R-WD-16-20

Bacteria Total Maximum Daily Load (TMDL) Report

for Camp Hadar Beach on Captain Pond in Salem, NH

(and Updated Bacteria Results for Camp Otter Beach)

(Final Report)

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1. INTRODUCTION

1.1 Overview of 303(d) List and TMDLs

Section 303(d) of the Federal Clean Water Act (CWA) and Federal Water Quality Planning and Management Regulations (40 CFR Part 130) require states to place certain waterbodies that do not meet established water quality standards (WQS) on a list of impaired waterbodies, commonly referred to as the 303(d) List. In New Hampshire, the Department of Environmental Services (DES) is responsible for the 303(d) listing process. The 303(d) List is updated, issued for public comment and submitted to the USEPA for approval every two years. The 303(d) List includes surface waters that: (1) are impaired or threatened by one or more pollutants; (2) are not expected to meet water quality standards even after implementation of technology-based controls; and (3) require a Total Maximum Daily Load (TMDL) study for the pollutant(s) causing the impaired or threatened status. In general, surface waters on the 303(d) list can only be removed if: (1) a TMDL has been conducted and approved by the USEPA; (2) there is sufficient evidence showing the waterbody is meeting water quality standards; or, (3) the reasons for listing the waterbody as impaired were found to be in error.

A TMDL establishes the allowable loadings for specific pollutants that a waterbody can receive without exceeding water quality standards. Water quality standards include numeric and narrative criteria that must be met to protect the uses of the surface water such as swimming, boating, aquatic life, and fish/ shellfish consumption. The TMDL process maps a course for states and watershed stakeholders to follow that should lead to restoration of the impaired water and its uses.

1.2 Background and Purpose of this Report

On September 21, 2010, the New Hampshire Department of Environmental Services (NHDES) received approval from the United States Environmental Protection Agency (USEPA) of a statewide total maximum daily load (TMDL) report for bacteria impaired waters[1] (the Statewide Bacteria TMDL). Bacterial contamination can render surface waters[2] unsuitable for uses such as swimming and shellfish consumption and may result from a variety of sources including human waste, excrement from barnyard animals, pet feces, and agricultural applications of manure.

The purpose of the Statewide Bacteria TMDL was to:

1. Provide documentation of the impairments;
2. Determine the TMDLs that will achieve water quality standards;

[1] Final Report New Hampshire Statewide Total Maximum Daily Load Prepared by F.B. Environmental Associates, Inc., for the New Hampshire Department of Environmental Services. September, 2010. A copy may downloaded from http://des.nh.gov/organization/divisions/water/wmb/tmdl/categories/publications.htm.

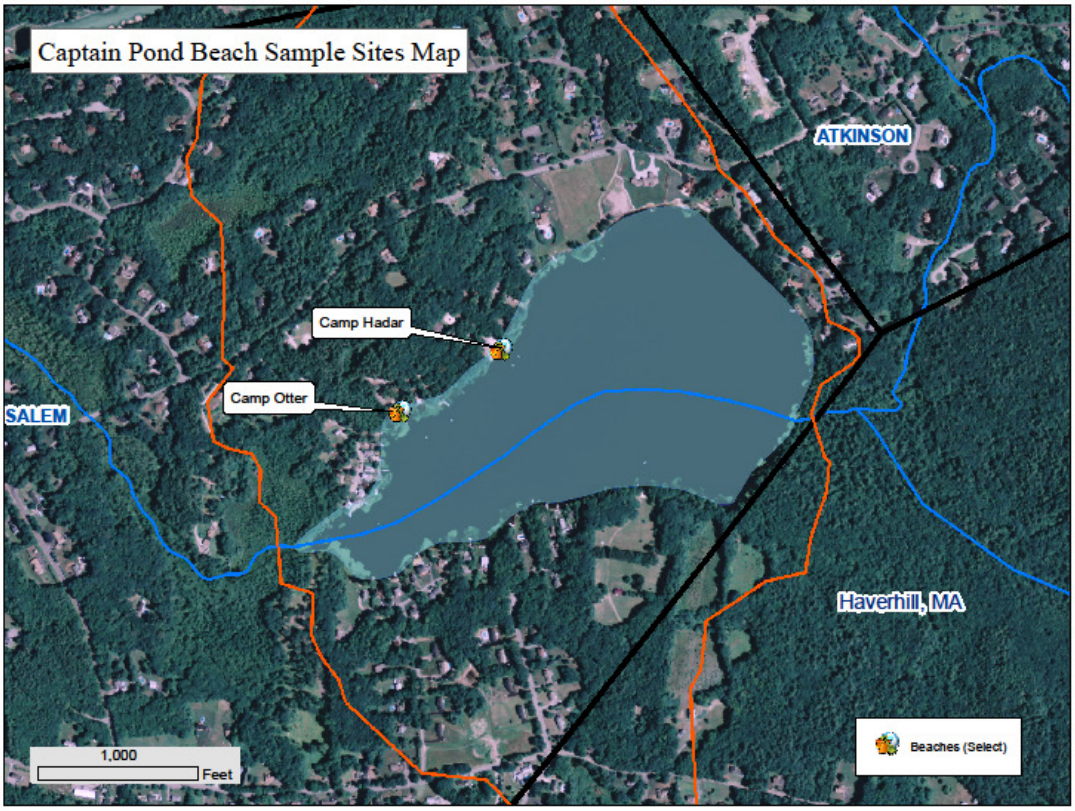
[2] Surface waters are defined in Env-Wq 1702.46. Examples of surface waters include rivers, streams, lakes, ponds, tidal waters and certain wetlands.

3. Provide an estimate of the reductions necessary to achieve the TMDLs; and
4. Provide information on possible restoration measures to help communities, watershed groups, and other stakeholders to implement the TMDL in a phased approach that will ultimately result in attainment of water quality standards.

The Statewide Bacteria TMDL specifically addressed 379 waters that were listed as impaired for bacteria on the 2008 303(d) List with the intent that if additional bacteria impaired waters were added to future 303(d) Lists, the bacteria TMDLs for the new listings could reference the Statewide Bacteria TMDL to satisfy many of the federal TMDL requirements.

The primary purpose of this report is to provide the bacteria TMDL for Camp Hadar Beach (assessment unit (AU) NHLAK700061102-03-06) on Captain Pond in Salem, NH, (see Figure 1-1) which is listed as impaired for bacteria (Escherichia coli) on the 2014 303(d) List3, and to provide specific recommendations regarding restoration measures that will eventually result in attainment of bacteria water quality standards (see Appendix A, section A3.4).

Figure 1-1: Map showing location of beaches on Captain Pond in Salem, NH



[3] The 2014 303(d) List is available at http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm.

A secondary purpose of this report is to provide an update on the status of water quality at Camp Otter Beach (AU NHLAK700061102-03-03) on Captain Pond as well as to provide restoration and monitoring recommendations (see Appendix A, section A4). Based on bacteria data collected from 2004 to 2007, Camp Otter Beach was listed as impaired for bacteria on the 2008 303(d) List and was therefore included in the 2010 Statewide Bacteria TMDL. Since 2010, more monitoring data has been collected.

1.3 Where to Find TMDL Information

This bacteria TMDL report for Camp Hadar Beach on Captain Pond serves as an extension of the approved Statewide Bacteria TMDL report. As such it relies, in part, on portions of the Statewide Bacteria TMDL to satisfy federal TMDL requirements. A list of the various TMDL elements and where they are addressed in the statewide report is provided in Table 1-1.

Table 1-1: Where to Find Information for Each TMDL Element in the Statewide Report

TMDL Element	Where to find this information
Water Quality Standards for Bacteria **-** Includes an overview of potential pathogenic impacts of bacteria; the selection of indicator bacteria to assess pathogen levels in waterbodies; and, a brief summary of New Hampshire bacteria standards for surface waters.	Statewide Bacteria TMDL - section 2
Bacteria Pollution Sources– Defines point and non-point sources of bacteria pollution and provides examples of bacteria sources that affect New Hampshire's waterbodies	Statewide Bacteria TMDL - section 3
Bacteria Impaired Waters - Provides a brief introduction to all bacteria impaired waters in New Hampshire (based on the *2008 303(d) List*). This section also includes an overview of the 303(d) listing process; a summary of agencies that collect bacteria data in New Hampshire; and, a description of the TMDL prioritization process.	Statewide Bacteria TMDL - section 4
TMDL Development - Provides a description of the TMDL calculation process including the key required elements for TMDL development and includes concentration based TMDLs and associated wasteload and load allocations for freshwaters (primary contact recreation) and tidal waters (primary contact recreation and shellfish consumption).	Statewide Bacteria TMDL - section 5
Implementation Plan - Provides a description of the implementation process, including coordination with local stakeholders and development of watershed based plans, and a menu of mitigative actions (organized by type of source) to reduce bacteria loadings.	General information is provided in the Statewide Bacteria TMDL - section 6. Data summaries and specific recommendations for restoration and monitoring activities for each impaired waterbody covered in this report are included in Appendix A (sections A3 and A4) of this document
Funding and Community Resources – Provides a description of funding sources available to address impaired waters in New Hampshire.	Statewide Bacteria TMDL - section 7

TMDL Element	Where to find this information
Bacteria Data Summaries and Reductions –this section includes available bacteria data, reductions needed for each impaired segment, and GIS maps of HUC watersheds and land cover.	Appendix A (sections A3 and A4) of this document
Public Participation – Includes a review of the process used to solicit public comment and NHDES' response to comments.	Section 3 of this document
TMDL Expressed as a Daily Load	Appendix B of this document
Examples of Detailed Implementation Plans to address bacteria impairment. One example is a Watershed-based Restoration Plan and the other is a Storm Drain Illicit Discharge Detention and Elimination Investigation.	Statewide Bacteria TMDL - section 9 .

2. BACTERIA DATA SUMMARY AND REDUCTION ESTIMATES

2.1 Overview

As discussed in section 1.3 and as shown in Table 1-1, this TMDL document relies on many sections in the Statewide Bacteria TMDL approved in 2010 to address many of the federally required TMDL elements. Specific information for Camp Hadar Beach, as well as Camp Otter Beach, is provided in Appendix A, sections A3 and A4 respectively. This includes the applicable bacteria water quality criteria, a summary of bacteria data collected since 2005, estimated bacteria reductions necessary to comply with bacteria standards, photos of each beach, and recommended restoration and monitoring activities. Section 2.2 below includes a description of the methodology used to estimate bacteria reductions and a summary of the estimated reductions needed in each of the impaired waterbodies (see Table 2-1) to comply with bacteria water quality standards.

2.2 Estimated Reductions Needed to Meet TMDL

A description of the methodology used to provide an estimate of the percent (%) reduction in bacteria necessary to comply with bacteria water quality standards is provided below. In general, the estimate of percent (%) reduction is based on the difference between measured ambient bacteria concentration and the water quality criteria for bacteria. A summary of the estimated percent reductions for the two bacteria impaired AUs is provided in Table 2-1.

For segments impaired by *E. coli*, the necessary % reduction was calculated based on both single sample and geometric mean water quality standards. The following process was used to estimate the % reduction necessary to achieve the water quality standard in each impaired segment:

For E. coli impaired segments: Select highest concentration level of single sample indicator bacteria among all current samples (both dry and wet conditions) taken within an impaired segment. For the highest concentration of bacteria for the impaired segment, calculate the % reduction in bacteria levels needed to meet the appropriate single sample water quality criteria.

For example, if the highest single sample value is 400 E. coli/100mL, the % reduction needed to meet the single sample criterion is 78% ([(400 – 88)/400] x 100 = 78% reduction).

For all impaired segments: Select highest geometric mean value, based on a rolling average of at least 3 independent samples within an impaired segment collected within 60 consecutive days, or at least 3 samples collected at the same location within the impaired segment provided at least 2 of the samples are separated by a period of at least one day (for more information on geometric mean calculation refer to the 2014 New Hampshire Consolidated Assessment and Listing Methodology report[4]). For the highest geometric mean value, calculate the % reduction in bacteria levels needed to meet the appropriate geometric mean water quality criteria.

While both single sample and geometric mean percent reductions are presented, it is recommended that the reductions needed to attain the geometric mean be used (when available) to guide an iterative approach to implementation and load reduction planning. This is because bacteria sampling results can be highly variable and the geometric mean helps to reduce the undue influence of any one data point.

Table 2-1: Summary of Estimated Percent Reductions Needed to Meet the TMDL

Watershed Name	Assessment Unit #	Waterbody Name	Primary Town	% Reduction Needed to meet the TMDL for the Geometric Mean*	% Reduction Needed to meet the TMDL for the Single Sample	Appendix containing data used in the calculations
Merrimack River	NHRIV700061102-03-06	Camp Hadar Beach	Salem	73%	78%	Appendix A, section A3
Merrimack River	NHRIV700061102-03-03	Camp Otter Beach	Salem	88%	78%	Appendix A, section A4

*It is recommended that the geometric mean % reduction target be used to guide an iterative approach to planning and implementation of restoration measures.

3. TMDL IMPLEMENTATION

Although not required by EPA for TMDL approval, recommended restoration measures to achieve the TMDL is typically provided in TMDL reports because of its importance in the restoration process. The success of TMDL implementation efforts rests largely with watershed stakeholders. To avoid unnecessary expenditure of funds, it is typically recommended that ambient monitoring be conducted after one or a few of the possible restoration measures are implemented. If water quality standards are not met, implementation of additional restoration measures would be conducted. This cycle of implementation followed by confirmation monitoring is called a phased implementation approach. Recommended restoration and

[4] The 2014 Consolidated Assessment and Listing Methodology is available at: http://des.nh.gov/organization/divisions/water/wmb/swqa/documents/2014calm.pdf.).

monitoring activities for Camp Hadar Beach, and Camp Otter Beach are provided in Appendix A (sections A3 and A4 respectively).

4. PUBLIC PARTICIPATION AND RESPONSE TO COMMENTS

4.1 Description of Public Participation Process

EPA regulations [40 CFR 130.7 (c) (ii)] require that calculations to establish TMDLs be subject to public review. The Draft Report was released for public review and comment on August 22, 2016 and written comments were accepted through 4pm on September 20, 2016. The Draft Report and public notice announcing the availability of the draft report for public comment was posted on the NHDES TMDL website at: http://des.nh.gov/organization/divisions/water/wmb/tmdl/index.htm. The following stakeholders were notified directly by email or mail:

- Town of Salem, NH
- Town of Atkinson, NH
- Town of Haverhill, MA
- The Captain Pond Lake Association
- Camp Hadar
- Camp Otter

A copy of the public notice is provided at the end of this section (Figure 4-1 below).

On August 30, 2016 at 7pm, NHDES conducted a public information meeting at the Salem Town Hall Knightly Meeting Room which was live-streamed on the community cable television station SGC-TV Channel 23.

4.2 Comments Received and NHDES Response

NHDES received two emails from Jonathan Heller, Director of Camp Hadar. The comments/questions (some are paraphrased and/or summarized) and the NHDES responses are provided below:

Comment #1:
Captain pond has had an increase of water fowl. We used scare tape this summer, and that significantly reduced the amount of water fowl and fecal matter on the docks.
NHDES Response:
NHDES agrees that water fowl appear to be a significant source of bacteria at Camp Hadar and Camp Otter beach. This is supported by our site visit to the pond in the spring of 2015 when we observed bird droppings at the beaches and in the water. NHDES supports the efforts of the owners and staff at Camp Hadar to deter waterfowl from the beach and swimming area and encourages the Camp to continue doing so in the future.

Comment #2:
Almost every time the town of Salem tests the water after rain, it tests higher in bacteria.
NHDES Response:
Knowing when bacteria levels spike (i.e., during wet or dry weather) can help guide implementation measures to reduce bacteria loads. For example, high counts during wet weather typically indicates that a major source of bacteria is on the land and that it is being washed into the pond by stormwater runoff. Examples of land-based sources include, but are not limited to, feces deposited on the land from pets or wildlife (i.e. waterfowl). High counts during dry weather, on the other hand, typically indicates either a sewer leak or that the source is in the pond such as birds defecating in the pond, or, in some cases, from the swimmers themselves (i.e. the bather load). To help determine the source, the report recommends installing a rain gage at the pond and collecting weather data when bacteria samples are collected.

Comment #3:
How does this report impact Camp Hadar for 2017 and beyond?
NHDES Response:
The report includes several recommendations for reducing the source(s) of bacteria in a phased approach with the ultimate goal of attaining bacteria standards at all times at both Camp Hadar and Camp Otter. To achieve this goal will require cooperation and participation by all stakeholders. NHDES encourages Camp Hadar staff to continue with their efforts to deter waterfowl and recommend that Camp Otter do the same. We also encourage the camps to cooperate with the Town as they continue their efforts to sample the beaches, identify the major sources of bacteria, and implement appropriate restoration measures.

NHDES also plans to assist restoration efforts by providing brochures, fact sheets and other prepared information to the Town that can be used to conduct outreach to the local landowners/stakeholders regarding proper septic system maintenance and pet waste disposal. In addition, NHDES will continue supporting the volunteer lake monitors through the NHDES Volunteer Lake Monitoring Program (VLAP) and, pending resources, plans to conduct a three year Lake Survey starting this summer which may provide further information regarding potential source(s) of bacteria to the pond.

Comment #4:
How will the town and state address the areas that you mentioned on Captain Pond for possible human fecal matter draining into the pond?
NHDES Response:
Appendix A Section 3.4 of the report recommends several implementation measures to investigate the potential human component of the bacteria load to the pond including conducting a septic system inventory, investigating the bather load component at the beach and following the additional recommendations in the FB Environmental report.

Comment #5:
I'm just curious as to why the report draws more interest on Camp Hadar when Camp Otter tests high every summer. I'm just concerned that the title focusing on only Camp Hadar is misleading to the public. I would respectfully ask that the report title be changed to be more reflective of the

issue throughout Captain Pond and not specifically state one camp or direct any public bias to one camp in a public report.

NHDES Response:

Because beaches have different (i.e., more stringent) bacteria standards than other surface waters, NHDES creates separate segments (called assessment units) for all designated beaches so that they can be assessed independently. Camp Hadar Beach and Camp Otter Beach are designated beaches.

NHDES is required by the federal Clean Water Act to conduct TMDLs on all impaired surface waters on the state's 303(d) List, which is a list of surface waters that are impaired by a pollutant and do not have an EPA approved TMDL. Camp Hadar Beach is the only assessment unit on Captain Pond that is listed as impaired for bacteria on the latest 303(d) List. Although Camp Otter Beach is also currently impaired for bacteria it is no longer on the 303(d) list because a bacteria TMDL for Camp Otter Beach was conducted and approved by EPA in 2010 as part of the 2010 Statewide Bacteria TMDL.

As stated in the report, the primary purpose of the report is to provide a bacteria TMDL for Camp Hadar Beach. A secondary purpose is to provide an update on the results of bacteria monitoring conducted at Camp Otter Beach since the bacteria TMDL was completed in 2010. With the above in mind, NHDES has revised the report title as follows:

"Bacteria Total Maximum Daily Load (TMDL) Report
for Camp Hadar Beach on Captain Pond in Salem, NH
(and Updated Bacteria Results for Camp Otter Beach)"

4.3 Summary of Substantive Changes Since the Draft Report

The following revisions were made after the draft report was issued for public comment:

- The Waterfowl Deterrence Section A.3.4 of Appendix A, was modified to include the measures that have been implemented at Camp Hadar over the last two years to deter birds from the swimming area, docks and beach.

- The Inventory Septic Systems Section A.3.4 of Appendix A was modified to include information on the shoreline survey of the specific conductivity that NHDES intends to conduct in the fall of 2016.

- Other revisions consisted of minor editing and formatting changes in the main report and appendices.

Figure 4-1: Public Notice

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Date: August 22, 2016

Subject: **PUBLIC NOTICE– Draft Bacteria Total Maximum Daily Load (TMDL) Report for Camp Hadar Beach on Captain Pond in Salem, NH is available for Public Comment**

PUBLIC COMMENTS WILL BE ACCEPTED UNTIL 4 PM ON September 20th, 2016

Dear Interested Party or Stakeholder:

The Draft Bacteria Total Maximum Daily Load (TMDL) Report for Camp Hadar Beach on Captain Pond in Salem, NH is now available for public review and comment on the New Hampshire Department of Environmental Services website at: http://des.nh.gov/organization/divisions/water/wmb/tmdl/categories/publications.htm.

Based on sampling data, the pond water at Camp Hadar Beach occasionally exceeds state bacteria standards in surface waters at designated beaches. High levels of bacteria can indicate the presence of waterborne disease organisms, known as pathogens, which can pose a public health risk and render a surface water unsuitable for uses such as swimming and shellfishing (in tidal waters). Surface waters include rivers, streams, lakes, ponds, wetlands and tidal waters. Examples of bacteria sources include improperly treated human waste and storm water runoff that has come in contact with feces from domesticated animals (pets, barnyard animals, etc.) and wildlife.

The purpose of a TMDL is to calculate the amount of pollutant (such as bacteria) that a surface water can assimilate without exceeding State surface water quality standards. An important goal of the TMDL process is to promote, encourage, and inform local community action for water quality improvement and protection of public health by addressing sources of bacterial contamination. To this end this report also provides valuable information on the probable sources of bacteria and recommended restoration and monitoring activities to help communities, watershed groups and stakeholders to implement the TMDL in a phased, community-based approach that will ultimately result in attainment of water quality standards.

This report also provides an update on the status of bacteria water quality at Camp Otter Beach on Captain Pond, which already has an approved TMDL.

A public information meeting to discuss the draft TMDL will be held at 7pm on August 30th 2016 at the Salem Town Hall, Knightly Meeting Room.

Public comments will be accepted until 4 pm on September 20th, 2016. Only written comments will be accepted. All comments must include the name of the TMDL, the date and contact information (your name, address, phone, e-mail, and organization). If you require additional time, information about the project or background data/materials to facilitate your review and prepare and submit your comments please contact Margaret Foss, NHDES TMDL Coordinator at (603) 271-5448 or via email at margaret.foss@des.nh.gov.

Comments can be mailed to:	TMDL Program, NHDES Watershed Management Bureau, 29 Hazen Drive, P.O. Box 95, Concord, NH 03302, Attention Margaret P. Foss, TMDL Coordinator
or emailed to:	Margaret.Foss@des.nh.gov

APPENDIX A - SPECIFIC INFORMATION FOR IMPAIRED WATERS IN THE MERRIMACK RIVER WATERSHED (HUC8: 01070006)

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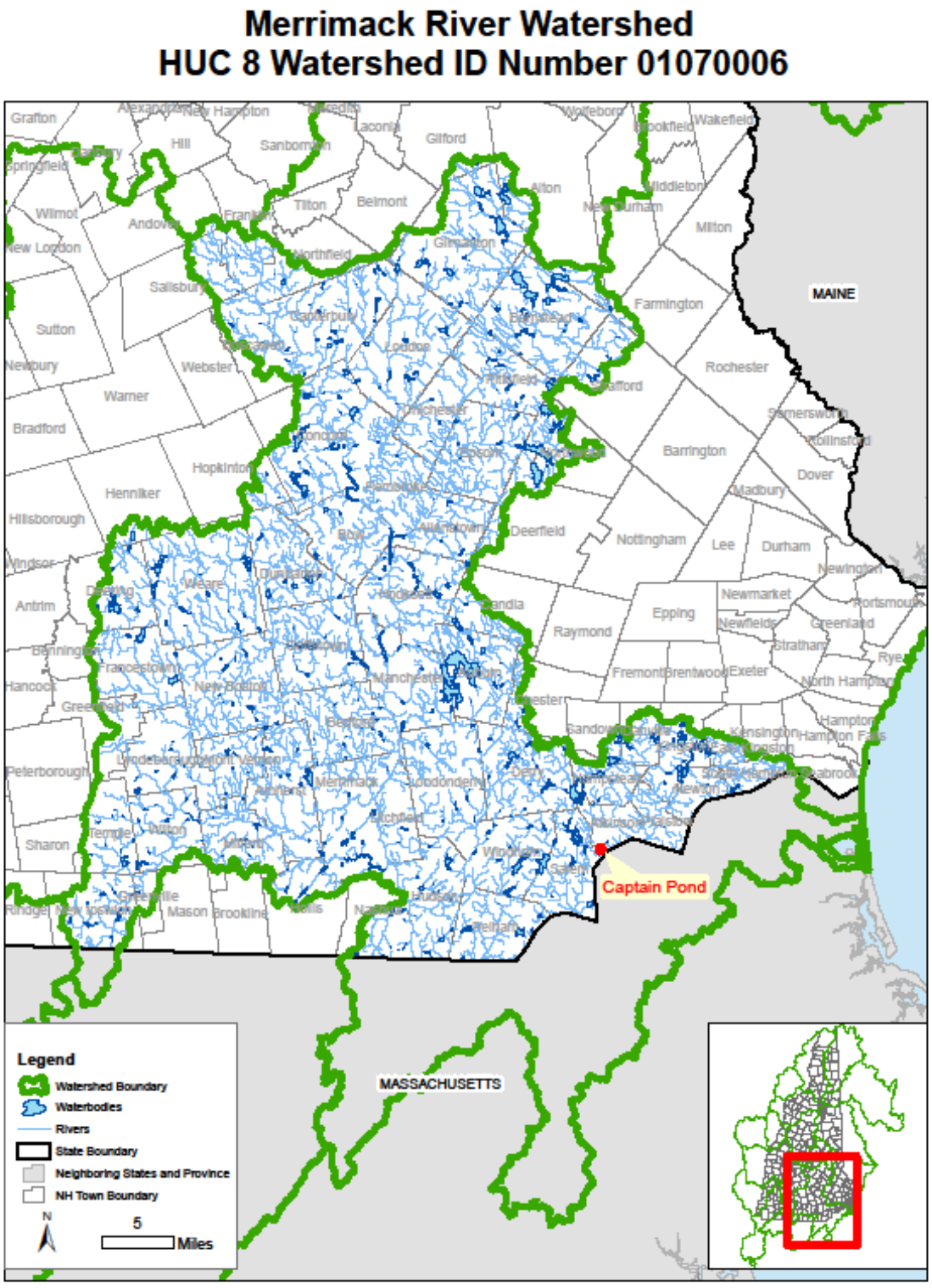
A1 OVERVIEW

This Appendix includes specific information for bacteria impaired waters in the Merrimack River watershed (Hydrologic Unit Code (HUC) 0107006). A general description of the Merrimack River Watershed is first provided in section A2. This is followed by sections that include specific information for each bacteria impaired assessment unit in the watershed. Specific information for each waterbody includes a description of the watershed draining to the impaired waterbody, a summary of water quality data and assessment information, a discussion regarding the probable sources of impairment and recommended restoration and monitoring activities.

A2 MERRIMACK RIVER WATERSHED DESCRIPTION

The Merrimack River Watershed (HUC8 number 0107006) covers an area of approximately 1,671 square miles in the southeast section of New Hampshire. A very small percentage of the watershed, including a coastal section, is located in Massachusetts. There are 71 towns located at least partially within the watershed, extending from the Massachusetts border to the northern-most town of Gilford; west to east the town boundaries are Greenfield and South Hampton, respectively. The primary watercourse in the region is the Merrimack River which is the outflow from the Franklin Falls Dam in Franklin. North of the dam the watercourse is the Pemigewasset River. Notable lakes in the area are Everett Lake, Suncook Lake, and Massabesic Lake. Much of the Merrimack River Watershed is rolling hills and urban areas with a few mountain ranges such as the Blue Hills Range on the eastern border, the Belknap Mountains to the north, and the Wapack Range along the southwest border. There is a US Military Reservation on the town intersection of New Boston, Amherst, and Mont Vernon. Figure A.2.1 below is a map of the Merrimack River Watershed with the location of Captain Pond, located in the southeastern part of the watershed, indicated by a red circle.

Figure A2.1: Merrimack River Watershed



A3 CAMP HADAR BEACH ON CAPTAIN POND

A3.1 Watershed Description

Camp Hadar Beach (NHLAK7000061102-03-06) is a designated beach[5] located on Captain Pond in Salem, New Hampshire. Captain Pond has a surface area of approximately 90 acres and a drainage area of approximately 1,269 acres which extends into the towns of Salem, NH, Atkinson, NH and Haverhill, MA. On Figure A3.1, the drainage area is depicted as two subwatersheds (labeled the Direct Drainage Area and the Northeast Watershed) which are outlined by the red line. The Northeast Watershed drains to an unnamed tributary which outlets into Captain Pond. The outlet of Captain Pond is Captain Pond Brook which is located on the western end of Captain Pond.

Figure A3.2 shows the location of Camp Hadar Beach on Captain Pond. As shown, Camp Hadar Beach is located near the middle of the northern shoreline of Captain Pond. The beach itself is a sandy cleared area that extends approximately 100 feet along the shoreline (see Figure A3.3). In the summer months there are docks placed in the water and a designated swimming area is located inside the footprint of the docks.

[5]According to Env-Wq 1102.18 "Designated beach" means a public bathing place that comprises an area on a water body and associated buildings and equipment, intended or used for bathing, swimming, or other primary water contact purposes. The term includes, but is not limited to, beaches or other swimming areas at hotels, motels, health facilities, water parks, condominium complexes, apartment complexes, youth recreation camps, public parks, and recreational campgrounds or camping parks as defined in RSA 216-I:1, VII. The term does not include any area on a water body which serves 3 or fewer living units and which is used only by the residents of the living units and their guests.

Figure A3.1: Drainage Area for Captain Pond

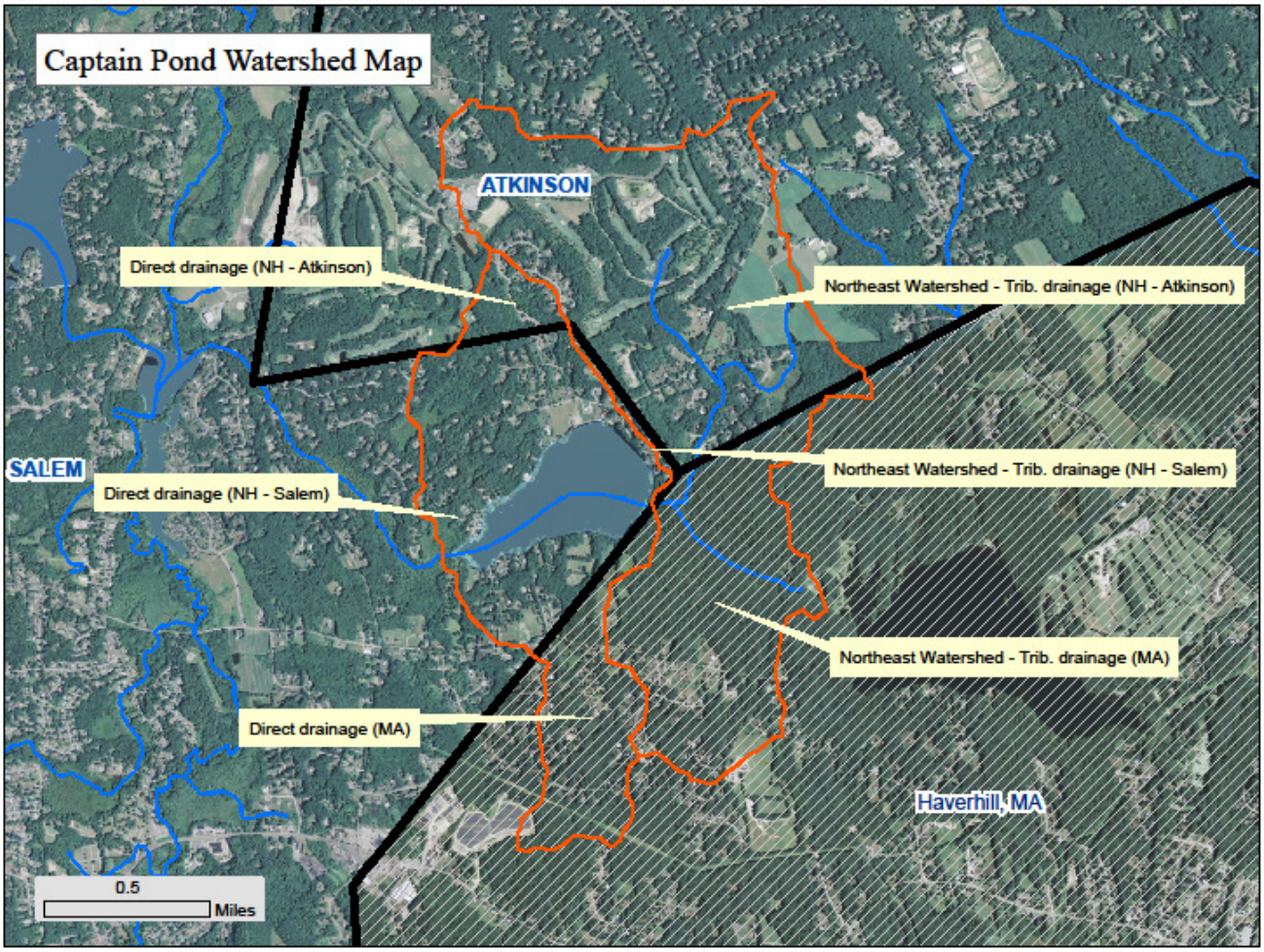


Figure A3.2: Location of Beaches on Captain Pond in Salem, NH

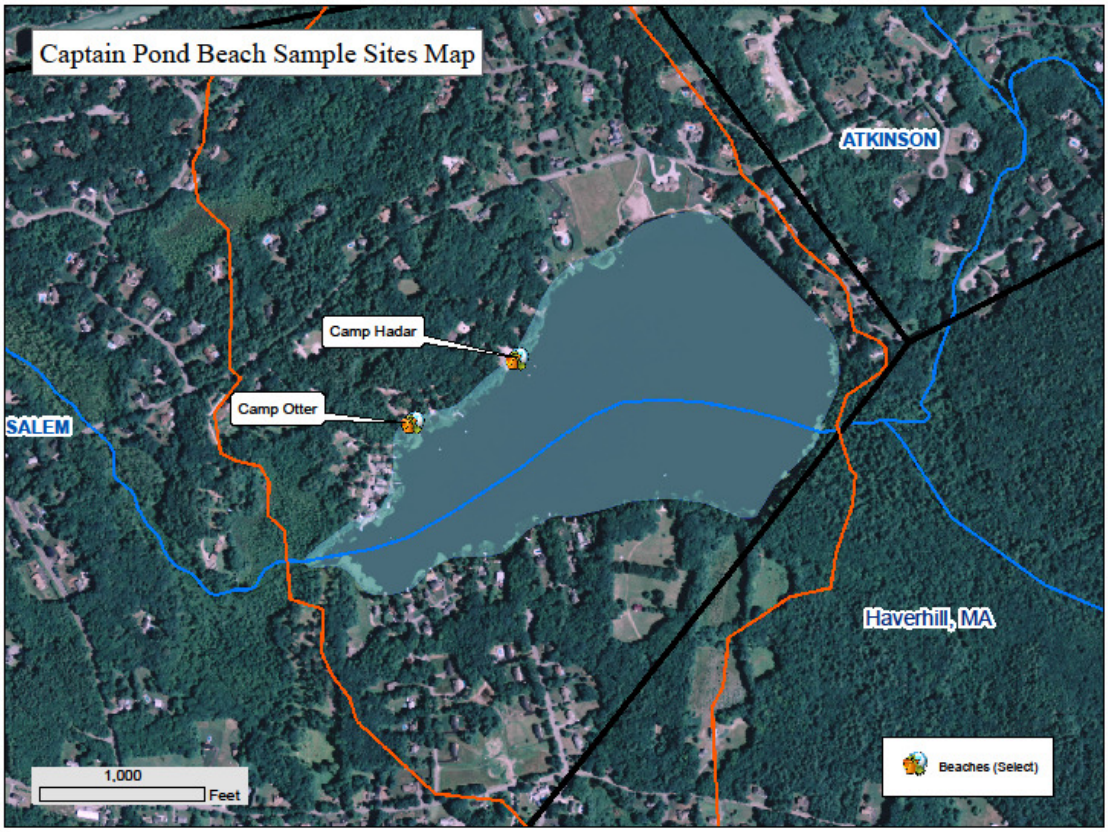


Figure A3.3: Photo of Camp Hadar Beach

A3.2 Water Quality Data and Assessment Information

A summary of the water quality information used to assess Camp Hadar Beach and to develop the TMDL is provided below. Based on the 2014 303(d) list, Camp Hadar Beach is listed as impaired for the designated use of Primary Contact Recreation due to levels of bacteria (*Escherichia coli* or *E. coli*) that exceed the *E. coli* water quality criteria shown below[6]. As discussed in the main text of this report (section 2.2), the TMDL for waters impaired by bacteria is equal to the bacteria water quality criteria.

The data used to list Camp Hadar Beach on the 303(d) List is also presented below and includes bacteria data collected from 2005-2015. Most of the data is from the Town of Salem which collects at least three bacteria samples each year (once per month from June through August) at the Camp Hadar and Camp Otter beaches with additional samples collected if results indicate violations of the bacteria surface water quality standards

An approximation of the percent (%) reduction needed to achieve bacteria water quality standards is also provided below. The methodology for computing the % reduction is discussed in section 2.2 of the main report. Where both single sample and geometric mean percent reductions are presented, it is recommended that the reductions needed to attain the geometric mean be used (when available) to guide an iterative approach to implementation and load reduction planning. This is because bacteria sampling results can be highly variable and the geometric mean helps to reduce the undue influence of any one data point.

[6] Camp Hadar Beach was first listed as impaired for bacteria on the 2012 303(d) List.

Camp Hadar Beach Assessment Unit (AU) Number: NHLAK7000061102-03-06
Freshwater or Tidal: Freshwater
Classification: Class B
Designated Beach[5]: Yes
Impaired Designated Use: Primary Contact Recreation
Cause of Impairment: *Escherichia coli (E. coli)*

Water Quality Criteria & TMDL for E coli
Single sample: 88 CTS/100mL
Geometric mean: 47 CTS/100mL

***Percent reduction for the Single Sample to meet the TMDL:* 78%**
***Percent reduction for the Geometric Mean to meet the TMDL:* 73%**

Data: from NHDES Environmental Monitoring Database (EMD)

Single sample *E coli* results (CTS/100ML) **Water Quality Criteria =** 88 CTS/100mL

Station Name	Station ID	Date	Result
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	7/13/2005	12
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	7/17/2006	24
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/20/2009	8
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/17/2010	270
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	7/27/2011	10
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	7/5/2012	400
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	7/9/2012	14
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/15/2012	400
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	6/4/2013	12
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	7/16/2013	10
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/4/2014	400
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/4/2014	400
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/6/2014	8
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/3/2015	48
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/5/2015	390
Camp Hadar, Left Side of the Beach	BCHJCDSALLF	8/10/2015	250
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	7/13/2005	30
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	7/17/2006	50
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/20/2009	8
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/17/2010	400
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	7/27/2011	14
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	7/5/2012	400
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	7/9/2012	34
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/15/2012	400
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	6/4/2013	42
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	7/16/2013	6
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/4/2014	280
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/4/2014	400
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/6/2014	12
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/3/2015	110
Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/5/2015	250

Camp Hadar, Right Side of the Beach	BCHJCDSALRT	8/10/2015	30

Shaded cells indicate exceedance of water quality criteria. Method detection limits are 2.0 – 400.0 cts/100mL. Results below 2.0 are listed as1.0 (½ the detection limit) and any counts greater than 400 are listed as 400.

Geometric mean *E. coli* results (CTS/100ML) Water Quality Criteria = 47 CTS/100mL

Station Name	Full Comparison Description	Date	Result
Camp Hadar, Left Side of Beach	E.COLI-GEO-CP	8/15/2012	130.8
Camp Hadar, Left Side of Beach	E.COLI-GEO-CP	8/6/2014	108.6
Camp Hadar, Left Side of Beach	E.COLI-GEO-CP	8/10/2015	167.3
Camp Hadar, Right Side of Beach	E.COLI-GEO-CP	8/15/2012	175.9
Camp Hadar, Right Side of Beach	E.COLI-GEO-CP	8/6/2014	110.4
Camp Hadar, Right Side of Beach	E.COLI-GEO-CP	8/10/2015	93.8

Shaded cells indicate exceedance of water quality criteria.

A3.3 Probable Source(s) of Impairment

Bacterial contamination of surface waters may result from a variety of sources including human waste, excrement from barnyard animals, pet feces, and agricultural applications of manure and wildlife, including large congregations of birds and small mammals. Bacteria can enter surface waters from a variety of ways including direct discharge (i.e., birds defecating directly on the surface water), stormwater runoff and groundwater (i.e. septic systems). Based on the information collected to date, the primary sources of bacteria in Captain Pond are currently believed to be waterfowl and humans as discussed below.

In the spring of 2015, NHDES staff from the TMDL and Beach Programs met with the Salem Public Health Officer and visited the three beaches on Captain Pond (Camp Hadar Beach, Camp Otter Beach and Camp Y Wood Beach). During the site visit there was obvious evidence of waterfowl scat on Camp Hadar and Camp Otter beaches, in the water and on the docks (see Figure A3.4). According to the Salem Public Health Officer there are often hundreds of birds on Captain Pond during the summer months, which is when the bacteria violations occurred.

In 2014, the Town of Salem contracted FB Environmental Associates (FBE) and Environmental Canine Services (ECS) to conduct a preliminary bacteria investigation including canine detection and water quality sampling on several waterbodies (including Captain's Pond) that are listed as impaired for bacteria. Two canines were used to detect the presence or absence of human wastewater in the water sample. A final report[7] was issued in 2014.

[7] Preliminary Bacteria Sampling and Canine Detection Report, Arlington Mill Reservoir, Millville Pond, Captain's Pond, Hedgehog Pond, Salem, NH. Prepared by FB Environmental Associates for the Town of Salem, NH. December 2014.

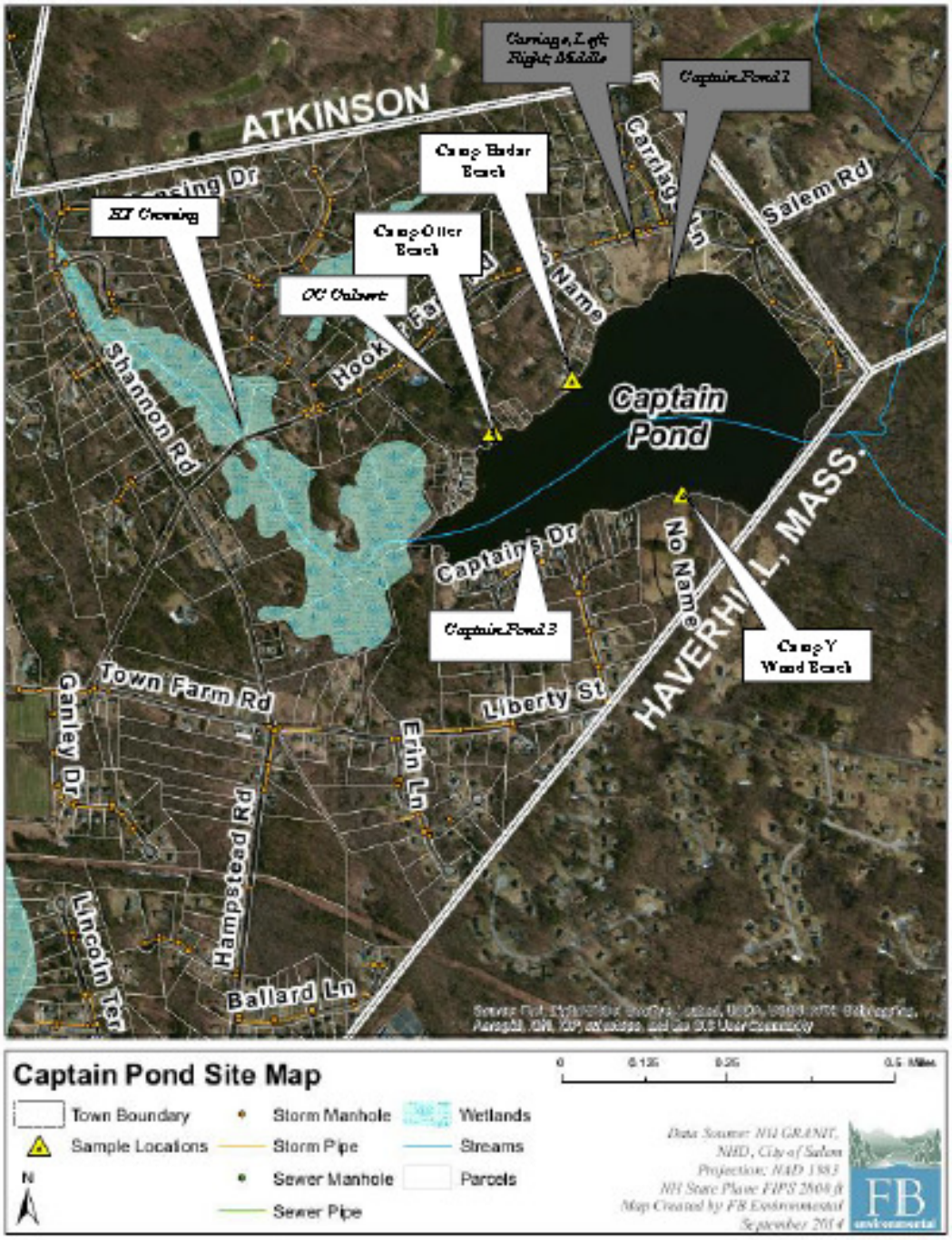
Figure A3.4: Photo of Bird Droppings at Camp Hadar Beach

Samples from Captain Pond (as well as a few outfall pipes and drainage ditches) were collected on October 29, 2014. Results are shown in Figure A3.5 (from the FB Environmental report[7]). As shown, human wastewater was detected at five of the sample locations (indicated by sites in italics) in the Captain Pond watershed. Two of the five sites (shaded and in italics) exceeded bacteria water quality criteria for beaches. The "Carriage Left, Right and Middle" site represents the outfalls for three side-by-side stormwater pipes on Hooker Farm Road near the intersection with Carriage Lane. The pipes discharge to a drainage ditch that discharges to the main pond at "Captain Pond 1". The "Middle" pipe had an *E. coli* concentration of 162 counts/100 mL. An investigation of the storm drain system on Carriage Lane was then conducted and was also found (by one of the canines) to have some human wastewater in all of the catch basins. The site labeled "Captain Pond 1" was taken in the pond below a house on Hooker Farm Road. The *E. coli* concentration at this site was 93 counts/100 mL. In addition to the above, an investigation was conducted of the storm drain system on Captain's Drive on the south side of the pond. At this location, the dogs detected human wastewater in a small drainage ditch near the outfall with the pond and it was noted that the adjacent home (a red house) appears to be an older building.

Since homes in the vicinity of Captain Pond are served by septic systems it is possible that malfunctioning septic systems could be a possible source of the human wastewater detected in the fall of 2014. In addition to human wastewater (which is described in the report as likely being a small component of the bacteria present in Captain Pond on the day sampled), the report also lists waterfowl as a potential source of bacteria in Captain Pond.

Figure A3.5: Sampling Locations and Results for Captain Pond (from 2014 FB Environmental Report[7])

Figure 2: Sampling locations and results for Captain's Pond (sites in italics indicate human wastewater was detected; shaded color indicates an exceedance of the water quality standard; triangles indicate locations of NHDES sampling stations).



Another possible source of human wastewater is from the people who recreate at the beaches (i.e., bather load). As discussed in section 6.2.8 of the Statewide Bacteria TMDL[8] residual fecal matter from swimmers may be washed from the body and contaminate the water with pathogens. In addition, small children in diapers may contribute to contamination of recreational waters. Since the bacteria violations at the designated beaches on Captain Pond are based on samples taken at the beach during the summer months (i.e., when swimming is most likely to occur), it is possible that the swimmers may be a significant source of bacteria. More work is needed to confirm this.

As discussed in section 6.2.5 of the Statewide Bacteria TMDL[8], pet waste can also be a significant contributor of pathogens in surface waters. If not properly disposed of, the waste can be washed into storm drains or directly into surface waters and contribute to pathogen impairment. According to the Salem Public Health Officer there is no history of issues with domestic pet waste in the beach area. Consequently, at the present time, pet waste is not believed to be a major source of bacteria to the Captain Pond.

A3.4 Recommended Restoration and Monitoring Activities

Phased Implementation Approach

Complying with state water quality standards for bacteria can be very challenging since ambient bacteria levels are typically highly variable and can originate from multiple sources. Because it is difficult to predict the level of restoration activities needed to result in compliance, a phased implementation approach is recommended wherein some key restoration measures are implemented followed by ambient monitoring to determine if water quality standards are being met. If standards are not met, additional measures would then be implemented followed by ambient monitoring to determine their effectiveness. This cycle would continue until compliance is achieved. A distinct advantage of the phased implementation approach is that it can save money by preventing "excessive implementation"; that is the implementation of potentially costly activities that are not needed to achieve ambient bacteria standards (because standards have already been achieved).

Recommended restoration measures and monitoring activities are provided below.

Continue Bacteria Beach Monitoring Program

For over 20 years, the Town of Salem has collected monthly bacteria (*E. coli*) samples at Camp Hadar Beach and Camp Otter Beach, and another youth camp on the southeast end of the pond called Camp Y Beach, from June through August of each year, the results of which are reported to the NHDES for input into the NHDES Environmental Monitoring Database (EMD). This data is presently used by the Town to determine compliance and when signs should be posted at the beaches informing the public that bacteria levels exceed state surface water quality standards. If

[8] Final Report New Hampshire Statewide Total Maximum Daily Load Prepared by F.B. Environmental Associates, Inc. for the New Hampshire Department of Environmental Services. September, 2010. A copy may downloaded from
http://des.nh.gov/organization/divisions/water/wmb/tmdl/categories/publications.htm

violations are discovered, additional samples are taken until compliance occurs. It is recommended that this practice continue as it will also help to determine the effectiveness of implemented restoration measures in accordance with the phased implementation approach. In addition, it is recommended that when the Town collects bacteria samples, that they also record the date, time and weather conditions (sunny, rain, air temperature, etc.), the approximate number of people on the beach and in the water, the approximate number of waterfowl in the area, observations of waterfowl droppings, as well as any other potential sources of bacteria in the vicinity of the beach that are obvious (i.e., pets, etc.) This information will help to further refine the understanding of which sources of bacteria are most significant and where future restoration measures should be targeted.

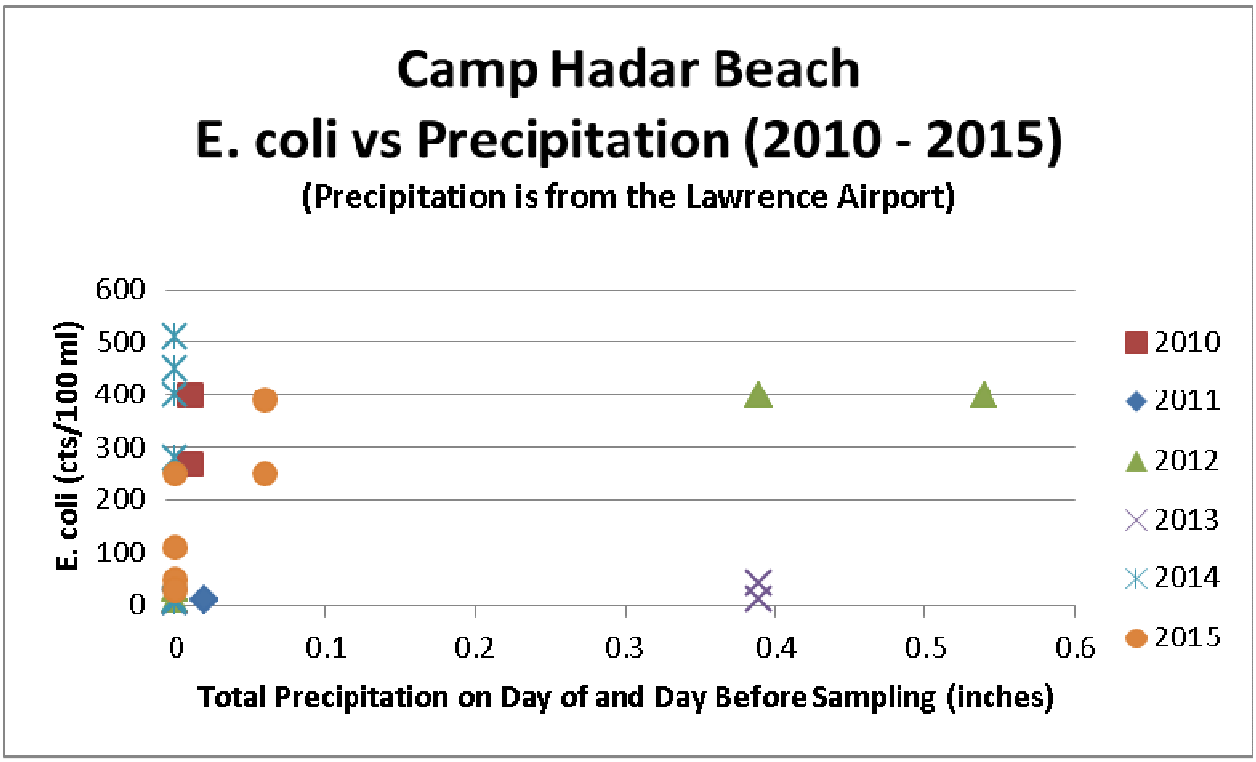
Prepare Plots of E coli vs Precipitation

Knowing if bacteria violations typically occur during wet or dry weather can help identify and prioritize appropriate restoration measures. For example if bacteria violations typically occur during wet weather, the majority of bacteria is likely from land-based sources (such as waterfowl or pet feces) that are conveyed to the surface water via storm water runoff. If violations occur during dry weather, the source could be animals or waterfowl that are defecating directly in the water or dry weather (or continuous) discharges such as from a treatment plant or groundwater. In many cases it can be both.

Plots of bacteria versus precipitation can shed light on conditions when bacteria exceedances typically occur. The closest known weather station with historical precipitation data is at the airport[9] in Lawrence, MA which is approximately 6.5 miles south of Captain Pond. A plot of the bacteria measured at Camp Hadar Beach versus the total precipitation on the day of sampling and the day prior (as measured at the Lawrence, MA airport) for the period 2010 to 2015, is shown in figure A3.6 below. As shown, based on precipitation at the airport, high bacteria levels have historically occurred during both wet and dry weather. However, this could change in the future as restoration activities are implemented and the primary sources of bacteria change. Consequently, it is recommended that plots such as Figure A3.6 be updated annually. To obtain a more accurate indication of wet weather it is also recommended that a rain gage be installed at Captain Pond with daily precipitation measurements recorded during the summer and that this data should be used to develop future plots of bacteria versus precipitation.

[9] Weather Station at the Lawrence, MA airport with historical precipitation data: https://www.wunderground.com/history/airport/KLWM/2016/07/21/DailyHistory.html?req_city=Salem&req_state=NH&reqdb.zip=03079&reqdb.magic=1&reqdb.wmo=99999

Figure A3.6: E. coli at Camp Hadar Beach vs Precipitation Data



Implement Waterfowl Deterrence Measures

As previously discussed, visual observations of waterfowl in Captain Pond and of droppings at the beaches suggest that waterfowl are likely the most significant source of bacteria at the present time. The staff at Camp Hadar has been using reflective tape around the docks and swimming area to deter birds for the last two years. Continued collection and proper disposal of bird droppings in the beach, docks and surrounding areas should also continue. According to the Town, water quality samples collected in the swimming area during the summer of 2016 did not exceed the state bacteria standard, however 2016 was a very dry summer so the implementation measures taken thus far should continue and additional sampling should be conducted in order to confirm the encouraging results in 2016. Additional measures to deter the presence of waterfowl include the installation of trumpeter swan decoys in the water and coyote decoys on the land adjacent to the swimming area. Educating the community about not feeding the birds and posting signs to discourage that activity are also highly encouraged. For further information regarding abatement of bacteria from wildlife (including waterfowl) see the NHDES Fact sheet[10] and the Statewide Bacteria TMDL[8] (Section 6 under Wildlife Waste).

Comply with the MS4 Permit

[10] The NH DES Fact Sheet titled " Canada Geese Facts and Management Options is available at http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-53.pdf

All three towns within the Captain Pond watershed (Salem, NH; Atkinson, NH; and Haverhill, MA), are required to comply with the EPA National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) general storm water permit. The MS4 permit for NH and MA that is currently applicable became effective in 2003[11]. However, a new MS4 permit for MA was recently finalized and signed by EPA in April 2016 and will become effective July 1, 2017 (i.e., the 2016 MA MS4 permit[12]). For NH, a new MS4 permit is in the works. The public comment period on the draft NH permit has ended and EPA expects to finalize and sign the new NH MS4 permit in 2016 (with an expected effective date in 2017 or 2018).

The 2003 MS4 permit requires implementation of the following six minimum control measures all of which can help to reduce bacteria levels.

1) Public Education and Outreach
2) Public Involvement and Participation
3) Illicit Discharge Detection and Elimination (IDDE) where an illicit discharge is defined as "any discharge to a municipal storm sewer that is not composed entirely of stormwater.
4) Construction Site Storm Water Runoff Control
5) Post Construction Storm Water Management in New Development and Redevelopment
6) Pollution Prevention and Good House Keeping in Municipal Operations

The 2016 MA MS4 permit also includes the six minimum control measures but with additional, more prescriptive requirements as well as additional requirements for impaired waters. For example, for waters impaired by bacteria (with or without an EPA approved TMDL), the permittee must enhance its public education and outreach (PEO) efforts by supplementing its residential PEO program with an annual message encouraging the proper waste management of pet waste, and by disseminating educational materials to dog owners that describes the detrimental impacts of improper management of pet waste, requirements for waste collection and disposal and penalties for non-compliance. In addition, the permittee must provide information to septic owners about proper maintenance in any catchment that discharges to a water body impaired for bacteria or pathogens.

With regards to illicit discharges, the 2016 MA MS4 permit requires implementation of the IDDE program (which includes monitoring of outfalls and interconnections discharging to the MS4 system) and to rank any waterbody impaired for bacteria or pathogens as either "Problem Catchments" or "High" priority in the IDDE program.

Assuming the new MS4 permit for NH will have similar requirements as the 2016 MA MS4 permit, compliance with the MS4 permits should help reduce and restore bacteria impaired surface waters such as Captain Pond. Although pet waste is not currently considered to be a

[11] EPA 2003 MS4 Storm Water General Permit:
https://www3.epa.gov/region1/npdes/permits/permit_final_ms4.pdf.

[12] EPA 2016 MA MS4 Storm Water General Permit:
https://www3.epa.gov/region1/npdes/stormwater/MS4_MA.html

significant source of bacteria to the pond, the MS4 PEO program will help to minimize the impact of pet waste in the future. In addition, the PEO program will also help ensure that residents in the Captain Pond watershed (most, if not all of which are served by septic systems) properly maintain their septic systems.

Each year the MS4 communities in NH and MA must submit annual reports to EPA. According to EPA, the "...purpose of the annual report is to document the status of Storm Water Management Program (SWMP) implementation with information including:

- a self-assessment review of compliance with the permit conditions;
- an assessment of the appropriateness of the selected BMPs;
- an assessment of the progress towards achieving the measurable goals;
- a summary of results of any information that has been collected and analyzed;
- a discussion of activities for the next reporting cycle;
- a discussion of any changes in identified BMPs or measurable goals; and
- reference to any reliance on another entity for achieving any measurable goal."

The 2016 annual MS4 report for Salem is available on the EPA website[13].

On May 2, 2016, NHDES staff from the TMDL Program and Watershed Assistance Section met at the Salem Town Hall with municipal staff from the Town of Salem Engineering Department and Public Health Department. The purpose of the meeting was to further discuss the development of this TMDL and provide information on assistance that is available to the town and stakeholders regarding potential implementation measures for reducing bacteria loading to the beaches and compliance with the MS4 permit. Staff from the NHDES Watershed Assistance Section provided information on educational/outreach materials that the state developed on good housekeeping practices regarding pet waste and septic systems that is available to the town at no cost[14].

Implement the 2014 FB Environmental Report Recommendations:

As discussed in section A3.3, the Town of Salem contracted FB Environmental Associate (FBE) and Environmental Canine Services (ECS) in 2014 to conduct preliminary bacteria investigations, including canine detection and water quality sampling on several waterbodies (including Captain Pond) that are listed as impaired for bacteria. The final report[7] included the following recommendations that NHDES agrees should be implemented in the Town's continuing efforts to identify major sources of bacteria to Captain's Pond:

1. Continue sampling at the camp beaches on Captain's Pond under various weather conditions;

[13] 2016 MS4 Annual Report for Salem, NH:
https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/nh/reports/2016/SalemNH16.pdf
[14]NHDES Watershed Assistance Section website:
http://des.nh.gov/organization/divisions/water/wmb/was/index.htm

2. Investigate the sources of bacteria to the outfall pipes on Hooker Farm Road and Carriage Lane; and

3. Investigate any possible sources of bacteria to the drainage ditch on Captain's Drive.

Review Annual VLAP Reports

Captain Pond is fortunate to have an active Lake Association that participates in the NHDES Volunteer Lake Assessment Program (VLAP)[15]. VLAP participants submit their annual monitoring results to NHDES. Each year NHDES prepares a lake report for each VLAP lake which includes morphometric data, water quality assessment information, a watershed land use summary, and a data summary with recommended actions and trend analyses. The 2015 VLAP report for Captain Pond is available on the NHDES website[16]. Although the VLAP volunteers do not sample the beaches on Captain Pond, they do sample for *E. coli* at other locations. For example, the 2015 VLAP report recorded bacteria levels of 160, 20 and 610 counts/100 ml at 7 Captain's Drive, the Boat Launch and Buzzell Cove respectively. It is therefore recommended that the Town of Salem review the Captain Pond VLAP reports on an annual basis as the information may assist the Town with prioritizing future restoration or monitoring efforts.

Inventory Septic Systems – Identify and Correct any Malfunctioning Septic Systems

As previously discussed, the 2014 FB Environmental Report indicated the likely presence of human bacteria at the beaches (see section A3.3). Since all residences in Salem that are within the Captain Pond watershed are served by septic systems, it's possible that septic systems could be a source of the human bacteria. To help determine if there are likely any malfunctioning septic systems, it is recommended that the Town of Salem conduct an inventory of the age and location of the septic systems surrounding the pond. All of the septic systems should be visually observed for any evidence of malfunction (such as "breakout" of untreated or partially treated sewage from a leach field). If any are found, the Town should immediately take steps to ensure that such deficiencies are corrected. In addition to Town records, the NHDES Subsurface Bureau maintains a database of subsurface systems which is available on the NHDES One Stop[17] website.

NHDES staff intends to conduct a shoreline survey of the specific conductivity around the entire Pond in the fall of 2016. High specific conductivity readings can be an indication of treated or untreated sewage from septic systems that have entered the pond via overland flow or through the groundwater. Where high specific conductivity measurements are found, bacteria samples will be collected in order to determine if it is likely due to a malfunctioning (or outdated) septic system. In addition, resources permitting, NHDES intends to update the Lake Trophic Survey (the last one was completed in 2007) over the next 3 years. As stated above (under "Comply

[15] VLAP website: http://des.nh.gov/organization/divisions/water/wmb/vlap/index.htm

[16] VLAP Annual Lake Reports:
http://des.nh.gov/organization/divisions/water/wmb/vlap/annual_reports/2015/lake-reports.htm

[17] DES Subsurface System database on One Stop:
http://www2.des.state.nh.us/OneStop/Subsurface_Application_Approval_Query.aspx

with MS4 Permit"), NHDES has prepared educational/outreach materials regarding good housekeeping practices for septic systems that can be distributed to homeowners around the pond[18].

Determine Significance of Bather Load

As previously mentioned, waterfowl are currently thought to be the major source of bacteria at Camp Hadar Beach, however, as discussed in section A3.3, people recreating at beaches can also contribute bacteria to the waterbody (i.e., the bather load). If bacteria violations persist after restoration efforts have been implemented to reduce waterfowl contamination, it is recommended that an analysis be conducted to determine if bather load is the likely source. To conduct such an analysis, information on the number of people on the beach and in the water on the day that bacteria samples are collected is needed. As previously mentioned (see "Conduct Annual Beach Monitoring" section above) it is recommended that this (and other) information be collected by the Town when they sample the beaches each summer. Graphs of bacteria versus the number people in the water and the total number of people at the beach (in the water and on the beach) can then be developed. If there is a relatively good relationship (i.e., bacteria levels increase with increasing number of swimmers or people at the beach), it is likely that the swimmers themselves are a significant source of the violations.

Monitor for Bacteria Contributions from Atkinson and Haverhill

As shown in Figure A3.2, the majority of the runoff from Atkinson, NH and Haverhill, MA enters Captain Pond via the wetland complex on the southeast side of the pond. At the present time it is not believed to be a significant source of bacteria contamination at Camp Hadar Beach because it is on the opposite (south) side of the pond from the beach. However, if, bacteria violations persist after implementation of some of the restoration measures described above, it may be informative to conduct wet and dry weather sampling of the main tributary through the wetland complex and in the pond near the wetland complex to determine if significant levels of bacteria are coming from Atkinson and/or Haverhill. If results indicate that it is discharging high levels of bacteria into the pond which could impact any of the designated beaches on the pond (including Camp Hadar Beach), further investigations should be conducted to identify the primary sources of the bacteria and appropriate restoration measures that should be implemented to abate them.

Stakeholder Participation

Stakeholder participation is critical to the success of restoration efforts such as those described above. As previously mentioned Captain Pond is fortunate to have an active Lake Association that is committed to protecting the water quality. Further, there is a good working relationship between the Salem Public Health Officer and the owners of the summer camps. Since Camp Hadar Beach, as well as many of the other beaches on Captain Pond are located at summer day camps, there is a great opportunity to educate the campers and the staff about how to protect

[18]NHDES Watershed Assistance Section website:
http://des.nh.gov/organization/divisions/water/wmb/was/index.htm

water quality and to solicit their help. In addition, as described above, the Town of Salem continues to monitor the pond and storm water outfalls in the watershed for bacteria "hot spots". Continued stakeholder involvement and assistance with implementing the recommended restoration/monitoring activities described above greatly improves the likelihood of successfully reducing bacteria to levels that meet state surface water quality standards.

Funding Opportunities

The state recognizes that committed watershed organizations need adequate resources to achieve the goals of the Clean Water Act and improve our nation's water quality. Funding assistance for bacteria mitigation and other watershed management projects is available from various government and private sources. Section 7 of the Statewide Bacteria TMDL[8] contains contact information for financial assistance programs offered by the state of New Hampshire and the U.S. Environmental Protection Agency (EPA). Staff from the Watershed Assistance Section of NHDES is available to assist stakeholders with obtaining information on the various funding sources that are available and can provide assistance with applications for funding.

A4 CAMP OTTER BEACH ON CAPTAIN POND

A4.1 Watershed Description

Camp Otter Beach (NHLAK7000061102-03-03) is a designated beach[19] located on Captain Pond in Salem, New Hampshire. For information about the Captain Pond watershed, see section A3.1. A map showing the location of beaches on Otter Pond (including Camp Otter Beach) is provided in Figure A3.2. As shown, Camp Otter Beach is located towards the western end of the northern shoreline of Captain Pond. The beach itself is a sandy cleared area that extends approximately 100 feet along the shoreline. In the summer months there are docks placed in the water on the right side of the beach and a floating rope line designates the swimming area (see Figure A4.1).

Figure A4.1: Photo of Camp Otter Beach

A4.2 Water Quality Data and Assessment Information

Based on bacteria data collected from 2004 to 2007, Camp Otter Beach was listed as impaired on the 2008 303(d) List for the designated use of Primary Contact Recreation due to levels of bacteria (*Escherichia coli* or *E. coli*) that exceed the *E. coli* water quality criteria shown below. In 2010, EPA approved DES' Statewide Bacteria TMDL[8] which included Camp Otter Beach. As discussed in the main text of this report (section 2.2), the TMDL for waters impaired by bacteria is set equal to the bacteria water quality criteria.

[19] See section A3.1 for the definition of "Designated Beach".

Since 2010, more monitoring data has been collected. A summary of the data collected from 2005 to 2015 is presented below. Most of the data is from the Town of Salem which collects at least three bacteria samples each year (once per month from June through August) at the Camp Hadar and Camp Otter beaches with additional samples collected if results indicate violations of the bacteria surface water quality standards.

An approximation of the percent (%) reduction needed to achieve bacteria water quality standards is also provided below. The methodology for computing the % reduction is discussed in section 2.2 of the main report. Based on the data collected from 2005 to 2010, the estimated % reduction is approximately 78% and 88% for single samples and the geometric mean respectively. This compares to a single sample % reduction of 51% in the 2010 Statewide Bacteria TMDL (based on data collected from 2004 to 2007). A geometric mean % reduction could not be calculated based on the data collected from 2004 to 2007. Consequently, the more recent data (2005-2010) indicates that reductions are still needed to meet bacteria water quality standards.

Where both single sample and geometric mean percent reductions are presented, it is recommended that the reductions needed to attain the geometric mean be used (when available) to guide an iterative approach to implementation and load reduction planning. This is because bacteria sampling results can be highly variable and the geometric mean helps to reduce the undue influence of any one data point.

Camp Otter Beach Assessment Unit (AU) Number: NHLAK7000061102-03-03

Freshwater or Tidal: Freshwater
Classification: Class B
Designated Beach[20]***:*** Yes
Impaired Designated Use: Primary Contact Recreation
Cause of Impairment: *Escherichia coli (E. coli)*

Water Quality Criteria & TMDL for E coli
Single sample: 88 CTS/100mL
Geometric mean: 47 CTS/100mL

Percent reduction for the Single Sample to meet the TMDL: **78%**
Percent reduction for the Geometric Mean to meet the TMDL: **88%**

Data: NHDES EMD, 2014 303(d) list

Single sample *E coli* results (CTS/100ML) **Water Quality Criteria =** 88 CTS/100mL

Station Name	Station ID	Date	Result
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/13/2005	33
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/17/2006	84
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/22/2007	120
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/20/2008	140
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/20/2009	120
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/24/2009	260
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/17/2010	400
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/20/2010	96
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/27/2011	130
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/29/2011	30
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	6/7/2012	120
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	6/11/2012	40
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/15/2012	400
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/17/2012	400
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/22/2012	400
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/8/2013	100
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/10/2013	58
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	7/16/2013	300
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	6/4/2014	6
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/4/2014	400
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/6/2014	240
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/8/2014	34
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	6/3/2015	64
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/5/2015	290
Camp Otter Beach Left side of the Beach	BCHOTTSALLF	8/10/2015	20

Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/13/2005	28
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/17/2006	78
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/22/2007	72
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/20/2008	140
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/20/2009	170
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/24/2009	400
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/17/2010	400
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/20/2010	101
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/27/2011	130
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/29/2011	31
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	6/7/2012	78
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	6/11/2012	74
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/15/2012	400
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/17/2012	400
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/22/2012	400
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/8/2013	84
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/10/2013	14
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	7/16/2013	170
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	6/4/2014	2
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/4/2014	400
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/6/2014	54
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/8/2014	62
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	6/3/2015	58
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/5/2015	190
Camp Otter Beach Right Side of the Beach	BCHOTTSALRT	8/10/2015	22

Shaded cells indicate exceedance of water quality criteria. Method detection limits are 2.0 – 400.0 cts/100mL. Results below 2.0 are listed as1.0 (½ the detection limit) and any counts greater than 400 are listed as 400.

Geometric mean *E. coli* results (CTS/100ML) Water Quality Criteria = 47 CTS/100mL

Station Name	Full Comparison Description	Date	Result
Camp Otter Beach, Left Side of Beach	E.COLI-GEO-CP	8/22/2012	400
Camp Otter Beach, Left Side of Beach	E.COLI-GEO-CP	7/16/2013	120.3
Camp Otter Beach, Left Side of Beach	E.COLI-GEO-CP	8/8/2014	148.3
Camp Otter Beach, Right Side of Beach	E.COLI-GEO-CP	8/22/2012	400
Camp Otter Beach, Right Side of Beach	E.COLI-GEO-CP	7/16/2013	58.5
Camp Otter Beach, Right Side of Beach	E.COLI-GEO-CP	8/8/2014	110.2

Shaded cells indicate exceedance of water quality criteria

A4.3 Probable Source(s) of Impairment

See section A3.3 as the probable sources of impairment for Camp Otter Beach are believed to be similar to those for Camp Hadar Beach.

A4.4 Recommended Restoration and Monitoring Activities

See the recommended restoration measures for Camp Hadar Beach in section A3.4.

APPENDIX B - TMDLS EXPRESSED AS DAILY LOAD

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B1 METHODOLOGY AND RESULTS

As explained in Section 5.4 of the EPA approved Statewide Bacteria Report, the State of New Hampshire prefers to express bacteria TMDLs as concentrations (counts of bacteria/100mL). However, in accordance with federal guidance, bacteria TMDLs are also expressed as daily loads in terms of mass per unit time [i.e., billions of bacteria per day as a function of flow (for rivers and streams)] and daily replacement volume of water for lakes, ponds and coastal embayments. Graphs and tables are provided for single sample and geometric means for E.coli.

In contrast to the concentration-based bacteria TMDLs, the margin of safety (MOS) in mass per unit time TMDLs is explicit when a discrete portion of the loading capacity is reserved to ensure that water quality standards will be attained. In the example mass per unit time bacteria TMDLs provided below, 10% of the loading capacity is reserved as the MOS, leaving 90% of the TMDL available for allocation among existing and future sources.

Mass per unit time TMDLs for rivers are calculated by multiplying river or stream flow at a given point in time by the allowable bacteria concentration and a conversion factor. If stream-flow data are not available, a range of flows can be assumed based on drainage area. Flows within the assumed range are multiplied by the water quality standard (WQS) for both instantaneous and geometric mean concentrations to obtain the loading capacity or TMDL for the stream segment or watershed. For lakes and ponds or estuarine and marine segments, the daily replacement volume of the water body is multiplied by the WQS concentration. The daily replacement volume is the flushing rate (number of times per year that the volume of the waterbody is completely exchanged), divided by 365, then multiplied by the volume of the water body. Formulas to calculate daily load (mass per unit time) can be found on the following pages.

The following figures contain daily load TMDL calculations for bacteria-impaired rivers and streams, lakes and ponds, and coastal embayments in New Hampshire. These figures are intended to provide the necessary formulas, tables, and graphs required for calculating bacteria TMDLs for any bacteria-impaired waterbody, and for any flow and/or volume.

Daily load (mass per unit time) bacteria TMDLs are presented for:

- ***Class B Freshwater Rivers & Streams -*** Figure B.1 shows TMDLs for these waters based on the single sample criterion for primary contact recreation of 406 *E.coli* per 100mL; Figure B.2 shows TMDLs based on the geometric mean criterion for primary

contact recreation of 126 *E.coli* per 100mL. These are flow-based daily load calculations for Class B freshwater rivers and streams.

- ***Class B Freshwater Lakes & Ponds -*** Figure B.3 shows TMDLs for these waters based on the single sample criterion for primary contact recreation of 406 *E.coli* per 100mL; Figure B.4 shows TMDLs based on the geometric mean criterion for primary contact recreation of 126 *E.coli* per 100mL. These daily load calculations for Class B freshwater lakes and ponds are based on the daily replacement volume, which is the volume of the water body that is exchanged each day upon a flushing time of one day.

- ***Class B Coastal Embayments -*** Figure B.5 shows TMDLs for these waters based on the single sample criterion for primary contact recreation of 104 Enterococci per 100mL; Figure B.6 shows TMDLs based on the geometric mean criterion for primary contact recreation of 35 Enterococci per 100mL. These daily load calculations for Class B coastal embayments are based on the daily replacement volume, which is the volume of the water body that is exchanged each day.

Figure B.1: Freshwater River & Stream Daily Loads based on SS WQS.

Flow (cfs)	SS WQS (#/100mL)	SS TMDL	MOS	LA and WLA
		billions of organisms/day		
0.5	406	5.0	0.5	4.5
1	406	9.9	1.0	8.9
2	406	19.9	2.0	17.9
3	406	29.8	3.0	26.8
4	406	39.7	4.0	35.8
5	406	49.7	5.0	44.7
10	406	99.3	9.9	89.4
20	406	198.7	19.9	178.8
50	406	496.7	49.7	447.0
75	406	745.1	74.5	670.6
100	406	993.4	99.3	894.1

Abbreviations:
SS WQS = Single Sample Water Quality Standard; SS TMDL = Single Sample Total Maximum Daily Load
WLAc = Waste Load Allocations for continuous point source discharges and all NPDES discharges other than Stormwater WLA
Stormwater WLA = Waste Load Allocations for all NPDES-regulated stormwater
LA = Load Allocations for all non-point sources of bacteria which includes all sources not regulated under the NPDES permit program.
MOS = Margin of Safety – set equal to 10% of single sample WQS.

Formula:
TMDL (billions of organisms per day) = WQS (#/100mL) x 1000 (mL/L) x Q (ft^3/sec) x 86400 (sec/day) x 28.32 (L/ft^3)/10^9
Where: WQS = 406/100mL *E. coli*
Q = Flow in cubic feet/second (ft^3/sec)
mL = milliliter; L = Liter

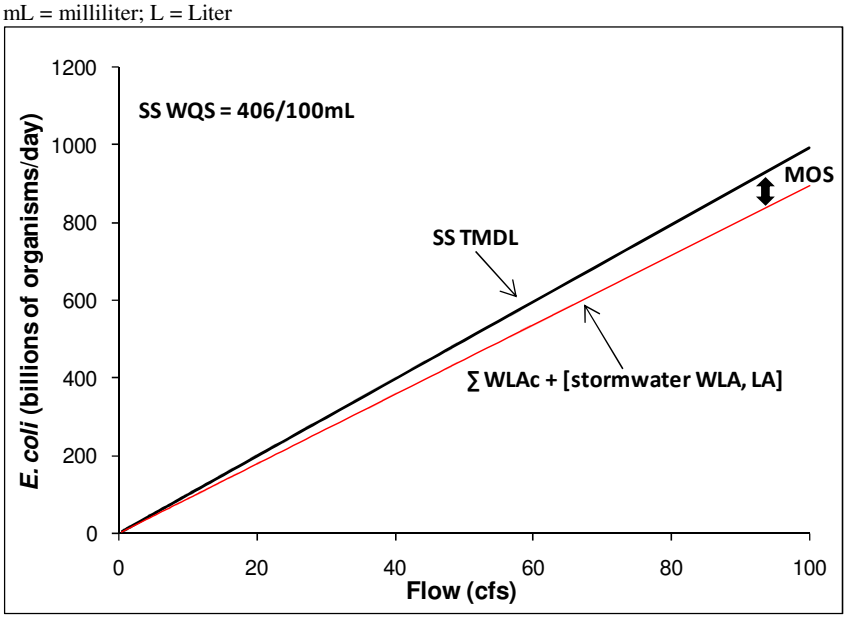

Figure B.2: Freshwater River & Stream Daily Loads based on GM WQS.

Flow (cfs)	GM WQS (#/100mL)	GM TMDL	MOS	LA and WLA
		billions of organisms/day		
0.5	126	1.5	0.2	1.4
1	126	3.1	0.3	2.8
2	126	6.2	0.6	5.5
3	126	9.2	0.9	8.3
4	126	12.3	1.2	11.1
5	126	15.4	1.5	13.9
10	126	30.8	3.1	27.7
20	126	61.7	6.2	55.5
50	126	154.2	15.4	138.7
75	126	231.2	23.1	208.1
100	126	308.3	30.8	277.5

Abbreviations:
GM WQS = Geometric Mean Water Quality Standard; GM TMDL = Geometric Mean Total Maximum Daily Load
WLAc = Waste Load Allocations for continuous point source discharges and all NPDES discharges other than Stormwater WLA
Stormwater WLA = Waste Load Allocations for all NPDES-regulated stormwater
LA = Load Allocation for all non-point sources of bacteria which includes all sources not regulated under the NPDES permit program.
MOS = Margin of Safety – set equal to 10% of geometric mean WQS.

Formula:
TMDL (billions of organisms per day) = WQS (#/100mL) x 1000 (mL/L) x Q (ft^3/sec) x 86400 (sec/day) x 28.32 (L/ft^3)/10^9
Where: WQS = 126/100mL *E. coli*
Q = Flow in cubic feet/second (ft^3/sec)
mL = milliliter; L = Liter

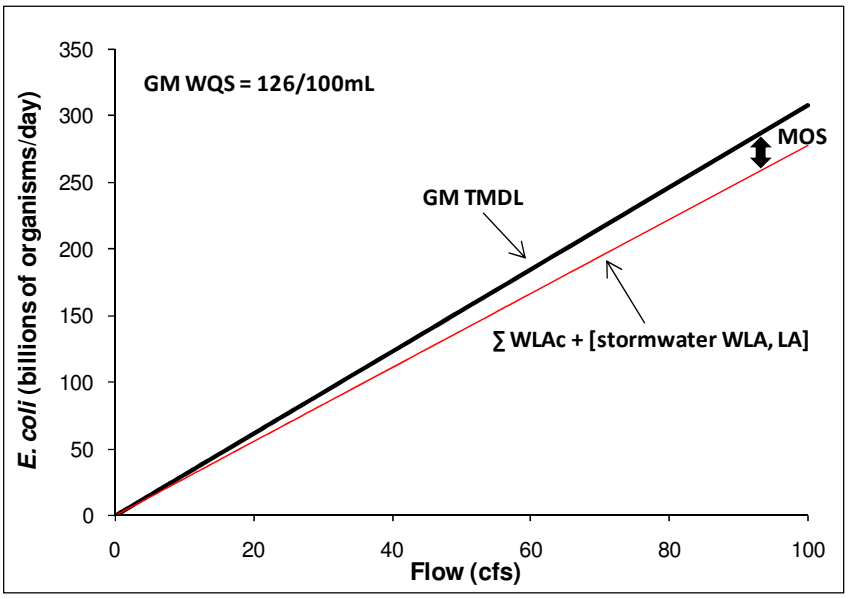

Figure B.3: Freshwater Lakes & Ponds Daily Loads based on SS WQS.

Daily Replacement Volume (ft^3)	SS WQS (#/100mL)	SS TMDL	MOS	LA and WLA
		billions of organisms/day		
1000	406	0.1	0.01	0.10
5000	406	0.6	0.06	0.52
10000	406	1.1	0.11	1.03
50000	406	5.7	0.57	5.17
100000	406	11.5	1.15	10.35
500000	406	57.5	5.75	51.74
1000000	406	115.0	11.50	103.48

Abbreviations:
SS WQS = Single Sample Water Quality Standard; SS TMDL = Single Sample Total Maximum Daily Load
WLAc = Waste Load Allocations for continuous point source discharges and all NPDES discharges other than Stormwater WLA
Stormwater WLA = Waste Load Allocations for all NPDES-regulated stormwater
LA = Load Allocation for all non-point sources of bacteria which includes all sources not regulated under the NPDES permit program.
MOS = Margin of Safety – set equal to 10% of single sample WQS.

Formula:
TMDL (billions of organisms per day) = WQS (#/100mL) x Volume (ft^3) x 1000 (mL/L) x 28.32 (L/ft^3)/10^9
Where: WQS = 406/100mL *E. coli*
Daily Replacement Volume = (Annual flushing rate/365) x Water Body Volume in cubic feet (ft^3)
Annual flushing Rate – number of times per year the waterbody's volume is exchanged
mL = milliliter; L = Liter

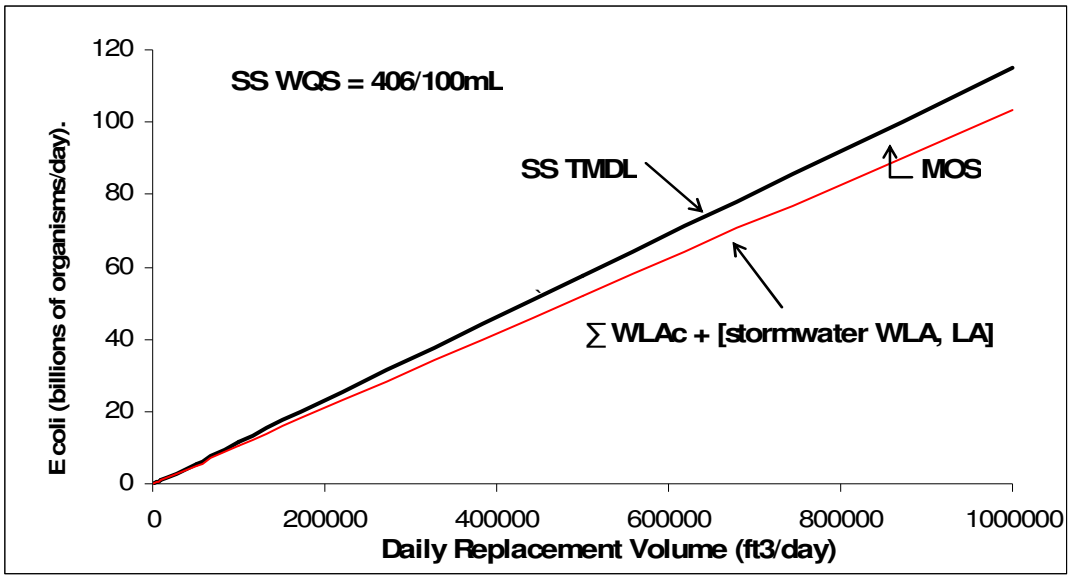

Figure B.4: Freshwater Lakes & Ponds Daily Loads based on GM WQS.

Daily Replacement Volume (ft^3)	GM WQS (#/100mL)	GM TMDL	MOS	LA and WLA
		billions of organisms/day		
1000	126	0.04	0.004	0.032
5000	126	0.18	0.018	0.161
10000	126	0.36	0.036	0.321
50000	126	1.78	0.178	1.606
100000	126	3.57	0.357	3.211
500000	126	17.84	1.784	16.057
1000000	126	35.68	3.568	32.115

Abbreviations:
GM WQS = Geometric Mean Water Quality Standard; GM TMDL = Geometric Mean Total Maximum Daily Load
WLAc = Waste Load Allocations for continuous point source discharges and all NPDES discharges other than Stormwater WLA
Stormwater WLA = Waste Load Allocations for all NPDES-regulated stormwater
LA = Load Allocation for all non-point sources of bacteria which includes all sources not regulated under the NPDES permit program.
MOS = Margin of Safety – set equal to 10% of geometric mean WQS.

Formula:
TMDL (billions of organisms per day) = WQS (#/100mL) x Volume (ft^3) x 1000 (mL/L) x 28.32 (L/ft^3)/10^9
Where: WQS = 126/100mL *E. coli*
Daily Replacement Volume = (Annual flushing rate/365) x Water Body Volume in cubic feet (ft^3)
Annual flushing Rate – number of times per year the waterbody's volume is exchanged
mL = milliliter; L = Liter

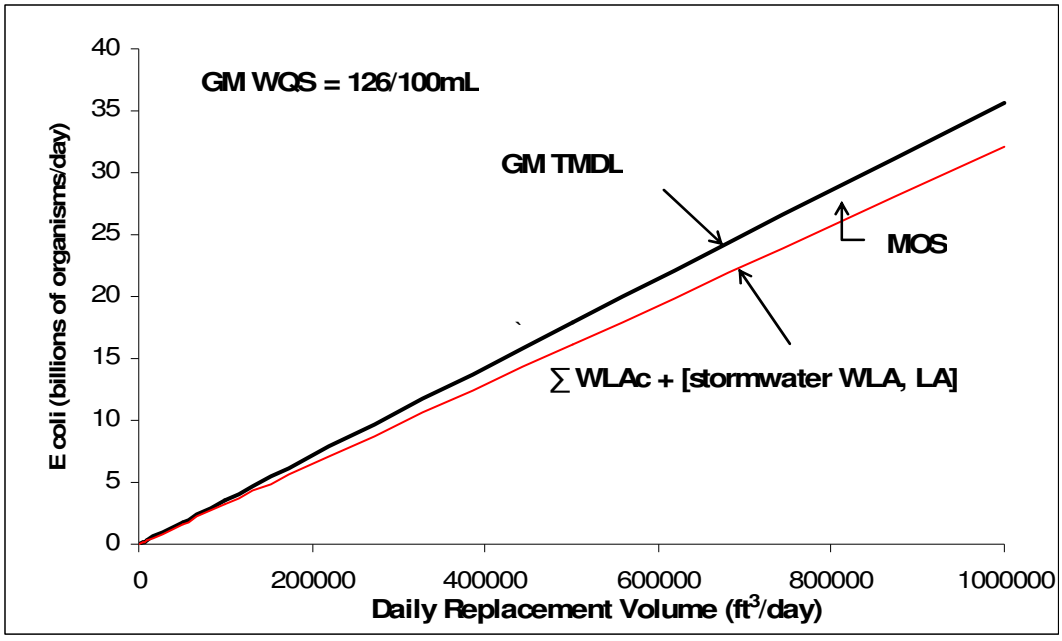

Figure B.5: Coastal Embayment Daily Loads based on Enterococcus SS WQS.

Daily Replacement Volume (ft^3)	SS WQS (#/100mL)	SS TMDL	MOS	LA and WLA
		billions of organisms/day		
1000	104	0.03	0.003	0.027
5000	104	0.15	0.015	0.133
10000	104	0.29	0.029	0.265
50000	104	1.47	0.147	1.325
100000	104	2.95	0.295	2.651
500000	104	14.73	1.473	13.254
1000000	104	29.45	2.945	26.508

Abbreviations:
SS WQS = Single Sample Water Quality Standard; SS TMDL = Single Sample Total Maximum Daily Load
WLAc = Waste Load Allocations for continuous point source discharges and all NPDES discharges other than Stormwater WLA
Stormwater WLA = Waste Load Allocations for all NPDES-regulated stormwater
LA = Load Allocation for all non-point sources of bacteria which includes all sources not regulated under the NPDES permit program.
MOS = Margin of Safety – set equal to 10% of single sample WQS.

Formula:
TMDL (billions of organisms per day) = WQS (#/100mL) x Volume (ft^3) x 1000 (mL/L) x 28.32 (L/ft^3)/10^9
Where: WQS = 104/100mL *Enterococcus*
Daily Replacement Volume = (Annual flushing rate/365) x Water Body Volume in cubic feet (ft^3)
Annual flushing Rate – number of times per year the waterbody's volume is exchanged
mL = milliliter; L = Liter

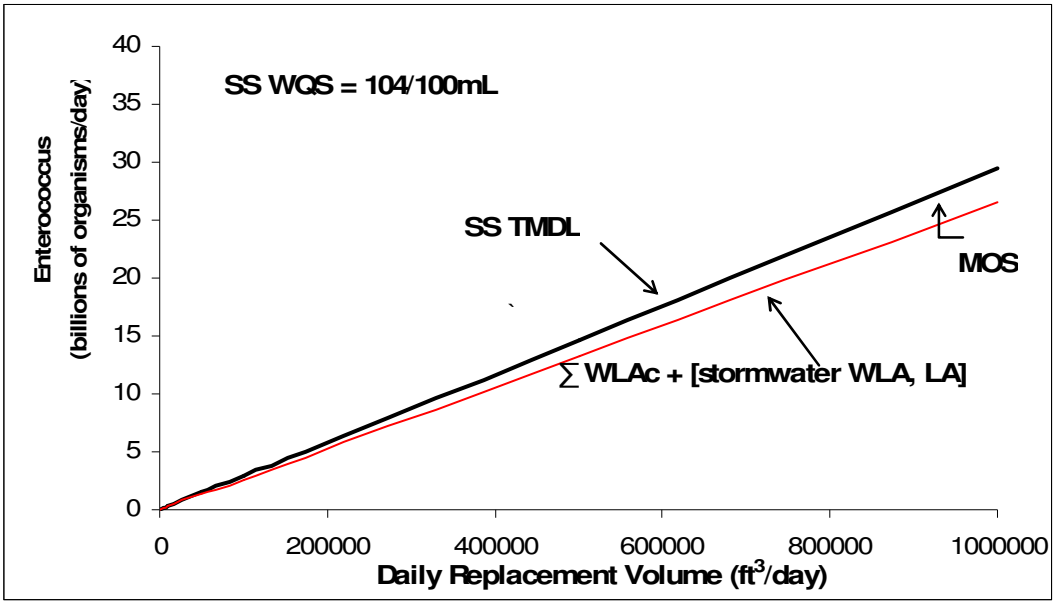

Figure B.6: Coastal Embayment Daily Loads based on Enterococcus GM WQS.

Daily Replacement Volume (ft^3)	GM WQS (#/100mL)	GM TMDL	MOS	LA and WLA
		billions of organisms/day		
1000	35	0.01	0.001	0.009
5000	35	0.05	0.005	0.045
10000	35	0.10	0.010	0.089
50000	35	0.50	0.050	0.446
100000	35	0.99	0.099	0.892
500000	35	4.96	0.496	4.460
1000000	35	9.91	0.991	8.921

Abbreviations:
GM WQS = Geometric Mean Water Quality Standard; GM TMDL = Geometric Mean Total Maximum Daily Load
WLAc = Waste Load Allocations for continuous point source discharges and all NPDES discharges other than Stormwater WLA
Stormwater WLA = Waste Load Allocations for all NPDES-regulated stormwater
LA = Load Allocation for all non-point sources of bacteria which includes all sources not regulated under the NPDES permit program.
MOS = Margin of Safety – set equal to 10% of geometric mean WQS.

Formula:
TMDL (billions of organisms per day) = WQS (#/100mL) x Volume (ft^3) x 1000 (mL/L) x 28.32 (L/ft^3)/10^9
Where: WQS = 35/100mL *Enterococcus*
Daily Replacement Volume = (Annual flushing rate/365) x Water Body Volume in cubic feet (ft^3)
Annual flushing Rate – number of times per year the waterbody's volume is exchanged
mL = milliliter; L = Liter