell Pond (MA71014);
- Judkins Pond (MA71021); and
- Mill Pond (MA71-31).

Boston Harbor Sub-basin:
- Winthrop Bay (MA70-10);
- Boston Inner Harbor (MA70-02);
- Pleasure Bay (MA70-11);
- Dorchester Bay (MA70-03);
- Quincy Bay (MA70-04; MA70-05);
- Hingham Harbor (MA70-08);
- Hingham Bay (MA70-06; MA70-07);
- Hull Bay (MA70-09); and
- Boston Harbor (MA70-01).

Weir & Weymouth Sub-basin:
- Cochato River (MA74-06);
- Monatiquot River (MA74-08);
- Town Brook (MA74-09);
- Town River Bay (MA74-15);
- Weymouth Fore River (MA74-14);
- Old Swamp River (MA74-03);
- Mill River (MA74-04);
- Weymouth Back River (MA74-05; MA74-13); and
- Weir River (MA74-02; MA74-11).

Data Sources:

- MADEP "Boston Harbor 1999 Water Quality Assessment Report"
- MyRWA "Mystic Monitoring Network Report 2002-2003" MyRWA Water Quality Sampling Data 2000-2003
- EMPACT Water Quality Data
- MyRWA "Mystic Monitoring Network Yearly Review: Baseline Water Quality Data for the Watershed (July 2000-February 2002)"

- MyRWA “Water Quality Monitoring Report: Centerline Survey of Island End, Mystic and Malden Rivers”
- MyRWA “Water Quality Monitoring Report: Lower Mystic River and Tributaries”

Data Mechanism: Massachusetts Surface Water Quality Standards for Fecal Coliform; The Federal BEACH Act; Massachusetts Department of Public Health Bathing Beaches; Massachusetts Division of Marine Fisheries Shellfish Sanitation and Management; Massachusetts Coastal Zone Management

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; No Discharge Areas; 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) harbormasters, public health officials and/or municipalities that are responsible for monitoring, enforcing or otherwise mitigating fecal contamination that results in beach and/or shellfish 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 Boston Harbor 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 Boston Harbor 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 Boston Harbor 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 32 pathogen impaired segments of the Boston Harbor 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 Boston Harbor 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 Boston Harbor 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, SA, SB	Illicit discharges to storm drains	0	N/A
A, B, SA, SB	Leaking sanitary sewer lines	0	N/A
A, B, SA, SB	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 & Not Designated for Shellfishing SA & SB	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 & Not Designated for Shellfishing SA & SB	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 & Not Designated for Shellfishing SA & SB	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 & Not Designated for Shellfishing SA & SB	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]
SA Designated Shellfishing Areas	NPDES – WWTP	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms[2]	N/A
SA Designated Shellfishing Areas	Storm water Runoff Phase I and II	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms[3]	N/A
SA Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms[3]
SB Designated Shellfishing Areas	CSOs	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[4]	N/A
SB Designated Shellfishing Areas	NPDES – WWTP	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[2]	N/A
SB Designated Shellfishing Areas	Storm water runoff Phase I and II	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[3]	N/A
SB Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[3]
No Discharge Areas	Vessels – raw or treated sanitary waste	0	N/A
Marine Beaches[5]	All Sources	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies

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[6]	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] Federal Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act) Water Quality Criteria

[6] 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.

Table of Contents

List of Tables

List of Figures

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 Boston Harbor watershed (excluding the Neponset River sub-basin) 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 Boston Harbor 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 only. 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 Boston Harbor waterbodies. These include water supply, shellfish harvesting, 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

Figure 1-1. Boston Harbor Watershed and Pathogen Impaired Segments

potential pollutant sources impacting a waterbody and increases the precision of identifying local problem areas or "hot spots" which may detrimentally affect water and sediment quality. It is within this watershed-level framework that the Massachusetts Department of Environmental Protection (MADEP) commissioned the development of watershed based TMDLs.

1.1. Pathogens and Indicator Bacteria

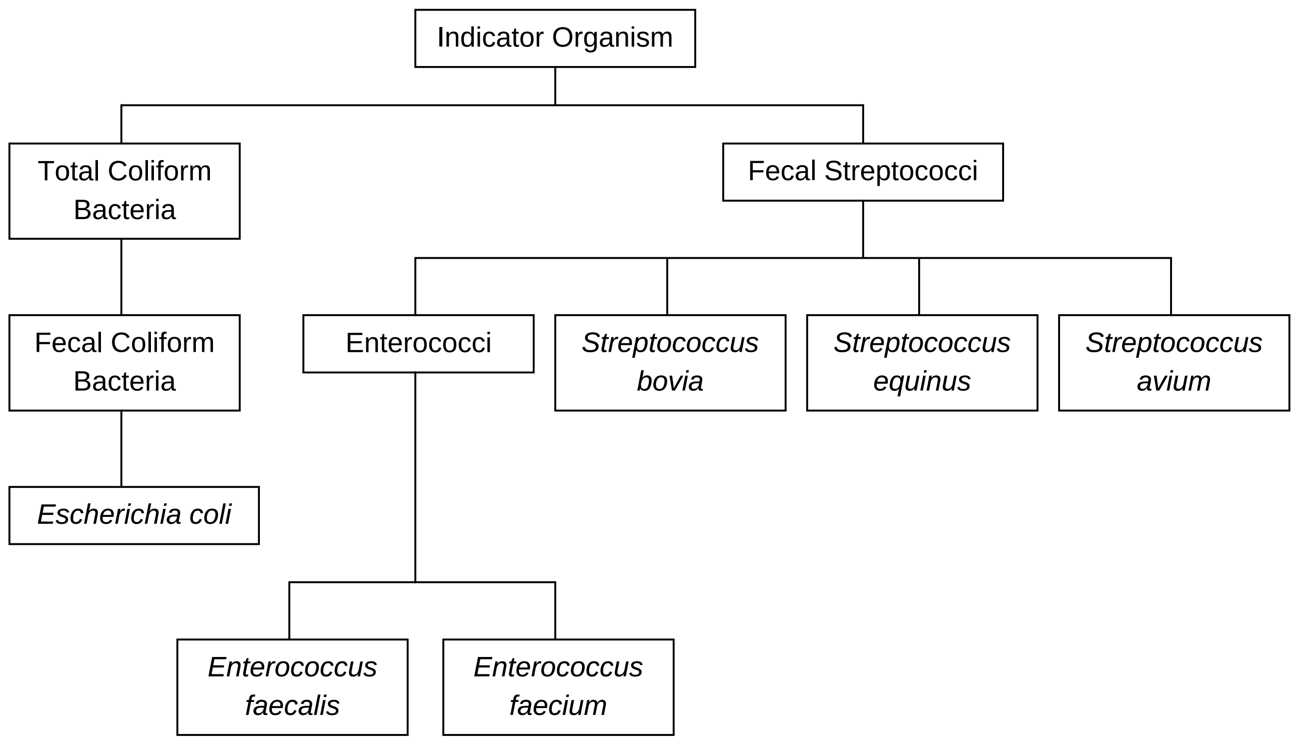
The Boston Harbor pathogen TMDL is designed to support reduction of waterborne disease-causing organisms, known as pathogens, to reduce public health risk. Waterborne pathogens enter surface waters from a variety of sources including sewage and the feces of warm-blooded wildlife. These pathogens can 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 Boston Harbor watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for fresh and marine waters and enterococci for marine beaches. 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 Boston Harbor 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 Boston Harbor 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 32 pathogen impaired segments of the Boston Harbor 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 Boston Harbor 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 53 waterbody segments assessed by the MADEP in the Boston Harbor watershed excluding the Neponset River sub-basin (65 segments in the Neponset River sub-basin) (MassGIS 2005). Of the 53 segments, 17 are estuaries, all of which are pathogen impaired. Twelve of the 16 river segments are pathogen impaired and three of the 20 lake segments are pathogen impaired and appear as such on the official list of impaired waters (303(d) list) (Figure 1-1). Pathogen impairment has been documented by the MADEP in previous reports, including the "*Boston Harbor 1999 Water Quality Assessment Report*" (MADEP WQA; MADEP 2002a), 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, are also 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 Boston Harbor 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 Boston Harbor watershed
- Identification of Sources (Section 5) – identifies and discusses potential sources of waterborne pathogens within the Boston Harbor 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 Boston Harbor watershed is made up of the Mystic River, the Neponset River, the Weymouth and Weir Rivers, and the Boston Harbor Proper (the Harbor coastline, waters, and islands) sub-basins. This report includes information regarding each of these sub-basins with the exception of the Neponset River sub-basin. A TMDL has been previously prepared for the Neponset River sub-basin in 2002 by the MADEP and is available on the worldwide web at http://www.mass.gov/dep/brp/wm/tmdls.htm.

Land use within the Boston Harbor watershed (excluding the Neponset River sub-basin) is approximately 35% undeveloped land (i.e., open space, water, wetlands, etc.) and 65% developed (i.e., residential, commercial/industry, etc.) (Table 2-1; Figure 2-2).

Surface waters in the watershed are commonly used for primary and secondary contact recreation (swimming and boating), viewing wildlife, habitat for aquatic life, and shellfishing. Figure 2-2 shows the marine swimming beach locations in this watershed. There are no offshore areas protected against the disposal of treated or untreated sewage from vessels in this watershed (i.e., No Discharge Areas; see Section 7.6) (Figure 2-3).

Table 2-1. Boston Harbor Watershed Land Use (excluding the Neponset River sub-basin).

Land Use Category	% of Total Watershed Area
Pasture	0.3
Urban Open	4.6
Open Land	2.5
Cropland	0.3
Woody Perennial	0.1
Forest	22.1
Wetland/Salt Wetland	2.4
Water Based Recreation	0.4
Water	2.6
General Undeveloped	35.4
Spectator Recreation	0.4
Participation Recreation	2.9
> 1/2 acre lots Residential	3.3
1/4 - 1/2 acre lots Residential	18.8
< 1/4 acre lots Residential	13.8
Multi-family Residential	6.6
Mining	0.5
Commercial	5.5
Industrial	5.4
Transportation	6.8
Waste Disposal	0.5
General Developed	64.6

Figure 2-1. Boston Harbor Watershed Land Use as of 1999.

Figure 2-2. Boston Harbor Watershed Marine Beach Locations.

Figure 2-3. General Location of Massachusetts' No Discharge Areas (USEPA 2004a).

2.1. Boston Harbor Proper Sub-basin

The Boston Harbor Proper sub-basin includes the shoreline areas of Boston, Quincy, Hull, and Chelsea. The Harbor Islands are also included in this sub-basin. The sub-basin extends south from the Chelsea River, east from the Charles River Dam, north from Hingham Bay, and east from the confluence of the Neponset River with Dorchester Bay to a line connecting the Boston Lighthouse to Deer Island in Boston and Point Allerton in Hull. The harbor is often dredged to maintain access to the Inner Harbor for deep draft vessels. More than 2,200 acres of Boston Harbor has been filled to expand Logan Airport. More than one million cubic yards of clays produced from the construction of the Ted Williams Tunnel have been disposed of in the outer harbor. Excavated materials from the central artery have been dosiposed of on Spectacle Island.

The Boston Harbor Proper sub-basin is highly urbanized (Table 2-2; Figure 2-1). The Boston Harbor Proper sub-basin waters are commonly used for primary and secondary contact recreation (swimming and boating), navigation, fishing, wildlife viewing, habitat for aquatic life, and shellfishing.

Table 2-2. Boston Harbor Proper Sub-basin Land Use.

Land Use Category	% of Total Watershed Area
Pasture	<0.1
Urban Open	10.2
Open Land	5.7
Cropland	<0.1
Woody Perennial	<0.1
Forest	2.5
Wetland/Salt Wetland	1.4
Water Based Recreation	0.8
Water	<0.1
General Undeveloped	20.7
Spectator Recreation	1.4
Participation Recreation	3.4
> 1/2 acre lots Residential	<0.1
1/4 - 1/2 acre lots Residential	0.2
< 1/4 acre lots Residential	5.8
Multi-family Residential	19.6
Mining	<0.1
Commercial	14.3
Industrial	4.6
Transportation	28.0
Waste Disposal	2.0
General Developed	79.3

2.2. Weir and Weymouth Rivers Sub-basin

The Weymouth and Weir Rivers sub-basin lies south of Boston Harbor. This sub-basin includes all or part of 16 municipalities. Five river systems make up this watershed: Furnace Brook, Town River, Weymouth Fore River, Weymouth Back River, and Weir River. Furnace Brook flows 2.7 miles northeast to Quincy Bay and the other rivers generally flow northeast to Hingham Bay. Town Brook originates in the Blue Hills and flows 3.2 miles from the Old Quincy Reservoir through downtown Quincy to the Town River. Town River flows into Town River Bay, which joins with the Weymouth Fore River before flowing into Hingham Bay. The Weymouth Fore River System originates at Lake Holbrook and flows for 4.0 miles as the Cochato River. When Farm River joins Cochato River, they form the Monatiquot River. The Monatiquot River flows north then east for a total of 4.3 miles before it becomes a tidal estuary and is considered the Weymouth Fore River. The Weymouth Back River originates as the Old Swamp River in Rockland. The river flows to the southern shore of Whitmans Pond in Weymouth. The Weymouth Back River flows from the outlet of Whitmans Pond to the Weymouth Back River estuary. The Weir River is formed at the confluence of Crooked Meadow River and Fulling Mill Brook. The river flows 2.8 miles to its tidal portion. The Weir River System includes the Plymouth, Cooked Meadow, and Weir Rivers.

The Weymouth and Weir Rivers sub-basin is urbanized along the coast with areas of forest mostly on the sub-basin southern border (Table 2-3; Figure 2-1). The impaired segments in the watershed tend to correlate with industrial and residential areas (Figure 1-1 and 2-1).

The Weymouth and Weir Rivers sub-basin waters are commonly used for primary and secondary contact recreation (swimming and boating), fishing, wildlife viewing, habitat for aquatic life, irrigation, agricultural uses, industrial cooling processes, shellfishing, and public water supply.

Table 2-3. Weir and Weymouth Rivers Sub-basin Land Use.

Land Use Category	% of Total Watershed Area
Pasture	0.6
Urban Open	3.2
Open Land	2.7
Cropland	0.3
Woody Perennial	<0.1
Forest	33.5
Wetland/Salt Wetland	3.1
Water Based Recreation	0.5
Water	2.8
General Undeveloped	46.8
Spectator Recreation	<0.1
Participation Recreation	2.2
> 1/2 acre lots Residential	4.6
1/4 - 1/2 acre lots Residential	21.7
< 1/4 acre lots Residential	11.4
Multi-family Residential	1.8
Mining	1.0
Commercial	3.9
Industrial	4.1
Transportation	2.2
Waste Disposal	0.2
General Developed	53.2

2.3. Mystic River Sub-basin

The Mystic River watershed includes all or part of 19 cities and towns within the northern section of the Greater Boston area. The Mystic River is fed by the Aberjona River and Hall's Brook. Horn Pond Brook, Mill Brook, and Alewife Brook are also tributaries to the Mystic River farther along its course. The Amelia Earhart Dam restricts the Mystic's flow just downstream of its confluence with the Malden River. The Chelsea River is the last river to flow into the Mystic River before it discharges into Boston Inner Harbor.

The Mystic River watershed is highly urbanized (Table 2-3; Figure 2-1). Nearly half (49.4%) of the land use is residential (Table 2-3). Open areas tend to be in the northwestern portion of the watershed. The southeastern portion of the watershed is dominated by high intensity residential areas and commercial/industrial/transportation areas. The impaired segments in the watershed tend to correlate with industrial and residential areas (Figure 2-1 and 2-3).

The Mystic River and tributaries are commonly used for primary and secondary contact recreation (swimming and boating), fishing, wildlife viewing, habitat for aquatic life, irrigation, agricultural uses, industrial cooling processes, shellfishing and public water supply.

Table 2-3. Mystic River Sub-basin Land Use.

Land Use Category	% of Total Watershed Area
Pasture	<0.1
Urban Open	5.1
Open Land	1.7
Cropland	0.3
Woody Perennial	0.3
Forest	12.6
Wetland/Salt Wetland	1.7
Water Based Recreation	0.2
Water	3.0
General Undeveloped	25.0
Spectator Recreation	0.5
Participation Recreation	3.6
> 1/2 acre lots Residential	2.5
1/4 - 1/2 acre lots Residential	19.0
< 1/4 acre lots Residential	18.3
Multi-family Residential	9.6
Mining	<0.1
Commercial	5.5
Industrial	7.2
Transportation	8.0
Waste Disposal	0.6
General Developed	75.0

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 2004b). 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 Boston Harbor watershed pathogen TMDL has been developed using fecal coliform as the pathogen indicator for fresh and marine waters and enterococci for marine beaches, 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 Boston Harbor watershed contains waterbodies classified as Class A, Class B, Class SA, and Class SB. 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, and Class SA and SB not designated for shellfishing - 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 for waters classified as Class B, and Class SA and SB not designated for shellfishing.

Class SA waters approved for open shellfishing - the geometric mean of a representative set of fecal coliform samples shall not exceed 14 organisms per 100 mL and no more than 10% of the samples shall exceed 43 organisms per 100 mL.

Class SB waters approved for open shellfishing - the geometric mean of a representative set of fecal coliform samples shall not exceed 88 organisms per 100 mL and no more than 10% of the samples shall exceed 260 organisms per 100 mL.

Shellfish growing areas are classified by the Massachusetts Division of Marine Fisheries (DMF). The classification system is provided below (MassGIS 2005). Figure 1-1 provides designated shellfish growing areas status as of July 1, 2000.

Approved – “Open for harvest of shellfish for direct human consumption subject to local rules and state regulations.” (MassGIS 2005) “The area is shown to be free of bacterial contaminants under a variety of climatological and hydrographical situations (i.e. assumed adverse pollution conditions).” (MADEP 2002b)

Conditionally Approved - "During the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations.” (MassGIS 2005) “This classification category may be assigned for growing areas subject to intermittent and predictable microbiological contamination that may be present due to operation of a sewage treatment plant, rainfall, and/or season.” (MADEP 2002b)

Conditionally Restricted – “During the time area is restricted it is only open for the harvest of shellfish with depuration subject to local rules and state regulations.” (MassGIS 2005) “A classification used to identify a growing area that meets the criteria for the restricted classification except under certain conditions described in a management plan.” (MADEP 2002b)

Restricted – “Open for harvest of shellfish with depuration subject to local rules and state regulations or for the relay of shellfish.” (MassGIS 2005) “A classification used to identify where harvesting shall be by special license and the shellstock, following harvest, is subject to a suitable and effective treatment process through relaying or depuration. Restricted growing areas are mildly or moderately contaminated only with bacteria.” (MADEP 2002b)

Management Closure – “Closed for the harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.” (MADEP 2002b)

Prohibited – “Closed for harvest of shellfish.” (MassGIS 2005) “A classification used to identify a growing area where the harvest of shellstock is not permitted. Growing area waters are so badly contaminated that no reasonable amount of treatment will make the shellfish safe for human consumption. Growing areas must also be classified as Prohibited if there is no or insufficient information available to make a classification decision.” (MADEP 2002b)

In general, shellfish harvesting use is supported (i.e., non-impaired) when shellfish harvested from approved open shellfish areas are suitable for consumption without depuration and shellfish harvested from restricted shellfish areas are suitable for consumption with depuration. For an expanded discussion on the relationship between the DMF shellfish growing areas classification and the MADEP designated use support status, please see the “*Boston Harbor Watershed 1999 Water Quality Assessment Report*” (MADEP WQA; MADEP 2002a).

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.

Figure 2-2 provides the location of marine bathing beaches, where the MADPH Marine Waters and the Federal BEACH Act standards would apply. A map of freshwater beaches is not available at this time. However, a list of beaches (fresh and marine) by community with indicator 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 Boston Harbor 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 these 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 2002c) 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.

There are 53 segments identified in the Boston Harbor watershed as defined by the MADEP in the *2002 List* (MassGIS 2005)[1]. Table 4-3 provides summary statistics of assessed and impaired waters within the Boston Harbor watershed. In total, 32 segments contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A, SA, B, or SB waterbodies (314 CMR 4.05)[2], the MADPH standard for bathing beaches[3], and/or the BEACH Act[4]. 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 Tables 4-4 through 4-6. 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 enteroccoci for marine beaches. Enterococci data are provided at the bottom of each table when data are available. 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. 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.

[1] Excludes Neponset River sub-basin. Details regarding this sub-basin can be found in the TMDL of Bacteria for Neponset River Basin available on the worldwide web at http://www.mass.gov/dep/brp/wm/tmdls.htm

[2] 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 SA (Shellfishing approved): Fecal coliform bacteria shall not exceed an arithmetic mean of 14 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 43 organisms per 100 mL.

Class SB (Shellfishing approved): Fecal coliform bacteria shall not exceed an arithmetic mean of 88 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 260 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.

[3] 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.

[4] BEACH Act - Marine bathing beaches: 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.

Table 4-3. Assessed and Pathogen Impaired Segment Statistics for the Boston Harbor Watershed (adapted from MassGIS 2005).

	Boston Harbor Proper	Weir/Weymouth Rivers	Mystic River	Total Boston Harbor[1]
Number of Estuary Segments Assessed - Impaired Estuary Segments (Percent Impaired)	11 – 11 (100%)	4 – 4 (100%)	2 – 2 (100%)	17 – 17 (100%)
Area (mi^2) of Estuaries Assessed – Area (mi^2) of Impaired Estuaries (Percent Impaired)	47.5 – 47.5 (100%)	6.7 – 6.7 (100%)	1.2 – 1.2 (100%)	55.4 – 55.4 (100%)
Number of River Segments Assessed - Impaired River Segments (Percent Impaired)	0 – 0 (0%)	11 – 7 (63.6%)	5 – 5 (100%)	16 – 12 (75%)
Length (mi) of Rivers Assessed – Length (mi) of Impaired Rivers (Percent Impaired)	0 – 0 (0%)	33.5 – 23.3 (69.6%)	21.6 – 21.6 (100%)	55.1 – 44.9 (81.5%)
Number of Lake Segments Assessed - Impaired Lake Segments (Percent Impaired)	0 – 0 (0%)	8 – 0 (0%)	12 – 3 (25.0%)	20 – 3 (15.0%)
Area (acres) of Lakes Assessed – Area (acres) of Impaired Lakes (Percent Impaired)	0 – 0 (0%)	373.3 – 0 (0%)	389.9 – 30.4 (7.8%)	763.2 – 30.4 (4.0%)

[1] excludes Neponset River sub-basin

Table 4-4. Boston Harbor Proper Sub-basin Pathogen Impaired Segments Requiring TMDLs (adapted from MADEP 2002a and MassGIS 2005).

Segment ID	Segment Name	Segment Size	Segment Description
MA70-10	Winthrop Bay	1.5 mi^2	From the tidal flats at Coleridge Street, East Boston to a line between Logan International Airport and Point Shirley, East Boston/Winthrop
MA70-02	Boston Inner Harbor	2.3 mi^2	From the Mystic and Chelsea rivers, Chelsea/Boston, to the line between Governors Island and Fort Independence, East Boston/ Boston (including Fort Point and Reserved channels, and Little Mystic River)
MA70-11	Pleasure Bay	0.22 mi^2	A semi-enclosed bay, the flow restricted through two channels between Castle and Head Islands, Boston
MA70-03	Dorchester Bay	4.6 mi^2	From the mouth of the Neponset River, Boston/Quincy to the line between Head Island and the north side of Thompson Island and the line between the south point of Thompson Island and Chapel Rocks, Boston/Quincy
MA70-04	Quincy Bay	1.0 mi^2	From Bromfield Street near the Wallaston Yacht Club, Quincy, northeast to N42.2781 W70.9941, southeast to N42.2735 W70.9678, and south to Newton Street on the northerly shore of Houghs Neck, Quincy
MA70-05	Quincy Bay	4.7 mi^2	Quincy Bay, north of the class SA waters (segment MA70-04), Quincy to the line between Moon Head and Nut Island, Quincy
MA70-08	Hingham Harbor	1.1 mi^2	Hingham Harbor, in Hingham, inside a line from Crows Point to Worlds End, Hingham
MA70-06	Hingham Bay	1.0 mi^2	The area south of the mouth of the Weymouth Fore River extending on the west along a line from Prince Head just east of Pig Rock to the mouth of the Weymouth Fore River (midway between Lower Neck and Manot Beach), Quincy
MA70-07	Hingham Bay	5.8 mi^2	The area defined between Peddocks Island and Windmill Point; from Windmill Point southeast to Bumkin Island; from Bumkin Island southeast to Sunset Point; from Sunset Point across the mouth of the Weir River to Worlds End; from Worlds End across the mouth of Hingham Harbor to Crow Point; from Beach Lane, Hingham across the mouth of the Weymouth Back River to Lower Neck; and from Lower Neck midway across the mouth of the Weymouth Fore River
MA70-09	Hull Bay	2.3 mi^2	The area defined east of a line from Windmill Point to Bumpkin Island and from Bumpkin Island to Sunset Point, Hull
MA70-01	Boston Harbor	23 mi^2	The area extending into Massachusetts Bay from the line between Fort Dawes on Deer Island to The Graves, and from The Graves south to Point Allerton; across the mouths of Quincy and Dorchester bays, Boston Inner Harbor and Winthrop Bay (including Presidents Roads and Nantasket Roads)

Table 4-5. Weir & Weymouth Sub-basin Pathogen Impaired Segments (adapted from MADEP 2002a and MassGIS 2005).

Segment ID	Segment Name	Segment Size	Segment Description
MA74-06	Cochato River	4 mi	Outlet Lake Holbrook to confluence with Farm and Monatiquot rivers, Braintree
MA74-08	Monatiquot River	4.3 mi	Headwaters at confluence of Cochato and Farm river, Braintree to confluence with Weymouth Fore River at Route 53, Braintree
MA74-09	Town Brook	3.5 mi	Outlet Old Quincy Reservoir, Braintree to confluence with Town River, north of Route 3A, Quincy (includes the “Canal”)
MA74-15	Town River Bay	0.5 mi^2	From the headwaters at the Route 3A bridge in Quincy, to its mouth at the Weymouth Fore River between Shipyard and Germantown Points, Quincy
MA74-14	Weymouth Fore River	3.3 mi^2	Route 53, Braintree to mouth (eastern point at Lower Neck, Weymouth and western point at Wall Street on Houghs Neck, Quincy
MA74-03	Old Swamp River	4.4 mi	Headwaters just west of Pleasant Street and north of Liberty Street, Rockland to inlet Whitmans Pond, Weymouth
MA74-04	Mill River	3.5 mi	Headwaters, west of Route 18 and south of Randolph Street, Weymouth to inlet Whitmans Pond, Weymouth
MA74-05	Weymouth Back River	0.8 mi	Outlet Elias Pond to the old Bay Colony Railroad tracks, Weymouth
MA74-13	Weymouth Back River	1.9 mi^2	Old Bay Colony Railroad tracks, Weymouth to mouth between Lower Neck to the west and Wompatuck Road, Hingham
MA74-02	Weir River	2.8 mi	Headwaters at confluence of Crooked Meadow River and Fulling Mill Brook, Hingham to Rockland Street, Hingham
MA74-11	Weir River	1.0 mi	Rockland Street and outlet Straits Pond, Hingham to mouth at Worlds End, Hingham/Hull

Table 4-6. Mystic River Sub-basin Pathogen Impaired Segments (adapted from MADEP 2002a and MassGIS 2005).

Segment ID	Segment Name	Segment Size	Segment Description
MA71-01	Aberjona River	9.2 mi	Source just south of Birch Meadow Drive in Reading to inlet Upper Mystic Lake, at Mystic Valley Parkway, Winchester
MA71-04	Alewife Brook	2.25 mi	Outlet of Little Pond, Belmont to confluence with Mystic River, Arlington/Somerville
MA71-05	Malden River	1.9 mi	Headwaters, south of Exchange Street, Malden to confluence with Mystic River, Everett/Medford
MA71-02	Mystic River	5.4 mi	Outlet Lower Mystic Lake, Arlington/Medford to Amelia Earhart Dam, Somerville/Everett
MA71-06	Chelsea River	0.5 mi^2	Confluence with Mill Creek, Chelsea/Revere, to confluence with Mystic River, Chelsea/East Boston/Charlestown
MA71-03	Mystic River	0.7 mi^2	Amelia Earhart Dam, Somerville to confluence with Chelsea River, Chelsea/East Boston (includes Island End River)
MA71-07	Mill Brook	2.8	Outlet of Arlington Reservoir to inlet of Lower Mystic Lake, Arlington (portions culverted underground)
MA71014	Ell Pond	22.4 acres	Melrose
MA71021	Judkins Pond	6 acres	Winchester
MA71-31	Mill Pond	2 acres	Winchester

Data from the Massachusetts Division of Marine Fisheries (DMF) were used, in part, as the basis for pathogen impairment for many of the estuarine areas (Figure 1-1). Numerous samples have been collected throughout the Boston Harbor watershed by the DMF. DMF has a well-established and effective shellfish monitoring program that provides quality assured data for each shellfish growing area. In addition, each growing area must have a complete sanitary survey every 12 years, a triennial evaluation every three years and an annual review in order to maintain a shellfishing harvesting classification with the exception of those areas already classified as Prohibited. The National Shellfish Sanitation Program establishes minimum requirements for sanitary surveys, triennial evaluations, annual reviews and annual fecal coliform water quality monitoring and includes identification of specific sources and assessment of effectiveness of controls and attainment of standards. “Each year water samples are collected by the DMF at 2,320 stations in 294 growing areas in Massachusetts's coastal waters at a minimum frequency of five times while open to harvesting” (DMF 2002). Due to the volume of data collected by the DMF, only a small sub-set of these data are provided herein. For the most recent indicator bacteria sampling data, please contact your local city or town shellfish constable or DMF's Shellfish Project.

Data for each impaired segment are summarized in a narrative or presented in tables. The summary data tables for each segment contain the data source and the dates data were collected (i.e., MyRWA 2001-2002). Depending on the information available, the tables may display different fields.

Data tables may contain:

- “Site Description” – column provides a short narrative description of the sampling location
- “Geometric Mean” – column provides the geometric mean for the samples collected
- “Min” – provides the minimum value reported
- “Max” – provides the maximum value reported
- “n” – provides the number of samples collected at that site over the time frame

Some tables have additional columns. The column entitled “# Samples >*Threshold* cfu/100 mL” provides the number of samples exceeding an established threshold. “Percent greater than *Threshold* cfu/100 mL” columns provide the percentage of samples exceeding an established threshold. Thresholds are generally 400, 2000 or 4000 cfu/100mL. These thresholds are established by the MADEP and correspond to primary and secondary contact recreation use criteria established in the MADEP WQA (see MADEP WQA for additional information). In some instances, agencies reported information just on the primary contact season (April 1 through October 15), which is either indicated as part of the site description or is displayed in a row above the columns where only the primary contact season information is provided. This TMDL was written based on the current WQS using fecal coliform as an indicator organism, however, enterococci and *E. coli* data are provided when available. The MADEP is in the process of developing new WQS incorporating *E. coli* and enterococci as indicator organisms.

Data summarized in the following subsections can be found at:

- **MyRWA** – downloaded from the Mystic River Watershed Association (MyRWA) website (http://www.mysticriver.org/) under research and then online data sources Mystic Monitoring Network (MMN).
- **MADEP WQA** – Boston Harbor 1999 Water Quality Assessment Report available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm. Includes data from MyRWA, United States Geological Survey (USGS), and Massachusetts Water Resources Authority (MWRA).
- **EMPACT** – The Environmental Monitoring for Public Access and Community Tracking (EMPACT) project data downloaded from the Mystic River Watershed Real-Time Water Quality Monitoring Website (www.mysticriveronline.org).

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.

An overview of the Boston Harbor 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 above listed sources were reviewed and are summarized by segment below for illustrative purposes.

The purpose of this section of the report is to briefly describe the impaired waterbody segments in the Boston Harbor watershed. For more information on any of these segments, see the "*Boston Harbor 1999 Water Quality Assessment Report*" on the MADEP website: http://www.mass.gov/dep/brp/wm/wqassess.htm

4.1. Boston Harbor Proper Sub-basin

Winthrop Bay Segment MA70-10

This 1.5 square mile Class SB, Shellfishing Restricted segment extends from the tidal flats at Coleridge Street in East Boston to a line between Logan International Airport and Point Shirley, East Boston/Winthrop. The MADEP WQA lists no regulated water withdrawals or NPDES permitted wastewater discharges in this segment. The Atlantis Marina is a vessel pump-out facility located within this segment. There are several storm water discharges in this segment. Logan MassPort has an individual storm water permit for four major storm water outfalls, which discharge to this segment. All communities in this segment's drainage area are required to apply for Phase II National Pollutant Discharge Elimination System (NPDES) storm water general permits for their municipal separate storm sewer system (MS4).

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Restricted for 0.62 square miles; Prohibited for 0.88 square miles (Figure 2-1).

The MWRA collected fecal coliform data as part of their Combined Sewer Overflow (CSO) monitoring program between 1998 and 2000 (MADEP 2002a). Results of this sampling are provided in Table 4-7. The MWRA also collected daily fecal coliform samples between June 12, 1996 and September 3, 2000 at three stations (Table 4-7 and 4-8) (MADEP 2002a).

Table 4-7. MA70-10 Winthrop Bay Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL
	cfu/100mL			
MWRA 1998-2000				
Station 130-Winthrop Harbor	<5	1,250	249	4 (1.6%)
MWRA 6/96-9/00				
Three Stations on Constitution Beach	<5	61,600	1049	see Table 4-8

Table 4-8. Constitution Beach Fecal Coliform Data Summary (collected by MWRA) (from MADEP 2002a).

Station	Percent greater than 400 cfu/100mL	Percent greater than 2000 cfu/100mL	Percent greater than 4000 cfu/100mL
MDC16 (n=349)	9%	3%	2%
MDC17 (n=350)	9%	2%	1%
MDC18 (n=350)	9%	1%	1%

<u>Boston Inner Harbor Segment MA70-02</u>

This 2.3 square mile Class SB, Combined Sewer Overflow (CSO) segment extends from Chelsea/Boston to East Boston/Boston. The segment includes the waters from the Mystic and Chelsea rivers to a line drawn from Governors Island to Fort Independence. Fort Point and Reserved channels and Little Mystic River are also included in this segment. The MADEP WQA lists no regulated water withdrawals in this segment. The following are permitted NPDES discharges include 36 CSO outfalls from the following: Massachusetts Water Resource Authority (MWRA), Boston Water & Sewer Commission (BWSC), and the City of Chelsea. In addition to CSO discharges, the following companies and organizations are permitted to discharge wastewater:

1. Gillette Company-Safety Razor Division is permitted to discharge non contact cooling water;
2. Massachusetts Bay Transit Authority (MBTA) - South Boston Piers/Transitway Project discharges construction dewatering via eight outfalls;
3. Coastal Oil N.E. Inc is permitted to discharge treated groundwater and storm water to the Reserved Channel;
4. New England Aquarium is permitted to discharge treated effluent; and
5. Seaboard Enterprises Inc

6. Boston Shipyard, and
7. U.S. Navy Department Supervisor of Ships

There are four vessel sewage pump-out facilities located within this segment: Boston Waterboat Marina, Long Wharf, Constitution Marina, Shipyard Quarters Marina, and Marina at Rowes Wharf. All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4. The separate storm drainage system serving the City of Boston is operated by the BWSC. The system has 104 major outfalls and 102 lesser outfalls, serving 13.85 square miles (not all discharging to this segment). The rest of the City is serviced by CSOs. According to the MADEP WQA, other state agencies operating public storm drains, including the Massachusetts Department of Public Works (DPW), Massachusetts Turnpike Authority (MTA), and the Metropolitan District Commission (MDC), are required to obtain NPDES storm water permits.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Prohibited (Figure 2-1).

The MWRA collected fecal coliform data as part of their CSO monitoring program between 1996 and 2000 (MADEP 2002a). Results of this sampling are provided in Table 4-9.

Table 4-9. MA70-02 Boston Inner Harbor Fecal Coliform Data Summary

Site Description	Min	Max	n	# Samples >400 cfu/100mL
	cfu/100mL			
MWRA 1996-2000				
Near New England Aquarium	<5	9,160	376	20 (5%)
Mouth of the Inner Harbor	<5	5,600	375	10 (3%)

Pleasure Bay Segment MA70-11

This is a 0.22 square mile Class SB Shellfishing Restricted segment in Boston. The segment is a semi-enclosed bay with two channels between Castle and Head Islands restricting flow. There are no regulated water withdrawals or wastewater discharges in this segment. The separate storm drainage system serving the City of Boston is operated by the BWSC. The system has 104 major outfalls and 102 lesser outfalls, serving 13.85 square miles (not all discharging to this segment). The rest of the City is serviced by CSOs. According to the MADEP WQA, other state agencies operating public storm drains, including the DPW, MTA, and the MDC, are required to obtain NPDES storm water permits.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Management Closure (Figure 2-1).

The MWRA collected weekly fecal coliform data at two stations between 1996 and 2000 (MADEP 2002a). Results of this sampling are provided in Table 4-10.

Table 4-10. MA70-11 Pleasure Bay Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL
	cfu/100mL			
MWRA 1996-2000				
Pleasure Bay, Broadway	<5	1,440	183	5 (3%)

<u>**Dorchester Bay Segment MA70-03**</u>

This 4.6 square mile Class SB Shellfishing Restricted, CSO segment is located in Boston/Quincy. The segment includes the waters delineated by the mouth of the Neponset River and a line drawn between the south point of Thompson Island and Chapel Rocks. This segment has one vessel sewage pump-out facility located at Marina Bay. There are no regulated water withdrawals in this segment. The following are NPDES permitted discharges are located within this segment:

1. seven CSO outfalls discharge to areas adjacent to Carson and L Street Beaches;
2. the Fox Point CSO Treatment Facility and the Commercial Point CSO Treatment Facility are permitted to discharge combined sewage; and
3. the BWSC is permitted to discharge combined sewage via seven outfalls.

The separate storm drainage system serving the City of Boston is operated by the BWSC. The system has 104 major outfalls and 102 lesser outfalls, serving 13.85 square miles (not all discharging to this segment). The rest of the City is serviced by CSOs. According to the MADEP WQA, other state agencies operating public storm drains, including the DPW, MTA, and the MDC, are required to obtain NPDES storm water permits.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.52 square miles; Closed for Seasonal Management for 0.05 square miles; Prohibited for 4.03 square miles (Figure 2-1).

The MWRA collected fecal coliform data as part of their CSO monitoring program between 1996 and 2000 (MADEP 2002a). Results of this sampling are provided in Table 4-11. Additionally, the MWRA and MDC took weekly fecal coliform bacteria samples between 1996 and 2000 at bathing beaches in this segment (MADEP 2002a). Bacteria counts ranged from <5 to 47,200 cfu/100 mL for the 1,277 samples collected. Bacterial counts exceeded 4,000 cfu/100 mL on 12 occasions. Most of the exceedances were associated with wet weather. A summary of the bathing beach sampling is presented in Table 4-12 below.

Table 4-11. MA70-03 Dorchester Bay Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL	# Samples >4,000 cfu/100mL
	cfu/100mL				
MWRA 1996-2000					
Columbia Point/Savin Cove	<5	9,160	366	20 (5%)	1 (<1%)

Table 4-12. MA70-03 Dorchester Bay Fecal Coliform Data Summary for Bathing Beaches.

Station	n	Percent >400 cfu/100mL	Percent >2,000 cfu/100mL	Percent >4,000 cfu/10 mL
Carson Beach, M St.	355	3	<1	0
Carson Beach, I St.	353	7	<1	<1
Carson Beach Bathhouse	354	7	2	2
Malibu Beach Bathhouse	81	12	5	1
Savin Hill Beach Bayside	77	13	5	4
Beades Bridge	57	12	5	0

<u>Quincy Bay Segment MA70-04</u>

This 1.0 square mile segment is a Class SA, Shellfishing Open, CSO waterbody in Quincy. The segment extends from Bromfield Street near the Wallaston Yacht Club northeast to N42.2781 W70.9941, southeast to N42.2735 W70.9678, and south to Newton Street on the northerly shore of Houghs Neck. There are no regulated water withdrawals or NPDES permitted wastewater dischargers on this segment. All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.36 square miles; Prohibited for 0.64 square miles (Figure 2-1).

The MWRA sampled fecal coliform at one location on this segment between 1996 and 2000 (MADEP 2002a). Results are summarized in Table 4-13 below.

Table 4-13. MA70-04 Quincy Bay Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL	# Samples >4,000 cfu/100mL
	cfu/100mL				
MWRA 1996-2000					
Off Merrymount Park	<5	11,100	374	23 (6%)	2 (<1%)

<u>Quincy Bay Segment MA70-05</u>

This 4.7 square mile Class SB, Shellfishing Restricted, CSO segment is located in Quincy. This segment is north of segment MA70-04 and extends to a line drawn between Moon Head and Nut Island. There are no regulated water withdrawals for this segment. All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.2 square miles; Prohibited for 4.5 square miles (Figure 2-1).

The MWRA sampled fecal coliform at two locations in this segment between 1996 and 2000 (MADEP 2002a). Results are presented in Table 4-14 below. Additionally, the MWRA took weekly fecal coliform bacteria samples between June 12, 1996 and September 21, 2000 at Wollaston Beach within this segment (MADEP 2002a). Bacteria counts ranged from <5 to 66,000 cfu/100 mL for the 1,605 samples collected. Fecal coliform counts exceeded 4,000 cfu/100 mL for 49 samples. Most of the exceedances were not associated with wet weather. A summary of the bathing beach sampling is presented in Table 4-15 below.

Table 4-14. MA70-05 Quincy Bay Fecal Coliform Data Summary.

Site Description	Min (cfu/100mL)	Max (cfu/100mL)	n	# Samples >400 cfu/100mL	# Samples >4,000 cfu/100mL
MWRA 1996-2000					
Two stations: Wollaston Beach at Sachem St. and Hangmans Island	<5	7,100	512	16 (3%)	2 (<1%)

Table 4-15. MA70-05 Wollaston Beach in Quincy Bay Fecal Coliform Data Summary.

Station	n	Percent >400 cfu/100 mL	Percent >2,000 cfu/100 mL	Percent >4,000 cfu/100 mL
Milton St.	398	18	7	4
Sachem St.	402	22	8	4
Channing St.	404	23	6	3
Rice St.	401	23	6	3

<u>Hingham Harbor Segment MA70-08</u>

This 1.1 square mile Class SA Shellfishing Open segment is located in Hingham. Hingham Harbor is bounded by a line from Crow Point to Worlds End. There are no permitted water withdrawals or wastewater discharges on this segment. There is one vessel sewage pump-out facility located on Hingham Harbor. All communities in this sub-basin are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.49 square miles; Prohibited for 0.61 square miles (Figure 2-1).

<u>Hingham Bay Segment MA70-06</u>

This is a 1.0 square mile Class SB Shellfishing Restricted segment in Quincy. The segment is enclosed by lines connecting the area north of the mouth of the Weymouth Fore River to Nut Island then to Prince Head and then to Pig Rock. There are no regulated water withdrawals on this segment. The MWRA has NPDES permits to discharge wastewater from nine outfalls within this segment. The MWRA also maintains a storm water NPDES permit for emergency discharges. All communities in this segment’s drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Closed Seasonally for Management for 0.01 square miles; Prohibited for 0.99 square miles (Figure 2-1).

The MWRA collected fecal coliform bacteria samples from the Quincy Yacht Club, Red Buoy #2 between 1996 and 2000. All fecal coliform sample counts were below 5 cfu/100mL for this site (MADEP 2002a).

Hingham Bay Segment MA70-07

This is a 5.8 square mile Class SB Shellfishing Restricted segment between Peddocks Island and Windmill Point. The area is defined by lines from Windmill Point southeast to Bumkin Island, from Bumkin Island southeast to Sunset Point, from Sunset Point across the mouth of the Weir River to Worlds End, from Worlds End across the mouth of Hingham Harbor to Crow Point, from Beach Lane, Hingham across the mouth of the Weymouth Back River to Lower Neck, and from Lower Neck midway across the mouth of the Weymouth Fore River. There are no regulated water withdrawals or NPDES permitted wastewater discharges in this segment. All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.15 square miles; Prohibited for 5.65 square miles (Figure 2-1).

The MWRA sampled fecal coliform at two locations in this segment between 1996 and 2000 (MADEP 2002a). Results are summarized in Table 4-16 below.

Table 4-16. MA70-07 Hingham Bay Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL	# Samples >4,000 cfu/100mL
	cfu/100mL				
MWRA 1996-2000					
Two stations	<5	4,400	485	12 (3%)	1* (<1%)

*Sample collected during wet weather.

Hull Bay Segment MA70-09

This is a 2.3 square mile Class SB, Shellfishing Restricted segment located in the Massachusetts Bay in that area defined as: between the west coastline of Hull and a line drawn from Winmill Point to Bumpkin Island to Sunset Point, Hull. There are no regulated water withdrawals or NPDES permitted wastewater discharges in this segment. All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.25 square miles; Prohibited for 2.05 square miles (Figure 2-1).

Boston Harbor Segment MA70-01

This is a 23 square mile Class SB Shellfishing Restricted segment. This Boston Harbor segment is in Massachusetts Bay and extends from the line between Fort Dawes on Deer Island to The Graves, and from The Graves south to Point Allerton, across Hull and West Guts; across the mouths of Quincy and Dorchester bays, Boston Inner Harbor and Winthrop Bay (including President Roads and Nantasket Roads). There are no regulated water withdrawals for this segment. The following have NPDES wastewater permits to discharge to Boston Harbor:

1. MWRA Deer Island Treatment Plant has several wastewater outfalls;
2. Sithe-New Boston Station has two condenser cooling water discharges;
3. Hull WWTP is permitted to discharge treated wastewater via one outfall.

All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4. The separate storm drainage system serving the City of Boston is operated by the BWSC. The system has 104 major outfalls and 102 lesser outfalls, serving 13.85 square miles (not all discharging to this segment). The rest of the City is serviced by CSOs. According to the MADEP WQA, other state agencies operating public storm drains, including the DPW, MTA, and the MDC, are required to obtain NPDES storm water permits.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.15 square miles; Closed for Seasonal Management for 4.63 square miles; Prohibited for 18.22 square miles (Figure 2-1).

The MWRA sampled fecal coliform at seven locations in this segment between 1996 and 2000 (MADEP 2002a). Results are summarized in Table 4-17 below.

Table 4-17. MA70-01 Boston Harbor Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL
	cfu/100mL			
MWRA 1996-2000				
Seven stations	<5	2,960	1,853	8 (<1%)

4.2. Weir & Weymouth Sub-basin

Cochato River Segment MA74-06

This is a 4 mile long Class B segment extending from Holbrook to Braintree. The segment begins at the outlet of Lake Holbrook and ends at its confluence with Farm and Monatiquot rivers. The Lake Holbrook Dam is located along this segment and is maintained by the Holbrook Conservation Commission. The Braintree Municipal Golf Course is permitted to withdraw water from an irrigation pond. There are no permitted NPDES wastewater discharges listed in the MADEP WQA for this segment. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

Monatiquot River Segment MA74-08

This is a 4.3 mile long Class B segment in Braintree. The segment begins at the confluence of Cochato and Farm rivers and ends at its confluence with Weymouth Fore River at Route 53. There are no permitted NPDES wastewater discharges or regulated water withdrawals listed in the MADEP WQA for this segment. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

The USGS collected wet and dry weather fecal coliform bacteria samples from the Monatiquot River for the Massachusetts Watershed Initiative MWI99-02 grant project in 1999 and 2000 (MADEP 2002a). Additionally, the Fore River Watershed Association (FRWA) collected fecal coliform bacteria samples from the Monatiquot River. Data from the USGS and FRWA samplings are summarized below in Table 4-18.

Table 4-18. MA74-08 Monatiquot River Fecal Coliform Data Summary.

					Primary Contact Season	
Site Description	Min (cfu/100mL)	Max (cfu/100mL)	n	# Samples >400 cfu/100mL	n	# Samples >400 cfu/100mL
USGS 1999-2000						
Commercial Street, East Braintree	270	4,800	10		7	5 (71%)
FRWA						
Shaw Street			18	8 (44%)		

Town Brook Segment MA74-09

This 3.5 mile long Class B segment extends from outlet of Old Quincy Reservoir in Braintree to its confluence with Town River, north of Route 3A (includes the "Canal") in Quincy. The Old Quincy Reservoir Dam is located on this segment. The brook is underground for approximately 2.6 miles from the Route 3 interchange in Braintree to Revere Road. There are no regulated water withdrawals listed in the MADEP WQA for this segment. The Massachusetts Bay Transit Authority (MBTA) Quincy Pump Station is permitted to discharge wet weather flow and groundwater to this segment. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

The USGS collected wet and dry weather fecal coliform bacteria samples from Town Brook for the Massachusetts Watershed Initiative MWI99-02 grant project between May 1998 and June 2000 (MADEP 2002a). Data from the USGS samplings are summarized below in Table 4-19.

Table 4-19. MA74-09 Town Brook Fecal Coliform Data Summary.

Site Description	Min (cfu/100mL)	Max (cfu/100mL)	n	# Samples >2,000 cfu/100mL	# Samples >4,000 cfu/100mL
USGS 1998-2000					
Downstream from Miller Stile Road	420	23,000	10	5 (50%)	1 (10%)

<u>Town River Bay Segment MA74-15</u>

This 0.5 square mile Class SA segment extends from its headwaters in Quincy at the Route 3A bridge to its mouth at the Weymouth Fore River between Shipyard and Germantown Points, also in Quincy. Two vessel sewage pump-out facilities are located on this segment: Bay Pointe Marina and Town River Yacht Club. There are no regulated water withdrawals listed in the MADEP WQA for this segment. Twin Rivers Technologies, L.P. discharge non-contact cooling water and boiler blow down via one outfall to this segment. Sprague Electric is permitted to discharge treated storm water runoff through one outfall. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.13 square miles; Prohibited for 0.37 square miles (Figure 2-1).

<u>Weymouth Fore River Segment MA74-14</u>

This 3.3 square mile Class SB, Shellfishing Restricted segment extends from Route 53 in Braintree to the river's mouth. The eastern point of the mouth is located at Lower Neck in Weymouth, and the western point of the mouth is located at Wall Street on Houghs Neck in Quincy. There are no regulated water withdrawals listed in the MADEP WQA for this segment. The following have NPDES permits to discharge to the Weymouth Fore River:

1. Twin Rivers Technologies, L.P. is permitted to discharge non-contact cooling water and storm water via one outfall to this segment;
2. the Fore River Station, a natural gas fired combined cycle power plant owned by Sithe Edgar Development, LLC, is permitted to discharge storm water; and
3. MWRA is permitted to discharge wastewater from construction site run-off and tunnel dewatering discharge generated during tunnel digging for the Nut Island Inter Island Tunnel.

All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.63 square miles; Management Closure for 0.11 square miles; Prohibited for 2.56 square miles (Figure 2-1).

As part of their receiving water monitoring program, the MWRA collected fecal coliform samples at site 116 Hingham Bay, mouth of Fore River, red Nun #28 between 1996 and 2000 (MADEP 2002a). Data from their sampling are summarized in Table 4-20 below.

Table 4-20. MA74-14 Weymouth Fore River Fecal Coliform Data Summary.

				Primary Contact Season			
Site Description	Min cfu/100mL	Max cfu/100mL	n	Min cfu/100mL	Max cfu/100mL	n	# Samples >400 cfu/100mL
MWRA 1996-2000							
Mouth of Fore River	<5	8,400	116	<5	2,560	69	5 (7%)

Old Swamp River Segment MA74-03

This 4.4 mile long Class A segment extends from its headwaters just west of Pleasant Street and north of Liberty Street in Rockland to the inlet to Whitmans Pond in Weymouth. The Weymouth DPW-Water Division is permitted to withdraw water from this segment. There are no NPDES wastewater discharge permits listed in the MADEP WQA for this segment. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

The USGS collected fecal coliform bacteria samples from Old Swamp River for the Massachusetts Watershed Initiative grant project between 1999 and 2000 (MADEP 2002a). Data from the USGS samplings are summarized below in Table 4-21.

Table 4-21. MA74-03 Old Swamp River Fecal Coliform Data Summary.

Site Description	Min	Max	n	# Samples >400 cfu/100mL
USGS 1999-2000				
USGS gage (01105600)	10	2,400	9	1 (11%)

Mill River Segment MA74-04

This 3.5 mile long Class A segment extends from the headwaters, west of Route 18 and south of Randolph Street, Weymouth to the inlet of Whitmans Pond, also in Weymouth. The Weymouth DPW-ter Division is permitted to withdraw water from this segment. There are no NPDES discharge permits listed in the MADEP WQA for this segment. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their municipal drainage systems.

Weymouth Back River Segment MA74-05

This 0.8 mile long Class B, warm water fishery, Outstanding Resource Water (ORW) segment is located in Weymouth. The river begins at the outlet of Elias Pond and extends to the old Bay Colony Railroad tracks. There are no permitted water withdrawals or wastewater discharges listed for this segment in the MADEP WQA. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

USGS collected fecal coliform bacteria samples during both wet and dry weather from their gage located on this segment for the Massachusetts Watershed Initiative grant project between 1999 and 2000 (MADEP 2002a). Data from the USGS samplings are summarized below in Table 4-22.

Table 4-22. MA74-05 Weymouth Back River Fecal Coliform Data Summary.

Site Description	Min (cfu/100mL)	Max (cfu/100mL)	n	# Samples >400 cfu/100mL	# Samples >2,000 cfu/100mL	# Samples >4,000 cfu/100mL
USGS 1999-2000						
Downstream from Broad Street, East Weymouth	40	28,000	10	7 (70%)	4 (40%)	3 (30%)

Weymouth Back River Segment MA74-13

This 1.9 square mile Class SA Shellfishing Open segment extends from Weymouth to Hingham. The segment begins at the Old Bay Colony Railroad tracks and continues to the river's mouth between Lower Neck to the west and Wompatuck Road. There are no permitted water withdrawals or wastewater discharges listed for this segment in the MADEP WQA. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.83 square miles; Prohibited for 1.07 square miles (Figure 2-1).

As part of their receiving water monitoring program, the MWRA collected fecal coliform samples at one station downstream from Route 3A bridge between 1996 and 2000 (MADEP 2002a). Data from their sampling are summarized in Table 4-23 below.

Table 4-23. MA74-13 Weymouth Fore River Fecal Coliform Data Summary.

				Primary Contact Season			
Site Description	Min (cfu/100mL)	Max (cfu/100mL)	n	Min (cfu/100mL)	Max (cfu/100mL)	n	# Samples >400 cfu/100mL
MWRA 1996-2000							
Downstream from Route 3A bridge	<5	1,630	113	<5	635	66	1 (2%)

Weir River Segment MA74-02

This 2.8 mile long Class B segment extends from its headwaters at the confluence of Crooked Meadow River and Fulling Mill Brook in Hingham to Rockland Street, also in Hingham. Foundry Pond Dam is located on this segment. The Norwell Water Department and the Mass American Water Company- Hingham withdraw water from the Weir River. Merriman Inc. was permitted to discharge to this segment; however their site is now listed as a MADEP 21e hazardous waste site. All communities in this segment drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

The USGS collected fecal coliform bacteria samples from the Route 3A bridge located on this segment for the Massachusetts Watershed Initiative grant project between 1999 and 2000 (MADEP 2002a). Data from the USGS samplings are summarized below in Table 4-24.

Table 4-24. Ma74-02 Weir River Fecal Coliform Data Summary.

Site Description	Min	Max	n	Primary Contact Season # Samples >400 cfu/100mL
	cfu/100mL			
USGS 1999-2000				
Route 3A bridge, Hingham	25	570	10*	2 (20%)

Weir River Segment MA74-11

This 1.0 mile long Class SA shellfishing open segment extends from Rockland Street and the outlet of Straits Pond in Hingham to the river's mouth at Worlds End in Hingham/Hull. There are no permitted water withdrawals or wastewater discharges listed for this segment in the MADEP WQA. All communities in this segment's drainage area (excluding Boston) are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Conditionally Restricted for 0.52 square miles; Prohibited for 0.48 square miles (Figure 2-1).

4.3. Mystic River Sub-basin

Aberjona River Segment MA71-01

This 9.2 mile long Class B, warm water fishery, CSO segment extends from its source just south of Birch Meadow Drive in Reading to the inlet of the Upper Mystic Lake at Mystic Valley Parkway, Winchester. There are five permitted water withdrawers listed in the MADEP WQA for this segment: Winchester Water Department, Woburn Water Department, Kraft General Foods, Parkview Condominiums, and Winchester Country Club. Olin Chemical is permitted to discharge treated wastewater to Halls Brook, a tributary to the Aberjona River. All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

The Mystic River Watershed Association (MyRWA) Monitoring Network (MMN) monthly bacteria data for this segment are summarized along with data from segments MA71-02, MA71-04 and MA71-05 at the end of this subsection. Additional data for the Aberjona River can be obtained from the MyRWA website (http://www.mysticriver.org).

Alewife Brook Segment MA71-04

This 2.25 mile long Class B, warm water fishery extends from the outlet of Little Pond in Belmont to its confluence with the Mystic River in Arlington/Somerville. MWRA Deer Island WWTP discharges treated wastewater via an outfall and 15 CSOs into Alewife Brook, Inner Harbor, Mystic River, Charles River, and Dorchester Bay. Somerville previously discharged combined sewage through their six CSOs but have eliminated five. Cambridge discharges via seven CSOs into the brook. All communities in this segment's sub-basin are required to apply for Phase II NPDES storm water general permits for their MS4.

The MyRWA MMN monthly bacteria data for this segment are summarized along with data from segments MA71-01, MA71-02 and MA71-05 at the end of this subsection. Additional data for the Alewife Brook can be obtained from the MyRWA website (http://www.mysticriver.org). The USGS collected three samples from Alewife Brook at Broadway in 1999. The MWRA sampled four stations between 1996 and 2000. Results of the USGS and MWRA sampling are provided in Table 4-25. One station along Alewife Brook is monitored daily for enterococci during the summer months by the Tufts University's Civil and Environmental Engineering Department and the Tufts Watershed Center as part of the Environmental Monitoring for Public Access and Community Tracking (EMPACT) program (Table 4-25). Additional data from the EMPACT program are available on the worldwide web at www.mysticriveronline.org.

Table 4-25. MA71-04 Alewife Brook Indicator Bacteria Data Summary.

Site Description	Min	Max	n
	cfu/100mL		
USGS 1999	**Fecal Coliform**		
Broadway	900	17,000	3
MWRA1996-2000	**Fecal Coliform**		
Four stations on Alewife Brook	10	110,000	257*
EMPACT 5/03-8/03	**Enterococci**		
Broadway	7	12000	24

* 152 samples were above 400 cfu/100 during the Primary Contact Season

Malden River Segment MA71-05

This 1.9 mile long Class B, warm water fishery extends from its headwaters south of Exchange Street in Malden to its confluence with Mystic River in Everett/Medford. There are five facilities noted in the MADEP WQA as NPDES surface water dischargers: Rohm Technology Inc, AVCO Everett Lab/Textron, Gateway Condominiums, Wellington Business Center, and Imported Stone Inc. All communities in this segment’s drainage basin are required to apply for Phase II NPDES storm water general permits for their MS4.

The MyRWA MMN monthly bacteria data for this segment are summarized along with data from segments MA71-01, MA71-02 and MA71-04 at the end of this subsection. Additional data for the Malden River can be obtained from the MyRWA website (http://www.mysticriver.org).

Mystic River Segment MA71-02

This 5.4 mile long Class B warm water fishery CSO extends from the outlet of Lower Mystic Lake in Arlington/Medford to the Amelia Earhart Dam in Somerville/Everett. The Winchester Water Department is permitted to withdraw surface water from two reservoirs. Several CSO discharges exist in this segment. A description of each and on-going mitigative measures for these discharges are provided in the MADEP WQA (MADEP 2002a). All communities in this segment’s drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

The MyRWA MMN monthly bacteria data for this segment are summarized along with data from segments MA71-01, MA71-04 and MA71-05 at the end of this subsection. Additional data for the Mystic River can be obtained from the MyRWA website (http://www.mysticriver.org).

The USGS collected three dry weather samples from the Mystic River at Route 60 (MADEP 2002a). The MWRA sampled seven stations between 1996 and 2000 under both wet and dry conditions. Results of the USGS and MWRA sampling are provided in Table 4-26. Three stations along the Mystic River are monitored daily for enterococci during the summer months by the Tufts University's Civil and Environmental Engineering Department and the Tufts WaterSHED Center as part of the EMPACT program (Table 4-26). Additional data from the EMPACT program are available on the worldwide web at www.mysticriveronline.org.

Table 4-26. MA71-02 Mystic River Indicator Bacteria Data Summary.

				Primary Contact Season			
Site Description	**Min** cfu/100mL	**Max** cfu/100mL	**n**	**Min** cfu/100mL	**Max** cfu/100mL	**n**	**# Samples >400 cfu/100mL**
USGS 1999	**Fecal Coliform**						
Route 60	20	70	3				
MWRA 1996-2000	**Fecal Coliform**						
Seven stations	<5	30,400	732	<5	30,400	543	107 (20%)
EMPACT 5/03-8/03	**Enterococci**						
High Street	<5	1,300	22				
Boys and Girls Club	<1	>2,500	20				
Upstream of Amelia Earhart Dam	<1	390	21				

<u>Chelsea River Segment MA71-06</u>

This 0.5 square mile Class SB, CSO segment extends from the river's confluence with Mill Creek in Chelsea/Revere to its confluence with Mystic River in Chelsea/East Boston/Charlestown. There are several NPDES wastewater and storm water dischargers to this segment, including three CSOs in the City of Chelsea. A complete list of dischargers can be found in the MADEP WQA (MADEP 2002a). All communities in this segment's drainage area are required to apply for Phase II NPDES storm water general permits for their MS4.

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Prohibited (Figure 2-1).

The MyRWA MMN bacteria data for this segment are summarized along with data from segment MA71-03 at the end of this subsection. Additional data for the Chelsea River can be obtained from the MyRWA website (http://www.mysticriver.org).

Mystic River Segment MA71-03

This 0.7 square mile Class SB, CSO segment extends from the Amelia Earhart Dam in Somerville to confluence with Chelsea River in Chelsea/East Boston, and includes the Island End River. There are no regulated water withdrawals in this segment. There are several NPDES wastewater and storm water dischargers to this segment, including CSOs. A complete list of dischargers can be found in the MADEP WQA (MADEP 2002a).

DMF Designated Shellfish Growing Areas Status as of July 1, 2000: Prohibited (Figure 2-1).

The MyRWA MMN bacteria data for this segment are summarized along with data from additional segments at the end of this subsection. Additional data for the Mystic River can be obtained from the MyRWA website (http://www.mysticriver.org).

Mystic River Segments Not Discussed in the MADEP WQA

There are four segments that are not discussed in the *Boston Harbor Watershed 1999 Water Quality Assessment Report.* Since these segments are not discussed in the MADEP WQA, there is no information available such as withdrawal or discharges within the drainage areas of these segments. These segments include:

- Mill Brook (MA71-07)
- Ell Pond (MA71014)
- Judkins Pond (MA71021)
- Mill Pond (MA71-31)

The MyRWA MMN performed sampling in the Mill Brook (station MIB001) segment. Results of their sampling are provided in the following subsection "General Indicator Bacteria Data for the Mystic River Sub-basin" below.

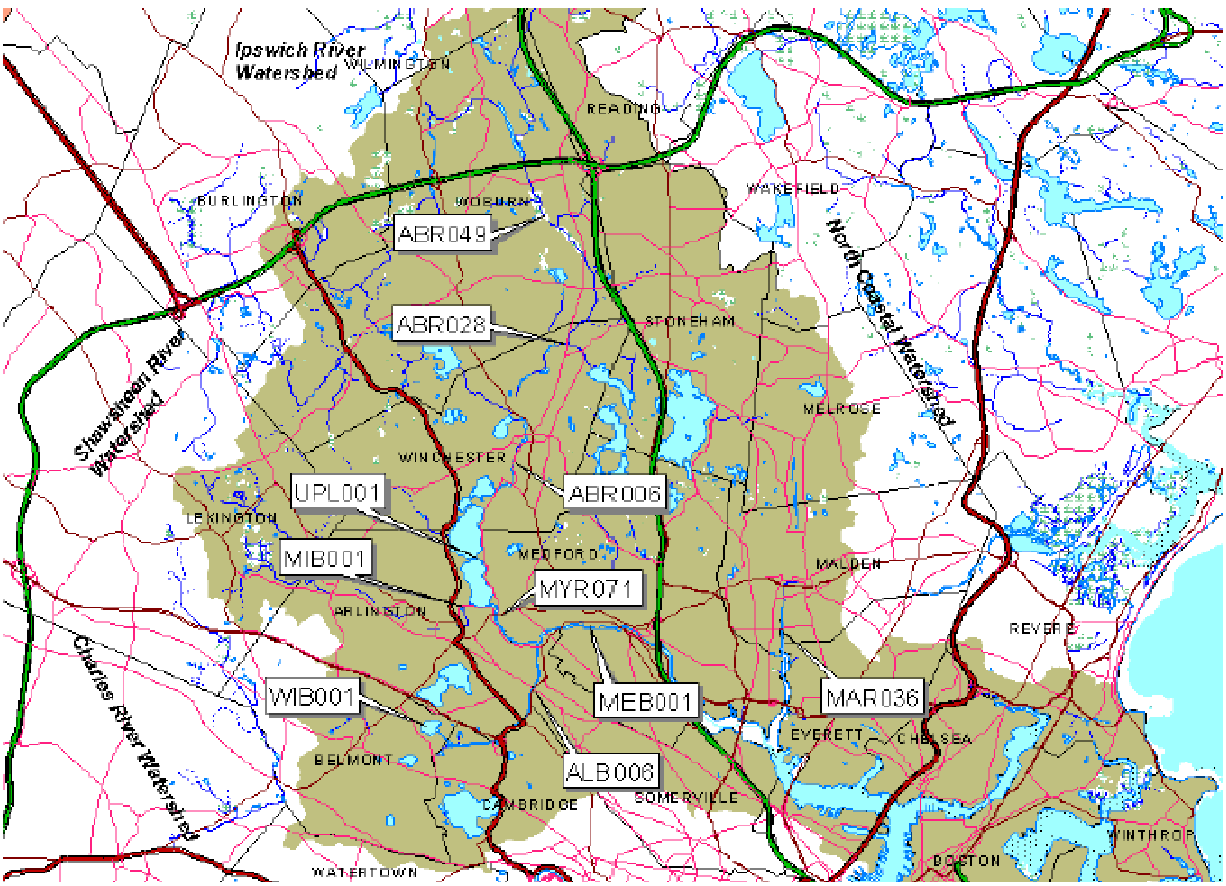
General Indicator Bacteria Data for the Mystic River Sub-basin

Monthly indicator bacteria monitoring was conducted by the MyRWA MMN from July 2000 to February 2002 and from June 2002 to March 2003. Sampling locations are provided on Table 4-27 and a sample location map is provided on Figure 4-1. Additional data for the Mystic River, tributaries and pipe discharges are available from the MyRWA on the worldwide web at http://www.mysticriver.org/research/.

Table 4-27. MyRWA MMN Sampling Locations (modified from MyRWA 2002).

Segment ID	MyRWA MMN Sample ID	Location Description
MA71-01 Aberjona River	ABR049	Aberjona River @ Salem St
MA71-01 Aberjona River	ABR028	Aberjona River @ Washington St
MA71-01 Aberjona River	ABR006	Aberjona River @ SGS Station
	UPL001	Upper Mystic Lake @ Dam
MA71-07 Mill Brook	MIB001	Mill Brook @ Mt Pleasant Cemetery
MA71-02 Mystic River	MYR071	Mystic River @ High St Bridge
	WIB001	Winn Brook, Outlet to Little Pond
MA71-04 Alewife Brook	ALB006	Alewife Brook @ Broadway
	MEB001	Meetinghouse Brook outlet to Mystic River
MA71-05 Malden River	MAR036	Malden River @ Medford St

Figure 4-1. MyRWA MMN Sampling Locations Map (from MyRWA 2003).



MyRWA MMN sampling from the 2001-2002 survey was conducted primarily during dry weather. One day, May 22, 2002, was sampled under wet weather conditions. Precipitation occurred on the day prior to sampling of dry weather on several occasions (see the *Mystic Monitoring Network Yearly Review: Baseline Water Quality Data for the Watershed July 2000 – February 2002* report available on the worldwide web at http://www.mysticriver.org/ for additional details). Fecal coliform counts ranged from <10 to 38,900 cfu/100mL during the sampling period (Tables 4-28 and 4-29; Figure 4-2).

Table 4-28. MyRWA MMN 2000-2002 Fecal Coliform Sampling Results (units = cfu/100mL; from MyRWA 2002).

Date	ABR049	ABR028	ABR006	UPL001	MIB001	MYR071	WIB001	ALB006	MEB001	MAR036
7/12/00	950	710	440	40	935*	40	940	650	840	<10
8/9/00	2700	1050*	560	40	1800	80	160	810	2550*	210
9/13/00	500*	600	1800	20*	6700	40	10000	920	2200	940
10/11/00	180	210	150	10	400	210	350	3700	240	<10
11/8/00	160	100	95*	30	400	35*	<10	260	330	50
12/13/00	30	140	230	<10	1400	6400	<10	890*	190	No Data
2/14/01	1400	200	110	No Data	440	390	390*	990	80	~~55*~~
3/14/01	1500	1080	890	No Data	595*	420*	340	880	230	920
4/11/01	90*	50	55*	100	380	60	200	2700	40	200
5/9/01	330	135*	150	<10	220	10	2400	22800	70*	50
5/22/01 **WET**	340	350	330*	<10	1650*	10	17300	38900	2200	680
6/13/01	920	790	1170	10	1400	210	850	740*	480	4500
7/11/01	4500	2200	770	20	4100	110	1300	2400	2100	370
8/8/01	840	760	4900	50	1160	50	800	270	4100	360
9/12/01	690	470	340	<10	650	280	3400	1650*	3500	960*
10/10/01	240	220	95*	380	10400	110*	13100	280	320	<10
11/14/01	250	50	200	400*	110	<10	1400*	430	110	120
12/12/01	440*	<10	560	10	3600	20	9900	1310	150*	9700
1/9/02	610	390	350	10	1400	320	11900	1500	445*	1310
2/13/02	140*	690	255*	20	2000	120	1700	690	170	2800
Geometric Mean	452	285	344	26	1079	91	978	1266	430	285
Dry Geo. Mean	459	282	345	27	1055	103	841	1057	394	1325
Median	470	370	335	20	1280	95	1120	905	325	365

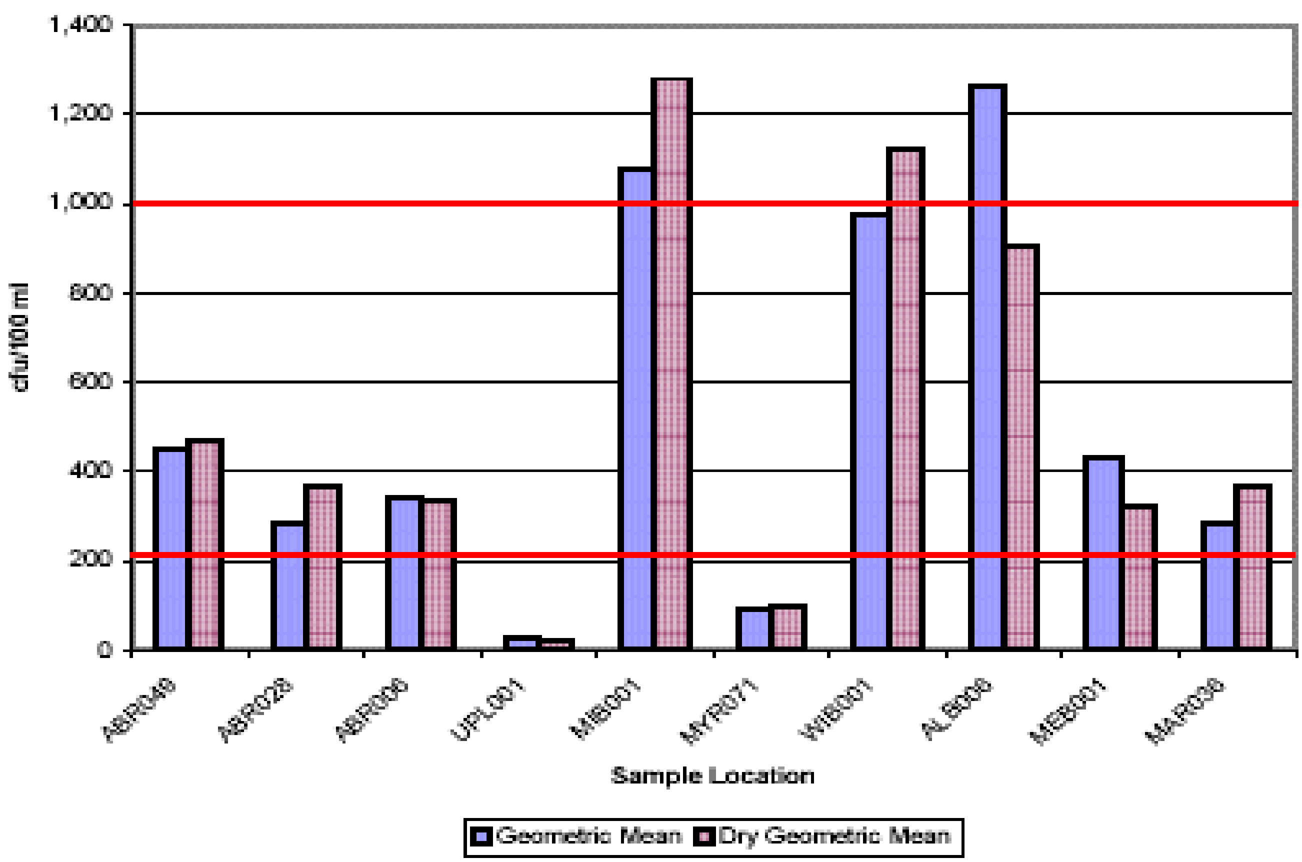
* average of two samples
strikethrough indicates result did not meet quality assurance standards
Exceeds the MA Surface Water Quality Standard for Primary Contact

To calculate averages and geometric means, results that were at the method detection limit (MDL), indicated by the < symbol, were treated as the lower reporting limit number, i.e. the number next to the < symbol.

Table 4-29. MyRWA MMN 2000-2002 Fecal Coliform Sampling Statistics and Primary and Secondary Contact Recreation Use Thresholds (units = cfu/100mL; from MyRWA 2002).

Site ID#	Site Description	Geometric Mean	Total # samples	# >400 cfu/100ml	% >400cfu/ 100ml	# >2000cfu/ 100ml	% >2000cfu/ 100ml
ABR049	Aberjona @ Salem St.	452	20	11	55%	2	10%
ABR028	Aberjona @ Washington St.	285	20	9	45%	1	5%
ABR006	Aberjona @ USGS station	344	20	8	40%	1	5%
UPL001	Upper Mystic Lake @ Mystic Lakes Dam	26	20	0	0%	0	0%
MIB001	Mill Brook @ Mt. Pleasant Cemetery	1079	20	15	75%	4	20%
MYR071	Mystic River @High St. Bridge	91	20	2	10%	1	5%
WIB001	Winn Brook, outlet to Little Pond	978	20	13	65%	7	35%
ALB006	Alewife Brook @ Broadway	1266	20	17	85%	5	25%
MEB001	Meetinghouse Brook, outlet into Mystic River	430	20	9	45%	6	30%
MAR036	Malden River @ Medford St.	285	19	8	42%	3	16%
	Indicates violation of MASWQS [Massachusetts Surface Water Quality Standards]						

Figure 4-2. MyRWA MMN Fecal Coliform Geometric Means (from MyRWA 2002).



MyRWA MMN sampling from the 2002-2003 survey was conducted primarily during dry weather. Two wet weather events were sampled during this survey (July 10, 2002 and November 13, 2002). Precipitation statistics during the survey are provided in the *Mystic Monitoring Network Report 2002-2003* available on the worldwide web at http://www.mysticriver.org/. *E. coli* counts ranged from <10 to 107,000 cfu/100mL (Tables 4-30 and 4-31; Figure 4-3). A summary of the two surveys is provided in Table 4-32.

Table 4-30. MyRWA MMN 2002-2003 *E. coli* Sampling Results (units = cfu/100mL; from MyRWA 2003).

Sample Date	ABR049	ABR028	ABR006	UPL001	MIB001	MYR071	WIB001	ALB006	MEB001	MAR036
6/12/02	580	530*	330	80	1,745*	770	1,500	470	640	550
7/10/2002 **wet**	28,800	8,900	107,000*	290	17,100	720	5,100	10,200	~~1,605*~~	71,000
8/14/02	540	480	120	<10	1,600	55*	1,480*	260	2,200	160
9/11/02	495*	190	300	<10	1,030	40	660	455*	550	20
10/9/02	1,900	1,800	470*	<10	2,700	40	1,000	200	330	49,000
11/13/2002 **wet**	18,000	8,500*	4,900	320	5,500	2,100	4,800	16,500*	1,500	6,800
12/11/02	40	250	290	<10	1,560	20	630	520	310*	1,130*
1/8/03										
3/12/03	60	220*	780	No Data	190	40	6,900	155	10	50
Geometric mean	*1,295*	*1,074*	*977*	*36*	*2,733*	*154*	*1,561*	*996*	*701*	*1,734*
Dry Geometric mean	*298*	*411*	*329*	*15*	*1,149*	*62*	*1,361*	*311*	*304*	*412*
Median	*560*	*505*	*400*	*10*	*1,673*	*48*	*1,490*	*463*	*595*	*840*

Violation of Minimum Standards for Bathing Beaches, 105 CMR 445.000

* average of two samples
Strikethrough indicates result did not meet quality assurance standards and was discarded.
Discarded results are not included in averages or other statistical calculations.

Table 4-31. MyRWA MMN 2002-2003 *E. coli* Sampling Statistics and Primary and Secondary Contact Recreation Use Thresholds (units = cfu/100mL; from MyRWA 2003).

Site ID#	Site Description	Geometric Mean	Total # samples	# >400 cfu/100ml	% >400cfu/ 100ml	# >2000cfu/ 100ml	% >2000cfu/ 100ml
ABR049	Aberjona @ Salem St.	1,295	8	6	75%	2	25%
ABR028	Aberjona @ Washington St.	1,074	8	5	63%	2	25%
ABR006	Aberjona @ USGS station	977	8	4	50%	2	25%
UPL001	Upper Mystic Lake @ Mystic Lakes Dam	36	7	0	0%	0	0%
MIB001	Mill Brook @ Mt. Pleasant Cemetery	2,733	8	7	88%	3	38%
MYR071	Mystic River @High St. Bridge	154	8	3	38%	1	13%
WIB001	Winn Brook, outlet to Little Pond	1,561	8	8	100%	3	38%
ALB006	Alewife Brook @ Broadway	996	8	5	63%	2	25%
MEB001	Meetinghouse Brook, outlet into Mystic River	701	7	4	57%	1	14%
MAR036	Malden River @ Medford St.	1,734	8	5	63%	3	38%
	Total		78	47	60%	19	24%
	Indicates probable violation of MASWQS						

Figure 4-3. MyRWA MMN *E. coli* Geometric Means (from MyRWA 2003).

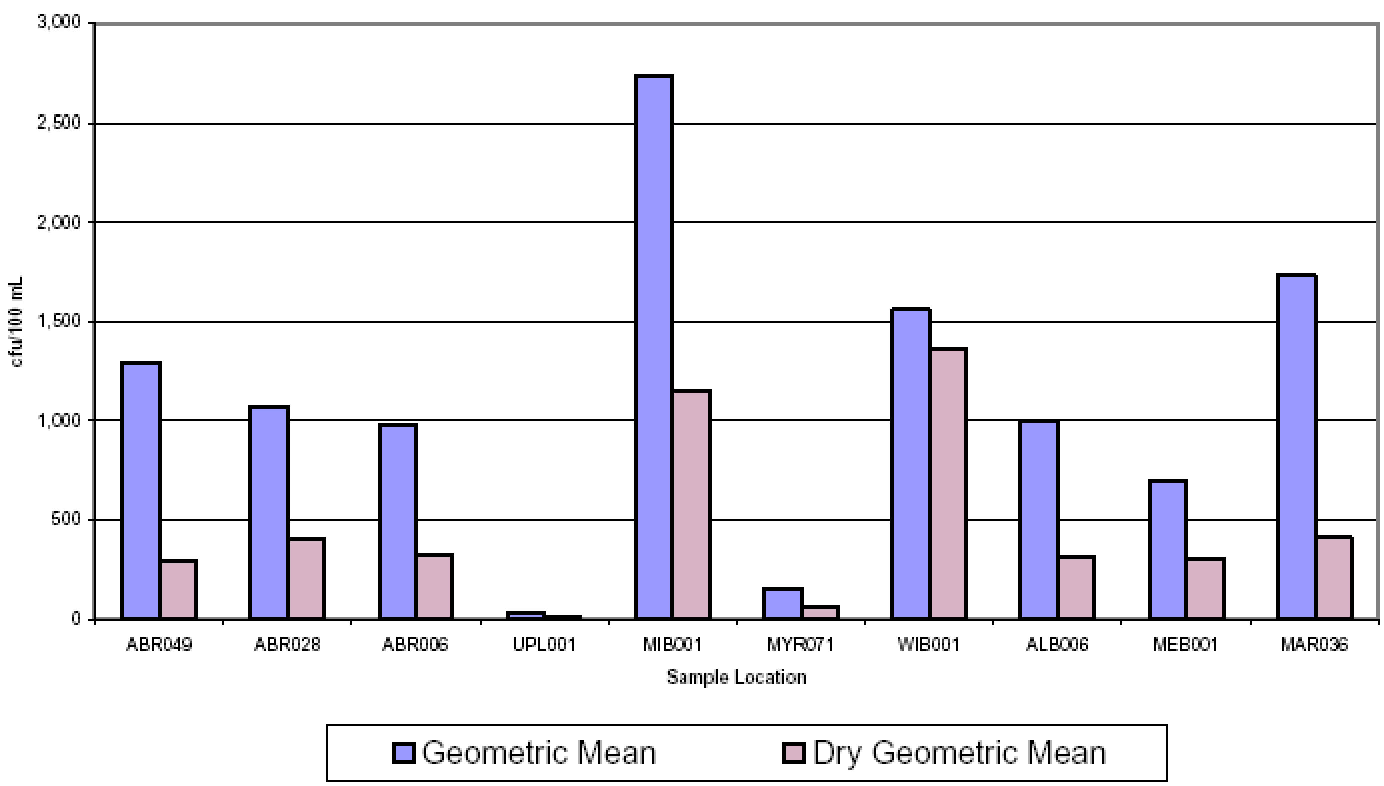


Table 4-32. MyRWA MMN Fecal coliform and *E. coli* Sampling Statistics (from MyRWA 2003).

Site ID	Location	July 2000 – February 2002 Geometric Mean for Fecal Coliform (cfu/100ml)	June 2002 – March 2003 Geometric Mean for *E. coli* (cfu/100ml)
ABR049	Aberjona @ Salem St.	452	1,295
ABR028	Aberjona @ Washington St.	285	1,074
ABR006	Aberjona @ USGS station	344	977
UPL001	Upper Mystic Lake @ Mystic Lakes Dam	26	36
MIB001	Mill Brook @ Mt. Pleasant Cemetery	1,079	2,733
MYR071	Mystic River @High St. Bridge	91	154
WIB001	Winn Brook, outlet to Little Pond	978	1,561
ALB006	Alewife Brook @ Broadway	1,266	996
MEB001	Meetinghouse Brook, outlet into Mystic River	430	701
MAR036	Malden River @ Medford St.	285	1,734

A lower Mystic River and tributary survey was conducted to identify areas of high indicator bacteria from outfall pipes in the saltwater section of the Mystic River. Nine pipes discharging to the Mystic River were sampled for enterococci on May 27, 2003 (MyRWA 2005a). Five of these sites contained concentrations in excess of the Massachusetts beach standards (Figure 4-4).

A Centerline Survey of Island End, Mystic and Malden Rivers was conducted by the MyRWA MMN on October 28, 2003 for *E. coli* (MyRWA 2005b). A graphical representation of these data is provided on Figure 4-5. The highest *E. coli* values were located in the Island End River and Malden River. Concentrations decreased at the confluence of these rivers with the Mystic River (Figure 4-5). The MyRWA suspects that this is due to mixing and dilution with the Mystic River.

Figure 4-4. MyRWA MMN Enterococci Results from the May 27, 2003 Lower Mystic River and Tributary Survey (from MyRWA 2005a).

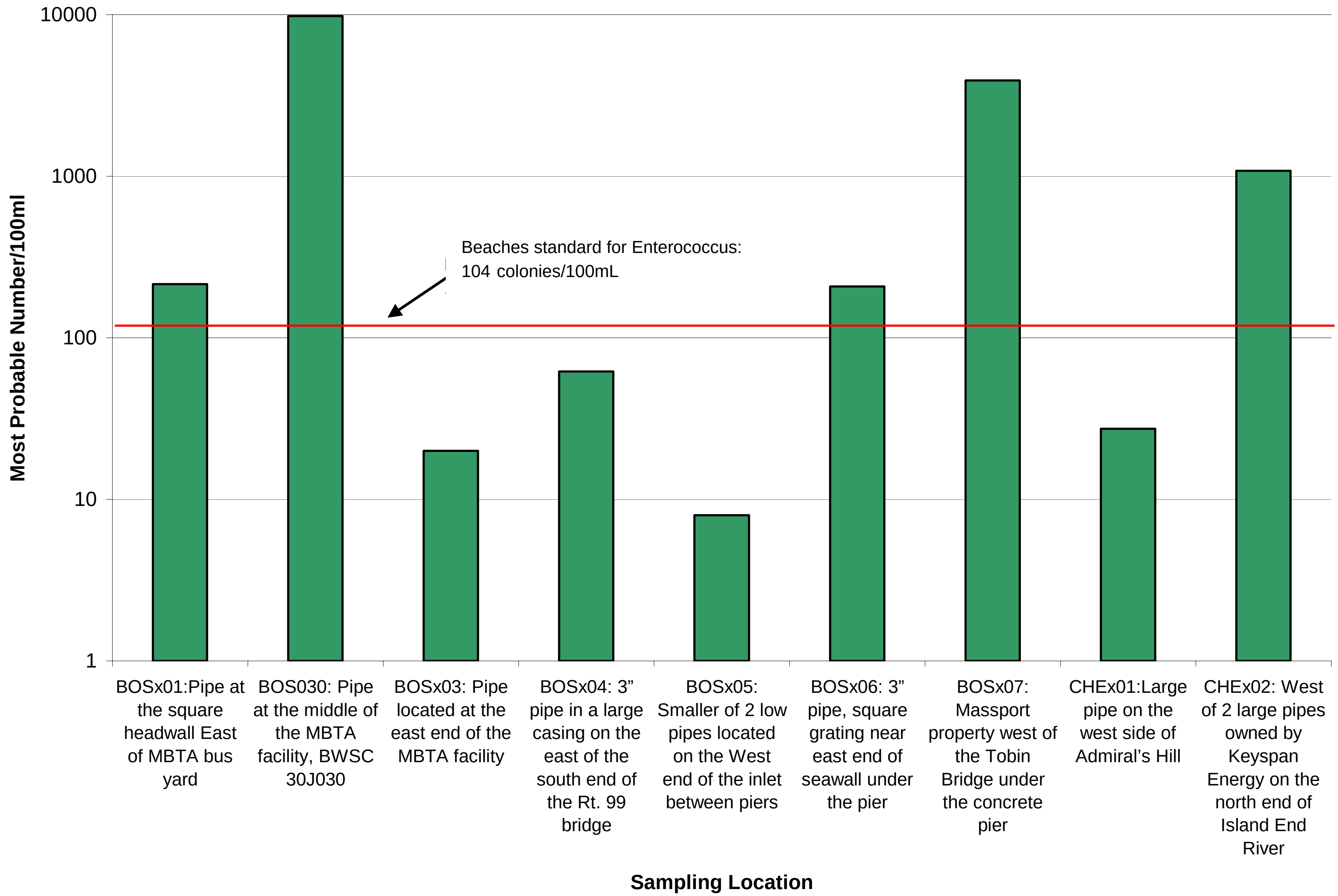
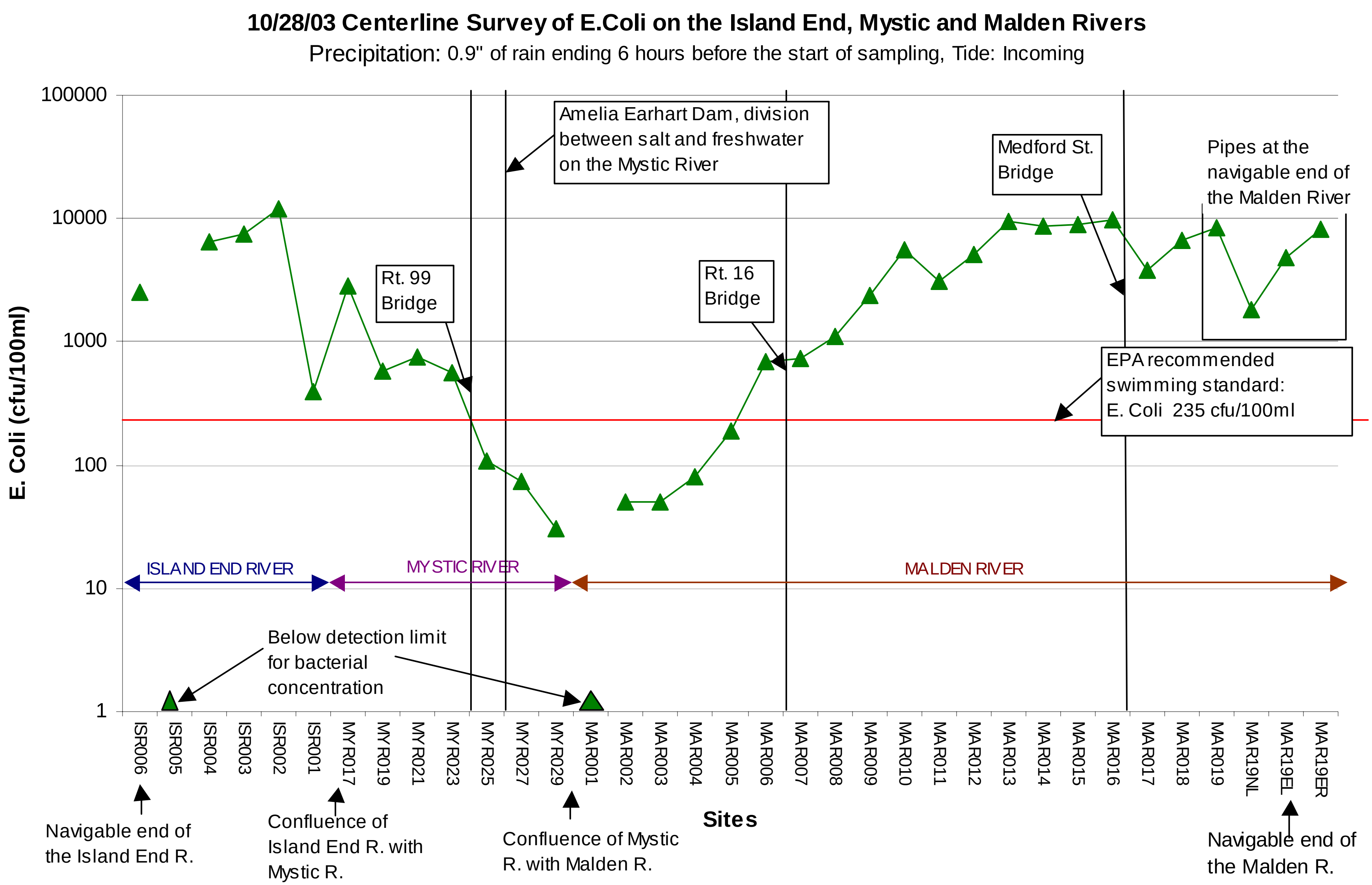


Figure 4-5. MyRWA MMN *E. coli* Results from the October 28, 2003 Centerline Survey (from MyRWA 2005b).



5.0 Potential Sources

The Boston Harbor watershed, excluding the Neponset sub-basin, has 32 segments that are listed as pathogen impaired requiring TMDLs. These segments represent 100% of the estuary area, 81.5% of the river miles, and 4.0% of the lake acres assessed in the Boston Harbor proper, Weir and Weymouth Rivers and Mystic River subwatersheds. Sources of indicator bacteria in the Boston Harbor watershed are many and varied. A significant amount of work has been done in the last decade to improve the water quality in the Boston Harbor watershed.

Largely through the efforts of the MWRA, DMF, BWSC, MyRWA and MADEP, numerous point and non-point sources of pathogens have been identified. Table 5-1 summarizes the impaired segments due to measured indicator bacteria densities and identifies some of the suspected and known sources identified in the WQA or by other organizations (e.g., MyRWA, BWSC, etc.).

Some dry weather sources include:

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

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 Boston Harbor 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 Table 5-2 and Table 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 MADEP 2002a).

Table 5-1. Some of the Potential Sources of Bacteria in Pathogen Impaired Segments in the Boston Harbor Watershed.

Segment ID	Segment Name	Potential Sources
Boston Harbor Proper Sub-basin		
MA70-10	Winthrop Bay	CSO, urban runoff/storm sewers
MA70-02	Boston Inner Harbor	Unknown
MA70-11	Pleasure Bay	Urban runoff/storm sewers
MA70-03	Dorchester Bay	CSO
MA70-04	Quincy Bay	Unknown
MA70-05	Quincy Bay	Urban runoff/storm sewers, municipal point source
MA70-08	Hingham Harbor	Unknown
MA70-06	Hingham Bay	Unknown
MA70-07	Hingham Bay	Unknown
MA70-09	Hull Bay	Unknown
MA70-01	Boston Harbor	Unknown
Weymouth and Weir Sub-basin		
MA74-06	Cochato River	Unknown
MA74-08	Monatiquot River	Unknown, urban runoff/storm sewers, municipal point source (SSO)
MA74-09	Town Brook	Unknown, urban runoff/storm sewers
MA74-15	Town River Bay	Unknown
MA74-14	Weymouth Fore River	Municipal Point source (SSO), urban runoff/storm sewers
MA74-03	Old Swamp River	Municipal point source (SSO), urban runoff/storm sewers
MA74-04	Mill River	Unknown
MA74-05	Weymouth Back River	Municipal point source (SSO), urban runoff/storm sewers
MA74-13	Weymouth Back River	Unknown
MA74-02	Weir River	Unknown
MA74-11	Weir River	Unknown
Mystic River Sub-basin		
MA71-01	Aberjona River	Illicit sewer connections, wildfowl
MA71-04	Alewife Brook	CSO, illicit sewer connections
MA71-05	Malden River	Unknown
MA71-02	Mystic River	CSO, urban runoff/storm sewers
MA71-06	Chelsea River	Urban runoff/storm sewers, industrial point sources, spills, CSO
MA71-03	Mystic River	CSO, urban runoff/storm sewers
MA71-07	Mill Brook	Unknown
MA71014	Ell Pond	Unknown
MA71021	Judkins Pond	Unknown
MA71-31	Mill Pond	Unknown

Most sources were identified in the MADEP WQA, although some sources have been identified by other organizations such as MyRWA.

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).

The Weymouth Fore River and Back River watersheds have chronic problems with SSOs in both their municipal sewer systems and the MWRA interceptor system. Hydraulic deficiencies in the systems, excessive amounts of infiltration and inflow in the municipal systems, and poor maintenance and operation have led to overflows into areas of public water supplies, shellfishing beds, and bathing beaches. In Weymouth between 1992 and March 1999, 530 overflow events occurred and flowed into Whitman's Pond, Mill River, Back River, Fore River, Old Swamp River, and other undetermined receiving waters. In Braintree between 1993 and 1999, 120 overflow events occurred and discharged to the Fore and Monatiquot River. The MWRA regional sewer system discharges overflows into the Fore River, Monatiquot River and Smelt Brook. The MWRA Smelt Brook Siphon overflows several times each year for periods up to 11 days because of excessive wet weather flows contributed by Weymouth, Braintree, Randolph, Holbrook, and Hingham.

The City of Chelsea discharges via four CSO locations to the Mystic River sub-basin. Six of the City of Somerville's CSO outfalls have been eliminated. The remaining two discharge to Alewife Brook and Mystic River. The City of Cambridge discharges via six CSO locations to Alewife Brook in the Mystic River sub-basin. The MWRA is permitted to discharge via four CSO locations to Boston Harbor, one CSO location to Alewife Brook, and two CSO locations to Mystic River. Boston Water and Sewer Commission (BWSC) are permitted to discharge via 53 CSO locations to the Boston Harbor sub-basin.

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 EPA, MWRA, the Boston Water and Sewer Commission (BWSC) and many communities throughout the commonwealth have been active in the identification and mitigation of these sources. It is estimated by EPA New England that over one million gallons per day (gpd) of illicit discharges were removed in the last decade. It is probable that numerous other illicit sewer connections exist in storm drainage systems serving the older developed portions of the Boston Harbor watershed.

Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Approximately 87.0 percent of the Boston Harbor watershed (including the Neponset River sub-basin) is classified as Urban Areas by the United States Census Bureau and is therefore subject to the Stormwater Phase II Final Rule 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. As a Phase I community, the City of Boston was required to apply for a NPDES storm water individual permit for their MS4. The BWSC operates the system and applied for the permit receiving it in 1999. The system has 104 major and 102 lesser outfalls.

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 pathogens in the Boston Harbor watershed. 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 bacterial 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 or tides is low.

Another potential source of pathogens is the discharge of sewage from vessels with onboard toilets. These vessels are required to have a marine sanitation device (MSD) to either store or treat sewage. When MSDs are operated or maintained incorrectly they have the potential to discharge untreated or inadequately treated sewage. For example, some MSDs are simply tanks designed to hold sewage until it can be pumped out at a shore-based pump-out facility or discharged into the water more than 3 miles from shore. Uneducated boaters may discharge untreated sewage from these devices into near-shore waters. In addition, when MSDs designed to treat sewage are improperly maintained or operated they may malfunction and discharge inadequately treated sewage. Finally, even properly operating MSDs may discharge sewage in concentrations higher than allowed in ambient water for fishing or shellfishing. Vessels are most likely to contribute to bacterial impairment in situations where large numbers of vessels congregate in enclosed environments with low tidal flushing. Many marinas and popular anchorages are located in such environments.

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. In 2000, the US Census reported that 589,141 people live in Boston. This translates to almost 60,000 dogs producing almost 30,000 pounds of feces per day in the City of Boston alone. 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 indicator 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 indicator bacterial loading from storm water and avoid overestimating or underestimating indicator 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 Massachusetts watersheds 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 2002c; 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 32 segments within the Boston Harbor watershed, excluding the Neponset River sub-basin, 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 and Class SB and SA areas not designated for shellfishing (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 Class SA open shellfish area surface waters (1) *the geometric mean of a representative set of fecal coliform samples shall not exceed 14 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 43 organisms per 100 mL.*

For Class SB open shellfish surface waters (1) *the geometric mean of a representative set of fecal coliform samples shall not exceed 88 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 260 organisms per 100 mL.*

For marine bathing beaches (BEACH Act standard) (1) *the geometric mean of a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period) shall not exceed 35 colonies per 100 mL* and (2) *no single enterococci sample shall exceed 104 colonies 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 several WWTPs and other NPDES-permitted wastewater discharges within the Boston Harbor watershed. 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 SA, Class SB, Class A and B segments within the Boston Harbor watershed. 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 several sets of WLAs and LAs, one for Class SA shellfish open waters, one for Class SB shellfish open waters, one for Class A waters, one for Class B and shellfish restricted Class SA and SB waters, one for no discharge areas, one for freshwater beaches, and one for marine 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 *Boston Harbor 1999 Water Quality Assessment Report*. 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.

Table 6-1. Indicator Bacteria Waste Load Allocations (WLAs) and Load Allocations (LAs) for the Boston Harbor 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, SA, SB	Illicit discharges to storm drains	0	N/A
A, B, SA, SB	Leaking sanitary sewer lines	0	N/A
A, B, SA, SB	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 & Not Designated for Shellfishing SA & SB	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 & Not Designated for Shellfishing SA & SB	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 & Not Designated for Shellfishing SA & SB	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 & Not Designated for Shellfishing SA & SB	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]
SA Designated Shellfishing Areas	NPDES – WWTP	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms[2]	N/A
SA Designated Shellfishing Areas	Storm water Runoff Phase I and II	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms[3]	N/A
SA Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms[3]
SB Designated Shellfishing Areas	CSOs	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[4]	N/A
SB Designated Shellfishing Areas	NPDES – WWTP	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[2]	N/A
SB Designated Shellfishing Areas	Storm water runoff Phase I and II	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[3]	N/A
SB Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms[3]
No Discharge Areas	Vessels – raw or treated sanitary waste	0	N/A
Marine Beaches[5]	All Sources	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies

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[6]	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] Federal Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act) Water Quality Criteria

[6] 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 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 32 pathogen impaired segments of the Boston Harbor 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 Boston Harbor 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 Boston Harbor 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 shellfish beds, 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 Boston Harbor watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the Boston Harbor 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, USEPA, MWRA, Save the Harbor/Save the Bay, MyRWA, BWSC, and MDC have 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 Boston Harbor 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 Boston Harbor 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/MyRWA, Massachusetts Community Water Watch (MCWW) Tufts Chapter
Development of comprehensive storm water management programs including identification and implementation of BMPs	Boston Harbor Communities
Illicit discharge detection and elimination	Boston Harbor Communities with MyRWA, MCWW Tufts Chapter
Leaking sewer pipes and sanitary sewer overflows	Boston Harbor Communities
CSO management	Boston Harbor Communities, BWSC, MWRA
Inspection and upgrade of on-site sewage disposal systems as needed	Homeowners and Boston Harbor Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	MADEP, MyRWA, BWSC, MWRA and Boston Harbor Communities
Organize and implement education and outreach program	MADEP, MyRWA and Boston Harbor Communities
Write grant and loan funding proposals	MyRWA and Boston Harbor 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 and MyRWA
Provide periodic status reports on implementation of remedial activities	EOEA, MyRWA

7.1. Summary of Activities within the Boston Harbor Watershed

There are several organizations focused on improving water quality within the Boston Harbor watershed, including the Mystic River Watershed Association (MyRWA), Tufts University, the Massachusetts Bays Program (MBP), Save the Harbor/Save the Bay, The Boston Harbor Association (TBHA), the Weir River Watershed Association (WRWA), and the Fore River Watershed Association (FRWA).

The MyRWA is a not-for-profit active steward of the Mystic River watershed. The MyRWA is a citizens group primarily focused on education, outreach, and water quality monitoring. The association has its own monitoring network (Mystic Monitoring Network (MMN)) supported by volunteers, which contributed much of the data displayed in the Mystic River sub-basin section of this report. The association has also encouraged the development of individual stream and river groups such as the Alewife/Mystic River Advocates, the Friends of the Mystic River, and the Alewife Brook/Little River Stream Team. These groups have been involved in shoreline surveys and water quality sampling. The Alewife Stream Team has also developed an Action Plan for the brook based on their shoreline survey that included noting land use, pipes, and odors potentially caused by sewage.

The MyRWA has formed a partnership with Tufts University to conduct research on the river and promote involvement from students at the university. Tufts has been able to secure grants for research on the Mystic River and has also planned classes incorporating issues surrounding the Mystic (Tufts Magazine 2003). The MyRWA, Tufts University, and the City of Somerville have also partnered to conduct real-time water quality monitoring in the Mystic River watershed. This project was started under an EPA program known as Environmental Monitoring for Public Access and Community Tracking (EMPACT) (USEPA 2004c).

The Massachusetts Bays Program (MBP) was established in 1988 with a scientific research focus to determine pollution problems in the Bays. A “Conference” of individuals from federal, state, and local government agencies, regional planning agencies, user groups, public and private institutions, and the public gathered to evaluate the research and worked together to create the Comprehensive Conservation Management Plan (CCMP). Completed in 1996, the CCMP details 15 major Action Plans with 72 specific action items. Since completion of the CCMP, the program’s focus has switched to implementing the plan. The program employs regional staff in five regions, one being Metro Boston. Regional staff lead Local Governance Committees (LCGs), made up of appointed members from each community in the region. The LCGs are focused on identifying needs in the region and implementing the CCMP. The MBP works closely with municipalities and often assists them in seeking funds and passing by-laws. The MBP is also focused on educating the local officials through technical workshops. The MBP provides training for volunteers to monitor storm water outfalls, and swimming beaches (EOEA 2003).

Save the Harbor/Save the Bay is focused on restoring and protecting Boston Harbor and Massachusetts Bay. Save the Harbor/Save the Bay aims to inform the public on the state of the harbor’s water quality, beaches, and waterfront. The organization also strives to educate and encourage the next generation of Stewards. Recent projects include educating the public on beach closings and the reasons behind them, formulating a plan to improve the Fort Point Channel to enable the public to use it for recreational purposes, and keeping the public informed about water quality issues relating to the outfall pipe in Massachusetts and Cape Cod Bays (Save the Harbor/Save the Bay 2005).

The Boston Harbor Association (TBHA) is focused on monitoring water quality in the harbor and restoring the harbor's beaches. The TBHA publishes a quarterly newsletter called "Harbor News", which gives members updates on water quality improvements and the association's programs. Promoting education and involvement in the community is of high importance to TBHA. TBHA offers several free educational programs for youths teaching students about water quality and pollution. Each year, over 1,200 high school students are taught about the Boston Harbor Project and career opportunities in the environmental and maritime fields through TBHA programs. TBHA has:

- published a Boston Harbor Curriculum Guide for middle school science teachers,
- hosted lecture series open to the public focusing on water quality and beaches,
- offered free Boston Harbor boat cruises open to the public providing speakers discussing water quality issues while cruising,
- written columns for Banker & Tradesman on issues affecting the harbor, and
- been involved in preparing a report on water quality improvements on Wollaston Beach and educating the public on beach water quality (TBHA 2004).

The Weir River Watershed Association (WRWA) promotes awareness and stewardship of the watershed. The WRWA is focused on gathering data through monitoring programs, conducting local projects to improve water quality, reporting findings on the state of the watershed to the public, governmental agencies, and others, and building partnerships with schools, businesses, community groups, and government agencies (WRWA 2005).

The Fore River Watershed Association's (FRWA) mission is to "promote, protect, restore, enhance and improve the water quality, natural resources, cultural sites, and recreational opportunities of the Fore River watershed" (FRWA 2004). The FRWA conducts shoreline and land use surveys of the river corridor, conducts a long-term water quality monitoring program, implements water quality improvement programs, educates the public, conducts river cleanups, offers educational and recreational programs for community outreach, monitors government activities, advocates the protection of open space, and works with government agencies and the public to promote more involvement.

The Neponset River Watershed Association, University of Massachusetts, Urban Harbors Institute, Boston Harbor Association, Fore River Watershed Association, and Weir River Watershed Association has prepared a "*Boston Harbor South Watersheds 2004-2009 Action Plan"* (NRWA et al. 2004). The Action Plan focuses on:

1. Sewer system improvements
2. Storm water management and groundwater recharge
3. Septic management
4. Management of landscaped areas

5. Water supply and streamflows
6. Riverine habitat
7. Public access to waterways
8. Watershed assessment
9. Boating initiatives
10. Financing, regional collaboration, and adapting to local conditions

Items relating to water quality improvements such as sewer system improvements, storm water management, and septic management make up a large portion of the action items in the "Common Action Plan for all Boston Harbor South Watersheds" section. 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/WAPs/Boston_Harbor_WAP_2004.pdf. The implementation of this TMDL is consistent with the goals and objectives of the Action Plan.

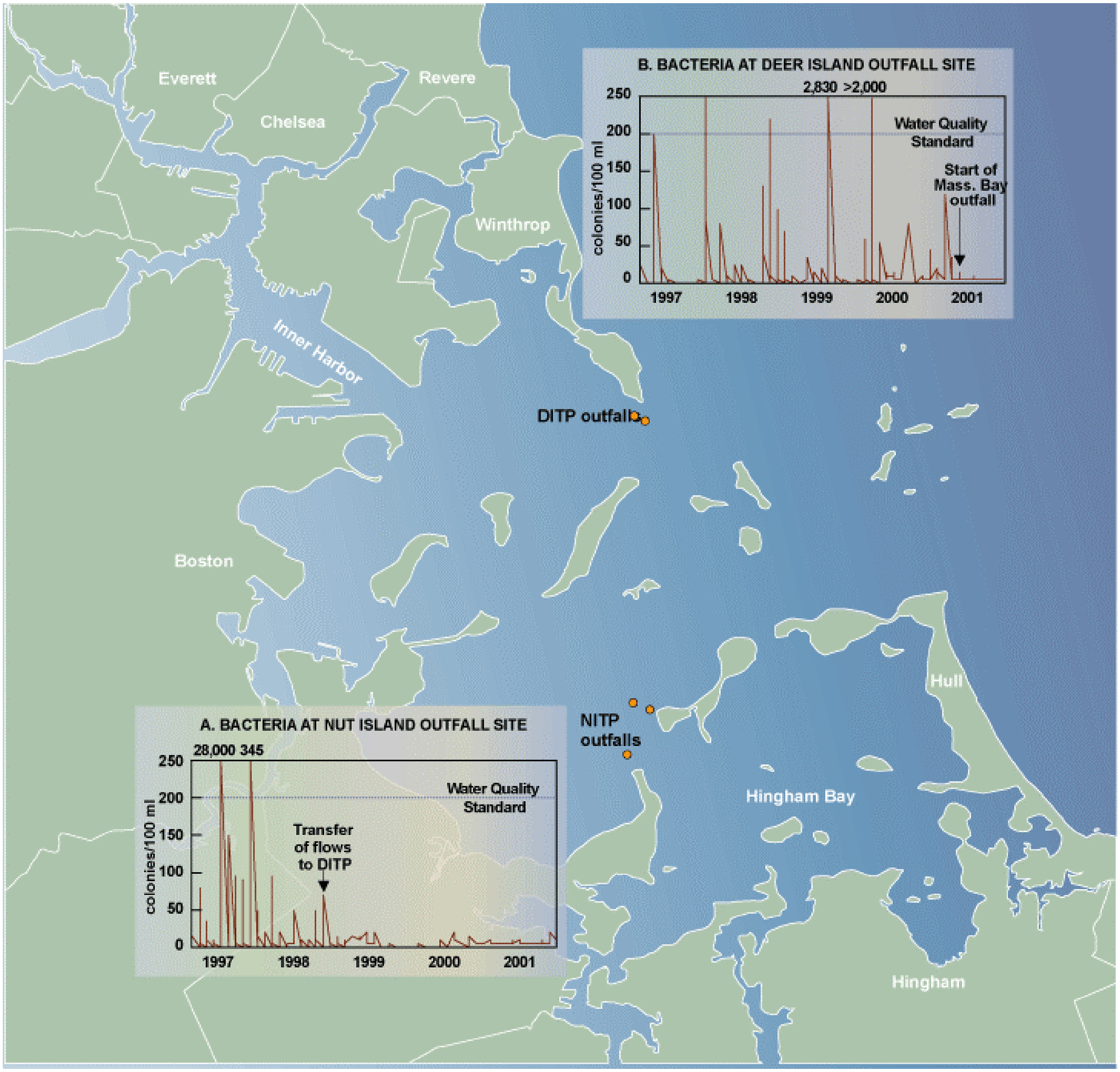
Data supporting this TMDL indicate that indicator bacteria enter the Boston Harbor from a number of contributing sources, under a variety of conditions. Activities that are currently ongoing and/or planned to ensure that the TMDL can be implemented include and are summarized in the following subsections. 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, SSOs and CSOs.

Elimination of illicit sewer connections, repairing failing infrastructure and controlling impacts associated with CSOs and SSOs are of extreme importance. Several steps are currently underway in this regard. The MyRWA, USGS, EPA, MWRA, Save the Harbor/Save the Bay, MADEP, and the BWSC have been active in the identification and mitigation of these sources. In the Mystic River and Alewife Brook, dry weather sampling has resulted in the identification of storm drains that were transporting wastewater. The MADEP has issued Notices of Noncompliance to these communities requiring them to create programs to identify the location of the illicit connections and to eliminate them.

The MDC, the EPA, and others were sued for violating the 1972 Clean Water Act in Boston Harbor in 1982. In 1985, the court ordered Boston to improve sewage treatment and issued a compliance schedule. To accomplish this, the Massachusetts Water Resources Authority (MWRA) was formed. The MWRA began the Boston Harbor Project. The project, now 94% complete, was projected to be an 11-year, $3.6 billion project (The Green Community 2005). Wastewater had been treated at the MWRA Nut Island facility until the Deer Island Sewage Treatment Plant was completed. The Deer Island Sewage Treatment Plant receives sewage from 43 greater Boston communities and has a higher capacity than the Nut Island Facility reducing back-ups and overflows throughout the system. The sewage then passes through primary and secondary treatment, sludge digestion, disinfection, eventually discharging through a 9.5 mile long tunnel into Massachusetts Bay at 100 feet below the water surface (MWRA 2004a). The switch to the Massachusetts Bay outfall has improved water quality at the previous outfalls in Boston Harbor (Figure 7-1) (MWRA 2004b). A study conducted by

Figure 7-1. Fecal Coliform Levels at the Old Nut and Deer Island Outfalls (from MWRA 2004b).



MWRA documented a decrease in fecal coliform in the South Harbor with little difference in the North Harbor (MWRA 2001). MWRA is responsible for monitoring the new outfall with the Outfall Monitoring Science Advisory Panel (OMSAP), an independent panel of scientists, providing advice on scientific issues related to the monitoring and discharge permit (MWRA 2004b).

Additionally, CSO discharges have decreased due to the MWRA CSO Control Plan (MWRA 2004a). The MWRA developed a Three-Phase CSO Plan in 1994. Table 7-2 provides a summary of the planned activities. Figure 7-2 displays the MWRA recommended goals and accomplishments. To date, the MWRA has succeeded in closing 21 CSO outlets, reducing CSO volumes by 70%, and increasing treatment of the remaining flow to 60%. Current CSO projects in Town of Somerville include marginal CSO facility upgrade, localized sewer separation projects, and floatable control. Projects in the City Chelsea include trunk sewer relief, MWRA Chelsea branch sewer relief, Chelsea outfall rehabilitation, and floatables control. CSO projects in the City of Boston include Fox Point CSO facility upgrade, Commercial Point CSO Facility upgrade, Neponset Sewer Separation, Constitution Beach Sewer Separation, East Boston Branch Relief Sewer, Union Park Detention/Treatment Facility, North Dorchester/Reserved Channel Conduits and Treatment, Fort Point Channel CSO Storage, South Dorchester Bay Sewer Separation, Stony Brook Sewer Separation, Floatables Control, and Localized hydraulics relief project. The Constitution Beach CSO Treatment Facility, which discharged screened and disinfected CSO flows approximately 16 times per year, was decommissioned in 2000. The Constitution Beach CSO was eliminated as well. The Union Park Detention/Treatment Facility, which is now under construction, will treat combined wet weather flows from the South End. This facility will eliminate 20 of the 26 CSO discharges to the Fort Point Channel, treat the remaining flow to the channel, and reduce fecal coliform bacteria loadings by 77% (MWRA 2004a). Segment specific information on CSOs can be found in the "*Boston Harbor 1999 Water Quality Assessment Report*".

Table 7-2. The MWRA CSO Plan: 1988 – 2008
(from http://www.mwra.state.ma.us/03sewer/html/sewcso.htm)

1988 — 1992	PHASE I	▪ Add CSO treatment facilities. ▪ Improve Deer Island Treatment Plant's ability to pump wet weather sewage flows.
	Results	▪ A reduction of CSO volume by 55% (over 1988 levels) ▪ Treatment of 50% of remaining CSO flows
1992 — 2000	PHASE 2	▪ Upgrade CSO treatment facilities ▪ Further increase the Deer Island Treatment Plant's ability to achieve full planned pumping and treatment capacity
	Results	▪ A reduction of CSO volume by 70% (over 1988 levels) ▪ Treatment of 60% of remaining CSO flows
1996 — 2008	PHASE 3	▪ Separate combined sewers in some areas ▪ Increase hydraulic capacity of the system in certain areas ▪ Screening/ disinfection/ dechlorination for Reserved Channel ▪ Construct storage facilities ▪ Upgrade CSO facilities to improve treatment performance
	Goals	▪ Close 36 of 84 CSOs ▪ Eliminate CSO discharges to swimming and shellfishing areas ▪ Reduce CSO volumes by 88% over 1988 levels ▪ Minimize untreated discharges ▪ Treat 95% of remaining flow

Figure 7-2. MWRA Recommended CSO Control Plan and Progress as of 3/2002.
(from http://www.mwra.state.ma.us/03sewer/html/sewcso.htm)

To abate the SSO problems in the Weymouth and Weir sub-basin, the MADEP began an initiative in 1998 to reduce the frequency, duration, and volumes of overflows from the MWRA Braintree-Weymouth Interceptor and the Braintree and Weymouth municipal sewer systems. MWRA worked to identify hydraulic deficiencies in their sewer system in 1993. MADEP signed an Administrative Consent Order (ACO) with MWRA requiring the MWRA to construct the Braintree-Weymouth Relief Facilities on a specified schedule. The $150 million project will increase the systems capacity by 19 million gallons per day (mgd) and streamline the route the wastewater takes from the communities to the treatment plants (MWRA 2001). Braintree and Weymouth both signed ACOs with MADEP to improve their sewer systems. Weymouth will be undertaking a $15 million capital improvement project and will perform work on extensive infiltration and inflow removal. Braintree has also begun infiltration reduction projects. The towns of Braintree and Weymouth have identified and removed hundreds of illegal sump pumps. In 2002, the Clean Water State Revolving Fund (SFRF) gave the Town of Randolph $210,000 to perform a sewer investigation in the Amelia Road area where severe sewer overflows had occurred in March 2001. As part of the ACO with MADEP, Braintree and Weymouth were required to perform dry weather sampling of storm drains to identify illegal connections to the storm drain system.

Guidance for illicit discharge detection and elimination has been developed by EPA New England (USEPA 2004d) for the Lower Charles River. 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. Although originally prepared for the Charles River watershed it is applicable to all watersheds throughout the Commonwealth. 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,
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.

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.

The BWSC has been making efforts to improve the quality of storm water runoff. The City of Boston has a dog fouling ordinance, the "Pooper Scooper Law", requiring dog owners to properly dispose of pet waste. The BWSC educates people on the importance of this law and also on the importance of not dumping waste into the streets. BWSC's storm drain stenciling program educates the public on storm water and stencils messages next to catch basins alerting people that what is dumped in the street can end up in the waterways (BWSC 2005).

7.4. Failing Septic Systems

Septic system bacteria contributions to the Boston Harbor watershed 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 and boats. 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. Options for controlling pathogen contamination from boats include:

- petitioning the State for the designation of a No Discharge Area (NDA);
- supporting installation of pump-out facilities for boat sewage;
- educating boat owners on the proper operation and maintenance of marine sanitation devices (MSDs);
- and encouraging marina owners to provide clean and safe onshore restrooms and pump-out facilities.

There are currently no areas proximal to the Boston Harbor watershed established as "no discharge area" (NDA). This designation by the Commonwealth of Massachusetts and approved by the EPA provides protection of this area by a Federal Law which prohibits the release of raw or treated sewage from vessels into navigable waters of the U.S. The law is enforced by the Massachusetts Environmental Police. The Massachusetts Coastal Zone Management (MCZM) and Massachusetts Environmental Law Enforcement are actively pursuing an amendment to State regulations allowing for the institution of fines up to $2000 for violations within a NDA (USEPA 2004a).

7.7. Funding/Community Resources

A complete list of funding sources for implementation of non-point 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 Boston Harbor watershed includes several components:

1. continue with the current monitoring of the Boston Harbor watershed (MyRWA and other stakeholders),
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