Final Pathogen TMDL for the Cape Cod Watershed

August 2009

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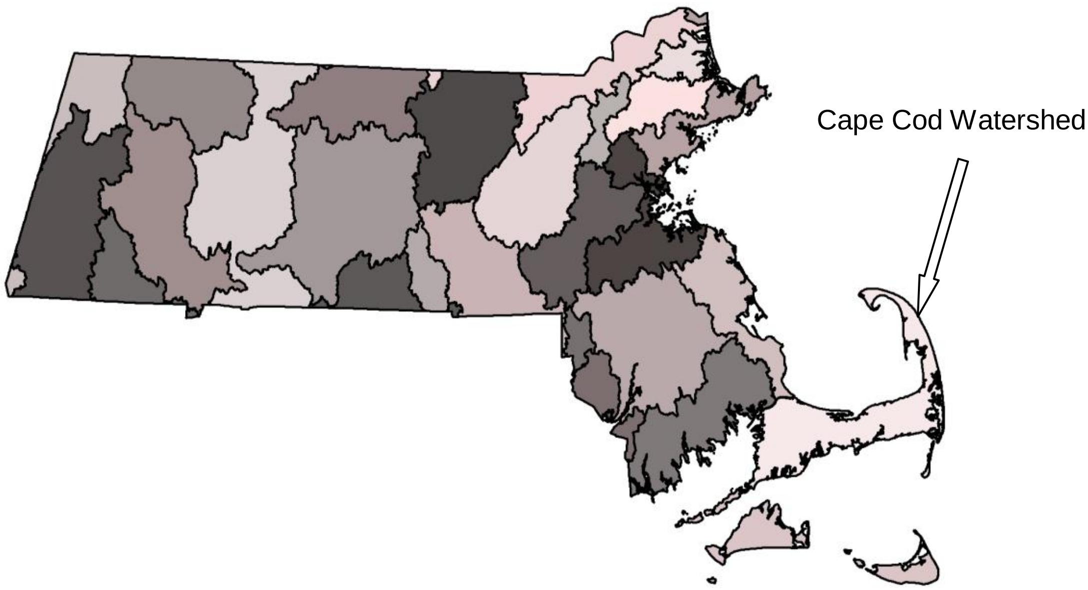

Prepared as a cooperative effort by:

Massachusetts DEP
1 Winter Street
Boston, Massachusetts 02108

USEPA New England Region 1
1 Congress Street, Suite 1100
Boston, Massachusetts 02114

ENSR International
2 Technology Park Drive
Westford, MA 01886

NOTICE OF AVAILABILITY

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

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

This report is also available from MassDEP's home page at:
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A complete list of reports published since 1963 is updated annually. This list, titled "Publications of the Massachusetts Division of Watershed Management (DWM) – Watershed Planning Program, 1963 - (current year)", is also available at www.mass.gov/dep/water/priorities.htm.

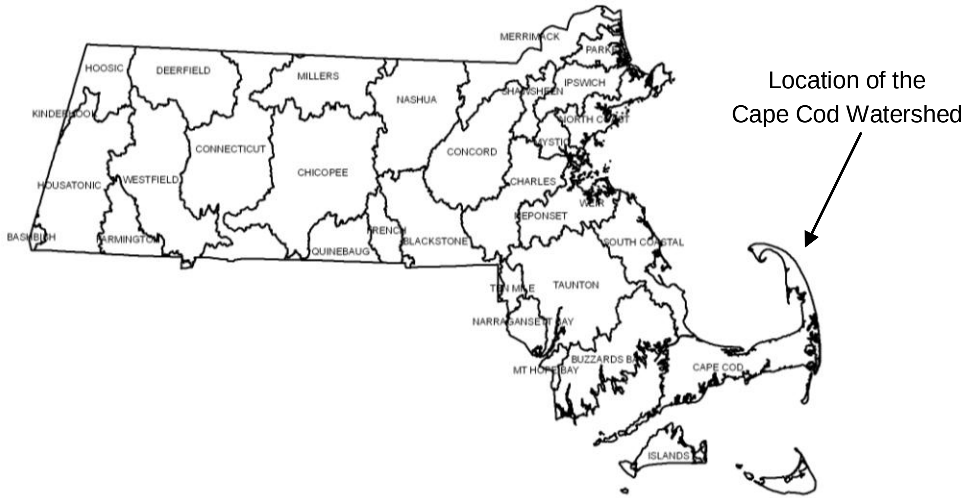
DISCLAIMER

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

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

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

Total Maximum Daily Loads for Pathogens within the Cape Cod Watershed



Key Features: Pathogen TMDL for the Cape Cod Watershed

Location: EPA Region 1

Land Type: New England Coastal

303(d) Listings: Pathogens

Barnstable Harbor (MA96-01)
Bass River (MA96-12)
Boat Meadow River (MA96-15)
Bournes Pond (MA96-57)
Bucks Creek (MA96-44)
Bumps River (MA96-02)
Centerville River (MA96-04)
Chase Garden Creek (MA96-35)
Duck Creek (MA96-32)
Falmouth Inner Harbor (MA96-17)
Great Harbor (MA96-18)
Great Pond (MA96-54)
Green Pond (MA96-55)
Hamblin Pond (MA96-58)
Harding Beach Pond (MA96-43)
Herring River (MA96-22)
Herring River (MA96-33)
Hyannis Harbor (MA96-05)
Lewis Bay (MA96-36)
Little Harbor (MA96-19)
Little Namskaket Creek (MA96-26)
Little River (MA96-61)
Maraspin Creek (MA96-06)
Mashpee River (MA96-24)

Mill Creek (MA96-37)
Mill Creek (MA96-41)
Namskaket Creek (MA96-27)
Oyster Pond (MA96-45)
Oyster Pond (MA96-62)
Oyster Pond River (MA96-46)
Pamet River (MA96-31)
Parkers River (MA96-38)
Perch Pond (MA96-53)
Popponesset Creek (MA96-39)
Provincetown Harbor (MA96-29)
Quashnet River (MA96-20)
Quivett Creek (MA96-09)
Rock Harbor Creek (MA96-16)
Ryder Cove (MA96-50)
Saquatucket Harbor (MA96-23)
Scorton Creek (MA96-30)
Sesuit Creek (MA96-13)
Shoestring Bay (MA96-08)
Stage Harbor (MA96-11)
Swan Pond River (MA96-14)
Taylors Pond (MA96-42)
Waquoit Bay (MA96-21)
Wellfleet Harbor (MA96-34)
Town Cove (MA96-68)

A special note is made here that starting with the 2004 303(d) integrated List of Impaired Waters, there are 14 segments in Bourne and Falmouth (formally listed as part of the Cape Cod Watershed) moved to the Buzzards Bay Watershed). These segments are covered in the Buzzards Bay Bacteria TMDL report. These segments include: MA95-14, Cape Cod Canal; MA95-48 Eel Pond; MA95-47 Back River; MA95-15 Phinneys Harbor; MA95-16 Pocasset River; MA95-17 Pocasset Harbor; MA95-18 Red Brook Harbor; MA95-21 Herring Brook; MA95-46 Harbor Head; MA95-20 Wild Harbor; MA95-22 West Falmouth Harbor; MA95-23 Great Sippewisset Creek; MA95-24 Little Sippewisset Marsh; MA95-25 Quissett Harbor. Five other segments are covered in the Three Bays TMDL Report. These Segments include: MA96-63 Cotuit Bay, MA96-64 Seapuit River,MA96-65 West Bay, MA96-66 North Bay and MA96-07 Prince Cove.

Data Sources:

- EEA "*Cape Cod Watershed Assessment and 5-Year Action Plan*"
- MassDEP "*Buzzards Bay Watershed 2000 Water Quality Assessment Report*"
- MACZM "*Atlas of Stormwater Discharges in the Buzzards Bay Watershed*"
- MassDEP "*Cape Cod Water Quality Assessment Report*"

- Cape Cod Commission "*Cape Cod Comprehensive Regional Wastewater Management Strategy Development Project*"
- Division of Marine Fisheries (for coastal estuaries with shellfishing use)
- Massachusetts Department of Public Health (for public swimming areas)

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

Monitoring Plan: Massachusetts Watershed Five-Year Cycle, MEP, Cape Cod Communities; Division of Marine Fisheries (DMF) Shellfish data; Department of Public Health Beaches data; Coastal Zone Management (CZM) data.

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

Executive Summary

Purpose and Intended Audience

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

Who should read this document?

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

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

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

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

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

e) government agencies that provide planning technical assistance, and funding to groups for bacterial remediation

Cape Cod Watershed

Bacteria pollution on Cape Cod presents itself in an unusually sensitive aquatic-water environment. Rich surface and subsurface water supplies traditionally abound: but are under extreme stress with population and land- use increases in recent decades. Both year-round and summer time human populations have substantially and steadily increased throughout the entire Cape area since the 1950's at a rate in excess of 10% per decade. Development of housing and commercial buildings has literally exploded as a result. Roughly 85% of the Cape Cod's watershed populations (including residences and businesses) have individual septic systems for disposal of human wastes. Only four towns (Falmouth, Barnstable, Chatham, Provincetown) have municipal waste water treatment plants, with only a very small percentage of the total area of these towns actually sewered (Cape Cod Commission, 2003). Septic system failures or poorly performing systems definitely play an important part to the bacterial contamination throughout the Cape. Stormwater runoff from wet weather events carries this contamination into surface and ground water aquifers, particularly in and around densely populated areas

Many parts of the Cape have sandy soils, which are usually very well suited for septic systems. However, the high number of residential systems, particularly with increased summer as well as year round residents, has put a strain on existing groundwater aquifer systems on the Cape. Properly functioning septic systems have been documented to remove bacteria quite effectively. A 1980 USGS study "Probable High Ground Water Levels on Cape Cod" found that quite a few areas were unsuitable for septic systems because the maximum ground water level during the year was not 4 feet below the bottom of the proposed or existing leach field. Areas with high groundwater in densely populated areas are prime locations for sewering considerations. The Cape Cod Commission (CCC) has sponsored and co- sponsored numerous studies in recent years on this subject, and is positioned to coordinate an area- wide sewering effort.

The Division of Marine Fisheries (DMF) has, for decades, conducted bacteria sampling and shoreline surveys in many of the coastal- estuary areas (encompassing nearly 50% of all land area on the Cape). Their activities and overall findings are summarized in a sub- section under Section 8.1, Summary of Activities within the Cape Cod Watershed. Overall, their experience finds that rain events often have little effect on overall water quality conditions in coastal estuary areas when compared to dry periods. This is likely because 1) most stormwater that infiltrates into the ground directly gets filtered and 2) tidal flushing often quickly removes or dilutes bacteria concentrations. Occasionally, there are segments where they have found that rainfall can exacerbate bacteria loadings. These areas are identified in the priority ranking of segments in Tables ES-1 and 6-1 and can be best seen by discrete differences between wet and dry weather concentrations. Areas of elevated bacteria levels have been attributed to failing septic systems, as well as bird and animal waste and are thought to be influenced by stormwater discharges from impervious surfaces immediately adjacent to and discharging to each segment. Birds also seem to be a problem, as populations have increased in recent years, particularly with migratory routes over the Cape, and increased observation of all- wintering patterns.

In an effort to provide guidance for setting bacterial implementation priorities within the Cape Cod Watershed, a summary table is provided. Table ES- 1 below provides a ranking of high, median, or low priority for pathogen-impaired segments to help focus additional bacterial source tracking work and stepwise implementation of structural and non-structural Best Management Practices (BMPs). For segments with insufficient data, additional sampling will likely be required. Since limited source information and data are available in each impaired segment, a simple scheme was used to prioritize segments based on pathogen indicator concentrations. High priority was assigned to those segments where concentrations (end of pipe or ambient) were equal to or greater than 10,000 cfu /100 ml. Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 CFU/100 ml. 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 or raw sewage and therefore they pose a greater risk to the public. It should be noted that in all cases, waters exceeding the water quality standards identified in Table ES- 2 are considered impaired.

Also, prioritization is adjusted upward based on proximity of waters, within the segment, to sensitive areas such as Outstanding Resource Waters (ORW's), or designated uses that require higher water quality standards than Class SB, such as Class SA, public swimming areas, or shellfish areas. Best professional judgment was used in determining this upward adjustment. Generally speaking, waters that were determined to be lower priority based on the numeric range identified above were elevated up 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 would indicate this situation. In many cases the DMF sampling results that were used to develop Table ES-1 don't differentiate whether the sampling was conducted during wet or dry weather. For these data sets Table ES-1 does not distinguish priority between wet and dry weather events.

Table ES-1. Prioritized List of Pathogen- Impaired Segments

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-01	Barnstable Harbor	3.3	From the mouths of Scorton and Spring Creeks east to an imaginary line drawn from Beach Point to the western edge of Mill Creek estuary, Barnstable.	High* Class SA, Shellfishing, ORW, Public Swimming	High* Class SA, ORW, Shellfishing Public Swimming
MA96-02	Bumps River	0.07	From the outlet of a pond at Bumps River Rd. through Scudder Bay to South Main St. bridge (confluence with Centerville River), Barnstable.	Medium* Class SA	Medium* Class SA
MA96-04	Centerville River	0.25	From headwaters in wetland west of Strawberry Hill Rd. to confluence with Centerville Harbor, including East Bay, Barnstable.	Medium*, Class SA Shellfishing Water, Public Swimming	High*, Class SA Shellfishing Water, Public Swimming
MA96-05	Hyannis Harbor	0.68	The waters from the shoreline to an imaginary line drawn from the	Medium*, SA,	Medium*, SA,

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
			light at the end of Hyannis breakwater to the point west of Dunbars Point, Barnstable.	Shellfishing Water, Public Swimming	Shellfishing, Public Swimming
MA96-06	Maraspin Creek	0.03	From headwaters just south of Rte. 6A to confluence with Barnstable Harbor at Blish Point, Barnstable.	Insufficient Data, Class SA, Shellfishing	Insufficient Data, Class SA, Shellfishing
MA96-08	Shoestring Bay	0.31	Quinaquisset Ave. to Ryefield Point, Barnstable/Mashpee.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-09	Quivett Creek	0.03	Outlet of unnamed pond just south of Rte. 6A to the mouth at Cape Cod Bay, Brewster/Dennis.	Medium*, (insufficient data) SA, Public Swimming, Shellfishing	Medium*, (insufficient data) SA, Public Swimming Shellfishing
MA96-11	Stage Harbor	0.58	The waters including Mitchell R. from Mill Pond to Sears Point and Harding Beach Point, Chatham.	Medium*, SA, Shellfishing	High*, SA, Shellfishing
MA96-12	Bass River	0.67	Rte. 6 to mouth at Nantucket Sound, Dennis/Yarmouth.	Medium*, SA, Public Swimming Shellfishing	High*, SA Public Swimming Shellfishing
MA96-13	Sesuit Creek	0.06	From Rte. 6A to mouth at Cape Cod Bay, Dennis.	Medium*, SA, Public Swimming, Shellfishing	High*, SA Public Swimming, Shellfishing
MA96-14	Swan Pond River	0.04	Outlet of Swan Pond to confluence with Nantucket Sound, Dennis.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-15	Boat Meadow River	0.04	Headwaters east of old Railway Grade to mouth at Cape Cod Bay, Eastham.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-16	Rock Harbor Creek	0.02	Outlet Cedar Pond to mouth at Cape Cod Bay, Eastham/Orleans.	Medium*, ORW, SA Public Swimming Shellfishing	Medium*, ORW,SA Public Swimming Shellfishing

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-17	Falmouth Inner Harbor	0.05	Waters included north of Inner Falmouth Harbor Light, Falmouth.	(insufficient data) SB, Public Swimming Shellfishing	(insufficient data) SB, Public Swimming Shellfishing
MA96-18	Great Harbor	0.31	The waters north of an imaginary line drawn southeast from Devils Foot to Juniper Point, Falmouth.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-19	Little Harbor	0.07	The waters north of an imaginary line drawn from Juniper Point east to Nobska beach, Falmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-20	Quashnet River	0.07	Just south of Rte. 28 to mouth at Waquoit Bay, Falmouth (also known as Moonakis R.).	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-21	Waquoit Bay	1.4	From mouths of Seapit R., Quashnet R., Little R., and Great R. to confluence with Vineyard Sound, Falmouth.	Low*, SA, Shellfishing Approved	Low*, SA, Shellfishing Approved
MA96-22	Herring River	0.07	Outlet of Reservoir northwest of Bells Neck Rd. to mouth at Nantucket Sound, Harwich.	Medium*, SA, Public Swimming Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-23	Saquatucket Harbor	0.02	South of Rte. 28 to confluence with Nantucket Sound, Harwich.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-24	Mashpee River	0.09	Quinaquisset Ave. to mouth at Popponesset Bay, Mashpee.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-26	Little Namskaket Creek	0.01	Source to mouth at Cape Cod Bay.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-27	Namskaket Creek	0.02	From outlet of unnamed pond north of Rte. 6A in Orleans to mouth at Cape Cod Bay, Brewster/Orleans.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-29	Provincetown Harbor	4.3	The waters northwest of an imaginary line drawn from the tip of	Medium*, SA, Public	High*, SA, Public

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority “Dry”	Priority “Wet”
			Long Point to Beach Point Beach, Provincetown.	Swimming, Shellfishing	Swimming, Shellfishing
MA96-30	Scorton Creek	0.07	Jones Lane to mouth at Cape Cod Bay, Sandwich.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-31	Pamet River	0.14	Rte. 6 to mouth at Cape Cod Bay (Including Pamet Harbor), Truro.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-32	Duck Creek	0.15	From Cannon Hill to Shirttail Point, Wellfleet.	Low*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-33	Herring River	0.39	Griffin Island to Wellfleet Harbor, Wellfleet.	Medium*, ORW, SA, Shellfishing	High*, ORW,SA, Shellfishing
MA96-34	Wellfleet Harbor	8.5	The waters north of an imaginary line drawn west from Jersey Point to Sunken Meadow, excluding the estuaries of Herring River, Duck Creek, and Blackfish Creek, Wellfleet.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-35	Chase Garden Creek	0.16	Source west of Rte. 6A, Dennis to mouth at Cape Cod Bay, Dennis/Yarmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-36	Lewis Bay	1.8	Includes Pine Island Creek and Uncle Roberts Cove to confluence with Nantucket Sound, Yarmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-37	Mill Creek	0.05	From Keveny/Mill Lane north to confluence with Cape Cod Bay Barnstable/Yarmouth.	Insufficient Data, SA Shellfishing	Insufficient Data, SA Shellfishing
MA96-38	Parkers River	0.04	Outlet Seine Pond to mouth at Nantucket Sound, Yarmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-39	Popponesset Creek	0.04	All waters west of Popponesset Island (from Popponesset Island Road bridge at the north to a line	Low*, SA, Shellfishing	Medium*, SA, Shellfishing

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
			extended from the southeastern most point of the island southerly to Popponesset Beach), Mashpee.		
MA96-41	Mill Creek	0.03	Outlet of Taylors Pond to confluence with Cockle Cove, Chatham.	Low*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-42	Taylors Pond	0.02	Chatham	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-43	Harding Beach Pond	0.07	Locally known as Sulfur Springs (northeast of Bucks Creek), Chatham.	Insuffficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-44	Bucks Creek	0.02	Outlet from Harding Beach Pond (locally known as Sulfur Springs) to confluence with Cockle Cove, Chatham.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-45	Oyster Pond	0.21	Including Stetson Cove, Chatham.	Medium*, SA, Shellfishing	High*, SA, Shellfishing
MA96-46	Oyster Pond River	0.14	Outlet of Oyster Pond to confluence with Stage Harbor, Chatham.	Low*, SA, Shellfishing	Low*, SA Shellfishing
MA96-50	Ryders Cove	0.17	Chatham	Low*, ORW, ACEC, SA Shellfishing.	Low*, ORW, ACEC,SA Shellfishing.
MA96-53	Perch Pond	0.03	Connects to northwest end of Great Pond, west of Keechipam Way, Falmouth.	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-54	Great Pond	0.40	From inlet of Coonamessett River to Vineyard Sound (excluding Perch Pond), Falmouth	Low*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-55	Green Pond	0.21	East of Acapesket Road, outlet to Vineyard Sound, Falmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-57	Bournes Pond	0.24	West of Central Avenue, to Vineyard Sound, Falmouth.	Low*, SA, Shellfishing	Medium* Data, SA, Shellfishing

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-58	Hamblin Pond	0.19	From inlet of Red Brook to outlet of Little River and inlet/outlet of Waquoit Bay west of Meadow Neck Road, Falmouth/Mashpee.	Medium*, SA, Public Swimming Shellfishing	Medium*, SA, Public Swimming Shellfishing
MA96-61	Little River	0.03	From outlet of Hamblin Pond to the Great River, Mashpee.	Medium*, ORW, SA, Shellfishing	Medium*, ORW,SA Shellfishing
MA96-62	Oyster Pond	0.10	East of Fells Road, Falmouth.	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-68	Town Cove	0.80	Entire Cove to Nauset harbor, including Rachael Cove and Woods Cove, Orleans/ Eastham.	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing

The MassDEP, beginning with the 2004 Integrated List of Impaired Waters, determined that 14 segments on the Western end of the Cape in Falmouth and Bourne most appropriately fit within the Buzzards Bay Watershed, as drainage from these segments went into Buzzards Bay. These segments include: MA95-14, Cape Cod Canal; MA95-48 Eel Pond; MA95-47 Back River; MA95-15 Phinneys Harbor; MA95-16 Pocasset River; MA95-17 Pocasset Harbor; MA95-18 Red Brook Harbor; MA95-21 Herring Brook; MA95-46 Harbor Head; MA95-20 Wild Harbor; MA95-22 West Falmouth Harbor; MA95-23 Great Sippewisset Creek; MA95-24 Little Sippewisset Marsh; MA95-25 Quissett Harbor. These segments are covered in the Buzzards Bay Bacteria TMDL Report (Mass DEP 2009). Five other segments are covered in the Three Bays TMDL Report (Mass DEP 2009a). These Segments include: MA96-63 Cotuit Bay, MA96-64 Seapuit River, MA96-65 West Bay, MA96-66 North Bay and MA96-07 Prince Cove.

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 2008 Integrated List of Waters contains a list of impairments, Category 5 waters "Waters requiring a TMDL (formerly known as the "303d list") which identifies impaired lakes, coastal waters and specific segments of rivers and streams and the reason(s) for impairment.

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 to the ultimate achievement of meeting the water quality standards.

Pathogen TMDL: This report represents a TMDL for pathogen indicators (e.g. fecal coliform, *E. coli*, and enterococcus bacteria) in the Cape Cod Bay Watershed, except Muddy Creek (MA96-51) and Frost Fish Creek (MA96-49) as TMDLs were prepared previously for these segments in 2004 and approved in 2005. Certain bacteria, such as coliform, *E. coli*, and enterococcus bacteria, are indicators of contamination from sewage and/or the feces of warm-blooded wildlife (mammals and birds). Such contamination may pose a risk to human health. Therefore, in order to prevent further degradation in water quality and to ensure that waterbodies within the watershed meet state water quality standards, the TMDL establishes indicator bacteria limits and outlines corrective actions to achieve that goal.

Sources of indicator bacteria in the Cape Cod watershed are believed to be primarily from boat wastes; failing septic systems; pets, wildlife, and birds; and stormwater. Note that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. A discussion of pathogen related control measures and best management practices are provided in the companion document: "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*".

This TMDL applies to the 49 pathogen impaired segments of the Cape Cod watershed that are currently listed on the CWA § 303(d) list of impaired waters. MassDEP recommends that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The concentration waste load and/or load allocation for each source and designated use would be the same as specified in this TMDL. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-2 and Table 7-1).

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

Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical stormwater bacteria concentrations. These data indicate that in general two to three orders of magnitude (i.e., greater than 90%) reductions in stormwater fecal coliform loading will be necessary, especially in developed areas.

TMDL goals for each type of bacteria source are provided in Table ES-2. Municipalities are the primary responsible parties for elimination of pathogen sources. TMDL implementation to achieve these goals should be an iterative process by first prioritizing areas based on available data while considering their impact to downgradient resources. This information should then be used to identify and remove specific sources including the removal of illicit connections (if applicable) contributing to wet and dry weather violations. Once illicit connections are removed then priority should be given to identifying and implementing best management practices (BMPs) to mitigate stormwater runoff. Certain towns in the watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan.

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

Table ES-2. Sources and Expectations for Limiting Bacterial Contamination in the Cape Cod 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	
	Leaking sanitary sewer lines	0	Not Applicable
	Failing septic systems	Not Applicable	0
A (Water supply **Intakes** in unfiltered public water supplies)	Any regulated discharge [7,9]- including stormwater runoff[4] subject to Phase I or II NPDES permits	Either; a) fecal coliform <=20 fecal coliform organisms per 100 ml[2] or **b)** total coliform <= 100 organisms per 100 ml[3;] where both are measured, only fecal must be met	Not Applicable
	Nonpoint source stormwater runoff[4]	Not Applicable	Either; a) fecal coliform <=20 fecal coliform organisms per 100 ml[2], or b) total coliform <= 100 organisms per 100 ml[3;] where both are measured, only fecal must be met
A (Includes filtered water supply) & **B**	Any regulated discharge-including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges [7,9], and combined sewer overflows[6].	Either; a) E. coli <=geometric mean[5] 126 colonies per 100 ml; single sample <=235 colonies per 100 ml; or b) Enterococci geometric mean[5] <= 33 colonies per 100 ml and single sample <= 61 colonies per 100 ml	Not Applicable
	Nonpoint source stormwater runoff[4]	Not Applicable	Either a) E. coli <=geometric mean[5] 126 colonies per 100 ml; single sample <=235 colonies per 100 ml; or b) Enterococci geometric mean[5]<= 33 colonies per 100 ml and single sample <= 61 colonies per 100 ml

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
SA (Designated for shellfishing)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	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 (Beaches[8] 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[7,9], and combined sewer overflows[6].	Enterococci - geometric mean[5] <= 35 colonies per 100 ml and single sample <= 104 colonies per 100 ml	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Enterococci -geometric mean[5] <= 35 colonies per 100 ml and single sample <= 104 colonies per 100 ml
SB (Designated for shellfishing w/depuration)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	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	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] In all samples taken during any 6 month period
[3] In 90% of the samples taken in any six month period;
[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] 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.
[6] Or other applicable water quality standards for CSO's

[7] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.
[8] Massachusetts Department of Public Health regulations (105 CMR Section 445)
[9] Seasonal disinfection may be allowed by the Department on a case-by-case basis.

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.

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List of Acronyms

7Q10	Seven Day Ten Year Low Flow
BMP	Best Management Practice
BWSC	Boston Water and Sewer Commission
cfu	colony forming units
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 require states to identify those waterbodies that are not expected to meet surface water quality standards after the implementation of technology-based controls and to prioritize and schedule them for the development of a total maximum daily load (TMDL).
CZM	Coastal Zone Management
DFW	Division of Fisheries and Wildlife
DMF	Division of Marine Fisheries
DWM	Division of Watershed Management
EEA (formerly EOEA)	Energy and Environmental Affairs
EMC	Event Mean Concentration
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
GIS	Geographic Information System
GLSD	Greater Lawrence Sanitary District
IDDE	Illicit Discharge Detection and Elimination System
LA	Load Allocation
LID	Low Impact Development
LTCP	Long Term Control Plan
MADPH	Massachusetts Department of Public Health
MassDEP	Massachusetts Department of Environmental Protection
MEP	Maximum Extent Practicable
MEPA	Massachusetts Environmental Policy Act
MG	Million Gallons
MHD	Massachusetts Highway Department
MOS	Margin of Safety
MPN	Most Probable Number
MSD	Marine Sanitary Device
MS4	Municipal Separate Storm Sewer Systems
NDA	No Discharge Area
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
ORW	Outstanding Resource Water

POTW	Publically Owned Treatment Works
RTI	Research Triangle Institute
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflows
SWMP	Stormwater Management Plan
SWPP	Stormwater Program Plan
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACOE	United States Army Corps of Engineers
VEMN	Voluntary Environmental Monitoring Network
WLA	Waste Load Allocation
WQS	Water Quality Standards
WWTP	Waste Water Treatment Plant

1.0 Introduction

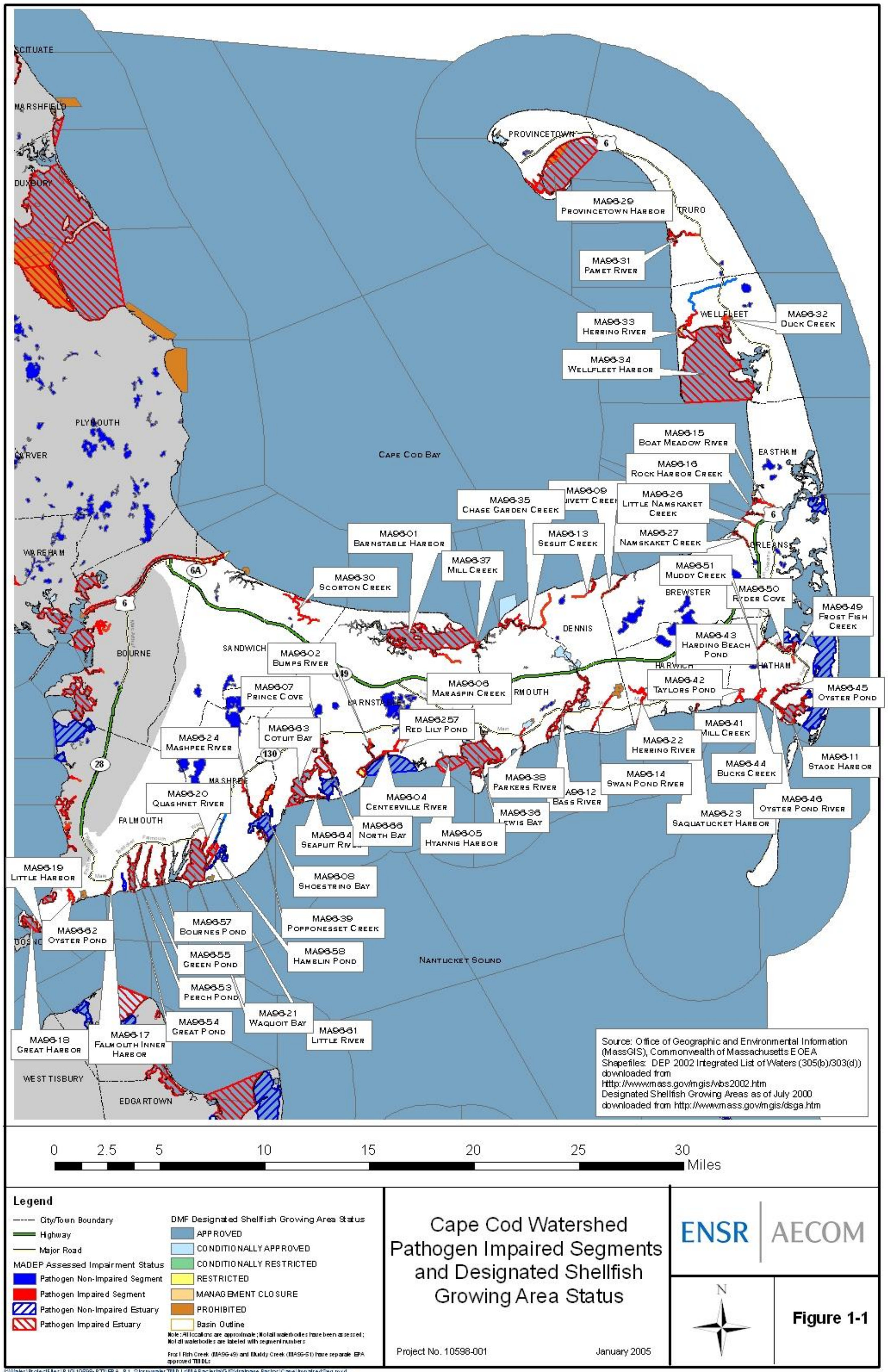
Section 303(d) of the Federal Clean Water Act (CWA) and Environmental Protection Agencies (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to place waterbodies that do not meet established water quality standards on a list of impaired waterbodies (commonly referred to as the "303d List") and to develop Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant(s) contributing to the impairment. In Massachusetts, impaired waterbodies are included in Category 5 of the "*Massachusetts Year 2008 Integrated List of Water: Part 2- Final Listing of Individual Categories of Waters*" (*2008 List*; MassDEP 2008a). Figure 1-1 provides a map of the Cape Cod watershed with pathogen impaired segments indicated. As shown in Figure 1-1, much of the Cape Cod waterbodies are listed as a Category 5 "impaired or threatened for one or more uses and requiring a TMDL" due to excessive indicator bacteria concentrations.

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

A major goal of this TMDL is to achieve meaningful environmental results with regard to the designated uses of the Cape Cod waterbodies. These include water supply, shellfish harvesting, fishing, boating, and swimming. This TMDL establishes the necessary pollutant load to achieve designated uses and water quality standards and the companion document entitled; "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" *(ENSR 2005)* provides guidance for the implementation of this TMDL.

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

Figure 1-1. Cape Cod Watershed and Pathogen Impaired Segments



problem areas or "hot spots" which may detrimentally affect water and sediment quality. It is within this watershed-level framework that the Massachusetts Department of Environmental Protection (MassDEP) commissioned the development of watershed based TMDLs.

1.1. Pathogens and Indicator Bacteria

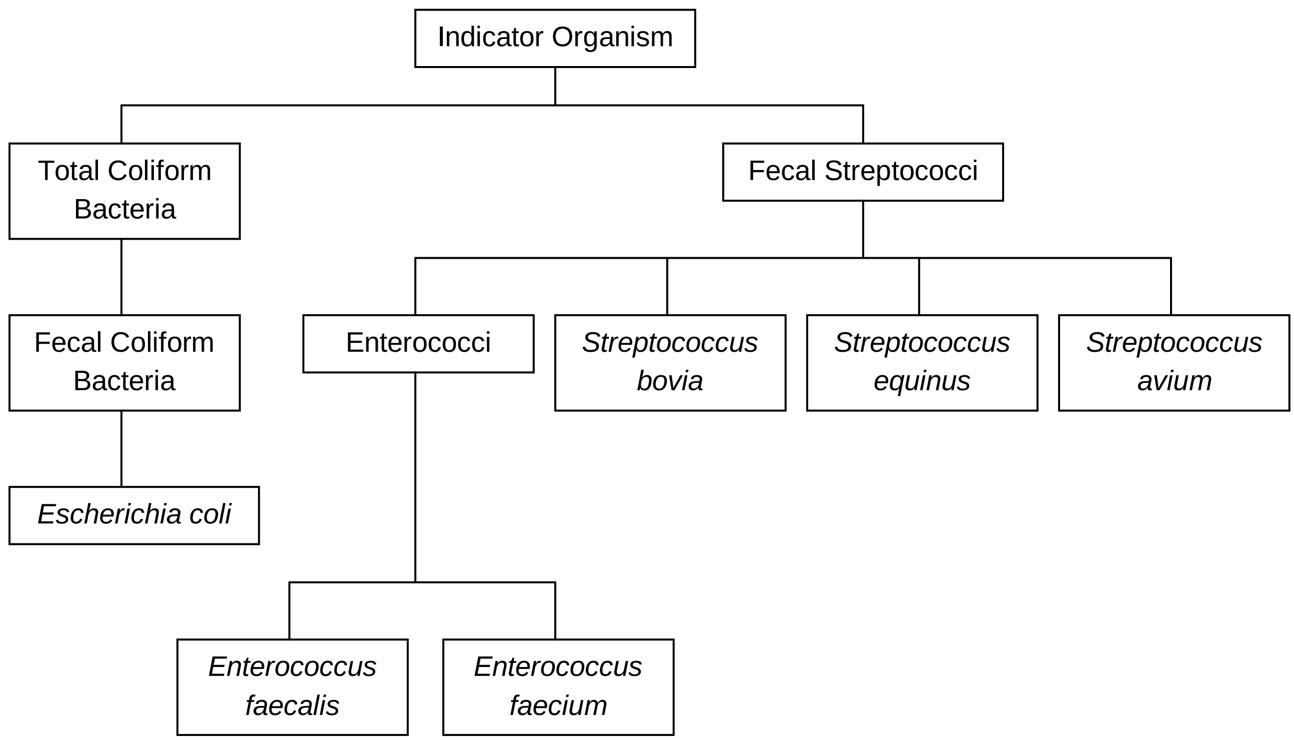
The Cape Cod pathogen TMDL is designed to support reduction of waterborne disease-causing organisms, known as pathogens, to reduce public health risk. Waterborne pathogens enter surface waters from a variety of sources including sewage and the feces of warm-blooded wildlife. These pathogens can pose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

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

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

Massachusetts now uses *E. coli* and enterococci as indicator organisms of potential harmful pathogens in fresh water. The water quality standards (WQS) that apply for fresh water were revised in late 2006 and *E. coli* has replaced fecal coliform as the indicator organism for pathogens (MassDEP 2007).View the WQS at http://www.mass.gov/dep/service/regulations/314cmr04.pdf.
Fecal coliform are still used by Massachusetts Division of Marine Fisheries (DMF) in their classification of shellfish growing areas. Enterococci or *E. coli* are used as the indicator organism for freshwater beaches and for marine beaches. Enterococci are used, as required by the Federal Beaches Environmental Assessment and Coastal Act of 2000 (Beach Act), an amendment to the CWA.

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



The Cape Cod watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for shellfish areas and enterococci for bathing in marine waters and generally E. *coli* for fresh waters (even though much of the much of the data reported in this TMDL is Fecal Coliform). Any future changes in the Massachusetts pathogen water quality standard will apply to this TMDL at the time of the standard change. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

1.2. Comprehensive Watershed-based Approach to TMDL Development

Consistent with Section 303(d) of the CWA, the MassDEP has chosen to complete pathogen TMDLs for all waterbodies in the Cape Cod watershed at this time, regardless of current impairment status (i.e., for all waterbody categories in the *2008 Integrated List*). MassDEP believes a comprehensive management approach carried out by all watershed communities is needed to address the ubiquitous nature of pathogen sources present in the Cape Cod watershed. Watershed-wide implementation is needed to meet WQS and restore designated uses in impaired segments while providing protection of desirable water quality in waters that are not currently impaired or not assessed.

As discussed below, this TMDL applies to the 49 pathogen impaired segments of the Cape Cod watershed that are currently listed on the CWA § 303(d) list of impaired waters and determined to be pathogen impaired in the "*Cape Cod Water Quality Assessment Report"* (MassDEP CCWQA; MassDEP 2002a) (see Figure 1, Table 4-3). 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. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3)[1].

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

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

There are 113 waterbody segments assessed by the MassDEP in the Cape Cod Watershed (MassGIS 2005). These segments consist of 67 estuaries, 55 of which are pathogen impaired and appear as such on the official list of impaired waters. Pathogen TMDLs have been previously prepared and approved for two of these segments – Muddy Creek and Frost Fish Creek. One of the 46 lake segments assessed is pathogen impaired, and the single fresh water river segment assessed (Herring River) is not pathogen impaired (Figure 1-1). Therefore, this report covers 49 pathogen impaired estuary segments. A special note is made here that starting with the 2004 303(d) integrated List of Impaired Waters, there are 14 segments in Bourne and Falmouth (formally listed as part of the Cape Cod Watershed) moved to the Buzzards Bay Watershed). Pathogen impairment has been documented by the MassDEP in previous reports, including the "*Buzzards Bay Watershed 2000 Water Quality Assessment Report (BBWQA)*" (MassDEP BBWQA; MassDEP 2003b) and the "*Cape Cod Water Quality Assessment Report (CCWQA)"* (MassDEP CCWQA; MassDEP 2002a), resulting in the impairment determination. In this TMDL document, an overview of pathogen impairment is provided to illustrate the nature and extent of the pathogen impairment problem. Additional data, not collected by the MassDEP or used to determine impairment status, are also

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[1] CWA Section 303(d)3: For the specific purpose of developing information, each State shall identify all waters within its boundaries which it has not identified under paragraph (1)(A) and (1)(B) of this subsection and estimate for such waters the total maximum daily load with seasonal variations and margins of safety, for those pollutants which the Administrator identifies under section 304(a)(2) as suitable for such calculation and for thermal discharges, at a level that would assure protection and propagation of a balanced indigenous population of fish, shellfish and wildlife.

provided in this TMDL to illustrate the pathogen problem on the Cape. Since pathogen impairment has been previously established, only a summary is provided herein.

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

The stepwise 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.

MassDEP believes that segments ranked as high priority in Table 6-1 are indicative of the potential presence of raw sewage and therefore they pose a greater risk to the public. Elevated dry weather bacteria concentrations could be the result of illicit sewer connections or failing septic systems. As a result, the first priority should be given to bacteria source tracking activities in those segments where sampling activities show elevated levels of bacteria during dry weather. Identification 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. Segments that remain impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with less costly non-structural practices first (such as street sweeping, and/or managerial approach using local regulatory controls with ongoing evaluation of the success of those programs. If it is determined that less costly approaches are not sufficient to address the issue then appropriate structural BMPs should be identified and implemented where necessary. Structural stormwater BMP implementation may require additional study to identify cost efficient and effective technology.

1.3. TMDL Report Format

This document contains the following sections:

- Watershed Description (Section 2) – provides watershed specific information
- Water Quality Standards (Section 3) – provides a summary of current Massachusetts WQS as they relate to indicator bacteria

- Problem Assessment (Section 4) – provides an overview of indicator bacteria measurements collected in the Cape Cod watershed
- Identification of Sources (Section 5) – identifies and discusses potential sources of waterborne pathogens within the Cape Cod watershed
- Prioritization and Known Sources (Section 6) –prioritizes impairments (high, medium, low) and identifies probable bacteria source locations where the information is available
- TMDL Development (Section 7) – specifies required TMDL development components including:
    - Definitions and Equation
    - Load and Waste Load Allocations
    - Margin of Safety
    - Seasonal Variability
- Implementation Plan (Section 8) – describes specific implementation activities designed to remove pathogen impairment. This section and the companion "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" document should be used together to support implementing management actions.
- Monitoring Plan (Section 9) – describes recommended monitoring activities
- Reasonable Assurances (Section 10) – describes reasonable assurances the TMDL will be implemented
- Public Participation (Section 11) – describes the public participation process, and
- References (Section 12)

2.0 Watershed Description

Located in southeastern Massachusetts, the Cape Cod watershed includes all or part of 15 communities within 410 square miles. The area lacks main rivers and tributaries characteristic of other watersheds in Massachusetts. In fact, the watershed has very few freshwater streams. The watershed does, however, abound with freshwater lakes and ponds (MassDEP 2002a). The area's groundwater supply is the watershed's most important freshwater resource, being the area's primary source of drinking water (EEA 2004). The groundwater in the Cape Cod Aquifer makes up roughly 96% of available water in Cape Cod. In this watershed, groundwater commonly discharges directly to coastal waters and embayments, unlike other watersheds where groundwater more commonly discharges to fresh surface water. The bordering saltwater bodies, which the river segments discharge to, are the Atlantic Ocean, Buzzards Bay, Cape Cod Bay, and Nantucket Sound. Cape Cod has 586 miles of coastline.

Forested area makes up the largest percentage of the land use (40%; Table 2-1; Figure 2-1). Residential areas make up another quarter of the land use (Figure 2-1). Impaired segments and residential areas are concentrated along the shoreline (Figures 2-1).

The Cape Cod drainage area is home to many rare, threatened or endangered species. There are eight Areas of Critical Environmental Concern (ACEC) within the watershed (EEA 2003). Four towns on Cape Cod are in the "top 10" in Massachusetts for the largest number of state-listed rare species records. The Town of Barnstable is one of only five towns in the state with more than 100 records of rare species (EEA 2003).

Several areas on Cape Cod are considered "No Discharge Areas" (NDAs). NDAs are waterbodies in which a state, with EPA approval, has determined to be important ecological or recreational areas worthy of special protection against the release of raw or treated sewage in navigable waters. Vessels are banned from discharging both raw and treated sewage in a NDA. NDAs in Massachusetts are provided in Figure 2-3 (USEPA 2004a).

Being heavily dependent on summer tourism, the area experiences strong seasonal fluctuations in population size (MassDEP 2002a). Full time year round population is estimated at 250,000, whereas peak summer population is as high as 500,000 (EEA 2003).

The waters in the Cape Cod watershed are commonly used for primary and secondary contact recreation (swimming and boating), fishing, wildlife viewing, habitat for aquatic life, irrigation, agricultural uses, industrial cooling, shellfish harvesting, public water supply, and beachfront. Seventy square miles have been designated as a National Park - *Cape Cod National Seashore*, which receives approximately 5 million visitors per year (EEA 2003). A map illustrating the numerous miles of public and semi-public marine beaches is provided in Figure 2-2.

Table 2-1. Cape Cod Watershed Land Use as of 1999.

Land Use Category	% of Total Watershed Area
Pasture	0.3
Urban Open	1.5
Open Land	7.2
Cropland	0.4
Woody Perennial	0.8
Forest	40.4
Wetland/Salt Wetland	7.0
Water Based Recreation	1.0
Water	4.4
General Undeveloped Land	63.1
Spectator Recreation	<0.1
Participation Recreation	2.2
> 1/2 acre lots Residential	14.9
1/4 - 1/2 acre lots Residential	11.3
< 1/4 acre lots Residential	3.0
Multi-family Residential	0.7
Mining	0.5
Commercial	1.8
Industrial	0.5
Transportation	1.8
Waste Disposal	0.3
General Developed Land	36.9

Figure 2-1. Cape Cod Watershed Land Use as of 1999.

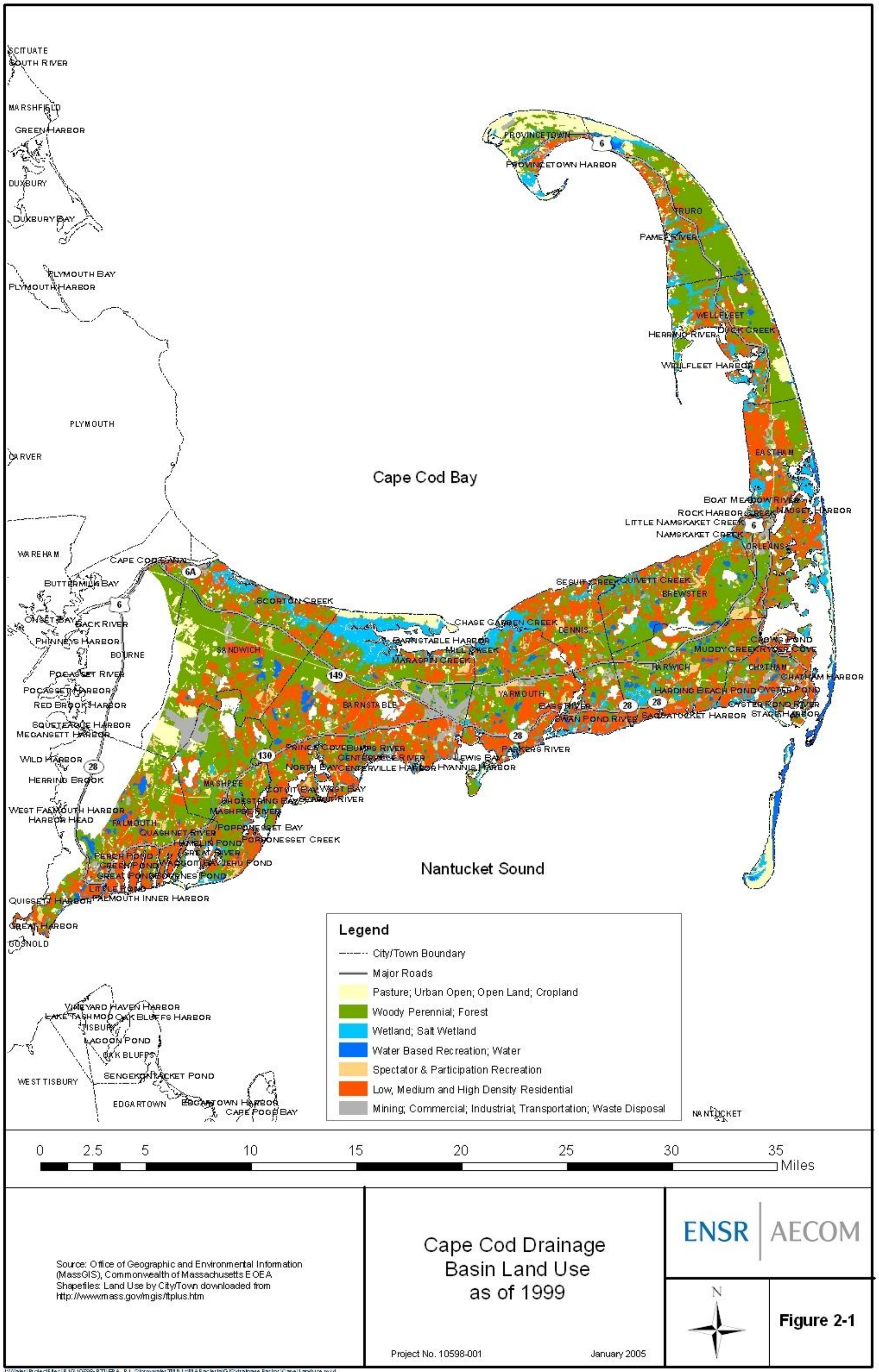


Figure 2-2. Cape Cod Watershed Marine Beach Locations and Pathogen Impaired Segments.

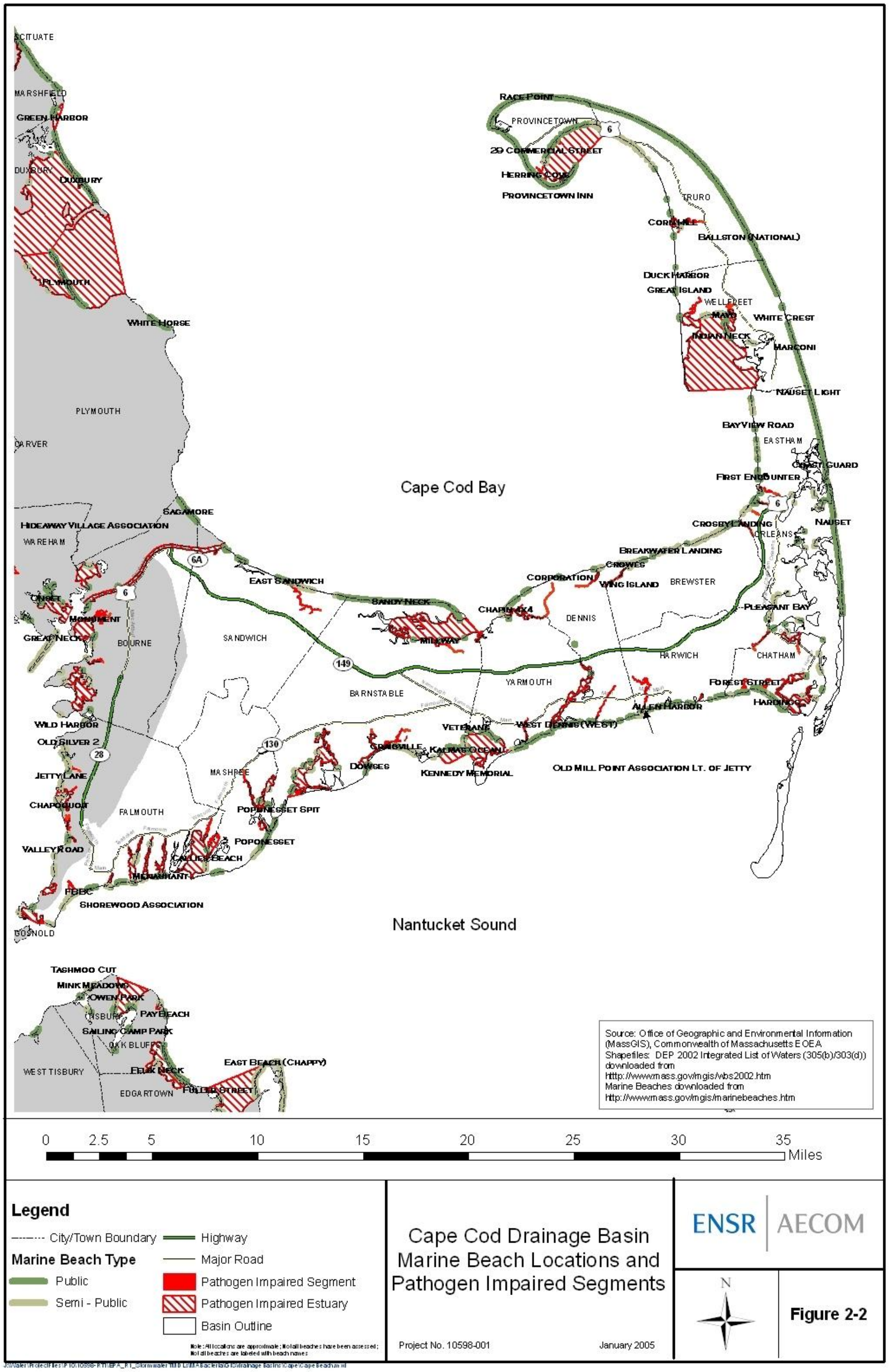


Figure 2-3. General Location of Massachusetts' No Discharge Areas (USEPA 2004a).

3.0 Water Quality Standards

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

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

Massachusetts recently revised its freshwater WQS in late 2006 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*” document (USEPA 1986). WQS can be accessed at: http://www.mass.gov/dep/service/regulations/314cmr04.pdf. The state had previously done so for public beaches through regulations of the Massachusetts Department of Public Health as discussed below. Up until January of 2007 Massachusetts used fecal coliform as the indicator organism for all waters except for marine bathing beaches, where the Federal BEACH Act requires the use of enterococci. Massachusetts adopted *E. coli* and enterococci for all fresh waters and enterococci for all marine waters, including non-bathing marine beaches. Fecal coliform will remain the indicator organism for shellfishing areas, however.

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

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

The Cape Cod watershed contains waterbodies classified as Class A, Class B, Class SA, and Class SB. The standards that apply to these classifications are presented in Table ES-2 and at the web address link: http://www.mass.gov/dep/service/regulations/314cmr04.pdf.

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

> **Approved** – Open for harvest of shellfish for direct human consumption subject to local rules and state regulations." (MassGIS 2005) "The area is shown to be free of bacterial contaminants under a variety of climatological and hydrographical situations (i.e. assumed adverse pollution conditions). (MassDEP 2002a).
>
> **Conditionally Approved** - During the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations. (MassGIS 2005) This classification category may be assigned for growing areas subject to intermittent and predictable microbiological contamination that may be present due to operation of a sewage treatment plant, rainfall, and/or season. (MassDEP 2002a).
>
> **Conditionally Restricted** – During the time area is restricted it is only open for the harvest of shellfish with depuration subject to local rules and state regulations. (MassGIS 2005) A classification used to identify a growing area that meets the criteria for the restricted classification except under certain conditions described in a management plan. (MassDEP 2002a).
>
> **Restricted** – Open for harvest of shellfish with depuration subject to local rules and state regulations or for the relay of shellfish. (MassGIS 2005) A classification used to identify where harvesting shall be by special license and the shellstock, following harvest, is subject to a suitable and effective treatment process through relaying or depuration. Restricted growing areas are mildly or moderately contaminated only with bacteria. (MassDEP 2002a).
>
> **Management Closure** – Closed for the harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not. (MassDEP 2002a).
>
> **Prohibited –** Closed for harvest of shellfish. (MassGIS 2005) A classification used to identify a growing area where the harvest of shellstock is not permitted. Growing area waters are so badly contaminated that no reasonable amount of treatment will make the shellfish safe for human consumption. Growing areas must also be classified as Prohibited if there is no or insufficient information available to make a classification decision. (MassDEP 2002a).

In general, shellfish harvesting use is supported (i.e., non-impaired) when shellfish harvested from approved open shellfish areas are suitable for consumption without depuration and shellfish harvested from restricted shellfish areas are suitable for consumption with depuration. For an expanded discussion on the relationship between the DMF shellfish growing areas classification and the MassDEP designated use support status, please see the "*Cape Cod Watershed 1999 Water*

Quality Assessment Report" (MassDEP BBWQA; MassDEP 2003b) and the "*Cape Cod Water Quality Assessment Report"* (MassDEP CCWQA; MASSDEP 2002a).

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

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

The Federal BEACH Act of 2000 established a Federal standard for marine beaches. These standards are essentially the same as the MADPH marine beach standard. The Federal BEACH Act and MADPH standards can be accessed on the worldwide web at http://www.epa.gov/waterscience/beaches/rules/act.html and www.mass.gov/dph/dcs/bb4_01.pdf, respectively.

Figure 2-2 provides the location of marine bathing beaches, where the MADPH Marine Waters and the Federal BEACH Act standards would apply. A map of freshwater beaches is not available at this time. However, a list of beaches (fresh and marine) by community with indicator bacteria data can be found in the annual reports on the testing of public and semi-public beaches provided by the MADPH. These reports are available for download from the MADPH website located at :
http://www.mass.gov/?pageID=eohhs2modulechunk&L=6&L0=Home&L1=Consumer&L2=Community+Health+and+Safety&L3=Environmental+Health&L4=Environmental+Exposure+Topics&L5=Beaches+and+Algae&sid=Eeohhs2&b=terminalcontent&f=dph_environmental_c_beach_annual_reports&csid=Eeohhs2.

4.0 Problem Assessment

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

Indicator bacteria levels also tend to increase with wet weather conditions as storm sewer systems overflow and/or 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 throughout the United States or 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 and residential areas are observed to have elevated indicator bacteria levels. Development activity generally leads to decreased water quality (e.g., pathogen impairment) in a watershed. Development-related watershed modification includes increased impervious surface area which can (USEPA 1997):

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

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

Table 4-1 Wachusett Reservoir Stormwater Sampling (as reported in MassDEP 2002b)[1].

Land Use Category	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, on septic systems), Storm 1	30 - 29,600
High Density Residential (not sewered, on septic systems), Storm 2	430 - 122,000

[1] original data provided in MDC Wachusett Stormwater Study (June 1997)

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

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

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

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

Pathogen impaired estuary segments represent 70.0% of the total estuary area assessed (30.7 square miles of 43.8 to square miles assessed (including areas associated with the two estuaries with existing pathogen TMDLs). Pathogen impaired lake segments included Red Lily Pond represent less than 1% of the total lake area assessed (4.4 acres of 5058.7 total acres assessed) . In total, 50 estuary segments requiring TMDLs contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A, SA, B, or SB waterbodies (314 CMR 4.05)[1], the MADPH standard for bathing beaches[2], and/or the BEACH Act. The basis for impairment listings is provided in the *2008 List* (MassDEP 2008a). Data presented in the Buzzards Bay Water Quality Assessment (BBWQA), Cape Cod Water Quality Assessment (CCWQA) and other data collected by the MassDEP were used to generate the *Integrated List*. For more information regarding the basis for

[1] *or* [2] ***See Table ES-2, or Table 7-1, or web address link:*** *http://www.mass.gov/dep/service/regulations/314cmr04.pdf*

listing particular segments for pathogen impairment, please see the Assessment Methodology section of the MassDEP WQA for this watershed.

A list of pathogen impaired segments requiring TMDLs is provided in Table 4-3. Additional details regarding each impaired segment including, discharges, use assessments and recommendations to meet use criteria are provided in the MassDEP WQA. This TMDL does not, however, apply to Muddy Creek (MA96-51) or Frost Fish Creek (MA96-49), as pathogen TMDLs for these segments have been previously developed.

An overview of the Cape Cod watershed pathogen impairment is provided in this section to illustrate the nature and extent of the impairments. Since pathogen impairment has been previously established and documented on the *Integrated List*, it is not necessary to provide detailed documentation of pathogen impairment herein. Data from the MassDEP BBWQA, CCWQA and Massachusetts Office of Coastal Zone Management (CZM) were reviewed and are summarized by segment below for illustrative purposes.

Table 4-3. Cape Cod Pathogen Impaired Segments Requiring TMDLs (adapted from MassDEP 2003b, MassDEP 2002a and MassGIS 2005).

Segment ID	Segment Name	Segment Size (sq mi)	Segment Description
MA96-01	Barnstable Harbor	3.3	From the mouths of Scorton and Spring Creeks east to an imaginary line drawn from Beach Point to the western edge of Mill Creek estuary, Barnstable. Class SA
MA96-02	Bumps River	0.07	From the outlet of a pond at Bumps River Rd. through Scudder Bay to South Main St. bridge (confluence with Centerville River), Barnstable. Class SA
MA96-04	Centerville River	0.25	From headwaters in wetland west of Strawberry Hill Rd. to confluence with Centerville Harbor, including East Bay, Barnstable. Class SA
MA96-05	Hyannis Harbor	0.68	The waters from the shoreline to an imaginary line drawn from the light at the end of Hyannis breakwater to the point west of Dunbars Point, Barnstable. Class SA
MA96-06	Maraspin Creek	0.03	From headwaters just south of Rte. 6A to confluence with Barnstable Harbor at Blish Point, Barnstable. Class SA
MA96-08	Shoestring Bay	0.31	Quinaquisset Ave. to Ryefield Point, Barnstable/Mashpee. Class SA
MA96-09	Quivett Creek	0.03	Outlet of unnamed pond just south of Rte. 6A to the mouth at Cape Cod Bay, Brewster/Dennis. Class SA
MA96-11	Stage Harbor	0.58	The waters including Mitchell R. from Mill Pond to Sears Point and Harding Beach Point, Chatham. Class SA
MA96-12	Bass River	0.67	Rte. 6 to mouth at Nantucket Sound, Dennis/Yarmouth. Class SA
MA96-13	Sesuit Creek	0.06	From Rte. 6A to mouth at Cape Cod Bay, Dennis. Class SA
MA96-14	Swan Pond River	0.04	Outlet of Swan Pond to confluence with Nantucket Sound, Dennis. Class SA
MA96-15	Boat Meadow River	0.04	Headwaters east of old Railway Grade to mouth at Cape Cod Bay, Eastham. Class SA
MA96-16	Rock Harbor Creek	0.02	Outlet Cedar Pond to mouth at Cape Cod Bay,

Segment ID	Segment Name	Segment Size (sq mi)	Segment Description
			Eastham/Orleans. Class SA
MA96-17	Falmouth Inner Harbor	0.05	Waters included north of Inner Falmouth Harbor Light, Falmouth. Class SB
MA96-18	Great Harbor	0.31	The waters north of an imaginary line drawn southeast from Devils Foot to Juniper Point, Falmouth. Class SA
MA96-19	Little Harbor	0.07	The waters north of an imaginary line drawn from Juniper Point east to Nobska beach, Falmouth. Class SA
MA96-20	Quashnet River	0.07	Just south of Rte. 28 to mouth at Waquoit Bay, Falmouth (also known as Moonakis R.). Class SA
MA96-21	Waquoit Bay	1.4	From mouths of Seapit R., Quashnet R., Little R., and Great R. to confluence with Vineyard Sound, Falmouth. Class SA
MA96-22	Herring River	0.07	Outlet of Reservoir northwest of Bells Neck Rd. to mouth at Nantucket Sound, Harwich. Class SA
MA96-23	Saquatucket Harbor	0.02	South of Rte. 28 to confluence with Nantucket Sound, Harwich. Class SA
MA96-24	Mashpee River	0.09	Quinaquisset Ave. to mouth at Popponesset Bay, Mashpee. Class SA
MA96-26	Little Namskaket Creek	0.01	Source to mouth at Cape Cod Bay. Class SA
MA96-27	Namskaket Creek	0.02	From outlet of unnamed pond north of Rte. 6A in Orleans to mouth at Cape Cod Bay, Brewster/Orleans. Class SA
MA96-29	Provincetown Harbor	4.3	The waters northwest of an imaginary line drawn from the tip of Long Point to Beach Point Beach, Provincetown. Class SA
MA96-30	Scorton Creek	0.07	Jones Lane to mouth at Cape Cod Bay, Sandwich. Class SA
MA96-31	Pamet River	0.14	Rte. 6 to mouth at Cape Cod Bay (Including Pamet Harbor), Truro. Class SA
MA96-32	Duck Creek	0.15	From Cannon Hill to Shirttail Point, Wellfleet. Class SA
MA96-33	Herring River	0.39	Griffin Island to Wellfleet Harbor, Wellfleet.. Class SA
MA96-34	Wellfleet Harbor	8.5	The waters north of an imaginary line drawn west from Jersey Point to Sunken Meadow, excluding the estuaries of Herring River, Duck Creek, and Blackfish Creek, Wellfleet.. Class SA
MA96-35	Chase Garden Creek	0.16	Source west of Rte. 6A, Dennis to mouth at Cape Cod Bay, Dennis/Yarmouth. Class SA
MA96-36	Lewis Bay	1.8	Includes Pine Island Creek and Uncle Roberts Cove to confluence with Nantucket Sound, Yarmouth. Class SA
MA96-37	Mill Creek	0.05	From Keveny/Mill Lane north to confluence with Cape Cod Bay Barnstable/Yarmouth. Class SA
MA96-38	Parkers River	0.04	Outlet Seine Pond to mouth at Nantucket Sound, Yarmouth. Class SA
MA96-39	Popponesset Creek	0.04	All waters west of Popponesset Island (from Popponesset Island Road bridge at the north to a line extended from the southeastern most point of the island southerly to Popponesset Beach), Mashpee. Class SA
MA96-41	Mill Creek	0.03	Outlet of Taylors Pond to confluence with Cockle Cove, Chatham. Class SA
MA96-42	Taylors Pond	0.02	Chatham. Class SA
MA96-43	Harding Beach Pond	0.07	locally known as Sulfur Springs (northeast of Bucks Creek), Chatham. Class SA
MA96-44	Bucks Creek	0.02	Outlet from Harding Beach Pond (locally known as Sulfur Springs) to confluence with Cockle Cove, Chatham. Class SA
MA96-45	Oyster Pond	0.21	Including Stetson Cove, Chatham. Class SA

Segment ID	Segment Name	Segment Size (sq mi)	Segment Description
MA96-46	Oyster Pond River	0.14	Outlet of Oyster Pond to confluence with Stage Harbor, Chatham. Class SA
MA96-50	Ryders Cove	0.17	Chatham. Class SA
MA96-53	Perch Pond	0.03	Connects to northwest end of Great Pond, west of Keechipam Way, Falmouth. Class SA
MA96-54	Great Pond	0.40	From inlet of Coonamessett River to Vineyard Sound (excluding Perch Pond), Falmouth. Class SA
MA96-55	Green` Pond	0.21	east of Acapesket Road, outlet to Vineyard Sound, Falmouth. Class SA
MA96-57	Bournes Pond	0.24	west of Central Avenue, to Vineyard Sound, Falmouth. Class SA
MA96-58	Hamblin Pond	0.19	From inlet of Red Brook to outlet of Little River and inlet/outlet of Waquoit Bay west of Meadow Neck Road, Falmouth/Mashpee. Class SA
MA96-61	Little River	0.03	From outlet of Hamblin Pond to Great River, Mashpee. Class SA
MA96-62	Oyster Pond	0.10	East of Fells Road, Falmouth. Class SA
MA96-68	Town Cove	0.80	Entire Cove to Nauset harbor, including Rachael Cove and Woods Cove, Orleans/ Eastham. Class SA

The MassDEP, beginning with the 2004 Integrated List of Impaired Waters, determined that 14 segments on the Western end of the Cape in Falmouth and Bourne most appropriately fit within the Buzzards Bay Watershed, as drainage from these segments went into Buzzards Bay. These segments include: MA95-14, Cape Cod Canal; MA95-48 Eel Pond; MA95-47 Back River; MA95-15 Phinneys Harbor; MA95-16 Pocasset River; MA95-17 Pocasset Harbor; MA95-18 Red Brook Harbor; MA95-21 Herring Brook; MA95-46 Harbor Head; MA95-20 Wild Harbor; MA95-22 West Falmouth Harbor; MA95-23 Great Sippewisset Creek; MA95-24 Little Sippewisset Marsh; MA95-25 Quissett Harbor. These segments are covered in the Buzzards Bay Bacteria TMDL Report (Mass DEP 2009). Four other segments are covered in the Three Bays TMDL Report (Mass DEP 2009a). These Segments include: MA96-63 Cotuit Bay, MA96-65 West Bay, MA96-66 North Bay and MA96-07 Prince Cove.

This TMDL is based on the current WQS using fecal coliform for shellfish areas, and E. *coli* for fresh and enterococcus for either salt or fresh water bathing respectively, as the indicator organisms. Enterococci data are provided at the bottom of each table when data are available. The MassDEP has incorporated *E. coli* and enterococci as indicator organisms for all waters other than shellfishing and potable water intake areas. Not all data presented herein were used to determine impairment listing, due to a variety of reasons (including data quality assurance and quality control). MassDEP used only a subset of the available data to generate the *Integrated Lists*. Other data presented in this section are for illustrative purposes only.

Data from the Massachusetts Division of Marine Fisheries (DMF) were used, in part, as the basis for pathogen impairment for many of the estuarine areas (Figure 1-1). Each year water samples are collected by the DMF at 2,320 stations in 294 growing areas in Massachusetts's coastal waters at a minimum frequency of five times while open to harvesting (DMF 2002). Due to the volume of data collected by the DMF, the complete range of results is not provided herein, but a small subset may be provided. For the most recent indicator bacteria sampling data, please contact your local city or town shellfish constable or DMF's Shellfish Project.

Available bacteria data are summarized in the following section. The primary sources of data include but are not limited to DMF, CZM, MassDEP.. Additional discussion can be found at:

- **MassDEP CCWQA** – Cape Cod Watershed Water Quality Assessment Report available for download at http://www.mass.gov/dep/water/resources/96wqar.pdf.

- **MassDEP BBWQA** – Buzzards Bay Watershed 2000 Water Quality Assessment Report available for download at http://www.mass.gov/dep/water/resources/95wqar1.pdf

The MADPH publishes annual reports on the testing of public and semi-public beaches for both marine and fresh waters. These documents provide water quality data for each bathing beach by community and note if there were exceedances of water quality criteria. There is also a list of communities that did not report testing results. These reports can be downloaded from http://www.mass.gov/?pageID=eohhs2modulechunk&L=6&L0=Home&L1=Consumer&L2=Community+Health+and+Safety&L3=Environmental+Health&L4=Environmental+Exposure+Topics&L5=Beaches+and+Algae&sid=Eeohhs2&b=terminalcontent&f=dph_environmental_c_beach_annual_reports&csid=Eeohhs2. Marine and freshwater beach status is highly variable and is therefore not provided in each segment description. Please see the MADPH annual beach report for specific details regarding swimming beaches.

The following section of this report is intended to briefly summarize the impaired waterbody segments and available data in the Cape Cod Watershed. For more information on any of these segments, see the "*Cape Cod Watershed Water Quality Assessment Report*" on the MassDEP website: http://www.mass.gov/dep/water/resources/96wqar.pdf.

Tens of thousands of additional samples have been collected throughout the Cape Cod watershed by DMF. DMF has a well-established and effective shellfish monitoring program that provides quality assured data for each shellfish growing area. In addition, each growing area must have a complete sanitary survey every 12 years, a triennial evaluation every three years and an annual review in order to maintain a shellfishing harvesting classification with the exception of those areas already classified as Prohibited. The National Shellfish Sanitation Program establishes minimum requirements for sanitary surveys, triennial evaluations, annual reviews and annual fecal coliform water quality monitoring and includes identification of specific sources and assessment of effectiveness of controls and attainment of standards. QAPP and QA/QC protocols for sampling, delivery of the samples to laboratories for analysis, and laboratory analysis strictly follow acceptable guidelines under the National Shellfish Sanitation Program, as well as the U.S. Department of Public

Health (DMF 2007). The following paragraphs summarize data and other available information on each segment being addressed by this TMDL.

Barnstable Harbor Segment MA96-01

This 3.3 square mile (mi^2) Class SA, Outstanding Resource Water (ORW) segment extends from the mouths of Scorton and Spring Creeks to Beach Point and the western edge of the Mill Creek estuary in Barnstable. The Barnstable Harbor recharge area contains 107.4 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Barnstable is in the process of applying for a National Pollutant Discharge Elimination System (NPDES) permit for the municipal separate storm sewer system (MS4).

DMF Designated Shellfish Growing Areas Status: Approved for 2.08 mi^2; Conditional Approved for 0.47 mi^2; Prohibited for 0.01 mi^2 (Figure 1-1). The following Table (4-4) summarizes ambient bacteria data collected by DMF within this segment between the years 1996-2001.

Table 4-4. MA96-01 Barnstable Harbor DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2001	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, 1997 - 2001 data base, excluding sanitary survey (CFU/100 ml)
481	1.9 - >1,000	3.59

A special DMF sanitary survey conducted in 2001, involving six stations from several creeks and streams at the Barnstable Yacht Club, found elevated fecal coliform levels ranging form 290 > 1,000; CFU/100 ml, and is speculated to be the result of Yacht Club related activities. A shoreline survey to identify pollution sources was conducted between October and November 2001. Most of the area is on septic systems, and although there were no breakouts observed, DMF recommended that the Board of Health inspect a number of systems, particularly in the summer area of Sandy Neck. Several other pipes coming from houses and sides of roads showed signs of a discharge and it was recommended that they be evaluated by the town.

The MA Department of Public Health (DPH) sampled for enterococcus levels at 5 public beach sites at least 13 times within this segment during 2006: Bone Hill Beach; Indian Trail Beach; Millway Beach; Sandy Neck, and Scudder Lane. Results ranged between <2 to 114 CFU/100ml with only one closure at Bone Hill Beach occurring (MDPH 2006).

Bumps River Segment MA96-02

This 0.07 mi^2 Class SA segment extends from the outlet of a pond at Bumps River Road to the South Main Street bridge in Barnstable. The Bumps River recharge area contains 53.6 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Barnstable is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Restricted for 0.03 mi^2; Prohibited for 0.07 mi^2 (Figure 1-1). The following Table (4-5) summarizes ambient bacteria data collected by DMF within this segment between the years 1996-2001.

Table 4-5. MA96-02 Bumps River DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2001	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, 1997- 2001 (CFU/100 ml)
77	1.9 - 312	3.59

Pollution sources were not identified in the data reports for this segment, although, as in many other segments, reports of scattered bird populations are reported.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Dowes Beach, (which is between this segment and Centerville River Segment MA96-04) at least 13 times during 2006. Results ranged between <2 and 4 CFU/100mL with no closures (MDPH 2006).

Centerville River Segment MA96-04

This 0.25 mi^2 Class SA segment extends from its headwaters in a wetland west of Strawberry Hill Road to its confluence with Centerville Harbor. The Centerville River recharge area contains 61.03 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Barnstable is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Restricted for 0.22 mi^2; Prohibited for 0.08 mi^2 (Figure 1-1). The following Table (4-6) summarizes the above described events where bacteria data were collected by DMF in this segment between the years 1996 -2005.

Table 4-6. MA96-04 Centerville River DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2001	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, 2004- 2005 sanitary surveys (150 data points) (CFU/100 ml)
432	1.9 - 4,200	17- 49.6 range

Of special note was a sanitary survey conducted by DMF between May and June 1997. This surveys focus was on the Bumps River- Scudder Bay MA 96-02, which drains directly into this segment at its western end. Six stations were sampled following rain events of 1.00” and 0.70”. Fecal coliform levels ranged between 10 - 4,200 CFU/100 ml (the town is aware of the problem at this park, and has replaced the stormwater drain system along that section of Main St.). As part of this survey, ten additional ambient stations directly within this segment (Centerville River MA 96-04) were sampled fifteen times. Fecal coliform geometric means ranged between 10 - 86 CFU/100 ml, with only one reading > 260 CFU/100 ml, (at #291 Bay Lane). Scudder Bay - Bumps River receives drainage from several cranberry bogs to the north and west, which warrants further analysis. A considerable portion of Scudder bay is prohibited to shellfishing as of the date of this report.

The DMF conducted a follow up sanitary survey between 2004 and 2005 at six stations (fifteen times) sampled in the 1997 survey (above). Geometric means ranged between 17 - 49.6 CFU/100 ml. An additional four stations (including culverts and catchment basins) were sampled fifteen times during the same time period. Geometric means were also high with fecal coliform ranges between 22.1 - 29.2 CFU/100 ml. The reports don't identify pollution sources except to indicate that populations of birds are evident in the area. Since bacteria problems persist, much of this segment remains closed to the taking of all shellfish. It appears that bacteria pollution has worsened over ten years, since much of the area was at one time conditionally open for shellfishing. Starting in 1997, much of the area proceeded to be rated as closed to all shellfishing, and further area closures were ordered by DMF in 2005.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Dowes Beach, (which is between this segment and Bumps River Segment, MA96-04), Craigville Beach, a private beach owned by the Craigville Beach Association, the Fifth Avenue boat launch, and at Wianno Avenue. Each location was sampled at least 13 times during 2006. At Dowes Beach, Craigville Beach, Craigville Beach Association, and Fifth Avenue (boat launch) results ranged from <2 and 4 CFU/100ml, <2 and 400 CFU/100ml, <2 and 20 CFU/100 ml, <2 and 242 CFU/100ml, respectively, with one closure at each location. Wianno Avenue results ranged between <2 and 4 CFU/100 ml with no closures (MDPH 2006).

Hyannis Harbor Segment MA96-05

This 0.68 mi^2 Class SA segment is bounded by a line drawn from the light at the end of Hyannis breakwater to the point west of Dunbar's Point. There are no regulated wastewater dischargers in this segment. However, the Town of Barnstable is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Approved for 0.38 mi^2; Conditionally Approved for 0.09 mi^2 (Figure 1-1).

The following Table (4-7) summarizes the above described events where bacteria data were collected by DMF in this segment between the years 1996-2004.

Table 4-7. MA96-05 Hyannis Harbor DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, 2002- 2004 ambient surveys(105 data points) (CFU/100 ml)
253	1.9 - 410	2.5 - 5.1 range

A DMF shoreline survey was conducted in July, 2004. Many potential pollution sources identified in the late 1990's shoreline survey (mainly septic systems) were taken off the list from the July 2004 survey. This was mainly due to sewering that has occurred in portions, and septic system upgrades that have been ordered by the town of Barnstable. The town has an active septic system inspection and maintenance Title 5 program. There are two tidal wetlands (one of them in a prohibited zone) that each have a monitoring station. Two stormwater pipes with flow were tested during July, 2004: 1) Ocean St. Culvert, with a reading of 410 CFU/100 ml; 2) Sea St. Bridge Culvert, with a reading of 100 CFU/100 ml. No other stormwater sources were identified in the survey. Waterfowl were identified as a significant potential contributor, with noteworthy numbers of geese, ducks, and various shorebirds observed throughout the area. There is one marina, the Hyannis Port Yacht Club with 241 moorings and two fixed station public MSD pump-out stations. Commercial and recreational vessels frequently transit the area through a channel accessing the mooring/marina areas of the Lewis Bay/ Hyannis Inner Harbor Area.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Estey Avenue Beach and the Keyes Beach (Sea Street) at least 13 times within this segment during 2006. Results at Estey Avenue ranged between <2 and 56 CFU/100 ml with no closures while the results ranged between 2 and 122 CFU/100 ml with two closures (MDPH 2006) at Keyes Beach.

Shoestring Bay Segment MA96-08

This 0.31mi^2 Class SA segment extends from Quinaquisset Avenue to Ryefield Point in Barnstable/Mashpee. The Shoestring Bay recharge area contains 99.15 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Towns of Barnstable and Mashpee are in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

The following Table (4-8) summarizes the bacteria data were collected by DMF in this segment between the years 1996- 2002.

Table 4-8. MA96-08 Shoestring Bay DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2002	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
230	1.9 - 137	2.01- 4.71 range

Only 3 stations had one reading each >28 CFU/100 ml. These overall figures are fairly low, indicating good to excellent water quality.

A one time sanitary survey on January 30, 2002, involving ten different stations (data included in Table 4-8 above) in adjoining ponds, bogs, and streams all had levels < 11 CFU/100 ml, except two stations: 1) coming from Mashpee Pond, flowing to Mashpee River with a level of 137 CFU/100 ml; 2) Pond off River Road on west side of Mashpee River with a reading of 36 CFU/100 ml. The sanitary survey in the winter of 2002 found no problems with septic systems in the area. There are only two possible stormwater contributors: 1) off the town landing on the southwest end of the Santuit River; and, 2) foot of Narrows Road. There is one existing marina called Half Tide Marina, with 57 slips and no overnight use. Waterfowl observed include Canada geese, white swans, seagulls, terns, and piping plovers. The DMF recommendation is to keep much of Shoestring Bay classified as Conditionally Approved, with one portion, SC:20-4 remaining closed.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Crocker's Neck and Mashpee Neck Road Town Landing at least 13 times within this segment during 2006. Results ranged between <2 and >400 CFU/100 ml with one closure at Croker's Neck and between <2 and 40 CFU/100 ml with no closures (MDPH 2006) at the Town Landing.

Quivett Creek Segment MA96-09

This 0.03 mi^2 Class SA segment extends from the outlet of an unnamed pond south of Route 6A to the mouth at Cape Cod Bay in Brewster/Dennis. The Town of Dennis is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

The following Table (4-9) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2002.

Table 4-9. MA96-09 Quivett DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2002	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
12	2 - >50	Insufficient data

The MA Department of Public Health (DPH) sampled for enterococcus levels at Robbins Hill Beach at least 13 times within this segment during 2006. Results ranged between <2 and >400 CFU/100 ml with two closures (MDPH 2006).

Stage Harbor Segment MA96-11

This 0.58 mi^2 Class SA segment includes Mitchell River from Mill Pond to Sears Point and Harding Beach Point in Chatham.

DMF Designated Shellfish Growing Areas Status: Approved for 0.85 mi^2; Conditionally Approved for 0.01 mi^2 (Figure 1-1).

The following Table (4-10) summarizes the bacteria data were collected by DMF in this segment between the years 1996- 2004.

Table 4-10. MA96-11 Stage Harbor DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 90 samples collected in 2004
268	1.9 - 1,550	2.1 - 2.6

The DMF collected fecal coliform samples during a sanitary survey (data included in Table 4-10 above) at four to five stations (including 3 discharge pipes), twice, along this segment between August and September 2001. A total of 9 samples were collected. Fecal coliform values ranged from 5 to 1550 CFU/100 ml. Champlain Creek had elevated readings of 265 and 1,550 CFU/100mL. Johnson Creek at the bridge had one reading of 270 CFU/100 ml, and Little Mill Pond Creek had one reading of 265 CFU/100 mL. Elevated readings were just following rainfall of approximately 0.33". Despite a few elevated readings in scattered locations, the analysis of overall results show that this area has continuing excellent water quality. Champlain Creek could be further investigated by the town to see if the high levels continue, and if so, what the cause(s) might be (MDPH 2006).

Bass River Segment MA96-12

This 0.67 mi^2 Class SA segment extends from Route 6 to the mouth at Nantucket Sound in Dennis/Yarmouth. There are no regulated wastewater dischargers in this segment. However, the Towns of Dennis and Yarmouth are in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved for 0.89 mi^2; Prohibited for 0.01 mi^2 (Figure 1-1).

The following Table (4-11) summarizes the bacteria data collected by DMF in this segment between the years 1996 - 2004.

Table 4-11. MA96-12 Bass River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 90 samples collected in 2004
342	1.9 - 1,270, and TNTC	2.5 - 4.7
TNTC = too numerous to count		

Additionally sanitary surveys (data included in Table 4-11 above) were conducted in October 2003 and November 2005. DMF sampled at 12 sites (Bass River, Center Portion), once (ramps, coves, feeder streams, and pipe outfalls). Readings were <10- 40 CFU/100 ml, with elevated levels at 3 sites just following 1" of rain: High Bank Road East S.D., 1,270 CFU/100 ml; Culvert pipe at 299 Old Main, 440 CFU/100 ml; and the Stream at Pinefield Lane, TNTC.

DMF collected fecal coliform samples (data included in Table 4-11 above) during sanitary surveys at five stations in the southern portion of this segment between December 1, 2002 and May 31, 2003. Four stations had geometric means readings ranging between 3.2 - 3.6, with the highest geometric reading of 5.5 CFU/100 ml at Portside Way. Additionally, six stations (4 stormdrains/ pipes, and 2 landing ramps) were sampled on October 15, 2003, right after a 1" rain event. Only two readings were >80 CFU/100 ml: Ferry Street stormdrain, 640 CFU/100 ml, and Wrinkle Point pipe, TNTC. Three other culvert type stations were sampled March 1, 2004. All readings were < 10 CFU/100 ml. With respect to sources of pollution with the higher counts noted above, the only noted source in the reports is the presence of a high number of boats and marinas in the area. It is suggested that further wet weather sampling of storm drain pipes with high levels above be conducted by Yarmouth and Dennis to better determine the sources.

The MA Department of Public Health (DPH) sampled for enterococcus levels at two locations in the Bass River (Bass River Beach East and West), and at Follins Road and West Dennis Beach at least 13 times during 2006. Results in the Bass River ranged between <2 and 36 CFU/100 ml with no closures. Results at Follins Road ranged between <2 and 356 CFU/100 ml, with one closure while at West Dennis Beach results ranged between <2 and 14 CFU/100 ml with no closures (MDPH 2006).

Sesuit Creek Segment MA96-13

This 0.06 mi^2 Class SA segment extends from Route 6A to its mouth at Cape Cod Bay in Dennis. There are no regulated wastewater dischargers in this segment. However, the Town of Dennis is in the process of applying for a MS4 NPDES permit.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved (Figure 1-1).

The following Table (4-12) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-12. MA96-13 Sesuit Creek DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 45 samples collected in 2002- 2003
197	1.9 - 3,380	2.5 - 3.0

A sanitary survey was conducted whereby 3 stations (culverts) were sampled April 30, 2003, with all readings 10 CFU/100 ml or less. Six stations (culverts and stormdrains) were sampled on July 29, 2003. A steady rainfall was reported to be occurring during the sampling. Elevated readings were observed at several stations including: Bridge St. stormdrain, 2,880 CFU/100 ml; Bridge St. culvert, 3,380 CFU/100 ml; Marina Parking Area drain, 460 CFU/100 ml; and Cold Storage culvert, 400 CFU/100 ml. The DMF identified the Bridge St. and Marina Parking area stormdrains as stormwater sources of pollution, however, no sources were identified. Follow-up monitoring indicated no problems. Additionally, 3 stations (culverts) were sampled December 5, 2005, with the range of readings between <10 and 30 CFU/100 ml. On January 18, 2006, five stations (culverts, etc., similar to July 29, 2003 survey above) were sampled. All readings were low this time (as compared to July 29, 2003), with ranges between <10 - 30 CFU/100 ml.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Harborview Beach and at Sea Street (east Dennis) at least 13 times during 2006. Results at Harborview Beach ranged between <2 and 50 CFU/100 ml with no closures and between <2 and 4 CFU/100 ml with no closures (MDPH 2006) at Sea Street.

Swan Pond River Segment MA96-14

This 0.04 mi^2 Class SA segment extends from the outlet of Swan Pond to the river's confluence with Nantucket Sound in Dennis. The Swan Pond River recharge area contains 22.34 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Dennis is in the process of applying for a MS4 NPDES permit.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

The following Table (4-13) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2002.

Table 4-13. MA96-14 Swan Pond River DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2002	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 35 samples collected 1996- 2001
690	1.7 - 280	20

Since 1988 the DMF has sampled this segment numerous times. In the years 1988-1996, there were numerous exceedances > 28 CFU/100 ml. In the time period 1997- 2002, there was some reduction in numbers of readings > 28 CFU/100 ml.

Additionally, the DMF, through Barnstable County, collected fecal coliform samples at four to five stations, eight times, along this segment between February and August, 2002. A total of 39 samples were collected. Fecal coliform values ranged from <10 to 280, with only one reading > 200 CFU/100 ml (Hydaway Creek). Hydaway Creek had another reading of 140 CFU/100 ml; Route 28, 90 CFU/100 ml; Upper County Road, 80 and 60 CFU/100 ml; Lower County Road and Mouth having readings of 50 CFU/100 ml each.

Since no sanitary type survey reports were prepared, no analysis by DMF was given as to potential pollution sources which may cause the elevated ambient levels. However, it is evident that Swan Pond is connected with drainage from cranberry bogs to the north. Also it is evident that many residences abound the area, all on septic systems.

The MA Department of Public Health (DPH) sampled for enterococcus levels at South Village Beach at least 13 times during 2006. Results ranged between <2 and 82 CFU/100 ml with no closures (MDPH 2006).

Boat Meadow River Segment MA96-15

This 0.04 mi^2 Class SA, ORW segment extends from the river's headwaters east of old Railway Grade to the river's mouth at Cape Cod Bay in Eastham. There are no regulated NPDES discharges in this segment.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

The following Table (4-14) summarizes the bacteria data collected by DMF in this segment between the years 1997 - 1998.

Table 4-14. MA96-15 Boat Meadow River DMF Fecal Coliform Data.

Total Number of Data Points 1997- 1998	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
11	1.9 - 51	Insufficient data

The MA Department of Public Health (DPH) sampled for enterococcus levels at First Encounter Beach at least 13 times during 2006. Results ranged between <2 and 14 CFU/100 ml with no closures (MDPH 2006).

Rock Harbor Creek Segment MA96-16

This 0.02 mi^2 Class SA, Outstanding Resource Water (ORW) segment extends from the outlet of Cedar Pond to the creek's mouth at Cape Cod Bay in Eastham/Orleans. There are no regulated NPDES discharges in this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 0.01 mi^2; Prohibited for 0.03 mi^2 (Figure 1-1).

The following Table (4-15) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2004.

Table 4-15. MA96-16 Rock Harbor Creek DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
12	1.9- 51	Insufficient data

The MA Department of Public Health (DPH) sampled for enterococcus levels at Dyer Prince Beach, Boat Meadow Beach and Rock Harbor Beach at least 13 times during 2006. Results at Dyer Prince Beach ranged between <2 and >400 CFU/100 ml with one closure. At Boat Meadow Beach results ranged between <2 and 62 CFU/100 ml with no closures while at Rock Harbor Beach results ranged between <2 and >400 CFU/100 ml with two closures (MDPH 2006).

Great Harbor Segment MA96-18

This 0.31 mi^2 Class SA segment includes the waters north of a line drawn from Devils Foot to Juniper Point in Falmouth. There are no NPDES regulated discharges in this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 0.03 mi^2; Prohibited for 0.05 mi^2 (Figure 1-1).

The following Table (4-16) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2004.

Table 4-16. MA96-18 Great Harbor Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
115	1.9 - 51	Not available

Little Harbor Segment MA96-19

This 0.07 mi^2 Class SA segment includes the waters north of a line drawn from Juniper Point to Nobska beach in Falmouth. There are no NPDES regulated discharges in this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 0.02 $mi^{2;}$ Conditionally Approved for 0.02 mi^2; Prohibited for 0.01 mi^2 (Figure 1-1).

The following Table (4-17) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-17. MA96-19 Little Harbor Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 45 samples collected 2002- 2003
178	1.9 - 51	2.64 - 3.39

The MA Department of Public Health (DPH) sampled for enterococcus levels at Nobska Beach Association Beach 12 times within this segment during 2006. Results ranged between <2 and 12 CFU/100 ml with no closures (MDPH 2006).

Quashnet River Segment MA96-20

This 0.07 mi^2 Class SA river segment extends from just south of Route 28 to its mouth at Waquoit Bay in Falmouth. This segment is also known as the Moonakis River. The recharge area contains 62.75 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 0.004 mi^2; Prohibited for 0.096 mi^2 (Figure 1-1).

The following Table (4-18) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2001.

Table 4-18. MA96-20 Quashnet River DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2001	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 35 samples collected 1996- 2001
37	1.9 - 51	20

<u>Waquoit Bay Segment MA96-21</u>

This 1.4 mi^2 Class SA, ORW segment extends from the mouths of Seapuit, Quashnet, Little, and Great Rivers to the confluence with Vineyard Sound in Falmouth. There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Approved (Figure 1-1).

The following Table (4-19) summarizes the bacteria data collected by DMF in this segment between the years 1999- 2001.

Table 4-19. MA96-21 Waquoit Bay Segment DMF Fecal Coliform Data.

Total Number of Data Points 1999- 2001	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
210	< 2 - >28	< 2 - 5.4

In the 1999 - 2001 survey, two stations had elevated mean values: 1) station #6 at Mouth of Moonakiss, 5.4 CFU/100 ml (with 2 readings >28 CFU/100 ml); 2) station 7A at culvert under Meadows Neck, 5.2 CFU/100 ml (with 2 readings >28 CFU/100 ml). The area was rated by DMF as having overall excellent water quality, with three small closures along the eastern side of the bay due to birds and stromwater runoff.

<u>Herring River Segment MA96-22</u>

This 0.07 mi^2 Class SA segment extends from the outlet of the reservoir northwest of Neck Road to the river's mouth at Nantucket Sound in Harwich. The Herring River recharge area contains 256.58 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved for 0.04 mi^2; Prohibited for 0.04 mi^2 (Figure 1-1).

The following Table (4-20) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2006.

Table 4-20. MA96-22 Herring River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2006	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 35 samples collected 1996-2001
690	1.9 - 51	2.1 - 4.1

Sanitary surveys in 2000 and 2003, and a follow-up triennial report in 2006 show the overall water quality is excellent during that time of the year and that the area has “open to shellfishing status”. Improved water quality has allowed the redefinition of the area north of the Route 28 bridge to open seasonal status for the fishing of oyster and quahog resources. Little monitoring or pollution analysis was provided in the continuing prohibited zone.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Innman Road Beach, Callie’s Beach (Waquoit Bay E), and Mashpee Neck Rd town Landing at least 13 times segment during 2006. Results for Innman Road ranged between <2 and 38 CFU/100 ml with no closures. Results for Callie’s Beach (Waquoit Bay E), and Mashpee Neck Rd town Landing ranged between <2 and 56 CFU/100 ml with no closures. Three marine beach organizations were also sampled at least 13 times. Results from Old Mill Point Association (Seaway), Strandway, and Belmont ranged between <2 to 56 CFU/100 ml (MDPH 2006).

Saquatucket Harbor Segment MA96-23

This 0.02 mi^2 Class SA segment runs from south of Route 28 to the confluence with Nantucket Sound in Harwich. The Saquatucket Harbor recharge area contains 33.34 acres of cranberry bog open space. There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved for 0.01 mi^2; Prohibited for 0.01 mi^2 (Figure 1-1).

The following Table (4-21) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2005.

Table 4-21. MA96-23 Saquatucket Harbor Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996 - 2005	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 45 data points 2004- 2005
171	1.9 - 51	1.9 - 3.3

Sampling results would indicate excellent water quality, with a continued year-round required closure to shellfishing in the marina proper area. DMF reports indicate that the marina area is regarded as a potential, but not actual, pollution source. No other potential or actual pollution sources are indicated in the reports, except the 1999 report indicates possible factors from the surrounding marshes and cranberry bogs which drain upland areas.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Neel Rd. Beach at least 13 times within this segment during 2006. Results ranged between <2 and 16 CFU/100 ml with no closures (MDPH 2006).

Mashpee River Segment MA96-24

This 0.09 mi^2 Class SA segment extends from Quinaquisset Avenue to the river's mouth at Popponesset Bay in Mashpee. The Mashpee River recharge area contains 0.29 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Mashpee is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved for 0.04 mi^2; Prohibited for 0.06 mi^2 (Figure 1-1).

The following Table (4-22) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2006.

Table 4-22. MA96-24 Mashpee River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2006	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 36 data points 2004- 2006
208	1.9 - 51	2.01 - 4.71

Additional sampling was carried out between April 2004 and April 2006 (12 times) for six stations with the range between <2 to 6 CFU/100 ml. The geometric means for all these stations ranged between 2.01 to 4.71 CFU/100 ml. Sources of bacteria were not identified by DMF monitoring staff. Boating activity is evident in summer, with boat pump-out facilities provided at the one marina. The existence of bird populations are also noted. The reports indicate that all septic systems appear to be functioning properly.

Little Namskaket Creek Segment MA96-26

This 0.01 mi^2 Class SA, ORW segment extends from the creek's source to its mouth at Cape Cod Bay in Orleans. There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

The following Table (4-23) summarizes the bacteria data collected by DMF in this segment between the years 1997- 1998.

Table 4-23. MA96-26 Little Namskaket Creek DMF Fecal Coliform Data.

Total Number of Data Points 1997- 8	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
9	1.9 - 18	Not available

The MA Department of Public Health (DPH) sampled for enterococcus levels at Skaket Beach at least 13 times just adjacent to this segment during 2006. Results ranged between <2 and 26 CFU/100 ml with no closures (MDPH 2006).

<u>Namskaket Creek Segment MA96-27</u>

This 0.02 mi^2 Class SA, ORW segment extends from the outlet of an unnamed pond north of Route 6A in Orleans to the creek's mouth at Cape Cod Bay in Brewster/Orleans. The Namskaket Creek recharge area contains 7.15 acres of cranberry bog open space. There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

The following Table (4-24) summarizes the bacteria data collected by DMF in this segment between the years2000- 2001.

Table 4-24. MA96-27 Namskaket Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 2000- 2001	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
10	1.9 - 11	Not available

The MA Department of Public Health (DPH) sampled for enterococcus levels at Crosby Landing Beach and Ginnell Landing Beach at least 13 times within this segment during 2006. At Crosby Landing results ranged between <2 and 160 CFU/100 ml with one closure. At Ginnell Landing Beach results ranged between <2 and 56 CFU/100 ml with no closures (MDPH 2006).

<u>Provincetown Harbor Segment MA96-29</u>

This 4.3 mi^2 Class SA segment includes the waters bounded by the shoreline and a line drawn from the tip of Long Point to Beach Point Beach in Provincetown. There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 3.04 mi^2; Conditionally Approved for 0.33 mi^2; Prohibited for 0.40 mi^2 (Figure 1-1).

The following Tables (4-25; 4-26) summarize the bacteria data collected by DMF in this segment between the years 1996- 2004.

Table 4-25. MA96-29 Provincetown Harbor Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
228	1.9 - 51	Not available

Table 4-26. MA96-29 Provincetown Harbor Segment (at Ryder Street Beach) DMF Enterococcus Data.

Total Number of Data Points 2001- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml)
15	10 - >400	Not available

In 2003 there were a number of (Ryder Street Beach) exceedances >104 CFU/100 ml. The exceedances were linked to storm events, and the sources were believed to be septic system failures, marine sanitary wastes, and pet waste.

The DMF wrote a particularly detailed “Sanitary Survey of Ryder Street Beach Report” in June 2004. Ryder Beach was selected by the EPA as a “flagship” beach as part of their New England Clean Beach Initiative. Since this selection, the town has creatively pursued the installation of a municipal sewer to tie-in suspected septic contributors in the immediate beach area as well as those in low-lying areas near stormwater collection systems where infiltration of contaminated groundwater is problematic. Additionally, the town installed particle separators in the beach area, and has completed an overall stormwater management study and is seeking funds to implement the control recommendations in that study. With boat wastes, the town provides a boat pumping service (holding tank). Studies have indicated that dog wastes play a key pollution role, so stricter pet access to the beach has been enforced, plus installation of mutt mitts and pooper scoopers have occurred to make removal of wastes more expedient. A follow-up monitoring survey is recommended, to determine if all these efforts have actually reduced bacteria pollution levels at the beach, and in surrounding water areas.

The MA Department of Public Health (DPH) sampled for enterococcus levels at some 18 sites along the beaches area off Commercial Street/ Route 28 Mid- Cape Highway at least 8 times within this segment during 2006. The summary includes: 29 Commercial St Site; 2 exceedances > 104 CFU/100 ml; 451 Commercial St., 2 readings > 400 CFU/100 ml’; 593 Commercial St., one exceedence >400 CFU/100 ml; 637 Commercial St., 2 exceedances >104 CFU/100 ml; Atkin’s Lane, one reading >400 CFU/100 ml; Court St., one level >104 CFU/100 ml; Kendal Lane, three readings > 104 (with one >400) CFU/100 ml; Ryder Beach, 3 stations, with 2 readings >104 CFU/100 ml (MDPH 2006).

Scorton Creek Segment MA96-30

This 0.07 mi^2 Class SA segment extends from Jones Lane to the creek's mouth at Cape Cod Bay in Sandwich. The Scorton Creek recharge area contains 86.01 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment; However, the Town of Sandwich is in the process of applying for a MS4 NPDES permit.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1). Part of the Scorton Creek area has a conditionally approved classification during the open period.

The following Table (4-27) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2004.

Table 4-27. MA96-30 Scorton Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2004	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml)
90	1.9 - >28	3.0 - 10.9

The only indication as to pollution sources in DMF reports are the presence of large numbers of birds from time to time. Species include several varieties of ducks, as well as Canadian geese, Cormorants, Seagulls, and Terns. A sanitary survey conducted in 2001, and a triennial report in 2005 both indicate the possibility of bacteria sources from outhouses, cesspools or septic systems throughout the entire Barnstable Harbor area (including Scorton Creek). DMF recommends that the town of Barnstable Board of Health should check out these possible sources.

The MA Department of Public Health (DPH) sampled for enterococcus levels at East Sandwich Beach and Torrey Beach Community at least 13 times during 2006. At East Sandwich Beach results ranged between <2 and 110 CFU/100 ml with one closure. At Torrey Beach Community Association Beach results ranged between <2 and 234 CFU/100 ml with one failure (MDPH 2006).

The DMF sampled in the Sandwich Harbor Area, which is just west and adjacent to this segment. Sampling occurred at 11 stations in 1998 and 1999. The fecal coliform geometric range in 1998 was 6.7- 79 CFU/100 ml (with the central mean 20.8 CFU/100 ml), and in 1999, the range was 6.7- 49.6 CFU/100 ml (with the central mean 18.6 CFU/100 ml). It should be noted that although the Sandwich Harbor Area is not an official MassDEP segment for classification, this area has relatively high bacteria levels such that DMF rates all shellfishing areas as "prohibited".

Pamet River Segment MA96-31

This 0.14 mi^2 Class SA river segment extends from Route 6 to the river's mouth at Cape Cod Bay (including Pamet Harbor) in Truro. There are no or NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved for 0.15 mi^2; Prohibited for 0.05 mi^2 (Figure 1-1).

The following Table (4-28) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2005.

Table 4-28. MA96-31 Pamet River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2005	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml)
234	1.9 - 311	2.5 - 5.6

A DMF shoreline survey (as part of the sanitary survey) was conducted during the Fall of 2006. Potential sources of bacteria pollution in the Pamet River area include: tidegates, storm drains, retention catch basins, culverts, and migratory waterfowl. Various sized concentrations of migratory waterfowl (Canada geese, cormorants, duck, and gull species) were observed at sampling stations throughout the survey area, and could be a significant factor to adverse water quality. Rain events seem to have an upward effect on pollutants. A special sanitary survey was conducted at 5 stations once on January 1, 2007. Fecal coliform levels ranged between 11- 311 CFU/100 ml, with the 311 reading coming from a stormdrain near Meetinghouse Road.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Pamet Harbor Beach at least 13 times during 2006. Results ranged between <2 and 48 CFU/100 ml with no closures (MDPH 2006).

<u>Duck Creek Segment MA96-32</u>

This 0.15 mi^2 Class SA segment extends from Cannon Hill to Shirttail Point in Wellfleet. There are no or NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 0.02 mi^2; Conditionally Approved for 0.076 mi^2; Prohibited for 0.004 mi^2 (Figure 1-1).

The following Table (4-29) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-29. MA96-32 Duck Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml)
273	1.9 - 51	2.6 - 3.8

Most of the readings above were quite low (<2- 4 CFU/100 ml), but there were a few exceptions. At station #3, adjacent to the athletic field (in Wellfleet), 2 readings (10/01/01, and 9/26/01) were > 27 CFU/100 ml. According to historical data, rainfall adversely impacts the area of Station #3 due in large part to a culvert pipe with a clapper valve that allows fresh water drainage of Mill Creek located across the street into Duck Creek (Wellfleet). Station #7, at the railroad bridge, also had two readings (9/26/01, and 9/17/01) >27 CFU/100 ml. On those same dates, station #8 at Richmond Road had readings of 22 CFU/100 ml. In 2003, station #10, in the Cove, where the geometric means were 3.8 CFU/100 ml, and station #8, at the bottom of the Creek/top of the Cove where the geometric means was 3.6 CFU/100 ml.

Herring River Segment MA96-33

This 0.39 mi^2 Class SA, ORW segment extends from Griffin Island to Wellfleet Harbor in Wellfleet. There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved for 0.41 mi^2; Restricted for 0.15 mi^2; Prohibited for 0.01 mi^2 (Figure 1-1).

The following Table (4-30) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-30. MA96-33 Herring River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 105 data points 2002- 2003
551	1.9 - 312	3.5 - 46.6

During the 2002-2003 sampling events, at the Boat Ramp, 47% of the readings >27 CFU/100 ml; at Chequesset Neck Bridge, 22% of the readings >27 CFU/100 ml; at Botleneck, 47% of the readings >27 CFU/100 ml; at Split of Land, 20% of the readings >27 CFU/100 ml; and at Ross Residence, and Tip of Great Island 10% of the readings >27 CFU/100 ml. Chequesset Neck Bridge, and the Boat ramp each had 3 readings >50 CFU/100 ml. The Gut had 2 readings > 50 CFU/100 ml. Site #8, Keller Residence, Ross Residence, and the Spit of Land each had one reading >50 CFU/100 ml.

Conditions show slightly worse conditions following wet conditions than dry conditions. Water quality issues were identified in this segment, with quite a few areas prohibited for shellfishing. Stormwater runoff as well as boating activities appear to have a significant pollutant effect in this area. The town of Wellfleet and/or MassDEP, need to conduct some follow-up source tracking activities. There is a chance that drainage from Herring River into the northwest corner of Wellfleet Harbor might, in the future, pose some bacteria related problems in at least that portion of the Harbor.

Wellfleet Harbor Segment MA96-34

This 8.5 mi^2 Class SA segment includes the waters north of a line drawn from Jeremy Point to Sunken Meadow (excluding the estuaries of Herring River, Duck Creek, and Blackfish Creek). There are no NPDES regulated discharges in the recharge area of this segment.

DMF Designated Shellfish Growing Areas Status: Approved for 7.25 mi^2; Prohibited for 0.02 mi^2 (Figure 1-1).

The following Table (4-31) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-31. MA96-34 Wellfleet Harbor Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean (CFU/100 ml) for 120 data points 2002- 2003
208	1.9 - 36	1.9 - 2.7

Despite the fact that there is a lot of pleasure and commercial boating activities in this harbor area, the segment enjoys excellent water quality. The Herring River, which flows into the harbor at its western end, was identified by DMF as a potential pollution source (but the above data do not document an actual pollution effect, see the Herring River Segment, MA 96-33 report above). Also, the DMF has identified Duck Creek, MA 96-32, which flows into the northeastern end of Wellfleet Harbor as a potential pollution source. The data in that segment report above does not indicate as much of a potential problem to the Harbor as compared with the Herring River.

The MA Department of Public Health (DPH) sampled for enterococcus levels at five stations in this segment during 2006 including Indian Neck Beach, Mayo Beach, Omaha Road Beach, Powers Landing Beach, and the Chequesset Yacht Club Beach. Results ranged between <2 and 70 CFU/100 ml, <2 and 180 CFU/100 ml (2 closures), <2 and 10 CFU/100 ml, <2 and 32 CFU/100 ml. and, 2 and 12 CFU/100 ml, respectively (MDPH 2006).

<u>Chase Garden Creek Segment MA96-35</u>

This 0.16 mi^2 Class SA segment extends from its source west of Route 6A in Dennis to the Creek's mouth at Cape Cod Bay in Dennis/Yarmouth. The Chase Garden Creek recharge area contains 16.29 acres of cranberry bog open space. Aquaculture Research Corporation has a permit to discharge into this segment. The Town of Dennis and Yarmouth are in the process of applying for a NPDES permit for their MS4.

DMF Designated Shellfish Growing Areas Status: Conditionally Approved (Figure 1-1).

The following Table (4-32) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-32. MA96-35 Chase Garden Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 190 data points 2000- 2003
344	1.9 - 51	2.2 - 6.5

In the above data sets a station at the Mouth of White's Brook had the highest geometric average at 6.5 CFU/100 ml, but no readings were > 28 CFU/100 ml. A shoreline survey was conducted in April

2001. Several pipes from houses (apparently sump pumps from cellars) reported in a 1992 shoreline survey were sampled, but were not found to be a problem. There was no indication of the cause(s) of relatively elevated levels at the Mouth of White's Brook. However, it was observed that abundant waterfowl populations (ducks and geese) have been observed in the Creek during the shoreline survey and during routine sampling runs.

In follow-up survey work in 2003, the station at the Mouth of White's Brook continued to have the highest geometric average at 6.5 CFU/100 ml, with 2 readings > 28 CFU/100 ml. Also, the station across from the Windmill have a geometric average of 4.1 CFU/100 ml, with 1 reading >28 CFU/100 ml, and the station at the Mouth of Clays Creek had a geometric average of 4.7 CFU/100 ml, with 1 reading > 28CFU/100 ml. Another follow-up shoreline survey was conducted during March 2004. Whites Brook (which has a fresh water source) and Clays Creek have fairly extensive drainage areas, and bacteria levels at the classification station at the base of each are consistently elevated. No sources are identified for either of these. An aquaculture operation was sampled, with no apparent problems. Stormwater runoff, septic systems, and boats do not appear to be contributors either. As in the 2001 shoreline survey, large populations of birds were evident throughout the marsh areas.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Bayview Beach and Gray's Beach at least 13 times during 2006. For Bayview Beach results ranged between <2 and 62 CFU/100 ml with no closures. At Gray's Beach results ranged between <2 and 162 CFU/100 ml with two closures (MDPH 2006).

Lewis Bay Segment MA96-36

This 1.8 mi^2 Class SA segment includes Pine Island Creek and Uncle Roberts Cove and extends to the confluence with Nantucket Sound in Yarmouth. The Lewis Bay recharge area contains 91.41 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Yarmouth is in the process of applying for a MS4 NPDES permit.

DMF Designated Shellfish Growing Areas Status: Approved for 1.27 mi^2; Conditionally Approved for 0.08 mi^2 (Figure 1-1).

The following Table (4-33) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-33. MA96-36 Lewis Bay Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 30 data points 2001 (Chilton Rd., Grist Mill Lane); 224 data sets 2002-2004
817	1.9 - 67	2.4 - 6.4

A shoreline survey was conducted by DMF personnel during the spring and summer of 2003. Three streams were identified and sampled: 1) stream under Route 28 from Mill Pond; 2) two additional streams draining cranberry bogs, flowing into the northwestern part of the area under Route 28. All samples had low bacteria counts. The survey report noted that the town of Yarmouth has a strict septic system maintenance and inspection program. Therefore, no evidence of septic failures were observed on the survey. Also noted was the fact that boating activity is limited due to the shallow depth in most parts of the Bay, so boating may not be a significant potential pollution cause. However, there is a large marina located on the Hyannis side (west side), and a large ferry terminal (going to the Islands).

The January 2005 Triennial Report indicates a recommendation for expansion of the seasonally managed Conditionally Approved sub- area from the previously Approved waters of Lewis Bay, due to increased boating activity in adjacent Hyannis Inner Harbor. But, improvements in water quality in the Mill Creek area have allowed a larger portion of that to be opened up to seasonal harvesting.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Baxter Avenue Beach, Bay Road Beach, Bayview St. Beach, Colonial Acres Beach East and Colonial Acres Beach West, Columbus Ave. Beach, Englewood Beach, Kalmus Beach, Kennedy Memorial Beach, veterans Beach, and Gray's Beach at least 13 times during 2006. Results of each location ranged between <2 and 106 CFU/100 ml (one closure), <2 and 80 CFU/100 ml , <2 and 388 CFU/100 ml (one closure), <2 and 146 CFU/100 ml with (one closure), and <2 and 240 CFU/100 ml (one closure), <2 and 270 CFU/100 ml (one closure), <2 and 60 CFU/100 ml, <2 and 80 CFU/100 ml, . <2 and 32 CFU/100 ml, <2 and 52 CFU/100 ml, <2 and 162 CFU/100 ml (two closures) (MDPH 2006), respectively.

Parkers River Segment MA96-38

This 0.04 mi^2 Class SA segment extends from the outlet of Seine Pond to the river's mouth at Nantucket Sound in Yarmouth. The Parkers River recharge area contains 105.29 acres of cranberry bog open space. There are no regulated wastewater dischargers in this segment. However, the Town of Yarmouth is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Approved for 0.008 mi^2; Conditionally Approved for 0.015 mi^2 (Figure 1-1).

The following Table (4-34) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-34. MA96-38 Parkers River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 105 data points 2002- 2003
599	1.9 - 51	Not available

The DMF conducted a thorough shoreline survey during March 2003. All residences have individual septic systems. The town of Yarmouth has a strict septic system set of regulations. No system failures were evident at the time of this survey. There are five potential sources from stormwater inputs, mostly from roadways. Of the total fifteen stream and creeks feeding the Parker River, there are five with the highest potential contribution between Seine Pond and Route 28, particularly one near a zooquarium property, (houses exotic birds and other wildlife), on Route 28. A marina exists on the eastern shore of the Parker River just south of Route 28. Seine Pond is, itself, another potential contributor, as a large cranberry bog drains into it on the north side, plus this is the scene of large annual herring runs, plus there are houses around the pond, and boating activities occurring in the pond. Also, numerous birds were spotted throughout the pond area.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Parker's River Beach East, Parker's River Beach West, and Seagull Beach, at least 13 times 2006. Results ranged between <2 and 78 CFU/100 ml at East Beach with no closures, and between <2 and 110 CFU/100 ml at West Beach, with one closure. Results for the three locations on Seagull Beach (East, West, and Back) ranged between <2 and 40 CFU/100 ml with no closures at either of the beaches (MDPH 2006).

<u>Popponesset Creek Segment MA96-39</u>

Popponesset Creek, SA shellfishing designated, is located in Mashpee, and is a narrow salt- water creek/ tributary, adjacent and just west of Popponesset Island, approximately ½ mile long and 100-150' wide, running north- northwest- south southeast in direction. It drains at both the northern and southern ends into the much larger Popponesset Bay (422 total acres) to the east. Popponesset Creek is impaired for pathogens by DEP/DWM assessment, but this segment, plus all of Popponesset Bay is officially fully "Approved" by DMF for shellfishing.

The following Table (4-35) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-35. MA96-39 Popponesset Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml)
45	1.9 - >43	3.1 - 3.5

All levels were well within the established NSSP parameters for approved classification. Prime potential pollution sources in the Creek area appear to be stormwater runoff from a fairly densely packed housing area in the immediate vicinity. There were no observed failing septic systems. A considerable number of birds were observed during monitoring activities and shoreline surveys. Species included: several varieties of ducks, Canada geese, white swans, cormorants, seagulls, terns, and piping plovers. The area should be revisited by DMF, and if conditions remain satisfactory for continued full "Approval" for shellfishing, this segment could be de- listed from the 303(d) list for pathogen impairments.

Mill Creek Segment MA96- 41

Mill Creek is located in Chatham, facing Nantucket Sound. It is approximately 3/4 mile west of Bucks Creek, MA 96-44. It is an SA, shellfishing designated, estuary area, which drains from Taylor's Pond, Segment MA 96-42, which is also impaired for pathogens, according to DEP/DWM assessments.

The following Table (4-36) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-36. MA96-41 Mill Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 105 data points 2002- 2003
45	1.9 - >28	2.2 - 2.4

In a DMF shoreline survey, no septic system failures were observed. Six stormwater runoff sites were identified, and stations were set up for future monitoring during rain events (but none of the sites appeared to be dry weather flow problems, or pollution threats). Several stream and creeks were identified, but did not appear to be threats. There are no marinas, and little boating activity in the area. Large numbers of geese and ducks were occasionally observed, particularly in the fall. This area has high water quality, and will continue to be conditionally approved for shellfishing.

Bucks Creek Segment MA 96-44

Bucks Creek is located in Chatham, approximately 3/4 mile east of Mill Creek MA 96-41. It is an SA, shellfishing designated, estuary area, which drains from Harding Beach Pond, Segment MA 96-43, which is also impaired for pathogens. See the following information on Cockle Cove Creek.

The following Table (4-37) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-37. MA96-44 Bucks Creek Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 105 data points 2002- 2003
45	1.9 - >28	3.0 - 3.1

All stations covered in Table 4-37 above met the criteria set by the NSSP for an approved classification during the portion of the year that the area is 'open to shellfishing' status. This report indicates that Cockle Cove Creek has some drainage into the southwestern portion of this study area (this is why the information study below on Cockle Creek is included in this report). Evidence suggests that pollution from the Cockle Creek area is not getting into the Bucks Creek Segment. No other potential sources of pollution are notable with the exception of birds throughout the area. Six additional stations, including the outlet of Cockle Cove, are listed in the report for future DMF follow-up sampling to determine whether or not these cause any pollution effects to the Bucks Creek water body.

Cockle Cove Creek is not a Massachusetts assessed segment, but it lies in-between Mill Creek and Bucks Creek Segments, and is relatively close to each (within approximately 0.4 miles). There was a town of Chatham sponsored project, "Town of Chatham Massachusetts, Bacteria Sources Assessment for a Wetland Dominated Watershed: Guidance Document and Case Study Report", published in 2005. This study concentrated on enterococcus sampling in the Cockle Cove and estuary areas. The study sampled seven sites, four times, along an approximately 1.5 mile length of Cockle Cove Creek in 2005. Enterococci levels ranged from 15 - 7,933 CFU/100 ml, with at least twelve readings exceeding 1,000 CFU/100 ml, concentrated in the upper reaches of the creek in late August 2005 following a 1" rain event. Two other wet weather events showed relatively higher readings (range 40- 3,065 CFU/100 ml) than several other dry weather events (range 1- 1,748 CFU/100 ml).

Additionally, the Town of Chatham Board of Health monitored two sites (upper reach area) for enterococcus several times each year in Cockle Cove 2001-2004. Readings ranged between 3-13,950 CFU/100 ml, with at least 3 readings above 7,650 CFU/100 ml. Additionally, the town of Chatham, during 2004, monitored some 20 beaches sites within the Chatham area. The data indicate particularly high levels at two sites in the lower end of Cockle Cove Creek: 1) station B4b, at the Cockle Cove Creek Parking Lot, where levels during June - August 2005 (12 samples) ranged between <2- 1,710, with a geometric mean of 248 CFU/100 ml, and June - August 2006 (21 samples) ranged between <3- 4,067, with a geometric mean of 620 CFU/100 ml; 2) station B4c, Cockle Cove Creek at Ridgevale Bridge, where levels during June- August 2005 (12 samples) ranged between <2- 232, with a geometric mean of 11 CFU/100 ml, and June- August 2006 (26 samples) where levels ranged between <2- 2,240, with a geometric mean of 126 CFU/100 ml.

As to prime pollution sources, the study really could not conclude that any principal human factors were the cause(s). Septic systems are strictly controlled by the town of Chatham, and stormwater runoff from roadways, etc., do not seem to be significant factors. It should be noted that there is a wastewater treatment facility (Chatham) in the northern most part of the Cockle Cove drainage area, whose discharge may affect that portion. Natural sources, including wildlife, and accumulation of vegetation and other material along shorelines, are thought to be major contributors. Considerable evidence of wildlife presence was observed in the marshes, including foxes, foxholes, birds, feces and remnants of meals. Animal by-products getting into the marsh areas may be very significant contributors to high bacteria counts according to the study. Of course, the study recommends that the town seriously re-check all currently operating septic systems to insure their proper operation, and check out possible stormwater runoff contributor factors from roadways, to see if these, too, might be bacteria contributors.

It should be pointed out that Cockle Cove Creek is adjacent to, and within a couple miles of, the two listed segments above, Mill Creek Segment MA 96-41, and Bucks Creek Segment MA 96-44. Although there is no available data actually within these two segments, the data in Cockle Cove indicates there could be bacteria contamination from there affecting Mill Creek and Bucks Creek, particularly at their lower ends, and in any public beach areas in between these two segments.

Oyster Pond Segment MA96-45

This segment is an SA, shellfishing designated, salt water pond- estuary, which is in Chatham, and begins at the end of Old Harbor Road at its northeast corner, and ends at its southwest end (pond approximately 2 miles long and ½ mile at its widest part) by draining into Oyster Pond River, Segment MA 96- 46.

The following Table (4-38) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-38. MA96-45 Oyster Pond Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 75 data points 2001
84	1.9 - 690	2.2 - 3.1

DMF conducted a special ambient survey for fecal coliform in the Oyster Pond area on January 29, 2002. Nine stations were sampled once, (including 3 pipe discharges), and the range of the readings were between <10- 690 CFU/100 ml. The highest reading was taken on Blaisdell Creek at the outlet. DMF conducted another survey involving four stations in the same area on January 31, 2002. The range of readings were between <10- 70 CFU/100 ml.

Additionally, the DMF conducted a shoreline survey on January 29, 2002. The last shoreline survey conducted was in 1999, where there were a number of possible sources from septic systems. All of those have been fixed. Remaining potential pollution sources are believed to be several large stormwater discharges going into the east end of the pond. These drain from Route 28, and Main St. Mass Highway has plans to fix the problems coming off Route 28, and the town of Chatham supposedly has already undergone engineering projects to eliminate/treat the stormwater components coming off Main St. Additionally, there is widespread runoff occurring at the Oyster Pond Furlong town landing area, going into the “prohibited area” part of the pond. There is also a large culvert draining a freshwater wetlands behind Route 28 that may be a contributing problem. Another problem is a ditch system that originates in a small pond wetland system behind Cross St., which drains into Oyster pond during rain periods. Engineering projects by Chatham are underway to remediate these problems. Wildlife have not been typically observed in very large numbers. There are a number (201 mooring permits) of small recreational boats on the pond, many of which have holding tanks for wastes. Boats could be a potential pollution source, although Oyster pond is part of the Stage Harbor Complex “No Discharge Area” which prevents the discharge of untreated or treated boat waste.

Oyster Pond River Segment MA 96-46

A salt water SA, shellfishing designated, estuary river in Chatham, beginning at the outlet at southwest corner of Oyster Pond Segment MA 96-45, flows approximately 2 miles southwesterly, then 2 miles southeasterly until it empties into Stage Harbor Segment MA 96-11 in Chatham.

The following Table (4-39) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-39. MA96-46 Oyster Pond River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 45 data points 2003
49	1.9 - 30	1.9 - 3.3

Since the counts were for the most part quite low, no pollution sources were mentioned in the DMF data reports.

Ryders Cove Segment MA 96-50

An elongated inland SA, shellfishing designated, estuary, running east- west in the northeastern part of Chatham, approximately 1 mile long and 1/5th mile wide. Runs from Orleans Road in its western most part, to Bassing Harbor ~ 1 mile to the east.

Ryders Cove is part of the Pleasant Bay ACEC and is covered by the Pleasant Bay ACEC Resource Management Plan (RMP) completed in 1998.

The following Table (4-40) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-40. MA96-50 Ryders Cove Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 82 data points 2000- 2004
88	1.9 - <28	2.1 - 3.3

From sanitary surveys, most potential pollution sources are small in scope and do not have any adverse impact on the resource area. The biggest impact could be the Ryder's Cove town landing and adjacent marina, however, that area is automatically seasonally closed for shellfishing because of marina usage. It should be pointed out that quite a few of the seasonally closed areas to shellfishing on the Cape involve marina areas, which DMF automatically designates as seasonally closed to insure protection of the public health. According to DMF, Ryder's Cove has excellent water quality conditions overall.

Great Pond Segment MA 96-54

An elongated coastal estuary (SA, shellfishing designated), salt- water lake, going several miles inland (1/3 to ½ mile at its widest part) to Falmouth Road in Falmouth.

The following Table (4-41) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-41. MA96-54 Great Pond Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996 - 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 293 data points 2001- 2006
443	1.9- >50	2.01 - 8.34

Between April 2005 and December 2006, 3 stations had elevated geometric means: 1) station #5, at Route 28, 6.79 CFU/100 ml; 2) station #6, at mouth of river, 8.34 CFU/100 ml; 3) station #3A, at Shorecrest, 5.98 CFU/100 ml.

As part of the data in Table 4-41 above 2 sets of data were gathered: 1) conditionally open period November 1- May 31, where 90 data points were gathered, where mean fecal coliform ranged between 2.01- 8.34 CFU/100 ml; 2) conditionally open period February 1- April 30 where 60 data points were gathered, where mean fecal coliform ranged between 4.4- 5.1 CFU/100 ml. During November 1- May 31, the Mouth of River station had 5 readings >28 CFU/100 ml; Route 28 station having 3 readings >28 CFU/100 ml; and the Shorecrest station having 2 readings >28 CFU/100 ml. During the February 1- April 30 data set, the stations at Mouth of River, Morris St., and Milton St., each having one reading >28 CFU/100 ml. DMF observed that the entire Great Pond basin is served by septic systems, but none were observed to be failing during the surveys. It should be noted that from the east and west shorelines of Great Pond, there are numerous roadways running perpendicular back from the shores, indicating heavy residential housing usage. Stormwater runoff from these residential areas running into Great Pond may be playing a role in any bacteria pollution getting into this water body. Well over 30 outfall pipes were identified. The town of Falmouth should conduct at least some dry weather testing of appropriate outfalls. Perhaps, septic systems should be thoroughly checked to be sure they are all functioning properly. Some waterfowl were observed during the surveys, particularly in areas that have consistently high counts: 1) station #6, Mouth of River;2) station #6B, Milton St. area) DMF is of the opinion that these congregations contribute to the high counts at these two stations. There are 39 docks and 520 boat moorings, none of which are for overnight stays.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Menauhant Beach, East and West and Shorewood Beach, at least 13 times during 2006. Results at Menauhant Beach ranged between <2 and 10 CFU/100 ml at both beach locations with no closures. Numerous failures occurred at the Shorewood Beach location with results ranging between <2 and 376 CFU/100 ml, with seven (failures) >104 cfu/ 100mL. Five of these readings were > 150 CFU/100 ml (MDPH 2006).

Green Pond Segment MA 96-55

An elongated coastal SA, shellfishing designated, estuary salt- water pond going several miles inland (1/3 to ½ mile at its widest part) to Falmouth Road in Falmouth. The history of shellfish classification indicates that Green Pond has, since 1992, been conditionally closed during the summer months.

The following Table (4-42) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-42. MA96-55 Green Pond Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996 - 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 96 data points 2000- 2002; 88 data points 2003- 2004
232	1.9 - >50	2.79 - 13.3 1.92 - 12.06

During 2000- 2002, 3 stations had elevated geometric means: 1) station #3, at Karyn Jane, 13.3 CFU/100 ml; 2) station #2 at Weatherglass, 6.59 CFU/100 ml; 3) station #4, at Partridge Lane, 4.53 CFU/100 ml. During 2003- 2004, 3 stations having elevated geometric means: 1) station #1, at Route 28, 12.06 CFU/100 ml; 2) station #2, at Weatherglass, 7.60 CFU/100 ml; 3) station #3 at Karyn Jane, 4.65 CFU/100 ml.

The DMF conducted a shoreline survey in November, 2004, and concluded: (1) that up to 20 stormdrains may have a potentially negative bacteria impact throughout; (2) migratory bird populations throughout (ducks, geese, and cormorants), but particularly in the cranberry bogs that drain into the pond (at stations 1, 2); (3) Marinas and boats (some 64 boat docks counted in survey). The boats and moorings do not seem to be the culprit, as the town has an aggressive patrol and pump-out program in place. The town of Falmouth should sample, some of the identified stormdrains, (particularly any dry weather flows), that discharge directly into Green Pond. But it would appear that DMF suggests that the bird population problem is the probable priority pollutant factor in this segment.

The MA Department of Public Health (DPH) sampled for enterococcus levels at Acapesket Improvement Association, 12 times just adjacent to this segment during 2006. Results ranged between <2 and 4 CFU/100 ml with no closures (MDPH 2006).

Bourne Pond Segment MA 96-57

An elongated coastal SA, shellfishing designated, estuary salt- water pond going several miles inland (1/4 mile wide, with a wider neck on the western portion called Israels Cove) to Falmouth Road in Falmouth, and then extending ~ 1 mile further north of Falmouth Road. This water body classification is conditionally approved status: Closed to Shellfishing May 1- October 31. The pond encompasses approximately 152 acres of productive shellfish growing waters.

The following Table (4-43) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-43. MA96-57 Bourne Pond Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 90 data points 2002- 2004
90	1.9 - >28	2.31 - 4.58

The highest average station was located adjacent to Rosemary Lane (with at least three individual readings >28 CFU/100 ml). Another station, adjacent to Terry Lou Road had one reading >28 CFU/100 ml.

The shoreline survey notes indicate that a structural change in the design and location of the entrance to Nantucket Sound in 1987 significantly improved the water quality (due to more efficient tidal flushing), and also resulted in an improvement in shellfish resources. Bottom muds have been gradually replaced with sands. There are approximately 13 houses around the pond, but they are all set back from the shoreline. All septic systems appeared to be functioning properly as of the 2004 survey. The very north end of the pond, to Falmouth Road, has at least several stormwater pollution sources that are apparent problems, so that area is classified as prohibited. The rest of the pond is seasonally open for both recreational and commercial shellfishing, and the DMF is suggesting consideration for this portion to be approved year- round.

<u>Hamblin Pond Segment MA 96- 58</u>

A tidal SA/ ORW, shellfishing designated, estuary (salt water) pond, (mostly in Mashpee) ½ mile long (running northeast to southwest), and ¼ mile wide, that has a drainway (Little River- 1/2 mile long) that drains from the southeast corner of Hamblins Pond into Waquoit Bay, Segment MA 96-21.

The following Table (4-44) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2003.

Table 4-44. MA96-58 Hamblin Pond Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996- 2003	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml)
35	1.9 - > 28	2.56 - 3.97

The DMF collected fecal coliform samples in sanitary surveys at two stations (71 Monomscoy Rd; Mouth of Hamblin), fifteen to twenty times during 2004- 2005. Fecal coliform geometric mean values were 3.97 and 2.56 CFU/100 ml at each, with one reading at each station > 28 CFU/100 ml.

A shoreline survey conducted in 2004 revealed that septic systems, marinas and boats, and stormdrains did not appear to be important pollution source factors. However, large flocks of birds appeared to inhabit the areas near the two stations, (as well as throughout the Little and Great Rivers Complex, including all of Hamblin Pond).

The MA Department of Public Health (DPH) sampled for enterococcus levels at Hamblins Pond Beach, 13 times within this segment during 2006. Results ranged between <4 and 44 CFU/100 ml. with no closures (MDPH 2006).

Little River Segment MA 96-61

A tidal estuary SA/ ORW, shellfishing designated, river, approximately ½ mile long and 1/10th mile wide, draining from Hamblin's Pond, MA segment 96- 58, (salt water, tidal).

The following Table (4-45) summarizes the bacteria data collected by DMF in this segment between the years 1996- 2005.

Table 4-45. MA96-61 Little River Segment DMF Fecal Coliform Data.

Total Number of Data Points 1996 - 2005	Fecal Coliform Bacteria Range (CFU/100 ml)	Geometric Mean, Range (CFU/100 ml) for 75 data points 1997- 1998; 120 data points 2004- 2005
205	1. 9- > 28	2.4 - 5.6 2.1 - 4.0

A shoreline survey conducted in 2004 revealed that septic systems, marinas and boats, and stormdrains did not appear to be important pollution source factors. Rather, large flocks of birds appeared to inhabit the areas near all the stations, (as well as throughout the Little and Great Rivers Complex, including all of Hamblin Pond).

Summary Of Findings (Segments With Data)

There were 8 segments above that are prioritized as "High" (see Table ES-1). These include: Barnstable Harbor MA96-01; Centerville River (Barnstable) MA96-04; Stage Harbor (Chatham) MA96-11; Bass River (Dennis/ Yarmouth) MA96-12; Seasuit Creek MA96-13; Provincetown Harbor MA96-29; Herring River (Wellfleet) MA96-33; and Oyster Harbor (Chatham) MA96-45.

Based on DMF data and sanitary survey reports, for the most part, all 8 of these demonstrate greater bacteria impacts during and just following wet weather events. The DMF sanitary survey reports suggest principal pollution sources as: (1) failing septic systems; (2) boats and marinas; and (3) birds. DMF also notes, however, the increased observance of bird populations in recent decades throughout the Cape region.

An extensive study carried out by Three Bays Preservation, Inc. of Osterville, MA, entitled, "Fecal Coliform Testing and DNA- Based Microbial Source Tracking in the Three Bays Estuarine System, 1999-2001" provides insight to many of the bacteria sources on the Cape. This study consisted of considerable ambient monitoring in bacteria impacted segments. The following segments were included in the Three Bays TMDL: North Bay MA96-66; Prince Cove MA96-07; Cotuit Bay MA96-63; Seapuit River MA96-64 as well as immediately adjacent and connecting Warren's Cove, Marston's Mill River, and West Bay The physical geography and human settlement patterns in these areas mirror many other parts of the Cape, including other segments covered above. Follow up lab work included both fecal coliform counts, as well as microbial human marker and animal DNA indicator analysis.

The conclusions of the study demonstrated a high correlation of human marker positive results from samples closely adjacent to boating marinas, and not in areas of suspected septic system failures. Examples of large marinas near stations showing human marker indicators included: the Crosby Yacht Club, Nauticus Marina, Oyster Harbor Yacht Basin, and the Prince Cove Marina. In non-marina areas, other DNA analysis findings showed a wide variety of other than human sources such as: a wide variety of birds (especially geese and gulls), dogs, cats, horses, foxes, rodents, and raccoons. Birds were the most common 'other than human' DNA indicator found from all the samples analyzed. Therefore, from the study (particularly the DNA) findings, the principal pollution sources suggested are (in the order of priority): (1) boats/ marina activities (human); (2) birds in particular, and other animals; (3) failing septic systems, and other human factors.

Summary Of Findings (Segments With out Data)

The following nine segments are listed on the 2008 Integrated List for pathogen impairment as well as mentioned in this report. Information indicator bacteria (fecal coliform) data, and certain other information were not available for these segments.

<u>Maraspin Creek Segment MA96-06</u>

This 0.03 mi^2 Class SA segment extends from its headwaters south of Rte. 6A to its confluence with Barnstable Harbor. Maraspin Creek's recharge area is a portion of Barnstable Harbor's recharge area. There are no regulated wastewater dischargers in this segment. However, the Town of Barnstable is in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

<u>Falmouth Inner Harbor Segment MA96-17</u>

This 0.05 mi^2 Class SB segment includes the waters north of Inner Falmouth Harbor Light in Falmouth. There are no NPDES regulated discharges in this segment. The MA Department of Public Health (DPH) sampled for enterococcus levels at two locations at Falmouth Heights Beach (East and West) at least 13 times within this segment during 2006. Results ranged between <2 and 18 CFU/100 ml with no closures.

DMF Designated Shellfish Growing Areas Status: Approved (Figure 1-1).

Mill Creek Segment MA96-37

This 0.05 mi^2 Class SA segment extends from Keveny/Mill Lane north to the confluence with Cape Cod Bay in Barnstable/Yarmouth. There are no regulated wastewater dischargers in this segment. However, the Towns of Barnstable and Yarmouth are in the process of applying for a NPDES permit for the MS4.

DMF Designated Shellfish Growing Areas Status: Prohibited (Figure 1-1).

Taylor's Pond MA 96-42

An 0.02 mi^2 SA waterbody, located in the town of Chatham.

Harding Beach Pond MA 96- 43

An 0.07 mi^2 SA waterbody, locally known as Sulfer Springs (northeast of Bucks Creek), in the town of Chatham.

Perch Pond MA 96-53

An 0.03 mi^2 SA waterbody, connecting with the northwest end of Great Pond, west of Keechipam Way, Falmouth.

Oyster Pond MA 96-62

An 0.10 mi^2 SA water body, east of Fells Road, Falmouth.

Town Cove MA96-68

This is a 0.80 square mile SA waterbody, including the entire Cove to Nauset harbor, including Rachael Cove and Woods Cove, Orleans/ Eastham.

5.0 Potential Sources

There are 114 waterbody segments assessed by the MassDEP in the Cape Cod Watershed (MassGIS 2005). These segments consist of 67 estuaries, 55 of which are pathogen impaired and appear as such on the official list of impaired waters (note 3 estuary segments are addressed in the Three Bays TMDL). Pathogen TMDLs have been previously prepared and approved for two of these segments – Muddy Creek and Frost Fish Creek. One of the 46 lake segments assessed is pathogen impaired, and the single fresh water river segment assessed (Herring River) is not pathogen impaired (Figure 1-1). Therefore, this report covers 49 pathogen impaired estuary segments which represent 70.0% (including 3 estuary segments included in the Three Bays TMDL) of the estuary area. Sources of indicator bacteria in the Cape Cod watershed are many and varied. A significant amount of work has been done in the last decade to improve the water quality in the Cape Cod watershed.

Largely through the efforts of the Cape and Islands outreach organizations and the MassDEP field staff, numerous potential point and non-point sources of pathogens have been identified. A list of Cape and Islands outreach organizations is provided by the Woods Hole Oceanographic Institution (WHOI SeaGrant) on the worldwide web at http://www.whoi.edu/seagrant/Resources/DirCapeI/Index.html.

Table 5-1 summarizes the segments impaired due to measured indicator bacteria densities and identifies some of the suspected and known sources identified in the MassDEP 2002 Cape Cod WQA.

Suspected and known dry weather sources include:

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

Suspected and known wet weather sources include:

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

It is difficult to provide accurate quantitative estimates of indicator bacteria contributions from the various sources in the Cape Cod 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., Tables 5-1 and 5-2). This approach is suitable for the TMDL analysis because it indicates the magnitude of the sources and illustrates the need for controlling them. Additionally, many of the sources (failing septic systems, leaking sewer pipes, sanitary sewer overflows, and illicit sanitary sewer connections) are prohibited, because they indicate a potential health risk and, therefore, must be eliminated.

The Division of Marine Fisheries has for decades done extensive monitoring in many of the coastal-estuarine areas of the Cape. They have identified at least several potential sources besides failing septic systems, illicit connections, SSO's, and overland stormwater. Please refer to the DMF subsection at the end of Section 8.1, (Summary of Activities within the Cape Cod Watershed) for more details.

Sanitary Waste

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

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. The existence of illicit sewer connections to storm drains is well documented in many urban drainage systems, particularly older systems that may have once been combined. It is probable that numerous illicit sewer connections exist in storm drainage systems serving the older developed portions of the basin (e.g., Falmouth and Hyannis).

Figure 5-1. Municipal Wastewater Facilities on Cape Cod (Cape Cod Commission 2003).

Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Approximately 62% of the Cape Cod watershed is classified as Urban Areas by the United States Census Bureau and is therefore subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. See Section 8. of this TMDL for information regarding illicit discharge detection guidance.

Septic systems designed, installed, operated and maintained in accordance with 310 CMR 15.000: Title 5, are not significant sources of fecal coliform bacteria. Studies demonstrate that wastewater located four feet below properly functioning septic systems contain on average less than one fecal coliform bacteria organism per 100 mL (Ayres Associates 1993). Failed or non-conforming septic systems, however, can be a major contributor of fecal coliform to the Cape Cod watershed, especially since most of the Cape's population relies on septic systems versus municipal sewer systems. Roughly eighty-five percent of the Cape Cod watershed's population has individual septic systems. Only four towns have WWTF with only a small portion of the Cape connected to the municipal sewer systems (Figure 5-1, (above); Cape Cod Commission 2003). Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Wet weather events typically increase the rate of transport of pollutant loadings from failing septic systems to surface waters because of the wash-off effect from runoff and the increased rate of groundwater recharge.

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

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

Wildlife and Pet Waste

Animals that are not pets can be a potential source of pathogens. Geese, gulls, and ducks are speculated to be a major pathogen source, particularly at lakes and stormwater ponds where large resident populations have become established (Center for Watershed Protection 1999). Additionally, many decades of sampling and shoreline survey work has been conducted by the Division of Marine Fisheries (DMF) on the Cape, particularly in tidal- estuary areas. The DMF observations over this period indicate that both resident and migrating bird populations have been significantly increasing in recent years throughout the entire Cape Region, and that these increases could have significant impacts on bacteria pollution in all surface water bodies.

Household pets such as cats and dogs can be a substantial source of bacteria – as much as 23,000,000 CFU/gram, according to the Center for Watershed Protection (1999). A rule of thumb estimate for the number of dogs is ~1 dog per 10 people producing an estimated 0.5 pound of feces per dog per day. Using the 2000 census population for Barnstable county (Cape Cod Times 2001), this translates to an estimated 22,223 dogs in the watershed producing 11,112 pounds of feces per day. Uncollected pet waste is then flushed from the parks, beaches and yards where pets are walked and transported into nearby waterways during wet-weather.

Stormwater

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

Extensive stormwater data have been collected and compiled both locally and nationally (e.g., Tables 4-1, 4-2, 5-1 and 5-2) in an attempt 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 avoid overestimating or underestimating bacteria loading, event mean concentrations (EMC) are often used. An EMC is the concentration of a flow proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler which can proportion sample aliquots based on flow. Typical stormwater event mean densities for various indicator bacteria in Massachusetts watersheds and nationwide are provided in Tables 5-1 and 5-2. These EMCs illustrate that stormwater indicator bacteria concentrations from certain land uses (i.e., residential) are typically at levels sufficient to cause water quality problems.

Table 5-1. Lower Charles River Basin Stormwater Event Mean Bacteria Concentrations (data summarized from USGS 2002) and Necessary Reductions to Meet Class B WQS.

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

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

Table 5-2. Stormwater Event Mean Fecal Coliform Concentrations (as reported in MassDEP 2002b; original data provided in Metcalf & Eddy, 1992) and Necessary Reductions to Meet Class B WQS.

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

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

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

6.0 Prioritization and Known Sources

Bacteria pollution on Cape Cod presents itself in an unusually sensitive aquatic-water environment. Rich surface and subsurface water supplies traditionally abound, but are under extreme stress with population and land-use increases in recent decades. Both year-round and summertime human populations have substantially and steadily increased throughout the entire Cape area since the 1950's at a rate in excess of 10% per decade. Construction of new housing and commercial buildings has dramatically increased as a result. Roughly 85% of the Cape Cod's watershed population (including residences and businesses) have individual septic systems for disposal of human wastes. Only four towns (Falmouth, Barnstable, Chatham, Provincetown) have municipal wastewater treatment plants, with only small percentage of the areas of these towns actually sewered (Cape Cod Commission, 2003). Septic system failures, or poorly performing systems, definitely play an important part to the bacterial contamination throughout the Cape. Stormwater runoff from wet weather events carry this contamination into surface and ground water aquifers, particularly in and around densely populated areas.

Many parts of the Cape have sandy soils, which are usually very well suited for septic systems. However, with the high number of systems, particularly with increased summer as well as year round residents and homes, has put a strain on existing groundwater aquifer systems on the Cape. Also, a 1980 USGS study "Probable High Ground Water Levels on Cape Cod" found that quite a few areas were unsuitable for septic systems because the maximum ground water level during the year was not lower than 4 feet below the bottom of the proposed or existing leach field. These areas, particularly where there is high development, are prime candidates for sewering considerations. This means either upgrading/increasing existing WWTP capacities (including possibly forming sewer authorities involving several towns).

The Cape Cod Commission has sponsored and co-sponsored numerous studies in recent years on this subject. One major recent study (in 2003) funded by the Massachusetts Watershed Initiative, "Cape Cod Comprehensive Regional Wastewater Management Strategy Development Project", provided methodologies and plans from a regional context for wastewater management solutions. A Watershed Implementation Committee (WIC) was set up as an advisory committee to come up with ultimate solutions to the overall wastewater treatment needs in the Cape as a whole. The WIC discussed such things as: 1) potential state legislation to generate funding for wastewater infrastructure on Cape Cod; 2) wastewater planning for future needs on the Cape; 3) County health on-site septic system technology and regulatory review; 4) linking future population growth with adequate wastewater treatment; 5) establishment of a county- wide wastewater management reserve fund. Also, the WIC prepared a regional assessment of wastewater planning and land-use analysis by using GIS maps to identify future population growth, existing water resources, sensitive or threatened water resources, existing wastewater discharges (both from WWTP's and septic systems) in each town to estuaries, and from all this information, delineate possible future WWTP sitings. The study estimated that the Cape now generates approximately 12 billion gallons of wastewater per year. Eighty percent of that goes directly, via groundwater and surface water flow, into watersheds that drain into marine estuary areas. Barnstable County provided an additional $55,000 to continue the project by using four case studies to test the tools developed in the MWI project, and to continue to support the WIC in its continued committee organization and work. There is currently (2007) another more expanded study effort by the Commission to actually formulate future project plans and locations.

From the details of Section 4.0 within each impacted segment, it would appear that beyond the septic system versus sewering/ WWTP issue, that in coastal- estuarine areas, bird populations and summertime boating activities play an extremely predominant role in generating the fairly constant, moderately high, background levels of fecal contamination that are evident in many areas. For shellfishing, these levels are critical to allowing this particular use to occur safely for humans. Over many decades, Division of Marine Fisheries monitoring and shoreline survey notes indicate, time and again, the predominance of resident and migrating bird populations in many parts of coastal areas on the Cape. These populations have the potential of adding high enough bacteria loadings to ambient waters to significantly impact the shellfishing use classification in a negative fashion. Coupled with this, many tidal estuary areas have a lot of warmer season boating activities that can impact these same waters through discharge of boat wastes. Efforts have been underway to increase the Federal “No Discharge (for boat wastes) Zone” areas, and to provide boat waste disposal facilities in every marina or public dock area.

In an effort to provide guidance for setting bacterial implementation priorities within the Cape Cod Watershed, a summary table is provided. Table 6-1 below provides a prioritized list of pathogen-impaired segments that will require additional bacterial source tracking work and implementation of structural and non-structural Best Management Practices (BMPs). Since limited 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 cfu /100 ml. Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 cfu100ml. 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 or raw sewage and therefore they pose a greater risk to the public. It should be noted that in all cases, waters exceeding the water quality standards identified in Table 6-1 are considered impaired.

Also, prioritization was adjusted upward based on proximity of waters, within the segment, to sensitive areas such as Outstanding Resource Waters (ORW’s), or designated uses that require higher water quality standards than Class B, such as Class A, or SA waters, public water supply intakes, public swimming areas, or shellfish areas. Best professional judgment was used in determining this upward adjustment. Generally speaking, waters that were determined to be lower priority based on the numeric range identified above were elevated up 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 would indicate this situation. In many cases the DMF sampling results that were used to develop Table ES-1 don't differentiate whether the sampling was conducted during wet or dry weather. For these data sets Table ES-1 does not distinguish priority between wet and dry weather events.

MassDEP believes that segments ranked as high priority in Table 6-1 are indicative of the potential presence of raw sewage and therefore they pose a greater risk to the public. Elevated dry weather bacteria concentrations could be the result of illicit sewer connections or failing septic systems. As a result, the first priority should be given to bacteria source tracking activities in those segments where sampling activities show elevated levels of bacteria during dry weather. Identification 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. Segments that remain impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with less costly non-structural practices first (such as street sweeping, and/or managerial approaches using local regulatory controls. If necessary, more expensive structural measures may be required, and additional study would be needed to identify the most cost efficient and effective technology prior to implementation.

Table 6-1. Prioritized List of Pathogen- Impaired Segments.

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-01	Barnstable Harbor	3.3	From the mouths of Scorton and Spring Creeks east to an imaginary line drawn from Beach Point to the western edge of Mill Creek estuary, Barnstable.	High* Class SA, Shellfishing, ORW, Public Swimming	High* Class SA, ORW, Shellfishing Public Swimming
MA96-02	Bumps River	0.07	From the outlet of a pond at Bumps River Rd. through Scudder Bay to South Main St. bridge (confluence with Centerville River), Barnstable.	Medium* Class SA	Medium* Class SA
MA96-04	Centerville River	0.25	From headwaters in wetland west of Strawberry Hill Rd. to confluence with Centerville Harbor, including East Bay, Barnstable.	Medium*, Class SA Shellfishing Water, Public Swimming	High*, Class SA Shellfishing Water, Public Swimming

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-05	Hyannis Harbor	0.68	The waters from the shoreline to an imaginary line drawn from the light at the end of Hyannis breakwater to the point west of Dunbars Point, Barnstable.	Medium*, SA, Shellfishing Water, Public Swimming	Medium*, SA, Shellfishing, Public Swimming
MA96-06	Maraspin Creek	0.03	From headwaters just south of Rte. 6A to confluence with Barnstable Harbor at Blish Point, Barnstable.	Insufficient Data, Class SA, Shellfishing	Insufficient Data, Class SA, Shellfishing
MA96-08	Shoestring Bay	0.31	Quinaquisset Ave. to Ryefield Point, Barnstable/Mashpee.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-09	Quivett Creek	0.03	Outlet of unnamed pond just south of Rte. 6A to the mouth at Cape Cod Bay, Brewster/Dennis.	Medium*, (insufficient data) SA, Public Swimming, Shellfishing	Medium*, (insufficient data) SA, Public Swimming Shellfishing
MA96-11	Stage Harbor	0.58	The waters including Mitchell R. from Mill Pond to Sears Point and Harding Beach Point, Chatham.	Medium*, SA, Shellfishing	High*, SA, Shellfishing
MA96-12	Bass River	0.67	Rte. 6 to mouth at Nantucket Sound, Dennis/Yarmouth.	Medium*, SA, Public Swimming Shellfishing	High*, SA Public Swimming Shellfishing
MA96-13	Sesuit Creek	0.06	From Rte. 6A to mouth at Cape Cod Bay, Dennis.	Medium*, SA, Public Swimming, Shellfishing	High*, SA Public Swimming, Shellfishing
MA96-14	Swan Pond River	0.04	Outlet of Swan Pond to confluence with Nantucket Sound, Dennis.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-15	Boat Meadow River	0.04	Headwaters east of old Railway Grade to mouth at Cape Cod Bay, Eastham.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-16	Rock Harbor Creek	0.02	Outlet Cedar Pond to mouth at Cape Cod Bay, Eastham/Orleans.	Medium*, ORW, SA Public Swimming	Medium*, ORW,SA Public Swimming

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
				Shellfishing	Shellfishing
MA96-17	Falmouth Inner Harbor	0.05	Waters included north of Inner Falmouth Harbor Light, Falmouth.	(insufficient data) SB, Public Swimming Shellfishing	(insufficient data) SB, Public Swimming Shellfishing
MA96-18	Great Harbor	0.31	The waters north of an imaginary line drawn southeast from Devils Foot to Juniper Point, Falmouth.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-19	Little Harbor	0.07	The waters north of an imaginary line drawn from Juniper Point east to Nobska beach, Falmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-20	Quashnet River	0.07	Just south of Rte. 28 to mouth at Waquoit Bay, Falmouth (also known as Moonakis R.).	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-21	Waquoit Bay	1.4	From mouths of Seapit R., Quashnet R., Little R., and Great R. to confluence with Vineyard Sound, Falmouth.	Low*, SA, Shellfishing Approved	Low*, SA, Shellfishing Approved
MA96-22	Herring River	0.07	Outlet of Reservoir northwest of Bells Neck Rd. to mouth at Nantucket Sound, Harwich.	Medium*, SA, Public Swimming Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-23	Saquatucket Harbor	0.02	South of Rte. 28 to confluence with Nantucket Sound, Harwich.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-24	Mashpee River	0.09	Quinaquisset Ave. to mouth at Popponesset Bay, Mashpee.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-26	Little Namskaket Creek	0.01	Source to mouth at Cape Cod Bay.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-27	Namskaket Creek	0.02	From outlet of unnamed pond north of Rte. 6A in Orleans to mouth at Cape Cod Bay, Brewster/Orleans.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-29	Provincetown Harbor	4.3	The waters northwest of an imaginary line drawn from the tip of Long Point to Beach Point Beach, Provincetown.	Medium*, SA, Public Swimming, Shellfishing	High*, SA, Public Swimming, Shellfishing
MA96-30	Scorton Creek	0.07	Jones Lane to mouth at Cape Cod Bay, Sandwich.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-31	Pamet River	0.14	Rte. 6 to mouth at Cape Cod Bay (Including Pamet Harbor), Truro.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-32	Duck Creek	0.15	From Cannon Hill to Shirttail Point, Wellfleet.	Low*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-33	Herring River	0.39	Griffin Island to Wellfleet Harbor, Wellfleet.	Medium*, ORW, SA, Shellfishing	High*, ORW,SA, Shellfishing
MA96-34	Wellfleet Harbor	8.5	The waters north of an imaginary line drawn west from Jersey Point to Sunken Meadow, excluding the estuaries of Herring River, Duck Creek, and Blackfish Creek, Wellfleet.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-35	Chase Garden Creek	0.16	Source west of Rte. 6A, Dennis to mouth at Cape Cod Bay, Dennis/Yarmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-36	Lewis Bay	1.8	Includes Pine Island Creek and Uncle Roberts Cove to confluence with Nantucket Sound, Yarmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-37	Mill Creek	0.05	From Keveny/Mill Lane north to confluence with Cape Cod Bay Barnstable/Yarmouth.	Insufficient Data, SA Shellfishing	Insufficient Data, SA Shellfishing
MA96-38	Parkers River	0.04	Outlet Seine Pond to mouth at Nantucket Sound, Yarmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-39	Popponesset Creek	0.04	All waters west of Popponesset Island (from Popponesset Island Road bridge at the north to a line extended from the southeastern most point of the island southerly to Popponesset Beach), Mashpee.	Low*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-41	Mill Creek	0.03	Outlet of Taylors Pond to confluence with Cockle Cove, Chatham.	Low*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-42	Taylors Pond	0.02	Chatham	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-43	Harding Beach Pond	0.07	Locally known as Sulfur Springs (northeast of Bucks Creek), Chatham.	Insuffficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-44	Bucks Creek	0.02	Outlet from Harding Beach Pond (locally known as Sulfur Springs) to confluence with Cockle Cove, Chatham.	Medium*, SA, Shellfishing	Medium*, SA, Shellfishing
MA96-45	Oyster Pond	0.21	Including Stetson Cove, Chatham.	Medium*, SA, Shellfishing	High*, SA, Shellfishing
MA96-46	Oyster Pond River	0.14	Outlet of Oyster Pond to confluence with Stage Harbor, Chatham.	Low*, SA, Shellfishing	Low*, SA Shellfishing
MA96-50	Ryders Cove	0.17	Chatham	Low*, ORW, ACEC, SA Shellfishing.	Low*, ORW, ACEC,SA Shellfishing.
MA96-53	Perch Pond	0.03	Connects to northwest end of Great Pond, west of Keechipam Way, Falmouth.	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-54	Great Pond	0.40	From inlet of Coonamessett River to Vineyard Sound (excluding Perch Pond), Falmouth	Low*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing
MA96-55	Green Pond	0.21	East of Acapesket Road, outlet to Vineyard Sound, Falmouth.	Medium*, SA, Public Swimming, Shellfishing	Medium*, SA, Public Swimming, Shellfishing

Segment ID	Segment Name	Size (Sq. mi.)	Segment Description	Priority "Dry"	Priority "Wet"
MA96-57	Bournes Pond	0.24	West of Central Avenue, to Vineyard Sound, Falmouth.	Low*, SA, Shellfishing	Medium* Data, SA, Shellfishing
MA96-58	Hamblin Pond	0.19	From inlet of Red Brook to outlet of Little River and inlet/outlet of Waquoit Bay west of Meadow Neck Road, Falmouth/Mashpee.	Medium*, SA, Public Swimming Shellfishing	Medium*, SA, Public Swimming Shellfishing
MA96-61	Little River	0.03	From outlet of Hamblin Pond to the Great River, Mashpee.	Medium*, ORW, SA, Shellfishing	Medium*, ORW,SA Shellfishing
MA96-62	Oyster Pond	0.10	East of Fells Road, Falmouth.	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing
MA96-68	Town Cove	0.80	Entire Cove to Nauset harbor, including Rachael Cove and Woods Cove, Orleans/ Eastham.	Insufficient Data, SA, Shellfishing	Insufficient Data, SA, Shellfishing

A special note is made here that starting with the 2004 303(d) integrated List of Impaired Waters, there are 14 segments in Bourne and Falmouth that are now covered in the Buzzards Bay Bacteria TMDL Report. These segments include: MA95-14, Cape Cod Canal; MA95-48 Eel Pond; MA95-47 Back River; MA95-15 Phinneys Harbor; MA95-16 Pocasset River; MA95-17 Pocasset Harbor; MA95-18 Red Brook Harbor; MA95-21 Herring Brook; MA95-46 Harbor Head; MA95-20 Wild Harbor; MA95-22 West Falmouth Harbor; MA95-23 Great Sippewisset Creek; MA95-24 Little Sippewisset Marsh; MA95-25 Quisett Harbor.

There were 8 segments above that are prioritized as "High" from a bacteria pollution standpoint in Table 6-1 above. These are: Barnstable Harbor MA96-01; Centerville River (Barnstable) MA96-04; Stage Harbor (Chatham) MA96-11; Bass River (Dennis/ Yarmouth) MA96-12; Seasuit Creek MA96-13; Provincetown Harbor MA96-29; Herring River (Wellfleet) MA96-33; and Oyster Harbor (Chatham) MA96-45.

From DMF data and sanitary survey reports, 7 of the 8 segments prioritized as "High" demonstrate greater bacteria impacts during and just following wet weather events. An additional 5 segments prioritized as "Medium" also have greater bacteria impacts during and just following wet weather events. These are: Duck Creek MA96-32; Popponesset Creek MA96-39; Mill Creek MA96-41; Great Pond MA96-54; Bournes Pond MA96-57. The DMF sanitary survey reports suggest principal pollution sources as (not necessarily in the order of priority): (1) failing septic systems; (2) boats and marinas; (3) birds; (4) stormwater. All three of these sources are mentioned frequently as possibilities. What is noted by DMF, however, is the observance of increased numbers of bird populations in recent decades throughout the Cape region.

Real clues to verify principal sources and priorities might come from a rather extensive study and report done by Three Bays Preservation, Inc. of Osterville, MA, entitled, “Fecal Coliform Testing and DNA- Based Microbial Source Tracking in the Three Bays Estuarine System, 1999-2001”. This study consisted of considerable ambient monitoring in bacteria impacted segments: The Seapuit River MA96-64; North Bay MA96-66; Prince Cove MA96-07; Cotuit Bay MA96-63; and West Bay MA96-65 are all addressed in the Three Bays bacteria TMDL. The physical geography and human settlement patterns mirror many other parts of the Cape, including other segments covered above. Follow up lab work included both fecal coliform counts, as well as microbial human marker and animal DNA indicator analysis.

The conclusions of the study demonstrated a high correlation of human marker positive results from samples closely adjacent to boating marinas, and not in areas of suspected septic system failures. In non- marina areas, other DNA analysis findings showed a wide variety of other than human sources such as: a wide variety of birds (especially geese and gulls), dogs, cats, horses, foxes, rodents, and raccoons. Birds were the most common ‘other than human’ DNA indicator found from all the samples analyzed. Therefore, from the study (particularly the DNA) findings, the principal pollution sources suggested are (in the order of priority): (1) boats/ marina activities (human); (2) birds in particular, and other animals; (3) failing septic systems, and other human factors.

7.0 Pathogen TMDL Development

Section 303 (d) of the Federal Clean Water Act (CWA) requires states to place water bodies that do not meet the water quality standards on a list of impaired waterbodies. The most recent impairment list, *2008* identifies 49 estuary segments within the Cape Cod watershed for use impairment caused by excessive indicator bacteria concentrations.

The CWA requires each state to establish Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant contributing to the impairment(s). TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating the water quality standards. Both point and non-point pollution sources are accounted for in a TMDL analysis. EPA regulations require that point sources of pollution (those discharges from discrete pipes or conveyances) subject to NPDES permits receive a waste load allocation (WLA) specifying the amount of pollutant each point source can release to the waterbody. Non-point sources of pollution (and point sources not subject to NPDES permits) receive load allocations (LA) specifying the amount of a pollutant that can be released to the waterbody. In the case of stormwater, it is often difficult to identify and distinguish between point source discharges that are subject to NPDES regulation 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 accordance with the CWA, a TMDL must account for seasonal variations and a margin of safety, which accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality. Thus:

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

Where:

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

LA = Load Allocation which is the portion of the receiving water's loading capacity that is allocated to each existing and future non-point source of pollution (and point sources not subject to NPDES permits).

This TMDL is explained using an alternative standards-based approach, which is based on indicator bacteria concentrations, but considers the terms of the above equation. This approach is more in line with the way bacterial pollution is regulated (i.e., according to concentration standards), however, the standard loading approach is provided as well.

7.1. General Approach: Development of TMDL Targets

For this TMDL the MassDEP developed two types of daily TMDL targets. First, MassDEP set daily concentration TMDL (WLA/LA) targets for each one of the discharge sources by category (i.e., stormwater, CSO, etc). MassDEP recommends that the concentration targets be used as the primary guide for implementation. Second, maximum daily loads were developed as a function of watershed size and runoff volume. For streams, since no USGS gages are located in this area the maximum loads were calculated as a function of the long-term average runoff observed at USGS gages in New England (which accounts for infiltration and evapotranspiration), the watershed size and water quality standard criteria for e-coli and enterococcus applicable to each segment. For embayment's, maximum daily loads were calculated as a function of the observed long-term precipitation on Cape Cod, the estimated average runoff associated within 200 feet from each embayment or entire contributing watershed area for each segment and the most stringent water quality criteria based on segment classification. Each methodology is described in greater detail in the following sections however both assure loading capacities are equal to or less than the Water Quality Standards.

MassDEP believes that expressing a loading capacity for bacteria in terms of concentrations set 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 believes that expressing the loading capacity for bacteria in terms of loadings (e.g., numbers of organisms per day) although provided, is more difficult for the public to interpret and understand because the "allowable" loading number varies with flow over the course of the day and season and is very large (i.e. billions or trillions of organisms per day) and therefore cannot be easily understood in the context of the State Water Quality Standards or public health criteria.

To ensure attainment with water quality standards throughout the waterbody, MassDEP emphasizes the simplest and most readily understood way of meeting the TMDL is to try to meet the bacteria standard at the point of discharge. The ultimate measure of determining if the standards are achieved will be determined by monitoring and assessing instream water quality.

It is important to note that MassDEP realizes given the vast potential number of bacteria sources and the complexity of identifying and removing bacterial sources, such as stormwater, implementation will require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed that includes prioritization of outfalls and the application of BMPs that should be used to achieve water quality standards. MassDEP believes this approach is consistent with current EPA guidance and regulations as stated in a November 22, 2002 EPA memo from Robert Wayland (see Appendix B) Further discussion on this issue is provided in Section 8.

Potential Sources of Bacterial Contamination

Some insight on potential sources of bacteria is gained using dry or wet weather bacteria concentrations as a benchmark for reductions. Where a segment is identified as having high dry weather concentrations, sources such as permitted discharges, failing septic tanks, illicit sanitary sewers connected to storm drains, and/or leaking sewers may be the 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/or stormwater runoff). In urban areas, sources of elevated bacteria concentrations can include runoff in areas with high populations of domestic animals or pets. In agricultural areas, sources may include runoff from farms, poorly managed manure piles or areas where wild animals or birds congregate. Other potential sources may include sanitary sewers connected to storm drains that result in flow that is retarded until the storm drain is flushed during wet weather. Sections 4, 5 and 6 of this document discuss in more detail the types of sources identified as well as their prioritization for implementation.

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

As previously noted there are many different potential sources of indicator bacteria on Cape Cod. Most of the bacteria sources are believed to be related to marinas and boating activities, wildlife (particularly birds), and failing septic systems. Some of this pollution is potentially exacerbated by stormwater. Table 7-1 presents the TMDL indicator bacteria WLAs and LAs for the various source categories as daily concentration targets for Cape Cod.

Most discharges on the Cape, involving potential pathogen pollutants, are groundwater discharges, and are not treated as point sources regulated by surface water quality standards. These discharges are regulated under a recently revised (March, 2009) Groundwater Program 314 CMR 5.00, related to groundwater discharge permits. Standards are established to coincide with Drinking Water Standards in order to promote maximum protection of groundwater as a drinking water source. For details on these requirements refer to: http://www.mass.gov/dep/water/wastewat.htm.

For point sources, Cape Cod has several wastewater treatment plants (WWTPs) and other NPDES-permit related wastewater discharges. NPDES wastewater discharge WLAs are set at the water quality standards. All piped discharges are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore a WLA set equal to the WQS criteria will be assigned to the portion of the stormwater that discharges to surface waters via storm drains. It should be noted that the load allocation (LA) for each segment throughout the Cape Cod watershed is zero since the runoff from pervious areas is assumed to be negligible on an annual basis. For any illicit sources, including illicit discharges to stormwater systems and sewer system overflows (SSO's) the goal is complete elimination (100% reduction). It is recommended that these concentration targets be used to guide implementation. The goal to attain WQS at the point of discharge is environmentally protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and others responsible for monitoring activities. Success of the control efforts and subsequent conformance with the TMDL will be determined by documenting that a sufficient number of bacteria samples from the receiving water meet the appropriate indicator criteria (WQS) for the water body.

Table 7-1. Indicator Bacteria Waste Load Allocations (WLAs) and Load Allocations (LAs) for the Cape Cod 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	
	Leaking sanitary sewer lines	0	Not Applicable
	Failing septic systems	Not Applicable	0
A (Water supply **Intakes** in unfiltered public water supplies)	Any regulated discharge [7,9]- including stormwater runoff[4] subject to Phase I or II NPDES permits	Either; c) fecal coliform <=20 fecal coliform organisms per 100 ml[2] or **d)** total coliform <= 100 organisms per 100 ml[3;] where both are measured, only fecal must be met	Not Applicable
	Nonpoint source stormwater runoff[4]	Not Applicable	Either; b) fecal coliform <=20 fecal coliform organisms per 100 ml[2], or b) total coliform <= 100 organisms per 100 ml[3;] where both are measured, only fecal must be met
A (Includes filtered water supply) & **B**	Any regulated discharge- including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges [7,9], and combined sewer overflows[6].	Either; b) E. coli <=geometric mean[5] 126 colonies per 100 ml; single sample <=235 colonies per 100 ml; or b) Enterococci geometric mean[5] <= 33 colonies per 100 ml and single sample <= 61 colonies per 100 ml	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	Either c) E. coli <=geometric mean[5] 126 colonies per 100 ml; single sample <=235 colonies per 100 ml; or d) Enterococci geometric mean[5]<= 33 colonies per 100 ml and single sample <= 61 colonies per 100 ml
SA (Designated for shellfishing)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	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 (Beaches[8] 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[7,9], and combined sewer overflows[6].	Enterococci - geometric mean[5] <= 35 colonies per 100 ml and single sample <= 104 colonies per 100 ml	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Enterococci -geometric mean[5] <= 35 colonies per 100 ml and single sample <= 104 colonies per 100 ml
SB (Designated for shellfishing w/depuration)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	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	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] In all samples taken during any 6 month period

[3] In 90% of the samples taken in any six month period;
[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] 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.
[6] Or other applicable water quality standards for CSO's
[7] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.
[8] Massachusetts Department of Public Health regulations (105 CMR Section 445)
[9] Seasonal disinfection may be allowed by the Department on a case-by-case basis.

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.

7.3. TMDL Expressed as Daily Load (CFU/Day)

The following section describes the approach to estimating daily bacteria loads in rivers. This description is included in the TMDL even though there are currently **no** river segments on the integrated list for pathogens in the Cape Cod Watershed (Mass DEP 2008). As of the date of this document very few river segments have been assessed on Cape Cod. A description of the approach for developing loads for rivers has been included for future possible reference in the event that river segment(s) becomes bacteria impacted.

7.3.1. Rivers

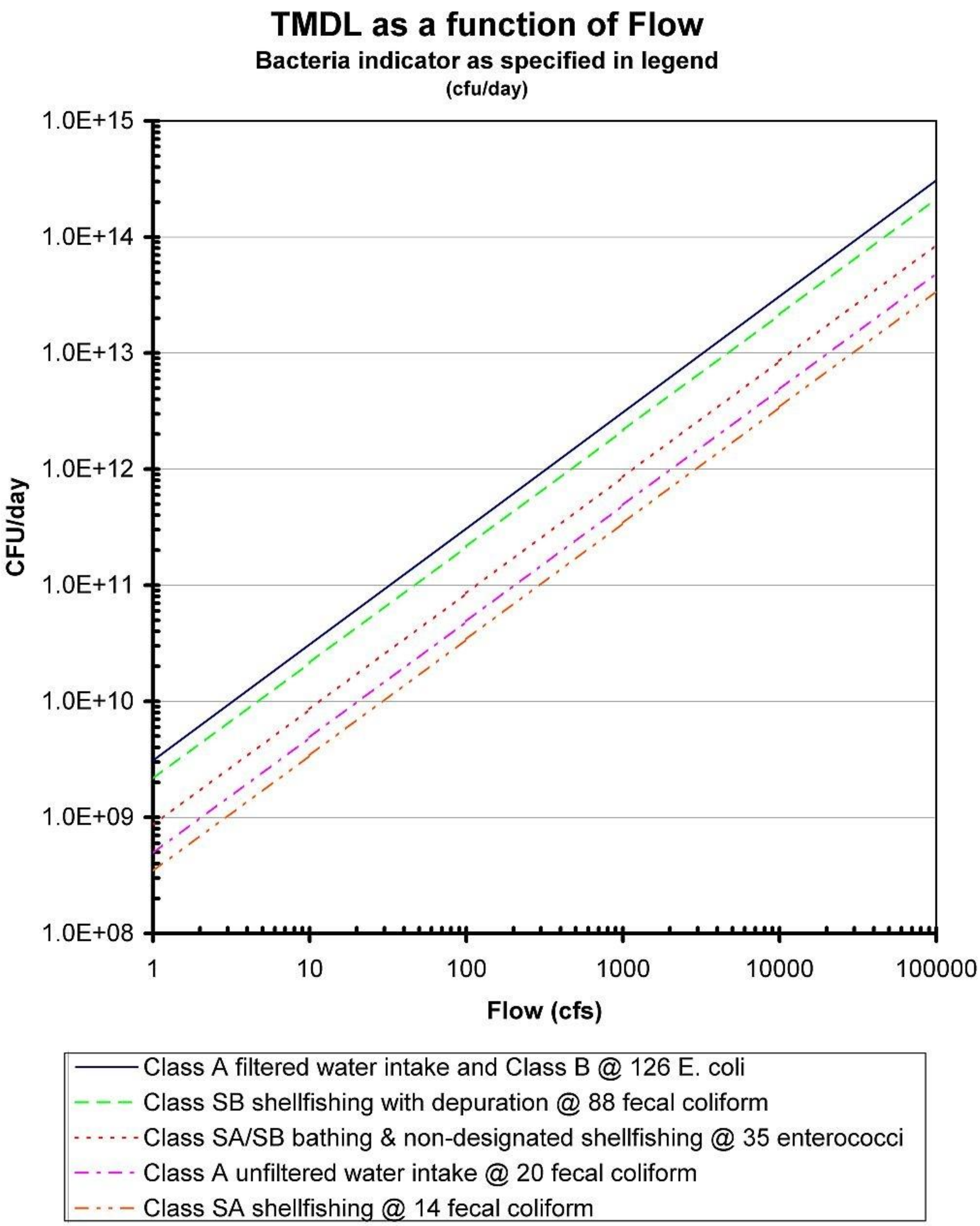
Background discussion: Flow in rivers and streams is highly variable. Nearly all are familiar with seeing the same river as a raging, flooding torrent and at another time as a tame and calm stream. In many areas, seasonal patterns are evident. A common pattern is high flow in the spring when winter snow melts and spring rains swell rivers. Summer time generally is a period of low flows except for the extreme events of heavy rainfall storms that can scale up to the high flows expected during hurricanes. Across the United States, the US Geological Survey and others maintain a network of stream gages that measure these flows on a continuous basis thus providing quantitative values to the qualitative scenarios described above. These flow measurements are reported in terms of a volume of water passing the gage in a given time period. Often the reported values are in cubic feet per second. A cubic foot of water is 7.48 gallons, and flows can range from less that a cubic foot per second to many thousands of cubic feet per second depending on the time of year and the size of the river or stream. The size of the river or stream and the amount of water that it usually carries is determined by the area of land it drains (known as a watershed), the type of land in the watershed, and the amount of precipitation that falls on the watershed. A common way the USGS reports flow is in cubic feet per second (cfs) averaged over a day since flow can vary over the course of a day.

In addition to quantity, there is of course a quality aspect to water. Most chemical constituents are measured in terms of weight per volume, generally using the metric system with milligrams (mg) per liter (L) as the units. A milligram is one thousandth of a gram, 28 of which weighs one ounce. A liter is slightly more than a quart, so there are 3.76 L in a gallon. The total amount of material is called mass and is the quantity in a given volume of water. For instance, if a liter of water had 16 milligrams of salt and one evaporated all of the water, the 16 milligrams of salt would remain. A volume of two liters with the same 16 mg/L of salt would yield 32 milligrams of salt upon evaporation of the water. So, the total amount of material in a volume of water is the combination of the amount (volume) of water and the concentration of the substance being assessed. These two characteristics, in compatible units, are multiplied to determine the quantity of the material present. In the case of a river or stream, the total amount of material passing a gaging station in a day is the total volume multiplied by the concentration of the chemical being assessed. This quantity often is referred to as "load", and if the time frame is a day, the quantity is called the "daily load." If another time frame is used, such as a year, the term used is "yearly" or "annual" load.

Application to Bacteria: Bacteria also can be discussed in terms of concentrations and loads. However, the common way of expressing concentrations of bacteria is in terms of numbers rather than weight (although one could use 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 the number of organisms that are determined to be in a given volume of water. Once again, the load is determined by the concentration multiplied by the volume of water. As can be seen, changes in concentration and/or changes in flow result in changes in the loads. Also, maximum loads can increase and if flow increases in proportion, the concentration will remain the same. For instance, if the total number of bacteria entering a section of stream doubles, but the flow also doubles, the concentration remains the same. This means that as flow increases, allowable load can increase so that concentration remains constant (or lower if dilution occurs) while continuing to meet the water quality criterion. In its simplest application, this is the concept of the flow duration curve approach. At each given flow, the maximum load that can enter and still meet the water quality concentration criterion is set. If the number of bacteria in a water body segment is higher than the allowable load as set by the water quality standard and flow, then a reduction is needed.

As a practical matter, determining the flow at each sampling point is resource intensive, expensive and generally is not done. This issue is magnified on the Cape where long-term records of USGS gages are not available. Given this, however, some estimates can be made of the volume of runoff based on long-term records of USGS gages in New England. This is the approach used in the development of this TMDL. Figure 7-1 shows the relationship between flow and load (CFU/day) for different water classifications.

Figure 7-1 TMDL by Classification and Uses as a function of flow (TMDL in CFU/Day).



7.3.2 Embayments

A different approach for estimating daily loads was developed for embayments that involved an approximation of the runoff from a buffer zone. USGS hydrology data for Cape Cod were employed to develop this estimate of daily bacteria load. Walter and Whealan (2005) report precipitation results covering a time period from 1941-1995 at the Hatchville weather station in Falmouth, MA. These data indicate that an annual average of 45 inches/year (3.75 feet/year) typically falls on Cape Cod varying from a low of about 25 inches (1965) to a high of 73 inches (1972). Rates of natural surface runoff on Cape Cod are generally very low to zero, because of the medium-to-coarse sandy soils (Walter and Whealan, 2005). Precipitation in sandy soils in Cape Cod has essentially two fates: (1) ground-water recharge, or (2) evapotranspiration. Walter and Whealan (2005) report an annual average ground water recharge rate of 27 inches/year for Cape Cod and Desimone (2003) estimates that approximately 24 inches of precipitation on Cape Cod is lost to evapotranspiration.

As a result it was assumed that no runoff occurs from the pervious areas and therefore no load allocation was provided. A buffer area of 200 feet was chosen as a reasonable estimate of the area which is likely to contribute stormwater discharges directly to each embayment. Within this 200 ft area it is assumed that all 45 inches per year of precipitation runs directly off any impervious area within this buffer zone and runoff is negligible from pervious surfaces (e.g., 0 inches/yr) because of the medium-to-coarse sandy soils on the Cape. A conservative assumption was made that all runoff from impervious surfaces is collected and piped directly to the embayment through stormdrain infrastructure. Hence, the allowable total number of bacteria per day is the water quality standard times the estimated daily runoff associated with impervious areas within the 200 foot buffer zone once conversions for the various units are applied.

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

$$TMDL = WLA + LA + MOS + NB$$

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

NB = natural background conditions

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) 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 in CFU/day is then calculated by dividing the allowable annual load by the number of days, on average, that it rains. Since it rains once every three to four days, this equates to approximately 105 days per year with rainfall and runoff (based on information interpreted from http://cdo.ncdc.noaa.gov/ancsum/ACS). It should be noted that an approximate average was taken between the total number of days with >0.01inch of precipitation. The resulting equations for Class SA waters where a fecal coliform standard of 14 CFU/100 ml applies is provided below:

Class SA - Annual Waste Load Allocation 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 (14 CFU/100 ml) x (1000 ml/l) x (28.32 l/ft^3) = CFU/Year

Class SA- Daily Waste Load Allocation (WLA) for Impaired Segment (CFU/Day) =

(CFU/Year) x (year/105 precipitation days) = CFU/day

For Class SB waters the fecal coliform standard of 88 CFU/100ml is applied. It should be noted that the load allocation (LA) for each segment on Cape Cod is zero since the runoff from pervious areas is assumed to be negligible on an annual basis.

Class SB - Annual Waste Load Allocation 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 (88 CFU/100 ml) x (1000 ml/l) x (28.32 l/ft^3) = CFU/Year

Class SB- Daily Waste Load Allocation (WLA) for Impaired Segment (CFU/Day) =

(CFU/Year) x (year/105 precipitation days) = CFU/day

In conformance with the requirements that maximum daily loads be explicit, MassDEP has calculated the daily bacteria loads associated with each impaired segment. The TMDL in CFU/day for each impaired segment contributing to runoff to estuaries on the Cape is summarized in Table 7-2.

Table 7-2. Waste Load Allocation and Total Maximum Daily Load (TMDL) by Segment.

Segment	**Applicable Water Quality Standard (CFU/100ml)**	**200 ft Buffer Area (Acres)**	**WLA**		**TMDL**
			Impervious Buffer Area		**(WLA + LA[1])**
			Percent of Impervious Area within 200 ft buffer **(%)**	Daily Load (CFU/day)	Daily Load CFU/day
MA96-01, Barnstable HBR	14	158.96	3	2.94E+07	2.94E+07

Segment	Applicable Water Quality Standard (CFU/100ml)	200 ft Buffer Area (Acres)	WLA		TMDL
			Impervious Buffer Area		**(WLA + LA[1])**
			Percent of Impervious Area within 200 ft buffer **(%)**	Daily Load (CFU/day)	Daily Load CFU/day
MA96-02, Bumps River	14	25.61	8.2	1.30E+07	1.30E+07
MA96-04, Centerville R.	14	45.84	8.5	2.40E+07	2.40E+07
MA96-05, Hyannis HBR	14	73.73	19.6	8.91E+07	8.91E+07
MA96-06, Maraspin Creek	14	17.76	6.9	7.56E+06	7.56E+06
MA96-08, Shoestring Bay	14	50.72	12.2	3.82E+07	3.82E+07
MA96-09, Quivett Creek	14	17.76	1.8	1.97E+06	1.97E+06
MA96-11, Stage Harbor	14	68.31	7.9	3.33E+07	3.33E+07
MA96-12, Bass River	14	73.21	13	5.87E+07	5.87E+07
MA96-13, Sesuit Creek	14	23.93	5.8	8.56E+06	8.56E+06
MA96-14, Swan Pond River	14	20.07	11.6	1.44E+07	1.44E+07
MA96-15, Boat Meadow River	14	20.07	1.5	1.86E+06	1.86E+06
MA96-16, Rock Harbor Creek	14	15.03	7.4	6.86E+06	6.86E+06
MA96-17, Falmouth Inner Harbor	88	22.09	26.4	2.26E+08	2.26E+08
MA96-18, Great Harbor	14	50.72	18.2	5.69E+07	5.69E+07
MA96-19, Little Harbor	14	25.61	23.7	3.74E+07	3.74E+07
MA96-20, Quashnet R.	14	25.61	6.4	1.01E+07	1.01E+07

Segment	Applicable Water Quality Standard (CFU/100ml)	200 ft Buffer Area (Acres)	WLA		TMDL
			Impervious Buffer Area		(WLA + LA[1])
			Percent of Impervious Area within 200 ft buffer **(%)**	Daily Load (CFU/day)	Daily Load CFU/day
MA96-21, Waquoit Bay	14	104.54	6.5	4.19E+07	4.19E+07
MA96-22, Herring River	14	25.61	6	9.48E+06	9.48E+06
MA96-23, Saquatucket Harbor	14	15.03	12.3	1.14E+07	1.14E+07
MA96-24, Mashpee R.	14	28.66	5.6	9.90E+06	9.90E+06
MA96-26, Little Namskaket Creek	14	11.47	4.6	3.26E+06	3.26E+06
MA96-27, Namskaket Creek	14	15.03	1.6	1.48E+06	1.48E+06
MA96-29, Provincetown Harbor	14	181.04	22.7	2.53E+08	2.53E+08
MA96-30, Scorton Crk	14	25.61	3.1	4.90E+06	4.90E+06
MA96-31, Pamet River	14	35.03	5.2	1.12E+07	1.12E+07
MA96-32, Duck Creek	14	36.16	16.9	3.77E+07	3.77E+07
MA96-33, Herring River	14	56.54	4.5	1.57E+07	1.57E+07
MA96-34, Wellfleet Hbr.	14	253.37	9.3	1.45E+08	1.45E+08
MA96-35, Chase Garden	14	37.25	3.6	8.27E+06	8.27E+06
MA96-36, Lewis Bay	14	118.15	11.8	8.60E+07	8.60E+07
MA96-37, Mill Creek	14	22.09	2.6	3.54E+06	3.54E+06
MA96-38, Parkers River	14	20.07	19.1	2.36E+07	2.36E+07

Segment	Applicable Water Quality Standard (CFU/100ml)	200 ft Buffer Area (Acres)	WLA		TMDL
			Impervious Buffer Area		**(WLA + LA[1])**
			Percent of Impervious Area within 200 ft buffer **(%)**	Daily Load (CFU/day)	Daily Load CFU/day
MA96-39, Popponesset Creek	14	20.07	17.4	2.15E+07	2.15E+07
MA-96-41, Mill Creek	14	17.76	5.6	6.14E+06	6.14E+06
MA96-42, Taylors Pond	14	15.03	13.7	1.27E+07	1.27E+07
MA96-43, Harding Beach Pond	14	25.61	8.1	1.28E+07	1.28E+07
MA96-44, Bucks Creek	14	15.03	11.6	1.08E+07	1.08E+07
MA96-45, Oyster Pond	14	42.25	10.7	2.79E+07	2.79E+07
MA96-46, Oyster Pond River	14	35.03	7.8	1.69E+07	1.69E+07
MA96-50, Ryder Cove	14	38.31	15.5	3.66E+07	3.66E+07
MA96-53, Perch Pond	14	17.76	21.4	2.34E+07	2.34E+07
MA96-54, Great Pond	14	57.22	23.6	8.33E+07	8.33E+07
MA96-55, Green Pond	14	42.25	15.3	3.99E+07	3.99E+07
MA96-57, Bournes Pd	14	44.97	12.6	3.50E+07	3.50E+07
MA96-58, Hamblin Pond	14	40.33	7.4	1.84E+07	1.84E+07
MA96-61, Little River	14	17.76	16.3	1.79E+07	1.79E+07
MA96-62, Oyster Pond	14	30.05	12.2	2.26E+07	2.26E+07
MA96-68, Town Cove	14	79.73	8	3.93E+07	3.93E+07
1 = Load Allocation (LA) equals zero since runoff from the pervious area is assumed to be negligible.					

7.4. Application of the TMDL To Unimpaired or Currently Unassessed Segments

This TMDL applies to the pathogen impaired segments of the Cape Cod watershed that are currently listed on the 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. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen-impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-2 and Table 7-1). Any discharge would need to be consistent with the applicable waste load allocations, as well as the antidegradation provision of the Massachusetts Water Quality Standards.

This Cape Cod watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments. Any new construction that complies with state stormwater standards and permits is presumed to comply with antidegradation requirements of the state water quality standards.

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 water quality standard, provided that the receiving water concentration does not exceed the TMDL concentration. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur. Third, the TMDL assumes that all the runoff from impervious areas throughout the contributing watershed actually makes it to the impaired segment, which is generally not the case especially in large watersheds where impervious surfaces are not continually connected.

7.6. Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Pathogen sources to Cape Cod waters arise from a mixture of continuous and wet-weather driven sources, and there may be no single critical condition that is protective for all other conditions. This TMDL has set WLAs and LAs for all known and suspected source categories equal to the Massachusetts WQS independent of seasonal and climatic conditions. This will ensure the attainment of water quality standards regardless of seasonal and climatic conditions. Controls that are necessary will be in place throughout the year, protecting water quality at all times.

8.0 Implementation Plan

Setting and achieving TMDLs should be an iterative process, with realistic expectation for goals to be achieved 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 Cape Cod watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the Cape Cod watershed, including; sewer connections to drainage systems, leaking sewer pipes, sanitary sewer overflows, and failing septic systems, are prohibited and must be eliminated. The Mass Division of Marine Fisheries has identified other contributing sources such as marinas and boating activities, and wildlife, particularly birds. 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, CZM, EPA, Cape Cod Commission (CCC) and Cape and Island stewards have been successful in carrying out such monitoring, identifying sources, and, in some cases, mobilizing the responsible municipality and other entities to begin to take corrective actions.

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 priority overall should be given to bacteria source tracking 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. This would include better control of boat wastes, particularly within EOEEA declared No Discharge Areas along the southern portion of Cape Cod, and in Wellfleet harbor along the western portion. 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: A Center for Watershed Protection Manual entitled: Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments which can be downloaded at:

http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/idde.htm

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 available at: http://www.neiwpcc.org/iddemanual.asp (CWP 2004, NEIWPCC 2003).

Stormwater runoff represents another potential major source of pathogens in the Cape Cod 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 Cape Cod watershed.

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" was developed to support implementation of pathogen TMDLs. 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/EPA
TMDL public meeting	MassDEP/EPA
Response to public comment	MassDEP
Organization, contacts with volunteer groups	MassDEP/Cape Cod Commission
Development of comprehensive stormwater management programs, particularly in close proximity to each embayment, including identification and implementation of BMPs	Cape Cod Communities
Illicit discharge detection and elimination (where applicable)	Cape Cod Basin Communities with Cape Cod Commission
Leaking sewer pipes and sanitary sewer overflows	Cape Cod Communities
Inspection and upgrade of on-site sewage disposal systems as needed	Homeowners and Cape Cod Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	MassDEP, Cape Cod Commission, and Cape Cod Communities

Task	Organization
Organize and implement education and outreach program	MassDEP, Cape Cod Commission, and Cape Cod Communities
Write grant and loan funding proposals	Cape Cod Commission, Cape Cod Communities and Planning Agencies with guidance from MassDEP
Inclusion of TMDL recommendations in Executive Office of Energy and Environmental Affairs (EEA) Watershed Action Plan	EEA
Surface Water Monitoring	MassDEP, MACZM, MDMF, Cape Cod Communities
Provide periodic status reports on implementation of remedial activities	Cape Cod Communities, Cape Cod Commission

8.1. Summary of Activities within the Cape Cod Watershed

There are numerous active stewards of the Cape Cod watershed, these include, but are not limited to:

- Barnstable Land Trust
- Brewster Ponds Water Quality Stewards
- Buzzards Bay Citizen Monitoring Program
- Cataumet Civic Associates
- Chatham Water Watchers
- Cotuit Waders
- Eastham Pond Stewards
- Falmouth Pond Watchers
- Garretts Pond Watchers
- Harwich Shellfish and Marine Water Quality Committee
- Nantucket Environmental Laboratory
- Mashpee Shellfish Department
- Orleans Water Quality Task Force
- Pleasant Bay Citizen Water Quality Monitoring Program
- Provincetown Harbor Water Quality Monitoring Program
- Shawme Pond Watershed Association
- Three Bays Water Quality Monitoring Program
- University of Massachusetts Cooperative Extension
- Wampanoag Tribe of Gay Head, Aquinnah
- Waquoit Bay National Estuarine Research Reserve
- Wequaquet Lake Protective Association
- Wheeler Road Association & Friends

Contact information for each of these groups can be obtained from the Massachusetts Water Watch Partnership Directory of Massachusetts Volunteer Monitoring Groups website (http://www.umass.edu/tei/mwwp/groups.html) as well as links to their respective websites, which provide details regarding past and on-going activities. These groups are generally involved in water quality sampling (may or may not be pathogen related) and outreach and education for residents within subwatersheds of Cape Cod. Other partners' efforts through the State, such as the Division of Marine Fisheries (DMF) and the Department of Environmental Protection (DEP), Southeast Regional Office, are discussed within this section below.

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

8.1.1. Massachusetts Division of Marine Fisheries Activities and Findings Pertaining to the Cape Cod Region

In 1988, the Massachusetts Division of Marine Fisheries accepted responsibility for the classification of all marine waters in the Commonwealth as they relate to water quality and shellfish. Within the mandates set forth in the National Shellfish Sanitation Program, the Division has been conducting analysis for fecal coliform contamination in 78 coastal communities (303 water quality classification areas in 1,746,000 acres) throughout the marine environs of the state. Fifteen of these 78 communities lie on the Cape, encompassing 220,000 water quality classification acres. Much of the inhabited part of the Cape lies within classified estuary segments, or immediately adjacent to these estuaries. This sampling effort and subsequent laboratory analysis entails several primary components: sanitary surveys composed of shoreline surveys and pollution source identification and analysis; development of water quality classifications for these areas into the categories of Approved, Conditionally Approved, Conditionally Restricted, Restricted or Prohibited; and, production of reports describing pollution and potential pollution sources, tables of water quality analysis, marina evaluations, agricultural impacts, wastewater treatment plant descriptions and potential impacts and maps depicting sample stations (both classification and pollution), specific demarcations of classified areas, closure zones, etc. (DMF, 2007).

In the above-noted processes, much is done to determine the point source and non-point source elements impacting the water quality areas. Beside the water analysis, attempts are made to range inland to identify potential impact sources such as failing septic systems, poorly managed agricultural areas, potential industrial influences and several other elements that may have deleterious impacts on the receiving water quality. When elevated coliform levels are noted during the surveys and no obvious pollution sources are immediately identified, limited forays are made to the surrounding neighborhood. Unfortunately, due to time and manpower constraints, the extent to which the Division biologists can affect any substantive analysis of upland areas and potential sources is extremely limited. In many instances the impact of these upland sources can be major (DMF, 2007).

Because the abatement of these sources is ultimately the responsibility of the local officials, these officials frequently accompany the area biologists during the shoreline surveys. The value of this cooperative effort cannot be overstated. With their firsthand observations, they can more readily respond to these conditions and thereby conduct more timely actions. Also, because the state area biologists, under Chapter 130 of the Massachusetts General Laws have the right of trespass while conducting sanitary surveys, the local officials are afforded an opportunity to inspect areas they may not otherwise have without “officially” responding to a complaint. Since the Division does not have direct jurisdiction relative to most pollution source abatements and the locals and/or the Massachusetts Department of Environmental Protection do, this symbiotic relationship has resulted in a more complete determination of both problems and solutions (DMF, 2007).

From the overall DMF sampling efforts over the years, there is no real hard and fast answer as to why fecal coliform bacteria problems continue to exist on the Cape. Its geology, on the one hand, and the geographical positioning on the other (a peninsula between two beautiful bodies of water) offer both desirable and undesirable elements relative to fecal coliform loading. The sandy substrates found throughout the Cape tend to act as very efficient sand filters and, in most cases, have, heretofore, effectively supported private sewage disposal systems. However, because of its desirability as a great place to live and vacation, the number of people and, subsequently, the number of systems have increased; especially directly along the shore of both fresh and salt water bodies throughout the Cape Area. Wastewater treatment plants would indeed affect a positive impact, especially if they were directed more specifically at those dwellings and businesses directly along the shore. Additionally, these plants, because of their processing capabilities, could perform nutrient (nitrogen) “scrubbing” and potentially reduce some of the nutrient loading in the area (DMF, 2007).

The increased popularity of boating in recent decades, along with increases in summer vacationing and recreational population, has added another potential as well as real bacterial contributor to the scene. Actual DMF water quality and sanitary surveys have verified this fact: in fact many seasonal closures of shellfish beds have been detected by elevated bacterial numbers in close proximity to boat docks and harbor areas where a lot of boats congregate, particularly during the warmer seasons of each year. The EOEEA, in conjunction with these DMF findings and closures have declared five Harbor areas along the southern and west sides, (including Wellfleet harbor), as No Discharge Areas, where special restrictions (i.e., no boat waste discharges) are imposed regarding all boat discharges. Perhaps, other areas along the south and west parts of the Cape should be considered by EOEEA for nomination as No Discharge Areas if these areas show significant bacteria problems due to boating related activities.

Another phenomenon that DMF surveys have revealed in recent years is the increased number of migratory waterfowl that are wintering over. While human pollution sources and their inherent disease potentials are of primary concern, animal feces are included as part of the fecal coliform mass and thus are, therefore, calculated into the overall geometric means and percentiles as they relate to classification levels. Control and reduction of this aspect of bacteria loadings is problematic and other wild animal waste also contributes to the problem (DMF, 2007).

If demographic trends of population increase persist, this will continue to add to the bacterial pool. The marine environment is further impacted by the number of vessels added by this increased population. DMF CVA pump out efforts have done much to reduce and in some cases eliminate bacterial loading from personal sanitation devices (PSAs), but unpredictable future funding and other constraints may tend to reverse this success (DMF, 2007).

8.1.2 Mass DEP, Division of Watershed Management Bacteria Source Tracking, Southeast Regional Office

To assist local communities in their efforts to reduce bacterial contamination, The MassDEP has implemented over the past several years a bacterial source tracking program. The primary goal is to implement bacteria source tracking in targeted, high- priority polluted areas (303(d) impaired list), where it is believed implementation solutions may result in improved water quality. This report, particularly in Section 4.0 Problem Assessment, has outlined past available bacteria related data, and there are at least several segments where the past data indicates high bacteria counts that would benefit from some source tracking efforts by this newly instated program. These include: (1) Barnstable Harbor Segment 96-01,(particularly around Barnstable Yacht Club); (2) Centerville River Segment MA 96-04, (particularly Bumps River- Scudder Bay area);(3) Bass River Segment MA 96-12, Yarmouth (particularly the extreme southern part near Nantucket Sound side); (4) Swan Pond River Segment 96-14, Dennis; (5) Herring River Segment MA 96-33, Wellfleet (goes into NW side of Wellfleet Harbor); (6) Cockle Cove Creek, Chatham (which is NOT a DEP listed Segment, however, bacteria problems were documented by a bacteria human marker project during 2000-1. This Creek is very near 2 other MA segments: Mill Creek MA 96-41 and Bucks Creek MA 96-44); (7) Great Pond Segment MA 96-54; and (8) Green Pond segment MA 96-55.

In summary, the success of attaining and maintaining good water quality in the marine environs requires a multi-faceted/ multi-jurisdictional approach. Each of the local, state and federal agencies has unique roles within their purview of responsibility and, though these roles may appear complex at times, all are extremely critical to the successful maintenance of the Commonwealth's aquatic and marine environs. In the final analysis, coliform loading, which ultimately originates on the terrestrial uplands peripheral to the marine shellfish areas, is transported via multiple vectors and, indeed, must be addressed via a multidisciplinary cooperative effort (DMF, 2007).

8.2. Illicit Sewer Connections and Failing Infrastructure

Although presently there are only a few POTWs on the Cape, the elimination of illicit sewer connections and repairing failing infrastructure are of extreme importance, in order to eliminate and prevent bacterial pollution. 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

As part of their applications for Phase II permit coverage, 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 communities on the Cape that are covered under the Phase II rule include: Bourne, Falmouth, Sandwich, Mashpee, Barnstable, Yarmouth, Dennis, Harwich, Brewster, Chatham, Orleans, and Esatham

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 Phase II rule (i.e., not designated as MS4 communities) are encouraged to implement a program for detecting and eliminating sewage discharges to storm sewer systems including illicit sewer connections. Implementation of the Phase II rule (USEPA 2000), whether voluntarily or mandated will help communities achieve bacteria TMDLs.

Guidance for implementing an illicit discharge detection and elimination program is available from several documents. EPA New England developed a specific plan for the Lower Charles River to identify and eliminate illicit discharges (both dry and wet weather) to their separate storm sewer systems (USEPA 2004b). Although originally prepared for the Charles River watershed it may be applicable to other watersheds throughout the Commonwealth, however it represents just one of the approved methodologies available. More generic guidance is provided in a document prepared for EPA by the Center for Watershed Protection and the University of Alabama entitled Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments which can be downloaded from:
http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/idde.htm

In addition, 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 available at: http://www.neiwpcc.org/iddemanual.asp. Implementation of the protocol outlined in these guidance documents satisfies the Illicit Discharge Detection and Elimination requirement of the NPDES program.

8.3. 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). Many point source stormwater discharges are regulated under the NPDES Phase I and Phase II permitting programs when discharged to a Waters of the United States. Municipalities that operate regulated municipal separate storm sewer systems (MS4s) must develop and implement a stormwater management plan (SWMP), which must employ and set measurable goals for the following six minimum control measures:

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

Portions of towns in this watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule. This rule requires the development and implementation of an illicit discharge detection and elimination plan. The communities on the Cape that are covered under the Phase II rule include: Bourne, Falmouth, Sandwich, Mashpee, Barnstable, Yarmouth, Dennis, Harwich, Brewster, Chatham, Orleans, and Esatham

The NPDES permit does not, however, establish numeric effluent limitations for 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.

A list of the municipalities in Massachusetts regulated by the Phase II Rule, as well as the Notices of Intent for each municipality can be viewed at http://www.epa.gov/region01/npdes/stormwater/ma.html.

A review of the progress in the Phase II Stormwater program for each community, listed under Phase II requirements, located within the Cape Cod Watershed follows. The overall review of Phase II program progress reveals less progress to date than might be desired. Future wastewater management strategies seem to be in the lime light from the planning standpoint, with stormwater management playing a distinctive secondary role. The towns of Bourne and Sandwich seem to have taken the lead with rather progressive Phase II efforts. There is a regional stormwater effort underway through a working committee, led by the Cape Cod Planning Commission, called ‘Project Storm’. Many Cape Cod communities are involved with this committee. Much of the effort of this committee has centered on helping communities to get the word out on the stormwater Phase II program, through outreach and education efforts.

Barnstable: The 2006 report states that the town has been attempting to address stormwater related issues for many years (prior to the Phase II permit). With public education, door hanger flyers on stormwater were produced, and have been distributed by the DPW when they are working in a particular neighborhood area. A stormwater citizens advisory committee was formed, and meets at least yearly. This group has initiated a storm drain stenciling effort. A stormwater management plan, though, has not been developed, nor an organization defined to develop it. Information on stormwater is available on the town’s website. There is a (related) nutrient management citizens advisory committee. In 2007 and 2008, the Mass Bays presentation “Stormy” was displayed during the Town’s ‘Think Blue’ campaign throughout Barnstable. Barnstable has an active water quality monitoring program, involving 53 stations that are monitored seven times each year during the warm season. Also, in the past five years, the community has participated in DMF sanitary surveys. In 2007-2008 several illicit connections were discovered through DMF surveys and corrected. Street sweeping is carried out annually with1,000 - 3,000 catch basins cleaned each year. ‘No Discharge Zones (for boat wastes) were declared by EPA & EEA for Three Bays, Centerville River, and the Barnstable Harbor areas in 2007-2008.

Bourne: With public education, the town has established a stormwater task force advisory committee. This committee meets monthly to provide outreach, work on developing a Phase II by-law, developing a management plan, an annual stormwater newsletter that goes out to all residences, and produce programs for the local cable TV station. The Board of Health produces a video program in all 3 rd grade classes each year. The task force meets with the Superintendent of the DPW twice yearly to discuss stormwater control progress. It also meets regularly with the Cape Cod Planning Commission, as part of an inter-group of Cape Cod communities working on stormwater (‘Project Storm’), and on low impact development applications in town. It also works with the Coalition for Buzzards Bay. The task force has set up a hotline for residents to file complaints. The town was part of the Buzzards Bay Stormwater Outfall Mapping Project in the northern estuary area, and is using that data to identify potential problems. The local Board of Health regularly samples the beaches. With stormwater conveyance mapping, The Buzzards Bay Outfall Mapping Project has been utilized in the Northern part of town, and Americorps Inc. has funded stormdrain mapping in areas not covered by this project. Two CPR grants were received in 2007 to alleviate problems in Squeteague Harbor (Buzzards Bay) and Conservation Pond/ Hen’s Cove areas. In 2008, another CPR (CZM) grant of $66,000 was received to put in Phase II Stormwater Remediation Controls on Conservation Pond. The DPW has begun a program to inventory dry weather flowing outfalls, and sample them for problems. It has displayed stormwater control posters all over town. With housekeeping, the DPW cleaned 479 catch basins in 2005, 400 in 2006, 378 in 2007, with 500 projected to be cleaned in 2008. At least 900 tons of debris is removed each year. Street sweeping has been performed annually on all roads. In 2008, the town signed a contract with a consultant to develop Draft By- Laws to address BMP #4 (construction site stormwater activity), and BMP #5 (housekeeping). It is anticipated that final By-Laws will be approved by town meeting by the end of 2008.

Brewster: Public education plans in 2007 include use of the town's website to post stormwater flyers, and a link for citizens to report related problems. Flyers were handed out at beaches, the transfer station, and town hall. Identification and sampling of suspected illicit connections has been carried out. With housekeeping, a geared up effort is underway for annual street sweeping and catch basin cleaning. 2007 saw two major grant projects awarded to the Town, with work begun: (1) a CZM NPS related grant, to assess Stony Brook Watershed through GIS mapping, to make 25 runoff scenario calculations, and identify what type of BMP's should be utilized and where they should be located within the Watershed; and (2) a Gulf of Maine Council grant to retrofit a culvert system along Route 6A, based on hydraulic and hydrological flow modeling, to restore tidal flow to Stony Brook. This project is being facilitated with the help of a consortium of organizations such as the Cape Cod Planning Commission, the Association for Preservation of Cape Cod, and the Mass Bays Program.

Chatham: A public education program is being developed including , a flyer entitled, "A Dog Owners Guide to a Cleaner Pleasant Bay". In conjunction with this, six mitt mutt dispensers and dog waste storage bins were installed on town public lands. Stormwater information is available on the town website. The EPA/ Weather Channel Video, "After the Storm", has been shown the past year twelve times on the local cable station. In 2007, the Town joined in on the Cape Cod Planning Commission, 'Project Storm' Consortium, which meets monthly on region wide Stormwater efforts. The Town's Comprehensive Wastewater Management Citizens Advisory Committee, activated in 2006, meets monthly (televised on local cable channel) to discuss Stormwater issues. The 'Friends of Chatham Waterways' conducted water quality sampling during summer 2005. With stormwater conveyance mapping, a GPS meter has been purchased, and by the end of 2008, the entire stormwater infrastructure will be mapped on GIS. Housekeeping includes annual street sweeping, and 1/3rd of all catch basins are cleaned annually. At the newly constructed DPW building/ grounds, a special effort was made to install BMP's to control stormwater by creating wetlands around the parking lot area. In 2007, the $300,000 Oyster Pond stormwater Mitigation Project was completed. This project eliminated several direct stormwater connections from roadways, as well as provided end- of- pipe treatment (through Stormceptor) for a significant volume of this runoff.

Dennis: This town has a full- time natural resource officer, who maintains an information tree on stormwater brochures in his office. He is actively involved in the Cape communities in the regional 'Project Storm' that meets regularly with C.C.P.C. In 2007, a committee was formed, 'Commercial Recreation Association for Better Shellfishing' to educate the public on pollution in estuaries. The town has a pet waste management program, which provides disposal mitts and waste receptacles at town beaches. This activity came as the result of a recently developed by-law on dog waste disposal. There is also a boat waste pump out program in the marine areas of town, with several pump out locations. An aggressive education program was launched in 2007-2008 on proper disposal of boat wastes in appropriate tank receptacles. With illicit connection detection work, there was a recent CPR grant project to eliminate stormwater flows into Bass River from Leif Erekson Drive, Old Fashioned Road, Old Fish House Road, and Hawthorn Road. Another grant was received in 2007 to eliminate two particularly troublesome outfalls into Bass River from Follins Road, and Shore Drive. In 2006, a Coast Sweep cleanup project occurred along 3 miles of shoreline, involving over 40 volunteers. Street sweeping and catch basin cleaning efforts are underway (3,200 catch basins were cleaned in 2006-2007). The Town is also involved with water quality sampling in various ponds and in the estuary areas. In 2006, The Town purchased a $3.1 million parcel to implement wetlands mitigation measures. The Town's Comprehensive Wastewater Task Force Committee on Stormwater Mitigation produced a final draft By- Laws for public comment during 2008.

Eastham: A public education program including, educational brochures and video development for airing on local cable TV is in process of being developed. The town participates in the CZM "Coast Sweep" program on a semi- annual basis. Additionally, some water quality monitoring is going on five times a week, during warmer months, in marine areas. A group of freshwater stewards are involved with monitoring in ponds. The storm conveyances mapping program has not had a good start due to lack of funding. This includes the identification of illicit connections, with corrective actions taken. Some dry weather flow screening is being conducted by DPW staff when they do their water quality monitoring five times a week in marine areas. Housekeeping includes catch basin cleaning and street sweeping twice per year. In 2007, 25 catch basins were repaired.

Falmouth: Maps of drainage systems, catch basins and outfalls were completed in 2007. A housekeeping program plan was developed, with regular street sweeping and catch basin cleaning activities initiated (including purchase of several cleaning and sweeping vehicles). The town developed a stormwater permit guidance tool through a 'driveway permit and regulations' pertaining to roadways.

Harwich: Drainage mapping, with full field verification was completed in 2006 and sampling of outfalls was initiated in 2007. Public education materials were developed including a stormwater video with BMP application examples. Additionally, flyers were developed and handed out, and relevant posters were developed and displayed in various town offices. A town website stormwater link was implemented in 2007. Completed and approved stormwater By-Laws and accompanying regulations were integrated into construction and post- construction regulations during 2008. The DPW has installed or retrofitted 57 drainage structures throughout town. The town has instituted a street sweeping program, and in 2006 and 2007 all streets were swept.

Mashpee: With public education, the town is part of the regional task for group of municipalities under, 'Project Storm' that meets with C.C.P.C. on Phase II progress. The focus of the town's involvement on this committee has been on public education/ helping to produce brochures on stormwater to distribute in town. The local DPW has itself produced several brochures to distribute around town. The DPW has sponsored several 'cleanups' in water areas of town. Pooper scoopers with receptacle bins have been placed on appropriate public town properties. Americorps, Inc., has assisted in developing a GIS data base on the town's drainage system. This was completed in 2007. A CPR proposal regarding Popponesset Bay was submitted in 2007, but was not awarded. The town has a proposed amended by- law, which will prohibit discharges to roadway drainage ditches, and the DPW is making serious strides at reducing direct roadway runoff into ditches with catch basins, swales, etc. With housekeeping, 70 miles of roadways were swept in each of 2006 and 2007, and approximately 1,200 catch basins were cleaned in each year 2005- 2007.

Orleans: Public education materials are under development with a Stormwater video planned, along with brochure and poster development. A water quality monitoring program has been underway for the past 10 years. An MEP water quality report was released on Pleasant Bay. A water quality management plan is being produced as a result of recently completed TMDL's for this area. Stormwater system mapping has been completed with the help of Americorps volunteers, but the database development to support it has not, (without the reception of grant funding). On- going illicit connection detections are noted during normal catch basin cleaning operations. Housekeeping includes annual street sweeping, where 414 tons of sand were collected in 2006, as well as catch basin cleaning where 423 tons debris were removed that same year. Additionally, $500,000 in drainage improvements related to stormwater controls are being completed each year during the five year permit period.

Sandwich: Is involved with 'Project Storm', the group of Phase II communities on the Cape that meet regularly with the Cape Cod Planning Commission on Phase II progress. With public education, the town receives support from Americorps, Inc., and the Cape Cod Commission to hold day- long water festivals at Oak Ridge School and Forestdale Elementary School, where stormwater control brochures are handed out, and information is displayed. The town Engineering Department annually makes a stormwater presentation to high school senior science classes, and assists the students with stormwater related projects. The high school sponsors, with the help of the town, an annual environmental expo in the spring. The town wrote an article on their Stormwater Management Plan in a national sewer and water professional journal in February, 2007. With stormwater conveyance mapping, the DPW staff produced GIS data layered maps showing location and type of drainage facilities and outfalls, pipe connections, and drainage easements. These maps are available on the town website, and citizens can locate (linking up to the website maps from their home computers) on these maps outfalls or other conveyances where they think problems, such as illicit connections, may exist. These are referred to the BOH office for follow-up checking. The town Engineering and DPW staffs attend regular seminars on stormwater with members of other towns in 'Project Storm'. The town has publicly displayed planning charts, showing each of the six goals of Phase II, with activities planned and completion dates over the five years of the permit. In 2008, the town received a 319 Grant award to mitigate stormwater entering Mill Brook.

Yarmouth: The town is involved with the 'Perfect Storm' collaborative (through the Cape Cod Planning Commission Project Storm Committee), particularly in helping develop stormwater materials to hand out. The town has distributed 500 bookmarks, 50 storm drain decals, and 100 door hangers in the Bass River Watershed. There is a Stormwater Management Committee which meets several times per year. The Committee has combined efforts with the Resource Management Planning Committee in town to develop goals, which are part and parcel of a town Stormwater

Management Plan. In 2007-2008, these two committees launched a public education program on the Plan, with an emphasis on the need for estuary protection implementation. This Plan has been submitted to the Board of Selectmen for approval. The stormwater drainage maps and outlets have been posted on the town website. Two CPR grants have been received to repair illicit discharge outlets into Bass River. The town has completed the outlet inventory mapping, and has made a priority list of outfalls to inspect in dry weather. The C.C.P.C. "project storm' committee is providing suggestions of appropriate BMP's to utilize in the town. A boat pump- out facility at Packet Landing on the Bass River was established 2006-2007. Annual street sweeping is carried out with 200 priority catch basin cleaned each year. All major storm drains were inspected in 2007-2008, with TV inspections of the two largest drainage outlets going into Bass River and Nantucket Sound. By-Laws dealing with Stormwater and BMP applications were upgraded in 2008.

As of the date of this document reports had not been posted for the towns of Truro, Provincetown, and Wellfleet.

In addition to the above, the Massachusetts Department of Environmental Protection's proposed new "Stormwater Management Regulations," that would establish a statewide general permit program aimed at controlling the discharge of stormwater runoff from certain privately-owned sites containing large impervious surfaces.

The proposed regulations would require private owners of land containing five or more acres of impervious surfaces to apply for and obtain coverage under a general permit; implement nonstructural best management practices (BMPs) for managing stormwater; install low impact development (LID) techniques and structural stormwater BMPs at sites undergoing development or redevelopment; and submit annual compliance certifications to the Department.

Where the Department has determined that stormwater runoff is causing or contributing to violations of the Massachusetts Surface Water Quality Standards, the proposed regulations would allow MassDEP to impose the same requirements on certain private owners of land with less than five acres of impervious surfaces and require the owners of such land to design and implement the LID techniques and stormwater BMPs needed to address these violations.

8.4. Failing Septic Systems

Much of the Cape Cod basin relies on on-site waste water systems such as septic systems (see Figure 5-1). Septic system bacteria contributions to the Cape Cod watershed may be reduced in the future through septic system maintenance and/or replacement. Additionally, the implementation of Title 5, which requires inspection of private sewage disposal systems before property ownership may be transferred, building expansions, or changes in use of properties, will aid in the discovery of poorly operating or failing systems. Because systems which fail must be repaired or upgraded, it is expected that the bacteria load from septic systems will be significantly reduced in the future. Regulatory and educational materials for septic system installation, maintenance and alternative technologies are provided by the MassDEP on the worldwide web at http://www.mass.gov/dep/brp/wwm/t5pubs.htm.

8.5. Wastewater Treatment Plants

For point sources, Cape Cod has several wastewater treatment plants (WWTPs) and other NPDES-permit related wastewater discharges

Most discharges on the Cape, involving potential pathogen pollutants, are groundwater discharges, and are not treated as point sources regulated by surface water quality standards. These discharges are regulated under a recently revised (March, 2009) Groundwater Program 314 CMR 5.00, related to groundwater discharge permits. Standards are established to coincide with Drinking Water Standards in order to promote maximum protection of groundwater as a drinking water source. For details on these requirements refer to: mass.gov/dep/water/wastewat.htm.

There is considerable information on WWTP future planning in other sections of this report. See Section 5.0, Potential Sources (for current WWTP's), and future WWTP planning efforts in Section 6.0, Prioritization and Known Sources.

8.6. Recreational Waters Use Management

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

- petitioning the State for the designation of additional No Discharge Areas (NDAs);
- 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.

The entire Buzzards Bay and select areas surrounding the Cape have already been established as a no discharge areas (NDA). This designation by the Commonwealth of Massachusetts and approved by the USEPA provides protection of this area by a Federal Law which prohibits the release of raw or treated sewage from vessels into navigable waters of the U.S. The law is enforced by the Massachusetts Environmental Police. The MACZM and Massachusetts Environmental Law Enforcement are actively pursuing an amendment to State regulations allowing for the institution of fines up to $2000 for violations within a NDA (USEPA 2004a).

8.7. Funding/Community Resources

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

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

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

9.0 Monitoring Plan

The long term monitoring plan for the Cape Cod watershed includes several components:

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

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

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

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 include Federal monies available under the CWA Section 319 NPS program and the CWA Section 604 and 104b programs, which are provided as part of the Performance Partnership Agreement between MassDEP and the EPA. Additional financial incentives include state income tax credits for Title 5 upgrades, and low interest loans for Title 5 septic system upgrades through municipalities participating in this portion of the state revolving fund program.

A brief summary of many of DEP's tools and regulatory programs to address common bacterial sources is presented below.

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. The MA Clean Water Act can be found at the following URL http://www.mass.gov/legis/laws/mgl/21-26.htm.

Surface Water Quality Standards (314 CMR 4.0): 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. The MA Surface Water Quality Standards can be found at: http://www.mass.gov/dep/service/regulations/314cmr04.pdf.

Ground Water Quality Standards (314 CMR 6.0): These standards consist of groundwater classifications, which designate and assign the uses for various groundwater's of the Commonwealth that must be maintained and protected. Like the surface water quality standards the groundwater standards provide specific ground water quality criteria necessary to sustain the designated uses and/or maintain existing groundwater quality. The MA Ground Water Quality Standards can be found at: http://www.mass.gov/dep/water/laws/regulati.htm#wqual.

River Protection Act: In 1996 MA passed the Rivers Protection Act. 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. More information on the Rivers Protection Act can be found on DEPs web site at: http://www.mass.gov/dep/water/laws/laws.htm.

Additional Tools to Address Combined Sewer Overflows (CSO's)

CSO Program/Policy: Massachusetts, in concert with EPA Region 1, have 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. DEP's 1995 regulatory revisions correspondingly decreased reliance on partial use designation as the sole regulatory vehicle to support CSO abatement plans[1].

[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, but the process was perceived as administratively cumbersome.

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 (POTW), 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.

As untreated CSOs cause violations of water quality standards, and thus are in violation of NPDES permits, all of the state's CSO permittees are under enforcement orders 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.

Presently, there are twenty–four (24) CSO communities in the Commonwealth. None are located in Cape Cod watershed.

Additional Tools to Address Failed Septic Systems:

Septic System Regulations (Title 5): 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 groundwaters from bacterial contamination. The regulations also provide minimum standards for replacing failed and inadequate systems. The Department has established a *mandatory* requirement that all septic systems must be inspected and upgraded to meet Title 5 requirements at the time of sale or transfer of the each property.

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 1 & 2 Stormwater Regulations: Existing stromwater discharges are regulated under the federal and state Phase 1 and Phase II stormwater program. In MA there are two Phase 1 communities, Boston and Worcester. Both communities have been issued individual permits to address stromwater discharges. The communities on the Cape that are covered under the Phase II rule include: Bourne, Falmouth, Sandwich, Mashpee, Barnstable, Yarmouth, Dennis, Harwich, Brewster, Chatham, Orleans, and Eastham.

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.

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 measureable 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's 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.

A full list of Phase II communities in MA can be found at:

http://www.mass.gov/dep/water/laws/p2help.htm

In addition to the Phase I and II programs described above the Massachusetts Department of Environmental Protection's proposed new "Stormwater Management Regulations," that would establish a statewide general permit program aimed at controlling the discharge of stormwater runoff from certain privately-owned sites containing large impervious surfaces. The proposed regulations would require private owners of land containing five or more acres of impervious surfaces to apply for and obtain coverage under a general permit; implement nonstructural best management practices (BMPs) for managing stormwater; install low impact development (LID) techniques and structural stormwater BMPs at sites undergoing development or redevelopment; and submit annual compliance certifications to the Department. Any new construction will have to comply with state stormwater standards and permits and with the antidegradation requirements of the state water quality standards.

Where the Department has determined that stormwater runoff is causing or contributing to violations of the Massachusetts Surface Water Quality Standards, the proposed regulations would allow MassDEP to impose the same requirements on certain private owners of land with less than five acres of impervious surfaces and require the owners of such land to design and implement the LID techniques and stormwater BMPs needed to address these violations.

The DEP Wetlands regulations (310 CMR 10.0) direct issuing authorities to enforce the DEP 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. A stormwater handbook was developed to promote consistent interpretation of the Stormwater Management Policy and Performance Standards: Volume 1: Stormwater Policy Handbook and Volume 2: Stormwater Technical Handbook can be found along with the Stormwater Policy at: http://www.mass.gov/dep/water/laws/policies.htm#storm.

Financial Tools

Nonpoint Source Control Program: DEP has established a non-point source program and grant program to address non-point source pollution sources statewide. The Department has developed a Nonpoint Source Management Plan 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, marina's 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 DEP's list of impaired waters. The program also provides high priority points to those projects designed to address TMDL recommendations. In 2005 approximately $5 million in EQIP funds are available to address water quality goals through the application of structural and non-structural BMPs. Over the past several years EQIP funds have been used throughout the Commonwealth are available to address water quality goals through the application of structural and non-structural BMPs.

MA, 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 303d listed waters and to implement TMDLs.

The 319 program also provides additional assistance in the form of guidance. The Department is in the process of updating the Massachusetts' Nonpoint Source Management Manual that will provide detailed guidance in the form of BMPs by landuse to address various water quality impairments and associated pollutants.

Finally, it should be noted that the approach and process outlined for implementing this TMDL has been previously demonstrated with documented success. A previous TMDL, which utilized this approach was developed and approved by EPA for the Neponset River Watershed. The recommendations outlined in that TMDL were similar to the current proposal. Since the time of approval, MassDEP worked closely with a local watershed group (Neponset River Watershed Association) to develop a 319 project to implement the recommendations of the TMDL. The total project cost was approximately $472,000 of which $283,000 was provided through federal 319 funds and the additional 40% provided by the watershed association and two local communities. Although the project is not yet completed, the Towns and watershed association have worked closely together to identify and install several new structural BMPs (enhanced wetland and bioretention cells) to reduce stormwater and bacterial inputs into Pine Tree Brook which was impaired due to pathogens. Additional BMPs are being evaluated for future implementation at this time.

Other examples include the Little Harbor in Cohasset and the Shawsheen River. Similar TMDLs were developed in these areas. In Little Harbor, the TMDL was used as the primary tool to obtain local approval and funding to design and install sewers around Little Harbor and other additional areas of Town impacted by sewerage contamination. Presently, the Town is seeking additional state funding to construct the sewers. In the Shawsheen Watershed the TMDL was used to obtain a state grant to identify and prioritize specific stormwater discharges for remediation. In addition, MassDEP has received a grant to a conduct additional sampling and refine field and laboratory techniques that will allow us to differentiate between human and non-human sources that will be useful statewide. MassDEP and EPA Region 1 are also working on an compliance & enforcement strategy to address the worst sources.

Additional information related to the non-point source program, including the Management Plan can be found at: http://www.mass.gov/dep/water/resources/nonpoint.htm.
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. Since July 2002 the MassDEP has issued millions of dollars in for the planning and construction of CSO facilities and to address stormwater. During the 2002- 2005 time period, a total of over $ 4 million in total loans have been distributed to 13 of the 15 communities on the Cape to upgrade and/or replace a total of 451 failed Title 5 systems. Since 2005, Barnstable County has loaned out a total of $ 13 million that has been distributed to these towns, resulting in the repair of 998 systems. These programs all demonstrate the State's commitment to assist local governments in implementing the

TMDL recommendations. Additional information about the SRF Program is located at: http://www.mass.gov/dep/water/wastewater/wastewat.htm#srf.

Bacteria Source Tracking Program: Over the last several years MassDEP has hired new regional staff and provided analytical capabilities in three regions (Northeast, Southeast, and West) to work with communities to track, identify and eliminate bacteria sources that contribute to water quality impairments.

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. DEP'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 CCC, Barnstable on 7/23/2005 to present the Bacteria TMDL and to collect public comments. The public comment period began on July 23, 2005 and closed on August 26, 2005. The attendance list, public comments, and the MassDEP responses are attached as Appendix A.

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APPENDIX A

Public Participation

Section II RESPONSE TO COMMENTS ON THE PATHOGEN TMDL FOR THE CAPE COD WATERSHED

Public Meeting Announcement Published in the Monitor	7/23/2005
Date of Public Meeting	8/1/2005
Location of Public Meeting	CCC, Barnstable
Times of Public Meeting	3 P.M. and 7 P.M.

CAPE COD WATERSHED DRAFT PATHOGEN TMDL PUBLIC MEETING ATTENDEES

Date 8/1/2005 Time 3 PM

Name	Organization
1. Ed Baker	Mashpee Environmental Coalition
2. Tom Cambareri	Cape Cod Commission
3. Scott Michaud	Cape Cod Commission
4. Mike Hill	EPA
5. Richard Ray	Nantucket Health Department
6. Susan Rohrbach	Senator Robert O'Leary

Date 8/1/2005 Time 7 P.M

Name	Organization
1. Peggy Funtozzi	Nantucket Conservation Commission
2. Mike Hill	EPA
3. Robert Duncanson	Chatham

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: Waste load 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 (WQS), do not have any waters designated for "non-contact recreation." All Massachusetts surface waters currently are designated in the WQS 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 WQS 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 colonies per 100 ml, typically based on a minimum of five samples, and 10% of such samples shall not exceed 1260 colonies 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 WQS 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 WQS, 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 is a promising but as yet not fully reliable tool in distinguishing between human and other sources of fecal bacteria. When perfected, this tool will be extremely valuable in helping target sources of pathogens and 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. Once developed MassDEP will include those techniques into our sampling programs, however, we hope local monitoring programs will also benefit from them.

5. Question: What is the current thought on e coli / entero 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, a 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: Phase I and Phase II municipalities already do regular reporting and provide annual status reports on their efforts. Any additional information can be coupled with existing reporting requirements and monitoring results to determine the success and failure of implementation measures. For non-Phase II municipalities it gets more difficult and MassDEP may have to work directly with each community or possibly add communities with known impairments to the Phase II list. The TMDL does not require volunteer groups, watershed organizations or towns to submit periodic reports - it is not mandatory. The MassDEP is relying on self interest and a sense of duty for communities to move ahead with the needed controls facilitated by some state aid. 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 became effective in Massachusetts in March 2003. 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 Phase II permit uses a best management practice framework and measurable goals to meet MEP and water quality standards. A requirement of the permit is that if a TMDL has been approved for any water body into which the small municipal separate storm sewer system (MS4) discharges, the permittee must determine whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the MS4. If the TMDL includes a pollutant waste load allocation, best management practices (BMPs) or other performance standards for stormwater discharges, the permittee must incorporate them into their SWMP. The permittee must assess whether the pollutant reduction required by the TMDL is being met by existing stormwater management control measures in their SWMP or if additional control measures are necessary. 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 for bacteria 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), "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, 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, 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, Wayland, Hanlon memorandum, page 5). Consistent with this, the Massachusetts' pathogen TMDLs state that BMPs may be used to meet WQS. 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 WQS, however, will be assessed through ambient monitoring.

In stormwater TMDLs, the issue of whether WQSs 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, Wayland, Hanlon memorandum, page 5).

A more detailed discussion / explanation of this response can be found in TMDL, a memorandum titled "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water 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 in regards 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 239 cities and towns in Massachusetts do have legal requirements to implement best management practices under their general NPDES storm-water permits. 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 required 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.

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 $2 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 eliminates 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 General Stormwater permit that is in the process of being developed.

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 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 waste load 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 waste load 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.

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 Phase II Program 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 and estimated the percent reduction 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 7-1 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 6-1. 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: All of the sources of impairments listed in Table 6-1 are addressed in Table 7-1, the text of Section 7, or both. Because Table 6-1 and 7-1 serve slightly different purposes it was not intended that the tasks needed to align with and exactly address the eight sources of impairment.

18. Comment: While the text in sections 7.1-7.7 of each TMDL describe some actions that can address the sources in Table 6-1, 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 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 as status of that work. Programs, such as Phase II Stormwater, 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.

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, Section 7.0 of each TMDL states 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 Phase II stormwater program required all communities to submit an application and plan in 2003. That plan must address the six minimum control measures and establish regulatory mechanisms to implement pre/post construction runoff controls and illicit discharge detection and elimination (IDDE) by 2008. Status reports are developed annually to report their progress on achieving that goal. Complete implementation, however, will likely take many more years.

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. 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 exceedences 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(CSO) or 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 (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 (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 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 new 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 new bacteria water quality criteria should be incorporated into the permitting process as well as the state 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. Readers / users of the bacteria TMDL reports should be aware that new water quality standards were developed and included in the December 29, 2006 revisions to 314 CMR 4.00: Massachusetts Surface Water Quality Standards. These standards have been included in the final Pathogen TMDL for the Merrimack 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: Mass Highway is included in the Stormwater Phase II Program, and as such is responsible for completing the six minimum controls mandated by that program, i.e., public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post construction stormwater management, and good housekeeping in operations. EPA and MassDEP have authorized MassHighway to discharge stormwater from its designated Small MS4 in accordance with its issued permit. However, as of January 2006, EPA has not approved of MassHighwy's SWMP and as a result has not authorized stormwater or allowable non-stormwater discharges from any portion of MassHighway's regulated Small MS4.

27. Comment: The current 303d list of impaired waters – is it the 2002 or the 2004 list?

Response: It is the 2008 list. The 2008 list was recently approved by EPA. All of the pathogen TMDLs will apply to the current 2008 303d list.

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, 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) will be targeted toward TMDL implementation. Also, the more TMDLs a state completes and gets approved by EPA the more funding it will receive from EPA and thus the more TMDL implementation it can initiate.

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 on implementation which includes a table 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 document "Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts" was developed to support implementation of pathogen TMDLs. The MassDEP working with EPA and other team partners shall make every reasonable effort to assure implementation of the TMDLs.

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 Stormwater Phase II 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 Phase II program 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 in regards to coordinating implementation tasks.

Response: This is a good comment. 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.

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: Section 9.0, Reasonable Assurances, should provide these assurances. This section has been drastically expanded in the Final version of the Draft Pathogen TMDL reports. The revised section 9.0 describes all of 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, 6217 coastal 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 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.

Watershed Specific Comments / Responses (Cape Cod and Islands Meetings)

1. Comment *(by CZM)*
p. 38, Section 5.0, first paragraph, Only estuaries and lakes are mentioned in the second paragraph. Were freshwater streams assessed? If so, are any freshwater streams impaired by bacteria?

Response: There are no freshwater streams assessed on the Cape, so there are none on the 2004, 2006, or 2008, Category 5 303(d) listing. All segments are either salt water estuaries or fresh water ponds. The TMDL reflects this.

2. Comment: Several comments noted that many towns continue strong efforts to control bacteria contamination and other pollution problems within the resources available. Among the comments to this effect were:

Richard Ray, Certified Health Officer, Town of Nantucket, (508) 228-7226:
Nantucket has created two "protection districts" with regard to sewage/septic issues. The first is in the Nantucket Harbor area, the second in the Madaket Harbor area. In the Nantucket Harbor area they have mandated that all septic systems be inspected and be brought up to code. They plan to do the same for

Madaket Harbor area. After these two zones are done, the town officials plan to do the same for all other septic systems on the island.

Another person commented that there is “Project Storm”, which was described as a loose coalition of representatives from many of the towns on the Cape that were attempting to address Phase II stormwater issues.

Response: MA DEP is aware of, and acknowledges and supports the long on-going work that many municipalities have devoted to protecting the environment. To the degree possible, the Department intends to help those towns continue their efforts and to encourage other, communities, which have been less active in this regard, to follow the initiative of the active communities.

3. Comment: Several comments were directed towards the complications associated with applying for and reporting details associated with state grant programs.

Some felt that the state should figure out a way to assist towns in both applying for and administering grants. Suggestions included using the Massachusetts Environmental Trust.

Mr. Duncanson, the health officer from Chatham, mentioned that applying and administering 319 grants was simply too onerous for someone at the town level to bother with. It was mentioned that the same rules apply for those applying for a large grant as for a small grant and that towns were simply not equipped to deal with the hassles.

Also, it was suggested that grant application announcements take into account local budget cycles since matching funds often are available only thorough Town Meeting or City budget action.

Response: MA DEP is sympathetic to the paper work issues raised. The Department will review the body of requirements to assess what streamlining may be possible; however, many programs such as the 319 are Federal programs that have certain requirements of which the Department cannot control. At the same time, the Department notes that accountability for spending public funds continues to be an important and required component of any grant program.

Announcements of grant application reflect Congressional and Budget Office timing, but the concern will be relayed to EPA.

4. Comment- It is noted that there are quite a few segments on the Western end of the Cape in Falmouth and Bourne that are not included in this report. Could you explain that?

Response- The MassDEP, beginning with the 2004 Integrated List of Impaired Waters, determined that 14 segments on the Western end of the Cape in Falmouth and Bourne most appropriately fit within the Buzzards Bay Watershed, as drainage from these segments goes into Buzzards Bay. These segments include: MA95-14, Cape Cod Canal; MA95-48 Eel Pond; MA95-47 Back River; MA95-15 Phinneys Harbor; MA95-16 Pocasset River; MA95-18; Pocasset Harbor MA95-17; Red Brook Harbor; MA95-21 Herring Brook; MA95-46 Harbor Head; MA95-20 Wild Harbor; MA95-22 West Falmouth Harbor; MA95-23 Great Sippewisset Creek; MA95-24 Little Sippewisset Marsh; MA95-25 Quissett Harbor. These segments are covered in the Buzzards Bay Bacteria TMDL Report.

APPENDIX B

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

OFFICE OF WATER

MEMORANDUM

NOV 22 2002

SUBJECT: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water 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 storm water 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 storm water discharges in TMDLs. The key points presented in this memorandum are as follows:

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

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

Storm water 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 storm water 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 storm water discharges (in the form of WLAs) and unregulated storm water (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 storm water 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 storm water 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 storm water discharges in WLAs in TMDLs;

(II). Options for addressing storm water in TMDLs; and

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

(I). Regulatory Basis for Including NPDES-regulated Storm Water 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 storm water. 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 storm water 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 storm water program to include discharges from smaller MS4s (including all systems within "urbanized areas" and other systems serving populations less than 100,000) and storm water 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 storm water permits depending on the source (industrial versus municipal storm water). Permits for storm water 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).

Storm water discharges that are regulated under Phase I or Phase II of the NPDES storm water program are point sources that must be included in the WLA portion of a TMDL. See 40 C.F.R. § 130.2(h). Storm water discharges that are not currently subject to Phase I or Phase II of the NPDES storm water 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 Storm Water 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 storm water data available for a TMDL varies from location to location. Nevertheless, EPA expects TMDL authorities will make separate aggregate allocations to NPDES-regulated storm water discharges (in the form of WLAs) and unregulated storm water (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 storm water 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 storm water discharges, or when information allows, as different WLAs for different identifiable categories, e.g., municipal storm water as distinguished from storm water discharges from construction sites or municipal storm water 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 storm water sources or dischargers).

(III). Determining Effluent Limits in NPDES Permits for Storm Water 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 storm water 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 Storm Water Permits*, 61 FR 43761 (Aug. 26, 1996). The Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in storm water 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 storm water 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 storm water 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 storm water. 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 storm water 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 storm water 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 storm water 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 storm water 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