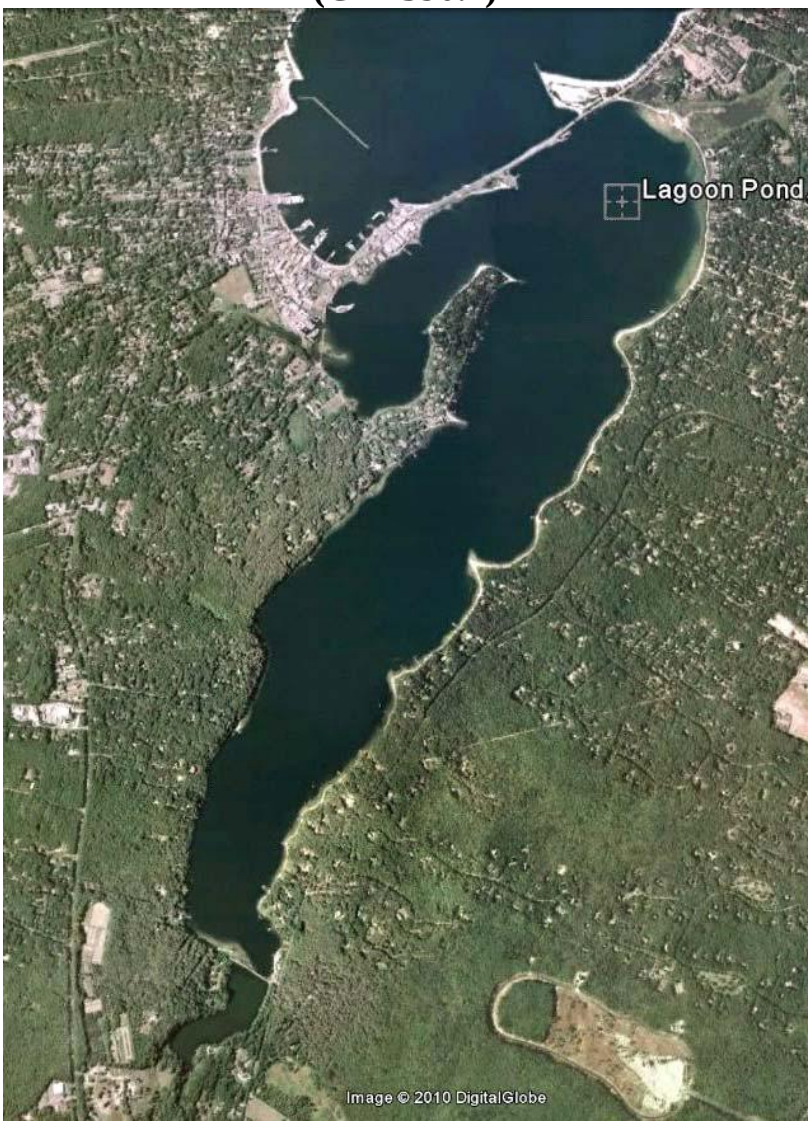
Attachment 8 Follows

Final
Lagoon Pond Estuarine System
Total Maximum Daily Loads
For Total Nitrogen
(CN- 390.1)



COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
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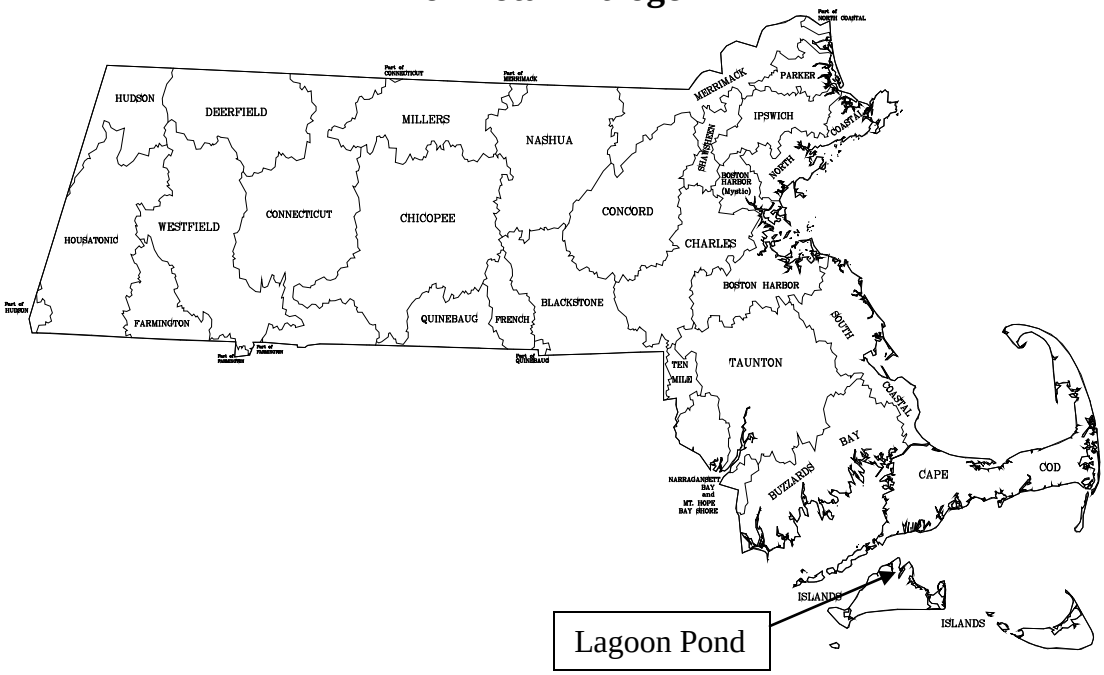
DOUGLAS FINE, ASSISTANT COMMISSIONER

July 2015

Lagoon Pond Estuarine System
Total Maximum Daily Loads
For Total Nitrogen



Key Feature:	Total Nitrogen TMDL for Lagoon Pond Estuarine System
Location:	EPA Region 1, Oak Bluffs and Tisbury, MA
Land Type:	New England Coastal
303d Listing:	Lagoon Pond (segment MA97-11) is listed in Category 5 of the 2012 MA Intergrated List of Waters as impaired for fecal coliform and estuarine bioassessments
Data Sources:	University of Massachusetts – Dartmouth/School for Marine Science and Technology; US Geological Survey; Applied Coastal Research and Engineering, Inc.; Cape Cod Commission; Martha's Vineyard Commission; Towns of Oak Bluffs and Tisbury
Data Mechanism:	Massachusetts Surface Water Quality Standards, Ambient Data and Linked Watershed Model
Monitoring Plan:	Martha's Vineyard Commission/Towns of Oak Bluffs and Tisbury - Lagoon Pond Water Quality Monitoring Program with technical assistance by SMAST
Control Measures:	Sewering, Stormwater Management, Attenuation by Impoundments and Wetlands, Fertilizer Use By-laws, Agricultural BMPs

Executive Summary

Problem Statement

Excessive nitrogen (N) originating from a variety of sources has added to the impairment of the environmental quality of Lagoon Pond. In general, excessive N in these waters is indicated by:

- Loss of eelgrass beds, which are critical habitats for macroinvertebrates and fish;
- Undesirable increases in macro-algae, which are much less beneficial than eelgrass;
- Periodic decreases in dissolved oxygen concentrations that threaten aquatic life;
- Reductions in the diversity of benthic animal populations;
- Periodic algae blooms.

With proper management of N inputs these trends can be reversed. Without proper management more severe problems might develop, including:

- Periodic fish kills;
- Unpleasant odors and scum;
- Benthic communities reduced to the most stress-tolerant species, or in the worst cases, near loss of the benthic animal communities.

Coastal communities, including Oak Bluffs and Tisbury, rely on clean, productive, and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing, and boating, as well as for commercial fin fishing and shellfishing. Failure to reduce and control N loadings could lead to further loss of eelgrass and possible increases in macro-algae, a higher frequency of undesirable decreases in dissolved oxygen concentrations and fish kills, widespread occurrence of unpleasant odors and visible scum, and a complete loss of benthic macroinvertebrates throughout most of the system. As a result of these environmental impacts commercial and recreational uses of Lagoon Pond will be greatly reduced.

Sources of Nitrogen

Nitrogen enters the waters of coastal embayments/ponds from the following sources:

- The watershed;
    - on-site subsurface wastewater disposal (septic) systems
    - natural background
    - runoff
    - fertilizers
    - wastewater treatment facilities
    - landfills
    - agricultural activities
- Atmospheric deposition
- Nutrient-rich bottom sediments in the embayments/ponds

Figures ES-A and ES-B below indicate the percent contributions of the various sources of N to Lagoon Pond. Values are based on Table ES-1 and Table IV-2 from the MEP Technical Report. Most of the controllable N load to Lagoon Pond originates from wastewater.

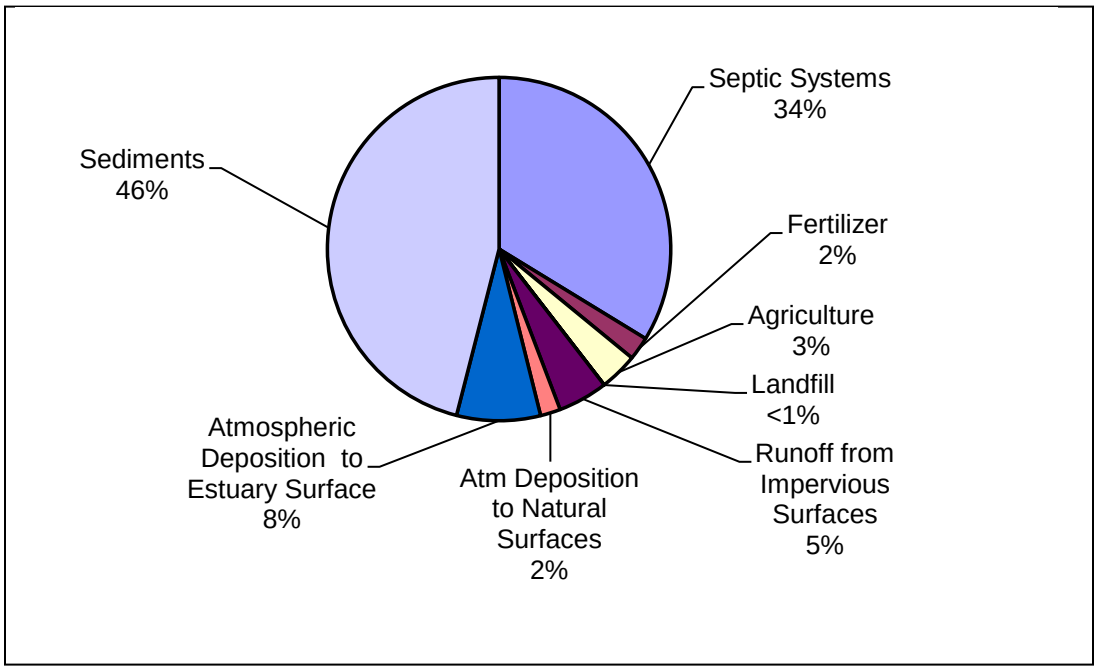


Figure ES-A: Percent Contributions of All Nitrogen Sources to Lagoon Pond

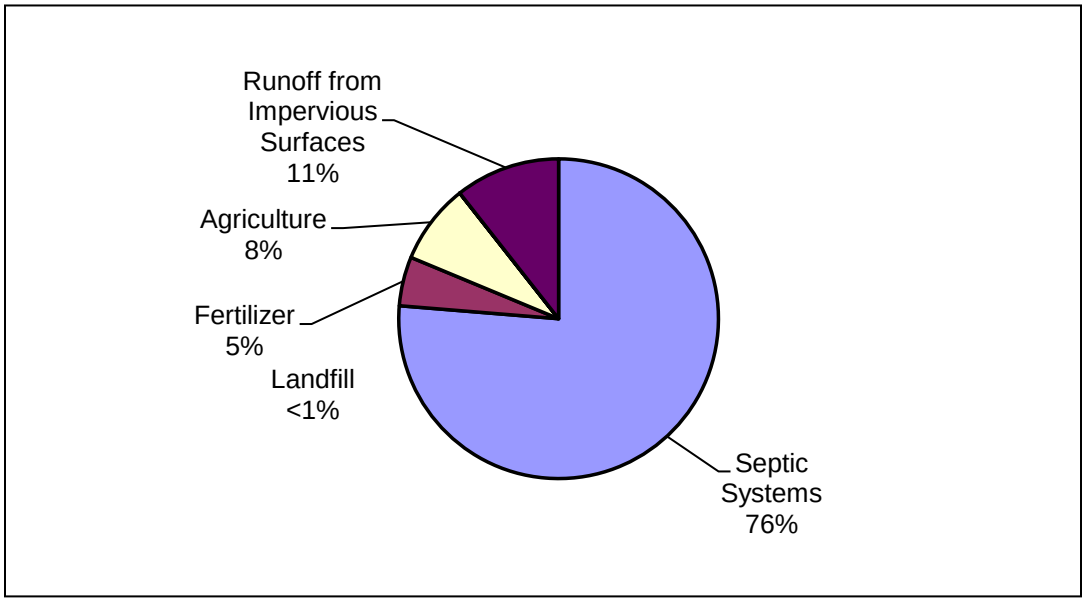


Figure ES-B: Percent Contributions of Controllable Nitrogen Sources to Lagoon Pond

Target Threshold Nitrogen Concentrations and Loadings

The N load to the estuary each day is 101.7 kg/day. The resultant concentrations of N in Lagoon Pond range from 0.333mg/L (milligrams per liter of N) to 0.418 mg/L (range of average of yearly means from 6 stations collected from 2002 – 2007 as reported in Table VI-1 the MEP Technical report and included in Appendix A of this report).

In order to restore and protect this embayment system, N loadings, and subsequently the concentrations of N in the water, must be reduced to levels below the thresholds that cause the observed environmental impacts. This concentration will be referred to as the *target threshold N concentration*. It is the goal of the TMDL to reach this target threshold N concentration, as it has been determined for each impaired waterbody segment. The Massachusetts Estuaries Project (MEP) has determined that for this embayment system a N tidally averaged concentration of 0.35 mg/L at the sentinel station (LGP-2) will improve fringing eelgrass habitat within the main basin of Lagoon Pond (East Arm) and restore benthic habitat for infaunal animals in the West Arm (South End Basin). The mechanism for achieving this target threshold N concentration is to reduce the N loadings to the Lagoon Pond estuarine system. Based on sampling and modeling analysis and the resulting Technical Report, the MEP has determined that the Total Maximum Daily Load (TMDL) of N to meet the target threshold N concentration of 0.35 mg/L is 74 kg N/day for the entire system. One scenario modeled by the MEP indicates that a reduction of 50% of the septic load from the subwatershed areas of Lagoon Pond (East Arm) and the West Arm (South End Basin) will meet this TMDL. This document presents the TMDL for this water body and provides guidance to the watershed communities of Oak Bluffs and Tisbury on possible ways to reduce the N loadings to within the recommended TMDL and protect the waters of this estuarine system.

Implementation

The primary goal of TMDL implementation will be lowering the concentrations of N. This can be achieved by reducing the loadings from on-site subsurface wastewater disposal systems by 50% in the Lagoon Pond (East Arm) and West Arm (South End Basin) subwatersheds. However, there are a variety of loading reduction scenarios that could achieve the target threshold N concentration. Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Wastewater Management Plan (CWMP). Implementing best management practices (BMPs) to reduce N loadings from fertilizers, agriculture and runoff where possible will also help to lower the total N load to these systems. Hydrologic modeling of the addition of culverts through Beach Road showed that N concentration improvements would be confined to the West Arm (South End Basin) and would not affect N concentrations in the main basin of Lagoon Pond. The recommended method of TMDL implementation will likely be a combination of reducing the loadings from any and all sources of N in the watershed. The appropriateness of any of the alternatives will depend on local conditions and will have to be determined on a case-by-case basis using an adaptive management approach. Finally, growth within the communities of Oak Bluffs and Tisbury that would exacerbate the problems associated with N loading should be guided by considerations of water quality-associated impacts. Methodologies for reducing

N loading from septic systems, stormwater runoff and fertilizers are provided in detail in the "MEP Embayment Restoration and Guidance for Implementation Strategies", available on the MassDEP website: http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html..

Table of Contents

Executive Summary iii
Introduction 1
Description of Water Bodies and Priority Ranking 2
Problem Assessment 5
Pollutant of Concern, Sources and Controllability 7
Description of the Applicable Water Quality Standards 8
Methodology - Linking Water Quality and Pollutant Sources 9
Total Maximum Daily Loads 17
TMDL Values for the Lagoon Pond Estuarine System 23
Implementation Plans 23
Monitoring Plan 25
Reasonable Assurances 26
Public Participation 27
Appendix A 28
Appendix B 29
Appendix C 30
Appendix D 31

List of Figures

Figure ES-A: Percent Contributions of All Nitrogen Sources to Lagoon Pond iv
Figure ES-B: Percent Contributions of Controllable Nitrogen Sources to Lagoon Pond..... iv
Figure 1: Overview of Lagoon Pond..... 3
Figure 2: Lagoon Pond Watershed Area Delineation 4
Figure 3: Oak Bluffs and Tisbury Resident Population..... 6
Figure 4: Percent Contribution of All Nitrogen Sources to Lagoon Pond..... 7
Figure 5: Lagoon Pond Long Term Monitoring Stations. 15
Figure 6: Controllable Nitrogen Loading Sources to Lagoon Pond 20

List of Tables

Table 1: Comparison of MassDEP and SMAST Impaired Parameters for Lagoon Pond 4
Table 2: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Lagoon Pond Estuarine System 5
Table 3: Observed Present Nitrogen Concentrations and Sentinel Station Threshold Nitrogen Target Concentration for Lagoon Pond..... 13
Table 4: Nitrogen Loading to Lagoon Pond 14
Table 5: Present Watershed Nitrogen Loading Rates, Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings 16
Table 6: Summary of the Present Septic System Loads and the Loading Reductions that would be Necessary to Achieve the TMDL by Reducing Septic System Loads Alone 17
Table 7: The Total Maximum Daily Load for the Lagoon Pond Estuarine System 23
Table A-1: Summary of the Nitrogen Concentrations for the Lagoon Pond Estuarine System 28
Table B-1: Lagoon Pond Estuarine System 2 Total Nitrogen TMDLs and 1 Pollution Prevention Total Nitrogen TMDL 29
Table C-1: The Lagoon Pond System Estimated Waste Load Allocation (WLA) from Runoff of all Impervious Areas within 200 Feet of Water Bodies..... 30

Introduction

Section 303(d) of the Federal Clean Water Act requires each state (1) to identify waters that are not meeting water quality standards and (2) to establish Total Maximum Daily Loads (TMDLs) for such waters for the pollutants of concern. The TMDL allocation establishes the maximum loadings (of pollutants of concern) from all contributing sources that a water body may receive and still meet and maintain its water quality standards and designated uses, including compliance with numeric and narrative standards. The TMDL development process may be described in four steps, as follows:

1. Determination and documentation of whether or not a water body is presently meeting its water quality standards and designated uses.

2. Assessment of present water quality conditions in the water body, including estimation of present loadings of pollutants of concern from both point sources (discernable, confined, and concrete sources such as pipes) and non-point sources (diffuse sources that carry pollutants to surface waters through runoff or groundwater).

3. Determination of the loading capacity of the water body. EPA regulations define the loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. If the water body is not presently meeting its designated uses, then the loading capacity will represent a reduction relative to present loadings.

4. Specification of load allocations based on the loading capacity determination for non-point sources and point sources that will ensure that the water body will not violate water quality standards.

After public comment and final approval by the EPA, the TMDL will serve as a guide for future implementation activities. The MassDEP will work with Oak Bluffs and Tisbury to develop specific implementation strategies to reduce N loadings and will assist in developing a monitoring plan for assessing the success of the nutrient reduction strategies.

In the Lagoon Pond estuarine system the pollutant of concern for this TMDL (based on observations of eutrophication) is the nutrient nitrogen. Nitrogen is the limiting nutrient in coastal and marine waters so as its concentration increases, so does plant productivity. This leads to nuisance populations of macro-algae and increased concentrations of phytoplankton and epiphyton and imperil the healthy ecology of the affected water bodies.

The TMDL for total N for the Lagoon Pond estuarine system is based primarily on data collected, compiled and analyzed by University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST), the Martha's Vineyard Commission/Towns of Oak Bluffs and Tisbury Water Quality Monitoring Programs, and others, as part of the Massachusetts Estuaries Project (MEP). The data were collected over a study period from 2002 to 2007. This study period will be referred to as the "Present Conditions" in the TMDL since it contains the most recent data available. The MEP Technical Report entitled: Linked Watershed Embayment Model to Determine Critical Nitrogen Loading Thresholds for the

Lagoon Pond Embayment System, Oak Bluffs and Tisbury Massachusetts,can be found at http://www.oceanscience.net/estuaries/reports.htm.

The MEP Technical Report presents the results of the analyses of this coastal embayment system using the MEP Linked Watershed-Embayment Nitrogen Management Model (Linked Model). The analyses were performed to assist Oak Bluffs and Tisbury with decisions on current and future wastewater planning, wetland restoration, anadromous fish runs, shellfisheries, open-space and harbor maintenance programs. A critical element of this approach is the assessment of water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements and benthic community structure that were conducted on this embayment. These assessments served as the basis for generating a N loading threshold for use as a goal for watershed N management. The TMDL is based on the site-specific target threshold N concentration generated for this embayment. Thus, the MEP offers a science-based management approach to support the wastewater management planning and decision-making process in the Towns of Oak Bluffs and Tisbury.

Description of Water Bodies and Priority Ranking

The Lagoon Pond estuarine system is a simple estuary with a single armored inlet through the barrier beach. Its 3,889 acre watershed is situated along the eastern edge of Martha's Vineyard and is bounded by the Sengekontacket Pond watershed to the east. Lagoon Pond itself is 573 acres and lies in a north/south orientation with one small tributary cove referred to as the West Arm (also called the South End Basin in the MEP Technical Report), and the main tidal reach (East Arm) consisting of a lower (North Basin), middle (Central Basin) and upper basin (South Basin) based upon geomorphologic features (see Figures 1 and 2). Tidal water from Vineyard Sound enters the basin at the northern end of the East Arm and circulates through channels and across flats moving southward up the East Arm or into the much smaller, shallow West Arm. In the Lagoon Pond watershed, freshwater directly discharges from Upper Lagoon Pond into the South Basin of the East Arm with the remainder of the freshwater watershed inputs to the estuary via direct groundwater.

The formation of the Lagoon Pond estuarine system has and continues to be greatly affected by coastal processes, specifically the role that the barrier beach plays in separating the pond from Vineyard Sound source waters. Prior to the inlet being armored for construction of the Beach Road Bridge, the ecological and biogeochemical structure of the pond is likely to have changed over time as the barrier beach naturally breached in different locations and intermittently closed in as a function of storm frequency and intensity.

The nature of enclosed embayments in populous regions brings two opposing elements to bear: 1) as protected marine shoreline they are popular regions for boating, recreation and land development; and 2) as enclosed bodies of water they may not be readily flushed of the pollutants that they receive due to the proximity and density of development near and along their shores. In particular, the Lagoon Pond estuarine system is at risk of further eutrophication from high nutrient loads in the groundwater and runoff from the watershed. This estuarine system is already listed as waters requiring a TMDL for fecal coliform and

estuarine bioassessments (Category 5) in the MA 2012 Integrated List of Waters (http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf), as summarized in Table 1.

Figure 1: Overview of Lagoon Pond

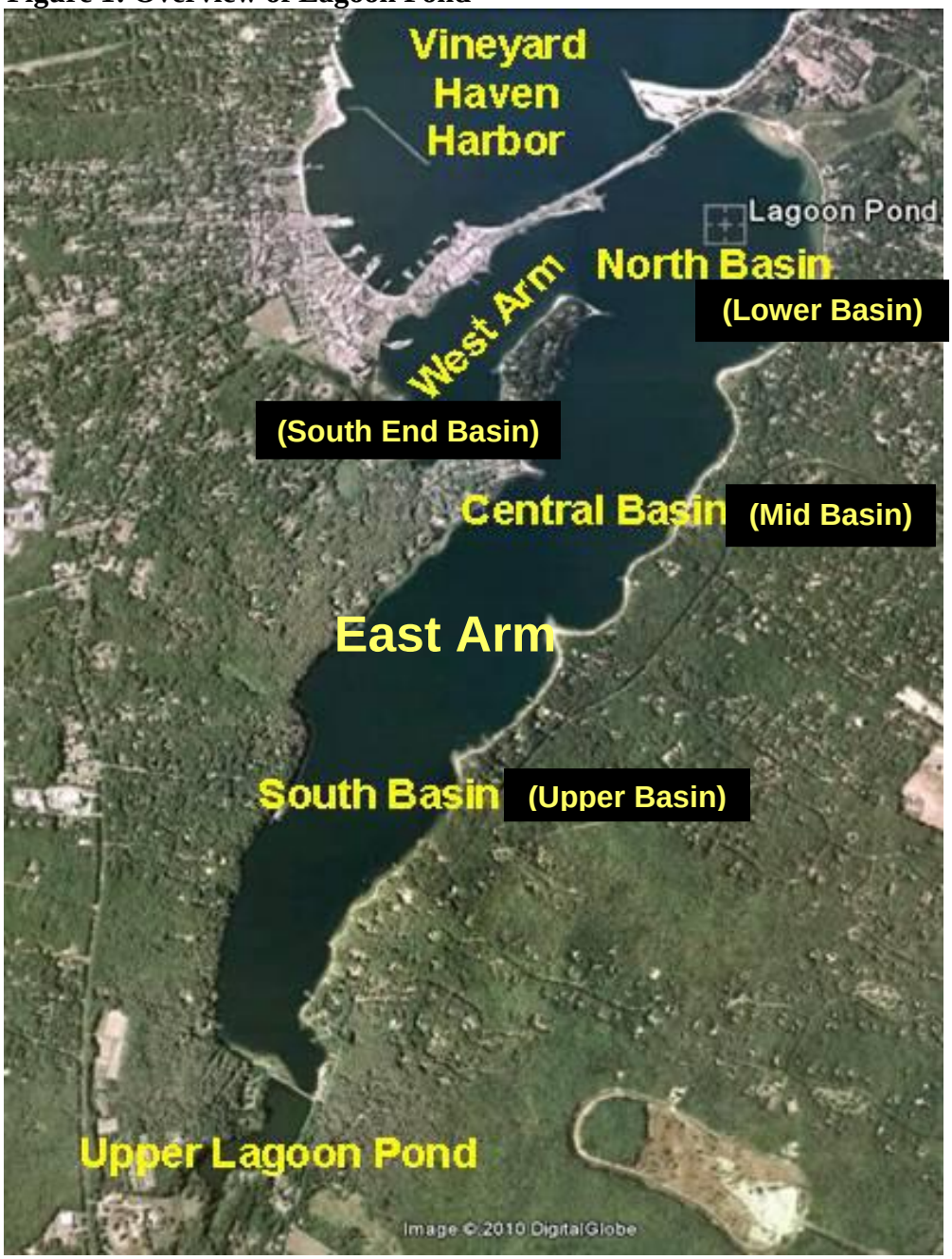


Figure 2: Lagoon Pond Watershed Area Delineation

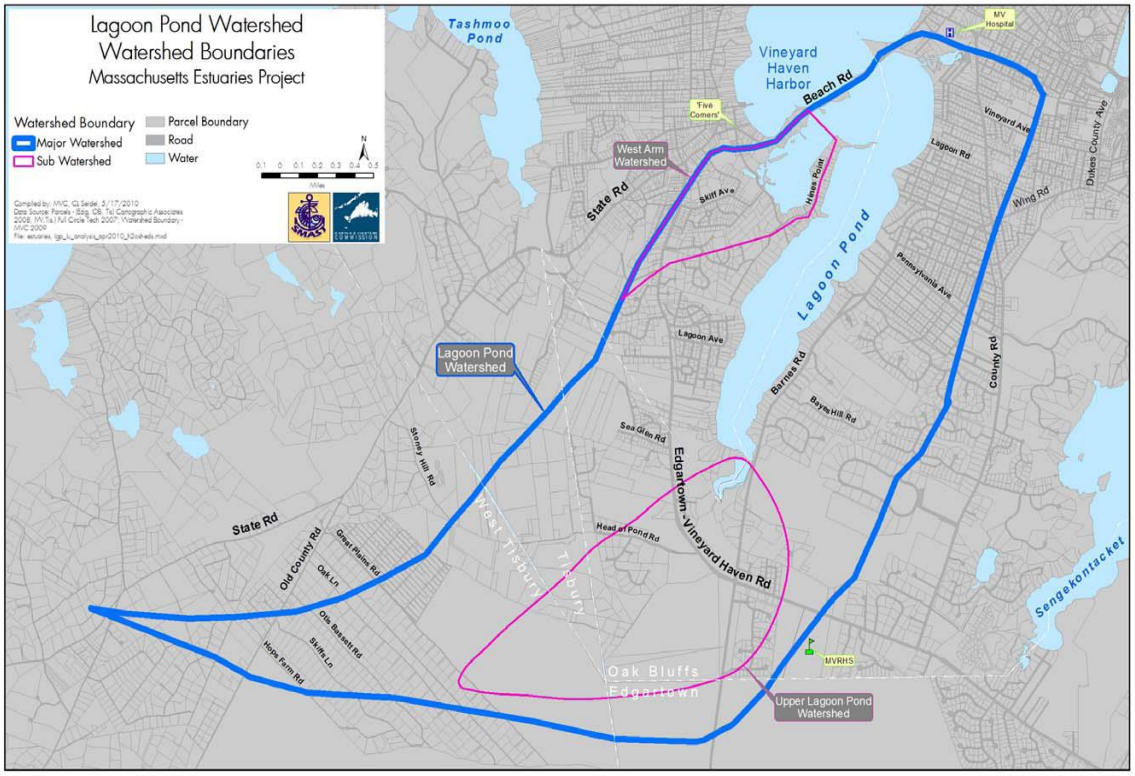


Table 1: Comparison of MassDEP and SMAST Impaired Parameters for Lagoon Pond

Name	Water Body Segment	Description	Size	DEP Listed Parameter[1]	SMAST Impaired Parameter[2]
Lagoon Pond	MA97-11	From Head of the Pond Road to confluence with Vineyard Haven Harbor at Beach Road, Tisbury/Oak Bluffs, Martha's Vineyard.	0.819 sq. mi.	-Estuarine Bioassessments -Fecal coliform	-Nutrients -DO level -Chlorophyll *a* -Eelgrass loss -Benthic fauna

[1] Water body segment is listed in Category 5 of the MA 2012 Integrated List of Waters)
[2] As determined by the MEP Lagoon Pond Study and reported in the Technical Report

A complete description of this embayment system is presented in Chapters I and IV of the MEP Technical Report. A majority of the information on this embayment system is drawn from this report. Chapters VI and VII of the MEP Technical Report provide assessment data that show that the Lagoon Pond estuarine system is impaired because of elevated nutrients, low dissolved oxygen levels, elevated chlorophyll *a* levels, eelgrass loss and degraded benthic fauna habitat. Please note that pathogens are listed in Table 1 for completeness. Further discussion of pathogens is beyond the scope of this TMDL.

The embayment addressed by this document is determined to be a high priority based on three significant factors: (1) the initiative that the towns have taken to assess the conditions of the entire embayment system; (2) the commitment made by the towns to restore and preserve the embayment; and (3) the extent of impairment in the embayment. In particular, this

embayment is at risk of further degradation from increased N loads entering through groundwater and surface water from the increasingly developed watershed. In both marine and freshwater systems an excess of nutrients results in degraded water quality, adverse impacts to ecosystems and limits on the use of water resources. Observations are summarized in Table 2 and the Problem Assessment section below and detailed in Chapter VII-Assessment of Embayment Nutrient Related Ecological Health of the MEP Technical Report.

Table 2: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Lagoon Pond Estuarine System

Embayment	Dissolved Oxygen	Chlorophyll *a*[1]	Eelgrass Loss	Benthic Fauna[2]
East Arm[3]	Oxygen levels frequently <4 mg/L, with periods of anoxia SI	Low to Moderate levels (<5 - 8 µg/L) H-MI	Significant decline in coverage from 1995 - 2006 MI-SI	Low to moderate numbers of individuals and species, no infauna in deep basin MI-SD
West Arm (South End Basin)	Oxygen levels range from 4.7 to >6 mg/L MI	Low levels H	No documentation that eelgrass was present in this basin	Moderate species numbers and eveness MI

[1] Algal blooms are consistent with chlorophyll *a* levels above 20µg/L
[2] Based on observations of the types of species, number of species and number of individuals
[3] East Arm includes South, Central and North Basins. Upper Lagoon Pond drains into the South Basin.

H - Healthy habitat conditions
MI – Moderately Impaired
SI – Significantly Impaired - considerably and appreciably changed from normal conditions
SD – Severe degradation*

* - These terms are more fully described in MEP report "Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators" December 22, 2003. http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html

Problem Assessment

The primary ecological threat to Lagoon Pond is degradation resulting from nutrient enrichment. Over half of the N load is from sources that are not locally controllable, i.e., atmospheric deposition to the surface of the estuary and from N-rich sediments. The N loading from locally controllable sources, i.e., septic systems, stormwater runoff, agriculture, fertilizer and the landfill, make up the remaining load. Nitrogen from these sources enters the groundwater system and eventually enters the surface water bodies. In the sandy soils of Martha's Vineyard nitrogen that has entered the groundwater travels toward the coastal waters at an average rate of one foot per day.

The towns of Martha's Vineyard have grown rapidly over the past two decades. In the period from 1970 to 2009 the number of year round residents in Oak Bluffs has about tripled and in Tisbury has almost doubled (Figure 3). The watershed of Lagoon Pond has had rapid and extensive development of single-family homes and the conversion of seasonal into full time residences. This is reflected in a substantial transformation of land from forest to suburban use

between the years 1970 to 2009. Water quality problems associated with this development result primarily from on-site wastewater treatment systems, and to a lesser extent, from runoff (including fertilizers) from these developed areas.

Almost all of the homes in the Lagoon Pond watershed rely on privately maintained septic systems for on-site treatment and disposal of wastewater.

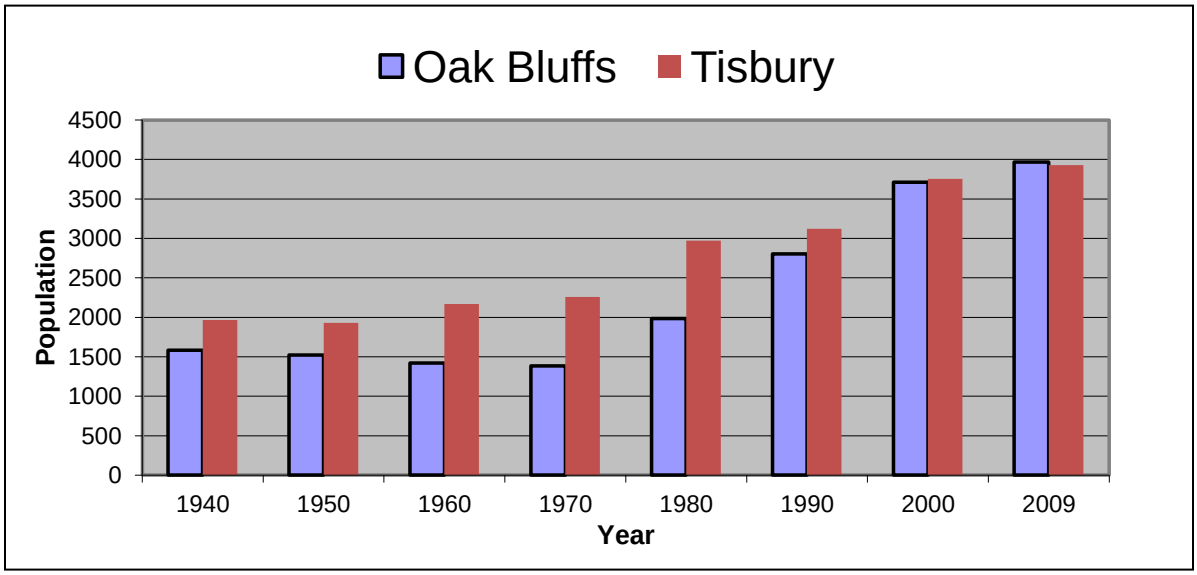


Figure 3: Oak Bluffs and Tisbury Resident Population

Prior to the 1970s there were few homes and many of those were seasonal. It is generally recognized that declines in water and habitat quality often parallel population growth in the The problems in Lagoon Pond include depletion of dissolved oxygen, significant decrease in diversity and quantity of benthic animals, significant decrease in eelgrass coverage and moderate levels of phytoplankton and patches of accumulated macroalgae. watershed. If the N concentration continues to increase, future habitat degradation could include periodic fish kills, unpleasant odors and scums, and near loss of the benthic community and/or presence of only the most stress-tolerant species of benthic animals.

Coastal communities, including Oak Bluffs and Tisbury, rely on clean, productive and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing, and boating, as well as commercial fin fishing and shellfishing. The continued degradation of this coastal embayment, as described above, could significantly reduce the recreational and commercial value and use of these important environmental resources.

Habitat and water quality assessments were conducted on this embayment system based upon water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen and chlorophyll *a* measurements, benthic community structure and sediment characteristics. The observed spatial pattern indicated that the level of oxygen depletion, chlorophyll *a* and total nitrogen levels increased with increasing distance from the tidal inlet. This pattern is also consistent with the observed pattern of eelgrass loss. Although eelgrass is confined to the shallow margins within the East Arm of the estuary, its pattern of temporal

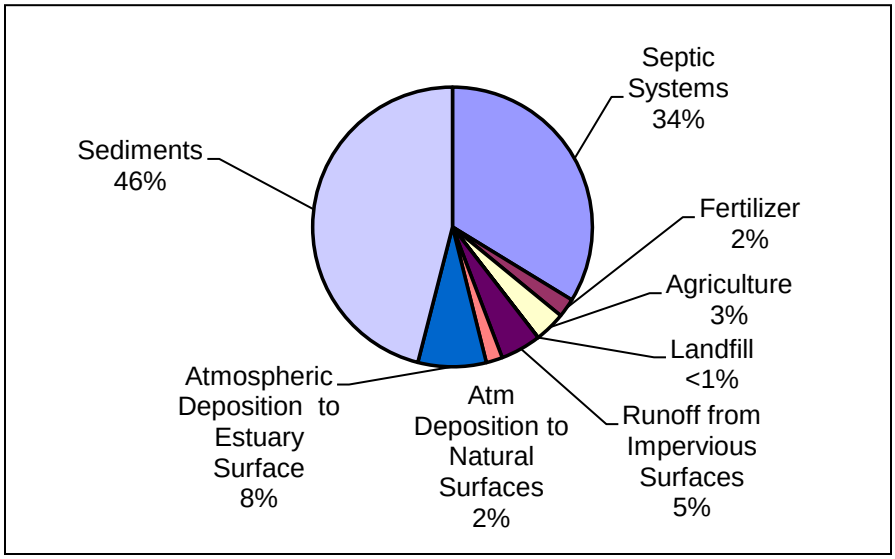
loss is consistent with an estuarine system that is beyond its ability to assimilate nitrogen loads without impairment. Benthic habitat is also impaired by nitrogen enrichment but the level appears to be worse in deep versus shallow water. The MEP study found that impacts from nutrient enrichment in Lagoon Pond are magnified by its basin structure, which when combined with the depositional nature of the basins and periodic reduced vertical mixing, results in poor quality benthic animal habitat within the deeper waters of the basins of the East Arm. At present, eelgrass exists mainly within the North Basin of Lagoon Pond closest to the inlet with narrow beds in the shallow (<2m) water margins fringing the basins within the Central and South Basins of the East Arm. There is no eelgrass in the West Arm although information from 1987 indicates that it did exist there. The absence of eelgrass in this basin is consistent with its level of nitrogen enrichment (average of 0.386 mg N/L which is the similar to the South Basin of the East Arm (average 0.384 mg N/L) which has also lost much of its fringing eelgrass beds while the eelgrass beds that persist are in areas with significantly lower nitrogen levels. Historical and present absence of eelgrass in the deep basins (4 – 10 m) is likely due to insufficient light based on depth rather than nutrient enrichment.

Pollutant of Concern, Sources and Controllability

In Lagoon Pond, as in most marine and coastal waters, the limiting nutrient is nitrogen (N). Nitrogen concentrations beyond those expected naturally contribute to undesirable water quality and habitat conditions (as described above).

Lagoon Pond has had extensive data collected and analyzed through the MEP with the cooperation and assistance from the Towns of Oak Bluffs and Tisbury and the Martha's Vineyard Commission. Data collection included both water quality and hydrodynamics as described in Chapters I, IV, V, VI, and VII of the MEP Technical Report. These investigations revealed that loadings of nutrients, especially N, are much larger than they would be under natural conditions and as a result the water quality has deteriorated. Figure 4 illustrates the sources and percent contributions of N into Lagoon Pond.

Figure 4: Percent Contribution of All Nitrogen Sources to Lagoon Pond



The level of "controllability" of each source, however, varies widely:

Agricultural – related N loadings can be controlled through agricultural BMPs.

Atmospheric deposition to estuary surface - cannot be controlled locally – it is only through regional and national air pollution control initiatives that significant reductions are feasible.

Atmospheric deposition to natural surfaces (forests, fields, etc.) in the watershed – atmospheric deposition (loadings) to these areas cannot adequately be controlled locally, however the N from these sources might be subjected to enhanced natural attenuation as it moves towards the estuary.

Fertilizer – related N loadings can be reduced through bylaws and public education.

Landfill – related N loadings can be controlled through appropriate BMP and management techniques;

Natural background - background load if the entire watershed was still forested and contained no anthropogenic sources. It cannot be controlled.

Nitrogen from sediments - control by such measures as dredging is not feasible on a large scale. However, the concentrations of N in sediments, and thus the loadings from the sediments, will decline over time if sources in the watershed are removed, or reduced to the target levels discussed later in this document. In addition, increased dissolved oxygen will help keep N from fluxing.

Septic systems - sources of N are the largest controllable sources. These can be controlled by a variety of case-specific methods including: sewering and treatment at centralized or decentralized locations, transporting and treating septage at treatment facilities with N removal technology either in or out of the watershed, or installing N-reducing on-site wastewater treatment systems.

Stormwater Runoff – related N loadings can be reduced through best management practices (BMPs), bylaws, stormwater infrastructure improvements and public education.

Cost/benefit analyses will have to be conducted for all possible N loading reduction methodologies in order to select the optimal control strategies, priorities, and schedules.

Description of the Applicable Water Quality Standards

The Water Quality Classification of Lagoon Pond is SA. Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, aesthetics, excess plant biomass and nuisance vegetation. The Massachusetts Water Quality Standards (314 CMR 4.00) contain numeric criteria for dissolved oxygen but have only narrative standards that relate to the other variables, as described below:

314 CMR 4.05(5)(a) states "Aesthetics – All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum, or other matter to form nuisances; produce objectionable odor, color, taste, or turbidity; or produce undesirable or nuisance species of aquatic life."

314 CMR 4.05(5)(c) states, "Nutrients. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established…"

314 CMR 4.05(5)(b) states: "Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms."

314 CMR 4.05(b) 1: Class SA

1. Dissolved Oxygen - Dissolved Oxygen. Shall not be less than 6.0 mg/L. Where natural background conditions are lower, DO shall not be less than natural background. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

Thus, the assessment of eutrophication is based on site-specific information within a general framework that emphasizes impairment of uses and preservation of a balanced indigenous flora and fauna. This approach is recommended by the US Environmental Protection Agency in their draft Nutrient Criteria Technical Guidance Manual for Estuarine and Coastal Marine Waters (EPA-822-B-01-003, Oct 2001). The Guidance Manual notes that lakes, reservoirs, streams and rivers may be subdivided by classes, allowing reference conditions for each class and facilitating cost-effective criteria development for nutrient management. However, individual estuarine and coastal marine waters tend to have unique characteristics and development of individual water body criteria is typically required.

Methodology - Linking Water Quality and Pollutant Sources

Extensive data collection and analyses have been described in detail in the MEP Technical Report. Those data were used by SMAST to assess the loading capacity of each sub-embayment. Physical (Chapter V), chemical, and biological (Chapters IV, VII, and VIII**)** data were collected and evaluated. The primary water quality objective was represented by conditions that:

1) Restore the natural distribution of eelgrass because it provides valuable habitat for shellfish and finfish;
2) Prevent algal blooms;
3) Protect benthic communities from impairment or loss;
4) Maintain dissolved oxygen concentrations that are protective of the estuarine communities.

The details of the data collection, modeling and evaluation are presented and discussed in Chapters IV, V, VI, VII and VIII of the MEP Technical Report. The main aspects of the data evaluation and modeling approach of this study are summarized below.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach. It fully links watershed inputs with embayment circulation and N characteristics and is characterized as follows:

- Requires site specific measurements within the watershed and each sub-embayment;

- Uses realistic "best-estimates" of N loads from each land-use (as opposed to loads with built-in "safety factors" like Title 5 design loads);

- Spatially distributes the watershed N loading to the embayment;

- Accounts for N attenuation during transport to the embayment;

- Includes a 2D or 3D embayment circulation model depending on embayment structure;

- Accounts for basin structure, tidal variations, and dispersion within the embayment;

- Includes N regenerated within the embayment;

- Is validated by independent hydrodynamic, N concentration, and ecological data;

- Is calibrated and validated with field data prior to generation of "what if" scenarios.

The Linked Model has been applied previously to watershed N management in numerous embayments throughout Southeastern Massachusetts. In these applications it became clear that the model can be calibrated and validated, and has use as a management tool for evaluating watershed N management options.

The Linked Model, when properly calibrated and validated for a given embayment, becomes a N management planning tool as described in the model overview below. The model can assess solutions for the protection or restoration of nutrient-related water quality and allows testing of management scenarios to support cost/benefit evaluations. In addition, once a model is fully functional it can be refined for changes in land-use or embayment characteristics at minimal cost. Also, since the Linked Model uses a holistic approach that incorporates the entire watershed, embayment and tidal source waters, it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. It should be noted that this approach includes high-order, watershed and sub-watershed scale modeling necessary to develop critical nitrogen targets for each major sub-embayment. The models, data and assumptions used in this process are specifically intended for the purposes stated in the MEP Technical Report, upon which this TMDL is based. As such, the Linked Model process does not contain the type of data or level and scale of analysis necessary to predict the fate and transport of nitrogen through groundwater from

specific sources. In addition, any determinations related to direct and immediate hydrologic connection to surface waters are beyond the scope of the MEP's Linked Model process.

The Linked Model provides a quantitative approach for determining an embayment's: (1) N sensitivity; (2) N threshold loading levels (TMDL); and (3) response to changes in loading rate. The approach is fully field validated and unlike many approaches, accounts for nutrient sources, attenuation, and recycling and variations in tidal hydrodynamics (Figure I-3 of the MEP Technical Report). This methodology integrates a variety of field data and models, specifically:

• Monitoring - multi-year embayment nutrient sampling;

• Hydrodynamics;
- Embayment bathymetry (depth contours throughout the embayment)
- Site-specific tidal record (timing and height of tides)
- Water velocity records (in complex systems only)
- Hydrodynamic model

• Watershed N Loading;
- Watershed delineation
- Stream flow (Q) and N load
- Land-use analysis (GIS)
- Watershed N model

• Embayment TMDL – Synthesis;
- Linked Watershed-Embayment N Model
- Salinity surveys (for linked model validation)
- Rate of N recycling within embayment
- Dissolved oxygen record
- Macrophyte survey
- Infaunal survey

Application of the Linked Watershed-Embayment Model

The approach developed by the MEP for applying the linked model to specific embayments for the purpose of developing target threshold N loading rates includes:

1) Selecting one or two sub-embayments within the embayment system located close to the inland-most reach or reaches which typically has/have the poorest water quality within the system. These are called "sentinel" stations;

2) Using site-specific information and a minimum of three years of sub-embayment-specific data to select target threshold N concentrations for each sub-embayment. This is done by refining the draft target threshold N concentrations that were developed as the initial step of the MEP process. The target threshold N

concentrations that were selected generally occur in higher quality waters near the mouth of the embayment system;

3) Running the calibrated water quality model using different watershed N loading rates, to determine the loading rate which will achieve the target threshold N concentration at the sentinel station. Differences between the modeled N load required to achieve the target threshold N concentration, and the present watershed N load represent N management goals for restoration and protection of the embayment system as a whole.

Previous sampling and data analyses and the modeling activities described above resulted in four major outputs that were critical to the development of the TMDL. Two outputs are related to N **concentration**:

- the present N concentrations in the sub-embayments;
- site-specific target threshold N concentrations.

Two outputs are related to N **loadings:**

- the present N loads to the sub-embayments;
- load reductions necessary to meet the site specific target threshold N concentrations.

In summary, meeting the water quality standards by reducing the N concentration (and thus the N load) at the sentinel station(s), the water quality goals will be met throughout the entire system.

A brief overview of each of the outputs follows.

Nitrogen concentrations in the embayment

a) Observed "present" conditions:

Table 3 presents the average concentrations of N measured in this system from data collected at six stations during the period 2002 through 2007. Nitrogen concentrations range from 0.333 – 0.418 mg/L throughout the Lagoon Pond estuarine system. The lowest average concentration is found in the North Basin closest to the inlet (Station LPG-9) and the highest average is from the South Basin at the southernmost station (LGP-6). See Figure 5 for station locations. The overall means and standard deviations of the averages are presented in Appendix A, Table A-1 (reprinted from Table VI-1 of the MEP Technical Report).

b) Modeled site-specific target threshold N concentrations:

The target threshold N level for an embayment represents the average water column concentration of N that will support the habitat quality or dissolved oxygen conditions being sought. The water column N level is ultimately controlled by the integration of the watershed N load, the N concentration in the inflowing tidal waters (boundary condition)

and dilution due to ground or surface water flows. The water column N concentration is also modified by the extent of sediment regeneration, by direct atmospheric deposition, and phytoplankton uptake.

Table 3: Observed Present Nitrogen Concentrations and Sentinel Station Threshold Nitrogen Target Concentration for Lagoon Pond

Embayment	Observed Nitrogen Concentration [1] (mg/L)	Sentinel Station[2] Target Threshold Nitrogen Concentration (mg/L)
Lagoon Pond	0.333-0.418	0.35
Nantucket Sound (Boundary Condition)	0.290	

[1]Concentrations shown as range of means from the six water quality monitoring stations within Lagoon Pond
[2] Sentinel Station LGP-2

A major component of TMDL development is the determination of the maximum concentrations of N (based on field data) that can occur without causing unacceptable impacts to the aquatic environment. Prior to conducting the analytical and modeling activities to determine this target threshold N concentration as described below, SMAST selected appropriate nutrient-related environmental indicators and tested the qualitative and quantitative relationship between those indicators and N concentrations. The Linked Model was then used to determine site-specific threshold N concentrations by using the specific physical, chemical and biological characteristics of each sub-embayment. Determination of the critical nitrogen threshold for maintaining high quality habitat within Lagoon Pond is based primarily on the nutrient and oxygen levels, temporal trends in eelgrass distribution and benthic community indicators.

As listed in Table 3 above, the site-specific target threshold N concentration is 0.35 mg/L. The findings of the analytical and modeling investigations to determine this target threshold nitrogen concentration for the embayment system are discussed below.

The N threshold for Lagoon Pond is based upon the goal of improving fringing eelgrass habitat within the East Arm and restoration of benthic habitat for infaunal animals in the West Arm. The MEP study concluded that there was no documented evidence (past or present) of eelgrass within the West Arm or the deep basins of the East Arm.

The absence of eelgrass within the West Arm and near loss of eelgrass from the upper basin of the East Arm are associated with tidally averaged total nitrogen (TN) levels of 0.378 mg N/L and 0.385 mg N/L, respectively. In contrast, some stable eelgrass beds were observed within the lower basin at tidally averaged nitrogen levels of 0.328 mg N/L, while fringing eelgrass beds presently exist in the shallow margins of the upper and mid basin at nitrogen levels between 0.371 mg N/L and 0.338 mg N/L. These TN levels and habitat stability/decline are consistent with persistence and loss of eelgrass at similar depths in other estuaries on Vineyard/Nantucket Sound. In Waquoit Bay at similar depths, eelgrass was found to slowly decline at average TN concentrations of 0.395 mg N/L (lower basin of

Waquoit Bay) and was also lost from the Centerville River at a tidally averaged TN of 0.395 mg N/L. In the West Falmouth Harbor Estuary on Buzzards Bay eelgrass declined when nitrogen enrichment resulted in levels over 0.35 mg N/L. Therefore, it appears that the threshold for stable eelgrass habitat in Lagoon Pond must be less than 0.385 mg N/L, as this is the present level and loss is continuing. Similarly, it appears that eelgrass beds presently exist in Lagoon Pond at nitrogen levels between 0.371 mg N/L and 0.338 mg N/L. However, at the higher end of this range some loss is continuing.

Based upon these observations and those from other systems, a tidally averaged nitrogen threshold for Lagoon Pond of 0.35 mg N/L was established to support restoration of the impaired eelgrass habitat at depth (~2 m) as found historically. This threshold is for the sentinel station LGP-2 located at the upper extent of the major fringing beds observed in 1995 (Figure 5). Lowering the level of nitrogen enrichment at the sentinel station will also lower nitrogen levels throughout the estuary with the concurrent effect of improving infaunal habitats in the West Arm.

Nitrogen loadings to the embayment

a) Present loading rates:

In the Lagoon Pond estuarine system overall, the highest N loading from controllable sources is from on-site wastewater treatment systems which is almost always the highest N loading source in other coastal embayments as well. The septic system loading is 34.4 kg N/day in Lagoon Pond. The total N loading from all sources is 101.7 kg N/day across the Lagoon Pond embayment. A further breakdown of N loading by source is presented in Table 5. The data on which Table 4 is based can be found in Table ES-1 of the MEP Technical Report.

Table 4: Nitrogen Loading to Lagoon Pond

Embayment	Present Non-Wastewater Watershed Load[1] (kg N/day)	Present Septic System Load (kg N/day)	Present Atmospheric Deposition[2] (kg N/day)	Present Load from Nutrient Rich Sediments (kg N/day)	Total nitrogen load from all sources (kg N/day)
Lagoon Pond	12.4	34.4	8.1	46.9	101.7

[1] Includes fertilizers, runoff, agriculture, landfill and atmospheric deposition to lakes and natural surfaces.
[2] Includes atmospheric deposition to the estuarine surface only.

As previously indicated, the present N loadings to Lagoon Pond must be reduced in order to restore conditions and to avoid further nutrient-related adverse environmental impacts. The critical final step in the development of the TMDL is modeling and analysis to determine the loadings required to achieve the target threshold N concentrations.

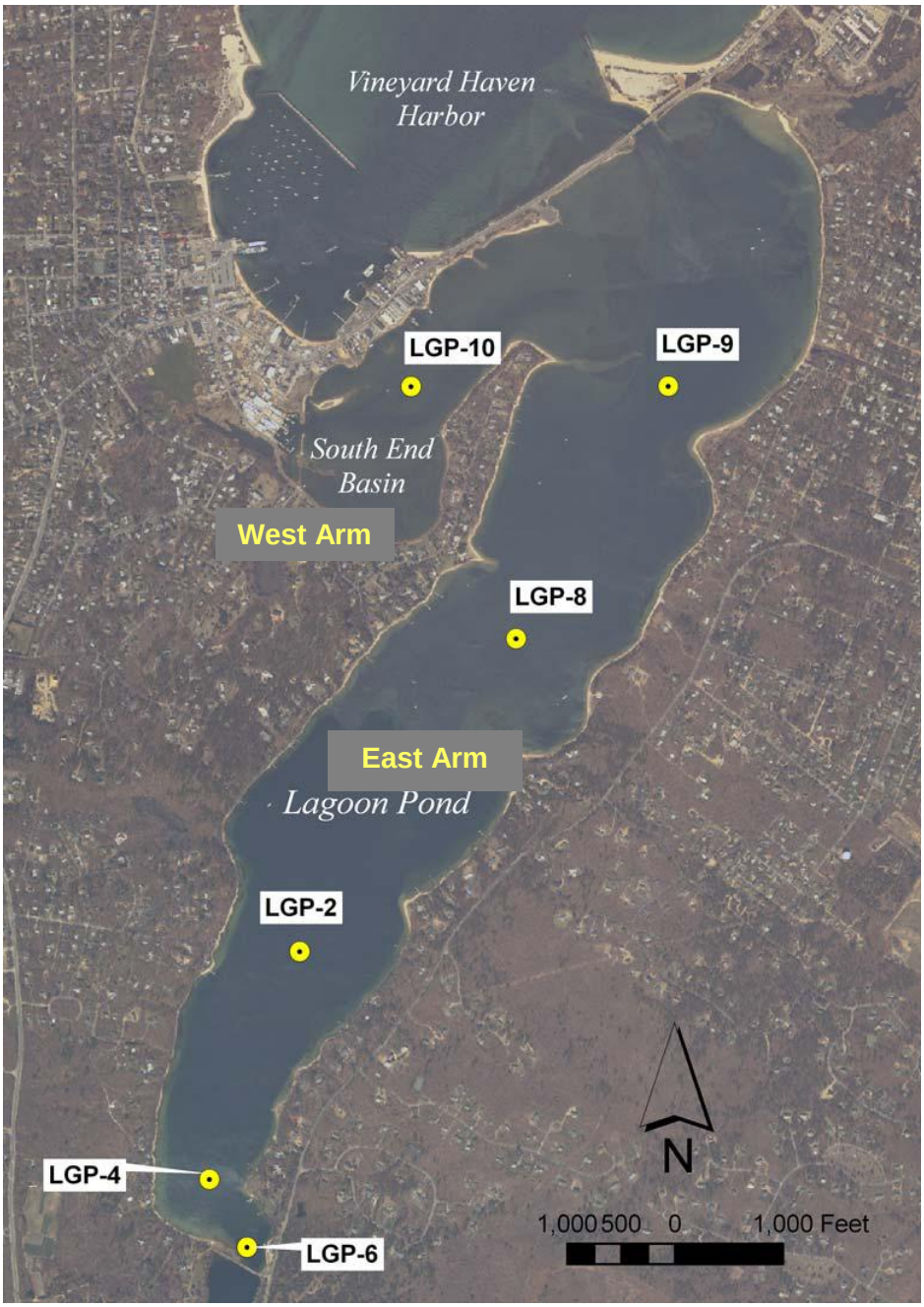


Figure 5: Lagoon Pond Long Term Monitoring Stations.

b) Nitrogen loads necessary for meeting the site-specific target threshold N concentrations:

The nitrogen threshold developed by SMAST (Section VIII.2 in the MEP Technical Report) and summarized above was used to determine the amount of total nitrogen mass loading reduction required for restoration of eelgrass and infaunal habitats in the Lagoon Pond system. Tidally averaged total nitrogen thresholds were used to adjust the calibrated water quality model (Section VI in the MEP Technical Report). Watershed nitrogen loads were sequentially lowered using reductions in septic effluent discharges only until the nitrogen levels reached the threshold level at the sentinel station chosen for Lagoon Pond (LGP-2). It is important to note that load reductions can be produced by reduction of any or all sources of N and/or by increasing the natural attenuation of nitrogen within the freshwater systems to the embayment. The load reductions presented here represent only one of a suite of potential reduction approaches that need to be evaluated by the community.

Table 5 presents the present and target threshold watershed N loadings to Lagoon Pond and the percentage reduction necessary to meet the target threshold N concentration at the sentinel station, LGP-2 (from Table ES-2 of the MEP Technical Report).

Table 5: Present Watershed Nitrogen Loading Rates, Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings

Sub-embayment	Present Total Watershed Load [1] (kg N/day)	Target Threshold Watershed Load[2] (kg N/day)	Watershed Load Reductions Needed to Achieve Threshold Loads	
			kg N/day	% change
Lagoon Pond (East Arm)[3]	36.21	22.42	13.79	-38.1
West Arm (South End Basin)	5.76	3.38	2.38	-41.4
Upper Lagoon Pond [4]	4.83	4.83	0	0
Total	46.8	30.62	16.18	-34.6 %

[1]Composed of fertilizer, runoff from impervious surfaces, septic systems, agriculture, landfill and atmospheric deposition to natural surfaces.
[2] Target threshold watershed load is the load from the watershed needed to meet the embayment target threshold N concentration identified in Table 3 above.
[3] East Arm includes South, Central and North Basins of Lagoon Pond.
[4] Upper Lagoon Pond drains into the South Basin of Lagoon Pond.

Table 6 (from Table VIII-2 of the MEP Technical Report) summarizes the present loadings from septic systems and the reduced loads that would be necessary to achieve the target threshold N concentration in the Lagoon Pond estuarine system under the scenario modeled here. A 47% reduction in present (2002-07) septic loading achieved the target threshold N concentration of 0.35 mg/L at the sentinel station, time averaged over the summer period. This septic load change will result in a 34.6% reduction in the total watershed load to the pond.

Table 6: Summary of the Present Septic System Loads and the Loading Reductions that would be Necessary to Achieve the TMDL by Reducing Septic System Loads Alone

Sub- embayment	Present Septic N Load (kg N/day)	Threshold Septic load (kg N/day)	Threshold Septic Load % Change
Lagoon Pond (East Arm)	27.58	13.79	-50%
West Arm (South End Basin)	4.77	2.39	-50%
Upper Lagoon Pond	2.06	2.06	0
Total	34.41	18.24	-47%

The above modeling results provide one scenario of achieving the threshold level for the sentinel site within the estuarine system. This example does not represent the only method for achieving this goal. The Towns of Oak Bluffs and Tisbury are encouraged to evaluate other load reduction scenarios and take any reasonable steps to reduce the controllable N sources.

Total Maximum Daily Loads

As described in EPA guidance, a total maximum daily load (TMDL) identifies the loading capacity of a water body for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. The TMDLs are established to protect and/or restore the estuarine ecosystem, including eelgrass, the leading indicator of ecological health, thus meeting water quality goals for aquatic life support. Because there are no "numerical" water quality standards for N the TMDL for the Lagoon Pond estuarine system is aimed at determining the loads that would correspond to specific N concentrations determined to be protective of the water quality and ecosystems.

The effort includes detailed analyses and mathematical modeling of land use, nutrient loads, water quality indicators and hydrodynamic variables (including residence time) for each sub-embayment. The results of the mathematical model are correlated with estimates of impacts on water quality including negative impacts on eelgrass (the primary indicator), as well as dissolved oxygen, chlorophyll and benthic infauna.

The TMDL can be defined by the equation:

$$TMDL = BG + WLAs + LAs + MOS$$

Where:

TMDL = loading capacity of receiving water
BG = natural background
WLAs = portion allotted to point sources
LAs = portion allotted to (cultural) non-point sources
MOS = margin of safety

Background Loading

Natural background N loading is included in the loading estimates, but is not quantified and presented separately. Background loading was calculated on the assumption that the entire watershed is forested with no anthropogenic sources of N. It is accounted for in this study but not defined as a separate component. Readers are referred to Table ES-1 of the MEP Technical Report for estimated loading due to natural conditions.

Waste Load Allocations

Waste load allocations identify the portion of the loading capacity allocated to existing and future point sources of wastewater. EPA interprets 40 CFR 130.2(h) to require that allocations for NPDES regulated discharges of stormwater be included in the waste load component of the TMDL. For purposes of the Lagoon Pond TMDL, there are no NPDES regulated areas for the discharges of stormwater in the watershed. However, MassDEP also considered the nitrogen load reductions from impervious areas adjacent to the waterbody necessary to meet the target nitrogen concentrations in the WLA. Since the majority of the N loading from the watershed comes from septic systems and to a lesser extent agriculture, fertilizer, the landfill, and storm water that infiltrates into the groundwater, the allocation of N for any stormwater pipes that discharge directly to this embayment is insignificant but is estimated here for completeness.

In estimating the nitrogen loadings from impervious sources, MassDEP considered that most stormwater runoff from impervious surfaces in the watershed is not discharged directly into surface waters, but, rather, percolates into the ground. The geology on Cape Cod and the Islands consists primarily of glacial outwash sands and gravels, and water moves rapidly through this type of soil profile. A systematic survey of stormwater conveyances on the Islands has never been undertaken. Nevertheless, most catch basins on the Islands are known to MassDEP to have been designed as leaching catch basins in light of the permeable overburden. MassDEP, therefore, recognized that most stormwater that enters a catch basin in these areas will percolate into the local groundwater table rather than directly discharge to a surface waterbody.

As described in the Methodology Section (above), the Linked Model accounts for storm water loadings and groundwater loading in one aggregate allocation as a non-point source. However, MassDEP also considered that some stormwater may be discharged directly to surface waters through outfalls. In the absence of specific data or other information to accurately quantify stormwater discharged directly to surface waters, MassDEP assumed that all impervious surfaces within 200 feet of the shoreline, as calculated from MassGIS data layers, would discharge directly to surface waters, whether or not it in fact did so. MassDEP selected this approach because it considered it unlikely that any stormwater collected farther than 200 feet from the shoreline would be directly discharged into surface waters. Although the 200 foot approach provided a gross estimate, MassDEP considered it a reasonable and conservative approach given the lack of pertinent data and information about stormwater collection systems on Martha's Vineyard. For Lagoon Pond this calculated stormwater WLA based on the 200 foot buffer is 0.40% of the total watershed N load or 0.19 kg N/day as compared to the overall watershed N load of 48 kg N/day to the embayment (see Appendix C

for details). This conservative load is a negligible amount of the total nitrogen load to the embayment when compared to other sources.

Load Allocations

Load allocations identify the portion of loading capacity allocated to existing and future nonpoint sources. In the case of the Lagoon Pond estuarine system, the controllable nonpoint source loadings are primarily from on-site subsurface wastewater disposal systems. Additional N sources include agriculture, stormwater runoff (except from impervious cover within 200 feet of the waterbody which is defined above as part of the waste load), fertilizers, landfill, atmospheric deposition and nutrient-rich sediments.

Figure ES-B (above) and Figure 6 (below) illustrate that septic systems are the most significant portion of the controllable N load (34.4 kg N/day), with stormwater runoff a distant second (4.8 kg N/day). Other controllable sources combined contribute 6.1 kg N/day (from Table IV-2 in the MEP Technical Report). In addition, there are nonpoint sources of N from sediments, natural background and atmospheric deposition that are not feasibly controllable.

Generally, stormwater that is subject to the EPA Phase II Program would be considered a part of the wasteload allocation rather than the load allocation. As presented in Chapters IV, V, and VI of the MEP Technical Report, on the Islands, the vast majority of stormwater percolates into the aquifer and enters the embayment system through groundwater. As a result, the TMDL accounts for stormwater loadings and groundwater loadings in one aggregate allocation as a non-point source. Ultimately, when the Phase II Program is implemented in Oak Bluffs and Tisbury, new studies and possibly further modeling will identify what portion of the stormwater load may be controllable through Best Management Practices (BMPs).

The sediment loading rates incorporated into the TMDL are lower than the existing sediment flux rates listed in Table 5 above because projected reductions of N loadings from the watershed will result in reductions of nutrient concentrations in the sediments, and therefore, over time, reductions in loadings from the sediments will occur. Benthic N flux is a function of N loading and particulate organic N (PON).

Projected benthic fluxes are based upon projected PON concentrations and watershed N loads and are calculated by multiplying the present N flux by the ratio of projected PON to present PON using the following formulae:

Projected N flux = (present N flux) (PON projected / PON present)

When: $PON\ projected = (R_{load})\ (D_{PON}) + PON_{present\ offshore}$

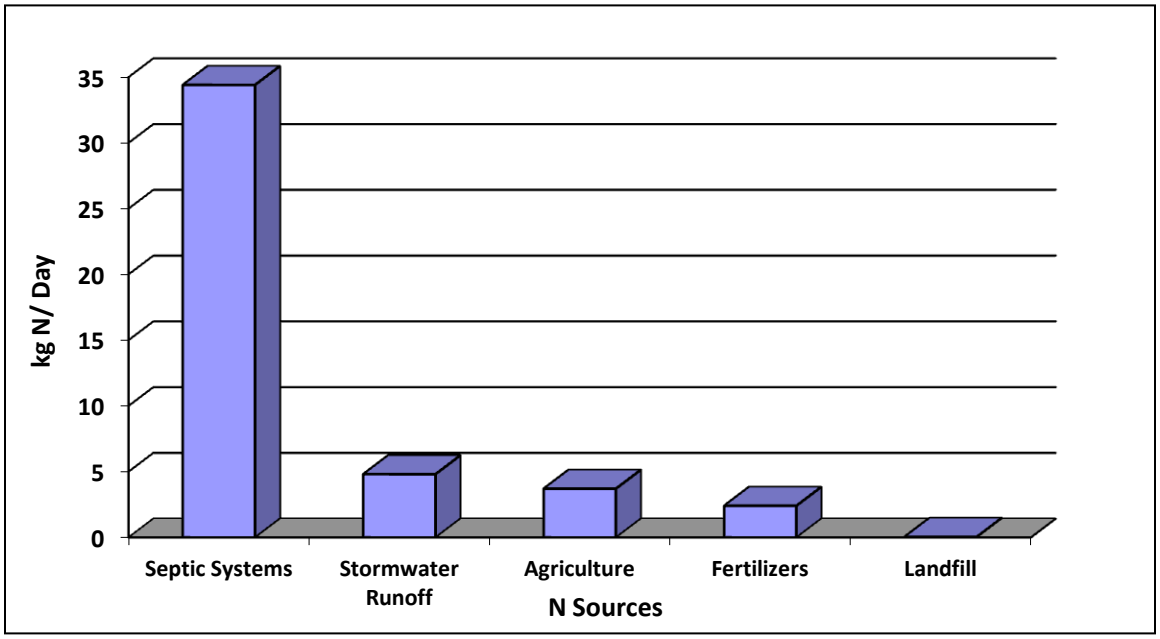
$When\ R_{load} = (projected\ N\ load) / (Present\ N\ load)$

And D_{PON} is the PON concentration above background determined by:
$D_{PON} = (PON_{present\ embayment} - PON_{present\ offshore})$

Benthic loading is affected by the change in watershed load. The benthic flux modeled for Lagoon Pond is reduced from existing conditions based on the load reduction from controllable sources.

The loadings from atmospheric sources incorporated into the TMDL are the same rates presently occurring because, as discussed above, significant control of atmospheric loadings at the local level is not considered feasible.

Figure 6: Controllable Nitrogen Loading Sources to Lagoon Pond



Margin of Safety

Statutes and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and waste load allocations and water quality [CWA para 303 (d)(20C, 40C.G.R. para 130.7C(1)]. The EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. The MOS for the Lagoon Pond estuarine system TMDL is implicit, and the conservative assumptions in the analyses that account for the MOS are described below.

1. <u>Use of conservative data in the linked model</u>

The watershed N model provides conservative estimates of N loads to the embayment. Nitrogen transfer through direct groundwater discharge to estuarine waters is based upon studies indicating negligible aquifer attenuation and dilution, i.e. 100% of load enters embayment. This is a conservative estimate of loading because studies have also shown that in some areas less than 100% of the load enters the estuary. In this context, "direct

groundwater discharge" refers to the portion of fresh water that enters an estuary as groundwater seepage into the estuary itself, as opposed to the portion of fresh water that enters as surface water inflow from streams, which receive much of their water from groundwater flow. Nitrogen from the upper watershed regions which travel through ponds or wetlands almost always enter the embayment via stream flow and are directly measured (over 12-16 months) to determine attenuation. In these cases, the land-use model has shown a slightly higher predicted N load than the measured discharges in the streams/rivers that have been assessed to date. Therefore, the watershed model as applied to the surface water watershed areas again presents a conservative estimate of N loads because the actual measured N in streams was lower than the modeled concentrations.

The hydrodynamic and water quality models have been assessed directly. In the many instances where the hydrodynamic model predictions of volumetric exchange (flushing) have also been directly measured by field measurements of instantaneous discharge, the agreement between modeled and observed values has been $\geq$95%. Since the water quality model incorporates all of the outputs from the other models, this good correlation indicates a high degree of certainty in the final result. The level of accuracy and precision of the model provides a high degree of confidence in the output so less of a margin of safety is required.

Similarly, the water column N validation dataset was also conservative. The model is validated to measured water column N. However, the model predicts average summer N concentrations. The very high or low measurements are marked as outliers. The effect is to make the N threshold more accurate and scientifically defensible. If a single measurement two times higher than the next highest data point in the series raises the average 0.05 mg N/L, this would allow for a higher "acceptable" load to the embayment. Marking the very high outlier is a way of preventing a single and rare bloom event from changing the N threshold for a system. This effectively strengthens the data set so that a higher margin of safety is not required.

Finally, the predicted reductions of the amount of N released from the sediments are most likely underestimates, i.e. conservative. The reduction is based solely on a reduced deposition of PON due to lower primary production rates under the reduced N loading in these systems. As the N loading decreases and organic inputs are reduced it is likely that rates of coupled remineralization-nitrification, denitrification and sediment oxidation will increase.

Benthic regeneration of N is dependent upon the amount of PON deposited to the sediments and the percentage that is regenerated to the water column versus being denitrified or buried. The regeneration rate projected under reduced N loading conditions was based upon two assumptions: (1) PON in the embayment in excess of that of inflowing tidal water (boundary condition) results from production supported by watershed N inputs; and (2) Presently enhanced production will decrease in proportion to the reduction in the sum of watershed N inputs and direct atmospheric N input. The latter condition would result in equal embayment versus boundary condition production and PON levels if watershed N loading and direct atmospheric deposition could be reduced to zero (an impossibility of course). This proportional reduction assumes that the proportion of remineralized N will be the same as

under present conditions, which is almost certainly an underestimate. As a result, future N regeneration rates are overestimated which adds to the margin of safety.

2. Conservative sentinel station/target threshold nitrogen concentration

Conservatism was used in the selection of the sentinel station and target threshold N concentration. The concentration was chosen based on areas within the system that showed somewhat stable eelgrass or benthic animal (infaunal) communities and not those just starting to show impairment, which would have slightly higher N concentration. Meeting the target threshold N concentration at the sentinel station will result in reductions of N concentrations in the rest of the system.

3. Conservative approach

The linked model accounted for all stormwater loadings and groundwater loadings in one aggregate allocation as a non point source and this aggregate load is accounted for in the load allocation. The method of calculating the WLA in the TMDL for impervious cover within the 200 foot buffer area of the waterbody was conservative as it did not disaggregate this negligible load from the modeled stormwater LA, hence this approach further enhances the MOS.

The target loads were based on tidally averaged N concentrations on the outgoing tide which is the worst case condition because that is when the N concentrations are the highest. The N concentrations will be lower on the flood tides; therefore, this approach is conservative.

In addition to the margin of safety within the context of setting the N threshold levels described above, a programmatic margin of safety also derives from continued monitoring of this embayment to support adaptive management. This continuous monitoring effort provides the ongoing data to evaluate the improvements that occur over the multi-year implementation of the N management plan. This will allow refinements to the plan to ensure that the desired level of restoration is achieved.

Seasonal Variation

Since the TMDLs for the waterbody segments are based on the most critical time period, i.e. the summer growing season, the TMDLs are protective for all seasons. The daily loads can be converted to annual loads by multiplying by 365 (the number of days in a year). Nutrient loads to the embayment are based on annual loads for two reasons. The first is that primary production in coastal waters can peak in both the late winter-early spring and in the late summer-early fall periods. Second, as a practical matter, the types of management necessary to control the N load do not lend themselves to intra-annual manipulation since a considerable portion of the N is from non-point sources. Thus, calculating annual loads is most appropriate, since it is difficult to control non-point sources of N on a seasonal basis and N sources can take considerable time to migrate to impacted waters.

TMDL Values for the Lagoon Pond Estuarine System

As outlined above, the total maximum daily loadings of N that would provide for the restoration and protection of the embayment were calculated by considering all sources of N grouped by natural background, point sources and non-point sources. A more meaningful way of presenting the loadings data from an implementation perspective is shown in Table 7.

Table 7: The Total Maximum Daily Load for the Lagoon Pond Estuarine System

Sub- embayment	Target Threshold Watershed Load [1] (kg N/day)	Atmospheric Deposition (kg N/day)	Load from Nutrient Rich Sediments (kg N/day)	TMDL [2] (kg N/day)
Lagoon Pond (East Arm)[3]	22.42	7.16	26.65	56.22
West Arm (South End Basin)	3.38	0.92	8.72	13.01
Upper Lagoon Pond [4]	4.83	-	-	4.83
System Total	30.62	8.08	35.37	74.07

[1] Target threshold watershed load is the load from the watershed needed to meet the embayment target threshold nitrogen concentration identified in Table 3.
[2] Sum of target threshold watershed load and atmospheric deposition load and benthic load.
[3] East Arm includes South, Central and North Basins of Lagoon Pond.
[4] Upper Lagoon Pond drains into the South Basin of Lagoon Pond.

In this table, N loadings from the atmosphere and from nutrient rich sediments are listed separately from the target watershed threshold loads. The watershed load is composed of atmospheric deposition to freshwater and natural surfaces along with locally controllable N from on-site subsurface wastewater disposal systems, stormwater runoff, landfill, agriculture and fertilizer sources. In the case of the Lagoon Pond estuarine system, the TMDL was calculated by projecting reductions in locally controllable septic systems. Once again the goal of this TMDL is to achieve the identified target threshold N concentration at the identified sentinel station, LGP-2.

Implementation Plans

The critical element of this TMDL process is achieving the sentinel station specific target threshold N concentration presented in Table 3. This is necessary for the restoration and protection of water quality, benthic invertebrate habitat, and eelgrass within Lagoon Pond. In order to achieve these target threshold N concentrations N loading rates must be reduced throughout the Lagoon Pond estuarine system. Table 7 lists the target threshold watershed N load for this system.

As previously noted, there is a variety of loading reduction scenarios that could achieve the target threshold N concentrations. Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Wastewater Management Plan (CWMP). It must be demonstrated however, that any alternative implementation strategies will be protective of the entire embayment system. To this end,

additional linked model runs can be performed by the MEP at a nominal cost to assist the planning efforts of the town in achieving target N loads that will result in the desired target threshold N concentration.

Because the vast majority of controllable N load is from individual septic systems from private residences, the CWMP should assess the most cost-effective options for achieving the target threshold N watershed loads, including but not limited to, sewering and treatment for N control of sewage and septage at either centralized or de-centralized locations, and denitrifying systems for all private residences.

The CWMP should include a schedule of the selected strategies and estimated timelines for achieving those targets. However, the MassDEP realizes that an adaptive management approach may be used to observe implementation results over time and allow for adjustments based on those results. If a community chooses to implement TMDL measures without a CWMP it must demonstrate that these measures will achieve the target threshold N concentration. (Note: Communities that choose to proceed without a CWMP will not be eligible for State Revolving Fund 0% loans.)

The watershed communities of Oak Bluffs and Tisbury are urged to meet the target threshold N concentrations by reducing N loadings from any and all sources, through whatever means are available and practical, including reductions in stormwater runoff and/or fertilizer use within the watershed through the establishment of local by-laws and/or the implementation of stormwater BMPs, in addition to reductions in on-site subsurface wastewater disposal system loadings.

All of the towns on Martha's Vineyard adopted identical fertilizer regulations in the spring of 2014. This Regulation provides for a reduction of nitrogen and phosphorus going into the Island's Water Resources by means of an organized system of education, licensure, regulation of practice, and enforcement. The Regulation is intended to contribute to the island's ability to protect, maintain, and ultimately improve the water quality in all its Water Resources and assist in achieving compliance with any applicable water quality standards relating to controllable nitrogen and phosphorus. http://mvboh.org/fertilizer.html

Although no towns in the Lagoon Pond watershed are Phase II regulated stormwater communities, the Oak Bluffs Board of Health has adopted "Stormwater Management Regulations" that have the same intentions as the Phase II Stormwater Regulations by providing adequate protection against pollutants, flooding, siltation, and other drainage problems.

MassDEP's MEP Implementation Guidance report (http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html) provides N loading reduction strategies that are available to Oak Bluffs and Tisbury that could be incorporated into the implementation plans. The following topics related to N reduction are discussed in the Guidance:

- Wastewater Treatment;
    - On-Site Treatment and Disposal Systems
    - Cluster Systems with Enhanced Treatment

    - Community Treatment Plants
    - Municipal Treatment Plants and Sewers
- Tidal Flushing;
    - Channel Dredging
    - Inlet Alteration
    - Culvert Design and Improvements
- Stormwater Control and Treatment*;
    - Source Control and Pollution Prevention
    - Stormwater Treatment
- Attenuation via Wetlands and Ponds;
- Water Conservation and Water Reuse;
- Management Districts;
- Land Use Planning and Controls;
    - Smart Growth
    - Open Space Acquisition
    - Zoning and Related Tools
- Nutrient Trading.

*The Towns of Oak Bluffs and Tisbury are not part of the 237 communities in Massachusetts currently covered by the Phase II stormwater program requirements.

Monitoring Plan

MassDEP is of the opinion that there are two forms of monitoring that are useful to determine progress towards achieving compliance with the TMDL. MassDEP's position is that implementation will be conducted through an iterative process where adjustments may be needed in the future. The two forms of monitoring include: 1) tracking implementation progress as approved in the town CWMP plan; and 2) monitoring ambient water quality conditions, including but not limited to, the sentinel station identified in the MEP Technical Report.

The CWMP will evaluate various options to achieve the goals set out in the TMDL and Technical Report. It will also make a final recommendation based on existing or additional modeling runs, set out required activities and identify a schedule to achieve the most cost effective solution that will result in compliance with the TMDL. Once approved by MassDEP, tracking progress on the agreed-upon plan will, in effect, also be tracking progress towards water quality improvements in conformance with the TMDL.

Relative to water quality, MassDEP believes that an ambient monitoring program, much reduced from the data collection activities needed to properly assess conditions and to populate the model, will be important to determine actual compliance with water quality standards. Although the TMDL load values are not fixed the target threshold N, concentrations at the sentinel stations are. Through discussions amongst the MEP it is generally agreed that existing monitoring programs which were designed to thoroughly assess conditions and populate water quality models can be substantially reduced for compliance monitoring purposes. Although more specific details need to be developed on a case by case

basis, MassDEP's current thinking is that about half the current effort (using the same data collection procedures) would be sufficient to monitor compliance over time and to observe trends in water quality changes. In addition, the benthic habitat and communities would require periodic monitoring on a frequency of about every 3-5 years. Finally, in addition to the above, existing monitoring conducted by MassDEP for eelgrass should continue into the future to observe any changes that may occur to eelgrass populations as a result of restoration efforts.

The MEP will continue working with the Towns of Oak Bluffs and Tisbury to develop and refine monitoring plans that remain consistent with the goals of the TMDL. It must be recognized however that development and implementation of a monitoring plan will take some time, but it is more important at this point to focus efforts on reducing existing watershed loads to achieve water quality goals.

Reasonable Assurances

MassDEP possesses the statutory and regulatory authority, under the water quality standards and/or the State Clean Water Act (CWA), to implement and enforce the provisions of the TMDL through its many permitting programs, including requirements for N loading reductions from on-site subsurface wastewater disposal systems. However, because most non-point source controls are voluntary, reasonable assurance is based on the commitment of the locality involved. Oak Bluffs and Tisbury have demonstrated this commitment through the comprehensive wastewater planning that they initiated well before the generation of the TMDL. The towns expect to use the information in this TMDL to generate support from their citizens to take the necessary steps to remedy existing problems related to N loading from on-site subsurface wastewater disposal systems, stormwater, and runoff (including fertilizers) and to prevent any future degradation of these valuable resources. Moreover, reasonable assurances that the TMDL will be implemented include enforcement of regulations, availability of financial incentives and local, state and federal programs for pollution control. Stormwater NPDES permit coverage will address discharges from municipally owned stormwater drainage systems. Enforcement of regulations controlling non-point discharges include local implementation of the Commonwealth's Wetlands Protection Act and Rivers Protection Act; Title 5 regulations for on-site subsurface wastewater disposal systems and other local regulations such as the Town of Rehoboth's stable regulations. Financial incentives include federal funds available under Sections 319, 604 and 104(b) programs of the CWA, which are provided as part of the Performance Partnership Agreement between MassDEP and EPA. Other potential funds and assistance are available through Massachusetts' Department of Agriculture's Enhancement Program and the United States Department of Agriculture's Natural Resources Conservation Services. Additional financial incentives include income tax credits for Title 5 upgrades and low interest loans for Title 5 on-site subsurface wastewater disposal system upgrades available through municipalities participating in this portion of the state revolving fund program.

As the towns implement this TMDL, the TMDL values (kg/day of N) will be used by MassDEP as guidelines for permitting activities and should be used by local communities as a management tool.

Public Participation

The Department publically announced the draft TMDL in October 25, 2012 and copies were made available to all key stakeholders. The draft TMDL was posted on the Department's web site for public review at the same time. In addition, a public meeting was held at the Oak Bluffs Public Library on November 28, 2012 for all interested parties and the public comment period extended until close of business January 18, 2013. Christine Duerring (MassDEP) summarized the Mass Estuaries Project and described the Draft Nitrogen TMDL Report findings. This final version of the TMDL report includes both a summary of the public comments together with the Department's response to the comments and scanned image of the attendance sheets from the meetings (Appendix E). MassDEP MEP representatives at the public meeting included Christine Duerring, Rick Dunn, Brian Dudley, Lynne Welsh and Cathy Vakalopoulos.

Appendix A

Table A-1: Summary of the Nitrogen Concentrations for the Lagoon Pond Estuarine System
(from Chapter VI of the accompanying MEP Technical Report)

Measured data and modeled Nitrogen concentrations for the Lagoon Pond estuarine system. All concentrations are given in mg/L N. "Data mean" values are calculated as the average of the separate yearly means. Data represented in this table were collected in the summers of 2002 through 2007.							
Sub-Embayment	MEP monitoring station	data mean	s.d. all data	N	model min	model max	model average
Lagoon Pond head at dike	LGP-6	0.418	0.071	23	0.408	0.424	0.413
Lagoon Pond Head	LGP-4	0.384	0.077	100	0.384	0.387	0.385
Lagoon Pond upper Basin	LGP-2	0.360	0.067	135	0.370	0.372	0.371
Lagoon Pond mid Basin	LGP-8	0.359	0.070	66	0.334	0.342	0.338
Lagoon Pond lower Basin	LGP-9	0.333	0.058	60	0.322	0.336	0.328
West Arm (South End Basin)	LGP-10	0.386	0.075	35	0.370	0.391	0.378
Nantucket Sound	NTKS	0.290	0.052	48	-	-	-

Appendix B

Table B-1: Lagoon Pond Estuarine System 2 Total Nitrogen TMDLs and 1 Pollution Prevention Total Nitrogen TMDL

Sub-Embayment	Segment ID	Description	TMDL (kg N/day)
Lagoon Pond (East Arm)	Portion of MA97-11	Previously determined to be impaired for nutrients by MassDEP.	56.22
West Arm (South End Basin)	Portion of MA97-11	Previously determined to be impaired for nutrients by MassDEP.	13.01
Upper Lagoon Pond	None assigned	Not impaired for total nitrogen, but nitrogen TMDL needed since embayments are linked. (Pollution Prevention TMDL)	4.83
System Total	MA97-11	From Head of the Pond Road to confluence with Vineyard Haven Harbor at Beach Road, Tisbury/Oak Bluffs, Martha's Vineyard. – 0.819 sq. mi.	74.07

Appendix C

Table C-1: The Lagoon Pond System Estimated Waste Load Allocation (WLA) from Runoff of all Impervious Areas within 200 Feet of Water Bodies

Embayment/ Subwatershed	Watershed Impervious Area in 200 ft Buffer of Embayment Waterbody (acres)[1]	Total Impervious Area in Watershed (acres)[2]	Total Watershed Area (acres)	% Impervious Area of Total Watershed Area	Impervious Area in 200 ft buffer as % of Total Watershed Impervious Area	MEP Total Unattenuated Impervious Watershed Load (kg N/day)[3]	MEP Total Unattenuated Watershed Load (kg N/day)[4]	Watershed Impervious buffer (200 ft) WLA (kg N/day)[5]	Watershed Buffer Area WLA as Percentage of MEP Total Unattenuated Watershed Load[6]
Lagoon Pond	10.3	357.2	3,390.0	10.5%	2.9%	3.40	36.2	0.10	0.27%
South End Basin	9.6	46.0	264.4	17.4%	20.9%	0.54	5.8	0.11	1.97%
Upper Lagoon Pond	0.9	118.0	804.5	14.7%	0.8%	0.89	6.0	0.01	0.11%
Lagoon Pond System Total	20.8	521.2	4,459	11.7%	4.0%	4.83	48.0	0.19	0.40%

[1]The entire impervious area within a 200 foot buffer zone around all waterbodies as calculated from GIS. Due to the soils and geology of Martha's Vineyard it is unlikely that runoff would be channeled as a point source directly to a waterbody from areas more than 200 feet away. Some impervious areas within approximately 200 feet of the shoreline may discharge storm water via pipes directly to the waterbody. For the purposes of the wasteload allocation (WLA) it was assumed that all impervious surfaces within 200 feet of the shoreline discharge directly to the waterbody.
[2]Total impervious surface for the watershed was obtained from SMAST N load data files.
[3]From Table IV-2 of the MEP Technical Report.
[4]From Table IV-2 of the MEP Technical Report.This includes the unattenuated nitrogen loads from wastewater from septic systems, fertilizer, farms, runoff from both natural and impervious surfaces, and atmospheric deposition to freshwater waterbodies. This does not include direct atmospheric deposition to the estuary surface.
[5]The impervious subwatershed 200 ft buffer area (acres) divided by total watershed impervious area (acres) then multiplied by total impervious subwatershed load (kg N/day).
[6]The impervious subwatershed buffer area WLA (kg N/day) divided by the total subwatershed load (kg N/day) then multiplied by 100.

Appendix D

Massachusetts Estuaries Project (MEP)
Response to Comments
For
DRAFT TOTAL MAXIMUM DAILY LOAD (TMDL) REPORT FOR FARM POND
(Report Dated September, 2012)
DRAFT TMDL REPORT FOR LAGOON POND
(Report Dated September, 2012)
DRAFT TMDL REPORT FOR SENGEKONTACKET POND
(Report Dated September, 2012)

Written Comments received from the Lagoon, Farm, and Sengekontacket Ponds TMDL Public Meeting November 28, 2012, Oak Bluffs, MA:

Comment letter received from David Grunden
Oak Bluffs Shellfish Constable
P.O. Box 1327
Oak Bluffs, Ma 02557
Email attachment dated November 29, 2012

The TMDL meeting here in Oak Bluffs went very well. The turnout for the meeting showed the concern of the town residents and support of improving the coastal pond water quality. I look forward to be working with you to meet the TMDL limits and improve the health of our ponds.

I am surprised, but pleased to hear that the required nutrient monitoring will be less than what we have been doing. This will free up some Town funds to move forward in other projects/programs that can benefit the ponds in other ways, including additional municipal shellfish and or sea vegetable aquaculture.

The Town has a grant proposal pending to begin a five year monitoring program to monitor the changes in Farm Pond with the installation of the planned larger culvert. Dr. Mary Carman (WHOI) and Dr Dan Blackwood (USGS) will be working with the Town if we receive the grant funding. We will be documenting pre and post culvert installation impacts. If you have macro-invertebrate monitoring protocols it is possible to include them in this project. I am sure there hasn't been any macro-invertebrate monitoring in the pond since it was done by MEP. I also have a good species inventory that was completed in 2005 as a historical baseline.

I would encourage you to consider and promote alternative denitrifying methods (not just alternative enhanced septic systems). The Town has been looking at several alternative approaches such as:

1. Shellfish remediation – we have a grant proposal pending to grow 500K oysters each year in Majors Cove (Sengekontacket). The proposal is to do this every year, holding the juveniles over the winter before planting them out for future recreational harvest. The Town of Edgartown is also seeking funding to conduct a mirror of this project on their side of Major's Cove; therefore culturing one

million animals each and every year. There are several peer reviewed scientific publications that report the benefit and calculate the nitrogen removed from the water by shellfish, particularly oysters. I would like to suggest you contact Dr. Bob Rhealt the Executive Director of the East Coast Shellfish Growers Association (401-783-3360 or bob@ecsga.org). I am also attaching a paper that speaks to using shellfish as "nutrient trading credits" that may finance additional shellfish aquaculture. "EPA's water quality guidelines would allow shellfish to be used in a nutrient trading process" (Golan, R. paper attached).

2. Oak Bluffs in collaboration with John Todd Associates filed a 319 proposal to develop a "floating island" in upper end of Lagoon Pond. This would essentially be hydroponically grown marsh grasses and other appropriate salt tolerant native plants. This approach has worked very successfully in fresh water systems. The 319 funding was not granted. We are currently looking for other funding sources for this approach.
3. We also want to explore the potential of promoting sea vegetable (sea weed) culture. There are trials being conducted this winter in Lagoon Pond growing Sugar Kelp (*Laminaria saccharina)*. This is a winter crop that is fast growing and utilizes nitrogen during the winter months. This coming summer we will be working with Dr. Scott Lindell of Marine Biological Laboratories in Woods Hole and grow out other species of sea vegetables during the summer months in Lagoon pond.
4. Perhaps not for these three ponds, but for Sunset Lake; currently in the MEP evaluation. There is methodology to essentially dig a trench and fill it with material that will fix the nitrogen in the ground water before entering this coastal pond and Oak Bluffs Harbor has some merit. One side has been sewered, but the other side has not and there is a large Town Park with space to implement this technology.
5. Restoring upland marshes should also be encouraged. If these systems can be restored or re-created they should increase the natural attenuation of nitrogen. As pointed out in your presentation there are currently no surface water inputs for Farm Pond. However, there once was a small alewife fishery there. Historically, there were two small inland ponds that have now been taken over by *Phragmites* so now there is little or no standing water and the alewife spawning habitat is lost.
6. Is there any consideration by MA DEP to partner with a Town (like Oak Bluffs) to evaluate any of the above alternatives? Oak Bluffs has partnered several times with other agencies on projects in our ponds. Currently we are collaborating on projects with Woods Hole Oceanographic Institute, US EPA Region 1 and US EPA Atlantic Ecology Division. I encourage partnering and collaboration using our ponds as the research/monitoring sites. Currently we have the following ongoing projects:

    - Dr Mary Carman – WHOI – fragmentation and re-attaching of the invasive colonial tunicate *Didemnum vexillun.* This has implications of introduction and colonization of other areas including on eelgrass leaves. Note: on related previous projects we documented *D. vexillum* growing on eelgrass for the first time in

scientific literature and also collected some data showing the colonial tunicates on the eelgrass does stress the plant, slows the growth rate and have fewer shoots.

- Dr Phil Colaruso US EPA Region 1 – obtained funding to further examine the impacts colonial tunicates are having on the eelgrass meadows. They grow on the eelgrass blades and reduce areas for photosynthesis – but they are filter feeders. Is this a net negative or a net positive for the eelgrass habitat? EPA's Atlantic Ecology Division is taking the lead on this project.

I am concerned that while during the presentation "adaptive management" was mentioned a few times, but in the question and answer portion it was made clear that a complete Comprehensive Wastewater Management Plan (CWMP) would need to be filed and approved at the start. This leaves little opportunity to do adaptive management. When asked the reply was that the CWMP could be changed or amended. That process would likely take months and make "adaptive management" simply a sound bite. I would encourage you to relax this posture to better consider and support alternative approaches that will likely be cost beneficial for the Town as opposed to sewering. Although we recognize that some amount of sewering will be required to meet the nitrogen thresholds and we are evaluating options of where to sewer.

(DEP Responses 1-6 are numbered to respond in accordance with the number of the questions in the letter above.)
DEP Response 1: MassDEP has no experience regarding the effectiveness of using shellfish farming as an implementation method for nitrogen attenuation in an embayment or salt pond in order to meet a nitrogen TMDL. We are aware that the states of Connecticut and New York have recently been investigating this possibility in Long Island Sound but no conclusions have been drawn as yet. Studies in the Chesapeake Bay area have suggested that very large areas of shellfish may be needed to see measurable improvements. In theory, the concept makes sense and could have very positive outcomes for the town by way of increased shellfish revenue and improved water quality, however at this time MassDEP cannot recommend or discourage shellfish farming as a viable TMDL implementation option without additional information. In general MassDEP promotes activities that reduce the nitrogen loads at their sources and encourages the town to explore all feasible alternatives to reduce sources of nitrogen.

DEP Response 2-5: MassDEP encourages the town to explore all feasible alternatives to reduce nitrogen. MassDEP acknowledges that the ongoing research on these alternatives may eventually provide adequate documentation include them as feasible nitrogen removal techniques. However, in addition to the questions MassDEP has regarding the documented effectiveness of in-situ treatments for water column nitrogen reduction to meet the TMDL such as you described using shellfish and/or macrophytes, these bio-remediation methods are dependent on often uncontrollable environmental factors that potentially could render the operation ineffective for extended period of time. DEP foresees that TMDL implementation plans that include such alternatives would still likely need to be coupled with sustainable and reliable methods that control N pollution at the source such as sewering, stormwater management BMPs and fertilizer controls.

DEP Response 6: DEP is presently discussing with EEEA how to assess alternative technologies and approaches to reduce nitrogen and what the minimum monitoring requirements should be however these monitoring approaches will vary a great deal depending on the technology being used as well as site-specific conditions thus requiring site-specific approaches. At the present time there is no established program within DEP designed to assess new technologies nor provide funding for this purpose but we are receptive to working with Towns on pilot studies that may be proposed for this purpose as CWMP studies identify specific technologies and potential site locations for pilot studies in the future.

Finally, we suggest the Town contact Dr. Brian Howes at UMass Dartmouth to obtain the specific macroinvertebrate monitoring protocols used during the MEP process to ensure that Town samples are comparable to those used to develop the TMDL.

Comment letter received from Dan Martino
Vineyard Haven, MA
Email dated November 29, 2012

Thank you for coming to Oak Bluffs last night and presenting your findings. Invaluable information. Thank you.

I am a little disappointed that there is no deadline or repercussions for the towns if they do not meet the set nitrogen limits. I would like a see a deadline set by the EPA, which states that the towns MUST present a plan by 2015. I would then like to see a deadline date of 2020 in which the towns must begin implementing the plan. If the towns do not meet these deadlines, fines or some similar type of punishment should be handed out. Failure to set a deadline, or repercussions, will only allow the projects to delay, as they have for the last 50 years.

Again, I would like to see deadlines put into place. I feel this is the only way we will see progress.

DEP Response: The amount of time needed to implement the CWMP plan will highly depend on what alternative actions are chosen to meet the TMDL. It is for this reason DEP has not specified a date certain in the TMDL. It is our position and anticipation however that the CWMP not only identify a recommended plan which will meet the TMDL but also that the CWMP will contain a schedule for implementation which would be formerly approved by DEP. As long as a plan is developed and actions are being taken at a reasonable pace to achieve the goals of the TMDL, MassDEP will use discretion in taking enforcement steps. However, in the event that reasonable progress is not being made, MassDEP can take enforcement action through the broad authority granted by the Massachusetts Clean Waters Act, the Massachusetts Water Quality Standards, and through point source discharge permits.

Verbal comments from the audience compiled by DEP during the Lagoon, Farm, and Sengekontacket Ponds TMDL Public Meeting, November 28, 2012, Oak Bluffs Library:

Comment: Does nitrogen entering the system close to shore (e.g. Ocean Heights, Sengekontacket) impair water quality more? If we have to sewer, wouldn't it make sense to sewer homes closer to the shore?
DEP Response: Homes closer to the waterbody allow nitrogen to get to that waterbody faster. Those further away may take longer but still get there over time and are dependent upon the underlying geology. However, what is more important is the density of homes. Larger home density means more nitrogen being discharged thus the density typically determines where to sewer to maximize reductions. Also there are many factors that influence water quality such as flushing and morphology of the water body.

Comment: Do you take into account how long it takes groundwater to travel?
DEP Response: Yes, the MEP Technical report has identified long term (greater than 10 years) and short term time of travel boundaries in the ground-watershed.

Comment: What if a town can't meet its TMDL?
DEP Response: A TMDL is simply a nutrient budget that determines how much nitrogen reduction is necessary to meet water quality goals as defined by state Water Quality Standards. It is unlikely that the TMDL cannot be achieved however in rare occasions it can happen. In those rare cases the Federal Clean Water Act provides an alternative mechanism which is called a Use Attainability Analysis (UAA). The requirements of that analysis are specified in the Clean Water Act but to generalize the process, it requires a demonstration would have to be made that the designated use cannot be achieved. Another way of saying this is that a demonstration would have to be made that the body of water cannot support its designated uses such as fishing, swimming or protection of aquatic biota. This demonstration is very difficult and must be approved by the U.S. Environmental Protection Agency. As long as a plan is developed and actions are being taken at a reasonable pace to achieve the goals of the TMDL, MassDEP will use discretion in taking enforcement steps. However, in the event that reasonable progress is not being made, MassDEP can take enforcement action through the broad authority granted by the Massachusetts Clean Waters Act, the Massachusetts Water Quality Standards, and through point source discharge permits.

Comment: What is the relationship between the linked model and the CWMP?
DEP Response: The model is a tool that was developed to assist the Town to evaluate potential nitrogen reduction options and determine if they meet the goals of the TMDL at the established sentinel station in each estuary. The CWMP is the process used by the Town to evaluate your short and long-term needs, define options, and ultimately choose a recommended option and schedule for implementation that meets the goals of the TMDL. The models can be used to assist the Towns during the CWMP process.

Comment: Is there a federal mandate to reduce fertilizer use?
DEP Response: No, it is up to the states and/or towns to address this issue.

Comment: Will monitoring continue at all stations or just the sentinel stations?
DEP Response: At a minimum, DEP would like to see monitoring continued at the sentinel stations monthly, May-September in order to determine compliance with the TMDL. However, ideally, it would be good to continue monitoring all of the stations, if possible. The benthic

stations can be sampled every 3-5 years since changes are not rapid. The towns may want to sample additional locations if warranted. DEP plans to continue its program of eelgrass monitoring.

Comment: What is the state's expectation with CWMPs?
DEP Response: The CWMP is intended to provide the Towns with potential short and long-term options to achieve water quality goals and therefore provides a recommended plan and schedule for sewering/infrastructure improvements and other nitrogen reduction options necessary to achieve the TMDL. The state also provides a low interest loan program called the state revolving fund or SRF to help develop these plans. Towns can combine forces to save money when they develop their CWMPS.

Comment: Can we submit parts of the plan as they are completed?
DEP Response: Submitting part of a plan is not recommended because no demonstration can be made that the actions will meet the requirements of the TMDL. With that said however the plan can contain phases using an adaptive approach if determined to be reasonable and consistent with the TMDL.

Comment: How do we know the source of the bacteria (septic vs. cormorants, etc.)?
DEP Response: This was not addressed because this is a nitrogen TMDL and not a bacteria TMDL.

Comment: Is there a push to look at alternative new technologies?
DEP Response: Yes, the Massachusetts Septic System Test Center is located on Cape Cod and operated by the Barnstable County Department of Health and Environment. This Center tests and tracks advanced innovative and alternative septic system treatment technologies. DEP evaluates pilot studies for alternative technologies but will not approve a system unless it has been thoroughly studied and documented to be successful.

Shellfish Constable: How about using shellfish to remediate and reduce nitrogen concentrations?
DEP Response: Although MassDEP is not opposed to this approach in concept and the approach is gaining favor in some areas of the country presently this is not an approved method because of a lack of understanding regarding how much nitrogen is removed over a specified period of time. Some examples of systems where research is being conducted include Long Island Sound (LIS), , Wellfleet, and Chesapeake Bay where oysters are being evaluated for remediation but the complete science is still not well defined. There are also many unknowns that can affect nitrogen uptake associated with proper management of the beds and it is likely that very large areas of shellfish may be needed to see measureable improvements.

Shellfish Constable: Dr. Mike Rice is studying quahogs….
DEP Response: Another question about this type of approach is how to manage harvesting. We just don't know enough about the viability of this kind of approach. See our comments in the prior response.

Comment: The TMDL is a maximum number, but we can still go lower.

DEP Response: The state's goal is to achieve designated uses and water quality criteria. There is nothing however that prevents a Town from implementing measures that go beyond that goal. It should also be noted that the TMDL is developed conservatively with a factor of safety included

Comment: Isn't it going to take several years to reach the TMDL?
DEP Response: It is likely that several years will be necessary to achieve reductions and to see a corresponding response in the estuary. However, the longer it takes to implement solutions, the longer it is going to take to achieve the goals.

Comment: The TMDL is based on current land use but what about future development?
DEP Response: The MEP Study and the TMDL also takes buildout into account for each community.

Comment: What about innovative technologies?
DEP Response: Through the CWMP there is a push to look at innovative alternatives but they need to be tested and approved by DEP. Other options to explore besides conventional sewering include: improving flushing and increasing opportunities for freshwater attenuation further up in the watershed (without worsening water quality).

Comment: We are an island and we need to work together to do some of these studies and see what works. We will have to eventually sewer because we won't be able to rely on these "cute" alternatives like oysters and banning fertilizers.
DEP Response: MassDEP agrees. That is one reason why it is important to develop a complete CWMP so that all of the pieces of the plan can be evaluated as a whole, working together.

General frequently asked questions:

1) **Can a CWMP include the acquisition of open space, and if so, can State Revolving Funds (SRF) be used for this?**

DEP Response: State Revolving funds can be used for open space preservation if a specific watershed property has been identified as a critical implementation measure for meeting the TMDL. The SRF solicitation should identify the land acquisition as a high priority project for this purpose which would then make it eligible for the SRF funding list. However, it should be noted that preservation of open space will only address potential future nitrogen sources (as predicted in the build-out scenario in the MEP Technical report) and not the current situation. The town will still have to reduce existing nitrogen sources to meet the TMDL.

2) **Do we expect eelgrass to return if the nitrogen goal is higher than the concentration that can support eelgrass?**

DEP Response: There are a number of factors that can control the ability of eelgrass to re-establish in any area. Some are of a physical nature (such as boat traffic, water depth, or even sunlight penetration) and others are of a chemical nature like nitrogen. Eelgrass decline in general has been directly related to the impacts of eutrophication caused by

elevated nitrogen concentrations. Therefore, if the nitrogen concentration is elevated enough to cause symptoms of eutrophication to occur, eelgrass growth will not be possible even if all other factors are controlled and the eelgrass will not return until the water quality conditions improve.

3) **Who is required to develop the CWMP? Can it be written in-house if there is enough expertise?**

DEP Response: The CWMP can be prepared by the town. There are no requirements that it must be written by an outside consultant; however, the community should be very confident that its in-house expertise is sufficient to address the myriad issues involved in the CWMP process. MassDEP would strongly recommend that any community wishing to undertake this endeavor on its own should meet with MassDEP to develop an appropriate scope of work that will result in a robust and acceptable plan.

4) **Have others written regional CWMPs (i.e. included several neighboring towns)? What about an island-wide CWMP?**

DEP Response: Joint CWMPs have been developed by multiple Towns particularly where Districts are formed for purposes of wastewater treatment. Some examples include the Upper Blackstone Water Pollution Abatement District that serve all or portions of the towns Holden, Millbury, Rutland West Boylston and the City of Worcester and the Greater Lawrence Sanitary District that serves the greater Lawrence area including portions of Andover, N. Andover, Methuen and Salem NH.. There have also been recent cases where Towns have teamed up to develop a joint CWMP where districts have not been formed. The most recent example are the Towns discharging to the Assabet River. They include the Towns of Westboro and Shrewsbury, Marlboro and Northboro, Hudson, and Maynard. The reason these towns joined forces was they received higher priority points in the SRF coming in as a group than they otherwise would have individually.

An island-wide CWMP is not required but towns may want to consider the economic, environmental and engineering benefits of some form of regional CWMP to address watershed-wide wastewater management issues that cross municipal boundaries.

PUBLIC MEETING SIGN IN SHEET 11/28/2012
Lagoon, Farm and Sengekontacket Ponds
Draft Nitrogen TMDL

Signature	Print Name	Affiliation
	Sara Brown	Vineyard Gazette
Sarah Carpenter	Sarah Carpenter	property on Hines Pt.
	DAVID W. GRUNDEN	O.B. SHELLFISH
Jennifer Stiy	JENNIFER STIY	
	MILES CARPENTER	HINES PT PROPERTY OWNER
Kathy Burton	Kathy Burton	Oak Bluffs Board of Selectmen
Michael L. Strada	Michael L. Strada	Vineyard Haven
	Richard Karney	M.V. Shellfish Group.
James D. Butterick	James D. Butterick	Lagoon Pond Assoc.
	Lisa Merritt	Oak Bluffs Wastewater
David Danielson		Lagoon Ridge Project
	Otribi Voumard	Lagoon Ridge Project

Signature	Print Name	Affiliation
Sheri Caseau	Sheri Caseau	MVC
MATT POOLE	Matthew Poole	EDGA. BD. OF HEALTH
Kris Vrooman	Kris Vrooman	FOS
Max McCreery	Max McCreery	FOS
Melinda Loberg	Melinda Loberg	Tis Wastewater
Megan Otten-Surgo	Megan Otten-Surgo	WA. Selectmen (Aquinnah) - Felix Neck
Roxanne Akerm		
Willie Whitcomb	Willie Whitcomb	Aquinnah Resident
LANI GOLDTHORPE	L Goldthorpe	LAGOON POND ASSN
Paul L Bampall		EDGARTOWN Shellfish Dept
Greg Coogan	Greg Coogan	OB BOS
Laurisa Rich	LAURISA RICH	LAGOON POND ASSN

16

SIGN IN SHEET 11/28/2012
Lagoon, Farm and Sengekontacket Ponds
Draft TMDL Public Meeting

Signature	Print Name	Affiliation
Terry L (Terry) Appenzellan	Terry Appenzellan	FOS, VCS, OB Com Comm
Ronald Moore	RONALD MOORE	Resident OB HARTHAVEN
Bruce E. Sanders	Bruce Sanders	FOS, BBTF
[illegible]	Robert Whitemour	Town of Oak Bluffs
Walter W. Vail	WALTER W. VAIL	OB Selectman
Jim Monteith	JIM MONTEITH	O.B. WASTEWATER
Elizabeth Mansur	Elizabeth Mansur	Shellfish Comm
William Alwardt	WILLIAM ALWARDT	Shellfish Com
Kurt A. Hrasky	KURT A. HRASKY	Civil Engineer
Margaret Curtin	Margaret Curtin	Lagoon Pond Assoc.
Gail Barmakian	Gail Barmakian	OB WW Commission / Selectman

Signature	Print Name	Affiliation
[illegible]	CHRIS FRIED	Tisbury
PATRICK PARKER	PAT PARKER	FOS
[illegible]	Richard Toole	V.C.S.
[illegible]	Matthew Crowther	Mink Meadows
[illegible]	Danelle Ewart	Tisbury Shellfish

Attachment 10 Follows

Table 5: Present Watershed Nitrogen Loading Rates, Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings

Sub-embayment	Present Total Watershed Load [1] (kg N/day)	Target Threshold Watershed Load[2] (kg N/day)	Watershed Load Reductions Needed to Achieve Threshold Loads	
			kg N/day	% change
Lagoon Pond (East Arm)[3]	36.21	22.42	13.79	-38.1
West Arm (South End Basin)	5.76	3.38	2.38	-41.4
Upper Lagoon Pond [4]	4.83	4.83	0	0
Total	46.8	30.62	16.18	-34.6 %

[1]Composed of fertilizer, runoff from impervious surfaces, septic systems, agriculture, landfill and atmospheric deposition to natural surfaces.

[2] Target threshold watershed load is the load from the watershed needed to meet the embayment target threshold

Attachment 11 Follows

Table 6: Summary of the Present Septic System Loads and the Loading Reductions that would be Necessary to Achieve the TMDL by Reducing Septic System Loads Alone

Sub- embayment	Present Septic N Load (kg N/day)	Threshold Septic load (kg N/day)	Threshold Septic Load % Change
Lagoon Pond (East Arm)	27.58	13.79	-50%
West Arm (South End Basin)	4.77	2.39	-50%
Upper Lagoon Pond	2.06	2.06	0
Total	34.41	18.24	-47%

Attachment 12 Follows

benthic community structure. At present, the Lagoon Pond Estuary is showing nitrogen enrichment and impairment of both eelgrass and infaunal habitats (Section VII), indicating that nitrogen management of this system will be for restoration rather than for protection or maintenance of an unimpaired system. The system is showing some nitrogen related habitat impairment throughout its tidal reaches. The East Arm historically has supported fringing eelgrass beds, presumably due to the limitation of the depth of eelgrass growth by light limitation in the deep basins. While fringing eelgrass beds are still found in each of the basins of the East Arm, their coverage is being reduced to shallower areas and also being disproportionately lost in the upper and mid basins. The pattern of loss is consistent with nitrogen enrichment. The decline in eelgrass within these basins makes restoration of eelgrass the target for TMDL development by MassDEP and the primary focus of threshold development by the MEP for these areas. The West Arm has not historically supported stable eelgrass beds and at present the infaunal communities in this portion of the system are moderately impaired. However, given the level of impairment and the location of the West Arm within the Lagoon Pond System, it is certain that restoring eelgrass habitat within the upper basin of the East Arm will result in restoration of the infaunal habitat in the West Arm, as nitrogen enrichment will be significantly reduced to the overall estuary (Section VIII.3).

Attachment 13 Follows

Town of Oak Bluffs

Comprehensive Wastewater Management Planning Project (CWMP)

Marc Drainville, PE
Anastasia Rudenko, PE

Agenda

1. Planning History
2. Massachusetts Estuaries Project Reports
3. CWMP Process
4. Project Schedule

Agenda

1. Planning History
2. Massachusetts Estuaries Project Reports
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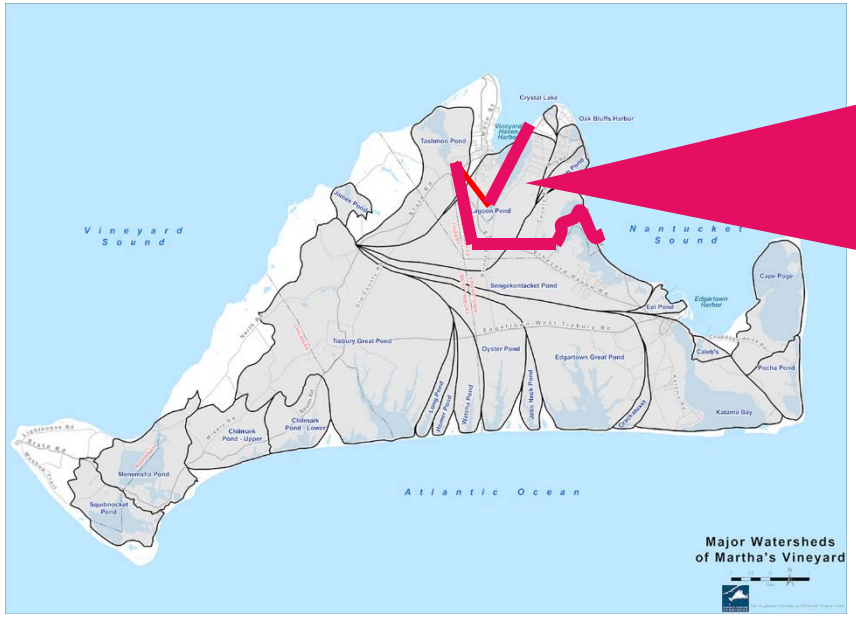
History

- Oak Bluffs initiated wastewater planning efforts in mid 1970's
- A Comprehensive Wastewater Management Plan (CWMP) was accepted by the Town at Special Town Meetings in 1998
- CWMP recommended construction of a centralized treatment facility
  - Completed in 2002
  - Sized to treat wastewater from lots requiring offsite solutions (small lots)
  - Equipment has 20 year design life
  - Facility approaching design capacity

History



Centralized treatment facility

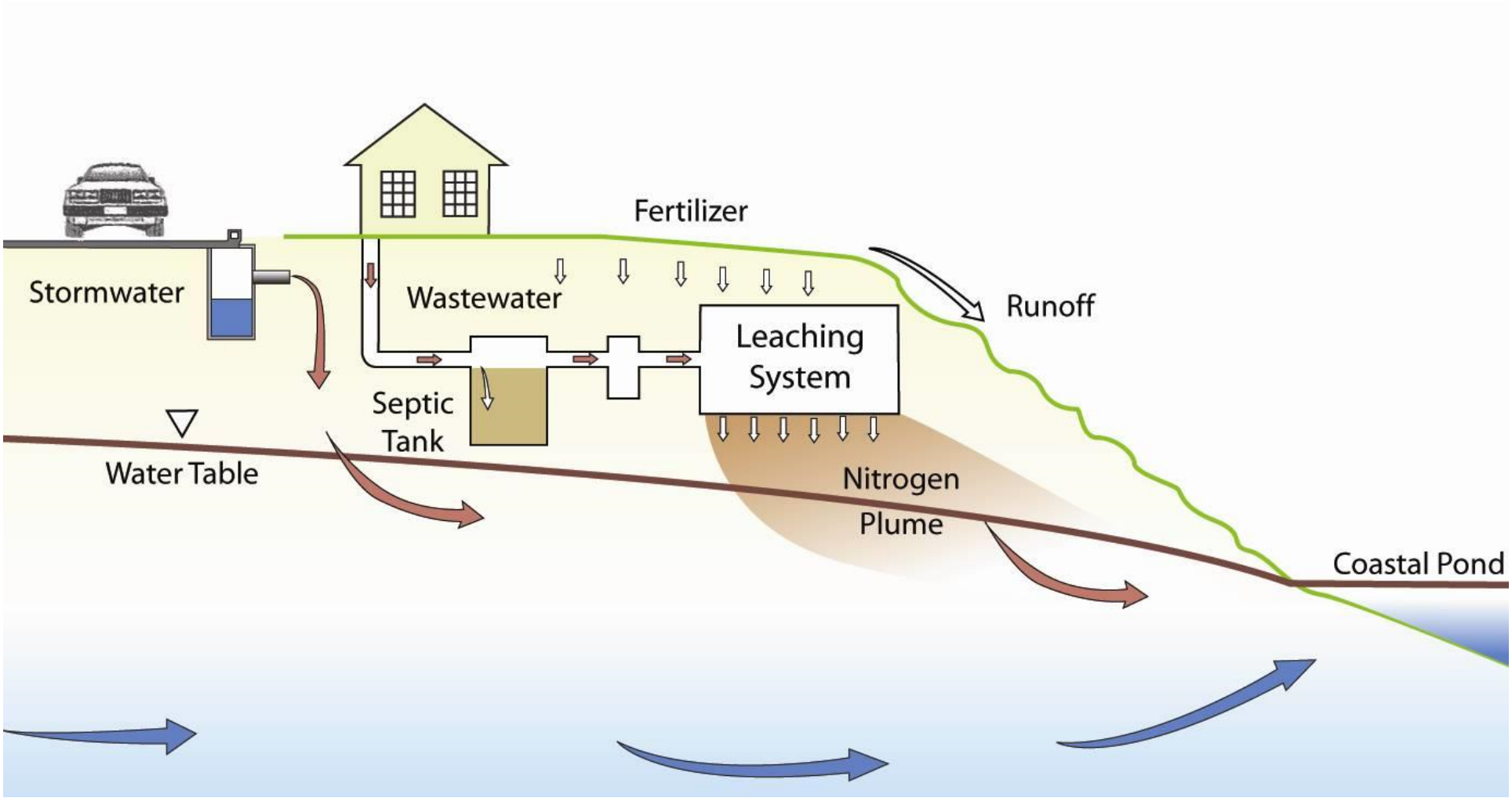
Agenda

1. Planning History
2. Massachusetts Estuaries Project Reports
3. CWMP Process
4. Project Schedule

Massachusetts Estuaries Project (MEP)

- MEP Reports developed by MassDEP and UMass/SMAST
- Classifies nitrogen sensitivity for SE Massachusetts coastal bays and estuaries
- Total Maximum Daily Limits (TMDLs) established based on findings of reports
- TMDLs established for:
  - Lagoon Pond
  - Sengekontacket Pond
  - Farm Pond
  - Lake Tashmoo (Draft)

Nitrogen Impacts



Agenda

1. Planning History
2. Massachusetts Estuaries Project Reports
3. CWMP Process
4. Project Schedule

CWMP Project

Goals:

- Comprehensively and effectively manage wastewater and nutrients in the Town of Oak Bluffs
- Improve water quality
- Protect public health
- Sustain and enhance the Town's economic vitality and property values
  - Valuation of the Ecosystem Services Provided by Oak Bluffs' Public Coastal Resources (presented at 9/2017 Conservation Committee Meeting)

CWMP Project

- Build upon work completed for the original CWMP, Lagoon Pond OB/Tisbury Joint Committee, Martha's Vineyard Commission and others

- Initiate planning for nutrient impacted estuaries

- Evaluate and recommend wastewater management solutions, to include a combination of:
  - Centralized collection and treatment
  - On-site Innovative/Alternative Systems
  - Sewering alternatives (shellfish, permeable reactive barriers, etc.)

- Determine most cost effective solution for wastewater needs

CWMP

Needs Assessment (Phase I) - Establish projected wastewater needs for 20 year planning period

Alternatives Analysis (Phase II) – Review alternatives to meet wastewater needs

Recommended Plan (Phase III) - Develop recommended plan to meet wastewater needs

CWMP

Needs Assessment (Phase I)

- Defines Town's goals for WW management
- Initial assessment of Town wastewater needs
- Evaluation of existing conditions
- Review of regulatory requirements
- Projection of future conditions
- Comparison of goals and conditions to the WW limitations in the Town

Alternatives Analysis (Phase II)

Recommended Plan (Phase III)

CWMP

Needs Assessment (Phase I)

Alternatives Analysis (Phase II)

- Development of alternative solutions for established needs
- Screening to identify most feasible alternatives - feasible solutions (technical as well as management) are then grouped into a limited number of alternative scenarios for detailed evaluation.

Recommended Plan (Phase III

CWMP

Needs Assessment (Phase I)

Alternatives Analysis (Phase II)

Recommended Plan (Phase III

- Detailed alternatives evaluation cost estimate development
- Development of a Recommended Plan to meet established wastewater needs

Public Participation

- Environmental review (MEPA) - Preparation of Draft and Final Environmental Impact Reports
- Public Involvement - Board of Selectmen, Wastewater Commissioners and a Public Hearing
- Website

Agenda

1. Planning History
2. Massachusetts Estuaries Project Reports
3. CWMP Process
4. Project Schedule

Tentative Project Schedule

Environmental Notification Form

Phase II - Alternatives Analysis Report

Final MEPA Review Period

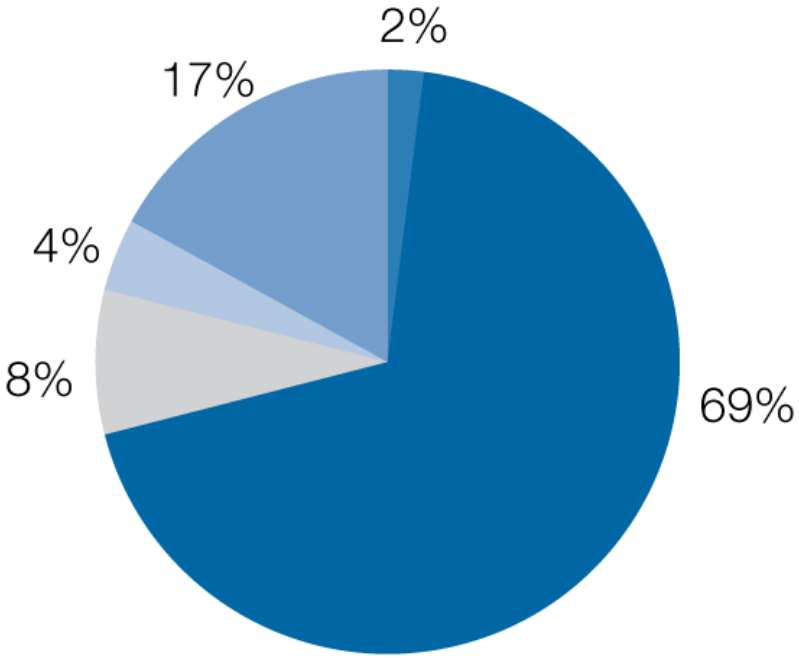
October 2017 → **January 2018** → **May 2018** → **Dec 2018** → **April 2019**

Phase I - Needs Assessment Report

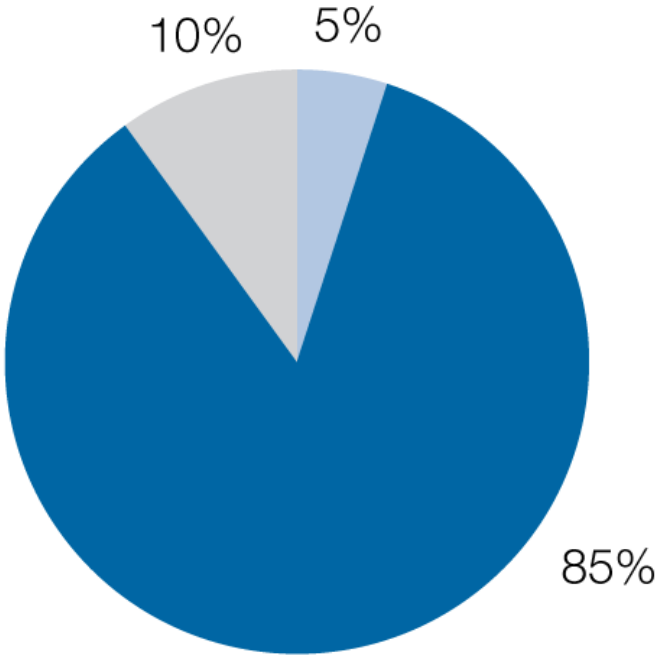
Phase III - Recommended Plan Report and Environmental Impact Report

Questions and Discussion

Typical nitrogen sources and contribution percentage



Total Sources

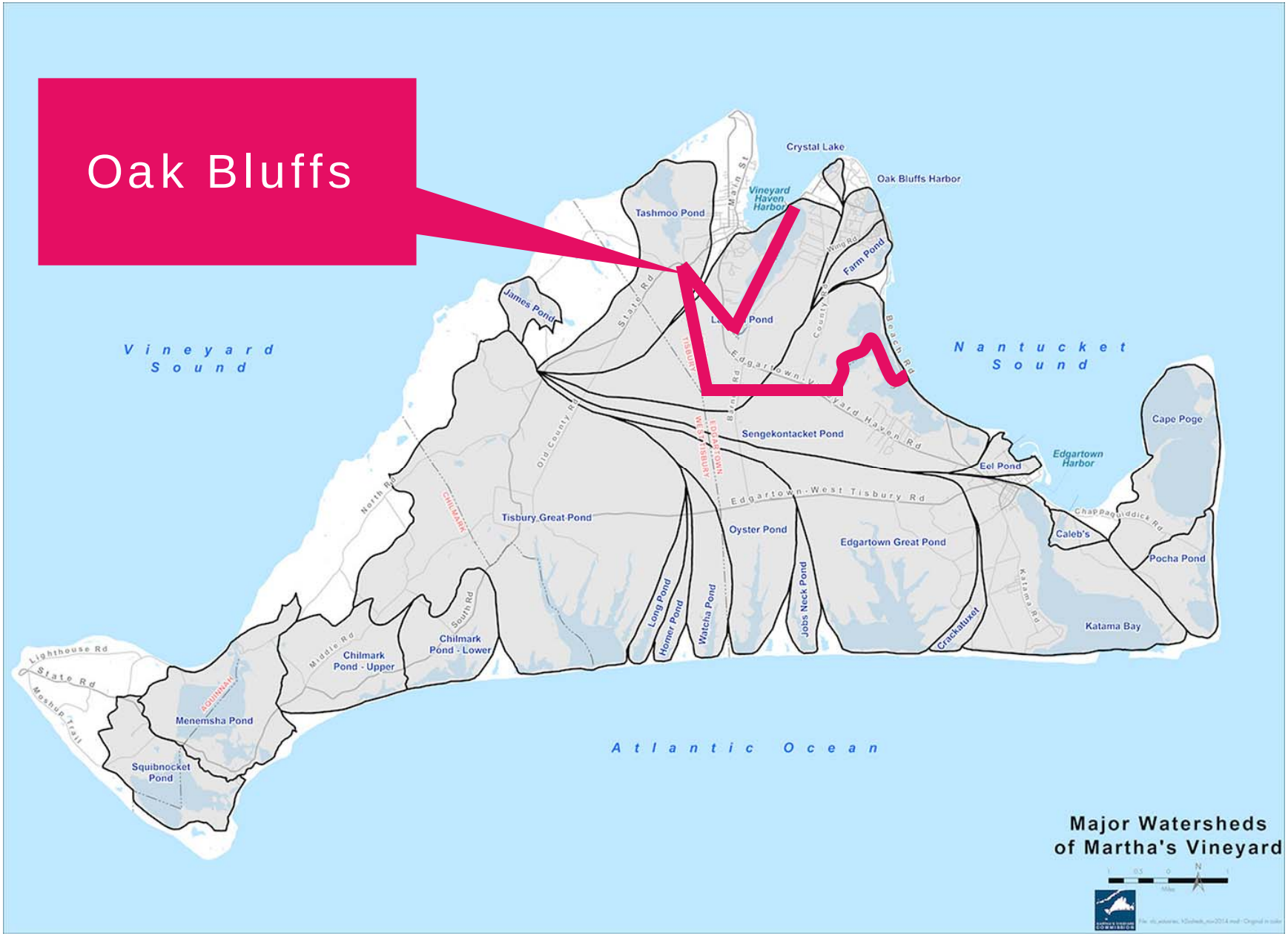


Controllable Sources

Wastewater
Fertilizers
Runoff from roads and roofs
Atomspheric deposition on ponds & bays
Atomspheric deposition on natural (forest) areas

Background

- Excess nitrogen is the main cause of decline in estuaries
- Principal sources of nitrogen:
  - Septic Systems
  - Fertilizers
  - Road Runoff


Oak Bluffs
Crystal Lake
Oak Bluffs Harbor
Vineyard Haven Harbor
Tashmoo Pond
Farm Pond
James Pond
Vineyard Sound
Nantucket Sound
Cape Poge
Edgartown Harbor
Eel Pond
Sengekontacket Pond
Edgartown-West Tisbury Rd
Tisbury Great Pond
Oyster Pond
Edgartown Great Pond
Caleb's
Pocha Pond
Katama Bay
Crackatuxet
Jobs Neck Pond
Watcha Pond
Long Pond
Homer Pond
Chilmark Pond - Lower
Chilmark Pond - Upper
Menemsha Pond
Squibnocket Pond
Lighthouse Rd
State Rd
Atlantic Ocean
Major Watersheds of Martha's Vineyard