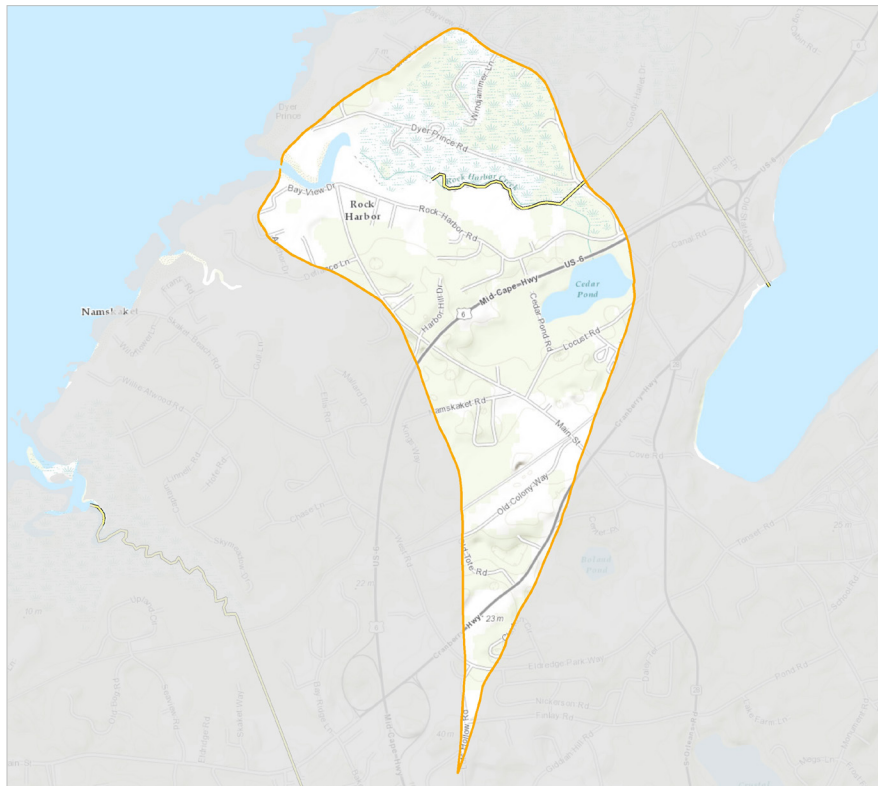
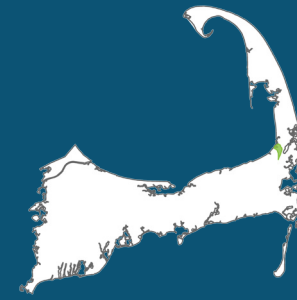


Rock Harbor

ORLEANS & EASTHAM

HIGH



Rock Harbor Watershed

Introduction to the Watershed Reports

In 2001, the Massachusetts Estuaries Project (MEP) was established to evaluate the health of 89 coastal embayment ecosystems across southeastern Massachusetts. A collaboration between coastal communities, the Massachusetts Department of Environmental Protection (MassDEP), the School of Marine Science and Technology (SMASST) at the University of Massachusetts-Dartmouth, the US Environmental Protection Agency (US EPA), the United States Geological Survey (USGS), the Massachusetts Executive Office of Energy and Environmental Affairs (EEA), and the Cape Cod Commission, the purpose of the MEP is to identify nitrogen thresholds and necessary nutrient reductions to support healthy ecosystems.

The Cape Cod 208 Plan Update, certified and approved by the Governor of the Commonwealth of Massachusetts and the US EPA in 2015, provides an opportunity and a path forward to implement responsible plans for the restoration of the waters that define Cape Cod.

On Cape Cod there are 53 embayment watersheds with physical characteristics that make them susceptible to nitrogen impacts. In its 2003 report, “The Massachusetts Estuaries Project – Embayment Restoration and Guidance for Implementation Strategies”, MassDEP identifies the 46 Cape Cod embayments included in the

MEP. Thirty-three embayments studied to date require nitrogen reduction to achieve healthy ecosystem function. A Total Maximum Daily Load (TMDL) has been established (or a draft load has been identified and is under review) for these watersheds. For those embayments not studied, the 208 Plan Update recommends planning for a 25% reduction in nitrogen, as a placeholder, until information becomes available.

The 208 Plan Update directs Waste Treatment Management Agencies (WMAs) to develop watershed reports within 12 months of certification of the Plan Update. The Watershed Reports outline potential “bookend” scenarios for each watershed that include two scenarios to meet water quality goals in the watershed – a traditional scenario, which relies completely on the typical collection and centralized treatment of wastewater, and a non-traditional scenario, which uses remediation, restoration, and on-site reduction techniques to remove nutrients from raw and treated wastewater, groundwater and affected waterbodies.

The intent of the Watershed Reports is to outline two distinct approaches for addressing the nutrient problem. The reports are not intended to identify preferred and detailed plans for each watershed, but to facilitate discussions regarding effective and efficient solutions, particularly in watersheds shared by more than one town. In some cases, towns have provided information on collection areas and non-traditional technologies that have been specifically considered by that town.

The 208 Update developed a regionally consistent database of the nitrogen load entering each watershed. This data set includes estimates of wastewater, stormwater and fertilizer loads - similar to methodologies used by the MEP. Using this regionally consistent database, the Watershed MVP tool (wMVP) was developed so that different strategies (i.e., bookend scenarios) to reduce excess nitrogen load

could be evaluated. The Watershed Reports use the MEP recommendations for the required nitrogen load reductions necessary to meet the threshold loads (that serve as the basis for nitrogen management), and then use the wMVP and the regionally consistent database values to develop bookend scenarios. There are variations of load between the MEP and wMVP, primarily due to differences in comparing older and newer databases.

Terms Defined

Total nitrogen load: the nitrogen load from the watershed contributed by septic, wastewater, fertilizer, stormwater, golf course, landfill, and natural sources.

Attenuated nitrogen load: the nitrogen load from the watershed that reaches the embayment after the effect of natural attenuation in wetlands, ponds or streams.

Threshold: the amount of nitrogen that a water body can receive from its watershed and still meet water quality goals; this number is based on MEP technical reports or Total Maximum Daily Load (TMDL) reports.

Reduction target: an approximation of the amount of nitrogen that needs to be removed from the watershed to achieve the threshold; this number is calculated by subtracting the threshold number from the attenuated total watershed load, and is for planning purposes only.

Percent contribution: the percent of attenuated nitrogen load that a town contributes to the watershed.

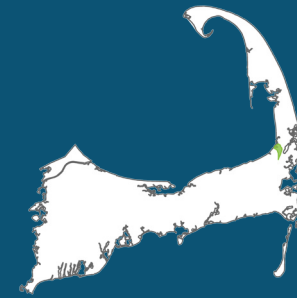
Kilogram responsibility: is calculated by applying the percent contribution to the reduction target and indicates the amount of nitrogen, in kg, that a community is responsible for addressing.

Total Maximum Daily Load: a regulatory term in the Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. Establishing a TMDL is necessary when a water body has been listed on the 303D list of impaired waters.

Rock Harbor

ORLEANS & EASTHAM

HIGH



The Rock Harbor estuary and embayment system is located in the Towns of Eastham and Orleans. It is comprised of a small basin, which requires regular dredging to maintain its connection to Cape Cod Bay, and a long riverine segment that extends up to Cedar Pond. The entrance to the harbor is armored and portions of the harbor are heavily used for recreational and commercial fishing.

The Problem

The Massachusetts Estuaries Project (MEP) technical report (available at <http://www.mass.gov/eea/agencies/massdep/water/watersheds/the-massachusetts-estuaries-project-and-reports.html>) indicates that the Rock Harbor system exceeds its critical threshold for nitrogen, resulting in impaired water quality. A MEP technical report has been completed and a draft Total Maximum Daily Load (TMDL) for nitrogen is in progress.

- **MEP TECHNICAL REPORT STATUS:** Final
- **TMDL STATUS:** In Progress

Watershed nitrogen load characteristics were published in the 2008 MEP report for Rock Harbor, reflecting current conditions at the time of writing:

- **TOTAL ATTENUATED NITROGEN LOAD (MEP CHAPTER VIII):** 3,309 Kg/Y
- **SOURCES OF ATTENUATED WATERSHED NITROGEN LOAD:**
 - 88% Septic Systems
 - 6% Fertilizer
 - 5% Stormwater from Impervious Surfaces
 - 1% Wastewater Treatment Facilities

Since the MEP report, the Commission compiled the following updated water use and nitrogen loads using the regional wMVP

database, enabling a more current estimate of nitrogen loading (see figure on page 1 for watershed boundary delineation):

- **TOTAL WASTEWATER FLOW:** 28 MGY (million gal per year)
 - Treated Wastewater Flow: 2 MGY
 - Septic Flow: 26 MGY
- **TOTAL ATTENUATED NITROGEN LOAD (wMVP):** 2,919 Kg/Y

CONTRIBUTING TOWNS

Percent contributions listed below are the aggregate sub-embayment contributions identified in Appendix 8C of the Cape Cod Section 208 Plan Update (contributions are based on attenuated load where available). See Appendix 8C for detailed town allocations by sub-embayment.

- **ORLEANS:** 81%
- **EASTHAM:** 19%

THE MEP RESTORATION SCENARIO

- **WATERSHED TOTAL ATTENUATED NITROGEN REDUCTION TARGET:** 59%
- **WATERSHED SEPTIC REDUCTION TARGET:** 69%
(The scenario represents the aggregated sub-

embayment percent removal targets from the MEP technical report)

Rock Harbor Estuary

- **EMBAYMENT AREA:** 6 acres
- **EMBAYMENT VOLUME:** 5 million cubic feet
- **2014 INTEGRATED LIST STATUS:** Category 4A for fecal coliform
 - Category 4a: TMDL completed
 - www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf

Rock Harbor Watershed

General watershed characteristics according to the current wMVP regional database (see figure on page 1 for watershed boundary) follow.

WATERSHED CHARACTERISTICS

- Acres: 609
- Parcels: 449
- % Developed Residential Parcels: 66%
- Parcel Density: 1.4 acres per parcel (approx.)

Ponds

- **IDENTIFIED SURFACE WATERS:** 4
- **NUMBER OF NAMED FRESHWATER PONDS:** 1
- **PONDS WITH PRELIMINARY TROPHIC CHARACTERIZATION:** 1
- **2014 INTEGRATED LIST STATUS:** 1 Listed

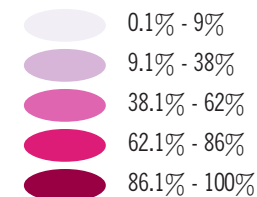
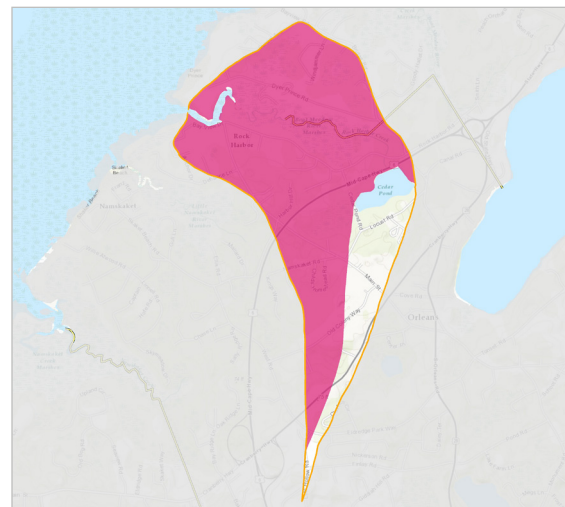
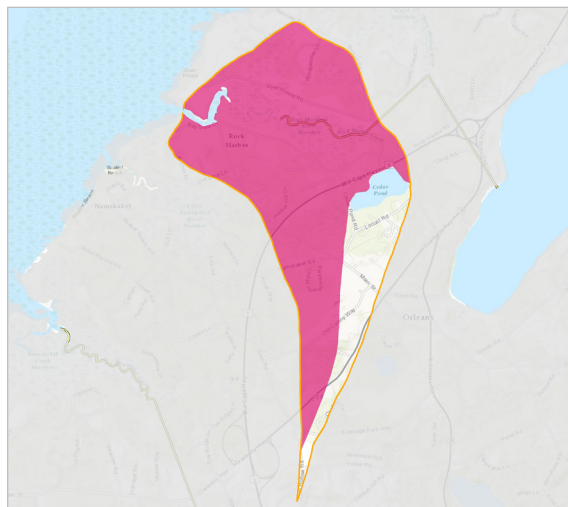
Cedar Pond is the only named pond in the Rock Harbor watershed and is listed on the 2014 Integrated List as requiring a TMDL. This pond is brackish, with an outlet to Rock Harbor. The Town has committed significant resources to further assess and develop strategies to restore its water quality.

Eastham and Orleans has participated in the Pond and Lake Stewardship (PALS) program that has helped establish baseline water quality.

Streams

- **SIGNIFICANT FRESHWATER STREAM OUTLETS:** 1
- Cedar Pond Stream:
 - Average Discharge: 1,271 cubic meters per day
 - Average Nitrate Concentrations: 0.116 milligrams per liter (mg/L)

Stream data from MEP technical report. Nitrate concentrations higher than 0.05 mg/L background concentrations, evident in public supply wells located in pristine areas, provide evidence of the impact of non-point source pollution on the aquifer and receiving coastal water bodies.



Subwatersheds with Total Attenuated Watershed Removal Targets

(Left) Benthic and atmospheric loads directly on embayments are not included.

Subwatersheds with Septic Attenuated Nitrogen Removal Targets

(Right)

Drinking Water Sources

- **WATER DISTRICTS:** 1
 - Orleans Water Department
- **GRAVEL PACKED WELLS:** 0
- **SMALL VOLUME WELLS:** 0

Drinking water data from Cape Cod Commission and MassDEP data sources.

Degree of Impairment and Areas of Need

For the purposes of the Section 208 Plan Update, areas of need are primarily defined by the amount of nitrogen reduction required as defined by the TMDL and/or MEP technical report. The technical report indicates that 59% of the total nitrogen load or 69% of the septic nitrogen load needs to be reduced (see the figures: Subwatersheds with Total Attenuated Watershed Removal Targets and Subwatersheds with Septic Attenuated Nitrogen Removal Targets). The technical report indicates that nitrogen removal is not necessary for Cedar Pond.

The nitrogen load from the watershed exceeds the threshold for Rock Harbor, resulting in impaired water quality and habitat. The ecological health of a water body is determined from water quality, extent of eelgrass, assortment of benthic fauna, and dissolved oxygen and ranges from severe degradation, significantly impaired, moderately impaired, or healthy habitat conditions. Habitat in the upper head waters of Rock Harbor are healthy. The lower portion of the embayment is indicated as impaired, partially due to its low standing volume relative

to the high nitrogen load. This is contrary to many of the other embayments where the upper head waters are impaired and the waters of the main body are healthier.

MEP ECOLOGICAL CHARACTERISTICS AND WATER QUALITY

The MEP report provides the following characterization of the estuary's health:

- **OVERALL ECOLOGIC CONDITION:** Healthy to significantly impaired
- **UPPER SALT MARSH:** Healthy
- **LOWER HARBOR BASIN:** Significantly impaired
- **SENTINEL STATION:**
 - Total Nitrogen Concentration Threshold: 0.50 mg/L
 - Total Nitrogen Concentration Existing: 0.69 mg/L
(As reported at the MEP sentinel water-quality monitoring station)

Traditional & Non-Traditional Scenarios

SCENARIO DEVELOPMENT

Through the 208 Stakeholder process, the Commission developed “bookend” scenarios – one looking at a possible solution using traditional collection and treatment, the other examining a possible suite of non-traditional technologies – to address the nitrogen management needs in each watershed. These bookend scenarios provide guidance for communities as they continue to discuss alternatives, priorities, and opportunities for identifying well-considered solutions that will address communities’ needs and interests.

REGIONAL DATA

In preparation for this effort, the Commission collected regionally consistent data for the purposes of watershed scenario development. Both parcel data and water use data was identified and collected for the entire region. While the scientific basis for planning is the thresholds identified in the MEP technical reports, each report uses data from different years, and in some cases the MEP data used are 10 or more years old. In addition, there are watersheds on Cape Cod without the benefit of an MEP report; therefore, similar data was not available for planning purposes.

The updated regional data set was used to estimate wastewater, stormwater and fertilizer loads, using the same methodologies as the MEP. This approach allows for a reevaluation of existing development, which may have changed

in the last 10 years. Parcel data included in the regional database is from 2010-2012 and water use data is from 2008-2011, depending on the water supplier and based on best available data. This approach allows for regionally consistent watershed scenario development.

WATERSHED SCENARIOS

The watershed scenarios that follow outline possibilities for the watershed. A series of non-traditional technologies that might be applicable are included, as well as the amount of residential load that would need to be collected if a traditional collection system and treatment facility was implemented. The pie charts show the load to be collected for treated effluent disposal both inside and outside the watershed.

Site specific analyses of collection areas may result in the need to collect wastewater from more or fewer parcels to meet the nitrogen reduction target. The scenarios presented are conceptual and are meant to inform discussions regarding effective and efficient solutions; they are not specific recommendations and should be viewed as resource information for additional and more detailed wastewater management planning.

In Rock Harbor, the Towns of Orleans and Eastham have done additional and more detailed planning. Included in the last section of this report is a description of their efforts, along with details of plans developed to date.








TOTAL ATTENUATED NITROGEN LOAD VALUES (FROM WMVP)

Rock Harbor Nitrogen Sources	Total Attenuated Watershed Nitrogen Load (kg-N/yr)
Wastewater ¹	2,237
Fertilizer ²	159
Stormwater	425
Other ³	98
TOTAL WATERSHED LOAD	2,919
Total Watershed Threshold	1,358
TOTAL ATTENUATED LOAD TO BE REMOVED	1,561

1. Includes nitrogen loads from septic systems and wastewater treatment facilities.
2. Includes nitrogen loads from lawns, cranberry bogs, and golf courses.
3. Includes nitrogen loads from landfills and atmospheric deposition to vacant land.

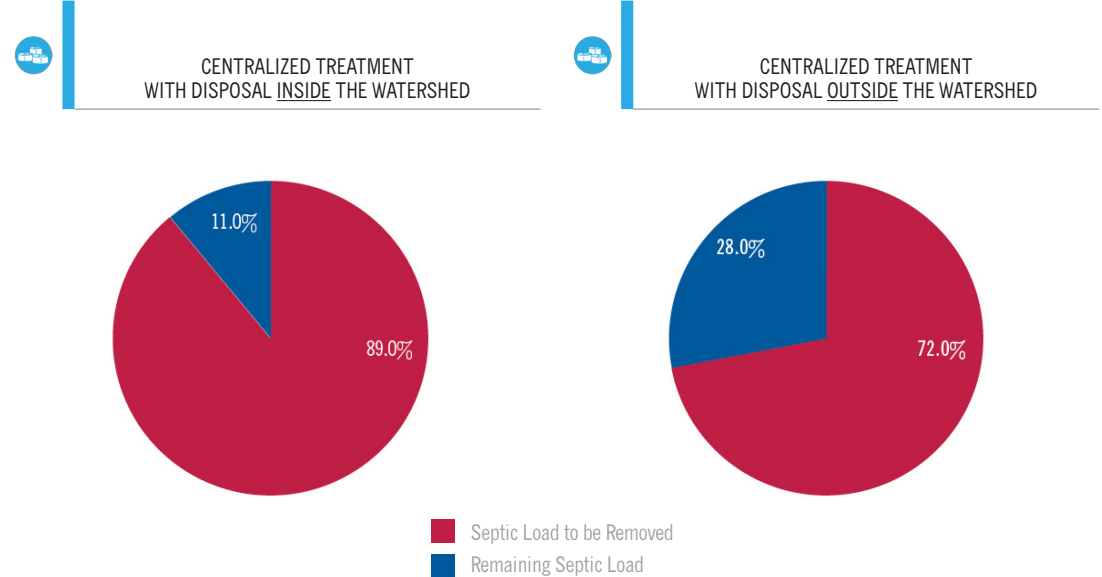
Traditional & Non-Traditional Scenarios

Non-Traditional

UNIT OF APPLIED TECHNOLOGY	ATTENUATED NITROGEN REMOVED IN KG/Y
 25 % Nitrogen Reduction - Fertilizer Management	40
 25 % Nitrogen Reduction - Stormwater Mitigation	106
 1,500 Linear Feet - Permeable Reactive Barrier (PRB) (Capture load calculated by wMVP: 1,146.2 kg/Y)	831
 2 Acres - Coastal Habitat Restoration	234
 46 Units - Ecotoilets (UD & Compost)	116
 101 Units - I & A Systems	167
 56 Units - Enhanced I & A Systems	167
TOTAL	1,661

A summary of the approach and methodology that was applied using non-traditional technologies follows at the end of this report.

Traditional



Assumes load to be collected and treated is disposed in the watershed, requiring additional collection to offset the load.

Assumes that the load to be collected and treated is removed from the watershed so no offset is required.

Town of Eastham Local Progress

The town of Eastham completed a town-wide needs assessment in March 2009. The needs assessment concluded that a new public water supply system to protect public health was an overriding concern.

The spring 2014 Town Meeting approved \$45.8 million to fund a scaled back version of the full town-wide water system. The Cape Cod Commission approved this project as a Development of Regional Impact (DRI) in February 2015.

In May 2015 Eastham staff, along with their consultant (GHD), met with Commission staff to discuss the 208 planning process, decision support tools, and scenario development for their watersheds, the beginnings of a shift toward wastewater planning after a necessary focus on securing a clean drinking water supply for residents.

Eastham shares the watershed to the Nauset estuary with the town of Orleans and is willing to have further discussions about potential opportunities to share the wastewater treatment facility proposed in the approved Orleans Comprehensive Wastewater Management Plan (CWMP). The town has sent a representative to each of the Orleans Water Quality Advisory Panel meetings, as they discussed potential scenarios in 2014 and early 2015. The town of Eastham is actively pursuing the protection and restoration of its freshwater ponds. The town completed a town-wide assessment and is pursuing in-pond restoration efforts. Alum

treatments for Herring Pond and Great Pond are complete and others are under consideration.

In the fall of 2014, Eastham adopted local nitrogen-oriented fertilizer management regulations consistent with the Cape-wide Fertilizer Management District of Critical Planning Concern (DCPC).

Eastham is a member of the Orleans, Brewster and Eastham Ground Water Protection District which, until June 1, 2016, operated the Tri-Town Septage Treatment Facility in Orleans. The member towns voted to decommission and remove the facility, which is expected to take place in 2017.

In addition, Eastham staff are working with the Commission and the Cape Cod National Seashore on a number of other projects to address nitrogen in their watersheds. The Commission is assisting the town to modify a design for stormwater management along Route 6 and to conduct hydrogeologic modeling at a previously identified site for a permeable reactive barrier.

Eastham submitted conceptual watershed scenarios based on discussions with the Commission, use of available decision support tools, and ongoing local water quality planning efforts. Those scenarios are included in this report.

At the Spring 2017 Town Meeting, Eastham voted to fund wastewater planning and pilot projects in the amount of \$150,000, as part of their Capital Plan.

Town of Eastham Watershed Scenario Details

The Town of Eastham's nitrogen management plan for Rock Harbor is to work collaboratively with the Town of Orleans to have it reclassified as a man-made boat basin. The Town as part of the Final Interim Needs Assessment & Alternatives Screening Analysis Report, March 2009, developed several options for Eastham to manage nitrogen. In addition, the Town of Eastham has the following regulations in place to manage nitrogen in Town:

- Fertilizer Bylaw: the Town of Eastham voted to adopt a Board of Health regulation on the content and application of fertilizer to turf on November 20, 2014 (see Reference 1). This regulation incorporates current Best Management Practices, which are deemed essential in this effort to protect the public health and aid in achieving compliance with the Total Daily Maximum Loads (TMDL) for the Towns water resources prescribed by the Commonwealth of Massachusetts while allowing reasonable use of fertilizers for the enhancement of turf quality.
- Board of Health Regulations: requirements for Nitrogen Reducing Septic Systems in Environmentally Sensitive Areas (see Reference 2). The use of nitrogen-reducing septic systems is required as a

condition of any of the following variances in any lot determined to be an environmentally sensitive area:

- Less than 100 feet separation distance exists between a drinking water supply well and a soil absorption system
 - Soil absorption system is located less than 100 feet from a salt marsh or any marine surface water, or fresh surface water body
 - When the lot is defined an environmentally sensitive area any setback reduction is requested
 - Distance to adjusted high groundwater is less than 5 feet
- Massachusetts Estuaries Project at Nauset Estuary: The Towns of Eastham and Orleans are working together to expand water quality monitoring for Nauset Estuary. Over the next three years, Eastham and Orleans will collect water samples from 15 stations in order to provide current water quality data. The data will be used to recalibrate or update the Massachusetts Estuary Program Model.
 - Public Education Newsletter: updates to the Town's wastewater management planning efforts are posted on the Town's website and available at Town Hall (see Reference 3). Another newsletter that is planned to update the public will discuss the watershed reports.

Traditional Approach

Three alternative wastewater management plans have been developed to address the environmental health need of this

estuary and its watershed. The two traditional approaches presented in 2009 are described below.

ROCK HARBOR WATERSHED (PLAN 1):

This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Construction of a new community/municipal wastewater treatment facility outside the watershed for treatment and recharge. The best treatment and recharge site will be developed as part of the final plan evaluations.

This plan is feasible, depending on the availability of an acceptable treatment and recharge site; and could be part of a long-term management and remediation plan for Rock Harbor.

ROCK HARBOR WATERSHED (PLAN 2):

This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Connection of this sewer system to the Orleans Wastewater Treatment Facility proposed to be constructed at the Tri-Town Facility site.

This plan received preliminary evaluation as part of the study being completed by the Town of Orleans and funded by the Cape Cod Water Protection Collaborative "Shared Watershed, Shared Responsibilities" Grant Program on regional

Town of Eastham Watershed Scenario Details

wastewater management solutions for the area; and the project did receive public support at Town Meeting. The costs and necessary inter-municipal coordination are not yet known.

Non-Traditional Approach

The third approach, based on a non-traditional method to address this watershed is as follows.

ROCK HARBOR WATERSHED (PLAN 3):

This plan would consist of further evaluation of ideas introduced by Brian Howes of MEP for possible aeration and dredging management of Rock Harbor beyond what is currently dredged by the Town for navigation maintenance. This type of management may be possible for Rock Harbor because it is not a natural estuary; it is a tidal creek that is continually dredged to maintain a boat basin. The feasibility of this plan is unknown and would require additional evaluation, possibly as a MassDEP pilot study.

The Town currently dredges Rock Harbor as part of their maintenance program. This maintenance dredging is for navigation and not for the purposes of nitrogen management. The last dredge occurred during the winter of 2015.

This approach (dredging for nitrogen management) has been discussed briefly with MassDEP and any determination will be

a function of the economic impact of more traditional solutions vs. this non-traditional/hybrid approach to this waterbody.

Hybrid Approach

Currently there is no TMDL developed for Rock Harbor. The Town of Eastham's nitrogen management plan for Rock Harbor is to work collaboratively with the Town of Orleans to have it reclassified as a man-made boat basin. The hybrid approach would be to work with the regulators further to determine the feasibility of this approach and combine with that the Town's efforts regarding existing BOH regulations and fertilizer management bylaws. At this time Eastham is waiting for a formal nitrogen TMDL determination before proceeding to consider whether this option would be combined with other traditional and non-traditional approaches to address nitrogen (if necessary) within this waterbody.

References

1. Town of Eastham, Massachusetts Fertilizer Bylaw, Approved 11/2014, http://www.easthamma.gov/Public_Documents/EasthamMA_Health/FertilizerRegulation/
2. Town Eastham Board of Health Regulations, Section I.E. Environmentally Sensitive Area, [http://www.easthamma.gov/Public_Documents/EasthamMA_Health/healthinfo/BOHRegulations2014.pdf](http://www.easthamma.gov/Public_Documents/EasthamMA_Health/BOHRegulations2014.pdf)

3. Public Outreach Newsletter – “Wastewater Management Planning Project – Newsletter” Spring 2016

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Town of Orleans Local Progress

The Orleans Comprehensive Wastewater Management Plan (CWMP) was approved by Massachusetts Environmental Policy Act (MEPA) and the Cape Cod Commission in 2011 and provides a strategy for wastewater management to achieve reductions of its share of nitrogen loading to restore and protect Orleans's coastal embayments. The CWMP also addresses freshwater ponds and areas with septic system problems associated with frequent pumping, intensity of use and mounded systems. It provides modest capacity for expanded residential housing in the commercial district and includes an adaptive management approach for its implementation.

The town received its MEPA certificate on the Final Environmental Impact Review (FEIR) and a Development of Regional Impact (DRI) approval in 2011. The town has since engaged independent consultants to review the use of alternative sewer collection technologies and the Massachusetts Estuaries Project findings about the Nauset Marsh. The town received significant input from the community as the board of selectmen considers its appropriate next steps.

The town appropriated \$1.045 million at the spring 2014 Town Meeting for engineering, planning and hydrogeologic studies necessary for the development of septage, wastewater, groundwater and stormwater management plans needed to maintain and protect the water resources of the town by integrating the CWMP with a new Adaptive Management Plan

and components of the Cape-wide Section 208 Water Quality Management Plan.

The town established a Water Quality Advisory Panel (WQAP) that included diverse representation and professional facilitation, consistent with the 208 planning process. The WQAP established a consensus plan for moving forward that includes reduction, remediation, and restoration strategies and is expected to achieve a 40% cost savings over the original CWMP. In 2015, Town Meeting appropriated an additional \$1 million to further investigate potential disposal sites and locations for innovative remediation and restoration solutions identified in the consensus plan. Those investigations are underway. An additional \$691,000 was approved by voters in May 2016 to fund an Amended Water Quality Management Plan and associated Adaptive Management Plan. Development of those plans are in progress. A Preliminary Amended Comprehensive Wastewater Management Plan (ACWMP) was published in January 2017. The preliminary ACWMP provides updates reflecting additional planning and engineering efforts undertaken in 2015 and 2016.

Orleans is a member of the Orleans, Brewster and Eastham Ground Water Protection District which, until June 1, 2016, operated the Tri-Town Septage Treatment Facility in Orleans. The member towns voted to decommission and remove the facility, which took place in May of 2016. Through the Pleasant Bay Alliance, the Town of Orleans has been working with their three neighboring communities in the Pleasant Bay

watershed to assess the combined effect of the four towns' wastewater and nitrogen management plans. This has resulted in the development of the Pleasant Bay Composite Nitrogen Management Analysis.

In the fall of 2014, Orleans added phosphorus to its local fertilizer management regulations consistent with the Cape-wide Fertilizer Management District of Critical Planning Concern (DCPC).

Orleans requested that the Commission use the consensus plan scenarios as its watershed report submission.

In June 2016, Orleans received \$15,000 from the Commission for implementation of shellfish/aquaculture demonstration project in Lonnie's Pond. Funding was part of \$142,149 in local grants made by the Commission in support of 208 Plan implementation.

At the Spring 2017 Town Meeting, Orleans voted to fund continued implementation of its water quality management plan in the amount of \$3,733,660 and demolition of the Tri-Town Facility in the amount of \$870,000.




Town of Orleans Watershed Scenario Details

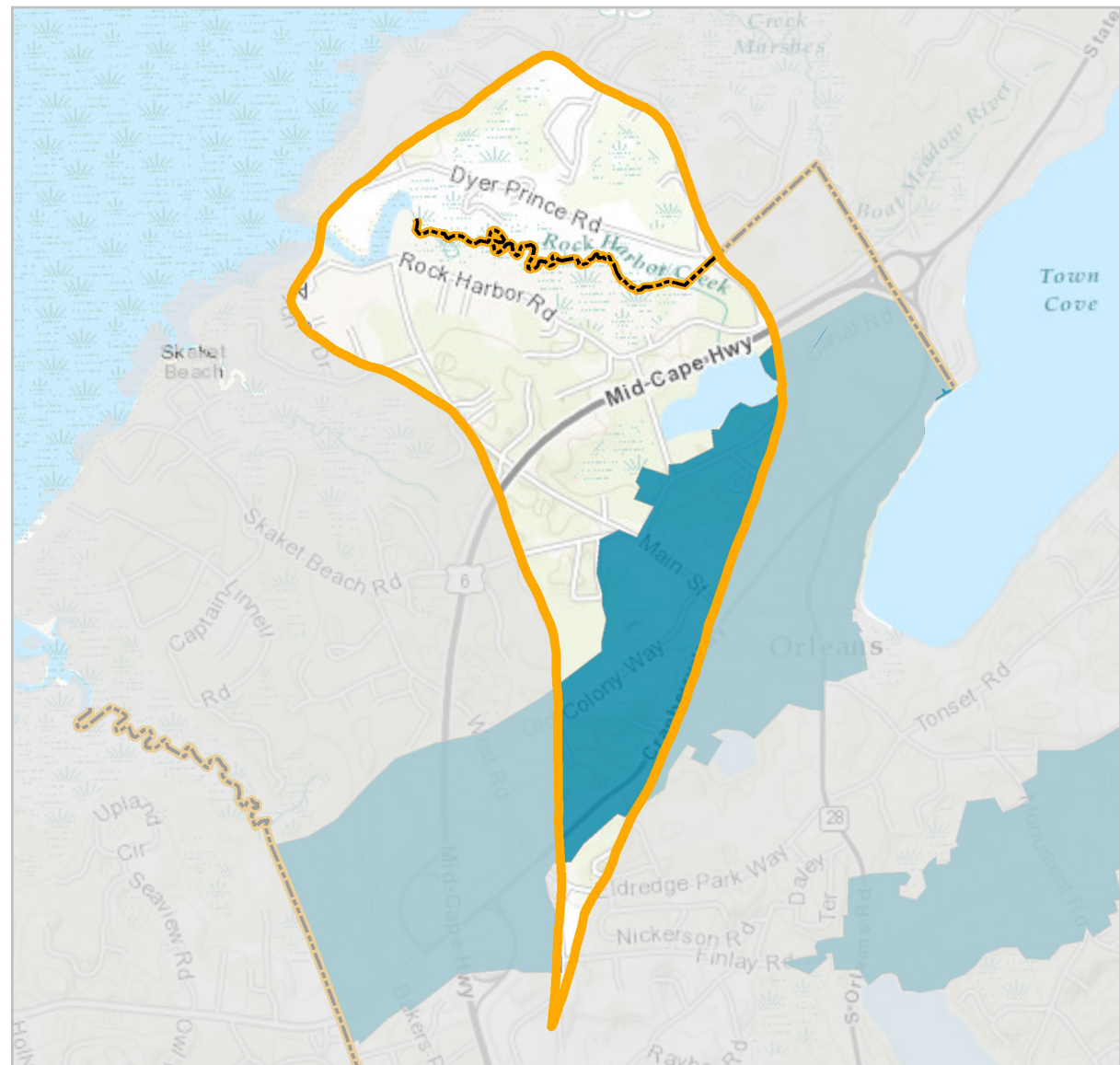
Rock Harbor	CREDITS		REDUCTION TECHNOLOGIES			REMEDIATION AND RESTORATION TECHNOLOGIES			REMOVAL
NAME OF TECHNOLOGY	% Nitrogen Reduction	Load Reduction (kg-N/yr)	# Properties / Units	Flow Collected (gpd)	Load Reduction (kg-N/yr)	# Units Proposed	Unit Metric	Load Reduction (kg-N/yr)	Total Scenario Load Reduction (kg-N/yr)
Scenario									2,441
Fertilizer Management	25%	48							
Centralized Sewer			Not Reported	29,758	1,427				
Permeable Reactive Barrier (PRB)						Not Reported		634	
I & A Systems			Not Reported		332				

Scenario Maps

Rock Harbor Watershed
Scenario
ORLEANS
Representative locations of conceptually
proposed infrastructure

Legend

-  Town Lines
-  Embayment Watersheds
-  Proposed Sewershed



Methodology for Selecting Non-Traditional Technology Scenarios

This section summarizes the approach and methodology that was applied during the 208 Update to develop plans for reducing nitrogen loading to estuaries using non-traditional (NT) technologies. It includes descriptions of regional credits for stormwater and fertilizer reductions, regional screening for potential sites for several technologies, and site-specific analyses for others. Nitrogen attenuation rates for each technology were derived from the Technologies Matrix. The nitrogen thresholds for each embayment were determined from the Massachusetts Estuaries Project (MEP).

This section summarizes the approach and methodology that was applied during the 208 Update to develop plans for reducing nitrogen loading to estuaries using non-traditional (NT) technologies. It includes descriptions of regional credits for stormwater and fertilizer reductions, regional screening for potential sites for several technologies, and site-specific analyses for others. Nitrogen attenuation rates for each technology are noted below, based on the Technologies Matrix or newer data. The nitrogen thresholds for each embayment were determined from the Massachusetts Estuaries Project (MEP).

Regional credits were developed for potential stormwater retrofits and fertilizer reductions. They were calculated as a percent reduction of existing nitrogen loads as identified in the MEP reports and updated GIS data developed by the Cape Cod Commission.

- **STORMWATER MANAGEMENT:** Most Cape communities have already begun the process of identifying significant untreated stormwater discharges and developing appropriate mitigation projects. With the prospect of the MS4 regulatory requirements it was assumed that additional mitigation efforts would be implemented. Based upon the evidence developed by the University of New Hampshire Stormwater Center that several vegetated stormwater management practices (including bioretention and constructed wetlands) are able to achieve nitrogen reductions of 50% or more and the assumption that only a portion (estimated at 50%) of identified sites would be retrofitted a 25% nitrogen reduction credit was assumed for each watershed. Specific locations and number of locations were not identified; this was deferred to individual towns to consider as part of the suite of nitrogen management strategies.
- **FERTILIZER REDUCTIONS:** Based upon the success of most Cape Cod towns to implement either regulatory or non-regulatory fertilizer management programs and the efforts of the Cape Cod Extension Service in

educating homeowners a 25% reduction in fertilizer applications was assumed for each watershed.

Regional GIS screening methods were developed to identify locations for some non-traditional technologies. A GIS viewer was developed as an on-line tool for staff and consultants to utilize during the watershed planning process.

- **CONSTRUCTED WETLANDS/ PHYTOREMEDIATION:** A GIS-based screening method was developed by the Cape Cod Commission to identify and rank parcels of land that have potential for the location of constructed wetlands and phytoremediation. The ranking utilized parcel size and ownership, depth to groundwater, suitable soils, distance from wetlands, and undeveloped parcels. A nitrogen removal rate of 500 kg/Y/acre and 532 kg/Y/acre was used for Constructed Wetlands and Phytoremediation, respectively.
- **PERMEABLE REACTIVE BARRIERS (PRBS):** A GIS-based screening method was developed to identify existing roads that are proximate to receiving waters, downgradient of high density development, run perpendicular to groundwater flow (to have the highest potential to intercept nutrients in groundwater), and where the depth to groundwater is relatively shallow to maximize the area of saturated thickness treated in the aquifer.

Methodology for Selecting Non-Traditional Technology Scenarios

■ **FERTIGATION WELLS:** Golf courses were mapped to identify areas where fertigation wells could be utilized to recapture nitrogen-enriched groundwater and re-apply it to the managed turf areas to serve both irrigation and fertilization needs. Most golf courses were assumed to be eighteen holes with a fertilized area of 75 acres. Fertigation water was assumed to have an average concentration of 5 mg/liter. An uptake/attenuation rate of 80% was applied resulting in an assumed nitrogen reduction of 300 kg/year for each golf course with effectively located fertigation wells. In some cases other irrigated areas (such as athletic fields and cemeteries) were identified as potential fertigation locations. Assuming the use of 730 gpd/acre for turf areas, a nitrogen removal rate of 4 kg/y/acre was used for fertigation of turf areas. Assuming a higher flow rate of 2,200 gpd/acre for cranberry bogs, a 12 kg/y/acre removal rate was used for fertigation of cranberry bogs.

The MVP tool and other site-specific tools were utilized to quantify nitrogen load reductions for several potential NT interventions.

■ **PERMEABLE REACTIVE BARRIERS:** for each PRB that was identified during the prior GIS-screening process an approximate capture area was identified using available water table maps and the wMVP tool. Upgradient contributing areas were digitized within wMVP and the nitrogen load was calculated. A nitrogen

reduction of 72.5% was applied (calculated as an average of the reported attenuation range from the Technologies Matrix).

■ **CONSTRUCTED WETLANDS (WITH COLLECTION):** Constructed wetlands were considered as a tertiary, polishing treatment for existing wastewater treatment plants. This included small-scale wastewater treatment systems. A nitrogen removal rate of 500 kg/Y/acre was used.

■ **AQUACULTURE/OYSTER REEFS:** Potential areas for aquaculture and/or oyster reef restoration were considered based upon discussions with town representatives and review of maps to identify potential areas for these operations without significant conflicts to navigation. In some cases actual recent aquaculture expansions were included where they were developed after the MEP reports were prepared. An assumption of 1 million oysters per acre was used with a nitrogen removal rate of 250 kg/Y/acre.

■ **FLOATING CONSTRUCTED WETLANDS:** Potential areas for floating wetlands were considered in areas where no conflicts with navigation or swimming areas were identified. A nitrogen removal rate of 0.4 kg/Y/sq foot was used.

■ **INLET WIDENING AND COASTAL HABITAT RESTORATION:** Only considered in areas where these projects were identified by towns or state agencies and where detailed hydrologic investigations and modeling

had been performed due to wide variations in nitrate load reduction, flushing impacts, impacts on flooding, and costs (dredging only, replacing infrastructure, removing and replacing roadways or bridges, etc.). Nitrogen removal rates were based on MEP or other studies.

■ **INNOVATIVE & ALTERNATIVE SEPTIC SYSTEMS AND ECOTOILETS:** In most cases specific locations for these technologies were not identified. Rather general estimates for the percent adoption were provided based upon discussions with the stakeholder groups and their views on potential adoption rates. In some watersheds a 5% adoption rate was included based upon this stakeholder input. In a limited number of instances specific locations for these technologies were included based upon town input and suggestions. A nitrogen removal rate of 1.658 kg/Y for each system was used for I&A Septic Systems, and 2.984 kg/Y for enhanced I&A systems. A removal rate of 2.542 kg/Y was used for each home installation of an Ecotoilet, and 0.467 kg/Y for installation of urine diversion toilets in public settings.

Finally, the locations of specific technologies were discussed during the 208 stakeholder engagement process. Stakeholders across the Cape 'groundtruthed' potential NT locations and NT scenarios were adjusted accordingly.