WATERSHED REPORT: UPPER CAPE

Popponesset Bay

MASHPEE, BARNSTABLE & SANDWICH

WATER THREAT LEVEL

HIGH

The Popponesset Bay estuary is located in the Towns of Mashpee and Barnstable. It is a large shallow embayment that extends from Nantucket Sound nearly three miles to its groundwater fed headwaters. The embayment includes four distinct sub-systems - Shoestring Bay, the Mashpee River, Ocway Bay and Popponesset Creek. The estuary supports a variety of recreational uses including boating, swimming, shell fishing and fin fishing.

The Problem

The Massachusetts Estuaries Program (MEP) technical report (available at www.oceanscience.net/estuaries/) indicates the Popponesset Bay system exceeds its critical threshold for nitrogen, resulting in impaired water quality. Popponesset Bay is one of the first to have received a MEP technical report. A nutrient Total Maximum Daily Load (TMDL) has been established by MassDEP and US EPA.

- **MEP TECHNICAL REPORT STATUS:** Final
- **TMDL STATUS:** Final TMDL
- **TOTAL WASTEWATER FLOW:** 456 MGY (million gal per year)
  - Treated Wastewater Flow: 61 MGY
  - Septic Flow: 395 MGY
- **UNATTENUATED TOTAL NITROGEN LOAD (MEP):** 48,513 kg/Y (kilograms per year)
- **ATTENUATED TOTAL NITROGEN LOAD (MEP):** 31,885 kg/Y
- **SOURCES OF CONTROLLABLE NITROGEN (MEP):**
  - 82% Septic Systems
  - 10% Lawn Fertilizer
  - 7% Stormwater From Impervious Surfaces
  - 1% Wastewater Treatment Facilities

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.

A portion of the land area in Sandwich and Mashpee is not in the control of the towns as it is part of Joint Base Cape Cod (JBCC), which is served by a wastewater treatment facility and discharged outside of the watershed.

- **MASHPEE:** 75%
- **BARNSTABLE:** 17%
- **SANDWICH:** 8%

THE MEP RESTORATION SCENARIO

- **WATERSHED TOTAL NITROGEN REDUCTION TARGET:** 45%
- **WATERSHED SEPTIC REDUCTION TARGET:** 61% (The scenario represents the aggregated sub-embayment percent removal targets from the MEP technical report)

POPPONESSET BAY ESTUARY

- **EMBAYMENT AREA:** 720 acres
- **EMBAYMENT VOLUME:** 119 million cubic feet

- **2014 INTEGRATED LIST STATUS:** Category 4a for estuarine bioassessments and fecal coliform
  - Category 4a: TMDL is complete
  - www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf

POPPONESSET BAY WATERSHED

- **ACRES:** 13,082
- **PARCELS:** 7,979
- **% DEVELOPED RESIDENTIAL PARCELS:** 78%
- **PARCEL DENSITY:** 1.6 acres per parcel (approx.)
- **WASTEWATER TREATMENT FACILITIES:** 6
  - Stratford Ponds: 35,500 gallons per day (GPD)
  - Willowbend: 113,000 GPD
  - Cotuit Meadows: 59,000 GPD
  - Windchime: 40,000 GPD
  - Mashpee Commons: 180,000 GPD
  - South Cape Village: 24,000 GPD

Freshwater Sources

PONDS

- **IDENTIFIED SURFACE WATERS:** 40
- **NUMBER OF NAMED FRESHWATER PONDS:** 13
- **PONDS WITH PRELIMINARY TROPHIC CHARACTERIZATION:** 5
- **2014 INTEGRATED LIST STATUS:** 4 listed

Mashpee recently conducted a pond assessment and installed Solar Bees in Santuit Pond in efforts to restore water quality. Mashpee and Barnstable have participated in the Pond and Lake Stewardship (PALS) program that has helped establish baseline water quality. Trophic characterizations are based on most recent Commission staff assessment.

STREAMS

- **SIGNIFICANT FRESHWATER STREAM OUTLETS:** 2

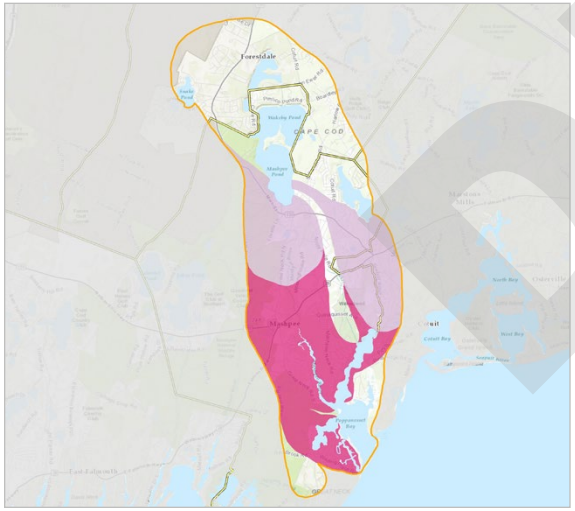
Mashpee River:
- Average Flow: 26,223 cubic meters per day (m3/d)
- Average Nitrate Concentrations: .318 milligrams per liter (mg/L)

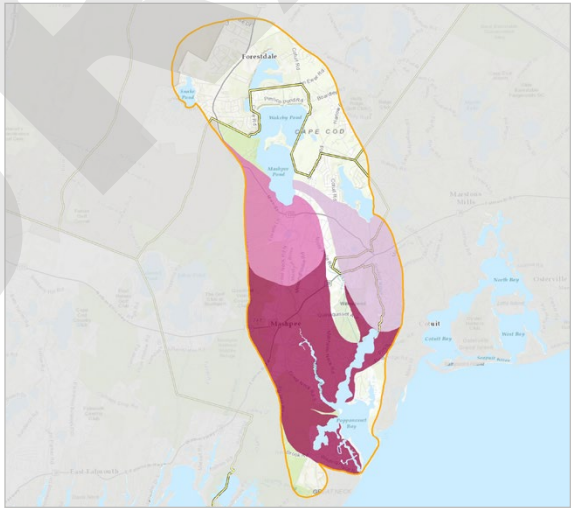
Santuit River:
- Average Flow: 13,164 m3/d
- Average Nitrate Concentrations: 0.702 mg/L

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.

DRINKING WATER SOURCES

- **WATER DISTRICTS:** 3
  - Sandwich Water District
  - Cotuit Water District
  - Mashpee Water District





0.1% - 9%
9.1% - 38%
38.1% - 62%
62.1% - 86%
86.1% - 100%

Subwatersheds with Total Watershed Removal Targets

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

Subwatersheds with Septic Nitrogen Removal Targets

(Right)

- **GRAVEL PACKED WELLS:** 9
  - 2 have nitrate concentrations between 0 and 0.5 mg/L
  - 1 have nitrate concentrations between 0.5 and 1 mg/L
  - 3 have nitrate concentrations between 1 and 2.5 mg/L
  - 1 have nitrate concentrations between 2.5 and 5 mg/L
  - 2 have no nitrate concentration data
- **SMALL VOLUME WELLS:** 2

The MEP includes contributing areas to the Rock Landing community water supply wells in its watershed map. These wells are located outside the Popponesset Bay watershed.

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. These were referred to above as a 61% reduction in septic nitrogen and a 45% reduction in total nitrogen. More specifically, the MEP provides a targeted amount of nitrogen reduction required by subwatershed, as shown in the figures Subwatersheds with Total Nitrogen Removal Targets and Subwatersheds with Septic Nitrogen Removal Targets.

The nitrogen load from the watershed exceeds the threshold or TMDL for Popponesset Bay, resulting in impaired water quality. 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 1-severe degradation, 2-significantly impaired, 3-moderately impaired, 4- healthy habitat conditions

MEP ECOLOGICAL CHARACTERISTICS AND WATER QUALITY

- **OVERALL ECOLOGIC CONDITION:** Healthy to Severely Degraded
- **LOWER POPPONESSET BAY:** Healthy to Moderately Impaired
- **OCKWAY BAY:** Significantly Impaired to Severely Degraded
- **MASHPEE RIVER:** significantly Impaired to Severely Degraded
- **SENTINEL STATION:**
  - Total Nitrogen Concentration Threshold: 0.38 mg/L
  - Total Nitrogen Concentration Existing: 0.45 mg/L (As reported at the MEP sentinel water-quality monitoring station)

Collection & Non-Collection Scenarios

Regional Data

In 2010, the Commission sought to collect 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 is 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 district. 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 flow and approximate number of residential parcels that would need to be collected if a traditional collection system and treatment facility was implemented. Some assumptions were made in determining the approximate flows and parcels for collection, including a treatment factor of 5 parts per million (ppm), disposal occurring inside the watershed, and no natural attenuation, therefore prioritizing parcels with a direct impact on the water body. Site specific determinations of collection areas may result in the need to collect more or less parcels to meet the nutrient reduction target. The scenarios presented are meant to act as a starting point for discussions regarding effective and cost efficient solutions.

POPPONESSET BAY NITROGEN SOURCES	TOTAL NITROGEN LOAD (kg-N/yr)
Wastewater	22,730
Fertilizer	3,571
Stormwater	4,143
Other	1,517
TOTAL	31,961
Total Watershed Load (including atmospheric)	31,961
Total Watershed Threshold	13,852
TOTAL LOAD TO BE REMOVED	18,109

Collection & Non-Collection Scenarios

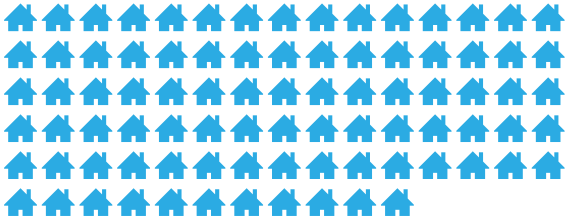
Non-Collection

- 25 % Nitrogen Reduction - Fertilizer Management
- 25 % Nitrogen Reduction - Stormwater Mitigation
- 4,000 Linear Feet - Permeable Reactive Barrier (PRB)
- 233 Acres - Fertigation - Turf
- 35 Acres - Fertigation - Cranberry Bogs
- 27 Acres - Aquaculture/Oyster Beds
- 1,938 Square Feet - Floating Constructed Wetlands
- 748 Units - Ecotoilets (UD & Compost)
- 1,202 Units - I & A Systems
- 668 Units - Enhanced I & A Systems

Collection

DEVELOPED RESIDENTIAL PARCELS IN WATERSHED

RESIDENTIAL EQUIVALENTS NECESSARY TO MEET NITROGEN REDUCTION TARGET VIA COLLECTION



= 50 Residential Parcels

4,284	616,846
Residential Equivalents Necessary to Meet Nitrogen Reduction Target	Flow Collected (gpd)

SCENARIO ASSUMPTIONS: Assumes treatment to 5 parts per million (ppm) nitrogen. Assumes disposal occurs inside the watershed. Assumes no natural attenuation; therefore, prioritizing parcels with a direct impact on the water body.

Town of Mashpee Local Progress

The Mashpee Comprehensive Wastewater Management Plan (CWMP) was scoped through a joint Massachusetts Environmental Policy Act (MEPA)/Development of Regional Impact (DRI) review as an Environmental Notification Form (ENF) in 2001. In 2007, the town submitted its Needs Assessment Report entitled, "Town of Mashpee, Popponesset Bay and Waquoit Bay-East Watersheds Needs Assessment Report." Also in 2007, the town completed a technology screening report, which was followed shortly by its draft alternative scenarios and site evaluation report in March 2008.

The Needs Assessment contains a characterization of the nine operating private sewage treatment facilities, including treatment efficiency and excess capacity. This work allowed the town to focus on three potential wastewater scenarios that were developed in 2012. These options were reviewed and served as the basis for development of their preferred alternative. The wastewater scenarios include use of the existing private plants at their planned capacity and either three or four subregional plants with consideration of shared town responsibility. Off-site disposal of effluent outside of the impaired watersheds is an important consideration for the plan's approach. The alternatives analysis included consideration of private effluent disposal sites at New Seabury, Willowbend, and others, in addition to the town's transfer facility site.

Following completion of the 208 Plan Update, the town incorporated non-traditional technologies into its CWMP.

In April 2014, the Sewer Commission met with Cape Cod Commission staff to begin the discussion around filing its CWMP. The current draft plan includes a significant aquaculture undertaking and an adaptive management approach to achieving water quality goals. In September 2014, the Massachusetts Secretary of Energy and Environmental Affair issued a certificate of adequacy for the Draft Environmental Impact Review (DEIR) for Mashpee's Comprehensive Watershed Nitrogen Management Plan. In the Summer of 2015, the Massachusetts Secretary of Energy and Environmental Affair issued a final certificate Mashpee's Comprehensive Watershed Nitrogen Management Plan. The plan is currently under review by the Commission, although the Commission has already notified the town that phase I of its plan is consistent with the 208 Plan Update.

At the October 2015 Mashpee Town Meeting, the town voted to appropriate $250,000 for shellfish propagation, $32,500 as the first installment on a 3-year monitoring study associated with the shellfish project, funded a full time permanent water quality technician position, $100,000 to reauthorize the Sewer Commission Facilities Study Account and hire a consultant to complete studies and develop a preliminary design for the connection of properties to existing treatment facilities, $80,000 to support the development of inter-municipal agreements with neighboring communities, as well as authorized the use of town-owned land for the purposes of developing wastewater treatment facilities.

In October 2015, the town also approached Barnstable and Sandwich regarding approaches for Popponesset Bay and a potential watershed permit. It is expected that these three towns will collaborate on the first watershed permit in the region in close coordination with the Cape Cod Commission and the Massachusetts Department of Environmental Protection. To accommodate for discussions with Barnstable and Sandwich regarding the watershed permit a DRI extension through the fall has been agreed upon.

In June 2016, Mashpee received $14,600 from the Commission for construction of a floating shellfish seed upweller system to grow quahog seed for initial implementation of their shellfish restoration plan. Funding was part of $142,149 in local grants made by the Commission in support of 208 Plan implementation.

Town of Mashpee Watershed Scenario Details

Popponesset Bay	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									10,490
Centralized Sewer			1,170	0.157	4,110				
Aquaculture/Oyster Beds						16.32 M	Shellfish	6,830	

Town of Barnstable Local Progress

The Cape Cod Commission and the Town of Barnstable met and discussed the use of WatershedMVP to evaluate targeted watershed approaches for each of the watersheds in which they have jurisdiction. In 2015, the town reformulated its Citizen's Advisory Committee (CAC) for wastewater planning to better address local needs. In addition to local participation, the newly formed committee (the Water Resources Advisory Committee or WRAC) includes state and regional representatives. Town staff provided modifications to Commission-developed watershed scenarios and presented those scenarios to their WRAC for review and discussion. Those scenarios are included in this report.

The Town of Barnstable operates the Hyannis Water Pollution Control Facility (WPCF), located off Bearses Way in Hyannis, which is the primary wastewater treatment facility serving approximately 2,900 properties in Hyannis and Barnstable village.

The treatment facility has been upgraded and permitted to treat additional flows up to a total of 4.2 million gallons per day (MGD), upon meeting requirements of an adaptive management plan approved by the Commission in 2007. Property along Route 132 was acquired by the town in 2002 to potentially accommodate future disposal needs. The site is approved under a 2006 Massachusetts Environmental Policy Act (MEPA) certificate to discharge up to 0.5 MGD. The site is not presently in use. However, a force main and sewer has been extended to the site from the WPCF.

The WPCF treats an average daily flow of 1.46 MGD and a maximum monthly average flow of 1.94 MGD. Treatment performance has averaged 5 milligrams per liter (mg/L) total nitrogen in the treated effluent and the facility has a discharge limit of 5 mg/L under the 2007 Development of Regional Impact (DRI) decision and a limit of 10 mg/L under a Groundwater Discharge Permit (GWDP). The facility is also equipped with sludge thickening, storage and dewatering facilities sized for the current process conditions.

The Town of Barnstable also operates two smaller facilities – the Marstons Mills Wastewater Treatment Facility (WWTF) and the Red Lily Pond Cluster System. The Marstons Mills WWTF is limited to a discharge flow of 42,900 gallons per day (GPD) and is intended to service the Barnstable United Elementary School and the Village at Marstons Mills affordable housing development. The Red Lily Pond Cluster System currently serves 17 homes. According to the comprehensive wastewater management plan (CWMP) approved in 2007, no performance sampling of the system occurs and the system is assumed to produce comparable effluent to any conventional single family septic system.

In addition to municipally-owned facilities, there are two privately-owned treatment facilities treating wastewater from the Cotuit Landing shopping plaza and the Cape Regency nursing and rehabilitation facility. These facilities provide high levels of wastewater treatment. The treatment facility at Cotuit Landing was designed with additional treatment capacity beyond the expected needs of the shopping plaza for potential treatment of flows from neighboring properties.

Barnstable is working on a town-wide nutrient management plan that will provide the basis of its Comprehensive Wastewater Management Plan (CWMP). The plan will address nitrogen and other needs in watersheds draining to Three Bays, Centerville River, and Lewis Bay. A nitrogen total maximum daily load (TMDL) for Barnstable Harbor has not been approved by US EPA. The MEPA certificate scope for the Final Environmental Impact Report (FEIR) includes engagement in a targeted watershed approach, consistent with the 208 Plan Update.

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

In 2015, the Town submitted a Statement of Interest to the US EPA for a hydrogeologic site characterization as an initial step toward piloting a permeable reactive barrier in the town. One of three sites proposed by the Town was selected for characterization. The work was completed in 2016. The draft report is presently being reviewed by the Town.

Also in 2015, the Town agreed to work with Mashpee and Sandwich on approaches for the Popponesset Bay watershed and a potential development of a watershed permit. It is

Town of Barnstable Watershed Scenario Details

Popponesset Bay	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)
Traditional Scenario - Disposal Outside the Watershed									2,400
Centralized Sewer			500	80,000	2,400				
Non-Traditional Scenario									826
Fertilizer Management	25%	64							
Stormwater Mitigation	25%	132							
Permeable Reactive Barrier (PRB)						654	Linear Feet	414	
I & A Systems			41	Units	108				
Enhanced I & A Systems			75	Units	108				

expected that these three towns will collaborate on the first watershed permit in the region in close coordination with the Cape Cod Commission and the Massachusetts Department of Environmental Protection.

In June 2016, Barnstable received $28,850 from the Commission to fund upgrades to three stormwater treatment BMPs. Funding was part of $142,149 in local grants made available to communities by the Commission in support of 208 Plan implementation.

Town of Sandwich Local Progress

The Town of Sandwich has an established water quality committee to oversee water quality and wastewater planning efforts. In October 2015 town staff and their consultant (Wright-Pierce) met with Cape Cod Commission staff to discuss watershed planning, decision support tools, and scenario development for Sandwich watersheds. In the same month the town was approached by Mashpee regarding approaches for Popponesset Bay, and a potential watershed permit, and has agreed to participate with Mashpee and Barnstable in this shared effort. It is expected that Barnstable, Mashpee, and Sandwich will collaborate on the first watershed permit in the region in close coordination with the Cape Cod Commission and the Massachusetts Department of Environmental Protection.

Previously the committee developed a scope of work for a Comprehensive Wastewater Management Plan (CWMP) and submitted the scope under the Sagamore Lens Natural Resource Damages Assessment, related to past groundwater contamination at the Textron facility at Joint Base Cape Cod (JBCC). The town received an award of $400,000 t0 conduct its water/wastewater plan and completed a comprehensive needs assessment, as well as an interim wastewater solutions plan to accommodate economic development in the South Sandwich Village Center.

The town spent several years working with a private developer on a development project that included a public-private wastewater component for the construction of a facility that would accommodate the private project, in addition to some public wastewater needs. That project will not be completed, but the town is again seeking a private partner to create new economic growth and to potentially participate in infrastructure development.

The town has participated in discussions at JBCC about the potential use of its existing wastewater infrastructure as a regional option for the Upper Cape towns.

In February 2016 the Town of Sandwich requested a meeting with Commission staff to discuss watershed scenarios and potential modifications to watersheds in which Sandwich has jurisdiction. The town provided collection footprints and assumptions for a single treatment facility to serve all three watersheds (Popponesset Bay, Three Bays, and Waquoit Bay), consistent with the Sandwich CWMP, and identified locations for non-traditional approaches, in addition to credits for stormwater and fertilizer reduction. The Town proposes a 25% fertilizer management credit and a 6.25% stormwater management credit. While the proposed interventions, alone, do not meet the nitrogen allocations identified in Appendix 8C of the 208 Plan Update, the town has expressed a preference to rely on nutrient trading or cost sharing to reduce the load allocated to the downgradient towns in the shared watersheds of Popponesset Bay, Three Bays and Waquoit Bay, where nitrogen reductions can be more cost effectively attained.

Town of Sandwich Watershed Scenario Details

Popponesset Bay	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)
Traditional Scenario - Disposal Outside the Watershed									1,782
Centralized Sewer			1,328	230,214	1,782				
Non-Traditional Scenario*									47
Fertilizer Management	6.25%	15							
Stormwater Mitigation	25%	32							

NOTES:

* Non-Traditional scenario underachievs nitrogen removal, this is to be addressed theough nutrient trading.

Scenario Maps

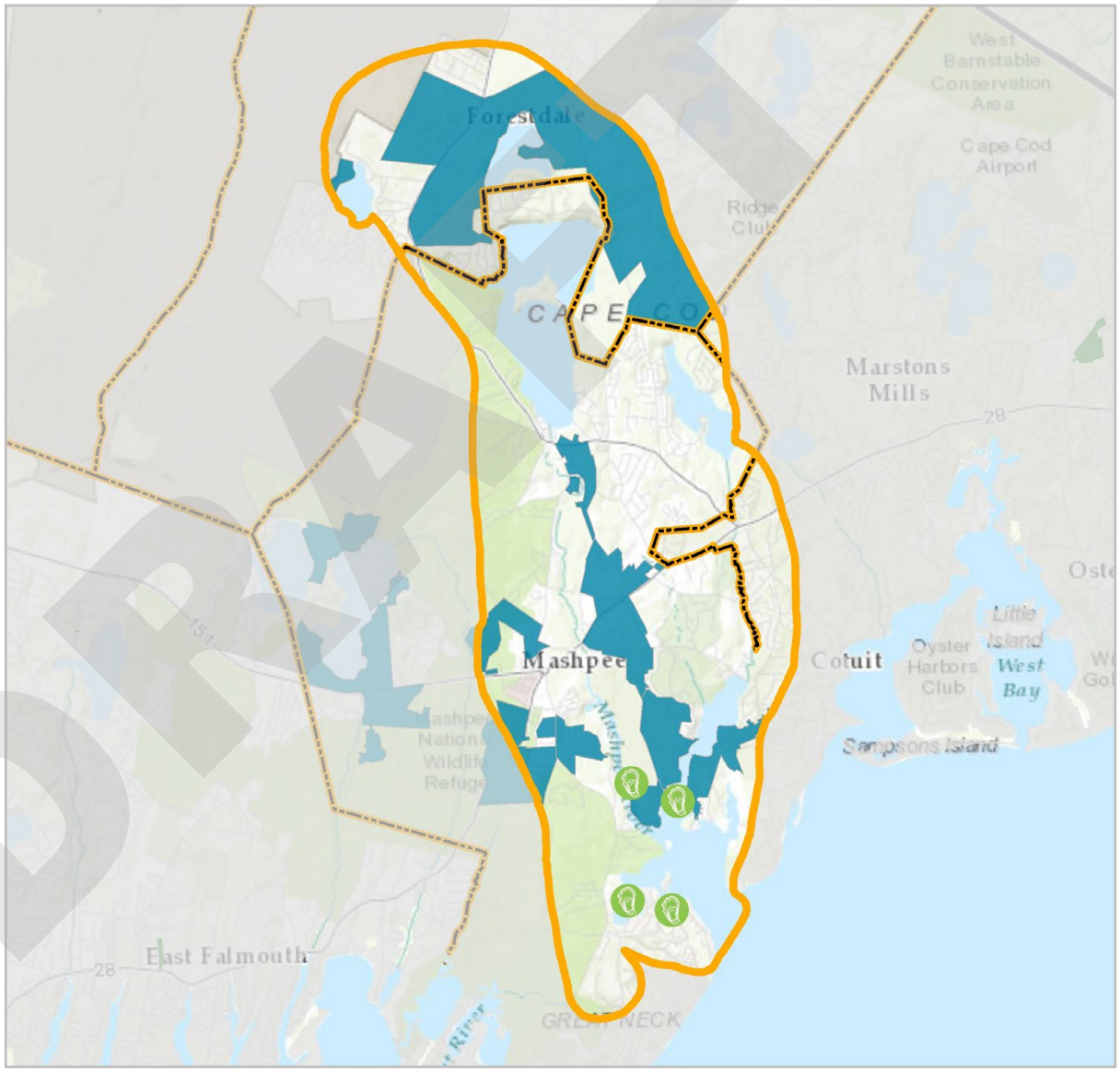
Popponesset Bay Watershed
Traditional Scenario

MASHPEE, BARNSTABLE & SANDWICH

Representative locations of conceptually proposed infrastructure

Legend

- Aquaculture
- Constructed Wetland
- Eco-Toilets
- Fertigation
- Fertilizer Management
- Floating Constructed Wetlands
- I/A Toilet
- Inlet Widening
- Permeable Reactive Barrier
- PhytoRemediation
- PhytoBuffer
- Coastal Restoration
- Stormwater
- Stormwater - Bio Retention
- Stormwater Management
- Widening
- Town Lines
- Embayment Watersheds
- Proposed Sewershed
- Sewered Areas



Scenario Maps

Popponesset Bay Watershed
Non-Traditional Scenario

MASHPEE, BARNSTABLE & SANDWICH

Representative locations of conceptually proposed infrastructure

Legend

- Aquaculture
- Constructed Wetland
- Eco-Toilets
- Fertigation
- Fertilizer Management
- Floating Constructed Wetlands
- I/A Toilet
- Inlet Widening
- Permeable Reactive Barrier
- PhytoRemediation
- PhytoBuffer
- Coastal Restoration
- Stormwater
- Stormwater - Bio Retention
- Stormwater Management
- Widening
- Town Lines
- Embayment Watersheds
- Proposed Sewershed
- Sewered Areas