Final
Sengekontacket Pond Estuarine System
Total Maximum Daily Loads
For Total Nitrogen
(CN-310.1)

COMMONWEALTH OF MASSACHUSETTS
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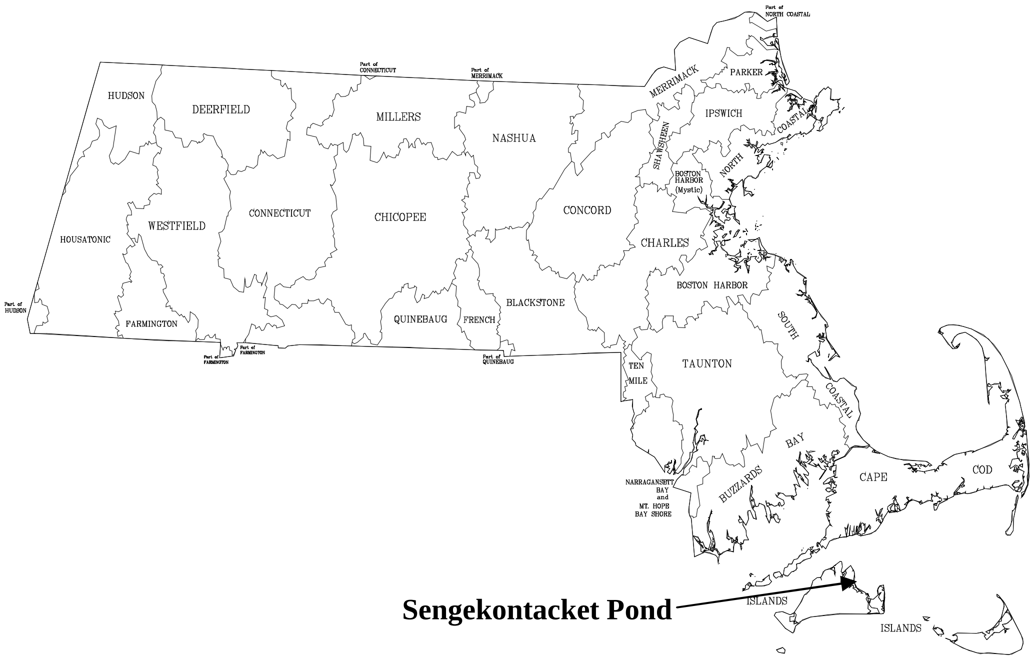


Key Feature:	Total Nitrogen TMDL for Sengekontacket Pond
Location:	US Environmental Protection Agency (EPA) Region 1, Edgartown and Oak Bluffs, MA
Land Type:	New England Coastal
303d Listing:	Sengekontacket Pond (segment MA97-10_2008) was found to be impaired for nutrients during the development of this TMDL.
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 Edgartown and Oak Bluffs
Data Mechanism:	Massachusetts Surface Water Quality Standards, Ambient Data, and Linked Watershed Model
Monitoring Plan:	Martha's Vineyard Commission and Towns of Edgartown and Oak Bluffs with technical assistance by the Coastal Systems Program at SMAST
Control Measures:	Sewering, Stormwater Management, Attenuation by Impoundments and Wetlands, Fertilizer Use By-laws

Executive Summary

Problem Statement

Excessive nitrogen (N) originating from a variety of sources has added to the impairment of the environmental quality of Sengekontacket 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.

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 Edgartown and Oak Bluffs, 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 Sengekontacket Pond waters will be greatly reduced.

Sources of Nitrogen

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

- the watershed, including
  - on-site subsurface wastewater disposal (septic) systems,
  - natural background,
  - runoff,
  - fertilizers,
  - agriculture,
  - landfills
  - wastewater treatment facilities;
- 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 entering Sengekontacket Pond. Values are based on Table ES-1 and Table IV-2 from the MEP Technical Report. Most (about 80%) of the controllable N load to Sengekontacket Pond originates from septic systems.

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

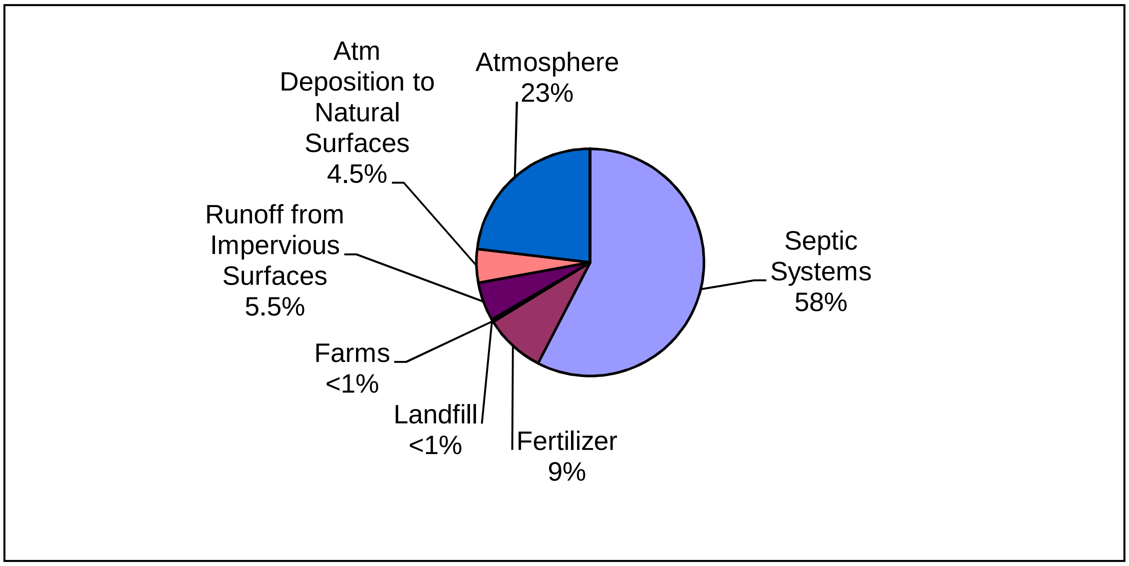
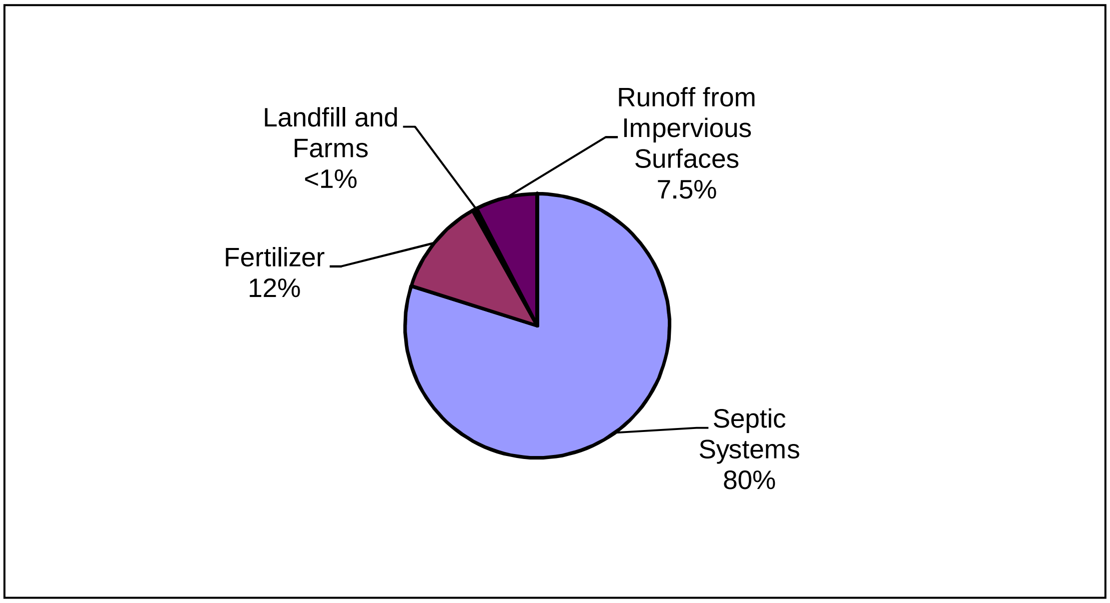


Figure ES-B: Percent Contributions of Controllable Nitrogen Sources to Sengekontacket Pond



Target Threshold Nitrogen Concentrations and Loadings

The total unattenuated N that enters the estuary each day (N load) is 48.8 kg N/day. Controllable loadings to the system range from 0.12 kg N/day (State Beach subwatershed) to 13.26 kg N/day (Ocean Heights subwatershed). Values are based on Table ES-1 and Table IV-2 from the Massachusetts Estuaries Project (MEP) Technical Report. (http://www.oceanscience.net/estuaries/documents.htm) The resultant concentrations of N in this embayment range from 0.21 mg/L (milligrams per liter of N) at the main inlet station to 0.61 mg/L in Majors Cove (range of averages from 2003 – 2009 data as reported in the MEP Technical report in Table VI-1 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 target threshold N concentration of 0.35 mg/L (measured at two separate sentinel stations) will restore historical eelgrass habitat within the entire main basin and will restore infaunal habitat quality throughout the system. The mechanism for achieving the target threshold N concentration is to reduce the N loadings to the embayment. Based on the MEP work and the resulting Technical Report, the MassDEP has determined that the Total Maximum Daily Load (TMDL) of N that will meet the target threshold N concentration is 50 kg/day.

This document presents the TMDL for this water body segment and provides guidance to Edgartown and Oak Bluffs on possible ways to reduce the N loadings to within the recommended TMDL and protect the waters for this embayment.

Implementation

The primary goal of implementation will be lowering the concentrations of N by greatly reducing the loadings from on-site subsurface wastewater disposal systems through a variety of centralized or decentralized methods such as sewering and treatment with nitrogen removal technology, advanced treatment of septage, and/or installation of N-reducing on-site systems. It is important to note that there are a variety of loading reduction scenarios that could achieve the target threshold N concentration.

Methodologies for reducing N loading from septic systems, stormwater runoff and fertilizers are provided in detail in the "MEP Embayment Restoration Guidance for Implementation Strategies" that is available on the MassDEP website:
(http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html.). 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 Edgartown and Oak Bluffs that would exacerbate the problems associated with N loadings should be guided by considerations of water quality-associated impacts.

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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 the towns of Edgartown and Oak Bluffs 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 Sengekontacket Pond System the pollutant of concern for this TMDL (based on observations of eutrophication) is the nutrient N. Nitrogen is the limiting nutrient in coastal and marine waters, which means that as its concentration is increased so is the amount of plant productivity. This leads to nuisance populations of macro-algae and increased concentrations of phytoplankton and epiphyton that threaten the healthy ecology of the affected water bodies.

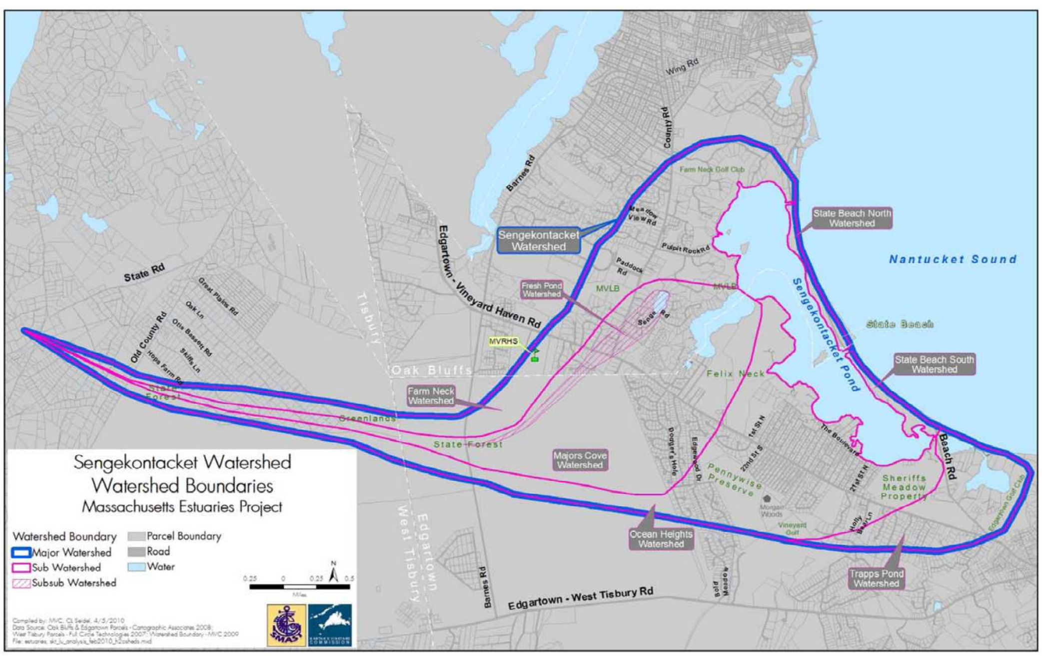
The TMDL for total N for the Sengekontacket Pond System is based primarily on data collected, compiled and analyzed by University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST), the Sengekontacket Pond Water Quality Monitoring Program with assistance from the Martha's Vineyard Commission and the towns, as part of the Massachusetts Estuaries Project (MEP). The data were collected over a study period from 2003-2009. 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 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 the towns with decisions on current and future wastewater planning, wetland restoration, anadromous fish runs, shellfisheries, open-space and inlet management. 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 was 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 Edgartown and Oak Bluffs.

Description of Water Bodies and Priority Ranking

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 used to develop the TMDL is drawn from this report.

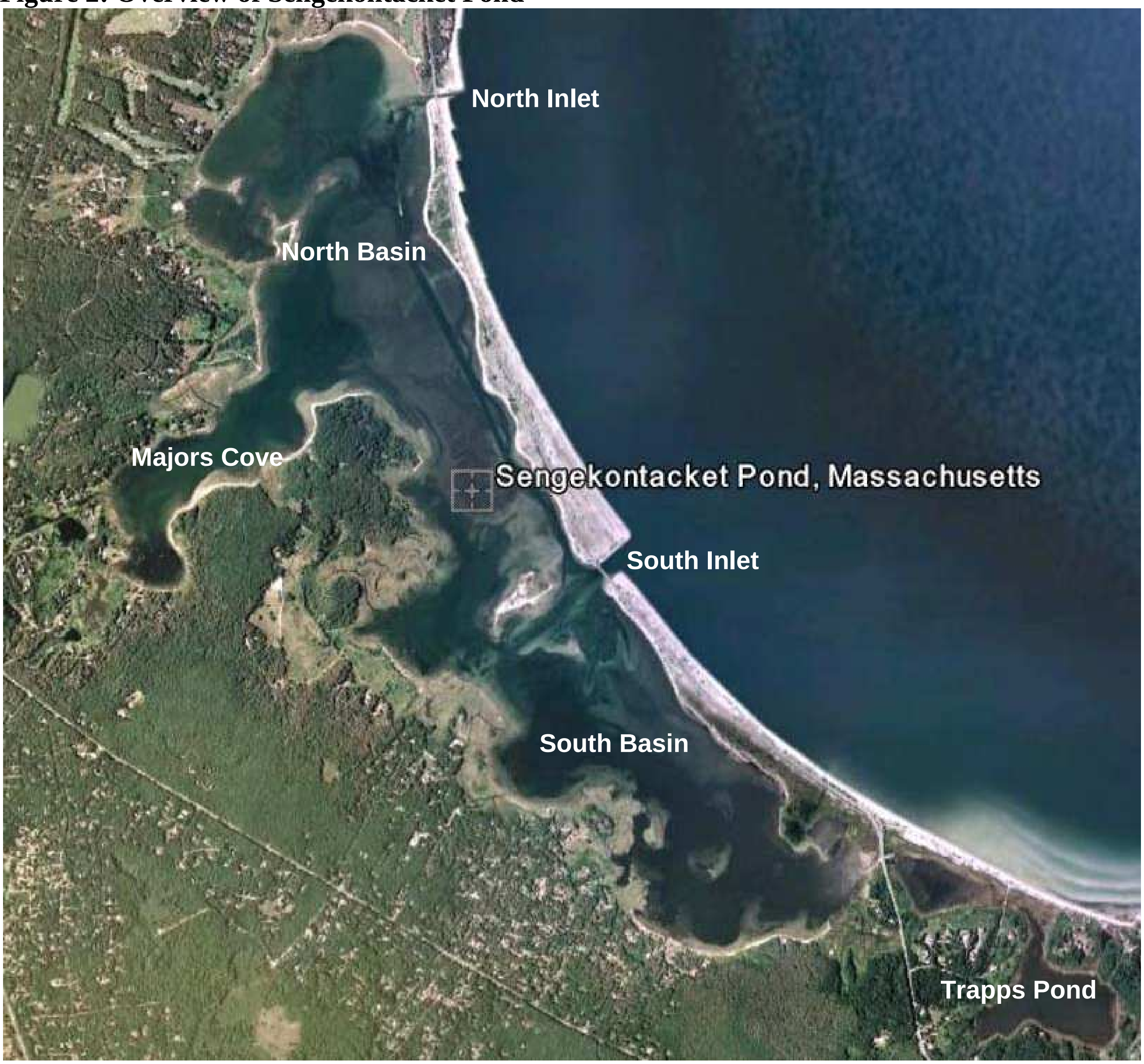
Sengekontacket Pond Embayment System is a moderately complex coastal lagoon type estuary located within the Towns of Oak Bluffs and Edgartown on the island of Martha's Vineyard, Massachusetts with an eastern shore bounded by water from Nantucket Sound. The 4,440 acre Sengekontacket Pond watershed is distributed primarily amongst the Towns of Oak Bluffs and Edgartown, with a small portion of the upper watershed extending into the Town of West Tisbury. A large region of the upper watershed is comprised primarily of "protected" forest land (Manuel F. Correllus State Forest). (See Figure 1, excerpted from the MEP Technical Report).

Figure 1: Sengekontacket Pond Watershed Area Delineation with Town Boundaries.



For the MEP analysis, the Sengekontacket Pond System was considered as two main basins, a northern basin and a southern basin, containing two tributary sub-embayments, Majors Cove and Trapps Pond. Tidal exchange between the main basin of Sengekontacket Pond and Nantucket Sound is through separate northern and southern inlets. Floodwater from the Sound enters the large main basin of Sengekontacket Pond from both the northern and primary southern inlet and circulates through channels and across flats making its way up the pond into Majors Cove as well as past the sand spits known as Haystack Point and Brant Point to enter Trapps Pond (Figure 2). While tidal flows within Sengekontacket Pond are unrestricted due to the width and depth of the channels, exchange with Trapps Pond is significantly restricted. This tidal restriction reduces the flushing of Trapps Pond waters and increases the sensitivity of the Pond to nitrogen loading.

Figure 2: Overview of Sengekontacket Pond



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 Sengekontacket Pond System is at risk of eutrophication from high nutrient loads in the groundwater and runoff. Although this embayment system is not listed as waters requiring a TMDL (Category 5) in the MA 2012 Integrated List of Waters (http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf), Chapter VI and VII of the MEP Technical Report provide data that show that the water and habitat quality of the Sengekontacket Pond System is impaired because of elevated nutrients, moderately low dissolved oxygen levels and degraded benthic fauna habitat, periodic elevated chlorophyll *a* levels and significant eelgrass loss and (Table 1). This assessment will be reflected in a future MA Integrated List of Waters.

Table 1: Comparison of DEP and SMAST Impaired Parameters for Sengekontacket Pond System

Name	Water Body Segment/Description	Size	DEP Listed Parameter	SMAST Impaired Parameter[1]
Farm Neck	Portion of MA97-10_2008	--	--	-DO level -macroalgae
Majors Cove	Portion of MA97-10_2008	--	--	-nutrients -DO level -eelgrass loss -macroalgae
Ocean Heights	Portion of MA97-10_2008	--	--	-DO level -eelgrass loss -macroalgae benthic fauna
State Beach	Portion of MA97-10_2008	-	-	-DO level -eelgrass loss -macroalgae
Sengekontacket Pond[2]	MA97-10_2008 Between East Vineyard haven Road and Beach Road, including Majors Cove, Edgartown/Oak Bluffs, MA	1.098 sq. miles	--	-nutrients -DO level -eelgrass loss -macroalgae benthic fauna
Trapps Pond	MA97-32_2016	--	--	--nutrients -DO level -chlorophyll -eelgrass loss -macroalgae -benthic fauna

[1] As determined by the MEP Study and reported in the Technical Report
[2] Sengekontacket Pond (segment MA97-10_2008) includes the subembayments of Farm Neck, Majors Cove, Ocean Heights and State Beach.

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, and Table VIII-1 of the MEP Technical Report.

Table 2: Summary of Conditions Related to the Major Indicators of Habitat Observed in the Sengekontacket Pond System

Embayment	Dissolved Oxygen Depletion	Chlorophyll *a*[1]	Eelgrass Loss[2]	Benthic Fauna[3]
Sengekontacket Pond System	Oxygen mostly always >4 mg/l but occasionally below 4 mg.l, with frequent depletions <6 mg/l H-MI	Levels low to moderate (avg. 5µg/l, rarely above 10 µg/l) H- MI	Extensive loss of eelgrass in coves and main basins, heavy epiphyte coverage present in Trapps Pond MI-SI	High to moderate numbers of individuals and species H- MI

[1] Algal blooms are consistent with chlorophyll *a* levels above 20µg/L
[2] Based on comparison of present conditions to 1951 survey data
[3] Based on observations of the types of species, number of species, and number of individuals
H - Healthy habitat conditions*
MI – Moderately Impaired*
SI – Significantly Impaired - considerably and appreciably changed from normal conditions*
* 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/dep/water/resources/coastalr.htm#guidance

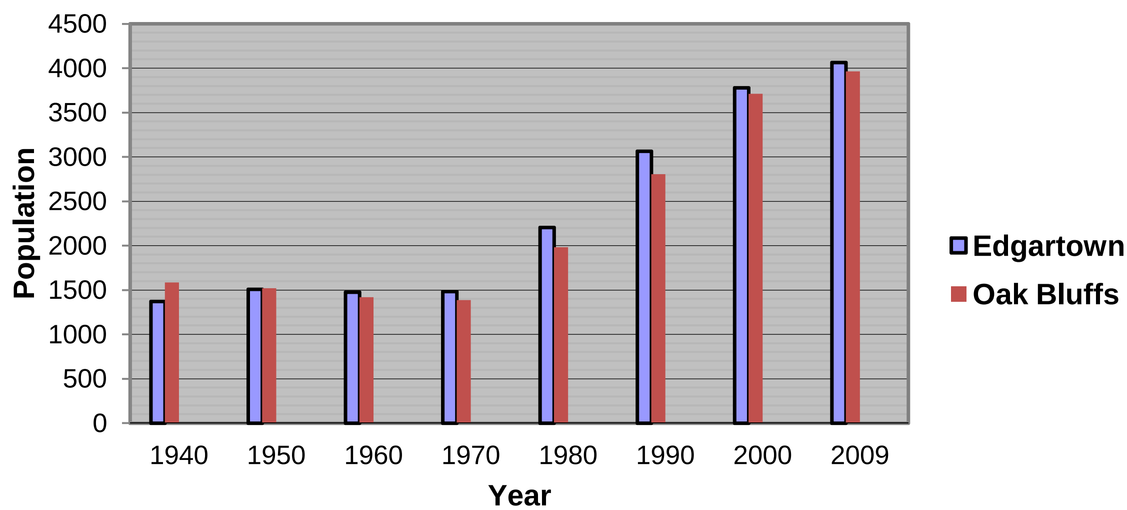
Problem Assessment

The primary ecological threat to Sengekontacket Pond is degradation resulting from nutrient enrichment. About 28% of the N load is from sources that are not locally controllable, i.e., atmospheric deposition to the surface of the estuary and natural surfaces. The N loading from locally controllable sources, i.e., septic systems, stormwater runoff, agriculture, fertilizer and the landfill make up the remainder of the load. Nitrogen from these sources enters the groundwater system and eventually enters the surface water bodies. In the sandy soils of Martha's Vineyard effluent that has entered the groundwater travels toward the coastal waters at an average rate of one foot per day.

Martha's Vineyard communities have grown rapidly over the past several decades. In the period from 1970 to 2009 the number of year round residents in Edgartown and Oak Bluffs has almost tripled (Figure 3). The watershed of Sengekontacket 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 2000. 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 Sengekontacket Pond watershed rely on privately maintained septic systems for on-site treatment and disposal of wastewater. However, the Town of Edgartown does have a centralized wastewater treatment system and several parcels within the watershed are connected to this WWTP facility. The facility discharges its tertiary treated effluent into the groundwater of the Edgartown Great Pond watershed and outside of the Sengekontacket Pond watershed.

Figure 3: Edgartown and Oak Bluffs 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 watershed. The problems in Sengekontacket Pond include periodic decreases of dissolved oxygen, decreased diversity and quantity of benthic animals, reduced density and loss of eelgrass, areas of dense macroalgae, and periodic algal blooms. If the N concentration continues to increase, future habitat degradation could include periodic fish kills, unpleasant odors, near loss of the benthic community and/or presence of only the most stress-tolerant species of benthic animals.

Coastal communities, including Edgartown and Oak Bluffs, 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 measurements, chlorophyll *a* concentrations and benthic community structure. With the exception of the Trapps Pond embayment, the Sengekontacket Pond System on the whole has good flushing conditions because of the two large tidal inlets. The MEP Technical

Report found that the magnitude of oxygen depletion, enhancement of chlorophyll *a* levels and total nitrogen concentrations increased with increasing distance from the tidal inlet, with highest nitrogen enrichment within the tidally restricted Trapps Pond. However, factors such as oxygen depletion, the magnitude of daily oxygen excursion and chlorophyll *a* levels indicate moderately nutrient enriched waters within critical regions of the main basin of Sengekontacket Pond as well as Trapps Pond. While Majors Cove and Trapps Pond have the highest levels of nitrogen enrichment (tidally averaged TN of 0.375 and 0.382 mg N L-1, respectively), they both support somewhat impaired eelgrass habitat. Eelgrass habitat is clearly impaired throughout most of the system which historically had extensive eelgrass coverage. At present eelgrass exists only within a small portion of the system at the upper reaches of Major's Cove and in the inner and outer basins of Trapps Pond. The observed loss of eelgrass is consistent with the sensitivity of eelgrass to declining light penetration resulting from nutrient enrichment and secondary effects of organic enrichment and oxygen depletion. Overall, the multi-basin decline of eelgrass beds relative to historical distributions is consistent given the moderate depths of these basins, periodic oxygen depletion and presence of significant drift algae, primarily within the lower half of Sengekontacket Pond. Infaunal habitat quality was generally high to just slightly impaired in all but the Trapps Pond embayment where moderately impaired benthic habitat quality was reported. The loss of the extensive historical eelgrass coverage makes restoration of this resource the primary focus for nitrogen management with the associated goal of restoring areas that have slightly impaired benthic habitat.

Pollutant of Concern, Sources and Controllability

In Sengekontacket 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, including the impacts described above, through the promotion of excessive growth of plants and algae.

Sengekontacket Pond has had extensive data collected and analyzed through the Massachusetts Estuaries Project (MEP) and with the cooperation and assistance from the Towns of Edgartown and Oak Bluffs and the Martha's Vineyard Commission. Data collection included both water quality and hydrodynamics as described in Chapters I, IV, V, 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 contribution of N into Sengekontacket Pond. The level of "controllability" of each source, however, varies widely:

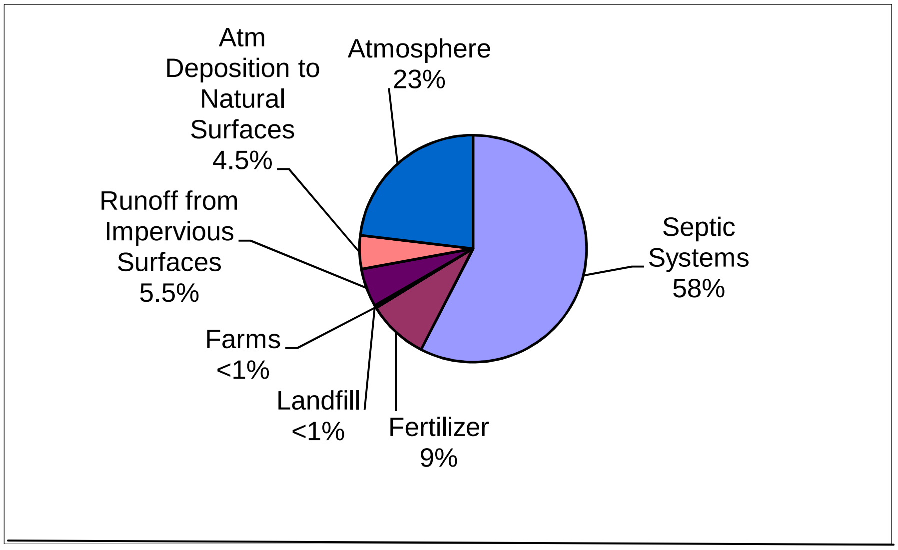
<u>Agricultural</u> – related N loadings can be controlled through agricultural BMPs;

<u>Atmospheric deposition of nitrogen on estuarine surfaces</u> - cannot be adequately 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;

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



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.

Runoff from impervious surfaces – related N loadings can be reduced through best management practices (BMPs), bylaws, stormwater infrastructure improvements and public education;

Sediment nitrogen - 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. 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;

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 Sengekontacket 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)(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(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(b) 1: Class SA

Dissolved Oxygen -

a. Shall not be less than 6.0 mg/L unless background conditions are lower;
b. Natural seasonal and daily variations above this level 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 EPA 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 both 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 over 30 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. In addition, 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 (in complex systems).

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 sites within the embayment system located close to the inland-most reach or reaches, which typically has 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 relate to N **concentration**:

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

And, two outputs relate to N **loadings:**

a) the present N loads to the sub-embayments;
b) 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.

<u>Nitrogen concentrations in the embayment</u>

a) Observed "present" conditions.

Table 3 presents the average concentrations of N measured in this system from data collected during the period 2003 through 2009. Yearly averages of N concentration ranged from 0.21-0.61 mg/L throughout the nine water quality monitoring stations in the Sengekontacket Pond System (Figure 5). Average N concentrations at the sentinel stations established in Majors Cove (SKT4) and Trapps Pond (SKT9) were the highest in the system (0.611, and 0 .601 mg/L, respectively). The overall means and standard deviations of the averages are presented in Appendix A (reprinted from Table VI-1 of the MEP Technical Report).

Table 3: Observed Present Nitrogen Concentrations and Sentinel Stations Threshold Nitrogen Target Concentration for Sengekontacket Pond

Embayment (Sentinel Stations)	Observed Nitrogen Concentration [1] (mg/L)	Sentinel Stations Target Threshold Nitrogen Concentration (mg/L)
Sengekontacket Pond (range from all 9 stations	0.21-0.61	
Sentinel Stations (SKT4 and SKT9)	0.35 – 0.61 mg/L	0.35
Nantucket Sound (Boundary Condition)	0.294	

[1] Range derived from the separate yearly means of 2003-2009 data.
(Overall means and standard deviations of the averages are presented in Appendix A and reprinted from Table VI-1 of the MEP Technical Report)

b) Modeled site-specific target threshold N concentrations:

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 described above, 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.

As listed in Table 3 above, the site-specific target threshold N concentration for Sengekontacket Pond is 0.35 mg/L at two sentinel stations (SKT4 and SKT9).

The findings of the analytical and modeling investigations for this embayment system are discussed below.

The target threshold N concentration 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 and by direct atmospheric deposition.

The target threshold N concentration for Sengekontacket Pond is based upon the goal of improving eelgrass habitat within the main basins of Sengekontacket Pond, Majors Cove and Trapps Pond (estimated in the MEP study to be more than 200 acres) as well as restoration of benthic habitat for infaunal animals in the slightly to moderately impaired regions of the southern basin of Sengekontacket Pond, Majors Cove and Trapps Pond.

The MEP approach for determining nitrogen loading rates that will maintain acceptable habitat quality throughout an embayment system is to first identify the critical spatial distribution and secondly, to determine the nitrogen concentration within the water column which will restore specific locations (sentinel stations) to a desired habitat quality. These sentinel station(s) are selected such that their restoration will necessarily bring the other regions of the system to acceptable habitat quality levels.

The MEP study demonstrated that Sengekontacket Pond currently has significantly impaired eelgrass habitat and slight to moderately impaired infaunal community at N levels of 0.375-0.382 mg/L. The loss of eelgrass at low to moderate levels of nitrogen enrichment was also seen in Lagoon Pond on Martha's Vineyard. In that system, eelgrass declined at tidally averaged TN levels of 0.378 - 0.385 mg/L. In Waquoit Bay at similar depths, eelgrass declined at TN concentrations of 0.395 mg/L and was lost from the Centerville River at TN concentrations of 0.395. In West Falmouth Harbor estuary, eelgrass declined at nitrogen enrichment levels over 0.35 mg/L. The need for a lower threshold in deeper (>2 m) versus shallower (< 1 m) has been seen in several MEP studies. Comparative analyses with similar organically enriched estuarine systems in Southeastern Massachusetts and Martha's Vineyard that were performed by MEP suggests that restoration of stable eelgrass habitat would be achieved at an average N level of 0.35 mg/L N. This threshold is similar to that for West Falmouth Harbor and Phinneys Harbor and is focused in part, on restoring eelgrass at depth (2 m) as found historically. The study predicts that by lowering the average N levels to 0.35 mg/L at the sentinel stations, historical eelgrass habitat and healthy infaunal habitat will be restored throughout the system. This target threshold N concentration is for the sentinel stations SKT4 and SKT9, located in the upper reach of Majors Cove and at the culvert to Trapps Pond (Figure 5). Both of these stations are included in the Martha's Vineyard Commission water quality monitoring program.

The MEP study used a dispersion-mass balance model of Sengekontacket Pond to accurately simulate the N conditions that exist under present N loadings and examined the effectiveness of various management alternatives to restore the observed N related habitat impairments (Section VIII.3 and Chapter IX of the MEP Technical Report).

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Figure 5: Sengekontacket Pond Long Term Water Quality Monitoring Stations. Stations SKT4 and SKT9 are the two sentinel stations.

Nitrogen loadings to the embayment

a) Present loading rates:

In the Sengekontacket Pond 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 28 kg N/day in Sengekontacket Pond. The total N loading from all sources (including sediment flux and atmospheric deposition) is 42.18 kg/day across Sengekontacket Pond embayment (Table 4). A further breakdown of N loading, by source and sub embayment, is also presented in Table 4. The data used for this table is based on Table ES-1 of the MEP Technical Report.

Table 4: Nitrogen Loadings to Sengekontacket Pond System Embayment

Sub-embayment	Present Landuse Load[1] (kg N/day)	Present Septic System Load (kg N/day)	Atmospheric Deposition[2] (kg N/day)	Present Load from Nutrient Rich Sediments (kg N/day)	Present Total nitrogen load from all sources (kg N/day)
Farm Neck	3.70	5.70	3.34	-0.90	11.83
Majors Cove	2.24	9.39	1.19	5.12	17.94
Ocean Heights	2.32	10.94	5.93	-15.71	3.48
State Beach	0.12	0.0	**	1.71	1.82
Trapps Pond	1.14	2.04	0.66	3.28	7.11
Sengekontacket Pond System Total[3]	9.51	28.06	11.12	-6.51	42.18

[1] Includes fertilizers, runoff, farms, landfill and atmospheric deposition to lakes and natural surfaces
[2] Includes atmospheric deposition to the estuarine surface only
** Atmospheric deposition for State Beach is included within the Ocean Heights value
[3] Sengekontacket Pond includes the subembayments of Farm Neck, Majors Cove, Ocean Heights and State Beach. The Sengekontacket Pond System includes Trapps Pond.

As previously indicated, the present N loadings to the Sengekontacket Pond System 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.

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

Table 5 presents the present and target threshold (attenuated) watershed N loadings to Sengekontacket Pond and one scenario of reduced loads and percentage reductions that would meet the target threshold N concentration at the sentinel station (see following section). This presentation is to establish the general degree and spatial pattern of reduction that will be required for restoration of these N impaired embayments. The loadings presented in Table 5 represent one, but not the only, N loading reduction scenario that can meet the TMDL goal. Other alternatives may also achieve the desired threshold concentration as well and can be explored using the MEP modeling approach. For example, loads to the system could potentially be reduced by increasing the natural attenuation of N within the freshwater systems. Modifying the tidal flushing through inlet reconfiguration is also a means of increasing the dilution of the N in the sub-embayment and thus reducing the impact (where appropriate and permitted). In this scenario, the percentage reductions in N loadings to meet the target threshold concentrations range from 0% in Farm Neck and State Beach subwatersheds to 64% in Trapps Pond.

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	Percent Reduction
Farm Neck	9.39	9.39	0	0
Majors Cove	11.63	6.37	5.26	-45.2%
Ocean Heights	13.26	13.26	0	0
State Beach	0.12	0.12	0	0
Trapps Pond	3.18	1.14	2.04	-64.1%
System Total[3]	37.58	30.28	7.3	-19.4%

[1]Composed of fertilizer, landfill, farms, runoff from impervious surfaces, septic systems 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. (From Table ES2 of the MEP Technical Report)

[3] Sengekontacket Pond includes the subembayments of Farm Neck, Majors Cove, Ocean Heights, and State Beach. The Sengekontacket Pond System includes Trapps Pond.

Table VIII-2 of the MEP Technical Report (and included as Appendix B of this document) summarizes the present loadings from on-site subsurface wastewater disposal systems and the reduced loads that would be necessary to achieve the target threshold N concentration in the Sengekontacket Pond System under the scenario modeled here. In this scenario only the on-site subsurface wastewater disposal system loads were reduced to achieve the level of the target threshold watershed load. It should be emphasized once again that this is only one scenario that will meet the target N concentrations at the sentinel stations, which is the ultimate goal of the TMDL. There can be variations depending on the chosen sub-watershed and which controllable source is selected for reduction. Alternate scenarios will result in different amounts of nitrogen being reduced in different sub-watersheds. For example, taking out additional nitrogen upstream will impact how much nitrogen has to be taken out downstream. Edgartown and Oak Bluffs should 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 Sengekontacket Pond 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), 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 storm water be included in the waste load component of the

TMDL. In the Sengekontacket Pond System there are no NPDES regulated point source discharges 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, fertilizer, landfill, farms 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 Sengekontacket Pond this calculated stormwater WLA based on the 200 foot buffer is 0.13% of the total watershed N load or 0.05 kg N/day as compared to the overall (unattenuated) watershed N load of 39.5 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.

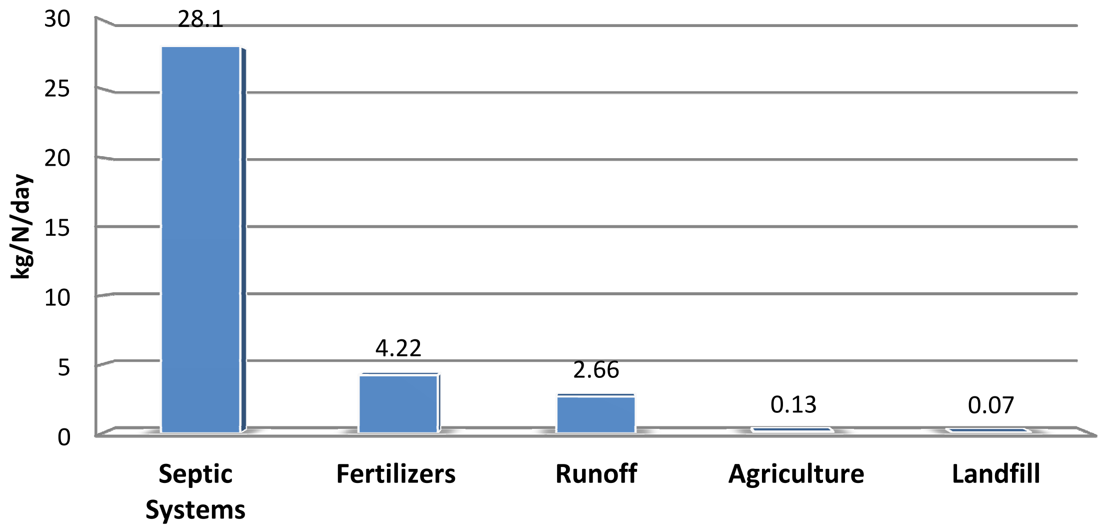
Load Allocations

Load allocations identify the portion of loading capacity allocated to existing and future nonpoint sources. In the case of the Sengekontacket Pond System the nonpoint source loadings are primarily from on-site subsurface wastewater disposal systems. Additional N sources include fertilizers, stormwater runoff from impervious surfaces (except from impervious cover within 200 feet of the waterbody which is defined above as part of the waste load), agriculture, the landfill, sediments and atmospheric deposition. Figures ES-B and 6 emphasizes the fact that the overwhelming majority of locally controllable N comes from on-site subsurface wastewater disposal systems (28 kg N/day) with fertilizers a distant second (4.22 kg N/day). Other controllable sources combined contribute 2.86 kg N/day (from Table IV-2 in the MEP Technical

Report.) Nonpoint sources of N from natural background, sediments and atmospheric deposition are not feasibly controllable.

Storm water that is subject to the EPA Phase II Program would be considered a part of the waste load 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 Edgartown, Oak Bluffs and West Tisbury, new studies and possibly further modeling will identify what portion of the stormwater load may be controllable through Best Management Practices (BMPs).

Figure 6: Controllable Nitrogen Load (kg/day) to Sengekontacket Pond



The sediment loading rates incorporated into the TMDL are lower than the existing sediment flux rates listed in Table 4 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 the Sengekontacket Pond System 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.

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 wasteload 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 Sengekontacket Pond 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. 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. 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. Nitrogen from the upper watershed regions which travel through ponds or wetlands almost always enter the embayment via stream flow and is directly measured (over 12-16 months) to determine attenuation.

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%. Field measurement of instantaneous discharge was performed using acoustic doppler current profilers (ADCP) at key locations within the embayment (for the water quality model, it was possible to conduct a quantitative assessment of the model results as fitted to a baseline dataset - a least squares fit of the modeled versus observed data showed an $R^2>0.95$, indicating that the model accounted for 95% of the variation in the field data). Since the water quality model incorporates all of the outputs from the other models this excellent fit indicates a high degree of certainty in the final result. The high level of accuracy of the model provides a high degree of confidence in the output, therefore, less of a margin of safety is required.

In the case of the nitrogen load assessed to lawn fertilization rates for residential lawns, based on an actual survey, it is likely that this represents a conservative estimate of the nitrogen load. This too makes a more conservative margin of safety.

The nitrogen loading calculations are based on a wastewater engineering assumption that 90% of water used is converted to wastewater. Actual water use and conversion studies in the area have shown that this conversion rate is conservative adding to the margin of safety.

The nitrogen loading calculations for homes which do not have metered water use are based on a conservative estimate of water use compared to actual water use in the metered sections of the watershed. This adds to the margin of safety.

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 site was chosen that had 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 Sengekontacket Pond 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 presented in Table 6.

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 the on-site subsurface wastewater disposal systems, stormwater runoff, agriculture, fertilizer and the landfill. In the case of the Sengekontacket Pond System the TMDL was calculated by projecting reductions in locally controllable on-site subsurface wastewater disposal systems. Once again the goal of this TMDL is to achieve the identified target threshold N concentrations at the identified sentinel stations. The target load identified in this table represents one alternative loading scenario to achieve that goal but other scenarios may be possible and approvable as well.

Table 6: The Total Maximum Daily Load for the Sengekontacket Pond System-Represented as the Sum of the Calculated Target Threshold Load, Atmospheric Deposition and Benthic Load

Sub-embayment	Target Threshold Watershed Load [1] (kg N/day)	Atmospheric Deposition (kg N/day)	Load from Nutrient Rich Sediments (kg N/day)[2]	TMDL [3] (kg N/day)
Farm Neck	9.39	3.34	0	12.73
Majors Cove	6.37	1.19	4.71	12.27
Ocean Heights	13.26	5.93	0	19.19
State Beach	0.12	**	1.60	1.72
Total for Sengekontacket Pond [4]	29.14	10.46	6.31	45.91
Trapps Pond	1.14	0.66	2.37	4.17

[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] Negative benthic flux values set to zero. Projected sediment N loadings obtained by reducing present loading rates (Table 4) proportional to proposed watershed load reductions and factoring in the existing and projected future concentration of PON.

[3] Sum of target threshold watershed load and atmospheric deposition load and benthic load

** Atmospheric deposition for State Beach is included within the atmospheric deposition for Ocean Heights.

[4] Sengekontacket Pond includes the subembayments of Farm Neck, Majors Cove, Ocean Heights, and State Beach.

Implementation Plans

The critical element of this TMDL process is achieving the specific target threshold N concentration for the sentinel stations presented in Table 3 above. This is necessary for the restoration and protection of water quality, benthic invertebrate habitat and eelgrass within the Sengekontacket Pond System. Table 6 above lists the target watershed threshold load that will result in attainment of the target threshold N concentration. If this threshold load is achieved, this embayment will be protected. In order to achieve this, the MEP is recommending a load reducing scenario based solely on reducing septic loads, specifically 56% from the Majors Cove subwatershed and 100% from the Trapps Pond subwatershed (See Appendix B below and Table VIII-2 of the MEP Technical Report)). However, as previously noted, there is a variety of loading reduction scenarios that could achieve the target threshold N concentration. Edgartown and Oak Bluffs are encouraged to explore loading reduction scenarios through additional modeling as part of the Comprehensive Wastewater Management Plan (CWMP). It must be demonstrated 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.

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.)

Because the vast majority of controllable N load is from individual septic systems for 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. For example, as part of their ongoing CWMP process, the Town of Edgartown has developed a potential sewer area for the Ocean Heights/Arbutus Park area which is completely contained within the Ocean Heights subwatershed. Under this plan, the sewage from this area would be collected and treated at the Edgartown Wastewater Treatment Facility (WWTF) and the treated effluent returned to a discharge site within the same watershed. An alternatives scenario analysis using the Linked Model was completed by SMAST to see if this alternative sewering plan would be adequate to achieve the target threshold N concentration at the sentinel stations. The results are reported in Chapter IX of the MEP Technical Report. The analysis found that although there would be a 50% reduction in total watershed N loading under this scenario, it would not be sufficient alone to achieve the target threshold N concentration at the sentinel stations and fully restore the N impairment to Sengekontacket Pond.

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

Edgartown and Oak Bluffs 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. It should be noted that although no towns in the Sengekontacket Pond watershed are Phase II 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.

It should also be noted that a small portion of the town of West Tisbury is in the upper watershed of this system. Thus the development of any implementation plan should also include this town when coordinating efforts to maximize the reduction in N loading, where appropriate.

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 Edgartown and Oak Bluffs and 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 watershed towns of Edgartown, Oak Bluffs and West Tisbury are not one of the 237 communities in Massachusetts 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 stations 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 the Department, 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 Edgartown and Oak Bluffs 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. Edgartown and Oak Bluffs 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, and stormwater 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

Summary of the Nitrogen Concentrations for Sengekontacket Pond System
(from Chapter VI of the accompanying MEP Technical Report)

Sengekontacket Pond water quality monitoring data, and modeled Nitrogen concentrations for the Sengekontacket Pond System. All concentrations are given in mg/L N. "Data mean" values are calculated as the average of the separate yearly means.									
Sub-Embayment	Farm Neck Inlet	Farm Neck Basin	Majors Cove	Majors Cove	Main Inlet	Ocean Heights	Ocean Heights	Ocean Heights	Trapps Pond
Monitoring station	Skt-1	Skt-2	Skt-3	Skt-4	Skt-5	Skt-6	Skt-7	Skt-8	Skt-9
2003 mean	0.457	0.451	0.554	0.611	0.306	0.365	0.420	0.604	0.607
2004 mean	0.350	0.369	0.416	0.366	0.288	0.315	0.299	0.417	0.413
2005 mean	0.268	0.285	0.351	0.356	0.205	0.268	0.217	0.311	0.396
2006 mean	0.351	0.373	0.421	0.437	0.355	0.319	0.312	0.412	0.516
2007 mean	0.348	0.336	--	0.392	0.257	0.259	0.279	0.380	--
2008 mean	0.402	0.365	0.347	0.373	0.336	0.270	0.429	0.381	0.380
2009 mean	0.295	0.294	0.342	0.347	0.248	0.264	0.263	0.378	0.422
mean	0.351	0.347	0.414	0.406	0.290	0.302	0.314	0.392	0.445
s.d. all data	0.073	0.064	0.098	0.100	0.071	0.083	0.104	0.094	0.089
N	24	24	25	25	25	25	27	24	20
model min	0.295	0.312	0.340	0.370	0.294	0.300	0.299	0.323	0.331
model max	0.324	0.328	0.363	0.380	0.320	0.325	0.317	0.337	0.476
model average	0.308	0.320	0.351	0.375	0.299	0.308	0.306	0.331	0.382

Appendix B

Summary of the Present On-Site Subsurface Wastewater Disposal System Loads and the Loading Reductions Necessary to Achieve the TMDL by Reducing On-Site Subsurface Wastewater Disposal System Loads Only

Sub-embayment	Present Septic System Load (kg N/day)	Threshold Septic System Load (kg N/day)	Threshold Septic System Load % Change
Farm Neck	5.696	5.696	0.0%
Majors Cove[1]	9.392	4.134	-56.0%
Ocean Heights	10.940	10.940	0.0%
Trapps Pond	2.036	0.000	-100%
State Beach	0.0	0.0	0.0

[1] Majors Cove is a combination of Majors Cove watershed and Fresh Pond watershed thus the 60% reduction in septic loading for the threshold does not result in a direct 60% reduction in septic loading.
(Note: Taken from Table VIII-2 of the MEP Technical Report. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff or fertilizer loading terms.)
[2] Sengekontacket Pond includes the subembayments of Farm Neck, Majors Cove, Ocean Heights, and State Beach. The Sengekontacket Pond System includes Trapps Pond.

Appendix C

The Sengekontacket Pond System Estimated Waste Load Allocation (WLA) from Runoff of all Impervious Areas within 200 Feet of Water Bodies

Embayment	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]
Farm Neck	0.52	96.98	1,104.5	8.8%	0.5%	0.862	9.416	0.00	0%
Majors Cove	1.30	135.91	1,522.9	8.9%	1.0%	0.777	12.873	0.01	0.08%
Ocean Heights	2.23	154.45	1,414.1	10.9%	1.4%	0.654	13.261	0.01	0.08%
Trapps Pond	2.03	44.86	439.9	10.2%	4.5%	0.302	3.836	0.01	0.26%
State Beach	2.94	8.58	97.9	8.8%	34.3%	0.069	0.116	0.02	17.24%
Sengekontacket System Total	9.02	440.78	4579.3	9.6%	2.0%	2.66	39.5	0.05	0.13%

[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

Sengekontacket Pond System Two Total Nitrogen TMDLs

Sub-embayment	Segment ID	Description	TMDL (kg N/day)
Farm Neck		Determined to be impaired for nutrients during the development of this TMDL.	12.73
Majors Cove		Determined to be impaired for nutrients during the development of this TMDL.	12.27
Ocean Heights		Determined to be impaired for nutrients during the development of this TMDL.	19.19
State Beach		Determined to be impaired for nutrients during the development of this TMDL.	1.72
Total for Sengekontacket Pond [1]	MA97-10_2008		45.91
Trapps Pond	MA97-32_2016	Determined to be impaired for nutrients during the development of this TMDL.	4.17
Total for Sengekontacket Pond System			50.08

[1]Sengekontacket Pond includes the subembayments of Farm Neck, Majors Cove, Ocean Heights, and State Beach. Sengekontacket Pond System includes Trapps Pond.

Appendix E

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.

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

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

Signature	Print Name	Affiliation
Sheri Caseau	Sheri Caseau	MVC
MATT POOLE	Matthew Poole	EDG. BD. OF HEALTH
Kris Vrooman	Kris Vrooman	FOS
Max McCreery	Max McCreery	FOS
Melinda Loberg	Melinda Loberg	Tis Wastewater
Megan Ottens-Sargent	Megan Ottens-Sargent	WA · Edey Foundation - Felix Neck (Aquinnah)
Roxann Alwin		
Wilde Whitcomb	Wilde Whitcomb	Aquinnah Resident
LANI GOLDTHORPE	L Goldthorpe	LAGOON POND ASSN
Paul L Bagnall		EDGARTOWN Shellfish Dept
Greg Coogan	GREG COOGAN	OB BOS
Laurisa Rich	LAURISA RICH	LAGOON POND ASSN

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

Signature	Print Name	Affiliation
Sally Z (Terry) Appenzeller	Terry Appenzeller	FOS, VCS, OB Con Comm
Ronald Moore	Ronald Moore	Resident OB Harthaven
Bruce E. Sanders	Bruce Sanders	FOS, BBTF
[illegible]	Robert Whritenour	Town of Oak Bluffs
Walter W. Vail	Walter W. Vail	OB Selectman
Jim Monteith	Jim Monteith	O.B. Wastewater
Elizabeth Mansure	Elizabeth Mansure	Shellfish Comm
William Alwardt	William Alwardt	Shellfish Com
[illegible]	Kurt A. Healy	Civil Engineer
Margaret Curtin	Margaret Curtin	Lagoon Pond Assoc.
Gail Barmakian	Gail Barmakian	OB WWCommission / Selectman

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