DRAFT
Tisbury Great Pond
Black Point Pond Estuarine System
Total Maximum Daily Load
For Total Nitrogen
(CN 398.0)
Draft Tisbury Great Pond/Black Point Pond System
Total Maximum Daily Loads
For Total Nitrogen

Key Feature: Total Nitrogen TMDLs for the Tisbury Great Pond/Black Point Pond Estuarine System
Location: EPA Region 1
Land Type: New England Coastal
303d Listing: Tisbury Great Pond was impaired for bacteria, Category 5, on the 2014 Integrated List. This waterbody (Segment #MA97-18) was found to be impaired for nutrients during the MEP study. This segment will be evaluated for nutrient impairment in a future 303(d) listing. Tisbury Great Pond includes Town Cove, Muddy Cove, Pear Tree Cove, Short Cove, Tiah Cove, Tississa Pond, Deep Bottom Cove, and Thumb Cove, in Chilmark/West Tisbury, Martha's Vineyard. (There is no listing for Black Point Pond.)

Data Sources: University of Massachusetts – Dartmouth/School for Marine Science and Technology; US Geological Survey; Applied Coastal Research and Engineering, Inc.

Data Mechanism: Massachusetts Surface Water Quality Standards, Ambient Data, and Linked Watershed Model

Monitoring Plan: Town of Chilmark monitoring program (technical assistance from SMAST) and Town of West Tisbury monitoring program (technical assistance from SMAST)

Control Measures: Sewering, Agricultural BMPs, Stormwater Management, Attenuation by Freshwater Waterbodies, Fertilizer Use By-laws, Landfill Management
Executive Summary

Problem Statement

The enclosed embayment structure and excessive nitrogen (N) originating from a range of sources has added to the impairment of the environmental quality of the Tisbury Great Pond/Black Point Pond estuarine system. Excessive N is indicated by:

- Undesirable increases in macro algae
- Periodic extreme decreases in dissolved oxygen concentrations that threaten aquatic life
- Reductions in the diversity of benthic animal populations
- Reduction or elimination of eel grass
- Periodic algal blooms

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

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

Coastal communities 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 result in an overabundance of macro-algae, a higher frequency of extreme decreases in dissolved oxygen concentrations and fish kills, widespread occurrence of unpleasant odors and visible scum, and loss of benthic macro-invertebrates throughout most of the embayments. Additionally, the number and duration of pond openings play a fundamental role in the maintenance of nutrient related water quality and habitat health throughout this estuary. As a result of these environmental impacts, commercial and recreational uses of the Tisbury Great Pond/Black Point Pond estuarine system will be greatly reduced.

Sources of Nitrogen

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

- The watershed
  - Natural background
  -Septic Systems
  -Runoff
  -Fertilizers
- Landfills
- Agricultural activities
- Wastewater treatment facilities
- Atmospheric deposition
- Nutrient-rich bottom sediments in the embayments

Figure ES-A and Figure ES-B illustrate the percent contribution of all watershed sources of N and the controllable N sources to the estuary system, respectfully. Values are based on Table IV-3 and Figure IV-7 from the Massachusetts Estuaries Project (MEP) Technical Report (Howes et al 2013). As evident, most of the present controllable load to this system comes from agriculture and septic systems.
Figure ES-A: Percent Contributions of All Watershed Nitrogen Sources to the Tisbury Great Pond/Black Point Pond Estuarine System

Overall Load

- Agriculture: 30%
- Water Body Surface Area: 21%
- Impervious Surfaces: 5%
- Natural Surfaces: 10%
- Fertilizers: 6%
- Impervious Surfaces: 5%
- Agriculture: 30%
- Water Body Surface Area: 21%

Figure ES-B: Percent Contributions of Controllable Nitrogen Sources to the Tisbury Great Pond/Black Point Pond Estuarine System

Local Control Load

- Wastewater: 40%
- Fertilizers: 8%
- Impervious Surfaces: 7%
- Agriculture: 44%
- Landfill: 1%
Target Threshold Nitrogen Concentrations and Loadings

Tisbury Great Pond/Black Point Pond estuarine system is made up of three units: main Tisbury Great Pond basin, approximately six (6) tributary coves and Black Point Pond. One of the coves, Town Cove, receives nitrogen loadings from two subwatersheds; Tiasquam River and Mill Brook. The total nitrogen loading (N) to the estuarine system is 72.26 kg N/day (Tables ES-1 and IV-2 of the MEP) including contributions from natural surfaces, atmospheric deposition, pond sediments, fertilizer, stormwater runoff, and septic system loadings. This total nitrogen load to Tisbury Great Pond/Black Point Pond system includes direct atmospheric deposition to the estuary surface (11.3 kg N/day) and net benthic flux (14.98 N/day) estimates, as well. The average annual surface water concentrations of N in Tisbury Great Pond ranged from 0.41 – 0.51 mg/L in the main basin and 0.42 mg/L - 0.79 mg/L in the tributary coves. These ranges represent the average annual mean concentrations collected from 10 stations between 1995 and 2007, and 2011, as reported in Table VI-1 of the MEP Technical Report (Howes et al 2013) and included in Appendix B of this report.

Eelgrass has not generally existed in Tisbury Great Pond throughout the past several decades. There is historical evidence of eelgrass distribution along the shallow margins of the main Tisbury Great Pond basin. (Figure VII-15, 1951 eelgrass, photo interpretation, Howes et al 2013) and anecdotally supported by reports from long-time residents. Based on this, return of sparse eelgrass habitat and improved benthic habitat restoration are the nitrogen management goals for Tisbury Great Pond Estuarine System. Improved conditions for eelgrass will necessarily produce supportive conditions for improved benthic habitat restoration.

In order to restore and protect this estuarine system, N loadings, and subsequently the concentrations of N in the surface water, must be reduced to levels below those that cause the observed environmental impacts. This N concentration will be referred to as the target threshold N concentration. The Massachusetts Estuaries Project (MEP) has determined from modeling that by achieving a time averaged N concentration of 0.46 mg/L within the main basin of Tisbury Great Pond near sentinel station TGP-7 will result in restoration of eelgrass habitat along the shallow margins of the main basin. The target sentinel station concentration of 0.46 mg/L is higher than typically observed in other estuaries for eelgrass restoration (0.3 to 0.35 mg/L) given the bathymetry of the main basin and limited area in which eelgrass was previously assumed to occur.

A secondary target of 0.48 mg/L was established within the tributary coves for infaunal habitat restoration near sentinel stations of TGP-4, TGP-5, and TGP-6. (See Figure 5 for sentinel station locations). The mechanism for achieving the target threshold N concentrations is to reduce the N loadings to the watershed and to increase flushing of the estuarine system. Based on the sampling and modeling analyses and the Technical Report, the MEP study has determined that the Total Maximum Daily Load (TMDL) of N that will meet the target threshold N concentrations of 0.46 and 0.48 mg/L at the sentinel stations identified above is 64.12 kg/day total N. To meet the TMDL the MEP report indicates that a 25.3% reduction of the total nitrogen load for the entire system along with an additional 17-day mid-summer breach of Tisbury Great Pond to allow mixing of the Atlantic Ocean waters will be required to meet the target threshold concentrations. (The additional 17-day breach was one scenario used for modeling purposes. Two or more breaches with a total of 17 days would approximate the original model results. Additional modeling of other scenarios may be completed as part of the Comprehensive Water Resources Planning.)

This document presents the TMDLs for the Tisbury Great Pond/Black Point Pond estuarine system and provides guidance to the watershed communities of West Tisbury and Chilmark on possible ways to reduce the N loadings to meet the recommended TMDL and protect the waters of this estuarine system.
Implementation

The primary goal of TMDL implementation will be a combination of reducing the loadings from any and all sources of N in the watershed, and maintaining at least a 17-day breach in the barrier beach to increase flushing in the Tisbury Great Pond main basin. The MEP Technical Report for the Tisbury Great Pond/Black Point Pond Estuarine System indicated that by reducing watershed loads by 18.6% from Mill Brook and by 36.8% in Tiasquam River (both in the Town Cove sub-watershed) and a 23.2% reduction in Tisbury Great Pond’s main basin, the target thresholds can be met. In evaluating septic loads alone (in addition to the breaching of the barrier beach), a 70% reduction in the Mill Brook and Tiasquam River sub-watersheds and an 80% reduction in the main basin would meet the target threshold water quality concentrations.

Agricultural load contributes the largest controllable N load (44%) to this system therefore it is recommended that the watershed communities also implement agricultural BMPs throughout the watershed with a goal of reducing N contribution from agricultural sources by 10% watershed-wide. The towns of West Tisbury and Chilmark should consider requesting an additional model run from SMAST that evaluates a scenario that includes recommendations for reductions in agriculture N loads, as well as, septic loads from the various subembayments. This will help focus agricultural BMP implementation activities to areas that will most effectively reduce N loads and perhaps reduce the need for sewering. In particular, reductions in N use on agricultural land located immediately adjacent to Town Cove, Pear Tree Cove and Tiah Cove would provide improvements to water quality. Massachusetts Department of Agricultural Resources, Plant Nutrient Application Requirements, 330 CMR 31.00, became effective December 2015. These regulations require basic plant nutrient applications for 10 or more acres and adherence to application and seasonal restrictions.

Current management of Tisbury Great Pond is coordinated by the Riparian Owners of Tisbury Great Pond Association (ROA). A number of considerations are taken into account; pond water level, fish spawning, salinity, nitrogen, turbidity, tidal cycles, shoaling, weather and nesting shore birds. Typically a trench is excavated through the barrier beach every 3 months to allow tidal exchange with the Atlantic Ocean. Records kept between 1993 and 2011 indicate the breach is typically opened three times each year with an average cumulative total of 144 open days per year. The average duration of all openings in the record was 42 days. Breaching of the pond is undertaken in part as a means of controlling salinity levels in the pond and as a flood control measure to keep groundwater levels low enough to prevent flooding of basements in homes bordering the pond. The threshold modeling assumptions included a mid-summer breach to remain open for 17 days, in addition to the typical spring breach that now occurs. More details may be found in the MEP Technical Report (Howes et al 2013). The length of time that each breach in the barrier beach actually remains open, varies widely due to the complexity of ocean currents, winds and weather patterns.

Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Water Resources (or Wastewater) Management Plan (CWRMP). Implementing best management practices (BMPs) to reduce N loadings from fertilizers and runoff where possible will also help to lower the total N load to the system. There are other loading reduction scenarios that could achieve the target threshold N concentrations and could be verified through additional modeling.

Methods for reducing N loadings from these sources are explained in detail in the “MEP Embayment Restoration Guidance for Implementation Strategies” which is available on the MassDEP website http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/mepmain.pdf

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 West Tisbury and Chilmark which would exacerbate the problems associated with N loading 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 these pollutants of concern, taking into consideration all contributing sources to that water body, while allowing the system to 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 West Tisbury and Chilmark 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 Tisbury Great Pond/Black Point Pond estuarine system the pollutant of concern for this TMDL (based on observations of eutrophication) is the nutrient nitrogen. Nitrogen is the limiting nutrient in coastal and marine waters, which means that as its concentration increase so does the amount of plant matter. This leads to nuisance populations of macro-algae and increased concentrations of phytoplankton and epiphyton which impairs the healthy ecology of the affected water bodies.

The TMDL for total N for the Tisbury Great Pond/Black Point Pond estuarine system is based primarily on data collected, compiled and analyzed by University of Massachusetts Dartmouth’s School of Marine Science and Technology (SMAST) Coastal Systems Program and the towns of West Tisbury, Chilmark and the Martha’s Vineyard Commission, as part of the Massachusetts Estuaries Project (MEP). The data were collected over a study period from 1995 through 2007 and 2011, a period which will be referred to as the “present conditions” in the TMDL report, since it contains the most recent data available. The accompanying MEP Technical Report can be found at http://www.mass.gov/eea/agencies/massdep/water/watersheds/the-massachusetts-estuaries-project-and-reports.html. The MEP Technical Report presents the results of the analyses of the coastal embayment system using the MEP Linked Watershed-Embayment N Management Model (Linked Model).
The analyses were performed to assist the watershed communities with making decisions on current and future wastewater planning, wetland restoration, anadromous fish runs, shellfisheries, open space, and estuary maintenance programs. A critical element of this approach is the assessments 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 total N loading threshold for use as a goal for watershed N management. The TMDLs are based on the site specific total N threshold generated for this estuarine system. Thus, the MEP offers a science-based management approach to support the wastewater management planning and decision-making process for both West Tisbury and Chilmark.

**Description of Water Bodies and Priority Ranking**

**Watershed Characterization**

The MEP team has delineated a watershed area of approximately 18.5 square miles for the Tisbury Great Pond/Black Point Pond Estuarine system. The delineated contributory watershed includes eight subwatersheds which were delineated for estimation of groundwater flows and nutrient export (Figure 1, Howes et al, 2013, pg. 34). The MEP team has estimated a total groundwater flow for the system of 89,728 m$^3$/day.

In the overall Tisbury Great Pond/Black Point Pond system, the predominant land use is residential, which accounts for 37% of the overall watershed area while public service lands represent the second highest percentage (33%) of watershed area (Howes et al 2013, pg 40). Overall, undeveloped lands account for 24% of the entire watershed area. Undeveloped land is the dominant land use in the Black Point Pond subwatershed (39%).

**Description of Waterbodies**

The Tisbury Great Pond/Black Point Pond estuarine system is one of the largest estuaries on Martha’s Vineyard and its watershed is shared by the towns of Chilmark and West Tisbury (see Figures 1 and 2). The system is comprised of three major functional units; the main basin, a lagoon formed by the barrier beach, the shallow and narrow tributary coves, and Black Point Pond, a shallow pond surrounded by wetlands. The estuarine system is a complex coastal open-water embayment as evidenced by its size and structure. The estuary is maintained by the periodic breaching of the Tisbury Great Pond barrier beach, coordinated by the Riparian Owners of Tisbury Great Pond Association with a single temporary inlet. Its ponds and coves delineate a number of sub-basins (Town Cove, including the tributaries Mill Brook and Tiasquam River), Tiah Cove, Short Cove, Muddy Cove, Pear Tree Cove, Deep Bottom Cove, Thumb Cove, Tississa Pond, and Black Point Pond). The upper reaches of the great pond appear to be the most nitrogen sensitive, however, the N loads emanating from the upper portion eventually has an impact on the lower reaches, and therefore the system has to be managed as a whole.

This estuary constitutes an important component of the area’s natural and cultural resources and the uses of the Tisbury Great Pond/Black Point Pond estuarine system must be balanced. The watershed is an attractive location due to its extensive shoreline, sheltered bays and accessibility for fishing, swimming and boating. These attributes also increase the pressure for development which tends to threaten the very qualities which make it so desirable. In particular, the estuary is at risk of further eutrophication from high nutrient loads in the groundwater and surface water, and runoff from the watershed. Tisbury Great Pond system is vulnerable to the effects of nutrient enrichment from the watershed considering that circulation is mainly through wind driven mixing in the small tributary sub-embayments, the long shoreline of the pond and only periodic flushing with the low nutrient waters of the Atlantic Ocean.
Tisbury Great Pond main basin and the freshwater tributaries to Tisbury Great Pond (Tiasquam River and Mill Brook) were determined to be impaired for dissolved oxygen, chlorophyll a, and benthic fauna during the course of the MEP study. Tisbury Great Pond will be evaluated for listing in a future List of Waters for nutrient impairment. Tisbury Great Pond is listed as impaired for pathogens in the 2014 Integrated List of Waters (Table 1). Further discussion of pathogens is beyond the scope of this TMDL.

Black Point Pond is functionally a saltwater wetland basin (e.g. a pond surrounded by significant wetland area) and therefore has a higher capacity to assimilate nitrogen input. Nitrogen management for eelgrass restoration in Tisbury Great Pond will protect Black Point Pond from nitrogen over-enrichment, either through management of nitrogen sources in the Black Point watershed or through lower nitrogen concentrations in the main basin.

The primary ecological threat to the Tisbury Great Pond/Black Point Pond Estuarine System, as a coastal resource, is degradation resulting from nutrient enrichment. Loading of the critical eutrophying nutrient, nitrogen, to this estuarine system has impaired its animal and plant habitats and resulted in ecological changes and lost marine resources. Nitrogen related habitat impairment within the Tisbury Great Pond Estuary shows a gradient of high to low concentrations moving from the upper coves of Tisbury Great Pond to the tidal inlet.

The nitrogen loading to the Tisbury Great Pond/Black Point Pond Estuarine System is primarily from agricultural load and on-site disposal of residential (and some commercial) wastewater. The towns of West Tisbury and Chilmark, like most of Cape Cod and the Islands, has seen rapid growth over the past five decades and does not have a centralized wastewater treatment system or decentralized facilities that remove nitrogen. As such, none of the developed areas in the Tisbury Great Pond/Black Point Pond

Figure 1: Watershed Delineations for the Tisbury Great Pond/Black Point Pond Estuarine System
Estuarine System watershed are connected to any municipal sewerage system and wastewater treatment and disposal is primarily through privately maintained on-site septic systems. As present and future increased levels of nutrients impact the coastal embayments in the towns of West Tisbury, water quality degradation will increase, with additional impairment and loss of environmental resources.

A complete description of this estuary system is presented in Chapters I and IV of the MEP Technical Report. A majority of the information presented here and used to develop this TMDL is drawn from the MEP Technical Report (Howes et al 2013). Chapters VI and VII of the MEP Technical Report provide assessment data that show that the Tisbury Great Pond/Black Point Pond estuarine system is impaired due to excess nutrients, low dissolved oxygen levels, elevated chlorophyll $a$ levels and the lack of a permanent estuary outlet which has resulted in loss of eelgrass and stressed benthic infauna habitat. Table 1 identifies the segment previously listed in Category 5 of the Integrated List of Waters by MassDEP for fecal coliform. As a result of the MEP assessment, Tisbury Great Pond and its’ tributary coves were determined to be impaired for nutrients as well. During the MEP evaluations Black Point Pond was not shown to be $N$ impaired but the analysis of its’ current condition indicates that it is at its limit of $N$ uptake and the sub-watershed build-out indicates that impairment could become a future condition. Black Point Pond was determined to be supporting high quality benthic animal habitat (Howes et al, 2013). MassDEP has included Black Point Pond in this TMDL as a ‘protective’ measure.
Figure 2: Map of the Tisbury Great Pond/Black Point Pond Estuarine System
Table 1: Comparison of MassDEP and SMAST Impaired Parameters for the Tisbury Great Pond/Black Point Pond Estuarine System

<table>
<thead>
<tr>
<th>System Component</th>
<th>MassDEP Segment Number (if applicable)</th>
<th>MassDEP Segment Description</th>
<th>Class</th>
<th>2014 Integrated List Category</th>
<th>SMAST Impaired Parameter</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tisbury Great Pond</td>
<td>MA97-18</td>
<td>Including Town Cove, Muddy Cove, Pear Tree Cove, Short Cove, Tiah Cove, Tississa Pond, Deep Bottom Cove, and Thumb Cove, Chilmark/West Tisbury, Martha’s Vineyard</td>
<td>SA, Shell-fishing</td>
<td>5, Fecal Coliform</td>
<td>Nutrients, Dissolved Oxygen, Chlorophyll a, Benthic Fauna, Eelgrass</td>
<td>705.9 (acres)</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>MA97-33</td>
<td>Chilmark (includes channel connector to Tisbury Great Pond)</td>
<td>SA, Shell-fishing</td>
<td>None</td>
<td>None</td>
<td>58.4 (acres)</td>
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<tr>
<td>Mill Brook</td>
<td>MA97-24</td>
<td>Source in wetlands west of Roth Woodland Road, Chilmark to Old Millpond Dam, West Tisbury, Martha’s Vineyard.</td>
<td>B</td>
<td>2</td>
<td>None</td>
<td>3.6 miles</td>
</tr>
<tr>
<td>Tiasquam River</td>
<td>MA97-25</td>
<td>Source in wetlands west of Tea Lane, Chilmark to Warren Pond Dam, Chilmark/West Tisbury, Martha’s Vineyard.</td>
<td>B</td>
<td>2</td>
<td>None</td>
<td>3.2 miles</td>
</tr>
</tbody>
</table>

1 As determined by the MEP Tisbury Great Pond/Black Point Pond System Study and reported in the Technical Report

Priority Ranking

The embayment addressed by this document has been determined to be “high priority” based on three significant factors: (1) the initiative that the towns of Chilmark and West Tisbury have taken to assess the conditions of the entire embayment system; (2) the support of the towns to restore the Tisbury Great Pond/Black Point Pond estuarine system; and (3) the extent of impairment in the Tisbury Great Pond/Black Point Pond Estuarine System. 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 the Problem Assessment section below and detailed in Chapter VII, Assessment of Embayment Nutrient Related Ecological Health, of the MEP Technical Report.

Description of Hydrodynamics of the Tisbury Great Pond/Black Point Pond System

Tisbury Great Pond is generally fully enclosed but is managed by periodic breaching of a barrier beach. Due to energetic wave action on the southern coast of Martha’s Vineyard breaches may be of short duration before the breach is filled in by sediment transport along the beach. There are generally three breaches per year with an average total number of days open of 144 days/year. (Howes et al 2013, pg. 75). The average breach recorded during the period 1993 to 2011, remained open for 42 days.

In order to understand the hydrodynamics of this system during a breach, the MEP study team deployed temperature depth recorders at two locations within the system (Black Point Pond and Town Cove) between March 22 and April 15, 2012 immediately after a breach on March 21. The tidal data collected
within the system was compared to data collected offshore of South Beach, at the Martha’s Vineyard Coastal Observatory. For a 19 day period beginning March 25 the mean tidal range at the offshore station was 2.9 feet while it was 1.0 foot at the Town Cove gage station and only 0.1 feet at Black Point Pond. The MEP project found that Black Point Pond had a mean tidal level of 1.3 feet which is higher than the offshore mean tide of 0.5 feet, indicating that Black Point Pond “does not drain well into the remainder of the Tisbury Great Pond system” (Howes et. al 2013, pg. 79). The large tidal attenuation seen in Black Point Pond is likely due to its physical structure and the impact of sand flats in Crab Creek which connects Black Point Pond and Tisbury Great Pond.

Using an RMA-2 model the MEP project estimated local residence times that ranged between 1.8 and 7.1 days within the Tisbury Great Pond System. Black Point Pond had the longest local residence time. The system residence time was estimated to range between 2.3 days for entire Tisbury Great Pond system and 153.3 days for Black Point Pond. The relatively short flushing time of 2.3 days for the entire Tisbury Great Pond system, “provides some confidence that the temporary channel allows enough exchange to significantly improve water quality during a typical breach event” (Howes et. al 2013, pg. 98).

**Problem Assessment**

Water quality problems associated with development within the watershed result primarily from agricultural activities, septic systems, stormwater runoff, and fertilizers. The water quality problems affecting nutrient-enriched embayments generally include periodic decreases of dissolved oxygen, decreased diversity and quantity of benthic animals and periodic algae blooms. In the most severe cases habitat degradation could lead to periodic fish kills, unpleasant odors and scums and near loss of the benthic community and/or presence of only the most stress-tolerant species of benthic animals.

Figure 3 illustrates population growth in West Tisbury and Chilmark since the 1950s. The population of West Tisbury has increased almost 8 fold from 347 people in 1950 to 2,740 people in 2010. In Chilmark, year round population increased from 183 people in 1950 to 866 people in 2010. Increases in N loading to estuaries are directly related to increasing development and population in the watershed. Communities throughout the Commonwealth have experienced rapid growth over the past three decades. This increase in population, both year round and summer visitors, contributes to a decrease in undeveloped land and an increase in septic systems, runoff from impervious surfaces and fertilizer use. All the residences in the Tisbury Great Pond/Black Point Pond estuarine system watersheds are serviced by septic systems. The greatest level of development and residential load is situated in the near shore regions of the system. These un-sewered areas contribute significantly to the estuary’s watershed through transport in direct groundwater discharges to estuarine waters and through surface water flows to Tisbury Great Pond. Additionally, significant agricultural land utilizing nutrient application and pasturing of farm animals occurs adjacent to and within the watershed of the estuaries.
Habitat and water quality assessments were conducted on this estuarine system based upon water quality monitoring data, changes in historical eelgrass distribution, time-series water column dissolved oxygen and chlorophyll $a$ measurements and benthic community structure. The MEP evaluation of habitat quality supported by each area considers its natural structure and its ability to support eelgrass beds and the types of benthic communities that they support (Table 2). Currently, there is no eelgrass within Tisbury Great Pond. Eelgrass was present in the lower portion of the main basin in 1951 according to historic aerial photographs; however, subsequent eelgrass surveys in 1995, 2001, and 2006 by MassDEP did not include Tisbury Great Pond. At present, given moderate levels of watershed nitrogen loading and limited tidal exchange, occurring periodically during managed breaches of the barrier beach, the nitrogen, chlorophyll $a$ and oxygen levels within the pond basins are not supportive of eelgrass. The infauna survey indicates that most sub-basins comprising the Tisbury Great Pond are presently near or beyond their ability to tolerate additional nutrient inputs without impairment. There was a clear spatial pattern in habitat quality with moderately to significantly impaired benthic animal habitat found in the tributary coves and the healthy to moderately impaired areas within the large main basin. The level of oxygen depletion and the magnitude of daily oxygen excursions and chlorophyll-$a$ levels are consistent with moderate to significant nutrient enrichment and impaired habitat quality within the main and tributary coves. Black Point Pond is functioning as a wetland basin (e.g. a pond surrounded by significant wetland area) and, therefore, has a higher tolerance for nitrogen inputs. Coastal salt marsh ecosystems intercept watershed derived nitrogen and improve water quality through microbial denitrification.

Coastal communities, including West Tisbury and Chilmark, 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 shell fishing. The continued degradation of this coastal embayment, as described above, will significantly reduce the recreational and commercial value and use of these important environmental resources.

Figure 3: Resident Population for West Tisbury and Chilmark
http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml
<table>
<thead>
<tr>
<th>Waterbody</th>
<th>Dissolved Oxygen</th>
<th>Chlorophyll a</th>
<th>Eelgrass</th>
<th>Infaunal Animals</th>
<th>Overall Health</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper Main Basin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oxygen levels at mouth of Town Cove</td>
<td>moderate chlorophyll-a levels, average 12 ug/L, with periodic blooms to 25 ug/L</td>
<td>Eelgrass beds (1951); now very sparse eelgrass periodically appearing in lowermost main basin (2009), not observed in MEP surveys. Major eelgrass loss, but density of beds unquantified</td>
<td>High numbers of individuals (&gt;1000), moderate-high species numbers (20), low- moderate diversity (2.3) and Evenness (0.54). Dominants include organic and nitrogen enrichment indicators (<em>Streblospio, Mediomastus</em>) comprising ~50% of community, but amphipods &amp; other crustaceans &amp; molluscs, some head down deposit feeders. Sediments have oxidized surface layer and bioturbation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(23% record), with periodic depletions to &lt;2 mg/L; lower basin southeast periodically &lt;4 mg/L and west &gt;6 mg/L 90% of record [MI]</td>
<td>WQMP average ~10 µg/L with blooms to ~30 ug/L [MI-SI]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lower Main Basin</strong></td>
<td></td>
<td>moderate chlorophyll-a levels, average 11 ug/L, with blooms typically 15-20 ug/L</td>
<td>Eelgrass beds (1951); now very sparse eelgrass periodically appearing in lowermost main basin (2009), not observed in MEP surveys. Major eelgrass loss, but density of beds unquantified</td>
<td>High numbers of individuals (&gt;1000), moderate-high species numbers (20), low- moderate diversity (2.3) and Evenness (0.54). Dominants include organic and nitrogen enrichment indicators (<em>Streblospio, Mediomastus</em>) comprising ~50% of community, but amphipods &amp; other crustaceans &amp; molluscs, some head down deposit feeders. Sediments have oxidized surface layer and bioturbation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>south west mooring, oxygen levels generally &gt;6 mg/L (90% of record) and WQMP &gt;6 mg/L; southeast mooring, &gt;5 mg/L, 80% or record, periodic diurnal declines to &lt;3 mg/L [H-MI]</td>
<td>WQMP average ~9 µg/L, with periodic blooms typically 15-20 ug/L [MI]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Town Cove</strong></td>
<td>mid &amp; lower mooring frequently &lt;4 mg/L, (14%–23% of record), &lt;3 mg/L (7%-11%) periodically to 1 mg/L; WQMP periodically &lt;4 mg/L and &lt;3 mg/L (4% of samples). Frequent levels &gt;10 mg/L indicate nitrogen enrichment and eutrophication. Deep basin [SI]</td>
<td>moderate-high chlorophyll-a levels, average 12-15 ug/L, frequently &gt;20 ug/L (11%–22% of record), with blooms &gt;30 ug/L; WQMP average 10-16 ug/L, with periodic blooms &gt;30 ug/L [MI-SI]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pear Tree Cove</strong></td>
<td>WQMP frequently &lt;5 mg/L and periodically &lt;4 mg/L (5% of samples), shallow basin [MI]</td>
<td>moderate chlorophyll-a levels, WQMP average 12 ug/L, with periodic blooms typically 15-20 ug/L [MI]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Great Pond/Black Point Pond System (excerpted Howes et. al. 2013, pg. 145)**

- **Upper Main Basin**: Oxygen levels at mouth of Town Cove frequently >4 mg/L (23% record), with periodic depletions to <2 mg/L; lower basin southeast periodically <4 mg/L and west >6 mg/L 90% of record [MI]. Eelgrass beds (1951); now very sparse eelgrass periodically appearing in lowermost main basin (2009), not observed in MEP surveys. Major eelgrass loss, but density of beds unquantified [MI-SI].
- **Lower Main Basin**: Oxygen levels generally >6 mg/L (90% of record) and WQMP >6 mg/L; southeast mooring, >5 mg/L, 80% or record, periodic diurnal declines to <3 mg/L [H-MI]. Eelgrass beds (1951); now very sparse eelgrass periodically appearing in lowermost main basin (2009), not observed in MEP surveys. Major eelgrass loss, but density of beds unquantified [MI-SI].
- **Town Cove**: Mid & lower mooring frequently <4 mg/L, (14%–23% of record), <3 mg/L (7%-11%) periodically to 1 mg/L; WQMP periodically <4 mg/L and <3 mg/L (4% of samples). Frequent levels >10 mg/L indicate nitrogen enrichment and eutrophication. Deep basin [SI]. Eelgrass beds (1951); now very sparse eelgrass periodically appearing in lowermost main basin (2009), not observed in MEP surveys. Major eelgrass loss, but density of beds unquantified [MI-SI].
- **Pear Tree Cove**: WQMP frequently <5 mg/L and periodically <4 mg/L (5% of samples), shallow basin [MI]. Eelgrass beds (1951); now very sparse eelgrass periodically appearing in lowermost main basin (2009), not observed in MEP surveys. Major eelgrass loss, but density of beds unquantified [MI-SI].
<table>
<thead>
<tr>
<th>Waterbody</th>
<th>Dissolved Oxygen</th>
<th>Chlorophyll (a)</th>
<th>Eelgrass</th>
<th>Infaunal Animals</th>
<th>Overall Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiah Cove</td>
<td>oxygen depletions frequently to &lt;5 mg/L (26% of record), &lt;4 mg/L (11% or record, periodically to 2 mg/L) [MI/SI]</td>
<td>high chlorophyll-a levels, average 27 ug/L, frequently &gt;40 ug/L, with blooms &gt;50 ug/L [SI]</td>
<td>High numbers of individuals (600-2000), moderate species numbers (14-18), low diversity (1.4-2.0) and Evenness (0.35 to 0.52). Dominated by organic and nitrogen enrichment indicators (Streblospio, Mediomastus) comprising &gt;75% of community [MI-SI]</td>
<td>--</td>
<td>no historic eelgrass, assessment based on impairment of benthic communities showing MI-SI as evidenced by moderate number of species, low diversity &amp; Evenness, with clear dominance by 2 organic enrichment tolerant species consistent with periodic oxygen depletion and high phytoplankton biomass. [MI-SI]</td>
</tr>
<tr>
<td>Deep Bottom Cove</td>
<td>oxygen &gt;5 mg/L (88% of record), rarely to &gt;4 mg/L (2% of record and 2% of WQMP samples [H-MI])</td>
<td>moderate-high chlorophyll-a levels, average 19 ug/L, frequently &gt;20 ug/L (38% of record), blooms &gt;30 ug/L; WQMP average ~10 ug/L, with periodic blooms &gt;30 ug/L [MI-SI]</td>
<td>High numbers of individuals (600-2000), moderate species numbers (14-18), low diversity (1.4-2.0) and Evenness (0.35 to 0.52). Dominated by organic and nitrogen enrichment indicators (Streblospio, Mediomastus) comprising &gt;75% of community [MI-SI]</td>
<td>--</td>
<td>no historic eelgrass, assessment based on impairment of benthic communities showing MI-SI as evidenced by moderate number of species, low diversity &amp; Evenness, with clear dominance by 2 organic enrichment tolerant species consistent with periodic oxygen depletion and high phytoplankton biomass. Nitrogen management to restore this key resource should be undertaken [MI-SI]</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>insufficient data for assessment on this Health Indicator</td>
<td>low-moderate chlorophyll-a levels, WQMP average 5 ug/L, with maximum 13 ug/L [H]</td>
<td>High numbers of individuals (&gt;600), moderate numbers of species (15), with high diversity (2.8) and Evenness (&gt;0.7). Benthic community is consistent with high quality habitat in a wetland basin [H]</td>
<td>--</td>
<td>Habitat indicators consistent with an unimpaired wetland influenced basin [H]</td>
</tr>
</tbody>
</table>

**H - Healthy habitat conditions, MI – Moderately Impaired, SI – Significantly Impaired, SD – Severely degraded, “—“ no evidence this basin is supportive of eelgrass**

These terms are more fully described in MEP report “Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators” December 22, 2003.

WQMP – Water Quality Monitoring Program (Martha’s Vineyard Commission, with field support from the Towns of Chilmark and West Tisbury)


**Aerial photographs from 1951, and confirmed by a long time resident, indicate this basin supported eelgrass at one time.**

## Pollutant of Concern, Sources, and Controllability

In the coastal embayments of the towns of Chilmark and West Tisbury, as in most marine and coastal waters, the limiting nutrient is N. Nitrogen concentrations beyond those expected naturally contribute to undesirable conditions including the severe impacts described above, through the promotion of excessive growth of plants and algae, including nuisance vegetation.

The embayments addressed in this TMDL report have had extensive data collected and analyzed through the Massachusetts Estuaries Program (MEP) and with the cooperation and assistance from the towns of...
West Tisbury and Chilmark, the USGS, 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.

Table 3 illustrates the sources of N to the Tisbury Great Pond/Black Point Pond estuarine system. Most of the controllable N affecting these systems originates from on-site subsurface wastewater disposal systems (septic systems).

The level of “controllability” of each source, however, varies widely as shown is Table 3 below. Cost/benefit analyses will have to be conducted on all possible N loading reduction methodologies in order to select the optimal control strategies, priorities and schedules.

**Table 3: Sources of Nitrogen and their Controllability**

<table>
<thead>
<tr>
<th>Nitrogen Source</th>
<th>Degree of Controllability at Local Level</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural fertilizer and animal wastes</td>
<td>Moderate</td>
<td>These nitrogen loadings can be controlled through appropriate agricultural Best Management Practices (BMPs).</td>
</tr>
<tr>
<td>Atmospheric deposition to the estuary surface</td>
<td>Low</td>
<td>It is only through region- and nation-wide air pollution control initiatives that significant reductions are feasible. Local control although helpful is not adequate.</td>
</tr>
<tr>
<td>Atmospheric deposition to natural surfaces (forests, fields, freshwater bodies) in the watershed</td>
<td>Low</td>
<td>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 toward the estuary.</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>Moderate</td>
<td>Lawn and golf course fertilizer and related N loadings can be reduced through BMPs, bylaws and public education.</td>
</tr>
<tr>
<td>Landfill</td>
<td>Moderate</td>
<td>Related N loadings can be controlled through appropriate BMP and management techniques.</td>
</tr>
<tr>
<td>Natural Background</td>
<td>None</td>
<td>Background load if the entire watershed was still forested and contained no anthropogenic sources. It cannot be controlled.</td>
</tr>
<tr>
<td>Septic system</td>
<td>High</td>
<td>Sources of N 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.</td>
</tr>
<tr>
<td>Sediment</td>
<td>Low</td>
<td>N loadings are not feasibly controlled on a large scale by such measures as dredging. However, the concentrations of N in sediments, and thus the loadings from the sediments, will decline over time if sources in the watershed are removed, or reduced to the target levels discussed later in this document. In addition, increased dissolved oxygen will help keep N from fluxing.</td>
</tr>
<tr>
<td>Stormwater runoff from impervious surfaces</td>
<td>Moderate</td>
<td>This nitrogen source can be controlled by BMPs, bylaws and stormwater infrastructure improvements and public education. Stormwater NPDES permit requirements help control stormwater related N loadings in designated communities.</td>
</tr>
</tbody>
</table>
Description of Applicable Water Quality Standards

The Tisbury Great Pond/Black Point Pond estuarine system water quality classification is SA (all surface waters subject to the rise and fall of the tide). The two freshwater waterbodies covered as part of a protective TMDL are considered Class B. Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, aesthetics, and excess plant biomass and nuisance vegetation. The Massachusetts water quality standards (314 CMR 4.0) (MassDEP, 2007) contain descriptions of coastal and marine classes and numeric criteria for dissolved oxygen but have only narrative standards that relate to the other variables, as described in Appendix A.
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 (Environmental Protection Agency, 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 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 harmful or excessive algal blooms;
3) Restore and preserve benthic communities;
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 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 60 embayments thus far throughout Southeastern Massachusetts. In these applications it became clear that the model can be calibrated and validated and has use as a management tool for evaluating watershed N management options.
The Linked Model, when properly calibrated and validated for a given embayment becomes a N management-planning tool as described in the model overview below. The model can assess solutions for the protection or restoration of nutrient-related water quality and allows testing of management scenarios to support cost/benefit evaluations. In addition, once a model is fully functional it can be refined for changes in land-use or embayment characteristics at minimal cost. Also, since the Linked Model uses a holistic approach that incorporates the entire watershed, embayment and tidal source waters, it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. It should be noted that this approach includes high-order, watershed and sub-watershed scale modeling necessary to develop critical nitrogen targets for each major sub-embayment. The models, data and assumptions used in this process are specifically intended for the purposes stated in the MEP Technical Report, upon which this TMDL is based. As such, the Linked Model process does not contain the type of data or level and scale of analysis necessary to predict the fate and transport of nitrogen through groundwater from specific sources. In addition, any determinations related to direct and immediate hydrologic connection to surface waters are beyond the scope of the MEP’s Linked Model process.

The Linked Model provides a quantitative approach for determining an embayment’s (1) N sensitivity, (2) N threshold loading levels (TMDL) and (3) response to changes in loading rate. The approach is fully field validated and unlike many approaches, accounts for nutrient sources, attenuation and recycling and variations in tidal hydrodynamics (Figure I-4 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 Nitrogen Loading**
  - Watershed delineation
  - Stream flow (Q) and N load
  - Land-use analysis (GIS)
  - Watershed N model

- **Embayment TMDL – Synthesis**
  - Linked Watershed-Embayment Nitrogen 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 N loading rates, includes:

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

2) Using site-specific information and a minimum of three years of sub-embayment-specific data to select target threshold N concentrations for each sub-embayment. This is done by refining the draft target threshold N concentrations that were developed as the initial step of the MEP process. The target threshold N concentrations that were selected generally occur in higher quality waters near the mouth of the embayment system;

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

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

- The present N concentrations in the sub-embayments
- Site-specific target threshold N concentrations

And, two outputs are related to N loadings:

- The present N loads to the sub-embayments
- Load reductions necessary to meet the site specific target N concentrations

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

A brief overview of each of the outputs follows:

Nitrogen concentrations in the embayment

a) Observed “present” conditions:

Table 4 presents the average concentrations of N measured in this estuarine system from ten years of data collection by the Martha’s Vineyard Commission, towns of Chilmark and West Tisbury, and SMAXT (1995-2010 and 2011). The overall means and standard deviations of the
averages are presented in Appendix B (taken from Table VI-1 of the MEP Technical Report). Water quality sampling stations are shown in Figure 5 below.

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 target threshold N concentrations by using the specific physical, chemical and biological characteristics of each harbor embayment system.

Table 4: Present Nitrogen Concentrations (Select Stations) and Sentinel Station Target Threshold Nitrogen Concentrations for the Tisbury Great Pond/Black Point Pond Estuarine System

<table>
<thead>
<tr>
<th>Sub-embayment</th>
<th>Station</th>
<th>Mean Observed Nitrogen Concentration(^1) (mg/L)</th>
<th>Target Threshold Nitrogen Concentration(^4) (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Bottom Cove</td>
<td>TGP-6</td>
<td>0.54</td>
<td>0.48 (^2)</td>
</tr>
<tr>
<td>Tiah Cove</td>
<td>TGP-5</td>
<td>0.42</td>
<td>0.48 (^2)</td>
</tr>
<tr>
<td>Town Cove Upper</td>
<td>TGP-1</td>
<td>0.64</td>
<td>--</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td>TGP-3</td>
<td>0.49</td>
<td>--</td>
</tr>
<tr>
<td>Town Cove Mid</td>
<td>TGP-4</td>
<td>0.53</td>
<td>0.48 (^2)</td>
</tr>
<tr>
<td>Tisbury GP lower main basin</td>
<td>TGP-7</td>
<td>0.51</td>
<td>0.46 (^3)</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>TGP-8(^5)</td>
<td>0.43</td>
<td>--</td>
</tr>
<tr>
<td><strong>Tisbury GP System Total</strong></td>
<td></td>
<td><strong>0.42 – 0.64</strong></td>
<td><strong>0.46 – 0.48</strong></td>
</tr>
</tbody>
</table>

\(^1\) Average total N concentrations from present loading based on an average of the annual N means from 1995-2010 and 2011
\(^2\) Secondary target threshold N concentrations at Tisbury Great Pond tributary coves stations TGP-4, TGP-5 and TGP-6
\(^3\) Primary target threshold N concentration for Tisbury Great Pond main basin, TGP-7.
\(^4\) Target concentrations through summer months, to be achieved by load reduction and successful breaching of the inlet in late spring and mid-summer.
\(^5\) TGP-8 is located at the outlet of Crab Creek to the main harbor.

The target threshold nitrogen concentrations for the sub-embayments listed in Table 4 were determined as follows:

The approach for determining nitrogen loading rates, which will maintain acceptable habitat quality throughout an embayment system, is to first identify a sentinel location within the embayment and second to determine the nitrogen concentration within the water column which
will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target threshold nitrogen concentration are determined, the MEP study modeled nitrogen loads until the targeted nitrogen concentration was achieved. In the case of Tisbury Great Pond, there are four sentinel stations distributed throughout the system.

The determination of the critical nitrogen threshold for maintaining high habitat within the Tisbury Great Pond/Black Point Pond estuarine system is based on the nutrient and oxygen levels, temporal trends in eelgrass distribution and benthic community indicators. The threshold analysis focused on the goal of restoring or maintaining SA waters of high habitat quality possibly supportive of eelgrass and diverse benthic animal communities. At the present moderate levels of watershed nitrogen loading with only periodic tidal exchange, the level of nitrogen enrichment has resulted in a condition no longer supportive of eelgrass (high chlorophyll $a$, oxygen depletion and high turbidity) and the infaunal survey indicated that most sub-basins are presently beyond their ability to tolerate additional nitrogen inputs without additional impairment.
The findings of the analytical and modeling investigations for these embayment systems are discussed and explained below.

The target threshold N concentration for an embayment represents the average water column concentration of N that will support the habitat quality and dissolved oxygen concentrations 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), dilution, and flushing via tidal flows. The water column N concentration is modified by the extent of sediment uptake and/or regeneration and by direct atmospheric deposition.
Eelgrass has not generally existed in Tisbury Great Pond throughout the past several decades. There is evidence of historical distribution as shown in a 1951 photo interpretation and supported by reports from local residents. At present eelgrass cannot be supported given the measured levels of nitrogen enrichment and resulting high chlorophyll-\(a\) and low dissolved oxygen. Based on this, habitat restoration in this nutrient enriched system should focus on improving eelgrass habitat within the lower main basin, as well as restoration of infaunal habitat quality, pond-wide.

Target threshold N concentrations in this study were developed to restore or maintain SA waters or high habitat quality. To restore a modest level of eelgrass habitat (consistent with the uncertainties in the historic distribution record) the target time-averaged TN concentrations in the main basin of Tisbury Great Pond, at sentinel station TGP-7, is 0.46 mg/L TN. This nitrogen level is predicted to be supportive of sparse eelgrass in the shallow margins of the main basin. This concentration is consistent with other estuaries with eelgrass restricted to shallow water areas. To achieve the restoration of benthic habitat in the Tisbury Great Pond/Black Point Pond estuarine system the average TN level is set at 0.48 mg/L at stations TGP-4, TGP-5 and TGP-6. These distributed locations for the target threshold stations are due to the variability within each tributary cove and the non-tidal nature of this system.

Black Point Pond differs from Tisbury Great Pond and its’ tributary coves. It functions as a shallow pond surrounded by wetlands and is connected to the main pond through Crab Creek, a small restricted connection to the main basin. As a wetland influenced salt pond, it supports relatively high quality benthic animal habitat. There is no evidence Black Point Pond ever supported eelgrass habitat. Setting the TN level at 0.46 mg/L at TGP-7 will be protective of Black Point Pond and its high quality benthic habitat.

**Nitrogen loadings to the embayment**

a) Present Loading rates:

The MEP Technical Report (Figure 4) calculated that agriculture and wastewater loads represent the largest controllable watershed contribution of N loading to Tisbury Great Pond/Black Point Pond estuarine system at 44% and 40%, respectively. Other sources calculated for controllable loads include fertilizers (8%), runoff from impervious surfaces (7%) and the landfill (1%). The MEP study determined that sediments contributed approximately 9.6 kg/day-N to the Tisbury Great Pond main basin. Atmospheric nitrogen deposition to the estuary and watershed surface area was found to be significant (21% of the overall load). Sediment flux and atmospheric deposition are not considered controllable sources of N.

A subwatershed breakdown of N loading, by source, is presented in Table 5. The data on which Table 5 is based can be found in Table ES-1 and Table IV-2 of the MEP Technical Report.
### Table 5: Present Attenuated Nitrogen Loadings to the Tisbury Great Pond/Black Point Pond Estuarine System

<table>
<thead>
<tr>
<th>Sub-embayment</th>
<th>Present Land Use Load(^1) (kg N/day)</th>
<th>Present Septic System Load (kg N/day)</th>
<th>Present Watershed Load(^2) (kg N/day)</th>
<th>Present Atmospheric Deposition(^3) (kg N/day)</th>
<th>Present Sediment Flux(^4) (kg N/day)</th>
<th>Total Nitrogen Load from All Sources(^5) (kg N/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Bottom Cove</td>
<td>1.57</td>
<td>1.23</td>
<td>2.80</td>
<td>1.51</td>
<td>0.55</td>
<td>4.86</td>
</tr>
<tr>
<td>Tiahs Cove</td>
<td>1.11</td>
<td>1.14</td>
<td>2.25</td>
<td>0.78</td>
<td>-1.34</td>
<td>3.03</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td>2.14</td>
<td>1.70</td>
<td>3.84</td>
<td>0.26</td>
<td>0.01</td>
<td>4.10</td>
</tr>
<tr>
<td>Tisbury GP main basin</td>
<td>15.69</td>
<td>6.41</td>
<td>22.10</td>
<td>7.83</td>
<td>9.59</td>
<td>39.52</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>0.35</td>
<td>0.45</td>
<td>0.80</td>
<td>0.93</td>
<td>6.17</td>
<td>7.90</td>
</tr>
<tr>
<td>Mill Brook</td>
<td>6.34</td>
<td>2.30</td>
<td>8.64</td>
<td>-</td>
<td>-</td>
<td>8.64</td>
</tr>
<tr>
<td>Tiasquam River</td>
<td>2.64</td>
<td>2.92</td>
<td>5.56</td>
<td>-</td>
<td>-</td>
<td>5.56</td>
</tr>
<tr>
<td>System Total</td>
<td>29.84</td>
<td>16.15</td>
<td>45.98</td>
<td>11.30</td>
<td>14.98</td>
<td>72.26</td>
</tr>
</tbody>
</table>

1 Composed of fertilizer, agriculture, runoff, landfills, and atmospheric deposition to lakes and natural surfaces.
2 Composed of fertilizer, agriculture, runoff, landfills, atmospheric deposition to lakes and natural surfaces, and septic inputs.
3 Atmospheric deposition to the estuarine surface only.
4 Nitrogen loading from estuarine sediments.
5 Total of fertilizer, agriculture, runoff, landfills, atmospheric deposition, septic inputs, and sediment nitrogen input.

As previously indicated, the present N loadings to these embayment systems must be reduced in order to restore the impaired 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 that will achieve the target threshold N concentrations.

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

Table 6 lists the present watershed N loadings from the Tisbury Great Pond/Black Point Pond estuarine system and the percent watershed load reductions necessary to achieve the target threshold N concentration at the sentinel stations (see following section).

It is very important to note that load reductions can be produced through a variety of strategies: reduction of any or all sources of N; increasing the natural attenuation of N within the freshwater systems; and/or modifying the tidal flushing through inlet reconfiguration (where appropriate). This scenario establishes the general degree and spatial pattern of reduction that will be required for restoration of the N impaired portions of this system. The towns of West Tisbury and Chilmark should take any reasonable action to reduce the controllable N sources.
Table 6: 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*

<table>
<thead>
<tr>
<th>Sub-embayment System</th>
<th>Present Total Watershed Load(^1) (kg/day)</th>
<th>Target Watershed Load(^2) (kg/day)</th>
<th>Percent Watershed Load Reductions Needed to Achieve Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Bottom Cove</td>
<td>2.80</td>
<td>2.80</td>
<td>0.0%</td>
</tr>
<tr>
<td>Tiah Cove</td>
<td>2.25</td>
<td>2.25</td>
<td>0.0%</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td>3.84</td>
<td>3.84</td>
<td>0.0%</td>
</tr>
<tr>
<td>Tisbury GP main basin</td>
<td>22.10</td>
<td>16.97</td>
<td>23.2%</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>0.80</td>
<td>0.80</td>
<td>0.0%</td>
</tr>
<tr>
<td>Town Cove – Mill Brook</td>
<td>8.64</td>
<td>7.03</td>
<td>18.6%</td>
</tr>
<tr>
<td>Town Cove – Tiasquam River</td>
<td>5.56</td>
<td>3.51</td>
<td>36.8%</td>
</tr>
<tr>
<td>Total system</td>
<td>45.98</td>
<td>37.20</td>
<td>19.1%</td>
</tr>
</tbody>
</table>

1 Composed of natural background, septic, fertilizer, agriculture, landfill and runoff loadings.
2 Target threshold watershed load is the N load from the watershed (including natural background) needed to meet the target threshold N concentrations identified in Table 4, above.
* From Tables ES-2 and VIII-3 in the MEP Technical Report with corrected % reductions.

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 TMDLs for the Tisbury Great Pond/Black Point Pond estuarine system are aimed at establishing the loads that would correspond to specific N concentrations determined to be protective of the water quality and ecosystems.

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

The TMDL can generally 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 or presented separately. It is a component of the target watershed threshold. 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 TMDL 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. In the Tisbury Great Pond/Black Point Pond estuarine system there are no NPDES regulated point source discharges in the watershed. EPA interprets 40 CFR 130.2(h) to require that allocations for NPDES regulated discharges of storm water also be included in the waste load component of the TMDL. It should be noted that no part of the towns of West Tisbury and Chilmark are designated as an urbanized area by EPA and thus are not required to obtain coverage under the NPDES Phase II General Permit for Storm-water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) that took effect March 31, 2017. Subsequently, in the Tisbury Great Pond/Black Point Pond estuarine system watershed there are no Phase II NPDES permitted stormwater discharges.

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.

Since the majority of the nitrogen loading comes from septic systems and agriculture, and to a lesser extent fertilizer, the landfill and storm-water runoff that infiltrates into the groundwater, the allocation of nitrogen for any storm-water pipes that discharge directly to any of the embayments is expected to be insignificant as compared to the overall groundwater load. 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.

Although the vast majority of storm water percolates into the ground and proceeds into the embayments through groundwater migration on the island, an estimated waste load was based on an assumption that runoff from all impervious surfaces within 200 feet of the shoreline discharges directly to the waterbodies. The calculated waste load allocation due to runoff from impervious surfaces within 200 feet of the estuary is 0.21 kg/day, or 0.36%, of the total unattenuated watershed load. (Refer to Appendix C for details.) This conservative load is obviously negligible 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 Tisbury Great Pond/Black Point Pond estuarine system the locally controllable nonpoint source loadings are from agriculture and on-site subsurface wastewater disposal systems (septic systems) and, to a lesser extent, the landfill and fertilizers (which include storm-water runoff, except from impervious cover within 200 feet of the waterbody which is defined above as part of the waste load). Figure 4 (above) and Figure 6 (below) illustrate that septic systems and agriculture are the most significant portion of the controllable N load (16.58 kg N/day and 17.83, respectively). Fertilizers and runoff combined, contribute 6.1kg N/day and a relatively small contribution from the landfill (0.28 kg N/day). (N loadings, in kg/day, are from Table IV-2 in the MEP Technical Report). In addition, there are nonpoint sources of N from sediments, natural background and atmospheric deposition that cannot be feasibly controlled.

Chilmark and West Tisbury are not subject to the EPA Phase II Program. Storm-water that is subject to the EPA Phase II Program is considered a part of the waste load allocation, rather than the load allocation (see waste load allocation discussion). As discussed above and presented in Chapter IV, V, and VI, of the MEP Technical Report, on Cape Cod and the Islands, the vast majority of storm-water percolates into the aquifer and enters the embayment system through groundwater, thus defining the stormwater in pervious areas to be a component of the nonpoint source load allocation. Therefore, the TMDL accounts for storm-water and groundwater loadings in one aggregate allocation as a non-point source, thus combining the assessments of wastewater and storm-water for the purpose of developing control strategies. A portion of the storm-water load may be controllable through implementation of Best Management Practices (BMPs).

The sediment loading rates incorporated into the TMDL are lower than the existing benthic input listed in Table 5 above because projected reductions of N loadings from the watershed will result in reductions of nutrient concentrations in the sediments and therefore, over time, reductions in loadings from the sediments will occur. Benthic flux of nitrogen from bottom sediments is a critical (but often overlooked) component of nitrogen loading to the shallow estuarine systems, therefore determination of the site specific magnitude of this component was also performed (see Section VI of the MEP Report). 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:

\[ D_{PON} = (PON_{present \ embayment} - PON_{present \ offshore}) \]

The benthic flux modeled for the Tisbury Great Pond/Black Point Pond estuarine system is reduced from existing conditions based on the load reduction and the observed PON concentrations within each sub-embayment relative to the Atlantic Ocean (boundary condition). The benthic flux input to each sub-embayment was reduced (toward zero) based on the reduction of N in the watershed load. The loadings from atmospheric sources incorporated into the TMDL however, are the same rates presently occurring because, as discussed above, local control of atmospheric loadings is not considered feasible.

**Figure 6: Tisbury Great Pond/Black Point Pond Estuarine System Locally Controllable N Sources (Unattenuated N)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Unattenuated N (kg N/day)</th>
<th>WLA</th>
<th>LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>18.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater</td>
<td>16.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizers</td>
<td>4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stormwater</td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landfill</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Margin of Safety

Statutes and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and waste load allocations and water quality [CWA para 303 (d)(20(c), 40C.G.R. para 130.7(c)(1)]. The MOS must be designed to ensure that any uncertainties in the data or calculations used to link pollutant sources to water quality impairment modeling will be accounted for in the TMDL and ensure protection of the beneficial uses. 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 Tisbury Great Pond/Black Point Pond estuarine system TMDL is implicit and the conservative assumptions in the analyses that account for the MOS are described below.

An explicit MOS quantifies an allocation amount separate from other Load and Wasteload Allocations. An explicit MOS can incorporate reserve capacity for future unknowns, such as population growth or effects of climate change on water quality. An implicit MOS is not specifically quantified but consists of statements of the conservative assumptions used in the analysis. The MOS for Tisbury Great Pond Embayment System TMDLs is implicit. MassDEP used conservative assumptions to develop numeric model applications that account for the MOS. These assumptions are described below, and they account for all sources of uncertainty, including the potential impacts of changes in climate.

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

Conservative assumptions that support an implicit MOS:

7. Use of conservative data in the linked model

The watershed N model provides conservative estimates of N loads to the embayment. Nitrogen transfer through direct groundwater discharge to estuarine waters is based upon studies indicating negligible aquifer attenuation and dilution, i.e. 100% of load enters embayment. This is a conservative estimate of loading because studies have also shown that in some areas less than 100% of the load enters the estuary. In this context, “direct groundwater discharge” refers to the portion of fresh water that enters an estuary as groundwater seepage into the estuary itself, as
opposed to the portion of fresh water that enters as surface water inflow from streams, which receive much of their water from groundwater flow. Nitrogen from the upper watershed regions, which travels through ponds or wetlands, almost always enters the embayment via stream flow, and is directly measured (over 12-16 months) to determine attenuation. In these cases the land-use model has shown a slightly higher predicted N load than the measured discharges in the streams/rivers that have been assessed to date. Therefore, the watershed model as applied to the surface water watershed areas again presents a conservative estimate of N loads because the actual measured N in streams was lower than the modeled concentrations.

The hydrodynamic and water quality models have been assessed directly. In the many instances where the hydrodynamic model predictions of volumetric exchange (flushing) have also been directly measured by field measurements of instantaneous discharge, the agreement between modeled and observed values was 95%. 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 N attenuation by freshwater ponds, attenuation was derived from measured N concentrations, pond watershed delineations and pond bathymetry. Mill Pond is the only major freshwater pond in the Tisbury Great Pond watershed with a delineated watershed. Due to its shallow bathymetry and short residence time (0.2-1.0 days) a conservative N attenuation rate of 5% was assigned to the Mill Brook, the outflow from the Mill Pond. Mill Pond is the terminal pond along Mill Brook and therefore integrates the attenuation of TN from each of the ponds and impoundments on Mill Brook. Similarly, the Tiasquam River is the stream outflow from Looks Pond. Measured N at the gage indicates only a 5% N attenuation.

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 in benthic regeneration of N 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. It was also conservatively assumed that the present negative benthic flux uptake measured in the Tisbury Great Pond System (Tiah Cove, -1.34 kg/day-N) does not exist under future loading conditions and such was designated as “0” for purposes of the TMDL.

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 stations and target threshold N concentrations. The sites were 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 concentrations at the sentinel stations will result in reductions of N concentrations in the rest of the system.

3. Conservative approach

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 and therefore this approach is conservative.

Finally, the linked model accounted for all stormwater loadings and groundwater loadings in one aggregate allocation as a nonpoint source and this aggregate load is accounted for in the load allocation. The method of calculating the WLA in the TMDL for regulated stormwater was conservative as it did not disaggregate this negligible load from the modeled stormwater LA, hence this approach further enhances the margin of safety.

In addition to the margin of safety within the context of setting the N threshold levels as described above, a programmatic margin of safety also derives from continued monitoring of these embayments 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 controls necessary to control the N load, the nutrient of primary concern, by their very nature do not lend themselves to intra-annual manipulation since the majority of the N is from non-point sources. Thus, the annual loads make sense 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 Tisbury Great Pond/Black Point Pond Estuarine System

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

In this table the N loadings from the atmosphere are listed separately from the target watershed threshold loads which are composed of natural background N along with locally controllable N from the on-site subsurface wastewater disposal systems, agriculture, fertilizer sources, stormwater runoff and the landfill. In the case of the Tisbury Great Pond/Black Point Pond estuarine system the TMDLs were calculated by projecting reductions in locally controllable septic systems in the Mill Brook and Tiasquam River subwatersheds. Once again the goals of these TMDLs are to achieve the identified target threshold N concentration at the identified sentinel stations.

Table 7: The Total Maximum Daily Loads (TMDL) for the Tisbury Great Pond/Black Point Pond Estuarine System. Represented as the Sum of the Calculated Target Threshold Loads, Atmospheric Deposition and Sediment Load

<table>
<thead>
<tr>
<th>System Component</th>
<th>Target Threshold Watershed Load¹ (kg N/day)</th>
<th>Atmospheric Deposition (kg N/day)</th>
<th>Load from Sediments² (kg N/day)</th>
<th>TMDL³ (kg N/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Bottom Cove</td>
<td>2.8</td>
<td>1.51</td>
<td>0.55</td>
<td>4.86</td>
</tr>
<tr>
<td>Tiah Cove</td>
<td>2.25</td>
<td>0.78</td>
<td>0</td>
<td>3.03</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td>3.84</td>
<td>0.26</td>
<td>0.01</td>
<td>4.1</td>
</tr>
<tr>
<td>Tisbury Great Pond-main basin</td>
<td>16.97</td>
<td>7.83</td>
<td>8.9</td>
<td>33.7</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>0.8</td>
<td>0.94</td>
<td>6.17</td>
<td>7.9</td>
</tr>
<tr>
<td>Mill Brook</td>
<td>7.03</td>
<td>-</td>
<td>-</td>
<td>7.03</td>
</tr>
<tr>
<td>Tiasquam River</td>
<td>3.51</td>
<td>-</td>
<td>-</td>
<td>3.51</td>
</tr>
<tr>
<td>System Total</td>
<td>37.2</td>
<td>11.3</td>
<td>15.63</td>
<td>64.12</td>
</tr>
</tbody>
</table>

¹ Target threshold watershed load (including natural background) is the load from the watershed needed to meet the target threshold nitrogen concentrations for the embayment, identified in Table 4.
² Projected sediment N loadings obtained by reducing the present sediment flux loading rates (Table 5) proportional to proposed watershed load reductions and factoring in the existing and projected future concentrations of PON. (Negative fluxes set to zero.)
³ Sum of target threshold watershed load, atmospheric deposition, and sediment load.

The target loads identified in this table represent one alternative-loading scenario to achieve that goal but other scenarios may be possible and approvable as well.
Implementation Plans

The critical element of this TMDL process is achieving the sentinel station specific target threshold N concentrations presented in Table 4, above, that are necessary for the restoration and protection of water quality and eelgrass/infaunal habitat within the Tisbury Great Pond/Black Point Pond estuarine system. In order to achieve these target threshold N concentrations, N loading rates must be reduced throughout the embayment system. Additionally, the MEP recommends adding a seventeen day plus (17 day +) late summer breach for Tisbury Great Pond to further reduce the buildup in nitrogen levels at a critical habitat stressor time.

Agricultural load contributes the largest controllable N load (44%) to this system therefore it is recommended that the watershed communities also implement agricultural BMPs throughout the watershed with a goal of reducing N contribution from agricultural sources by 10% watershed-wide. By reducing the agricultural N load by just 10%, the need for sewering could be reduced in some areas. The towns of West Tisbury and Chilmark should consider requesting an additional model run from SMAST that evaluates a scenario that includes recommendations for reductions in agriculture N loads, as well as, septic loads from the various subembayments. This will help focus agricultural BMP implementation activities to areas that will most effectively reduce N loads and perhaps reduce the need for sewering. In particular, reductions in N use on agricultural land located immediately adjacent to Town Cove, Pear Tree Cove and Tiah Cove would provide improvements to water quality. Massachusetts Department of Agricultural Resources, Plant Nutrient Application Requirements, 330 CMR 31.00, became effective December 2015. These regulations require basic plant nutrient applications for 10 or more acres and adherence to application and seasonal restrictions.

Septic system loads from private residences is the second largest contributor to the controllable N load (40%), therefore as part of the Comprehensive Water Resources Management Plan (CWRMP) the town should assess the most cost-effective options for achieving the target 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.

Breaching the barrier beach. Current management of Tisbury Great Pond involves excavation of a trench through the barrier beach roughly every 3 months to allow tidal exchange with the Atlantic Ocean. Pond water levels must be at least one meter above mean sea level before a breach is attempted in order to have sufficient head to erode a channel to the sea. Breaching of the pond is undertaken mainly as a means of controlling salinity levels in the pond and as a flood control measure to maintain groundwater levels low enough to prevent flooding of basements of the homes bordering the pond. Records kept between 1993 and 2011 indicate the breach is typically opened three times each year with an average cumulative total of 144 days open per year. The average duration of all openings in the record was 42 days.

The riparian Owners of Tisbury Great Pond Association, coordinate and manage the breaching of pond. A number of considerations are taken into account; pond water level, fish spawning, salinity, nitrogen, turbidity, tidal cycles, shoaling, weather and nesting shore birds. Typically an
the trench is excavated through the barrier beach every 3 months to allow tidal exchange with the Atlantic Ocean.

One recommended alternative to evaluate for management of low to moderate nutrient impairment of Black Point Pond, is to reduce the restriction in the channel connecting it to Tisbury Great Pond. Reducing the restriction will increase tidal exchange when Tisbury Great Pond is open to the low N waters of the Atlantic Ocean.

Table 8 presents a load reducing scenario to achieve the target threshold N concentration based on reducing the septic loads from three of the subwatersheds and includes a late spring and a mid-summer breach which remains open for 17 days. The modeling assumed that the breach openings allowed the pond-averaged TN concentrations to lower to 0.30 mg/L. The model also assumed that the breach closed for 60 days between breaches to allow the water level in the pond to rise sufficiently to allow flow through after the next breach.

Table 8: Summary of the Present Septic System Loads and the Loading Reductions Necessary to Achieve the TMDL by Reducing Septic System Loads and Breaching the Inlet

<table>
<thead>
<tr>
<th>System Component</th>
<th>Present Septic N Load (kg N/day)</th>
<th>Threshold Septic load (kg N/day)</th>
<th>Threshold Septic Load % Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Bottom Cove</td>
<td>1.23</td>
<td>1.23</td>
<td>0.0%</td>
</tr>
<tr>
<td>Tiah Cove</td>
<td>1.14</td>
<td>1.14</td>
<td>0.0%</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td>1.70</td>
<td>1.70</td>
<td>0.0%</td>
</tr>
<tr>
<td>Tisbury GP main basin</td>
<td>6.41</td>
<td>1.28</td>
<td>-80.0%</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>0.45</td>
<td>0.45</td>
<td>0.0%</td>
</tr>
<tr>
<td>Town Cove – Mill Brook</td>
<td>2.30</td>
<td>0.69</td>
<td>-70.0%</td>
</tr>
<tr>
<td>Town Cove – Tiasquam River</td>
<td>2.92</td>
<td>0.88</td>
<td>-70.0%</td>
</tr>
<tr>
<td>Total system</td>
<td>16.15</td>
<td>7.36</td>
<td>-54.4%</td>
</tr>
</tbody>
</table>

From Table VIII-2, Howes et al, 2013.

As previously noted, there is a variety of loading reduction scenarios that could achieve the target threshold N concentrations. Local officials can explore other loading reduction scenarios through additional modeling as part of their CWRMP. It must be demonstrated however, that any alternative implementation strategies will be protective of the entire embayment system. To this end, additional linked model runs can be performed by the MEP at a nominal cost to assist the planning efforts of the town in achieving target N loads that will result in the desired target threshold N concentration. The CWRMP 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 CWRMP it must demonstrate that these measures will achieve the target threshold N concentration. (Note: Communities that choose to proceed without a CWRMP will not be eligible for State Revolving Fund 0% loans.)
Climate Change:
MassDEP recognizes that long-term (25+ years) climate change impacts to southeastern Massachusetts, including the area of this TMDL, are possible based on known science. Massachusetts Executive Office of Energy and Environmental Affairs 2011 Climate Change Adaptation Report: http://www.mass.gov/eea/waste-mgmt-recycling/air-quality/green-house-gas-and-climate-change/climate-change-adaptation/climate-change-adaptation-report.html predicts that by 2100 the sea level could be from 1 to 6 feet higher than the current position and precipitation rates in the Northeast could increase by as much as 20 percent. However, the details of how climate change will affect sea level rise, precipitation, streamflow, sediment and nutrient loading in specific locations are generally unknown. The ongoing debate is not about whether climate change will occur, but the rate at and the extent to which it will occur and the adjustments needed to address its impacts. EPA’s 2012 Climate Change Strategy http://water.epa.gov/scitech/climatechange/upload/epa_2012_climate_water_strategy_full_report_final.pdf states: “Despite increasing understanding of climate change, there still remain questions about the scope and timing of climate change impacts, especially at the local scale where most water-related decisions are made.” For estuarine TMDLs in southeastern Massachusetts, MassDEP recognizes that this is particularly true, where water quality management decisions and implementation actions are generally made and conducted at the municipal level on a sub-watershed scale.

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

In 2013, EPA released a study entitled, “Watershed modeling to assess the sensitivity of streamflow, nutrient, and sediment loads to potential climate change and urban development in 20 U.S. watersheds.” (National Center for Environmental Assessment, Washington D.C.; EPA/600/R-12/058F). The closest watershed to southeastern Massachusetts that was examined in this study is a New England coastal basin located between Southern Maine and Central Coastal Massachusetts. These watersheds do not encompass any of the watersheds in the Massachusetts Estuary Project (MEP) region, and it has vastly different watershed characteristics, including soils, geography, hydrology, and land use – key components used in a modeling analysis. The initial “first order” conclusion of this study is that, in many locations, future conditions, including water quality, are likely to be different from past experience. However, most significantly, this study did not demonstrate that changes to TMDLs (the water quality restoration targets) would be necessary for the region. EPA’s 2012 Climate Change Strategy also acknowledges that the Northeast, including New England, needs to develop standardized regional assumptions regarding future climate change impacts. EPA’s 2013 modeling study does not provide the scientific methods and robust datasets needed to predict specific long-term climate change impacts in the MEP region to inform TMDL development.

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

As more information and tools become available, there may be opportunities to make adjustments in TMDLs in the future to address predictable climate change impacts. When the science can support assumptions about the effects of climate change on the nitrogen loadings to the Tisbury Great Pond/Black Point Pond Estuarine System the TMDL can be reopened, if warranted.

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

Based on land-use and the fact that the watershed of this system is located completely within the towns of Chilmark and West Tisbury it follows that nitrogen management necessary for the restoration of the Tisbury Great Pond System may be formulated and implemented entirely through the two towns.

MassDEP’s MEP Implementation Guidance report: [http://www.mass.gov/dep/water/resources/coastalr.htm#guidance](http://www.mass.gov/dep/water/resources/coastalr.htm#guidance) provides N loading reduction strategies that are available to Chilmark and West Tisbury and 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
- Storm-water Control and Treatment *
  - Source Control and Pollution Prevention
  - Storm-water Treatment
- Attenuation via Wetlands and Ponds
- Water Conservation and Water Reuse
- Management Districts
- Land Use Planning and Controls
  - Smart Growth
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 CWRMP plan and 2) monitoring water quality and habitat conditions in the estuaries, including but not limited to, the sentinel stations identified in the MEP Technical Report.

The CWRMP will evaluate various options to achieve the goals set out in the TMDL report and the MEP 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. Through the adaptive management approach ongoing monitoring will be conducted and will indicate if water quality standards are being met. If this does not occur other management activities would have to be identified and considered to reach the goals outlined in this 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 values are not fixed, the target threshold N concentrations at the sentinel stations are fixed. 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 believes 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 watershed communities 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. 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, agriculture, the landfill, storm-water 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. Storm-water NPDES permit coverage will address discharges from municipally owned storm-water drainage systems (where applicable). 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). West Tisbury adopted a Wetlands Bylaw in 2006 which includes a 100 foot setback for septic system leach fields near salt ponds.

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 the 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 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 these TMDLs the loading values (kg/day of N) will be used by MassDEP for guidance for permitting activities and should be used by the communities as a management tool.

Public Participation

To be completed after the public review process:
References


MassDEP (2007). Massachusetts Surface Water Quality Standards (314 CMR 4.00). Massachusetts Department of Environmental Protection, 1 Winter Street, Boston, MA.

Appendix A: Overview of Applicable Water Quality Standards

Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, bottom pollutants or alterations, aesthetics, excess plant biomass, and nuisance vegetation. The Massachusetts water quality standards (314 CMR 4.0) contain numeric criteria for dissolved oxygen, but have only narrative standards that relate to the other variables. This brief summary does not supersede or replace 314 CMR 4.0 Massachusetts Water Quality Standards, the official and legal standards. A complete version of 314 CMR 4.0 Massachusetts Water Quality Standards is available online at http://www.mass.gov/eea/agencies/massdep/water/regulations/314-cmr-4-00-mass-surface-water-quality-standards.html

**Applicable Narrative Standards**

314 CMR 4.05(5)(a) states “Aesthetics – All surface waters shall be free from pollutants in concentrations 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)© 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 by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.”

**Description of Coastal and Marine Classes and Numeric Dissolved Oxygen Standards**

*Excerpt from 314 CMR 4.05(4) (a):*

(4) **Class SA.** These waters are designated as an excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting without depuration (Approved and Conditionally Approved Shellfish Areas). These waters shall have excellent aesthetic value.
1. **Dissolved Oxygen.** Shall not be less than 6.0 mg/l. Where natural background conditions are lower, DO shall not be less than natural background. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

*Excerpt from 314 CMR 4.05(4) (b):*

(b) **Class SB.** These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas). These waters shall have consistently good aesthetic value.

1. **Dissolved Oxygen.** Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.

*Excerpt from 314 CMR 4.05(3) (b):*

(b) **Class B.** These waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment (“Treated Water Supply”). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.

1. **Dissolved Oxygen.** Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

**Waterbodies Not Specifically Designated in 314 CMR 4.06 or the tables to 314 CMR 4.00**

Note many waterbodies do not have a specific water quality designation in 314 CMR 4.06 or the tables to 314 CMR 4.00. Coastal and Marine Classes of water are designated as Class SA and presumed High Quality Waters as described in 314 CMR 4.06 (4).

*314 CMR 4.06(4):*

(4) **Other Waters.** Unless otherwise designated in 314 CMR 4.06 or unless otherwise listed in the tables to 314 CMR 4.00, other waters are Class B, and presumed High Quality Waters for inland waters and Class SA, and presumed High Quality Waters for coastal and marine waters. Inland fisheries designations and coastal and marine shellfishing designations for unlisted waters shall be made on a case-by-case basis as necessary.
**Applicable Antidegradation Provisions**
Applicable antidegradation provisions are detailed in 314 CMR 4.04 from which an excerpt is provided:

*Excerpt from 314 CMR 4.04:*


(4) **Protection of Existing Uses.** In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(2) **Protection of High Quality Waters.** High Quality waters are waters whose quality exceeds minimum levels necessary to support the national goal uses, low flow waters, and other waters whose character cannot be adequately described or protected by traditional criteria. These waters shall be protected and maintained for their existing level of quality unless limited degradation by a new or increased discharge is authorized by the Department pursuant to 314 CMR 4.04(5). Limited degradation also may be allowed by the Department where it determines that a new or increased discharge is insignificant because it does not have the potential to impair any existing or designated water use and does not have the potential to cause any significant lowering of water quality.

(3) **Protection of Outstanding Resource Waters.** Certain waters are designated for protection under this provision in 314 CMR 4.06. These waters include Class A Public Water Supplies (314 CMR 4.06(1)(d)1.) and their tributaries, certain wetlands as specified in 314 CMR 4.06(2) and other waters as determined by the Department based on their outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these waters shall be protected and maintained.

(a) Any person having an existing discharge to these waters shall cease said discharge and connect to a Publicly Owned Treatment Works (POTW) unless it is shown by said person that such a connection is not reasonably available or feasible. Existing discharges not connected to a POTW shall be provided with the highest and best practical method of waste treatment determined by the Department as necessary to protect and maintain the outstanding resource water.

(b) A new or increased discharge to an Outstanding Resource Water is prohibited unless: the discharge is determined by the Department to be for the express purpose and intent of maintaining or enhancing the resource for its designated use and an authorization is granted as provided in 314 CMR 4.04(5). The Department’s determination to allow a new or increased discharge shall be made in agreement with the federal, state, local or private entity recognized by the Department as having direct control of the water resource or governing water use; or the discharge is dredged or fill material for qualifying activities in limited circumstances, after an alternatives analysis which considers the Outstanding Resource Water designation and further minimization of any adverse impacts. Specifically, a discharge of dredged or fill material is allowed only to the limited extent specified in 314 CMR 9.00 and 314 CMR 4.06(1)(d). The Department retains the authority to deny discharges which meet the criteria of 314 CMR 9.00 but will result in substantial adverse impacts to the physical, chemical, or biological integrity of surface waters of the Commonwealth.
(4) Protection of Special Resource Waters. Certain waters of exceptional significance, such as waters in national or state parks and wildlife refuges, may be designated by the Department in 314 CMR 4.06 as Special Resource Waters (SRWs). The quality of these waters shall be maintained and protected so that no new or increased discharge and no new or increased discharge to a tributary to a SRW that would result in lower water quality in the SRW may be allowed, except where:

(a) the discharge results in temporary and short term changes in the quality of the SRW, provided that the discharge does not permanently lower water quality or result in water quality lower than necessary to protect uses; and

(b) an authorization is granted pursuant to 314 CMR 4.04(5).

(5) Authorizations.

(a) An authorization to discharge to waters designated for protection under 314 CMR 4.04(2) may be issued by the Department where the applicant demonstrates that:

1. The discharge is necessary to accommodate important economic or social development in the area in which the waters are located;

2. No less environmentally damaging alternative site for the activity, receptor for the disposal, or method of elimination of the discharge is reasonably available or feasible;

3. To the maximum extent feasible, the discharge and activity are designed and conducted to minimize adverse impacts on water quality, including implementation of source reduction practices; and

4. The discharge will not impair existing water uses and will not result in a level of water quality less than that specified for the Class.

(b) An authorization to discharge to the narrow extent allowed in 314 CMR 4.04(3) or 314 CMR 4.04(4) may be granted by the Department where the applicant demonstrates compliance with 314 CMR 4.04(5)(a)2. Through 314 CMR 4.04(5)(a)4.

(c) Where an authorization is at issue, the Department shall circulate a public notice in accordance with 314 CMR 2.06. Said notice shall state an authorization is under consideration by the Department, and indicate the Department’s tentative determination. The applicant shall have the burden of justifying the authorization. Any authorization granted pursuant to 314 CMR 4.04 shall not extend beyond the expiration date of the permit.

(d) A discharge exempted from the permit requirement by 314 CMR 3.05(4) (discharge necessary to abate an imminent hazard) may be exempted from 314 CMR 4.04(5) by decision of the Department.

(e) A new or increased discharge specifically required as part of an enforcement order issued by the Department in order to improve existing water quality or prevent existing water quality from deteriorating may be exempted from 314 CMR 4.04(5) by decision of the Department.

(6) The Department applies its Antidegradation Implementation Procedures to point source discharges subject to 314 CMR 4.00.

(7) Discharge Criteria. In addition to the other provisions of 314 CMR 4.00, any authorized Discharge shall be provided with a level of treatment equal to or exceeding the requirements of the Massachusetts Surface Water Discharge Permit Program (314 CMR 3.00). Before authorizing a discharge, all appropriate public participation and intergovernmental coordination shall be conducted in accordance with Permit Procedures (314 CMR 2.00).
Appendix B: Summary of the Nitrogen Concentrations for Tisbury Great Pond/Black Point Pond Estuarine System.
(Excerpted from Howes et al. 2013, pg. 100)

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>Station ID</th>
<th>Years of Data</th>
<th>Mean* (mg/L)</th>
<th>Standard deviation (mg/L)</th>
<th>N</th>
<th>Mean* (ppt)</th>
<th>Standard deviation (ppt)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Town Cove upper</td>
<td>TGP-1</td>
<td>12</td>
<td>0.643</td>
<td>0.254</td>
<td>48</td>
<td>9.9</td>
<td>7.1</td>
<td>50</td>
</tr>
<tr>
<td>Tiasquam River</td>
<td>TGP-2</td>
<td>11</td>
<td>0.563</td>
<td>0.219</td>
<td>42</td>
<td>10.5</td>
<td>6.9</td>
<td>44</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td>TGP-3</td>
<td>6</td>
<td>0.485</td>
<td>0.132</td>
<td>23</td>
<td>12.6</td>
<td>6.8</td>
<td>24</td>
</tr>
<tr>
<td>Muddy Cove</td>
<td>TGP-3A</td>
<td>1</td>
<td>0.785</td>
<td>0.422</td>
<td>4</td>
<td>14.7</td>
<td>4.4</td>
<td>4</td>
</tr>
<tr>
<td>Town Cove mid</td>
<td>TGP-4</td>
<td>12</td>
<td>0.528</td>
<td>0.197</td>
<td>68</td>
<td>14.7</td>
<td>7.7</td>
<td>71</td>
</tr>
<tr>
<td>Tiah Cove</td>
<td>TGP-5</td>
<td>3</td>
<td>0.422</td>
<td>0.134</td>
<td>21</td>
<td>12.0</td>
<td>4.3</td>
<td>21</td>
</tr>
<tr>
<td>Deep Bottom Cove</td>
<td>TGP-6</td>
<td>12</td>
<td>0.536</td>
<td>0.213</td>
<td>49</td>
<td>14.3</td>
<td>5.8</td>
<td>53</td>
</tr>
<tr>
<td>Tisbury Great Pond low</td>
<td>TGP-7</td>
<td>11</td>
<td>0.509</td>
<td>0.263</td>
<td>49</td>
<td>17.0</td>
<td>6.3</td>
<td>53</td>
</tr>
<tr>
<td>Crab Creek</td>
<td>TGP-8</td>
<td>3</td>
<td>0.430</td>
<td>0.124</td>
<td>13</td>
<td>13.1</td>
<td>4.1</td>
<td>13</td>
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<td>Tisbury Great Pond mid</td>
<td>TGP-9</td>
<td>1</td>
<td>0.413</td>
<td>0.156</td>
<td>4</td>
<td>13.2</td>
<td>5.7</td>
<td>4</td>
</tr>
<tr>
<td>Atlantic Ocean</td>
<td></td>
<td></td>
<td>0.232</td>
<td>0.044</td>
<td>17</td>
<td>32.3</td>
<td>0.6</td>
<td>5</td>
</tr>
</tbody>
</table>

*The mean values represent the average of separate yearly means. Data represented were collected from 1995 through 2007 and 2011 in Great Pond. Offshore Atlantic Ocean data are from the summer of 2005.
Appendix C: The Tisbury Great Pond and Black Point Pond Estuarine System estimated waste load allocation (WLA) from runoff of all impervious areas within 200 feet of its waterbodies.

<table>
<thead>
<tr>
<th>Estuary System Name</th>
<th>Watershed Impervious Area in 200ft Buffer of Embayment Waterbody (acres)</th>
<th>Total Watershed Impervious Area (acres)</th>
<th>Watershed Impervious Area in 200ft buffer as % of Total Watershed Impervious Area</th>
<th>MEP Total Unattenuated Watershed Impervious Load (kg/day)</th>
<th>MEP Total Unattenuated Watershed Load (kg/day)</th>
<th>Watershed buffer area WLA as percentage of MEP Total Unattenuated Watershed Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tisbury Great Pond and Black Point Pond</td>
<td>13.81</td>
<td>182.44</td>
<td>7.6%</td>
<td>2.82</td>
<td>59.15</td>
<td>0.21</td>
</tr>
</tbody>
</table>

1. The entire impervious area within a 200 foot buffer zone around all waterbodies as calculated by MassGIS. Due to the soils and geology of Cape Cod and the Islands 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 stormwater via pipes directly to the waterbody. For the purposes of the waste load 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. This includes the unattenuated nitrogen loads from wastewater from septic systems, fertilizer, runoff from both natural and impervious surfaces, and atmospheric deposition to freshwater waterbodies.

5. The impervious watershed 200 ft. buffer area (acres) divided by total watershed impervious area (acres) then multiplied by total impervious watershed load (kg/day).

6. The impervious watershed buffer area WLA (kg/day) divided by the total watershed load (kg/day) then multiplied by 100.
Appendix D: Tisbury Great Pond/Black Point Pond Estuarine System Total Nitrogen TMDLs (One TMDL for Restoration, Three Protective TMDLs)

<table>
<thead>
<tr>
<th>Sub-embayment</th>
<th>Waterbody Segment ID</th>
<th>Impairment</th>
<th>Type of TMDL</th>
<th>TMDL (kg N/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Bottom Cove¹</td>
<td></td>
<td></td>
<td></td>
<td>4.86</td>
</tr>
<tr>
<td>Tiah Cove</td>
<td></td>
<td></td>
<td></td>
<td>3.03</td>
</tr>
<tr>
<td>Pear Tree Cove</td>
<td></td>
<td></td>
<td></td>
<td>4.10</td>
</tr>
<tr>
<td>Tisbury Great Pond-main basin</td>
<td></td>
<td></td>
<td></td>
<td>33.70</td>
</tr>
<tr>
<td>Tisbury Great Pond²,³</td>
<td>MA97-18</td>
<td>Nutrients, Dissolved Oxygen, Chlorophyll a, Benthic Fauna, Eelgrass.</td>
<td>Restoration</td>
<td>45.69</td>
</tr>
<tr>
<td>Black Point Pond</td>
<td>MA97-33</td>
<td>Not found to be impaired for nutrients during MEP but TMDL needed since waterbodies are hydraulically linked.</td>
<td>Protective⁴</td>
<td>7.90</td>
</tr>
<tr>
<td>Mill Brook⁵</td>
<td>MA97-24</td>
<td>Not found to be impaired for nutrients during MEP but TMDL needed since waterbodies are hydraulically linked.</td>
<td>Protective⁴</td>
<td>7.03</td>
</tr>
<tr>
<td>Tiasquam River⁵</td>
<td>MA97-25</td>
<td>Not found to be impaired for nutrients by MEP but TMDL needed since waterbodies are hydraulically linked.</td>
<td>Protective⁴</td>
<td>3.51</td>
</tr>
<tr>
<td><strong>Total for System</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>64.13</strong></td>
</tr>
</tbody>
</table>

¹ MEP study included Thumb Cove as part of Deep Bottom Cove.
² The total load for Tisbury Great Pond includes the load for Deep Bottom Cove, Tiah Cove, Pear Tree Cove, and Tisbury Great Pond main basin.
³ This segment will be evaluated for nutrient impairment in a future Massachusetts Integrated List of Waters.
⁴ Not impaired for nutrients, but TMDL needed since embayments are linked. (Pollution Prevention TMDL)
⁵ Freshwater segments.