Final Pathogen TMDL for the Parker River Watershed

January 2021

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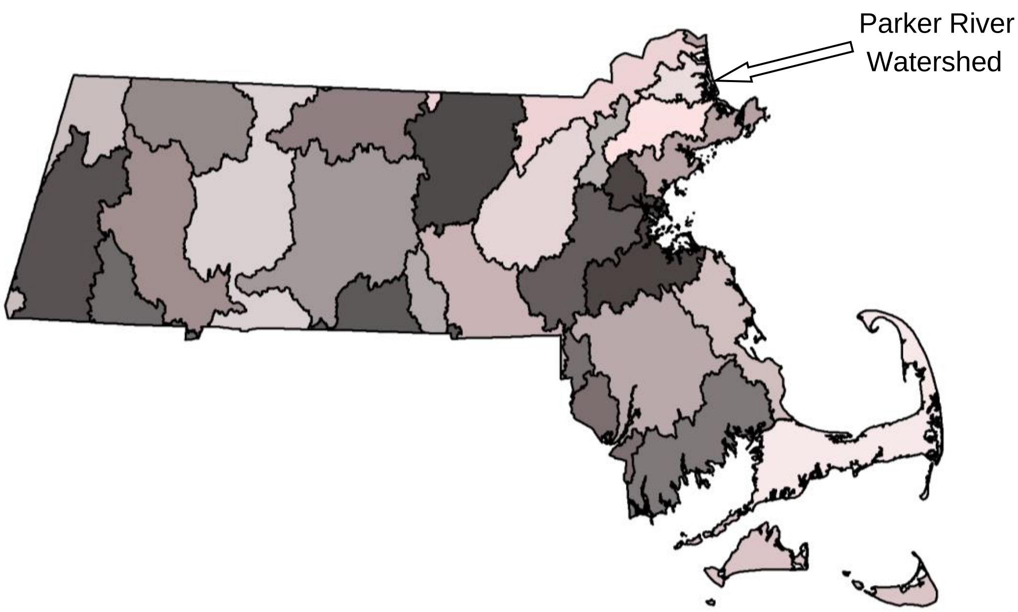

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NOTICE OF AVAILABILITY

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

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This report is also available on MassDEP's TMDL web page.

DISCLAIMER

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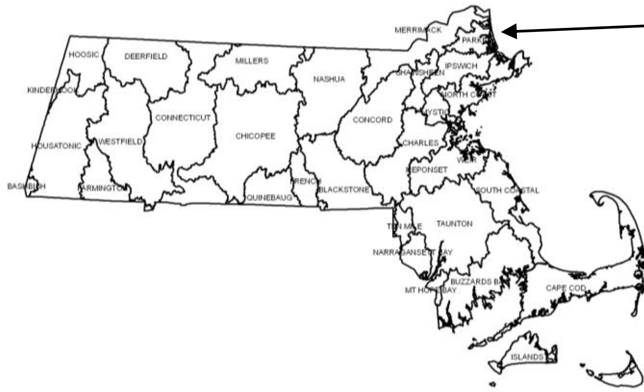
Acknowledgement
This report was developed by ENSR (now AECOM) through a partnership with Resource Triangle Institute (RTI) contracting with the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection Agency (MassDEP) under the National Watershed Protection Program. The report follows the same format and methodology for previously approved bacteria TMDLs (Boston Harbor, Weymouth-Weir, and Mystic Rivers, Buzzards Bay, Charles River, North Coastal, South Coastal, and Islands).

Total Maximum Daily Loads for Pathogens within the Parker River Watershed



Location of the Parker River Watershed

Key Features: Pathogen TMDL for the Parker River Watershed

Location: EPA Region 1

Land Type: New England Coastal

303(d) Listings[1]: Pathogens:

Eagle Hill River (MA91-06);
Egypt River (MA91-14);
Little River (MA91-11);
Mill River (MA91-09);
Paine Creek (MA91-03);
Parker River (MA91-02);
Plum Island River (MA91-15);
Plum Island Sound (MA91-12);
Rowley River (MA91-05)

Data Sources: MassDEP Parker River Watershed 2004-2008 Water Quality Assessment Report; MA Division of Marine Fisheries (DMF) Shellfish Sanitation and Management Water Quality Reports 1997-2018; MA Coastal Zone Management (CZM)

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

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[1] This TMDL includes water body segments included in the public meeting and notice in 2005. Waterbodies impaired for bacteria after that time will be included in a future TMDL.

Monitoring Plan: Massachusetts Watershed Basin Cycle; Massachusetts Coastal Zone Management; Massachusetts Division of Marine Fisheries; Merrimack Valley Planning Commission; Parker River Clean Water Association

Control Measures: Watershed Management; Stormwater Management (e.g., illicit discharge removals, public education/behavior modification); Agricultural and other Best Management Practices (BMPs); No Discharge Areas; By-laws; Ordinances; Septic System Maintenance/Upgrades

LIST of ACRONYMS AND ABBREVIATIONS

7Q10	Seven Day Ten Year Low Flow
ACEC	Area of Critical Environmental Concern
BEACH Act 2000	(federal) Beaches Environmental Assessment and Coastal Health Act of 2000
BMP	Best Management Practice
BST	Bacteria source tracking
CALM	Consolidated Assessment and Listing Methodology
CFR	Code of Federal Regulations
Cfu/ml	Colony-forming units per milliliter
CMR	Code of Massachusetts Regulations
CSO	Combined Sewer Overflow
CWA	Clean Water Act, Federal
CWA § 303(d)	Section 303 (d) of the CWA and the implementing regulations at 40 CFR 130.7
CZM	Massachusetts Office of Coastal Zone Management
DCR	Massachusetts Department of Conservation and Recreation
DFG or MA DFG	Massachusetts Department of Fish and Game
DMF or MA DMF	Massachusetts Division of Marine Fisheries
DWM	Massachusetts Division of Watershed Management
E. coli	*Escherichia coli*
EEA	Massachusetts Executive Office of Energy and Environmental Affairs
EMC	Event Mean Concentration
EPA or US EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
GIS	Geographic Information System
gpd	Gallons per day
IDDE	Illicit Discharge Detection and Elimination System
ILOW	Massachusetts Integrated List of Waters
LA	Load Allocation
LID	Low Impact Development
LTCP	Long Term Control Plan
MassBays	Massachusetts Bays Estuary Program
MADPH or DPH	Massachusetts Department of Public Health
MassDEP	Massachusetts Department of Environmental Protection
MBTA	Massachusetts Bay Transit Authority
MEP	Maximum Extent Practicable
MEPA	Massachusetts Environmental Policy Act

MG	Million Gallons
Mg/L	Milligrams per liter
MHD	Massachusetts Highway Department
mi^2	Square mile
MOS	Margin of Safety
MSD	Marine Sanitary Device
MS4	Municipal Separate Storm Sewer Systems
MVPC	Merrimack Valley Planning Commission
NDZ	No Discharge Zone
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
ORW	Outstanding Resource Water
POTW	Publicly Owned Treatment Works
PRCWA	Parker River Clean Water Association
PRWCAC	Parker River Watershed Clean Action Committee
SA	SWQS classification for highest quality salt waters
SB	SWQS classification for moderate quality salt waters
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflows
SWMP	Stormwater Management Plan
SWPP	Stormwater Program Plan
SWQS	Surface Water Quality Standards
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	United States Geological Survey
WLA	Waste Load Allocation
WPP	Watershed Planning Program
WQA	Water Quality Assessment
WWTP	Wastewater Treatment Plant

Executive Summary

Purpose and Intended Audience

This document provides a framework to address bacterial pathogens and other fecal pollution in surface waters of Massachusetts. The term “pathogens” refers to the set of indicator bacterial organisms that includes fecal coliform, *Escherichia coli* (*E. coli*), and enterococci, that represents a threat to human health and the environment. Although not all bacteria are pathogenic, the words “pathogens” and “bacteria” are used interchangeably in this Total Maximum Daily Load (TMDL) report. Pathogen 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. Discharges of inadequately treated boat waste are of concern in urban coastal areas. It can also result from large congregations of birds such as geese and gulls. Inappropriate disposal of human and animal wastes can negatively affect public health and degrade aquatic ecosystems. Pathogen pollution can also result in closures of shellfish beds, bathing beaches, swimming areas, and drinking water supplies. The contamination of such important public resources can erode the quality of life and diminish property values.

Coastal communities rely on clean, productive, aesthetically-pleasing marine and estuarine waters for swimming, boating, fishing, shellfishing and tourism. Failure to reduce and control sources of bacterial contamination results in illness in humans, closures of shellfishing areas and bathing beaches, fish kills, unpleasant odors, and visible scum. TMDLs for pathogens have been established for waterbody segments within the Parker River Watershed to restore critical uses to contaminated areas. This TMDL report will be used to set permit limits and provide stakeholders with a document to identify bacterial sources and take appropriate actions to reduce their effects.

Who should read this document?

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

a) Towns and municipalities, especially those with urbanized areas covered under the 2018 General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4 Stormwater Permit) (EPA, 2016). Regulated communities are required by law to address stormwater 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 Surface Water Quality Standards (SWQS) 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 contamination that results in beach and/or shellfish closures or results in the failure of other surface waters to meet Massachusetts SWQS for pathogens;

d) Citizens who wish to become more aware of pollution issues and who may be interested in helping build local support for implementation of remediation measures; and

e) Government agencies that provide planning, technical assistance, and funding to groups for remediation of pollution including pathogens.

Parker River Watershed

Located in northeastern Massachusetts, the Parker River Watershed covers 82 square miles and encompasses all or parts of nine towns: Boxford, Georgetown, Groveland, Ipswich, Newbury, Newburyport, North Andover, Rowley, and West Newbury. The Parker River flows in a northeasterly direction from the confluence of two unnamed brooks in West Boxford through small ponds and wetland areas. The last nine miles of the River, from Newbury to its mouth at Plum Island Sound, is tidal. Over the course of the river's path, its elevation falls 95 feet and the river travels over 6 dams.

Progress in Discovering and Reducing Bacteria Sources in the Watershed

During the last decade, municipalities and certain members of the private sector have made considerable investments and progress in controlling bacteria and nutrient impacts to the various rivers, tributaries and estuaries in the Parker River Watershed. Principal pollution sources have been more related to non-point factors than to point sources. There are no major municipal WWTPs in the watershed. The Governor Dummer Academy in Newbury has a small WWTP permitted for 52,000 gpd, but averages 22,000 gpd.

All nine of the segments covered in this document that are on the 2016 Integrated List of Waters (ILOW) (MassDEP 2019a) as impaired for fecal coliform impairment and are within estuary areas that are classified as SA. Five segments are designated for shellfishing and all nine are classified by EEA as Outstanding Resource Waters, or ORWs. It should be emphasized that Class SA and SB standards are much more stringent than Class B standards (see pages xii and xiii herein). For impaired estuary areas to meet SA and SB standards, pollution remediation work is necessary in all upstream Parker River segments to detect and eliminate bacteria sources. The major value of SA waters meeting these stringent standards is meeting the goal of maintaining existing shellfishing areas or reopening closed shellfishing areas. In order to meet this goal in the estuarine areas, all major upstream waters must at least meet Class B standards, if not higher. Reducing or eliminating stormwater related pollution and other contributing sources is a difficult task requiring long term commitment. Frequently, bacteria problems increase during, and just following, wet weather events, including snowmelts. Overland stormwater runoff gathers pollutants; pet and/or wildlife wastes, failing septic systems, illicit connections into storm lines, catch basins, agricultural or animal husbandry activities, and boating wastes all appear to be possible pollution contributors in the Parker Watershed.

Approximately 25% of the area of this watershed (comprised of nine communities) is covered under the General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems, or MS4 Permits. These areas are subject to the six-point minimum pollution control program, which, specific to bacteria controls, would include education on farmland, backyard and pet waste disposal, illicit discharge detection and elimination (IDDE) programs going into stormwater conveyances, and catch basin/street sweeping housekeeping practices. Septic system maintenance programs reduce the potential for bacteria migration through groundwater. Marinas and boats are also important areas in which to control bacteria within estuaries.

Massachusetts state agencies have been active in conducting bacteria monitoring: (1) Division of Marine Fisheries (DMF), in the tidal-estuary areas; and (2) Coastal Zone Management (CZM) in the Little River subwatershed. Both agencies conducted monitoring activities over the 2006-2018 time-period, with CZM attempting to combine its efforts with the Parker River Clean Water Association (PRWCAC) to do some hotspot and source detection monitoring in the Little River area, as well as other possible hotspot areas.

Bacterial Water Quality Indicators

The terms “pathogens” and “bacteria” in this report refer to bacteriological data collected and analyzed for fecal coliform, *E. coli*, or enterococci. The Massachusetts SWQS, 314 Code of Massachusetts Regulations (CMR) 4.0, water quality indicator for both fresh and marine waters is *E. coli.* and enterococci for fresh water and enterococci for marine waters (MassDEP 2007). Fecal coliform is the water quality indicator used by Division of Marine Fisheries (DMF) for shellfish harvesting in coastal-estuarine segments. Readily available data for the Parker River segments in the 2016 ILOW are listed in tables in Section 4 of this report.

Bacterial Implementation Priorities

In the effort to provide guidance for setting bacterial implementation priorities within the Parker River Watershed, Table ES-1 below provides a prioritized list of pathogen-impaired segments that will require additional bacterial source tracking work as well as stepwise implementation of structural and non-structural Best Management Practices (BMPs). Since limited source information and data are available in each impaired segment, a simple scheme was used to prioritize segments based on fecal coliform concentrations.

High priority was assigned to those segments where either dry or wet weather concentrations (end of pipe or ambient) were equal to or greater than 10,000 colony-forming units per 100 milliliters of sample (cfu/ml) Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 cfu/100ml. Low priority was assigned to segments where concentrations were observed less than 1,000 cfu/100 ml. MassDEP believes the higher concentrations are indicative of the potential presence of raw sewage and therefore these waters present a greater risk to the public. It should be noted that in all cases, waters exceeding the water quality standards identified in Table ES- 1 are considered impaired.

Also, prioritization is adjusted upward based on proximity of waters within the segment to sensitive areas such as ORW's, or designated uses that require higher water quality standards than Class B, such as public water supply intakes, public swimming areas, or shellfish areas. Best practical judgment was used in determining this upward adjustment. Waters that were determined to be lower priority based on the numeric range identified above were elevated one level of priority if that segment was adjacent to or immediately upstream of a sensitive use. An asterisk * in the priority column of the specific segment indicates this situation.

Pet and/or wildlife wastes, failing septic systems, illicit connections into storm lines, catch basins, agricultural or animal husbandry activities, and boating wastes all appear to be possible pathogen pollution contributors to overland stormwater runoff. Therefore, control and/or elimination of them is a relatively high priority goal in order to improve water quality. It is likely that failing septic systems and overland stormwater flows are the prime pathogen pollution culprits within this watershed. Failing infrastructure probably plays less of a role than in surrounding, more populated watersheds. Where they do occur, eliminating illicit connections and fixing failing septic systems in the future are critical to improving bacterial water quality.

A top priority activity for finding illicit connections should be bacteria source tracking activities during dry weather in those segments with elevated pathogen levels measured during dry periods. Identification and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. Finding and eliminating direct and indirect illicit bacteria sources will result in a dramatic reduction of bacteria concentration in the segment in both dry and wet-weather.

Finding and repairing the bacteria related pollution sources from failed infrastructure is very challenging. Overland stormwater runoff greatly exacerbates the pollution from failed infrastructure sources. Segments that remain impaired during wet weather should be evaluated for stormwater BMPs starting with less costly non-structural practices (such as street sweeping, catch basin cleaning, and/or managerial approaches using local regulatory controls), then more expensive structural measures. Unfortunately, many failed infrastructure problems require the more expensive structural repair measures to be considered. This would require additional study to identify the most cost-efficient and effective technology.

Table ES-1. Pathogen Impaired Segment Priorities for the Parker River Watershed

Segment ID	Segment Name	Class/ Qualifier	Size- (mi^2)	Segment Description	Priority	Indicators
MA91-06	Eagle Hill River	SA, B/ ORW	0.35	Headwaters north of Town Hill, east of Town Farm Road, Ipswich to the mouth at Plum Island Sound, Ipswich.	Medium*	Fecal Coliform
MA91-14	Egypt River	SA, B/ ORW	0.03	East of Jewett Hill (Latitude 42:42:23.40, Longitude 70:51:47.58 DMS), Ipswich to mouth at confluence with Rowley River, Rowley/Ipswich.	Medium*	Fecal Coliform
MA91-11	Little River	SA, B/ ORW	0.09	Scotland Road/Parker Street, Newbury/Newburyport to mouth at confluence with Parker River, Newbury.	Medium*	Fecal Coliform
MA91-09	Mill River	SA/ Shellfishing/ ORW	0.09	Route 1, Rowley/Newbury to mouth at confluence with Parker River, Newbury.	Medium*	Fecal Coliform
MA91-03	Paine Creek	SA/ ORW	0.06	Headwaters east of Town Farm Road, Ipswich to confluence with Eagle Hill River, Ipswich	Medium*	Fecal Coliform
MA91-02	Parker River	SA/ Shellfishing/ ORW	0.6	Central Street, Newbury to mouth at Plum Island Sound, Newbury	Medium*	Fecal Coliform
MA91-15	Plum Island River	SA/ Shellfishing/ ORW	0.39	From "high sandy" sandbar just north of the confluence with Pine Island Creek, Newbury to confluence with Plum Island Sound, Newbury	Medium*	Fecal Coliform
MA91-12	Plum Island Sound	SA/ Shellfishing/ ORW	4.47	From the mouth of both the Parker River and Plum Island River, Newbury to the Atlantic Ocean, Ipswich (includes Ipswich Bay)	Medium*	Fecal Coliform
MA91-05	Rowley River	SA/ Shellfishing/ ORW	0.25	Headwaters, confluence with Egypt River, Rowley/Ipswich to mouth at Plum Island Sound, Rowley/Ipswich	Medium*	Fecal Coliform

* use elevated due to class qualifier or proximity to sensitive use segment

TMDL Overview

The Massachusetts Department of Environmental Protection (MassDEP) 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 Massachusetts Year 2016 Integrated List of Waters (ILOW) contains a list of impaired waters (Category 5 Waters) that require a TMDL. It should be noted that all the impaired waterbodies are influenced by seasonal variations in flow and temperature and the tidal cycles in the estuaries, and these variations will directly impact the extent to which these waterbodies are impaired.

Once a water body is identified as impaired, the MassDEP 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 in order to reach the goal of restoring uses and meeting the water quality standards in stream.

Pathogen TMDL: This report represents a TMDL for pathogen indicators (e.g. fecal coliform, *E. coli*, and enterococci) in the Parker River Watershed. Certain bacteria, such as fecal coliform, *E. coli*, and enterococci bacteria , are indicators of contamination from sewage (human) 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 Parker River Watershed were found to be many and varied, although most are believed to be stormwater related. In Section 5, Table 5-1 provides a compilation of likely bacteria sources in the Parker River Watershed including failing septic systems, certain recreational activities, wildlife including birds along with domestic pets and animals, and direct overland stormwater 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 is provided in the companion document: "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL*

Implementation Guidance Manual for Massachusetts" (ENSR 2005)[1]; and the Massachusetts Clean Water Toolkit developed by Geosyntec Consultants, Inc. for MassDEP, and available at https://megamanual.geosyntec.com/npsmanual/default.aspx (Geosyntec 2016).

This TMDL applies to the nine bacteria-impaired estuary segments of the Parker River Watershed that were publicly noticed in 2005 and that are currently identified as Category 5 waters (MassDEP 2019a), impaired by fecal coliform. MassDEP recommends, however, that the information contained in this TMDL will guide management activities for all waters throughout the watershed to help maintain and protect existing water quality. Water quality has improved in some areas since the publication of the draft TMDL and continued sampling to assess progress towards reducing bacterial pollution is recommended.

The analyses conducted for the bacteria impaired segments in this TMDL apply to the non-impaired segments as well, since the sources and their characteristics are equivalent. The concentration waste load and/or load allocation for each source and designated use would be the same as specified in this TMDL. Pollution prevention TMDLs are assigned to waterbody segments where the indicator bacteria in the SWQS has changed from fecal coliform to enterococci and no enterococci data is available. The pollution prevention TMDLs have identical waste load and load allocations (WLA, LA) based on the sources present and the designated use of the water body segment (see Table ES-2 and Table 6-1). This Parker River Watershed TMDL may also be applied to segments that may be listed for bacteria impairment in future Massachusetts Integrated Lists of Waters. For such segments, this TMDL may apply if, after listing the waters for bacteria impairment and considering all relevant comments submitted on the Integrated List of Waters, this TMDL should apply to newly listed bacteria impaired segments.

Since accurate estimates of pathogen levels from 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 stormwater bacteria concentrations. These data indicate that in general two to three orders of magnitude (i.e., greater than 90%) reductions in stormwater bacteria loading will be necessary to meet SWQS, especially in developed areas. This goal is expected to be accomplished through "stepwise" implementation of IDDE programs and BMPs, such as those associated with the General Permits for MS4 communities in Massachusetts.

[1]This document was created at the initiation of the project in 2005 to be used as a companion guide by communities for addressing bacteria pollution impairments and should be used judiciously since the content does not represent current status of regulations, permits, and grant programs.

TMDL goals for each type of bacteria source are provided in Table ES-2. Municipalities are the primary responsible parties for achieving water quality standards through elimination 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 stormwater runoff volume. Certain towns in the watershed are classified as Urban Areas by the United States Census Bureau and are subject to the MS4 General Stormwater Permit, which requires the development and implementation of an IDDE. Combined sewer overflows (CSOs) will be addressed through on-going long-term control plans, associated state and federal court orders, and other actions to require compliance with Massachusetts water quality standards. There are no CSOs currently within this watershed. There are six groundwater discharge permits, however none are located within the subwatersheds of the waterbodies included in this TMDL.

In most cases, the 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 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. All communities should be encouraged to develop stormwater utilities or other administrative mechanisms to secure a dedicated funding stream to address stormwater issues. Sources of funding for TMDL implementation in NPDES regulated areas are scarce. 319 Nonpoint Source Competitive grant funds, previously a major source of funding for TMDL implementation in urban areas, cannot be used for work that addresses the requirements of NPDES permits; however, this funding can be used to develop stormwater utilities in regulated municipalities. MassDEP's Water Quality Management Planning Grants (Section 604b) and CZM's Coastal Pollution Remediation grants remain available on a competitive basis. State Revolving (Loan) Fund Program (SRF) funds can provide low-interest loans for pollution mitigation.

Table ES-2. Sources and Expectations for Limiting Bacterial Contamination in the Parker River Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
A, B, SA, SB	Illicit discharges to storm drains	0	Not applicable
	Leaking sanitary sewer lines	0	Not Applicable
	Failing septic systems	Not Applicable	0

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
A (Includes filtered water supply) &**B**		Either: a) E. coli <=geometric mean[2]- 126 colonies per 100 mL; single sample <=235 colonies per 100 mL[3]; or b) Enterococci geometric mean[2] <= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL[3]	Not Applicable
	Nonpoint source stormwater runoff[4]	Not Applicable	Either: a) E. coli <=geometric mean[2] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL; or b) Enterococci geometric mean[2]<= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL
SA (approved for shellfishing)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[5,6], and combined sewer overflows[7]	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL
SA & SB[8] (Beaches[9] and non-designated shellfish areas)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[5,6], and combined sewer overflows[7]	Enterococci - geometric mean[2] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL[3]	Not Applicable

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Enterococci -geometric mean[2] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL
SB (approved for shellfishing w/depuration)	Any regulated discharge - including stormwater runoff[7] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[5,6], and combined sewer overflows[7]	Fecal Coliform <= median or geometric mean, MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL[3]	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= median or geometric mean, MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.
[2] Geometric mean of the 5 most recent samples is used at bathing beaches. For all other waters and during the non-bathing season the geometric mean of all samples taken within the most recent six months, typically based on a minimum of five samples.
[3] Threshold for beach closure. Beaches Environmental Assessment and Coastal Health (BEACH) Act.
[4] The expectation for WLAs and LAs for stormwater discharges is that they will be achieved through the implementation of BMPs and other controls.
[5] Or shall be consistent with the Wastewater Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.
[6] Seasonal disinfection may be allowed by the Department on a case-by-case basis.
[7] Or other applicable water quality standards for CSO's

Note: This table represents waste load and load allocations based on water quality standards current as of the publication date of these TMDLs. If the pathogen criteria change in the future, MassDEP intends to revise the TMDL by addendum to reflect the revised criteria. Waste load allocation (WLA) as a concept in this document refers to pollutants discharged from pipes and channels that require a discharge permit (point sources). Load allocation refers to pollutants entering waterbodies through overland runoff (nonpoint sources). A major difference between the two categories is the greater legal and regulatory control generally available to address point sources while voluntary cooperation added by incentives in some cases is the main vehicle for addressing non-point sources.

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1.0 Introduction

Section 303(d) of the Federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (EPA) 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 (Integrated List of Waters, or ILOW) and to develop Total Maximum Daily Loads (TMDL) for listed waters and the pollutant(s) contributing to the impairment. In Massachusetts, impaired waterbodies are included in Category 5 of the "*Massachusetts Year 2016 Integrated List of Waters: Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d)* of the Clean Water Act" (MassDEP 2019a). Figure 1-1 below provides a map of the Parker River Watershed with bacteria impaired segments indicated. As shown in Figure 1-1 below, nine of the Parker River Watershed waterbodies are listed in Category 5, "impaired or threatened for one or more uses and requiring a TMDL" due to excessive indicator bacteria concentrations.

TMDLs must 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 in-stream 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 (EPA 2001). TMDLs allow watershed stewards to establish measurable water quality goals based on the difference between site-specific in-stream 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 Parker River Watershed waterbodies. These include water supply, shellfish harvesting, fishing, boating, and swimming. This TMDL establishes the necessary pollutant load to achieve designated uses and the bacteria water quality standard, and the companion document entitled: "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" (ENSR 2005)[1] is provided to give guidance for the implementation of this TMDL. This, as well as the Massachusetts Clean Water Toolkit (MassDEP, Geosyntec) provide additional details on the implementation of pathogen control measures summarized below as well as additional measures such as by-laws, ordinances, and public outreach and education.

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[1] This document was created at the initiation of this TMDL project in 2005 to be used as a companion guide by communities for addressing bacteria pollution impairments and should be used judiciously since content of does not represent the current status of regulations, permits, and grant programs.

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 estuaries, lakes, ponds, or river segments. While this localized approach may be appropriate under certain situations, it typically fails to characterize the more subtle and chronic sources of pollutants that are widely scattered throughout a broad geographic region such as a watershed (e.g., roadway runoff, failing septic systems in high groundwater, areas of concentrated wildfowl use, fertilizers, pesticides, pet waste, and certain agricultural sources). These so-called nonpoint sources of pollution often contribute significantly to the decline of water quality through their cumulative impacts. A watershed-level approach that uses the surface drainage area as the basic study unit enables managers to gain a more complete understanding of the potential pollutant sources impacting a waterbody and increases the precision of identifying local 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 (MassDEP) commissioned the development of watershed-based TMDLs.

1.1 Pathogens and Indicator Bacteria

The Parker River Watershed pathogen TMDL is designed to support the reduction of waterborne disease-causing organisms, known as pathogens, to minimize 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 contact and ingestion of 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 existing methods of detection and the strength of correlation of indicator bacteria and human illness. Currently, coliform and fecal streptococcal bacteria are commonly used as indicators of the potential presence of pathogens (i.e., indicator bacteria). Parameters used to measure coliform bacteria include total coliform, 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. The presence of coliform bacteria in water indicates the possible presence of fecal contamination. Fecal streptococcal 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) (EPA 2001). The relationships among indicator organisms is provided in Figure 1-2. The EPA, in the "*Ambient Water Quality Criteria for Bacteria – 1986"* (EPA 1986) and *"2012 Recreational Water Quality Criteria for Bacteria*" (EPA 2012a), recommends the use of *E. coli* or Enterococci as potential pathogen indicators in fresh water and Enterococci in marine waters.

Figure 1-1. Parker River Pathogen Impaired Segments and Designated Shellfish Growing Areas (MassGIS 2015)

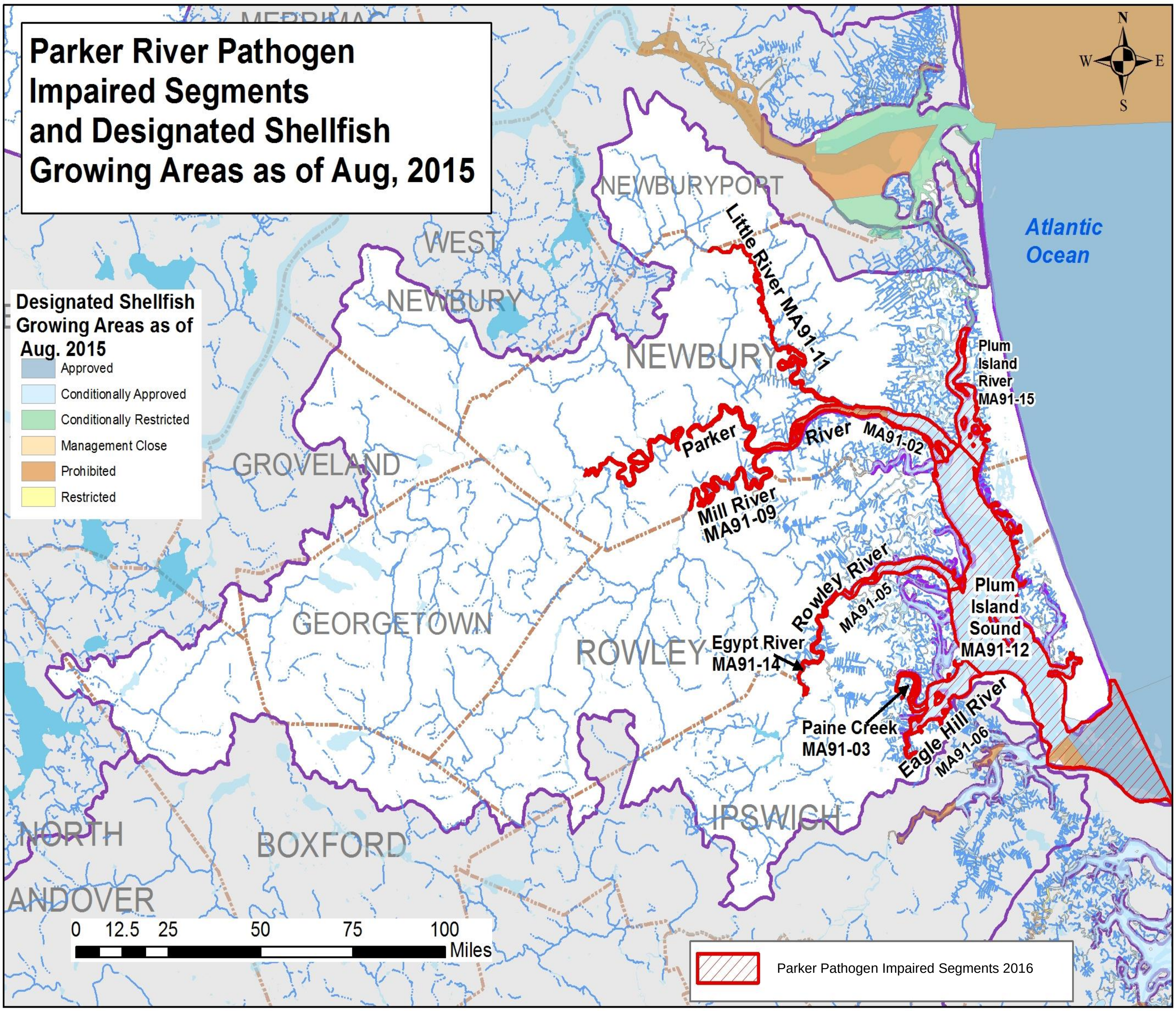
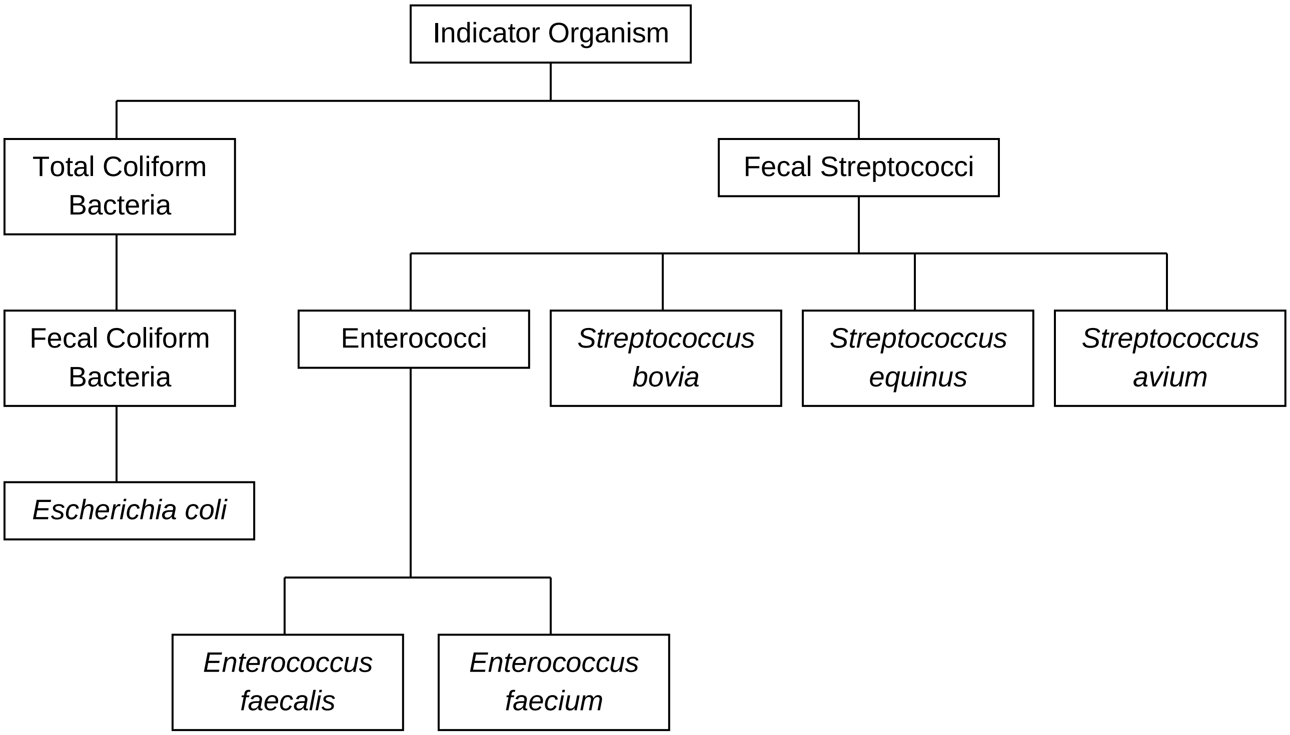


Figure 1-2. Relationships Among Indicator Organisms (EPA 2001).



The Parker River Watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for shellfish areas, enterococci for bathing in marine waters, and generally *E. coli* for fresh waters, although enterococcus is also acceptable for fresh waters. Any future changes in the Massachusetts pathogen surface water quality standards (SWQS) 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 SWQS and any future modifications to the SWQS for pathogens.

Consistent with Section 303(d) of the CWA, the MassDEP has chosen to complete pathogen TMDLs for all waterbodies in the Parker River Watershed at this time, regardless of current impairment status (i.e., for all waterbody categories in the *2016 Integrated List of Waters*). MassDEP believes a comprehensive management approach carried out by all watershed communities is needed to address the pathogen sources present in the Ipswich River watershed. Watershed-wide implementation is needed to meet

SWQS and restore designated uses in impaired segments while providing protection of desirable water quality in waters that are not currently impaired or not assessed.

1.2 Comprehensive Watershed-based Approach to TMDL Development

As discussed below, this TMDL applies to the nine pathogen-impaired segments in the Parker River Watershed that are listed in the 2016 ILOW. MassDEP 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.

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 7-1).

This Parker River Watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such future-impaired 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) ILOW, the MassDEP determines (with EPA approval of the CWA § 303(d) list) that this TMDL should apply to future pathogen impaired segments.

The nine estuarine river segments in this report are pathogen-impaired and listed in Category 5 (i.e., requiring a TMDL) in the Massachusetts 2016 Integrated List of Waters (MassDEP 2019a) (see Figure 1-1). Pathogen impairment has been documented by MassDEP in previous reports, including the MassDEP Water Quality Assessment Report (WQA)(MassDEP 2010), resulting in the impairment determination. In this TMDL document, an overview of pathogen impairment is provided in Chapter 4 to illustrate the nature and extent of the pathogen impairment problem. Since pathogen impairment has been previously established, only a summary is provided herein.

The watershed-based approach that was applied to the Parker River pathogen TMDL focused on the identification of sources, source reduction, and implementation of appropriate management plans. Once identified, sources are required to meet applicable SWQS for indicator bacteria, or they must 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 stormwater management, to reducing the influence from inadequate and/or failing sanitary sewer infrastructure.

2.0 Watershed Description

Located in northeastern coastal Massachusetts, the Parker River Watershed covers 82 square miles (mi^2) and encompasses all or parts of nine towns: Boxford, Georgetown, Groveland, Ipswich, Newbury, Newburyport, North Andover, Rowley, and West Newbury. The Parker River flows from the confluence of two unnamed brooks in western Boxford in a northeasterly direction through small ponds and wetland areas. The lower nine miles of the River, from Newbury to its mouth at Plum Island Sound, are tidal. The Parker River falls 95 feet in 23 miles, flowing over 6 dams (MassDEP 2001; MassDEP 2010). The Parker River is the largest tributary to Plum Island Sound.

During extreme high tides, water can pass over a sand bar between the Merrimack River and Pine Island Creek. Under these conditions, water from the Merrimack River flow to Pine Island Creek and then to the Plum Island River. In this way, the Parker River Watershed and Merrimack River watershed are hydrologically connected during extreme high tides (MassDEP 2001). Plum Island Sound receives flow from Plum Island River and its tributaries, the Rowley and Eagle Hill River systems, the Parker River, and the Ipswich River (Figure 1-1).

The 25,500 acre Parker/Essex Bay Area of Critical Environmental Concern (ACEC), located in this watershed, is known best for its barrier beaches and extensive salt marsh system. The Parker River National Wildlife Refuge, located within the Parker/Essex Bay ACEC, is an important stop on the Atlantic Fly-way Migration route. Additional protect areas located in the ACEC are the Crane Reservation, Crane Wildlife Refuge, and Plum Island State Park.

Land use within the Parker River Watershed is approximately 82% undeveloped (i.e., open space, agriculture, forest, water, wetlands), and 18% developed (i.e., suburban-urban residential, commercial/industry, et cetera) (MassGIS 2005) (See Figure 2-1, Table 2-1 below). Surface waters in the watershed are commonly used for primary and secondary contact recreation (swimming and boating) and habitat for aquatic life. As of the date of this TMDL report, shellfishing is largely prohibited or conditionally approved in the watershed because of management closures, restrictions, or poor water quality.

The Department of Conservation and Recreation (DCR) manages several beaches within the watershed; Figure 2-2 shows the marine swimming beaches. Information and locations of DCR saltwater, ocean beaches can be found at: https://www.mass.gov/saltwater-ocean-beaches (MassDCR 2020a), and inland, freshwater beaches information can be found at: https://www.mass.gov/freshwater-inland-beaches (MassDCR 2020b).

Estuary waters within and surrounding this watershed are protected against the disposal of treated or raw sewage from vessels and have been declared “No Discharge Zones” or NDZs, see Figure 2-3 (EPA 2015).

It should be noted that all waterbodies are influenced by seasonal variations in flow and temperature, and the tidal cycles in the estuaries. All will directly impact the extent to which these waterbodies are impaired at any given time.

Table 2-1. Parker River Watershed Land Use as of 2005

Landuse Description	Acres	Percent of Total
Brushland Successional and Forest	21902.20	41.57
Agricultural Uses	3091.92	5.87
Industrial, Mining, Powerlines, Junkyards	1423.46	2.70
Urban/Public, Cemetaries, Institutional	1044.77	1.98
Recreation	631.93	1.20
Open Land	638.67	1.21
High Density and MultiFamily Residential	508.00	0.96
Medium, Low and Very Low Density Residential	6031.62	11.45
Wetland, Forested Wetland and Saltwater Wetlands	15101.50	28.66
Saltwater Sandy Beach	1184.64	2.25
Water	1133.20	2.15

Figure 2-1. Parker River Watershed Land Use as of 2005 (MassGIS 2005)

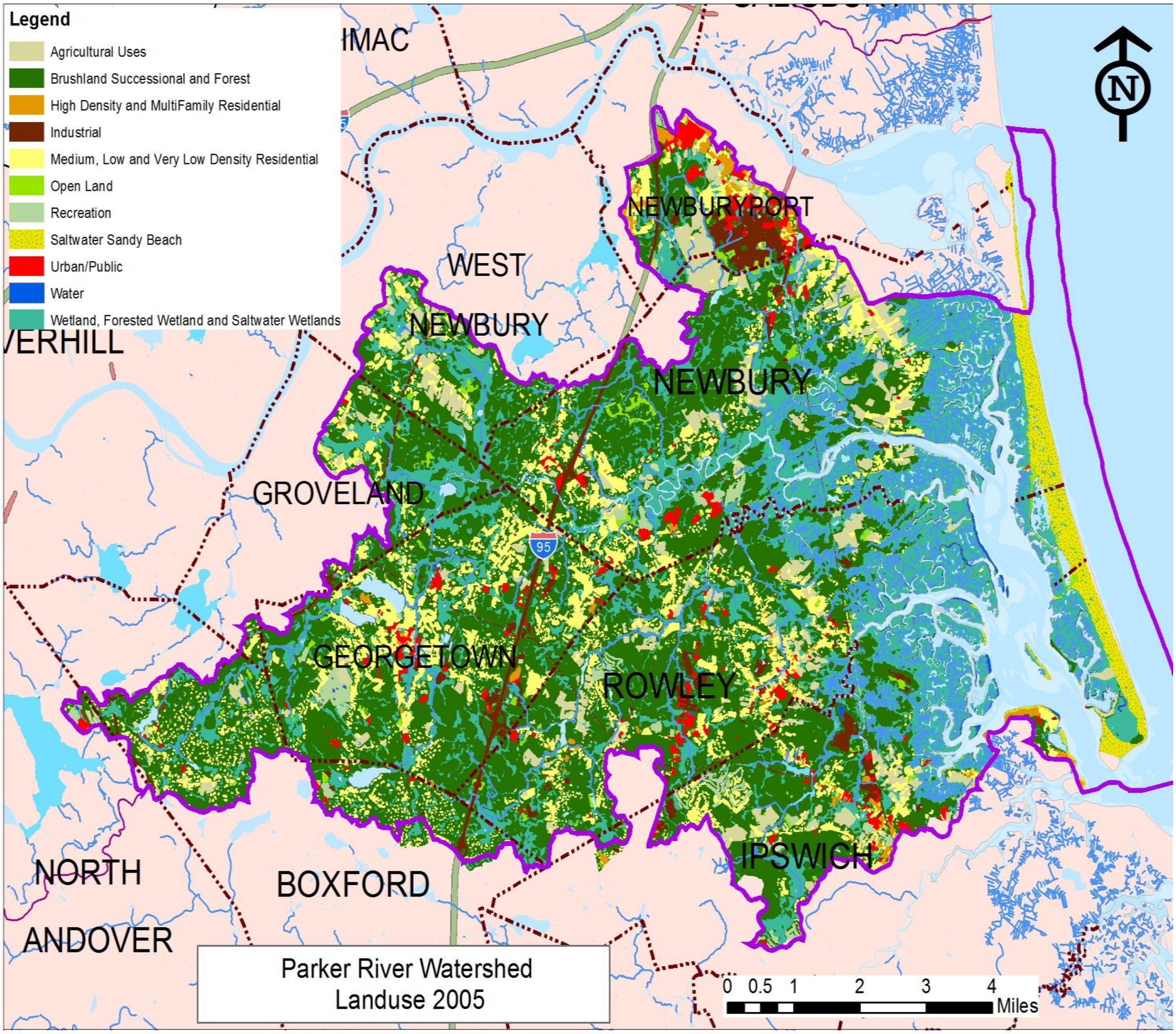


Figure 2-2. Parker River Watershed Marine Beach Locations and Pathogen-Impaired Segments

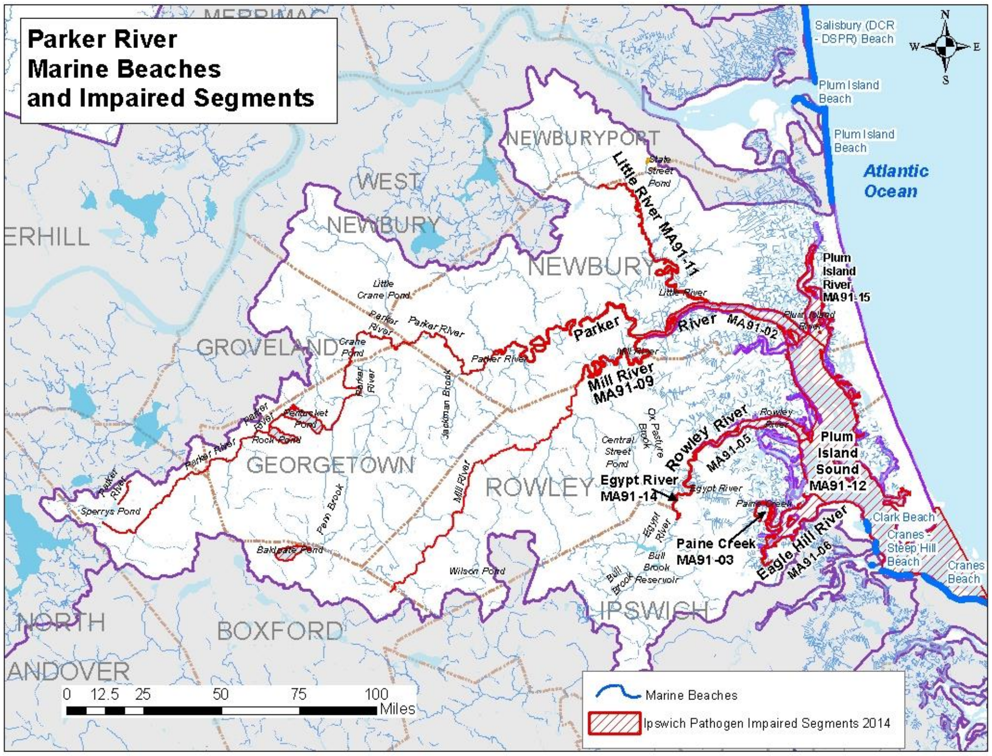


Figure 2-3 No Discharge Zones Massachusetts (DMF 2015)

3.0 Water Quality Standards

The Surface Water Quality Standards (SWQS) for the Commonwealth of Massachusetts establish chemical, physical, and biological standards for the restoration and maintenance of the most sensitive uses of our aquatic resources (MassDEP 2007). The SWQS limit the discharge of pollutants to surface waters for the protection of existing uses and attainment of designated uses in downstream and adjacent segments.

The Parker River Watershed contains waterbodies classified as Class A (tributaries), B, SA, and SB. According to the Massachusetts SWQS, these waters should be suitable for the following uses: (1) habitat for fish, other aquatic life, and wildlife, (2) primary and secondary contact recreation, (3) shellfish harvesting in approved areas, and (4) should have consistently good aesthetic value (SA should be excellent). The pathogen impairments (exceedances of fecal coliform, enterococci, and *E. coli* bacteria criteria) associated with the waterbodies of interest in this report affect primary contact recreation and shellfishing uses. Bacteria indicator standards are presented in Table ES-2 and 7-1 (MassDEP 2007).

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. These bacteria are often used as indicator bacteria since it is cost-prohibitive and resource-intensive to test for the presence of individual pathogenic organisms.

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 rises 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 through the EPA:

- Water Quality Criteria: Microbial (Pathogen) (EPA 2020),
- Advisories and Technical Resources for Fish and Shellfish Consumption (EPA 2019)
- Swimming Advisories (2020b):

Until January 2007, Massachusetts used fecal coliform as the indicator organism for all waters except for marine bathing beaches, where the Federal Beaches Environmental Assessment and Coastal Health Act (BEACH Act) required the use of *enterococci*. Massachusetts revised its bacteria SWQS in 2007 by replacing fecal coliform with *E. coli* and enterococci as the regulated indicator bacteria in freshwater systems, as recommended by the EPA in the “Ambient Water Quality Criteria for Bacteria – 1986” and

“2012 Recreational Water Quality Criteria” documents (EPA 1986, EPA 2012a) (the state had previously done so for public beaches through regulations of the Massachusetts Department of Public Health, MassDPH, as discussed below). Massachusetts adopted enterococci for all marine waters, including non-bathing marine beaches in January 2007; fecal coliform remains the indicator organism for (saltwater) shellfishing areas.

Some of the threshold values provided in this TMDL are those established by MassDEP in the SWQS (MassDEP 2007):

- **Class A:** Unfiltered water supply intakes – either fecal coliform shall not exceed 20 colony forming units, or cfu, per 100 ml in all samples taken in any six month period, or total coliform shall not exceed 100 cfu/100 ml in 90% of the samples in any six- month period.
- **Class SA:** Shellfishing Approved- geometric mean for fecal coliform shall not exceed 14 cfu/100 mL, and 10% of the samples shall not exceed 28 cfu/100 mL;
- **Class SB:** Shellfishing Approved (but not necessarily open)- geometric mean for fecal coliform shall not exceed 88 cfu/100 mL, and 10% of samples shall not exceed 260 cfu/100 mL;
- **Class SA** and **SB** Beaches and non-designated shellfish areas: geometric mean for enterococci shall not exceed 33 cfu/100 mL, and a single sample shall not exceed 104 cfu/ 100 mL for the purposes of beach closure.
- **Class B** –Beaches- geometric average for *E. coli* shall not exceed 126 cfu/100 mL, and a single sample shall not exceed 235 cfu/100 mL.

Shellfish growing areas are classified by the Massachusetts Division of Marine Fisheries and are listed at https://www.mass.gov/service-details/shellfish-classification-areas (DMF 2020). The classification system as provided below is a summary of the DMF classification included in the MassDEP Consolidated Assessment and Listing Methodology, or CALM (MassDEP 2018). Figure 2-2 provides the status of designated shellfish growing areas as of July 2015.

> **Approved** "...open for harvest of shellfish for direct human consumption subject to local rules and regulations..." An approved area is open all the time and closes only due to hurricanes or other major coastwide events.”
>
> **Conditionally Approved** "...subject to intermittent microbiological pollution..." During the time the area is open, it is "...for harvest of shellfish for direct human consumption subject to local rules and regulations…" A conditionally approved area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, shellfish harvested are treated as from an approved area.”
>
> **Restricted** “…area contains a "limited degree of pollution." It is open for "harvest of shellfish with depuration subject to local rules and state regulations" or for the relay of shellfish. A restricted area is used by DMF for the relay of shellfish to a less contaminated area.”
>
> **Conditionally Restricted** "...subject to intermittent microbiological pollution..." During the time area is restricted, it is only open for "the harvest of shellfish with depuration subject to local

rules and state regulations." A conditionally restricted area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, only soft shell clams may be harvested by specially licensed diggers (Master/Subordinate Diggers) and transported to the DMF Shellfish Purification Plant for depuration (purification)."

Prohibited – "Closed for harvest of shellfish."

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 when 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 MassDEP designated use support status, please see any of the completed MassDEP Water Quality Assessment Reports available on-line e.g., the *"Parker River Watershed 2004-2008 Water Quality Assessment Report*", available online at https://www.mass.gov/doc/parker-river-watershed-2004-2008-assessment-report-0/download (MassDEP 2010).

In addition to the SWQS, the Mass DPH has established minimum standards for bathing beaches (105 CMR 445.000) under the State Sanitary Code, Chapter VII (MassDPH 2014). These standards have been adopted by MassDEP as the surface SWQS for fresh and marine waters and will apply to this TMDL. The MADPH bathing beach standards are generally the same as those recommended in the US EPA's "Ambient Water Quality Criteria for Bacteria – 1986" (EPA 1986) and the 2012 Recreational Water Quality Criteria (EPA 2012a). 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 - 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 - 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 national standard for public health and safety at marine beaches. These standards are essentially the same as the MADPH marine beach standard. The Federal BEACH Act and MADPH Marine Waters standards can be accessed at:
https://www.epa.gov/beach-tech/about-beach-act (EPA 2018b), and
http://www.mass.gov/eohhs/docs/dph/regs/105cmr445.pdf (MADPH 2014), respectively.

Figure 2-3 provides the location of marine bathing beaches, where the MADPH Marine Waters and the Federal BEACH Act standards both apply. A list of beaches, both 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: https://matracking.ehs.state.ma.us/Environmental-Data/recreational-water/index.html (MADPH 2020).

4.0 Problem Assessment

Pathogen impairment has been documented at nine estuarine locations throughout the Parker River Watershed, as shown in Figure 1-1. Excessive concentrations of indicator bacteria (e.g., fecal coliform, enterococci, *E. coli* etc.) can indicate the presence of sewage contamination and possible presence of pathogenic organisms. The amount of indicator bacteria and potential pathogens entering waterbodies is dependent on several factors including watershed characteristics and meteorological conditions. Indicator bacteria levels generally rise 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 stormwater runoff carries fecal matter that has accumulated to the river via overland flow and stormwater 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 within each watershed.

Tables 4-1 and 4-2 provide ranges of fecal coliform concentrations in stormwater associated with various land use types. Pristine areas are observed to have low indicator bacteria levels, while residential areas are observed to have elevated indicator bacteria levels. Development activities generally lead to decreased water quality (e.g., pathogen impairment) in a watershed. Development-related watershed modification typically results in an increase in impervious surface area which can:

- Increase flow volume,
- Increase peak flow,
- Increase peak flow duration,
- Increase stream temperature,
- Decrease base flow, and
- Change sediment loading rates (EPA 1997).

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

Table 4-1 Wachusett Reservoir Stormwater Sampling

Land Use Category[1]	Fecal Coliform Bacteria[2] (CFU / 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, with on-site septic systems), Storm 1	30 - 29,600
High Density Residential (not sewered, with on-septic systems), Storm 2	430 - 122,000

[1] Original data provided in MDC Wachusett Stormwater Study (MDC-CDM 1997) as reported in MassDEP 2002.
[2] Grab sample collected for four storms between September 15, 1999 and June 7, 2000.

Table 4-2 Lower Charles River Basin Stormwater Event Mean Bacteria Concentrations[1,2]

Land Use Category	Fecal coliform (CFU/100 mL)	Enterococci 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] Data summarized from the United States Geological Survey (USGS) 2002.
[2]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 9 estuarine pathogen-impaired segments that MassDEP identified in the Parker River Watershed in the *2016 Integrated List of Waters* (ILOW; MassDEP 2019), which includes the basis for impairment listing(s). Table 4-1 provides summary statistics of assessed and impaired waters within the Parker River Watershed. In total, nine segments covered in this report contain indicator bacteria concentrations in excess of the Massachusetts SWQS for Class A, SA, or B waterbodies (314 CMR 4.05), the MADPH standard for bathing beaches, and/or the BEACH Act. Pathogen impaired estuary segments represent 100% of the total estuary area assessed (6.44 mi^2); in contrast, none of the total river miles assessed are pathogen-impaired (0 miles impaired of 74.0 total river miles). Under its current listing approach, a waterbody remains on the impaired waters list until a new assessment reveals that the waterbody is meeting all applicable waters quality standards or when the original basis for listing is determined to be inaccurate or flawed. The methods used to develop listing decisions are described in the Comprehensive Assessment and Listing Methodology, (CALM; MassDEP 2018a).

A list of pathogen-impaired segments requiring TMDLs is provided in Table 4-3. An overview of the Parker River Watershed pathogen impairments 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 ILOW, it is not necessary to provide detailed documentation of pathogen impairment herein. Available data from MassDEP, Massachusetts Department of Fish and Game (DFG) Division of Marine Fisheries (DMF), and the Massachusetts Office of Coastal Zone Management (CZM) were reviewed and are summarized in the segments below (see Figures 4-4 to 4-22 below). Additional details regarding each impaired segment including large water withdrawals, permitted discharges, use assessments and recommendations to meet designated use criteria are provided in the MassDEP Water Quality Assessment (WQA) reports (MassDEP 2002, MassDEP 2010).

This TMDL was based on the current SWQS using fecal coliform as an indicator for shellfish areas, and *E. coli* for fresh and enterococci for either marine or freshwater bathing.

Table 4-3. Parker River Watershed Pathogen Impaired Segments Requiring TMDLs

Segment ID	Segment Name	Segment Type	Size (mi^2)	Segment Description
Eagle Hill River System				
MA91-06	Eagle Hill River	Estuary	0.35	Headwaters north of Town Hill, east of Town Farm Road, Ipswich to the mouth at Plum Island Sound. Ipswich
MA91-03	Paine Creek	Estuary	0.06	Headwaters east of Town Farm Road, Ipswich to confluence with Eagle Hill River, Ipswich
Parker River System				
MA91-11	Little River	Estuary	0.09	Scotland Road/Parker Street, Newbury/Newburyport to mouth at confluence with Parker River, Newbury.
MA91-09	Mill River	Estuary	0.09	Route 1, Rowley/Newbury to mouth at confluence with Parker River, Newbury.
MA91-02	Parker River	Estuary	0.6	Central Street, Newbury to mouth at Plum Island Sound, Newbury
Plum Island Sound System				
MA91-15	Plum Island River	Estuary	0.39	From "high sandy" sandbar just north of the confluence with Pine Island Creek, Newbury to confluence with Plum Island Sound, Newbury
MA91-12	Plum Island Sound	Estuary	4.47	From the mouth of both the Parker River and Plum Island River, Newbury to the Atlantic Ocean, Ipswich (includes Ipswich Bay)
Rowley River System				
MA91-14	Egypt River	Estuary	0.03	East of Jewett Hill (Latitude 42:42:23.40, Longitude 70:51:47.58 DMS), Ipswich to confluence with Rowley River, Rowley/Ipswich.
MA91-05	Rowley River	Estuary	0.25	Headwaters, confluence with Egypt River, Rowley/Ipswich to mouth at Plum Island Sound, Rowley/Ipswich

Data from DMF were used, in part, as the basis for pathogen impairment for many of the estuarine areas (Figure 1-1). DMF has collected numerous samples in Parker River Watershed estuary areas; they have a well-established and effective shellfish monitoring program, consistent with the National Shellfish Sanitation Program, that provides quality assured data for every shellfish growing area. Each 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 shellfish harvesting classification, except for those areas already classified as Prohibited. Annual fecal coliform water quality monitoring includes identification of specific sources and assessment of effectiveness of controls and attainment of standards. DMF reports that "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 2016). Designated Shellfish Growing Areas Status as of July 1, 2015 are shown on Figure 1-1.

Available bacteria data are summarized in the following section. The primary sources of data include but are not limited to DMF, CZM, MADPH, MassDEP, and the Merrimack Valley Planning Commission (MVPC).

MADPH publishes annual reports of the results of the testing conducted at public and semi-public beaches for both marine and fresh waters, noting where exceedances of water quality criteria led to beach closures. These reports are available for download from the MADPH website at https://www.mass.gov/beach-water-quality (mass.gov 2020).

4.1 Parker River Watershed

Eagle Hill River System

The Eagle Hill River System includes the Eagle Hill River and its tributary, Paine Creek. Both waterbodies are impaired due to elevated indicator bacteria concentrations.

Eagle Hill River Segment MA91-06

This ORW segment is a 0.35 mi^2 Class SA estuary extending from the headwaters near Town Hill, east of Town Farm Road to the mouth at Plum Island Sound, Ipswich. The Ipswich town dock has a vessel pump-out facility on this segment. The MassDEP WQA lists no discharges for this segment.

Shellfish growing status as of July 2000 and July 2016 (0.33 mi^2): Conditionally Approved (see Figure 1-1).

The DMF collected dry weather samples from one station on this segment between January 1997 and February 2001. The results of their sampling are summarized in Table 4-4 below.

Table 4-4. MA91-06 Eagle Hill River DMF Fecal Coliform Data Summary

Site Description	Min	Max	n
DMF 1997-2001	**cfu/100mL**		
One station	2	347	53[1]
[1]Thirty-two samples were collected during the primary contact recreation season.			

DMF collected samples from one station in this segment between January 2011 and December 2015. The results of their sampling are summarized in Table 4-5 below.

Table 4-5. MA91-06 Eagle Hill River DMF Fecal Coliform Data Summary 2011-2020

Site Description	Min	Max	Geo Mean Range	n
DMF 2011-2015	**cfu/100mL**		**cfu/100mL**	
Eagle Hill R. station	0.9	13	1.11- 1.58	~60
DMF 2016-2020	**cfu/100mL**		**cfu/100mL**	
Mouth of Greens Point Creek/Joins Eagle Hill River	0.9	81	N/A	74
Eagle Hill River Landing	0.9	75	N/A	74

Paine Creek Segment MA91-03

This segment is a 0.06 mi^2 Class SA estuary running from its headwaters east of Town Farm Road, to the confluence with Eagle Hill River, Ipswich. The MassDEP WQA lists no discharges for this segment.

Shellfish growing status as of July 2000 and July 2016 (0.053 mi^2): Conditionally Approved (see Figure 1-1).

Parker River System

The Parker River System includes the Parker River mainstem from its source in Boxford to Plum Island Sound in Newbury and includes 2 connecting tributaries. The pathogen-impacted portions of this system include the mainstem segment (MA 91-02) running from Central St. to Plum Island Sound, Newbury; and the Little River (MA91-11) and Mill River (MA91-09), which both connect to the mainstem in Newbury.

Little River Segment MA91-11

This ORW segment is a 0.09 mi^2 Class SA estuary which runs from Scotland Road/Parker Street, Newbury/Newburyport to mouth at confluence with Parker River, Newbury. The Hero Coatings, Inc. Newburyport facility had a multi-sector stormwater permit to discharge to a tributary of the Little River but has not reapplied for the new general permit since their permit expired in 2005 (EPA 2005). Seven facilities have coverage under multi-sector stormwater permits for discharge to the Little River: Newbury Auto, JRM Hauling and Recycling Services, Newburyport Layover, GI Plastek Limited Partnership, Bixby International Corp (two permits), and the Massachusetts Bay Transit Authority (MBTA).

Shellfish growing status as of July 2000, and July 2016 (0.039 mi^2): Prohibited (see Figure 1-1).

The DMF collected fecal coliform samples from five stations within this segment between October 1992 and November 2016. The results of their sampling are summarized in Table 4-6 below.

Table 4-6. MA91-11 Little River DMF Fecal Coliform Data Summary

Sampling Dates/Site Description	cfu/100mL		N
	Max	Min	
10/1992 to 9/1996-Little River at Newman Road, Newbury	10	1,587	19
6/2016 to 12/2016-Little River at Newman Road, Newbury	10	81	5
8/2008 to 5/2012- Little River at Hay Street, Newbury	40	1,300	9
3/1992 to 5/2010- Little River at Boston Road, Newbury	87	1,587	9
4/2008 to 5/2012-Little River at Route 1, Newbury	70	2,400	10
8/2008 to 5/2012-Little River at Scotland Road, Newbury	20	24,000	8
1/2012 to 12/2012-Little River	0.9	70	17
1/2013 to 8/2013- Little River	0.9	8	6
1/2014- Little River	4	4	1
01/2016 to 12/2016- Little River	0.9	81	30
2/2017 to 12/2017- Little River	0.9	81	31
1/2018 to 12/2018- Little River	0.9	37	18
2/2019 to 11/2019- Little River	0.9	81	12
01/2020- Little River	7	7	1

Between April 1999 and April 2000, the Merrimack Valley Planning Commission (MVPC) sampled fecal coliform bacteria bi-weekly from 27 sites in the Little River subwatershed (9–Little River; 17–Little River tributaries; 1-Parker River) (MassDEP 2010); Table 4-7 summarizes the results of the 127 samples. Sampling stations are listed from upstream to downstream.

Table 4-7. MA91-11 Little River MVPC Fecal Coliform Bacteria Summary- (MassDEP 2010)

Station Number	Number of Samples		Fecal Coliform Range (cfu/100mL)		Fecal Coliform Geometric Mean (cfu/100mL)	
	Dry	Wet	High	Low	Dry	Wet
LR-9 Hale St	11	1	30	3	5	30
LR-8 Colby Farm NW	10	2	2,400	5	152	379
LR-7 Colby Farm SE	12	2	625	10	179	68
LR-6 Scotland Rd	3	0	5	5	5	-
LR-5 Route 1	16	2	435	5	89	87
LR-4 Hanover St	16	2	520	5	91	81
LR-3 Boston Rd	18	2	900	5	76	36
LR-2 Hay St	15	2	390	5	57	192

Station Number	Number of Samples		Fecal Coliform Range (cfu/100mL)		Fecal Coliform Geometric Mean (cfu/100mL)	
LR-1 Newman Rd	11	2	347	5	48	250

The Executive Office of Environmental Affairs (EOEA) CZM has conducted its own bacteria sampling in the Little River subwatershed on both the mainstem and tributaries during 2002 and 2005 (data summarized in Table 4-8 below).

Table 4-8. MA91-11 Little River CZM Fecal Coliform Data Summary

Site Description	Min	Max	n	Primary Contact Season	
	cfu/100mL			# Samples >400 cfu/100mL	n
CZM 2002-2005					
Nine stations	13	1,200	numerous	>6	numerous

Mill River Segment MA91-09

This ORW segment is a 0.09 mi^2 Class SA estuary from Route 1, Rowley to mouth at confluence with Parker River, Newbury. The Governor Dummer Academy is the only NPDES permitted facility in the Parker River Watershed. It has a minor NPDES permit for a maximum flow of 52,000 gpd. The permit allows the discharge of treated sanitary wastewater via one outfall to a small unnamed freshwater tributary of the Mill River. Georgetown has an urbanized area and is subject to the General Municipal Separate Storm Sewer System (MS4) Stormwater Permit.

Shellfish growing status as of July 2000, and July 2016 (.054 mi^2): Prohibited (see Figure 1-1).

The DMF collected 23 fecal coliform samples from one station on this segment from January 1997 to February 2001. Results of that sampling are summarized in Table 4-9 below.

Table 4-9. MA91-09 Mill River DMF Fecal Coliform Data Summary.

Site Description	Min	Max	n	Primary Contact Season	
	cfu/100mL			# Samples >400 cfu/100mL	n
DMF 1997-2001					
One station	3	900	23	2 (13%)	15

Recent 2015-16 DMF sampling occurred at 1 station on the Mill River MA91-09, with fecal coliform results reviewed in Table 4-10 below:

Table 4-10. MA91-09 Mill River DMF Fecal Coliform Data Summary

Site Description	Min	Max	n
	CFU/100mL		
DMF 2015-2016			
DMF Station 19- Mill River	0.9	81	53

<u>Parker River Segment MA91-02</u>

This ORW segment is a 0.6 mi^2 Class SA estuary running from Central Street in Newbury to mouth at Plum Island Sound, Newbury. Riverfront Marina on High Street has a vessel sewage pump-out facility.

Shellfish growing status as of July 2000: Prohibited. Shellfish growing status as of July 2016: Conditionally Approved 0.22 mi^2; Prohibited 0.28 mi^2 (see Figure 1-1)

The DMF collected dry weather fecal coliform samples from five stations on this segment from January 1997 to February 2001. The results of their sampling are summarized in Table 4-11 below.

Table 4-11. MA91-02 Parker River DMF Fecal Coliform Data Summary

Site Description	Min	Max	n
	CFU/100mL		
DMF 1997-2001			
Five Stations	2	347	115

The DMF collected samples from one station in this segment between January 2011 and December 2016. The results of their sampling are summarized in Table 4-12 below.

Table 4-12. MA91-02 Parker River DMF Fecal Coliform Data Summary

Site Description	Min	Max	Geo Mean Range	n
	cfu/100mL		cfu/100mL	
DMF 2011-2015				
Cottage Row station	0.9	20	1.23- 2.89	~60
DMF 2015-2020				

Cottage Rd-01/2015 to 01/2020	0.9	81	N/A	111
Hackers-01/2016 to 01/2020	0.9	81	N/A	80

Plum Island Sound System

The Plum Island Sound System includes Plum Island Sound and Plum Island River. Tributaries of Plum Island Sound include the Parker River, the Plum Island River, the Rowley River, and the Eagle Hill River. Plum Island Sound is surrounded by extensive areas of salt marsh (Figure 2-1). During extreme high tides the Plum Island River receives flow from the Merrimack River watershed which borders it on the North. Two segments in the Plum Island Sound System, the Plum Island River and Plum Island Sound, are impaired due to elevated indicator bacteria concentrations.

Plum Island River MA91-15

This ORW segment is a 0.39 mi^2 Class SA estuary located in Newbury. The segment extends from "high sandy" sandbar just north of the confluence with Pine Island Creek to confluence with Plum Island Sound, Newbury.

Shellfish growing status as of July 2000 and July 2016 (0.35 mi^2): Conditionally Approved (see Figure 1-1).

The DMF collected dry weather samples from one station on this segment between January 1997 and February 2001. The results of their sampling are summarized in Table 4-13 below.

Table 4-13. MA91-15 Plum Island River Fecal Coliform Data Summary

Site Description	Min	Max	n
	cfu/100mL		
DMF 1997-2001			
One station	2	243	89[1]

[1]Fifty-two samples were taken during the primary contact recreation season.

Plum Island Sound MA91-12

This ORW segment is a 4.47 mi^2 Class SA tidal estuary extending from the mouth of both the Parker and Plum Island Rivers, Newbury to the Atlantic Ocean, Ipswich (includes Ipswich Bay). A vessel sewage pump-out facility operates on this segment.

Shellfish growing status as of July 2000: Approved for 1.19 mi^2; Conditionally Approved for 3.33 mi^2; Prohibited for 0.18 mi^2. Shellfish growing status as of July 2016: Approved for 1.09 mi^2; Conditionally Approved for 3.10 mi^2; Prohibited for 0.14 mi^2 (see Figure 1-1).

The DMF collected dry weather samples from three stations on this segment between January 1997 and February 2001. The results of their sampling program are summarized in Table 4-14 below.

Table 4-14. MA91-12 Plum Island Sound Fecal Coliform Data Summary

Site Description	Min	Max	n
	cfu/100mL		
DMF 1997-2001			
Three stations	2	110	140[1]
[1]Eighty-two samples were taken during the primary contact recreation season.			

The DMF collected samples from two stations within this segment between January 2011 and December 2015, and then between February 2016 and February 2020. The results of their sampling program are summarized in Table 4-15 below.

Table 4-15. MA91-12 Plum Island Sound Fecal Coliform Data Summary

Site Description	Min	Max	Geom Mean Range	n
	cfu/100mL			
DMF 2011-2015				
Minuteman station	0.9	18	1.3- 1.88	~60
Alewives station	0.9	20	1.4- 3.15	~60
Dance Hall Station- 01/2011-12/2015	0.9	18	1.2- 1.73	~60
DMF 2016-2019				
Cranes Center Offshore - 03/2016 to 11/2019	0.9	23	N/A	20
Horseshoe- 01/2016 to 01/2020	0.9	17	N/A	67
Middle Ground- 01/2016 to 01/2020	0.9	81	N/A	66
Mouth Ipswich River- 01/2016 to 02/2020	0.9	52	N/A	63
Stage Island Pond, East of Dam- 01/2016	32	32	N/A	1

Steephill Beach-01/2016 to 02/2016	0.9	0.9	N/A	2
Steephill Beach, West Rocks-01/2016 to 02/2016	0.9	0.9	N/A	2
Dance Hall Station-02/2016-02/2020	0.9	70	N/A	820

Rowley River System

The Rowley River System includes the Rowley River and its tributary, the Egypt River. The Rowley River flows into Plum Island Sound. Two segments in the Rowley River System, the Egypt River and the Rowley River, are impaired due to elevated indicator bacteria concentrations.

Egypt River Segment MA91-14

This segment is a 0.03 mi^2 Class SA estuary running from East of Jewett Hill (Latitude 42:42:23.40, Longitude 70:51:47.58 DMS), Ipswich to the confluence with Rowley River, Rowley/Ipswich.
Shellfish growing status as of July 2000 and July 2016 (0.008 mi^2): Conditionally Approved (see Figure 1-

Rowley River Segment MA91-05

This ORW segment is a 0.25 mi^2 Class SA estuary extending from the headwaters, confluence with Egypt River to the mouth at Plum Island Sound, Rowley/Ipswich. Perley's Marina on Warehouse Lane in Rowley has a vessel sewage pump-out facility. There is also a pump-out boat on the Rowley River. The MassDEP WQA lists no discharges for this segment.

Shellfish growing status as of July 2000 and July 2016 (0.25 mi^2): Conditionally Approved (see Figure 1-1).

The DMF collected dry weather samples from one station on this segment between January 1997 and February 2001. The results of their sampling are summarized in Table 4-16 below.

Table 4-16. MA91-05 Rowley River DMF Fecal Coliform Data Summary

Site Description	Min	Max	n
	cfu/100mL		
DMF 1997-2001			
One station	2	46	46[1]
[1]Twenty-seven DMF samples were taken during the primary contact recreation season.			

DMF collected samples from one station in this segment between January 2011 and December 2016. The results of their sampling are summarized in Table 4-17 below.

Table 4-17. MA91-05 Rowley River, DMF Fecal Coliform Data Summary

Site Description	Min	Max	Geo Mean Range	n
	cfu/100mL		cfu/100mL	
DMF 2011-2015				
Gill's Island	0.9	11	1.23- 2.89	~60
DMF 2016-2020				
Gill's Island	0.9	42		16
Mouth of West	0.9	29		67
Rowley River	0.9	18		67
Rowley River at Railroad Ave.	0.9	200		19
Rowley River at Town landing	1.0	90		19

5.0 Potential Sources

The Parker River Watershed has nine estuary segments that are listed in the 2016 ILOW as pathogen-impaired requiring a TMDL (MassDEP 2019). These segments represent 100% of the Parker River Watershed estuary areas that are assessed. Sources of indicator bacteria in the Parker River Watershed are many and varied. A significant amount of work has been done to improve the water quality in the Parker River Watershed.

Largely through the efforts of the EPA, MassDEP, DMF, local governments, and the volunteers of numerous local conservation groups such as the Massachusetts Audubon Society (MAS), the MVPC, and the PRCWA, numerous point and non-point sources of pathogens have been identified.

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

Segment	Potential Sources
Parker River System	
Parker River MA91-02	Failed septic systems, stormwater, improper waste disposal from marinas and boats
Mill River MA91-09	Non-point source pollution, failed septic systems, cesspools,

Segment	Potential Sources
	domestic and feral animals, agricultural sources, wastewater treatment facility
Little River MA91-11	Stormwater, agricultural land use
Rowley River System	
Egypt River MA91-14	Stormwater
Rowley River MA91-05	Stormwater, Waterfowl
Eagle Hill River System	
Paine Creek MA91-03	Stormwater
Eagle Hill River MA91-06	Stormwater
Plum Island System	
Plum Island River MA91-15	Stormwater, Waterfowl
Plum Island Sound MA91-12	Waterfowl

Suspected and known dry weather sources include:

- animal feeding operations,
- animal grazing in riparian zones,
- stormwater drainage systems (illicit connections of sanitary sewers to storm drains),
- failing septic systems,
- recreational activities,
- wildlife including birds, and
- illicit boat discharges.

Suspected and known wet weather sources include:

- wildlife and domesticated animals (including pets), and
- stormwater runoff including municipal separate storm sewer systems (MS4),

It is difficult to provide accurate quantitative estimates of bacteria contributions from the various sources in the Parker River Watershed because many of the sources are diffuse and intermittent, and extremely difficult to monitor or accurately model. Therefore, a general level of quantification according to source category is provided (e.g., see Tables 5-2 and 5-3). This approach is suitable for the TMDL analysis because it indicates the magnitude of the sources and illustrates the need for controlling them. Additionally, many of the sources (failing septic systems, illicit connections) are prohibited, because they indicate a potential health risk and must be eliminated. 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 MassDEP 2010).

Agriculture

Agricultural activities can contribute to bacteria impairments of surface waters. Activities with the potential to contribute to bacterial contamination include:

- field application of manure,
- runoff from grazing areas,
- direct deposition from livestock in streams,
- animal feeding operations,
- leaking manure storage facilities, and
- runoff from barnyards.

Indicator bacteria levels are generally associated with sediment loading. Reducing sediment loading often results in a reduction of indicator bacteria levels as well. Brief summaries of some of these techniques are provided in the "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" (ENSR 2005).

Sanitary Waste

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

The existence of illicit sewer connections to storm drains, which directly discharge sewage into surface waters, is well documented in many urban drainage systems, particularly older stormwater systems that may, originally, have been combined with wastewater conveyances. The US EPA, MassDEP, municipalities, and environmental organizations throughout the Commonwealth have actively pursued identifying and mitigating these sources. The US EPA Region I estimate is that over one million gallons per day (gpd) of illicit discharges were removed in the last decade in the Boston Harbor Watershed, for example. It is probable that illicit sewer connections exist in storm drainage systems serving the older, developed portions of the Parker watershed.

In general, storm drains should only discharge during wet weather events (including snow melt); the presence of discharge during dry weather may indicate illicit connections or illegal hookups to the stormwater conveyance system. Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of (human) sewage in the drainage systems. Approximately 22.4% of the Parker River Watershed is classified as Urbanized Area by the United States Census Bureau and is therefore regulated under the General MS4 Stormwater Permit (EPA 2016) that requires the development and implementation of an illicit discharge detection and elimination plan (IDDE). See Section 8.0 of this TMDL for information regarding IDDE guidance.

Septic systems designed, installed, operated and maintained in accordance with 310 CMR 15.000: Title 5, are not significant sources of bacteria. Studies demonstrate that wastewater located four feet below properly-functioning septic systems contains, on average, less than one fecal coliform bacteria organism per 100 mL (Ayres Associates 1993). Failed or non-conforming septic systems, however, have been found to be a major contributor of bacteria to some segments of the Parker River Watershed. Wastes from failing septic systems enter surface waters either as direct overland flow or via emergent 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. Failed and antiquated septic systems, especially those close to the waterways, represent a high risk to water quality and public health.

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. 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 emptied at a shore-based pump-out facility or discharged into the water more than 3 miles from shore. Uneducated boaters may illegally 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.

In 2014, the US EPA approved the designation of all Massachusetts waters as “No Discharge Zones” (NDZ)(See Figure 2-3); (CZM 2020, EPA 2015). An NDZ means that any discharge of boat sewage is prohibited. This was enacted to better protect the waters from receiving nutrient and bacterial wastes from marine vessels operating within these waters.

Wildlife and Pet Waste

Animals can be a potential source of pathogens. Gatherings of geese, gulls and ducks are speculated to be major pathogen sources, particularly at lakes and stormwater ponds where large resident populations have become established.

Household pets such as cats and dogs can be substantial sources of bacteria. Depending on the size of the dog, research has found that daily fecal production was between 7.6 and 52 grams per day and from 3 million to 8.8 billion enterococci CFU per fecal event. Based on loading estimates to a Florida beach, one dog fecal event was equivalent to fecal shedding from 7,000 adult swimmers or bird fecal events and was the largest source of enterococci to recreational waters (Wright *et al* 2009). One estimate for calculating the fecal waste represented by dogs is ~one dog per ten people producing an estimated 0.5 pound of feces per dog per day. Using the EOEA's 2003 population estimate , this translates to an estimated 16,000 dogs in the Parker River Watershed producing 8,000 pounds of feces per day. Uncollected pet waste is then flushed from parks, beaches and yards where pets are walked to nearby waterways through stormwater runoff.

Stormwater

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

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

Table 5-2. Stormwater Event Mean Fecal Coliform Concentrations*

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	36,600 (98.9)
Multifamily Residential	17,000		16,600 (97.6)
Commercial	16,000		15,600 (97.5)

Land Use Category	Fecal Coliform[1] Organisms / 100 mL	Class B WQS[2]	Reduction to Meet WQS (%)
Industrial	14,000	mL	13,600 (97.1)

* Note: original data provided in (Metcalf and Eddy 1992), as reported in (MassDEP 2002)
[1] Derived from NURP study event mean concentrations and nationwide pollutant buildup data (EPA 1983).
[2] This table was developed under the previous Class B Standard (revised in 2007): Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. The number 400 was used to illustrate required reductions in the "Reduction to Meet WQS (%)" Column. The current standards are discussed in the Executive Summary and Sections 1.

6.0 Prioritization and Known Sources

Efforts to address water quality issues have been carried out by Towns, organizations, state agencies, and citizens to resolve various water quality problems in the basin. The identification of nutrient sources has been the priority, however, measures to address nutrients in an ancillary way have also addressed pathogen pollution and its principal sources. As the introduction to this document states, in general, the principal contributors are failing septic systems, illicit connections to stormwater conduits, catch basins, septic system failures, and pet and/or wildlife wastes (which can be transported by overland stormwater flows into streams, rivers, lakes/ponds, and eventually into coastal-estuary areas). Rigorous efforts are necessary in controlling pollutants such as bacteria in the Parker River Watershed because most of this area is within a short distance (a few miles) to coastal/estuarine locations and shellfish habitat.

All nine estuary segments covered in this TMDL document and classified as SA by MassDEP) designated for shellfishing) are impaired for fecal coliform and included in the 2016 ILOW (MassDEP 2019a). The standards for these potential shellfishing waters (<14 cfu/100mL fecal coliform) are far more stringent than the primary contact recreation standard for inland Class B waters (*E. coli* <126 cfu). For estuary areas to meet SA standards, exhaustive pollution remediation work is necessary in all upstream Parker River segments to detect and eliminate bacteria sources. All drainage areas, including rivers, streams and smaller tributaries from the inland areas, must have especially clean waters, with very low background bacteria levels for shellfishing beds to remain open in formerly closed areas, or to open in presently closed areas. Table 6-1 below provides a listing of the segments covered in this TMDL and a prioritization guide for implementing restoration strategies based on principal bacteria sources.

Table 6-1. Pathogen Impaired Segment Priorities for the Parker River Watershed

Segment ID	Segment Name	Class/ Qualifier	Size- (mi^2)	Segment Description	Priority	Indicators
MA91-06	Eagle Hill River	SA, B/ ORW	0.35	Headwaters north of Town Hill, east of Town Farm Road, Ipswich	Medium*	Fecal Coliform

				to the mouth at Plum Island Sound, Ipswich.		
MA91-14	Egypt River	SA, B/ ORW	0.03	East of Jewett Hill (Latitude 42:42:23.40, Longitude 70:51:47.58 DMS), Ipswich to mouth at confluence with Rowley River, Rowley/Ipswich.	Medium*	Fecal Coliform
MA91-11	Little River	SA, B/ ORW	0.09	Scotland Road/Parker Street, Newbury/Newburyport to mouth at confluence with Parker River, Newbury.	Medium*	Fecal Coliform
MA91-09	Mill River	SA/ Shellfishing/ ORW	0.09	Route 1, Rowley/Newbury to mouth at confluence with Parker River, Newbury.	Medium*	Fecal Coliform
MA91-03	Paine Creek	SA/ ORW	0.06	Headwaters east of Town Farm Road, Ipswich to confluence with Eagle Hill River, Ipswich	Medium*	Fecal Coliform
MA91-02	Parker River	SA/ Shellfishing/ ORW	0.6	Central Street, Newbury to mouth at Plum Island Sound, Newbury	Medium*	Fecal Coliform
MA91-15	Plum Island River	SA/ Shellfishing/ ORW	0.39	From “high sandy” sandbar just north of the confluence with Pine Island Creek, Newbury to confluence with Plum Island Sound, Newbury	Medium*	Fecal Coliform
MA91-12	Plum Island Sound	SA/ Shellfishing/ ORW	4.47	From the mouth of both the Parker River and Plum Island River, Newbury to the Atlantic Ocean, Ipswich (includes Ipswich Bay)	Medium*	Fecal Coliform
MA91-05	Rowley River	SA/ Shellfishing/ ORW	0.25	Headwaters, confluence with Egypt River, Rowley/Ipswich to mouth at Plum Island Sound, Rowley/Ipswich	Medium*	Fecal Coliform
* use elevated due to class qualifier or proximity to sensitive use segment						

The Little River subwatershed has been the subject of study over the past 20 years. The Merrimack Valley Planning Commission developed the “Parker River Watershed, Assessment and Management of Nonpoint Source Pollution in the Little River Subwatershed” in 1998-2001 (MVPC 2001). Significant factors found in the study included: (1) farms contributing animal and agricultural wastes (including bacteria) to the Little River and tributaries; (2) leaking sub-surface sewer lines; (3) septic system failures discharging wastes through overland and subsurface flows into stormwater conveyances, the Little River mainstem/or tributaries; and (4) poor household waste management (including pet wastes) resulting in contamination of stormwater. Any one or more of these factors could result in fecal coliform levels exceeding 14 cfu/100mL, the standard for Class SA waters. These situations may exist elsewhere in the Parker River Watershed, including the Eagle Hill, Mill and Rowley Rivers systems, and Plum Island Sound. Identifying land uses and sewered/unsewered areas within each sub-watershed is the first step in identifying causes and sources of pollution. Much of the Parker River Watershed is serviced by on-site sewer systems, except Newbury and the southernmost portion of Newburyport. Elevated bacteria levels in tributaries adjacent to sewered residential and/or mixed residential/commercial areas may originate in sewer line leaks reaching stormwater conveyances. Elevated bacteria levels in tributaries in non-sewered areas may indicate failing septic systems. Within estuary areas, including the Parker River National Wildlife Refuge, large bird populations congregate at certain times each year; such gatherings generate fecal wastes which are then moved by stormwater or tidal action. Recreational waters with high bacteria counts may point to rest room facility failures, or pet/nuisance bird wastes. The MS4 General Stormwater Permit requires the detection and elimination of principal sources, as well as increased education and outreach on proper pet and agricultural waste management and disposal.

Prioritization of Future Activities

As a basis for setting bacterial implementation priorities within the Parker River Watershed, Table 6-1 (above) provides a prioritized list of pathogen-impaired segments that will require additional bacterial source tracking and stepwise implementation of structural and non-structural Best Management Practices (BMPs). Priority should be given to segments with insufficient information to understand the current conditions. Since limited source information and data are available for each impaired segment, a simple scheme was used to prioritize segments based on bacteria concentrations. Data for the waterbody segments in the ILOW in the Parker River Watershed are listed in Tables 4-4 to 4-22 in Section 4 of this report.

- Segments are prioritized for restoration according to the following metrics: The highest priority is assigned to segments where dry or wet weather concentrations equal or exceed 10,000 col/100 ml, as such high levels generally indicate a direct sanitary source.
- Medium priority is assigned to segments where concentrations ranged from 1,000 to 9,999 col/100ml, as this range of concentrations generally indicates a direct sewage source that may be diluted in the conveyance system.
- The lowest priority is assigned to segments where concentrations were consistently below 1,000 col/100 ml.

The highest fecal coliform, *E. coli*, or enterococci counts from Table 4-4 to 4-22 of this report (above) were used to prioritize segments for additional bacteria source tracking (BST) surveys and implementation of BMPs. Additional prioritization metrics include the proximity of waters within the segment to sensitive areas such as Outstanding Resource Waters (ORWs), or designated uses that require higher water quality standards than Class B, such as public water supplies, public swimming areas, shellfish areas, or Outstanding Resource Waters (ORWs). Best professional judgment is used in determining whether one or more of these factors warrant an upward adjustment of the level of priority.Waters that were determined to be lower priority based on the numeric range identified above, were elevated one level of priority if that segment were adjacent to or immediately upstream of a sensitive use. An asterisk (*) in the priority column of Table 6-1 for a segment with a qualifying sensitive use indicates this upward adjustment.

All nine segments in this TMDL were assigned Medium priority for restoration based on available data, sensitive use such as shellfishing or ORW designation. Failing septic systems, runoff from horse farms, and stormwater runoff appear to be the highest overall contributors to bacteria pollution present in the Parker River watershed. Therefore, control and elimination of these are the highest priority actions to take to reduce bacteria levels and improve water quality. Significant factors contributing to elevated dry weather bacteria concentrations are illicit sewer connections; under wet weather conditions, the significant sources are sanitary sewer overflows (SSO's) and failing sewer infrastructure systems. Eliminating illicit connections and SSOs, and repairing failing infrastructure will result in reductions in bacterial pollution. As stated in Section 8.2 and other parts of this report, considerable progress has been made in addressing all these sources.

Under dry weather conditions, BST surveys are very effective in locating illicit connections, as well as other human pathogen sources. Identification and remediation of dry weather bacteria sources is typically more straightforward and successful in reducing pathogen levels in surface waters than in addressing wet weather sources. If illicit connections and other human infrastructure sources are found and eliminated in the Parker River watershed, significant reductions in surface water bacteria levels are anticipated in both dry and wet-weather flows.

Finding and fixing bacteria-related pollution from sources such as illicit connections and failed infrastructure poses significant logistical challenges. Segments impaired during wet weather should be evaluated for the effectiveness of stormwater BMP strategies, starting with non-structural practices (e.g., more frequent street sweeping and catch basin cleaning, local regulatory controls), followed by structural measures, as the former tend to be less costly than the latter. Failed infrastructure requires repair or replacement to eliminate the source(s) of pathogenic pollution.

7.0 Pathogen TMDL Development

Section 303 (d) of the Federal Clean Water Act (CWA) requires states to identify waters that do not meet the water quality standards on a list of impaired waterbodies. The *2016 Integrated List of Waters*

(MassDEP 2019a) identified nine estuary segments within the Parker River Watershed as impaired by excessive (indicator) bacteria concentrations.

The CWA requires each state to establish Total Maximum Daily Loads (TMDLs) for the pollutant(s) impairing each Category 5-listed water. TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating state water quality standards, including both point and non-point pollution sources. EPA regulations require that point sources of pollution (those discharges from discrete pipes or conveyances) subject to permits from the National Pollution Discharge Elimination System (NPDES) program receive a waste load allocation (WLA) specifying the maximum amount of a pollutant they can release to a waterbody. Non-point sources of pollution (all sources of pollution other than point sources) receive load allocations (LA) specifying the amount of a pollutant that they can release to the waterbody. Where stormwater is a source of pathogenic pollution, it is often difficult to identify and distinguish between point source discharges that are subject to NPDES regulations and those that are not. Therefore, EPA has stated that it is permissible to include all point source stormwater discharges in the WLA portion of the TMDL; MassDEP has taken this approach in developing TMDLs. In accordance with the CWA, a TMDL must account for seasonal variations, and include a margin of safety (MOS), to account for the potential lack of knowledge concerning the relationship between effluent limitations and water quality. Thus:

TMDL = WLAs + LAs + MOS

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 sources 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 (and point sources not subject to NPDES permits).

MOS = Margin of safety, either explicitly or implicitly.

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 bacteria pollution is regulated i.e., according to concentrations standards, however, the standard loading approach is provided as well.

7.1 General Approach: Development of TMDL Targets

MassDEP set daily concentration TMDL targets for all potential pathogen sources by category (i.e., stormwater, NPDES discharges, etc.) and surface water classification (e.g., Class A ORW). Expressing a loading capacity for bacteria in terms of concentrations equal to the Commonwealth's adopted criteria, as provided in Table 7-1, provides the clearest and most understandable expression of water quality goals to the public and to groups that conduct water quality monitoring. MassDEP recommends that the concentration targets be used as the primary guide for implementation (see Section 7.2).

For estuaries, total maximum daily pathogen loads were typically calculated based on long-term average runoff volumes. The loading calculations for all 9 estuary segments included in this TMDL were estimated by using 1) the concentration allowed by appropriate criteria from the Massachusetts SWQS and 2) the estimated volume of runoff entering the estuary from each contributing watershed (See Section 7.3 for detailed methodology).

Based on the potentially large number of pollution sources and the difficulty of identifying and eliminating them, meeting the TMDL end points will take time to accomplish. For example, with stormwater, an iterative approach is needed that includes prioritization of outfalls and the application of BMPs, until water quality standards are met. MassDEP believes this approach is consistent with current EPA guidance and regulations as stated in a November 22, 2002 EPA memo from Robert Wayland with an addendum from Andrew Sawyers provided November 26, 2014 (see Attachment B).

7.2 Waste Load Allocations (WLAs) and Load Allocations (LAs) As Daily Concentration (CFU/100mL).

To ensure attainment with SWQS throughout the waterbody, the TMDL goal is to meet the applicable SWQS at the point of discharge, with a MOS included in the calculation.

Sections 4, 5 and 6 of this document discuss in more detail the types of sources identified as well as their prioritization for implementation. Although the sources of bacteria in the Parker River Watershed are varied, data indicate that most of them are likely to be associated with stormwater transport. Point sources within the Parker River Watershed that can potentially affect bacteria pollution levels include any stormwater system discharges in the communities regulated under the Stormwater Phase II MS4 Program that discharge to impaired waterbodies.

Waste load allocations for discharges from NPDES-permitted wastewater treatment plants (WWTP) are set to equal the applicable water quality standards. All discharges from a pipe, conduits, et cetera are point sources regardless of whether they are currently subject to a NPDES permit. Therefore, a WLA equal to the SWQS criteria will be assigned to that portion of the stormwater load that discharges to surface waters via storm drains. For any illegal sources, including illicit discharges to stormwater systems, the goal is complete elimination (100% reduction). The TMDL goal is to meet applicable water quality standards through implementation of prioritized control measures. Attaining SWQS at the point of discharge is environmentally protective and a practical means of identifying and evaluating the effectiveness of ongoing control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and others responsible for monitoring activities. Success of control efforts and subsequent conformance with this TMDL will be determined when bacteria values meet the indicator criteria SWQS for each water body.

Table 7-1 presents the TMDL indicator bacteria WLAs (point sources) and LAs (load allocations) for the various source categories as daily concentration targets for the nine Parker River Watershed estuaries. The full version of the revised SWQS can be accessed at the MassDEP website (MassDEP 2007).

Table 7-1 Sources and Expectations for Limiting Bacterial Contamination in the Parker River Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
A, B, SA, SB	Illicit discharges to storm drains	0	Not applicable
	Leaking sanitary sewer lines	0	Not Applicable
	Failing septic systems	Not Applicable	0
A (Includes filtered water supply) &**B**		Either: a) E. coli <=geometric mean[2] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL[3]; or b) Enterococci geometric mean[2] <= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL[3]	Not Applicable
	Nonpoint source stormwater runoff[4]	Not Applicable	Either: c) E. coli <=geometric mean[2] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL[3]; or d) Enterococci geometric mean[2] <= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL[3]

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
SA (approved for shellfishing)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[5,6], and combined sewer overflows[7].	Fecal Coliform <= geometric mean[2], MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL[3]
SA & SB (Beaches and non-designated shellfish areas)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[5,6], and combined sewer overflows[7].	Enterococci - geometric mean[2] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL[3]	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Enterococci -geometric mean[2] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL[3]
SB (approved for shellfishing w/depuration)	Any regulated discharge - including stormwater runoff[7] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[5,6], and combined sewer overflows[7].	Fecal Coliform <= median or geometric mean[2], MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL[3]	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= median or geometric mean[2], MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL[3]

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]

Note: This table represents waste load and load allocations based on water quality standards current as of the publication date of these TMDLs. If the pathogen criteria change in the future, MassDEP intends to revise the TMDL by addendum to reflect the revised criteria.

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.
[2] Geometric mean of the 5 most recent samples is used at bathing beaches. For all other waters and during the non-bathing season the geometric mean of all samples taken within the most recent six months, typically based on a minimum of five samples.
[3] Threshold for beach closure. Beaches Environmental Assessment and Coastal Health (BEACH) Act.
[4] The expectation for WLAs and LAs for stormwater discharges is that they will be achieved through the implementation of BMPs and other controls.
[5] Or shall be consistent with the Wastewater Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.
[6] Seasonal disinfection may be allowed by the Department on a case-by-case basis.
[7] Or other applicable water quality standards for CSO's.

MassDEP recommends that these concentration targets be used to guide implementation actions. The goal of meeting SWQS at the point of discharge can be easily understood by the public and others responsible for monitoring activities. Success of control efforts and subsequent conformance with the TMDL can be determined by documenting that a sufficient number of valid bacteria samples from the receiving water meet the appropriate indicator criteria (WQS) for the water body. Compliance will be determined by concentrations measured in the receiving water.

Potential Sources of Bacterial Contamination

The potential sources of bacteria impairing a waterbody can be tentatively determined based on whether the data indicate the highest pollutant concentrations occur under wet or dry weather conditions. When data indicate that a segment has elevated bacteria levels during dry weather, sources such as point source discharges, failing septic systems, combined sewer overflows, illicit sanitary sewer connections to storm drains, and/or leaking sewer infrastructure, may be primary contributors. Where elevated levels are observed during wet weather, potential sources may include flooded septic systems, surcharging sewers (combined sewer overflows or sanitary sewer overflows), and stormwater runoff. In urban areas, sources of elevated bacteria concentrations can include runoff carrying wastes from domestic animals or pets. Sections 4, 5 and 6 of this document provide more detail on the types of sources identified in the Parker River Watershed, as well as their prioritization for implementation actions.

7.3 TMDL Expressed as Daily Load (cfu/Day)

The following section describes the approach taken in this TMDL for deriving allowable daily bacteria loads for estuaries in the Parker River Watershed.

Bacteria can be described in terms of concentrations and loads. However, the common way of expressing concentrations of bacteria is in terms of the number of organisms, or colony-forming units, rather than weight. Bacteria standards for water are written in terms of concentrations, and while the method of determining the concentrations can be by direct count or estimated through the outcome of some reaction, it is numbers that are judged in a given volume of water. As described above, the load is determined by multiplying the concentration by the volume of water.

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). TMDLs are expressed as total maximum daily loads (e.g., pounds per day). Expressing stormwater pathogen TMDLs in terms of daily loads is difficult to interpret given the very high numbers of indicator bacteria.

7.3.1 Embayments

For all nine of the Parker River estuarine segments included in this TMDL, loading was estimated using the methodology employed in other Massachusetts estuarine pathogen TMDLs (MassDEP 2009, MassDEP 2012, MassDEP 2014, MassDEP 2018, MassDEP 2020). Land-uses in the subwatersheds draining to these embayments include populated areas, as shown in Figure 2-1; areas within these land uses span 22% of the Parker River Watershed. Many of these areas have a moderate to high percentage of impervious cover. As a result, the allowable pathogen loading for these embayments was calculated by multiplying the concentration allowed by the Massachusetts SWQS by the estimated volume of runoff entering from each contributing watershed. Runoff estimates for the region were extracted from historical precipitation and runoff data maintained by MassDCR and USGS. MassDCR precipitation records from 1915-2007 show an average precipitation for the Eastern Coastal Area of Massachusetts of 45.7 inches per year (3.8 ft/year) (MassDCR 2010). Based on USGS gage data collected from 1905-2007, the average runoff for Massachusetts is 2.0 feet per year. The estimated volume of runoff entering the nine embayments from each contributing watershed was conservatively estimated by assuming that all precipitation to impervious areas ran directly into a local waterway (average runoff value of 45.7 inches per year or 3.8 feet). In pervious areas, a conservative estimate of 24 inches per year (2.0 feet) was used, which represents the 50^{th} percentile of runoff values observed at USGS gages in New England (Hydrologic Unit 1) from 1905 through 2007.

The derived runoff value was then multiplied by the contributing watershed acreage and the most stringent water quality standard for each segment to calculate the allowable annual load as total number of bacteria per year (cfu/year). The daily TMDL was then calculated by dividing the allowable annual load by the number of days in a year (365). Finally, the total daily load allocation was divided into wasteload and load allocations based on the ratio of impervious to pervious land within each watershed.

The resulting TMDL for embayments is reflected in the following equation:

TMDL = WLA + LA + MOS

Where:

WLA = allowable load for point source categories (including piped stormwater) within 200 ft buffer zone

LA = allowable load for nonpoint source categories associated with pervious areas within 200 ft buffer zone = 0

MOS = margin of safety

Hence, the allowable total bacteria load on an annualized basis was calculated as the water quality standard (14 CFU/100 ml of fecal coliform for Class SA shellfishing; 33 CFU/100 ml of enterococci for Class SA Primary Contact) times the estimated annual runoff associated with impervious areas within the 200-foot buffer zone (once conversions for the various units are applied). The daily load of pathogens in CFU/day is then calculated by dividing the allowable annual load by 365 days. The formula and calculations are provided below in Section 7.3.3, 'Calculating the TMDL as Daily Loads'.

7.3.2 Water Quality Criteria

The water quality criteria used to develop the TMDL was based on the most stringent designated use identified in the Massachusetts SWQS. In the case of the Parker River Watershed the principal and most sensitive uses include primary contact recreation and shellfishing use. A summary of the relevant water quality criteria that apply to the Parker River Watershed are summarized in Table 7-2.

Table 7-2 Water Quality Targets for the Parker River Watershed.

Waterbody Use	**Shellfishing Criterion (apply in DMF approved areas)**		**Primary Contact Recreation Criterion**	
	Fecal coliform (CFU/100LmL)		*E. coli* (CFU/100mL)	Enterococci (CFU/100mL)
Waterbody Class	Geometric Mean	10% of samples not to exceed	Geometric Mean	Geometric Mean
SA	14[a]	28[a]	None	33[b]
B			126[b]	33

[a] Fecal coliform is the indicator.
[b] *E.Coli* and Enterococci are indicators, the MA Surface Water Quality Standards can be found in 314 CMR 4: The Massachusetts Surface Water Quality Standards.

7.3.3 Calculating the TMDL as Daily Loads (CFU/Day)

For this TMDL MassDEP expresses indicator bacteria proportional to flow. Because the Surface Water Quality Standard is also expressed in terms of the concentration of colony-forming organisms per 100 mL, the acceptable daily load or TMDL for each estuary is the product of the contributing watershed runoff and the SWQS criterion, which is the same approach used for any pollutant with a numerical criterion.

The TMDL is based on volume and the concentration of the applicable Massachusetts SWQS criterion for bacteria. Once the volume is estimated, the total maximum daily load of bacteria in colony-forming units per day is derived by multiplying the estimated runoff volume by the SWQS criterion for the indicator bacteria.

Example calculations for determining the TMDL are provided as follows:

Class SA - Fecal Coliform Annual Waste Load Allocation (WLA) for Impaired Segment (CFU/Year) =

(200 ft buffer area in acres) x (43,560 ft^2/acre) x (fraction impervious area in 200-foot buffer area) x (3.75 ft/year annual precipitation) x (1.4 CFU/ml) x (1000 ml/l) x (28.32 l/ft^3) = CFU/year

(note the Fecal Coliform Standard is 14 CFU/100 ml or 1.4 CFU/mL)

Class SA- Fecal Coliform Daily WLA for Impaired Segment (CFU/Day) =

(CFU/year) x (year/365 days) = CFU/day

Class SA - Enterococci Annual Waste Load Allocation (WLA) for Impaired Segment (CFU/Year) =

(200 ft buffer area in acres) x (43,560 ft^2/acre) x (fraction impervious area in 200-foot buffer area) x (3.75 ft/year annual precipitation) x (3.5 CFU/1 ml) x (1000 ml/l) x (28.32 l/ft^3) = CFU/year

(note the Enterococci standard is 35 CFU/100 ml or 3.5 CFU/mL)

Class SA- Enterococci Daily WLA for Impaired Segment (CFU/Day) =

(CFU/year) x (year/365 days) = CFU/day

The Embayment TMDL is proportioned between the WLA and LA by multiplying the daily load by the percent impervious for the WLA, and by multiplying the daily load by the percent pervious for the contributing watershed for the LA. Table 7-3 summarizes the TMDL for the 303(d) impaired marine segments in the Parker River Watershed.

Table 7-3 WLA and LA TMDL by Embayment for the Parker River Watershed (CFU/Day).

Segment	Name	SWQS Class	% Impervious	% Pervious	Water-shed Area Acres	Shellfishing Indicator Fecal Coliform (cfu/100mL)	Swimming Indicator Enterococci (cfu/100mL)	TMDL Fecal Coliform *WLA* (cfu/day)	TMDL Fecal Coliform LA (cfu/day)	TMDL Fecal Coliform Total (cfu/day)	TMDL *Entero-cocci WLA* (cfu/day)	TMDL *Entero-cocci* LA (cfu/day)	TMDL Entero-cocci Total (cfu/day)
MA91-06	Eagle Hill River	SA	3.5%	96.5%	1,151	14	35	7.23E+07	1.05E+09	1.12E+09	1.81E+09	2.62E+09	4.43E+09
MA91-14	Egypt River	SA	6.8%	93.2%	4,179	14	35	5.10E+06	3.68E+09	4.19E+09	1.28E+09	9.20E+09	1.05E+10
MA91-11	Little River	SA	11.1%	88.9%	6,707	14	35	1.34E+09	5.63E+09	6.97E+09	3.34E+09	1.41E+10	1.74E+10
MA91-09	Mill River	SA	7.2%	92.8%	11,771	14	35	1.52E+09	1.03E+10	1.18E+10	3.80E+09	2.58E+10	2.96E+10
MA91-03	Paine River	SA	1.0%	99.0%	246	14	35	4.42E+06	2.30E+08	2.35E+08	1.10E+07	5.75E+08	5.86E+08
MA91-02	Parker River	SA	7.6%	92.4%	32,101	14	35	4.38E+09	2.80E+10	3.24E+10	1.09E+10	7.01E+10	8.10E+10
MA91-15	Plum Island River	SA	1.2%	98.8%	658	14	35	1.42E+07	6.14E+08	6.28E+08	3.54E+07	1.53E+09	1.57E+09
MA91-12	Plum Island Sound	SA	5.7%	94.3%	454	14	35	4.65E+07	4.04E+08	4.51E+08	1.16E+08	1.01E+09	1.13E+09
MA91-05	Rowley River	SA	5.5%	94.5%	6,271	14	35	6.19E+06	5.60E+09	6.22E+09	1.55E+09	1.40E+10	1.56E+10

7.3.4 Wasteload Allocations (WLAs) and Load Allocations (LAs)

The only WWTP in the Parker River Watershed is at Governor Dummer Academy in Newbury (permitted for 52,000 gpd). However, there are numerous stormwater 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. All piped discharges are set at the SWQS. Therefore, a WLA set equal to the WQS will be assigned to the portion of the stormwater 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 segments within the Parker River 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 in the extreme northern part of the watershed represent significant primary dry weather point sources of indicator bacteria, while failing septic systems, animal, bird and pet wastes represent principal non-point sources. Wet weather point sources include discharges from stormwater drainage systems (including MS4s). Wet weather non-point sources primarily include diffuse stormwater runoff.

7.3.5 Stormwater Contribution

Part of the stormwater contribution originates from point sources and is included in the wasteload allocation, and part comes from non-point sources and is included in the load allocation of the TMDL. The fraction of the runoff load attributed to the wasteload allocation is estimated from the fraction of the watershed that has impervious cover because stormwater from impervious cover is more likely to be diverted, collected and conveyed to the receiving water by stormwater collection systems than pervious areas. The fraction of the TMDL associated with the wasteload allocation was estimated, using MassGIS and the algorithm within it to estimate the extent of impervious surface. The wasteload allocation was then defined by multiplying the TMDL for each segment by the percent of imperviousness in each watershed. Likewise, the load allocation was estimated using the percent pervious cover in each watershed. MassDEP believes this approach is conservative because it assumes that all runoff from impervious areas enters the waterbody segment in question, which may or may not always be the case.

For example, based on information from MassGIS and the algorithm within it used to estimate the extent of impervious versus pervious surface area, within the Parker River Watershed (from everything upstream of the USGS gage, in Segment MA91-02, Class SA, in Byfield) 7.6% is impervious and 92.4% pervious. Thus, 7.6% of the acceptable bacteria load at a given flow is assigned as wasteload allocation while 92.4% of the total load represents the load allocation. Therefore, in a segment for which the average daily flow (on the Parker River, at the Byfield MA USGS Gage) is 37.2 cfs, the allowable bacteria load for that day and location or segment is $1.27x10^{10}$ fecal coliform/day (from Figure 7-1). Therefore, for that flow in the Parker River at the Byfield Gage, the wasteload allocation is $9.68x10^{8}$ bacteria per day (i.e., (0.076) x ($1.27x10^{10}$ bacteria/day) and the load allocation is $1.17x10^{10}$ bacteria per day (i.e., (0.924) x ($1.27x10^{10}$ bacteria/day).

7.4 Application of the TMDL to Unimpaired or Currently Unassessed Segments

This TMDL applies to the 9 pathogen impaired estuary segments of the Parker River Watershed that are currently listed on the 2016 CWA § 303(d) list of impaired waters. MassDEP 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. Water quality has improved in some areas after the publication of the draft TMDL and continued sampling to assess progress towards reducing bacterial pollution is recommended.

This TMDL may be used as a pollution prevention TMDL as it would have identical wasteload and load allocations (WLA, LA) based on the sources present and the designated use of the water body segment (see Table 7-1). This Parker River Watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such future-impaired 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) ILOW, the MassDEP determines (with EPA approval of the CWA § 303(d) list) that this TMDL should apply to future pathogen impaired segments.

7.5 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 SWQS, 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. Third, the TMDL assumes that all the runoff from impervious areas throughout the contributing watershed enters the impaired segment, which is generally not the case especially in large watersheds where impervious surfaces are not directly connected.

While the general vulnerabilities of coastal areas to climate change can be identified, specific impacts and effects of changing estuarine conditions are not well known at this time. Because the science is in progress, MassDEP is unable to analyze detailed climate change impacts on streamflow, precipitation, and nutrient loading with any degree of certainty for TMDL development. Considering these uncertainties and informational gaps, MassDEP has opted to address all sources of uncertainty through an implicit MOS. MassDEP does not believe that an explicit MOS approach is appropriate under the circumstances or will provide a more protective or accurate MOS than the implicit MOS approach, as the available data simply does not lend itself to characterizing and estimating loadings to derive numeric allocations within confidence limits. Although the implicit MOS approach does not expressly set aside a specific portion of the load to account for potential impacts of climate change, MassDEP has no basis to conclude that the conservative assumptions that were used to develop the numeric model applications are insufficient to account for the lack of knowledge regarding climate change.

7.6 Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Pathogen sources to Parker River Watershed 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 SWQS 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.

8.0 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 Parker River Watershed. MS4 Communities with stormwater infrastructure that discharges to impaired waterbodies with TMDLs are subject to additional requirements under the MS4 General Stormwater permit.

Elevated dry weather bacteria concentrations could be the result of illicit sewer connections, leaking sewer pipes, sanitary sewer overflows, or failing septic systems. These sources are illegal and must be eliminated, so first overall priority should be given to BST activities to investigate potential illicit bacteria sources in segments impaired by bacteria during dry weather. Tracking and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. If illicit bacteria sources are found and eliminated it should result in a dramatic reduction of bacteria concentration in the segment in both dry and wet weather. A comprehensive program is needed to ensure illicit sources are identified and that appropriate actions will be taken to eliminate them. Guidance can be found in the following references: Center for Watershed Protection Manual entitled: "*Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments"* (EPA 2004); Practical guidance for municipalities is provided in a New England Interstate Water Pollution Control Commission publication entitled "*Illicit Discharge Detection and Elimination Manual, A Handbook for Municipalities"* (NEIWPCC 2003).

Stormwater runoff represents another major source of pathogens in the Parker River Watershed, and the current level of control is inadequate for standards to be attained in several segments. Improving stormwater runoff quality is essential for restoring water quality and recreational uses. It may not be cost effective or even possible to track and identify all wet weather sources of bacteria, therefore segments impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with intensive application of less costly non-structural practices (such as street sweeping, and/or managerial strategies using local controls). Periodic monitoring to evaluate the success of these practices should be performed and, depending on the degree of success of the non-structural stormwater BMPs, more expensive structural controls may become necessary to meet water quality standards. This adaptive management approach to controlling stormwater contamination is the most practical and cost- effective strategy to reduce pathogen loadings as well as loadings of other stormwater pollutants (e.g., nutrients and sediments) contributing to use impairment in the Parker River Watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the Parker River Watershed including sewer connections to drainage systems, leaking sewer pipes, sanitary sewer overflows, and failing septic systems, are prohibited and must be eliminated. Individual sources must be first identified in the field before they can be abated. Pinpointing sources typically requires extensive monitoring of the receiving waters and tributary stormwater 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 MassDEP, Office of Coastal Zone Management, Merrimack Valley Planning Commission, Massachusetts Audubon Society, Marine Biological Laboratory Marine Ecosystem Research Center, Parker River Clean Water Association (PRCWA), DMF, and communities within the Parker River Watershed 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 action.

For these reasons, a basin-wide implementation strategy is recommended. The strategy includes a mandatory program for implementing stormwater BMPs and eliminating illicit sources. The "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual* *for Massachusetts*" ", (ENSR 2005) and the Massachusetts Clean Water Toolkit (MassDEP, Geosyntec), were both developed to support implementation of pathogen TMDLs (including BMPs).

TMDL implementation-related tasks are shown in Table 8-1. The MassDEP, 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 8-1. Tasks

Task	Organization
Writing TMDL	MassDEP
TMDL public meeting	MassDEP
Response to public comment	MassDEP
Organization, contacts with volunteer groups	MassDEP/PRCWA
Development of comprehensive stormwater management programs, particularly near each embayment, including identification and implementation of BMPs	Parker River Watershed Communities
Illicit discharge detection and elimination (where applicable)	Parker River Watershed Communities and PRCWA
Inspection and upgrade of on-site sewage disposal systems as needed Education of No-Discharge Zone Regulations	Homeowners, Parker River Watershed Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	MassDEP, Parker River Watershed Communities, and PRCWA
Organize and implement education and outreach program	Parker River Watershed Communities
Write grant and loan funding proposals	MassDEP, Parker River Watershed Communities, and PRCWA
Inclusion of TMDL recommendations in Executive Office of Energy and Environmental Affairs (EEA) Watershed Action Plan	EEA
Surface Water Monitoring	MassDEP, CZM, DMF, Parker River Watershed Communities, and PRCWA
Provide periodic status reports on implementation of remedial activities	MassDEP, Parker River Watershed Communities, and PRCWA

8.1 Summary of Organizations and Activities within the Parker River Watershed

The Parker River Clean Water Association (PRCWA) is dedicated to preserving and protecting the watershed. The group focuses on education, volunteering, and technical assessment. The Association strives to be a leader in the community. The Association's volunteers collect information on the watershed to help educate local government and citizens. The PRCWA's water quality monitoring program focuses on sites throughout the watershed and monitors for many parameters including fecal coliform (PRCWA 2020). Data has not been collected under an approved by PRCWA and therefore could not be used by MassDEP in this TMDL.

The Parker-Ipswich-Essex River Watersheds Action Plan (PIE Rivers, 2019) The report identifies several areas of concern including failing septic systems and other wastewater systems, stormwater runoff, agricultural runoff, and removal of natural vegetative buffers. This TMDL is consistent with the Pie Rivers report in that it addresses some of the concerns presented in the report.

Implementation of measures to meet Parker River Watershed TMDL targets will proceed at the local level. This approach is particularly appropriate for the Parker River Watershed as it consists not of a single river basin, but of many drainage sub-basins, each with their own conditions and problems. The MassDEP will work with local governments, plus local watershed and conservation organizations (such as Massachusetts Audubon Society, Merrimack Valley Planning Commission, and the Parker River Clean Water Association), EPA, CZM – North Shore Regional Office and other team partners to make every reasonable effort to assure implementation of this TMDL.

Data supporting this TMDL indicate that indicator bacteria enter the Parker River Watershed from several contributing sources, under a variety of conditions. Activities that are currently ongoing and/or planned to ensure that the TMDL can be implemented 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.

In addition, the DEP, CZM, and EPA have sponsored various program (MWI, 319, 104(b)(3), CPR (Coastal Pollution Remediation- CZM) grant projects related to controlling bacteria throughout the basin over the past decade. Projects specifically funded by the Massachusetts Watershed Initiative Grants program include: (1) Development of Watershed Management Plans for Rock and Pentucket Ponds- a $29,850 project to assess existing data as well as point and nonpoint source pollution, evaluate existing land- use and pollution control measures and to prepare action oriented watershed management plans for both Rock and Pentucket Ponds (MVPC 2002); and (2) A past EOEA effort, the Parker River Watershed Year 5

Watershed Action Plan (2006-2010), encompassed water quality action planning and included bacteria controls (EOEA 2005).

To assist local communities in their efforts to reduce bacterial contamination, the MassDEP had implemented a bacterial source tracking program in the early 2000's, headquartered at the MassDEP office in Wilmington. The primary goal was to implement BST in targeted, high- priority polluted areas on the 303(d) impaired list, where it was believed implementation solutions would result in improved water quality..

A project funded by the 319 Grant program included the Mill River Nonpoint Source Management Program, 1994. This was a $49,063 project awarded to the Massachusetts Audubon Society to remediate stormwater, septic system, and agricultural nonpoint sources of pollution in the Mill River subwatershed through BMP implementation. This involved efforts of stormwater road runoff control, and agricultural controls, accompanied by public education and changes in local bylaws and policies in the Town of Rowley.

With respect to the CZM, Coastal Pollutant Remediation Program, the MVPC and the Town of Georgetown received a CPR grant in 1999 for the Pentucket Pond Stormwater Assessment Project, which conducted six rounds of bacteria and other parameters sampling at sixteen (16) sites around Pentucket Pond (MVPC 2000).

A 604 and 604(b) Grant funded project, Parker River Watershed, Assessment and Management of Nonpoint Source Pollution in the Little River Subwatershed, was conducted by the Merrimack Valley Planning Commission during 1998-2001 (MVPC 2001). The principal findings, already reviewed in Section 6.0 (Prioritization and Known Sources), indicates a number of bacteria sources and considerations: (1) farm- agricultural and animal husbandry aspects; (2) failing sub-surface sewer carrying lines in areas that are sewered, or have sewer lines passing through them; (3) failing or substandard septic systems whose (surface or sub-surface) drainage goes into tributaries or stormwater conveyances; (4) poor private residence yard/pet waste management practices; (5) poor boat waste disposal or other waste disposal practices in estuarine/coastal or in marina areas, or restroom leakage from facilities in swimming areas.

Study and Rehabilitation of Closed Coastal Shellfish Beds

Shellfish beds along the Parker River Watershed coast have been closed or conditionally restricted for decades yet clamming in estuary areas or off the beach areas was once an integral part of those communities. While not confined to the Parker River Watershed, the Massachusetts Bays Comprehensive Conservation & Management Plan (MassBays 2004) lists the following initiatives intended to protect and enhance safe (health-wise) shellfishing opportunities throughout the watershed estuary areas.

- Conduct three Sanitary Survey Training Sessions annually- one each on the North Shore, Metro Boston/South Shore, and Cape Cod- to educate local shellfish constables and health officers on the proper technique for identifying and evaluating pathogen inputs into shellfish harvesting areas; Local partner: Division of Marine Fisheries

- Develop and administer a local Shellfish Management Grants Program to help communities finance the development and implementation of affective local shellfish management plans (progress: substantial); Local partner: Division of Marine Fisheries

- Continue and expand the Shellfish Bed Restoration Program to restore and protect shellfish beds impacted by non-point source pollution; Local partner: Shellfish Bed Restoration Program

- Through the Shellfish Clean Water Initiative, complete an Interagency Agreement defining agency roles and contributions to protect shellfish resources from pollution sources; Local partner: Office of Coastal Zone Management.

8.2 Agriculture

Techniques have been developed to reduce the contribution of agricultural activities to pathogen contamination. There are also many BMP methods intended to reduce sediment loads contained in stormwater runoff from agricultural lands. Since bacteria are often associated with sediments, these techniques are likely to result in a reduction in bacterial loads in run off as well. Brief summaries of some of these techniques are provided in the *Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts* (ESNR 2005). Techniques generally include BMPs for field application of manure, animal feeding operations, barnyards, and managing animal grazing areas.

These aspects have obvious pertinence here, as was revealed in the project Parker River Watershed, Assessment and Management of Nonpoint Source Pollution in the Little River Subwatershed conducted by the Merrimack Valley Planning Commission (MVPC) 1998-2001 (MVPC 2001). Three distinct farming type operations were identified to be contributors to bacteria loadings in the Little River sub watershed, and an earlier 319 study in the adjacent Mill River subwatershed indicated similar types of farming operations there as well. The Parker River Clean Water Association as well as the communities can do an assessment of these operations to determine what BMP’s might be needed. Farming operations can ask for and receive technical and monetary grant assistance from the Natural Resources Conservation Service (NRCS) office in Littleton MA.

8.3 Illicit Sewer Connections and Failing Infrastructure

Although presently there are no POTWs in the Parker watershed, the elimination of illicit sewer connections and repairing failing infrastructure are of extreme importance, in order to eliminate and prevent bacterial pollution. There are sewer lines in the towns of Newbury and Newburyport in the Parker watershed (on Plum Island, and in the Little River subwatershed) that connect to the Newburyport WWTP. EPA's Phase II rule specifies an MS4 community must develop, implement, and enforce a stormwater management program that is designed to reduce the discharge of pollutants to the maximum extent practicable, protect water quality, and satisfy the applicable water quality requirements of the Clean Water Act. Illicit discharge detection and elimination (IDDE) is one of the six minimum control measures that must be included in the stormwater management program. The other control measures are:

• Public education and outreach on stormwater impacts
• Public involvement and participation
• Construction site stormwater runoff control
• Post-construction stormwater management in new development and redevelopment
• Pollution prevention and good housekeeping for municipal operations

MS4 communities must identify the best management practices they will use to comply with each of these six minimum control measures and the measurable goals they have set for each measure. The MS4 communities within the Parker watershed that are covered include: Georgetown, Rowley, Ipswich, Boxford, Newburyport, West Newbury, and Newbury.

In general, a comprehensive IDDE Program must contain the following four elements:

1) Develop (if not already completed) a storm sewer system map showing the location of all outfalls, and the names and location of all waters of the United States that receive discharges from those outfalls.

2) Develop and promulgate municipal regulations that require the municipality to comply with Phase II regulations including prohibition of illicit discharges and appropriate enforcement mechanisms.

3) Develop and implement a plan to detect and address illicit discharges, including illegal dumping, to the system. EPA recommends that the plan include the following four components: locating priority areas; tracing the source of an illicit discharge; removing the source of an illicit discharge; and program evaluation and assessment.

4) Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste. IDDE outreach can be integrated into the broader stormwater outreach program for the community. Fulfilling the outreach requirement for IDDE helps the MS4 community to comply with this mandatory element of the stormwater program.

Communities that are not covered under the MS4 General Stormwater Permit are encouraged to implement a program for detecting and eliminating sewage discharges to storm sewer systems, including illicit sewer connections. Implementation of the MS4 General Stormwater Permit (EPA 2016), whether voluntarily or mandated will help communities achieve bacteria TMDLs.

8.4 Stormwater Runoff

Stormwater runoff can be categorized in two forms 1) point source discharges and 2) non-point source discharges (includes sheet flow or direct runoff). The term "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act. Many point source stormwater discharges are regulated under the NPDES Phase I and Phase II permitting programs when discharged to a Water of the United States. Municipalities that operate regulated municipal separate storm sewer systems (MS4s) must develop and implement a stormwater management plan (SWMP) which must employ and set measurable goals for the minimum control measures listed in the previous section.

Portions of towns in this watershed are classified as Urban Areas by the United States Census Bureau and are subject to the MS4 General Stormwater Permit (EPA 2016). MS4 communities are required to develop and implement an illicit discharge detection and elimination plan (IDDE).

The NPDES General MS4 Stormwater Permit does not, however, establish numeric effluent limitations for bacteria in stormwater 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 sheet flow 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 stormwater contamination.

Numerous organizations have already been actively addressing fecal coliform sources associated with stormwater. The Merrimack Valley Planning Commission (MVPC) has been involved in two major projects with the cooperation and funding of towns and state agencies: 1) the identification of bacterial sources to the Georgetown town beach and 2) the watershed assessment of Rock and Pentucket Ponds. The MVPC identified sources of stormwater discharges to the pond and provided the town with recommendations for controlling the sources (MassDEP 2001).

The Massachusetts Audubon Society developed a program to address non-point source pollution in the Plum Island Sound that included a stormwater management program to treat roadway and agricultural runoff. In addition, the Massachusetts Audubon Society assisted the Town of Rowley to incorporate stormwater best management practices (MassDEP 2001).

MS4 Stormwater Phase II Annual Reports from the various communities are submitted and received in May of each year (EPA 2018a). Indications are that substantial progress has been made, particularly with certain communities on those aspects of the six- point plan requirements that would address bacteria pollution. A brief review is made herein on each community covered under the Program in the watershed and their progress:

Boxford- The Town participates in an annual stream cleanup day. By early 2008, the Town, with the help of MVPC, had completed mapping of all stormwater outfalls. In May 2006, the Town formally approved a stormwater management by- law, which includes an illicit connection detection program. Potential pollutant "hotspot" activities have been incorporated into a Stormwater Management Bylaw. Boxford has no industry and very little commercial development. Septic discharge is controlled by the Board of Health. A final map of outfalls was completed in 2010 and updated for the East Village in 2015 with new detail on outfalls. The Town of Boxford MS4 map includes outfalls and receiving waters, open channel conveyances, pipes, culverts, structures, and inlets. Further refinements, completed by June 30, 2020, included initial catchment delineations, identification of additional stormwater treatment structures, interconnections with other stormwater systems (if any) and indication of applicable water body impairments as identified on the most recent EPA approved Massachusetts Integrated Waters List. The Town of Boxford completed Catchment Investigation in 2019 and will conduct Screening of Outfalls/Interconnections in order to update the existing initial prioritization of outfalls by June 30, 2021.

Georgetown- The Town continued website posting and hardcopy distribution of public education materials on non-point source pollution prevention and implementation through installation of residential BMPs. This includes proper septic system use and maintenance, yard and pet waste management, and impervious surfaces reduction. The Town’s Stormwater Management Committee is a multi-departmental, multi-disciplinary committee, which met during 2013-14 to increase its capabilities. During 2013-14, the Town was active in cleaning, inspection, maintenance, and repair of 1,200 municipal catch basins and drain manholes, and the removal of accumulated sediment and debris from obstructed storm drains. Special attention continued with storm drainage systems in downtown areas, and around the periphery of Rock and Pentucket Ponds, where clustered home developments have created yard and other waste runoff, which has exacerbated nutrient introduction to both ponds. In this connection, special attention has been given to street sweeping, from the standpoints of removing fall and winter debris that could compromise stormwater drainage systems, which has in the past added nutrient and pathogen pollution factors to the two ponds mentioned, plus to other fresh water pond areas in Town. Along with this, the Board of Health has been on a public education campaign, mainly through Town mailers to citizens on the do's and dont's with septic system maintenance, and has actually participated in the fixing or upgrading of 38 septic systems particularly in the Rock and Pentucket Pond areas to conform with the State's Title V Regulations. Activities required by the MS4 General Stormwater Permit include: (1) developing an inventory of all permittee owned facilities in the categories of parks and open space, buildings and facilities, vehicles and equipment; (2) review and updating of all former stormdrain mapping; (3) planning for illicit connection detection program; (4) planning for SW infrastructure upgrading and repair; (5) a written SWPPP for maintenance garages, public works yards, transfer stations, and other waste handling stations exposed to stormwater; (6) Enclosing/covering storage piles of salt used for deicing.

Ipswich- The Town has continued to fund the preparation of stormwater related educational materials and these materials have been made available at the Town Hall and within other public buildings. The materials include a brochure entitled "Don't Let Your Pet Pollute" which provides educational information regarding the pollution impacts of pet waste. Stormwater related information has periodically been posted on the Town's website, and in the past has included a Stormwater Information link within the Conservation Commission's webpage to provide general stormwater quality and BMP information to citizens. In 2014, the Town was awarded a 319 Nonpoint Source Pollution Grant to investigate potential sources of pollutants detected in Farley Brook. Work on the related project included extensive sampling within Farley Brook and the contributing stormwater collection system, a screening program by a canine detection service to identify potential pollutant contributing areas, multiple planning meetings of a recently established Farley Brook advisory committee, a public project update presentation to the Ipswich Shellfish Advisory Committee, and the development of a preliminary design for an engineered wetland. Other related stormwater support activities in 2014-16 have included: (a) the Town's manhole and catchbasin inspection and GPS location program being approximately 95% complete; (b) the Town employing a clam shell bucket to clean 1,365 catch basin structures during permit year (2015); (c) while cleaning each storm drain structure, internal inspections of each structure was also completed to determine their condition, and when identified, a program was instituted for planning the replacement or modification of those structures in need of improvement; (d) the Ipswich Shellfish Department continuing its sampling program throughout the permit year within select sections of the Ipswich River to monitor for elevated levels of bacteria; (e) the Department of Public Works along with the Shellfish Department has continued working with a consultant to conduct specific monitoring of Farley Brook (part of the 319 Grant), which is a recognized contributor of pollutants to the Ipswich River; (f) although no specific illicit connections were discovered this past year, the Town continuing to investigate high fecal coliform counts in Farley Brook to see if it is linked to an illicit connection. Under the new 2018 permit, a renewed effort is underway to 'ramp up' the IDDE effort by obtaining public input on the proposed plan based on the Draft Pathogen TMDL on listed waters: Ipswich River, Labor-in-Vain Creek, Kimball Brook, Farley Book, and Muddy Run.

Newburyport- The City continues to maintain and implement stormwater related signs and public education brochures developed in previous years. City field crews continue to markup stormwater system maps printed from the latest GIS layer, and it has been routinely meeting with MVPC to discuss further possibilities of utilizing and improving the City's GIS system. In part, the City and MVPC plan on using Computer Maintenance Management Software (CMMS), which is an asset management system to record and maintain the City's stormwater system. The current mayor has been a strong proponent of projects by the City that provide stormwater improvements. The Stormwater Advisory Committee has made significant progress by adopting the City's first Stormwater Ordinance, with associated Rules and Regulations. These include a City Stormwater Permit, fee system, and retention standard. The Stormwater Permit will be required on all projects where 10,000 square feet or more is proposed to be disturbed. The Stormwater Advisory Committee is currently exploring various funding options, including the formation of a Stormwater Utility as a means of revenue to fund improvements in stormwater pollution control. The City and MVPC member communities have recently received a Community Innovation Challenge (CIC) Grant from the State to assist member communities in all aspects of the NPDES MS4 permit compliance. The work involved with this grant, plus implementation of the City's Ordinance and Rules & Regulations, will best promote stormwater pollution prevention in the City's waters. For housekeeping, the City cleaned 900 catch basins in April 2016, and repaired 16 catch basins, replaced 19 catch basins, repaired 7 drain manholes, and replaced 3 drain manholes in 2015 to 2016. A new DPW engineering position was created 2018 to address the MS4 General Stormwater Permit, which focused on doing an inventory of all SW treatment structures in town and developing recommendations for a plan to upgrade structures in need with BMPs and timelines over the next 2 years for implementation.

Newbury- The Town Clerk and Police continue to provide pet waste information handouts to dog license applicants. A septic system flyer was sent out to all households with September 2015 tax bills. A 'Stormwater Faire' was held on April 25, 2015 at the USFWS Visitors Center. With IDDE, dry weather flow was investigated at a previously reported outfall where a broken pipe was encountered. The upstream source of flow appears to be from watermain leakage, or possibly groundwater. Fecal coliform test showed well below the maximum allowable limit. Large scale mapping updates have been ongoing, including field checking, locating outfalls, manholes, catch basins, and catch basin pipe sizes. Over the past several years several illicit connections have been found and removed. All catch basins were cleaned during 2015. Streets are swept a minimum of twice per year, with some streets having additional sweeping as needed. As required under the MS4 General Permit (effective July 1, 2018) permit, the town has facilitated consolidating the paper map information which included all stormwater piping and manholes in town, and preparing an updated electronic version of current conveyances and manholes with their present state of conditions, with plans made to address deteriorated structure conditions in the next several permit years.

Rowley- During 2015, the Board of Selectmen and Town Meeting continued to support the funding of the Greenscapes Program, a coalition consisting of the Ipswich River Watershed Association, Eight Towns and The Bay, the Great Marsh Committee, and Salem Sound Coastwatch. Through Greenscapes, the Town of Rowley receives public education and outreach materials as well as educational workshop opportunities for residents. The Town partnered with Newbury and Newburyport in offering a Stormwater Colloquium event on April 25, 2015, targeting public education about stormwater concerns directed at a young audience. The Town has continued active implementation of the Stormwater Management and Erosion Control Bylaw. The map and database of stormwater outfalls in Rowley's Urbanized Areas has been updated as necessary. The Rowley Board of Health continues their oversight on their regulation under the EPA protocols: "Prohibiting Illicit Connections and Discharges to the Municipal Separate Storm System (MS4)". In response to water quality monitoring readings from Ox Pasture Brook near Central St., the Board of Health has engaged the services of Horsley Witten Group to investigate pathogen readings that indicated a high level of concern. The Town has continued efforts on annual street sweeping in high priority areas and conducting catch basin cleaning with rehabilitation repairs as needed. As required under the MS4 General Permit (effective July 1, 2018), the Town has posted the Draft SWMP and IDDE Plans on the DPW SW webpage (June 2019), and has conducted public meetings as part of the Conservation Commission on July 1, and July 9 of that year to address each plan. Rowley has also upgraded its interest in participating in the regular meetings of the Merrimack Stormwater Collaborative.

West Newbury- The Town continued to participate in the Green Scapes program and has continued to send out stormwater flyers to residents and businesses. The Town is working on a new website that will incorporate all town stormwater information, including requirements in MS4 General Stormwater Permit (EPA 2016). Also, the Green Scapes program information will be added to the web site. The Town is progressing well in achieving the goals stated in the original Notice of Intent for Phase II, including the adoption of new By-Laws. In addition, the Planning Board in conjunction with other boards has approved new Rules and Regulations that contain pro-active stormwater requirements to help meet town SW goals. Included are provisions for competent supervision of projects, site cleanup requirements, and catch basin cleaning with related rehabilitation details. Additionally, the town has signed on with the Merrimac Valley Planning Commission to utilize their resources in reaching the goal of full compliance with the MS4 General Stormwater Permit. With housekeeping, all streets are swept at least once per year, and all 445 catch basins are cleaned annually, with 150 cubic yards of detritus removed. Although little public outreach on the Draft SWMP had occurred, as a result of the new 2018 SW Permit, a series of 10 official public informational meetings (properly noticed) were held on separate dates between September 2018 and June 2019, providing many inputs on how the plan could be effective.

A list of the MS4 municipalities in Massachusetts, as well as the Notices of Intent for each municipality can be viewed at: https://www.epa.gov/npdes-permits/massachusetts-small-ms4-general-permit.

8.5 Failing Septic Systems

Septic system bacteria contributions to the Parker River Watershed waters may be reduced in the future through septic system maintenance and/or replacement. Additionally, the implementation of Title 5

(310 CMR 15.00), 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. The majority of the Parker River Watershed is on septic systems. Significant improvement to water quality as a result of septic system upgrades is a distinct likelihood. Regulatory and educational materials for septic system installation, maintenance and alternative technologies may be found on the MassDEP website at: www.mass.gov/dep/water/wastewater/septicsy.htm.

Organizations within the Parker River Watershed have taken steps to address failing septic systems. For example, the Massachusetts Audubon Society was awarded a 319 Non-Point Source Competitive Grant. As part of this grant, the Massachusetts Audubon Society implemented a septic system management program and a public education program (MassDEP 2010). An attempt was made to remediate stormwater, septic system, and agricultural nonpoint sources in the Mill River subwatershed through BMP implementation, public education, and changes in local bylaws and policies in the Town of Rowley.

8.6 Wastewater Treatment Plants

The only WWTP in the Parker River watershed is at the Governor Dummer Academy in Newbury (permitted for 52,000 gpd). 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. The Massachusetts groundwater permit program is regulated under MA 314. CMR 5.00.

8.7 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:

- 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.

Currently the area proximal to the Parker River watershed estuary area has been established as a "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.

8.8 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 (MassDEP 2000) available on line at: https://www.mass.gov/service-details/nonpoint-source-pollution. 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.

State monies are also available through the Massachusetts Office of Coastal Zone Management: Coastal Pollution Remediation, Coastal Nonpoint Source Pollution Control, and Coastal Monitoring programs.

8.9 Mitigation Measures to Address Pathogen Pollution in Surface Water

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. The guidance can be downloaded at: http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/impguide.pdf

8.10 Climate Change

MassDEP recognizes that long-term (25+ years) climate change impacts to Massachusetts, including the area of this TMDL, are possible based on known science. Massachusetts Executive Office of Energy and Environmental Affairs 2011 Climate Change Adaptation Report predicts that by 2100 the sea level could be from 1 to 6 feet higher than the current position and precipitation rates in the Northeast could increase by as much as 20 percent (EOEA 2011). However, the details of how climate change will affect sea level rise, precipitation, streamflow, sediment and nutrient loading in specific locations are generally unknown. The ongoing debate is not about whether climate change will occur, but the rate at and the extent to which it will occur and the adjustments that will be needed to address its impacts. EPA's 2012 climate change strategy (EPA 2012b) states: "Despite increasing understanding of climate change, there still remain questions about the scope and timing of climate change impacts, especially at the local scale where most water-related decisions are made." For estuarine TMDLs in Massachusetts, MassDEP recognizes that this is particularly true, where water quality management decisions and implementation actions are generally made and conducted at the municipal level on a sub-watershed scale.

EPA's Climate Change Strategy identifies the types of research needed to support the goals and strategic actions to respond to climate change. EPA acknowledges that data are missing or not available for making water resource management decisions under changing climate conditions. In addition, EPA recognizes the limitation of current modeling in predicting the pace and magnitude of localized climate change impacts and recommends further exploration of the use of tools, such as atmospheric, precipitation and climate change models, to help states evaluate pollutant load impacts under a range of projected climatic shifts.

In 2013, EPA released a study entitled, Watershed modeling to assess the sensitivity of streamflow, nutrient, and sediment loads to potential climate change and urban development in 20 U.S. watersheds (EPA 2013). The closest watershed to southeastern Massachusetts that was examined in this study is a New England coastal basin located between Southern Maine and Central Coastal Massachusetts. These watersheds do not encompass any of the watersheds in the Massachusetts Estuary Project (MEP) region, and it has vastly different watershed characteristics, including soils, geography, hydrology and land use – key components used in a modeling analysis. The initial "first order" conclusion of this study is that, in many locations, future conditions, including water quality, are likely to be different from past conditions. However, most significantly, this study did not demonstrate that changes to TMDLs (the water quality restoration targets) would be necessary for the region. EPA's 2012 Climate Change Strategy also acknowledges that the Northeast, including New England, needs to develop standardized regional assumptions regarding future climate change impacts. EPA's 2013 modeling study does not provide the scientific methods and robust datasets needed to predict specific long-term climate change impacts in the MEP region to inform TMDL development.

Impacts of climate change should be addressed through TMDL implementation with an adaptive management approach in mind. Adjustments can be made as environmental conditions, pollutant sources, or other factors change over time. Massachusetts Coastal Zone Management (CZM) has developed a StormSmart Coasts Program (2008) to help coastal communities address impacts and effects of erosion, storm surge and flooding which are increasing due to climate change. The program, available at https://www.mass.gov/stormsmart-coasts-program, offers technical information, planning strategies, legal and regulatory tools to communities to adapt to climate change impacts.

As more information and tools become available, there may be opportunities to adjust existing TMDLs in the future to address predictable climate change impacts.

9.0 Monitoring Plan

The long- term monitoring plan for the Parker River Watershed includes several components:

1. Conduct monitoring of the Parker River Watershed under an approved QAPP (PRCWA and other stakeholders),
2. Monitor areas within the watershed where data are lacking or absent to determine if the waterbody meets the use criteria,

3. 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,
4. 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
5. 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 to pin-point sources,
- researching new and proven technologies for separating human from animal bacteria sources, and
- assessing efficacy of BMPs.

10.0 Reasonable Assurances

Reasonable assurances that the TMDL will be implemented include both application and 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. Stormwater NPDES permit coverage is designed to address discharges from municipal owned stormwater drainage systems. Enforcement of regulations controlling non-point discharges includes local enforcement of the state Wetlands Protection Act and Rivers Protection Act, Title 5 regulations for septic systems and various local regulations including zoning regulations. Financial incentives may include Federal monies available under the CWA Section 319 NPS program and the CWA Section 604b and 104b programs, which are provided as part of the Performance Partnership Agreement between MassDEP and the EPA. However, 319 Nonpoint Source funds cannot be used for point source remediation, and therefore cannot be used to address the requirements of NPDES stormwater permits. 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. State monies are also available through the Massachusetts Office of Coastal Zone Management's Coastal Pollutant Remediation, Coastal Nonpoint Source Pollution Control, and Coastal Monitoring grant programs. The primary goal of all three programs is to improve coastal water quality by reducing or eliminating nonpoint sources of pollution.

10.1 Overarching Tools

Massachusetts Clean Water Act: The MA Clean Water Act (M.G.L. Chapter 21, sections 26-53) provides MassDEP with specific and broad authority to develop regulations to address both point and non-point sources of pollution. There are numerous regulatory and financial programs, including those identified in the preceding paragraph, that have been established to directly and indirectly address pathogen impairments throughout the state. Several of them are briefly described below.

Surface Water Quality Standards (314 CMR 4.00): The MA Water Quality Standards (WQS) assign designated uses and establish water quality criteria to meet those uses. Water body classifications (Class A, B, and C, for freshwater and SA, SB, and SC for marine waters) are established to protect each class of designated uses. In addition, bacteria criteria are established for each individual classification.

Ground Water Discharge Permit Program (314 CMR 5.00): This program regulates the discharge of pollutants to the groundwaters of the Commonwealth to assure that groundwaters are protected for their actual and potential use as a source of potable water and surface waters are protected for their existing and designated uses and to assure the attainment and maintenance of the MA SWQS.

River Protection Act: In 1996 MA passed the Rivers Protection Act (MGL c 258 Acts of 1996). The purposes of the Act were to protect the private or public water supply; to protect the ground water; to provide flood control; to prevent storm damage; to prevent pollution; to protect land containing shellfish; to protect wildlife habitat; and to protect the fisheries. The provisions of the Act are implemented through the Wetlands Protection Regulations, which establish up to a 200-foot setback from rivers in the Commonwealth to control construction activity and protect the items listed above. Although this Act does not directly reduce pathogen discharges it indirectly controls many sources of pathogens close to water bodies.

Regulation of Plant Nutrients: In 2012, the Massachusetts Department of Agricultural Resources (MDAR) developed regulations (330 CMR 31.00) to ensure that plant nutrients are applied in an effective manner to provide sufficient nutrients for maintaining healthy agricultural lands as well as turf and lawns while minimizing the impacts of the nutrients on surface and groundwater resources to protect human health and the environment. The regulations include setbacks from surface waters, public drinking water, and wetlands and seasonal application restrictions.

10.2 Additional Tools to Address Combined Sewer Overflows (CSOs)

CSOs discharge stormwater with untreated or partially treated human and industrial waste, toxic materials and debris and as a result are a significant source of bacterial contamination. Control or reduction of CSOs will result in improvements to water quality in the receiving waters. CSO Program/Policy: Massachusetts, in concert with EPA Region 1, has established a detailed CSO abatement program and policy. CSO discharges are regulated by the Commonwealth in several ways. Like any discharge of pollutants, CSOs must have an NPDES/MA Surface Water Discharge Permit under federal and state regulations. Municipalities and districts seeking funding for wastewater treatment, including CSO abatement, must comply with the facilities planning process at 310 CMR 41.00. Entities obtaining funding or exceeding specific thresholds must also comply with the Massachusetts Environmental Policy Act (MEPA) regulations at 301 CMR 11.00. Each of these regulations contains substantive and procedural requirements. Because both MEPA and facilities planning require the evaluation of alternatives, these processes are routinely coordinated.

All permits for a CSO discharge must comply with Massachusetts Surface Water Quality Standards at 314 CMR 4.00. The water quality standards establish goals for waters of the Commonwealth and provide the basis for water quality-based effluent limitations in NPDES permits. Any discharge, including CSO discharges, is allowed only if it meets the criteria and the antidegradation standard for the receiving segment. EPA's 1994 CSO Control Policy revised some features of its 1989 version to provide greater flexibility by allowing a minimal number of overflows, which are compatible with the water quality goals of the Clean Water Act. MassDEP's 1995 regulatory revisions correspondingly decreased reliance on partial use designation as the sole regulatory vehicle to support CSO abatement plans[1].

In all cases, NPDES/MA permits require the nine minimum controls necessary to meet technology-based limitations as specified in the 1994 EPA Policy. The nine controls may be summarized as; operate and maintain properly; maximize storage, minimize overflows, maximize flows to Publicly Owned Treatment Works (POTWs), prohibit dry weather CSO's, control solids and floatables, institute pollution prevention programs, notify the public of impacts, and observe monitoring and reporting requirements. The nine minimum controls may be supplemented with additional treatment requirements, such as screening and disinfection, on a case-by-case basis. The Department's goal is to eliminate adverse CSO impacts and attain the highest water quality achievable. Separation or relocation of CSOs is required wherever it can be achieved based on an economic and technical evaluation.

Untreated CSOs are likely to cause violations of water quality standards and thus violation of NPDES permits. CSO permittees are required to either eliminate the CSO or plan, design, and construct CSO abatement facilities. Each long-term control plan must identify and achieve the highest feasible level of control. The process also requires the permittee to comply with any approved TMDL.

10.3 Additional Tools to Address Failed Septic Systems

Septic System Regulations (Title 5) (310 CMR 15.00): The MassDEP has regulations in place that require minimum standards for the design of individual septic systems. Those regulations ensure, in part, protection for nearby surface and ground waters from bacterial contamination. The regulations also provide minimum standards for replacing failed and inadequate systems and include a requirement that

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[4] DEP's 1990 CSO Policy was based on EPA's 1989 CSO Control Policy and established the goal of eliminating adverse impacts from CSOs, using partial use designation where removal or relocation was not feasible. The three month design storm was identified as the minimum technology-based effluent limitation, which would result in untreated overflows an average of four times a year. Abatement measures to meet these minimum standards were necessary for a CSO discharge to be eligible for partial use designation. Presumably, all CSOs exceeding this standard required downgrading to Class C or SC status. No partial use designations or downgrades to Class C were actually made, because the process was perceived as administratively cumbersome.

all septic systems must be inspected and upgraded to meet Title 5 requirements at the time of sale or transfer of each property.

10.4 Additional Tools to Address Stormwater

Stormwater is regulated through both federal and state programs. Those programs include, but are not limited to, the federal and state Phase I and Phase II NPDES stormwater program, and, at the state level, the Wetlands Protection Act (MGL Chapter 130, Section 40), the state water quality standards, and the various permitting programs previously identified.

Federal Phase I & II NPDES Stormwater Regulations: Existing stormwater discharges are regulated under the federal and state Phase I and Phase II stormwater program. In MA there are two Phase I communities, Boston and Worcester. Both communities have been issued individual permits to address stormwater discharges. In addition, 7 communities in the Parker River Watershed are covered by Phase II. These include Boxford, Georgetown, Ipswich, Newburyport, Newbury, Rowley, and West Newbury. Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting use controls on the unregulated sources of stormwater discharges that have the greatest likelihood of causing continued environmental degradation including those from municipal separate storm sewer systems (MS4s) and discharges from construction activity. Any new construction that complies with state stormwater standards and permits is presumed to comply with antidegradation requirements of the state water quality standards.

The Phase II Final Rule, published in the Federal Register on December 8, 1999, requires permittees to determine whether or not stormwater discharges from any part of the MS4 contribute, either directly or indirectly, to a 303(d) listed waterbody. Operators of regulated MS4s are required to design stormwater management programs to 1) reduce the discharge of pollutants to the "maximum extent practicable" (MEP), 2) protect water quality, and 3) satisfy the appropriate water quality requirements of the Clean Water Act. Implementation of the MEP standard typically requires the development and implementation of BMPs and the achievement of measurable goals to satisfy each of the six minimum control measures. Those measures include 1) public outreach and education, 2) public participation, 3) illicit discharge detection and elimination, 4) construction site runoff control, 5) post-construction runoff control, and 6) pollution prevention/good housekeeping. In addition, each permittee must determine if a TMDL has been developed and approved for any water body into which an MS4 discharges. If a TMDL has been approved, then the permittee must comply with the TMDL including the application of BMPs or other performance requirements. The permittee must report annually on all control measures currently being implemented or planned to be implemented to control pollutants of concern identified in TMDLs. Finally, the Department has the authority to issue an individual permit to achieve water quality objectives. Links to the MA Phase II permit and other stormwater control guidance can be found at: http://www.mass.gov/dep/water/wastewater/stormwat.htm

EPA and MassDEP reissued the MS4 permit which became effective July 1, 2018. A full list of MS4 Phase II communities in MA can be found at on the EPA website. This TMDL forms the basis for the implementation plans to meet the Pathogen loading capacity. MS4 permittees within the Merrimack River Watershed are required to identify in their respective Stormwater Management Plans and Annual Reports those discharges that are subject to TMDL related requirements, as identified in part 2.2.1 of the renewal permit, and those that are subject to additional requirements to protect water quality, as identified in part 2.2.2. of the renewal permit. Communities in the Parker River Watershed are required to comply with the applicable provisions in Appendix H to address their respective bacteria discharges to the maximum extent practicable, as required by CWA Section 402(p)(3)(B)(iii). Although EPA's Phase II MS4 regulations only require a small MS4 to implement its program in the urbanized area subject to permitting, EPA and MassDEP nonetheless encourage permittees to update and implement their respective SWMPs jurisdiction-wide to further water quality improvements.

The MassDEP Wetlands regulations (310 CMR 10.0) direct issuing authorities to enforce the MassDEP Stormwater Management Policy, place conditions on the quantity and quality of point source discharges, and to control erosion and sedimentation. The Stormwater Management Policy was issued under the authority of the 310 CMR 10.0. The policy and its accompanying Stormwater Performance Standards apply to new and redevelopment projects where there may be an alteration to a wetland resource area or within 100 feet of a wetland resource (buffer zone). The policy requires the application of structural and/or non-structural BMPs to control suspended solids, which have associated co-benefits for bacteria removal. The Massachusetts Stormwater Handbook was developed to promote consistent interpretation of the Stormwater Management Policy and Performance Standards; Volumes 1 through 3, and can be found at: http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html, as well as, the Stormwater Policy at http://www.mass.gov/eea/agencies/massdep/water/regulations/water-resources-policies-and-guidance-documents.html#11.

10.5 Financial Tools

MassDEP's non-point source and grants programs helps address non-point source pollution sources statewide. The Nonpoint Source Management Program Plan (MassDEP 2019b): https://www.mass.gov/service-details/nonpoint-source-pollution, that sets forth an integrated strategy and identifies important programs to prevent, control, and reduce pollution from nonpoint sources and more importantly to protect and restore the quality of waters in the Commonwealth. The Clean Water Act, Section 319, specifies the contents of the management plan. The plan is an implementation strategy for BMPs with attention given to funding sources and schedules. Statewide implementation of the Management Plan is being accomplished through a wide variety of federal, state, local, and non-profit programs and partnerships. It includes partnering with the Massachusetts Coastal Zone Management on the implementation of Section 6217 program. That program outlines both short, and long-term strategies to address urban areas and stormwater, marinas and recreational boating, agriculture, forestry, hydromodification, and wetland restoration and assessment. The CZM 6217 program also addresses TMDLs and nitrogen sensitive embayments and is crafted to reduce water quality impairments and restore segments not meeting state standards.

In addition, the state is partnering with the Natural Resource Conservation Service (NRCS) to provide implementation incentives through the national Farm Bill. As a result of this effort, NRCS now prioritizes its Environmental Quality Incentive Program (EQIP) funds based on MassDEP's list of impaired waters. The program also provides high priority points to those projects designed to address TMDL recommendations. Over the past several years EQIP funds have been used throughout the Commonwealth to address water quality goals through the application of structural and non-structural BMPs.

MassDEP, in conjunction with EPA, also provides a grant program to implement nonpoint source BMPs that address water quality goals. The section 319 funding provided by EPA is used to apply needed implementation measures and provide high priority points for projects that are designed to address impaired waters on the ILOW (MassDEP 2019a) and to implement TMDLs. MassDEP has funded numerous projects through 319 that were designed to address stormwater and bacteria related impairments. It is estimated that 75% of all projects funded since 2002 were designed to address bacteria related impairments. Under new EPA guidance issued in 2003, 319 funds cannot be used to address the requirements of NPDES permits, including MS4, Residual Designation, Phase I and Phase II permits. This severely curtails eligibility of most urban implementation work that had previously been accomplished using 319 funds.

The 319 Program also provides additional assistance in the form of guidance. The Massachusetts Clean Water Toolkit (MassDEP, Geosyntec) will provide detailed guidance in the form of BMPs by land use to address various water quality impairments and associated pollutants.

State Revolving Fund: The State Revolving Fund (SRF) Program provides low interest loans to eligible applicants for the abatement of water pollution problems across the Commonwealth. MassDEP has issued millions of dollars in loans for the planning and construction of CSO facilities and to address stormwater pollution.

Loans have also been distributed to municipal governments statewide to upgrade and replace failed Title 5 systems. These programs all demonstrate the State's commitment to assist local governments in implementing the TMDL recommendations. Additional information about the SRF Program may be found on the MassDEP website at: http://www.mass.gov/dep/water/wastewater/wastewat.htm#srf.
In summary, MassDEP's approach and existing programs set out a wide variety of tools both MassDEP and communities can use to address pathogens, based on land use and the commonality of pathogen sources (e.g., combined sewer overflows (CSOs), failing septic systems, stormwater and illicit connections, pet waste, etc.) Since there are only a few categories of sources of pathogens, the

necessary remedial actions to address these sources are well established. MassDEP's authority combined with the programs identified above provide sufficient reasonable assurance that implementation of remedial actions will take place.

11.0 Public Participation

Two public meetings were held at 3 p.m. and 7pm. at the Lawrence Heritage Park in Lawrence, on 8/18/2005 to present this TMDL and to collect public comments. The public comment period began on August 18, 2005 and ended on September 12, 2005. The attendance list, public comments, and the MassDEP responses are attached as Appendix A. The final TMDL will be sent to U.S. EPA Region 1 in Boston for final approval.

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Appendix A: Response to Comments on Draft TMDL

Section II RESPONSE TO COMMENTS ON THE DRAFT PATHOGEN TMDL FOR THE PARKER RIVER WATERSHED

Public Meeting Announcement Published in the Monitor	7/23/05
Date of Public Meeting	8/18/05
Location of Public Meeting	Lawrence Heritage Park, Lawrence, MA
Times of Public Meeting	3 P.M. and 7 P.M.

PARKER RIVER WATERSHED DRAFT PATHOGEN TMDL PUBLIC MEETING ATTENDEES

DATE 8/18/05 Time 3 PM

Name	Organization
Russell Isaac	Department of Environmental Protection
William Dunn	Department of Environmental Protection
Mike Hill	Environmental Protection Agency
Peter Phippen	Merrimack Valley Planning Commission
Elizabeth Coughlin	Environmental Consultants Association
John Keeley	Town of Burlington
Christine Tabak	Merrimack River Watershed Association
Emily Levin	Ipswich River Watershed Association
Richard Hogan	Greater Lawrence Sanitary District
Brendan O'Regan	Newburyport DPW

Date 8/18/05 Time 7 PM

Name	Organization
Russell Isaac	Department of Environmental Protection
William Dunn	Department of Environmental Protection

This appendix provides detailed responses to comments received during the public comment process. MassDEP received many comments/questions that were of a general nature (i.e. related to terminology, statewide programs, the TMDL development process and regulations, etc.) while others were watershed specific. Responses to both are presented in the following sections.

General Comments:

1. Question: On the slide titled "components of a TMDL" what does "WLA" and "LA" stand for.

Response: Wasteload allocation (WLA) refers to pollutants discharged from pipes and channels that require a discharge permit (point sources). Load allocation (LA) refers to pollutants entering waterbodies through overland runoff (non-point sources). A major difference between the two categories is the greater legal and regulatory control generally available to address point sources while voluntary cooperation added by incentives in some cases is the main vehicle for addressing non-point sources.

2. Question: What is the Septic System Program?

Response: Cities and Towns can establish a small revolving fund to help finance repairs and necessary upgrades to septic systems. The initial funding is from the Commonwealth's State Revolving Fund Program (SRF). These programs generally offer reduced interest rate loans to homeowners to conduct such improvements. Many communities have taken advantage of this effort. A discussion of the septic system programs may be seen in the TMDL companion document "A TMDL Implementation Guidance Manual for Massachusetts" under Section 3.2.

3. Question: What is the WQS for non-contact recreation in terms of bacteria?

Response: The Massachusetts Surface Water Quality Standards, 314 CMR 4.00 (SWQS), do not have any waters designated for "non-contact recreation." All Massachusetts surface waters currently are designated in the SWQS for both primary and secondary contact recreation, among other uses. The bacteria criteria protect waters for their most sensitive uses, accordingly, the recreation- based bacteria criteria for all Class A, SA, B and SB waters are protective of primary contact recreation. While the SWQS do contain C and SC water classifications, with associated criteria, which are described to include waters designated for secondary contact recreation, there are no waters assigned to these classes. The bacteria criteria for Class C fresh waters are: "The geometric mean of all E. coli samples taken within the most recent six months shall not exceed 630 colony forming units (CFU) per 100 ml, typically based on a minimum of five samples, and 10% of such samples shall not exceed 1260 CFU per 100 ml. This criterion may be applied on a seasonal basis at the discretion of the Department."

The Class C geometric mean bacteria criterion is five times the Class A and B geometric mean bacteria criterion for primary contact recreation. The SWQS take the same approach with the Class SC bacteria criteria, that is, the SC geometric mean is five times that for SA and SB waters. With respect to bacteria criteria for secondary contact recreational waters, EPA has guidance that "states and authorized tribes may wish to adopt a criterion five times that of the geometric mean component of the criterion adopted to protect primary contact recreation, similar to the approach states and authorized tribes have used historically in the adoption of secondary contact criterion for Fecal coliforms." Note that in the Massachusetts SWQS, secondary contact recreation is defined to include water contact that is "incidental" so that contact incidental to such activities as boating and fishing would be anticipated.

4. Question: On the topic of DNA testing for bacterial source tracking what is MassDEP doing or planning to do?

Response: DNA testing can be extremely valuable in helping target sources of pathogens, whether animal, bird or human, then target remedial actions. At the same time, one needs to recognize that even if the source of the bacteria is identified as non-human, any concentrations exceeding the criteria still impair the use, such as swimming or shellfishing, associated with those criteria. MassDEP is already working with our Wall Experiment Station to help develop reliable techniques to address this issue. Several commercial laboratories have developed reliable techniques to identify biomarkers. We hope local monitoring programs will also benefit from these laboratory analyses.

5. Question: What is the current thought on E. coli /enterococci bacteria survival and reproduction in the environment, especially in wetlands?

Response: There are reports that indicator bacteria can survive in sediment longer than they can in water. This may be a result of being protected from predators. Also, there is some indication that reproduction may occur in wetlands, but until wildlife sources can be ruled out through, for example, reliable DNA testing, this possibility needs to be treated with caution. Also, die-off of indicator bacteria tends to be more rapid in warm water than in cold.

6. Question: For the implementation phase of TMDLs who will do the regular progress reporting and who will pay for it?

Response: For municipalities with urbanized areas and subject to stormwater permits (Phase I and Phase II municipalities) already do regular reporting and provide annual status reports on their efforts. For municipalities that do not have stormwater permits, MassDEP encourages them to implement stormwater controls, both structural and non-structural Best Management Practices (BMPs) as specified in the MS4 Stormwater Permit. The TMDL alone does not require volunteer groups, watershed organizations or towns to submit periodic reports - it is not mandatory. The MassDEP feels that the cooperative approach is the most desirable and effective but also believes that we possess broad regulatory authority to require action if and when it is deemed appropriate.

7. Question: How does the Phase II program and TMDL program coordinate with each other?

Response: The National Pollutant Discharge Elimination System (NPDES) Stormwater Phase II General Permit Program was first implemented in Massachusetts in March 2003. The municipal separate storm sewer systems (MS4) general permit was reissued April 2016 and became effective July 1, 2018. The permit requires the regulated entities to develop, implement and enforce a stormwater management program (SWMP) that effectively reduces or prevents the discharge of pollutants into receiving waters to the Maximum Extent Practicable (MEP). Stormwater discharges must also comply with meeting state water quality standards. The MS4 General Stormwater permit uses a best management practice framework and measurable goals to meet MEP and water quality standards. If there is a discharge from the MS4 to a waterbody that is subject to an approved TMDL identified in part 2.2.1 of the re-issued permit, the permittee shall comply with all applicable schedules and requirements for that TMDL listed in Appendix F. If there is a discharge from the MS4 to a waterbody that is water quality limited identified in part 2.2.2 of the re-issued permit, the permittee shall comply with all applicable schedules and requirements for that water quality limited waters listed in Appendix H. A permittees' compliance with its requirements in Appendix F and/or H shall constitute compliance with its requirement to ensure that its discharges do not cause or contribute to an exceedance of water quality standard. As TMDLs are developed and approved, permittees' stormwater management programs and annual reports must include a description of the BMPs that will be used to control the pollutant(s) of concern, to the maximum extent practicable. Annual reports filed by the permittee should highlight the status or progress of control measures currently being implemented or plans for implementation in the future.

Records should be kept concerning assessments or inspections of the appropriate control measures and how the pollutant reductions will be met.

8. Question: Will Communities be liable for meeting bacteria water quality standards at the point of discharge?

Response: No. While this is the goal stated in the TMDL, compliance with the water quality standards is judged by in-stream measurements. For instance, in an extreme case, it could be possible for a community to meet this criterion in their storm drains and yet still be responsible for reducing the impacts of overland runoff if the in-stream concentrations of bacteria exceeded the water quality standard. So, no matter how the TMDL is expressed, compliance is measured by the concentrations in the ambient water.

This approach is consistent with current EPA guidance and regulations. As stated in the November 22, 2002 Wayland/Hanlon memorandum (TMDL Appendix B, Attachment A), "WQBELs for NPDES-regulated stormwater discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. 1342(p)(3)(B)(iii); 40 C.F.R. 122.44(k)(2)&(3)" (TMDL Appendix B, Attachment A Wayland/Hanlon memo, page 2). This memorandum goes on to state:

"...because stormwater discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction stormwater discharges. The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual or projected loadings for individual dischargers or groups of dischargers. Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs, and that numeric limits will be used only in rare instances" (TMDL Appendix B, Attachment A Wayland, Hanlon memorandum, November 22, 2002, page 4).

The TMDL attempts to be clear on the expectation that BMPs will be used to achieve WQS as stated in the Wayland/Hanlon memorandum: "If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the stormwater component of the TMDL, EPA recommends that the TMDL reflect this." (TMDL Appendix B, Attachment A Wayland, Hanlon memorandum, page 5). Consistent with this, the Massachusetts' pathogen TMDLs state that BMPs may be used to meet SWQS. The actual WLA and LA for stormwater will still be expressed as a concentration-based/WQS limit which will be used to guide BMP implementation. The attainment of SWQS, however, will be assessed through ambient monitoring.

In stormwater TMDLs, the issue of whether SWQSs will be met is an ongoing issue and can never be answered with 100% assurance. MassDEP believes that the BMP-based, iterative approach for addressing pathogens is appropriate for stormwater. Indeed, "[t]he policy outlined in [the Wayland/Hanlon] memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and non-structural BMPs) that address stormwater discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality" (TMDL Appendix B, Attachment A Wayland, Hanlon memorandum, page 5).

A more detailed discussion / explanation of this response can be found in TMDL Appendix B, Attachment A, a memorandum titled "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements Based on Those WLAs" by Robert H. Wayland and James A. Hanlon of EPA (11/22/02).

9. Question: What are the regulatory hooks for this TMDL with regard to non-point sources?

Response: In general, the MassDEP is pursuing a cooperative approach in addressing non-point sources of contamination by bacteria. A total of 247 cities and towns in Massachusetts do have legal requirements to implement best management practices under the general NPDES storm-water permit issued jointly by MassDEP and EPA. In addition, failing septic systems are required to be corrected once the local Board of Health becomes aware of them and at the time of property transfer should require inspections reveal a problem. Other activities, such as farming involving livestock, are the subject of cooperative control efforts through such organizations as the Natural Resources Conservation Service (NRCS) which has a long history of providing both technical advice and matching funds for instituting best management practices on farms. While MassDEP has broad legal authority to address non-point source pollution and enforcement tools available for use for cases of egregious neglect, it intends to fully pursue cooperative efforts which it feels offer the most promise for improving water quality.

10. Question: Why is there little mention in the draft TMDL reports on incorporation of LID (Low Impact Development) principles as a way through implementation to control Bacteria pollution?

Response: Part of the Statewide TMDL project was to produce an accompanying TMDL implementation guidance document for all the TMDL reports, "Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Document for MA". There is an entire section in that document (Section D.4) that discusses LID principles and TMDL implementation in detail. There is additional information on LID on the interactive web site for non-point source pollution, *Massachusetts Clean Water Toolkit*, (MassDEP, Geosyntec)

11. Question: What about flow issues and TMDL requirements?

Response: Although flow can have both positive and negative impacts on water quality, flow is not a pollutant and therefore is not covered by a TMDL. TMDLs are required for each "pollutant" causing water quality impairments.

12. Question: Is there a way that the TMDL can be integrated with grants, and can the grants be targeted at TMDL implementation?

Response: The 319 Grant program is a major funding program providing up to $1 million per year in grants in MA. TMDL implementation is a high priority in the 319 Program. In fact, projects designed to address TMDL requirements are given higher priority points during project evaluation.

The 319 Grant program RFP Includes this language: "Category 4a Waters: TMDL and draft TMDL implementation projects – The 319 program prioritizes funding for projects that will implement Massachusetts' Total Maximum Daily Load (TMDL) analyses. Many rivers, streams and water bodies in the Commonwealth are impaired and thus do not meet Massachusetts' Surface Water Quality Standards. The goal of the TMDL Program is to determine the likely cause(s) of those impairments and develop an analysis (the TMDL) that lists those cause(s)."

Several comments were also directed towards the complications associated with applying for and reporting details that are required with state grant programs. The MassDEP is sympathetic to the paper work requirements of State and Federal grant programs. The MassDEP will review the body of requirements to assess what streamlining may be possible. At the same time, the MassDEP underscores that accountability for spending public funds continues to be an important and required component of any grant program.

13. Question: How will implementation of the TMDL address the major problem of post- construction run-off?

Response: Proper design and implementation of stormwater systems during construction will address both pre- and post-construction runoff issues and thus eliminate future problems. Post-construction runoff is also one of the six minimum control measures that Phase II communities are required to include in their stormwater management program in order to meet the conditions of their National Pollutant Discharge Elimination System (NPDES) permit. In short, Phase II communities are required to:

- Develop and implement strategies which include structural and/or nonstructural best management practices (BMPs);
- Have an ordinance or other regulatory mechanism requiring the implementation of post-construction runoff controls to the extent allowable under State or local law;
- Ensure adequate long-term operation and maintenance controls; and
- Determine the appropriate best management practices (BMPs) and measurable goals for their minimum control measure.

The general permit implementing the Phase II requirements also contains requirements for permittees that discharge into receiving waters with an approved TMDL. In summary, municipalities covered under Phase II are required to incorporate and implement measures and controls into their plans that are consistent with an established TMDL and any conditions necessary for consistency with the assumptions and requirements of the TMDL.

It should be noted that there are a number of other permitting programs that regulate pre/post construction run-off including the construction general permit, wetlands requirements and the Mass DEP/EPA MS4 General Stormwater permit. EPA and MassDEP reissued the MS4 permit in April 2016 with an effective date of July 1, 2018. A full list of MS4 Phase II communities in MA can be found at on the EPA website. This TMDL forms the basis for the implementation plans to meet the Pathogen loading capacity. Although EPA's Phase II MS4 regulations only require MS4 communities to implement the required program in the urbanized area subject to permitting, EPA and MassDEP nonetheless encourage permittees, to update and implement their respective SWMPs jurisdiction-wide to further water quality improvements.

14. Question: How does a pollution prevention TMDL work?

Response: MassDEP recommends that the information contained in the pathogen TMDLs guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA s. 303(d)(3). Pollution prevention TMDLs encourage the Commonwealth, communities, and citizens to maintain and protect existing water quality. Moreover, it is easier and less costly in the long term to prevent impairments rather than retrofit controls and best management practices to clean up pollution problems. The goal of this approach is to take a more proactive role to water quality management.

The analyses methods employed for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are similar. The wasteload and/or load allocation for each source and designated use would be the same as specified in the TMDL documents. Therefore, the pollution prevention TMDLs would have comparable wasteload and load allocations based on the sources present and the designated use of the waterbody segment.

The TMDLs may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA s. 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's 303(d) list, the Commonwealth determines with EPA approval of the CWA's 303(d) list that this TMDL should apply to future pathogen impaired segments. For such segments, this TMDL may apply if, after listing the waters for bacteria impairment and taking into account all relevant comments submitted on the particular future Integrated List of Waters, this TMDL should apply to newly listed bacteria impaired segments. Additional waterbodies identified as impaired after public notice of the Draft TMDL (2005), will be released for public comment and included in an addendum to this document.

Pollution prevention best management practices form the backbone of stormwater management strategies. Operation and maintenance should be an integral component of all stormwater management programs. This applies equally well with the requirements of the MS4 Stormwater Permit as well as TMDLs. A detailed discussion of this subject and the BMPs involved can be found in the TMDL companion document "Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Document for Massachusetts" in Section 3.

It should also be noted that sometimes the MassDEP will develop a "preventative" TMDL. Preventative TMDLs are not required by Federal Law, however, MassDEP does establish them on occasion to prevent waters from becoming impaired or where it is necessary to maintain waters at a certain level of water quality to meet the goals of a TMDL where the impaired water body is downstream from a non-impaired segment. In simple terms a preventative TMDL establishes goals to prevent degradation of good water quality.

15. Comment: The TMDL methodology uses concentrations based on water quality standards to establish TMDL loads, not traditional "loads".

Response: The TMDL has been revised to provide not only a concentration- based approach but also a loading approach. It should be noted, however, that MassDEP believes that a concentration-based approach is consistent with EPA regulations and more importantly more understandable to the public and easier to assess through monitoring activities. Clean Water Act Section 130.2(i) states that "TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure". The TMDL in this case is set at the water quality standard. Pathogen water quality standards (which are expressed as concentrations) are based on human health, which is different from many of the other pollutants. It is important to know immediately when monitoring is conducted if the waterbody is safe for human use, without calculating a "load" by multiplying the concentration by the flow – a complex function involving variable storm flow, dilution, proximity to source, etc.

The expectation to attain water quality standards at the point of discharge is conservative and thus 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.

MassDEP believes that it is difficult to provide accurate quantitative loading estimates of indicator bacteria contributions from the various sources because many of the sources are diffuse and intermittent, and flow is highly variable. However, based on public comment we have included loads for each segment based on variable flow conditions and the water quality standards. Because of the high variability of bacteria and flows experienced over time, loads are extremely difficult to monitor and model. Therefore, "loadings" of bacteria are less accurate than a concentration-based approach and do not provide a way to quickly verify if you are achieving the TMDL.

16. Comment: There is concern with the "cookie-cutter" nature of the draft TMDL. Particularly the lack of any determination about the causes and contributions to pathogen impairment for specific river and stream segments.

Response: The MassDEP feels the pathogen TMDL approach is justified because of the commonality of sources affecting the impaired segments and the commonality of best management practices used to abate and control those sources. The MassDEP monitoring efforts are targeted towards the in-stream ambient water quality and not towards tracking down the various sources causing any impairments. It should be noted however that MassDEP has conducted additional efforts to try to identify sources where information was available. Based on this additional information, MassDEP added tables to help identify and prioritize important segments and sources where that information was known. Also MassDEP revised Section 7 of the document to include segment-by-segment load allocations required to meet standards. All of these actions were intended to provide additional guidance on potential sources and areas of concern and to help target future activities.

17. Comment: While Table 8-1 of each TMDL lists the Tasks that the agencies (MassDEP/EPA) believe need to be achieved, it isn't clear exactly how these tasks line up with and address the eight sources of impairment listed in Table 7-1. CZM recommends that the final TMDL be more specific and couple the Implementation Plan tasks with the known or expected sources of contamination. This would make the document more useful to a community

Response: Because Table 7-1 and 8-1 serve significantly different purposes it was not intended that the tasks needed to align with and exactly address the eight sources of impairment. With regard to pollution sources, it might be more pertinent to compare Table 7-1 with Table 5-1, where it would be appropriate according to geographic location of known potential sources in Table 5-1. Table 8-1 is more of a suggested possible planning tool, matching tasks with potential organizations for action.

18. Comment: While the text in sections 8.1-8.7 of each TMDL describe some actions that can address the sources in Table 7-1, the issue of failing infrastructure is only mentioned in a sub-section title and in the text, but not addressed in any detail.

Response: Failing infrastructure is a very broad term, and is addressed, in part in such discussions as those on leaking sewer pipes, sanitary sewer overflows, and failed septic systems. It should be mentioned that in the Final TMDL reports, information on infrastructure rehabilitation efforts and progress has been expanded in Section 8. It is outside of the scope of the TMDL documents to detail every possible type of infrastructure failure. Nonetheless, additional information is provided in the TMDL companion document titled: "Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Document for Massachusetts."

19. Comment: There is a need for more specific information about what individual communities are currently doing and how much more effort is required (e.g., how many more miles of pipe need to be inspected for illegal connections in a specific community).

Response: MassDEP and the EPA recognize that the municipalities have done, and are continuing to do, a tremendous amount of work to control bacterial contamination of surface waters. The TMDL has been expanded to provide additional examples of that overall effort. However, the additional discussion is not designed nor intended to include an exhaustive listing of all the work required by each municipality to finalize this effort and provide a status of that work. Programs, such as the MS4 General Stormwater permit, require such status reports, and those will be very valuable in assessing priorities and future work. Phase II reports for each community are available on EPAs website: https://www.epa.gov/npdes-permits/massachusetts-small-ms4-general-permit.

20. Comment: There are no milestones to which individual communities should aim (e.g., all stormwater lines upstream of known contamination inspected for illegal connections in five years). As another example, Sections 7 and 8 of each TMDL state that "The strategy includes a mandatory program for implementing stormwater BMPs and eliminating illicit sources" but it is not clear over what timeframe a community should be acting.

Response: MassDEP recognizes that the addition of timelines in the TMDLs would appear to strengthen the documents; however, the complexity of each source coupled with the many types of sources which vary by municipality simply does not lend itself to the TMDL framework and therefore must be achieved through other programmatic measures.

For example, the MS4 General Stormwater permit, effective July 1, 2018, establishes a requirements on a timeline for each regulated community with specific goals related to the identification and control of illicit pollution sources.

A second example would be the control of combined sewer overflows (CSOs). Many municipalities are required by NPDES permits to develop and implement initial measures (commonly referred to as the Nine Minimum Controls (NMCs) and long-term control plans to address the issue. Since CSO discharges are defined as a point source under the Clean Water Act, an NPDES permit must be jointly issued by EPA and MassDEP for those discharges. (It should be noted that in the case of the Parker Watershed there are no CSO discharges). The permit sets forth the requirements for implementation and assessment of the EPA mandated NMCs and the requirement for developing a long-term CSO control strategy. Many municipalities are under enforcement orders by EPA and MassDEP that outline timelines for reaching the objectives of the long-term control plan.

21. Comment: Under "Control Measures" does "Watershed Management" include NPDES permitting?

Response: Stormwater management includes NPDES Phase I and II and could include additional permitting actions where deemed necessary and appropriate. Properly functioning wastewater treatment plants already have permit limitations equal to the water quality standards and as such are not generally a source of bacteria that would result in water quality exceedances and therefore they are not included as a control measure.

22. Comment: Absent from each report under “Who should read this document?” are the government agencies that provide planning, technical assistance, and funding to groups to remediate bacterial problems.

Response: The TMDL report has been edited to include groups and individuals that can benefit from the information in this report. It is beyond the scope of the TMDL to provide an exhaustive list of agencies that provide funding and support. Chapter 8.0, however, includes a link to this information, which is provided in the Massachusetts Nonpoint Source Strategy.

23. Comment: For coastal watersheds the section that describes funding sources should include grant programs available through the Massachusetts Office of Coastal Zone Management.

Response: Please see response to comment #22.

24. Comment: Table ES-1 and the similar tables throughout the report do not list B, or SB(CSO) as a surface water classification – this classification and its associated loadings allocations are missing. Although the footnote to the table refers to Long Term CSO Control Plans, the relationship between the TMDL, LTCP, and the B(CSO) water classification are unclear.

Response: The 1995 revisions to the MA Water Quality Standards created a B, or SB (CSO) water quality category by establishing regulatory significance for the notation “CSO” shown in the “Other Restriction” column at 314 CMR 4.06 for impacted segments. The B, or SB (CSO) designation was given, after public review and comment, to those waters where total elimination of CSOs was not economically feasible and could lead to substantial and widespread economic and social impact and the impacts from remaining CSO discharges were minor. Although a high level of control must be achieved, Class B standards may not be met during infrequent, large storm events.

The goal of the TMDL and the long-term control plan is to minimize impacts to the maximum extent feasible, attain the highest water quality achievable, and to protect critical uses. Given this, the TMDL establishes in Table ES-1 (as well as other tables) the goal of meeting class B, or SB standards in CSO impacted waters but recognizes that this criteria cannot be met at all times and therefore defers to the EPA and MassDEP approved long-term control CSO plan to define the infrequent occasions when the criteria may not be met.

25. Comment: The implementation of latest bacteria water quality criteria into NPDES permits should be determined during the permit writing process rather than by the TMDL process – and that should be made clear in the TMDL document.

Response: MassDEP agrees that implementation of the most current bacteria surface water quality criteria should be incorporated into the permitting process as well as the state Surface Water Quality Standards. This is already the case. The criteria are also being included in the TMDL because it is a required element of the TMDL process. The most current surface water quality standards were developed and included in the December 6, 2013 revisions to 314 CMR 4.00: Massachusetts Surface Water Quality Standards. These standards have been included in the final Pathogen TMDL for the Parker River Watershed.

26. Comment: Coastal resources are significantly impacted from the stormwater run-off from Mass Highway roads. This goes beyond the control of municipalities to upgrade and is often beyond the capability of local groups to monitor. MHD (Massachusetts Highway Department (Mass Highway)) continues to evade stormwater standards and it is thus our opinion that MHD deserves special recognition, complete with implementation strategy to upgrade the drainage systems along its web of asphalt.

Response: The Mass Highway Department, now officially known as the Massachusetts Department of Transportation (MassDOT), are subject to the 2003 MS4 permit and have requested that EPA issue an individual MS4 permit to DOT. EPA plans to include MassDOT under the umbrella of individually issued permittees for facilities such as transportation depots, airports, military facilities, and other such enterprise operations. Each of these facility permittees have separate requirements depending on the particular operations that occur at that facility.

27. Comment: What is the current 303d list of impaired waters?

Response: This TMDL was written to reflect the 2016 Integrated List of Waters, formerly known as the 303d list. This Parker River Watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for bacteria impairment in future Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for bacteria impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the future CWA § 303(d) Integrated List of Waters that this TMDL should apply to newly listed bacteria impaired segments. Additional waterbodies identified as impaired after public notice of the Draft TMDL (2005), will be released for public comment and included in an addendum to this document.

28. Comment: Does the NPDES non-delegated state status of Massachusetts affect the TMDLs in any way?

Response: No. The MassDEP and EPA work closely together and the non-delegated status will not affect the TMDLs. The EPA has not written any of the pathogen TMDLs but has helped fund them.

29. Comment: The TMDL report does not tell the watershed associations anything they didn’t already know.

Response: True. The MassDEP is taking a cooperative approach and by working together as a team (federal, state, municipal, local watershed groups) we can make progress in addressing bacterial problems, especially stormwater related bacterial problems.

30. Comment: What will the MassDEP do now for communities that they have not already been doing?

Response: Grants that can be used for implementation (such as the 319 grants for projects and for developing Watershed Based Plans) will be targeted toward TMDL implementation.

31. Comment: The State Revolving Fund (SRF) should support municipalities with TMDLs and Phase II status a lot more.

Response: As with any grant program, there are some very competitive projects looking for funds from the SRF. A lot of these are the traditional sewage treatment plants and sewering projects which are very expensive. The SRF currently does allocate funds to stormwater related projects and gives higher priority points to projects developed in response to TMDLs.

32. Comment: Who will be doing the TMDL implementation?

Response: Each pathogen TMDL report has a section (8.0) on implementation which includes a table (8-1) that generally lists the various tasks and the responsible entity. Most of the implementation tasks will fall on the authority of the municipalities. Probably two of the larger tasks in urban areas include implementing stormwater BMPs and eliminating illicit sources. The MassDEP working with EPA and other team partners shall make every reasonable effort to assure implementation of the TMDLs. Communities with discharges to impaired waters with TMDLs have additional requirements under the MS4 General Stormwater permit.

33. Comment: Several watershed groups believe that active and effective implementation and enforcement is essential to carry out the objectives in the pathogen TMDLs. They define effective implementation as the MassDEP partnering with them and municipalities to identify funding opportunities to develop stormwater management plans, implement Title 5 upgrades, and repair failing sewer infrastructure. The groups define effective enforcement as active MassDEP application of Title 5 regulations and implementation of MS4 General Stormwater permitting requirements for Phase II municipalities.

Response: The MassDEP has every intention of assisting watershed groups and municipalities with implementing the high priority aspects of the pathogen TMDLs, including identification of possible funding sources. With respect to Title 5 regulations and the MS4 General Stormwater Permit requirements, the MassDEP will continue to emphasize and assist entities with activities that lead to compliance with those program requirements.

34. Comment: The MassDEP Division of Watershed Management (DWM) should network implementation planning efforts in the coastal watersheds with the Coastal Zone Management's (CZM) Coastal Remediation Grant Program and the EPA Coastal Nonpoint Source Grant Program. Also, the DWM should make the pathogen TMDL presentation to the Mass Bays Group, and network with them with regards to coordinating implementation tasks.

Response: The MassDEP DWM intends, through its basin planning program, to do both.

35. Comment: Why are specific segments or tributaries of watersheds addressed in the Draft TMDL but not all of the segments?

Response: In accordance with the EPA regulations governing TMDL requirements, only segments that are included on the state's 303(d) list of impaired waterbodies need to be included in any TMDL. An addendum TMDL will be issued at a later date in the event additional segments are listed as impaired for pathogens after the public notification period.

36. Comment: When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source reductions will occur; EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures can achieve expected load reductions in order for the TMDL to be approvable.

Response: Refer to Section 10.0, Reasonable Assurances, . This section has been expanded in this Final version of the Draft Pathogen TMDL reports. The revised section 10.0 describes the appropriate state programs and their enabling statutes and relevant regulations which actively address nonpoint source pollution impacting waters of the Commonwealth. Many of these programs involve municipality first line defense mechanisms such as the Wetlands Protection Act (which includes the Rivers Protection Act). This expanded section also covers grant programs available to municipalities to control and abate nonpoint source pollution such as 319 grants, 604b grants, 104b(3) funds, Section 6217 coastal zone nonpoint source grants, low interest loans for septic system upgrades, state revolving fund grants, and many others.

37. Comment: The Draft TMDLs indicate that for non-impaired waters the TMDL proposes "pollution prevention BMPs". The term is not defined in any state regulation and the origin of the term is unclear.

Response: An explanation of pollution prevention BMPs can be found in the pathogen TMDL companion document "Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts". Section 3.1 of that manual describes pollution prevention as one of the six control measures for minimizing stormwater contamination under the EPA Phase I or II Stormwater Control Program. Control Measure #6, "Pollution Prevention / Good Housekeeping" involves a number of activities such as maintenance of structural and nonstructural stormwater controls, controls for reducing pollutants from roads, municipal yards and lots, street sweeping and catch basin cleaning, and control of pet waste. Also, the term "pollution prevention" can include a far wider range of pollution control activities to prevent bacterial pollution at the source. For instance, under Phase I and II, minimum control measures #4 and #5, construction site and post construction site runoff controls, would encompass many pollution prevention type BMP measures. Proper septic system maintenance and numerous agricultural land use measures can also be considered pollution prevention activities. Further information may be found in Sections 3.0, 4.0, and 5.0 in the Guidance Manual.

38. Comment: EPA regulations require that a TMDL include Load Allocations (LAs) which identify the portion of the loading capacity attributed to existing and future nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. s.130.2(g)). Where possible, load allocations should be described separately for natural background and nonpoint sources. The Draft TMDL makes no such allocation. Also, EPA regulations require that a TMDL include Waste Load Allocations (WLAs) which identify the portion of the loading capacity allocated to individual existing and future point sources. The Draft TMDL makes no such allocation. Because it makes no estimate of the TMDL, it makes no WLA for point sources.

Response: This comment (and several others which addressed the same topic) relates to the establishment and allocation of an acceptable pollutant load so that surface water quality standards can be met and maintained (see response to comment 9 & 16). As touched upon elsewhere in this document, TMDLs can be expressed in a variety of ways so long as they are rational. MassDEP has chosen to use concentration as the metric for bacteria TMDLs for several reasons. First, there is a numeric standard that can be used. Second, and more important, bacteria, unlike some other pollutants, can increase with flow rather than decrease. As such, the bacteria load applicable at low flow (7Q10) would be very stringent if applied to higher flows. In essence, this TMDL recognizes that higher loads are likely at higher flows and therefore the emphasis is on meeting the in-stream water quality. In-stream water quality inherently includes an accounting of background loading.

Watershed Specific Comments / Responses

1. Comment: MassDEP DWM should network implementation planning efforts in coastal parts of the three watersheds (Parker, Ipswich, Merrimack) with the CZM Coastal Remediation Grant program and the EPA Coastal Non- Point Source grant program. Also, why doesn't the MassDEP DWM make the same presentation as is being given today to the Mass Bays Group, as well as coordinating other possible efforts with them.

Response: Good comments, MassDEP DWM intends, through its basin planning program, to do both.

2. Question: Why are specific segments or tributaries addressed in the Draft TMDL, while certain others are not?

Response: According to the federal EPA regulations governing TMDL requirements, only segments that are included on the State's 303(d) Category 5 list for a particular impairment should be covered for that particular TMDL.

3. Question: What about the whole issue of the TMDL requiring "end of pipe/point of discharge" limits that meet Mass. Water Quality Standards?

Response: This is answered in the general comments portion above, question/response # 8.

Appendix B: EPA Memorandum: TMDLs and WLA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 2 6 2014

OFFICE OF WATER

MEMORANDUM
SUBJECT: Revisions to the November 22, 2002 Memorandum "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements Based on LAs"
FROM: Andrew D. Sawyers, Director
Office of Wastewater Management
Benita Best-Wong, Director
Office of Wetlands, Oceans and Water
TO: Water Division Directors
Regions 1 - 10

This memorandum updates aspects of EPA's November 22, 2002 memorandum from Robert H. Wayland, III, Director of the Office of Wetlands, Oceans and Watersheds, and James A. Hanlon, Director of the Office of Wastewater Management, on the subject of "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements Based on Those WLAs" (hereafter "2002 memorandum' ') .

Today's memorandum replaces the November 12, 2010, memorandum on the same subject; the Water Division Directors should no longer refer to that memorandum for guidance. This memorandum is guidance. It is not a regulation and does not impose legally binding requirements on EPA or States. EPA and state regulatory authorities should continue to make permitting and TMDL decisions on a case-by-case basis considering the particular facts and circumstances and consistent with applicable statutes, regulations, and case law. The recommendations in this guidance may not be applicable to a particular situation. EPA may change or revoke this guidance at any time.

Background

Stormwater discharges are a significant contributor to water quality impairment in this country, and the challenges from these discharges are growing as more land is developed and more impervious surface is created. Stormwater discharges cause beach closures and contaminate shellfish and surface drinking water supplies. The increased volume and velocity of stormwater discharges causes streambank erosion, flooding, sewer overflows, and basement backups. The decreased natural infiltration of rainwater reduces groundwater recharge, depleting our underground sources of drinking water.[1] There are stormwater management solutions, such as green infrastructure, that can protect our waterbodies from stormwater discharges and, at the same time offer many other benefits to communities.

Section III of the 2002 memorandum recommended that for NPDES-regulated municipal and small construction stormwater discharges, effluent limits be expressed as best management practices (BMPs) or other similar requirements, rather than as numeric effluent limits. The 2002 memorandum went on to provide guidance on using "an iterative, adaptive management BMP approach" for improving stormwater management over time as permitting agencies, the regulated community, and other involved stakeholders gain more experience and knowledge. EPA continues to support use of an iterative approach, but with greater emphasis on clear, specific, and measurable permit requirements and, where feasible, numeric NPDES permit provisions, as discussed below.

Since 2002, States and EPA have obtained considerable experience in developing TMDLs and WLAs that address stormwater sources (see Box 1 in the attachment for specific examples). Monitoring of the impacts of stormwater discharges on water quality has become more sophisticated and widespread.[2] The experience gained during this time has provided better information on the effectiveness of stormwater controls to reduce pollutant loadings and address water quality impairments. In many parts of the country, permitting agencies have issued several rounds of stormwater permits. Notwithstanding these developments, stormwater discharges remain a significant cause of water quality impairment in many places, highlighting a continuing need for more meaningful WLAs and more clear, specific, and measurable NPDES permit provisions to help restore impaired waters to their beneficial uses.

With this additional experience in mind, on November 12, 2010, EPA issued a memorandum updating and revising elements of the 2002 memorandum to better reflect current practices and trends in

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[1] DEP's 1990 CSO Policy was based on EPA's 1989 CSO Control Policy and established the goal of eliminating adverse impacts from CSOs, using partial use designation where removal or relocation was not feasible. The three month design storm was identified as the minimum technology-based effluent limitation, which would result in untreated overflows an average of four times a year. Abatement measures to meet these minimum standards were necessary for a CSO discharge to be eligible for partial use designation. Presumably, all CSOs exceeding this standard required downgrading to Class C or SC status. No partial use designations or downgrades to Class C were actually made, because the process was perceived as administratively cumbersome.

[2] The Alabama Dept. of Transportation, among many others. See also Section 4.2 (Monitoring/Modeling Requirements) of EPA's Municipal Separate Storm Sewer System Permits: Post-Construction Performance Standards & Water Quality-Based Requirements – A Compendium of Permitting Approaches (EPA, June 2014), or "MS4 Compendium" available at
http://water.epa.gov/polwaste/npdes/stormwater/upload/sw_ms4_compendium.pdf, for other examples of note.

permits and WLAs for stormwater discharges. On March 17, 2011, EPA sought public comment on the November 2010 memorandum and, earlier this year, completed a nationwide review of current practices used in MS4 permits[1] and industrial and construction stormwater discharge permits. As a result of comments received and informed by the reviews of EPA and state-issued stormwater permits, EPA is in this memorandum replacing the November 2010 memorandum, updating aspects of the 2002 memorandum and providing additional information in the following areas:

• Including clear, specific, and measurable permit requirements and, where feasible,
numeric effluent limitations in NPDES permits for stormwater discharges;
• Disaggregating stormwater sources in a WLA; and
• Designating additional stormwater sources to regulate and developing permit limits for
such sources.

Including Clear, Specific, and Measurable Permit Requirements and, Where Feasible, Numeric Effluent Limitations in NPDES Permits for Stormwater Discharges. At the outset of both the Phase I and Phase II stormwater permit programs, EPA provided guidance on the type of water quality-based effluent limits (WQBELs) that were considered most appropriate for stormwater permits. See Interim Permitting Policy for Water Quality-Based Limitations in Stormwater Permits [61 FR 43761 (August 26, 1996) and 61 FR 57425 (November 6, 1996)] and the Phase II rulemaking preamble 64 FR 68753 (December 8, 1999).
Under the approach discussed in these documents, EPA envisioned that in the first two to three rounds of permit issuance, stormwater permits typically would require implementation of increasingly more effective best management practices (BMPs). In subsequent stormwater permit terms, if the BMPs used during prior years were shown to be inadequate to meet the requirements of the Clean Water Act (CWA), including attainment of applicable water quality standards, the permit would need to contain more specific conditions or limitations.

There are many ways to include more effective WQBELs in permits. In the spring of 2014, EPA published the results of a nationwide review of current practices used in MS4 permits in Municipal Separate Storm Sewer Systems Permits: Post-Construction Performance Standards & Water Quality-Based Requirements – A Compendium of Permitting Approaches (June 2014). This MS4 Compendium demonstrates how NPDES authorities have been able to effectively establish permit requirements that are more specifically tied to a measurable water quality target and includes examples of permit requirements expressed in both numeric and non-numeric form. These approaches, while appropriately permit-specific, each share the attribute of being expressed in a clear, specific, and measurable way. For example, EPA found a number of permits that employ numeric, retention-based performance standards for post-construction discharges, as well as instances where permits have effectively incorporated numeric effluent limits or other quantifiable measures to address water quality impairment (see the attachment to this memorandum).

[1] See EPA's MS4 Permit Compendium, referenced in the above footnote.

EPA has also found examples where the applicable WLAs have been translated into BMPs, which are required to be implemented during the permit term to reflect reasonable further progress towards meeting the applicable water quality standard (WQS). Incorporating greater specificity and clarity echoes the approach first advanced by EPA in the 1996 Interim Permitting Policy, which anticipated that where necessary to address water quality concerns, permits would be modified in subsequent terms to include "more specific conditions or limitations [which] may include an integrated suite of BMPs, performance objectives, narrative standards, monitoring triggers, numeric WQBELs, action levels, etc."

EPA also recently completed a review of state-issued NPDES industrial and construction permits, which also revealed a number of examples where WQBELs are expressed using clear, specific, and measurable terms. Permits are exhibiting a number of different approaches, not unlike the types of provisions shown in the MS4 Compendium. For example, some permits are requiring as an effluent limitation compliance with a numeric or narrative WQS, while others require the implementation of specific BMPs that reduce the discharge of the pollutant of concern as necessary to meet applicable WQS or to implement a WLA and/or are requiring their permittees to conduct stormwater monitoring to ensure the effectiveness of those BMPs. EPA intends to publish a compendium of permitting approaches in state-issued industrial and construction stormwater permits in early 2015.

Permits for MS4 Discharges

The CWA provides that stormwater permits for MS4 discharges "shall require controls to reduce the discharge of pollutants to the maximum extent practicable … and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." CWA section 402(p)(3)(B)(iii). Under this provision, the NPDES permitting authority has the discretion to include requirements for reducing pollutants in stormwater discharges as necessary for compliance with water quality standards. Defenders of Wildlife v. Browner, 191 F.3d 1159, 1166 (9th Cir. 1999).

The 2002 memorandum stated, "EPA expects that most WQBELs for NPDES-regulated municipal and small construction stormwater discharges will be in the form of BMPs, and that numeric limitations will be used only in rare instances." As demonstrated in the MS4 Compendium, NPDES permitting authorities are using various forms of clear, specific, and measurable requirements, and, where feasible, numeric effluent limitations in order to establish a more objective and accountable means for reducing pollutant discharges that contribute to water quality problems.[1] Where the NPDES authority determines

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[1] The MS4 Compendium presents examples of different permitting approaches that EPA has found during a nationwide review of state MS4 permits. Examples of different WQBEL approaches in the MS4 Compendium include permits that have (1) a list of applicable TMDLs, WLAs, and the affected MS4s; (2) numeric limits and other quantifiable approaches for specific pollutants of concern; (3) requirements to implement specific stormwater controls or management measures to meet the applicable WLA; (4) permitting authority review and approval of TMDL plans; (5) specific impaired waters monitoring and modeling requirements; and (6) requirements for discharges to impaired waters prior to TMDL approval.

that MS4 discharges have the reasonable potential to cause or contribute to a water quality standard excursion, EPA recommends that the NPDES permitting authority exercise its discretion to include clear, specific, and measurable permit requirements and, where feasible, numeric effluent limitations[1] as necessary to meet water quality standards.

NPDES authorities have significant flexibility in how they express WQBELs in MS4 permits (see examples in Box 1 of the attachment). WQBELs in MS4 permits can be expressed as system-wide requirements rather than as individual discharge location requirements such as effluent limitations on discharges from individual outfalls. Moreover, the inclusion of numeric limitations in an MS4 permit does not, by itself, mandate the type of controls that a permittee will use to meet the limitation.

EPA recommends that NPDES permitting authorities establish clear, specific, and measurable permit requirements to implement the minimum control measures in MS4 permits.

With respect to requirements for post-construction stormwater management, consistent with guidance in the 1999 Phase II Rule, EPA recommends, where feasible and appropriate, numeric requirements that attempt to maintain pre-development runoff conditions (40 CFR § 122.34(b)(5)) be incorporated into MS4 permits. EPA's MS4 Compendium features examples from 17 states and the District of Columbia that have already implemented retention performance standards for newly developed and redeveloped sites. See Box 2 of the attachment for examples.

Permits for Industrial Stormwater Discharges

The CWA requires that permits for stormwater discharges associated with industrial activity comply with section 301 of the Act, including the requirement under section 301(b)(1)(C) to contain WQBELs to achieve water quality standards for any discharge that the permitting authority determines has the reasonable potential to cause or contribute to a water quality standard excursion. CWA section 402(p)(3)(A), 40 CFR § 122.44(d)(1)(iii). When the permitting authority determines, using the procedures specified at 40 CFR § 122.44(d)(1)(ii), that the discharge causes or has the reasonable potential to cause or contribute to an in-stream excursion of the water quality standards, the permit must contain WQBELs as stringent as necessary to meet any applicable water quality standard for that pollutant. EPA recommends that NPDES permitting authorities use the experience gained in developing WQBELs to design effective permit conditions to create objective and accountable means for controlling stormwater discharges. See box 3 in the attachment for examples.

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[1] For the purpose of this memorandum, and in the context of NPDES permits for stormwater discharges, "numeric" effluent limitations refer to limitations with a quantifiable or measurable parameter related to a pollutant (or pollutants). Numeric WQBELs may include other types of numeric limits in addition to end-of-pipe limits. Numeric WQBELs may include, among others, limits on pollutant discharges by specifying parameters such as on-site stormwater retention volume or percentage or amount of effective impervious cover, as well as the more traditional pollutant concentration limits and pollutant loads in the discharge.

Permits should contain clear, specific, and measurable elements associated with BMP implementation (e.g., schedule for BMP installation, frequency of a practice, or level of BMP performance), as appropriate, and should be supported by documentation that implementation of selected BMPs will result in achievement of water quality standards. Permitting authorities should also consider including numeric benchmarks for BMPs and associated monitoring protocols for estimating BMP effectiveness in stormwater permits. Benchmarks can support an adaptive approach to meeting applicable water quality standards. While exceeding the benchmark is not generally a permit violation, exceeding the benchmark would typically require the permittee to take additional action, such as evaluating the effectiveness of the BMPs, implementing and/or modifying BMPs, or providing additional measures to protect water quality.[1] Permitting authorities should consider structuring the permit to clarify that failure to implement required corrective action, including a corrective action for exceeding a benchmark, is a permit violation. EPA notes that, as many stormwater discharges are authorized under a general permit, NPDES authorities may find it more appropriate where resources allow to issue individual permits that are better tailored to meeting water quality standards for large industrial stormwater discharges with more complex stormwater management features, such as multiple outfalls and multiple entities responsible for permit compliance.

All Permitted Stormwater Discharges

As stated in the 2002 memorandum, where a State or EPA has established a TMDL, NPDES permits must contain effluent limits and conditions consistent with the assumptions and requirements of the WLAs in the TMDL. See 40 CFR § 122.44(d)(1)(vii)(B). Where the TMDL includes WLAs for stormwater sources that provide numeric pollutant loads, the WLA should, where feasible, be translated into effective, measurable WQBELs that will achieve this objective. This could take the form of a numeric limit, or of a measurable, objective BMP-based limit that is projected to achieve the WLA. For MS4 discharges, CWA section 402(p)(3)(B)(iii) provides flexibility for NPDES authorities to set appropriate deadlines for meeting WQBELs consistent with the requirements for compliance schedules in NPDES permits set forth in 40 CFR § 122.47.

The permitting authority's decision as to how to express the WQBEL(s), either as numeric effluent limitations or as BMPs, with clear, specific, and measurable elements, should be based on an analysis of the specific facts and circumstances surrounding the permit, and/or the underlying WLA, including the nature of the stormwater discharge, available data, modeling results, and other relevant information. As discussed in the 2002 memorandum, the permit's administrative record needs to provide an adequate demonstration that, where a BMP-based approach to permit limitations is selected, the BMPs required

[1] For example, Part 6.2.1 of EPA's 2008 MSGP provides: "This permit stipulates pollutant benchmark concentrations that may be applicable to your discharge. The benchmark concentrations are not effluent limitations; a benchmark exceedance, therefore, is not a permit violation. Benchmark monitoring data are primarily for your use to determine the overall effectiveness of your control measures and to assist you in knowing when additional corrective action(s) may be necessary to comply with the effluent limitations …"

by the permit will be sufficient to implement applicable WLAs. Permits should also include milestones or other mechanisms where needed to ensure that the progress of implementing BMPs can be tracked. Improved knowledge of BMP effectiveness gained since 2002[1] should be reflected in the demonstration and supporting rationale that implementation of the BMPs will attain water quality standards and be consistent with WLAs.

EPA's regulations at 40 CFR § 122.47 govern the use of compliance schedules in NPDES permits. Central among the requirements is that the effluent limitation(s) must be met "as soon as possible." 40 CFR § 122.47(a)(1). As previously discussed, by providing discretion to include "such other provisions" as deemed appropriate, CWA section 402(p)(3)(B)(iii) provides flexibility for NPDES authorities to set appropriate deadlines towards meeting WQBELs in MS4 permits consistent with the requirements for compliance schedules in NPDES permits set forth in 40 CFR § 122.47. See Defenders of Wildlife v Browner, 191 F.3d at 1166. EPA expects the permitting authority to document in the permit record the basis for determining that the compliance schedule is "appropriate" and consistent with the CWA and 40 CFR § 122.47. Where a TMDL has been established and there is an accompanying implementation plan that provides a schedule for an MS4 to implement the TMDL, or where a comprehensive, integrated plan addressing a municipal government's wastewater and stormwater obligations under the NPDES program has been developed, the permitting authority should consider such schedules as it decides whether and how to establish enforceable interim requirements and interim dates in the permit.

EPA notes that many permitted stormwater discharges are covered by general permits. Permitting authorities should consider and build into general permits requirements to ensure that permittees take actions necessary to meet the WLAs in approved TMDLs and address impaired waters. A general permit can, for example, identify permittees subject to applicable TMDLs in an appendix, and prescribe the activities that are required to meet an applicable WLA.

Lastly, NPDES permits must specify monitoring requirements necessary to determine compliance with effluent limitations. See CWA section 402(a)(2); 40 CFR 122.44(i). The permit could specify actions that the permittee must take if the BMPs are not performing properly or meeting expected load reductions. When developing monitoring requirements, the NPDES authority should consider the variable nature of stormwater as well as the availability of reliable and applicable field data describing the treatment efficiencies of the BMPs required and supporting modeling analysis.

Disaggregating Stormwater Sources in a WLA

In the 2002 memorandum, EPA said it "may be reasonable to express allocations for

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[1] See compilation of current BMP databases and summary reports available at http://water.epa.gov/infrastructure/greeninfrastructure/gi_performance.cfm, which has compiled current BMP databases and summary reports.

NPDES-regulated stormwater discharges from multiple point sources as a single categorical wasteload allocation when data and information are insufficient to assign each source or outfall individual WLAs." EPA also said that, "[i]n cases where wasteload allocations are developed for categories of discharges, these categories should be defined as narrowly as available information allows." Furthermore, EPA said it "recognizes that the available data and information usually are not detailed enough to determine waste load allocations for NPDES-regulated stormwater discharges on an outfall-specific basis."

EPA still recognizes that "[d]ecisions about allocations of pollutant loads within a TMDL are driven by the quantity and quality of existing and readily available water quality data," but has noted the difficulty of establishing clear, specific, and measurable NPDES permit limitations for sources covered by WLAs that are expressed as single categorical or aggregated wasteload allocations. Today, TMDL writers may have more information—such as more ambient monitoring data, better spatial and temporal representation of stormwater sources, and/or more permit-generated data—than they did in 2002 to develop more disaggregated TMDL WLAs.

Accordingly, for all these reasons, EPA is again recommending that, "when information allows," WLAs for NPDES-regulated stormwater discharges be expressed "as different WLAs for different identifiable categories" (e.g., separate WLAs for MS4 and industrial stormwater discharges). In addition, as EPA said in 2002, "[t]hese categories should be defined as narrowly as available information allows (e.g., for municipalities, separate WLAs for each municipality and for industrial sources, separate WLAs for different types of industrial stormwater sources or dischargers)." EPA does not expect states to assign WLAs to individual MS4 outfalls; however, some states may choose to do so to support their implementation efforts. These recommendations are consistent with the decision in Anacostia Riverkeeper, Inc. v. Jackson, 2011 U.S. Dist. Lexis 80316 (July 25, 2011).

In general, states are encouraged to disaggregate the WLA when circumstances allow to facilitate implementation. TMDL writers may want to consult with permit writers and local authorities to collect additional information such as sewer locations, MS4 jurisdictional boundaries, land use and growth projections, and locations of stormwater controls and infrastructure, to facilitate disaggregation. TMDLs have used different approaches to disaggregate stormwater to facilitate MS4 permit development that is consistent with the assumptions and requirements of the WLA. For example, some TMDLs have used a geographic approach and developed individual WLAs by subwatershed[1] or MS4 boundary (i.e., the WLA is subdivided by the relative estimated load contribution to the subwatershed

[1] Wissahickon Creek Siltation TMDL (Pennsylvania) www.epa.gov/reg3wapd/tmdl/pa_tmdl/wissahickon/index.htm.

or the area served by the MS4). TMDLs have also assigned percent reductions[1] of the loading based on the estimated wasteload contribution from each MS4 permit holder. Where appropriate, EPA encourages permit writers to identify specific shares of an applicable wasteload allocation for specific permittees during the permitting process, as permit writers may have more detailed information than TMDL writers to effectively identify reductions for specific sources.

Designating Additional Stormwater Sources to Regulate and Developing Permit Limits for Such Sources

The 2002 memorandum states that "stormwater discharges from sources that are not currently subject to NPDES regulation may be addressed by the load allocation component of a TMDL." Section 402(p)(2) of the Clean Water Act (CWA) requires industrial stormwater sources, certain municipal separate storm sewer systems, and other designated sources to be subject to NPDES permits. Section 402(p)(6) provides EPA with authority to identify additional stormwater discharges as needing a permit.

In addition to the stormwater discharges specifically identified as needing an NPDES permit, the CWA and the NPDES regulations allow for EPA and NPDES authorized States to designate additional stormwater discharges for regulation. See:
40 CFR §§122.26 (a)(9)(i)(C), (a)(9)(i)(D), (b)(4)(iii), (b)(7)(iii), (b)(15)(ii) and 122.32(a)(2). Accordingly, EPA encourages permitting authorities to consider designation of stormwater sources in situations where coverage under NPDES permits would, in the reasonable judgment of the permitting authority and, considering the facts and circumstances in the waterbody, provide the most appropriate mechanism for implementing the pollution controls needed within a watershed to attain and maintain applicable water quality standards.

If a TMDL had previously included a newly permitted source as part of a single aggregated or gross load allocation for all unregulated stormwater sources, or all unregulated sources in a specific category, the NPDES permit authority could identify an appropriate allocation share and include a corresponding limitation specific to the newly permitted stormwater source. EPA recommends that any additional analysis used to identify that share and develop the corresponding limit be included in the administrative record for the permit. The permit writer's additional analysis would not change the TMDL, including its overall loading cap.

In situations where a stormwater source addressed in a TMDL's load allocation is not

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[1] Liberty Bay Watershed Fecal Coliform Bacteria TMDL (Washington). https://fortress.wa.gov/ecy/publications/SummaryPages/1310014.html and Upper Minnehaha Creek Watershed Nutrients and Bacteria TMDL (Minnesota) http://www.pca.state.mn.us/index.php/view-document.html?gid=20792

currently regulated by an NPDES permit but may be required to obtain an NPDES permit in the future, the TMDL writer should consider including language in the TMDL explaining that the allocation for the stormwater source is expressed in the TMDL as a “load allocation” contingent on the source remaining unpermitted, but that the “load allocation” would later be deemed a “wasteload allocation” if the stormwater discharge from the source were required to obtain NPDES permit coverage. Such language would help ensure that the allocation is properly characterized by the permit writer should the source’s regulatory status change. This will help the permit writer develop limitations for the NPDES permit applicable to the newly permitted source that are consistent with the assumptions and requirements of the TMDL’s allocation to that source.

If you have any questions please feel free to contact us or Deborah Nagle, Director of the Water Permits Division, or Tom Wall, Director of the Assessment and Watershed Protection Division.

cc: Association of Clean Water Administrators
TMDL Program Branch Chiefs, Regions 1 – 10
NPDES Permits Branch Chiefs, Regions 1 – 10

ATTACHMENT: MS4 and Industrial Stormwater Permit Examples

BOX 1. Examples of WQBELs in MS4 Permits:
1. Numeric expression of the WQBEL: The MS4 Permit includes a specific, quantifiable performance requirement that must be achieved within a set timeframe. For example:
- Reduce fine sediment particles, total phosphorus, and total nitrogen loads by 10 percent, 7 percent, and 8 percent, respectively, by September 30, 2016 (2011 Lake Tahoe, CA MS4 permit)
- Restore within the 5-year permit term 20 percent of the previously developed impervious land (2014 Prince George’s County, MD MS4 permit)
- Achieve a minimum net annual planting rate of 4,150 planting annually within the MS4 area, with the objective of an MS4-wide urban tree canopy of 40 percent by 2035 (2011 Washington, DC MS4 permit)
- Discharges from the MS4 must not cause or contribute to exceedances of receiving water limits for Diazinon of 0.08µg/L for acute exposure (1 hr averaging period) or 0.05µg/L for chronic exposure (4-day averaging period), OR must not exceed Diazinon discharge limits of 0.072 µg/L for acute exposure or 0.045µg/L for chronic exposure (2013 San Diego, CA Regional MS4 permit)

2. Non-numeric expressions of the WQBEL: The MS4 Permit establishes individualized, watershed-based requirements that require each affected MS4 to implement specific BMPs within the permit term, which will ensure reasonable further progress towards meeting applicable water quality standards.
- To implement the corrective action recommendations of the Issaquah Creek Basin Water Cleanup

Plan for Fecal Coliform Bacteria (part of the approved Fecal Coliform Bacteria TMDL for the Issaquah Creek Basin), King County is required during the permit term to install and maintain animal waste education and/or collection stations at municipal parks and other permittee owned and operated lands reasonably expected to have substantial domestic animal use and the potential for stormwater pollution. The County is also required to complete IDDE screening for bacteria sources in 50 percent of the MS4 subbasins, including rural MS4 subbasins, by February 2, 2017 and implement the activities identified in the Phase I permit for responding to any illicit discharges found (2013 Western Washington Small MS4 General Permit)

- For discharges to Segment 14 of the Upper South Platte River Basin associated with WLAs from the approved E. coli TMDL, the MS4 must identify outfalls with dry weather flows; monitor priority outfalls for flow rates and E. coli densities; implement a system maintenance program for listed priority basins (which includes storm sewer cleaning and sanitary sewer investigations); install markers on at least 90% of storm drain inlets in areas with public access; and conduct a public outreach program focused on sources that contribute E. coli loads to the MS4. By November 30, 2018, dry weather discharges from MS4 outfalls of concern must not contribute to an exceedance of the E. coli standard (126 cfu per 100 ml for a geometric mean of all samples collected at a specific outfall in a 30-day period) (2009 Denver, CO MS4 Permit)

3. Hybrid approach with both numeric and non-numeric expressions of the WQBEL:

- Discharges of trash from the MS4 to the LA River must be reduced to zero by Sept. 2016. Permittees also have the option of complying via the installation of defined “full capture systems” to prevent trash from entering the MS4 (2012 Los Angeles County, CA MS4 Permit).
- To attain the shared, load allocation of 27,000 metric tons/year of sediment in the Napa River sediment TMDL, municipalities shall determine opportunities to retrofit and/or reconstruction of road crossings to minimize road-related sediment delivery (≤ 500 cubic yards/mile per 20-year period) to stream channels (2013 CA Small MS4 General Permit).

Box 2. Examples of Retention Post Construction Standards for New and Redevelopment in MS4 Permits

- 2009 WV small MS4 permit: Keep and manage on site the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation.
- 2011 DC Phase I MS4 permit: Achieve on-site retention of 1.2" of stormwater from a 24-hour storm with a 72-hour antecedent dry period through evapotranspiration, infiltration and/or stormwater harvesting.
- 2012 Albuquerque, NM Phase I MS4 permit: Capture the 90th percentile storm event runoff to mimic the predevelopment hydrology of the previously undeveloped site.
- 2010 Anchorage, AK Phase I MS4 permit: Keep and manage the runoff generated from the first 0.52 inches of rainfall from a 24 hour event preceded by 48 hours of no measureable precipitation.
- 2013 Western WA small MS4 permit: Implement low impact development performance standards to match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year flow to 50% of the 2-year flow.

BOX 3. Examples of WQBELs in Industrial (including Construction) Stormwater Permits:

1. Numeric expression of the WQBEL: The permit includes a specific, quantifiable performance requirement that must be achieved:

- Pollutant concentrations shall not exceed the stormwater discharge limits specified in the permit (based on state SWQS), including (for example): Cadmium-0.003 mg/l; Mercury-0.0024 mg/l; Selenium-0.02 mg/l (2013 Hawaii MSGP)
- Beginning July 1, 2010, permittees discharging to impaired waters without an EPA-approved TMDL shall comply with the following effluent limits (based on state SWQS), including (for example): Turbidity-25 NTU; TSS-30 mg/l; Mercury-0.0021 mg/l; Phosphorus, Ammonia, Lead, Copper, Zinc-site-specific limits to be determined at time of permit coverage (2010 Washington MSGP)
- If discharging to waters on the 303(d) list (Category 5) impaired for turbidity, fine sediment, or phosphorus, the discharge must comply with the following effluent limit for turbidity: 25 NTU (at the point of discharge from the site), or no more than 5 NTU above background turbidity when the background turbidity is 50 NTU or less, or no more than a 10% increase in turbidity when background turbidity is more than 50 NTU. Discharges to waterbodies on the 303(d) list (Category 5) for high pH must comply with the numeric effluent limit of pH 6.5 to 8.5 su (2010 Washington CGP) (2010 Washington CGP)

2. Narrative expression of the WQBEL: The permit includes narrative effluent limits based on applicable WQS:

- New discharges or new dischargers to an impaired water are not eligible for permit coverage, unless documentation or data exists to show that (1) all exposure of the pollutant(s) of concern to stormwater is prevented; or (2) the pollutant(s) of concern are not present at the facility; or (3) the discharge of the pollutant(s) of concern will meet instream water quality criteria at the point of discharge (for waters without an EPA-approved TMDL), or there is sufficient remaining WLAs in an EPA-approved TMDL to allow the discharge and that existing dischargers are subject to compliance schedules to bring the waterbody into attainment with SWQS (2011 Vermont MSGP; similar requirements in RI, NY, MD, VA, WV, SC, AR, TX, KS, NE, AZ, CA, AK, OR, and WA permits)
- In addition to other applicable WQBELs, there shall be no discharge that causes visible oil sheen, and no discharge of floating solids or persistent foam in other than trace amounts. Persistent foam is foam that does not dissipate within one half hour of point of discharge (2014 Maryland MSGP)

3. Requirement to implement additional practices or procedures for discharges to impaired waters:

- For sediment-impaired waters (without an approved TMDL), the permittee is required to maintain a minimum 50-foot buffer zone between any disturbance and all edges of the receiving water (2009 Kentucky CGP)
- For discharges to impaired waters, implement the following: (1) stabilization of all exposed soil areas immediately, but in no case later than 7 days after the construction activity in that portion of the site has temporarily or permanently ceased (as compared to 14 days for no-impaired waters); (2) temporary sediment basins must meet specified design standards if they will serve an area of 5 or more acres (as compared to 10 or more acres for other sites); (3) retain a water quality volume of 1

inch of runoff from the new impervious surfaces created by the project (though this volume reduction requirement is for discharges to all waters, not just impaired waters) (2013 Minnesota CGP).
- If the site discharges to a water impaired for sediment or turbidity, or to a water subject to an EPA-approved TMDL, the permittee must implement one or more of the following practices: (1) compost berms, compost blankets, or compost socks; (2) erosion control mats; (3) tackifiers used with a perimeter control BMP; (4) a natural buffer of 50 feet (horizontally) plus 25 feet (horizontally) for 5 degrees of slope; (5) water treatment by electro-coagulation, flocculation, or filtration; and/or (6) other substantially equivalent sediment or turbidity BMP approved by the state (2010 Oregon CGP)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
OFFICE OF
WATER
MEMORANDUM
SUBJECT: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements Based on Those WLAs
FROM: Robert H. Wayland, III, Director
Office of Wetlands, Oceans and Watersheds
James A. Hanlon, Director
Office of Wastewater Management
TO: Water Division Directors
Regions 1 - 10

This memorandum clarifies existing EPA regulatory requirements for, and provides guidance on, establishing wasteload allocations (WLAs) for stormwater discharges in total maximum daily loads (TMDLs) approved or established by EPA. It also addresses the establishment of water quality-based effluent limits (WQBELs) and conditions in National Pollutant Discharge Elimination System (NPDES) permits based on the WLAs for stormwater discharges in TMDLs. The key points presented in this memorandum are as follows:

NPDES-regulated stormwater discharges must be addressed by the wasteload allocation component of a TMDL. See 40 C.F.R. § 130.2(h).

NPDES-regulated stormwater discharges may not be addressed by the load allocation (LA) component of a TMDL. See 40 C.F.R. § 130.2 (g) & (h).

Stormwater discharges from sources that are not currently subject to NPDES regulation may be addressed by the load allocation component of a TMDL. See 40 C.F.R. § 130.2(g).

It may be reasonable to express allocations for NPDES-regulated stormwater discharges from multiple point sources as a single categorical wasteload allocation when data and information are insufficient to assign each source or outfall individual WLAs. See 40 C.F.R. § 130.2(i). In cases where wasteload allocations are developed for categories of discharges, these categories should be defined as narrowly as available information allows.

The WLAs and LAs are to be expressed in numeric form in the TMDL. See 40 C.F.R. § 130.2(h) & (i). EPA expects TMDL authorities to make separate allocations to NPDES- regulated stormwater discharges (in the form of WLAs) and unregulated stormwater (in the form of LAs). EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability in the system.

NPDES permit conditions must be consistent with the assumptions and requirements of available WLAs. See 40 C.F.R. § 122.44(d)(1)(vii)(B).

WQBELs for NPDES-regulated stormwater discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C.

§1342(p)(3)(B)(iii); 40 C.F.R. §122.44(k)(2)&(3). If BMPs alone adequately implement the WLAs, then additional controls are not necessary.

EPA expects that most WQBELs for NPDES-regulated municipal and small construction stormwater discharges will be in the form of BMPs, and that numeric limits will be used only in rare instances.

When a non-numeric water quality-based effluent limit is imposed, the permit's administrative record, including the fact sheet when one is required, needs to support that the BMPs are expected to be sufficient to implement the WLA in the TMDL. See 40 C.F.R. §§ 124.8, 124.9 & 124.18.

The NPDES permit must also specify the monitoring necessary to determine compliance with effluent limitations. See 40 C.F.R. § 122.44(i). Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved (e.g., BMP performance data).

The permit should also provide a mechanism to make adjustments to the required BMPs as necessary to ensure their adequate performance.

This memorandum is organized as follows:

(I). Regulatory basis for including NPDES-regulated stormwater discharges in WLAs in TMDLs;

(II). Options for addressing stormwater in TMDLs; and

(III). Determining effluent limits in NPDES permits for stormwater discharges consistent with the WLA

I). Regulatory Basis for Including NPDES-regulated Stormwater Discharges in WLAs in TMDLs

As part of the 1987 amendments to the CWA, Congress added Section 402(p) to the Act to cover discharges composed entirely of stormwater. Section 402(p)(2) of the Act requires permit coverage for discharges associated with industrial activity and discharges from large and medium municipal separate storm sewer systems (MS4), i.e., systems serving a population over 250,000 or systems serving a population between 100,000 and 250,000, respectively. These discharges are referred to as Phase I MS4 discharges.

In addition, the Administrator was directed to study and issue regulations that designate additional stormwater discharges, other than those regulated under Phase I, to be regulated in order to protect water quality. EPA issued regulations on December 8, 1999 (64 FR 68722), expanding the NPDES stormwater program to include discharges from smaller MS4s (including all systems within "urbanized areas" and other systems serving populations less than 100,000) and stormwater discharges from construction sites that disturb one to five acres, with opportunities for area-specific exclusions. This program expansion is referred to as Phase II.

Section 402(p) also specifies the levels of control to be incorporated into NPDES stormwater permits depending on the source (industrial versus municipal stormwater). Permits for stormwater discharges associated with industrial activity are to require compliance with all applicable provisions of Sections 301 and 402 of the CWA, i.e., all technology-based and water quality-based requirements. See 33 U.S.C. §1342(p)(3)(A). Permits for discharges from MS4s, however, "shall require controls to reduce the discharge of pollutants to the maximum extent practicable ... and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." See 33 U.S.C. §1342(p)(3)(B)(iii).

Stormwater discharges that are regulated under Phase I or Phase II of the NPDES stormwater program are point sources that must be included in the WLA portion of a TMDL. See 40 C.F.R. § 130.2(h). Stormwater discharges that are not currently subject to Phase I or Phase II of the NPDES stormwater program are not required to obtain NPDES permits. 33 U.S.C. §1342(p)(1) & (p)(6). Therefore, for regulatory purposes, they are analogous to nonpoint sources and may be included in the LA portion of a TMDL. See 40 C.F.R. § 130.2(g).

(II). Options for Addressing Stormwater in TMDLs

Decisions about allocations of pollutant loads within a TMDL are driven by the quantity and quality of existing and readily available water quality data. The amount of stormwater data available for a TMDL varies from location to location. Nevertheless, EPA expects TMDL authorities will make separate aggregate allocations to NPDES-regulated stormwater discharges (in the form of WLAs) and unregulated stormwater (in the form of LAs). It may be reasonable to quantify the allocations through estimates or extrapolations, based either on knowledge of land use patterns and associated literature values for pollutant loadings or on actual, albeit limited, loading information. EPA recognizes that these allocations might be fairly rudimentary because of data limitations.

EPA also recognizes that the available data and information usually are not detailed enough to determine waste load allocations for NPDES-regulated stormwater discharges on an outfall-specific basis. In this situation, EPA recommends expressing the wasteload allocation in the TMDL as either a single number for all NPDES-regulated stormwater discharges, or when information allows, as different WLAs for different identifiable categories, e.g., municipal stormwater as distinguished from stormwater discharges from construction sites or municipal stormwater discharges from City A as distinguished from City B. These categories should be defined as narrowly as available information allows (e.g., for municipalities, separate WLAs for each municipality and for industrial sources, separate WLAs for different types of industrial stormwater sources or dischargers).

(III). Determining Effluent Limits in NPDES Permits for Stormwater Discharges Consistent with the WLA

Where a TMDL has been approved, NPDES permits must contain effluent limits and conditions consistent with the requirements and assumptions of the wasteload allocations in the TMDL. See 40 CFR § 122.44(d)(1)(vii)(B). Effluent limitations to control the discharge of pollutants generally are expressed in numerical form. However, in light of 33 U.S.C. §1342(p)(3)(B)(iii), EPA recommends that for NPDES-regulated municipal and small construction stormwater discharges effluent limits should be expressed as best management practices (BMPs) or other similar requirements, rather than as numeric effluent limits. See Interim Permitting Approach for Water Quality-Based Effluent Limitations in Stormwater Permits, 61 FR 43761 (Aug. 26, 1996). The Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in stormwater discharges. Specifically, the policy anticipates that a suite of BMPs will be used in the initial rounds of permits and that these BMPs will be tailored in subsequent rounds.

EPA's policy recognizes that because stormwater discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction stormwater discharges.

The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual and projected loadings for individual dischargers or groups of dischargers. Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs, and that numeric limits will be used only in rare instances.

Under certain circumstances, BMPs are an appropriate form of effluent limits to control pollutants in stormwater. See 40 CFR § 122.44(k)(2) & (3). If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the stormwater component of the TMDL, EPA recommends that the TMDL reflect this.

EPA expects that the NPDES permitting authority will review the information provided by the TMDL, see 40 C.F.R. § 122.44(d)(1)(vii)(B), and determine whether the effluent limit is appropriately expressed using a BMP approach (including an iterative BMP approach) or a numeric limit. Where BMPs are used, EPA recommends that the permit provide a mechanism to require use of expanded or better-tailored BMPs when monitoring demonstrates they are necessary to implement the WLA and protect water quality.

Where the NPDES permitting authority allows for a choice of BMPs, a discussion of the BMP selection and assumptions needs to be included in the permit's administrative record, including the fact sheet when one is required. 40 C.F.R.§§ 124.8, 124.9 & 124.18. For general permits, this may be included in the stormwater pollution prevention plan required by the permit. See 40 C.F.R. § 122.28. Permitting authorities may require the permittee to provide supporting information, such as how the permittee designed its management plan to address the WLA(s). See 40 C.F.R. § 122.28. The NPDES permit must require the monitoring necessary to assure compliance with permit limitations, although the permitting authority has the discretion under EPA's regulations to decide the frequency of such monitoring. See 40 CFR § 122.44(i). EPA recommends that such permits require collecting data on the actual performance of the BMPs. These additional data may provide a basis for revised management measures. The monitoring data are likely to have other uses as well. For example, the monitoring data might indicate if it is necessary to adjust the BMPs. Any monitoring for stormwater required as part of the permit should be consistent with the state's overall assessment and monitoring strategy.

The policy outlined in this memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and non-structural BMPs) that address stormwater discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality. This approach is further supported by the recent report from the National Research Council (NRC), Assessing the TMDL Approach to Water Quality Management (National Academy Press, 2001). The NRC report recommends an approach that includes "adaptive implementation," i.e., "a cyclical process in which TMDL plans are periodically assessed for their achievement of water quality standards" . . . and adjustments made as necessary. NRC Report at ES-5.

This memorandum discusses existing requirements of the Clean Water Act (CWA) and codified in the TMDL and NPDES implementing regulations. Those CWA provisions and regulations contain legally binding requirements. This document describes these requirements; it does not substitute for those provisions or regulations. The recommendations in this memorandum are not binding; indeed, there may be other approaches that would be appropriate

in particular situations. When EPA makes a TMDL or permitting decision, it will make each decision on a case-by-case basis and will be guided by the applicable requirements of the CWA and implementing regulations, taking into account comments and information presented at that time by interested persons regarding the appropriateness of applying these recommendations to the particular situation. EPA may change this guidance in the future.

If you have any questions please feel free to contact us or Linda Boornazian, Director of the Water Permits Division or Charles Sutfin, Director of the Assessment and Watershed Protection Division.
cc:
Water Quality Branch Chiefs
Regions 1 - 10
Permit Branch Chiefs
Regions 1 - 10

Appendix C: Summary of TMDLs in Parkers River Watershed

Segment ID	Name	Impaired Use	Cause	TMDL Type (Cause)
MA91-06	Eagle Hill River	Primary Contact	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-14	Egypt River	Primary Contact	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-11	Little River	Primary Contact	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-09	Mill River	Shellfish Harvesting	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-03	Paine Creek	Primary Contact	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-02	Parker River	Shellfish Harvesting	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-15	Plum Island River	Shellfish Harvesting	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-12	Plum Island Sound	Shellfish Harvesting	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)
MA91-05	Rowley River	Shellfish Harvesting	Fecal Coliform	Restoration (Fecal Coliform), Preventative (Enterococci)