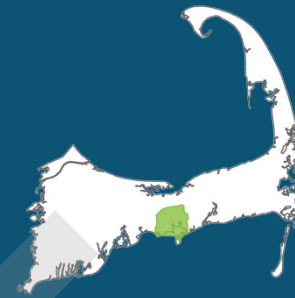


Lewis Bay

BARNSTABLE & YARMOUTH

WATER THREAT LEVEL
MODERATE



The Lewis Bay estuary and embayment system shoreline is located in the Towns of Barnstable and Yarmouth. It is comprised of several primary segments that include Hyannis Inner Harbor, Mill Creek, Snows Creek and Stewarts Creek. Lewis Bay is guarded by Great Island which contains Uncle Roberts Cove and Pine Island Creek. The Bay supports commercial fishing and a variety of recreational uses including boating, swimming, shell fishing and fin fishing.

The Problem

The Massachusetts Estuaries Project (MEP) technical report (available at www.oceanscience.net/estuaries) indicates that the Lewis Bay system exceeds its critical threshold for nitrogen, resulting in impaired water quality. The MEP Technical Report indicates that the cause of eutrophication to the system is excess nitrogen from the contributing watershed.

- **MEP TECHNICAL REPORT STATUS:** Final
- **TMDL STATUS:** Final TMDL issued March 3, 2015
www.mass.gov/eea/docs/dep/water/resources/a-thru-m/lewisbay.pdf

Town submitted watershed reports (by Yarmouth) included watershed characteristics that slightly differ from the regional database, both values are reported below.

- **TOTAL WASTEWATER FLOW:**
 - Regional Database Total Wastewater Flow: 1.1 BGY (billion gal per year)
- Treated Wastewater Flow:**
 - Regional Database Treated Wastewater Flow: 657 MGY
 - Town Reported Treated Wastewater Flow: 632 MGY
- Septic Flow:**
 - Regional Database Septic Flow: 475 MGY
 - Town Reported Septic Flow: 475 MGY

- **UNATTENUATED TOTAL NITROGEN LOAD (MEP):**
62,504 Kg/Y (kilograms per year)
- **ATTENUATED TOTAL NITROGEN LOAD (MEP):**
56,327 Kg/Y
- **SOURCES OF CONTROLLABLE NITROGEN (MEP):**
 - 63% Septic Systems
 - 6% Lawn Fertilizer
 - 9% Stormwater from Impervious Surfaces
 - 22% 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.

- **BARNSTABLE:** 66%
- **YARMOUTH:** 34%

THE MEP RESTORATION SCENARIO:

- **WATERSHED TOTAL NITROGEN REDUCTION TARGET:** 27%
- **WATERSHED SEPTIC REDUCTION TARGET:** 39%
(The scenario represents the aggregated sub-embayment percent removal targets from the MEP technical report)

LEWIS BAY ESTUARY

- **EMBAYMENT AREA:** 1,737 acres
- **EMBAYMENT VOLUME:** 452 million cubic feet
- **2014 INTEGRATED LIST STATUS:**
 - Snows Creek: Category 4a for fecal coliform
 - Lewis Bay: Category 4a, 5 for fecal coliform and estuarine bioassessments
 - Mill Creek: Category 5 for fecal coliform and nitrogen
 - Category 4a - TMDL is completed; Category 5 - Waters requiring a TMDL
 - www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf

LEWIS BAY WATERSHED

Town submitted watershed reports (by Yarmouth) included watershed characteristics that slightly differ from the regional database, both values are reported below.

- **ACRES:**
 - Regional Database Acres: 8,704
 - Town Reported Acres: 8,759
- **PARCELS:**
 - Regional Database Parcels: 9,531
 - Town Reported Parcels: 8,805
- **% DEVELOPED RESIDENTIAL PARCELS:**
 - Regional Database: 77%
 - Town Reported: 84%
- **PARCEL DENSITY:**
 - Regional Database Parcel Density: 0.91 acres per parcel (approx.)
 - Town Reported Parcel Density: 0.99 acres per parcel (approx.)

- **WASTEWATER TREATMENT FACILITIES:** 5
 - Hyannis Water Pollution Control Facility (Barnstable)
 - Mill Pond Villages (Yarmouth)
 - Mayflower Place (Yarmouth)
 - The Cove Resort (Yarmouth)
 - Buck Island Condominium (Yarmouth)

Freshwater Sources

PONDS

- **IDENTIFIED SURFACE WATERS:** 71
- **NUMBER OF NAMED FRESHWATER PONDS:** 8
- **PONDS WITH PRELIMINARY TROPHIC CHARACTERIZATION:** 6
- **2014 INTEGRATED LIST STATUS:** None listed

Barnstable and Yarmouth 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. Barnstable completed a Pond Action Report as part of its 2012 Draft Comprehensive Wastewater Management Plan (CWMP).

STREAMS

- **SIGNIFICANT FRESHWATER STREAM OUTLETS:** 6
 - Halls Creek:
 - Average Flow: 1,185 cubic meters per day (m3/d)
 - Average Nitrate Concentrations: 0.85 milligrams per liter (mg/L)
 - Stewarts Creek:
 - Average Flow: 31,966 m3/d
 - Average Nitrate Concentrations: 1.17 mg/L

- Snow's Creek:
 - Average Flow: 5,298 m3/d
 - Average Nitrate Concentrations: 1.14 mg/L
- Hospital Bog:
 - Average Flow: 1,318 m3/d
 - Average Nitrate Concentrations: 0.64 mg/L
- Mill Pond:
 - Average Flow: 15,655 m3/d
 - Average Nitrate Concentrations: 0.61 mg/L
- Chase Brook:
 - Average Flow: 3,255 m3/d
 - Average Nitrate Concentrations: 0.45 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

Town submitted watershed reports (by Yarmouth) included watershed characteristics that slightly differ from the regional database, both values are reported below.

- **WATER DISTRICTS:** 2
 - Hyannis Water Division
 - Yarmouth Water Department
- **GRAVEL PACKED WELLS:**
 - Regional Database Gravel Packed Wells: 22
 - 12 have nitrate concentrations between 0 and 0.5 mg/L
 - 4 have nitrate concentrations between 0.5 and 1 mg/L
 - 3 have nitrate concentrations between 2.5 and 5 mg/L
 - 3 have no nitrate concentration data

Town Reported Gravel Packed Wells: 14

- 11 have average nitrate concentrations between 0 and 1 mg/L
- 3 have no nitrate concentration data

■ **SMALL VOLUME WELLS: 0**

Each of the Towns has acquired significant portions of land in their Zone IIs for water quality protection which together with adopted land use controls recommended from the 1978 Section 208 Plan has resulted in excellent water quality. The wells with high nitrate concentrations are coincident with high density development and indicative of septic and wastewater impacts to groundwater quality.

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 aggregated watershed removal rates are 27% and 39% for total watershed and septic nitrogen loads, respectively. More specifically, the targeted amount of nitrogen reduction required by subwatershed ranges from 68% to 80% removal as indicated in the following figures, Subwatersheds with Total Nitrogen Removal Targets and Subwatersheds with Septic Nitrogen Removal Targets.

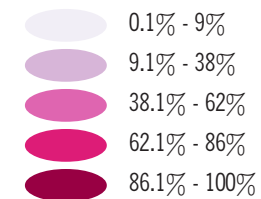
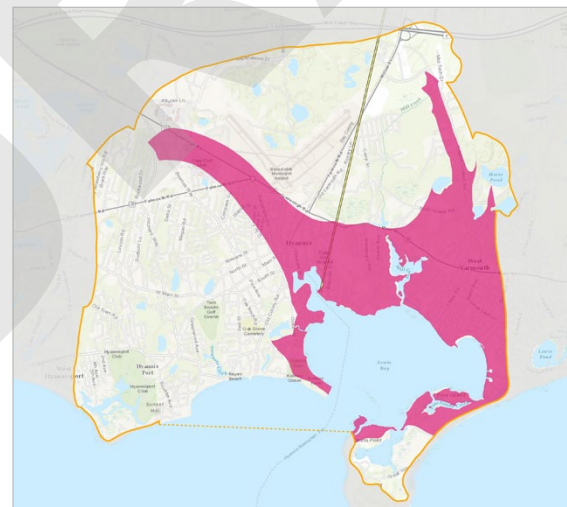
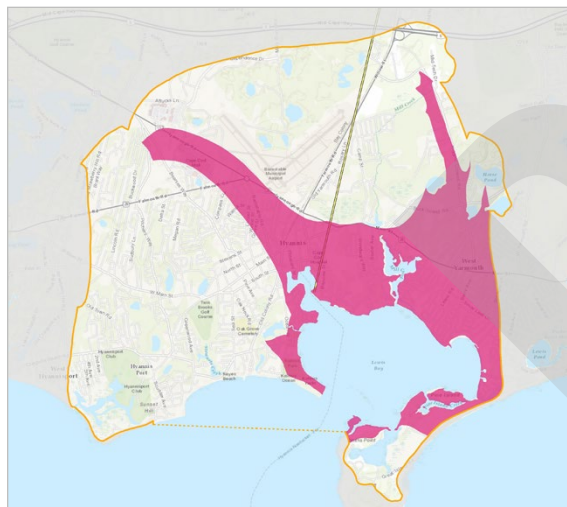
The Lewis Bay subwatershed in Yarmouth requires 80% septic nitrogen removal.

The nitrogen load from the watershed exceeds the threshold for Lewis Bay, resulting in impaired water quality. The upper headwaters of Lewis Bay are particularly impaired. 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.

ECOLOGICAL CHARACTERISTICS AND WATER QUALITY

- **OVERALL ECOLOGIC CONDITION:** Healthy to Significantly Impaired
- **OUTER LEWIS BAY:** Significantly Impaired
- **INNER LEWIS BAY:** Significantly Impaired
- **UNCLE ROBERTS COVE:** Significantly Impaired
- **HYANNIS INNER HARBOR:** Moderately Impaired
- **MILL CREEK:** Moderately Impaired
- **HALLS CREEK:** Healthy
- **SENTINEL STATION:**
 - Total Nitrogen Concentration Threshold: 0.378 mg/L
 - Total Nitrogen Concentration Existing: 0.407 mg/L (As reported at the MEP sentinel water-quality monitoring station)



Subwatersheds with Total Watershed Removal Targets

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

Subwatersheds with Septic Nitrogen Removal Targets

(Right)

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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.


In Lewis Bay, the Towns of Barnstable and Yarmouth 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.


LEWIS BAY NITROGEN SOURCES	TOTAL NITROGEN LOAD (kg-N/yr)
Wastewater	42,815
Fertilizer	3,389
Stormwater	8,029
Other	1,105
TOTAL	55,338
Total Watershed Load (including atmospheric)	55,338
Total Watershed Threshold	35,705
TOTAL LOAD TO BE REMOVED	19,633


Collection & Non-Collection Scenarios

Non-Collection

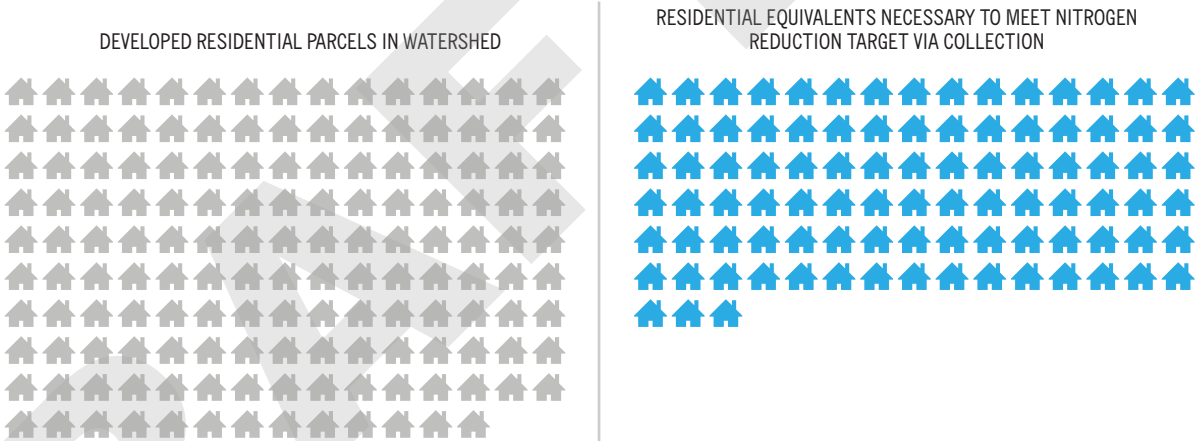
-  25 % Nitrogen Reduction - Fertilizer Management


-  25 % Nitrogen Reduction - Stormwater Mitigation

-  15,200 Linear Feet - Permeable Reactive Barrier (PRB)

-  34 Acres - Aquaculture/Oyster Beds

Collection



 = 50 Residential Parcels	4,644	668,758
	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 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.

Barnstable is also working closely with Mashpee and Sandwich on a watershed permit for the Popponeset Bay watershed.

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).

Since the approval of the 208 Plan Update, the Commission has been working for several months with Barnstable and Yarmouth to develop a targeted watershed scope of work for the Lewis Bay watershed to address excess nitrogen entering the system. In addition, the town was a recipient of a technical assistance grant through the Southeast New England Coastal Watershed Restoration Program (SNEP) and a stormwater best

Town of Barnstable Watershed Scenario Details

Lewis Bay	CREDITS		REDUCTION TECHNOLOGIES			REMEDATION 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									2,804
Centralized Sewer			303	82,823	2,804				

management practice (BMP) was constructed in the Lewis Bay watershed in the spring of 2015.

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.

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 Yarmouth Local Progress

In 2010, the Town of Yarmouth submitted its Comprehensive Wastewater Management Plan (CWMP) as a Draft Environmental Impact Report (DEIR). The draft CWMP targeted areas that would require wastewater collection to restore water quality in the Lewis Bay and Parkers River watersheds and deal with the Title 5 constraints on economic redevelopment in the area of Route 28. The town's plan included approximately 125 miles of sewer lines and the collection of 2.75 million gallons per day (MGD) of wastewater to be treated at a single facility in the Parkers River watershed. The project would ultimately serve 9,580 properties by 2035. Phase 1 of the plan would begin with the treatment facility and main trunk line sewer to serve Route 28 and portions of the Parkers River and Lewis Bay watershed.

The plan relies on gravity, pressure, and vacuum sewers. The MEP nitrogen reduction goals were the primary factor in choosing sewer locations. The phasing of these sewered areas also takes the town's economic goals into consideration.

The town submitted its Final Environmental Impact Report (FEIR) and received Massachusetts Environmental Policy Act (MEPA) approval in July 2011, but did not complete the Cape Cod Commission Development of Regional Impact (DRI) process before going to September 2011 Town Meeting to seek Phase 1 design and construction funds. Phases 1 through 5 were scheduled to be implemented over a 25-year period. The estimated cost of the total plan was \$275 million. The first phase had an estimated cost of \$55 million. Town Meeting did

not approve the expenditure. The town withdrew the CWMP from the DRI review process.

Wastewater planning in the community had effectively come to a stop prior to the development of the 208 Plan Update.

In January 2016 town staff met with the Board of Selectmen to discuss a new financing plan for implementation of a program that would meet water quality standards in all of their watersheds.

The recommended plan includes a combination of traditional sewerage methods with centralized treatment facilities as well as non-traditional nitrogen management options including a permeable reactive barrier (PRB) at the Buck Island Road effluent recharge site. The Town of Yarmouth is proposing a phased wastewater program that includes a collection system, a conveyance system and a centralized treatment facility, each constructed over several years. In addition to the proposed sewerage, the recommended plan involves public outreach to promote nitrogen reduction and to prevent sewer system inflow, zoning modifications for growth management and establishment of the activity centers, development of sewer ordinances, and continued maintenance of Title 5 and I/A systems in the northern and western areas of the town that will not be served by the proposed wastewater collection system. The town also plans to implement stormwater and fertilizer improvement programs. As suggested in the 208 Plan Update, up to a 25% nitrogen reduction credit can be obtained by

towns that implement stormwater and fertilizer management programs to reduce nitrogen contributions to each watershed. To achieve a 25% nitrogen reduction from stormwater in the Lewis Bay watershed, 50% of the total roads in the watershed are assumed to require stormwater best management practices (BMPs). Yarmouth plans to achieve 25% nitrogen reduction in fertilizers by implementing a town-wide fertilizer education program.

During the spring 2016 town meeting, the town approved \$200,000 for additional CWMP planning.

In April 2016, Yarmouth submitted a request for assistance to continue CWMP development and town staff met with the Commission to discuss the request in early May. In FY17 the Commission will work with Yarmouth to move forward toward implementation.

In June 2016, Yarmouth received \$35,000 from the Commission for the Towns of Dennis, Harwich and Yarmouth for a regional treatment facility cost study. Funding was part of \$142,149 in local grants made by the Commission in support of 208 Plan implementation.

Town of Yarmouth Watershed Scenario Details

Lewis Bay	CREDITS		REDUCTION TECHNOLOGIES			REMEDICATION 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									Not reported**
Fertilizer Management	25%	Not reported**							
Stormwater Mitigation	25%	Not reported**							
Centralized Sewer			2,209	582,376	Not reported**				

NOTES:

* Average daily flow collected includes buildout and estimated inflow and infiltration.





















** Scenario details received from the town did not include load reduction.

Scenario Maps

Lewis Bay Watershed Scenario BARNSTABLE & YARMOUTH

Representative locations of conceptually proposed infrastructure

Legend

-  Aquaculture
-  Constructed Wetland
-  Eco-Toilets
-  Fertigation
-  Fertilizer Management
-  Floating Constructed Wetlands
-  IA 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

